The importance of deliberation in valuing ecosystem services in developing countries—Evidence from the Solomon Islands

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ABSTRACT

Monetary valuation of ecosystem services enables more accurate accounting of the environmental costs and benefits of policies, but this has rarely been applied in developing countries. In such contexts, there are particular methodological and epistemological challenges that require novel valuation methodologies. This paper introduces a new participatory, deliberative choice experiment approach conducted in the Solomon Islands. The research aimed to determine the value people placed on ecosystem services and whether participatory interventions to elicit deeper held values influenced the preferences expressed. Results found that the initial willingness to pay for a number of tropical forest ecosystem services amounted to 30% of household income. Following deliberative intervention exercises, key ecosystem services effectively became priceless as participants were unwilling to trade them off in the choice experiment scenarios, regardless of financial cost. The group based deliberative approach, combined with participatory interventions, also resulted in significant learning for participants. This included a more sophisticated view of ecological-cultural linkages, greater recognition of deeper held values, and greater awareness of the consequences of human actions for the environment. The use of a group-based participatory approach instead of a conventional individual survey helped to overcome many of the practical difficulties associated with valuation in developing countries. Given the impact of learning on valuation outcomes, participation and deliberation should be integrated into valuation of any complex good, both in developing and developed economies. However, such a methodology raises questions about how valuation can deal with unwillingness to trade-off key ecosystem services, which results in the breakdown of monetary valuation methods. Evaluation of the appropriateness of valuation processes and methodologies for assessing deeper held values and use of mixed-method approaches will be essential to ensure policies take into account the extent to which human life is dependent on ecosystem services.

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1. Introduction

There are increasing calls to estimate the value of ecosystem services in monetary terms (Carpenter et al., 2006, 2009; Sutherland et al., 2009; TEEB, 2010). However, research on the valuation of environmental goods and services is limited in developing countries, where much of the worlds biodiversity is located (Abaza and Rietbergen-McCracken, 1998; Christie et al., 2008; Fazey et al., 2005; Georgiou et al., 2006). This paper introduces a novel, participatory and deliberative approach to ecosystem service valuation in a developing country context, and discusses how deliberation may impact on the way environmental values are expressed.

Ecosystem services are the ecological processes and mechanisms that result in the conditions that fulfil and sustain human life (Daily, 1997). They can be categorised as provisioning services (e.g. food, fuel and fibre); regulating services (e.g. water purification, climate regulation); supporting services (e.g. photosynthesis); and cultural services (which provide spiritual, aesthetic, educational and recreational benefits) (Millennium Ecosystem Assessment, 2005). The contribution of ecosystem services to human wellbeing is enormous (Costanza et al., 1997; TEEB, 2010), but many ecosystem services are rarely traded directly or taken into consideration by economic markets. This has led to a lack of appreciation in policy-making of the critical role of ecosystem services in maintaining livelihoods and wellbeing.

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Over the last 10 years, there has been increasing interest in methods that can estimate the monetary value of ecosystem services so that the environmental costs and benefits of policies and land use change can be accounted for (Carpenter et al., 2006, 2009; Costanza et al., 1997; Sutherland et al., 2009; TEEB, 2010). In developing countries, the number of Payment for Ecosystem Services schemes is increasing, for example where water users pay to protect upstream water resources or farmers are paid to prevent erosion through afforestation. Such projects, if implemented as community-based schemes, have the potential to both conserve nature and improve the welfare of rural people (Tallis et al., 2008). However, relatively few environmental valuations have been conducted in countries with the least developed economies (Abaza and Rietbergen-McCracken, 1998; Christie et al., 2008; Fazey et al., 2005; Georgiou et al., 2006), despite such countries harbouring the majority of the world's biodiversity and the high dependence of people on those services for their survival and livelihoods (Christie et al., 2008).

There are many different tools for monetary valuation of ecosystem services. These include market-based, revealed preference and stated preference methods. An example of a market-based approach is replacement-cost analysis, where the cost of replacing certain ecosystem services by technology is calculated, e.g. replacing flood protection by mangroves with coastal defence works (Gunawardena and Rowan, 2005; Winpenny, 1991). However, the reliability of such methods is frequently undermined by limited or incomplete knowledge of ecological systems (Gunawardena and Rowan, 2005; McCauley and Mendes, 2006). Also, they fail to capture the total value of such environmental goods because many services, such as nutrient cycling (supporting service) or aesthetic values of ecosystems (cultural service) are not easily replaced by technology.

Another approach is to use revealed preference methods, where some kind of marketed good that has a monetary value, such as house prices or travel cost, is used as a proxy to reveal the value of a non-marketed good. It is nonetheless difficult to establish meaningful relationships between the price of a marketed good and all but a few ecosystem services. This is particularly the case where markets such as property and transport are underdeveloped, as in many rural areas of developing countries (Christie et al., 2008).

The third approach is to use stated preference methods, which do not rely on existing markets. Instead, respondents are asked for their willingness to pay for environmental goods in a number of hypothetical scenarios. For example, participants may be asked for their willingness to pay for conservation programmes which improve biodiversity or a number of ecosystem services such as erosion protection, water availability or even 'ecosystem health' (Barkmann et al., 2007). Because a hypothetical market is simulated, there is the advantage that practically any good can be valued, including more subtle benefits of the environment such as those provided by cultural ecosystem services. Stated preference techniques are therefore likely to be the most suitable approach for monetary valuation of many ecosystem services in developing countries.

Nonetheless, a number of theoretical, methodological and epistemological challenges remain. These include low literacy rates and language barriers, especially as the techniques often rely on questionnaires (Christie et al., 2008; Whittington, 1998); difficulties in explaining hypothetical scenarios (Whittington, 1998); lack of local research capacity for implementing complex techniques (Alam, 2006; Christie et al., 2008; Whittington, 1998, 2002); and assumptions by researchers that participants have similar ways of thinking as they do (Alam, 2006; Christie et al., 2008; Lu et al., 1996).

Another challenge are the utilitarian assumptions associated with welfare-economic theory that form the basis of monetary valuation (Hanemann, 1984). These state that individuals seek to maximise their benefit and minimise their cost, that preferences are stable and transitive, and that utility curves are comparable between individuals (Kahneman, 1986; Urama and Hodge, 2006). Further, values may be lexicographic (meaning that they will not be traded-off), or individuals may express multiple values (Spash, 1998; Urama and Hodge, 2006). These issues can be challenging in any context. In many developing countries, however, people can have limited experience of market mechanisms if they rely on subsistence livelihoods. It is also not clear whether the assumptions underlying monetary valuation are upheld in these circumstances.

A key issue specific to stated preference methods is that they require respondents to take income constraints into account when stating preferences (Arrow et al., 1993). But when incomes are low and when people heavily rely on biodiversity for their livelihoods, the values expressed may not properly reflect the true value of an environmental good or service to their wellbeing (Abaza and Rietbergen-McCracken, 1998; Hearne, 1996). For example, for those dependent on subsistence farming, livelihoods will rely heavily on nutrient cycling services. However, their monetary income could be very low relative to what they believe is the actual value of nutrient cycling for maintaining wellbeing. If participants take their income restraints into account when asked what they would be willing to pay for this service, the full value of the services to them is not reflected. If they don't take income constraints into account, the assumption that people make choices as if they would actually have to pay the amount asked for in a hypothetical scenario, is violated.

A further, more general issue with stated preference techniques is the assumption that preferences are pre-formed. This has encouraged methods that use individual preference surveys. However, values are not pre-formed but 'constructed' through deliberation, and conventional methodological individualism fails both to capture collective values and to make use of dialogue in order to encourage reflection of what a persons' values truly are (Spash, 2008b).

Communal discussion for decision-making is particularly important for many indigenous societies, such as those with customary tenure systems, where land management and decision-making on environmental goods is decided upon at the clan or extended family level. Dialogue and deliberation that promote reflection are also a key component of participatory and action research methods, which are receiving increasing attention as research funders recognise the need to find new mechanisms for knowledge exchange and the co-production of knowledge (Armitage et al., 2008; Fazey et al., 2010; Folke et al., 2005; Pahl-Wostl, 2009). Such processes are important for enhancing learning at a range of scales, promoting adaptive capacity for responding to complex social and ecological issues, and for promoting more equitable decision-making (Armitage et al., 2008; Fazey et al., 2010; Folke et al., 2005; Pahl-Wostl, 2009).

Not surprisingly, introducing communal discussion and providing time for participants to think in valuation has been shown to improve the quality of decisions (Urama and Hodge, 2006; Whittington et al., 1992). This is particularly the case when research is conducted with those who have had poor access to education (Urama and Hodge, 2006). It has also been suggested that group dynamics draw out greater attention to less obvious values of the environment (Kaplowitz, 2001; Kaplowitz and Hoehn, 2001), which is important for indigenous societies that may have strong but subtle ties to the natural capital upon which they depend.

While there is certainly potential for integrating group discussion with stated preference techniques, it is not clear whether these methods and their underlying assumptions can be

applied for regions where monetary economies are weak, where there is strong dependence on biodiversity, and where collective decision-making is common. It is also not clear whether group deliberation changes the values expressed by participants and what this means for understanding the value people place on the services they rely on. There is a paucity of economic valuation studies from countries with developing economies where strong reliance on subsistence-based economies remains and there have been no previously published studies of social, group based decision-making in environmental choice experiments.

This paper therefore presents a case study from the Solomon Islands that develops and implements a participatory, group-based methodology to determine the value of ecosystem services. It uses stated preference techniques in a context where there is a strong emphasis on subsistence economies (Bourke et al., 2006) and where precedents have been set for participatory research methods that aim to promote capacity building and enhance local learning about complex social and ecological issues (Fazey et al., 2010). The expectation is that the participatory and deliberative methodology elicits deeper held values and more sophisticated points of view on environmental goods. Specifically, the research addresses three main questions: (1) What value do local people place on ecosystem services? (2) Does deliberation change the values expressed? And (3) What type of learning was encouraged by deliberation? After a presentation of methods and results, we discuss the implications of this research for valuing the environment in rural areas of developing countries.

2. Materials and methods

2.1. Study area

Kahua (162°0′E to 162°15′E, 10°25′S to 10°40′S), on the island of Makira, consists of Wards 12 and 13 of the Makira-Ulawa province of the Solomon Islands (SI) (Fig. 1). Average rainfall in Makira is 3600–4000 mm, with little annual variation (Allen et al., 2006), while rainfall may be significantly higher in the more mountainous Kahua region (Garonna et al., 2009). Topography consists of a narrow coastal area, steeply rising into rainforest-covered hills. Kahua has two large rivers, the Pihuru in the east and Warihito that marks the border of Kahua in the west. Leaf-hut villages are dotted along the coast and along these rivers. People largely subsist on banana and sweet potato, with copra and cocoa being produced for the market on a small scale (Allen et al., 2006; Fazey et al., 2007). There are no roads or electricity. Rough seas also limit transport.

The SI archipelago has extremely high species endemism and diversity (Lamoreux et al., 2006) and is one of a limited number of places globally with large remaining tracts of coastal tropical rainforest (Bayliss-Smith et al., 2003). The SI harbour an exceptional cultural diversity, and are part of the Melanesian biocultural hotspot (Loh and Harmon, 2005; Maffi, 2005).

Rural communities in the SI live a life that is directly dependent on local ecosystem services, relying on subsistence agriculture, fishing, hunting, wild food and non-food harvesting (Bourke et al., 2006; Jansen et al., 2006). But they face a number of pressures on resources, such as those from logging and mining companies, conservation organisations (Hviding, 2003), increasing impacts of climate change (Donner et al., 2005; Ebi et al., 2006) and endogenous processes such as rapid population growth (Bourke et al., 2006; Fazey et al., 2007). Although it is one of the few unlogged areas of the SI (URS Sustainable Development, 2006), in other aspects the Kahua region is no exception. Recent remote sensing research shows that primary productivity has decreased in recent years, with more marked decreases near villages (Garonna et al., 2009). Locals state that the provision level of many ecosystem services on which they depend, including provision

of building materials, water purification, crop disease regulation and soil fertility building has decreased. The stress that this causes in communities leads people to look for monetary solutions (Bourke et al., 2006; Fazey et al., 2007), but this appears to reinforce many of the problems by intensifying pressure on resources. While social life revolves around traditional customs and values, these have also come under pressure from the drive for monetary wealth and population growth (Fazey et al., 2007).

Kahua consists of western, central and eastern zones, and between these, there are clear differences in levels of income and amount of outside influence and cultural change, related to the amount of cash crops grown and transport opportunities for accessing markets. The largest central area has little access to flat, fertile land and no sheltered anchorages, making shipping connections unreliable and extremely limited. The eastern and especially western areas have access to wider river flood plains enabling the planting of more cash crops than in the central region. Further, west Kahua has a reliable regular shipping connection to the SI capital Honiara and is close to a small road that leads to the provincial capital Kirakira. This means that the west has both the greatest area of highly fertile land for planting cash crop and has greater access to markets. West Kahuans have on average over four times the number of cocoa trees as east Kahuans, and over 12 times more than the central region (Fig. 2). Nonetheless, even in the west, monetary income is extremely limited.

In 2000, a grassroots non-governmental organisation, the Kahua Association (KA), was founded by local people without external assistance to improve ability for communities to respond to mounting pressures. The KA is committed to sustainability and equality, has a focus on learning and building capacity, and has strong support within Kahuan society (Fazey et al., 2010). Both past research and that presented in this paper placed significant emphasis on co-management and co-design of research programmes. This approach has been widely supported by the KA and local communities, and has received high rates of participation, interest, and trust in external and trained local researchers (Fazey et al., 2010).

In summary, Kahua has high biodiversity, strong dependence on the local environment, low levels of income and education and high levels of illiteracy, customary land-ownership, strong traditional culture, and precedents and desire from local people to engage in participatory and deliberative research approaches. Kahua therefore provides a useful context for investigating the influence of deliberative valuation approaches.

2.2. Research approach

The research approach combined participatory methods with stated preference valuation techniques to develop new deliberative and group based valuation methods. We adopted a set of key participatory principles: local people were considered to be capable of analysing their own realities and would be empowered to do so; the main purpose of outside researchers was to catalyse, convene, and facilitate the process; and learning of the participants should be experiential rather than determined by transmissive modes of information delivery managed by outsiders (Kumar, 2002). These principles were implemented by conceptualising a process of learning occurring within three-tiers where external researchers (tier one) trained and worked closely with local research assistants (tier two), who facilitated the implementation of focus groups and participation of community members (tier three) (see Fazey et al., 2010). Group facilitation by local research assistants, where input from external researchers was kept limited, not only helped bridge language barriers, but also reduced the chances of participants conforming to what they might believe outside researchers would want to hear.
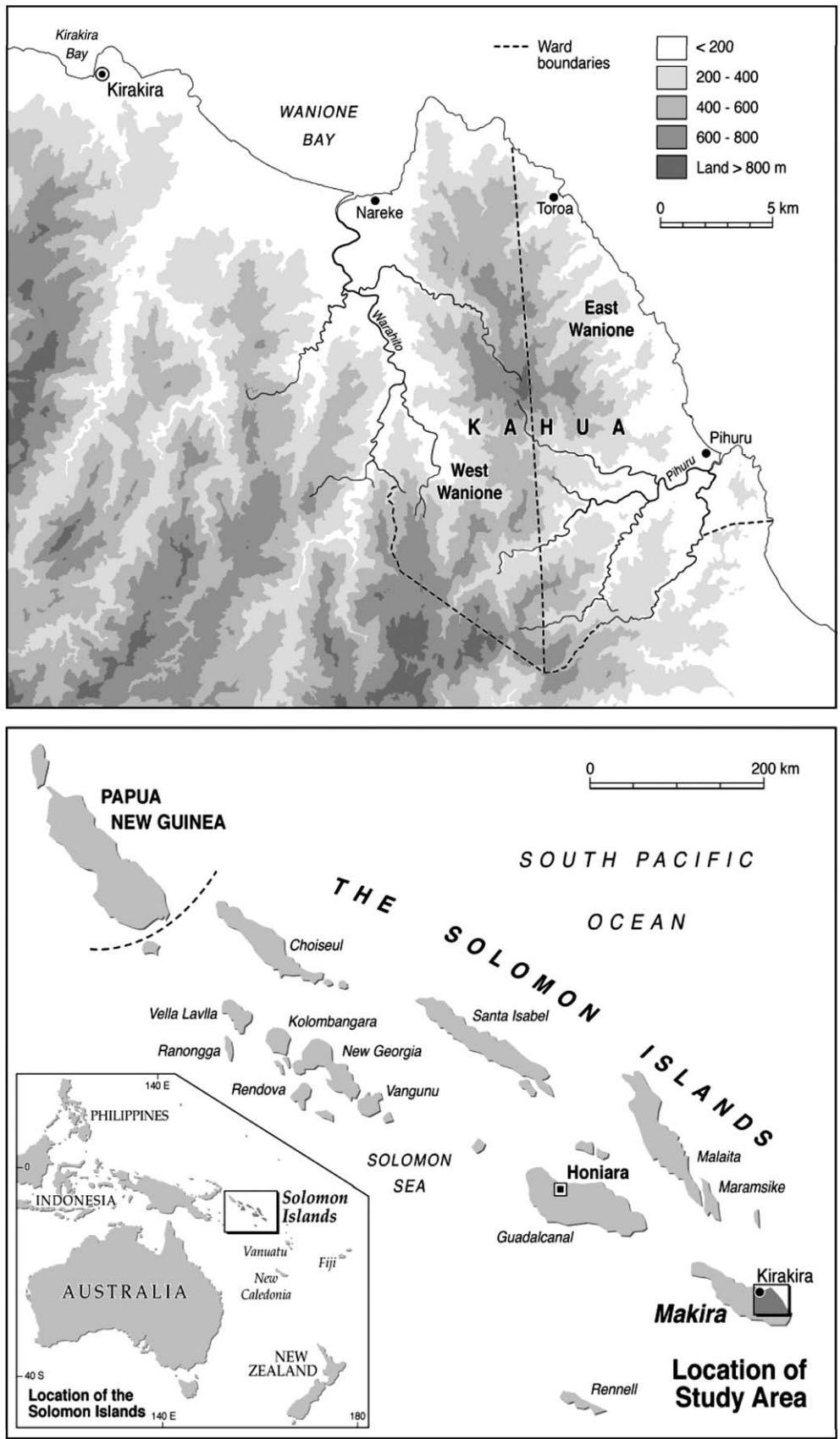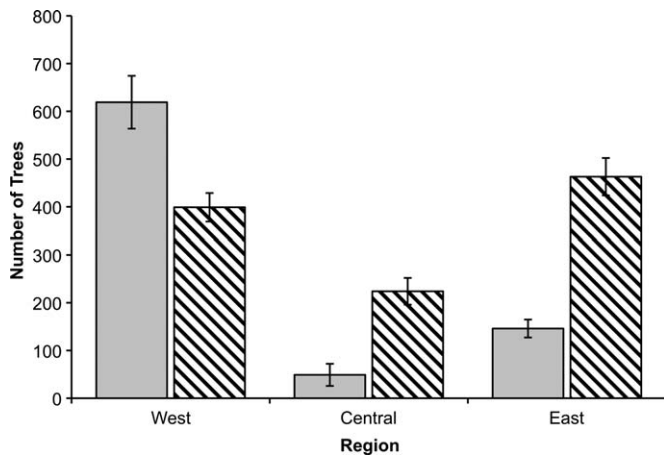
Fig. 1. The study area and its location (from Fazey et al., 2010).

Fig. 2. Cash crops in Kahua per region, per household (adapted from Fazey et al., 2007). Striped bars indicate coconut trees, shaded bars cocoa trees. Error bars represent standard errors.

Choice experiments (CEs) provided the basis to the valuation methodology. CEs are a stated preference technique where respondents are presented with a series of choices between more or less desirable alternatives (Hanley et al., 1998). These consist of a number of attributes, with each attribute being available at different levels. For example, a simple CE could include water purification; plants used for building materials and cost as attributes. One alternative would be four months of clean water per year and 15 min walk to ample building materials for $20. Another could be 12 months of clean water and 3 h walk for

building materials for $30. An example of a choice task used in this study is depicted in Fig. 3. The choice outcomes are used to construct a probability model that is used to calculate the relative importance of each attribute (Louviere et al., 2000). Usually, one of these attributes provides a price tag (monetary, or a proxy measure of value, such as travel time or distance), and this allows the analyst to calculate a marginal *willingness to pay* for each attribute. By interacting social, economic or demographic characteristics of participants, such as gender, income or level of comprehension of the choice tasks, with the choice attributes, differences in willingness to pay between groups can be evaluated.

The general participatory approach provided the basis for social, group based rather than individual based choice experiments. While there is a disadvantage in that sample sizes are reduced by using focus groups, the group format encouraged greater involvement of people and reduced the resources and effort that would have been required to conduct individually based interviews. A further disadvantage of a group-based approach may be that participants conform to social norms rather than form their own opinion. This was ameliorated to some degree by facilitators proactively prompting participants for their personal opinion. Further, the social approach was more appropriate for a cultural context where resource management decisions tend to be made collectively through a process of discussion (Allen et al., 2006; Bourke et al., 2006; Fazey et al., 2010).

To increase comprehension, deliberation, and reflection, the choice experiment exercises were complemented by additional participatory exercises and interventions (Section 2.3.4).

CEs for valuing ecosystem services of tropical forests in developing countries have only been used in two previously published studies, with both conducted in Indonesia (Barkmann
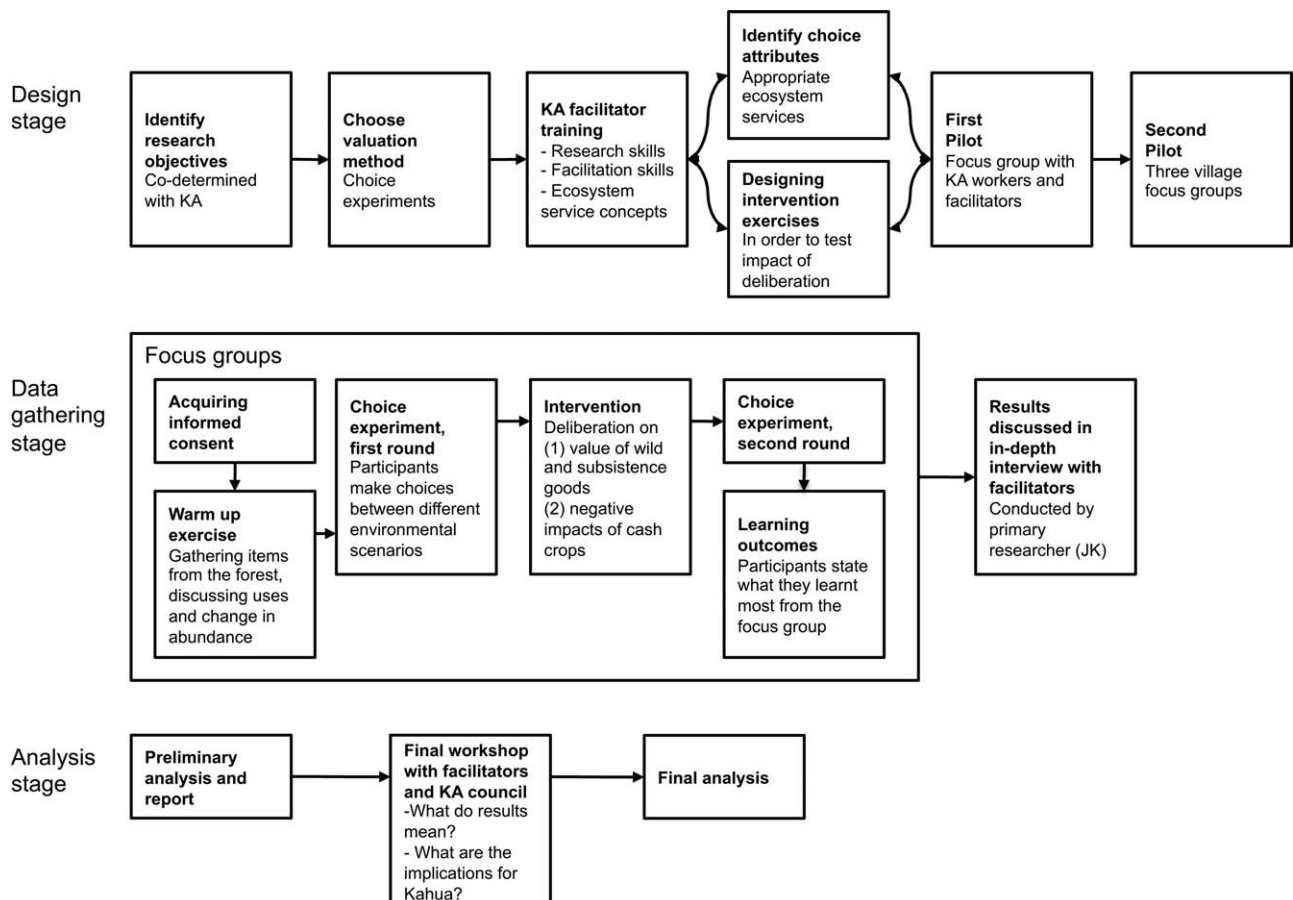
Fig. 3. Stages in the research design, execution and analysis, and staged structure of the focus groups. KA stands for Kahua Association (see Section 2.1).

	Program A	Program B	Program C
Gue	•	• • • •	•
Water quality	• • • •	•	•
Food gardens	•	• • •	•
Cocoa gardens	• • •	•	• • •
Cost	$500	$300	$0

Fig. 4. A sample choice task, where participants would choose between three hypothetical scenarios. • shows number of stones placed, representing attribute levels. Scenarios were described as the potential future outcome of a development program. Costs attached to the programmes were the costs per household, which would go into a community fund to finance the program. Program C is the default scenario at no extra cost. This program remains identical across tasks.

et al., 2007, 2008; Glenk et al., 2006, 2008; and see TEEB, 2010 for an overview of studies). As far as we are aware, there are no studies that have used social choice experiments for valuing ecosystem services.

2.3. Research design and data collection

2.3.1. Overall experimental design and data collection

Key stages of the valuation are outlined in Fig. 4. In the initial design phase research objectives were developed with the KA, local facilitators were trained, and logistical and methodological aspects designed and piloted. Data was then collected using a total of 46 focus groups held across Kahua, in 18 communities. 8 groups (17%) were held in the eastern area, 25 (54%) in the largest central region, 13 (28%) in west Kahua. Groups were conducted separately for women and men. In total 447 people participated from 30 villages (10% of the total population) (Fazey et al., 2007). All village inhabitants were invited to participate. Average size of groups was 9.7 (±2.89), average mean age 36 (±8.7). With 55% of the Kahua population under 20 (Fazey et al., 2007), young people were under-represented, as most of the research period fell within the school term.

Focus groups lasted between 3 and 4 h, and comprised several staged exercises (Fig. 4). The central element was a choice experiment, where focus groups expressed their preferences for different scenarios describing change in a number of ecosystem

services. The workshop started with a warm-up exercise, which asked participants to find 15 items representing important plants from the forest, discuss their use, and whether their abundance was increasing or decreasing, and why. The aim of the exercise was to get participants to think about their forest environment and discuss change within it, and to deliberate on why this change was taking place. It also had the purpose of building participants' confidence in their own knowledge. After this exercise, focus groups undertook one set of choice tasks, then two intervention exercises, followed by a second set of choice tasks. The purpose of these interventions was to stimulate deliberation on issues related to the ecosystem services that were being valued. Following the second set of choice tasks, participants were asked to state what they had learned most from the workshop. Further details on choice experiment design, attribute selection and the intervention exercises are outlined below.

2.3.2. Choice experiment design

The design of choice experiments includes decisions about alternatives, attributes and their levels, a potential base or reference scenario, the nature of the cost attribute, and the framing of choices in putting them to participants. A dichotomous, fold over choice task design with four attributes was used (Table 1), resulting in eight possible choice tasks. Four sets of choice task orders were made which were randomly allocated to groups. The simple design, which omitted gradients in attribute levels, was chosen to allow participants to focus on discussion rather than having to re-interpret attributes, and to aid illiterate people by only having two different attribute levels that could quickly be committed to memory.

The baseline alternative at no extra cost consisted of all attributes at base level. This approach was chosen instead of a status quo scenario, because of variation between villages and the complexity of implementing a variable status quo scenario in combination with a dichotomous design without intermediate levels. It also maximised time spent on deliberating scenarios without the need to establish a status quo with participants.

The meaning of the alternatives, attributes and their levels was explained in great detail before commencing with the choice experiment, and then repeated more summarily before each choice task in order to remind participants of the meaning of attributes and their levels (Table 1). The importance of taking income constraints into account was underlined. Alternatives were framed as scenarios similar to development programmes, which participants were familiar with. Participants were therefore making choices between programmes based upon their preference and their ability to pay the associated cost for delivering such a programme. In terms of decisions, participants reached consensus,

Table 1
Choice attributes, their scenario levels and current situation in Kahua. Participants perform a number of tasks where they choose between three scenarios that consist of a combination of ecosystem service attributes at either a base or an alternative level. One scenario always stays the same (the default scenario), has all attributes at the base level, and has nil cost. The other scenarios have a cost attached to them, but provide alternatives that are generally seen as improvements. By modelling repeated choice tasks, the relative importance of attributes and their monetary values can be estimated.

Attribute	ES types	Base level	Alternative level	Current situation
Gue (rattan/vine) (proximity)	Cultural, provisioning	4 h walk needed to harvest enough to build a house	15 min walk needed to harvest enough to build a house	2–5 h walk needed in most places.
Water quality	Regulating	Water unfit to drink for 8–10 months/year	Water of drinking quality all year round	Mostly good year round, occasional issues in eastern and western areas.
Gardens (type)	Provisioning, cultural, supporting	Three cocoa gardens, one food garden	Three food gardens, one cocoa garden	Cash crops very limited in central area, increasing in east and especially west. Subsistence mainstay everywhere.
Cost (SBD)		No cost	SBD $300 (US $20) or $500 (US $33) into a community development program	

ES: ecosystem services; SBD: Solomon Island dollar, SBD $15 equalled circa US $1 at time of data collection.

Fig. 5. A focus group considering a choice task.

or, when differences of opinion went unresolved, voted. Facilitators recorded discussed motivations for making particular choices as well as the choices themselves.

Various participatory tools were used to enhance comprehension and inclusion. For example, ecosystem service attribute levels were represented by stones, and when moving on to the next choice task, facilitators would move stones around, explicitly illustrating how scenarios (and therefore attribute levels) changed from one scenario to the other. In the debates around which choices to make, participants actively interacted with the scenarios through pointing and temporarily altering represented scenarios by moving stones around themselves to illustrate their position and facilitate debate (Figs. 5 and 6). Participation of illiterate and otherwise potentially less empowered members of the focus groups members was enhanced by representing scenarios on outside ground rather than using a school class setting, repeated explanations, active inclusion by facilitators of all participants and other techniques common to participatory action research (Chambers, 2002; Kumar, 2002).

2.3.3. Attribute selection

Attribute selection aimed to identify goods that were comprehensive in terms of representing different ecosystem services as well as being both relevant and understandable to participants. The four attributes used in the choice experiments were gue, water quality, food/cocoa gardens, and cost (Table 1). 'Gue' (Calamus spp.)

Fig. 6. The outside setting, where choice attributes are physically represented by stones, makes it easy to interact with the choice scenarios. This aids deliberation and participation.

is the local name for a rattan that is harvested for use as rope in construction of dwellings. There has been a severe decrease in its local distribution due to overharvesting, and as such gue is representative of overexploited provisioning forest ecosystem services. It also provides cultural services, as it is a key material for maintenance of traditional huts and feasting houses.

The second attribute was water quality. Hydrological regulatory services have not been degraded in most areas of Kahua, but are known by locals to have diminished in neighbouring regions after logging operations, and the relationship between deforestation, erosion and water quality is generally understood. As a comprehensive good, water quality relates to both turbidity and sanitation issues. In most villages, either water from standpipes connected to uphill sources or from rainwater collection tanks is used for drinking, but rivers and streams are used for washing and bathing.

A combination of subsistence and cocoa gardens formed the third attribute. One of the most important supporting service outcomes of forest functions is to generate soil, prevent its erosion and replenish nutrients for shifting cultivation food gardens. As they are tended by extended families under traditional tenure, where rights, benefits and labour are shared between relatives, food gardens perform an important cultural as well as provisioning function. Cash crop planting leads to an increase in monetary income, but also to erosion of cultural elements associated with subsistence agriculture (see Section 4). Food gardens have been partially displaced by cocoa and coconut, though Kahuans still have a far greater reliance on subsistence than cash crops. Gardens are ca. 0.5–1 ha, and in 2009 an average sized cocoa garden generated a profit of around SBD $2700 (US $180) year^{-1}. Households typically manage three to four shifting cultivation gardens; though in west and east Kahua some families also have access to more extensive floodplain plantations. Cocoa and food gardens form one rather than two attributes, because households have a limit to how much gardens they can tend, and displacement of one by the other is more realistic than additive scenarios. Scenarios did not include complete displacement either way.

For the cost attribute, a standard monetary version was used, as previous research in Kahua showed that almost all households interact with the monetary economy through growing cocoa or copra (Fazey et al., 2007), and most families pay school fees. In terms of the payment vehicle, the attribute was presented as a contribution to a community fund. Attributes and their levels were established in a separate, exploratory focus group with Kahua Association representatives and cost levels established using a bidding game. The research design was piloted with the same group, and a second pilot was held with three additional focus groups, which led to upward adjustment of the cost attribute levels. Levels of the attributes are detailed in Table 1. Data from the pilots were not used in the analysis of the results presented in this paper.

2.3.4. Intervention exercises

Two intervention exercises were conducted between the sets of choice tasks to determine whether choices changed as the result of deliberation (Fig. 4). These interventions provided specific focus on the role of some of the ecosystem services participants were discussing. The exercises took around 30 min each. No outside information from, or perspectives of the researchers or local facilitators was delivered. A detailed review of the results of the intervention exercises is beyond the scope of this paper, but they are summarised briefly below.

In the first intervention exercise, participants were asked to quantify their use per household for a range of subsistence and wild goods, and then price them according to the local market and total them. The purpose of this was to make the use value of goods associated with the forest environment more explicit in monetary

Table 2
Themes surfacing in discussions in the second intervention exercise.

Deforestation and decrease of food security	Cash crop plots are cleared in the forest, or more commonly they displace food gardens away from the coastal and river plains, where the most fertile land is, into newly cleared areas in the hills, where soil erodes quickly and yields are lower. This is partly because men tend to take care of cash crops and prefer to grow them nearby, forcing women to grow food further away. There is also less time to grow food, while the income from cash crops is irregular, not always sufficient to purchase imported rice, and is often spent on other things such as school fees or alcohol.
Violation of Kahua principles	The four Kahua principles consist of the related principles of discussion, asking permission, sharing and care. These are violated when an area of forest is cleared and cash crops are planted without proper discussion/permission, and when land, labour and proceeds are not shared with others who have rights to the same land.
Privatisation of land	This leads to land disputes, and this is rarely resolved by uprooting cash crops, but usually land is divided up, such that the dispute-plot is privatised to the original user and other plots or uncleared forest are allocated to relatives who shared rights to the original plot. This privatisation has major cultural impacts in that it erodes tradition of shared land, labour and risk, and leads to further forest clearance.
Loss of community and social cohesion	People are increasingly concerned with private instead of community business, mostly due to increased work pressure. Increasingly money comes before kastom, and people with a lot of money are reported to be more disrespectful of others, as they can afford to pay compensation to the aggrieved party, the traditional method of doing justice. The 'cocoa life' is very different from the 'kastom life', where families grow food and work together; they share and take care of each other. Because of the increasing importance of money and private business, family members now sometimes ask to be paid for their labour/help, people sell food to each other instead of sharing and do not respect kastom prices set by chiefs but demand market prices.
More inequality, jealousy and division	While some people have started to grow a lot of cocoa, others either do not have the land available or do not want to grow a lot of cash crops. This leads to inequality, hatred and jealousy in communities between the cocoa growers and others. Because of this it is becoming more difficult for people to work together in communities.

terms. In each group there were at least one or two participants who had the basic arithmetic skills necessary to help the group complete the exercise. All of the focus groups stated surprise at the total value, which was on average SBD $13,149 ($SE$ = 632) per annum, equivalent to US $877.

The second intervention exercise asked participants to name and rank five negative impacts of cocoa and other cash crops, and then name and rank five negative impacts on *kastom* specifically. This Melanesian Pijin word broadly relates to traditional culture, including religion and economics, practices and values. Kahuans, like other Melanesians, generally identify strongly and positively with kastom, both under the influence of intense cultural diversity of Melanesia and the pressures of modernisation (Akin, 2004; Lindstrom and White, 1994). The discussions that ensued were mostly related to the five themes outlined in Table 2: deforestation and decrease of food security; violation of cultural principles; privatisation of land; loss of community and social cohesion; and more inequality, jealousy and division. Participants clearly established a number of social-ecological linkages and exposed vulnerabilities associated with an increase of cash crop growing, stating explicitly the relationship between environmental degradation and social-economic changes.

2.4. Data analysis

Choice results were used to construct a *multinomial logit model* using NLOGIT 3 software. The model is specified in the appendix, for more detail also see Kenter (2010). For a full derivation, see McFadden (1973) or Louviere et al. (2000). For further details on using choice modelling to value the environment, see Boxall et al. (1996) and Hanley et al. (1998).

Separate models were used for the first and second set of choices (rather than coding the intervention as a dummy variable and interacting it with the attributes). The rationale for this was the excellent model fit of these models (see Section 3.1), and that it facilitated evaluating interactions between the intervention and social-economic variables. A single alternative specific constant (ASC) was set to 0 for the baseline scenario, and 1 for the other scenarios. Age, gender, comprehension rating and area were effects coded and interacted with attributes rather than the ASC, as the number of choices for the baseline scenario was limited (Section 3.1). Associations between these data were tested with *Pearson's chi-square*, using SPSS 17.

Learning outcomes per participant were coded into a multiple response set of 16 categories, with 2 out of 286 (0.17%) answers not being assigned at least one code. Codes were aggregated per focus group, as individuals tended to respond to, add to or confirm each other. Using SPSS, we calculated *Kendall tau-B* coefficients to evaluate correspondence of learning outcomes between different areas, level of comprehension and gender. The coefficient τ (tau) expresses the proportion of pairs of values, in this case the number of groups stating a certain learning outcome, that is concordant at the ordinal level.

3. Results

3.1. The value of ecosystem services

Model fit was excellent for both for the first (ρ^2 = 0.45, $p < 0.0001$) and second set of choices (ρ^2 = 0.44, $p < 0.0001$). In both choice tasks participants overwhelmingly chose for scenarios with environmental improvements (Table 3). Overall, the baseline scenario with no additional cost was chosen in a mere 0.72% of the tasks. Water quality (1st set: β = 2.120, $p < 0.0001$; 2nd set: β = 1.934, $p < 0.0001$) and subsistence gardens (1st set: β = 1.893, $p < 0.0001$; 2nd set: β = 2.157, $p < 0.0001$) were deemed to be more important than the vine gue (1st set: β = 0.678, $p < 0.01$; 2nd set: β = 0.644, $p < 0.0001$). The lower value and significance of the gue attribute suggests it is of second-order influence compared to water quality and gardens in choice making.

Willingness to pay for an attribute can easily be calculated by dividing its coefficient by the negative of the cost coefficient. In the first set of choice tasks, before the intervention exercises, participants were willing to pay SBD $495 (US $33) per household per year for an increase in water quality, SBD $442 (US $29) for an increase in food over cash crop gardens and SBD $159 (US $11) for an improvement in gue abundance. The value attributed to gue from direct market prices obtained during the intervention exercise was similar to that obtained in the first set of choices (SBD $141, SE = 18.07). While the latter is non-marginal, given the wide margin maintained between our dichotomous attribute levels, the comparison suggests that implicit prices from this choice model reflect reality to a high degree. Certainly, these prices are very high, given that annual monetary income for almost all households in Kahua is US $150–500 per year (estimate based on survey results from Fazey et al., 2007).

Table 3

Choice models (multinomial logit). β expresses the weight of an attribute in choices made. Positive values indicate that preference for a scenario increases with an increase in the level of the attribute. Indented variables represent the weight of attributes when interacted with certain characteristics of the participants. ASC represents variation that cannot be ascribed to other variables. Overall probability of the model expresses the likelihood that it is significantly different from a constants only model. ρ^2 (Pseudo R^2) is an expression of model goodness-of-fit.

Weight parameter (β)	Choices before intervention		Choices after intervention	
Gue	0.678	**	0.644	**
Water	2.120	****	1.934	****
Gardens (subsistence over cocoa)	1.893	****	2.157	****
Male	1.518	***	2.467	****
Cost	−0.428	***	(−0.131)	NS
East + central areas	−0.638	****	−0.273	*
Mean age < 30	−0.708	**	−0.431	T
Mean age 30–40	−0.464	**	(−0.184)	NS
CR: good	−0.641	**	(−0.150)	NS
CR: very good	−0.280	T	(−0.055)	NS
ASC (non-default)	2.647	***	2.406	*
Observations	184		230	
Log-likelihood	−54.7		−91.6	
p (Chi^2); DF	<0.0001; 4		<0.0001; 4	
ρ^2 (Pseudo R^2)	0.45		0.44	

****Significant at $p < 0.0001$; ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$; T: tendency at $p < 0.01$; ASC: alternative specific constant, equal to 1 for non-default scenarios; CR: comprehension rating; NS: not significant; DF: degrees of freedom; cost-coefficients at SBD $100 (Solomon Island dollars); ρ^2 in reference to a constants only model – $\rho^2 > 0.4$ is comparable to an R^2 of over 0.8 in a linear regression model (Domencich and McFadden, 1975; Hensher et al., 2005).

Eastern and central areas showed lower value outcomes (1st set: $\beta_{cost} = -0.638$, $p < 0.001$) than overall (1st set: $\beta_{cost} = -0.428$, $p < 0.001$). Young groups (mean age < 30) expressed a stronger preference for lower-cost scenarios (1st set: $\beta_{cost} = -0.708$, $p < 0.01$), while middle aged-groups had an average cost coefficient (1st set: $\beta_{cost} = -0.464$, $p < 0.01$). Thus value placed on the environmental services increased with age.

3.2. Did deliberation influence choices?

The intervention strongly influenced choices made (Table 3). The cost attribute became insignificant, indicating that overall this attribute stopped influencing choice making in the second set of choices. In other words, after the intervention, participants solely based their decisions on the level of environmental improvements and began to ignore the monetary costs. While it is clear that willingness to pay for the ecosystem services was much greater in the second than the first set of choices, because respondents overall did not trade off cost against other attributes, it was not possible to estimate implicit prices for the post-intervention choices.

There were also differences in the choices made in different regions, in gender, and in relation to the extent to which participants comprehended the exercise and discussions. For regional differences, when the western area was excluded from analysis, the remaining areas showed a cost-coefficient that still bears significance, though much reduced in strength, as is the co-efficient itself (before intervention: $\beta = -0.638$, $p < 0.0001$; after: $\beta = -0.273$, $p = 0.02$). Therefore, those from the west placed higher value on the environment from the beginning and were affected more by the intervention than those in east and central regions.

With regards to gender, there was no major difference between women and men as regards total willingness to pay, but there were gender-specific effects of the intervention exercises on the perception of subsistence versus cocoa gardens. Whereas men cared less for food gardens than women before the intervention (overall: $\beta = 1.893$; males: $\beta = 1.518$), in the second set of choices men chose more strongly in favour of subsistence (overall: $\beta = 2.157$; males: $\beta = 2.467$).

Finally the quality of deliberation in the choice experiments also influenced outcomes. Discussion quality was measured in that it formed a component of the comprehension rating (CR) set by facilitators per group after completion of the choice experiments. None of the focus groups had a very poor or poor rating, 9% was deemed to be moderate, 37% good and 54% very good. A moderate
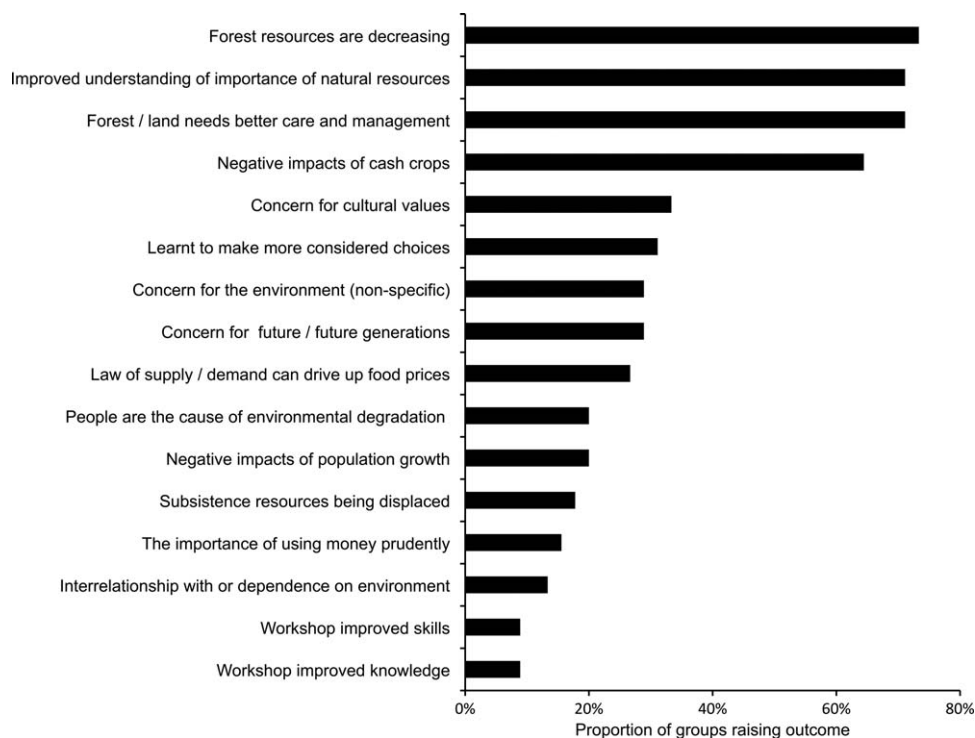
Fig. 7. The different aspects learnt by participants through engaging in the participatory valuation process.

Table 4
Kendall tau-B coefficients of similarity between learning outcomes of different areas, comprehension ratings and genders. Tau (τ) coefficients express the proportion of rank concordance.

	East + central		West		CR: M-G		CR: VG		Male	
East + central	1.00									
West	0.56	**	1.00							
CR: M-G	0.84	***	0.65	**	1.00					
CR: VG	0.71	***	0.80	***	0.65	**	1.00			
Male	0.62	**	0.53	**	0.60	**	0.56	**	1.00	
Female	0.68	***	0.76	***	0.72	***	0.77	***	0.33	T

***Significant at $p < 0.001$ (2-tailed); **$p < 0.01$; T: tendency at $p < 0.1$; CR: comprehension rating; M: moderate; G: good; VG: very good (highest rating).

CR meant that participants generally understood the tasks but had not fully grasped the meaning of all attributes. 'Good' meant that participants had a complete understanding of all aspects of the choice tasks. The difference between 'good' and 'very good' comprehension was defined as the latter having a higher degree of discussion and deliberation before making choices, with choice making being more considered.

CR clearly influenced results. Groups with 'merely' a good CR showed a much stronger preference for less costly scenarios in pre-intervention choices ($\beta_{cost} = -0.641$, $p < 0.01$) than those with the highest rating ($\beta_{cost} = -0.280$, $p = 0.06$). The low significance of the cost attribute for the highest CR groups shows that they only tended to look at cost in choosing scenarios, even before the intervention, with decisions largely being based on the environmental attributes.

3.3. What did groups learn from the participatory, deliberative approach?

Participants stated a wide range of learning outcomes. These relate to 16 topics (Fig. 7), ranging from improved knowledge, such as uses of certain plants, and skills (both raised by 9% of groups) to general learning outcomes about the environment, such as decreasing forest resources (73% of groups), that the forest or land needs better management (71%) or that they felt they now had a better understanding of the value of the environment (71%). The majority of groups also stated that they had learnt about the negative impacts of cash crops (64% of groups).

Learning outcomes were not homogenous across groups (Table 4, Fig. 8). There were differences across different regions of Kahua ($\tau = 0.56$, $p < 0.01$; Fig. 8a), comprehension rating ($\tau = 0.65$, $p < 0.01$; Fig. 8b) and gender ($\tau = 0.33$, tendency at $p < 0.1$; Fig. 8c). In relation to regions, groups in the eastern and central areas of Kahua less often raised cultural values or cash crops than western groups, and more often made more general statements, such as that they had learnt to be more concerned about the environment, or that they had acquired a better understanding of its importance. The same differences can be seen between groups with the highest comprehension rating, and groups with a moderate to good CR. This similarity in the 'shape' of learning outcomes (Fig. 8) is confirmed by tau coefficients: outcomes for the eastern/central area are considerably more akin to those of groups with a moderate to good comprehension rating ($\tau = 0.84$, $p < 0.001$) than to the western area ($\tau = 0.56$, $p < 0.01$). Chi square tests show no significant associations between regions and comprehension ratings, which implies that there is some other reason why western groups and groups with the highest CR, and thus the highest quality of discussion, have similar learning outcomes that are distinct from other groups. These differences in learning outcomes appear to reflect differences in valuation outcomes, where both high-CR groups and western groups showed much stronger than average preferences for environmental improvements.

Care for future generations, impacts of population growth, displacement of subsistence resources (such as food gardens), concerns about cultural values, and rising food prices due to increased demand and reduced supply were more often raised as a learning outcome by women than men (Fig. 8c). Men said they learnt most regarding the need for better land management and the negative sides of cash crops.

4. Discussion

4.1. What values do people of Kahua place on ecosystem services?

In the second choice tasks the value placed on ecosystem services was so high as to be incalculable; as cost of the scenarios stopped influencing choices, no tradeoffs are made, so it becomes impossible to anchor preferences to a monetary value. But even in the first tasks, participants were willing to pay markedly high amounts for improvement in environmental goods given that most households make less than US $1 per day. The total willingness to pay was US $73, approximately 30% of mean annual monetary income per household. Most notable is the strong preference for subsistence over cocoa gardens. This outcome may in part be a case of status quo bias, the effect where attachment to the present situation and aversion to loss limits a person's enthusiasm for change (Kahneman et al., 1991; Samuelson and Zeckhauser, 1988). However, important explanations given for these choices were that people preferred home grown food for its traditional cultural significance (including its use in feasting) and greater nutrition than substitute imported food. Thus, though the amount of cash crops grown has been increasing in Kahua (Fazey et al., 2007), when having to make a direct trade-off, subsistence is clearly preferred.

This has important implications for managing vulnerability. Planting of cash crops may decrease food security, as they are grown in high fertile areas previously used for food crops. At the same time there is considerable desire to earn money, driven as much by personal interests in accumulating wealth as by the need to meet important needs such as paying for health care, transport, and school fees. The continued recognition of the importance of food gardens highlighted in this study means that the desire for money has not yet superseded considerations for maintenance of essential ecosystem services, and may provide an important social hook to help promote more sustainable activities.

As regards water quality, participants strongly associated this with a clean and healthy environment and intact forests. The attachment to living in such a place and maintaining it for future generations seemed to be of greater importance than the simple use value of clean water, which, participants realised, could also be achieved by rainwater catchment tanks or similar substitutes. As such, the attribute of water quality effectively represented regulating ecosystem services.

Gue, a vine that is mainly used as rope for traditional houses, was seen to be of less fundamental importance than the other two
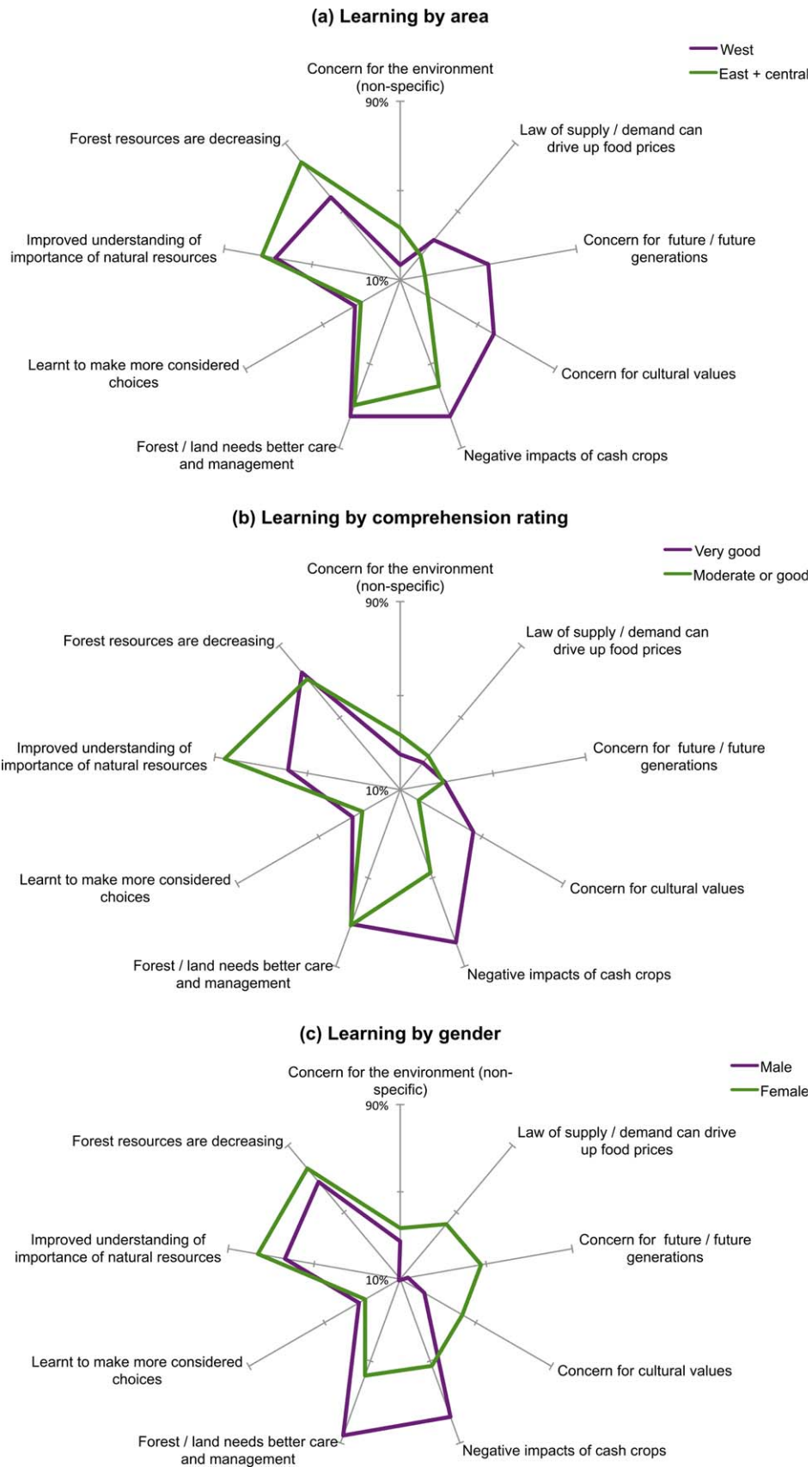
Fig. 8. Comparison of the proportion of groups that identified different learning outcomes, for the nine most stated outcomes. Comparisons are between (a) different regions of Kahua, (b) comprehension ratings by facilitators and (c) gender. The axes indicates the percentage of groups stating a certain outcome.

attributes. Though it was associated with other plants and trees used in building that were also in decline, having food security and clean water were of greater importance than improved proximity of plants that were only required once in a few years.

4.2. Did deliberation influence valuation outcomes?

The results clearly demonstrated that deliberation influenced valuation outcomes. Three outcomes pointed to this: overall intervention impact, specific impact of the intervention on male choices, and the influence of discussion quality during choice experiments on choice outcomes.

The main impact of the intervention was that the price of scenarios lost significance to the focus groups. In other words, participants started making decisions based almost solely on the levels of the environmental attributes rather than the monetary cost. This was clearly a result of new insights gained from the deliberative exercises, as there was a congruent shift in discussions and decision making in the focus groups. Participants, when asked, consistently stated that they would pay their whole income towards safeguarding ecosystem services; they would simply have to 'make sacrifices' because of this imperative, which did not surface as such in the first round of choices. Simply put, participants stated that because ecosystem services are so valuable, their conservation should take absolute priority over short-term economic gains. This is rarely fully or explicitly expressed by participants of valuation studies in countries with more developed economies, suggesting that, when given time to think and deliberate, those relying on subsistence more readily appreciate the value of ecosystem services than those depending on a monetary income. This raises important questions about whether willingness to pay approaches are able to fully capture the benefits of ecosystem services, unless those surveyed are in their daily lives directly confronted with their dependence on these services.

The second indicator of the importance of deliberation is the specific impact of the interventions on the extent to which men appreciate subsistence gardens. At first, while men still valued subsistence over cocoa gardens, they did so to a lesser extent than women. This is not surprising: women spend more time in subsistence gardens, especially in areas where cash crops are more abundant. Conversely, tending plantations (and spending profits gained from them) is men's work. After the intervention discussions, men radically strengthened their preference for subsistence, which was confirmed by more frequently stating the negative impacts of cash crops as a learning outcome than women (Fig. 8c).

Thirdly, the impact of deliberation within choice experiments is clearly shown by the differences in valuation outcomes between groups with the highest comprehension rating and groups with lower ratings (Table 3), as the difference between the highest rating and the level below was solely defined in terms of quality of discussion and participation. Those who lacked lively discussion tended to choose cheaper scenarios. Notably, quality of deliberation appears to be much more important than level of formal education in terms of valuation; while education levels of participants were not known, we do know that females and older-aged tend to be less educated (Fazey et al., 2007), but they neither had lower comprehension of the scenarios nor bid lower (Table 3).

4.3. What type of learning was encouraged by deliberation?

4.3.1. Range of learning outcomes

Results clearly demonstrated a range of learning outcomes for participants demonstrating the potential value of participatory approaches to valuation research (Fig. 7). First, participants better understood the use value of subsistence goods. They became aware that prices of these goods, if one were to buy them, would rise if more cash crops were grown at the expense of traditional crops. Second, many individuals had not realised before that new plantations displaced traditional resources, and participants worried about food security if they could depend less on subsistence. Third, there was increased awareness of the cultural value of the attributes and participants expressed worry that the decrease in ecosystem services would lead to an erosion of cultural principles, loss of community cohesion, and increased greed, disputes, and social problems (c.f. Sillitoe et al., 1998). Fourth, participants stated that they only realised after the focus groups that decreased abundance of wild resources, such as gue, was a result of human impact (overharvesting and increased land clearing). This related to increased awareness of the interdependence between humans and their environment. Fifth, participants expressed a greater *bequest value* of the environment. That is, they expressed a desire for their children to be able to maintain current ways of living, and a desire to conserve the environment for future generations. These findings suggest that the interventions elicited deeper held beliefs and better appreciation of socio-cultural, economic and environmental sustainability, and realisation that sustainability was threatened by erosion of natural and cultural capital.

4.3.2. Learning and understanding of environment-culture relationships

The results from the participatory approach that encouraged learning have important implications for the way people from Kahua relate to their environment, and how recognition of this relationship can be used to promote more sustainable activities in the region. Ecological knowledge, environmental management, values, culture and identity are intimately intertwined in many indigenous societies (Houde, 2007) and this may especially be the case in places such as the Solomon Islands, where subsistence dominates livelihoods. Key principles of Kahua society are sharing, particularly of land and labour; discussion with and asking permission of everyone who may be affected by a decision; and mutual care (Fazey et al., 2010). Reproduction of these principles is strongly linked to traditional interactions with the environment, such as shared felling, tillage and crop care in shifting cultivation systems under customary tenure, where land and labour is shared within the clan or extended family. Thus natural capital performs socio-cultural functions as well as ecological and economic ones (Berkes and Folke, 1994; Chiesura and de Groot, 2003).

A mixture of environmental and cultural concerns is reflected in stated learning outcomes (Fig. 7). The two most frequently expressed outcomes relate to environmental themes. These are recognition of the need for better forest and land management and improved understanding of the importance of natural resources. These themes were stated by a majority of groups in all regions, for both genders and for all levels of comprehension. The third and fourth most stated themes, the negative impacts of cash crops and concern for cultural values, were specifically most stated by those groups who also made the highest bids in the choice tasks: people from West Kahua and groups with the highest comprehension rating scores (Table 3, Fig. 8). In west Kahua, access to transport and markets is greatest and cash crops have been developed most extensively (Fazey et al., 2007). Remote sensing suggests that areas in West Kahua have also suffered some of the greatest environmental change (Garonna et al., 2009). There are also indications that it is in the western area where the most rapid recent social change has occurred, such as in consumption of alcohol and erosion of social cohesion, which may be mediated by greater circulation of money generated through cash crops. Thus,

people from West Kahua have probably had the greatest experience of environmental and social change, and thus a greater awareness of its consequences. Similarities in the shape of learning outcomes between western groups and groups with very good comprehension suggest that the latter have achieved a similar awareness, but through deliberation instead of experience, as increased learning led to high value outcomes for both groups.

4.3.3. Relating learning to theories of environmental values

The findings can be understood in relation to theories of human–environment relationships. In environmental psychology, the values-beliefs-norms (VBN) theory of environmental behaviour (Stern, 2000; Stern et al., 1999) has become increasingly established (Dietz et al., 2005; Hansla et al., 2008; Snelgar, 2006), though it has not been tested in a developing country context. The theory describes the process of translation of deeper held values, consisting of a three-factor base of self-interest, altruistic and biocentric values, into behaviour regarding the environment, through a number of linkages (Fig. 9). Deeper values shape an ecological worldview, and this is linked to awareness of consequences of actions and perceived ability to reduce threats to the environment, which eventually direct norms and behaviours (Hansla et al., 2008; Stern, 2000; Stern and Dietz, 1994; Stern et al., 1999). The VBN theory predicts the type of learning that would need to take place to generate changes in choice outcomes: the surfacing of deeper held environmental values, increased awareness of human responsibility for environmental degradation, and a realisation that this outcome is not inevitable, i.e. the result of an implicit choice.

Each of these types of learning can be seen in the results of this study. In terms of deeper held values, utilitarian reasoning (best goods for the best price), made way for more altruistic concerns such as the Kahua principles and consideration for future generations, and for biocentric values in the sense of a realisation of the interdependence with nature. In terms of norms, participants expressed a need for better management, citing examples of what they now understood to be wrong, such as felling large trees for planking and leaving half of it to waste due to lack of planning, and then doing the same thing over again the next year. And indeed, focus groups that may have had a greater awareness of the consequences of land use change also showed greater appreciation for environmental goods.

4.3.4. Synthesis: the effects of learning on perceptions of the environment

The results demonstrated five main consequences as a result of learning. These were: (1) Increased and more sophisticated understanding of social–ecological linkages (e.g. linking the environmental and cultural consequences of land privatisation); (2) Explicit recognition of deeper held values, such as the wish to leave a healthy environment to one's children, or the sense that one is interdependent with nature; (3) Clarification of the use value of non-marketed goods, such as subsistence resources; (4) Increased appreciation of less obvious values of environmental goods (e.g. goods may not just be important for their direct use but also for their contribution to cultural identity); (5) Increased awareness of the consequences of actions, and of one's ability to intervene or change behaviour (e.g. if resources are decreasing, deliberation may help one realise that this may be due to human actions rather than natural processes). This type of learning also includes better appreciation of the 'you can't eat your cake and have it too' principle.

4.4. Implications for environmental valuation

Our case study was conducted in a remote area where the mainstay of livelihoods consists of subsistence gardening, access to markets was extremely limited, land is not privately owned and local prices are set through traditional mechanisms rather than the market. Nonetheless, the excellent model fit and strong consistency in cost appreciation in the first set of choices clearly demonstrate that participants were able to engage in utilitarian thinking. Moreover, utilitarian strategies, in particular maximising benefits while minimising costs, dominated the discussions during the first round of choices. The high values expressed, which represented 30% of participants' estimated modal monetary income, demonstrated that participants were able to translate their reliance on these ecosystem services into rational choices. This study therefore confirms that, at least in terms of participants' capacity, choice experiments can be applied to measure non-market environmental values in rural areas of developing countries, even where subsistence makes up the mainstay of livelihoods (cf. Barkmann et al., 2007, 2008).

The application of the methodology was, however, made easier by existing precedents for participatory research approaches, and because participants already relied on deliberative, group-based decision-making structures and tenure systems. The use of a group-based participatory approach instead of a more conventional individual style survey helped to overcome many of the practical difficulties associated with valuation in developing countries (e.g. illiteracy), though this is dependent on facilitators being given appropriate training. It also addressed the problem of establishing equal knowledge among participants, which is heterogeneous to start with (Urama and Hodge, 2006).
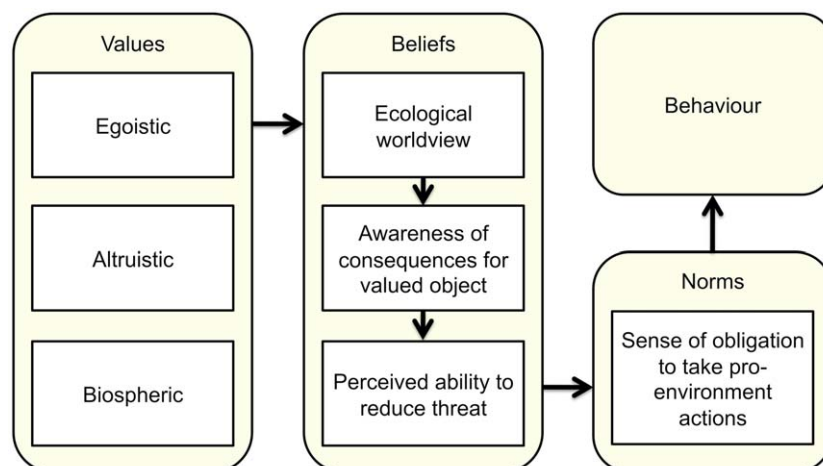
Fig. 9. Representation of the values-beliefs-norms theory of environmental behaviour (adapted from Dietz et al., 2005; Stern, 2000).

Table 5
Methods that can help to avoid lexicographic preferences with their advantages and disadvantages.

	Description	Advantages	Disadvantages
Willingness to accept (WTA) approach	Asks participants for their willingness-to-accept compensation for loss of ecosystem services, rather than their willingness to pay.	Avoids income constraints and can make it possible to price attributes of extremely high value.	Does not reflect real market behaviour in the absence of budgetary considerations. Can lead to vastly inflated values. Discouraged by accepted valuation protocols (Arrow et al., 1993).
Attributes with marginal changes only	Avoidance of drastic changes in ecosystem service provision levels in choice scenarios. Participants are not asked to make major sacrifices one way or the other.	Tradeoffs more tolerable/plausible.	Difficult to establish in advance what constitutes a non-marginal change. More subtle values of environment may not be elicited. Potentially less meaningful discussion and reduced social learning.
Attributes of lesser importance only	Survey restricted to less important ecosystem services (e.g. amount of shading in plantations or specific non-timber forest products)	Tradeoffs more tolerable/plausible.	Important services not valued. Potentially less meaningful discussion and reduced social learning.
Scenarios without cost attribute	Choice experiments where participants make tradeoffs between ecosystem services only.	Key ecosystem services can be effectively traded off against each other (e.g. food crops versus forest produce) providing insight into their relative value.	No monetary estimates. Attributes need to be carefully selected. Risk of reducing quality of discussion and reduced social learning.
Proxy cost attribute	Use of some good which can replace money as a cost-indicator, e.g. Shyamsundar and Kramer (1996) used bags of rice, or one might ask for willingness to invest time to achieve a scenario outcome.	May improve comprehension of choice tasks.	Using culturally highly significant goods (e.g. pigs or shell money in the Solomon Islands) may lead to unexpected implications in terms of how tradeoffs are made. Relatively neutral non-local goods (e.g. bags of rice) or time may still face issues of budget constraints and still lead to lexicographic preferences regarding important ecosystem services (unless a WTA approach is used in concordance).

However, after the post-intervention choices, the choice experiment broke down, as the cost attribute became insignificant. Participants were unwilling to trade-off ecosystem services as a result of social learning. The importance of information and discussion to valuation has been expressed many times (Arrow et al., 1993; Hoehn and Randall, 2002; Macmillan et al., 2006; Niemeyer and Spash, 2001; Schiffman and Kanuk, 1991; Spash, 2002, 2007, 2008a; Urama and Hodge, 2006; Whilehead and Blomquist, 1991; Whittington, 1998; Whittington et al., 1992), but in many cases this is only related to the direct consequences of a change in management or policy. Rarely is a fully participatory process proposed where information originates with participants rather than experts, and where external researchers chiefly act as facilitators (cf. Kumar, 2002; Pretty et al., 1995). High quality discussion, particularly in combination with appropriate interventions that stimulate analysis and linking social-economic, ecological and cultural processes and change, increase the degree to which deeper held value-bases and more sophisticated perspectives are realised. This is particularly important for capturing the value of the more subtle aspects of environmental goods, such as the cultural ecosystem service of identity formation. Also, political theory suggests that deliberation will prompt participants to look beyond their immediate self-interest (Niemeyer, 2004).

If, as this research suggests, such learning is a requirement for full realisation of the importance of nature, then the short surveys that form the mainstay of valuation practice are inappropriate for the elicitation of preferences for environmental goods, irrespective of whether they are conducted in developing or developed countries. At the least, preferences are not pre-formed but are constructed through the process of eliciting them (Hoehn and Randall, 2002; Spash, 2002; Urama and Hodge, 2006). This means that environmental economists need to engage with other disciplines that have developed theories of value (e.g. ethics,

social psychology) or give insights into social processes (e.g. political science, anthropology), in order to design more sophisticated processes for eliciting preferences. Issues that need to be considered include confidence and trust in process and structure, models of decision making, power relations, legitimacy and inclusiveness, and the need to understand attitudes and motivation (Spash, 2007). Evaluation of the appropriateness of processes and methodologies for eliciting and assessing deeper held values will be essential.

Incorporating deliberation into the valuation process has, however, raised an important methodological issue. Those surveyed in this study came to the conclusion that key ecosystem services and money were not of the same order of importance and that the services they depended upon for livelihoods were priceless. This poses a major methodological challenge, as tradeoffs between services are required to generate estimates of monetary value. We can see five methodological approaches that can help reduce the chances of eliciting lexicographic preferences. These are (1) using a so-called willingness to accept instead of willingness to pay approach; (2) valuing less drastic, more marginal changes in ecosystem service provision; (3) only valuing less important ecosystem services; (4) scenarios without a cost attribute; (5) scenario's using a proxy good as a cost attribute (e.g. bags of rice, livestock). However, these options have significant disadvantages (Table 5), such as the risk of reducing quality of deliberation and social learning.

The alternative is to accept cost-insignificance as a valid outcome in its own right and to use non-monetary methods to qualify values in addition to monetary valuation techniques. If the primary aim of the valuation process is learning for both participants and researchers regarding why nature is valuable, rather than just a figure outcome, the conclusion that key ecosystem services are priceless is quite valid.

Appendix A. Specification of the multinomial logit model

In order to analyse choice experiments, a model is constructed based on choice outcomes. This allows us to understand the influence that each attribute of the experiment had on choices made. Here, a *multinomial logit* model was utilised, which is the most common choice model used. Choice models are rooted in Lancastrian consumer theory, and random utility theory. The first states that when an alternative is chosen, it is not preferred *per se*, but for its component attributes (Lancaster, 1966). In valuing ecosystem services, these alternatives consist of different environmental scenarios, composed of a number of ecosystem services as attributes. Random utility theory states that utility U, or net benefit of an alternative i has a systematic component V_i that can be observed and related to known variables, and a stochastic, unobserved component ε_i, which reflects individual idiosyncrasies (Manski, 1977; McFadden, 1973):

$$U_i = V_i + \varepsilon_i \tag{1}$$

The randomness referred to here is only from the point of view of the researcher; respondents are fully aware of their utility function. Utility is the satisfaction one gains from, or desirability of, a good. When we assume that choice experiment participants aim to maximise their utility, the probability P that an alternative i is chosen over j from choice set C can be expressed as:

$$P(i|C) = P(U_i > U_j) = P[(V_i + \varepsilon_i) > (V_j + \varepsilon_j)] = P[(V_i - V_j) > (\varepsilon_j - \varepsilon_i)]$$
$$\forall\, i, j \in C; i \neq j \tag{2}$$

In order to estimate the probabilities in Eq. (2), one needs to make a number of assumptions on the nature of the random component. *Multinomial logit* models, also known as conditional logit models, assume that the random term is independently but identically distributed (IID) across alternatives. This means that, while values of the random term are different between alternatives, we maintain the assumption that their variance will be identical, while there is no cross-correlation between them. As a consequence of this, alternatives have to be independent from irrelevant alternatives (IIA). This means that the probability ratio of choosing i over j is unaffected by the presence of other alternatives (This can be tested using a Hausman test). If the IID or IIA assumptions are violated, a *mixed logit* (random parameters) or *nested logit* model can be used instead of multinomial logit. The distribution that is typically chosen for the random component of utility is a type 1 extreme values (Gumbel) distribution, which is appropriate for large numbers of IID random values (Hensher et al., 2005). Armed with these assumptions, we can now estimate the probability of an alternative i being chosen from choice set C (McFadden, 1973):

$$P(i|C) = \frac{\exp \mu V_i}{\sum_{j=1}^{C} \exp \mu V_j} \; \forall\, i, j \in C; j = 1, \ldots, i, \ldots C; i \neq j \tag{3}$$

where μ is a scale factor, which may be normalised to one.

Then, we maintain that V_i is composed of individual attributes, accompanied by weights that determine their relative contribution to utility:

$$V_i = \beta_0 ASC + \beta_1 x_{1i} + \beta_2 x_{2i} + \beta_3 x_{3i} + \cdots + \beta_m x_{mi} \tag{4}$$

where x_{ni} is the nth attribute of I, β_m is the weight coefficient of attribute x_{mi}, β_0 is the weight coefficient associated with an *alternative specific constant* (ASC) and represents the average of unobserved utility, i.e. utility that cannot be ascribed to other parameters (Tardiff, 1978). An ASC equals 1 for a single alternative and 0 for other alternatives, or the inverse. If there are j alternatives, a maximum of $j - 1$ ASCs may be included. Social-economic variables can either be interacted with attributes or an ASC.

As we only know the relative utility obtained from choosing one alternative over another, the weight of different attributes cannot be interpreted in absolute terms, though we can estimate marginal rates of substitution between attributes. If one of the attributes is a reflection of cost ($\beta_\$$), then we can calculate tradeoffs as implicit prices:

$$\text{Implicit price} = -\frac{\beta_m}{\beta_\$} \tag{5}$$

Ceteris paribus, the implicit price reflects marginal willingness to pay (WTP) for improvement of an attribute, or in this case, an ecosystem service.

In order to estimate significance of a model, the log likelihood ratio is tested over a base model, assuming a chi-square distribution. This base or constants-only model consists of alternative specific constants only, ignoring attributes or socio-demographic variables. The test shows whether the likelihood of the model, and thus predictive ability of the model, has significantly improved by introducing variables, and can also be used to evaluate whether two models are significantly different. The test value D can be calculated as follows:

$$D = -2(LL_{\text{base model}} - LL_{\text{estimated model}}) \sim X^2 \tag{6}$$

Similarly, one can calculate goodness of fit (expressed as McFadden's pseudo-R^2, or ρ^2):

$$\rho^2 = \frac{LL_{\text{base model}} - LL_{\text{estimated model}}}{LL_{\text{base model}}} \tag{7}$$

For a full derivation of the multinomial logit model, see McFadden (1973) or Louviere et al. (2000). For further details on using choice experiments to value the environment see Boxall et al. (1996) and Hanley et al. (1998).

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