

Analysis

Ecosystem Service Arguments Enhance Public Support for Environmental Protection - But Beware of the Numbers!



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ABSTRACT

The trend in the discourse around environmental protection towards arguments based on ecosystem services and monetary valuation has prompted considerable controversy among academics and practitioners concerned with conservation. This paper informs the debate by exploring which arguments are most effective in garnering support for environmental protection. In a survey-based online experiment, participants stated their level of (dis)approval of a large-scale hydropower dam project after being presented with various kinds of arguments and information about the environmental impacts. The results show that ecosystem service arguments reduced levels of approval of the dam significantly (i.e. they increased support for environmental protection). However, moral-ecological arguments for protecting the environment proved even more effective, while a combination of both types of arguments reduced the dam approval ratings the most. Including a cost-benefit analysis (CBA) with monetary valuation of the costs of losing ecosystem services altered dam approval upwards or downwards, depending on the outcome of the CBA. The approval rates of males, of older participants and of politically right-wing participants were particularly sensitive to the outcomes of monetary valuation. More research is needed to understand the short and long term influence of different environmental discourses on peoples' judgments and levels of environmental concern.

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1. Introduction

All over the world, proposals for new infrastructure projects, agricultural expansion or resource extraction often prompt fierce public debate, reflecting a major global challenge of striking a balance between economic progress and protecting the natural environment (Krausmann et al., 2009; Rockström et al., 2009). Is it desirable, for example, to build a dam that provides electricity to millions but involves flooding a natural ecosystem? In view of these struggles, governmental agencies and non-governmental environmental organizations are keen to understand the factors that shape public concern for environmental protection in order, among other things, to develop effective awareness-raising campaigns (see, e.g., EC, 2008, Crompton and Kasser, 2009).

Since at least the early 20th century, various justifications for environmental protection have been brought forward (Blandin, 2009). In the public discourse, arguments based on a duty to preserve species and natural ecosystems, grounded in a recognition of their intrinsic value,¹ dominated for a long time. More recently, arguments emphasizing the ways nature renders 'ecosystem service' benefits to human well-being have taken over (De Groot et al., 2002; Norgaard, 2010; Mace, 2014; Kareiva, 2014). The ecosystem service discourse is supported by a rapidly growing body of research that focuses on better understanding the processes by which nature has value for human well-being, including carbon sequestration, flood protection, sediment reduction, pollination, and tourism (Doak et al., 2014). An ecosystem service approach to evaluating and communicating environmental impacts can be operationalized in many ways. For instance, relevant ecosystem services may be evaluated and communicated in qualitative - or at least non-monetary - terms, potentially supported by quantitative biophysical measures such as the carbon balance, trends in the loss of pollinators, or hydrological data (Christie et al., 2012). Recent methodological

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¹ For want of more precise nomenclature, such arguments will be referred to in the following as "moral-ecological" arguments.

advances include numerous participatory assessment approaches and tools to better integrate the social and cultural values of biodiversity (Chan et al., 2012; Scholte et al., 2015). Despite these advances, practical applications that focus on ecosystem service arguments typically involve a monetary valuation of the costs and benefits from changing ecosystem services (Balmford et al., 2002; TEEB, 2010; Marvier, 2014; Costanza et al., 2014) and promote the inclusion of these monetary values within an ‘environment-inclusive’ cost-benefit analysis² (CBA). CBA has a long tradition as a decision support tool for the evaluation of environmental impacts, in particular in the US (Arrow et al., 1996; Pearce et al., 2006), although its use has always been controversial (Hanley and Spash, 1993). In spite of significant advances in methods and tools to calculate the monetary values of ecosystem services (Fisher et al., 2008; Christie et al., 2012), a range of concerns remain about the philosophical foundations of CBA and ecosystem service valuation, and about their methodological limitations and shortcomings (Wegner and Pascual, 2011; Jax et al., 2013).

The trend towards an environmental discourse based on ecosystem service arguments has led to controversy not only in academic circles but also in the realm of environmental policy making and among NGOs. Various critiques of the ecosystem service approach have been formulated including, for example, a rejection of its anthropocentric and instrumental view of nature conservation on philosophical and ideological grounds (O’Neill, 2001; *The Economist*, 2002; McCauley, 2006; Spash, 2008; Redford and Adams, 2009; Soule, 2013; Kareiva, 2014; Fisher and Brown, 2014). The debate also encompasses diverse views about the effectiveness of such an approach in heightening public concern, which is the focus of this paper. Proponents of the ecosystem service approach argue that “broadening the message to include benefits for people will not lose those who value nature for its own sake but will gain additional supporters” (Marvier and Wong, 2012). Further, Costanza et al. (2014) write that “[monetary valuation] can help to raise awareness of the importance of ecosystem services to society and serve as a powerful and essential communication tool”. Opponents of the ecosystem service approach, on the other hand, argue that “protection of the environment is best served by [...] defending environmental goals in terms of established ethical, aesthetic, political and scientific standards” (O’Neill, 2001), even fearing that “economic arguments about services valued by humans will overwrite and outweigh noneconomic justifications for conservation” (Redford and Adams, 2009) and that “monetary valuation’s framing and crowding effects can decrease (demand and support for) environmental protection” (Neuteleers and Engelen, 2015). It has been pointed out, however, that these arguments require more empirical evidence (Skroch and Lopez-Hoffman, 2010; Adams and Redford, 2010).

It is indeed possible that arguing for the importance of environmental protection in terms of ecosystem services rather than moral duties and intrinsic ecological value might not be as effective in altering public opinion. Ample evidence from literature in psychology and linguistics suggests that the frame in which a message is presented matters for opinion formation and decision making in the context of environmental protection (Tversky and Kahneman, 1981; Liberman et al., 2004; Hsee and Rottenstreich, 2004; Lakoff, 2010; Satterfield et al., 2000). Experimental studies have shown that framing environmental conservation in moral terms can be more effective than doing so in terms of monetary self-interest if the aim is to increase personal pro-environment behaviour, such as recycling (Evans et al., 2013), checking tyre pressure (Bolderdijk et al., 2013), and saving energy (Steinhorst et al., 2015). Other studies have investigated the drivers of public support for climate change policies (Drews and van den Bergh, 2015; Bain et al., 2016). Bernauer and McGrath (2016) suggest that arguments based on “co-benefits” (economic, health) do not fare any better in enhancing support compared to justifications based on “direct climate risks”. Thus

far, little empirical work has been done on the influence of the type of discourse on public concern for the natural environment. Marvier and Wong (2012) present data from two national surveys in the US that asked participants to state their preferences among different arguments for nature conservation. The population was evenly divided between favouring arguments based on the intrinsic value of nature and arguments based on ecosystem services. Crompton et al. (2014) find that intrinsic primes focusing on people’s inherent appreciation of nature fared better than economic primes in prompting intentions to offer non-financial support to a nature conservation organization, but that these did not increase intentions to offer financial support. Further empirical evaluation of the effectiveness of different arguments has hitherto been lacking.

This paper presents the results of a survey-embedded experimental study that provides a controlled testing ground. We use the case of a hydropower project in the Amazon to explore the effects of a discourse using ecosystem service arguments on people’s level of support for environmental protection, and how they compare to presenting moral-ecological arguments. We test the effect of a qualitative presentation of the ecosystem services affected by dam construction on people’s support for building the dam versus support for environmental protection. At the same time, we investigate people’s sensitivity to including a monetary valuation of ecosystem services within a CBA.

2. Method and Materials

2.1. Test Case

We used the Bala hydropower project in the Bolivian Amazon as a decision context to empirically assess the effectiveness of different arguments in shaping people’s support for environmental protection. The Bala dam construction has been considered several times since the 1990s, recently being spurred on by Brazilian demand for energy imports. In 2016 discussions about the Bala dam are ongoing. In the survey, participants indicated their (dis)approval of the dam project after exposure to different types of arguments for environmental protection. The participants were not from Latin America, so they did not have a personal stake in the specific decision context. It is true that public opinion expressed within the same jurisdiction as the project concerned is usually decisive in influencing policy decisions. Personal stakes can complicate the analysis, however: they may generate strategic responses or self-serving biases (Babcock and Loewenstein, 1997; Rode and Le Menestrel, 2011). In our attempt to set an empirical benchmark to investigate the effectiveness of environmental discourses, we chose to avoid a setting involving strong personal stakes.

2.2. Participants

The online survey was programmed in Qualtrics (www.qualtrics.com) and participants were recruited via the Prolific Academic platform (www.prolific.ac, a service providing online participant recruitment for academic studies). A screening filter ensured they were at least 16 years old and had high English language proficiency. In line with the procedures of the recruiting platform, participants were told in advance that they would receive a lump sum payment of GBP 4.00 for an average duration of 45 min. A total of 383 participants finished the study, but the data of six participants were excluded from the analysis because they finished the study in an unrealistically fast time or provided clearly inconsistent and nonsensical answers. The remaining 377 participants were between the ages of 17 and 72 (mean 31.3); 200 (53%) were male and 177 (47%) female. They had over 20 different nationalities, but the vast majority was from the UK (193) and the US (91).

² In the following, “environment-inclusive cost-benefit analysis” will be used to designate a CBA that takes account of the monetary value of ecosystem services.

Table 1
Overview of the experimental procedure and design.

Phase	T ₀	T _{ES}	T _{ES-}	T _{ES+}	T _M	T _{MES}	T _{MES-}	T _{MES+}	
1 Basic information	Participants receive information about the Bala dam case in the Bolivian Amazon (location, rationale for hydropower, necessity for a reservoir that would flood parts of a protected area) and a standard CBA showing that dam construction makes sense according to a narrow view of economic values (revenue from energy exports to Brazil and from new employment exceeds construction costs).								
2 Treatment manipulation	Standard Economics: NO further information	Ecosystem services arguments for environmental protection	Environmental costs of losing ecosystem services described in qualitative terms.	Environment-inclusive CBA argues against the dam.	Environment-inclusive CBA argues for the dam.	Moral-ecological arguments for environmental protection, based on ecological value, duties, rights, people's relationship to the land.	Combination of ecosystem-services and moral-ecological arguments	Environmental costs of losing ecosystem services described in qualitative terms.	Environment-inclusive CBA argues against the dam.
3 Dependent measure	Elicitation of support for environmental protection measured by rate of (dis)approval of the dam, within hypothetical recommendations to the Bolivian government								
4 Post-questionnaire	Elicitation of personal characteristics (including Environmental Worldview Scale)								
5 Debrief	Explanation that some of the information had been modified for the purpose of the study								

2.3. Procedure and Measures

Table 1 summarizes the experimental procedure. In a first phase, all the participants received background information on the Bala hydro-power dam proposal, including the economic rationale for exporting energy to Brazil, the location of the dam and its reservoir. The instructions also indicated that, if construction actually went ahead, the reservoir would flood parts of two protected areas. The participants also saw a standard cost-benefit analysis (CBA) implying that dam construction makes sense according to a narrow view of economic value: the revenue expected from energy exports to Brazil and from newly generated employment would exceed construction costs. In a second phase, the participants were allocated at random to one of eight experimental treatments. In each treatment condition, the participants were presented with general arguments for environmental protection and with specific information on the environmental impact of the Bala dam. The differences between the conditions are clarified in Section 2.4. In a third phase, all the participants were asked to imagine being part of an international advisory committee and to give a recommendation to the Bolivian government, on a 7-point Likert scale ranging from “strongly against” (1) to “strongly in favour” (7) of dam construction. Those who chose the neutral position were further asked whether they were truly neutral or whether they did not want to take a position; the latter were excluded from the analysis as protest bids (Fiske and Tetlock, 1997). All the participants then completed questionnaires corresponding to the Environmental Worldview Scale (Nooney et al., 2003), and they provided personal data (gender, age, professional background, nationality, previous experience with hydropower, political orientation, whether active in an environmental organization). On a “debriefing” page, the participants were told that some pieces of information had been modified for the purpose of the study.

2.4. Experimental Treatments and Manipulations

We constructed eight experimental treatments (see Table 1). In a baseline treatment (T₀) participants were given no further information beyond the basic context information and the narrow set of economic costs and benefits that all the participants received in the first phase. In the other seven treatments, further arguments and specific information on environmental impacts were given. In the “moral-ecological” treatment (T_M), information and arguments for environmental protection were based on the intrinsic ecological value of species and ecosystems in the affected area, the duty to protect the rights of nature, and of local people's relationship to the land. In three “ecosystem services” treatments (T_{ES}, T_{ES+}, and T_{ES-}), arguments for environmental protection were based on the loss of ecosystem services provided by the

natural environment around the construction site. In three combination treatments (T_{MES}, T_{MES+}, and T_{MES-}) the information and arguments based on the moral-ecological and the ecosystem service arguments were both presented, one after the other.

The information material in the treatment groups first included arguments for environmental protection in general terms, followed by specific information on the environmental impacts of the Bala dam. The material was either taken directly from the Bala dam proposal or adapted to fit the Bala case. It was selected to closely represent the environmental discourse(s) as observed in current policy debates, the aim being to achieve a high degree of ecological validity for the treatment manipulations (Roe and Just, 2009). The instructions necessarily reflected stylized and idiosyncratic forms of communication based on moral-ecological or ecosystem service arguments. For each of the two types of discourse, the manipulation involved presenting general arguments presented in the form of text and videos, but also information presented in types and formats specific to each type of discourse (e.g. narratives, species lists, numerical values, etc.). An inherent drawback of this experimental design is that it is not possible to identify which of the different dimensions in the treatment manipulations is or are the exact cause of an effect on the dependent variable.

In the treatments that used moral-ecological arguments, the general arguments involved a paragraph of text and quotes about the view of nature formulated in current political discourse in Bolivia (focusing on the idea of “Mother Earth” and on people's rights to live among unspoiled Nature) as well as a video by RightsOfNature (2012), arguing that the Earth has rights and needs to be protected. The specific information on the impacts of the Bala dam focused first on the ecological value of the affected area, specifying IUCN red-listed plant and animal species (adapted from UNESCO, 2015). In addition, a letter from the affected indigenous communities was presented, stating their historical rights to and connection with the natural environment of the Bala basin (adapted from InternationalRivers, 2010 on a dam proposal in Brazil).

In the treatments with ecosystem service arguments, the general arguments consisted of quotes about the necessity to include the benefits provided by nature in economic analysis (e.g. by Achim Steiner from UNEP) and a video by Pavan Sukhdev (2010) on the problems of a global economy that ignores the economic value of nature. The specific information presented an assessment of important ecosystem services affected by the Bala dam, which was said to be commissioned by the Bolivian government. In treatments T_{ES} and T_{MES}, the assessment merely presented a list and qualitative explanations of the costs of losing the ecosystem services (based on Reid, 1999): additional greenhouse gas emissions, lost income from tourism, lost use value of non-timber forest products, and lost ‘existence value’ of the natural environment. The (–)

and (+) treatments further assigned monetary estimates to the environmental costs and described the monetary valuation methods used to calculate the monetary values. These costs were added to the economic costs and benefits presented in the basic information, leading to an environment-inclusive cost-benefit analysis (CBA) (see Appendix 1). The numerical values of ecosystem service costs were modified such that the CBA results in the (–) treatments argued against construction of the dam (i.e. costs of US\$ 3673 m > benefits of US\$ 3269 m), while in the (+) treatments the CBA results argued for the dam (i.e. costs of US\$ 2973 m < benefits of US\$ 3269 m).

In order to ensure that participants had paid attention to and understood the material presented, we asked them to write down four reasons for protecting the natural environment in the project area to which they had been exposed, to name the source of their information (e.g. video x or text by y) and to rate how relevant they personally found each of the reasons presented.

2.5. Analysis and Statistical Methods

For the quantitative analysis of results, we assigned values from –3 to +3 to the Likert scale data, where +3 represents ‘strongly in favour of dam construction’. In the results section, we analysed first whether there was an overall effect of the treatments on participants’ approval of dam construction, using a non-parametric Kruskal–Wallis H test. Subsequently, the non-parametric Mann–Whitney U Test was used to test for the statistical significance of the pairwise differences in stated dam approval between treatments. We analysed the data according to the following questions:

- What is the effect of an ecosystem service approach, compared to the baseline treatment?
- How does the ecosystem service approach compare to moral-ecological arguments and to a combination of both approaches? What are the marginal effects of adding one approach to the other?
- What is the effect of including an environment-inclusive CBA with monetary valuation of ecosystem services?

To rule out biases due to the influence of participants’ personal characteristics, we used the Kruskal–Wallis H test to test for overall differences in sample characteristics between treatments. In addition, we ran ordinary least squares regressions with dummy variables for the five treatments in order to test for the influence of personal characteristics on stated approval of the dam. Finally, we explored whether the participants’ sensitivity to the environmental discourses differed

depending on their gender, age, political orientation, previous experience with hydropower, and their environmental world view score. For each of these variables, we split the sample into two subsamples – with median splits for the four numerical variables – and then compared the mean values of dam approval rates across treatments. Where deviating patterns emerged, the Kruskal–Wallis H test and the Mann–Whitney U Test were used to test for statistical significance.

3. Results

Five observations were excluded as protest votes, leaving 372 valid observations (between 38 and 50 observations for each of the eight treatments).

The Kruskal–Wallis H test indicated a different distribution of approval ratings, both across all eight treatments (Chi-square = 99.3, $p < 0.01$) and across the seven environmental discourse treatments without T_0 (Chi-square = 34.6, $p < 0.01$). Fig. 1 shows the mean values of dam approval ratings in the eight treatments and the 95% confidence intervals.

Ecosystem service arguments strongly reduced approval of the Bala dam (i.e. they increased support for environmental protection) compared to the baseline treatment T_0 – with a qualitative presentation of the ecosystem services affected (T_{ES} vs. T_0 : $U = -5.59$, $p < 0.01$), when the results of the environment-inclusive CBA argued against the dam (T_{ES-} vs. T_0 : $U = -6.14$, $p < 0.01$), and when the CBA results argued for the dam (T_{ES+} vs. T_0 : $U = -4.42$, $p < 0.01$). Presenting moral-ecological arguments only (T_M) also significantly reduced approval for dam construction compared to the baseline treatment (T_M vs. T_0 : $U = -6.80$, $p < 0.01$). Moral-ecological arguments reduced rates of dam approval significantly more than an ecosystem service approach based on qualitative description (T_M vs. T_{ES} : $U = -2.55$, $p = 0.01$) and compared to the situation in which the environment-inclusive CBA argued for the dam (T_M vs. T_{ES+} : $U = -3.09$, $p < 0.01$). There was no statistically significant difference between approval rates with moral-ecological arguments and an ecosystem service approach in which the CBA argued against the dam (T_M vs. T_{ES-} : $U = -1.30$, $p = 0.19$). The lowest approval rates were achieved when both discourses were combined, with almost identical mean approval rates in the case of a qualitative presentation of ecosystem services (T_{MES-} vs. T_0 : $U = -7.24$, $p < 0.01$) and the CBA arguing against the dam (T_{MES-} vs. T_0 : $U = -0.96$, $p < 0.01$). A combined discourse with a CBA arguing for the dam still significantly reduced approval rates with respect to the baseline treatment (T_{MES+} vs. T_0 : $U = -5.60$, $p < 0.01$).

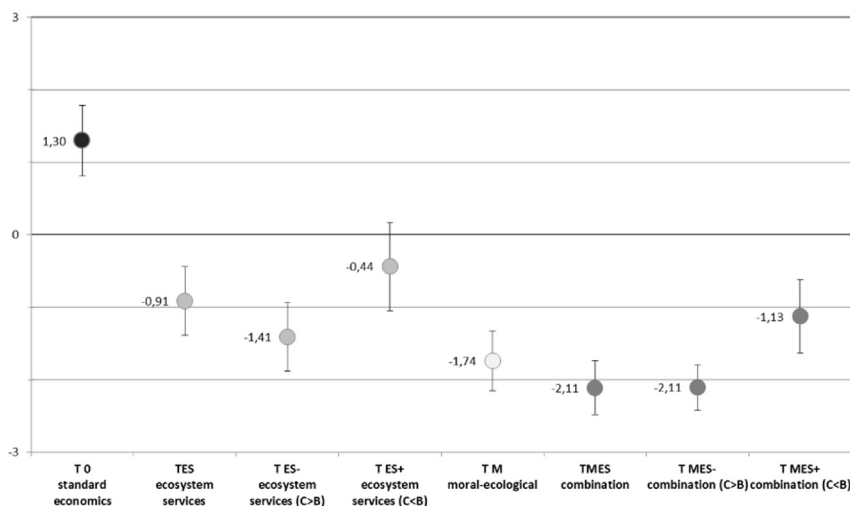


Fig. 1. The figure shows the mean of the stated rate of dam approval in the eight treatments, with bars for the 95% confidence intervals. The figure shows that all environmental discourses lower rates of approval for the dam, but to different degrees.

The marginal effect of adding ecosystem services arguments to moral-ecological arguments was mixed: adding ecosystem services arguments lowered dam approval slightly (but non-significantly) when presented in qualitative terms (T_M vs. T_{MES} : $U = -1.51$, $p = 0.13$) and when the CBA argued against the dam (T_M vs. T_{MES-} : $U = -0.89$, $p = 0.38$); however, it increased dam approval when the CBA argued for the dam (T_M vs. T_{MES+} : $U = -1.87$, $p = 0.06$). The marginal effect of adding moral-ecological arguments to ecosystem services arguments is clearer: it significantly reduced dam approval for the case of a qualitative presentation of ecosystem services (T_{ES} vs. T_{MES} : $U = -3.94$, $p < 0.01$) and for the case of a CBA that argues against the dam (T_{ES-} and T_{MES-} : $U = -2.04$, $p = 0.04$). For the case of a CBA arguing for the dam it also reduced dam approval, but the difference was not statistically significant (T_{ES+} vs. T_{MES+} : $U = -1.46$, $p = 0.15$).

The influence of numerical values on the costs of losing ecosystem services within an environment-inclusive CBA revealed a slightly different pattern when ecosystem services arguments were presented in isolation and when they were presented in combination with moral-ecological arguments. When presented in isolation, assigning numerical values affected dam approval in the expected ways, but the differences between T_{ES} and T_{ES-} ($U = -1.35$, $p = 0.18$) as well as between T_{ES} and T_{ES+} ($U = -1.06$, $p = 0.29$) were not statistically significant. However, approval for dam construction was significantly lower in T_{ES-} compared to T_{ES+} ($U = -2.11$, $p = 0.04$). When ecosystem service arguments were combined with moral-ecological arguments, assigning numerical values increased dam approval when the CBA argues for the dam (T_{MES} vs. T_{MES+} : $U = -3.25$, $p \leq 0.01$), but there was no effect when the CBA argues against the dam (T_{MES} vs. T_{MES-} : $U = -0.60$, $p = 0.55$). The difference in dam approval between T_{MES-} and T_{MES+} was statistically significant ($U = -0.264$, $p = 0.01$).

The Kruskal–Wallis H test reveals that the participant population did not differ significantly across treatments in terms of age, gender, score on the environmental worldview scale, and self-stated political orientation. A marginally significant difference was found for the variable “previous experience with hydropower” (Chi-square = 13.8, $p = 0.05$), driven by significantly lower previous experience in T_{ES-} .

The ordinary least squares regression analysis shows again that all the environmental discourses lowered rates of dam approval significantly compared to the control treatment (see Table 2). Moreover, it shows that a more right-wing political orientation is associated with higher dam approval ($t = 3.55$, $p < 0.01$) and that the men tended to have significantly higher dam approval ratings than the women ($t = 2.16$, $p = 0.03$). Age, previous experience with hydropower, and the score on the environmental world view scale had no significant influence on the rate of dam approval.

Table 2
Ordinary least squares regression results to explain stated rate of dam approval.

Independent variable	Coef.	t-Statistic
T_{ES}	-2.07	(-6.87)**
T_{ES-}	-2.61	(-8.24)**
T_{ES+}	-1.83	(-5.51)**
T_M	-3.01	(-9.50)**
T_{MES}	-3.29	(-10.27)**
T_{MES-}	-3.31	(-9.92)**
T_{MES+}	-2.37	(-7.54)**
Political orientation	0.21	(3.55)**
Gender (male = 1)	0.37	(2.16)*
Age	-0.01	(-1.18)
Environm. worldview score	-0.01	(-0.76)
Experience w. hydropower	-0.03	(-0.46)
Constant	1.17	(1.63)+
Observations	372	
R-squared	0.35	
Adjusted R-squared	0.33	

+ Significant at 10%.
* Significant at 5%.
** Significant at 1%.

In the exploratory analysis of dam approval ratings across treatments for the selected sub-samples, we dropped the variable “previous experience with hydro-power” from the analysis due to insufficient observations in two cells. For participants with low vs. high score on the environmental world view scale, the two sub-samples revealed an almost identical pattern. Some differences were found for the remaining three personal characteristics: male vs. female participants, young vs. old participants, and participants with left-wing vs. right-wing political orientation (illustrated in Fig. 2). We obtained satisfactory numbers of observations per treatment for gender (17 to 32) and age (17 to 33), slightly less so for political orientation (13 to 33).

For the sub-samples divided by gender (see top of Fig. 2), the data show that the women were insensitive to the numerical results of ecosystem services costings when ecosystem service arguments were presented in isolation: female approval ratings remained stable across the three treatments T_{ES} , T_{ES-} , and T_{ES+} (Kruskal–Wallis H test: Chi

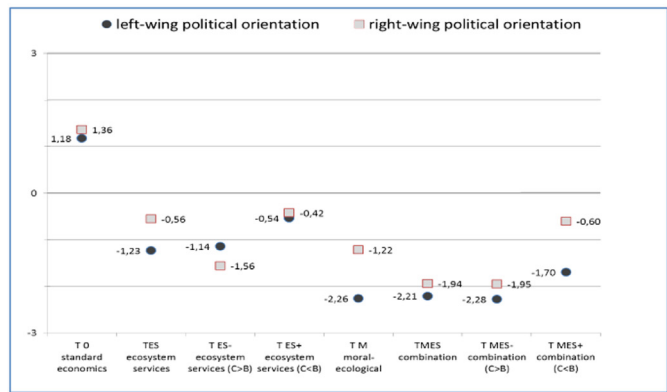
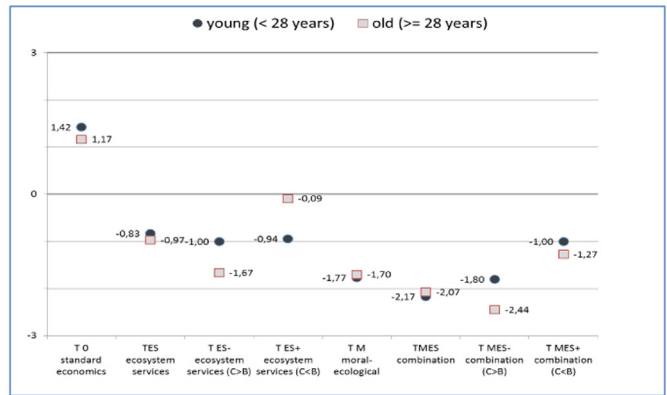
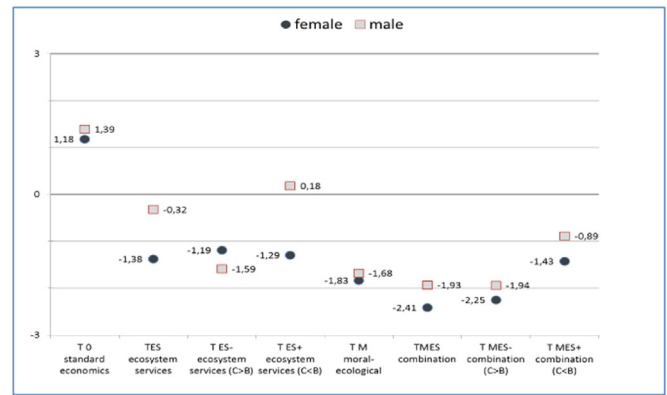


Fig. 2. The figure shows the mean of the stated level of dam approval in the eight treatments, separated for selected personal characteristics: male vs. female participants (top), young vs. old participants (middle), and participants with left-wing vs. right-wing political orientation (bottom).

square = 0.02, $p = 0.99$), as opposed to significant sensitivity among male respondents (Chi square = 9.16, $p = 0.01$). The differences in the pattern between male and female participants were less pronounced when moral-ecological arguments were presented, either in isolation (T_M) or alongside the ecosystem services arguments (T_{MES-} vs. T_{MES+}).

A similar difference in sensitivity to numerical outcomes of ecosystem service valuation was observed for a sample split into two age groups (middle of Fig. 2). Across the treatments T_{ES} , T_{ES-} , and T_{ES+} in which ecosystem service arguments were presented in isolation, the ratings of participants older than 28 years differed significantly (Chi square = 7.94, $p = 0.02$), whereas they were rather stable among the younger participants (Chi square = 0.19, $p = 0.91$). Again, the differences between sub-samples were less pronounced in the treatments that involved moral-ecological arguments.

The sub-samples sorted along political orientation are illustrated at the bottom of Fig. 2. The data of the treatments where ecosystem service arguments were presented in isolation (T_{ES} , T_{ES-} , and T_{ES+}) reveal that only participants who considered themselves right wing were significantly sensitive to the outcomes of ecosystem service valuation (right wing: Chi-square = 5.94, $p = 0.05$; left-wing: Chi-square = 0.75, $p = 0.69$). Moreover, in comparison to the left-wing participants, the right-wing participants tended to be significantly more responsive to an environment-inclusive CBA in favour of the dam in T_{MES+} ($U = -2.02$, $p = 0.04$; sample sizes of 23 vs. 21 observations) and they were less responsive to moral-ecological arguments against dam construction in T_M ($U = -1.82$, $p = 0.07$; sample sizes of 23 vs. 23).

4. Discussion

4.1. Effectiveness of Ecosystem Service Arguments and Moral-ecological Arguments

Our study provides an empirical benchmark for testing the effectiveness of different environmental discourses in garnering public support for protection of the natural environment. Specifically, we were interested in how the ecosystem service approach, which has gained prominence over the last few decades, would fare. The results suggest that ecosystem service arguments can enhance public support for environmental protection. It additionally shows, however, that moral-ecological arguments are highly effective; in the present setting, they are even more effective than the arguments based on ecosystem services. The highest level of support for environmental protection is achieved by presenting ecosystem services arguments and moral-ecological arguments in combination. While the marginal effect of the moral-ecological discourse over and above an ecosystem service discourse is clearly positive, the marginal effect of the ecosystem service approach over and above a moral-ecological argument is weaker and depends on the way the costs of losing ecosystem services are presented. In fact, adding ecosystem service arguments can backfire if the numerical result of an environment-inclusive CBA argues against environmental protection (see also further discussion below). Notably, when both types of arguments are presented side by side, it does not matter whether the costs of losing ecosystem services are described in qualitative terms or whether an environment-inclusive CBA explicitly argues against the dam by showing numerically that the overall costs of constructing the dam outweigh the benefits. Hence, although our study can serve as counter-evidence against some of the criticism of an ecosystem service approach, one key conclusion is that campaigns for environmental causes will be most effective in garnering public support when they rely on both types of arguments in combination.

By demonstrating that a combination of arguments is most effective in garnering support for environmental protection, our study supports the current evolution of the ecosystem services concept towards a more holistic approach and away from a focus on monetary valuation (Chan et al., 2012). It also highlights the importance of conceptual

work that clarifies the environmental value dimensions beyond ecosystem services (Jax et al., 2013; Chan et al., 2016) and of developing integrated assessment methods that combine economic, ecological, social, and moral values for the evaluation of (positive and negative) impacts (Saarikoskia et al., 2016).

4.2. Sensitivity of Public Opinion to the Result of an Environment-inclusive CBA

To identify the effect of including monetary valuation within an ecosystem service approach, we included treatments in which the costs of losing ecosystem services were presented in qualitative terms, and treatments in which an environment-inclusive CBA that assigns monetary values to losses in ecosystem services argues either against or in favour of dam construction. Our results show that including numerical results within an economic cost-benefit analysis can significantly alter people's support for environmental protection. This tendency is most pronounced when the ecosystem service arguments are presented in isolation. Interestingly, the sensitivity to monetary valuation outcomes seems to depend on personal characteristics. Our data suggests that when the environmental discourse focuses on ecosystem service arguments, then men, older people, and those who consider themselves as politically right-wing are particularly responsive to the results of an environment-inclusive CBA.

Now, whether the observed sensitivity to numerical values can be considered high or low is in the eye of the beholder. Proponents of CBA may regard it as strikingly low, and might be puzzled in particular why women or young people do not seem to consider the numbers in their evaluation of the dam proposal. Also, it may come as a surprise that compared to the baseline treatment an ecosystem service discourse reduces dam approval even when the environment-inclusive CBA argues for the dam. We conjecture that the dominant effect of an ecosystem service approach is to make participants aware of environmental issues they had not considered in the first place. Thus, the ecosystem service approach triggers stronger opposition against the dam, regardless of the outcome of the CBA.

Critics of monetary valuation and of a focus on CBAs may argue that the reliance on numerical outcomes is still too high; and they may be glad to see that at least women, young people and those with left-wing political orientation seem unimpressed by the numbers. Results of monetary ecosystem service valuation depend on a variety of decisions made in the valuation process, including which ecosystem services to assess, which valuation methods to use, how to collect the data, whether and how to account for uncertainty and irreversibility, or which discount rate to apply for aggregating values that accrue over time (Gowdy et al., 2010; Boithias et al., 2016). Consequently, the results "are heavily shaped and filtered by the perspectives and beliefs of those developing and undertaking them" (Berghöfer et al., 2016). To non-experts who are unaware of these technical challenges behind valuation studies, the results may convey an illusory completeness, precision, and determinacy (see e.g. O'Neill and Spash, 2000; Norgaard, 2010; Wegner and Pascual, 2011). Moreover, when environment-inclusive CBAs are embedded in a political process (Laurans and Mermet, 2014) – as part of the impact assessment for a project proposal, for instance – they are frequently subject to a struggle between conflicting interests. It is reasonable to expect that environmental organizations with an advocacy agenda have an interest in highlighting the high costs of environmental destruction. Project proponents such as construction companies have an interest – and possibly strong economic incentives – to show low environmental costs, both to increase the chances that the project will be accepted and to reduce potential compensation payments (Lim, 1985; Rode et al., 2015). Monbiot (2014) has raised the concern that "the accounting exercise would be used as a weapon by the developers. The woods are worth £x, but by pure chance the road turns out to be worth £x + 1." Our results suggest that this "weapon"

can potentially be effective and substantially reduce support for environmental protection, at least within some parts of the population.

In any case, the sensitivity of public opinion to the outcomes of an environment-inclusive CBA deserves further empirical investigation. Ackerman and Heinzerling (2002) note the tendency to base judgments disproportionately on the numerical results, writing that “no matter how many times the EPA, for example, says that one of its rules will produce many benefits – like the prevention of illness or the protection of ecosystems – that cannot be quantified, the non-quantitative aspects of its analyses are almost invariably ignored in public discussions of its policies”. Our results suggest that this effect is not necessarily systematic across the entire population (men and women may react differently, for instance), and that it could be reduced by using integrated assessment methods that combine monetary and non-monetary economic and other moral (ecological and social) values. It would also be interesting to assess the extent to which lay peoples’ judgments incorporate an awareness of vested interests of the party that commissions a study (e.g. an NGO vs. a construction company) and whether this influences their confidence in the numerical results of an analysis. For the present study, participants were told that the environment-inclusive CBA was commissioned by the Bolivian government – supposedly interested in an unbiased assessment.

4.3. Generalizability

Results from a survey-embedded experiment with hypothetical recommendations on a particular case example raise obvious questions concerning generalizability (Levitt and List, 2007, Falk and Heckman, 2009). First, many parameters of the present study are specific to the Bala dam example. For instance, we cannot rule out the possibility that moral-ecological arguments are particularly powerful for this case, characterized by environmental impacts in an area with extremely high biodiversity and home to indigenous people. The effects of different arguments could vary substantially for cases with other contextual parameters, including type or scope of environmental impacts as well as social and economic costs and benefits to affected groups, or the extent to which (human) rights or deeply held values are at stake. More extreme numerical results of the environment-inclusive CBA may have led to different approval rates, both against or in favour of dam construction. Or again, additional information on economic and social benefits of the dam may boost approval rates.

A second point is that the results of this study show short-term effects. We can neither ensure the long-term persistence of the observed effects, nor can we rule out the possibility that other effects may occur in the longer term. A ‘one-off’ experiment cannot represent the functioning of a lengthy socialization process or even a policy campaign or gradual change in the public discourse. For instance, we do not claim that our results can convincingly alleviate concerns in the nature conservation community that, over a longer period of time, a public discourse based on ecosystem service arguments may undermine the influence of moral-ecological arguments (Fisher and Brown, 2014).

Finally, there could be different effects of discourse type on particular groups of people. Our results indicate variations in the responsiveness to numerical results of the environment-inclusive CBA between male and female participants, between young and old participants, and between those with a left-wing and right-wing political orientation. At this point we can only speculate about the reasons for these effects. For instance, are women and people with left-wing political orientation more likely to intuit that the ecosystem services approach lacks critical value dimensions of environmental impact? Moreover, we mentioned at the outset that arguments may resonate differently with people who are directly involved or affected. Since indeed these people are most influential for actual policy decisions, we strongly encourage further research in this direction. There may also be cultural differences. Our sample in this study is biased towards participants from the Western developed world, with the majority of participants living in the US

and the UK. Environmental discourses could fare differently in non-western cultures. Finally, the ecosystem service discourse is frequently held to be particularly useful for making the case for environmental protection to people outside the environmental sphere (Daily et al., 2009; Gómez-Baggethun and Ruiz-Pérez, 2011). A large number of publications based on ecosystem services arguments is targeted specifically at business actors, and at public decision-makers who may feel professionally inclined to reach decisions predominantly in economic terms, such as treasury officials (WRI, 2008; WBCSD, 2011; TEEB, 2012). Follow-up research could explicitly test the resonance of different arguments to different groups. As a note of caution, however, targeted communication could face the practical challenge of remaining confined within specific (business or policy-making) circles and of not seeping into wider public debate (Crompton and Weinstein, 2015).

5. Conclusions

The present study was motivated by the heated controversy among environmentally concerned academics and practitioners in policy circles and NGOs regarding the recent trend towards arguments based on ecosystem services and monetary valuation. With respect to the effectiveness of different discourses, the results somewhat attenuate the controversy between proponents and opponents of the ecosystem services approach. The data suggest that arguments based on ecosystem services – and the specific information that goes with them – resonate with people and have persuasive power in communication and advocacy for environmental protection. Those interested in advocacy for the environment should beware of the divisive aspect of the controversy and keep in mind that their true adversaries are not the ones who use other arguments but rather those who promote a narrow view of economic progress without taking the environment into account. In a sense, the focus on standard economic arguments in our baseline treatment can be thought of as a campaign itself, namely, by those actors who disregard environmental concerns altogether. However, our results also show that other moral arguments, such as those based on a moral duty to preserve nature or on people’s connection to ancestral land, can also be very effective in garnering support for environmental protection. Ultimately, campaigns for environmental causes are best advised to rely on both in combination, and possibly pre-test effectiveness for particular cases and audiences. Our results also point to the importance of understanding the various dimensions of values behind support for environmental protection and of developing integrated assessment methods that combine economic, ecological, social, and moral values for the evaluation of (positive and negative) impacts, such as those related to the construction of a dam.

We emphasize that this study presents merely a snapshot of the persuasive power of different arguments and reveals nothing about the potential long-term effects of changing the environmental discourse. More empirical evidence is clearly needed in order to evaluate the impact of different discourses on public concern for the environment, in light of the extensive resources from governmental and non-governmental funding sources dedicated to environmental awareness raising and campaigning. This study can serve as an empirical benchmark, while further studies should test the robustness of our results in various directions. A wide range of different priming materials and for different contexts and case examples could be used, so that a more generalizable set of conclusions and recommendations can emerge (Crompton et al., 2014). Then, one could test whether the observed effects hold for different populations, including people with a direct personal stake, and whether the discourses also affect pro-environmental behaviour as opposed to hypothetical recommendations. Finally, it may be interesting to further investigate people’s sensitivity to the results of cost-benefit analyses, both with and without environmental costs and benefits. Given the prominence of CBA as a decision-support tool to guide public policy, the effects on public opinion – and also the potential to steer it – should be thoroughly understood.

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Appendix 1. Environment-inclusive CBA as Presented to Participants (Here: CBA Results Arguing Against Dam Construction as in Treatments T_{ES-} and T_{MES-})

The Bolivian government has commissioned an analysis of the economic costs and benefits of the dam proposal, which explicitly calculates social and environmental costs using state-of-the-art methods. The study shows that if environmental costs are considered, then the project is no longer economically viable.

Component	Description and method	Benefits (in million US \$)	Costs (in million US \$)
Construction costs	Estimation of capital cost for a 169 m tall concrete structure with 2460 MW of installed capacity (excluding costs for transmission lines, taxes, environmental mitigation, access roads, and opportunity costs).		2400
Income from construction	Calculates benefits for foreign construction contractors, cement suppliers, consulting firms, and local business serving workforce	343	
Earnings from electricity export	Profit estimates, assuming 2460 MW of installed capacity and capacity factor of 55% (100% would be 24 h per day, 365 days a year); electricity price predictions according to historical extrapolation	2302	
Agricultural production downstream	Agricultural benefits of the dam calculated with regard to compatibility of flood control and/or irrigation with power generation, agricultural potential with flood control and/or irrigation	626	
Navigation on river downstream and upstream	No reliable data was available to calculate potential navigation benefits from fluvial transport of cargo.	?	
Income for displaced indigenous people	Calculating the entire cash and non-cash incomes of the Tacana, Tsimane, Mosenen and other indigenous inhabitants of the area from farming, hunting and other harvest of forest and river products.		334
Income for neighbouring communities	Calculating lost tourism revenue and lost income from fisheries and timber due to inundations for reservoir (incl. much-visited Tuichi valley)		231
Greenhouse gas emissions	Calculation of net carbon balance: reservoir inundation with rotting of plants and trees causes emissions of carbon dioxide (CO ₂) and methane (CH ₄), but hydropower substitutes other sources of power (here: natural gas). The projected value of carbon emission reductions estimated at \$5.45 per ton of CO ₂ .		176
Existence value of natural environment	A survey-based technique with “existence-to-use factor” to account for uncertainty is used to calculate the value Bolivians place on the conservation of the Beni watershed.		532
Other environmental services	Due to lack of data, effects on other environmental services (erosion/sedimentation, biodiversity, etc.) could not be included in the analysis.		?
Result		3269	3673

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