Universitat de les Illes Balears

DOCTORAL THESIS
2015

CHALLENGES IN ECONOMIC VALUATION OF WETLAND PROTECTION UNDER CLIMATE CHANGE IMPACTS

Michela Faccioli

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Doctoral Programme in Applied Economics

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Michela Faccioli

Thesis supervisor: Antoni Riera Font

Thesis supervisor: Catalina M. Torres Figuerola

Thesis tutor: Antoni Riera Font

Doctor by the Universitat de les Illes Balears

To my family

In memory of my beloved grandparents

Our duty to the whole, including the unborn generations, bids us to restrain an unprincipled present-day minority from wasting the heritage of these unborn generations.

Theodore Roosvelt
A Book-Lover's Holidays in the Open, 1916

ACKNOWLEDGEMENTS

My first words of acknowledgement are for my supervisors, Dr. Antoni Riera Font and Dr. Catalina M. Torres Figuerola, who have helped and supported me during the process of this doctoral thesis. Without their advice, professionalism, encouragement, dedication and patience this work would not have been what it is. From them I have learnt that all defeats represent opportunities and that research is no closed process.

I also want to thank Prof. Nicholas Hanley for giving me the opportunity of working with him during the visiting research stay that I have undertaken at the Department of Geography and Sustainable Development at the University of St. Andrews (Scotland). I am also grateful for the fruitful comments I have received from him along this research work. A few words of gratitude need also to go to Dr. Laure Kuhfuss, from the University of St. Andrews, for some helpful comments in the last chapters of my doctoral thesis.

I am indebted with Dr. Àngel Bujosa Bestard for having introduced me into the world of programming with Matlab and being constantly available when I needed help. I can not forget to thank my colleagues at the Economic Analysis of the Impact of Tourism (AEIT) research group and the Applied Economics Department at the University of the Balearic Islands for providing me with financial and technical support, crucial to undertake this doctoral work. This research has mainly been funded through a scholarship within the FPU program of the Ministry of Education, Culture and Sport (ref. AP2010-3810) and through the Special Action program of the Government of the Balearic Islands (ref. AAEE025/2012).

I want to thank the Director of S'Albufera Natural Park, Maties Rebassa, and the rest of the staff for their collaboration, especially, during the primary data gathering. I appreciate also the work of the four surveyors involved in the project, Ms. Barbara von Siebenthal, Ms. Mari Carmen Burgueño Martinez, Ms. Ruth Muñoz Florit and Mr. Pere Josep Pons Vives, who have carried out the interviews with visitors.

I have no words to thank my parents, Emilia and Pergiuseppe, and my sister, Veronica, for their support and love during these years. Despite being thousands of kilometers away, they have been with me all the time with their constant encouragement and trust. I want to express my gratitude and love especially to my life companion, Federico. He, more than anyone, knows what this doctoral thesis has meant to me. Seeing his eyes full of proud in the face of each accomplishment and full of confidence during each difficult moment has been the energy I needed for never giving up despite all the obstacles I have encountered along the path.

ABSTRACT

The conservation of humid lands emerges as a priority within the social debate. Given the contribution of wetlands to sustain human well-being, their protection in the face of increasing anthropogenic stresses is perceived as socially desirable. This is especially true in the face of climate change (CC), which is expected to become the major source of wetlands' deterioration in the future. In this sense, to be welfare-maximizing, policy design should be guided by knowledge about the valuation of the social benefits of wetlands' protection.

In this framework, while the valuation task becomes a crucial tool to better inform policy-makers, it is also associated with some challenges. These are due to the fact that CC is a future time-persistent problem and its impacts are expected to be complex, inherently uncertain and extended over the long- and very long-term. Regardless of the fact that these aspects are anticipated to affect social welfare, their role in stated preference valuation has been largely underexplored.

To shed some light on these issues, three are the research questions addressed in this thesis. First, the trade-offs between the social value of avoiding different and complex wetland impacts. Second, the effect on the social preferences for preservation measures of incorporating information about the inherent uncertainty of environmental processes. Third, the role of sustainability issues by examining whether social preferences for

policies having their benefits in the long- and very long-term are non-declining. To answer these questions, a choice experiment has been undertaken in S'Albufera wetland (Mallorca, Spain). In specific, the valuation exercise has been designed to consider: separate attributes for the complex impacts of CC, alternative scenarios of probability of impacts' occurrence to express inherent uncertainty and different time horizons in the long- and very long-term.

Results have shown that complexity, inherent uncertainty and sustainability issues are relevant aspects. Individuals overall care about the impacts of CC on wetlands, even though they assign unequal values to the different impacts considered, suggesting substitution and complementarity patterns that are useful for the design of environmental policies. Respondents are sensitive to the inherent uncertainty associated with the natural variability of CC effects. They also care about sustainability issues, by equally valuing preservation in the long-term and very long-term, due to a concern for the well-being of future generations.

These findings are important not only to better inform wetland management under CC, but also to guide stated preference valuation practitioners. Indeed, results show that the challenges associated with valuation in the face of time-persistent environmental problems, like CC, need to be carefully considered, given that ignoring them can have important social welfare implications.

RESUMEN

La conservación de las zonas húmedas ocupa un lugar central en el debate social. Y es que dada su contribución al bienestar humano y ante la creciente presión antropogénica, su protección se percibe hoy día como socialmente deseable. Este hecho adquiere, si cabe, más importancia ante el cambio climático (CC), un fenómeno que se prevé se convierta en la principal fuente de deterioro de los servicios ecológicos que proporcionan las zonas húmedas. Así las cosas, en un intento de maximizar el bienestar social, resulta fundamental apoyar la toma de decisiones públicas con un conocimiento detallado de las preferencias sociales y, en particular, del valor que la sociedad asigna a la protección de estas zonas.

En este contexto, a pesar que la valoración económica resulta una herramienta fundamental para mejorar la toma de decisiones, no hay que obviar que lleva implícitos importantes desafíos. No en balde, el CC es un problema persistente en el tiempo y sus efectos son, por definición, complejos, inherentemente inciertos y se extienden desde el presente al futuro más cercano y más lejano. Todos estos aspectos, independientemente de la influencia que se espera tengan en el bienestar social, han sido poco explorados en los estudios de valoración basados en preferencias declaradas.

En este sentido, en un intento de mostrar la influencia que ejercen estos aspectos en los ejercicios de valoración económica, el presente trabajo gira

alrededor de tres preguntas. En primer lugar, se examinan los componentes del valor social de políticas encaminadas a evitar los complejos y variados impactos del CC. En segundo lugar, se estudia el efecto que la incorporación de información sobre la incertidumbre inherente a los procesos ecológicos tiene sobre las preferencias sociales. Y en tercero y último lugar, se analizan cuestiones relacionadas con la sostenibilidad, y concretamente, si las preferencias sociales por políticas que tienen beneficios en el largo plazo y muy largo plazo son no-decrecientes. Para abordar estas cuestiones, se ha realizado un experimento de elección en la zona húmeda de S'Albufera (Mallorca, España). En particular, el ejercicio de valoración se ha diseñado teniendo en cuenta: diferentes atributos para capturar la complejidad de los impactos del CC, escenarios alternativos de probabilidad de ocurrencia de los impactos, para expresar la incertidumbre inherente a los procesos ecológicos, y diferentes horizontes temporales.

Los resultados han mostrado que la complejidad, la incertidumbre inherente y la sostenibilidad son aspectos relevantes. En general, los individuos se preocupan por los impactos del CC en las zonas húmedas, aunque asignan valores diferentes a los atributos considerados, sugiriendo patrones de sustitución y complementariedad útiles a la hora de diseñar políticas ambientales. Así mismo, se confirma que los individuos son sensibles a la incertidumbre inherente asociada a la variabilidad natural de los efectos del CC, a la vez que se muestran sensibles a las cuestiones relacionadas con el bienestar de las generaciones futuras, valorando igual la preservación en el largo plazo como en el muy largo plazo.

Estos resultados son importantes no sólo para informar la gestión de zonas húmedas en un contexto de CC, sino también para guiar los expertos de valoración basados en preferencias declaradas. De hecho, los resultados confirman que los desafíos específicos asociados a problemas ambientales persistentes, como el CC, se deben tener en cuenta en los ejercicios de valoración.

RESUM

La conservació de les zones humides ha esdevingut un tema rellevant en el debat social. I és que atesa la seva contribució en el benestar humà, la seva protecció davant la creixent pressió antropogènica es percep avui dia com a socialment desitjable. Aquest fet adquireix, si cal, més importància davant el canvi climàtic (CC), un fenomen que es preveu es converteixi en la principal font de deteriorament dels serveis ecològics que proporcionen les zones humides. Així les coses, en un intent de maximitzar el benestar social, esdevé fonamental recolzar la presa de decisions públiques amb un coneixement detallat de les preferències socials i, en particular, del valor que la societat assigna a la protecció d'aquestes zones.

En aquest context, tot i que la tasca de valoració econòmica esdevé una eina fonamental per a millorar la presa de decisions, no cal obviar que també du implícits importants desafiaments. No debades, el CC és un problema persistent en el temps i els seus efectes són, per definició, complexos, inherentment incerts i s'estenen des del present al futur més proper i més llunyà. Tots aquests aspectes, independentment de la influència que s'espera tinguin en el benestar social, han estat poc explorats en els estudis de valoració basats en preferències declarades.

En aquest sentit, en un intent de mostrar la influència que exerceixen aquests aspectes en els exercicis de valoració econòmica, el present treball gira al voltant de tres punts. En primer lloc, s'examinen els components del

valor social de polítiques encaminades a evitar els complexes i variats impactes del CC. En segon lloc, s'estudia l'efecte que la incorporació d'informació sobre la incertesa inherent als processos ecològics té sobre les preferències socials. I en tercer i darrer lloc, s'analitzen qüestions relacionades amb la sostenibilitat, i concretament, si les preferències socials per polítiques que tenen beneficis en el llarg termini i en el molt llarg termini són no-decreixents. Per abordar aquestes qüestions, s'ha realitzat un experiment d'elecció en la zona humida de S'Albufera (Mallorca, Espanya). En particular, l'exercici de valoració s'ha dissenyat tenint en compte: diferents atributs per capturar la complexitat dels impactes del CC, escenaris alternatius de probabilitat d'ocurrència dels impactes, per expressar la incertesa inherent als processos ecològics, i diferents horitzons temporals.

Els resultats suggereixen que la complexitat, la incertesa inherent i la sostenibilitat són aspectes rellevants. En general, els individus es preocupen pels impactes del CC en les zones humides, encara que assignen valors diferents als atributs considerats, tot suggerint patrons de substitució i complementarietat útils alhora de dissenyar polítiques ambientals. Així mateix, es confirma que els individus són sensibles a la incertesa inherent associada amb la variabilitat natural dels efectes del CC i, alhora, es mostren sensibles a les qüestions relacionades amb el benestar de les generacions futures, valorant igual la preservació en el llarg termini com en el molt llarg termini.

Aquests resultats són importants no només per informar la gestió de zones humides en un context de CC, si no també per guiar els experts en exercicis de valoració basats en preferències declarades. De fet, els resultats mostren que els desafiaments específics associats a problemes ambientals persistents, com el CC, s'han de tenir en compte en els exercicis de valoració.

LIST OF PUBLICATIONS

Faccioli, M., Riera, A., Torres, C.M. (2015). Valuing the recreational benefits of wetland adaptation to climate change: a trade-off between species' abundance and diversity. *Environ. Manage.* 55(3): 550-563.

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License Number	3662980802920
License date	Jul 06, 2015
Licensed content publisher	Springer
Licensed content publication	Environmental Management
Licensed content title	Valuing the Recreational Benefits of Wetland Adaptation to Climate Change: A Trade-off Between Species' Abundance and Diversity
Licensed content author	Michela Faccioli
Licensed content date	Jan 1, 2014
Volume number	55
Issue number	3
Type of Use	Thesis/Dissertation
Portion	Full text
Number of copies	7
Author of this Springer article	Yes and you are the sole author of the new work
Order reference number	None
Title of your thesis / dissertation	Challenges in economic valuation of wetland protection under climate change impacts
Expected completion date	Nov 2015
Estimated size(pages)	160

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Universitat de les Illes Balears

Dr. ANTONI RIERA FONT and Dr. CATALINA M. TORRES FIGUEROLA, of the UNIVERSITY OF THE BALEARIC ISLANDS,

DECLARE:

that the thesis entitled CHALLENGES IN ECONOMIC VALUATION OF WETLAND PROTECTION UNDER CLIMATE CHANGE IMPACTS, presented by MICHELA FACCIOLI to obtain a doctoral degree, has been completed under our supervision and meets the requirements to opt for an International Doctorate.

For all intents and purposes, we hereby sign this document.

Signatures

Antoni Riera Font　　Catalina M. Torres Figuerola

Palma de Mallorca, [13/09/2015]

CO-AUTHORS’ AGREEMENT

Universitat de les Illes Balears

Dr. ANTONI RIERA FONT and Dr. CATALINA M. TORRES FIGUEROLA, as co-authors of the following article:

Faccioli, M., Riera, A., Torres, C.M. (2015). Valuing the recreational benefits of wetland adaptation to climate change: a trade-off between species’ abundance and diversity. *Environ. Manage.* 55(3): 550-563.

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ACRONYMS

BAU	Business-As-Usual
CBA	Cost-Benefit Analysis
CC	Climate Change
CE	Choice Experiment
CL	Conditional Logit
CV	Contingent Valuation
ECBA	Environmental Cost-Benefit Analysis
EU	Expected Utility
IIA	Independence from Irrelevant Alternatives
LR	Likelihood-Ratio
MCDA	Multi-Criteria Decision Analysis
RPL	Random Parameter Logit
RUM	Random Utility Maximization
SEU	Subjective Expected Utility
SP	Stated Preference
WTP	Willingness To Pay

LIST OF TABLES

LIST OF FIGURES

INDEX

1. INTRODUCTION

Wetlands –including marshes, fens, peatlands or coastal areas– are amongst the most complex and unique, as well as amongst the world's most biologically productive ecosystems. They lie at the intersection between aquatic and terrestrial habitats, as they are seasonally or permanently covered by water, which they receive as inflows from groundwater, surface waters and precipitations. As a result of these water inputs, they are continuously nourished with nutrients, minerals, sediments, gases and organic materials, responsible for triggering a long chain of biogeochemical transformations that support a complex net of wildlife (Keddy 2010). Indeed, wetlands are within the biodiversity-richest habitats, cradles of species of plants and animals, such as invertebrates, fishes, amphibians and most importantly birds (Cherry 2011).

Because of the ecological characteristics of wetlands, they are also amongst the most important ecosystems for people. Indeed, they supply disproportionately more goods and services supporting human well-being than most other systems (Hayal et al. 2012). They contribute to provide food, timber and fiber and to store and supply water for human use, as they represent natural water sinks which collect water and slowly release it thanks to the extraordinary capacity of wetlands' soils to absorb and retain more water than other ecosystems' soils. For this reason, humid lands also play an important part in controlling water flood and flows, as well as in recharging groundwaters. Additionally, they are crucial in regulating water quality, as they contribute to water purification and detoxification, thanks to the role of especially wetlands' vegetation in filtering inflows and in retaining and assimilating nutrients and pollutants (McLaughlin and Cohen 2013). Wetlands also contribute to carbon sequestration, by trapping it in large quantities in wetlands' soils, such that they play a central part in the mitigation of carbon emissions and, hence, of global warming (Jenkins et al. 2010). They regulate local weather and temperature fluctuations, by affecting heat, evapotranspiration, precipitation and humidity patterns, and they contribute to erosion control especially because of the stabilizing action of the vegetation's root system (Gedan et al. 2011). Concerning the supporting services, they provide habitats for resident and migratory species and they sustain soil formation, through sediment retention and accumulation of organic matter, as well as nutrient cycling, by storing, recycling, processing, and acquiring nutrients. They are also increasingly important for the supply of cultural services including recreational, educational and spiritual experiences, relying on the aesthetic value and on the flora and fauna species of wetlands.

The fact that these ecosystems can provide multiple services and goods has encouraged a high interest in wetlands. It is not by chance that mankind has been constantly attracted by humid lands, such that most of socio-economic activities have been, and still are, organized in the proximity of wetland areas (Schnaiberg et al. 2002). However, the often public good nature of wetlands and of their resources –frequently available for free– has prevented society from recognizing the true scarcity of these ecosystems, thus leading to an over-demand for their associated services and to the over-degradation of these habitats.

In fact, wetlands have become amongst the most threatened and degraded ecosystems by human-induced action (Lotze et al. 2006). Within the primary anthropogenic pressures on wetlands, land conversion and drainage for agricultural or other human-related development are to be considered. In this sense, the fertile and productive nature of these ecosystems together with the high opportunity costs of their conservation instead of development, have led during the 20th century to the conversion and loss of more than 50% of wetlands, currently extending over 1,280 million ha at global level. Another prominent source of stress for wetlands is represented by excessive nutrient loading from residential, industrial and especially agricultural activities, being responsible particularly over the last four decades of generating eutrophication problems in humid lands. Increasing freshwater withdrawal from humid lands also plays a central role in the destabilization of these ecosystems by reducing the amount of water available to maintain the ecological character of many inland wetlands. On the top of these, other sources of stress for wetlands are: infrastructural development, including the construction of dams or dykes, channels or roads, which have been responsible for major alterations in wetlands' water flows, sediment transfer, connectivity and habitat disruption; the leakage of polluting substances; and the introduction of invasive alien species (Millennium Ecosystem Assessment 2005). While these represent the major human-induced pressures that wetlands have suffered over the past and still suffer in the present, additional stresses are expected to appear in the future.

This is the case of climate change (CC), which is projected to become the number one source of wetlands' loss and degradation in the 21st century. This is not only because CC will contribute to amplify current human-induced impacts on humid land ecosystems (Johnson et al. 2005; Edwards and Winn 2006), but also because these stresses will last over an extended period of time. Indeed, CC is anticipated to exert its influence over the present century and most likely also beyond it, due to the long-lived radiative forcing of greenhouse gases responsible for changes in the climate system (Solomon et al. 2010). Especially alterations in precipitation and temperature regimes are anticipated to become the major stresses on wetlands by intensifying current pressures on water quantity and quality, to which wetlands are highly sensitive, given these ecosystems' reliance on specific hydrological conditions. Examples of CC-intensified stresses on water in wetlands include further changes in base flows, alterations in hydrological depth and in seasonal inundation patterns, sea level rise or increased flooding (Erwin 2009).

CC-related hydrological imbalances are anticipated to be particularly sharp in wetlands located in the Mediterranean region, a CC hotspot. Here, projections are of outstanding temperature increases, precipitation rates decreases and higher frequencies of extreme events, such as droughts and heavy rain episodes. These are expected to strengthen the already high anthropogenic pressures on freshwater resources in this region, currently due to elevated population density and growth, agricultural exploitation and tourism (Candela et al. 2009). Hence, particularly sharp CC-intensified stresses on water resources are expected to have detrimental effects especially for prevalently freshwater wetlands in this region –such as Doñana wetland or S'Albufera of Mallorca in Spain, the Po floodplain in Italy, some areas of the Camargue humid land in France, the Prespa Lakes in the Balkans or the Ichkeul Lake in Tunisia.

Especially in this context, CC-induced impacts are expected to result in the intensification of current negative pressures on wetland-dependent flora and fauna species. In specific, they are expected to intensify losses in both species' abundance and diversity. The first one will be the result of an accelerated decline in both the population of plants and animals and the extinction of species, regardless of the type. The second one will appear from a process of substitution, in which less vulnerable species will replace more vulnerable ones. As a result, not only a quantitative but also, and even more importantly, a qualitative loss of species will take place, which contributes to a progressive homogenization of these highly heterogeneous wetlands. This acquires special importance because Mediterranean wetlands, and especially freshwater ones, represent a world's biological hotspot with a wide variety of species and high rates of endemism (Mediterranean Wetlands Observatory 2012a).

Beyond the fact that some regions will be more affected than others, forecasted CC-induced impacts on wetlands are expected to be detrimental at global level and they are anticipated to generate considerable welfare losses for society. This is because, under CC, wetlands will overall decrease their capacity to supply the great number of ecosystem services that contribute to human wellbeing. In this sense, the livelihood, economic system, social cohesion, security, health of people are expected to be greatly endangered by the further degradation of humid lands. Projections are that the survival of entire communities will be at stake; economic activities, including agriculture, tourism, energy generation, will be weakened; the security of individuals will be threatened by increased flooding probability; and health will be impoverished due to the spread of water-borne diseases (Russi et al. 2013).

The prospect of social welfare losses under CC has motivated an increasing preoccupation among policy-makers concerning the need for management solutions oriented to guarantee wetlands' conservation and public use. In other words, it has particularly put in evidence the urgency of designing and implementing CC adaptation policies, consisting in anticipatory measures oriented to avoid or reduce CC-induced negative impacts to support the supply of ecosystem services for humans (Füssel 2007; Pielke et al. 2007). In this sense, given that current policy measures will be insufficient to counteract CC-intensified pressures, policy-makers will be obliged to strengthen their efforts on current management practices in different key areas at the core of wetland management systems. These mostly refer to water management –including flood control or water quality management–, vegetation management –including controlled burning or silvicultural management– and wildlife management –including invasive species control or species reintroduction– (Sorolla 2011).

Though, the design of CC adaptation policies needs to be based on the knowledge about the social benefits associated with policy implementation if the aim is to minimize welfare losses for society. This is because information about the social preferences for alternative management practices of preservation of wetland ecosystems can guide planners in decision-taking based on the social desirability of interventions. Hence, it allows to take decisions based on principles of welfare-maximization and, consequently, of efficiency. Information on social preferences is required to better inform policy-makers not only to design CC adaptation policies, but also to prioritize interventions, which acquires special interest particularly in a context in which shrinking public budgets are available for conservation purposes. For these reasons, knowledge about the social benefits of environmental policies is more and more demanded by public bodies, as increasingly formalized by regulations. For instance, in the Convention on Wetlands of International Importance, also called Ramsar Convention (1971), the need for knowledge about the full range of benefits provided by humid lands has been deemed necessary for the 'wise use of wetlands and their resources', namely for sustaining the supply of these ecosystems' services for human wellbeing.

Given that most of the social benefits of wetland protection are invisible to markets and, thus, they are normally not taken into account, non-market valuation techniques are required to identify the social value of preserving these ecosystems' goods and services and to place them on policy-makers' agenda (Turner et al. 2008). Among these methods, the stated preference (SP) techniques, namely the contingent valuation (CV) and especially the choice experiment (CE), need to be considered. They usually rely on the construction of simulated markets in which a good or a bundle of non-market goods are offered at a given price and individuals are required to express their preferences. By working with hypothetical contexts, these methods allow to obtain information about social preferences for environmental quality states that people have not previously experienced, such as CC impacts. To inform policy-makers about the social benefits of proposed environmental changes, preferences are commonly expressed in monetary terms. In the case of the CV method, individuals are usually displayed different bids for a proposed environmental quality variation and they are asked each time whether they would accept or reject the bid. Modelling this information allows to estimate their willingness to pay (WTP), which reflects preferences for the environmental good of interest. Instead, in the CE, individuals are presented with some alternatives, described in terms of different attributes –including a monetary one– with different levels and organized into choice sets, among which respondents are required to choose their most preferred option. By observing and modeling how people change their preferred alternative in response to variations in the attributes' levels, information can be obtained about the monetary value of each non-monetary attribute. This way, the CE allows disentangling the WTP for each possible level of each non-monetary attribute within the framework of one unique experiment, while the CV only allows identifying an overall welfare measure for the hypothetical scenario considered (Hanley et al. 1998; Hoyos 2010).

Regardless of the centrality of the SP analysis, the contribution of this literature to policy-making has been limited. Indeed, only few studies have taken an economic valuation approach to the analysis of the social benefits of wetlands' conservation in a CC context. In specific, these studies have prevalently focused on the benefits of limiting surge-related problems and therefore they have helped to better inform policy-makers concerning welfare-maximizing flood control interventions (O'Garra and Mourato 2013; Yue and Swallow 2014). Despite the contribution of these papers to efficient wetland decision-making, their focus is believed to be only partial, since they have not considered the implications of dealing with an environmental problem with time-persistent effects when examining the social benefits of wetland policies. In other words, they have traditionally neglected that the time-persistent impacts of CC will be complex and multi-faceted and that the benefits of adaptation policies to counteract them will arise in the future, which is uncertain, and over different time periods, in the long- but more importantly in the very long-term. This is regarded as a limitation because these aspects are starting to be pointed out as important determinants of social preferences.

In this context, despite the prevalent approach has been to assume certainty, research within the SP literature has increasingly been concerned with examining social preferences in a context in which environmental policy outcomes are uncertain, meaning in the presence of outcome uncertainty (Dekker and Brouwer 2010; Brouwer and Schaafsma 2013; Veronesi et al. 2014). In particular, it has found that uncertainty around policy effectiveness, which is assumed to depend on management changes, social, political, economic environments or on the uncertainty around ecosystems' dynamics, should be considered in social preference analysis. Indeed, by finding that WTP for policies aimed at reducing environmental problems is sensitive to the probability of outcome achievement, these studies have shown that assuming certainty may have important implications for the analysis of a policy's social return if events are not as expected. However, despite research in this direction seems promising, it is still incomplete.

These studies have focused on the fact that outcome uncertainty can be controllable by policy-makers' intervention through increasing scientific research and knowledge about ecosystems' functioning. In this sense, they have provided useful information about social preferences to better inform wetland planners on the social benefits of reducing the risks to which wetlands are exposed, as recommended by the Ramsar Convention on Wetlands (Ramsar Convention Secretariat 2010a). Though, despite it is true that outcome uncertainty can be controlled and reduced to some extent, these studies have so far overlooked that it also displays an uncontrollable and irreducible component, associated with the inherent uncertainty of environmental processes, which depends on the variability of natural systems and the randomness of environmental dynamics. In this sense, while inherent uncertainty is unpredictable and uncontrollable, it is nevertheless still possible to forecast how critical the situation might be, namely how serious could be the risk of overstepping critical loads, thresholds or ecosystems' resilience. Given this, examining the role of inherent uncertainty on social welfare can be relevant to better inform policy-makers on the management of environmental systems when the situation is characterized by so many unknown variables. Therefore, understanding the role of inherent uncertainty on social preferences represents a first important challenge for the valuation of wetland conservation in contexts of time-persistent effects, like CC.

Besides being sensitive to inherent uncertainty, wetland policy benefits might also depend on the timing of the improvement. Evidence in this direction especially comes from outside the SP valuation literature and it shows that people prefer sooner to delayed rewards (Almansa and Calatrava 2007; Pindyck 2007; Hanley and Barbier 2009). However, there is still lack of consensus on the time sensitivity of social preferences, which might induce to make wrong assumptions, with important social welfare implications, especially in a context of time-persistent environmental effects. This is the case of CC, which is projected to take place in the long-term and especially in the very-long term. Then, there is an urgent need to assess the time sensitivity of preferences of current generations for measures oriented to avoid environmental impacts in the long-term and the very long-term, concerning the present and the future generations, respectively. Such information can be useful for wetland planners to design policies to counteract time-persistent effects taking not only efficiency, but also inter-generational equity into account.

Indeed, current generations might care about wetlands' preservation also in the very long-term because they may be willing to give future generations at least the same welfare opportunities from nature preservation, associated with both use and non-use of the environment. In other words, they might assign a non-declining weight to wetlands' protection in the very long-term with respect to the long-term due to sustainability concerns. In this sense, it is expected that sustainability issues play an important role, given the increasing demand by the public for sustainable policies, especially in wetlands, as formalized by the Third

Meeting of the Conference of the Contracting Parties (1987), which calls for the need for a sustainable use of these ecosystems. Hence, examining the role of sustainability concerns in explaining the time sensitivity of social preferences represents another important challenge to the valuation of wetland protection in the face of CC time-persistent impacts.

In this framework, the present doctoral thesis, organized into three papers, will address some issues that are expected to be relevant for the analysis of social preferences for CC adaptation policies in wetlands, by means of a CE application undertaken in S'Albufera humid land in Mallorca (Spain). Three are the research questions taken into account. First, this thesis examines the trade-offs between the social preferences for alternative CC adaptation policies, oriented to avoid the complex and multifaceted CC-induced impacts in terms of losses in wetland-dependent species' abundance and diversity. Second, it investigates the implications for social welfare of delivering information about inherent uncertainty. Third, it analyzes the role of sustainability concerns in explaining the time sensitivity of social preferences. Answering these questions aims to better inform policy-makers in the design of adaptation policies in the face of the challenges of CC in wetland areas. However, in addition to this, it also aims to contribute to the environmental SP literature. This is because especially the effects of inherent uncertainty and timing of environmental impacts on social preferences have been largely underexplored issues, not only in a context of wetland adaptation but also in a wider framework of environmental management (Glenk and Colombo 2013; Meyer 2013). Hence, by shading some light on the welfare relevance of these dimensions, another purpose of this doctoral work is to catch the attention of SP practitioners and public decision-makers for the promotion of further debate and investigation around these challenging issues. Despite the expected contributions of this research, its limitations and possible extensions also need to be discussed. This will be the purpose of the last chapter.

2. VALUING THE RECREATIONAL BENEFITS OF WETLAND ADAPTATION TO CLIMATE CHANGE: A TRADE-OFF BETWEEN SPECIES' ABUNDANCE AND DIVERSITY

CC will further exacerbate wetland deterioration, especially in the Mediterranean region. On the one side, it will accelerate the decline in the populations and species of plants and animals, this resulting in an impoverishment of biological abundance. On the other one, it will also promote biotic homogenization, resulting in a loss of species' diversity. In this context, different CC adaptation policies can be designed: those oriented to recovering species' abundance and those aimed at restoring species' diversity. Based on the awareness that knowledge about visitors' preferences is crucial to better inform policy makers and secure wetlands' public use and conservation, this paper assesses the recreational benefits of different adaptation options through a CE study carried out in S'Albufera wetland (Mallorca). Results show that visitors display positive preferences for an increase in both species' abundance and diversity, although they assign a higher value to the latter, thus suggesting a higher social acceptability of policies pursuing wetlands' differentiation. This finding acquires special relevance not only for adaptation management in wetlands but also for tourism planning, as most visitors to S'Albufera are tourists. Thus, given the growing competition to attract visitors and the increasing demand for high environmental quality and unique experiences, promoting wetlands' differentiation could be a good strategy to gain competitive advantage over other wetland areas and tourism destinations.

2.1. Introduction

Wetlands –including marshes, fens, peatlands or coastal areas– are not only among the richest ecosystems in biodiversity, but also among the most fragile environments (Russi et al. 2013). Indeed, they are subject to a process of continuous deterioration driven by anthropogenic pressures such as infrastructure development and land conversion, water withdrawal, eutrophication and pollution, overharvesting and overexploitation (Seilheimer et al. 2009; Elliott et al. 2014). Recent studies show that most of these impacts will be exacerbated under CC, especially those related to alterations in water quantity and quality (Cross et al. 2012; Krauss et al. 2014; Tong et al. 2014). The increase in temperatures and the change in precipitation rates forecasted at a global level are projected to perturb hydrological equilibria in wetlands, this resulting in variations in the seasonal pattern of water levels, altered flooding, recharge and discharge of aquifers, and sea level rise (IPCC 2013a). Given wetlands' dependence on water conditions, CC-derived impacts will further accentuate the deterioration of these ecosystems (Erwin 2009).

This is especially true for wetlands located in the Mediterranean region, as it represents a CC hotspot (Giorgi and Lionello 2008). Further degradation of humid lands is expected to intensify current negative repercussions on wetland-dependent species. On the one hand, it will accelerate both the decline in populations of plants and animals and the extinction of species, this resulting in an impoverishment in biological abundance (Amezaga et al. 2002; Johnson et al. 2005; Cuttelod et al. 2008). Indeed, most of organisms will be unable to adapt to the environmental perturbations, thereby they will not naturally develop sufficient physiological and behavioral responses to cope with changed conditions (Doney et al. 2012). On the other one, it will also promote biotic homogenization, that is, the process through which many 'specialist' species are replaced by few 'generalist' ones (Dawson et al. 2003; Lemoine et al. 2007; Lougheed et al. 2008; Willis et al. 2008; Araújo et al. 2011; Mediterranean Wetlands

Observatory 2012b; Garssen et al. 2014). Indeed, CC-induced degradation will alter species' composition by accentuating the current differences across species in terms of their capacity to adapt to disturbances. In this sense, Clavel et al. (2010) state it will constrain the adjustment potential not only of the species relying on few environmentally stable habitats ('specialist' species), but also of those occupying a wider habitat range ('generalist' species). As the former are less resilient and hence more vulnerable to environmental disturbances, this will result in a substitution pattern leading not only to a quantitative but also, and even more importantly, to a qualitative loss of species, which will generate a loss of species' diversity.[1] This phenomenon is forecasted to reduce the original heterogeneity of wetlands, thus accentuating the current process of homogenization particularly experienced by Mediterranean humid lands.

In this context, welfare losses are expected especially for visitors, who increasingly appraise wetlands for their biological abundance and diversity (Millennium Ecosystem Assessment 2005). To avoid or minimize these welfare losses, that is, to secure wetlands' public use and conservation, the design of adaptation policies should be of high priority for wetlands' managers.[2] In this sense, and by strengthening efforts on current management practices, decision-makers can opt for different strategies to counteract the abovementioned CC-induced impacts on wetland-dependent species. Indeed, they can pursue to recover species' abundance, thus taking action to avoid a quantitative loss of species, regardless of the species' type. Also, they can seek to preserve original wetlands' heterogeneity, thus acting against biotic homogenization by undertaking measures to avoid the quantitative loss of many 'specialist' species. Although both strategies contribute to the goals of conservation

[1]Throughout the manuscript, a loss of species' diversity refers to the qualitative rather than the quantitative implications of species' loss.

[2]Note that we refer to adaptation policies as planned measures engineered by human interventions on the environment. This should not be confounded with the concept of environmental adaptation, which refers to the autonomous responses to CC by organisms and ecosystems through natural, physical and biological processes (Hobday et al. 2009).

and public use, the latter type of policy has been argued to be more desirable from an ecological point of view. Indeed, it contributes to achieve more complex and healthier, hence more resilient, ecosystems (Norberg et al. 2008; Robledano et al. 2010). In addition, it allows promoting wetlands' differentiation which could represent a good strategy to gain competitive advantage given the growing competition among wetlands to attract visitors and their increasing demand for high environmental quality and unique experiences (Secretariat of the Ramsar Convention on Wetlands and World Tourism Organization 2012). In this context, adaptation policies should be not only feasible but also socially acceptable. Thus, knowledge about the economic value users assign to species' diversity and abundance in wetlands is crucial to guarantee the design of welfare-maximizing interventions.

Unfortunately, research on adaptation to CC-derived impacts in the context of wetlands has mainly focused on the issue of species' abundance rather than diversity. Most of studies have been concerned with policies aimed at counteracting the loss of species from a quantitative perspective without consideration of the species' type (Nicholls and Hoozemans 1996; El-Raey 1997; Mortsch et al. 2006; Snoussi et al. 2008; Ayache et al. 2009; Jeppesen et al. 2011; Withey and van Kooten 2011). Wetland adaptation studies dealing with the loss of species' abundance and diversity have been scarce (Anthony et al. 2009; Palmer et al. 2009; Kingsford 2011). Also, it seems that wetland adaptation literature has paid little attention to the analysis of the social acceptance of policies, thus overlooking efficiency issues in their design. To our knowledge, research on the economic valuation of the benefits of species' conservation in wetlands has only given guidance on welfare-maximizing management practices outside the context of CC adaptation. Examples of this are Birol et al. (2009) and Rolfe and Windle (2010), which have focused on species' diversity, and Birol et al. (2010) and Luisetti et al. (2011), which have dealt with species' abundance issues.

In this framework, this study analyses visitors' preferences for two types of adaptation policies: those oriented towards a quantitative recovery of species and populations and those pursuing a restoration of the species' diversity. This way, it not only adds to the scarce adaptation research focusing on a loss of species' diversity but also it includes a welfare-based analysis of adaptation measures. More specifically, it allows prioritizing socially desirable wetland management practices due to the joint economic valuation of species' abundance and diversity, which is of great relevance when budgets allocated for environmental conservation are shrinking (Christie et al. 2006). By assuming policies aimed at preserving original wetlands' heterogeneity are more desirable, the hypothesis that visitors assign a higher value to 'specialist' species-abundant rather than to 'generalist' species-abundant wetlands, is tested for. To do this, preferences of visitors to S'Albufera wetland (Mallorca), an outstandingly vulnerable site to CC stresses in the Mediterranean (Candela et al. 2009), are examined through a CE.

The structure of the chapter is as follows. Next section describes S'Albufera wetland case study. Then, the methodology is highlighted, with a description of the main steps of the CE design and the statistical model employed for data analysis. Afterwards, sample descriptive statistics and model results are reported. A discussion and conclusions section ends the paper.

2.2. Case study description

S'Albufera is the largest wetland in the Balearic Islands, with 1,646.38 ha protected by law.[3] It is placed at the coastal plain of an extensive water catchment area in the North East of Mallorca and it is nourished by surface

[3]Decree-Law No. 4/1998 of the Ministry of Agriculture and Fisheries of the Balearic Islands (January 28th)

runoff waters, precipitations, underground springs and sea water (Parc Natural de S'Albufera de Mallorca 2005). The prevalently freshwater nature of this wetland makes it different from most Mediterranean coastal humid lands[4] at the time it supports diverse and abundant flora and fauna species of international importance (Sato and Riddiford 2008). Bird species are its major natural asset. In this sense, there is a community of 'specialist' species that find in S'Albufera their ideal habitat, including both sedentary and migratory birds regularly moving to this site for breeding during spring or stopping over during winter. Additionally, 'generalist' bird species can also be watched which are not exclusively found in S'Albufera but migrate to this wetland or even establish there sedentarily, as they are better adapted to the growing salinization process of the site.

Indeed, S'Albufera ecosystem has been experiencing considerable human-induced stresses over the years, which have mostly affected its hydrological conditions. Water quantity and quality reaching the wetland are influenced by (i) the nitrates from intensively used agricultural fertilizers in the surrounding areas; (ii) the waste waters from inefficient –and sometimes saturated– watershed's sewage treatment plants; (iii) the sea water spilling through the underground pipes responsible for the cooling system of the thermal power station Es Murterar, placed near the park; and (iv) the unsustainable freshwater extraction for agricultural, residential and tourism consumption. In specific, this latter source of stress has been considerably increasing over the last years mainly due to the sustained growth in tourist arrivals to Mallorca, one of the leading Mediterranean tourism destinations (Riddiford et al. 2014). The human-induced pressures affecting S'Albufera are common sources of stress in Mediterranean wetlands and have generally been responsible for an increasing process of eutrophication and salinization of their waters (García et al. 2011; Marco-Barba et al. 2013).

[4] [http://www.medwetlands-obs.org/node/33 accessed in September 2015]

Especially salinization, one of the major threats for freshwater ecosystems (Jin 2008), is expected to be further intensified in S'Albufera under CC. Indeed, increased temperatures and decreased precipitations forecasted for the western Mediterranean region are anticipated to lead to an additional decline in freshwater volumes (Candela et al. 2009). This, coupled with an increased sea water intrusion, is expected to elevate the concentration of salt in waters with repercussions over plant and animal species. Overall, current impacts in terms of declines in flora and fauna richness and biomass, shifts towards salt-tolerant communities and the inhibition of seeds germination are anticipated to be accentuated in the future (Waterkeyn et al. 2008). However, the most serious effect on S'Albufera ecosystem is expected to be the decrease in the number of 'specialist' bird species, which will generate a loss in the site's species' diversity.

CC will also be responsible of increasing stresses over migratory bird species –especially spring ones– by shifting their migration timing (Tingley et al. 2009). This phenomenon has been well documented for the case of the Mediterranean (Robson and Barriocanal 2011). The projected rise in temperatures in their home region is expected to stimulate their advanced departure, such that they will arrive earlier to S'Albufera for resting and breeding. In this context, they might not find the optimal nesting conditions, such as peak food availability, thus being forced to abandon the site. As a result of this, the abundance of both 'specialist' and 'generalist' migratory bird species in S'Albufera is expected to decline.

Drops in both bird species' abundance and diversity under CC are expected to generate welfare losses especially for visitors. Indeed, visitors to S'Albufera have steadily grown in number since the declaration of the wetland as a Natural Park in 1988 (Espais de Natura Balear – Conselleria de Medi Ambient 2008), attracted by a wide range of nature-based recreation activities (contemplation of nature, sport, bird watching, etc.). In this context, management practices aimed at counteracting the human-induced stresses experienced by the park have been implemented by managers to guarantee the wetland's conservation and hence wetland's demand by visitors. In particular, over the last 15 years, water management interventions have been undertaken to control for seawater intrusion and to favor the diffusion of freshwater throughout the channels of the park, as the best way to recover 'specialist' bird species. Additionally, managers have undertaken policies oriented to creating optimal nesting and breeding conditions to increase the chances of attracting migratory bird species to S'Albufera, regardless of whether they are 'specialist' or 'generalist'. Vegetation diversity actions –through the use of cattle and horses– have also been carried out to maintain landscape heterogeneity and restore the environmental conditions in sensitive areas, such as the riverbank wood and the dune system.

2.3. Methodology

Measuring visitors' welfare changes associated with CC-derived impacts requires the use of SP methods. This is because SP techniques allow valuing non-market goods by constructing hypothetical scenarios that have not been previously experienced by individuals, as it happens when it comes to projected variations in climate and their derived impacts. In this context, among the SP techniques, the CE is considered to be more appropriate than the CV method. Indeed, the CV only allows assessing the effect of a single attribute on utility. In contrast, the CE allows estimating the value of a set of multiple attributes simultaneously considered. In specific, for each attribute or a combination of them, it allows measuring the related welfare changes over a range of possible outcomes (Hanley et al. 2001), thus better informing policy-makers. In a CE, each attribute takes different levels, whose combination allows generating diverse hypothetical scenarios or alternatives, which are grouped into choice sets presented to respondents. From each choice set, individuals are asked to select their most preferred alternative and, through the statistical analysis of responses, preferences for different attributes can be inferred. In case the cost of the alternative is also presented to respondents, the monetized value individuals assign to each attribute can be obtained (Hanley et al. 1998).

2.3.1. Choice experiment design

The first step in the development of the CE study consisted of the identification of the relevant management attributes and their levels, which were selected after consultation with S'Albufera managers and experts. Agreement was reached on the fact that, unless current management efforts are strengthened, CC will mainly provoke a reduction in the number of 'specialist' and 'generalist' bird species of the wetland. Thus, two environmental management attributes were considered: 1) the change in the number of 'specialist' bird species to reflect the effects of CC-induced salinization on species' diversity; and 2) the change in the number of 'generalist' migratory bird species to capture the impacts on species' abundance of CC-intensified shifts in migration timing.

Additionally, based on the results of previous visitors' satisfaction surveys in S'Albufera, the levels of efforts to manage congestion and facilities in the wetland were found to be relevant for users, this motivating the inclusion of two non-environmental attributes in the CE. As a proxy for the degree of congestion, the waiting time for a seat in an observation cabin set to facilitate birds' viewing was used –with longer (shorter) waiting times associated to a greater (smaller) number of visitors and hence to higher (lower) congestion levels. To reflect wetland services, the number of rest-stop benches in the park was employed. Finally, a cost attribute was included, consisting of an entrance fee for adult visitors. The appropriateness of the selected attributes and levels was tested in focus group sessions with park visitors. Table 1 describes the attributes and their levels used in this application.

Table 1 Description of the attributes and their levels

Attribute	Description	Levels
'Specialist' bird species	Change in the number of 'specialist' bird species (with respect to current level)	+5[a] 0[b] -10[c]
'Generalist' migratory bird species	Change in the number of 'generalist' migratory bird species (with respect to current level)	+5[a] 0[b] -10[c]
Waiting time	Waiting time for a seat in an observation cabin	About 3 minutes[a] About 7 minutes[b] About 15 minutes[c]
Rest-stop benches	Number of rest-stop benches throughout the park	Triple current number[a] Double current number[b] Keep current number[c]
Entrance Fee	Entrance fee per adult visitor and trip (in euros) (BAU level: 0 euros)	4, 8, 12, 16, 20, 24

Attribute levels resulting from a high ([a]), moderate ([b]) or no increase ([c]) in management efforts.

After the identification of the relevant attributes, experimental design techniques were employed to combine the attribute levels to generate the alternatives and the choice sets. Among the different methods, the D-efficient Bayesian design was considered as the most superior approach (Rose and Bliemer 2009) and it was employed to create 18 profile combinations, generated by using the Ngene software (version 1.1.1). Each choice set consisted of three options: two alternatives showing improvements in at least one attribute, as a result of strengthened management efforts; and a third option, kept constant across choice sets, representing the business-as-usual (BAU) scenario that would occur in 10 years under CC if management efforts were not strengthened.[5] The number of choice sets per individual was reduced by blocking the 18 profile combinations into 3 groups, randomly assigned across respondents, such that only 6 choice sets per person were considered.

[5]An example of choice set is shown in the Appendix (Sample choice card 1).

To present choice sets to respondents, a questionnaire was designed consisting of 5 sections.[6] The first one was aimed to identify the visitors' profile, with specific questions designed for Mallorcan residents and tourists. The following section was focused on gaining knowledge about the visitors' recreational behavior in S'Albufera. The third block described the CC-induced environmental impacts and the possible solutions park managers could adopt to counteract them. Next block was devoted to the choice of alternatives. Follow up questions were also included to identify possible protest answers within the sample. The survey concluded with some questions about the visitors' socio-demographic profile.

Data were collected by contacting individuals on-site to participate in the survey. They were randomly drawn from some pre-defined strata, discriminating the visitors' population of S'Albufera of 18 years of age or older according to their home country. To maximize visitors' participation, the surveying process was conducted during the peak visitation season of the park –i.e. between April the 15th and June the 30th, 2013– by trained interviewers. Taking into account a population of 23,172 visitors, 4 representative sub-samples were drawn. To each of them a different probabilistic scenario of CC impacts' occurrence was presented. A total of 1,271 surveys were collected across the 4 subsamples. For the purposes of this study, and following common practice in the SP literature, the focus was on the sub-sample of visitors facing a BAU scenario described by CC impacts assumed to happen with a probability of 100%. The sample size for this application, consisting of 322 visitors, was obtained by considering a confidence interval of 95% and a sample error of 5.47%.

[6] A copy of the survey is reported in the Appendix.

2.3.2. Statistical modelling

Preference analysis in a CE is performed through the use of statistical models relying on the random utility maximization (RUM) theory (McFadden 1974). In this sense, individuals' choices are modeled by assuming respondent *n* chooses the alternative *j* providing him with the highest utility level (U_{nj}) from a set of options. Given that U_{nj} is only partly observed by the researcher, it is specified by considering a stochastic (ε_{nj}) in addition to a deterministic component (V_{nj}):

$$U_{nj} = V_{nj}(x_{nj}, x\_cost_{nj}, \beta) + \varepsilon_{nj} \tag{1}$$

where x_{nj} and x_cost_{nj} are respectively the non-monetary and monetary attributes of the alternative, β are the parameters to be estimated and ε_{nj} represents the error term capturing all the unobserved factors affecting individuals' choice but unknown to the researcher. In a CE, it is common to first model preferences by considering the conditional logit (CL), the simplest RUM model, identified under the assumption that the error follows a type I extreme value distribution and is independently and identically distributed (McFadden 1974).[7] Under the usual premise that utility is linear-in-parameters, the probability of choice of the j alternative within a set of C options under the CL is:

$$P_{nj} = \frac{exp^{V_{nj}}}{\sum_{k \in C} exp^{V_{nk}}} \tag{2}$$

However, the random parameter logit (RPL) model is increasingly used as a superior modelling approach with respect to the CL due to its higher flexibility. Its major advantage over the CL is that of dealing with individual-specific preference heterogeneity, which is accounted for by incorporating

[7]Under the CL, the independence from irrelevant alternatives (IIA) property holds, this involving that the relative probability of choosing one option over another is independent of the presence or absence of other alternatives.

random parameters in the utility specification (McFadden and Train 2000; Train 2009). For each parameter specified as random, a vector of individual-specific coefficients is estimated, where each coefficient (β_n) is defined as the sum of a population's mean and an individual-specific deviation from this mean. The vector of individuals' coefficients is described by means of a continuous random density function, $f(\cdot)$, provided that the RPL assumes that the source of heterogeneity affecting the parameter is unknown. To identify the distribution of $f(\cdot)$, a parameter for both the mean and standard deviation need to be estimated. Given that, the probability for individual n to choose alternative j under the RPL is:

$$P_{nj} = \int \frac{exp^{V_{nj}(\beta n)}}{\sum_{k \in C} exp^{V_{nk}(\beta n)}} f(\beta_n)\, d\beta_n \qquad (3)$$

Due to the superiority of the RPL model over the CL, only the results of the former will be reported in this study. Indeed, the result of a likelihood-ratio (LR) test (468.53) suggested we should reject, at 1% significance level, the null hypothesis that the RPL performed as well as the CL model, showing that it rather better fitted the data.[8]

To specify the utility function in both models, main effects and two-way interactions have been considered. Concerning the main effects, both the environmental attributes (change in the number of 'specialist' bird species and 'generalist' migratory ones) and the cost attribute have entered the utility function as continuous variables. However, only this latter has been assumed to have linear effects on utility.[9] In contrast, the non-environmental attributes (waiting time and rest-stop benches) have been specified as dummies. As these two attributes have three levels each, it has been possible to test for the presence of non-linear effects on utility.

[8]The estimation results for the CL model are available from the authors upon request.
[9]Note that quadratic effects have also been specified for the two environmental attributes.

Regarding the interaction effects, a squared term for each environmental attribute has also been incorporated to test for the hypothesis of non-linear attribute effects on utility (Luisetti et al. 2011; Torres et al. 2011). Additionally, an interaction term between the ‘specialist’ bird species attribute and the ‘generalist’ migratory one has been included to check whether the expected benefits obtained from a marginal increase in one bird category depend on the level of the other one. Interactions between environmental and non-environmental attributes have also been considered. In particular, an interaction between ‘specialist’ bird species and waiting time reduction has been specified to check whether the level of congestion affects preferences for environmental improvements, as shown in Torres et al. (2009). Estimating the utility effect of this interaction can provide policy-relevant information, given the increasing number of users to S’Albufera and the fact that the peak visitation period of the wetland partly overlaps with the high season of tourist inflows to Mallorca.

Equation 4 describes the utility function used to model CE responses in this study:

$$
\begin{aligned}
U_{nj} = \; & \beta_1 X_{SPEC_{nj}} + \beta_2 X_{GEN_{nj}} + \beta_3 X_{TIME(less)_{nj}} \\
& + \beta_4 X_{BENCHES(double)_{nj}} + \beta_5 X_{BENCHES(triple)_{nj}} \\
& + \beta_6 X^2{}_{SPEC_{nj}} + \beta_7 X^2{}_{GEN_{nj}} + \beta_8 X_{SPEC_{nj}} \cdot X_{GEN_{nj}} \\
& + \beta_9 X_{SPEC_{nj}} \cdot X_{TIME(less)_{nj}} + \beta_{10n} X_{COST_{nj}} + \varepsilon_{nj}
\end{aligned} \tag{4}
$$

where $X_{SPEC_{nj}}$ and $X_{GEN_{nj}}$ reflect the levels of the ‘specialist’ and ‘generalist’ migratory bird species attributes; $X_{TIME(less)_{nj}}$ is a dummy variable taking value 1 for less than 15 minutes waiting time, and 0 otherwise; $X_{BENCHES(double)_{nj}}$ and $X_{BENCHES(triple)_{nj}}$ are dummies, taking value 1 for doubling and tripling the number of benches with respect to current level, respectively, and 0 otherwise; $X_{COST_{nj}}$ is the cost attribute.

To value welfare changes associated to a variation in a given non-monetary attribute, the WTP formula for compensating variation presented in Hanemann (1984) has been considered. To test for the hypothesis of this study, welfare estimates need to be compared. To this aim, T-tests have been employed based on simulated WTPs, which have been obtained by means of the bootstrapping technique due to its advantages over alternative methods, as discussed in Hole (2007). Given that the focus of this study is on 'specialist' bird species, Equation 5 reports the WTP formula for a unit increase in ${X_{SPEC}}_{nj}$, based on the utility specification in Equation 4. Superscripts ^{1} and ^{0} indicate the attribute levels after the change and in the initial reference situation, respectively.

$$\begin{aligned} WTP_{X_{SPEC}} = -\frac{1}{\beta_{10n}} \Big[& \beta_1 ({X_{SPEC}}_{nj}^{\;1} - {X_{SPEC}}_{nj}^{\;0}) \\ & + \beta_6 ({X^2_{SPEC}}_{nj}^{\;1} - {X^2_{SPEC}}_{nj}^{\;0}) \\ & + \beta_8 \cdot {X_{GEN}}_{nj}^{\;0} ({X_{SPEC}}_{nj}^{\;1} - {X_{SPEC}}_{nj}^{\;0}) \\ & + \beta_9 \cdot {X_{TIME(less)}}_{nj}^{\;0} ({X_{SPEC}}_{nj}^{\;1} - {X_{SPEC}}_{nj}^{\;0}) \Big] \end{aligned} \qquad (5)$$

2.4. Results

2.4.1. Descriptive statistics

As common when it comes to the analysis of wetlands' users (Lee 2011), the descriptive statistics of the sampled individuals shows they can be viewed as nature-based visitors in the terms described by Shrestha et al. (2007), Luo and Deng (2008) and Arnegger et al. (2010). Indeed, most of them were non-residents (84.47%), mostly motivated to travel to Mallorca for nature enjoyment (44.12%) and displaying a longer mean length of stay (10.79 days) than that of the average traveler to the island over the same period (6 days).[10] On average, S'Albufera visitors tended to be middle-aged (53 years old), had a high education level (50.16% finalized university or post-graduate studies) and belonged to the upper middle class (monthly average net household income was between 3,000 and 4,000 euros). They also showed repeat visitation rates to the park (69.39% of residents yearly visited S'Albufera an average of 2.26 times and 53.73% of non-residents had visited the park an average of 3.67 times over the last 5 years) and to other humid lands, especially within their region (with a mean of 25 visits per year). Most of users visited S'Albufera to 'contemplate and enjoy nature' (42.86%), while 29.19% engaged in a more specific activity like 'bird-watching'.

Visitors were also found to generally travel in small groups (52.17%) and they were environmentally aware. Indeed, 37.27% of them were members of environmental groups, 23.29% belonged to a birding organization, 53.11% regularly consumed organic food, 98.14% separated waste for recycling and 36.95% collaborated with some non-governmental organizations.

2.4.2. Choice experiment results

After invalid and protest questionnaires were eliminated from the sample, 298 out of 322 surveys were considered for estimation.[11] These provided a total of 1,788 observations for estimation purposes, as each individual faced 6 choice sets. CE responses were initially modeled by means of a CL. However, the results from the Hausman-McFadden test suggested we

[10] Data provided by the *Agència del Turisme de les Illes Balears* for the II trimester of 2013 [http://www.caib.es/sacmicrofront/archivopub.do?ctrl=MCRST865ZI154103&id=154103 accessed in September 2015].

[11] Surveys were considered invalid when some missing responses were detected in the section concerning the choice of the alternatives due to the respondent's lack of cooperation or when the surveyor considered the respondent was insincere. Protests included those questionnaires in which the choice of the BAU alternative was motivated by one of the following reasons: *"I am already paying for wetlands' conservation"*, *"Others should pay"* and *"I don't trust the local authorities"*.

should reject, at 1% significance level, the null hypothesis that the IIA property held. Therefore, the RPL model was specified. Data showed that all coefficients should be fixed, except for the cost parameter (β_{10n}), which was specified as random, following a lognormal distribution to constrain the coefficient to have the same sign across individuals, as increasingly done in the literature (Torres et al. 2011). Table 2 presents the RPL model results based on Equation 4. Model estimation was performed in Matlab 7.12 based on a Halton sequence with 100 draws.

Table 2 RPL model estimations

Variables	Coeff.[a]	*Std. error*
Fixed parameters		
X_{SPEC}	2.113***	*0.286*
X_{GEN}	1.245***	*0.236*
$X_{TIME(less)}$	0.455***	*0.139*
$X_{BENCHES(double)}$	0.584***	*0.150*
$X_{BENCHES(triple)}$	0.276	*0.173*
X^2_{SPEC}	-0.780***	*0.274*
X^2_{GEN}	-0.758***	*0.255*
$X_{SPEC} \cdot X_{GEN}$	-0.290*	*0.165*
$X_{SPEC} \cdot X_{TIME(less)}$	-0.684***	*0.167*
Random parameters[b]		
X_{COST}_mean	1.371***	*0.065*
X_{COST}_std. deviation	0.718***	*0.043*
Log-likelihood	-1,050.601	
R^2	0.461	
Observations	1,788	
N	298	

[a]Note: *** 1% significance level; ** 5% significance level; * 10% significance level; [b]Reported estimated parameters are those of the normal distribution associated with the lognormal one. Mean and standard deviation of the lognormal distribution are, respectively, 5.094 and 4.155.

Concerning main effects, the sign of the estimated coefficients for the environmental attributes indicated that visitors displayed positive preferences for a marginal increase in the number of both 'specialist' and 'generalist' migratory bird species. However, the coefficient of 'specialist' bird species was almost double in magnitude. On the other side, they showed preferences for lower waiting times (with respect to the current level), even though they seemed to be insensitive to the magnitude of congestion reduction.[12] In other words, a decrease in waiting time had a linear effect on utility. Regarding rest-stop benches, visitors displayed positive preferences for doubling the number of resting places, while being indifferent to tripling it. According to expectations, and due to the assumption of a lognormal distribution for the cost coefficient, the estimated parameters for the mean and standard deviation were positive and significant.

Looking at the coefficients for the quadratic terms, the benefits from a marginal increment in the number of both types of bird species increased at a decreasing rate. The individuals' utility function was concave with respect to the number of 'specialist' bird species and 'generalist' migratory ones. Therefore, it was possible to identify a specific number of both types of bird species for which the associated individual part-worth utility was maximized. The negative sign of the coefficient of the interaction between both environmental attributes showed visitors perceived them as substitutes, thus assigning a higher value to 'specialist' bird species when the number of 'generalist' migratory ones is lower, and vice versa. As expected, congestion was also found to affect the part-worth utility of 'specialist' bird species: the negative coefficient of the interaction between 'specialist' bird species and decreased waiting time suggested that visitors

[12] A Wald test was performed under the null hypothesis of parameters' equality between the coefficients of two separate dummies initially created for different waiting time reductions (from 15 to either 7 or 3 minutes). Results of the Wald test (0.10) suggested we should not reject the null hypothesis at the 5% significance level and hence create a unique variable ($X_{TIME(less)_{nj}}$) for waiting time reduction, as seen in Equation 4.

valued more ‘specialist’ bird species when congestion was high. In other words, when the overall chances of viewing all types of birds from the observation cabins are reduced, due to the higher number of users and the longer waiting time, visitors prioritized seeing a ‘specialist’ over other types of bird species.

Other interactions were also initially included in the model because they were expected to explain choices, but they were later excluded for the insignificance of their effect. Indeed, LR tests showed that none of these interacting variables could be retained in the model.[13] This was the case for the interaction between the reduced waiting time and the ‘generalist’ migratory bird species attributes, included to test whether the level of congestion significantly affected preferences also for this other environmental attribute (Torres et al. 2009). Additionally, both ‘specialist’ and ‘generalist’ migratory bird species attributes were also interacted with a dummy variable indicating whether the visitor was a birdwatcher or not to test if preferences for environmental goods changed according to the type of visitor, as in Christie et al. (2007).[14] The rejection of this latter hypothesis was probably due to the high environmental awareness and nature-based profile displayed by all visitors to S’Albufera.

The WTP for a change in each non-monetary attribute was calculated by following the Hanemann (1984)’s formula, which is provided in Equation 5 for a marginal increase in the ‘specialist’ bird species attribute. The WTP was measured for each attribute over a change with respect to the policy-off (BAU) situation. A unit change was considered for the environmental attributes and a discrete change for the non-environmental ones. The BAU level was assumed for the interacting variables. This way, the marginal attribute values were measured. Given the cost coefficient was assumed to

[13]The LR statistic (2.51) suggested not rejecting, at 1% significance level, the null hypothesis that the joint effect of these interactions did not significantly contribute to improve model fit.
[14]A specific question was included in the survey to identify respondents’ interests in visiting S’Albufera, thus allowing distinguishing between birdwatchers and non-birdwatchers.

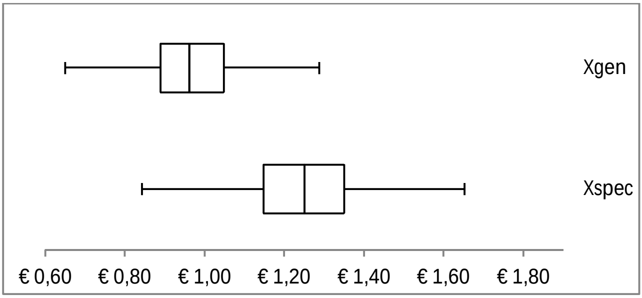
be lognormally distributed, the estimated marginal WTP for each attribute followed a lognormal distribution reflecting the individual-specific marginal attribute values. Table 3 reports the mean and standard deviation describing each attribute's WTP distribution. According to it, the individuals would be willing to pay, on average, for all the proposed improvements in the attributes' levels.

Table 3 Mean and standard deviation of the marginal WTP per attribute

	Mean	Std. deviation
X_{SPEC}	1.31	1.12
X_{GEN}	1.00	0.86
$X_{TIME(less)}$	3.84	3.29
$X_{BENCHES(double)}$	1.97	1.69

According to Table 3, the mean marginal WTP for 'specialist' bird species (€1.31) was higher than that for 'generalist' migratory bird species (€1.00). To test for the significance of this difference, a T-test for mean equality was performed, after simulating mean marginal values for both attributes through the bootstrapping technique. This latter procedure consisted of repeating the estimation of the RPL model 1,000 times, each one over a different sample of individuals drawn with replacement from the original sample (N=298). From each replication, a lognormal distribution of individual marginal attribute values was derived and its mean, retained. After all replications, a distribution of 1,000 mean WTP estimations for each attribute was obtained. Results of the T-test (46.29), performed over the bootstrapped mean marginal WTP for 'specialist' and 'generalist' migratory bird species, suggested we should reject the null hypothesis of mean equality at 5% significance level. Indeed, the WTP for 'specialist' bird species was found to be significantly greater than that for 'generalist' migratory ones. Figure 1 shows the boxplot representation of the bootstrapped mean marginal values for X_{SPEC} and X_{GEN} over 1,000 replications.

Fig. 1 Bootstrapped mean marginal WTP for X_{SPEC} and X_{GEN} over 1,000 replications



Based on this result, it would be suitable to particularly safeguard 'specialist' bird species under CC and hence to protect the heterogeneous character of S'Albufera. However, any intervention in this direction requires taking into account that the benefits from incrementing the number of 'specialist' bird species depend on the levels of efforts that managers might implement on X_{GEN} and $X_{TIME(less)}$. To inform planners about the effect that their decisions concerning other policies might have on the benefits from 'specialist' bird species preservation, Table 4 analyzes the sensitivity of the mean marginal value of the 'specialist' bird species attribute under different levels of X_{GEN} and $X_{TIME(less)}$.

Table 4 Mean marginal WTP for X_{SPEC} under different levels of X_{GEN} and $X_{TIME(less)}$ [a]

	$X_{TIME(less)} = 0$	$X_{TIME(less)} = 1$
$X_{GEN} = -10$	1.31	1.08
$X_{GEN} = 0$	1.21	0.98
$X_{GEN} = +5$	1.16	0.93

[a] To check if the mean marginal value of X_{SPEC} was sensitive to changes in the levels of the interacting variables (X_{GEN} or $X_{TIME(less)}$), T-tests for mean equality were undertaken. Each time, a T-test was performed by comparing a pair of vectors of 1,000 bootstrapped mean marginal values of X_{SPEC}, which only differed from each other in the level of one of the interacting variables. When changing the level of X_{GEN}, T-test statistics ranged between 5.89 and 31.10; and when different levels of $X_{TIME(less)}$ were considered, t-statistics varied between 28.26 and 53.99. In all cases, T-tests suggested we should reject the null hypothesis of mean equality at 5% significance level, meaning that different levels of X_{GEN} and $X_{TIME(less)}$ significantly affected the mean marginal value of 'specialist' bird species.

Results of this sensitivity analysis show that the mean value for a marginal increment in 'specialist' bird species was found to significantly decrease by €0.01 for each extra 'generalist' migratory bird species, in line with the results in Table 2, showing 'specialist' bird species and 'generalist' migratory ones acted as substitutes. Furthermore, findings indicated that the value of one additional 'specialist' bird species was significantly higher by €0.23 under current congestion levels with respect to a reduced congestion scenario, supporting the idea that visitors appreciated more 'specialist' bird species under high congestion.

The sensitivity analysis in Table 4 was then employed to provide policy-makers with useful information concerning the optimal number of 'specialist' bird species that should be preserved under various possible scenarios, characterized by different levels of efforts on the interacting variables (X_{GEN} and $X_{TIME(LESS)}$). For each scenario, this information can be obtained by identifying the number of 'specialist' bird species making the mean marginal value equal to zero and, hence, maximizing the effect on the utility visitors get from this attribute (i.e. part-worth utility of the 'specialist' bird species' attribute). Overall, results of this analysis, shown in Table 5, indicated that visitors wished an increase in the number of 'specialist' bird species with respect to the current level. This means that the implementation of adaptation policies oriented to maintaining the present number of 'specialist' bird species would be sub-optimal. However, the required increment in the number of species for this avian group was also found to vary according to the level of the interacting variables considered. Visitors would demand a lower increase in the number of 'specialist' bird species (1 less) in a scenario of higher availability of 'generalist' migratory bird species (5 more). Similarly, they would require a lower increase in 'specialist' bird species (5 less) under a reduced congestion scenario.

Table 5 Part-worth utility maximizing number of 'specialist' bird species under different levels of X_{GEN} and $X_{TIME(less)}$ [a]

	$X_{TIME(less)} = 0$	$X_{TIME(less)} = 1$
$X_{GEN} = -10$	+ 16	+ 11
$X_{GEN} = 0$	+ 14	+ 9
$X_{GEN} = +5$	+ 13	+ 8

[a]Part-worth utility maximizing number of 'specialist' bird species is reported as a variation with respect to the current level.

2.5. Discussion and conclusions

This study has focused on wetland management in a context of increasing need for adaptation to CC. Indeed, adaptation in wetlands should represent a priority for managers to avoid the welfare losses that especially visitors are expected to suffer due to CC-induced negative impacts on wetland-dependent species (Millennium Ecosystem Assessment 2005). Under the recognition that welfare-based analysis can better inform policy-makers in the design of socially efficient interventions, this work has examined, through a CE application, the preferences for two types of adaptation policies of a sample of visitors to S'Albufera wetland (Mallorca).

Results show the importance of preserving species' diversity under CC. In this sense, they acquire special relevance because the loss of species' diversity has represented a largely neglected impact in mainstream wetland adaptation literature. Indeed, the existing studies have almost exclusively focused on policies aimed at avoiding the loss of species' abundance, thus dealing only scarcely with species' diversity (Anthony et al. 2009; Palmer et al. 2009; Kingsford 2011). To provide evidence of the value of species' diversity, this CE study has used two separate management attributes: the change in the number of 'specialist' bird species to reflect the loss of species' diversity and the change in the number of 'generalist' migratory ones to reflect the loss of species' abundance. Findings show that visitors display positive preferences for both 'specialist' and 'generalist' migratory bird species, though the first ones have a significantly higher mean marginal value than the second ones (€1.31 vs. €1.00). Thus, results highlight a higher desirability of adaptation policies oriented to avoiding the loss of 'specialist' species and hence of species' diversity, thus suggesting the need for reversing current trends and adaptation management practices in wetlands. These findings contribute to an emerging literature drawing similar conclusions in contexts other than wetlands. Indeed, Lundhede et al. (2014) and Lundhede et al. (2015) also outline people tend to prefer actions targeted at native instead of immigrating species under CC when it comes to conservation of bird species in Denmark. However, the results of this study acquire special relevance when the focus is on humid lands, as they are among the biodiversity-richest ecosystems. Thus, prioritizing the preservation of species' diversity in wetlands will not only positively contribute to maintain the local but also the global level of biological diversity, which represents one of the major goals set by the International Community (Ramsar Convention Secretariat 2010b; Araújo et al. 2011).

The importance of preserving species' diversity has been further reinforced by the fact that visitors not only found it desirable to maintain but even to increase the level of species' diversity. Indeed, they were found to maximize their utility under CC when the number of 'specialist' bird species was incremented with respect to the current level. Though, the achievement of this target will be progressively harder given the growing homogenization process in wetlands, especially in the Mediterranean region, through which many 'specialist' species will be substituted by few 'generalist' ones (Clavel et al. 2010). For this reason, just the maintenance of current levels of these species would already represent a challenge. In this sense, the results highlight that managers might also consider combining policies to protect specialist' bird species with measures to increase 'generalist' migratory ones or to reduce waiting time. This is because the analysis shows that a lower increase in the number of 'specialist' bird species would maximize visitors' utility under these scenarios.

The findings of this CE application have important implications not only for wetland management in a context of adaptation to CC, but also for tourism planning. Indeed, higher preferences for preserving 'specialist' bird species and hence species' diversity reflect the tastes of a sample of visitors to S'Albufera mostly being nature-based tourists (84.47%), coming to Mallorca for nature enjoyment (44.12%) and being repeaters to this wetland (53.73%). Under this light, it is to expect that the implementation of policies oriented to increasing the heterogeneous character of wetlands would attract more nature-based tourists to the destination. Given that nature-based tourism is a fast growing segment (annual rate of increase between 10% and 30%), this is believed to represent a good strategy of differentiation and creation of a long-term competitive advantage, allowing the wetland and the destination to achieve a better position over competitors. In these terms, promoting the preservation of environmental quality seems to be desirable both as a wetland management measure of adaptation to CC and as a tourism plan.

As a matter of fact, in a framework of increasing environmental awareness and tourist demand for high environmental quality, tourism has the potential to positively contribute to wetland and environmental protection and, in turn, to benefit from that. However, there is a number of bidirectional influences, both positive and negative (Ballantyne et al. 2011), characterizing the binomial tourism-environment, which need to be carefully considered to make this relationship work favorably (Marton-Lefèvre and McCool 2008). In this sense, environmental planners need to incorporate more the anthropogenic dimension into the management of ecosystems, while tourism planners are required to design more sustainable tourism activities, which implies including the consideration of the environment in policy-making processes. This involves not only undertaking measures oriented to promoting environmental conservation, research and divulgation; spreading cultural values associated to the local environment; and sustaining the local community (Walpole and Thouless 2005; Fischer et al. 2014), but also doing it on the basis of welfare-maximization. This rests on the use of decision tools such as the economic cost-benefit analysis (CBA) to ensure the chosen policies are socially desirable. However, since CBA is based on the monetization of benefits and costs, it mainly focuses on economic efficiency issues. Despite an in-depth analysis of the winners and losers of the decision can help to incorporate distributional aspects into the CBA, this allowing for the consideration of a social dimension in the analysis, other relevant issues could be overlooked. Indeed, hardly quantifiable aspects such as community quality of life or satisfaction that might play a relevant role in the analysis of the social desirability of policy interventions cannot be considered under a CBA framework. Thus, an alternative approach such as multi-criteria decision analysis (MCDA) could be of interest when it comes to giving guidance to policy makers in a complex context like the environment-tourism one, with many actors exerting reciprocal influences.

Indeed, MCDA represents a social decision-making process where the objectives of all key interest groups are considered, all value judgments are made explicit and crucial problem complexities are analyzed. As one of the key stages of MCDA is communicating all aspects of the analysis to the interested parties, it would require the participation of all the affected stakeholder groups, from visitors to residents and from hoteliers to landowners. This way, it would contribute to minimize social frictions, thus easing the process of policy design and implementation, making it more socially acceptable. In turn, it would better meet the goals of strict planning and collaborations between the stakeholders set by the RAMSAR Convention and the UNWTO (Secretariat of the Ramsar Convention on Wetlands and World Tourism Organization 2012), given the recognition that target achievement is not only in the hands of wetland managers alone.

In conclusion, and despite the contribution of this study, there is still room to further extend and enrich the analysis. In this sense, some limitations and recommendations for future research need to be outlined. On the one hand, further research is encouraged to investigate preferences for adaptation policies addressing both the quantitative and qualitative implications of CC impacts on wetland-dependent species to check for the robustness and generalizability of our conclusions. On the other hand, the analysis of this study has been developed under the assumption of environmental certainty, which is common in the SP literature. However, important sources of uncertainty are associated with CC impacts. Indeed, it is difficult to predict the increase in the global average temperature and its associated consequences on climate due to either unforeseen variations in the ocean and cloud systems or the outbreaks of unexpected extreme events (IPCC 2013a). In this framework, extending the analysis to a context of environmental uncertainty would be recommended, as the assumption of certainty might not be without consequences in social welfare terms.

3. DELIVERING INHERENT UNCERTAINTY INFORMATION IN STATED PREFERENCE METHODS: A FRAMEWORK TO ESTIMATE PRESERVATION BENEFITS

With a focus on expected CC risks, this paper analyzes the effects of inherent uncertainty on the WTP for a preservation policy. To do this, it relates outcome uncertainty to the probability of occurrence of an expected CC impact within a given time horizon. Thus, unlike the existing studies, this paper links outcome uncertainty to the uncontrollable component of environmental uncertainty derived from the stochastic nature of ecosystems' behavior. Results show the support for the preservation policy is stronger in the presence of inherent uncertainty, this indicating risk aversion. In contrast, findings are not conclusive with respect to individuals' sensitivity to the probability of impact occurrence. These results are policy relevant since they can serve to stimulate rather than discourage environmental action when it comes to contexts characterized by many uncertainties.

3.1. Introduction

Risk and uncertainty are becoming central in environmental cost-benefit analysis (ECBA). In this sense, it has been recognized that ECBA of public policies cannot be undertaken under the assumption that the expected policy outcomes are certain. In a risky world, the analyst has an incomplete understanding of the complex environmental, social, institutional and economic processes that interact jointly to produce policy results (Glenk and Colombo 2011). So, assuming outcome certainty rather than uncertainty could lead to wrong conclusions about the *true* policy benefits, and hence the *true* policy's social return if events are not as expected, this leading to poorly inform policy makers. Consequently, it could lead to consider as optimal environmental policies being less effective in terms of results, intensity or implementation timing (Pindyck 2007).

Outcome uncertainty has been argued to depend on many factors such as policy's technical performance, social, political and economic contexts, and environmental uncertainty (Wielgus et al. 2009; Bartczak and Meyerhoff 2013; Lundhede et al. 2015; Rolfe and Windle 2015). In this sense, it has been considered that improving training and education as well as increasing scientific knowledge about ecosystems' functioning can lead to reduce outcome uncertainty (Langsdale 2008). Implicitly, this means that many of the factors influencing outcome uncertainty can be controllable to some extent. However, outcome uncertainty also depends on an uncontrollable factor which is derived from the stochastic nature of ecosystems' behavior: inherent uncertainty. Inherent uncertainty is the component of environmental uncertainty which derives from the ordinary variability of natural systems resulting from interactions among physical, chemical, ecological and human factors (Thom et al. 2004; Ascough II et al. 2008). As it is associated with the non-linear, chaotic behavior patterns of ecosystems, increasingly recognized to be inherently unpredictable (Berkes 2007), the presence of inherent uncertainty makes it difficult to predict the occurrence of many environmental phenomena. Accordingly, this type of uncertainty cannot be controlled by any action and hence it is difficult to be reduced.

This paper analyzes the effects on the WTP for environmental policies of delivering information about inherent uncertainty. To our knowledge, no paper has focused on the difficulty to know with certainty the policy result due to the influence of the uncontrollable component of environmental uncertainty. Indeed, environmental uncertainty has been treated as scientific uncertainty, that is, the incomplete knowledge about the natural systems in terms of gaps in the model's structure or in the data required to support the model. Thus, it has been assumed to be reducible through further scientific research (Cameron 2005; Viscusi and Zeckhauser 2006; Akter and Bennett 2012). The assumption scientific uncertainty can be reduced through increasing knowledge about models' structure or data has been at the core of the existing papers focusing on outcome uncertainty. In fact, these works try to gain some understanding about the WTP to reduce uncertainty in order to give information to policy makers about the desirability of measures aimed at reducing scientific uncertainty. Glenk and Colombo (2011) state that 'significant WTP to reduce uncertainty can be a signal for policy-makers to invest more into scientific research which has the potential to reduce delivery uncertainty'. Likewise, Koundouri et al. (2014) conclude that 'scientific research that reduces environmental uncertainty should be encouraged and promoted'. In contrast, when it comes to inherent uncertainty, no amount of research will generate absolute predictions about the probability of occurrence of many environmental phenomena (Langsdale 2008). While increasing scientific knowledge in terms of ecosystems' responses to critical loads and carrying capacities could contribute to shed some light on this, knowing how close a natural system is to a critical threshold is still highly difficult to predict in many contexts. As the probability of occurrence of a given environmental phenomenon is unknown to the analyst, outcome uncertainty could still emerge even if it is assumed that the remaining (controllable) factors influencing outcome uncertainty don't affect the policy result.

The difficulties to control (and reduce) inherent uncertainty by means of further scientific research helps to explain the low attention valuation researchers have paid to the issue. This is reasonable in a context in which policy makers usually consider scientific certainty as a prerequisite for environmental decision-making (Mitchell 2002; Sethi et al. 2005). In this setting, researchers put emphasis on the importance of reducing uncertainty through increasing scientific knowledge in an attempt to stimulate environmental action. However, even if inherent uncertainty is difficult to be controlled and hence reducible through further research, the analysis of its effects on WTP is also relevant for environmental decision-making. Informing individuals that outcome uncertainty can emerge due to the difficulty of knowing if an environmental phenomenon will occur or not could also affect their WTP for measures pursuing to counteract the expected derived impacts. Would individuals be willing to pay for these measures in a framework in which these impacts might not occur? Gaining understanding of the voting public's preferences in this context could have interesting implications for policy-making. Viscusi and Zeckhauser (2006) state that, in settings characterized by many inherent uncertainties, 'those who wish to "go slow" point to the level of scientific uncertainty; they propose that we wait to learn more, and possibly learn that the risk was greatly overstated'. Preference analysis in the presence of inherent uncertainty could offer an insight into this. It could contribute to stimulate rather than discourage environmental action aimed at addressing (inherently) uncertain expected impacts.

This paper examines, through a CE, the effects on WTP of delivering information about inherent uncertainty over the occurrence of a CC impact on wetland's biodiversity. Difficulties to predict climate system's alterations due to unforeseen variations and trends both in the drivers of change and the associated system's responses indicate CC is beset with lots of uncertainties (Heal and Millner 2014). The structure of the paper is as follows. Next section reviews the SP literature concerned with the analysis of risk preferences to show that examining the effects on WTP of inherent uncertainty has been an overlooked issue to date. Section 3.3. describes the data source and the methodology employed for the analysis. Results are reported in section 3.4., followed by a discussion and conclusions section that ends the paper.

3.2. Analysis of risk preferences in the stated preference literature: a review

The growing concern among researchers about how to handle risk and uncertainty in economic valuation has resulted in an extensive SP literature on risk preference analysis. Three broad approaches can be distinguished. The first one is followed by papers which put emphasis on the estimation of the WTP for policies aimed at reducing health or environmental risks to examine individuals' preferences for changes in risk exposure. Concerning risk factors to health, most of papers focus on valuation of mortality risks induced by air pollution problems, which has been mainly undertaken through a CV. Examples are Krupnick et al. (1999), who estimate the WTP for air pollution control equipment in Japan; Alberini et al. (2006), who analyze preferences for air pollution control policies in UK, France and Italy; Hammitt and Zhou (2006), who measure the WTP for medical treatments and cures in China; Wang and Mullahy (2006), who assess programs aimed at reducing the death risks induced by coal combustion in China; and Alberini and Chiabai (2007a), who focus on the fatality risks induced by environmental and thermal (heat waves) stresses in Italy. On the other side, Fu et al. (1999) and Bateman et al. (2005) value, also through a CV, the risk of cancer induced by the use of pesticides on vegetables in Taiwan and by solar UV radiation in New Zealand, Scotland, England and Portugal, respectively.

Valuation of health risks has also been undertaken in papers which measure, through a CE, the WTP for policies aimed at reducing a specific environmental risk: the risk of flooding. These papers value, together with flood risks, the health risks induced by flooding episodes. This is the case of Veronesi et al. (2014), who focus on valuing the benefits from adapting the sewer treatment in Switzerland to maintain the current service levels in the face of CC; and Zhai (2006) and Reynaud and Nguyen (2013), who value alternative flood management strategies in Japan and Vietnam, respectively, with emphasis on fatality risks. In fact, valuation of flooding risks through a CE has been another topic of interest within this approach. It has been central in Birol et al. (2009), who value river management strategies aimed at reducing flooding episodes in Poland; and Dekker and Brouwer (2010) and Brouwer and Schaafsma (2013), who measure the WTP for reducing CC induced risk of flooding in the Netherlands.

Other environmental risks that have captured the attention of researchers are related to endangered species, algae bloom episodes and wildfires. By means of a CE, Mitani et al. (2008), Lew et al. (2010) and Bartczak and Meyerhoff (2013) value, respectively, vegetation restoration and conservation programs in Japan, management actions to enhance western stock of Steller sea lion protection in the US, and programs aimed at increasing the chances of survival of two distinct Eurasian Lynx populations in Poland. Roberts et al. (2008) also use a CE to value policies of nutrient and phosphorus concentration control to reduce algal bloom episodes, as well as the construction of dams or reservoirs to control for water level changes in the Tenkiller Ferry Reservoir, Oklahoma. Finally, Fried et al. (1999) use a CV to assess the WTP for a reduction in risk of wildfires threatening properties in Michigan.

The papers following this first approach never assume a total reduction of risk. This would not be realistic in a world which, by definition, is risky. The studies belonging to this first group consider individuals can exert some degree of control over risks through specific actions. In fact, they value policies which are aimed at reducing a given risk with the purpose of examining individuals' preferences for changes in risk exposure. Particular cases are Cameron (2005) and Viscusi and Zeckhauser (2006). With a focus on the influence on WTP of subjective perceptions about future CC risks, these two CV studies calculate ex-ante WTP for policies which are assumed to totally eliminate future environmental risks. The main findings of these studies show a positive WTP for risk reduction (or elimination), this suggesting risk aversion.

The second approach is followed by studies focusing on measuring the WTP for environmental policies with uncertain outcomes in an attempt to analyze the effects on policy's benefits of delivering information about outcome uncertainty. These papers state that outcome uncertainty depends on different factors such as management changes, social, political and economic contexts, and environmental uncertainty. The first papers within this approach apply a CV and hence deliver information about outcome uncertainty through the scenario description. Examples are Johansson (1989) and MacMillan et al. (1996), which are the first studies in this context concerned with the estimation of money measures in an uncertain environmental setting. Johansson (1989) assesses WTP for species' conservation programs in Swedish forests and MacMillan et al. (1996) estimate the benefits of acid rain reduction programs in Scotland uplands. Both papers focus on the analysis of individuals' attitudes towards risk and they present outcome uncertainty through two possible policy results, each associated with a given probability.

However, delivering information about outcome uncertainty through an attribute representing policy effectiveness has become common practice among researchers due to the increasing use of CEs. In this sense, most of studies published in the last years focus on estimating preferences for policy effectiveness. The majority assume the evaluation of the uncertainty measures is not affected by subjective perceptions. Examples are Ivanova et al. (2010), who value both the *'certainty that the option will make* *significant contribution to the target'* and the *'percent of emissions covered by international participation'* in a context of reduction of greenhouse gas emissions contributing to CC in Queensland; Glenk and Colombo (2011), who estimate preferences for *'risk of failure'* of agri-environmental measures aimed at CC mitigation through soil carbon sequestration in Scotland; and Koundouri et al. (2014), who measure the WTP for *'investment on research'* under different revised water management plans in a framework of groundwater dependent ecosystems' damage due to water losses in Finland. Additionally, with a focus on US public agency managers' preferences, Wibbenmeyer et al. (2013) focus on the *'probability of success'* of strategies aimed at minimizing the expected loss from wildland fire incidents, as well as on the *'probability of fire reaching homes or the watershed in the absence of suppression efforts'*.

In this context, some authors put emphasis on analyzing the effect on WTP of different ways of delivering information about uncertainty around policy effectiveness. This is the case of Wielgus et al. (2009), who provide this information through both the *'probability of occurrence of the valuation scenarios'* and the use of *'attribute levels with narrow and wide ranges around an average value'* to estimate preferences for the enforcement of fishing regulations and control of fishing activities in Mexico. In contrast, other authors focus on analyzing the impact of alternative ways to model choice behavior when uncertainty around policy effectiveness is present. One example is Glenk and Colombo (2013), who estimate preferences for soil-land carbon sequestration policies in Scotland which are subject to a *'risk of failure'* attribute. Another paper is Rolfe and Windle (2015), who extend the work by Glenk and Colombo (2013) to explore alternative generalizations of expected utility theory. They value policies aimed at restoring good quality conditions of the Great Barrier Reef where information about policy effectiveness is delivered through the attribute *'level of certainty'*. Additionally, Rigby et al. (2010) compare different utility specifications when valuing water to irrigation producers in Spain under uncertain scenarios of water allocation. They illustrate uncertainty around policy effectiveness through the attribute '*probability of additional water'.*

Only in recent years the analysis of the influence on WTP of subjective perceptions about uncertainty around policy effectiveness has captured the attention of researchers applying CEs. Examples are Lundhede et al. (2015), who analyze if individuals' prior assessments of the *'probability that the policy will be effective'* have an effect on the value of policies aimed to reduce CC threats to bird populations and species in Denmark. Likewise, Akter et al. (2012) focus on the impact of different types of skepticism on WTP for CC mitigation policies in Australia. Uncertainty around policy effectiveness is referred to as impact skepticism and presented to respondents as *'chances that the rise in temperature will be achieved'*. On the other side, Cerroni et al. (2013) center on subjective elicitations of perceived risk when valuing research and development programs aimed to find alternatives for growing apples without the use of pesticides in Italy. They deliver information about program effectiveness through the *'probability of occurrence'* of a specific percentage of apples containing pesticides and, additionally, they ask individuals about their subjective perception of risks.

The papers following this second approach put emphasis on the fact that outcome uncertainty can be reduced through improving training and education, as well as increasing scientific knowledge. Indeed, they consider that many of the factors influencing outcome uncertainty can be controllable to some extent. This is especially true in the papers applying a CE which explicitly value a policy effectiveness attribute. The interest in knowing preferences for policy effectiveness is motivated by the assumption that some control can be exerted over the final policy results. The main findings of this literature are consistent with predictions of the economic theory which state that individuals are risk-averse because their WTP decreases when outcome uncertainty is present.

The third approach is followed by papers focusing on preference uncertainty, which refers to how confident individuals have felt while stating their preferences and is normally assessed through a follow up question to the valuation exercise (Akter et al. 2008; Martínez and Lyssenko 2012). Preference uncertainty tends to be high either when the utility difference between the chosen option and the best alternative to it is small (Balcombe and Fraser 2011; Olsen et al. 2011) or when an offered referendum bid is not clearly different from the mean value of one's valuation distribution (Wang et al. 1997). The effect of stated preference uncertainty on WTP has received considerable attention by CV practitioners and, most recently, also by researchers applying CEs. Mixed results have emerged concerning this effect. Some studies find that WTP tends to increase when respondents' uncertainty is accounted for (Ready et al. 1995; Alberini et al. 2003), while others show the opposite (Li and Mattson 1995). In addition, some evidence also exists that WTP may increase or decrease with preference uncertainty depending on the approach employed to classify respondents as certain or uncertain basing on their stated degree of uncertainty (Loomis and Ekstrand 1998; Shaikh et al. 2007; Lundhede et al. 2009; Ready et al. 2010).

This literature review shows that inherent uncertainty has been an overlooked issue in the SP literature to date. In specific, the analysis of the effects on WTP of delivering information about this type of uncertainty has not captured the attention of researchers dealing with outcome uncertainty. This paper will show that a focus on the uncontrollable factor of outcome uncertainty is also of great relevance for environmental policy-making.

3.3. Data source and methodology

3.3.1. Data source

The data used to test for the effects on WTP of delivering information about inherent uncertainty come from Faccioli et al. (2015), who undertook a CE study in S'Albufera wetland between April the 15th and June the 30th, 2013. The humid land, which is located in Mallorca, is outstandingly vulnerable to CC risks related to both the increase in temperature and the decrease in precipitation rates expected for the Mediterranean region. The CE focuses on the analysis of visitors' preferences for adaptation policies aimed at counteracting expected CC impacts on bird species. On the one hand, it centers on the effects of the above-mentioned CC risks on 'specialist' bird species, which mostly rely on S'Albufera habitat. Indeed, CC might lead to declines in freshwater volumes which might intensify salinization problems currently suffered by the wetland. If this happens, it is expected to particularly affect 'specialist' bird species, thus generating a qualitative loss in the site's biological diversity. On the other hand, the CE also considers the CC effects on 'generalist' migratory bird species, which suit a wider habitat range and move to this humid land for resting and breeding. In specific, it is assumed that the projected rises in temperature at their origin places might stimulate their advanced departure, such that they might arrive earlier to S'Albufera. In this case, if nesting and breeding conditions were not optimal, either they could pass by without stopping or they could die if they stopped, this leading to a loss in their number in this wetland. As a result, the number of both 'specialist' bird species and 'generalist' migratory ones might decline.

In this context, Faccioli et al. (2015) estimate the social benefits of two different adaptation policies. First, an adaptation action aimed at preserving species' diversity and, hence, the original wetland heterogeneity, by avoiding a quantitative loss of 'specialist' bird species.

This measure pursues to counteract a potential increase in water salinization by strengthening efforts on current water management practices. Second, an adaptation strategy oriented to recovering species' abundance, regardless of the species' type, by avoiding a quantitative loss of bird species. This strategy aims to advance work on creating optimal nesting conditions for 'generalist' migratory bird species. Management efforts are assumed to be either moderate or high for both adaptation policies.

Table 6 reports the attributes employed in the CE to generate the experimental design, which is a D-efficient Bayesian:[15]

Table 6 Attributes' description and their levels

Attribute	Description	Levels
'Specialist' bird species	Change in the number of species[a]	+5 0 -10[c]
'Generalist' migratory bird species	Change in the number of species[a]	+5 0 -10[c]
Waiting time	Minutes waited for an observation cabin's seat	About 3 About 7 About 15[c]
Rest-stop benches	Number of benches throughout the park[b]	Triple Double Equal[c]
Entrance fee	Entrance fee per adult visitor and trip (in euros)	4, 8, 12, 16, 20, 24

[a]Changes with respect to the current number of 'specialist' bird species and 'generalist' migratory bird species.
[b]Number measured with respect to the current level of rest-stop benches.
[c]BAU levels, being €0 for the Entrance fee attribute.

[15]See Faccioli et al. (2015) for a detailed description of the case study and the experimental design.

3.3.2. Delivering information about outcome uncertainty linked to inherent uncertainty

The present analysis wants to identify the effect on WTP of inherent uncertainty. So, it relates the impossibility of knowing with certainty the policy result to the difficulty of knowing if an environmental phenomenon will occur or not. In other words, the analysis links outcome uncertainty only to inherent uncertainty. To do this, it assumes that the remaining (controllable) factors influencing outcome uncertainty don't affect the policy result derived from each type of management effort. In specific, the analysis associates outcome uncertainty with the probability of occurrence p_1 of a specific decline in freshwater volumes in S'Albufera within a given time horizon. This decline would lead to an increase in water salinization and hence a decrease in the number of 'specialist' bird species. Thus, following Faccioli et al. (2015), it is assumed a loss of 10 species with a probability p_1 in a 10 years' time if CC finally leads to a decline in freshwater volumes and no adaptation policy is undertaken today (BAU). Consequently, it is considered that, under a moderate management effort, a policy outcome representing a 0 increase in the number of species will be achieved with a probability $p_{1.}$ Put another way, a moderate management effort will lead to keep the current levels of species with a probability p_1. Likewise, a policy outcome representing an increase by 5 is considered to be achieved under a high management effort with a probability p_1.

To give a better picture of the stochastic nature of inherent uncertainty, and hence better identify the effects on WTP of this type of uncertainty, respondents are also provided with information about what is going to happen in case the impact does not occur in a 10 years' time. In this sense, they are informed about the probability of impact non-occurrence p_2, where p_2=1-p_1, together with the associated change in the number of species. In specific, it is assumed that if CC does not finally lead to a decline in freshwater volumes, which will happen with a probability p_2, the number of 'specialist' bird species will not change if no adaptation policy is undertaken today (BAU). Accordingly, the possibility of achieving another policy outcome with a probability p_2 is considered under each management effort. In particular, increases by both 5 and 10 in the number of species are assumed to be achieved under a moderate and high management effort, respectively.

Note that under both types of management efforts, policy results always represent a number of 'specialist' bird species which is either equal to or higher than the present one. This is reasonable since adaptation both ensures at least to keep constant the current levels of species if the impact occurs and leads to higher numbers in the absence of the impact.[16] Table 7 shows the levels of the 'specialist' bird species attribute considered for each scenario:

Table 7 Levels of the 'specialist' bird species attribute[a]

	Probabilities of impact occurrence and non-occurrence in a 10 years' time	
	p_1	p_2
BAU	-10	0
Adaptation	0[b]/+5[c]	+5[b]/+10[c]

[a]Changes in the number of 'specialist' bird species with respect to current levels.
[b]Changes in the number of 'specialist' bird species under a moderate management effort.
[c]Changes in the number of 'specialist' bird species under a high management effort.

[16]As S'Albufera wetland already suffers water salinization problems, respondents considered reasonable to strengthen efforts on current water management practices to reduce these problems in the presence of inherent uncertainty. Indeed, they believed the policy oriented to preserve species' diversity could lead to recover some 'specialist' bird species in case the decline of freshwater volumes didn't finally occur. So, they perceived as credible the policy outcomes representing an increase in the number of these species by both 5 and 10 in a non-occurrence scenario. In contrast, focus groups showed that they didn't believe in additional increases in the number of 'generalist' migratory bird species in a context in which they didn't arrive earlier to the humid land due to an advancement in their departure (non-occurrence). As a consequence, the CC impact on the number of 'generalist' migratory bird species is considered to occur with certainty and, hence, outcome uncertainty is not assumed for the adaptation policy aimed at counteracting this impact.

To facilitate choice, information about p_1 and p_2 together with the associated attribute values is given through text and visual representations. In this sense, each alternative in each choice card depicts the same values for p_1 and p_2. This allows linking outcome uncertainty (present in the improving alternatives) to inherent uncertainty around the expected loss in the number of 'specialist' bird species (present in the BAU scenario). Besides, to make clearer the uncontrollable nature of the probability of impact occurrence, information about p_1 is also included in the CE design through a framing statement, as shown below. A framing statement is useful in valuation contexts where the likelihoods of outcomes cannot be influenced (Glenk and Colombo 2011).

The evolution of the number of 'specialist' bird species in 10 years' time is uncertain. To make a comparison, it is like in a lottery, results are subject to a probability. In this sense, experts think that if park managers' efforts on current management practices are not strengthened, the decrease in the number of 'specialist' bird species will occur with a probability equal to p_1. Of course, the changes in the number of 'specialist' bird species resulting from strengthening efforts will also be uncertain.

To investigate whether the inclusion of inherent uncertainty has some effects on the WTP, three scenarios are considered. On the one hand, a scenario of no inherent uncertainty (*No_Inherent*) where respondents are informed that the probability p_1 of a loss of 10 'specialist' bird species in a 10 years' time is equal to 100%. In this case, the policy leads with certainty both to keep the current levels of species under a moderate management effort and to increase their number by 5 under a high management effort. Thus, only one policy outcome is presented to respondents under each effort. Information about p_1=100% is only given through the framing statement.[17] On the other one, two inherent uncertainty scenarios are taken into account, where p_1 (and hence p_2) takes two different values: a

[17]This is the valuation scenario used in Faccioli et al. (2015).

value of 80% (20% for p_2) to represent a scenario of low inherent uncertainty (*Inherent_80*) and a value of 60% (40% for p_2) to depict a scenario of high inherent uncertainty (*Inherent_60*). According to the classic distinction made by Knight (1921), uncertainty is applied to situations where probabilities are unknown to the analyst. However, it is worth noting the probability values used in this analysis are applied to the same expected impact in a random fashion. Assigning probabilities randomly to a given outcome implicitly indicates no knowledge of the probability distribution that this outcome will be achieved (Glenk and Colombo 2011). In this sense, while p_1 cannot be predicted with certainty, it is assumed that scientific knowledge of ecosystems' responses to critical loads and carrying capacities could contribute to shed some light on it. Thus, by using objective probabilities, it is assumed that further research will lead to provide some empirical knowledge that allows assigning probabilities and hence providing information about how near extinction the species might be.

Table 8 depicts the attribute levels considered for each scenario together with the probabilities of both impact occurrence (p_1) and non-occurrence (p_2):

Table 8 Levels of the 'specialist' bird species attribute under each scenario[a]

		Inherent uncertainty			
		Inherent_80		Inherent_60	
	No_Inherent	p_1 =80%	p_2 =20%	p_1 =60%	p_2 =40%
BAU	-10	-10	0	-10	0
Adaptation	0[b]/+5[c]	0[b]/+5[c]	+5[b]/+10[c]	0[b]/+5[c]	+5[b]/+10[c]

[a]Changes with respect to current levels.
[b]Changes in the number of 'specialist' bird species under a moderate management effort.
[c]Changes in the number of 'specialist' bird species under a high management effort.

In the Appendix, a sample card for a probability of impacts' occurrence p_1 equal to 60% (Sample choice card 2) and to 80% (Sample choice card 3) are reported.

SP studies dealing with outcome uncertainty have usually shown that individuals' WTP decreases with uncertainty. Indeed, outcome uncertainty has been usually related to policy effectiveness in such a way that higher uncertainty implies a lower probability of policy success (Lundhede et al. 2015) or a higher risk of failure (Glenk and Colombo 2011), which makes the policy less desirable when the scenario becomes more uncertain. However, in this analysis, the WTP for the adaptation policy is expected to be higher in the presence of inherent uncertainty. This is because increasing this type of uncertainty leads to a lower risk of species' loss and, as predicted by the EU theory, low risk increases WTP (Wielgus et al. 2009).

Besides, the way outcome uncertainty is illustrated in the present analysis shows a policy which, under a moderate management effort, leads at least to keep the current number of 'specialist' bird species with probability p_1, while it increases this number with probability p_2. If the management effort is high, the two potential increases in the number of species are even higher (+5 with p_1 and +10 with p_2). Provided the policy leads to the same two outcomes under each given management effort in the three considered scenarios (being the value of p_1 and p_2 the only difference between *No_Inherent*, *Inherent_80* and *Inherent_60*), it leads to higher expected outcomes with inherent uncertainty. This is because, as p_1 diminishes while p_2 increases, policy outcomes become more desirable under the uncertain scenarios. Wielgus et al. (2009) state that individuals should be willing to pay more in contexts with a higher probability of occurrence of the environmental improvement, as it leads to a higher expected outcome. Bartczak and Meyerhoff (2013) also show that the WTP increases with the probability of survival of a given species.

According to this, this paper tests these two null hypotheses:

1. *Delivering information about inherent uncertainty does not affect the WTP for the adaptation policy.*
2. *WTP does not decrease with the probability of impact occurrence.*

To test for these hypotheses, a split sample approach was used to show each person only one scenario of p_1 (and p_2) to reduce respondents' burden. In particular, three versions of the CE questionnaire were considered, only differing in terms of the value of p_1 and p_2. Data were collected by means of on-site interviews. Sample sizes, which ranged from 310 to 322, were obtained by considering a confidence interval of 95% and a sample error of 5.5%.

3.3.3. Modelling approach

Preference analysis through CEs is carried out on the basis of the RUM theory. In this sense, individual choices are modelled by assuming respondent *n* chooses the alternative *j* providing him with the highest utility level from among a set of options. As shown in Equation 6, utility is defined as the sum of two components. First, a deterministic part $V_{nj}(\cdot)$ consisting of the alternative's non-monetary (X_{nj}) and monetary ($X_{COST_{nj}}$) attributes, as well as a set of parameters (β) to be estimated. Second, a stochastic part ε_{nj} capturing all the unobserved factors affecting choice and indicating the analyst's incomplete knowledge about the individual decision process:

$$U_{nj} = V_{nj}(X_{nj}, X_{COST_{nj}}, \beta) + \varepsilon_{nj} \tag{6}$$

A common way to analyze decisions involving risk and uncertainty is to draw on the expected utility (EU) theory (von Neumann and Morgenstern 1944) or the subjective expected utility (SEU) theory (Savage 1954). Both approaches are linear in the probabilities that characterize risks and assume individuals have preferences over outcomes only and not over probabilities. In recent years, alternative approaches to risk have emerged which suggest that treatment of probabilities may be non-linear or that people may emphasize the probability of extreme events (Rolfe and Windle 2015). Another recent approach assumes the effect of probability on utility can be partially or fully separable from the utility effect of the risky good, namely that probability provides 'direct utility' (Gneezy et al. 2006). In this context, recent studies focusing on comparing different representations of choice under risk show that findings are mixed, this suggesting further research is still needed to draw conclusions about which specification is better. For instance, Rolfe and Windle (2015) don't find significant non-linear effects. Besides, they find mixed evidence for increased certainty to be valued independently from the expected value of the environmental good of interest. In contrast, Glenk and Colombo (2013) find that a direct utility specification shows the greatest model fit to data, although they don't believe individuals don't conduct any probability weighting of outcomes in the choice process. In this sense, they cautiously advocate for the use of a non-linear EU model over models that consider linear probability-weighted outcomes and in combination with direct utility from risk. Interestingly, both papers find significant support for different types of EU models.

According to this, the present paper assumes respondents process information on risk within the choice task according to the EU framework. Besides, it is a common theoretical assumption in the SP literature which appears well suited to the present application. In particular, it is considered a non-linear EU for the risky attribute whose outcomes are weighted by their objective probability of both occurrence (p_1) and non-occurrence (p_2).

To allow comparing model results under inherent uncertainty with those under no inherent uncertainty, the model employed in Faccioli et al. (2015) is considered. There, parameter estimation is carried out through a RPL model, which has many advantages over the CL model (McFadden and Train 2000; Train 2009), firstly being the fact that it considers individual-specific preferences by assuming parameters are random and follow a given distribution. In fact, the coefficients result from the sum of a population mean parameter and an individual-specific deviation over this mean. In Faccioli et al. (2015), only the cost parameter has been considered to be random, which is not uncommon (Carlsson et al. 2005), and, in specific, it has been assigned a lognormal distribution to constrain it to have the same sign over all individuals (Torres et al. 2011).[18] Equation 7 shows the utility specification considered for estimation purposes, which has been adapted from Faccioli et al. (2015):

$$\begin{aligned} U_{nj} = {} & \beta_1[(p_1 \cdot X_{SPEC1_{nj}}) + (p_2 \cdot X_{SPEC2_{nj}})] + \beta_2 X_{GEN_{nj}} + \beta_3 X_{TIME(less)_{nj}} \\ & + \beta_4 X_{BENCHES(double)_{nj}} + \beta_5 X_{BENCHES(triple)_{nj}} \\ & + \beta_6[(p_1 \cdot X^2{}_{SPEC1_{nj}}) + (p_2 \cdot X^2{}_{SPEC2_{nj}})] + \beta_7 X^2{}_{GEN_{nj}} \\ & + \beta_8 X_{GEN_{nj}} \cdot [(p_1 \cdot X_{SPEC1_{nj}}) + (p_2 \cdot X_{SPEC2_{nj}})] \\ & + \beta_9 X_{TIME(less)_{nj}} \cdot [(p_1 \cdot X_{SPEC1_{nj}}) + (p_2 \cdot X_{SPEC2_{nj}})] \\ & + \beta_{10n} X_{COST_{nj}} + \varepsilon_{nj} \end{aligned} \tag{7}$$

for respondent *n* and alternative *j*, $X_{SPEC1_{nj}}$ is the level of the 'specialist' bird species attribute under a probability of impact occurrence equal to p_1, and $X_{SPEC2_{nj}}$ is the attribute level when the probability of impact non-occurrence is p_2; $X_{GEN_{nj}}$ is the level of the 'generalist' migratory bird species attribute; $X_{TIME(less)_{nj}}$ is a dummy variable taking value 1 for less than 15 minutes waiting time for a seat in an observation cabin and 0 otherwise; $X_{BENCHES(double)_{nj}}$ and $X_{BENCHES(triple)_{nj}}$ are two dummy variables taking value 1 when the number of benches throughout the park

[18]Specifying the cost coefficient as random was supported not only by a strong evidence of this parameters' heterogeneity across respondents, but also by the conclusions in Torres et al. (2011). There, it is suggested that specifying as homogeneous the cost coefficient when it is not, is highly unrecommendable because of the severe implications this might have for the analysis of welfare measures.

is double and triple with respect to the current one, respectively, and 0 otherwise; and β_1, β_2, β_3, β_4, β_5, β_6, β_7, β_8 and β_9 are the fixed attribute coefficients and β_{10n} is the individual-specific parameter for $X_{COST_{nj}}$.

Given the formulated hypotheses, the focus is on the WTP for a unit increase in the expected number of 'specialist' bird species. This is calculated following the Hanemann (1984)'s formula for compensating variation, derived from Equation 7 and shown in Equation 8:

$$
\begin{aligned}
WTP_{X_{SPECnj}} = -\frac{1}{\beta_{10n}} \{ & \beta_1[(p_1 \cdot ({X_{SPEC1}}_{nj}{}^1 - {X_{SPEC1}}_{nj}{}^0)) \\
& + (p_2 \cdot ({X_{SPEC2}}_{nj}{}^1 - {X_{SPEC2}}_{nj}{}^0))] \\
& + \beta_6[(p_1 \cdot ({X^2}_{SPEC1_{nj}}{}^1 - {X^2}_{SPEC1_{nj}}{}^0)) \\
& + (p_2 \cdot ({X^2}_{SPEC2_{nj}}{}^1 - {X^2}_{SPEC2_{nj}}{}^0))] \\
& + \beta_8 \cdot {X_{GEN}}_{nj}{}^0 \cdot [(p_1 \cdot ({X_{SPEC1}}_{nj}{}^1 - {X_{SPEC1}}_{nj}{}^0)) \\
& + (p_2 \cdot ({X_{SPEC2}}_{nj}{}^1 - {X_{SPEC2}}_{nj}{}^0))] \\
& + \beta_9 \cdot {X_{TIME(less)}}_{nj}{}^0 \cdot [(p_1 \cdot ({X_{SPEC1}}_{nj}{}^1 - {X_{SPEC1}}_{nj}{}^0)) \\
& + (p_2 \cdot ({X_{SPEC2}}_{nj}{}^1 - {X_{SPEC2}}_{nj}{}^0))]\}
\end{aligned}
\tag{8}
$$

where superscripts ^{1} and ^{0} respectively indicate the level of the attribute after and before the change, respectively.

3.4. Results

After having eliminated the invalid and protest questionnaires[19] and taking into account each respondent faces 6 choice sets, the RPL models for the three scenarios depicted in Table 8 have been estimated. Table 9 reports models' results:

[19]Surveys are considered to be invalid when missing responses are detected in the section concerning the choice of the alternatives. Protests refer to questionnaires where the choice of the BAU option is motivated by one of the following reasons: "*I consider I am already paying for these services*", *"Others should pay"* and *"I don't trust the local authorities"*.

Table 9 Results from RPL models under No_Inherent, Inherent_80 and Inherent_60 scenarios[a]

	No_Inherent		Inherent_80		Inherent_60	
Variables	Coeff.	*Std. error*	Coeff.	*Std. error*	Coeff.	*Std. error*
Fixed parameters						
$p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}$	2.113***	*0.286*	1.956***	*0.181*	1.613***	*0.180*
X_{GEN}	1.245***	*0.236*	0.568***	*0.177*	1.729***	*0.188*
$X_{TIME(less)}$	0.455***	*0.139*	1.118***	*0.118*	0.150	*0.109*
$X_{BENCHES(double)}$	0.584***	*0.150*	0.116	*0.109*	0.600***	*0.125*
$X_{BENCHES(triple)}$	0.276	*0.173*	0.838***	*0.140*	0.274*	*0.140*
$p_1 \cdot X^2_{SPEC1} + p_2 \cdot X^2_{SPEC2}$	-0.780***	*0.274*	-1.567***	*0.236*	-1.841***	*0.249*
X^2_{GEN}	-0.758***	*0.255*	-0.968***	*0.256*	0.685***	*0.226*
$(p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}) \cdot X_{GEN}$	-0.290*	*0.165*	-0.998***	*0.151*	-1.097***	*0.165*
$(p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}) \cdot X_{TIME(less)}$	-0.684***	*0.167*	-1.901***	*0.173*	-0.075	*0.215*
Random parameters[b]						
X_{COST}_mean	1.371***	*0.065*	1.087***	*0.073*	0.996***	*0.076*
X_{COST}_std. deviation	0.718***	*0.043*	0.861***	*0.053*	0.966***	*0.061*
Log-likelihood	-1,050.601		-1,061.169		-1,183.264	
Observations	1,788		1,734		1,746	
N	298		289		291	

[a] *** Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.
[b] Coefficients of the normal distribution associated with the lognormal one.

As shown in Table 9, when respondents make choices in a scenario where the future loss in the number of 'specialist' bird species is assumed to be certain, they prefer a policy which leads to a higher number of both 'specialist' bird species and 'generalist' migratory ones, allows for less waiting time for a seat in an observation cabin and doubles the number of benches throughout the park. However, the presence of some interaction effects indicate that the utility they get from a specific attribute sometimes also depends on the level of the same or other attributes. In this sense, it can be observed that the utility they obtain from an increase in both $E(X_{SPEC})$ (where $E(X_{SPEC})=p_1 \cdot X_{SPEC1}+p_2 \cdot X_{SPEC2}$, that is, the expected number of 'specialist' bird species) and X_{GEN} increases at a decreasing rate with the number of 'specialist' and 'generalist' migratory bird species, respectively. Additionally, they seem to perceive 'specialist' bird species as substitutes of 'generalist' migratory ones. A substitution pattern can also be observed between $E(X_{SPEC})$ and $X_{TIME(less)}$, which suggests that individuals value less the 'specialist' bird species when congestion in the wetland is low ($X_{TIME(less)}=1$), as a lower waiting time can be related to a lower number of visitors. In other words, they value more this type of species when congestion is high. This could be explained by the fact that, under high congestion, they would have less chances of viewing all types of bird species from an observation cabin, which could lead them to prioritize viewing 'specialist' bird species over other types of species. As expected, the cost coefficient is random, thus indicating the marginal utility of income is heterogeneous.

When respondents make choices in the face of inherent uncertainty around the expected loss of 'specialist' bird species, the magnitudes of attribute coefficients vary although their sign and significance don't change in most of cases. According to the Swait and Louviere (1993) test, the differences in parameters are not explained by changes in scale, which suggests individuals' preferences could be impacted when inherent uncertainty information is included in the CE design.[20] To test for this, differences in the mean marginal value of $E(X_{SPEC})$ under *No_Inherent*, *Inherent_80*, *Inherent_60* have been examined through the Poe et al. (2005)'s test. Marginal values have been calculated following Equation 8,

[20] The null hypothesis of scale parameters' equality across the models cannot be rejected at 1% level.

which is referred to a unit increase in the expected number of 'specialist' bird species from the BAU situation, and considering the BAU levels for the interacting attributes (X_{GEN}=-10 and $X_{TIME(less)}$=0). The Poe et al. (2005)'s test has relied on simulated vectors of mean marginal values, obtained through bootstrapping for all the scenarios (Hole et al. 2007). Models have been replicated 1,000 times, this leading to three vectors consisting of 1,000 mean marginal values for *No_Inherent*, *Inherent_80*, *Inherent_60*. For each pair of vectors, differences between all vector elements have been calculated to obtain a new vector for which a confidence interval has been computed. An entirely positive or negative confidence interval indicates significant differences in the mean marginal values. Table 10 reports the mean marginal values under each scenario together with the confidence intervals resulting from Poe et al. (2005)'s test:

Table 10 Mean marginal value of E(X_{SPEC}) under No_Inherent, Inherent_80 and Inherent_60 scenarios[a]

	Test 1		Test 2		Test 3	
E(X_{SPEC})	No_ Inherent	Inherent_ 80	Inherent_ 80	Inherent_ 60	No_ Inherent	Inherent_ 60
Mean marginal value	1.31	2.43	2.43	2.75	1.31	2.75
Interval	[0.54;2.37]***		[-1.03;1.41]		[0.65;2.61]***	

[a]The mean marginal value of E(X_{SPEC}) has been calculated by computing the mean of the individual-specific marginal values, which follow a lognormal distribution due to the random cost parameter.
***Significant difference between values at the 1% level.

As shown in Table 10, the mean marginal value under *No_Inherent* is significantly lower than those obtained under *Inherent_80* and *Inherent_60* (1.31<2.43<2.75). This suggests visitors are willing to pay more for a unit increase in the expected number of 'specialist' bird species when inherent uncertainty is present. In other words, they show a stronger support for a policy aimed at preserving species' diversity when they don't know with certainty if the expected loss of 'specialist' bird species will occur. Thus, the null hypothesis, that delivering information about inherent uncertainty does not affect the WTP for the adaptation policy, is rejected. As expected, individuals find more desirable the adaptation policy in the presence of inherent uncertainty. This is reasonable since this type of uncertainty implies a lower risk of species' loss (p_1 diminishes) and hence the possibility of achieving a better policy outcome under each management effort with a probability $p_2>0$. In specific, if the expected impact finally occurs, undertaking the policy will allow at least keeping the current level of species with a probability p_1 under a moderate management effort, while leading to a higher number of species if the impact does not occur. In addition, it will lead to better environmental improvements under a high management effort with both p_1 and p_2 (see Table 8). Consequently, the policy leads to higher expected outcomes with uncertainty, thus becoming more desirable to respondents.

Interestingly, the Poe et al. (2005)'s test indicates that there is no significant difference between the marginal values under both *Inherent_80* and *Inherent_60* (2.43 and 2.75, respectively), this indicating the WTP does not decrease with the probability of impact occurrence. In other words, it seems individuals are insensitive to the magnitude of uncertainty while expressing their preferences. This would suggest that the second null hypothesis should not be rejected.

To test for the robustness of these results, differences in the marginal value of $E(X_{SPEC})$ under *No_Inherent*, *Inherent_80* and *Inherent_60* have been examined by considering also the remaining levels of X_{GEN} and $X_{TIME(less)}$ (0 and +5 for X_{GEN} and 1 for $X_{TIME(less)}$). Table 11 depicts the value for a unit increase in the expected number of 'specialist' bird species for all the levels of waiting time and 'generalist' migratory bird species. It also provides information about whether the difference between the mean marginal values is statistically significant or not:[21]

[21]The confidence intervals resulting from the Poe et al. (2005)'s tests are available from the

Table 11 Mean marginal value of $E(X_{SPEC})$ for different levels of $X_{TIME(less)}$ and X_{GEN} [a]

X_{GEN}	$X_{TIME(less)}=0$					$X_{TIME(less)}=1$				
	No_Inherent		Inherent_80		Inherent_60	No_Inherent		Inherent_80		Inherent_60
-10	1.31	≠	2.43	=	2.75	1.08	≠	1.56	≠	2.75
0	1.21	≠	1.97	=	2.11	0.98	=	1.10	≠	2.11
+5	1.16	≠	1.74	=	1.79	0.93	=	0.87	≠	1.79

[a] For each given level of $X_{TIME(less)}$ and X_{GEN}, '=' means the average marginal values of $E(X_{SPEC})$ are not significantly different from each other, while '≠' means they are significantly different from each other.

authors upon request.

As seen, when congestion is high ($X_{TIME(less)}$=0), the marginal value of E(X_{SPEC}) when inherent uncertainty is present is significantly higher than that obtained in a context of certain future losses regardless of the number of 'generalist' migratory bird species. Likewise, when congestion is low ($X_{TIME(less)}$=1), the marginal values under inherent uncertainty tend to be, in most of cases, significantly higher than those estimated under *No_Inherent*. Therefore, regardless of the levels of X_{GEN} and $X_{TIME(less)}$, visitors show a stronger support for the preservation policy in the presence of inherent uncertainty. This confirms that the null hypothesis, that delivering information about inherent uncertainty does not affect welfare measures, can be rejected.

A different story concerns the sensitiveness of WTP to information about the probability of impact occurrence. In particular, individuals seem to be insensitive to this information when congestion is high regardless of the level of X_{GEN}, as all differences in value under *Inherent_80* and *Inherent_60* are not significant. In contrast, when congestion is low, they seem to become more sensitive to this information, as the marginal values under *Inherent_60* are always significantly higher than those obtained under *Inherent_80*. In specific, the values under *Inherent_80* diminish in such a way that, on the one hand, they become significantly lower than those under *Inherent_60*, which don't change when passing from a higher to a lower congestion scenario.[22] On the other one, they become, in most of cases, not significantly different from those under *No_Inherent*, which diminish in a lower proportion. According to these findings, it is difficult to draw conclusions about the sensitivity of WTP to the probability of impact occurrence. Indeed, the substitution patterns between E(X_{SPEC}) and both X_{GEN} and especially $X_{TIME(less)}$ identified under each scenario seem to be strong determinants of how individuals react to information about impact probabilities. In this specific context, it seems that probabilities of impact

[22]Note that the values under *Inherent_60* don't change with respect to the scenario where $X_{TIME(less)}$=0 as the time attribute is not significant in this context (see Table 10).

occurrence around 80% might represent switching points in respondents' behavior.

3.5. Discussion and conclusions

With a focus on expected CC risks, this paper analyzes the effects of inherent uncertainty on the WTP for an adaptation policy aimed at preserving species' diversity in S'Albufera wetland. To do this, it links outcome uncertainty to the probability of occurrence of a loss in the number of 'specialist' bird species in a 10 years' time. Thus, unlike the existing studies, this paper links outcome uncertainty to inherent uncertainty, that is, to the uncontrollable component of environmental uncertainty derived from the stochastic nature of ecosystems' behavior.

Results show individuals are willing to pay more for the policy in the presence of inherent uncertainty. So, the null hypothesis, that delivering information about inherent uncertainty does not have any impact on the WTP, is rejected. The stronger support for the preservation policy under an inherently uncertain scenario is consistent with predictions of EU theory which states that, especially for risk-averse individuals, WTP increases when the risk is lower. Indeed, results are reasonable since the inherent uncertainty scenarios depict a lower risk of species' loss and higher expected policy outcomes compared to a no inherent uncertainty scenario. This is because i) inherent uncertainty is illustrated through a probability of impact occurrence p_1 which is lower than 100%, this implying the existence of a positive probability of impact non-occurrence p_2, and ii) p_1 and p_2 are associated with current or increased number of 'specialist' bird species under adaptation efforts.

Findings also show that the substitution patterns found between 'specialist' bird species and both 'generalist' migratory bird species and waiting time for a seat in an observation cabin seem to be strong determinants of how individuals react to information about impact probabilities. In this sense, they seem to be insensitive to this information when congestion in the wetland is high. In other words, their WTP in a scenario where the degree of inherent uncertainty is high (p_1=60%) is not significantly different from their WTP in a context in which uncertainty is lower (p_1=80%), regardless of the level of 'generalist' migratory bird species. However, when congestion is low, they seem to become more sensitive to information about the probability of impact occurrence as their WTP under p_1=60% is significantly higher than that under p_1=80%. It seems that probability values of p_1 around 80% might represent switching points in respondents' behavior. However, these results don't allow us to draw robust conclusions about the sensitivity of WTP to different degrees of uncertainty, so further research is recommendable to gain more insights into this issue.

The analysis has been undertaken by considering the EU framework which assumes utility of outcomes are linearly weighted by their probabilities. However, and in the light of the results, respondents might also have treated probability in a non-linear manner, thus overweighing the chance of impact non-occurrence (Shaw and Woodward 2008). Thus, it would be interesting to further explore alternative treatments of risk when inherent uncertainty is present. In specific, further research could examine whether individuals treat probabilities in a non-linear way or whether they emphasize the chance of extreme events. The analysis could then be replicated by treating risk according to prospect theory (Kahneman and Tversky 1979), the rank dependent utility theory proposed by Quiggin (1982) and/or prospective reference theory (Viscusi 1989). After all, this paper is the first one analyzing the effects of inherent uncertainty on the WTP for a preservation policy and hence many questions still remained unanswered.

Additionally, it would also be of interest to study whether and how different ways of delivering inherent uncertainty can influence choice strategies and consequently can impact on the WTP for the policy. Indeed, it has been argued that specific elicitation formats might drive respondents' attention during the choice (Lipkus 2007; Spiegelhalter et al. 2011). In this paper, the probabilities of impact occurrence and non-occurrence have been depicted through a mix of visual and text information to facilitate understanding. However, this way of delivering uncertainty information could also have led respondents to focus more on the policy outcome associated with impact non-occurrence. Also, information about p_2 and the associated outcomes has been provided to respondents to emphasize the stochastic nature of inherent uncertainty. As earlier discussed, consideration of additional policy outcomes associated with p_2 can help to explain the results. Thus, it would be interesting to test whether the effects of inherent uncertainty on WTP remain the same if only p_1 is considered in the analysis.

One of the limitations of this paper has to do with the low sample sizes used for each split sample. In fact, the representative sub-samples were drawn from a population of 23,172 visitors. However, given the way inherent uncertainty is illustrated in this analysis, a split sample approach was considered more appropriate to reduce respondents' burden and hence facilitate choice. Indeed, inherent uncertainty is presented to respondents through two possible levels for the 'specialist' bird species attribute in each alterative in each choice card, where the levels are linked to a probability of both impact occurrence and impact non-occurrence. Besides, a mix of visual and text information is employed. Focus groups showed that presenting individuals different choice cards each linked to a different probability of both impact occurrence and non-occurrence substantially increased respondents' burden. Despite this, it is undeniable that the use of low sample sizes could imply some or all the results may be due to random factors and hence further research is of course recommendable.

Nevertheless, findings are still suggestive and indicate inherent uncertainty potentially impacts on the benefits of a policy aimed at preserving species' diversity. In this sense, it is worth noting the policy relevance of illustrating inherent uncertainty through the probability of occurrence of a specific impact within a given time horizon. While it is true that inherent uncertainty information could have also been depicted by considering different uncontrollable impact magnitudes, a focus on the probability of occurrence makes the analysis more policy relevant. Indeed, it allows drawing more straightforward conclusions for policy making. Note that the analysis revolves around a relevant question: Would individuals be willing to pay for measures aimed to counteract expected environmental impacts in a context in which these impacts might not occur? Results can be viewed as a vote for environmental action when it comes to contexts of many inherent uncertainties. Viscusi and Zeckhauser (2006) find that, if respondents are risk-averse, they 'predominantly view the current scientific uncertainty as a rationale for greater support of policy interventions rather than for a wait-and-see approach'. Thus, people seem to advocate for the adoption of a precautionary approach in contrast to the opinion of those who wish 'to go slow' to avoid assuming the costs of action. Findings suggest people view action today as something desirable as it will allow avoiding future losses in case of impact occurrence, while leading to higher environmental quality levels in the absence of impacts.

Results should also be viewed as a signal to stimulate action to increase knowledge about the natural system. Despite inherent uncertainty makes it difficult to predict with certainty the probability of occurrence of a given environmental phenomenon, knowledge on ecosystems' responses to critical loads and carrying capacities can provide some insight on how close a natural system is to a critical threshold. This knowledge is crucial for policy making as it leads to increase system reliability and hence design more effective measures aimed at reducing environmental risks. Langsdale (2008) states that 'once inherent uncertainties dominate, then the focus should shift away from reducing uncertainties and move on to clarifying and communicating what is known about the system and determining effective and robust responses'.

Thus, an approach to outcome uncertainty which focuses on the effects of inherent uncertainty on WTP for preservation measures can play a role in environmental decision-making when thresholds are threatened. Indeed, it can stimulate action oriented to guarantee an effective intergenerational allocation of natural endowments on the basis of welfare maximization issues. Therefore, it is undoubtedly a relevant issue for further research.

4. DO WE CARE ABOUT SUSTAINABILITY? AN ANALYSIS OF TIME SENSITIVITY OF SOCIAL PREFERENCES UNDER ENVIRONMENTAL TIME-PERSISTENT EFFECTS

ECBA has traditionally assumed that environmental policies' social benefits are sensitive to the timing of the improvement. Indeed, it has relied on the idea that policies' outcomes, taking place at different moments in the future depending on the intervention's performance or on environmental dynamics, are preferred if occurring earlier. However, this assumption is still controversial and it may lead to consider as socially desirable policies being less so. This is especially true when interventions aim at counteracting time-persistent environmental problems, whose impacts take place in the long- and very long-term, respectively involving the present and the future generations. In this framework, this study analyzes the time sensitivity of social preferences for preservation policies to adapt to time-persistent CC stresses in wetlands with the objective to identify the role of sustainability concerns. Results have shown that preferences are time insensitive due to sustainability issues, as current generations equally care about nature preservation in the long-term, when they will enjoy it, and in the very long-term, when future generations will. These outcomes are relevant to better inform decision-making in the design of policies in the face of time-persistent environmental problems, by pointing out that, to be welfare-maximizing, interventions also need to be sustainable.

4.1. Introduction

ECBA focuses on assessing the social profitability of environmental projects or policies by comparing their associated social benefits and costs, which take place at different moments in time. Often, financial costs arise in the present while environmental benefits occur at some point in the future, depending on policy implementation and performance and/or on the complexity of ecosystems' dynamics (Meyer 2013). In this sense, ECBA literature has long recognized that the time profile of environmental benefits is a critical issue for the analysis of a policy's social return. This is because, for more than 50 years, applied welfare economics has been concerned with individuals' sensitivity to social benefits' timing through the analysis of social discount rate issues, finding that time affects preferences.

Especially over the last decade, the analysis of individuals' inter-temporal choices has demonstrated that society tends to prefer sooner to later rewards, as evidenced by the positive discount rates found by researchers (Pindyck 2007; Hanley and Barbier 2009). This also reflects the conduct individuals adopt when making inter-temporal choices over private monetary benefits, based on experimental economics' studies. The result that society should assign a greater weight to sooner outcomes and, hence, that the future should be discounted have also been pointed out by a normative social discounting literature (Cropper et al. 2014). Though, consensus is just apparent, as it is still debated what discount rate should be employed (Almansa and Calatrava 2007; Birol et al. 2010). Taking into account the increasing environmental problems requiring urgent policy design and implementation, research on individuals' sensitivity to policy benefits' timing becomes of high relevance. Indeed, the assumptions made about how people value environmental benefits arising over different time periods can have big impacts on a policy's social profitability.

This is especially true when it comes to interventions whose environmental results occur not only in the long-term, affecting the present generation, but more importantly in the very long-term, affecting the future generations. These policies usually pursue to counteract the effects of an increasing number of time-persistent environmental problems –like CC, nuclear waste or pollution– which arise because of the accumulation in the environment of some long-lasting pollutants which interact in a complex way with ecosystem processes' dynamics (Underdal 2010). In this context, the time sensitivity assumption that individuals allocate a lower weight to policy benefits occurring in the long-term but especially in the very long-term future can have important negative welfare implications for unborn generations (Scarborough 2011). Indeed, the social discounting literature has shown that the consideration of a positive discount rate could make socially unacceptable those policies whose major environmental benefits arise in the very long-term future (Weitzman 1998; Azqueta 2002; Gollier 2013). In other words, assuming individuals discount the future could prevent policy makers from undertaking environmental policies with positive welfare impacts for the unborn. Under these premises, given that there is a concern for the welfare not only of the present but also of future generations, the analysis of the time sensitivity of current generations' preferences for policies oriented to avoiding impacts in the long- and very long-term future acquires special importance. Given that current generations represent, as trustees, the unborn (Thomson 2010), considering results from this analysis in ECBA can better inform decision-makers. In fact, it can lead to the design of welfare-maximizing policies that can also include sustainability considerations, which are expected to play an important role in this context.

Sustainability concerns may exist when current generations' preferences for environmental benefits occurring in the very long-term are equal or higher with respect to those for benefits occurring in the long-term. This is because sustainability is about equity of use and non-use welfare opportunities between the present and future generations (Baumgärtner and Quaas 2010; Kuhlman and Farrington 2010). In these terms, the above definition of sustainability responds to a precautionary principle, which seems to be recommendable due to the fact that the future is characterized by inherent uncertainties. Inherent uncertainty, which has been found to significantly affect social preferences in chapter 3, refers to the fact that, due to non-linear and chaotic behavior of ecosystems, environmental impacts are unpredictable and uncontrollable and, consequently, so are the results of policies to counteract them. Based on this, in the face of unpredictable and potentially irreversible environmental damages, current generations should preserve at least the same critical level of environmental resources for themselves and for future generations if concerned about sustainability. In other words, they should at least equally care about conservation in the very long-term as in the long-term. Then, this idea of sustainability differentiates from the more commonly used concepts of weak and strong sustainability. With respect to weak sustainability, it rejects the idea that intergenerational equity can be achieved by allowing for unlimited substitution between natural and non-natural capital (i.e. man-made, human capital, etc.), provided the aggregated level is maintained over time. In other words, despite accepting some degree of substitution, it argues that the decrease in natural capital beyond some thresholds leads to irreversible losses that cannot be fully compensated by increased availability of other forms of capital (Luckert and Williamson 2005). With respect to the idea of strong sustainability, it agrees that some constraints should be put on natural capital to avoid environmental losses, even though it additionally argues that these should be set taking social preferences into account (Crowards 1998; Berrens 2001). Despite the increasing claims for incorporating inter-generational equity issues into the design of environmental policies (Barr 2008; Carlsson et al. 2011; Moldan et al. 2012), the role of sustainability concerns over preferences' time sensitivity has been underexplored in economic valuation studies.

This is attributable to the fact that within the SP valuation literature, which needs to be considered when ex-ante social benefits of future environmental policies are to be estimated, little attention has been dedicated to the sensitivity to time of social preferences. Most importantly, the disregard for the role of sustainability concerns has been motivated by the choice of the temporal frame in this scarce literature, which has examined social preferences over different time scenarios either in the long- or in the very long-term. According to this, the question of whether the value current generations assign to a given future environmental outcome when it occurs in the long-term is the same as that assigned to it when it occurs in the very long-term still remains unanalyzed. Consequently, the issue of whether values are driven by intergenerational equity reasons is still an open question. So: *which is the role of sustainability concerns in explaining the time sensitivity of social preferences in a context of time-persistent environmental effects?*

To find an answer to this question, this paper will examine which are the values individuals attach to a given environmental improvement in the long- and the very long-term and whether there are differences between them. In this framework, our study will rely on a CE application examining preferences for interventions of CC adaptation in wetlands. The fact that the benefits of these policies will emerge from counteracting CC impacts, which are expected to arise both in the long- and in the very long-term (Hasselmann et al. 2003; IPCC 2013b), makes the focus on this challenging problem very appropriate for the present analysis. For a better measurement of social preferences in the long- and very long-term, the research will be undertaken by considering the existence of inherent uncertainty, based on the recommendations in chapter 3 that this should be included in hypothetical SP valuation studies for its significance in welfare terms. The structure of the paper is as follows. Next section reviews the literature concerned with the time sensitivity analysis of social preferences for environmental policy results. Section 4.3. describes the methodology used. Results are reported in section 4.4., followed by a discussion and conclusions section that ends the paper.

4.2. Time sensitivity in the environmental stated preference valuation literature

Individuals are expected to value environmental policies' outcomes differently depending on when they take place. For this reason, over recent years, the issue of time sensitivity of preferences has attracted the attention of environmental economists working with SP methods. On the one hand, researchers have focused on the time sensitivity of social preferences for environmental policies generating health benefits, expressed as lives saved or mortality risk reductions (Cairns 2001), finding that individuals prefer not to delay improvements in their health status (Cropper et al. 1994; Alberini and Chiabai 2007b; Krupnick 2007; Rheinberger 2011). On the other hand, some attention has been given also to the analysis of the sensitivity to time of social preferences for environmental improvements.

With respect to this latter, two groups of studies, consisting of CE and CV applications, can be identified: those focusing on different time horizons in the long-term and those in the very long-term. The first group has examined time sensitivity of social preferences in the long-term and it has assumed that environmental benefits will only accrue to the current generation. Indeed, these studies have considered policies whose timing of outcome provision will be less than one or two decades at most, depending on how policy-makers design and implement the intervention. In specific, this research has been concerned with various issues around the measurement of individuals' time preferences.

Crocker and Shogren (1993), by means of a CV study, have investigated the role of dynamic inconsistencies in the discounting of future environmental benefits. They have found that the yearly marginal rate of time preference for avoiding delayed access of 2 years to a mountain environment in North Carolina commercial ski areas is lower than the yearly rate for acquiring extended access to it over the following 10 years. Strazzera et al. (2010), in the framework of a CE exercise to value the benefits of a plan to improve environmental quality in an Italian beach, have investigated the implicit discount rate that individuals employ. In specific, by considering an attribute reflecting the duration of the project, either 10, 15 or 20 years, they have found high but acceptable rates of discount. Viscusi et al. (2008) and Meyer (2013) have both focused on identifying which discounting specification, among the exponential and the hyperbolic ones, works better. They have answered this question by introducing a specific time attribute in their CE applications about hypothetical water quality improvements, namely '*year when the improvement begins*' (with levels 'now' or '2, 4 or 6 years from now') and '*time when cleanup is fulfilled*' (with levels set to '0, 1, 2, 3, 4 or 5 years from now'), respectively. While for Viscusi et al. (2008) there is evidence of hyperbolic discounting, for Meyer (2013) the exponential specification is superior. Kim and Haab (2009), by means of a split sample approach in a CV analysis, have focused on improving the methodology for measuring temporal sensitivity of WTP. In particular, and taking into account a hypothetical oyster reef restoration program in Chesapeake Bay in Maryland, they have analyzed sensitivity to different payment schedules and time of completion of the project, either 5 or 10 years in the future. Findings have shown that individuals care about the final environmental result of the program but not about the timing of its delivery. Excluding this latter case, results of these studies have concluded that individuals are sensitive to the timing of the environmental benefits and, in specific, that they prefer earlier to delayed outcomes when these accrue to the present generation.

The second group of studies has focused on social preferences for environmental policies to generally counteract CC impacts, assumed to take place in different moments in the very long-term and benefiting future generations. In this case, the analysis of time sensitivity of preferences has been motivated by the fact that environmental impacts and, consequently, policy results in the very long-term are characterized by uncertainty, such that there is a lack of scientific knowledge concerning their timing of occurrence. However, these studies have tended to present the different time horizons by means of a split sample approach, such that each respondent only faced one time scenario and hence did not consider any uncertainty during his choice.

MacMillan et al. (1996) have examined, through a CV approach, the social value of avoiding ecosystem declines in the Scottish Highlands due to acid rain deposition in 20 and 120 years. Layton and Brown (2000) have examined, through a CE exercise, preferences for CC mitigation policies to avoid adverse forest impacts in the Rocky Mountains area in 60 or 150 years. Kinnell et al. (2002), through a CV study, have focused on the WTP of hunters for policies to avoid duck population decline in the Prairie Pothole Region due to combined agriculture and global warming pressures in 40 and 100 years. By means of a follow up question to the CE exercise, Riera et al. (2007) have asked individuals whether their preferences for policies to avoid CC impacts such as wildfires, soil erosion and shrubland loss occurring in Catalonia over 50 years would have changed if the scenario was 25 or 100 years in the future. All these studies have concluded that individuals are supportive towards very long-term policies benefiting future generations, but they do not distinguish between the different time scenarios considered. Slightly diverging outcomes have been reached by Layton and Levine (2003), who have combined the data employed in Layton and Brown (2000) concerning the most preferred alternatives with information about the least preferred ones. Their findings have shown that people tend to slightly prefer policy benefits occurring in 60 to those occurring in 150 years.

Despite the contribution of these studies to the environmental valuation literature, none of them has considered social preferences in the long- and very long-term, thus overlooking the role of sustainability concerns in social welfare. Our analysis will try to address this research gap.

4.3. Methodology

4.3.1. The choice experiment application

To investigate the role of sustainability concerns on the social benefits of preservation, we rely on the data collected between April the 15th and June the 30th, 2013 to carry out the CE presented in chapter 3. This becomes a suitable reference study because it is developed in a context of CC, which represents an excellent example of time-persistent environmental problem. This CE has examined the preferences of visitors for different management attributes in S'Albufera wetland (Mallorca, Spain), an outstandingly exposed Mediterranean humid land to CC threats. As explained later in this section, identifying these preferences has been possible because the alternatives in the CE have been described by diverse attributes, each showing the results of a different policy effort, taking different levels. More concretely, the focus has been on one attribute, reflecting the outcomes of an adaptation policy aimed at avoiding the potential CC-induced loss in the number of 'specialist' bird species, being characteristic of the site.

Despite in chapter 3 only preference information collected over a time horizon of 10 years (T=10) has been considered, this latter representing an example of long-term scenario, sampled individuals have also been confronted with a very long-term situation. This has made these data suitable to fulfill the purposes of the present research. In fact, respondents were requested to imagine that the timing of the alternatives' results, was first set to T=10 and then to 70 years in the future (T=70). In this sense, it needs to be remarked that 70 years was identified as a sufficiently long period in the future to oblige individuals to think beyond their lifetime and it was elicited based on focus group discussions. After choosing their preferred alternatives for T=10, individuals were requested to state whether their preferences over the same choice sets would have changed for T=70. If they reported their choices would have been different, they were invited to repeat the choice exercise and to indicate how their preferences would have changed for T=70. Otherwise, their preferences over T=10 were also maintained over T=70. Thus, for each individual, information is available on preferences over T=10 and T=70.[23]

Whether individuals decided to change their choices for T=70 or not, they were asked about their underlying motives in order to help understanding the role of sustainability-related issues in their choice to support or not support nature preservation in the distant future. By eliciting among some predetermined options, they could state that their choices had been driven by the willingness to give future generations the possibility of either enjoying access to environmental resources or simply benefiting from nature conservation regardless of use. Alternatively, they could state that they were not interested in preserving the environment for such a long period of time. Multiple responses were also allowed. With the major purpose of identifying protesters in the hypothetical market set for T=70 years, an ‘open answer’ option was additionally included.

Given that both T=10 and T=70 represent future situations, the analysis has taken into account information about the inherent uncertainty of the scenario, following the approach presented in chapter 3. To reflect the idea that we don’t know what will happen in terms of CC impacts, it has assumed that the levels of the ‘specialist’ bird species attribute, reflecting the results of current or BAU, moderate and high efforts, are subject to

[23]The text of the specific follow-up question that has been used in the survey to ask individuals about their preferences over T=70 after they have completed the CE exercise over T=10, is: “If the attributes’ combinations that I have showed you in each card were the results of a given policy in S’Albufera not in 10 years’ time **but in 70 years’ time**, would your choices be different from the ones that you have previously made?”

two possible states of nature in the future for each given time horizon: impacts' occurrence or non-occurrence. On the one hand, if current efforts are maintained, there can be a decline by 10 in the number of 'specialist' bird species under a scenario of impacts' occurrence. On the other hand, if CC impacts do not occur, no change is considered in the number of 'specialist' bird species under current efforts. In this sense, also the outcomes of adaptation policies aimed to avoid the decline in the current number of 'specialist' bird species through moderate or high efforts are presented as being inherently unpredictable. In fact, under inherent uncertainty, policy results cannot be guaranteed, even though interventions are perfectly designed. Table 12 presents the levels considered for the 'specialist' bird species attribute when there is inherent uncertainty concerning impacts' occurrence:

Table 12 Levels of the 'specialist' bird species attribute[a]

	States of nature	
	Impact occurrence	Impact non-occurrence
BAU	-10	0
Adaptation	0[b]/+5[c]	+5[b]/+10[c]

[a]Changes with respect to current levels.
[b]Changes in the number of 'specialist' bird species under a moderate management effort.
[c]Changes in the number of 'specialist' bird species under a high management effort.

In this context, while under inherent uncertainty it is difficult to forecast the occurrence of an environmental loss, it is assumed that scientific research can help to make predictions about the probability of being close to a critical threshold. However, despite it is assumed that the probability of impacts' occurrence (p_1) and, consequently, the probability of impacts' non-occurrence ($1-p_1=p_2$) can be formulated, the analyst is not sure about how 'critical' the situation could really be with respect to species' extinction. To reflect this uncertainty, two scenarios of probability of impacts' occurrence have been taken into consideration for the 'specialist' bird species attribute levels presented in Table 12.[24] In specific, one scenario has taken into account a very critical situation with a probability of 80% of occurrence and 20% of non-occurrence of impacts (from now on, *Inherent_80*). Another scenario has shown a less critical situation with a probability of 60% of occurrence and 40% of non-occurrence (from now on, *Inherent_60*). The levels of the 'specialist' bird species attribute under these different scenarios of inherent uncertainty are illustrated in Table 13:

Table 13 Levels of the 'specialist' bird species attribute under each inherent uncertainty scenario[a]

	Inherent_80		*Inherent_60*	
	p_1=80%	p_2=20%	p_1=60%	p_2=40%
BAU	-10	0	-10	0
Adaptation	0[b]/+5[c]	+5[b]/+10[c]	0[b]/+5[c]	+5[b]/+10[c]

[a]Changes with respect to current levels.
[b]Changes in the number of 'specialist' bird species under a moderate management effort.
[c]Changes in the number of 'specialist' bird species under a high management effort.

As anticipated at the beginning of this section, apart from the 'specialist' bird species attribute, other attributes have been included in the experiment to reflect different management aspects that might be improved and that are relevant to visitors to S'Albufera. These refer to an attribute for: the change in the number of 'generalist' migratory bird species, being non-characteristic of the site, the level of waiting time and of rest-stop benches. An entrance fee has also been considered as a payment vehicle (Table 14). These attributes and their levels have been combined into alternatives by means of a D-efficient Bayesian design.[25]

[24]Individuals have additionally been informed about the uncertainty of the scenarios through a framing statement, as described in chapter 3.
[25]See Faccioli et al. (2015) and chapter 3 for more details about the experimental design.

Table 14 Other attributes' description and their levels

Attribute	Description	Levels
'Generalist' migratory bird species	Change in the number of species[a]	+5 0 -10[c]
Waiting time	Minutes waited for an observation cabin's seat	About 3 About 7 About 15[c]
Rest-stop benches	Number of benches throughout the park[b]	Triple Double Equal[c]
Entrance fee	Entrance fee per adult visitor and trip (in euros)	4, 8, 12, 16, 20, 24

[a]Changes with respect to the current number of 'generalist' migratory bird species.
[b]Number measured with respect to the current level of rest-stop benches.
[c]BAU levels, being €0 for the Entrance fee attribute.

The CE was then structured in different versions, one for each inherent uncertainty scenario considered. To reduce the cognitive burden on respondents, each person was exposed, thanks to a split sample approach, to only one CE version. Therefore, each respondent had to consider two time horizons in the CE exercise but just one scenario of inherent uncertainty. For the CE with a probability of occurrence of 80% and for that with a probability of 60%, sample sizes accounted for 321 and 310 individuals, respectively, taking into account a 5.5% sample error, calculated over a 95% confidence interval.[26]

4.3.2. Modelling choices

To estimate preferences over T=70 and compare them with those obtained over T=10, the same RUM model specification as in chapter 3 has been considered for each time period under each scenario of probability of

[26]More information on the sampling procedure is available in Faccioli et al. (2015) and in chapter 3.

impacts' occurrence. The model relies on a RPL to take individual-specific preferences into account, which requires assuming that parameters are random. In our model, only the cost parameter has been specified as random and it has been assigned a lognormal distribution to constrain the coefficient to have the same sign over all individuals (Torres et al. 2011). Taking into account that individuals make their choices of their preferred alternatives in the face of risks of impacts' occurrence on 'specialist' bird species, the utility function specification used for estimation purposes, which is illustrated in Equation 9, is assumed to follow the EU theory approach. In addition, it incorporates a reference to the time horizon considered (*t*):

$$\begin{aligned} U_{njt} = {} & \beta_{1t}[(p_1 \cdot X_{SPEC1_{njt}}) + (p_2 \cdot X_{SPEC2_{njt}})] + \beta_{2t}X_{GEN_{njt}} \\ & + \beta_{3t}X_{TIME(less)_{njt}} + \beta_{4t}X_{BENCHES(double)_{njt}} + \beta_{5t}X_{BENCHES(triple)_{njt}} \\ & + \beta_{6t}[(p_1 \cdot X^2{}_{SPEC1_{njt}}) + (p_2 \cdot X^2{}_{SPEC2_{njt}})] + \beta_{7t}X^2{}_{GEN_{njt}} \\ & + \beta_{8t}X_{GEN_{njt}} \cdot [(p_1 \cdot X_{SPEC1_{njt}}) + (p_2 \cdot X_{SPEC2_{njt}})] \\ & + \beta_{9t}X_{TIME(less)_{njt}} \cdot [(p_1 \cdot X_{SPEC1_{njt}}) + (p_2 \cdot X_{SPEC2_{njt}})] \\ & + \beta_{10nt}X_{COST_{njt}} + \varepsilon_{njt} \end{aligned} \tag{9}$$

For respondent *n*, alternative *j* and time horizon *t*, $X_{SPEC1_{njt}}$ is the level of the 'specialist' bird species attribute under a probability of impact occurrence equal to p_1 (either 80% or 60%), and $X_{SPEC2_{njt}}$ is the attribute level under a probability of impacts' non-occurrence of p_2 (either 20% or 40%); $X_{GEN_{njt}}$ is the level of the 'generalist' migratory bird species attribute; $X_{TIME(less)_{njt}}$ is a dummy variable taking value 1 for less than 15 minutes waiting time for a seat in an observation cabin and 0 otherwise and it is considered as a proxy for congestion reduction; $X_{BENCHES(double)_{njt}}$ and $X_{BENCHES(triple)_{njt}}$ are two dummy variables taking value 1 when the number of benches throughout the park is double and triple with respect to the current one, respectively, and 0 otherwise; and β_{1t}, β_{2t}, β_{3t}, β_{4t}, β_{5t},

β_{6t}, β_{7t}, β_{8t} and β_{9t} are the fixed attribute coefficients and β_{10nt} is the individual-specific parameter for $X_{COST_{njt}}$.

Starting from Equation 9, the WTP has been calculated by using the Hanemann (1984)'s formula for compensating variation. The monetary value individuals assign to a unit increase in the expected number of 'specialist' bird species from the BAU, meaning from the policy-off situation, to a policy-on context is shown in Equation 10:

$$\begin{aligned} WTP_{X_{SPECnjt}} = -\frac{1}{\beta_{10nt}} \{ & \beta_{1t}[(p_1 \cdot (X_{SPEC1_{njt}}{}^1 - X_{SPEC1_{njt}}{}^0)) \\ & + (p_2 \cdot (X_{SPEC2_{njt}}{}^1 - X_{SPEC2_{njt}}{}^0))] \\ & + \beta_{6t}[(p_1 \cdot (X^2{}_{SPEC1_{njt}}{}^1 - X^2{}_{SPEC1_{njt}}{}^0)) \\ & + (p_2 \cdot (X^2{}_{SPEC2_{njt}}{}^1 - X^2{}_{SPEC2_{njt}}{}^0))] \\ & + \beta_{8t} \cdot X_{GEN_{njt}}{}^0 \cdot [(p_1 \cdot (X_{SPEC1_{njt}}{}^1 - X_{SPEC1_{njt}}{}^0)) \\ & + (p_2 \cdot (X_{SPEC2_{njt}}{}^1 - X_{SPEC2_{njt}}{}^0))] \\ & + \beta_{9t} \cdot X_{TIME(less)_{njt}}{}^0 \cdot [(p_1 \cdot (X_{SPEC1_{njt}}{}^1 - X_{SPEC1_{njt}}{}^0)) \\ & + (p_2 \cdot (X_{SPEC2_{njt}}{}^1 - X_{SPEC2_{njt}}{}^0))]\} \end{aligned} \tag{10}$$

where superscripts ^{1} and ^{0} respectively indicate the level of the attribute after the change and in the BAU scenario.

4.4. Choice experiment results

RPL models have been estimated for T=10 and for T=70 in each probability scenario *(Inherent_80* and *Inherent_60).* After excluding invalid and protest questionnaires, 289 and 279 surveys have respectively been considered for T=10 and T=70 in *Inherent_80*, providing a total of 1,734 and 1,674 observations, while in *Inherent_60,* 291 and 274 surveys were collected, supplying 1,746 and 1,644 observations, respectively. Only 26 respondents have changed their choices when moving from T=10 to T=70 in

Inherent_80 and 15 in *Inherent_60*. Tables 15 and 16 report models' results for T=10 and T=70 in both probability scenarios.

Table 15 Results from RPL models for T=10 and T=70 under *Inherent_80*[a]

	T=10		T=70	
Variables	Coeff.	*Std. error*	Coeff.	*Std. error*
Fixed parameters				
$p_1 \cdot X_{SPEC1}+p_2 \cdot X_{SPEC2}$	1.956***	*0.181*	1.727***	*0.170*
X_{GEN}	0.568***	*0.177*	0.533***	*0.170*
$X_{TIME(less)}$	1.118***	*0.118*	1.172***	*0.115*
$X_{BENCHES(double)}$	0.116	*0.109*	0.280***	*0.106*
$X_{BENCHES(triple)}$	0.838***	*0.140*	1.001***	*0.137*
$p_1 \cdot X^2_{SPEC1}+p_2 \cdot X^2_{SPEC2}$	-1.567***	*0.236*	-1.764***	*0.231*
X^2_{GEN}	-0.968***	*0.256*	-0.822***	*0.243*
$(p_1 \cdot X_{SPEC1}+p_2 \cdot X_{SPEC2}) \cdot X_{GEN}$	-0.998***	*0.151*	-0.710***	*0.142*
$(p_1 \cdot X_{SPEC1}+p_2 \cdot X_{SPEC2}) \cdot X_{TIME(less)}$	-1.901***	*0.173*	-1.720***	*0.164*
Random parameters[b]				
X_{COST}_mean	1.087***	*0.073*	0.892***	*0.078*
X_{COST}_std. deviation	0.861***	*0.053*	0.928***	*0.060*
Log-likelihood	-1,061.169		-1,076.351	
Observations	1,734		1,674	
N	289		279	

[a]***Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.
[b]Coefficients of the normal distribution associated with the lognormal one.

Table 16 Results from RPL models for T=10 and T=70 under *Inherent_60*[a]

	T=10		T=70	
Variables	Coeff.	*Std. error*	Coeff.	*Std. error*
Fixed parameters				
$p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}$	1.613***	*0.180*	1.619***	*0.183*
X_{GEN}	1.729***	*0.188*	1.699***	*0.192*
$X_{TIME(less)}$	0.150	*0.109*	0.136	*0.110*
$X_{BENCHES(double)}$	0.600***	*0.125*	0.569***	*0.127*
$X_{BENCHES(triple)}$	0.274*	*0.140*	0.233	*0.143*
$p_1 \cdot X^2_{SPEC1} + p_2 \cdot X^2_{SPEC2}$	-1.841***	*0.249*	-1.933***	*0.256*
X^2_{GEN}	0.685***	*0.226*	0.612***	*0.231*
$(p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}) \cdot X_{GEN}$	-1.097***	*0.165*	-0.978***	*0.167*
$(p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}) \cdot X_{TIME(less)}$	-0.075	*0.215*	-0.132	*0.220*
Random parameters[b]				
X_{COST}_mean	0.996***	*0.076*	0.942 ***	0.081
X_{COST}_std. deviation	0.966***	*0.061*	1.004***	0.065
Log-likelihood	-1,183.264		-1,121.929	
Observations	1,746		1,644	
N	291		274	

[a]***Significant at 1% level; ** Significant at 5% level; * Significant at 10% level.
[b]Coefficients of the normal distribution associated with the lognormal one.

Results in Tables 15 and 16 indicate that there are few differences in the estimated parameters between T=10 and T=70 and both the sign and significance of these coefficients tend to be maintained. In specific, regardless of the probability scenario, similar patterns can be observed between T=10 and T=70 for what concerns the main and interaction effects associated with '$p_1 \cdot X_{SPEC1} + p_2 \cdot X_{SPEC2}$', namely $E(X_{SPEC})$, that is the expected number of 'specialist' bird species, which represents the focus of the analysis. In fact, preferences for a marginal change in $E(X_{SPEC})$ have been found, in each scenario, to increase at decreasing rates and to decline with both X_{GEN} and $X_{TIME(less)}$, being perceived as substitute goods for $E(X_{SPEC})$.[27]

To investigate the time sensitivity of welfare in the face of different scenarios of probability, implicit prices have been considered for the 'specialist' bird species attribute. Based on Equation 10, the individual-specific marginal values of $E(X_{SPEC})$, that is, the WTP for a unit increase in this attribute from the BAU situation, have been calculated and the mean has been taken into account. The BAU level has also been considered for the interacting attributes. As summarized in Figure 2 and Table 17, the mean marginal value of $E(X_{SPEC})$ seems to increase when moving from T=10 to T=70 both in *Inherent_80* and *Inherent_60*. However, based on the results of the Poe et al. (2005)'s test presented in Table 17, there is no significant difference between the welfare measures obtained in T=10 and T=70 under each scenario of probability.[28]

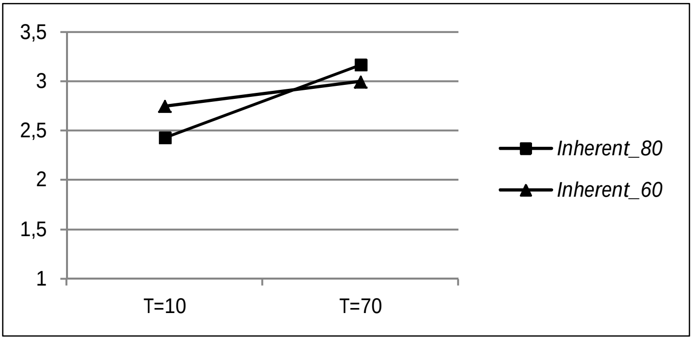


Fig. 2 Mean marginal value of $E(X_{SPEC})$ for T=10 and T=70 in *Inherent_80* and *Inherent_60*

[27]The only exception is *Inherent_60*, in which the level of waiting time has been found to play no role over the effect of $E(X_{SPEC})$ on utility.

[28]To perform this test, the mean marginal value of $E(X_{SPEC})$ both in *Inherent_80* and in *Inherent_60* has been simulated for T=70 through 1,000 bootstrapped replications of the underlying RPL models, analogously to what has been done in chapter 3 for T=10. Taking into account the resulting vectors of simulated mean marginal values, confidence intervals have been calculated for the differences between all elements of the vectors of WTP in T=10 and in T=70, for each given scenario of probability.

Table 17 Mean marginal value of $E(X_{SPEC})$ for T=10 and T=70 under *Inherent_80* and *Inherent_60*[a]

	Test 1		Test 2	
	Inherent_80		*Inherent_60*	
$E(X_{SPEC})$	T=10	T=70	T=10	T=70
Mean marginal value	2.43	3.17	2.75	3.00
Interval[b]	[-0.22; 1.44]		[-0.57; 1.12]	

[a]The mean marginal value has been calculated as the average of individual-specific WTP, following a lognormal distribution, due to the random cost coefficient.
[b]Confidence intervals for the differences in mean marginal values are based on a 10% significance level.

The fact that WTP for environmental preservation over T=10 is not significantly different from that over T=70 indicates that individuals are not sensitive to the timing of benefits' provision, despite the considerable temporal distance between the time horizons elicited. This emerges to be true for both *Inherent_80* and *Inherent_60*, suggesting that the level of probability of impact occurrence does not appear to play a role in determining social preferences' sensitivity to time. Then, individuals are equally willing to contribute to avoid the risk of losing species by supporting preservation, regardless of both the likelihood of species extinction or, in other words, how critical the situation is, and whether they will be the beneficiaries of these interventions or not. Hence, individuals are adopting a 'risk averse' and precautionary attitude independently of 'which generation' is exposed to risks. This indicates that they display a positive attitude towards sustainability issues.

A better picture about the role of sustainability concerns can be obtained by examining the motivations provided by individuals in their choice process. Table 18 summarizes the reasons provided by respondents for changing or not changing their preferred alternatives over T=70 with respect to T=10. Most of respondents have reported not to have changed their preferences because in the long-term they had already considered the need to preserve nature also for the very long-term. In specific, it appears that if the situation is very critical (*Inherent_80*), respondents are primarily concerned with conserving nature for giving future generations the same possibility as current generations of enjoying and having access to environmental resources. If the situation is less critical (*Inherent_60*), they seem to be motivated not only by the fact that environmental quality provides use opportunities but also because it is a source of utility regardless of its use. Based on this, there is the impression that sustainability concerns of individuals mostly rotate around the need to preserve nature especially for the use benefits it offers. In fact, preserving nature for recreational and access purposes represents their main motivation when the situation is critical, while consideration of nature preservation regardless of its use by humans appears to be a weaker driver of preferences and it acquires more importance only when the situation is less critical.

Table 18 Reasons underlying respondents' choices for T=70

	Inherent_80		*Inherent_60*	
	Not changing	Changing	Not changing	Changing
Preserve the environment in itself[a]	22.58%	2.87%	14.24%	0.73%
	25.45%		14.97%	
Preserve the environment for future generations' enjoyment[a]	*50.18%*	*2.15%*	*39.05%*	*1.09%*
	52.33%		*40.14%*	
Preserve the environment in itself and for future generations' enjoyment[a]	15.41%	*4.3%*	*40.15%*	*3.28%*
	19.71%		*43.43%*	
Not interested in environmental preservation for such a long period	0.36%	0.00%	0.00%	0.00%
	0.36%		0.00%	
Other[b]	2.15%	0.00%	1.10%	0.36%
	2.15%		1.46%	
TOTAL	90.68%	9.32%	94.54%	5.46%

[a]The need to preserve the environment in itself, for future generations' enjoyment or for both reasons had already been considered in T=10 by those individuals using these motivations for not changing their preferences in T=70.

[b]Other reasons provided, include: *'the choice made is the best option for T=70'* and *'I will not be alive in 70 years'.*

To check for the robustness of the role of sustainability issues, a sensitivity analysis has also been undertaken by considering different levels of the interacting variables, X_{GEN} and $X_{TIME(less)}$. The reason for this analysis is to examine whether the endowment of other forms of capital affect sustainability concerns for $E(X_{SPEC})$. In fact, on the one hand, X_{GEN} indicates the number of 'generalist' migratory bird species, which reflects the level of a different form of natural capital with respect to $E(X_{SPEC})$. On the other hand, $X_{TIME(less)}$ could be interpreted as reflecting the level of man-made capital, given that a lower degree of waiting time and congestion can be achieved through increasing the availability of observation cabins in S'Albufera. To examine the significance of the difference between mean marginal values of $E(X_{SPEC})$ in T=10 and T=70 under each level of X_{GEN} and $X_{TIME(less)}$ and for each scenario of probability, Poe et al. (2005)'s tests have been conducted. Results of the sensitivity analysis are reported in Table 19.

Table 19 Mean marginal value of $E(X_{SPEC})$ for T=10 and T=70 as a function of $X_{TIME(less)}$ and X_{GEN}

		Inherent_80		*Inherent_60*	
	X_{GEN}	T=10	T=70	T=10	T=70
$X_{TIME(less)}=0$	-10	2.43	3.17	2.75	3.00
	0	1.97	2.73	2.11	2.38
	+5	1.74	2.51	1.79	2.07
$X_{TIME(less)}=1$	-10	1.56	2.10	2.75	3.00
	0	1.10	1.66	2.11	2.38
	+5	0.87	1.43	1.79	2.07

Results of the sensitivity analysis seem to confirm the findings obtained in Table 17 and Figure 2. Despite showing that the mean marginal value of $E(X_{SPEC})$ in T=70 tends to be higher than in T=10, WTP has emerged not to be significantly different between the two time horizons for whatever scenario considered, based on the results of the Poe et al. (2005)'s test.[29]

[29]For this robustness analysis, the confidence intervals resulting from the Poe et al. (2005)'s

However, preferences for $E(X_{SPEC})$, which determine the optimal level of 'specialist' bird species that should be conserved for present and future generations, meaning the number of species maximizing part-worth utility, appear to be affected by the endowment of a different type of natural capital (i.e. X_{GEN}) or of man-made capital (i.e. $X_{TIME(less)}$). This is because the marginal value of $E(X_{SPEC})$ has been found to significantly decrease at 1% level with both X_{GEN} and $X_{TIME(less)}$, based on the results of Poe et al. (2005)'s tests, due to the substitution patterns identified between these attributes and $E(X_{SPEC})$.[30] In this sense, these findings show that despite respondents are willing to conserve 'specialist' bird species in the same way over the long- and very long-term, they accept some degree of substitution between different forms of capital and are willing to give up some 'specialist' bird species if there is more endowment of other natural capital or man-made capital. In specific, when the endowment of man-made capital is higher, namely when waiting time is low ($X_{TIME(less)}=1$), individuals have been found to be willing to conserve a lower level of $E(X_{SPEC})$ for present and future generations when the situation is more critical (*Inherent_80*) than when it is less critical (*Inherent_60*). This is because, when waiting time becomes low ($X_{TIME(less)}=1$), the marginal value of $E(X_{SPEC})$ decreases at either 1% or 10% significance level under *Inherent_80*, based on the results of the Poe et al. (2005)'s test, while it does not change under *Inherent_60*. Without entering more into details, all this indicates that, despite sustainability concerns have been found to be strong determinants of respondents' preferences, the level of environmental quality that respondents wished to equally preserve for present and future generations displays some context-dependency.

test are available from the authors upon request.

[30]Such substitution patterns have been detected in all scenarios, except in *Inherent_60*. There, the part-worth utility of $E(X_{SPEC})$ has been found not to be sensitive to variations in $X_{TIME(less)}$.

4.5. Discussion and conclusions

This paper has examined the role of sustainability issues on social preferences for policies to avoid time-persistent environmental problems, which take place over the long- and the very long-term due to complex environmental dynamics. In other words, given that environmental impacts occurring in the long-term affect the present generation and those occurring in the very long-term affect the future generations, the present analysis has addressed the question of whether social preferences for conservation policies in this context are driven by intergenerational equity concerns. By examining, through a CE application, social preferences for environmental preservation in the face of CC impacts in the long-term (T=10) and very long-term (T=70), results have shown that individuals assign the same weight to environmental quality conservation regardless of whether the present or the future generations will benefit from it. Hence, they are strongly driven by sustainability concerns when making choices in the face of time-persistent environmental problems.

These results are relevant because the role of sustainability concerns in social preferences has been an overlooked issue by the economic valuation literature, despite the increasing claims for incorporating intergenerational equity considerations in environmental policy design. Indeed, some research has been undertaken to explore the time sensitivity of social preferences but it has only focused either on the long- or on the very long-term (Layton and Brown 2000; Viscusi et al. 2008; Kim and Haab 2009; Meyer 2013). To our knowledge, no study has explored the value that current generation assigns to an environmental outcome occurring over the very long-term with respect to the long-term and, hence, whether there are sustainability concerns. By showing that current generations give the same importance to outcomes accruing to present and future generations, the results of our analysis have proved that the usual approach in ECBA to give priority to earlier than later results, can have important social welfare implications. This is not only because the welfare of future generations is at risk if environmental policies generating improvements especially in the very long-term are seen as less socially desirable. It is also because, due to sustainability concerns, current generations are negatively affected by the knowledge that future generations' wellbeing is at stake.

Based on our results, most of sampled individuals already considered over T=10 the need to equally preserve nature for present and for future generations, especially to provide the unborn with the same use opportunities associated with nature conservation. In addition, even though to a lesser extent, they also reported to be equally interested in environmental conservation over the long- and very long-term for the importance that nature preservation acquires for people, regardless of use. These results can be explained by considering the profile of our respondents, who are nature-based recreationists to S'Albufera wetland. As argued in Viscusi et al. (2008), visitors to natural areas are, in general, more future-oriented and, hence, they are more forward-looking when making their choices over T=70, which seems to be especially true if visitors display an emotional attachment to the environmental good. This is the case with our recreationists, being repeat visitors in 81.18% of cases when residents are considered and 57.35% when non-resident visitors are taken into account. In addition, they also display particularly high levels of environmental consciousness, which might have contributed to make them so sensitive to the environmental situation in the very long- in addition to the long-term. In fact, a good portion of sampled respondents are active members of environmental groups (38.76 %) and they regularly practice recycling (98.41%). Given that in our study the focus is on the preferences of this very specific segment of individuals, it would be interesting to compare our findings with others taking into account different publics, with a less nature-based orientation, which becomes especially important when the focus is on non-use values in addition to use values.

The analysis under T=10 and T=70 has been undertaken by considering the existence of inherent uncertainty, which refers to the unpredictability of environmental dynamics, making the results of policy interventions unknown in advance. This decision has been motivated by the results in chapter 3, showing the significance of the effect on WTP of inherent uncertainty. In specific, inherent uncertainty has been expressed as the uncertainty around the occurrence of future adverse impacts on ‘specialist’ bird species. Based on the recognition that scientific knowledge can help to make predictions about how close the system is to the risk of extinction, even though no such prediction can be guaranteed, two different probability scenarios have been considered, of either 80% or 60% probability of impacts’ occurrence. Results of our study have shown that preferences for preservation policies are driven by intergenerational equity concerns regardless of how dangerous the situation is expected to be. In other words, respondents appear to be worried about sustainability independently of how significant the risk of environmental quality loss will be. By opting for sustainable conservation in the face of inherent uncertainty, this result shows that individuals are adopting a precautionary attitude. Hence, the risk of irreversible environmental losses both for present and future generations might have motivated the willingness to conserve the same critical level of natural resources in the long- and in the very long-term future. In this sense, the level of natural capital that should be preserved, which depends on individuals’ preferences, has emerged to be influenced by the specific context of the analysis. Indeed, individuals in our case study have been found to be willing to substitute, to some extent, some level of environmental quality if the availability of other forms of capital, both natural and man-made, is increased. All this indicates that, despite sustainability concerns always drive support for nature preservation, the level of environmental resources that individuals wish to conserve can be context-specific.

Despite these findings, one may also argue that the results of the analysis don’t reflect a genuine concern for intergenerational equity but rather depend on the design employed in our CE application. In fact, given that individuals have first been requested to choose over T=10 and, then, they were asked whether they would change their preferences over T=70, it would be legitimate to think that they might have reported to be unwilling to modify their preferred choices over the longer time horizon to avoid repeating the exercise. In this sense, one might assert that the analysis of time sensitivity should have best been performed by splitting the sample of respondents into different groups, each of which presented with a separate time scenario, as commonly done in the valuation studies dealing with time sensitivity. Even though the split sample approach may be argued to be more desirable because it minimizes the cognitive burden on respondents (Day et al. 2012), thus providing possibly more reliable results, it can be replied that implementing it would not have been feasible in our case. In fact, collecting at least four, instead of two, representative split samples of respondents, one for each probability scenario and for each time horizon, would have been difficult due to budget constraints. Despite not following a split sample approach, a low percentage of respondents in our study protested against the prospect to think about an additional time horizon (3.11% in the split sample with 80% probability and 5.48% in the split sample with 60% probability) and, apart from that, no important signs of cognitive burden were detected. Hence, there are no clues that the design might have driven our results. In any case, the issue of outcomes' consistency between the results in our approach and in a split sample treatment of time sensitivity remains one of interest for future research.

Similarly, it would be interesting to investigate whether the order through which temporal horizons have been presented to respondents may have affected their choices. In any case, based on tests undertaken during the pilot survey, it is sure that individuals could clearly distinguish between the two time horizons elicited, such that the 'temporal embedding effect' can be safely discarded as a possible reason for time insensitivity in the analysis (Arrow et al. 1993). In this sense, despite the results of our study indicate that individuals do not choose differently depending on the timing, it is of interest to investigate the issue of time sensitivity by taking into account more periods, to check for the consistency of respondents' conduct. In fact, it remains to be clarified why research focusing on the long-term has commonly found that earlier outcomes are preferred, while studies over the very long-term have usually found time-insensitivity. Also, it could be of interest to test for possible ways of communicating information about different horizons in a time-persistent framework. Indeed, instead of using specific time horizons, which might mean different things to respondents depending on their age, another way of obtaining preferences in an intergenerational context might be to describe the scenarios in terms of 'who' will be affected (i.e. the respondent, his children, his grandchildren, etc.). To have a better picture of social preferences over different time horizons, more research should be done in this sense. The analysis of the role of sustainability could be further extended by additionally taking into consideration distributional and, hence, intra-generational equity issues, as these also form part of sustainability concerns, according to Baumgärtner and Quaas (2010). In this sense, it would be necessary to know whether individuals are sensitive to distributional questions regarding who gains and who loses from a given situation, to better inform policy makers in the design of sustainable policies (Barbier et al. 1990).

To sum up, despite numerous questions still remain unanswered, the results of this study add to the emerging literature dealing with environmental valuation over time. They provide evidence that, due to sustainability concerns, individual preferences are insensitive to time regardless of the scenario considered, this indicating the importance of intergenerational equity issues. Findings also suggest that earlier environmental improvements are not necessarily always preferred, as traditionally assumed in ECBA (Pindyck 2007) and, hence, that the time sensitivity of welfare measures should not be arbitrarily set, but rather it should be based on preference analysis. In this sense, our work shows the importance of including sustainability issues in the analysis of social preferences to better inform ECBA. Thus, it offers a basis for an effective intergenerational allocation of natural endowments taking welfare maximization principles into account, even though it also acknowledges that more research in this direction is warranted.

5. CONCLUSIONS

The present doctoral thesis has focused on the economic valuation of wetland protection under CC impacts in an attempt to respond to a pressing demand among policy-makers for more guidance in the management of humid land areas. Indeed, in the face of growing anthropogenic pressures on wetlands, among which CC represents the most prominent one, there is increasing urgency for the design of conservation measures to support these ecosystems' supply of goods and services, which is crucial for human well-being. In this sense, information about the social benefits of policy interventions, which can be inferred through SP analysis, represents a critical tool to help planners in decision-making because it allows to take into account social desirability and, hence, welfare-maximization criteria.

Despite this, only little attention has been dedicated by the SP literature to the value of wetlands' preservation under CC threats, possibly because of the numerous challenges associated with this task. Indeed, valuing the social benefits of CC adaptation requires the consideration that CC effects will be time-persistent, this implying that the impacts against which policies will need to be designed will be complex and multi-faceted, inherently uncertain and extended over the long-term and the very long-term. Therefore, with the purpose of shading some light on the welfare relevance of these issues, three are the research questions on which this doctoral work has focused. Firstly, it has investigated the trade-offs between the social benefits of avoiding different and complex CC-induced impacts on wetlands. Secondly, it has examined the role on social preferences of delivering information about the inherent uncertainty which characterizes CC dynamics and which is uncontrollable and unpredictable. Thirdly, it has analyzed the significance of sustainability concerns in determining the time sensitivity of social preferences for policies to avoid long- and very long-term impacts. To answer these questions, the present doctoral thesis has relied on a CE application taking the case of S'Albufera wetland into account, as an example of an outstandingly exposed site to CC stresses.

In a nutshell, results have shown that respondents display sensitivity to the type of impact that the policy should counteract, as well as to the inherent uncertainty of the scenario, and that they care about sustainability issues when expressing their preferences for adaptation policies to CC impacts. In specific:

a) Based on the consideration of different impacts that CC is expected to generate on wetland ecosystems, meaning the loss of species' abundance and diversity, findings have shown that positive preferences exist for avoiding both of them, even though the value of preventing the second one is significantly higher. This result highlights that not all wetland impacts are regarded in the same way by respondents and that some of them are more valuable and should deserve more attention by policy-makers.

b) The analysis has also focused on the effects of inherent uncertainty on the WTP for a preservation policy. To do this, it has related outcome uncertainty to the probability of occurrence of an expected CC impact, which is uncontrollable and unpredictable due to the stochastic nature of ecosystems' behavior. Results have shown that there are significant differences between social preferences in a certain *versus* inherently uncertain scenario. This illustrates the relevance for policy-making of conducting preference analysis under inherent uncertainty, given that ignoring it, as traditionally done, can generate severe social welfare implications. In specific, individuals are willing to pay more for conservation when the loss of species is inherently uncertain, this showing they are averse to the risks of environmental quality declines. Though, findings have been found not to be conclusive with respect to individuals' sensitivity to the probability of impact occurrence.

c) Through the examination of the time sensitivity of social preferences, by considering different scenarios in the long-term and very long-term, results have displayed that social preferences are insensitive to the timing of impacts. This is because current generations are willing to pay the same amount for wetlands' preservation regardless of whether policy benefits will arise in the long-term or in the very long-term, due to sustainability concerns. In fact, findings have shown that current generations care about future generations' well-being and they would be willing to pay to preserve nature for the unborn to give them at least the same welfare opportunities derived from the use of nature or simply from the knowledge about its preservation. This outcome has emerged to be robust to the scenario of probability of CC impacts' occurrence considered.

The outcomes of our research primarily contribute to the scarce economic valuation literature dealing with wetland protection under CC impacts by providing welfare-based information to take socially desirable decisions. In specific, they offer guidelines to improve policy-making strategies by pointing out the limitations of the management approaches currently adopted and by showing that these would not be optimal in the face of future CC-induced challenges. Indeed, results suggest that, instead of focusing on the conservation of species' abundance, a renovated attention should be promoted among wetland managers for the preservation of species' diversity (Snoussi et al. 2008; Ayache et al. 2009; Jeppesen et al. 2011; Withey and van Kooten 2011). Rather than opting for inaction or risks' neglect, findings advise to implement conservation measures in the face of uncontrollable or unavoidable inherent uncertainty about environmental impacts' occurrence (Walshe and Massenbauer 2008; Grant et al. 2013; Downard et al. 2014). Instead of taking a short-sight approach to management, a longer term attitude is recommended as a strategy to improve society's well-being (Crooks et al. 2001; Müller et al. 2010).

An in-depth analysis has shown that the findings of this doctoral work are relevant also for the overall SP research dealing with the economic valuation of the environment. Despite the growing employment of SP methods in frameworks characterized by environmental problems with a time-persistent nature –such as CC, nuclear waste generation, the discharge of persistent pollutants in the air, soil or water systems– the role on social welfare of complex and different impacts, inherent uncertainty and timing of repercussions have received only little attention. Regardless of the fact that these issues were pointed out as important challenges to be addressed within the valuation literature more than a decade ago (Deacon et al. 1998; Adamowicz 2004), only limited progress has been made so far in this direction. Traditionally, the SP literature has tended to present the valuation scenarios in a simple and plain fashion to avoid overcomplicating the choice task. It has tended to simplify the hypothetical market description presented to respondents by downsizing ecological impacts to an abstraction, rather than a real representation, of the complexities of reality (Kontogianni et al. 2010).

Furthermore, SP research has generally assumed certainty of policy results and only in a limited, despite growing, number of cases it has taken outcome uncertainty into account (Wielgus et al. 2009). Even though it has showed that preferences are sensitive to outcome uncertainty, as in our case, it has generally hypothesized that this uncertainty depends on the scientific knowledge about environmental processes and hence it lies under the control of the policy maker, while overlooking the fact that it also depends on uncontrollable and unpredictable ecosystems' dynamics. Additionally, SP research has also tended to under-investigate the sensitivity of social preferences to time (Meyer 2013). Indeed, despite a few studies have showed that individuals are sensitive to time in the long-term, while they tend to be insensitive to it in the very long-term, as in our study, this has not been enough to investigate the role of sustainability concerns, which requires the joint consideration of the long- and the very long-term. Even though scarce, research in this context has contributed to improve efficiency in environmental management, but it does not represent an adequate tool to better inform policy-makers in the face of time-persistent events. In fact, the valuation context does not commonly take into account that environmental impacts are complex, inherently uncertain and will occur in the long-term and very long-term. This is a consequence of the fact that economic valuation rests on ECBA guidelines, which have been recognized to insufficiently and inadequately take into consideration especially the effects of true uncertainty and intergenerational issues on welfare (Hanley and Spash 1993; Boardman et al. 2006).

Given the results of this doctoral thesis, overlooking or inadequately considering these aspects would result in socially undesirable policy-making solutions and, hence, in adverse social welfare implications. In this context, our study has shown that it is important to deal within ECBA with the challenges of time-persistent environmental problems. In this sense, this doctoral thesis has attempted not only to create awareness around the role of the challenges of time-persistent environmental problems, but also to offer a framework to stimulate their explicit consideration in ECBA and economic valuation and, hence, in policy-making. However, some questions still remain open and deserve future attention:

Firstly, taking into account the complexities and variety of impacts associated with a given environmental problem, a suggestion for further research is in the direction of integrating and reinforcing investigation between ecology or natural sciences and economic valuation (Turner et al. 2003). This is perceived to be a crucial matter in the case of time-persistent environmental effects because a much better picture needs to be gained concerning which are the relevant ecological impacts for society, in order to realistically design the valuation exercise and, consequently, to better inform policy-makers. In this sense, and despite the difficulties of taking this interdisciplinary approach, it is believed that numerous are the expected advantages from this collaboration (Polasky and Segerson 2009).

Secondly, gaining a deeper insight into ecosystems' dynamics obliges to consider the inherent uncertainty of environmental processes, as there is true uncertainty around whether impacts might occur or not occur. Despite this, something can be said by scientific research about how critical the situation might be. In a context in which the environmental scenario is more or less unknown, results of our analysis suggest that knowledge about natural systems' functioning and, in specific, about environmental resilience should be increased. In this sense, more needs to be understood concerning the capacity of ecosystems to avoid drastic changes that might underpin services' provision in the face of various possible scenarios (Vergano and Nunes 2007; TEEB 2010; Admiraal et al. 2013). Given that, examining preferences for specific environmental outcomes, as done in our analysis, appears to be over-simplistic. Indeed, it seems more appropriate to present information about minimum ecosystem structures and processes required to maintain a well-functioning ecosystem. In fact, displaying to respondents exact levels of environmental goods without any reference to their capacity to support ecosystem services' provision may not be very helpful. This represents an underexplored but expanding line of research in economic valuation (Kontogianni et al. 2010; Bateman et al. 2011; Morse-Jones et al. 2011).

Thirdly, another need for further research appears in the area of individuals' decision-making process in the face of irreducible uncertainties. With this respect, the discussion of our results has shown that more sophisticated models other than the basic EU theory might be worth being examined to extend our analysis (Young 2001; de Palma et al. 2008). In this sense, some candidates might be rank dependent EU or the maxmin EU theories. This is because both allow for a better modeling of the choice process under uncertainty, while allowing for non-linear weighting of probabilities, which is something that our respondents might have considered in their choices (Shaw and Woodward 2008). Consideration of non-EU theories, such as prospect theory, might also be appropriate to better model the loss aversion attitude towards the risk of a species' decline that individuals might have adopted. In other words, it would allow to test whether people display different sensitivities to risky outcome changes depending on whether there might be an increase or decrease with respect to a reference point, which is normally the current situation (Bartczak et al. 2015).

Fourthly, the role of inherent uncertainty on social preferences acquires importance especially in the presence of irreversibility. This is believed to characterize time-persistent environmental problems because impacts are likely to be permanent or difficult to revert due to the accumulation of damages over time (Pindyck 2000). Despite it is to expect that respondents in our study might have taken irreversibility into account, it remains to be tested what is the role of explicitly including information about it to check whether it affects individuals' choice process. In specific, it would be interesting to test how information about irreversibility interacts with the complexity, inherent uncertainty and long-lasting nature of persistent environmental impacts. Indeed, almost no attention has been dedicated to this issue by the environmental SP literature (Isik 2006; Strazzera et al. 2010).

Fifthly, in a context of intricate time-persistent environmental problems, it would be of interest to investigate the trade-offs between more realistic and detailed valuation scenarios and the level of fatigue of respondents, because this latter can have potential implications for the consistency and reliability of welfare measurement (Carlsson et al. 2012). Despite all efforts to try to minimize the information burden, which has prevented the identification of signs of cognitive tiredness among respondents, it would be of interest to investigate whether individuals have experienced some fatigue effect. In this sense, this latter could vary depending on the scenario considered, given that each sampled individual was exposed to two different time horizons in a given probability framework. Similarly, it would be worthwhile to analyze whether the order effect through which the different time horizons have been presented exerted some influence on the responses of individuals (Fischhoff 2005).

Sixthly, related to the previous point, it would be worthwhile to check for the presence of hypothetical and strategic biases in respondents' behavior, which might be a relevant issue in our case study. This is because the sampled respondents in this doctoral thesis are recreationists visiting a public wetland area, who are asked to pay for an entrance fee, conditional upon visitation, to contribute to environmental quality improvements. In this sense, there is a concern that individuals could have over-stated their preferences while answering the questionnaire, which might have been possible given the weak consequentiality of the payment vehicle employed, which only needs to be paid if the visit to the wetland is undertaken. In other words, the respondent might have not revealed his true preferences because of the awareness that he might free-ride, i.e. namely benefit from a given environmental improvement, without having to pay for it, which might have led to inflate the valuation's responses (Gubanova et al. 2009; Loomis 2014). The result of this conduct, which would lead to the appearance of a hypothetical bias, where respondents would be willing to pay less than they hypothetically state, would be significant in terms of economic valuation and policy-making. Hence, given there is still an open debate among practitioners, this issue deserves more attention (Broadbent 2012).

Seventhly, it appears to be equally relevant within the economic valuation of time-persistent environmental problems, to explore in more detail the role of distributional issues. Indeed, impacts resulting from the complexities of time-persistent environmental problems are expected to non-homogeneously affect the involved stakeholders, such that, depending on the role of intragenerational equity concerns and inequality aversions among society members, choices to support a given policy might be influenced. As reported in Scarborough and Bennett (2008), this represents a highly underexplored issue in SP methods, which is further reinforced by the fact that it has largely been overlooked also by the ECBA (Organisation for Economic Co-operation and Development 2006). In this sense, respondents might be sensitive to issues such as such 'who' gains and 'who' loses or which stakeholder groups are involved in the democratic process of voting (Reed 2008) and, if this is the case, this needs to be reflected also into the mechanisms of preferences aggregation across individuals. Similarly, in a context in which policy interventions need to be sustainable and, hence, have a long-term and very long-term orientation, respondents might place particular interest in 'how' the policy will be implemented, 'how' transparent the process will be and whether control mechanism are considered to guarantee long-term commitment.

The presence of still numerous open questions to answer shows that the research presented through this doctoral thesis only represents a first step towards filling some important knowledge gaps around rather common issues characterizing the economic valuation of the environment. In any case, despite still much needs to be done, the answers provided by this research work have made a contribution to the SP literature, as well as to policy-making, by highlighting the social welfare relevance of some aspects of time-persistent environmental problems, like CC. Hopefully, and by raising further research questions, it is expected that it will also contribute to catch the attention of other practitioners in order to stimulate a lively and constructive debate to provide policy-makers with improved solutions based on social welfare considerations to tackle increasingly persistent, complex and uncertain environmental problems.

APPENDIX

In this Appendix, a copy of the survey employed in the CE designed under certainty, is first reported. Then, an example of choice card from the certain CE is shown (Sample choice card 1), together with one from each of the CEs taking into account inherent uncertainty, namely depicting a probability of impacts' occurrence of 60% and 80% (Sample choice card 2 and 3, respectively).

Universitat de les Illes Balears

VISITORS' SURVEY ON S'ALBUFERA NATURAL PARK

Statistical confidentiality

All the data you have provided will be protected by statistical confidentiality and, hence, they will only be employed to obtain information at aggregated level, being illegal the use of individual data by whatever public or private institution.

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BLOCK A: INTERVIEWEE IDENTIFICATION

2. Is Mallorca your main place of residence?

1 Yes

2.1. In which town do you live? ____________________

2.2. Is this your first visit to S'Albufera?

1 Yes **[skip to block B]**

2 No

2.2.1. On average, how many times do you visit S'Albufera in a year?

☐☐ time(s) **[If none, skip to block B]**

2.2.2. In which season do you mostly visit S'Albufera?

1 In winter
2 In spring
3 In summer
4 In autumn
5 In spring and autumn
6 In whatever season

[skip to block B]

2 No

2.3. Which is your main place of residence?

1 Other Balearic Islands
2 Rest of Spain
3 Germany
4 UK
5 Other: ____________________

2.4. Is this your first trip to Mallorca?

1 Yes **[skip to 2.5.]**

2 No

2.4.1. How many times –excluding the present one– have you visited the Island during the last 5 years?

☐☐ time(s) **[if none, skip to 2.5.]**

2.4.2. Over these last 5 years, how many times –excluding the present one– have you visited S'Albufera?

☐☐ time(s) **[if none, skip to 2.5.]**

2.4.3. In which season have you mostly visited S'Albufera?

1 In winter
2 In spring
3 In summer
4 In autumn
5 In spring and autumn
6 In whatever season

2.5. Now, please, focus on your **current trip to Mallorca**.

2.5.1. How long are you staying on the Island in total? ☐☐ day(s)

2.5.2. When did you arrive to Mallorca? ☐☐ day(s) ago

2.5.3. How many times –excluding this visit- have you visited S'Albufera since you arrived? ☐☐ time(s)

2.5.4. Have you bought a package tour?

1 Yes

2 No

2.5.4.1. Besides transportation, what does it include?

1 Only accommodation
2 Accommodation and half board
3 All inclusive
4 Other: ____________________

2. ☐
2.1. ☐☐
2.2. ☐
2.3. ☐
2.2.1. ☐☐
2.2.2. ☐
2.4. ☐
2.4.1. ☐☐
2.4.2. ☐☐
2.4.3. ☐
2.5.1. ☐☐
2.5.2. ☐☐
2.5.3. ☐☐
2.5.4. ☐
2.5.4.1. ☐

2.5.5. In which town are you accommodating? ______________________________

2.5.6. Have you rented a vehicle?

[1] Yes

2.5.6.1. How much did it cost? ______________________ **[specify currency]**

2.5.6.2. This amount refers to: [ ][ ] day(s) [ ][ ] person(s)

[2] No

2.5.7. Which is the main interest of your trip?

[1] Sun and beach
[2] Relax
[3] Nature enjoyment
[4] Sport
[5] Fun and entertainment
[6] Family and friends
[7] Culture (art, history, gastronomy)
[8] Holidays in a second home

2.5.8. Which natural areas other than S'Albufera have you visited since you arrived?

[1] Cabrera Archipelago National Park
[2] Mondragó Natural Park
[3] Llevant Natural Park
[4] Sa Dragonera Natural Park
[5] Other: ______________________
[6] None

BLOCK B: FREQUENTATION OF S'ALBUFERA

3. Are you visiting S'Albufera alone?

[1] Yes
[skip to 4]

[2] No

3.1. How many persons are with you? [ ][ ] person(s)

3.2. How many of them are below 12? [ ][ ] person(s)

4. Which is the main interest of your visit to S'Albufera today? Please, be as specific as possible.

[1] Contemplation/enjoyment of nature
[2] Relax and catch some fresh air
[3] Practice some exercise (walk or cycle)
[4] Share experiences with others
[5] Observe flora and fauna of interest

[skip to 5]

[6] Bird watching

4.1. How skilled would you define yourself in identifying birds?

[1] Beginner
[2] Intermediate
[3] Expert

4.2. How long have you been practicing bird watching? For [ ][ ] year(s)

4.3. Which of these activities do you mostly appreciate while birding?

[1] Watch as many birds as possible, regardless of the species type
[2] Watch as many bird species as possible, regardless of whether they are typical of the wetland
[3] Watch as many bird species as possible being typical of the wetland
[4] Share experiences with others
[5] Improve birding skills and learn about birds

5. How many times a year do you visit wetlands in your region? [ ][ ] time(s)

6. Over the last 5 years, how many times have you visited wetlands out of your region? **[in case of non-residents, add]** excluding the present one to S'Albufera?

[ ][ ] time(s)

2.5.5.	[ ][ ]
2.5.6.	[ ]
2.5.6.1.	[ ][ ][ ] [ ]
2.5.6.2.	[ ][ ] day(s) [ ][ ] pers.
2.5.7.	[ ]
2.5.8.	[ ]
3.	[ ]
3.1.	[ ][ ]
3.2.	[ ][ ]
4.	[ ]
4.1.	[ ]
4.2.	[ ][ ]
4.3.	[ ]
5.	[ ][ ]
6.	[ ][ ]

BLOCK C: CLIMATE CHANGE IMPACTS ON S'ALBUFERA

S'Albufera Natural Park is basically a freshwater-dependent wetland. However, increased temperatures and decreased precipitation rates induced by climate change are intensifying salt concentrations in the park's waters, thus affecting 'specialist' bird species that are typical of the wetland.

7. How do you think these climate change induced impacts affect 'specialist' bird species that are typical of S'Albufera?

   1 Positively   2 Negatively   3 I don't know   4 No effect

7. ☐

Climate change also affects birds' migration timing since increased temperatures at the origin place stimulate earlier departure. Due to this phenomenon, migratory bird species start to arrive earlier to S'Albufera for resting and breeding.

8. How do you think these climate change induced impacts affect migratory bird species coming to S'Albufera?

   1 Positively   2 Negatively   3 I don't know   4 No effect

8. ☐

Experts anticipate that, if no extra action is undertaken, climate change will negatively affect the environmental quality of S'Albufera. Indeed, intensification of salt concentrations in the waters will have an effect on the ecological conditions of the park, thus leading to a decrease in the number of 'specialist' bird species. On the other hand, migratory bird species arriving earlier to S'Albufera for resting and breeding might not find optimal nesting conditions –such as food availability– then they could not remain at the park, this causing a decrease in their number.

9. Do you think this is credible?   1 Yes   2 No

9. ☐

In this context, park's managers plan to undertake two types of interventions:

a) First, aware that water is at the core of the biodiversity richness of S'Albufera, they plan to strengthen efforts on water management practices to prevent the loss of 'specialist' bird species and, hence, conserve the distinctive character of S'Albufera with respect to other wetlands.
b) Second, park's managers plan to advance efforts on practices related to migratory bird species to earlier create the optimal nesting conditions and avoid a decrease in their number. Unlike the water management practices, these latter policies pursue to maximize the quantity of migratory bird species, regardless of whether they are typical or non-typical of the park.

10. Do you think these practices would be suitable to counteract the climate change induced impacts in S'Albufera?

    1 Yes   2 Partially   3 No

10. ☐

BLOCK D: CHOICE OF ALTERNATIVES

Logically, strengthening efforts on current management practices is costly. In this sense, park's managers are evaluating the possibility of charging, from now on, an entrance fee to visitors over 18.

I will show you some cards like this one   **[show card 1]**

They show different levels for the change in the number of both 'specialist' bird species and 'generalist' migratory bird species (these latter being non-typical of the park), the waiting time for a seat in an observation cabin and the availability of rest-stop benches in the park. Each card includes three options that differently combine these four attributes. Each option is the result of a given policy at the park **in 10 years' time** and it has been assigned a cost, which represents the price of the daily entrance fee that adult visitors would be charged. From each card, you have to choose your most preferred option by taking into account the combination of the before-mentioned attributes and the price you should pay to benefit from them. In case you decide not to pay anything, the last column shows the situation that would result **in 10 years' time** if park's managers did not strengthen efforts on current management practices. There are no better or worse options, only your opinion matters.

Before telling me what you think, I will ask you to keep in mind two things:

1) Experts think that if park managers' efforts on current management practices are not strengthened, the decrease in the number of 'specialist' bird species in a time horizon of 10 years' time will occur with certainty, that is, with a probability equal to 100%. Of course, the changes in the number of 'specialist' bird species resulting from strengthening efforts will also be certain.

2) If you assume the cost of one of these policies, then you and your family will be unable to spend this money on other things.

Survey version number: ☐ ☐

11. **[Show choice card 1]** Which is your most preferred alternative? 11. ☐

1 A **[continue]**
2 B **[continue]**

3 C

11.1. Why did you choose C? 11.1. ☐

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ____________
[skip to block E] (options 2–5)

12. **[Show choice card 2]** Which is your most preferred alternative? 12. ☐

1 D **[continue]**
2 E **[continue]**

3 C

12.1. Why did you choose C? 12.1. ☐

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ____________
[skip to block E] (options 2–5)

13. **[Show choice card 3]** Which is your most preferred alternative? 13. ☐

1 F **[continue]**
2 G **[continue]**

3 C

13.1. Why did you choose C? 13.1. ☐

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ____________
[skip to block E] (options 2–5)

14. **[Show choice card 4]** Which is your most preferred alternative? 14. ☐

1 H **[continue]**
2 I **[continue]**

3 C

14.1. Why did you choose C? 14.1. ☐

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ____________
[skip to block E] (options 2–5)

15. **[Show choice card 5]** Which is your most preferred alternative?

1 J **[continue]**
2 K **[continue]**

3 C

15.1. Why did you choose C?

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ____________________________
[skip to block E] (options 2–5)

15. ☐
15.1. ☐

16. **[Show choice card 6]** Which is your most preferred alternative?

1 L **[continue]**
2 M **[continue]**

3 C

16.1. Why did you choose C?

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ____________________________
[skip to block E] (options 2–5)

16. ☐
16.1. ☐

17. When choosing among alternatives, have you taken into account the possibility to visit the park in 10 years' time? 1 Yes 2 No

17. ☐

18. If the attributes' combinations that I have showed you in each card were the result of a given policy at the park not in 10 years' time **but in 70 years' time**, would your choices be different from the ones that you have previously made?

1 Yes

18.1. **[Show choice card 1]** Which is your most preferred alternative?

1 A **[continue]**
2 B **[continue]**

3 C

18.1.1. Why did you choose C?

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ____________________
[skip to block E] (options 2–5)

2 No

18.8. Why? **[More than one option is possible]**

1 I already considered that the park's environmental quality must be preserved, regardless of the time horizon.
2 I already considered that future generations have the right to enjoy the same park's environmental quality that I enjoy today.
3 I am not interested in contributing to the preservation of the park's environmental quality for such a long period of time.
4 Other: ________________________

[skip to 19]

18. ☐
18.1. ☐
18.1.1. ☐
18.8. ☐

18.2. **[Show choice card 2]** Which is your most preferred alternative?

1 D **[continue]**
2 E **[continue]**

3 C

18.2.1. Why did you choose C?

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ____________________________
[skip to block E] (options 2–5)

18.2. ☐
18.2.1. ☐

18.3. **[Show choice card 3]** Which is your most preferred alternative?

1 F **[continue]**
2 G **[continue]**

3 C

18.3.1. Why did you choose C?

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ______________

[skip to block E]

18.4. **[Show choice card 4]** Which is your most preferred alternative?

1 H **[continue]**
2 I **[continue]**

3 C

18.4.1. Why did you choose C?

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ______________

[skip to block E]

18.5. **[Show choice card 5]** Which is your most preferred alternative?

1 J **[continue]**
2 K **[continue]**

3 C

18.5.1. Why did you choose C?

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ______________

[skip to block E]

18.6. **[Show choice card 6]** Which is your most preferred alternative?

1 L **[continue]**
2 M **[continue]**

3 C

18.6.1. Why did you choose C?

1 I believe it is the best one **[continue]**
2 I don't perceive any problem to justify extra efforts on current practices
3 I consider I am already paying for these services
4 I can't afford any entrance fee
5 Other: ______________

[skip to block E]

18.7. When choosing among alternatives, what have you considered? **[More than one option is possible]**

1 The wish to preserve the park such that future generations will enjoy it
2 The wish to contribute to the preservation of all the species of flora and fauna of the park
3 Other: ______________

19. Choosing between the alternatives has been ...

1 ...very easy
2 ...easy
3 ...normal
4 ...difficult
5 ...very difficult

18.3. ☐
18.3.1. ☐
18.4. ☐
18.4.1. ☐
18.5. ☐
18.5.1. ☐
18.6. ☐
18.6.1. ☐
18.7. ☐
19. ☐

20. When choosing among alternatives, have you paid equal attention to all the attributes or have you mainly focused on one of them?

[1] I have paid equal attention to all the attributes

[2] I have mainly focused on one of them

20.1. On which one? **[Only one option is possible]**

[1] 'Specialist' bird species
[2] 'Generalist' migratory bird species
[3] Waiting time for a seat in observation cabins
[4] Availability of rest-stop benches
[5] Entrance fee

20. ☐
20.1. ☐

BLOCK E: SOCIO-ECONOMIC VARIABLES

Before ending the survey, I would like you to answer some personal questions that are relevant for the study. Please, keep in mind that this information will be treated anonymously and will be kept strictly confidential.

21. Which is your nationality?________________________ 21. ☐☐

22. Which is the highest education level you have achieved? 22. ☐

[1] I don't have any education level
[2] Primary education (elementary school)
[3] Secondary education (middle and high school)
[4] Tertiary education (university and postgraduate studies)

23. What is your occupation? 23. ☐

[1] Part-time employee
[2] Full-time employee
[3] Entrepreneur
[4] Freelancer
[5] Own house-keeping
[6] Unemployed
[7] Retired
[8] (Non-working) student

24. How many persons –you included– are living in your household? Remember that a household is defined as a group of individuals living together and sharing expenses. 24. ☐

[1] One person

[2] Two persons
[3] Three persons
[4] Four persons
[5] More than four: ______________

24.1. How many of them are children below 16? ☐☐ 24.1. ☐☐

25. In which of these income ranges would you put your **monthly after-tax household income**? 25. ☐

[1] 0 – 1.000 € *(0 – 850 £)*
[2] 1.000 – 2.000 € *(850 – 1.700 £)*
[3] 2.000 - 3.000 € *(1.700 – 2.550 £)*
[4] 3.000 – 4.000 € *(2.550 – 3.400 £)*
[5] 4.000 - 5.000 € *(3.400 – 4.250 £)*
[6] 5.000 - 6.000 € *(4.250 – 5.100 £)*
[7] 6.000 – 7.000 € *(5.100 – 5.950 £)*
[8] More than 7.000 € *(More than 5.950 £)*

26. To finish, please, answer *yes* or *no*:

	YES	NO	
26.1. Are you a member of an environmental organization?	1	2	26.1. ☐
26.2. Are you a member of a birding group?	1	2	26.2. ☐
26.3. Are you a member of a sport/leisure group?	1	2	26.3. ☐
26.4. Do you regularly buy organic food?	1	2	26.4. ☐
26.5. Do you regularly sort out domestic waste for recycling?	1	2	26.5. ☐
26.6. Do you collaborate with an NGO?	1	2	26.6. ☐

27. Would you like to make some comments on the survey?______________________________

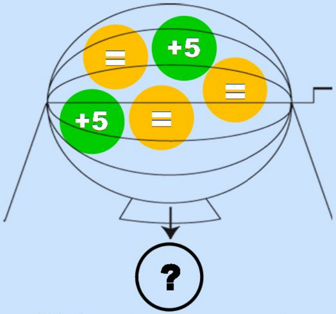
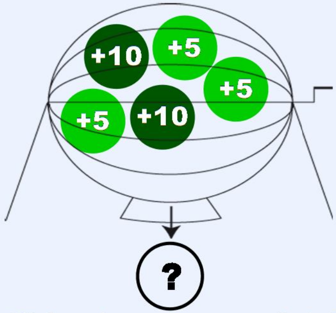
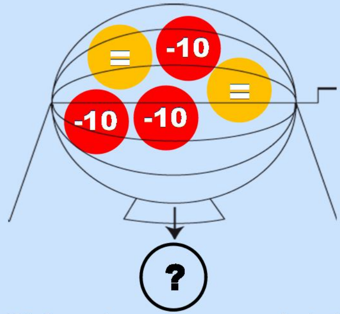
____

[The survey has finished! Thank you very much for your collaboration!]

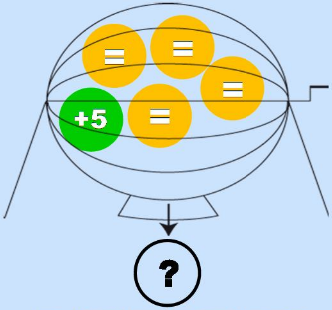
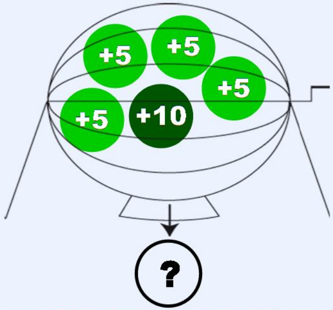
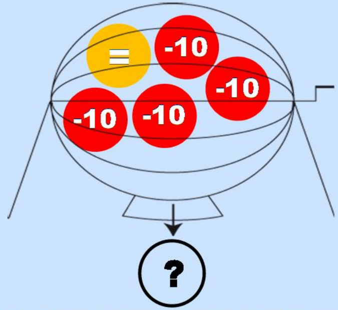
Sample choice card 1

ATTRIBUTES	POLICY A	POLICY B	NO POLICY INTERVENTION (C)
'SPECIALIST' BIRD SPECIES	+5 Increase the current number by 5	= Keep the current number	-10 Decrease the current number by 10
'GENERALIST' MIGRATORY BIRD SPECIES	+5 Increase the current number by 5	+5 Increase the current number by 5	-10 Decrease the current number by 10
WAITING TIME	≃3' Wait about 3 minutes for a seat in observation cabins	≃7' Wait about 7 minutes for a seat in observation cabins	≃15' Wait about 15 minutes for a seat in observation cabins
REST-STOP BENCHES	x2 Double the current number throughout the park	x3 Triple the current number throughout the park	= Keep the current number
ENTRANCE FEE	16€	8€	0€

Sample choice card 2

ATTRIBUTES	POLICY A	POLICY B	NO POLICY INTERVENTION (C)
'SPECIALIST' BIRD SPECIES	 **60% chance**, keep the current number **40% chance**, increase the current number by 5	 **60% chance**, increase the current number by 5 **40% chance**, increase the current number by 10	 **60% chance**, decrease the current number by 10 **40% chance**, keep the current number
'GENERALIST' MIGRATORY BIRD SPECIES	= Keep the current number	-10 Decrease the current number by 10	-10 Decrease the current number by 10
WAITING TIME	≃15' Wait about 15 minutes for a seat in observation cabins	≃15' Wait about 15 minutes for a seat in observation cabins	≃15' Wait about 15 minutes for a seat in observation cabins
REST-STOP BENCHES	x3 Triple the current number throughout the park	x2 Double the current number throughout the park	= Keep the current number
ENTRANCE FEE	**16€**	**24€**	**0€**

Sample choice card 3

ATTRIBUTES	POLICY A	POLICY B	NO POLICY INTERVENTION (C)
'SPECIALIST' BIRD SPECIES	 **80% chance**, keep the current number **20% chance**, increase the current number by 5	 **80% chance**, increase the current number by 5 **20% chance**, increase the current number by 10	 **80% chance**, decrease the current number by 10 **20% chance**, keep the current number
'GENERALIST' MIGRATORY BIRD SPECIES	= Keep the current number	-10 Decrease the current number by 10	-10 Decrease the current number by 10
WAITING TIME	≃3' Wait about 3 minutes for a seat in observation cabins	≃7' Wait about 7 minutes for a seat in observation cabins	≃15' Wait about 15 minutes for a seat in observation cabins
REST-STOP BENCHES	x3 Triple the current number throughout the park	= Keep the current number	= Keep the current number
ENTRANCE FEE	**8€**	**20€**	**0€**

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