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SOCIAL PREFERENCES FOR WETLAND ATTRIBUTES AND ITS IMPLICATIONS FOR AGRICULTURAL HOUSEHOLDS WELLBEING IN OUEME DELTA IN BENIN

BY

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DECLARATION

This thesis is the result of research work undertaken by Pythagore Kpossame Hongbete in the Department of Agricultural Economics and Agribusiness, University of Ghana, under the supervision of Prof. Daniel Bruce Sarpong, Dr. John Baptist D. Jatoe, Dr. Yaw Osei-Asare, and Prof. Charlemagne B. Igue. It has never been submitted in whole or in part for any degree in this University or elsewhere. References to other people's work have been duly acknowledged.

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ABSTRACT

In Benin, Oueme Delta wetlands, as an ecological life support system, play a vital role in contributing to the local population's livelihood, health and wellbeing. The paucity of knowledge about the value of the Oueme Delta wetlands and their attributes to society, especially to agricultural households undermines the ability of decision makers to develop and implement sustainable wetland use and management policies that maximize societal welfare. To fill that gap, this thesis has been undertaken to reveal to society and specifically to Benin's wetland managers and policy makers, the value local populations attach to the Oueme Delta wetland attributes, so as to assist decision makers in the decision making process. Attribute-based discrete choice experiment (DCE) approach was used to unveil society preferences for Oueme Delta wetland attributes, from which welfare change implications were derived for agricultural households. The results and their analysis showed that the key Oueme Delta wetland attributes, ranged from the most to the least important based on their contributions to societal wellbeing are: species diversity; cropping area and irrigation facilities; recreation and tourism facilities; and wetland area and their state (habitat). More specifically, agricultural households' welfare analysis has also indicated the same trends in terms of their preferences for the Oueme Delta wetland attributes. So, it appears that agricultural development, characterized by an increase in land use and irrigation facilities, is not the most important contributor to social welfare in Oueme Delta, rather species diversity. Moreover, the analysis of agricultural households' welfare changes under different attribute-based wetland improvement policy scenarios reveals that there is an ever important need for policy makers to develop an integrated Oueme Delta wetland improvement policy, which might take into account both the ecological and socioeconomic values of these wetlands for local population wellbeing.

DEDICATION

To my Father, Mother, Sisters, and Brothers

To Arielle, Harmonie, and Divine

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ABREVIATIONS AND ACRONYMS

ABE:	Beninese Environment Agency
CARDER:	Rural Development Support Public Office
CBD:	Convention on Biological Diversity
CFA:	Money unit in West African Economic and Monetary Union (WAEMU)
DCE:	Discrete Choice Experiment
EEA:	European Environment Agency
FAO:	Food and Agriculture Organization
GDP:	Gross Domestic Product
GIZ:	German Development Agency
INSAE:	Benin's National Institute of Statistics and Economic Analysis
IP:	Implicit Price
MA:	Millennium Ecosystem Assessment
MCA:	Multi-Criteria Analysis
MWTP:	Marginal Willingness To Pay
NGO:	Non-Governmental Organization
RAMSAR	Ramsar Convention on wetlands
RUT:	Random Utility Theory
TEEB:	The Economics of Ecosystems and Biodiversity
TEV:	Total Economic Value
WTP:	Willingness To Pay

CHAPTER ONE

INTRODUCTION

1.1 Background

Wetlands, as defined by Ramsar Convention (1982), are "extensions of marshes, fens, bogs or water bodies, natural or artificial, permanent or temporary, where the water is stagnant or flowing, freshwater, brackish or salty including extensions of marine water where the depth is not more than six meters at low tide". Wetlands cover various types of habitats, including rivers, peatlands, lakes, coral reefs, and floodplains. Wetland ecosystems are part of the world's most productive environments (Barbier et al., 1997), on which many species of plants, fish, and animals rely for food and survival (Mitsch and Gosselink, 1993). The interactions between the physical, biological and chemical components of wetlands (water, soils, plants, and animals), enable them to perform and deliver several vital ecosystem functions and services (Turner et al., 2000); among which many play essential role in human wellbeing, especially for health and livelihoods (MA, 2005). Wetland ecosystem services can broadly be described as *provisioning services*: water, food, raw materials; *regulating services*: waste treatment, maintenance of soil fertility, flood prevention, local climate moderation; *supporting or habitat services*: nursery, and conservation of gene pool; and *amenity and cultural services*: inspiration for culture and art, recreation and tourism, and cognitive development (TEEB Foundations, 2010; MA, 2005; Barbier et al., 1997). Humans, then, derive important benefits from natural ecosystems for societal development (MA, 2005; Arrow et al. 1995).

In Benin, a West Africa developing country, the hydrographic network consists of five major basins: Volta, Niger, Mono, Couffo and Oueme. Covering an area of 50,000 km² with a maximum length of nearly 510 km, Oueme is the Benin's largest Basin. In its southern part, Oueme Basin with its receptacles, Lake Nokoue and the Lagoon of Porto-Novo, constitute the eastern complex of Benin's wetlands, an area of international importance (Ramsar site 1018). Aside from the seacoast, lakes and lagoons, this complex covers the Oueme Valley, which has a unique ecosystem called Oueme Delta, along which, the slope of the river becomes extremely low (5m for 85 km) and, it appears as a broad floodplain, where water is available throughout the year.

Oueme Delta wetlands have a vital importance for local populations, particularly agricultural households who derive from them the essentials of their subsistence products, such as fish, wild fruits, crops and vegetables. They are excellent supports for dry as well as rainy season farming, as a result of improvement in productivity, consequence of the use of water and silt, and for other activities such as animal breeding, pisciculture (fish holes), hunting or tourism. Each of the wetland ecosystem service contributes to the households' food security and welfare, enabling availability of good and services, and providing income from various human economic activities developed around wetlands (Kakuru et al., 2013; Turyahabwe et al., 2013; Sossou-Agbo, 2013).

Though it is a Ramsar site, the Oueme Delta ecosystem is facing great pressure on its natural resources resulting in hazardous deterioration (Ramsar, 2015) compromising nature. The Oueme Delta wetlands' functions are thus under threat from population pressures and this situation is threatening its ability to continue to provide goods and services for populations' livelihood and wellbeing (Daily et al., 2009; de Groot et al., 2012). Wetland depreciation has implicit costs for society, in terms of loss of the benefits provided by these resources to society (TEEB Foundations, 2010; TEEB in Policy, 2011).

1.2. Problem Statement

Ecosystem services are the benefits society derives from nature (MA, 2005). Since the natural environment is required to produce many goods and services, it can be regarded as capital stock, and their services as the interest society receives from that capital (Thampapillai and Uhlin, 1997; Costanza and Daly, 1992). Two essential features characterize capital goods: durability and provision of services over time. Natural capital is durable, and produces services over time (Thampapillai and Uhlin, 1997). Likewise, the value of wetlands and their resources, to society, can be derived from their capacity to provide goods and services and from society's demand for them (Barbier et al., 2009). It can then be said that changes in natural ecosystems, specifically, changes in their characteristics or attributes, resulting in changes in ecosystem services will impact on human wellbeing (TEEB Foundations, 2010; MA, 2005).

From an economic perspective, wetland managers, as private investors, need to choose a level of wetland resources or attributes to maintain future delivery of ecosystem services, so as to ensure sustainable wetland resource use and human wellbeing, including poverty reduction (TEEB Foundations, 2010; Perrings et al., 2006; TEEB, 2008).

However, sustainable use and management of natural ecosystems are suffering from two failure situations (TEEB Foundations, 2010). Firstly, *information failure*, which is the case where there is a lack of knowledge about the value of the contribution of natural ecosystems to human wellbeing (Costanza et al., 1997). Secondly, *market failure*, which is the situation where actual markets fail to provide information about the value of a broad range of ecosystem services, since most natural ecosystems and their resources are non-marketed goods. This limits the ability of markets to provide an accurate information about the ecological and economic values of natural assets that need to be accounted for in the decision making process regarding natural resource use and management (Barbier, 2007; MA, 2005; TEEB in Policy, 2011). Due to these two failures, there is a lack of information about how changes in the state of natural ecosystems, specifically changes in their attributes affect society welfare, which in turn affects economic decision-making (TEEB Foundations, 2010; Turner et al., 2003). In consequence, in spite of the net improvement in national as well as global awareness about the basic role that natural ecosystems, such as wetlands, play in human wellbeing, they tend to be over exploited, leading to their degradation on a large scale around the world, given that most natural resources are public goods with generally open access (TEEB Foundations, 2010; TEEB Synthesis, 2010; de Groot et al., 2012; Turner et al., 2000). To address these failures and reveal to decision makers useful information about the value of natural ecosystems and their attributes to society, economic valuation of natural capital is required (Costanza et al., 1997; TEEB Foundations, 2010; Hanley et al., 1998). According to Costanza et al. (1989), environmental valuation is difficult and complex but fundamental for sustainable natural resource use and management.

In Benin, the Oueme Delta wetlands, as a “life support system”, provide several types of ecosystem services that are primordial for economic production and society wellbeing (Sossou-Agbo, 2013; INSAE, 2016; de Groot et al., 2002). The benefits derived by local populations from the Oueme Delta wetlands range from their direct use (cropping, fishing, animal breeding, and spiritual or cultural wellbeing); through their indirect use (water regulation, pollination, soil fertility); to their non-use (satisfaction derived from the simple existence of natural resources, and satisfaction derived from the fact that future generations will also benefit from natural resources) (Barbier et al., 1997; TEEB Foundations, 2010; Sossou-Agbo, 2013).

Moreover, to date in the case of the Oueme Delta wetlands, little is known about the value of their contribution to local population, mainly agricultural households' welfare and more importantly about the value of their attributes to society.

Agriculture is important to the inhabitants in the Oueme Delta. However, the situational analyses within the wetland reveals that the wetlands have dried up in some areas, there are reduction as well as the disappearance of certain species of fish, plants and animals, there are increased farming activities in the bed of the Oueme River increasing the lack of this Ramsar site, and pollution of water and air. The possible solutions that have been identified and even implemented through public projects and NGOs are: environmental awareness creation, training of local populations on environmental friendly activities, best farming practices, income diversification to reduce the level of dependence of local population on wetland resources, but also several projects aiming at improvement in habitat and species diversity, reinforced by projects for food security and poverty alleviation in the area. However, despite the awareness of Benin's wetland managers and policy makers about the importance of the Oueme Delta wetlands in terms of their contribution to local population, especially agricultural households' wellbeing, and their steady efforts, through policies and programmes to maintain the ecological characteristics of these natural resources for poverty alleviation and food security, the Oueme Delta wetland degradation is persistent (Ramsar, 2015), threatening their ecological processes. The ability of policy makers and wetland managers to properly understand the changes in social welfare resulting from changes in the Oueme Delta wetland attributes and to identify priorities when designing policies both for the Oueme Delta wetland quality improvement and socioeconomic development within that ecosystem becomes ever more important.

1.2.1 The Conceptual framework underlying the thesis

Figure 1.1 presents the conceptual framework of the thesis, showing how natural ecosystems and biodiversity provide services for human wellbeing, and the importance of measuring that wellbeing in terms of benefits and values from various scientific disciplines to inform decision making process to designing and implementing more rational management policies that will impact on direct and indirect drivers of change in natural asset state, so as to maintain a continuous flow of ecosystem services.

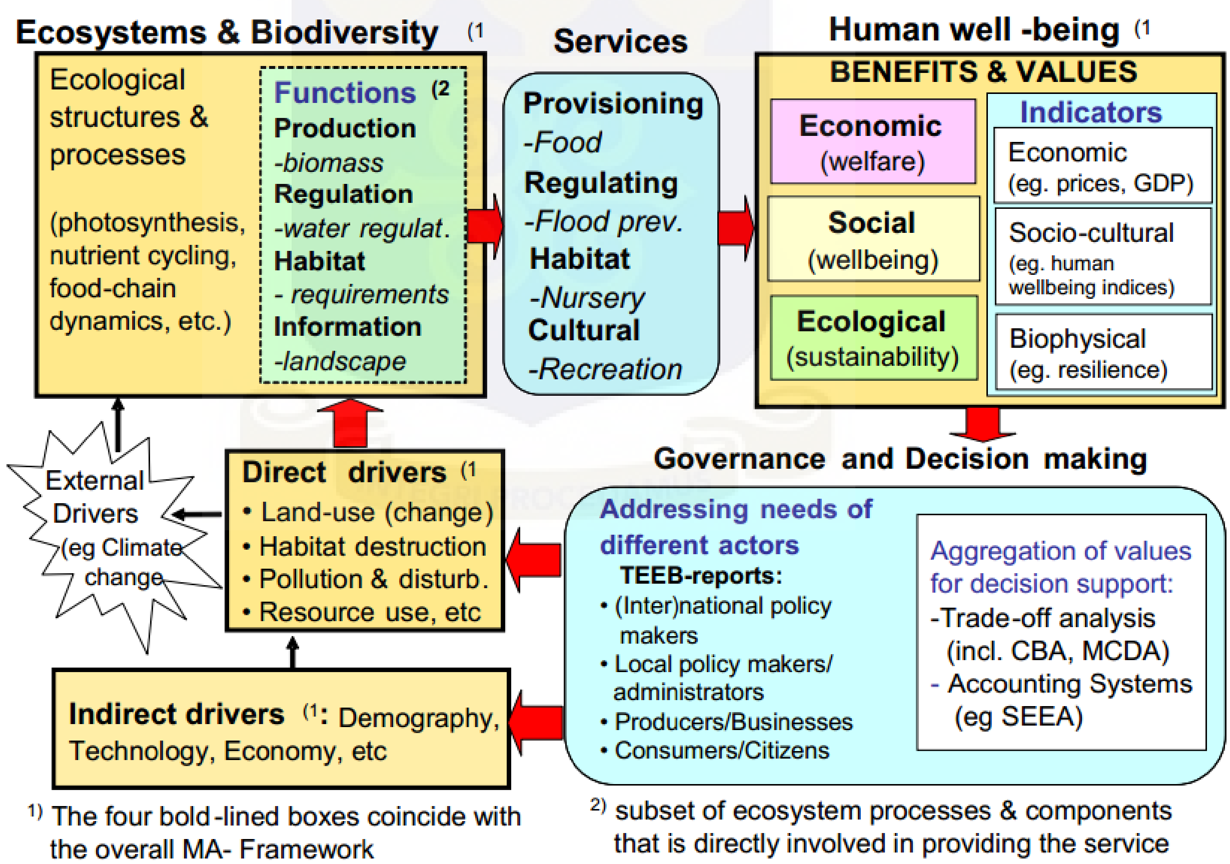

Figure 1. 1. Conceptual Framework of the Thesis

Source: TEEB Foundations (2010)

To assist decision makers in sustainable wetland use and management policy design that will meet societal welfare maximization goal, the values of the Oueme Delta wetlands and their attributes to society, especially agricultural households need to be assessed in economic or monetary terms. Societal welfare change analysis can then be done based on the relative values of the Oueme Delta wetland attributes. The additional information generated from monetary valuation of the Oueme Delta wetlands and their attributes complement the available knowledge in the hands of decision makers from other scientific disciplines to guide decision making process (Turner and Daily, 2008). However, in Economics, environmental valuation is the expression of individual preferences for environmental goods in monetary terms (TEEB Foundations, 2010), and relies on human behavior analysis. Thus, social or individual preference elicitation reveals the values of natural capital as well as economic policies (Adamowicz, 2004; McFadden, 2000).

Against this backdrop, the main research question of this thesis is: What are local population's preferences for the Oueme Delta wetland attributes and what are the implications for agricultural households' wellbeing? Specifically, this thesis aims to address the following questions:

1. What are the key Oueme Delta wetland attributes?
2. What are the relative importance local populations attach to the Oueme Delta wetland attributes?
3. To what extent does the Oueme Delta wetland attributes contribute to agricultural households' welfare
4. How do the different attribute-based wetland improvement policy scenarios impact on agricultural households' wellbeing?

1.3. Objectives of the Study

The main objective of this thesis is to assess local population's preferences for the Oueme Delta wetland attributes and derive its implications for agricultural households' wellbeing. The specific objectives are:

1. to identify and describe the key Oueme Delta wetland attributes
2. to evaluate local population's preferences for Oueme Delta wetland attributes
3. to estimate agricultural households' welfare and determine how much the Oueme Delta wetland attributes' contribute
4. to estimate the impact of the different attribute-based wetland improvement policy scenarios on agricultural households' wellbeing

1.4. Relevance of the Study

The Oueme Delta wetlands and their multiple resources underpin the production of numerous ecosystem services that are of primary importance for humans' life and specifically for economic activities. As a natural capital stock, a certain level of resources needs to be maintained to allow the ecological processes to function so that ecosystem services can continue to be delivered for current and future generations (TEEB Foundations, 2010). In this vein, given the current level of the Oueme Delta wetland degradation (Ramsar, 2015) that is threatening its ability to continue to supply goods and services for society, particularly agricultural households' wellbeing, there is the need to advocate for a more rational Oueme Delta wetland use and management policy. However, there is a paucity in the knowledge available in terms of the contribution of Oueme Delta wetlands and their attributes to societal welfare that allows wetland managers and policy makers to appreciate such use and management policies.

In this regards, this thesis fills that gap of information, using social preferences for Oueme Delta wetland attributes to unravel the value or benefit of these wetlands to society in monetary terms, to assist decision makers in the decision making process. Specifically, this thesis identifies and describes the key Oueme Delta wetland attributes to provide information about the most important wetland resources and potentials for local populations. Local population's preferences for wetland attributes are assessed to reveal to society, wetland managers, and policy makers the relative importance society attaches to wetland resources, to help policy makers identify priorities in the decision making process. Furthermore a special focus is given to changes in agricultural households' welfare due to changes in wetland attributes for an integrated agricultural policy development in that unique ecosystem.

1.5. Organization of the Study

The rest of this thesis is presented in four complementary chapters. Chapter two deals with the literature review on the valuation of benefits natural resources provide to society, taking into account a special view of human preference elicitation in this field. Chapter three develops the methodology of the thesis and provides its theoretical framework. Following this, Chapter four presents the study's results and discussions. Chapter five concludes the thesis and provides policy recommendations. References and Appendix are added at the end the thesis.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

In spite of the growing effort both at national and international levels to preserve natural resources and maintain continuous flows of their services for human wellbeing, their depreciation and degradation still continue. Being public goods, natural resource use levels are difficult to know and regulate. Though individuals in society benefit from ecosystem goods and services, they do not have enough motivations to preserve natural assets from their continuous degradation (TEEB Foundations, 2010). For instance, open access fishery practices usually lead to considerable declines in fish stocks, due to overexploitation of resources over a certain period. There is now the need for society to reconsider the way natural assets are being used and valued so that more rational natural ecosystem management plans can be developed and implemented for population wellbeing. This paves the way for a need to provide information on the value of the contribution of natural assets to human wellbeing, to guide policy maker in decision making process.

In this chapter, the thesis reviews related literature on the value of natural ecosystems to society; from biophysical processes to ecosystem values; accounting for natural ecosystems' value; human preference assessment as foundation for environmental valuation and attributes based stated preference elicitation, among others. The chapter ends with a summary of why wetland attributes are important for agricultural households and other key issues required to aid with the thesis methodology.

2.2. The Value of Natural Ecosystems to Society

2.2.1. Natural ecosystems and human wellbeing

The search for understanding the relationships between humans and their environment can be traced back for centuries, including Roman times where there were already writings about the rapid increase in human population and decrease in the benefits humans derive from nature (Johnson, 2000; Westman, 1977; Carson, 1962). Over the past few decades many attempts (Ramsar, 1971; CBD, 1992; MA, 2003, 2005; TEEB, 2008; Turner et al., 2000, 2003) have been made to improve society's knowledge about how natural ecosystems and humans interact. Specifically, the main concern was to reveal to society information on the various ways natural ecosystems and biodiversity contribute to human wellbeing and how humans' actions impact on natural resources' state in return.

According to the Convention on Biological Diversity (CBD, 1992), an ecosystem can be considered as "the complex of living organisms and the abiotic environment with which they interact at a specified location"; and biodiversity, "the sum total of organisms including their genetic diversity and the way in which they fit together into communities and ecosystems". The concept of "ecosystem services" has been developed by Ehrlich and Ehrlich (1981), followed by the development of the concept of "ecosystem", considered by ecologists as "life support system" that has the ability to provide ecological and economic benefits (or services) to society (de Groot, 1992; Ehrlich and Mooney, 1983). In 1997, after the publication of the seminal work of Costanza et al. (1997), the concepts of "ecosystem" and "ecosystem services" have gained more attention within the scientific community. These authors showed the important role played by natural ecosystems in producing and delivering many goods and services for human wellbeing and societal development. Later on, the publication by de Groot et al. (2002) has made more explicit the relationships between ecosystem processes, functions, and services, and has shown how natural assets, through the provision of ecosystem services, contribute to human wellbeing.

Moreover, in 2001, the Millennium Ecosystem Assessment (MA) was launched by the United Nations with the main goal of assessing the impacts of ecosystem changes on society wellbeing. Though there are still debates about the classification of the multiple ways natural resources contribute to society wellbeing (Fisher and Turner, 2008; Fisher et al., 2009; Boyd and Banzhaf, 2007; Costanza, 2008; Wallace, 2008), the Millennium Ecosystem Assessment, to achieve its goal, has categorized ecosystem services into four main groups, namely: provisioning services (water, food, raw material); regulating services (water regulation, climate regulation, erosion control); supporting services (soil formation, nutrient cycling); and cultural services (recreation, education, spiritual). Figure 2.1 presents the conceptual framework of the Millennium Ecosystem Assessment, which shows how human wellbeing depends on natural ecosystems and biodiversity, but also how human actions impact on environmental assets. According to The Economics of Ecosystems and Biodiversity (TEEB Foundations, 2010), the global acceptance of the notion of "ecosystem services" through the Millennium Ecosystem Assessment has provided valuable information on the necessity to maintain a critical amount of the earth's natural ecosystems to achieve the Millennium Development Goals (MDG), now termed as Sustainable Development Goals (SDG).

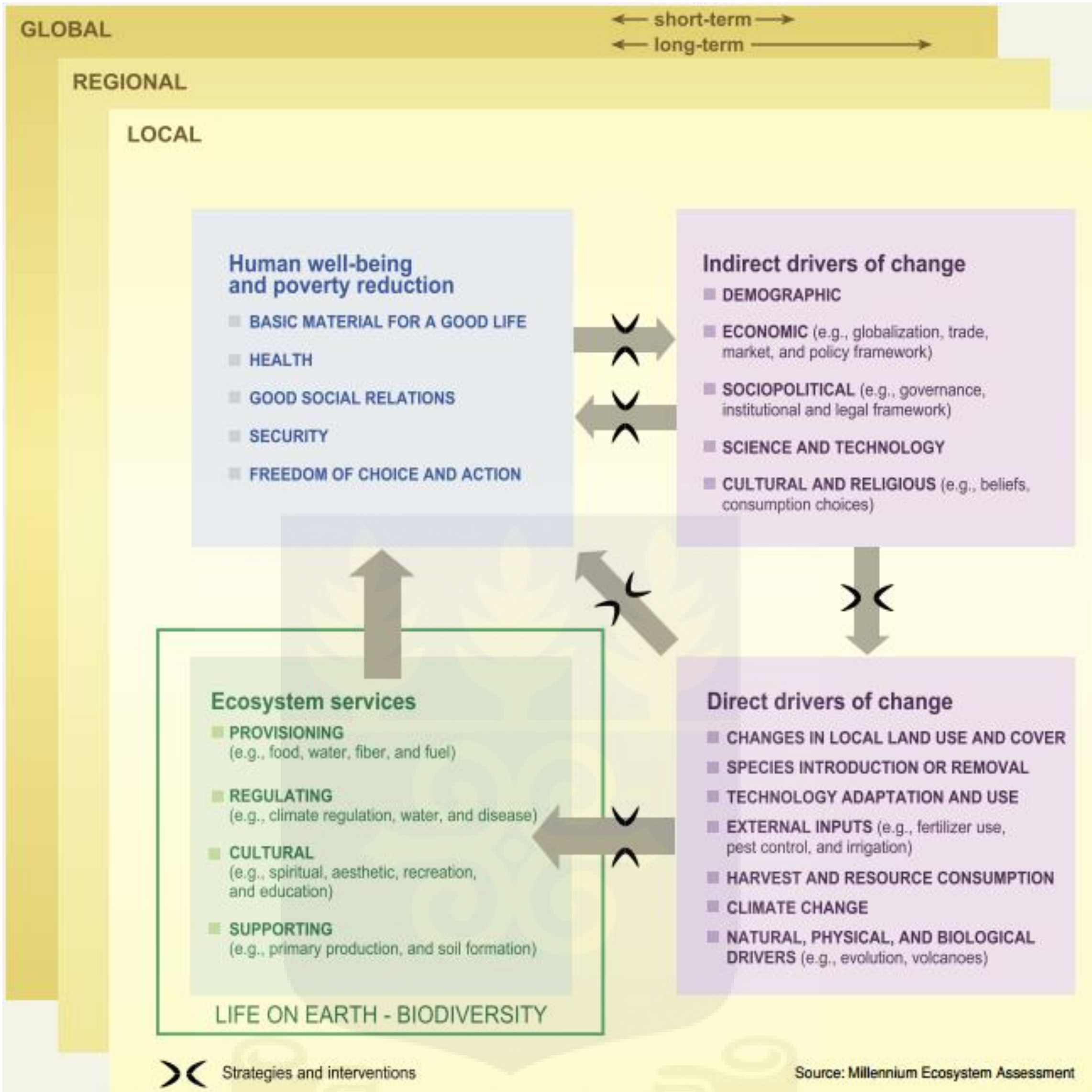

Figure 2. 1. Ecosystem services and human wellbeing

Source: MA (2005)

Furthermore, another important concept that has been developed by environmental economists is the consideration of the earth's natural ecosystems as natural or environmental capital (including both renewable and non-renewable resources) that are able to generate a flow of services over time (Thampapillai and Uhlin, 1997; Jansson et al., 1994; Costanza and Daly, 1992). For the Millennium Ecosystem Assessment (MA, 2005), the concept of natural capital has been coined by economists to help make society more aware about the limited stocks of the natural resources found on earth. Several debates have been raised about the continuous decline in natural capital and the capacity of human economies to substitute these natural resource losses with human-made capital such as “buildings”, to help society achieve sustainable development (Pezzey, 1992; Thampapillai and Uhlin, 1997). However, the extent to which natural capital can be substituted to human-made capital is a pure scientific questioning, but it is well accepted that there are limits to substitution (Daly, 1996; Barbier 1994). This means that a certain level of natural capital must be maintained to allow continuous delivery of ecosystem services.

In recent years, scientific research about the way natural ecosystems impact on human wellbeing have strongly increased (Fisher et al., 2009) and have provided essential information to decision makers (private and public) to assist them in their decision making processes (TEEB Foundations, 2010).

2.2.2. From biophysical processes to ecosystem values

2.2.2.1. Biophysical processes, ecosystem services, and ecosystem benefits

Ecosystem services are delivered only after natural ecosystems have completed several processes and functions and natural resource managers and decision makers need to understand its implications (Turner et al., 2000, 2003; MA, 2005). The distinction between ecosystem processes, functions, services, and even benefits are of primary importance for scientists and decision makers, and particularly for economists who are interested on the measurement of the value of nature to society. These distinctions allow economists to avoid double counting of the benefits nature provides to society (because some ecosystem services – regulating, supporting services – are inputs to others) (Fisher and Turner, 2008;

Wallace, 2008; Boyd and Banzhaf, 2007). It can be said that ecosystem functions depend on the deep ecological processes, and can be considered as the potential that makes the provision of ecosystem services possible (Fisher et al., 2009; Fisher and Turner 2008; de Groot et al., 2002; TEEB Foundations, 2010). For example, an ecological process such as “primary production” is required to have a certain level of fish stocks (function) that can be subject to harvest for food purposes (service). Several benefits can be derived from a single ecosystem service, for instance, water provisioning service can provide drinking water (benefit one), but also water for swimming (benefit two).

Ecosystem services can actually be regarded as conceptualizations of the essential things society obtains, either directly or indirectly, from nature. However, it is important to note that ecosystem components that are useful for society today can change in the future (TEEB Foundations, 2010).

Moreover, though for economic valuation a clear categorization of ecosystem functions, their contribution to human wellbeing (services), and the benefits they provide is useful, in practice it is often difficult to classify them into different categories in a consistent manner (Daily et al., 2009).

One important factor that make ecosystem services valuation difficult is the lack of information about the way some ecosystem services are produced and affected by changes in the physical environment (Daily et al., 2009). Also, it is important to know that a considerable number of individuals in society are not aware of the many ways, through which, natural ecosystems contribute to their wellbeing, and in consequence they are not able to recognize the true value of natural assets in their life (TEEB Foundations, 2010). Then, environmental valuation research must take into account all the ranges of benefits provided by natural assets, namely direct benefits, indirect benefits, but also non-use benefits (Krutilla, 1967; Mitchell and Carson, 1989).

Another important factor that needs to be taken into account when doing environmental valuation exercise is the notion of "dis-service" or "dis-benefit" that can also be provided by natural ecosystems (TEEB Foundations, 2010; EEA, 2010). As an example, natural ecosystems can sometimes favor the production of species that may be harmful for agricultural production or for human health.

2.2.2.2. Ecosystem benefits and ecosystem values

Given the many ways natural ecosystems, through the provision of their services, contribute to human wellbeing, several indicators can be used to assess their contribution to society welfare. Important debates exist related to the use of the notion of "value" in measuring the various benefits humans derive from nature. According to Costanza (2000), Farber et al. (2002), and MA (2003), "value" means the contribution of an action or object to user specific goals or conditions. "Value" can be measured based on various indicators from different scientific backgrounds with regard to their specific perception about the notion of "value" (TEEB Foundations, 2010).

Similar to the distinction made by economists between ecosystem services and ecosystem benefits in assessing the contribution of natural ecosystems to human wellbeing, they have also distinguished ecosystem benefits from their values. According to the economic valuation literature, how individuals in society value the various benefits they derive from a single ecosystem service is subjective (TEEB Foundations, 2010; Fisher et al., 2011; Fisher et al., 2009). For instance harvested fish can be used for nutrition (benefit one), can give cultural identity (benefit two), and can also provide cash income (benefit three).

However, some people may assign high value to the income aspect of these benefits than their nutrition aspect and may want to give up a particular category of benefits over another.

2.2.2.3. Typology of benefits and values

Three categories of benefits and values have been developed by The Economics of Ecosystems and Biodiversity (TEEB), based on the Millennium Ecosystem Assessment (MA) framework (TEEB Foundations, 2010; de Groot et al., 2012; Farber et al., 2002), namely "ecological benefits and values", "socio-cultural benefits and values", and "economic benefits and values".

"Ecological benefits and values"

According to Farber et al. (2002), some concepts of "value" are essential for natural scientists and can be briefly elucidated here as the extent to which an "item" contributes to an objective or condition in a particular system. Based on that definition approach of the concept of "value" in natural sciences, the ecological value of an ecosystem can be inferred as the causal relationships between various elements (or parts) of an ecosystem. For instance, the important role of fires in forest nutrient recycling (Farber et al., 2002). For MA (2003), at the global level, several ecosystems and their multiple components underpin critical ecological processes that are essential for life, such as biogeochemical cycling. To identify critical thresholds in ecology, several indicators of value can be used, including resilience, health, and integrity. Although ecological values contribute to human wellbeing, there should not be any confusion between ecological indicators of value and value indicators used in economics, because value indicators in ecology cannot be integrated into individual preference elicitation framework, as it is the case in economics (TEEB Foundations, 2010). Moreover, according to Farber et al. (2002), though there are still debates about the concept of value in natural science (e.g. in ecology), the value of the earth's ecosystems can be approximated based on their contribution to life in general and to human life in particular.

"Socio-cultural benefits and values"

Natural ecosystems also contribute to a wide variety of socio-cultural benefits (non-tangible wellbeing), including social, spiritual, religious identities, as well as mental health (TEEB Foundations, 2010; MA, 2005). Although theories and practices of environmental valuation have been developed to assess the value of a large categories of ecosystem (tangible and non-tangible) benefits (Mitchell and Carson, 1989), they cannot capture the full range of socio-cultural benefits provided by natural resources for human wellbeing. In this respect economic valuation of environmental capital needs to be supported by others ethical approaches to generate more useful and scientific knowledge to inform decision making. This situation occurs when for example the ecosystem service to be valued is inherent to society cultural identity. Several indicators can be used to measure the value of socio-cultural benefits provided by nature, but a major indicator in this field is the Human Wellbeing Index (MA, 2005; TEEB Foundations, 2010).

"Economic benefits and values"

There are uncountable reasons why people demand ecosystem goods and services (Barbier, 2007). Each of these reasons represents a particular aspect of the total benefit society derive from ecosystems (Mitchell and Carson, 1989). Then, within the environmental valuation framework, the total economic value (TEV) of an ecosystem or more specifically of their services represents simply the expression in monetary terms of all the reasons why (benefits) people have demands for those ecosystem services. Since Krutilla's 1967 seminal work, these benefits can be categorized into two main groups leading to the two categories of values, namely: (1) the use benefits (use values), including direct use benefits as well as indirect use benefits; and (2) the non-use benefits (non-use values) which is for example associated with the satisfaction people derive from the simple existence of natural ecosystems without accounting for any direct or indirect benefits (Mitchell and Carson, 1989; de Groot et al., 2002; Barbier et al., 1997). Economic valuation is of prime importance when externalities need to be internalized within the decision making process (Krutilla, 1967).

2.3. Accounting for Natural Ecosystems' Value

Multiple concepts of value exist in the valuation literature (Gómez-Baggethun and de Groot, 2010; Farber and Costanza, 1987; Farber et al., 2002; Costanza et al., 1989). There is a need for researchers to be transparent about their preferred valuation paradigm. Two well-known and differentiated valuation paradigms exist in the valuation literature, namely biophysical approaches, more used in natural sciences, and preference-based approaches, usually applied in economics (Gómez-Baggethun and de Groot, 2010).

2.3.1. Biophysical Approaches

Biophysical approaches derives values based on the assessment of the physical costs or the cost of producing a particular environmental good or service (Gómez-Baggethun and de Groot, 2010). In fact biophysical valuation try to measure the physical costs involved in the maintenance of a specific condition or state of environmental resources. Several scientists (Farber et al., 2002; Costanza, 1980; Cleveland et al., 1984; Costanza et al., 1989; Hall et al., 1992) have proposed the use of biophysical approaches when trying to measure the value of environmental goods or services. According to Patterson (1998), biophysical valuation methods derive value from the intrinsic properties of a particular good. Thus, biophysical values are of fundamental importance if the stock of natural capital needs to be measured, rather than the measurement of a marginal change in the state of natural assets used in economics (Goulder and Kennedy, 1997). Moreover, when working under the assumption of total absence of substitution between natural capital and human-made capital, biophysical approaches are still very useful for valuing depreciation in natural assets (TEEB Foundations, 2010; Valero et al., 2009; Daniels and Moore, 2002).

2.3.2. The Approach used in Economics

The concept of value used in economics (Blaug, 1985; Krutilla, 1967; Norton et al., 1998; Daly, 1992) relies on the commensurability assumption (using monetary unit) between ecosystem services and all human-made capital and assets. In contrast to biophysical valuation approaches, human preference-based approaches are used by environmental economists to assess natural asset values (Goulder and Kennedy, 1997; Farber et al., 2002; Gómez-Baggethun and de Groot, 2010). The idea underlying economic valuation of natural ecosystems is that their values are measured based on the utility society derives from them (Goulder and Kennedy, 1997). These approaches try to measure the intensity of changes in individual preferences resulting from marginal changes in natural ecosystem state. The value of natural ecosystems can be viewed as what individuals will be willing to give up to preserve a certain state or condition of these natural assets (Mitchell and Carson, 1989; Goulder and Kennedy, 1997; Farber et al., 2002; Costanza et al., 1989). Thus, the concept of value used in environmental valuation is fundamentally anthropocentric and instrumental in nature (Farber et al., 2002; Goulder and Kennedy, 1997), in the sense that it provides information that can inform and guide policy making process.

Economic valuation is essential to create markets for the preservation of natural ecosystem and their services (Muradian et al., 2010; Engel et al., 2008). However, economic valuation is not a panacea (Barbier et al., 1997), and needs to be complemented with other scientific knowledge related to natural resource preservation for human wellbeing (Turner and Daily, 2008; TEEB Foundations, 2010).

2.4. Human Preference Assessment as Foundation for Environmental Valuation

In principle, valuing natural resources in economic terms is not different from valuing goods that are usually sold in actual markets. However, in reality, valuing ecosystem services is problematic and complex (Costanza et al., 1989). It is easy to find the value estimates of various provisioning services, such as raw material, food, drinking water; but difficult to find the value estimates of several cultural and regulating services, such as spiritual experiences, flood control, maintenance of soil fertility, climate moderation (Barbier et al., 2009; Carpenter et al., 2006).

Economic valuation of natural ecosystems first derives value from individual choice behavior on actual markets that are directly related to the ecosystem service to be valued. When this information is not available, individual choice behavior can be inferred from surrogate markets, indirectly related to the ecosystem service in question. Finally, if both direct and indirect individuals' spending behavior related to the ecosystem service are not available, environmental economists create hypothetical markets on which the ecosystem service can be traded, then individual choice behavior can be elicited. This description corresponds to the three main approaches used in the environmental valuation exercise, namely: direct market, revealed preference, and stated preference approaches (Barbier et al., 1997; Chee, 2004; TEEB Foundations, 2010).

2.4.1. Direct market approaches

Direct market approaches can be classify into three different methods, namely market price method, cost-based methods, and production function method. The main advantage of using these approaches is that they use data from actual markets, and thus reflect actual preferences or costs to individuals. Moreover, such data (prices, quantities and costs) exist and are relatively easy to obtain (Barbier et al., 1997).

Market price method is mostly used to valuing provisioning services, since the commodities produced in terms of provisioning services (e.g. fish, timber, fuelwood, drinking water) are usually traded on domestic or international markets. In actual markets the marginal cost of production is reflected in the market prices that represent the private WTP for ecosystem services. Market prices can then be considered as a good indicator of monetary value measurements. To assess the economic value of ecosystem services (for example fuelwood, transport, fish, non-timber products, etc.) provided by the Sourou River Valley in Burkina Faso, Somda and Nianogo (2010) have used market price approach. This study has revealed to policy makers the relative economic importance of these ecosystem services.

Cost-based methods are based on the assumption that the cost of maintaining an ecosystem benefit is a reasonable indicator of its value (Garrod and Willis, 1997). In the valuation literature, various techniques exist, such as avoided cost; replacement cost; and the restoration cost. A cost-based method has been used by Emerton (1998) to assess the opportunity costs of wildlife conservation for the communities around Lake Mburo National Park in Uganda.

Production function method is based on the measurement of the direct contribution of natural assets to income or productivity (Barbier et al., 1997). This method usually uses cause-effect analysis to measure how much natural ecosystems or their services contribute in monetary terms to the output of a marketed good or service. It is an objective valuation of biophysical resources. In that respect, Barbier et al. (2009) have noted that, the production function method for valuing natural ecosystems can be applied in various situations, but only in cases where a considerable level of scientific knowledge is available. In the literature, the approach has been applied to assess for example the contribution of wetlands resources to economic activities, e.g. farming (Barbier et al., 1991; Costanza et al., 1997).

2.4.2. Revealed preference approaches

Revealed preference approaches rely on the study of people's choice behavior in parallel markets that are related to the ecosystem service of interest to derive values. Within that framework, individuals reveal their preferences based on their choices (Adamowicz et al., 1994; Barbier et al., 1997). The approach consists of two main techniques:

The travel cost (TC) method measures willingness to pay for ecosystem goods and services located in a specific environment, based on the amount of time and money people will spend to visit that particular environment (Kontoleon and Pascual, 2007; Bateman et al., 2002) . The TC method is mostly used to estimate the value of recreational sites including public parks and wildlife reserves (Verma, 2008). The TC approach has been used by Pak and Türker (2006) to estimate the recreational value of Kayabasi Forest. This study provide information about the use value of this Forest.

The hedonic pricing (HP) method derives values from information about people's implicit demand for an environmental attribute inherent to a marketed commodity (e.g. a property). The basic assumption of the method is that the observed property value reflects a flow of benefits directly related to the ecosystem conditions. This allows researchers to isolate the value of the ecosystem attribute of interest through the estimation of a demand function for the marketed commodity. To study the environmental economic impact of woodland in Britain, Garrod and Willis (1992) have assessed the amenity value of forestry using a two-stage HP model.

2.4.3. Stated preference approaches

Stated preference methods create a hypothetical market and demand for environmental resources using a survey questionnaire. Stated preference techniques are used to measure all form of values (direct use, indirect use, and non-use values) of ecosystems (Mitchell and Carson, 1989; Adamowicz et al., 1998). They circumvent the absence of actual and surrogate markets. The main stated preference approaches are:

Contingent valuation (CV) method: relies on survey questions to elicit people's preferences by finding out their willingness to pay or willingness to accept respectively for an improvement or deterioration in the state of, for example, a natural asset. Kontoleon and Pascual (2007) have pointed out that the CV method usually presents only one alternative description of the good subject to valuation to the respondents. They are then asked to express their vote in terms of the amount of money they would be willing to pay to support a new alternative or to reject it and stay in their current situation (Blamey et al., 1995).

Kramer et al. (2003) have applied contingent valuation method to assess the structure, health, and extent of forest ecosystems to uncovering non-market values of forest quality. In 2007, Wattage and Mardle have used CV method to estimate the total economic value of wetlands in Sri Lanka. The authors were able to measure the use and non-use values of these wetlands to motivate their conservation.

Choice modeling (CM): is a group of survey based-methods, designed to model individuals' preferences for goods, but fundamentally for goods' attributes or characteristics. The assumption underlying this approach is that people's demand for a particular good can be decomposed into demands for its attributes (Hanley et al., 2001; Louviere et al., 2000). Unlike CV approach, respondents are faced with two or more alternative descriptions of the good with shared attributes set at different levels. Thus, through a survey questionnaire, respondents are asked to express their preferences with regard to the alternative descriptions of the good based on tradeoffs between the different levels of the attributes. Christie et al. (2007) have applied CM method to value biodiversity conservation policy scenarios (hypothetical alternative descriptions of the state of biodiversity) in UK. These authors were able to assess the total economic value of biodiversity, as well as the marginal values of changes in biodiversity characteristics.

Although the application of CM approach requires more effort from the researcher than CV approach, CM (like CV) has the ability to estimate the total value of a good, but is also capable to generate information about the values of the specific attributes of that good (Adamowicz et al., 1998); something that is very useful in environmental decision making and management.

2.5. Attributes Based Stated Preference Elicitation: The Discrete Choice Experiment approach

2.5.1. Discrete Choice Experiments (DCE)

A review of the environmental valuation literature reveals that from 1990s, there has been a rapid development in theories and applications of stated preference approaches (Adamowicz, 2004; Adamowicz et al., 1998). The basic idea underlying the stated preference approaches is the elicitation of people's preferences based on their choice behavior with respect to hypothetical environmental policy scenarios presented to them in a hypothetical market (Mitchell and Carson, 1989; Louviere et al., 2010). Various techniques (mainly CV and CM methods) have been used over the years to assess consumers' stated preferences for several categories of goods (Adamowicz et al., 1998; Hanley et al., 2001; Louviere et al., 2010). In the family of choice modelling techniques (discrete choice experiments (DCE), contingent ranking, contingent rating, and paired comparisons), DCE is totally consistent with welfare economics and is based on random utility theory (Hanley et al., 2001).

The conceptual foundation for attribute-based preference elicitation stems from the hedonic approach that considers the demand for a good as a demand for its characteristics (Court, 1939; Griliches, 1961). Lancaster's (1966) consumer demand theory provides a firm theoretical basis to the hedonic approach, and assumes that the consumer utility for a good can be decomposed into utilities for the good's specific attributes (Adamowicz et al., 1998; Louviere et al., 2000). Lancaster's demand theory provides the conceptual basis that allows the application of attribute-based preference elicitation in economics. However, a more direct approach to eliciting human choice behavior was developed under the discrete choice theory, especially as conceived by McFadden (1974), based on Thurstone's (1927) notion of random utility (Manski, 1977; Adamowicz et al., 1998; Hanley et al., 1998). This notion states that people make choices that are associated with their highest (or maximum) expected utility. McFadden extended Thurstone's original approach, limited to paired-alternative comparisons, to multiple-alternative comparisons (Thurstone, 1927; McFadden 1974; McFadden, 1986; McFadden and Train, 2000). Starting from the choice axiom established by Luce (1959), as related to Marschak's (1960) random utility model, McFadden (1986) has developed a new framework that combines hedonic approach (then Lancaster's (1966) characteristic demand theory) with random utility theory. This constitutes the theoretical foundation for DCE.

In spite of the wide acceptance of CV method in the scientific world as well as by policy makers, there is a long standing debate concerning its uses in various scientific disciplines (Hanley et al., 2001; Mitchell and Carson, 1989; Blamey et al., 1999). Specifically, Blamey et al. (1999) have identified three main concerns with CV method:

1. CV is subject to "yea-saying", this is the case where respondents do not express their own perception but just agree with the requests of the interviewers;
2. sensitivity to scope: WTP estimates in CV application may not be sensitive to the size of environmental change; and
3. CV method usually presents respondents with only one alternative description of the good to be valued.

However, according to Hanley et al., (1998), the DCE method appears to have some advantages, including its facility to value in monetary terms individual attributes, and its ability to avoid the "yea-saying". DCE allows the researcher to assess marginal values of attributes that are often difficult to be estimated in revealed preference approaches. Early applications of DCE to analyze people's demands for good attributes were in marketing and transportation research (Louviere and Hensher, 1982; Louviere and Woodworth, 1983; Ben-Akiva and Lerman, 1985). It has firstly been applied in environmental valuation studies by Adamowicz et al. (1994). However, it is important to know that DCE applications seem to be subject to several problems (Hanley et al., 2001), including the cognitive burden on respondents inherent to multiple complex choices (Swait and Adamowicz, 1996), resulting both in learning and fatigue effects that can lead to irrational respondents' choices. Also, as any stated preference techniques, welfare estimates with DCE are sensitive to the experimental design (Hanley et al., 2001).

Overall, DCE can provide useful information to decision makers about how much individuals or society as a whole value(s) environmental goods as well as their specific attributes; this can greatly impact on the quality of the designed environmental policy (Birol and Cox, 2007; Hoyos, 2010; Hanley et al., 2001; Adamowicz et al., 1998) for human wellbeing.

2.5.2. Output of Discrete Choice Experiments

DCE provides essentially two value estimates, namely implicit price and compensating or consumers' surplus for the good under valuation (Adamowicz et al., 1994; Hanley et al., 1998; Bateman et al., 2003). An implicit price represents respondents' marginal willingness to pay for an improvement in a specific attribute level, holding all other attribute levels constant. A simple comparison of the marginal willingness to pay estimates for the various attributes of a good, reveals the relative importance respondents attach to the attributes of that good. Compensating surplus (CS) or consumer welfare represents their mean willingness to pay for improvements in multiple attribute levels (Hanley et al., 1998). Welfare analysis is very useful to assessing and comparing the economic value of alternative environmental management policies (Adamowicz, 2004; McFadden, 2000). A special application of welfare analysis is cost-benefit analysis (Hoyos, 2010), where environmental project impacts can be assessed. According to Scarborough and Bennett (2012), DCE approach has the ability to free decision makers from value judgments, what makes this approach a very helpful tool in policy analysis.

2.6. Summary of Chapter

Wetlands provide a variety of ecosystem services (e.g. water, raw materials, inspiration for culture, opportunities for recreation and tourism, and information for cognitive development) that are essential to life and economic performance (MA, 2005; de Groot et al., 2002; Barbier et al., 1997). In developing countries such as Benin, local population, especially agricultural households highly depend on wetland ecosystem services for their livelihood (TEEB, 2008) and as an opportunity to choose certain ways of life (Sossou-Agbo, 2013; TEEB Foundations, 2010).

However, the delivery of those vital wetland ecosystem services depends on the interactions between their physical, biological, and chemical components or attributes (Turner et al., 2000; Barbier et al., 1997). So, the benefits local populations derive from Oueme Delta wetlands in Benin are inherent to their basic characteristics (or attributes). Any modification in the state of the wetlands, meaning modifications in the quality or quantity of their attributes impact on society and more directly on agricultural households' wellbeing in Oueme Delta.

From an economic perspective, the lack of knowledge about the importance (or value) of natural ecosystems and their multiple resources (attributes) to society, limits the ability of natural ecosystem managers and policy makers to design and implement sustainable use and management policies that maximize society welfare (Costanza et al., 1989; Perrings et al., 2006; Costanza and Daly, 1992; Hanley et al., 1998). Natural resource valuation, especially through attribute-based human preference elicitation approach, appears to be one of the promising ways to unravel the complex relationships between human society and ecological systems, and make clear to society and decision makers the values (in monetary terms) of natural ecosystem attributes that need to be taken into account in policy decision making (Adamowicz, 2004; Mooney et al., 2005).

CHAPTER THREE

METHODOLOGY OF THE STUDY

3.1. Introduction

The aim of this thesis is to elicit social preferences for wetland attributes, and to derive the welfare implication for agricultural households in Oueme Delta in Benin, based on Discrete Choice Experiment (DCE), so as to assist policy makers in decision making process, regarding the need to develop and implement rational Oueme Delta wetland management policies for population's wellbeing.

DCE is a survey-based approach for modelling social preferences for a good, where the good is described in terms of its characteristics (or attributes, including price) and of the levels (improvement or not) that these take in a simulated (or hypothetical) market, where the good in question can be traded (Hanley et al., 2001; Lancaster, 1966). In this approach, different aspects of the good are designed by the researcher based on the good characteristics and their levels to be presented to the respondents, who are asked to choose their most preferred aspects of that good. DCE provides quantitative measures of substitutions between attributes and is an appropriate method for assessing, after changes in attributes, how much money will be needed to make an individual as well off (in terms of utility or satisfaction) as he was before changes occur. Consumer welfare (utility expresses in terms of willingness to pay – WTP) can then be derived based on their stated choice in monetary terms in this hypothetical market (Hanley et al., 2001; Bateman, 2003).

3.2. Theoretical Framework of the Thesis

The whole thesis falls under random utility theory (RUT) associated with welfare economics. They are prominent in human choice behavior and welfare analysis.

3.2.1. Random utility theory (RUT)

Random utility theory was developed on the basis of human choice behavior analysis (Adamowicz et al., 1998; Louviere et al., 2010; Louviere et al., 2000). Specifically, random utility theory posits that there is a "latent" utility in the individual's (making a particular choice) head that is not observable to researchers (Thurstone, 1927; McFadden 1974; McFadden, 1986). That is, an individual has different levels of satisfaction (utility) associated with the choice alternatives presented to him, but these individual levels of satisfaction can never be known with certainty by researchers. According to the economic doctrine of consumer sovereignty, an individual spending behavior (choices) in markets is a sufficient signal of his preferences for various goods, but the reasons why he made these choices are unknown (Penz, 1986; Mitchell and Carson, 1989). This is why the person's utility inherent to each choice alternative is called latent. For analytical purpose, RUT decomposes the latent utility in two components: (i) a deterministic or systematic (observed) component, and (ii) a random or stochastic (unobserved) component (Adamowicz et al., 1998; Hanley et al., 1998; Louviere et al., 2000; Louviere et al., 2010). The deterministic component consists basically of the good's attributes that are used to define various aspects of the good (termed "choice alternatives"), and optionally individual specific variables, included to capture differences in individuals making choices. The random component in the latent utility reflects researcher uncertainty about individuals' choices and consists of all unidentified factors that explain choices (Do and Bennett, 2009; Morrison et al., 1999; Hensher et al., 2005). Moreover, from psychologists' point of view, individuals are "imperfect measurement devices", then the random component is also supposed to include factors that explain differences in choices, but that are purely related to the nature of individuals making choices and not to the differences in choice alternatives (Louviere et al., 2010). The basic axiom underlying random utility theory is (Adamowicz et al., 1998; Louviere et al., 2010; Westerberg et al., 2010):

$$U_{in} = V_{in} + \varepsilon_{in} \quad (3.1)$$

where U_{in} is the true but latent utility associated by individual *n* to the choice alternative *i*, V_{in} is the deterministic component of utility associated by individual *n* to the choice alternative *i*, and ε_{in} is the stochastic component related to individual *n* and alternative *i*.

In random utility models, only the probability that individual *n* will choose alternative *i*, can be predicted by researchers, but not exactly the choice alternative that will be chosen by that individual, due to the presence of the stochastic component of utility in the model (Louviere et al., 2010). This stochastic component allows the researcher to make probabilistic statements about individuals' choice behavior. Then, RUT constitutes the theoretical basis for some classes of probabilistic discrete choice models developed to elicit people's preferences for goods' attributes, based on the analysis of their stated choices (Louviere et al., 2000; Adamowicz et al., 1998; Hanley et al., 1998). The basic probabilistic discrete choice model that underlies empirical model specifications can be written as:

$$P(i|C_n) = P\left[(V_{in} + \varepsilon_{in}) > \left(V_{jn} + \varepsilon_{jn}\right)\right] \;\; \forall\, j \in C_n \quad (3.2)$$

meaning the probability that individual *n* will choose alternative *i* over any other alternative *j* from the choice set C_n is equal to the probability that the true utility $(V_{in} + \varepsilon_{in})$ derived by individual *n* when choosing altenative *i* is superior to its true utility $\left(V_{jn} + \varepsilon_{jn}\right)$ associated with any other alternative *j* belonging to C_n.

Various probabilistic choice models can be formulated from equation (3.2) based on the researcher assumptions related to the distribution of the errors ε_{in} (stochastic components). Thurstone (1927) has considered cases like the bivariate normal distribution resulting in the binary probit model that can be extended to the multivariate normal distribution leading to the multinomial probit model (Adamowicz et al., 1998; McFadden and Train, 2000; Yellott, 1977). In contrast, McFadden (1974) assumed the random components were IID Gumbel Extreme Value Type 1. Similar to the normal distribution, the Gumbel distribution is slightly asymmetric and results in the conditional logit (CL) model (McFadden, 1974; Ben-Akiva and Lerman, 1985; Hanley et al., 1998; Birol et al., 2006). Also, the Generalized Extreme Value (GEV) distribution leads to the nested logit (NL) model (McFadden, 1981). However, if random components are not IID, both Gumbel distributions as well as Thurstone's normal distributions do not have closed-form expressions for the choice probabilities. This last case has given rise to new approaches to estimate probabilistic choice models, such as simulated maximum likelihood or hierarchical Bayes (Adamowicz, 2004; Louviere et al., 2010). To sum up, it can be said that random utility theory is adapted to different distributional assumptions on its random components, which determine the type of probabilistic discrete choice model to be used in human choice behavior studies.

3.2.2. Random utility theory and welfare economics

A further development in human's preference elicitation based on human's choice behavior analysis, is the direct linkage found between RUT and welfare economics (Holmes and Adamowicz, 2003; McFadden, 1999; Small and Rosen, 1981). In reality, in random utility models, the utility function is conditional to the individuals' choices between competing alternatives from choice sets. Given that one of the attributes describing the good or actually the various aspects of the good (named choice alternatives), is the price or cost of these alternatives, researchers can indirectly recover consumer economic welfare (compensating surplus (CS) or willingness to pay – WTP) from individuals' choices (Small and Rosen, 1981). Then, theoretically, DCE is well rooted in random utility theory as well as in the neoclassical theory of economic value (welfare economics). This means that individuals' stated choices are related to their underlying preferences that can be valued in monetary terms. Moreover, DCE, like Contingent Valuation, can measure all categories of values, namely direct use, indirect use, and non-use values (Hanley et al., 2001).

In DCE framework, and especially as applied in this thesis, respondents make choices relating to the wetland improvement policy alternatives, given that their level of utility or satisfaction is determined by the choice of their most preferred Oueme Delta wetland policy scenario from each choice set (Christie et al., 2007; Birol et al., 2006).

In this study, each choice set contains three alternative descriptions (or aspects) of Oueme Delta wetlands, where two represent possible outcomes of wetland improvement policies and the last, the current situation or "do nothing". The alternatives are characterized by the Oueme Delta wetland attributes set at different levels. The levels represent hypothetical changes (improvement or not) in the quality or state of each wetland attribute. Individual choices are determined by tradeoffs between the different levels taken by each attribute used to describe the choice alternatives presented to them. As the cost attribute is included in each wetland policy scenario, total as well as marginal willingness to pay for changes in wetland attributes can be estimated.

Welfare estimates (CS - total willingness to pay for changes in multiple attributes) as well as implicit price (marginal willingness to pay (MWTP) for a change in specific wetland attribute) will provide more information to wetland managers and policy makers and guide them in making rational policy decisions with regard to both conservation and socioeconomic development of the Oueme Delta.

3.3. Analytical Framework of the Thesis

The analytical framework of the thesis is based on the discrete choice experiment (DCE) framework. This section presents in detail the methods used to achieve each specific objective of the study.

3.3.1. Specific objective 1: Identify and describe the key Oueme Delta wetland attributes

To identify and describe the key Oueme Delta wetland attributes, this thesis follows the approach defined by Kragt and Bennet (2008). For these authors, the experimental design process requires five steps:

1. *Identification of the problem*: here the researcher needs to address a series of questions very important for the design process. He needs to properly define the natural asset to be valued, identify the stakeholders, describe the current situation, and identify threats (problems faced) to these natural assets;
2. *Develop possible policy options*: the aim for the researcher at this second stage is to conceive various possible management options that can be implemented to address the problems identified during the first step;
3. *Attribute selection*: basically this step focuses on the selection of the key attributes associated to the good or service subject to valuation and relevant to the possible management policies identify in step two;

4. *Defining attribute levels*: at this fourth stage, the researcher needs to identify the current level (state or condition) of each selected attribute as well as all possible and realistic (understandable and applicable) changes (in these current levels) for each of the good's attributes;
5. *Experimental design*: the final stage of the design process requires from the researcher to choose among the various statistical design techniques the one that will help him to develop the choice alternatives (termed in this thesis as "hypothetical wetland improvement policy scenarios) as well as the choice sets, based on multiple different combinations of the attribute levels. The results of the design are included into the survey questionnaire.

Thus the specific objective 1 falls under steps 1 to 4. The approach used to implement these four steps is through literature review, focus group discussions, and wetland expert consultations (Adamowicz et al., 1998; Hanley et al., 2001; Louviere et al., 2000). The fifth step is highlighted later on in the section 3.5 on choice experiment data collection.

However, it is important to note that the execution of the five steps of the experimental design is required before the design of the study questionnaire and the main survey; meaning that the first specific objective is a preliminary question for the study of social preferences and represents a step in the data collection process, then for the methodology of the study. This is due to the experimental nature of the study. Section 3.5 of the methodology fully covers the first specific objective of this study.

3.3.2. Specific objective 2: Evaluate local population's preferences for Oueme Delta wetland attributes

Random utility theory provides the conceptual basis for assessing local population's preferences for Oueme Delta wetland attributes. The basic random utility model describes the probability that an individual in a choice situation will choose his most preferred alternative over other possible alternatives, presented in equation (3.2) as follows:

$$P(i|C_n) = P\left[(V_{in} + \varepsilon_{in}) > (V_{jn} + \varepsilon_{jn})\right] \quad \forall\, j \in C_n$$

which represents the probability that individual *n* chooses alternative *i* over other alternatives *j* from a set of competing alternatives. As it has been said earlier (subsection 3.2.1), different probabilistic discrete choice models can be derived from equation (3.2) by making different assumptions about probability distributions for the error component.

3.3.2.1. McFadden's Conditional Logit (CL) Model

The usual assumption made is that the errors are Gumbel-distributed and independently and identically distributed (McFadden 1974). This implies that the probability of choosing *i* is given by (Hanley et al., 1998; Ben-Akiva and Lerman, 1985; Train, 2003):

$$Prob(i) = \frac{exp^{uV_i}}{\sum_{j \in C} exp^{uV_j}} \quad (3.3)$$

where *u* is a scale parameter, which is usually assumed to be equal to 1 (implying constant error variance). Equation (3.3) is estimated by means of a conditional logit regression.

The CL model, though based on strong assumptions, remains the most applied in human choice behavior studies for its simplicity in estimation and its robustness in term of prediction accuracy (Louviere et. al, 2000). The three main restrictions associated with the

CL model (Holmes and Adamowicz; 2003; Ben-Akiva and Lerman, 1985; Swait and Louviere, 1993) are:

1- Preferences are homogeneous amongst respondents;
2- The independence from irrelevant alternatives (IIA), which posits that, the ratio of choice probabilities of two alternatives is not affected by the systematic utilities of other alternatives for any individual;
3- The scale parameter is identical for all error terms (Swait and Louviere, 1993).

Another issue associated with the specification of the CL model is the use of independent dummy variables called "alternative-specific constants" (ASCs). These variables help to capture systematic but unobserved information about individuals' choices (Birol, 2006; Morrison et al., 1999), and play an important role in the interpretation of people's preferences (Morrison et al., 2002). So, the introduction of ASCs into the CL model affects the estimated results (Louviere et al., 2000; Mogas et al., 2006) by preventing the model parameters from capturing those effects that may lead to biased estimates.

The basic CL model derived from equation (3.3) can be written as:

$$V_{in} = ASC_i + \sum \beta Z_{in} \qquad (3.4)$$

where, V_{in} is the deterministic component of the respondent's utility associated with choice alternative *i*, assumed to be linear in parameters, *n* denotes local person, *i* is the wetland improvement policy scenarios (*i* = Policy A, Policy B and Status quo), β are the parameters associated with the wetland attributes, *Z* is a vector of alternative-specific variables (namely wetland attributes, which describe each wetland improvement policy scenario), and ASC_i the alternative specific constant, which helps here to capture the unobserved effects of the stochastic components of the model (Blamey et al., 1999). For Train (1986) ASCs are also helpful to mitigate the IIA assumption violation. In this thesis an ASC has been used and which takes the value "zero" for the current situation of Oueme Delta wetlands, and "one" for any Oueme Delta wetland improvement policy scenario. However, one issue related to the basic CL model (equation 3.4) is its incapacity to capture preference heterogeneity among respondents. Then, to improve the accuracy of the basic CL model and to be able to capture individuals' preference heterogeneity, the introduction of individual-specific variables (socioeconomic and attitudinal variables) into the basic CL model is required (Morrison et al., 1999; Do and Bennet, 2009; Birol et al., 2006; García-Llorente et al., 2012). Thus, the interaction CL model can be obtained from equation (3.4) as follows:

$$V_{in} = ASC_i + \sum \beta Z_{in} + \sum \alpha S_n \qquad (3.5)$$

where, α are the coefficients associated with socioeconomic and attitudinal variables, and S_n a vector of socioeconomic and attitudinal variables.

The socioeconomic and attitudinal variables used in the interaction CL model are: gender, age, environmental care, households' income, number of children, agricultural households, and education.

3.3.2.2. Evaluation of social preferences

The estimation of the basic CL model (equation 3.4) provides information only about the importance of each wetland attribute in the utility respondents associate to their stated choices regarding wetland policy scenarios. In equations (3.4) and (3.5), the coefficients associated with the non-cost attributes are called taste or preference parameters (Train, 2003). The values taken by each of these coefficients are direct indicators of society preferences for the attributes.

To be more explicit, the equation (3.5) consists of alternative specific variables (or attribute variables (Z)), which vary across policy alternatives and individuals, and individual-specific variables (or socioeconomic and attitudinal variables (S)), which vary only across individuals and remain constant across alternatives. In this model, each individual faces three alternatives per choice set, thus the number of observations is equal to the total number of alternatives from all choice sets, not the number of individuals. Moreover, given that respondent choices and model estimates are based on utility differences across the alternatives contained in choice sets, any variable that remains constant across alternatives, namely the individual-specific variables, drops out during the estimation process, as shown in equation 3.2. Then, individual-specific variables (or socioeconomic and attitudinal variables) cannot inter into the model as simple variables. The solution found in the literature (Long, 1997; Morrison et al., 1999) is to introduce the individual-specific variables into the basic CL model as interaction terms (either with the ASC or the wetland attributes). The full CL regression model (the explicit form of equation 3.5) to be estimated in this study and derived from equation 3.3 is:

$$\begin{aligned} V_{in} = ASC_i + \beta_1 habitat + \beta_2 biodiversity + \beta_3 croparea + \beta_4 recreation + \beta_5 cost \\ + \alpha_1 ASC_i * male + \alpha_2 ASC_i * educ + \alpha_3 ASC_i * env\_care + \alpha_4 ASC_i \\ * children + \alpha_5 cost * income + \alpha_6 cost * age + \alpha_7 cost \\ * agric\_hh \end{aligned} \quad (3.6)$$

with V_{in} as the dependent variable, which represents the observable component of the respondents' latent utility inherent to their choices of policy alternatives. V_{in} is then approximated in this model by respondents' choices. The independent variables used in the model are: ASC, habitat, biodiversity, croparea, recreation, cost, male (gender), educ (education), env_care (environmental care), children (number of children per households), income, age, and agric_hh (agriculture households). The variables habitat, biodiversity, croparea, recreation, and cost represent the wetland attributes (information about the identification and design of the attribute variables are given in section 3.5 of this Chapter). The coefficients β_1 to β_4 represent the preference parameters, β_5 is considered as the marginal utility of income in this model (Adamowicz et al., 1994), and α_1 to α_7 represent the parameters of the socioeconomic and attitudinal variables. Moreover, ASC has been interacted with some of the individual specific variables, while cost has been interacted with the rest. This is due to the fact that during the estimation process several interaction terms were tested and only those who improved the model accuracy and are more statistically significant have been retained (García-Llorente et al., 2012; Morrison et al., 1999).

Preference elicitation condition

The condition for the elicitation of social preferences for wetland attributes can be stated as follows: a wetland attribute is preferred to another one if its preference parameter (the attribute coefficient) is superior in value to the preference parameter of the other attribute.

Validation of the condition

The validation of this condition can be made under two criteria:

- First criterion: the analysis of the statistical significance of the preference parameters;

In this thesis, the statistical significance of any of the model parameters is accepted at 10%, meaning that if the p-value of any parameter is less than 0.1 (p-value < 0.1), that parameter is statistically significant.

Thus, if a preference parameter or an attribute coefficient is not statistically significant (p-value ≥ 0.1), it means that people do not find any interest in that attribute. Changes in the quality of that attribute will not affect, whether positively or negatively, their level of utility. Then, the attention of the researcher needs to be focused on the preference parameters that are statistically significant.

- Second criterion: the analysis of the values and signs of the statistically significant preference parameters.

In this case three different situations can appear and need to be separately analyzed:

i- All preference parameters are negative: in this situation, attribute 1 is preferred to attribute 2 if and only if the absolute value of attribute 1 preference parameter (β_1) is inferior to the absolute value of attribute 2 preference parameter (β_2) ($|\beta_1| < |\beta_2|$);

ii- All preference parameter are positive: here, attribute 1 is preferred to attribute 2 if and only if the value of attribute 1 preference parameter (β_1) is superior to the value of attribute 2 preference parameter (β_2) ($\beta_1 > \beta_2$); and

iii- There are positive as well as negative preference parameters: the rule of decision, in this situation is that any attribute associated with positive preference parameter is preferred to the attribute associated with negative preference parameter.

Moreover, Table 3.1 describes all the variables used to estimate the basic and interaction CL models in this study as well as their measurements.

Table 3. 1. Description of the CL model variables

Variables	Definition	Measurement
Dependent variable		
V_{in}	Deterministic component of the respondents' latent utility inherent to their choices of policy alternatives, then represented in the model by the choices made	**1** if individual *n* chooses alternative *i*, and **0** otherwise
Independent variables		
ASC	Alternative specific constant, associated with the policy alternatives per choice set	**1** if improvement policy alternative, and **0** otherwise
Wetland attribute variables (see subsection 3.5.1 for details)		
Habitat	Wetland area and their state	**1** if high improvement in habitat, and **0** if status quo
biodiversity	Species diversity	**1** if high improvement in biodiversity, and **0** if status quo
croparea	Cropping area and irrigation facilities	**1** if high improvement in cropping area, and **0** if status quo
recreation	Recreation and tourism facilities	**1** if high improvement in Recreation facilities, **0** if status quo
Cost	Annual cost for each policy alternative	**Continuous variable**
Respondents' socioeconomic and attitudinal variables		
Male	Gender	**1** if male, and **0** female
Educ	Education level	**1** if at least JHS, and **0** otherwise
env_care	Environmental care, when respondents' answer is "all" (Government, NGOs, and simple citizens, etc.) to the question: wetland protection responsibility	**1** if response = all, and **0** otherwise
Children	The number of children per household.	**Continuous variable**
Income	Households' income	**Continuous variable**
Age	Age of the respondents	**Continuous variable**
agric_hh	Agricultural household (Farmers + Fishermen + Breeders)	**1** if agricultural household **0** if not

Source: Author (2017)

An important information from Table 3.1 is the measurement of the wetland attribute variables and how policy scenarios can be defined and measured in the analytical model (equation 3.6). The Table indicates that researchers just need to assign the value one (1) to any attribute that will be improved through a particular policy and zero (0) otherwise in the regression model. This allows researchers to assess how changes in the state of the attributes will affect the utility society derives from the natural resource.

3.3.3. Specific objective 3: Estimate agricultural households' welfare and determine how much the Oueme Delta wetland attributes' contribute

The DCE method is consistent with utility maximization and demand theory (Bateman et al., 2003), therefore when the parameter estimates are obtained by the use of the appropriate model, welfare measures can be derived (Small and Rosen, 1981; Hanemann, 1999; Morey, 1999).

3.3.3.1. Agricultural households' welfare

Adamowicz et al. (1994) showed that compensating or consumers' surplus (CS) estimates for changes in attribute levels can be derived from the logit equation implicit in equation (3.4) or (3.5). This is based on an interpretation of the coefficient on the "cost" attribute in the logit equation as equal to the marginal utility of income (Hanley et al., 1998). In addition, the consumers' surplus (Agricultural households' welfare) of increasing all attribute levels simultaneously can be calculated using the formula (Bergmann et al., 2008; Bennett and Blamey, 2001; Boxall et al., 1996):

$$CS = -\frac{1}{\beta_{cost}}(V^1 - V^0) \qquad (3.7)$$

where V^0 is the utility of the current situation, V^1 the utility after improving all the wetland attributes simultaneously, and β_{cost} the marginal utility of income (represented in equation 3.6 by β_5). The value of V^0 is obtained when all the wetland attributes are set to zero (0) and V^1 when all the attributes are set to one (1). CS represents the person's willingness to pay (WTP) for the improvement in all wetland attributes. It is interpreted as the utility in monetary terms that the person receives in the choice situation (Train, 2003).

However, because of the focus of this study on the measurement of agricultural households' welfare and not the entire sample population, a dummy variable called "agricultural household" (=1 if agricultural household and 0 otherwise) is introduced into the society's interaction CL model (equation 3.5) to check whether there is observed source of preference heterogeneity between the two groups. If the variable is statistically significant, then a specific agricultural households' interaction CL model will be derived from the one of society to be used in the estimation of their welfare. But if the variable is not significant equation (3.5) will be kept for the analysis.

3.3.3.2. Contribution of wetland attributes to agricultural households' welfare

For the linear utility function, the marginal value of change in a single wetland attribute can be represented as a ratio of coefficients (Morrison et al., 1999; Birol et al., 2006), reducing equation (3.6) to

$$Implicit\ price\ (IP) = -\frac{\beta_k}{\beta_{cost}} \qquad (3.8)$$

where β_k is the coefficient of the non-cost attribute. This implicit price (or "part-worth") expression represents the marginal rate of substitution (MRS) between income and the good's attribute, that is the MWTP for a change in that attribute state. The implicit prices can be used to inform decision makers about the value society assigns to each wetland attribute, so as to assist them in taking decisions that maximize societal welfare (Hanley et al., 2001).

However, implicit prices, being non-linear combinations of the estimated model parameters, are obtained under the ceteris paribus assumption. So confidence intervals are needed (Kosenius, 2010), to check for the statistical validity of the estimated implicit prices before any use of these indicators for policy analysis.

3.3.4. Specific objective 4: Estimate the impact of the different attribute-based wetland improvement policy scenarios on agricultural households' wellbeing

The goal of many DCE studies is to estimate welfare impacts so they can be used in policy analysis. Compensating surplus welfare measures can be obtained for different wetland improvement policy scenarios associated with multiple changes in attributes (Birol et al., 2006). To assess welfare impacts, four hypothetical wetland improvement policies is designed based on the information from the questionnaire. The Chapter four provides more information about the policy scenarios. Equation (3.7) is still used for welfare impact assessment with V^1 representing the utility of each hypothetical wetland improvement policy. The utility of each improvement policy is compared to the utility of the current situation V^0 to derive the welfare value of each policy. The analysis of the welfare impact is done by comparing the welfare values of the different policy scenarios.

3.4. Study Area

Located in West Africa, Benin is between the parallels 6°30 and 12°30 North and the meridians 1° and 3°40 East. Benin is bounded to the North by the Republic of Niger and to the Northwest by Burkina Faso, to the South by the Atlantic Ocean, to the West by Togo and to the East by the Federal Republic of Nigeria. Benin's population is about 10 million people (RGPH4, 2013). Its GDP composition by sector is: agriculture 35.9%, industry 13.8% and services 50.3% (INSAE, 2014). The hydrographic network of Benin consists of five major basins, namely Volta, Niger, Mono, Couffo and Oueme. Among them, Oueme is the largest, covering an area of 50,000 km² with a maximum length of nearly 510 km.

3.4.1. The Oueme Delta

When the Oueme River penetrates into the southern sedimentary formations, it receives its main tributary Zou, at the latitude of Pobe. It notches a fairly deep Valley before flowing into Lake Nokoue and the Lagoon of Porto-Novo by a vast inland Delta (Oueme Delta), characterized by a floodplain and measuring 90 km from north to south. The flood plain is bounded to the south by Lake Nokoue and the Lagoon of Porto-Novo; to the north, east and west, its limits are imprecise as they vary with the importance of floods. Its surface area can therefore vary from 1000 to 9000 km² depending on when the observations were made (Laleye, 1995). However, it is recognized that it is bounded on the east by the plateau of Pobe-Porto-Novo and on the west by the marshes of the So River. Oueme Delta is part of the eastern complex of Benin's wetlands, an area of international importance (Ramsar site 1018).

Being located in the south-eastern part of Benin (Oueme Region), Oueme Delta is mainly shared between four municipalities: Bonou, Adjohoun, Dangbo, and Aguegues, and is commonly divided into three zones, namely:

- The upper Delta: this is the northern limit of the delta; it extends beyond Bonou;

- The middle Delta: it is a long plain of 50 km that goes from Bonou to Azowlisse in the municipality of Adjohoun. It has a relatively uniform width of about 10 km. The bed of the river is sandy, the banks fairly high, with a shallow depth of water in the dry season;

- The lower Delta: it goes downstream from Azowlisse where the Delta widens up to 20 km to the south facade where the river flows into the Lagoon Complex formed of Lake Nokoué and the Lagoon of Porto-Novo.

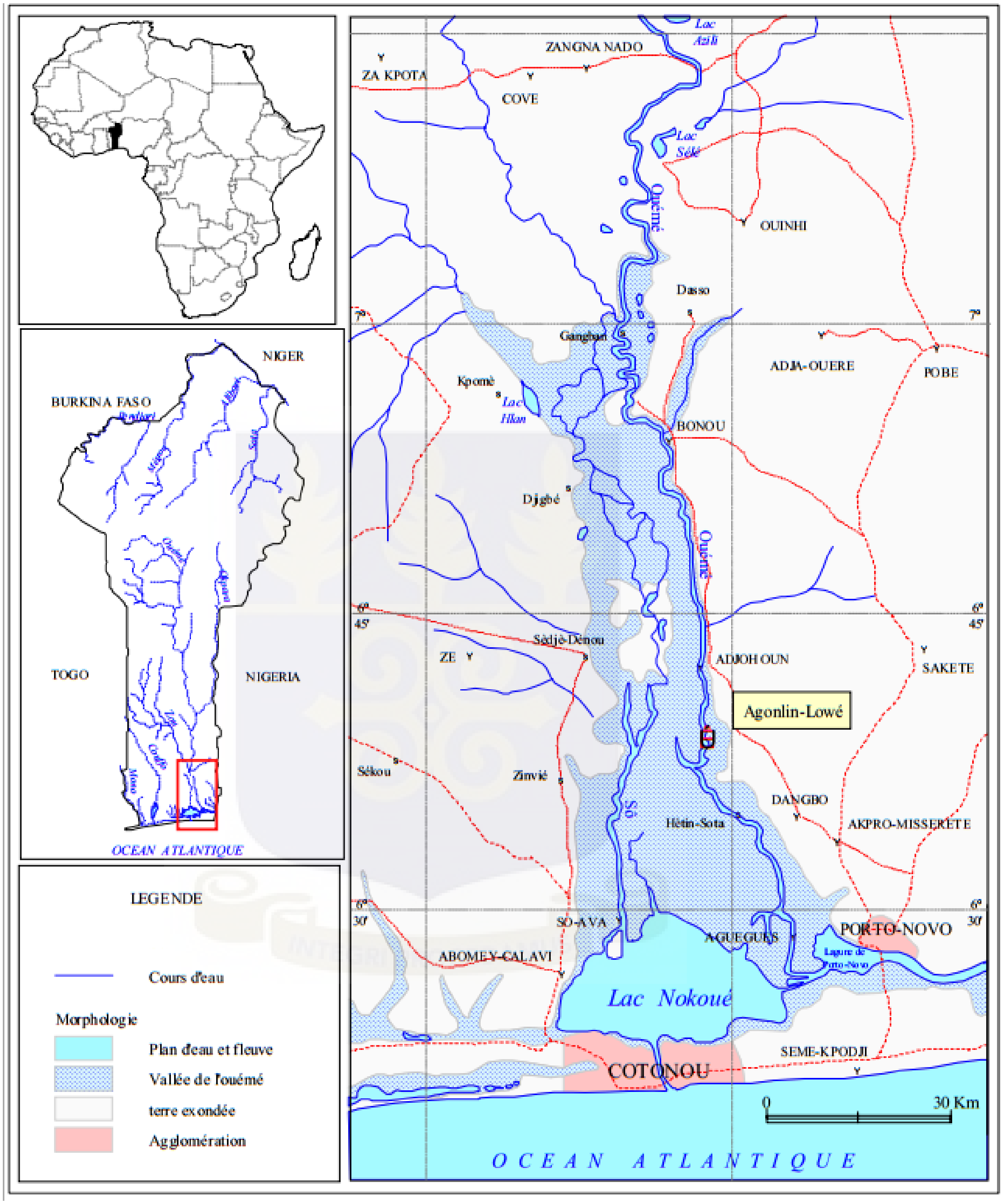

Figure 3. 1. The Oueme Delta

Source: ABE (2008)

This zone is characterized by two rainfall seasons, the largest of which is from April to July and the smallest from October to November; and two dry seasons, the largest of which runs from December to March and the smaller from August to September (Adam and Boko, 1993). The area is experiencing a flood period every year. The overflowing of Oueme River usually occurs from late August to mid-October, but can occur from July to early November (Laleye et al., 2004).

Furthermore, The Oueme Delta is in the geomorphological ensemble of the alluvial plains constituted by recent detrital formations. These plains consist of "gley mineral hydromorphic soils, hydromorphic gley (rich in organic matter) soils, and hydromorphic halomorphic soils". The vegetation is dominated by "large flooded meadows with Paspalum vaginatum (Poaceae), graminaceous formations of Sacciolepis africana, Oryza barthii, Echinochloa otusiflora, all of the family of Poaceae". Considering the Middle and Lower Delta, Lake Nokoue and the Lagoon of Porto-Novo, there are "78 species of fish recorded, including seven species of tilapia of which the most important are Sarotherodon melanotheron and Tilapia guineensis". Among the mammals are "sitatunga, guib arnaché, mongoose, potamochère, speckle-throated otter, African python, ball python, red-bellied guenon, land tortoises and marine turtles. Approximately 168 species of birds were identified in Benin in 1996, of which 72 per cent were found in this area, especially herons, waders, birds of prey, ducks (Dendrocygna) and sterns" (Ramsar, 2000).

3.4.2. Populations and economic activities

Taking into account only the four main municipalities Oueme Delta covers (knowing that the Delta extends the limits of Bonou), namely Bonou, Adjohoun, Dangbo, and Aguegues, the total population is about 260,660 inhabitants for 51,106 households (Table 3.2). In the municipalities of Dangbo and Bonou, agricultural sector (cropping, fishing, hunting, animal breeding) is the main economic activity sector, with 44.1% and 33.3% of their active populations engaged in, against 31.6% and 30.5% engaged in the service sector (trade, restauration, accommodation), respectively. In Adjohoun, the service sector comes a little ahead of agricultural sector, with respectively 36.4% and 35.7% of their active populations. Finally, Aguegues is the municipality where the service sector is clearly the principal one, with 49.5% of its active population engaged, against 44.4% of them engaged in agriculture sector.

Table 3. 2. Socio-demographic information on Oueme Delta

	Bonou	**Adjohoun**	**Dangbo**	**Aguegues**	**Total**
Number of Districts	5	8	7	3	23
Total population	44,349	75,323	96,426	44,562	260,660
Number of households	7,721	15,309	19,613	8,463	51,106
Number of agricultural households	3,689	7,141	10,369	2,719	23,918
Percentage of agricultural households	48%	47%	53%	32%	47%
Multidimensional Poverty Index	35.1	40.5	51.7	60.7	-

Source: INSAE (RGPH4, 2013)

Moreover, agricultural households represent 47% of the total number of households in the area. Vegetable production is the more important agricultural activity in Oueme Delta with more than 97% of the agricultural households engaged in Adjohoun, Bonou, and Dangbo. In Aguegues, about 74% of the agricultural households are engaged in vegetable production, with about 25% of them in the fishery sector. Some of the most cultivated products in the area are: rice, plantain, maize, Oil palm tree, Pepper, garlic, spices, peanuts, sugar cane, bean etc.

Furthermore, as indicated in Table 3.1, Aguegues is the poorest municipality among the four.

3.5. Choice Experiment Data Collection

Discrete choice Experiments follow a particular approach that leads to data collection and regression analysis. This approach requires an experiment design that allows to develop the study questionnaire. Kragt and Bennett's (2008) experiment design approach is used in this study.

3.5.1. Kragt and Bennett's choice experiment design

This subsection presents the different stages in discrete choice experiment design to help elicit social preferences for wetland attributes and derive welfare implication for agricultural households in Oueme Delta in Benin.

Five steps have been defined by Kragt and Bennett (2008) (see subsection 3.3.1 for more details) to conduct an experimental design in DCE studies, such as: (1) identification of the environmental problems; (2) development of possible policy options to address the identified problems; (3) the selection of the good's attributes taking into account the identified problems; (4) defining attribute levels (their state or condition and possible changes); and (5) the experimental design itself, which leads to the development of choice alternatives as well as choice sets.

3.5.1.1. Steps 1 and 2: Identifying the problematic issues and possible solutions

A broad literature review on books, Public environmental agency reports (ABE, 2008), Ramsar reports, NGOs reports, consultancy reports for FAO, and IUCN, has been undertaken to identify the major issues concerning Oueme Delta and the possible solutions. The results of this exercise reveal mainly that Oueme Delta wetlands have dried up in some areas (for example at Adjohoun), the reduction as well as the disappearance of certain species of fish, plants and animals, farming activities in the bed of Oueme River, the lack of protected areas, and pollution of water and air. The possible solutions that have been identified and even implemented through public projects and NGOs are: environmental awareness creation, training of local populations on environmental friendly activities, best farming practices, income diversification through numerous projects, especially microfinance projects, to reduce the level of dependence of local population on wetland resources, but also several projects aiming at improvement in habitat and species diversity, reinforced by projects for food security and poverty alleviation in the area.

Focus group discussions and senior citizen consultations

Focus group discussions and also consultation with senior citizens, because of their experiences in the area, have been undertaken about the problems that face Oueme Delta wetlands and the possible solutions to those problems. A total of eight (08) focus group discussions were held through the four municipalities of the study in September and October 2016, with two discussions per municipality. The focus groups were selected with the help of the communities' Chiefs in terms of mobilization of the inhabitants, and covered a wide range of stakeholders, including farmers, fishermen, craftsmen, and public servants.

Local populations agreed that extensive agricultural production has led to wetland conversion in agricultural lands. Population pressure has also resulted in overexploitation of fish and other wetland resources. They identified several current threats to the Oueme Delta wetlands such as: the degradation in water quality and fish stock; the decrease and even the extinction of certain local plant and animal species; the decrease in the size of wetlands; and encroachment of wetlands for human habitat development. Moreover, the local population explained the occurrence of these problems by the current high degree of disbelief in traditional principles. They also appeal to public authorities to change and improve the current management regime of the wetlands.

Therefore, based on the various meetings held with Oueme Delta local populations, the major problems face by these wetlands are: decrease in fish population, decline in water level and quality, extinction of some species (animals and plants), and the encroachment of water bodies. Then, Oueme Delta wetland conservation actions need to be taken in accordance with local population wellbeing improvement.

3.5.1.2. Step 3: Selection of attributes

In DCE application, the design of the hypothetical wetland improvement policies is firstly subjected to the identification of the wetland attributes. According to Bergmann et al. (2006), the selected attributes must be practical, simple to be understood, well-rooted in the identified problems, and useful in policy analysis. To select the key Oueme Delta wetland attributes to be used during the hypothetical policy design process, this study has undertaken the following tasks (Hanley et al., 2001): literature reviews, discussions with NGOs, scientists, as well as local populations. Based on the above mentioned approach, the most important Oueme Delta wetland attributes have been selected to account for wetland habitat preservation, species conservation, but also socioeconomic and cultural values (mainly agriculture and tourism) that can lead to improved ecosystem of Oueme Delta wetlands as well as society wellbeing in general (Bennett et al., 2004; Portney, 1994; Morrison et al., 1999). Especially, though Oueme Delta has a great potential in tourism (Sossou-Agbo, 2013), the sector is still in its infancy.

Furthermore, a thorough literature review of previous studies using DCE to value wetland attributes from other areas of the world has been undertaken to complement the local information. From the informed literature (consultation of EVRI and TEEB data base as well as other literature resources), the most frequent attributes that have been valued in the literature are: biodiversity (represented by the number of species, specified according to the study context); habitat (including wetland area, vegetation cover, and protected area); water quality; recreation, tourism and culture values; and water regulation and lands for agriculture.

Based on the information gathered and taking into account the problems faced by Oueme Delta wetlands, two ecological and two socioeconomic attributes were selected to include the broad range of benefits provided by the wetland into the valuation process. The attributes are: wetland area and their state (habitat); number of fish, animal and plant species (biodiversity), cropping area and irrigation facilities, recreation and tourism facilities.

The experimental design process also involves the use of a price or cost attribute, termed as "payment vehicle" (Birol et al., 2006; Hensher et al., 2005; Bennett and Blamey, 2001). In fact, any DCE study always include a price attribute, to help derive welfare estimate from society choices regarding the wetland improvement policy alternatives.

The payment vehicle (the price or cost attribute)

About the payment vehicle, all projects (here Oueme Delta wetland improvement policy scenarios) require a mechanism to raise funds to be implemented. To be successful, a DCE study has to use a payment vehicle that is adapted to the study context. It might be acceptable, relevant and applicable, but also not too costly for the study's population (Do and Bennett, 2009). However, some authors have advocated the use of compulsory payment vehicles, such as taxation through, for example, income, as well as water and electricity use (Carson and Groves, 2007; Whitehead, 2006; Ivehammar, 2009). According to Whitehead (2006), taxation is preferable to voluntary donations, because voluntary donations could motivate the respondent to free-ride. Also, Ivehammar (2009) has pointed out that voluntary donations tend to relatively high value estimates of WTP.

However, in this study context, though voluntary donations have some limits, compulsory payments cannot cover all ranges of respondents, since most of them are agricultural households, then not familiar with income tax. Moreover, an important number of households do not pay water or electricity bills in the area. Thus, voluntary donation is chosen as the best payment vehicle to raise funds for Oueme Delta wetland improvement projects. Chaikumbung (2015) has used the same approach to value wetland attributes in Thailand.

The most important issue in developing countries is the mechanism or institution through which the payment will be done by local population, as most people do not believe their government will use the money collected for the right purpose (McCauley and Mendes, 2006). To control for that issue, questions have been asked to local population through the focus group discussions and senior citizen consultations about their most preferred institution pattern regarding the collection of their donation to assure the concerned policies will be duly implemented. As a result of this, it has been found that a trustworthy and independent body needs to be created to build confidence of the local population. This trustworthy and independent body is considered by Oueme Delta citizens as the proper management entity that will motivate them to financially contribute to the sustainability of the wetlands. The local population indicated that the ideal management entity must be composed by representatives from: (1) government, (2) municipalities, (3) NGOs, (4) traditional rulers, (5) each of the socio-professional categories, and (6) scientists. They will be in charge of the design and implementation of Oueme Delta improvement projects, as well as fund raising activities.

3.5.1.3. Step 4: Determining attribute levels

The levels of the attributes reflect a change in quality or quantity of the given attributes. Two relevant conditions need to be taken into account when defining attribute levels (Kosenius, 2010), namely: (1) there must be enough number of attribute levels to help obtain the correct utility function and value estimates; and (2) the limits of attribute levels should be beyond the current situation, though still relevant to the respondents.

As it has been recommended by the DCE literature, it is good to keep the set of attributes and their levels as simple as possible, because how individuals react when facing complex survey questions are not known (Holmes and Adamowicz., 2003; Swait and Adamowicz, 2001a, 2001b; Mazzotta and Opaluch, 1995).

This thesis, acknowledging that the local population has low levels of literacy, has tried to keep attributes and their levels as simple as possible, to reduce the usual burden of DCE questionnaire on respondents and to make the choice situation understandable by everyone, so that the choices can be more rational. The number of levels in this study is held at two (2) for the non-cost attributes and three (3) for the cost attribute. In consequence, a particular approach has been followed for the choice set design to increase the probability to estimate efficient preference parameters.

Due to the lack of knowledge in biophysical terms about Oueme Delta wetlands and their resources, qualitative measurement of the non-cost attributes have been adopted following several previous studies in this area. The cost attribute is represented as usual as a continuous variable. Table 3.3 presents the wetland attributes and their levels.

Table 3. 3. Description of attributes and their levels

Attributes	Description	Levels	
		N	Denomination
Wetland area and their state (**Habitat**)	Surface occupied by the wetlands and their conditions (pollution)	2	- Current level (**Low**) - Improve wetland surface area and their conditions (**High**)
Species diversity (**Biodiversity**)	Number of fish, animal, and plant Species	2	- Current level (**Low**) - Improve species diversity (**High**)
Cropping area and irrigation facilities	Surface occupied by agricultural production and availability of irrigation facilities	2	- Current level (**Low**) - Increase cropping area and irrigation facility supply (**High**)
Recreation and tourism facilities	Recreation and tourism activities motivated by nature and cultural identity; represented by the number of roads, availability of clean water, electricity, and resting facilities	2	- Current level (**Low**) - Improvement in recreation and tourism facilities such as roads, clean water, electricity and resting facilities (**High**)
Cost	Annual payment in the form of donation per household per year	3	- Current situation **0 CFA** - Improvement **500CFA** - Improvement **1000CFA**

Source: Author (2017), Literature review and Focus group discussions

The current level of all the study attributes has been set to low. This is so considering the problem that has been identified in the area, especially for the attributes such as biodiversity, habitat, and recreation. But considering cropping area and irrigation facilities, though the problem of wetland conversion into agricultural lands was raised by some local people, during the focus group discussions, it has been observed that there are still demands for increasing the current land use for agricultural purposes by other groups of respondents. Moreover, government policies in Benin concerning agricultural sector development have always aimed to increase the land use for agricultural production in Oueme Delta (for example, the current government of Benin (2016) has decided to increase the current land use by 6000ha). Thus, this study agreed that the current level of land use in Oueme Delta could be a low level regarding agricultural production.

Furthermore, based on all the information gathered for this thesis work, no previous studies exist in the area, even in Benin using stated preference approach to measure natural asset values. This study has relied on the focus group discussions to predetermine local population willingness to pay for an overall improvement in Oueme Delta wetland quality. Out of that exercise, the lower bound of their willingness to pay was 500CFA and the upper bound was 1000CFA per year. It is also important to note that those bounds have been kept to capture the preferences of all possible range of respondents (poor and non-poor).

3.5.1.4. Step 5: Experiment design

Orthogonal and efficient designs

Experiment design is a critical part for DCE studies. It is the stage where the researcher generates the attribute-based hypothetical policy alternatives to be presented to the respondents, using a particular experimental design technique. The design exercise is based on multiple different combinations of the attribute levels to form the choice alternatives that are grouped into various choice sets (Selassie, 2006), to be included in the survey questionnaire. In the experiment design literature, two main techniques can be found, namely orthogonal design and efficient design. The orthogonal design technique combines the attribute levels under two conditions: (i) there must be balance in the attribute levels (each attribute level appears the same times, considering all alternatives), and (ii) each attribute is statistically independent from others. This technique reduces the degree of correlation between attribute levels in the experimental design results (Louviere et al., 2000). However, according to Sandoz and Webel (2002), Bliemer et al. (2009), and Scarpa and Rose (2008), when dealing with highly non-linear discrete choice models, such as mixed logit model, orthogonal design technique may not be appropriate to analyze human choice behavior.

The efficient design technique, according to Rose and Bliemer (2006), is used by researchers when their goal is to maximize the level of information from choice situations and to obtain the lowest standard error for the estimated coefficients. In Bliemer and Rose's (2010) publication, it has been shown that the efficient design technique relies basically on previous study parameter estimates to generate the choice alternatives. So, efficient design depends on the accuracy of previous study results.

Thus, the difficulty to use such an approach in the context of this thesis arises from the need of information from previous study in similar context, such as Oueme Delta. For the purpose of this thesis shifted design approach has been identified in the literature of choice set design, based on orthogonal design principles, but that has been improved in that framework and which is highly efficient for choice set design and for preference parameter estimation, and well adapted to the McFadden conditional logit (CL) model.

Shifted design

This technique has been developed by Bunch et al. (1996) and basically assumes that the values of the prior parameters from previous studies, necessary for the efficient design, are equal to zero. The efficient design in this approach is based on the orthogonal design technique, used to develop the choice alternatives that are finally grouped into various choice sets using "the shifting technique". In this approach, each choice alternative obtained from the orthogonal design technique is considered as a seed alternative, on which each choice set is developed. Explicitly, to obtain one choice set, the researcher has to shift the seed alternative attribute levels to the next level. Furthermore, it has been demonstrated by Bunch et al. (1996), and Ferrini and Scarpa (2007) that if there are a lack of information about the accuracy of previous study results and an uncertainty about their data generating processes, which is a common situation in natural ecosystem valuation, then researchers can rely on the shifted design technique to develop efficient choice sets.

Choice set design for this study

In the case of his study, shifted design technique (Bunch et al., 1996) has been used for the choice set design. All attribute levels were kept except for the cost attribute level that has been set to two (500 CFA and 1000 CFA), due to the fact that any possible improvement alternative will have a price different from zero. The zero value of the price attribute accounts only for the current situation where no improvement policy will be available (all attributes levels will be "low"). The design will then focus on the conception of hypothetical Oueme Delta wetland improvement policy alternatives (characterized by different levels of the attributes), to be presented to the respondents.

A large number of unique wetland improvement policy alternatives can be generated from these attributes and their levels. The number of wetland improvement policy alternatives that can be obtained from 5 attributes and 2 levels is $2^5 = 32$. An experimental design technique (see Bunch et al., 1996; Louviere et al., 2000), especially shifted design, through SPSS software, was used to produce an orthogonal design, which resulted in 8 main effect wetland improvement policy alternatives. Among the 8 profiles was one that characterized the current situation where no improvement in any wetland attributes has been observed, but this alternative have a price (500 CFA), something that is not realistic. Let say that situation correspond to the case called “opt out” or “current situation” or “do nothing” alternative that is going to be presented in each choice set at price zero. The “opt out” alternative can be viewed as a baseline alternative, whose introduction in the choice sets is to help the researcher to obtain welfare measures that are consistent with demand theory (Bateman et al., 2003; Bennett and Blamey, 2001).

Following the shifted design technique, the seven other policy alternatives were considered as seeds to determine their complementary policy alternatives. These seven choice sets have been designed with each choice set containing two wetland improvement alternatives and an option to select neither improvement scenarios (current situation). It was explained to the respondents that if they chose the “opt out” alternative, no payment will be requested from them, however there will be no active wetland improvement plan, and the degradation of the Oueme Delta wetlands will continue.

Example of choice set

Attributes	POLICY A **(Improvement)**	POLICY B **(Improvement)**	STATUS QUO **(Do nothing)**
Wetland area and their state **(**Habitat**)**	**HIGH**	LOW	LOW
Number of fish, animal and Plant species **(**Biodiversity**)**	LOW	**HIGH**	LOW
Cropping area and Irrigation facilities	**HIGH**	LOW	LOW
Recreation and tourism Facilities	LOW	**HIGH**	LOW
Annual donation for 5 years	**1000F**	**500F**	**0F**
Your choice	[ ]	[ ]	[ ]

Furthermore, another important aspect considered in this subsection is the questionnaire design (Adamowicz et al., 1998; Louviere et al., 2000) before describing how data are collected.

3.5.1.5. Questionnaire Design

Discrete choice experiments require essentially three parts for their questionnaires. One is the collection of information on the socioeconomic characteristics of the respondents, the second collects information about respondent attitudinal characteristics regarding environmental issues; and the last part is designed to collect information on respondent choices with respect to the choice alternatives.

3.5.2. Data collection

For this study, data were collected from February to March 2017 involving 210 respondents from local households, using face-to-face interview techniques using structured questionnaires that contained the 7 choice sets. Sampling was conducted in the four major municipalities covered by the Oueme Delta (Bonou, Adjohoun, Dangbo, and Aguegues, INSAE, 2016). The sample sites were distributed across all socioeconomic sectors in Oueme Delta. The population sampled was randomly selected with the aim of covering a wide range of backgrounds and beneficiaries such as farmers, fishermen, animal breeders, housewives, craftsmen, and public servants. In the municipality of Bonou, 42 respondents were interviewed from 3 Districts (Bonou, Affame, and Atchonsa); in Adjohoun, 63 were interviewed from 5 Districts (Adjohoun, Gangban, Akpadanou, Kode, and Azowlisse); in Dangbo, 67 individuals have responded to the study questionnaire from 4 Districts (Dangbo, Kessounou, Houedomey, and Hozin); and finally in Aguegues, 38 respondents were interviewed by the enumerators from 2 Districts (Avagbodji and Zoungame). The sampling population was restricted to citizens 18 years of age and older. The questionnaire was tested through a prior pre-sampling.

Moreover, the enumerators used in this study were all students and before the main survey, a training course has been delivered to them. The objective of the training was to reduce biases that may be due to the misunderstanding of the questionnaire by the enumerators. The main information that have been communicated through this training were: the reason of this thesis, its objectives, a proper explanation of the questionnaire, how the survey must be done, and discussions about issues related to the survey.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.1. Introduction

The present chapter presents the thesis results, their interpretation and discussions. The next section concentrates on the respondents' socioeconomic and attitudinal characteristic descriptions. This is followed by three successive sections essentially based on the presentation and interpretation of the results from specific objectives two, three, and four; the first objective being already treated in subsection 3.5.1 of Chapter three (Methodology of the study) as a step for the data collection process, due to the experimental nature of the thesis. The last section of this Chapter is the discussions of the study results. STATA 14.0 has been used for descriptive statistics and regression analysis.

4.2. Socioeconomic and Attitudinal Characteristics

The study has covered the four most important municipalities, in terms of the Delta coverage, namely Bonou, Adjohoun, Dangbo, and Aguegues. A total of 210 face-to-face interviews has been conducted with 100% response rate. This is not surprising when local enumerators are engaged for data collection in developing countries (O'Garra, 2009; Hung et al., 2007; Chaikumbung, 2015). Among these responses, 200 (95%) were usable, with the remaining 10 (5%) having not been well answered by respondents.

Table 4.1 describes the socioeconomic and attitudinal characteristics of respondents. The enumerators tried first to interview the heads of the households who were mostly male (INSAE, 2016). The interviews were mostly conducted in the morning through afternoon.

The socioeconomic information about the respondents reveal that men account for 76.5% of the total sample population. The average age of the respondents was 41.59 years. The mean family size was 6.78 people, with 3.36 children on average per household. Respondents have lived in Oueme Delta area on average for 29.6 years, and are mostly agricultural households (63%), namely farmers, fishermen and breeders. The average income of the sample population was about 77,975 CFA per months. In terms of education, 31.5% of the respondents have at least Junior High School level.

Information about respondents' attitude towards Oueme Delta wetlands have also been collected, to explore their knowledge on use, state, and management of wetlands, as well as their potential support for Oueme Delta wetland improvement projects.

Table 4. 1. Socioeconomic and attitudinal characteristics of the respondents

Indicators	Mean	Std. dev.
Socioeconomic information		
Male (%)	76.5	-
Age (years)	41.59	10.59
Education (% at least Junior High School)	31.5	-
Household size (number of peoples)	6.78	2.75
Number of children (<18years)	3.36	1.64
Years of living in the area	29.6	14.26
Agricultural households (% of farmers + fishermen + breeders)	63.0	-
Household income (CFA/month)	77975	46228.06
Attitudinal information		
Current state of Oueme Delta wetlands (% of bad)	85.5	-
Major problem of Oueme Delta wetlands (% of yes: fishing degradation)	22.4	-
Oueme Delta wetland protection responsibility (% of everyone)	32.2	-
Current state of Oueme Delta management (% of bad)	94.0	-
Future state (20 plus years) if current management (% of worse)	80.5	-
Dependence on Oueme Delta wetlands for subsistence (% of high)	57.5	-
Population benefits from Oueme Delta wetlands (% of yes: cropping area)	27.2	-
Support Oueme Delta wetland improvement projects (% of yes)	100.0	
Respondents' general opinion (% of SOS to the public authorities)	70.5	-

Source: Author (2017)

The majority of respondents (85.5%) think that Oueme Delta wetlands are currently in bad conditions, having as major problem fishing degradation (22.4%), followed by climate change (18%), and wetland conversion into farmlands (16.5%). Thirty-two per cent (32%)

of respondents admitted that everyone has the responsibility to protect the Oueme Delta wetlands and that it is not exclusively the responsibility of government, public agencies, and traditional Chiefs. Concerning management issues, 94% of the sample population consider the current Oueme Delta wetland management as bad, and further, they think (80.5%) that if nothing is done to change the current management options, the situation of the Delta will be worse in the future (20 plus years).

Moreover, it is important to note that most of the respondents (57.5%) depend on Oueme Delta wetlands for their subsistence, with agricultural lands being the major benefit (27.2%) they obtain from wetlands, closely followed by fishing (27%), and the consumption of plants and animals (23.2%). All respondents from the sample agreed to support any project that aim to improve the current state of Oueme Delta wetlands, yet they almost all appeal to the public authorities to come and help them improve Oueme Delta wetland conditions, and beyond that their living conditions.

4.3. Social Preferences for Oueme Delta Wetland Attributes

To assess society preferences for wetland attributes, two conditional logit regressions have been estimated. The first is the basic McFadden's conditional logit (CL) model, which shows the importance of the wetland attributes in explaining respondents' preferences for the hypothetical wetland improvement policies in the choice sets. Each choice set consisted of two wetland improvement policy scenarios and the status quo alternative or "do nothing" option. As suggested by previous studies (Morrison et al., 1999; Do and Bennet, 2009), to improve the CL model accuracy and detect potential observable heterogeneity, a second model, namely Interaction CL model has been estimated. This model, apart from the use of wetland attributes as independent variables, includes also the respondents' socioeconomic and attitudinal characteristics, which are interacted with the alternative specific constant of the model, as well as with the cost attribute. The results are presented in Table 4.2.

An important note related to social preference analysis is that the McFadden's CL model, provide directly the population taste (or preference) parameters, which are the parameters associated with the attributes of the good being valued, here Oueme Delta wetlands (Train, 2003). Then, each of the Oueme Delta wetland attribute parameter in the models presented in Table 4.2 represents directly the importance society attaches to that attribute.

4.3.1. Results of the basic CL model

The results of the basic CL model are reported in the first column of Table 4.2. All of the attributes were significant in explaining respondents' utility inherent to their choices of Oueme Delta wetland improvement policies and higher levels of any unique attribute increased the probability that a new policy option would be chosen. In other words, respondents preferred those wetland improvement policies that resulted in the improvement of wetland area and their state (habitat); a net improvement in biological diversity, especially in the number of plant, animal and fish species; an improvement in cropping area and irrigation facilities; as well as considerable improvement in recreation and tourism facilities. The negative sign of the cost attribute shows the disutility associated with a choice of policy alternatives with a higher cost level. The positive and significant sign of the alternative-specific constant (ASC) coefficient, related to wetland improvement policies, indicates a positive utility impact on any choice alternative that is different from the current situation. The most preferred Oueme Delta wetland attributes by society were, ranked from most to least important: biodiversity, cropping area and irrigation facilities, recreation and tourism facilities, and wetland area and their state.

Table 4. 2. Results of conditional logit models

VARIABLES	(Basic CL Model) **Choice**	(Interaction CL Model) **Choice**
ASC	8.796***	8.209***
	(1.194)	(1.209)
Habitat	1.052***	1.109***
	(0.0813)	(0.0842)
Biodiversity	5.355***	5.453***
	(0.591)	(0.593)
Croparea	5.066***	5.148***
	(0.591)	(0.593)
Recreation	4.920***	4.993***
	(0.592)	(0.593)
Cost	-0.00981***	-0.0111***
	(0.00122)	(0.00135)
ASC x male		0.859***
		(0.176)
ASC x educ		0.294**
		(0.149)
ASC x env_care		-0.0894
		(0.133)
ASC x children		-0.485*
		(0.268)
Cost x income		0.00109***
		(0.000299)
Cost x age		2.58e-05*
		(1.42e-05)
Cost x agric_hh		-0.000545*
		(0.000302)
Respondents/Obser	200 / 4,200[1]	200 / 4,200

Notes: Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[1] Although there are 200 respondents, there are 7 choice sets of 3 alternatives making 21 observations per respondent for a total of 4200 observations.

4.3.2. Results of the Interaction CL model

To capture observable source of preference heterogeneity and improve the basic CL accuracy, a CL model with interactions including socioeconomic and attitudinal information was estimated, whose results are shown in the second column of Table 4.2. The following variables were included into the basic CL model: male, education, environmental care, children, income, age and agricultural households. The latter variable has been included to account for possible preference heterogeneity between agricultural and non-agricultural households. This will provide more confidence in terms of the specification of the utility function that will serve as a basis for the assessment of agricultural households' welfare later on.

The coefficients on male, education, income, and age are positive and statistically significant, indicating that older and male respondents with higher income and at least Junior High School level, prefer Oueme Delta wetland restoration policies than young and female respondents with lower income and less education. In contrast, the coefficient on children and agricultural households are negative and statistically significant. The meaning is that, respondents that are agricultural households with more than five children are more likely to choose the current wetland policy, compare to non-agricultural households with less than five children. However, the coefficient on environmental care is not statistically significant, implying its effect on the choice probability is negligible.

Furthermore, the statistical significance and signs of all attribute coefficients were consistent with the previous model (the basic CL model), implying that, controlling for the observed source of society preference heterogeneity do not change the preference structure for the population. In consequence, the most preferred attributes of Oueme Delta wetlands are still, ranging from the more important to the less: biodiversity, cropping area and irrigation facilities, recreation and tourism facilities, and wetland area and their state.

4.4. Agricultural households' welfare and contribution of Oueme Delta wetland attributes

The third objective of the thesis aims to derive agricultural households' total welfare and to determine the contribution of each Oueme Delta wetland attribute to that welfare.

Agricultural households account for 63% of the sample population, namely farmers, fishermen, and breeders. The survey results reveal that, among the highly dependent on Oueme Delta wetland resources, especially for subsistence, agricultural households represent 83.48%. This is not surprising, taking into account the basic role plays by Oueme Delta in supporting agricultural production in the area (Sossou-Agbo, 2013; INSAE, 2016). Compared to the non-agricultural households, they are the less educated with lower income. Agricultural households then, appear to be the most exposed and vulnerable to any change in the state of Oueme Delta wetlands. In this section, special attention has been given to that subcategory of the population to value their welfare and how any change in one of the attributes affect their level of wellbeing.

4.4.1. Agricultural households' welfare measurement

Welfare measurement (compensating surplus – CS) in DCE is the expression of utility changes in monetary terms, which represents the amount of money the household will be willing to give up to obtain an improvement in all Oueme Delta wetland attributes simultaneously. However, due to the fact that, the variable agricultural household has been statistically significant in society conditional logit regression (Table 4.2, second column), there is an observed preference heterogeneity between agricultural households and the remaining sample population. To properly account for agricultural households' welfare, freed from the identified preference heterogeneity, society conditional logit regression has been run (see Table 4.3), conditional to the agricultural household sample population (126 individuals) (Nunes, 2008).

4.4.1.1. Results of the Interaction CL model for agricultural households

Table 4.3 presents the estimated results of the agricultural households' utility function that have been used to measure their welfare (WTP).

Table 4. 3. Results of conditional logit for agricultural households

VARIABLES	(Interaction CL model) **Choice**
ASC	7.415***
	(1.250)
Habitat	1.179***
	(0.113)
Biodiversity	5.182***
	(0.602)
Croparea	4.817***
	(0.603)
Recreation	4.341***
	(0.603)
Cost	-0.0111***
	(0.00147)
ASC x male	0.775***
	(0.271)
ASC x educ	-0.0462
	(0.240)
ASC x env_care	-0.229
	(0.173)
ASC x children	-0.427
	(0.338)
Cost x income	0.000742*
	(0.000390)
Cost x age	3.71e-05**
	(1.66e-05)
Agric_hh /Obser	126 / 2,646[2]

Notes: Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The key information from these results is the consistency of agricultural households' preferences regarding Oueme Delta wetland attributes with the overall sample population preferences. The values of the taste parameters show that biodiversity is the most preferred,

[2]Although there are 126 respondents, there are 7 choice sets of 3 alternatives making 21 observations per respondent for a total of 2646 observations.

followed by cropping area and irrigation facilities, recreation and tourism facilities, and wetland area and their state.

4.4.1.2. Welfare implication for agricultural households

Compensating surplus estimates for changes in attribute levels can be derived from the conditional logit regression results reported in Table 4.3. This is based on the consideration of the cost attribute coefficient in the CL models as the marginal utility of income (Adamowicz et al., 1994). Agricultural households' welfare (WTP) results from improvement in all the wetland attribute levels simultaneously, as an improvement in any one of the attribute leads to an improvement in their utility. It was estimated using the formula 3.7, Chapter three (Garcia-Llorente et al., 2012; Bergmann et al., 2008; Bennett and Blamey, 2001). The welfare has been estimated using Delta method in STATA 14.0 and is reported in Table 4.4.

Table 4. 4. Total agricultural households' welfare

Choice	**Coef.**	**[95% Conf. Interval]**	
T-welfare	2008.258***	1892.807	2123.709

Notes: *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 4.4 shows that, on average per year, individual agricultural household earns about 2008 CFA as total benefit from Oueme Delta wetlands, resulting from a policy option based on high improvement in all the wetland attributes, namely habitat, biodiversity, cropping area and irrigation facilities, and recreation and tourism facilities. Each agricultural household, on average per year, is then willing to pay about 2008 CFA for a net improvement in all Oueme Delta wetland attribute levels.

4.4.2. Contribution of each attribute to the total agricultural households' welfare

Point estimates of the willingness to pay for a change in a specific attribute were found by estimating implicit prices or marginal willingness to pay for each wetland attribute. The formula 3.8, Chapter three, was used to perform the calculation. The results on the implicit prices are presented in Table 4.5. They have been estimated using Delta method in STATA 14.0.

Table 4. 5. Estimates of implicit prices for each wetland attribute

Choice	Coef.	[95% Conf. Interval]	
IP_Habitat	127.7137***	82.93377	172.4935
IP_Biodiversity	561.3577***	525.0424	597.6729
IP_Croparea	521.8608***	492.3039	551.4177
IP_Recreation	470.297***	442.6742	497.9198

Notes: *** p<0.01, ** p<0.05, * p<0.1

Table 4.5 reveals that each agricultural household was willing to pay the most for biodiversity (species diversity, an average of 561.36 CFA), followed by cropping area and irrigation facilities (521.86 CFA), and recreation and tourism facilities (470.3 CFA). Wetland area and their state yielded the lowest willingness to pay per agricultural household (127.71 CFA). The estimated values of the implicit prices indicate that the most preferred attribute is biodiversity as shown in society and specifically in agricultural households' preferences for improvement in fish, animal, and plant species.

Figure 4.1 presents the relative importance of each attribute in the agricultural household' welfare.

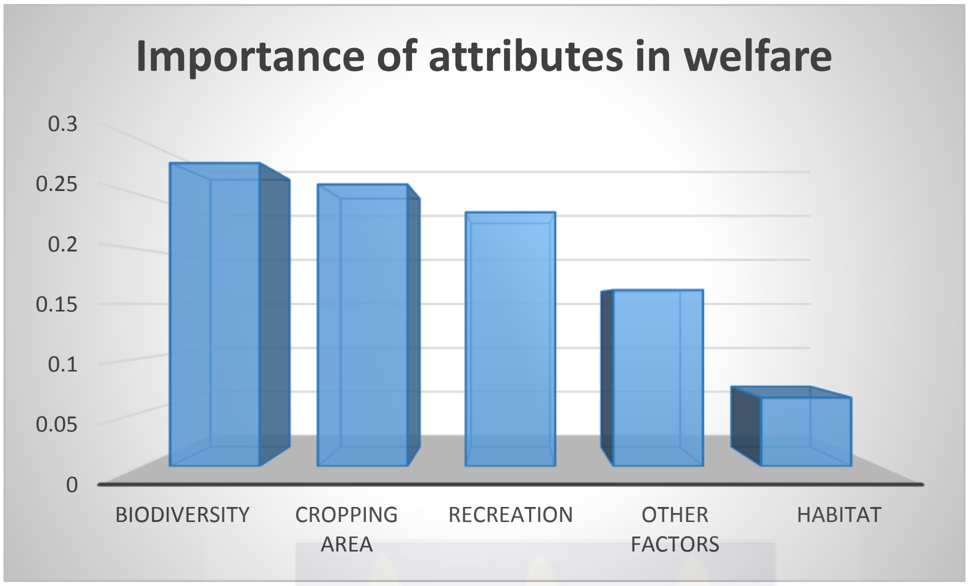

Figure 4. 1. Weight of each attribute in an agricultural household' welfare

Figure 4.1 has been drawn based on the values of the attributes from Table 4.5. The explanation is that the marginal effect of an improvement in cropping area and irrigation facilities will have a lower impact on agricultural households' welfare than a marginal improvement in biodiversity.

An important note concerning Figure 4.1 is the consideration of other factors in welfare analysis. Implicit prices alone cannot provide compensating surplus estimates. The estimation of the mean willingness to pay for a change from the status quo requires more substantial calculations. This is because the attributes cannot capture all the reasons why respondents have chosen a particular wetland improvement policy. This is the major reason why an alternative specific constant was introduced into the model to capture systematic but unobserved information (not related to the good's attributes) about respondents' choices (Morrison et al., 1999; Birol et al., 2006). Thus, the value of other factors is estimated by removing the total value of the attributes (1681.23 CFA) from the total welfare (2008.26 CFA).

4.5. Economic valuation of hypothetical Oueme Delta wetland improvement policies

For policy analysis, this thesis is interested in measuring the change in agricultural households' welfare that is associated with a particular Oueme Delta wetland improvement policy. In this vein, four hypothetical Oueme Delta wetland improvement policies have been designed based on the information compiled from the questionnaire. Each policy is characterized by a particular combination of Oueme Delta wetland attribute levels. The four policy scenarios presented in Table 4.6 are as follows: (1) *Conservation policy*, characterized by high improvement in habitat and biodiversity, and current levels in cropping area and recreation facilities; (2) *Biodiversity and agricultural policy*, represented by high improvement in biodiversity and cropping area, and current levels in habitat and recreation facilities; (3) *Biodiversity and tourism policy*, defined as high improvement in biodiversity and recreation facilities, and current levels in habitat and cropping area; and (4) *Development policy*, characterized by high improvement in cropping area and recreation facilities, and current levels in habitat and biodiversity. The monetary value of the policies was assessed through agricultural households' maximum willingness to pay for each of them using the formula 3.7. The results are reported in Table 4.6.

Table 4. 6. Agricultural households' willingness to pay for policy scenarios

Attributes	Oueme Delta wetland improvement policy scenarios			
	Conservation policy	Biodiversity and agricultural policy	Biodiversity and tourism policy	Development policy
Habitat	High level	Current level	Current level	Current level
Biodiversity	High level	High level	High level	Current level
Cropping area	Current level	High level	Current level	High level
Recreation	Current level	Current level	High level	High level
WTP	1016.1***	1410.247***	1358.683***	1319.186***

Notes: *** p<0.01, ** p<0.05, * p<0.1 and WTP at 95% Confidence Interval

The results showed that agricultural households derived the highest utility from "Biodiversity and agricultural policy" with, on average, a maximum willingness to pay of 1410.25 CFA per household per annum. An agricultural household was willing to provide 1358.68 CFA, on average, for "Biodiversity and tourism policy" and 1319.19 CFA, on average, for a "Development policy" scenario. "Conservation policy" provided the lowest welfare gain to agricultural households with a maximum willingness to pay of 1016.1 CFA per annum per household. Thus, Oueme Delta wetland improvement policy that will more concentrate on high improvement in species diversity and cropping area and irrigation facilities is preferred to the others by the agricultural households. Moreover, it is important to note that none of the hypothetical policies design in this section 4.5 yielded more welfare gain than the one resulted from high improvement in all the attribute levels (section 4.4).

4.6. Analysis of Society Preferences for Oueme Delta Wetland Attributes and its Implication for Agricultural Households' Wellbeing

In this section the full discussion of the study results is provided in three parts. The first part presents the discussions on the analysis of social preferences for Oueme Delta wetland attributes; the second, a discussion on agricultural households' wellbeing and how marginal changes in each attribute will impact their wellbeing; and the third analyzes changes in agricultural households' wellbeing due to changes in Oueme Delta wetland improvement policies.

4.6.1. Society preferences for Oueme Delta wetland attributes

The preliminary results of this study reveals that the key Oueme Delta wetland attributes are: wetland area and their state, biodiversity (number of fish, animal and plant species), cropping area and irrigation facilities, and recreation and tourism facilities (from Chapter three, Methodology of the study). The assessment of society preferences for those attributes indicates that high improvement in any wetland attribute increases the probability that a new management policy would be chosen by the local population. The most preferred attributes were, first biodiversity (number of fish, animal and plant species), second cropping area and irrigation facilities, third recreation and tourism facilities, and fourth wetland area and their state. These results inform policy makers about the relative importance local population attaches to the key Oueme Delta wetland attributes. Moreover, the analysis of the results from the population's Interaction Conditional Logit model shows that there are observed sources of preference heterogeneity in the study population, as shown by the significant effects of population's socioeconomic and attitudinal characteristics on their choices.

The results indicate that males are more willing to contribute to new wetland management policies than females. That result could be explained by the fact that most households in Oueme Delta are headed by males. Also, according to FAO (2012), males have the ability to manage household's income, agricultural products and their sales, and are more involved into economic and social decision making processes than females in developing countries. Similar results have been found by a study conducted by Chaikumbung (2015) in Thailand.

Another important result found in this thesis is that respondents' income is significantly and positively related to their choices, meaning that Oueme Delta improvement policies have more been preferred by the high income respondents over the current management option than the low income respondents. This result is consistent with those obtained in the studies done by Chaikumbung (2015), Rai and Scarborough (2012), Do and Bennett (2007), and Birol et al. (2006). One important feature of this finding is that respondents' WTP for Oueme Delta wetland improvement is positively related to their income (Wiabel et al., 2006; Mukhapadhaya et al., 2004), then completely consistent with economic theory (Eckert and Leftwich, 1998), which simply posits that WTP is positively explained by income.

In line with previous Choice Experiment studies, it has been found that people with high level of education have mostly preferred the wetland improvement policies than those who are less educated (see Rai and Scarborough, 2012; Do and Bennett, 2007).

Also, older respondents were found to be more likely to contribute to new Oueme Delta wetland management policies. This may be explained by the fact that older respondents who have probably lived longer in the area, as the average year of living in the area is 29 years, are more aware of the degree of deterioration in the state of Oueme Delta wetland than the young respondents, and therefore have a higher preference for their restoration.

However, the variable “children” have been found to be negatively related to the choice probabilities, as found in the study by Birol et al. (2006). The explanation is that as the number of children increase, the household expenditures increase, and their ability to choose a new management option, involving a cost for the household, decreases.

More importantly, it has been found that being an agricultural household reduces the probability of the household to choose a new management policy. This situation is in line with economic theory (Eckert and Leftwich, 1998), as WTP is positively related to income, and knowing that agricultural households have low income level compare to the non-agricultural households. They are also less educated.

However, in spite of the observed preference heterogeneity between agricultural households and the remaining sample population, agricultural households’ preferences are still consistent with the overall population preferences. Accordingly, any Oueme Delta wetland improvement policy that aims to maximize agricultural households’ wellbeing will also be positively welcomed by the overall local population. This results give more confidence to the direction taken by this study, to be more focus on the most dependent on Oueme delta wetlands (agricultural households) for welfare and policy analysis.

4.6.2. Agricultural households’ wellbeing and impact of changes in attribute levels

Agricultural households’ wellbeing has been approached in this study by expressing the change in their utility or satisfaction due to an improvement in all Oueme Delta wetland attributes, in monetary terms, called in this study agricultural households’ total welfare.

This wellbeing measurement can be defined as the higher level of satisfaction, in monetary terms, that an agricultural household receives when choosing improvement in all attribute levels, simply viewed as their maximum willingness to pay for wetland improvement.

The study results indicate that, on average the maximum amount an agricultural household would be willing to pay for full improvement in all Oueme Delta wetland attributes is about 2008 CFA a year. Each Oueme Delta wetland household, despite the fact that natural resources such as wetlands are public goods, agreed to contribute to any wetland improvement policy that will impact on wetland area and their state, biodiversity (number of fish, animal and plant species), cropping area and irrigation facilities, and recreation and tourism facilities. The importance of Oueme Delta wetlands for agricultural households is thus shown.

Moreover, the assessment of agricultural households' marginal willingness to pay (MWTP) for improvement in specific attribute reveals the relative importance of each attribute in their wellbeing. Agricultural households' wellbeing is mostly dependent on improvement in biodiversity (species diversity, MWTP of 561.36 CFA), followed by cropping area and irrigation facilities (MWTP of 521.86 CFA), and recreation and tourism facilities (MWTP of 470.3 CFA). Wetland area and their state appear to be the lowest contributor to agricultural households' wellbeing (MWTP of 127.71 CFA). The results are also consistent with the overall population's preference structure regarding Oueme Delta wetland attributes.

The main import of these results is that improvement in cropping area and irrigation facilities do not appear as the most preferred Oueme Delta wetland attribute for agricultural households, as well as for the entire population. It shows that the wellbeing of agricultural households depend more on improvement in species diversity than improvement in cropping area and irrigation facilities, which appear to be the second most important attribute. Similar results were found in Burkina Faso by Somda and Nianogo (2010), where the economic valuation of Sourou River Valley revealed that agriculture was not the most important economic activity. The study showed that timber products for fuelwood and construction were the most important for local population, followed by non-timber forest products, pastures, fishery, transportation on water, agricultural production, and tourism. Therefore, as in Burkina Faso, there is a need to conceive an integrated development policy for Oueme delta wetlands, taking into account the relative importance of each attribute in explaining local population wellbeing.

The importance of recreation and tourism facilities in explaining agricultural households' wellbeing is noticeable compare to wetland area and their state, given the fact that the development of this sector is still in its infancy. The low value of wetland area and their state can be explained by the still high demand in agricultural lands and irrigation facilities by agricultural households and other local population.

4.6.3. Impact of Oueme Delta wetland improvement policy scenarios on agricultural households' wellbeing

To assess agricultural households' welfare changes under various hypothetical Oueme Delta wetland improvement policies, four wetland improvement policy scenarios have been designed, namely conservation policy (*high improvement in habitat and biodiversity, and current levels for cropping area and recreation*), biodiversity and agricultural policy (*high improvement in biodiversity and cropping area, and current levels in habitat and recreation*), biodiversity and tourism policy (*high improvement in biodiversity and* *recreation, and current levels in habitat and cropping area*), and finally development policy (*high improvement in cropping area and recreation, and current levels in habitat and biodiversity*).

The results revealed that agricultural households derived, among these four policy scenarios, the highest benefit from "Biodiversity and agricultural policy" with, on average, a maximum willingness to pay of 1410.25 CFA per household per annum. The second most preferred policy was "Biodiversity and tourism policy", for which an agricultural household was willing to provide 1358.68 CFA, on average per year. "Development policy" scenario was the third most preferred policy with an average willingness to pay of 1319.19 CFA per annum. "Conservation policy" provided the lowest utility to agricultural households with a maximum willingness to pay of 1016.1 CFA per annum per household.

These results show that conservation policies constrained by development policies are the most preferred by agricultural households, as well as local population, knowing that the preference structure is the same. This information strengthens the need to develop more integrated Oueme Delta wetland improvement policies that will take both conservation and economic development of Oueme Delta in the same framework. Moreover, as shown by the value of agricultural households' total welfare (2008 CFA), which is much greater than the one of Biodiversity and agricultural policy (1410.25 CFA), and resulting from improvement in all attribute levels, an improvement in ecological as well as in economic wetland attributes is the most preferred by society, especially agricultural households. This last finding is of much interest, given the fact that current Oueme Delta wetland management options are not properly using an integrated approach to address conservation and local population wellbeing issues (RAMSAR, 2015).

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Introduction

The previous Chapters have provided the theoretical and methodological background of the thesis, followed by the presentation of the study results and their analysis. The aim of this last Chapter is to present the summary of the findings of the whole study, its conclusions as well as policy recommendations.

5.2. Findings of the Study

This thesis has dealt with the analysis of social preferences for wetland attributes and its implication for agricultural households' wellbeing in the Oueme Delta in Benin. The main findings of the study are as follows:

1. The key Oueme Delta wetland attributes are:

- Oueme Delta wetland area and their state or condition (habitat);
- The number of fish, animal, and plant species (biodiversity);
- Cropping area and irrigation facilities; and
- Recreation and tourism facilities

They can be classified into two groups, namely ecological attributes (habitat, and biodiversity) and socioeconomic attributes (cropping area and irrigation facilities, and recreation and tourism facilities).

2. The analyses of social preferences for the Oueme Delta wetland attributes have revealed that the most important attribute is biodiversity (species diversity),

followed by cropping area and irrigation facilities, recreation and tourism facilities, and the least important is habitat.

3. Agricultural households' welfare assessment based on their stated preferences, in monetary terms for the Oueme Delta wetland attributes, indicated that on average an agricultural household is willing to pay per annum about 2008 CFA for high improvement in all the wetland attribute levels.
4. The relative importance of each Oueme Delta wetland attribute in agricultural households' welfare has been assessed through the estimates of their marginal willingness to pay for the attributes. The results showed that on average per annum, an agricultural household is willing to assign the most important value to biodiversity (561.36 CFA), followed by cropping area and irrigation facilities (521.86 CFA), recreation and tourism facilities (470.3 CFA), and the least important value to wetland area and their state (127.71 CFA). This result is consistent with the overall population preferences for wetland attributes.
5. The evaluation of agricultural households' welfare changes, resulting from changes in Oueme Delta wetland improvement policy scenarios revealed that agricultural households preferred and were willing to pay more for Oueme Delta conservation policy constrained by development policy. They preferred policies that take into account both the ecological and the economic value of Oueme Delta wetlands.

5.3. Conclusion

Oueme Delta wetlands, as an ecological life support system, provide various ecosystem services essential to economic production and human wellbeing (MA, 2005; de Groot et al., 2002). Though it is a Ramsar site, Oueme Delta wetlands are suffering from degradation problems, which is threatening its ability to continue to provide benefits (Daily et al., 2009) for the local population, especially agricultural households. Agricultural households are the most exposed and vulnerable to any change in the state of Oueme Delta wetlands, due to the basic role these wetlands play in their livelihood.

However, the lack of knowledge in terms of the contribution of natural resources such as wetlands to human wellbeing, and more specifically the lack of knowledge on the relative importance society attaches to the various attributes of natural resources, limit the ability of natural resource managers and policy makers to take both the ecological and the economic values of these ecosystems during the decision making processes, so as to design policies for rational natural resource management that maximize society wellbeing.

To assist decision makers in Oueme Delta wetland management policy design and implementation, the main objective of this thesis was to assess society preferences for Oueme Delta wetland attributes and to derive the welfare implication for agricultural households.

In conclusion, this thesis reveals the following information to be taken into account when designing new Oueme Delta wetland improvement policies for local population wellbeing:

- ❖ The most important Oueme Delta wetland attributes on which wetland managers and policy makers could most concentrate their efforts when taking decision are: Oueme Delta wetland area and their state (habitat), the number of fish, animal, and plant species (biodiversity), cropping area and irrigation facilities, and recreation and tourism facilities;

- Oueme Delta's population and especially agricultural households mostly prefer, from the most important to the least, wetland attributes as follows: biodiversity, cropping area and irrigation facilities, recreation and tourism facilities, and finally Oueme Delta habitat and their state.
- The most important note about the relative importance agricultural households attach to the Oueme Delta wetland attributes is that improvement in cropping area and irrigation facilities is not their most preferred attribute, rather biodiversity. Accordingly, policy makers need to properly take these factors into account when taking policy decisions, for wetland conservation and human wellbeing improvement.
- Recreation and tourism facilities appear to have quiet important value for agricultural households, as well as for the entire population, compared to wetland habitat.
- In terms of the impact of Oueme Delta wetland improvement policy scenarios on agricultural households' wellbeing, the highest utility is gained by society from wetland conservation policies constrained by development policies. This means that Oueme Delta local population will welcome any wetland policy that take into account both the ecological and the economic value of Oueme Delta wetlands.

5.4. Policy Recommendations

Based on the study results the following policy recommendations can be made:

- Any Oueme Delta wetland improvement policy that aims the maximization of social wellbeing, and especially agricultural households' wellbeing must concentrate on the improvement of the wetland attributes in the following order:

Number of fish, animal, and plant species (species diversity); cropping area and irrigation facilities; recreation and tourism facilities, and finally wetland area and their state.

- That public education and sensitization of the local populace, together with technical support from public agencies as well as NGOs are needed to better take care of the wetland area and their conditions, as the local population expresses low interest on them.
- Government policies that always aim to increase the land use need now must consider more the value of biodiversity for the local population. As more improvement in land use for agriculture could harm biodiversity preservation.
- The most important policy of this thesis is that wetland managers and policy makers in Benin could develop an integrated Oueme Delta wetland use and management policies that takes into account both the ecological and economic values of these wetlands; as this is not the current behavior;
- Furthermore, it will be for a great interest to create a particular Oueme Delta wetland Authority for its rational use and management as society preference and welfare assessment only cannot solve the degradation problems.

5.6. Limitations of the Study and future research

The use of qualitative measurement of attribute cannot provide quantitative threshold for policy makers to determine how much improvement is needed when implying there is the need for high improvement in wetland attributes. Cross disciplinary future research is needed to determine those thresholds for specific guidance of policy makers.

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APPENDIX

UNIVERSITY OF GHANA

DEPARTMENT OF AGRICULTURAL ECONOMICS AND AGRIBUSINESS

ANALYSIS OF SOCIAL PREFERENCES FOR OUEME DELTA WETLAND ATTRIBUTS

QUESTIONNAIRE FOR THE STUDY

This survey is conducted as part of a PhD research. The objective of the survey is to value the Oueme Delta wetland resources.

Your participation in this survey will be highly appreciated, as it will contribute to the design of sustainable Oueme Delta use and management policies. The information you provide in this survey will be kept confidential and only used for academic research purposes.

Would you like to be part of this survey? Yes / No

Date ……. /……../………….

Name of enumerator ……………………….................................

Municipality ………………………………………………………..

District ……………………………………………………..

Village/Community ………………...

Name of respondent ……………………………………………..

Contact ………………………..

Start time …………………………..

SECTION I: SOCIO-ECONOMIC CHARACTERISTICS

1- Gender [ ] Female [ ] Male Age……………………..…….

2- Marital status

[ ] Single [ ] Widowed

[ ] Married [ ] Other (spécify)……………………………..

[ ] Divorced

3- Religion:

[ ] Christian [ ] Atheist

[ ] Muslim [ ] Other (specify)……………………………

[ ] Traditional

4- a. Level of education

[ ] None

[ ] Primary

[ ] JHS

[ ] SHS

[ ] University

[ ] Other (spécify) …………………………

b. Number of years spent to attain that level of education …………………………………

c. Informal training

[ ] None

[ ] Mechanical

[ ] Dress-making

[ ] Hairdressing

[ ] Carpentry

[ ] Mason

[ ] Other (specify) …………………

d. Number of years spent in the training ………………………………………

5- Number of members in your household? ……………… persons

Number of adults (≥18 years)	Number of children (< 18 ans)	Nomber of dependent children

6- How long have you lived in this village? ....

7- What is your occupation ?

a. Main occupation	**b.** Other occupation (s) (multiple choices allowed)
[ ] Farmer /Cropping area [...........Kantins] Main crop ………………………………...	[ ] Farmer /Cropping area [...........Kantins] Main crop ………………………………...
[ ] Fisherman	[ ] Fisherman
[ ] Breeder	[ ] Breeder
[ ] Salaried employed, specify	[ ] Salaried employed, specify ....
[ ] Trader, specify ………………………………..	[ ] Trader, specify ………………………………..
[ ] Travail cache	[ ] Travail cache
[ ] Mason	[ ] Mason
[ ] Capentry	[ ] Capentry
[ ] Hairdresser	[ ] Hairdresser
[ ] Other (specify)	[ ] Other (specify) ....

8- Your monthly income (2016 basis)

a. Respondent income	**b.** Household income (all members)
[ ] 0 – 10.000 FCFA	[ ] 0 – 10.000 FCFA
[ ] 10.001 – 20.000 FCFA	[ ] 10.001 – 20.000 FCFA
[ ] 20.001 – 30.000 FCFA	[ ] 20.001 – 30.000 FCFA
[ ] 30.001 – 50.000 FCFA	[ ] 30.001 – 50.000 FCFA
[ ] 50.001 – 80.000 FCFA	[ ] 50.001 – 80.000 FCFA
[ ] 80.001 – 100.000 FCFA	[ ] 80.001 – 100.000 FCFA
[ ] 100.001 – 130.000 FCFA	[ ] 100.001 – 130.000 FCFA
[ ] 130.001 – 150.000 FCFA	[ ] 130.001 – 150.000 FCFA
[ ] 150.001 – 200.000 FCFA	[ ] 150.001 – 200.000 FCFA
[ ] Other (specify)	[ ] Other (specify) ....

SECTION II: ENVIRONMENTAL KNOWLEDGE

9- How will you describe the current state of the Oueme Delta wetlands?

[ ] Good [ ] Bad [ ] Worse

10- What do you think are the three major problems currently affecting the Oueme Delta wetlands and rank them in order of importance? (use 1, 2, 3)

[ ] Disappearance (drying up) of wetlands [ ] Climate change

[ ] Converting wetlands into farmland [ ] Pollution of water and air

[ ] Degradation of fishing [ ] Lack of protected area

[ ] Reduction and disappearance of certain species of plants and animals

[ ] Other, specify ....

11- Who are responsible for these problems? (multiple responses allowed)

[ ] Inhabitants [ ] Government [ ] Municipalities [ ] Nature [ ] Other, ...

12- Who are responsible for the protection of the Oueme Delta wetlands?

[ ] Government [ ] Municipalities [ ] Traditional Chiefs [ ] Everyone [ ] Other, ...

13- What do you think about the current management of the Oueme Delta wetlands?

[ ] Good [ ] Bad [ ] Worse

14- What will be the state of the wetlands in 10, 20 or even 30 years if this mode of management continued?

[ ] Good [ ] Bad [ ] Worse

15- How much do you depend on the Oueme Delta wetlands for your livelihood?

[ ] High [ ] A little [ ] Not at all

16- What benefits do you derive from the Oueme Delta wetlands?

[ ] Consumption of plants (leaves, wood, etc.)

[ ] Consumption of fishery products

[ ] Consumption of animals

[ ] Tourism / Recreation / Culture

[ ] Agricultural lands

[ ] Medicine and Research

[ ] Source of water (irrigation, transport, etc.)

[ ] Other, ...

17- Would you like your grandchildren to take advantage of the Oueme Delta resources?

[ ] Yes [ ] No, if no, why? ....

18- Would you agree to contribute to a project that would aim to preserve the Ouémé Valley?

[ ] Yes [ ] No, if no, why?

....

SECTION III: CHOICE EXPERIMENT

The Ouémé valley is characterized by a wide floodplain in the shape of a Delta. It covers four municipalities, namely: Bonou, Adjohoun, Dangbo and Aguégués.

This floodplain offers a unique and very favorable habitat for the life of millions of species of plants and animals.

Due to its wet nature, its rich biodiversity (plants and animals) and its internal functioning, it provides goods and services necessary for the subsistence and wellbeing of local populations. We can mention among others: water (fishing, irrigation, transport, etc.), fertile agricultural lands, grazing areas, a variety of forest resources (wood, animals, fruits, etc.), raw materials, its great tourism potential (sacred forests, villages on stilts, culture), etc.

However, nowadays, there is a continuous degradation of this natural resource, causing serious threats to its ability to provide goods and services necessary for the livelihood and wellbeing of many populations. These include:

- l’assèchement ou la disparition des zones humides à certains endroits

- reduction, as well as disappearance of plants, fish, and animals

- conversion of wetlands into agricultural lands

- pollution, etc.

Therefore, to enable current and future generations to continue to benefit from the goods and services provided by this natural resource, the development and implementation of sustainable Oueme Delta use and management policies are of prime importance.

To do this, it has been decided to create an independent wetland management fund in the Oueme Delta. The fund will cover the four municipalities and will be made up of representatives of the population, municipalities, and the government. The fund will take care of the restoration of the Oueme Delta wetlands.

The management fund’s work will focus on improving the quality of four key attributes of the wetlands: wetland area and their state; biodiversity (plants, fish and animals); agriculture, and tourism / recreation.

In addition, the design and implementation of Oueme Delta wetland improvement policies, through the independent management fund, will require annual and voluntary financial support from the local population.

The objective of this part of the survey is to elicit the preferences of each citizen on various possible Oueme Delta improvement policies, as well as the amount of their annual donation to support these different policies.

Below, you will find seven choice scenarios of different wetland improvement options where the option C always represents the current situation of the wetlands, for which you will not pay anything if it is chosen; however the degradation of the wetlands will continue.

19- CHOIX SCENARIO 1

Attributes	**POLICY A (Improvement)**	**POLICY B (Improvement)**	**STATUS QUO (Do nothing)**
Wetland area and their state (Habitat)	**HIGH**	LOW	LOW
Number of fish, animal and Plant species (Biodiversity)	LOW	**HIGH**	LOW
Cropping area and Irrigation facilities	**HIGH**	LOW	LOW
Recreation and tourism Facilities	LOW	**HIGH**	LOW
Annual voluntary Donation	**1000F**	**500F**	**0F**
a. Your choice	[ ]	[ ]	[ ]

b. If option C is chosen, why?...

20- CHOIX SCENARIO 2

Attributes	**POLICY A (Improvement)**	**POLICY B (Improvement)**	**STATUS QUO (Do nothing)**
Wetland area and their state (Habitat)	LOW	**HIGH**	LOW
Number of fish, animal and Plant species (Biodiversity)	**HIGH**	LOW	LOW
Cropping area and Irrigation facilities	LOW	**HIGH**	LOW
Recreation and tourism Facilities	LOW	**HIGH**	LOW
Annual voluntary donation	**1000F**	**500F**	**0F**
a. Your choice	[ ]	[ ]	[ ]

b. If option C is chosen, why?...

……………………………………………………………………………………………

21- CHOIX SCENARIO 3

Attributes	**POLICY A (Improvement)**	**POLICY B (Improvement)**	**STATUS QUO (Do nothing)**
Wetland area and their state (Habitat)	LOW	**HIGH**	LOW
Number of fish, animal and Plant species (Biodiversity)	LOW	**HIGH**	LOW
Cropping area and Irrigation facilities	**HIGH**	LOW	LOW
Recreation and tourism Facilities	LOW	**HIGH**	LOW
Annual voluntary donation	**1000F**	**500F**	**0F**
a. Your choice	[ ]	[ ]	[ ]

b. If option C is chosen, why?...

22- CHOIX SCENARIO 4

Attributes	POLICY A (Improvement)	POLICY B (Improvement)	STATUS QUO (Do nothing)
Wetland area and their state (Habitat)	LOW	**HIGH**	LOW
Number of fish, animal and Plant species (Biodiversity)	LOW	**HIGH**	LOW
Cropping area and Irrigation facilities	LOW	**HIGH**	LOW
Recreation and tourism Facilities	**HIGH**	LOW	LOW
Annual voluntary donation	**1000F**	**500F**	**0F**
a. Your choice	[ ]	[ ]	[ ]

b. If option C is chosen, why?...

....

23- CHOIX SCENARIO 5

Attributes	POLICY A (Improvement)	POLICY B (Improvement)	STATUS QUO (Do nothing)
Wetland area and their state (Habitat)	**HIGH**	LOW	LOW
Number of fish, animal and Plant species (Biodiversity)	**HIGH**	LOW	LOW
Cropping area and Irrigation facilities	LOW	**HIGH**	LOW
Recreation and tourism Facilities	LOW	**HIGH**	LOW
Annual voluntary donation	**1000F**	**500F**	**0F**
a. Your choice	[ ]	[ ]	[ ]

b. If option C is chosen, why?...

24- CHOIX SCENARIO 6

Attributes	**POLICY A (Improvement)**	**POLICY B (Improvement)**	**STATUS QUO (Do nothing)**
Wetland area and their state (Habitat)	**HIGH**	LOW	LOW
Number of fish, animal and Plant species (Biodiversity)	LOW	**HIGH**	LOW
Cropping area and Irrigation facilities	LOW	**HIGH**	LOW
Recreation and tourism Facilities	LOW	**HIGH**	LOW
Annual voluntary donation	**500F**	**1000F**	**0F**
a. Your choice	[ ]	[ ]	[ ]

b. If option C is chosen, why?..

....

25- CHOIX SCENARIO 7

Attributes	**POLICY A (Improvement)**	**POLICY B (Improvement)**	**STATUS QUO (Do nothing)**
Wetland area and their state (Habitat)	**HIGH**	LOW	LOW
Number of fish, animal and Plant species (Biodiversity)	LOW	**HIGH**	LOW
Cropping area and Irrigation facilities	LOW	**HIGH**	LOW
Recreation and tourism Facilities	**HIGH**	LOW	LOW
Annual voluntary donation	**1000F**	**500F**	**0F**
a. Your choice	[ ]	[ ]	[ ]

b. If option C is chosen, why? ....

26- Do you have any special thing to say about the current and future management of the Oueme Delta wetlands?

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....

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Thanks for your interest.

End of the discussion

End time…………………….. Signature of enumerator ………………….