Non-market use and non use values for preserving ecosystem services over time: a choice experiment application to marine ecosystems in New-Caledonia

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Abstract: Non-use values are probably some of the most compelling reasons for Ecosystem Goods and Services (EGS) preservation (Chan et al., 2012). Nevertheless, there still exist challenges to their precise characterization and quantitative estimation, especially when it comes to EGS economic valuation and when the willingness-to-pay estimation exercise focuses on EGS users. We tackle this issue by: (1) reviewing briefly the literature about non-use values in EGS economic valuation; (2) offering a pragmatic economic interpretation of non-use values through EGS preservation over time, which allows estimating them individually for users in addition to and separately from non-market use values; (3) applying empirically our approach with a choice experiments case study in New-Caledonia in two coral reef coastal areas with different institutional, cultural, environmental and socio-economic contexts (4) discuss critically our methodology and the results we obtained, notably non-linear part worth utilities functions and a significant cost attribute non-attendance, in view of supporting decision-making.

Keywords: *non-use values, ecosystem services, non-market valuation, willingness to pay, discrete choice experiment, panel latent class model, non-compensatory preferences.*

JEL codes: Q51, Q57

1. Introduction

We are currently facing a major and global environmental crisis with alarming consequences (Stern, 2007; Millenium Ecosystem Assessment, 2005). In particular, coastal and marine ecosystems are some of the most heavily exploited globally (UNEP, 2006; Halpern et al., 2008). As Barbier (2012) noted, the degradation and loss of coastal and marine ecosystems are intense and increasing worldwide, with 50% of marshes, 35% of mangroves, 30% of coral reefs, and 29% of sea grasses either lost or degraded (FAO 2008,2007; MA 2005; Orth et al. 2006; UNEP 2006; Waycott et al. 2009). Thus, services provided by those ecosystems to Humans are threatened (e.g. provision of renewable resources through the number of viable fisheries, filtering and detoxification, protection against shore erosion, coastal flooding or storm events). All this appeals for urgent and effective actions.

In order to manage effectively ecosystems and balance between use and conservation, it is crucial to examine the consequences of ecosystems changes in terms of social welfare, which also means examining what are the costs or benefits of preserving or losing ecosystem services. This is the origin of

the Ecosystems Goods and Services (EGS) economic valuation approach, which has rapidly developed as a new pragmatic way to support decision-making in the domain of biodiversity conservation (Pearce and Moran, 1994; Costanza et al., 1997; Boyd and Banzhaf, 2007; TEEB, 2008; Liu et al., 2010). Non-market valuation (Adamowitz, 2004) was designed to account for all the changes regarding EGS which would usually escape the market and therefore imply no economic signals regarding their contributions to social welfare or threats in their capacity to do so. The call for increased non market valuation of EGS has particularly been observed in coastal and marine ecosystems (Spurgeon, 2004; Brander et al., 2007; Barbier, 2011).

The costs or benefits of losing or preserving ecosystems services have been broadly classified into use values (direct or indirect), option values and non use values (e.g. Bateman et al., 2002; Turner et al., 2003). The later have became a crucial component in non-market valuation when assessing socio-economic impact of conservation (Hoagland et al. 1995), mainly since these values are of primary importance when appealing for EGS preservation. However there still exist challenges to their precise characterization and quantitative estimation (Chan et al., 2012), especially when it comes to EGS economic valuation through willingness-to-pay (WTP) and when the valuation exercise focuses on EGS users[1] (Cummings and Harrison, 1995), which are usually the stakeholder of interest in many management cases.

This paper aims at critically exploring the frontiers between use and non-use values in WTP estimates through a temporal dimension. It offers a methodology to differentiate implicitly between use and non-use values components in stated WTP, and discusses the limits of the exercise through an empirical application. Our main objective is therefore a quantitative estimation of NUV for users, in different contexts to allow testing our methodology robustness. It is organized as follows. Section 2 reviews the literature about non-use values in EGS economic valuation. Section 3 presents the motivations behind estimating NUV for users and provides a pragmatic economic interpretation of non-use values through EGS preservation over time, which allows estimating them a minima in addition to and separately from non-market use values through stated preference method. Section 4 shows how this approach is empirically applied through a choice experiments case study in New-Caledonia in two coral reef coastal areas with different institutional, cultural, environmental and socio-economic contexts. Section 5 provides the theory and econometric specification underlying our analysis. Section 6 presents our main results and the estimation of both use and non-use values for the populations living in these coastal areas. Finally, section 7 provides a critical discussion of our methodology and the results we obtained in view of supporting decision-making: notably non-linear part worth utilities functions and a significant cost attribute non-attendance.

[1] We define here a user as any individual who directly (through a physical or eye contact) or indirectly benefits from the EGS of interest, either in a more passive or active way. As such, an inhabitant of a coastal area that never goes into the water but simply enjoys the beauty of the coastal landscapes would be considered as a user. Another inhabitant who is never going to the coast but who is benefiting from coastal protection services is a user as well.

2. Literature review

2.1. Definition of NUV in the economic literature

Non-use values (NUV) have been defined in many ways over the past forty years in the economic literature. Their main "raison d'être" in economics is to account for monetary benefits that help justifying conservation (e.g. McVittie and Moran, 2010) or to help settling proper compensation in case of damage or degradation of EGS (e.g. Carson et al., 2003) in addition to direct or indirect benefits (or losses) linked to uses. In the environmental or ecological economics literature, the concept of NUV has been discussed extensively through an important diversity of dimensions and associated terminologies. NUV are often linked to a seminal article from Krutilla (1967), where existence and aesthetic values are discussed in terms of their importance regarding the values attached to conservation. Existence values were then the main component of non-use values discussed (Brookshire, 1983 & 1986; Fisher and Krutilla, 1985; Madariaga and Mc.Connell, 1987; Loomis, 1988; Stevens et al., 1991; Edwards, 1992; Larson, 1993; Aldred, 1994; Attfield, 1998). Within the work done about non-use values, other dimensions or "values" were discussed including aesthetic values (Krutilla, 1967; Sober, 1986; MA, 2005; Chan et al., 2012), bequest values (Loomis, 1988; Aldred, 1994; MA, 2005; O'Garra, 2009), altruistic values (Aldred, 1994; MA, 2005; Ojea and Loureiro, 2007) and even more broadly cultural values (MA, 2005; Chan et al., 2012) and intrinsic values (Aldred, 1994; Attfield, 1998; Sagoff, 2008; Chan et al., 2007 & 2012). Furthermore, it should be noted that non-use values have also been called passive-use values (e.g. Carson et al., 1992, 2003; Adamowitz et al., 1998; Hanley et al., 1998), certainly to emphasize the instrumental or utilitarian dimension of those values within the economic framework of analysis[2].

All these terminologies might be confusing, and this is probably why non-use values have been most of the time simply classified as existence and bequest values. Existence value is commonly presented as the value assigned by the agent on the good's continued existence, independent from his use(s) or possible use(s) of this good. Bequest value is the value attached to preserving a good or service for use by future generations, independent of one's own use of the good/service. Within the neoclassical economic framework, these values are defined and measured in dollar as willingness-to-pay (WTP) or willingness-to-accept (WTA). Thus, one could define NUV more broadly as *the WTP or WTA regarding a specific change in EGS that is not motivated by any uses or future uses' consideration.*

2.2. Limits of the economic definition

This typical economic interpretation of NUV is controversial, and has been discussed intensively (e.g. Loomis, 1988; Kahneman and Knetsch, 1992; Cicchetti and Wilde, 1992; Larson, 1993; Castle et al., 1994; Lazo et al., 1997; Chan et al., 2012). The main general concern is probably that NUV involve many dimensions so that their economic definition and subsequent quantification necessarily fails to capture

[2] This definition has the advantage of illustrating the fact that non-use values cannot be reasonably considered as totally independent from any uses (since one's uses of EGS necessarily influence all the values one holds for this EGS or different ones). However, we argue this formulation is as problematic as the NUV one since a proper distinction between passive and active uses seems also unclear to us, especially in view of the indirect use values concept.

all of them in a single metric (Attfield, 1998; Chan et al., 2012; Daniel et al., 2012). Furthermore, confusions and conflations amongst those dimensions are frequently encountered, although NUV are present in all major typologies (Chan et al., 2012, 2011; Daniel et al., 2012). More broadly, it has also been argued that NUV fall into the domain of incommensurability (Chan et al., 2012; Martinez-Alier et al., 1998). Therefore, a quantitative valuation exercise of NUV is necessarily non exhaustive and strongly needs additional information from other disciplines such as philosophy, anthropology and sociology (Chan et al., 2012).

2.3. Estimation of NUV and associated challenges

Non-use values as WTP are estimated through stated preference methods, and altogether crystallize an important part of the criticism concerning the validity and robustness of EGS valuation methodologies and theory. Both traditional stated preference techniques have been used: contingent valuation method (CVM) and more recently discrete choice experiment (DCE). The first is to ask how much respondents are willing-to-pay for an EGS (or several of its attributes in case of DCE) which we are absolutely sure they will never use - thus interviews are based on non-users; and the second is to ask the respondent to partition their total WTP for an EGS into various motivations, such as bequest, existence, own use etc. (e.g. Walsh et al. 1984; Vesely, 2007; Togridou et al., 2006; Sattout et al., 2007)[3]. Stated decomposition approaches were applied in numerous CVM applications concerning EGS and have been helpful in understanding the relative shares of value categories in WTP estimates (e.g. Kontogianni et al., 2012; O'Garra, 2009; Kaoru, 1993; Sattout et al., 2007; Vesely, 2007) or in identifying warm glow effects (Chilton and Hutchinson, 2000). Most of the time, the percentage of non-use values in WTP allocation are found to be much higher than the percentage of use values: as an example, in a synthetic table presented by Kontogianni et al. (2012) of use and non-use values estimates for charismatic species found in the literature, NUV represent between 65 and 90% of total WTP, whereas use values represent between 5 and 12%[4]. More broadly, it is clear that NUV are often found to be substantial in non-market valuation.

Despite its popularity, the stated decomposition approach has considerable shortcomings and is highly controversial, mainly because of the cognitive difficulty on deciding about unfamiliar and non-separable aspects of the valuation process (Silberman et al., 1992; Carson et al., 1999; Cummings and Harrison, 1995). As noted by Carson et al. (1992) and Cummings and Harrison (1995), an individual's total WTP for a resource may be driven by many different, overlapping and interrelated motivations, which may be inseparable and as such unavailable to the researcher. In addition, recent concerns regarding possible conflation between use and non-use values arose, following the development of non-use valuation exercises (Weikard, 2002; Bateman, 2008, O'Garra, 2009).

As a consequence of these limitations, the other approach i.e. directly estimating non-use values by deriving non-users' WTP/WTA, was argued by some authors to be more appropriate (e.g. Carson et al.; 1992) and is also frequently encountered in the literature (e.g. Gillespie and Bennett, 2011; McVittie and

[3] Specific techniques such as the Analytic Hierarchy Process (AHP) have also been used in order to distinguish between use and non-use values, or the different motivations (e.g. Wattage and Mardle, 2008).

[4] The percentage left being option values.

Moran, 2010; Windle and Rolfe, 2005). It is clear that this approach is simpler since it avoids dealing with motivations and definition. Nevertheless, it constraints the valuation exercise on non-users, which implies the loss of information regarding users' NUV.

More broadly, several other challenges exist when dealing with the estimation of NUV through stated WTP: avoidance of common bias linked to stated preference methods such as yea-saying (Blamey, Bennett and Morrison, 1999), unfamiliarity problems (Barkmann et al., 2008) and, at last but not least, the warm glow effect pointed out by Kahneman and Knetsch (1992) who argued that such WTP values are typically not specific to the goods under evaluation but reflect the warm glow of moral satisfaction when supporting any good cause. Understanding and estimating NUV is therefore highly complex, especially regarding marine ecosystems where in some cases many individuals will never observe the key ecological features protected, nor know what functions they have (Martin-Lopez et al., 2008).

From this brief literature review, we can conclude that there still exist major challenges to NUV precise characterization and quantitative estimation, especially when it comes to EGS economic valuation and when the valuation exercise focuses on EGS users. We highlight four major characteristics concerning non-use values: (1) Conflation of multiple dimensions and motivations; (2) Conflation and interaction with use values in the case of users; (3) Incommensurability issues (4) Highly dependent from socio-cultural context. As such, it has to be noted Non-Use values challenge the realm of the neoclassical behavioral model, and any attempt to estimate them within this model is necessarily incomplete and over-simplifying. However, this does not mean that it is pointless to consider and quantify WTP arising from multiple non-use motivations, although it is important to be aware of the challenges underlying this process. With respect to the economic valuation approach, issues (1) and (2) lead to a need to develop and test new frameworks for assessing non-use values that would also allow robust differentiation and estimation of non-market use and non-use values for users. None of the studies identified in our literature review have attempted to estimate this decomposition implicitly, i.e. without directly asking individual respondents and thus avoid the issues involved in stated decomposition methods.

3. Differentiating use and non-use values through time

3.1 Why focus on users

It is first necessary to explain briefly the interest in estimating NUV for users. We argue that users are generally the stakeholders of interest in a management context, since their perceptions and values are crucial to a better understanding of the issues faced by decision-makers. Indeed, if in some context preservation implies mostly NUV, preservation is also often needed in contexts with multiple users where decision making thus becomes much more complex and trade-offs between use and non-use values are becoming more relevant. In several documented cases (e.g. MA, 2005; O'Garra, 2009; Chan et al., 2012; Casey et al., 2008), it has also been shown that users possess strong non-use values (e.g. bequest values, cultural values such as traditional knowledge and practices). These can also be a source of conflicts. Since any valuation exercise primary aims at helping decision-making, it is clear that when management is more concerned about users, economic valuation should be able to provide some tools to study and estimate the different categories of values that can be relevant for helping decision-making.

In this context, it is also interesting to critically examine in further details the frontier and possible links between use and non-use values, since an individual's perceptions relative to his own non-use values may have a great influence on his uses of EGS, and vice versa.

Finally, there is a strong advantage that can facilitate the process of estimating non-use values of users: compared to non-users, they are certainly less subject to several biases such as the "warm-glow" effect (Kahneman and Knetsch, 1992), "yeah-saying" and unfamiliarity problems (Barkmann et al., 2008): in short, users have a better knowledge of the EGS and a priori well-formed preferences. They will also tend to be more involved, and this can facilitate the credibility of the valuation exercise, or make it more complex in case of a polemic issue.

3.2 A pragmatic definition

In order to develop a new framework, we argue there is a need of a more pragmatic definition of non-use values that can be easily applied to users and non-users and that would minimize the issue of mixed motivation and dimensions.

Non-use values arise because of many different individual or collective systems of thoughts or beliefs, and can be studied under many dimensions. As such, and as are all kind of values hold by humans, they are necessarily cultural. An economist should concentrate his work on the actual behavioral consequences of such non-use values: the extent to which non-use values affect quantitatively individuals or group of individuals' economic preferences and behaviors. Within the neoclassical economic framework, those changes are directly observable and measurable in terms of WTP (or WTA). As discussed before, from the non-user's perspective this is more straightforward, whereas, for users, conflation issues may arise. In order to solve this problem, we propose to study non-use values relative to their temporal dimension, where we offer a definition that allow to isolate some non-use values of users in an exclusive way.

Our point is that the main characteristic of non-use values regarding a given EGS is the wish from both users and non-users that it continue to exist during an indefinite period of time, which extends after their death, for different kind of reasons. This does not refer only to existence values, since, for example, it could be mainly motivated by a bequest motivation or be based on other moral grounds (e.g. biocentrism) (Mazzotta and Kline, 1995). We therefore argue that most non-use values will result in the willingness to preserve the EGS continuously, from the current moment to beyond the holder's own existence and life-time perception. In an economic perspective, this can be interpreted as a WTP for preserving the EGS over time. For users, any WTP for preserving the EGS during their life period may be linked to both use and non-use incentives. But any WTP for preserving it over their life-time is undoubtedly solely linked to non-use motivations. For users, we thus interpret economic non-use values as an individual's WTP for preserving any EGS beyond his life-time, which can be more practically interpreted as "beyond his life-expectancy". Such a definition of non-use value bears similarities with life-insurance concepts. It includes not only bequest values but also other non-use values (e.g. existence, spiritual, moral/ethical commitments). We do not attempt to quantify the contribution of each of these different components, although exploring this issue qualitatively may provide some interesting insights. For non-users, in a temporal dimension, the economic quantification of non-use values can simply be estimated in terms of WTP to preserve any EGS over any period of time.

Table 1 synthesizes our interpretation in comparison to the commonly encountered estimation procedures of non-use values, where the approaches to their estimation values are based either on: (1) the spatial distance between the individuals and the EGS considered to establish whether people are susceptible to derive any use value from these EGS, or if any willingness to pay for their preservation reflects only non-use values; or (2) the present and expected future inability to materially interact with the EGS considered.

Therefore, our interpretation allows us to define more clearly the NUV concept in an economic perspective, and provides the opportunity to estimate NUV in theory for any EGS user, separately from use values. However, as pointed out, users' WTP for preserving EGS within their life expectancy is certainly a result of a mix between use and non-use values, and it then becomes difficult to distinguish between the two. This is the main limit of our approach, and in this respect two points can be made.

Our definition supposes that when faced with the choice between preserving an EGS during one's expected lifetime, and preserving it beyond, the individual will decide to support the first option if this entails a mix of use and non-use values, while supporting the second option implies only non-use values. So any WTP for the second option can be considered as a conservative measure of the non-use values associated with preserving the EGS over a horizon that extends beyond the expected lifetime of the individual.

Table 1 Estimating Non-use values for users and non-users: a temporal perspective

	Time	**Spatial**
Estimation of non-use values for non-users	WTP for preserving EGS over any time	WTP for preserving EGS unreachable or never to be encountered *(e.g. McVittie and Moran, 2010)*
Estimation of non-use values for users	WTP for preserving EGS within life-expectancy: mixed use, option and non-use values; WTP for preserving EGS beyond life-expectancy: exclusive non-use values	Stated percentage of total WTP for EGS currently used *(e.g. Wattage and Mardle, 2008)*

In the case where WTP for preservation within life expectancy presents non-use components, it can be argued that non-use values held at a specific moment are perceived by the holder as being absolute and universal, and as such held continuously through time (even if the motivations underlying NUV and their intensity are subject to changes over the individual's lifetime). In other words, most non-use values would usually appear "timeless" for the individual and would be perceived as independent of any considerations regarding their temporal existence, so that these values motivate both a WTP before and over life-expectancy, in an equivalent way. That is, most non-use values that motivate a wish to preserve an EGS today or in coming years would motivate in an equivalent way the wish that the EGS will be preserved over a long time (after our death). This would mean that the non-use component of an EGS's general value through a WTP to preserve it beyond life expectancy is present at least in an equivalent

way in the WTP to preserve it before life expectancy: to protect the EGS until after one's life expectancy, one would first have to pay for it to be preserved while still alive.

Our quantitative estimation of NUV should thus be interpreted as an "a minima" estimate, though we think it captures several important dimensions of non-use values, at least the one traditionally considered in the economic valuation literature (bequest and existence values).

3.3 Application through Discrete Choice Experiments

Based on the above definition of economic non-use values for both users and non-users, we develop an approach to estimate them in practice. Estimating WTP over several time periods involves using stated preference methods: either contingent valuation method or discrete choice experiments. Although both methods are based on a robust theoretical framework, namely Random Utility Theory (Thurstone, 1927), DCE have several advantages compared to the CVM (Hanley et al., 1998), the main one being the possibility to describe a specific good under multiple characteristics, which can be especially useful when studying highly complex and multi-dimensional goods such as ecosystems. In addition, the construction of scenarios allows a more implicit form of preferences' elicitation. These multiple characteristics or attributes can be described by several levels, which give the opportunity to study marginal utilities associated with the attributes, and in our case to study more generally the individual demand regarding preservation over time. DCE also allow for testing several assumptions regarding choice behaviors (Hensher et al., 2005) or even looking for possible lexicographic or discontinuous preferences (Campbell et al., 2008) and the interactions between WTP and characteristics/dimensions of the EGS.

The main task is to develop scenarios involving a payment for preserving several EGS attributes over time, from now until a period beyond the individual respondent's expected lifetime. For example, in one scenario, the individuals' payments would allow to preserve the EGS in the near future only, but without any insurance concerning a more distant future. In another case, the payments could be used in a way that guarantees preservation over the next few years, but also over a long-term period: part of the money could be kept and secured (e.g. as a trust fund) in order to insure the success of a long lasting preservation, as in a life-insurance concept.

The methodology we offer to put our non-use values interpretation into practice follows the commonly encountered steps listed below: (1) identify through focus group discussions and multiple interviews the different non-monetary attributes of the EGS that is to be preserved, which should correctly represent the preferences of the population relative to preservation issues; (2) choose the levels of these attributes, in such a way that they represent different preservation durations, which encompass the life expectancy of the population; (3) identify a monetary attribute, again with the help of focus groups or interviews that can take the form of a payment[5]; (4) anticipate a choice model and design the choice experiments, (5) create a questionnaire, with several sections, which aims at gathering data which could help understand choices and qualitatively study non-use values; (5) test the questionnaire and choices, and after final reviews, launch the final survey with an appropriate representation of the different contextual elements we want to study; (6) analyze the results using several choice models, from simple

[5] Compensation and willingness to accept scenarios can also be interesting, although one ould have to be aware of endowment effects (Kahneman et al., 1990).

ones to (e.g. Conditional Logit) to, if necessary, more complex ones (e.g. Mixed Logit, or Latent Class models).

4. New-Caledonian case study

4.1 Context

Our empirical application focuses here on two coral reef coastal areas in New Caledonia[6] and therefore aims at estimating general WTP for preserving coral reef ecosystems for New Caledonia's populations[7] (which are almost exclusively composed of users) and quantifying implicitly the non-use values component in this WTP. This work took part in a larger study that aimed at estimating the economic values of coral reef ecosystem services in New Caledonia, conducted by the French National Initiative for Coral Reefs (IFRECOR) program for French and New Caledonian public institutions (French Ministry for Ecology and Sustainable Development, French Ministry for Overseas Territories, French Republic High Commission of New Caledonia). This study was motivated by an informative and advocacy approach, so that its results can be used to inform policy-making in a very broad way as well as the local populations.

New Caledonia represents a very specific socio-ecological and economic context. A substantial coral reef complex (more than 4.500 km^2 of reef and more than 20.000 km^2 of lagoon zones, the biggest lagoon of the World) surrounds its coast, with a low-density population (245.000 habitants, of which around two thirds are located in or around the capital city Nouméa). Interactions between people and the reef are contrasted amongst the different cultural groups present in New Caledonia. Part of the population is involved in a service-based economy and has a high purchasing power; the other part living on a less merchant economy relying partly on subsistence agriculture and fishing, mainly within a tribe system. Thus, New-Caledonian marine ecosystems are characterised by a high diversity of uses, populations (from a cultural as well as socio-economic perspective), anthropogenic pressures (which can vary from almost none, to intense, due to important mining industries or urbanization) and associated environmental states. In recognition of its outstanding biodiversity of international importance, with a high level of endemism, almost two-thirds of the lagoon are listed as UNESCO World Heritage. All this tends to motivate our interest in studying the non-use values attached by the populations to the marine ecosystems.

Furthermore, in a broader perspective, we also found no study attempting to carry out non-use values analysis for coral reef ecosystems that involved populations of users with important cultural and income differences, multiple uses and ecological contexts.

We then selected two specific areas to capture the different contexts and populations, and with respect to the administrative division of the New-Caledonian mainland. One area is facing pressures from coastal mining, and a growing development and urbanization in the Northern Province with a prevalent Kanak population; this area is called here VKP. The other area – called ZCO – was a UNESCO-listed area in the Southern Province with a prevalent population of New-Caledonian European descendant people, where the CRE are in good conditions. Individuals in both areas are concerned about future development

[6] New Caledonia is a collectivity (sui generis) of France located in the southwest Pacific Ocean.

[7] This is the first WTP estimations for marine ecosystems in New Caledonia.

projects (a considerable mining project in VKP, and an important hotel complex in ZCO); those ongoing transformations implying new conservation issues and need for management, which can help justifying the conservation scenarios presented in the choice experiments (see Appendix A for further details).

Figure 1 Map of New-Caledonia, VKP and ZCO areas

Thus our two areas, covering eight districts in both South and North Province illustrate quite well the diversity of contexts present in New-Caledonia: different institutions, the various anthropogenic pressures including growing populations, mining industry or other development projects, the existence of significant UNESCO World Heritage sites, the diversity of ecosystems, the diversity of ethnical, cultural origins and associated ways of life (e.g. tribe system). In conducting the same survey and choice experiments across these two areas, this will allow us to study the role of several contextual elements in individuals' preferences regarding preservation over time and non-use values.

4.2 Selection of attributes and levels

The selection of attributes and their levels is undeniably one of the most crucial step in a choice experiment them (Lancaster, 1966; Hensher et al., 2005), and results in a trade-offs between precision and complexity of choices (Adamowicz et al., 1998). It involved discussions with different stakeholder groups. Several interviews with various scientists and stakeholders were organized,[8] as well as focus group discussions with the IFRECOR local committee[9], two UNESCO committees from different areas made up of representative of users and populations and with resource users (recreational and professional fishers, scuba-divers, general recreational users). Interviews and tests within targeted populations (Kanak people living in tribe or not, New-Caledonian white people, European people) were also conducted in ZCO, VKP and Noumea.

The list of selected attributes and associated levels is presented in Table 2 below. Regarding the monetary attribute, a monthly payment (in Pacific Franc[10]) was finally selected among other possibilities, implying one major concern: such WTP through a tax or any compulsory regular contribution is not really

[8] These interviews and discussions were realized with members of all research institutions present in New-Caledonia: the international French research organism IRD (Institut de Recherche pour le Dévelopment), the IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer) and the University of New-Caledonia (UNC), from various disciplines (marine biology, anthropology, geography, economy, geology…). Several discussions have also been conducted with the program manager of the Coral Reef Initiative for South Pacific (CRISP) as well as with members of local preservation associations, diving centers and economic and development agencies.

[9] The committee is composed of scientists from different field and institutions, representative of the provinces and French government, representative of conservations associations, and other stakeholders from different socio-professional fields.

[10] In 2013, 100 cpf is equal to around 0.84 € or 1.08 US$.

realistically expected from the current institutions in New-Caledonia and thereby threatens the credibility of our methodology[11]. However, this does not necessarily mean that such a payment would be perceived as unlikely to exist in a longer term by all the population so that we decided to keep this payment attribute and study properly during the analysis how it was specifically handled and accounted for by individuals during their choices. The other attributes are:

- The ***quantity of animals fished***, referring to the total catches of finfish, crustaceans, molluscs etc. from the different fisheries (recreational, commercial, subsistence/traditional) in the area, which can be sustained over the long term
- The ***health and richness of marine life***, referring to the multiple dimensions of CRE: abundance and diversity of habitats, species, water quality; in regards to anthropogenic pressures.
- The ***coastal and lagoon natural landscapes***, referring to a possible preservation of the natural aspect of current coastal (mangroves, beaches, estuaries, bays) and lagoon (islets, reefs) landscapes facing economic development and growing populations as well as the conservation of current wild and pristine areas.
- The ***areas of practice***, referring to a possibility to secure over time the areas and places (coast and lagoon) that the agent and its community are currently using for common activities.

Table 2 Attributes and levels

Attributes	Levels	Status quo
Payment	**500**, **1000**, **1500**, **2000** cfp per month	0 cfp
Quantity of fished animals	Preservation for **20**, **50** or **100** years	Progressive decline
Health and richness of underwater life	Preservation for **20**, **50** or **100** years	Progressive degradation
Coastal and lagoon natural landscapes	Preservation for **20**, **50** or **100** years	Less natural areas and more constructions
Areas of practice	Secured for **20**, **50** or **100** years	Sufficient areas of practice not guaranteed for future

Regarding the levels, several preservation lengths (20, 50 and 100 years) were finally chosen after several field tests and such a quantitative framing allows for a more precise computation and possible continuous representation of preservation demand over time. The status quo was interpreted and presented to respondent as “what would happen in the future if no additional preservation measures are taken”, and as such represents a preservation of the marine ecosystems for the next coming months (around four to six) only followed by a “progressive degradation” in the long run for the different attributes, in view of the different local development projects under way in both areas, the growing

[11] The other potential cost-attributes that were also examined, such as willingness-to-accept or even willingness to spend time, would raise exactly the same kind of issue within the New-Caledonian context. WTP was selected to keep the exercise simple and generic, especially since we aimed at conducting the DCE in two different areas with different institutional and socio-cultural contexts.

number of recreational users in the lagoon and international pressures (e.g. climate change), thus requiring additional management.

Therefore the scenarios implied a monthly payment that could be used by local institutions to guarantee a preservation of coral reef and associated ecosystems in each area during 20, 50 or 100 years. The time frame of these scenarios was set as 20 years, so that each month part of the payment can be kept aside and secured (e.g. in a trust fund) to guarantee preservation over longer periods of time (i.e. 50 or 100 years).

The potential lack of credibility of the choice experiment was carefully considered: for example through reminding clearly respondents of their budget constraint or justifying the relevance of the choices in view of the broad context and risks in the future. The questionnaire and choice scenarios were also supported by major institutions so that the legitimacy of the exercise was optimal.

4.3 Questionnaire, surveys design and data collection

The statistical design for the choice experiment was generated using SSI Web 6.0 Sawtooth Software. The number of random alternatives in each choice task was set to two (both unlabelled), with a third fixed alternative corresponding to the status quo[12]. A 48 choice cards design was generated and blocked into six different versions of eight choice cards[13]. The selected method by which the random choice tasks were generated is complete enumeration[14], allowing us to produce an orthogonal main effects fractional factorial design, balanced and with minimal overlap. The statistical design was tested[15] (see Appendix B) using SSI Web 6.0 and found to be efficient (D-efficiency comparisons).

Also, within the survey itself, another option of "Choice refusal" was added, so that the individuals who actually refuse to participate to the exercise could say so (with of course a further asking for their

[12] Two random alternatives and a status quo imply easier choices than three or more random alternatives.

[13] The final number of choice tasks was selected after field tests, design simulation, and efficiency comparison with lower choice tasks.

[14] This design strategy considers all possible alternatives and chooses each one so as to produce the most nearly orthogonal (attribute levels vary independently of each other) fractional factorial design in terms of main effects. The concepts within each task are also kept as different as possible, and each level of an attribute is used exactly the same number of times.

[15] In testing our design four criteria were examined (see appendix for the tests results):

- The standard errors of the main effects using a Multinomial Logit Model (MNL) and simulated response data for our design; a comparison of D-efficiency with another design with 30 versions instead of 6 - same test specifications (MNL and simulated response data). This is to test whether the number of version was a significant limitation on the design (the restriction on the number of versions of the survey to six may also be a source of inefficiency);
- A comparison of D-efficiency with a random design (instead of full enumeration that we used) - same test specifications. This is to test whether the full enumeration design is a significant improvement on a random design.

The design was found to allow estimation of statistically significant main effects given a sample size of 500 respondents, assuming 15% of no-response (based on the experience from our field tests).

reasons). Hence, it avoids considering that these individual have a preference for the status quo while they are just opposed to the choice exercise in itself, or to the formulation of the management problem.

The creation of the questionnaire was done progressively over a period of several months, in which several field tests and reviews were conducted in order to make sure the questions were clear and understandable, given the complexity of targeting various populations from totally different socio-cultural background. It included several sections that aimed at collecting extensive information on the socio-economic background of the individual and his household, on his uses of marine ecosystems (and the ones of the households), on his perception about preservation issues and on the choices realized during the DCE section. The last section regarding the choices also included questions about choice heuristics, mainly to examine whether individuals did consider or not the different attributes: this method has been referred as the stated nonattendance approach (e.g. Carlsson et al., 2010; Hussen Alemu et al., 2012). More precisely this was done by asking individuals to state and rate the way they considered each attributes. The objective behind these questions was to help coping with the main limit of our methodology, namely the potential lack of credibility of our scenarios and associated payment mentioned earlier, by looking at the way individuals considered (or not) the payment attribute.

The base population of the survey covers all the residents in the areas selected (ZCO and VKP). A random stratified sampling method based on various quotas derived from the last population and socio-economic census data from the "Institut de la Statistique et des Etudes Economiques" (ISEE, 2009 and 2004) was used for sample selection. Several representative quotas for the surveys were thus identified for each area and each districts, in view of several criteria: age, gender; cultural origin, populations living in tribes; socio-professional categories. The total target number of surveys was set to 250 for the ZCO area[16], and 300 for the VKP area, leading to a total of 550 surveys. The final sampling frame thus included a substantial amount of quotas to be respected, hence allowing our survey to be highly representative and insuring the capacity to conduct future possible analysis regarding all these populations' categories. In addition to the quota, each choice set version was utilized the same amount of time.

The 550 surveys were conducted through face-to-face interviews from November 2011 to February 2012, through the help of a professional survey company and with local experienced and trained interviewers. All the quotas were completed for each area, and all sections subsequently analyzed (Marre and Pascal, 2010). Choice data and socio-economic variables of interests were then compiled for an econometric analysis.

5. Econometric analysis

5.1 Random utility theory and choice models

The econometric analysis is based on Random Utility Theory (Thurstone, 1927; Mc Fadden, 1974), where individual's utility function is described as the sum of two different components: a rational or systematic

[16] Though both population have almost the same number of more than 20 years old inhabitants (around 6700 inhabitants for ZCO et 6400 for VKP), it was decided to conduct more survey in VKP in order to allow us to interview enough individual living in tribes, thus insuring that we have collect enough choice data for analysis regarding this population.

one (i.e. corresponding to explainable factors of choice), and a random one (i.e. unexplainable factors of choice). Thus, utility (U) for an individual n facing alternative i, is a function of the systematic component $\mathbf{V_{in}}$ and of an unobservable component $\boldsymbol{\varepsilon_{in}}$, both associated with the individual and alternative.

$$\mathbf{U_{in} = V_{in} + \varepsilon_{in}}$$

It is then assumed that the probability of an individual n choosing alternative i depends upon the utility of i in relation to the utility of all other possible alternatives j within a choice set C_n. Therefore, following the maximization principle, individual n will choose an alternative i over alternative j if the individual's utility for i exceeds the utility associated with j. This gives the following formulation (after being rearranged):

$$\mathbf{P(i/i,j \in Cn) = P[(V_{in} - V_{jn}) > (\varepsilon_{jn} - \varepsilon_{in})] \ ,\forall\ i \neq j}$$

Following equation (3), assumptions now have to be made in order to detail the form of this probability, first regarding the rational component. The most commonly made assumption is the additivity and linearity of the attributes or characteristics relative to the alternative[17], thus describing this component as a vector of attributes X (Hensher et al. 2005): $\mathbf{V_{in}=\beta\ X_i}$, where β is the vector of parameters associated with each attributes.

Then, in order to allow for discrete choice modeling and econometric analysis, assumptions must be made regarding the random/error component, since it is unobservable, by specifying a random distribution. Once this has been done, the choice model can be applied to the data in order to estimate the different parameters. The WTP is then derived through dividing each non-monetary attributes parameter by the payment parameter.

The most commonly encountered assumption is that error terms are independently and identically distributed (IID) and take on the form of a Gumbel distribution (Mc Fadden, 1974; Hensher et al. 2005). This is the multinomial logit (MNL) model, which we first used in our analysis as the general specification for both regrouped areas, each area, and several pre-defined specific groups of individuals (age, tribe versus non-tribe, cultural origin). This model also allows studying the role of various context variables through their inclusion in the utility function. The MNL model is the most widely used in the field of choice modeling, as it allows for a quick and good understanding and exploration of the data (Hensher et al., 2005), thus helping formulating hypothesis or further analysis that would need a more complex model to be tested or implemented correctly.

Despite its common use, there are severe limitations to this model with respect to its ability to capture random taste heterogeneity across individuals, in particular the panel nature of repeated choices and the well-known assumption of independence of irrelevant alternatives (Train, 2003). Therefore, in the second phase of our analysis two more flexible econometric models wre used and tested, namely the mixed multinomial logit model (MXL) and the latent class model (LCM). In the MXL, each individual's tastes for an attribute is assumed to be random and defined from a specified distribution. Alternatively, the LCM assumes that each individual belongs to exactly one group but that group membership is based on unobservable segmentation regarding tastes. Both models allow relaxing all the strong MNL

[17] This concurs with Lancaster's microeconomic theory of value proposed in 1966.

assumptions: the IID assumptions (via different classes for the LCM and via error component specification for MXL), the assumption of the independence nature of the observed choices by taking into account the panel nature of our data (i.e. the fact that each individual made eight repeated choices) and the homogeneity of preferences. Compared to the MXL, the LCM was finally selected for our analysis since it proved to be the most relevant one, with higher model fits compared to the MXL and also because the MXL do not allow for studying possible attribute non-attendance.

Indeed, a specific attention has been focused more recently on the potential limits of the continuity axiom, which forms the basic assumption of DCEs where there is complete substitutability between the selected attributes (Campbell et al., 2011). Indeed, the implicit assumption in random utility theory is that individuals' decisions follow compensatory rules, although different studies (e.g. Scarpa et al. 2009; Araña and Leon, 2009; Campbell et al., 2008; Sælensminde, 2006; Kahneman and Frederick, 2002) have provided empirical evidence where this assumption do not hold. Observing discontinuous preferences is one of the main issues recently observed in DCEs, and non-compensatory heuristics have been shown to be mainly due to the complexity of the choice task and contextual factors (Hoyos, 2010). This implies that marginal rates of substitution between the attributes cannot be computed at the individual level. Hence there is a recent trend that aims at accommodating both the processing of attributes and the choice outcome under the same framework (Hensher, 2008), allowing marginal rate of substitution from the estimated parameters to be derived and thus, WTP estimates. Recent results have shown that failing to do so biases WTP estimates (Campbell et al., 2011; Puckett and Hensher, 2009). Furthermore, some studies also revealed that for a significant number of individuals interviewed, WTP cannot even be defined since they did not consider the payment attribute during their choices (e.g. Scarpa et al., 2012). In our context, this will have to be tested in view of the issue mentioned earlier regarding the potential lack of credibility of our payment scenarios.

In practice, an answer to this issue is to study through follow-up questions or model attribute non-attendance (i.e. ignoring one or more attributes implies discontinuous preferences), which can be allowed through particular specification of the LCM among other strategies (Campbell et al., 2008; Scarpa et al., 2009; Hess and Hensher, 2010).

5.2 The panel Latent Class Model

As Beharry-Borg and Scarpa (2010, p.1130) noted, “preference intensity may vary in a ‘lumpy’ rather than in a smooth way across the population of interest. In some populations, preference values may coalesce around some intensities due to the particular nature of the populations, giving rise to a finite number of preference groups, each with strong homogeneity within them.” This is the case where the panel latent class model is useful.

The LCM model sorts decision makers by different classes based on similar choice behaviors, and simultaneously estimates their utility parameter conditional on class membership (Swait, 1994). For each decision maker, probabilities to belong to each segment are thus estimated. Two different kinds of LCM can then be used: either the analyst chooses to specify some observable variables (e.g. age) to predict an individual’s membership in a class, thereby capturing observed taste heterogeneity (e.g. Ruto et al., 2008; Boxall and Adamowicz, 2002); or there are no obvious observable variables and the model accounts for only unobserved taste heterogeneity based on the influence of the attributes that were

captured (e.g. Beharry-Borg and Scarpa, 2010). In both ways the analyst is defining the number of classes, based on judgments as well as on comparing models with different number of classes and examining the Akaike Information Criteria[18] (Beharry-Borg and Scarpa, 2010).

Furthermore, the LCM (as the MXL) allows the estimation of 'individual-specific' or 'conditional' parameters (i.e. based on the individual's choices), thus identifying the distribution of preferences among the sample (Train, 2003). As such, based on Bayes' theorem, it is possible to calculate the probability of an individual n being in a class c conditional on the choices made by that individual (Q^*_{nc}) (Greene, 2005; Scarpa and Thiene, 2005) and it is then possible to derive individual-specific posterior estimates of marginal WTP through the β parameters (Scarpa and Thiene, 2005; Beharry-Borg and Scarpa, 2010):

$$WTP_{n,att} = \sum_{C} Q^*_{nc} \left(-\frac{\beta_{c,att}}{\beta_{c,payment}} \right)$$

where $\beta_{c,att}$ and $\beta_{c,payment}$ are respectively the parameters for a non-monetary attribute and for the payment in class c.

In our context, after having examined our data and specified our utilities functions through MNL models, we used LCM in order to account for both the possibility that preference heterogeneity can be better explained in terms of several groups of preferences, and the possibility that individuals may have not considered some of the attributes (especially the payment one as our scenario may lack credibility in the view of some individuals), thus basing their decision solely on one or two attributes. Furthermore, a panel specification was used to account for the repeated choices. All our analysis was conducted using NLogit 5.0.

6. Estimation results: preservation over time, use and non-use value

6.1 Individuals choice behaviors

Before starting the econometric analysis, a crucial step was to look at the follow-up questions regarding the choice experiment and choice behaviors. This had two main consequences. First, a procedure was established to dismiss respondents whose preferences were not appropriate for the choice modelling analysis: this included individuals who skipped some of the choice tasks, or completed the choices but stated that they did it randomly (no understanding of the exercise), or stated that they refused to make choices for various reasons that cannot be considered as preferences for the status quo (e.g. they did not understand the CE, they were firmly opposed to such a payment scenarios, they thought the choices were not relevant or not realistic). In total, 116 individuals were thus dismissed from our analysis (out of the 550 individuals surveyed), among which 82 individuals refused to make any choice. Hence, around 18 percent of the interviewed population refused to make choices, implying that no WTP can be estimated for them.

[18] The Akaike Information Criteria is defined as follow: AIC=−2(LL−K) where K is the number of estimated parameters, N is the number of individuals in the sample and LL is the log likelihood of the model. This criterion, alongside of other similar criteria such as BIC and AIC-3, is suggested and used in the literature for determining the number classes (Beharry-Borg and Scarpa, 2010; Campbell et al., 2008).

Second, we examined attributes processing rules and attendance issues. The major result, detailed in table 3, is that around half of the individuals who completed the eight choices declared having not paid serious attention to the payment attribute and its associated levels. This will need to be checked first (mainly because of possible individuals' failure to assess correctly their choice heuristics or attributes attendance behavior); and then accounted for during the analysis, since for these individuals, no WTP can be derived. According to individuals' responses to follow-up questions, all other attributes seemed to have been considered in a quite homogeneous way.

Table 3 Stated payment attribute consideration during choice process for each area

	ZCO			VKP		
Stated importance of payment during choices	No importance	Medium importance	Important to decisive	No importance	Medium importance	Important to decisive
Percentage	45%	16%	39%	27.5%	26%	46.5%

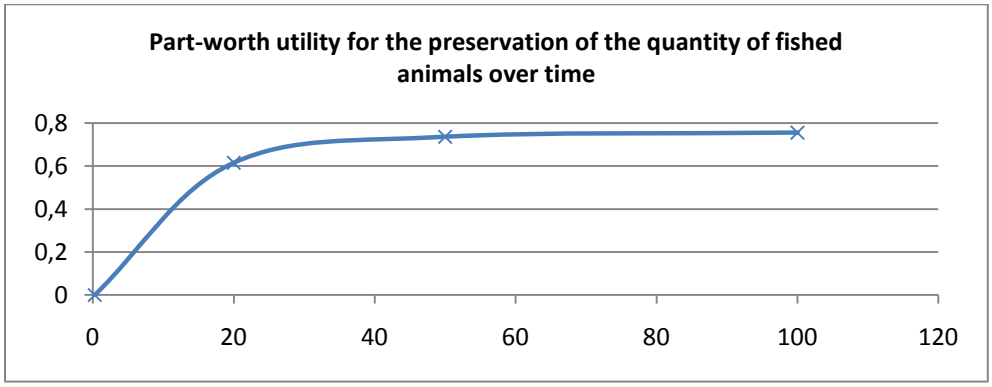
6.2 MNL and non-linear utility specification

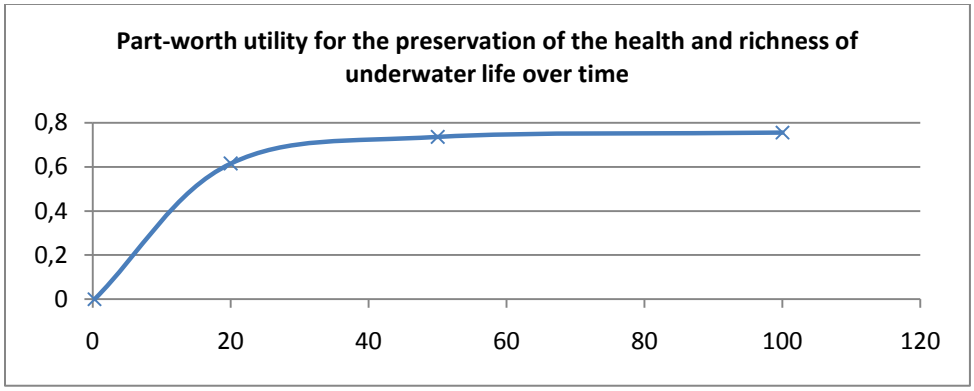
In the first stage of the analysis, a range of different MNL models were used in order to gain a better understanding of the data. This also allowed several assumptions to be tested that arose during the field work and questionnaire analysis, namely that preferences and choices are different between ZCO and VKP, as well as influenced by several observable variables such as gender, age, cultural origin, life in tribe or not, environmental awareness, types or frequency of activities. Detailing all these models and their associated results goes beyond the scope of this paper, and we focus here on two main results: first an original specification of the utility function where some attributes enter the utility under a non-linear continuous form (namely logarithmic), second the differences between both areas as well as the influence of specific observable variables. Appendix 2 presents the MNL results with both areas either pooled or separated, where each attribute's level is able to enter the utility function for all the non-monetary attributes (quadratic MNL models). The payment is considered as continuous and linear.

The MNL results show that while almost all parameters are significant, the model fit is not really good (R^2=0.108), suggesting that not all important information is being captured. This is probably linked to the simplicity of the MNL and its relative assumptions supposing independent choices and preference homogeneity. Besides, due to a very low associated parameter (and only significant at the 10% level for the ZCO area), the WTP estimates are unrealistically high and far higher than the actual maximum payment proposed within the experiment (2000 FCFP/month) for both pooled model and area specific models. All this leads to abnormal results from a welfare estimation point of view.

Also, and perhaps most importantly, the first three non-monetary attributes (Quantity of animals fished, Health and richness of the underwater life, Coastal and lagoon natural landscapes) can all be considered as continuous, but in a non-linear way. The last attribute exhibit strange results that need further considerations. A graphic representation of the different part-worth utilities of those three first

attributes is shown in Figure 9, extrapolated from our four points through time in the pooled MNL. When having a look at these different curves, one can notice that the shape is close to a logarithmic function[19].





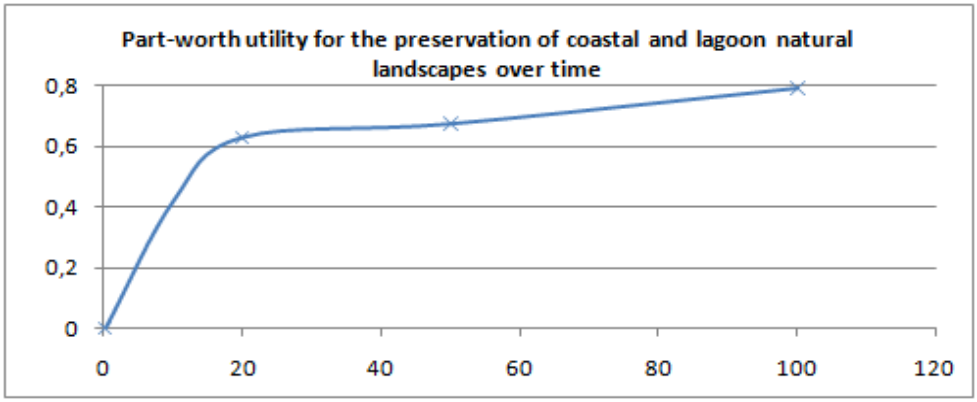


Figure 2 Part-worth utilities of three attributes over time: Quantity of animals fished, Health and richness of the underwater life, Coastal and lagoon natural landscapes

We can now consider a new assumption regarding utility specification: all these three attributes could enter the utility function under a logarithm function[20]. Besides, we observed that there are significant differences between the two areas. An important one concerns the attribute areas of practice. For the

[19] The status quo is here defined as 0.3 years of preservation since it implies anyway current conservation practices to be continue and efficient for at least the next four months (due to the rapid undergoing changes in both areas and the need of additional preservation measures).

[20] With a value defined as -1 for the status quo level (corresponding to preservation for around 4 months).

ZCO area, this attribute shows similar logarithmic shaped part-worth utilities than for the other attributes. For VKP, only the 50 years preservation level is significant[21]. Therefore, the last non-monetary attributes (areas of practice) was kept under its previous quadratic form for VKP, and enter the utility as a logarithm function for ZCO. This new utility specification with logarithmic functions was thus tested using MNL models for each area and results are given in appendix B (table 5). Most of the parameters are highly significant, and the WTP estimates are still unrealistic. The model fits and predictions are similar, with new pseudo-R^2 around 0.107 for ZCO and 0.112 for VKP (respectively 0.108 and 0.115 for the previous model). This suggests that the new specifications of the utility function do not imply any significant changes in models predictions[22], and work as well as the quadratic version.

The poor model fits and predictions encountered with the MNL models and the unrealistically high WTP estimates imply a need for further analysis in two directions: relax MNL hypothesis regarding preference homogeneity, include the panel nature of our data, and deal with a possible cost attribute non-attendance.

6.3 LCM and payment non-attendance

We therefore run several panel LCM models considering our two objectives: (1) check for possible cost attribute non-attendance; and (2) estimate individual WTP and differentiate use and non-use values. Regarding objective (1) we chose to use the answers to the follow-up questions regarding attributes attendance for selecting individuals who did consider the payment during their choices[23]. However, since this method has some limits (Campbell and Lorimer, 2009; Hess and Hensher, 2010; Hussen Alemu, 2012), we had to make sure that individuals payment attributes attendance statements were actually corresponding to their choices. After several tests (i.e. running models for each groups presented in table 3), we finally break our sample into two categories: individuals who stated nil or poor attendance to the payment (including the “medium importance” group), and individuals who stated important and systematic consideration. Results of panel-LCM with two classes for these two groups are presented in table 4, for each area and with the non-linear utility specifications previously selected. Adjusted pseudo

[21] This result can be explained due to the contexts of these areas: in ZCO, the lagoon is very narrow, with significant parts being marine reserves, thus implying conflict of uses or concerns form the populations regarding a potential of areas of practices and an important attention paid to this attribute during the choices. In VKP, however, there are no reserves and the lagoon is huge, with small conflicts regarding areas of practice (only for the coastal tribes which claimed the official recognition of their traditional reserves), which explained less attention paid to this attribute through time.

[22] The performances of the models were both assessed and compared through looking at pseudo-R^2 and examining the proportions of correct and incorrect predictions through contingency tables for each model. These proportions are similar between quadratic MNL and logarithm MNL.

[23] As noted before there are different ways to deal with possible attributes non-attendance. As such, we also run panel LCM with parameters restrictions with respect to the payment attribute, whose parameter was specified as being 0 for one class, and different than 0 for the other one, with a last class accounting for individuals that did not considered any of the attributes (thus unable to be correctly modeled). It confirmed the stated non-attendance results with an even larger cost attribute non-attendance for both areas; however we did not select these LCM parameters restrictions models for our analysis here since they do not allow the inclusion of an alternative specific constant, which would thus biased our WTP estimates.

R-squared are much higher compared to MNL model, confirming the major benefit of allowing for preference heterogeneity and considering the panel nature of our data. The low number of classes – two – was selected using AIC criteria, and also in order to keep results interpretation simple. Two important conclusions can be made:

- Statements of individuals are actually corresponding to their choice heuristics: for both area, LCM results for individuals who stated no or slight attendance for payment attribute show two classes with insignificant payment parameter, whereas results for individuals who stated consideration of cost show a good homogeneity with a major dominant class (90% of individuals) with significant payment parameter (the second class regrouping unexplained choices).
- We are now able to estimate credible WTP for the group of individuals who did consider the payment and thus derive use and non-use values.

We then investigated in more details the payment non-attendance issue, since it concerns half our sample, through examining if there were any specific socio-economic pattern in individuals who stated consideration or non-consideration of the payment. We also run other panel-LCM for different categories in age, income, life in tribe versus non-tribe and intensity of marine activities (results for the VKP area are presented in Appendix D as an example). Our results show that, in ZCO area, payment consideration is mainly coming from people between 20 and 30 years old, with a low to medium household income. In VKP area, payment consideration is mainly coming from people living in tribe: indeed more than 95% of individuals who are living in tribes (Kanak people) did consider the payment, with a bit less than 15% for people living in villages or farms (mainly white Caledonian people). This is an interesting result as it goes against the common intuition that individuals whose economy is less grounded within the modern monetary system (and still living in a traditional tribal system) would find such a payment unacceptable or would not consider it in a rational economic way. Payment non-attendance in VKP came from individuals aged between 30 and 40 years old, with an average household income. Both individuals with very low and high household income did consider the payment, so that non-attendance was not due to insufficient payment levels (it was worth checking this issue even if the levels were selected properly through focus group discussions).

6.4 Estimation of individual use and non-use values

We now focus on the 82 individuals in the ZCO area, and 113 individuals for the VKP area that show payment consideration. From the panel LCM results, we can now derive marginal WTP for preserving the different attributes over several durations. LCM results and mean WTP for the different attributes are presented in table 4.

Table 4 Panel LCM results for each area: individuals who stated attendance or non-attendance of payment

	ZCO			VKP		
	Stated non-attendance	Stated attendance		Stated non-attendance	Stated attendance	
	Parameters	*Parameters*	*WTP* (fcfp/month/household)	*Parameters*	*Parameters*	*WTP* (fcfp/month/household)
Class 1						
Payment	-0.000012 (NS)	-0.00024**		-0.00012 (NS)	-0,00048***	
Ln (Quantity of animals fished)	0.142***	0.112***	**477**	0.269***	0,137***	**285**
Ln (Health of underwater life)	0.184***	0.159***	**675**	0.533***	0,208***	**434**
Ln (Coastal and lagoon landscapes)	0.166***	0.145***	**616**	0.342***	0,090***	**187**
Ln (Areas of practices)	0.144***	0.094***	**401**			
Preservation Areas of practice 20 years				0.069 (NS)	0,215***	**448**
Preservation Areas of practice 50 years				0.449***	0,317***	**660**
Preservation Areas of practice 100 years				0.098 (NS)	-0,104 (NS)	Not defined
ASCsq	-19.69 (NS)	-0.934***		0.824 (NS)	-1.479***	
Class probabililty	0.83***	0.88***		0.74***	0.9***	
Class 2						
Payment	-0.00025 (NS)	NS		-0.00011 (NS)	NS	
Ln (Quantity of animals fished)	0.249***	NS		0.029 (NS)	NS	
Ln (Health of underwater life)	0.458***	NS		0.0008 (NS)	NS	
Ln (Coastal and lagoon landscapes)	0.450***	NS		-0.013 (NS)	NS	
Ln (Areas of practices)	0.317***	NS				
Preservation Areas of practice 20 years				-0.093 (NS)	NS	
Preservation Areas of practice 50 years				0.274***	NS	
Preservation Areas of practice 100 years				-0.257 (NS)	NS	
ASCsq	5.331***	NS		-2.62***	NS	
Class probabililty	0.17***	0.12***		0.26***	0.1***	
Mc Fadden Adjusted *Pseudo-R^2*	0.4	0.36		0.47	0.39	
AIC criteria	1.33	1.45		1.19	1.37	
Number of individuals	131	82		131	113	

NS: Not significant

In order to differentiate between use and non-use values, which depend on individuals' life expectancy, we first estimated individual specific WTP for all the different attributes and then computed individual specific WTP for preservation below or strictly beyond their life expectancy with respect to individuals' current ages. Average life expectancy at birth in New-Caledonia is 76 years so for each individual we calculated his WTP for a preservation strictly over (76 - Individual's age) years, which is equivalent to a NUV component, and his WTP for a preservation below (76 - Individual's age) years, which is equivalent to a use values component (including also minor NUV, and option values components)[24]. For both areas WTP before and over life-expectancy were thus calculated this way for each non-monetary attributes[25], and total UV and NUV were then derived by adding up the different attributes' individual WTP. Figure 3 presents the Kernel density estimator plots for both individual UV and NUV for each area. This is a useful tool for graphically presenting the distributions of parameter estimates (in case of an MXL) or individual WTP (Hensher et al., 2005). The mean of individual specific WTP are shown on each graph.

When looking at figure 3, it can be noticed that the mean WTP estimated for ZCO are much higher than the one for VKP. This can be explained in two ways[26]. First there might be a stronger commitment to preserve marine ecosystems in the ZCO area: it is a UNESCO world heritage area (with marine reserves and touristic activities) and inhabitants of this area showed a strong stewardship with respect to preserving these costal and marine ecosystems, whereas the VKP area is facing a huge mining industry project, with a much bigger lagoon without any touristic activities (although local recreational fishing is strongly present). Second, consideration of the payment attributes is probably less important in ZCO area (as shown with the associated parameter, which is less significant than the one for the VKP area): this can be due to a more secured feeling in ZCO area regarding the future of marine ecosystems, implying less attention to the payment within the scenarios.

An important result from this analysis is that the calculated NUV component represents between 25 and 30% of total WTP. This is a significantly more conservative estimate that the one usually found in the literature, where NUV usually represents between 65 and 90% of WTP. This has to be replaced within the framework of our definition, which allows exclusive but a minima estimates of NUV.

[24] For the very few individuals who were actually over than 76 years old, we considered than their WTP for any additional year of preservation were NUV.

[25] For the VKP area, since the attribute area of practice could not be considered under a continuous form, NUV were estimated only for people over 56 years old (through the WTP to go from 20 to 50 years of preservation), which explained mainly why their part in total WTP is smaller compared to ZCO area. Similarly, use values WTP in VKP for the area of practice were derived for people below 26 years old.

[26] As an aside, it is worth noting that this difference is not due to any specific income effect.

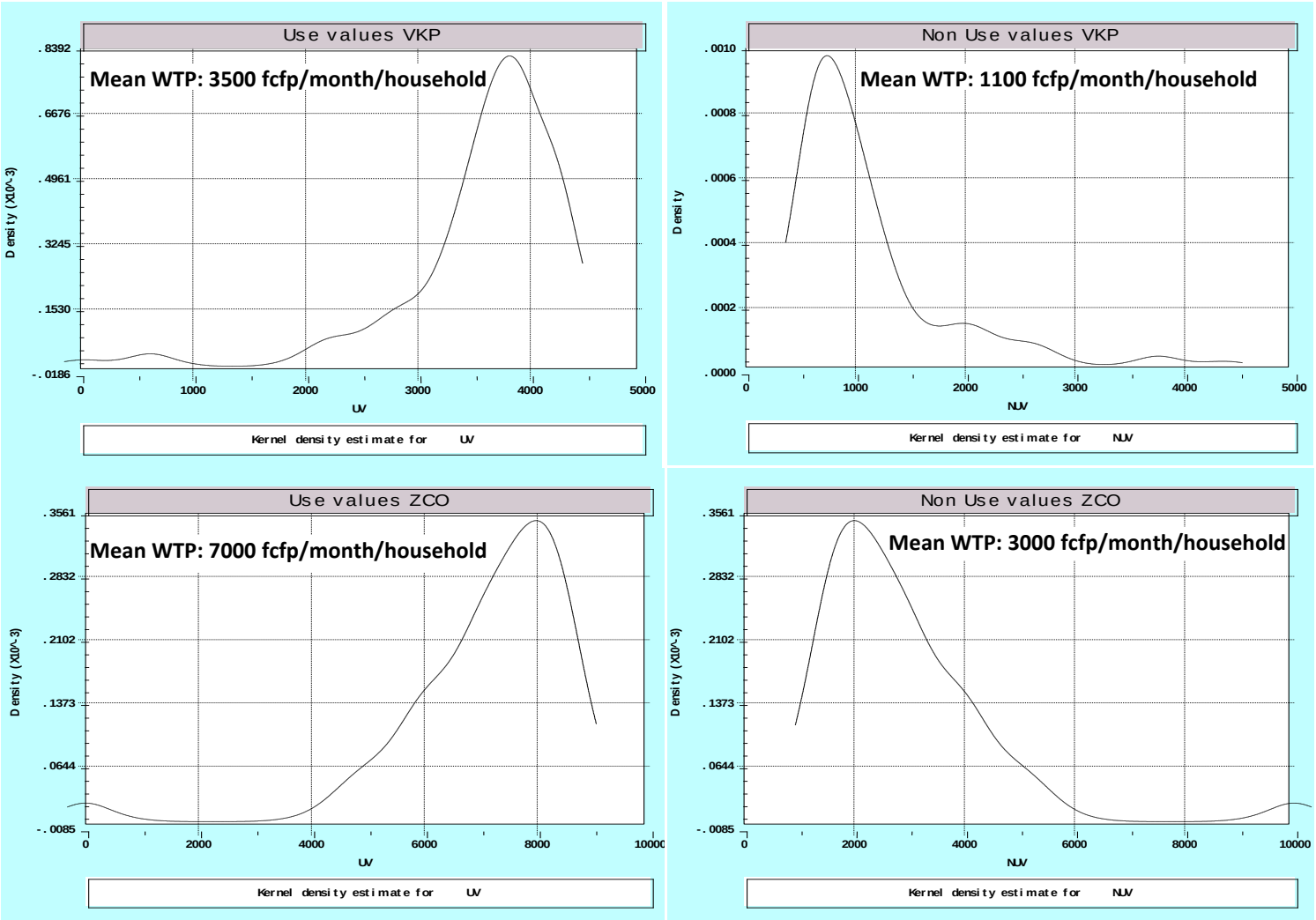


Figure 3 Distribution of individual use and non-use values for VKP and ZCO

7. Discussion and conclusions

Several important general results from our case study can be pointed out. We saw that numerous contextual elements are playing a role in individuals' preferences and WTP. More precisely, we highlighted substantial differences between both areas, although they are very close geographically and share some characteristics in terms of environment and populations. We also observed various levels of attribute attendance and different choices among similar types of population (age, income, tribe or non-tribe). Our models worked well in explaining and illustrating the different contextual elements of each area. These results confirm that during an economic valuation exercise, institutional, socio-economic and cultural contexts, as well as the status of the environment play a crucial role, which needs to be accounted for. WTP estimates should thus be used with caution. It also support concerns that have been voiced regarding benefit transfer, which even within a small regional context need careful consideration before being implemented.

Second, we saw that ignoring possible cost attribute non attendance can lead to extremely biased and unrealistic WTP estimates; and the existence of WTP itself cannot be assumed if the payment is not considered by the respondent. In all the models where the payment non-attendance was taken into account, we also noted a substantial gain in terms of general prediction and model fit. We thus argue that, even if WTP estimates do not seem unrealistically high, DCE studies should systematically test for cost attribute non attendance, as a routine check, i.e. the mere existence of WTP should be tested. More generally, any attribute processing rules that respondents could use should be accounted for. Although this general result is not new to the recent literature (e.g. Campbell et al., 2011), most of the studies we are aware of did not examine the details of the cost attribute attendance issue (with the notable exception of Scarpa et al., 2009), and we found no studies examining the distribution of this attendance issue within and between different populations. In our context, we showed that cost attribute non-attendance was not due to a payment range issue and we also showed that attendance was different following age or cultural criteria that can go against general intuition (individuals living in tribe system with small and recent market economy paid more attention to the cost).

Regarding our main objective, which was to examine the issue of measuring non-use values, several important results can be highlighted. First, our approach allowed us to specify part-worth utilities regarding the preservation of the different attributes over time under a logarithmic form. This is in itself a significant contribution concerning the DCE literature, where it has been argued that linear utility function specifications are not likely to be robust due to the existence of diminishing marginal utilities or gain-loss asymmetries, and as such represent an important limit of current practice in DCE (Hoyos, 2010). This also confirms the theoretical basis of our approach. Second, we were able to differentiate WTP between use and non-use values at the individual level, and implicitly isolate an a minima but exclusive non-use WTP component, which represents between 25 and 30% of total mean WTP estimate. Both results – the logarithmic shape of utility for preserving EGS over time and the implicit a minima component of NUV in WTP – can be useful[27] to decision-making process in New-Caledonia, either in an informative or advocacy context, either in a cost-benefits approach when dealing with identifying benefits linked to preservation of marine and coastal ecosystems.

It is of course necessary to examine critically our approach through this case study implementation. The main limitation is with respect to the cost attribute attendance issue, which precludes the possibility of deriving WTP for an important part of our sample, although it constitutes an important result of our analysis. The main question here is to ask why we are facing such a strong non consideration of the payment attribute. This might be due to four possible reasons: (1) the DCE was badly conducted; (2) the payment levels were too low; (3) the overall exercise was not realistic enough leading to a lack of credibility of the payment scenarios in practice; (4) the payment was not considered by individuals because of a belief that preservation should be guaranteed no matter how much they pay. We invalidate option (1) since the surveys were implemented with great caution, especially regarding the DCE section,

[27] A meeting was also organized with public institutions to discuss the possible interest and application of our results. As costs-benefits analysis are not practiced in New-Caledonia, our results are meant to be used for informative and advocacy purposes, at the local and national level (e.g. French Ministry of Overseas Territories).

involving double-checking and contacts with interviewed individual after the survey. Option (2) was invalidated by our analysis.

We thus believe the cost-attendance result is due to option (3) and option (4), with no real possibility to estimate the exact role they are each playing. The credibility of the DCE is certainly an important limit of this experiment, although many efforts were made to make the exercise as serious as possible for the individual respondents. It should also be pointed out that during the survey, few individuals actually stated that the choices were unrealistic (around 14%), although they had the possibility to do so. This is why we believe that our last assumption is also valid, suggesting that a moral commitment to preservation over the long term could possibly make any monetary schemes irrelevant. In other words, part of the cost non-attendance observed is related to the issue of incommensurability and lexicographic preferences. This is especially interesting in view of our initial and main objective regarding non-use values, which we saw have often been described as involving motivations that cannot be tackled by any quantitative metrics. As a more factual example, almost all respondents stated that preserving the lagoon is predominantly justified by the idea that ecosystems must continue to exist independently of human uses and considerations[28]. Such a deontological ethical position would thus explain partly the refusal to consider the payment attributes levels, while accepting to complete the choices.

A second limit concerns our definition of non-use values itself. As stated before, we are able through our method to securely capture exclusive non-use values for users through WTP for preservation beyond life-expectancy, but the complementary WTP before life-expectancy also certainly includes non-use components.

This last point also raises a crucial issue. We already saw and justified why estimating non-use values economically has been considered as important, especially in a cost-benefits analysis context. However we argue this quantification should be conducted with a critical and complementary analysis: the claim of the quantitative and static principle underlying the estimation of non-use values through WTP has to be moderated by a more dynamic (i.e. change in values) and multi-dimensional analysis. In view of our exercise, it becomes necessary to ask another question: is it really relevant to distinguish quantitatively between use and non-use values once a value has been estimated in a decision-making context? At this stage, we have tested our approach through an empirical case study, and in view of our various results regarding the WTPs, our answer is somehow ambivalent. Non-use values definitely represent values that policy makers or stakeholders as well as any scientific disciplines which aim at supporting decision-making have to consider very seriously, regarding users and non-users of any EGS. However, whether or not their identification and measurement in monetary terms is necessary, it must certainly never be considered as sufficient. In order to gain a better understanding of this last problem, it would be interesting to ask decision-makers or stakeholders themselves about the extent to which they would consider such values in their decision-making.

[28] This does not necessarily go against the low observed share of NUV in total WTP (around 25-30%) we estimated as it is a conservative estimate.

Appendix A

The area selected in the Southern Province is called "Zone Côtière Ouest" (ZCO) for West Coastal Area. It includes five districts: La Foa, Moindou, Bourail, Farino, Sarraméa. This area is among the sites listed as UNESCO World-Heritage, covering around 500 km^2 of coral reefs, mangroves, sea grass and estuaries, with a further 300 km^2 listed as UNESCO marine buffer zone. In addition, 1700 km^2 of terrestrial lands are listed under UNESCO buffer zones. Besides its outstanding beauty, the ZCO was listed in recognition of its significant role in New-Caledonian coastal biodiversity: it encompasses some of the most important nesting sites for Loggerhead and Green Sea turtles, and it is home to one of the biggest populations of Dugongs in New-Caledonia. The area also provides nesting sites for several sea bird species. Furthermore, compared to other areas in New-Caledonia, the lagoon is especially narrow in this area, with the reef being close to the shore (less than 1km in some areas). That makes it more sensitive to anthropogenic pressures (e.g. erosion, domestic pollution), which are becoming more important as the population of the area is growing with a subsequent increase of uses and activities in the lagoon. In addition, the area is also facing a growing number of people coming from Noumea (the capital of New Caledonia, less than two hours car trip) for the week-ends, in holiday homes or for camping. Finally, a hotel complex development project (Sheraton) on the coast of Bourail (Gouaro Deva), right near the beach and in front of an important marine reserve, has been started after long discussions, polemics (especially regarding the potential lack of clients and tourists) and twists and turns. Its main public justification is the potential boost to regional socio-economic development. The hotel complex is supposed to be completed by the beginning of 2014.

Figure 4 Map of ZCO area and associated UNESCO world-heritage zones

The area selected in the Northern Province is called VKP, in relation to its three districts: Voh, Koné and Pouembout. This is an especially crucial area for the Northern Province as it is hosting a considerable mining project (several nickel extraction sites and the building of a processing plant), which is supposed to redress the economic imbalance between the South and North of New-Caledonia. Indeed, almost two-third of the NC population is concentrated in the greater Noumea metropolitan area (Grand Noumea), and is the area where most socio-economic development is taking place, thereby attracting individuals from the Northern Province looking for a job or in some case for a more "modern" life to escape the tribe system well-established in the North. Therefore, this mining project aims – in addition to the resource rent it is expected to generate – at creating a socio-economic dynamic in the area, with a growing urbanization and immigration from other Northern areas (as well as foreign countries), thereby securing the economic independence for the Northern Province. The vast lagoon and CRE in VKP are therefore increasingly subject to external pressures, the main concerns being erosion, the dredging for vessels' channel and the waste release of the Nickel processing plant into the sea. Those CRE, though not listed UNESCO for obvious reasons, host an important biodiversity (coral reefs, sea grasses, huge areas of mangroves) with several protected species (e.g. green and hawksbill turtles, dugongs). Further, several populations present in this area are highly depending on it, with several coastal Kanak tribes whose people life is almost entirely based on traditional and subsistence fisheries activities. It is worth noting that there is also an important quantity of frequent recreational users (mainly fisheries), amongst other populations. All in all, this is an area facing rapid economic development, with growing mining industry as well as domestic pressures, and where preserving CRE becomes a crucial issue due to the number of recreational and traditional uses.

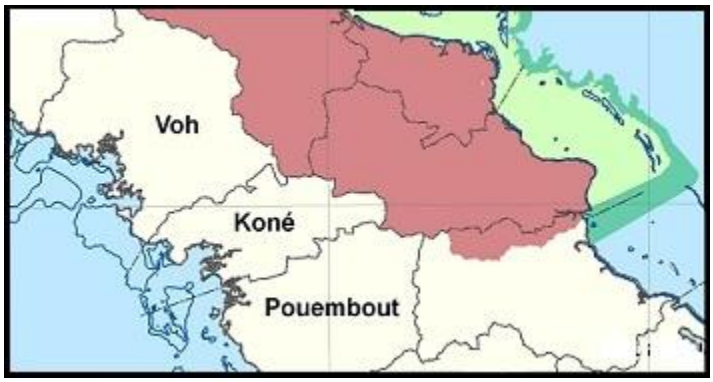


Figure 5 Map of Voh-Koné-Pouembout (VKP) area

Appendix B: Tests of the experimental design

Table 5 MNL model outputs with simulated data

	Effect	Standard errors	t-ratio
Payment 500 FCFP/month	0.029	0.038	0.777
Payment 1000 FCFP/month	0.017	0.038	0.455
Payment 1500 FCFP/month	-0.021	0.037	-0.581
Payment 2000 FCFP/month	-0.025	0.041	-0.613
Fished animals Progressive degradation	-0.005	0.037	-0.142
Preservation Fished animals 20 years	0.009	0.037	0.233
Preservation Fished animals 50 years	-0.039	0.036	-1.098
Preservation Fished animals 100 years	0.036	0.038	0.945
Progressive degradation Health underwater life	-0.016	0.037	-0.416
Preservation Health underwater life 20 years	-0.028	0.037	-0.755
Preservation Health underwater life 50 years	0.009	0.037	0.231
Preservation Health underwater life 100 years	0.035	0.038	0.928
Less natural areas	0.019	0.036	0.538
Preservation Landscapes 20 years	0.046	0.036	1.257
Preservation Landscapes 50 years	-0.048	0.036	-1.350
Preservation Landscapes 100 years	-0.017	0.037	-0.459
Areas of practice not guaranteed	-0.024	0.038	-0.634
Preservation Areas of practice 20 years	0.041	0.036	1.133
Preservation Areas of practice 50 years	0.0103	0.039	0.266
Preservation Areas of practice 100 years	-0.028	0.039	-0.712

Table 6 Our design efficiency in comparison to other design (D-efficiency is computed as the ratio of design strength; Chrzan et Orme, 2000)

	Sawtooth Strength of design	D-efficiency (comparison with our design)
Full enumeration design: 6 choice sets versions with 8 choices (our design)	909.55	1,0
Alternative design: 30 choice sets versions with 8 choices	958.33	1,054 -> +5,4%
Random design: 6 choice sets versions with 8 choices	653.33	0,72 -> -38%

Appendix C

Table 7 MNL quadratic models results

	Pooled model ZCO+VKP		VKP	ZCO
	Parameters (normalized)	WTP (FCFP/month)	Parameters (normalized)	Parameters (normalized)
Payment	-0,00015***		-0.00020***	-0.00010*
Preservation Fished animals 20 years	0,615**	4045	0,638*	0,613
Preservation Fished animals 50 years	0,736***	4840	0,776***	0,709***
Preservation Fished animals 100 years	0,756***	4969	0,780***	0,826***
Preservation Health underwater life 20 years	0,899***	5910	**0,972***	**0,828****
Preservation Health underwater life 50 years	1,053***	6924	**1,215*****	**0,893*****
Preservation Health underwater life 100 years	1,131***	7436	**1,274*****	**0,993*****
Preservation Landscapes 20 years	0,663***	4362	0,632***	0,706*
Preservation Landscapes 50 years	0,674***	4436	0,647***	0,720**
Preservation Landscapes 100 years	0,792***	5211	0,645***	0,984***
Preservation Areas of practice 20 years	0,311	2045	0,342	0,283**
Preservation Areas of practice 50 years	0,647***	4254	0,634***	0,674***
Preservation Areas of practice 100 years	0,451**	2966	0,226	0,707***
ASCsq	0, 299***		0.036	0.602***
Mc Fadden *Pseudo-R^2*	0,108		0,111	0,115

**** Significant at the 1% level** Significant at the 5% level * Significant at the 10% level*

Table 8 MNL models results with logarithmic utilities specifications

	ZCO Parameters	VKP parameters
Payment	-0.00010*	-0.00024***
Ln (Quantity of animals fished)	0.135***	0.146***
Ln (Health of underwater life)	0.180***	0.229***
Ln (Coastal and lagoon landscapes)	0.163***	0.124***
Ln (Areas of practices)	0.129***	
Preservation Areas of practice 20 years		0.0545
Preservation Areas of practice 50 years		0.337***
Preservation Areas of practice 100 years		-0.059
ASCsq	0.57***	-0.0376
Mc Fadden *Pseudo-R^2*	0,107	0,112

Appendix D

Table 9 Panel LCM for different groups of populations in VKP area

		Tribu/Non Tribu		Age				Income			
	VKP: All	**Tribe**	**Non Tribe**	**20-30**	**30-40**	**40-50**	**50 et +**	**Low**	**Low-Med**	**Mid**	**High**
CLASS 1											
Payment	-0.00035**	-0.00041***	-0.00002	-0.00068***	0.00003	0.00091	-0.00052***	0.00085**	-0.00057***	-0.00012	-0.00041
Ln Catches	0.267***	0.169***	0.116***	0.253***	0.144***	0.295***	0.175***	0.189**	0.171***	0.124***	0.193***
Ln Health	0.563***	0.237***	0.233***	0.489***	0.200***	0.422***	0.236***	0.131	0.237***	0.255***	0.354***
Ln Landscape	0.311***	0.147***	0.104***	0.270***	0.127***	0.482***	0.127***	-0.115	0.149***	0.173***	0.130***
Areas 20 years	0.14	0.040	-0.049	0.186	-0.065	-0.169	-0.062	-0.231	-0.107	0.131	-0.062
Areas 50 years	0.500***	0.431***	0.313***	0.275	0.445***	0.640*	0.268**	0.299	0.379***	0.192*	0.472***
Areas 100 years	0.103	-0.039	-0.052	0.406*	-0.15722	0.677*	0.085	-0.567	0.085	0.007	0.127
ASCsq	1.302**	-1.58***	-3.798***	-0.246	-1.158***	-25.633	-1.887***	-29.75	-1.910***	-1.38***	-1.366*
CLASS 2											
Payment	-0.00026***	NS	-0.0016***	-0.00027**	NS	-0.00082***		-0.00084	NS	NS	NS
Ln Catches	0.062***	NS	0.510***	0.046	NS	0.169***		0.165***	NS	NS	NS
Ln Health	0.049***	NS	0.453***	-0.001	NS	0.504***		0.576***	NS	NS	NS
Ln Landscape	0.021	NS	0.308***	-0.042	NS	0.147***		0.458***	NS	NS	NS
Areas 20	0.062	NS	0.668***	0.211	NS	0.17598		0.628***	NS	NS	NS
Areas 50	0.245***	NS	0.197	0.268**	NS	0.284**		1.200***	NS	NS	NS
Areas 100	-0.22***	NS	-0.183	-0.462***	NS	-0.15825		0.074	NS	NS	NS
ASCsq	-3.235***	NS	2.50786***	-1.580***	NS	0.19636		2.566***	NS	NS	NS
Pseudo-R2	0.44	0.42	0.42	0.35	0.4	0.47	0.44	0.41	0.42	0.4	0.43
AIC	1.25	1.3	1.31	1.49	1.38	1.23	1.3	1.46	1.32	1.39	1.29
Prob CLASS 1	0.56**	0.98	0.8*	0.62***	0.96	0.39**	0.9*	0.35	0.94	0.97	0.91
Prob CLASS 2	0.39**	0.03**	0.13***	0.38***	0.04*	0.61***	0.01***	0.51	0.06**	0.03	0.09**
Prob CLASS 3	0.05***		0.07***					0.14**			
Number Individuals	244	122	122	60	72	54	58	38	61	59	59

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