ISSN 1835-9728

Environmental Economics Research Hub Research Reports

Environmental value and valuation over time

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Research Report No. 6

November 2008

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Environmental Economics Research Hub Research Reports are published by The Crawford School of Economics and Government, Australian National University, Canberra 0200 Australia.

These Reports present work in progress being undertaken by project teams within the Environmental Economics Research Hub (EERH). The EERH is funded by the Department of Environment and Water Heritage and the Arts under the Commonwealth Environment Research Facility.

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Abstract

Throughout the ages, time and value have been classical topics in human thinking. Time and value are highly related concepts as both influence human behaviour. However, only a few environmental economic studies concerned with non-market valuation have attempted to link these two concepts. Economists have been engaged in the development and application of methods to estimate non-market environmental values in monetary terms for over 30 years. This history of valuation provides an opportunity to make comparisons of value estimates and the performance of valuation techniques over time.

The goal of this research is to make such comparisons with reference to the existence benefits of a protected natural area. In 1978, the first contingent valuation method application undertaken in Australia was focused on Nadgee Nature Reserve on the far south coast of New South Wales. The intention is to replicate that study using both the original questionnaire and sampling techniques of the contingent valuation method used in 1978 as well as state of the art non-market valuation tools. The comparison over time afforded by this replication will provide insights into the extent and direction of changes in environmental values and the impact on value estimates through methodological evolution. Such insights will be supportive of improved efficiency in resource allocation.

1 Research motivation

Throughout the ages, time and value have been classical topics in human thinking. Time and value are highly related concepts as both influence human behaviour. However, only a few environmental economic studies have attempted to link these two concepts in order to better understand and predict the stability or volatility of values across time. The goal of this study is to address this gap.

For over 30 years, economists have been engaged in developing, employing and refining non-market valuation methods to estimate environmental benefits in monetary terms. This history of value estimation provides an opportunity to analyse the behaviour of environmental values and the preferences that underlie them over time, the impact of the evolution of non-market valuation methods on value estimates as well as the temporal reliability of these methods.

So far, only a limited number of value estimation studies have been conducted in this context. Most of them have been concerned with analysing the temporal reliability by comparing value estimates obtained at different points in time over relatively short time spans. Thus, little is known either about the extent and direction of possible changes in environmental values over extended time periods nor the impact of the evolution of non-market valuation methods on value estimates.

Questions about the “shelf life” of, for instance, existence value estimates (Stevens et al. 1994, p.355), are of key importance. Decisions about policy changes affecting the natural environment often have long-term and irreversible impacts and thus require a forecast of future preferences and an extrapolation of value estimates over extended time periods. This is especially the case if the WTP estimates employed in a cost-benefit analysis are obtained some significant time prior to that study or are transferred across space and time using benefit transfer. Even though the valuation method itself may exhibit temporal stability, factors that determine environmental value such as the underlying preferences or constraints may change over time. For instance, if a value is growing faster than the employed discount rate, the WTP estimate has to be adapted before it is meaningful to transferring them across time and space. Krutilla and Cicchetti (1972) discussed the relationship between increasing marginal benefit and the discount rate used in the Hells Canyon context. If the increase in marginal value is greater than the discount rate the time horizon of provision is infinite. This, however, implies an infinite present value. That means, in turn, that ignoring value changes across time may

result in an underestimation of environmental value due to an incorrectly calculated time horizon. Note, however, that as values change over time, it is likely that people will adjust by changing both supply (if unconstraint) and demand (reference dependency) and hence value. Consequently, economic choices about the allocation of natural resources across time that ignore dynamic preferences and values may lead to inefficiency in the long run. A better understanding of the relationship between values and underlying variables impacting on them through time would thus support more informed decision-making.

Moreover, extreme events such as large scale environmental pollution (for example, Exxon Valdez oil spill), extreme weather events (for example, Hurricane Katrina) or long term "threats" (for example, climate change) may change environmental values and underlying preferences. Using non-market valuation methods such as contingent valuation (CV) to estimate compensation for environmental damage raises the question of the "right" point in time to be used as a reference. According to Carson et al. (1997), immediate short term responses to an extreme event may change over time with increased availability and distribution of more information regarding the causes and consequences of that event. This, in turn, gives the individual the opportunity to reassess the incident. In this context a better understanding of value and preference behaviour over time may be able to support informed decision-making in choosing the "right" point in time.

In addition, the evolution of non-market valuation methods most likely impacts on value estimates through procedural change such as sampling methods, survey design, elicitation format, underlying economic models, econometric analysis & interpretation of results. A comparison of WTP estimates obtained by outdated non-market valuation tools with those elicited using state-of-the-art tools may provide information to evaluate the usability of the former.

Finally, WTP estimates are subject to changes if the valuation method is not reliable across time. A temporally reliable valuation method produces test-retest WTP estimates, which are not significantly different from each other, assuming that the underlying variables impacting on these estimates (income, prices of related goods, preferences, etc.) have not changed significantly and carry-over (also called recall) effects are absent (Whitehead and Hoban 1999). Some studies undertaken in this regard (e.g., McConnell et al. 1998; Reiling et al. 1990) suggest that, over relatively short time periods, the contingent valuation (CV) method produces reliable results. However, few studies have been conducted considering extended time spans.

2 Theoretical background

"Value" is a widely used term in the academic literature. However, its interpretation differs significantly across disciplines and depends on the respective underlying paradigms[1]. The neo-classical microeconomic theory of consumer behaviour provides the foundation for the definition of economic value (e.g., Mas-Colell et al. 1995). Since value has frequently been misinterpreted as being equivalent to revenue, cost or price, a precise definition of economic value is needed. Economic value is based on the assumption that consumers make economic choices based on individual preferences and constraints. A discrete change in quantitative and qualitative characteristics of an environmental commodity can be evaluated by using the Hicksian compensating surplus or the Hicksian equivalent surplus, which represent the maximum a consumer is willing to pay (WTP) to enjoy an increase or to prevent a decrease in some environmental commodity, respectively (Mitchell and Carson 1989). The choice of whether to use the compensating or the equivalent measure depends on the property rights allocation. The compensating measure reflects a situation with the consumer having the property rights to keep the current level of utility, whereas the equivalent measure represents a situation, in which the consumer is entitled to some alternative level of utility (Mitchell and Carson 1989).

Hicksian surplus is the classic tool for measuring welfare change in an environmental economics context. Economic value is defined as a change in Hicksian surplus (expressed in WTP) due to a change in resource use, for instant, an improvement in environmental quality. Consequently, WTP will vary due to changes in the values individuals place on environmental commodities. Neo-classical microeconomic theory of consumer behaviour suggests possible drivers for WTP volatility across time on both the demand and the supply side affecting preferences, and thus utility functions, and/ or constraints.

So far, only a limited number of studies have examined volatility of economic value estimates, mainly focused on relatively short time spans. Some of these studies have reported relatively stable values over relatively short time spans, whereas others looked at a longer time period and found indications for value volatility (Brouwer 2006; Brouwer and Bateman 2005; Carson et al. 1997; Loomis 1989; McConnell et al. 1998; Reiling et al. 1990; Stevens et

[1] For instance, psychologists analyse people's value orientations and ethical beliefs toward natural resources. Philosophers, environmentalists, and economists who have declined the neo-classical paradigm, discuss the existence and relevance of intrinsic values based on an ecocentric worldview irrespective of human needs and preferences. Neo-classical economists measure environmental values based on consumers' preferences assuming an anthropocentric perspective.

al. 1994; Teisl et al. 1995; Whitehead and Aiken 2007; Whitehead and Hoban 1999; Zandersen et al. 2005a; b). Nevertheless, little is known about the extent and direction of possible changes in environmental value estimates over extended time periods.

Norton et al. (1998) argue that preferences often are estimated from "snapshots" rather than as a dynamic process assuming they are at least stable for the duration of the analysis. They argue that since preferences are assumed to change relatively slowly the hypothetical construct of temporal stable preferences makes sense in the short term. However, many economic choices about policy changes regarding the natural environment have long term consequences. Ignoring the dynamics of preferences and values may lead to inefficient resource allocation.

According to neoclassical microeconomic theory of consumer behaviour, a consumer's WTP should be sensitive to quantitative and qualitative characteristics of an environmental commodity – known as scope and scale effect (see for example, Carson 2000; Carson and Mitchell 1995; Kahneman and Knetsch 1992; Smith and Osborne 1996). For instance, a consumer's marginal WTP for the maintenance of a nature reserve covering 50,000 hectare should be higher than for one covering only 10,000 hectare. Consequently, changes in quantitative and qualitative characteristics of a natural asset across time may change its marginal value – in both directions. Note however, that according to the principle of diminishing marginal utility, WTP estimates are not expected to increase proportional to the magnitude of change, but at a decreasing rate.

Other important factors, which are assumed to influencing preferences and thus individuals' WTP are the price and the availability of close natural or human-made substitutes. A change in these two factors may produce a change in demand of the respective environmental resource. For example, through time the recreational value of a national park may decrease with increasing availability of cheap indoor recreational opportunities. However, the range of substitutes for some environmental values, such as the aesthetic value of special geomorphologic phenomena, may be both limited and mainly imperfect (Krutilla and Cicchetti 1972).

Additionally, many natural resources are depletable in nature. That is, progressing environmental deterioration will reduce their availability. Both the absence of close substitutes and the depletability of many natural resources inhibit an increase in supply (Krutilla and Cicchetti 1972). Consequently, over time, decreasing availability of and/ or increasing demand for such natural resources will increase their scarcity value, and thus, in

turn may increase their marginal value to consumers (Krutilla and Cicchetti 1972). For example, the less available irreplaceable pristine natural areas are the more valuable the remaining areas are to consumers. However, Söderquist et al. (2000) argue in the context of wetlands that this holds only to a certain degree of degradation before the ecosystems begin to be dysfunctional and the marginal value drops to zero (marginal value paradox). Following this reasoning, the marginal value of pristine areas increases with increasing scarcity across time up to a point at which the size is too small for having any value for consumers at all. The findings of Krutilla and Cicchetti (1972) may also be relevant if considering the increasing supply. Rollins and Lyke (1998), for example, found that marginal WTP significantly decreased with an increased number of (hypothetically) existing national parks. That is, policy directed to an ongoing conversion of areas into national parks may decrease their marginal value across time.

Unfamiliarity with the natural resource under consideration has been suggested as being another possibly relevant factor influencing individual preferences. A study undertaken by Tisdell et al. (2007) suggests that people cannot be expected, necessarily, to be familiar with either the environmental good or the task to value it. Consequently, an individual's value for such a good may be controlled over time by an increasing level of knowledge (information and experience). Information may reshape existing preferences or may enable consumers to detect unknown preferences (Loomis 1989).

Reference dependency is another behavioural property, which may affect the estimation of benefits (Horowitz 2002). The concept of reference dependencies was introduced by Tversky and Payne (1991). According to them, values are estimated from a reference point (typically defined as current situation). Since reference points may vary over time value estimates are always relative measures. Following Horowitz (2002), reference dependencies may result in different acceptance levels of environmental degradation at different points in time. Following this rational, '[…] future decision-makers will "accept" low environmental quality that present decision-makers would want to avoid' (Horowitz 2002, p.252). Thus, using stated preference valuation to estimate compensations for environmental damage raises the question about the "right" point in time to be used as a reference. According to Carson et al. (1997) immediate short term responses to an extreme event may change over time with increased availability and distribution of more information regarding the causes and consequences of that event, which gives the individual the opportunity to reassess the incident.

Socio-demographics such as age, education, sex, and cultural background have been found to be significant variables to explain WTP through their influence on preferences. For instance, education may influence an individual's taste for examining and enjoying nature, which in turn may influence her preferences regarding, for example, the choice between going hiking and staying at home. This example shows that value may change across time due to impacts of changing socio-demographics on tastes, and thus preferences. Norton et al. (1998) suggest that preferences are influenced by both "nature" and "nurture". That is, preferences may fluctuate over time, for instance, under the influence of genetic evolution as well as education, advertising, or changing cultural assumptions.

A shift of a budget constraint due to variations in income or in the relative price of composite goods will change demand. That is, an increase or decrease in disposable income may change, for example, the WTP for the maintenance of a nature reserve. Therefore, WTP may change as income varies across time. Horowitz (2002) reviews numerical results of a range of studies reporting income elasticises, which gives an overview of the relevance of income as a variable impacting on WTP.

Socio-demographics such as age, education, sex, and cultural background have been found to be significant variables to explain WTP through their influence not solely on preferences but also on constraints. For instance, socio-demographics may impact on a budget constraint, suggesting, for example, a relationship between education level and wage rate. Thus, a change towards better educated people may result in a shift of individuals' budget constraints to the right reflecting a higher disposable income. Apart from a monetary budget there are other factors, including consumers' time or capabilities, which may constrain individuals' choices and which may change across time. For instance, the capability of an older adult to participate in extreme activities might be limited, and thus constrains their choice set. However, a limited time budget or restricted capabilities are primarily relevant with respect to choices involving use value and have less influence on those concerned with non use value.

Social psychological research has made progress in understanding possible relevant aspects of human behaviour with respect to economic choices such as environmental attitude and behaviour, the influence of information and experience, and value orientations. These are all aspects, which may increase the understanding of preferences and thus economic choices across time. Therefore, apart from examining changes in choice behaviour solely on the basis of traditional economic variables, considering underlying psychological processes may support a broader understanding of the process of and reasons for value changes over time

(e.g., Ajzen 1985; Ajzen et al. 1996; Ajzen and Peterson 1988; Albarracín et al. 2005; Casey and Scott 2006; Cooper et al. 2004; Fischer and Hanley 2007; Fishbein and Ajzen 1975; Green and Tunstall 1999; Kroeber-Riel and Weinberg 1996; Larson and Lach 2007; Schwartz 1977; Spash 2006; Stern 2000; Werner et al. 2002).

3 Case Study

Using the Nadgee Nature Reserve (henceforth referred to as NNR) as an example, this study evaluates the change of its existence value estimate over a 30-year time period. The NNR is the only coastal wilderness area in NSW and covers an area of 17,116 ha. It is characterized by a pristine character and a high level of landscape diversity.

The reference for this study is a CV carried out in 1979 in Australia (Bennett 1981; Bennett 1984) (henceforth referred to as the *original CV study*). Respondents were asked in an open ended format how much they were willing to pay in order to prevent the development of a highly pristine area. The area was described in term of the features of the NNR, even though its identity was not revealed. The described features included large beaches, sand dunes, a large salt water lake, three completely unpolluted river estuaries, large areas of coastal heathland, undisturbed stands of rare dry and wet eucalypt forest, and rare upland heath. Respondents were told that funds had to be raised to enable the government to purchase the land, and thus conserve the area. Apart from the WTP questions (including reasons for being willing to pay or not being willing to pay), respondents were asked about their socio-demographics, environmental attitudes and behaviour.

4 Research questions and methods

Economists have been engaged in the development and application of methods to estimate non-market environmental values in monetary terms for over 30 years. This history of valuation provides an opportunity to make comparisons of value estimates and the performance of valuation techniques over time. The goal of this study is to make such comparisons with reference to the existence benefits of a protected natural area. The intention is to replicate the *original CV study* using both the original questionnaire and sampling techniques and a state of the art non-market valuation tools. The comparison over time afforded by this replication will provide insights into the extent and direction of changes in

environmental preferences/ values in Australia and the impact on value estimates of methodological evolution. Such insights will be supportive of improved efficiency in resource allocation.

Drivers of change: demand and supply factors

Possible drivers of value estimate volatility are manifold and their individual impact on WTP across time is probably undistinguishable. In addition, the *original CV study* obtained only a few of those possible drivers, such as socio-demographics as well as some behavioural and attitudinal variables. From a current perspective, the tools used to elicit these attitudinal variables are problematic with respect to producing valid information. Hence, it will be very difficult – if not impossible – to analyse and explain the reasons for a change in value estimates given the temporal and budget constraints of this study. Furthermore, temporal unreliability of the CV method as well as changes in possibly omitted variables are assumed to influence value estimates, which further complicates the analysis. Therefore, the research questions and hypotheses of this study will be limited to the following:

Question 1.1

What is the direction and extent of a possible change in the estimates of the existence value of the NNR over a 30-year time period?

Hypothesis 1.1:

The WTP for the existence of the NNR has been constant over a 30-year period.

Question 1.2

What are drivers motivating temporal volatility of the NNR existence value estimates?

Hypothesis 1.2A:

Respondents' socio-demographics, attitudes and behaviour are statistically insignificant in explaining the existence benefits of the NNR.

Hypothesis 1.2B:

Respondents' socio-demographics, attitudes and behaviour have been constant over a 30-year period.

The main method used is a comparison of the original CV study carried out in 1979 with a replication of that original study, which will be undertaken in 2009. Both data sets will be

assessed using both original and state-of-the-art econometric analysis. The following variables will be analysed:

- WTP
- Socio-demographics (age; sex; country of birth; education; income)
- Acceptance of payment vehicle (choice proportions between income tax and donation to conservation organisation)
- Attitudes (importance of conservation in general/ reasons; importance of preserved areas for education, recreation, research, existence/ reasons)
- Behaviour (frequency and reasons for (not) visiting preserved areas; subscription to and level of annual donations to any conservation organisation/ reasons for not subscribing; frequency of reading books or watching TV programmes featuring the study of nature).

Additionally, other survey data (e.g., Australian related data of the World Value Survey) and the evolution of conservation areas/ related policies in Australia will be analysed to assess possible changes in environmental attitudes and behaviour (qualitative analysis of demand context) and changes in relative scarcity and availability of close substitutes (qualitative analysis of supply context)[2], respectively.

Driver of change: methodological evolution

The evolution of stated preference valuation methods including the CV method most likely impacts on value estimates through procedural changes across time. The CV method was first suggested in theory by Ciriacy-Wantrup (1947). The first practical application was pioneered by Davis (1963), which initiated a range of further applications (e.g., Brown and Hammack 1973; Hammack and Brown 1974; Randall et al. 1974). The *original CV study* carried out in 1979 was the first CV studies applied in an Australian context (Bennett 1981; Bennett 1984). Over the last 45 years, economists have been engaged in developing, employing and refining the CV method to estimate environmental benefits. Consequently, since then the published literature has advanced significantly, for instance, with respect to elicitation format, payment vehicle, follow-up questions, provision rule, and econometric analysis. Hence from a current perspective, the *original CV study* is problematic with respect to the validity of its estimates.

Irrespective of it's (from a today's perspective) shortcomings, the estimates of the original CV study are still listed in the benefit transfer data base for policy applications. This has motivated the idea to re-estimating the existence value of the NNR using a state-of-the-art

[2] Based on neo-classical microeconomic theory of consumer behaviour (expectation: diminishing marginal utility with increasing number/ size of conservation areas)

stated preference method. In general, both CV and CM could be used for this task. However, this study will use the CM method to re-estimate existence value of the NNR. The reasons for this decision are the following:

- Significant changes in relation to both CV and CM (different 'commodities')
- Unmanageable number of split samples required to rigorously test for changes in CV
- Current trend towards using CM, especially in Australian
- CM is better suited to research task currently faced

Testing for causes explaining this difference, however, is beyond the capacity of this comparison. The aim of such a comparison is rather to raise awareness that using outdated stated preference surveys for current policy decisions is not advisable. Therefore, the following research question will be discussed:

Question 2.1

To what extent and in what direction are the WTP estimates for the existence of the NNR obtained by the original CV study replicated in 2009 different from those elicited by a state-of-the-art CM 2009 study?

Hypothesis 2.1

The WTP estimates for the existence of the NNR obtained by the two different methods are equal.

The main method used is a comparison of WTP estimated by a replicated CV study in 2009 with a CM study in 2009.

Potentially incentive (in)compatibility in choice experiments

Most concerns towards the original CV study are associated with incentive incompatibility problems. A large number of studies have analysed and refined the CV method in this regard (recently e.g., Bateman et al. 2008; Carson and Groves 2007; Kanninen 2007; Schläpfer and Braeuer 2007). However, with respect to CM this issue seems to be almost ignored in the literature and the few studies addressing it are mainly focused on laboratory experiments rather than field surveys (e.g., Carson and Burton 2008; Harrison 2006; Kanninen 2007, Bennett 2008???; Lusk et al. 2008; Lusk and Schroeder 2004; Racevskis and Lupi 2008; Taylor et al. 2007). The current research aims to expand the limited prior research by evaluating potential incentive compatibility in CM surveys using the existence value of the NNR as an example.

According to the Gibbard-Satterthwaite-Theorem (Gibbard 1973; Satterthwaite 1975) solely a single binary choice elicitation format is a potentially incentive compatible, that is, demand revealing mechanism. However, the use of a single binary choice elicitation format is not a sufficient condition for incentive compatibility. A potentially incentive compatible mechanism is based on the assumption of a consequential survey design and questions in terms of Carson and Groves (2007). That is, the respondents understand the choice task, the scenario is plausible, the policy is credible, the commodity is of relevance to the respondent, and the respondent beliefs that their choice has an impact on the outcome. Therefore, follow-up questions to elicit information about these criteria are essential.

Abbreviations:
Single binary choice (S2) – 1 choice-set/ respondent ('multiple' in the sense that they will be given to many respondents)
Multiple binary choices (M2) – 6 choice-sets/ respondent
Single 3 choice (S3) - 1 choice-set/ respondent ('multiple' in the sense that they will be given to many respondents)
Multiple 3 choices (M3) – 6 choice-sets / respondent
Different efficient choice set designs to test for design effects – D1, D2
Application of a provision rule – pr

In particular, this study will address the following research questions and according hypotheses:

Question 3.1

Does the application of a provision rule influence choice behaviour with respect to the existence of the NNR?

Provision rule (pr): Binding majority vote (potentially incentive compatible only in SB): 'The option with the majority of votes will be implemented and everyone has to pay.'

Hypothesis 3.1:
The application of a provision rule does not change implicit prices for choice attributes characterizing the NNR.

Method 3.1
Comparison: S2 – S2pr; M3 - M3pr;

Question 3.2:

Do elicitation formats with – theoretically - different potentially incentive compatibility properties[3,4] *influence respondents' choice behaviour with respect to the existence of the NNR?*

Hypothesis 3.2:

Implicit prices for choice attributes characterizing the NNR are the same with differing elicitation formats, which – theoretically - exhibit different potentially incentive compatibility properties.

Methods 3.2

Comparison of 2-option single choice set elicitation format versus 2-option multiple choice sets elicitation format: S2pr – M2pr;

Comparison of sequence of 2-option choice sets elicitation format versus 3-option multiple choice sets elicitation format: M2prD1 – M3pr; M2prD2 – M3pr;

Comparison of 2-option single choice set elicitation format versus 3-option multiple choice sets elicitation format: S2pr – M3pr;

5 Conclusion

Throughout the ages, time and value have been classical topics in human thinking. Time and value are highly related concepts as both influence human behaviour. However, only a few environmental economic studies concerned with non-market valuation have attempted to link these two concepts.

One of the first economists who analysed this link was Samuelson (1937) by looking at inter-temporal choice behaviour. According to his discounted-utility model, individuals make trade-offs between current and future consumption in order to maximize their lifetime utility (equalizing marginal utility across time). These trade-offs are guided by a personal marginal rate of time preferences (personal discount rate). Krutilla and Cicchetti (1972) investigated the relationship between value volatility and relative scarcity of natural resources. They argued that many natural resources are depletable in nature. That is, proceeding environmental

[3] Assuming consequentiality as defined by Carson and Groves (2007)

[4] A single binary choice elicitation format is assumed to be potentially incentive compatible, whereas multiple binary choice and single n(3) choice elicitation formats are assumed to be not potentially incentive compatible.

deterioration will reduce their availability. Both the absence of close substitutes and the depletability of many natural resources inhibit an increase in supply. Consequently, over time, decreasing availability of and/ or increasing demand for such natural resources will increase their scarcity value, and thus, in turn may increase their marginal value to consumers. Other factors, which are assumed to influence value change across time are income and relative prices of composite goods, price and availability of close substitutes, quantitative and qualitative characteristics of environmental commodities, socio-demographics, unfamiliarity with the environmental commodity and the choice task, and reference dependency.

Economists have been engaged in the development and application of methods to estimate non-market environmental values in monetary terms for over 30 years. This history of valuation provides an opportunity to make comparisons of value estimates and the performance of valuation techniques over time.

The goal of this research is to make such comparisons with reference to the existence benefits of a protected natural area. In 1978, the first contingent valuation method application undertaken in Australia was focused on Nadgee Nature Reserve on the far south coast of New South Wales. The intention is to replicate that study using both the original questionnaire and sampling techniques of the contingent valuation method (CVM) used in 1978 as well as state of the art non-market valuation tools (choice experiments - CE). The comparison over time afforded by this replication will provide insights into (1) the extent and direction of changes in environmental values due to changes on both the demand and the supply side, and (2) the impact on value estimates through methodological evolution, with a focus on incentive compatibility issues related to the influence of differing elicitation formats and the application of a provision rule. Such insights will be supportive of improved efficiency in resource allocation.

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