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Analysis

Assessing the contribution of ecosystem services to human wellbeing: A disaggregated study in western Rwanda



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ABSTRACT

Lack of attention to social complexity has created a gap between current ecosystem service research and the kind of insights needed to inform ecosystem management in the tropics. To contribute to closing this gap, this study applies a methodology for exploring complex linkages between ecosystem services and human wellbeing. This builds on emerging frameworks for studying multiple dimensions of human wellbeing, drawing on Amartya Sen's capabilities approach to human development. The approach is applied to an empirical case study of three sites adjacent to native tropical forest in western Rwanda. The value of exploring social complexity in ecosystem services research is illustrated through its contribution to understanding a) different types of values; b) disaggregation of people; c) power relations and their influence on trade-offs; d) the importance of multiple land use types in the landscape; and e) changes and their drivers at multiple scales. The analysis reveals that the majority of services valued by forest-adjacent Rwandan inhabitants are not provided by tropical forests but by other habitats. We suggest that more integrated landscape governance may offer synergistic opportunities for conservation and development.

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1. Introduction

Much ecosystem service research has attempted to recognise the economic value of nature to global stakeholders, assuming that fuller valuation of nature's services will lead to clearer specification of governance trade-offs, increased investment in natural resource conservation, and consequent gains for human wellbeing (Gómez-Baggethun et al., 2010; Norgaard, 2010). However, this direction has been criticised for failing to embrace the complexity inherent in social-ecological systems and, as a result, failing to find long-term solutions which might promote the achievement of social as well as ecological objectives (Carpenter et al., 2009; Ostrom and Cox, 2010; Lele et al., 2013). Combining both objectives is already well enshrined in policy. For example almost three quarters of international financial aid directed towards biodiversity conservation explicitly details joint conservation and development aims (Miller, 2014). Furthermore, there is a widely held view that social outcomes should be equitable, as is now specified in formal conventions such as the Nagoya Protocol of the Convention on Biological Diversity and voluntary agreements such as the Conservation Initiative on Human Rights (Sikor and Stahl, 2011; Martin et al., 2013).

This paper makes a contribution towards better understanding the linkage between ecosystem services and human wellbeing, as a necessary step towards more effective and equitable integration of ecological

and social objectives through ecosystem service governance. It unpacks some of the local realities of these linkages through the application of a multidimensional wellbeing approach. In doing so, it responds to five current weaknesses that are common in ecosystem service analysis. We refer to these weaknesses as five (interrelated) instances of socio-ecological reductionism, as summarised in Table 1:

- Failure to consider different types of values: The way in which people value ecosystem services are often represented as monetary values. This fails to recognise that different people may value a similar ecosystem service differently based on how it contributes to their wellbeing (Jax et al., 2013). For example collection of food from a forest may be important for the very survival of one person, provide a source of income for a second, and provide a way of caring for ancestors for a third. Those three people may react quite differently to changes in governance of that resource. Each individual may themselves value a resource in multiple ways, making different claims about value in different social contexts (Sen, 2007). Understanding this plurality of ways of valuing ecosystem services is critical to identifying suitable ways to manage trade-offs and to promote adaptive management of complex social-ecological systems (Folke et al., 2005; Norgaard, 2010).
- Aggregation of people and their preferences: Simplified approaches to complex human-environment problems may lack policy relevance due to a tendency to aggregate people across large scales (Ostrom and Cox, 2010; Duraipappah, 2011). For example average statistics may suggest that the population of an entire region are

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Table 1
Simplifications of social complexity common to ecosystem services research.

	Problem to be addressed	Illustration of problem	Lesson for ecosystem service framing
Failure to consider different types of values	Assumed singularity of value and under-emphasis of some value types, such as non-material and subsistence values	Under-emphasised values are more likely to be priorities for less powerful groups, and also a cause of their marginalisation	Investigate subjectivity and plurality
Aggregation of people	Assumed homogeneity of values and interests within and between stakeholder groups.	Potential winners and losers of intervention or change are not recognised	Need for fine-scale, differentiated understanding of stakeholders and impacts upon them
Oversight of power relations	Assumed power symmetry among stakeholders. Interests of marginalised remain invisible	Attempts to alleviate poverty or reconcile needs of marginalised groups unsuccessful	Specific attention to be paid to relative power between identified stakeholders
Focus on single land use type (e.g. native forests)	Narrow focus only on core areas of interest to ecosystem managers	Poor assessment of use of wider landscape; oversight of threats and opportunities for synergy and trade-offs	Research into matrix of habitats in wider landscape as deemed important by local populations for wellbeing
Lack of attention to changes and their drivers at multiple scales	Links between ecosystem and wellbeing considered as operating in isolation, treated as closed to external influence	Unforeseen changes in wellbeing which represent threats or opportunities for ecosystem management	Research into multiple factors affecting wellbeing of stakeholders

poor smallholder farmers (Vedeld, 2004; Shackleton et al., 2007) who all share the same interest in maintaining forest cover to provide regulating services to maintain their agricultural output (Byron and Arnold, 1999). However, similarly to point 'a' above, such simplification may result in a lack of recognition of winners and losers, whether materially or socially and culturally (Daw et al., 2011). Understanding differences in people's land use preferences and how they may be impacted by environmental management requires finer-scale social understanding (Long and Ploeg, 1989; Wollenberg and Springate-Baginski, 2009).

- c) Oversight of power relations: Failure to understand the power and politics surrounding ecosystem trade-offs can lead to the assumption that conflicting objectives of different interest groups can be easily managed, for example through material redistribution (Wegner and Pascual, 2011). To understand the nature of trade-offs, both at local and wider scales, requires methods which embrace both plurality of interests, and differences in power (Edmunds and Wollenberg, 2001). Power is exercised through individual agency, formal and informal institutions, and cultures of discrimination. Through these channels it determines who may control or benefit from ecosystem services, who suffers from ecosystem disservices, which services may be considered legitimate and whose values and perspectives are acknowledged and accounted for (Armitage et al., 2009; McShane et al., 2011). These factors are critical in finding long-term solutions for environmental management (Leach et al., 1999; Ribot and Peluso, 2003), and in securing just outcomes for marginalised groups (Naidoo and Adamowicz, 2006; Sommerville et al., 2010).
- d) A focus on single land use types: In order to find locally-relevant solutions to conservation and development issues, it is essential to consider multiple habitats beyond core areas of biodiversity and to differentiate between different uses and users across those habitats (McNeely and Scherr, 2005; Termorshuizen and Opdam, 2009). Landscapes which may be partially forested also consist of agricultural land, wetlands, scrub, fallows and perhaps commercial crops and tree plantations which provide numerous and likely complementary services to local inhabitants. Rural people in developing countries often perceive the environment as consisting of a diverse landscape with numerous connected habitats which change over time and with the seasons, and which may have different meanings, importance and uses to people based on experience, knowledge and culture (Leach and Fairhead, 2000a; Cheng et al., 2003; de Groot et al., 2010).
- e) Lack of attention to changes and their drivers at multiple scales: The relationship between ecosystem services and wellbeing is not only affected by environmental change but also social, demographic, political, economic and technological changes which may impact demand for ecosystem services (Leach et al., 2010). Such changes operate at

different spatial and temporal scales. People's wellbeing may be influenced by microsocial processes but equally may be impacted by global economic fluctuations. Some changes may be slow and gradual such as climate or traditional practices, whereas others may be rapid shocks such as political unrest, outbreaks of a communicable disease, or earthquakes. While tropical ecosystems and their inhabitants are commonly subject to increasing global influences and to rapid changes, people's values and longstanding practices may prevent rapid behavioural modification (Smith and Stirling, 2010). We define drivers of change very broadly, as factors which directly or indirectly cause changes to the wellbeing of the participants, and those changes include perceived changes in the uncertainty and risk people face.

The capabilities approach to understanding human wellbeing (Sen, 1984) has been recognised as a promising framework for exploring connections between ecosystem services and wellbeing (Costanza et al., 2007; Polishchuk and Rauschmayer, 2012; Forsyth, 2015). This paper draws on a capabilities approach to help address the five forms of reductionism described above. Sen objected to utilitarian aggregation of both values and people, recognising that different people will achieve different outcomes, even with a similar set of resources. This is partly due to the set of capabilities they have to choose what to do with those resources (their power of agency to convert resources into desired ends) and partly due to their subjective preferences for what ends they most value (Sen, 1984).

While a capabilities and wellbeing framing can help us to disaggregate values, people and some aspects of power, we also find it suitable for a more holistic approach to understanding landscape level ecosystem service contributions to wellbeing. Our empirical study in Rwanda details the multiple ways in which ecosystem services contribute to human wellbeing from the perspective of rural populations living alongside tropical forests. By incorporating a relatively holistic definition of wellbeing, the question being addressed is not simply 'what are the links between forest ecosystem services and wellbeing?' but 'what changing role do ecosystem services from the landscape play in different people's wellbeing?' In this respect this study is not only concerned with the ecosystem services which stem from tropical forests and the impacts of protected area governance. Instead it takes a more holistic view of rural inhabitants' wellbeing and of the habitats contained within the wider landscape which influence their wellbeing.

1.1. Conceptualising Wellbeing

The wellbeing approach used in this study draws on Sen's, (1999) ideas about capabilities to conclude that "wellbeing arises from what a person has, what they can do and how they think and feel about what

they both have and can do,” (McGregor et al., 2007, 110). Wellbeing therefore comprises not only material concerns but two further, inter-related dimensions: the relational, representing the social and political processes which determine the distribution of costs and benefits, and; a subjective dimension, which addresses individual, social and cultural norms and values which influence people’s preferences and behaviour (Gough et al., 2007). This practical approach to researching wellbeing in developing country contexts is gaining momentum as a tool for understanding the links between ecological and social systems (Armitage et al., 2012; Franks et al., 2014). The resources, wellbeing outcomes and factors influencing meaning or values which comprise this wellbeing approach are illustrated in Fig. 1.

Resources are described as “what a person has,” in terms of five types of resource: natural, human, material, cultural and social, building on the capitals described in the sustainable livelihood framework (Scoones, 1998; Bebbington, 1999). Ecosystem services (considered to consist of provisioning, regulating and cultural services) constitute resources to people, directly as a natural resource but also interlinked with cultural, social, material and human resources. The ability to benefit from an ecosystem service may even be dependent on access to other resources such as knowledge and skills and so the resources which a person has also influence demand for ecosystem services.

Wellbeing outcomes or “what a person can do” is split between meeting basic needs and other quality of life outcomes. The distinction between basic needs and other outcomes is an important distinction for wellbeing theorists (Doyal and Gough, 1991; Sen, 1999; McGregor et al., 2007; Cruz et al., 2009). Basic needs, a more objective element of wellbeing, are here represented along the lines of Doyal and Gough’s (1991) theory of human need to include: 1) sufficient food, 2) adequate water, 3) physical and economical security, 4) shelter, 5) fuel for warmth and cooking, 6) physical and mental health and access to medical treatment (including childbirth), 7) autonomy or freedom of action, and 8) not to suffer from isolation or negative relationships. Basic needs are universal as for any individual there are lower thresholds of each of these eight categories below which they could not meaningfully function or where serious harm of an objective kind will result (Doyal and Gough, 1991).

The wellbeing framework does not only emphasise what people have and can do but also how they think and feel about these (McGregor et al., 2007). This subjective dimension of wellbeing (see Fig. 1) is concerned with the meaning that groups and individuals attach to resources and associated opportunities. This is a key insight that distinguishes a wellbeing framework from a livelihoods analysis. It suggests that understanding wellbeing outcomes requires a detailed exploration of the individual and collective factors which shape individual preferences (Camfield and Skevington, 2008). It assumes that both these contextual factors and the

resultant aspirations differ greatly between individuals. Therefore what actually constitutes meaning to people, whether healthy children, freedom of speech, meaningful relationships or all of these is not prescriptively listed here beyond universal basic needs. Fig. 1 identifies three key determinants of socially differentiated subjective meaning. Firstly, meaning is derived from an individual’s agency, their intrinsic motivation and feeling of competence to act in pursuit of their goals (Ryan and Deci, 2000; Alkire, 2005). But meanings or values are also constructed collectively. Within society, groups form systems of norms and values, often relating to certain social, political or geographical settings and these cultures or identities influence the attachment of meaning to goals and actions (Gupta and Ferguson, 1992). For that reason, social relations and culture are both also included in Fig. 1 as the second and third factors affecting subjective meanings attached to resources and outcomes. As a result culture is seen here as both a resource helping to attain wellbeing outcomes, and also a factor influencing the social construction of meaning (Fig. 1).

This wellbeing framework places considerable importance on social differentiation in determining the values attributed to ecosystem services. By implication, this requires attention to the relational dimension of wellbeing, which in this context represents the power relations between different stakeholders who value ecosystem services in different ways. This conceptualisation of the lives of those in developing countries does not consider wellbeing to be a state that is attained, but rather an ongoing process. Therefore attention to the drivers which affect wellbeing, and to the ongoing renegotiation of social and cultural values is inherent in the approach.

2. Materials and Methods

Rwanda has the highest population density on mainland Africa and around 90% of its rapidly growing population depend on small-scale agriculture (UNDP, 2007). Poverty is widespread in rural areas and more than half of under-fives are malnourished (WFP, 2012). Rwanda’s natural forests have diminished considerably in size since the 1970s. Both Gishwati Forest in the northwest of Rwanda and Nyungwe National Park (Nyungwe NP) in the southwest (Fig. 2) are montane rainforests reaching up to 3000 m altitude, and contain rich biodiversity including numerous species endemic to the Albertine Rift (Plumptre et al., 2007). Nyungwe forest received greater protection in the 1990s, became a National Park in 2003 and its size has remained relatively stable since at approximately 1000 km², with an estimated half a million people inhabiting clusters of villages which border it (Plumptre et al., 2007). Gishwati was of similar size to Nyungwe in the 1970s, but was cleared for cattle ranching projects, pine plantations and military zones in the 1980s and was further converted to cropland and human settlement for returnees from DRC after the genocide in the mid-1990s, (Plumptre et al., 2001), leaving a patch of degraded forest only 6 km² in size in 2002, which has been strictly protected since 2008.

Three ethnic groups make up the current Rwandan population, which comprises a majority of c.85% Hutu, minority of c.15% Tutsi and less than 1% Twa. However, in Rwanda there are also strong regional identities (Des Forges, 2005) and processes of globalisation have further blurred distinctions, reinforcing the need to look beyond commonly applied ethnic labels (de Lame, 2005). In this study we employ three broad socio-ethnic groups based on shared history, and the commonly distinct settlements they inhabit: 1) local Twa are an indigenous group, many of whom led very different lives until recently, but who have now been removed from forests to live in typical Rwandan settlements; 2) returnees from the Democratic Republic of Congo (DRC) who were resettled in the study sites after re-entering Rwanda following the 1994 genocide and temporarily homed in refugee camps; 3) the majority of the population are described as long-term residents of the mountainous regions of western Rwanda.

Research took place from October 2011 to May 2012, at eight villages across three sites: four villages in two sites bordering Nyungwe NP in

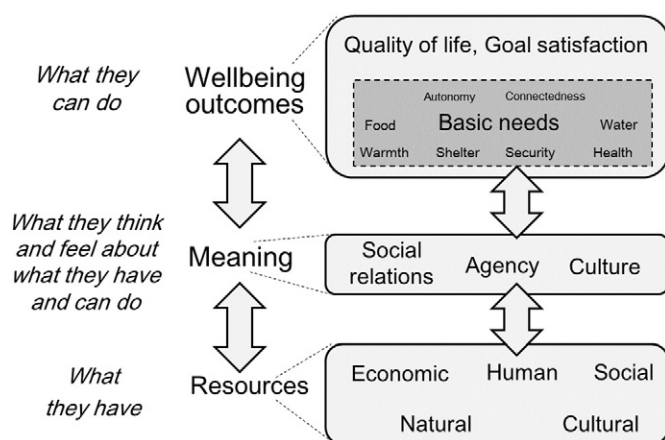


Fig. 1. A conceptual framework for multidimensional wellbeing. (adapted from Gough and McGregor, 2007).

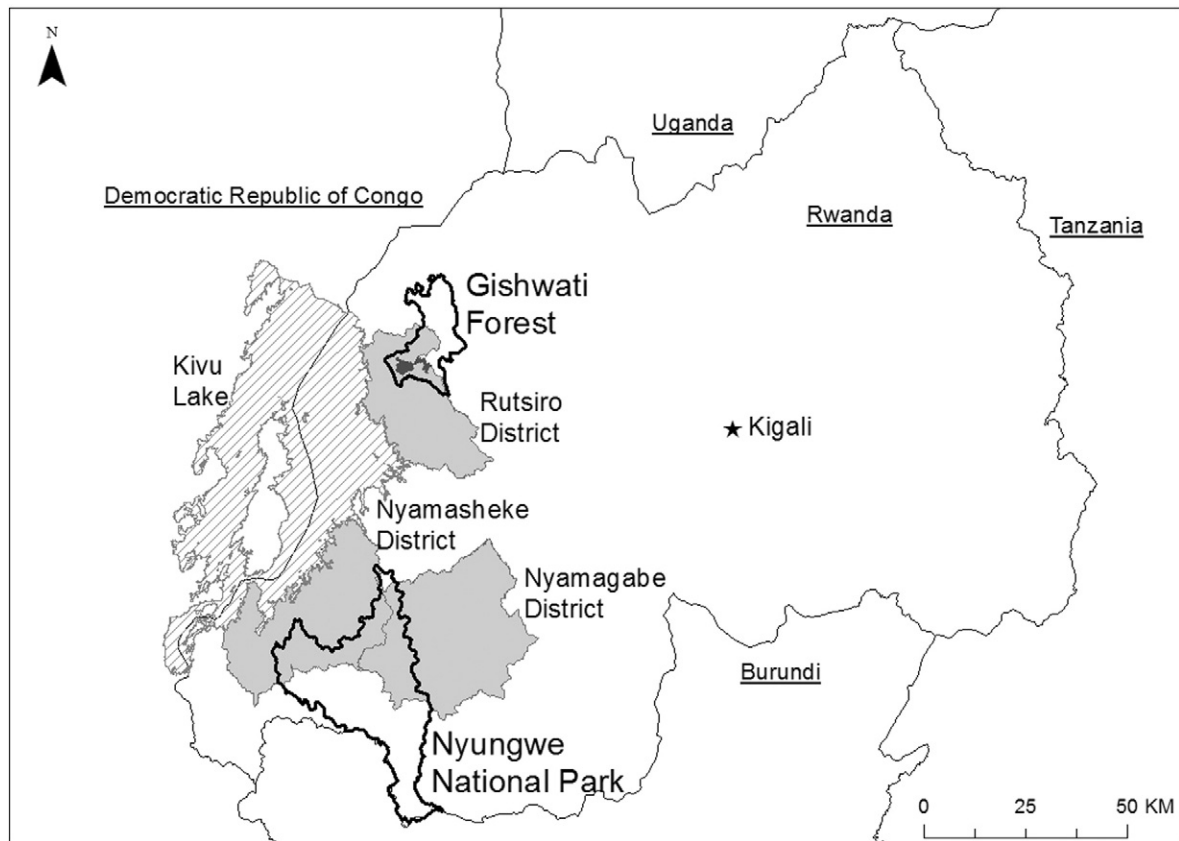


Fig. 2. Map showing the three Rwandan districts in which study sites were located alongside the two adjacent forest areas. The current extent of Gishwati Forest is shown by the darker grey area, while the black line shows its extent in 1986. The villages are not named or displayed for ethical purposes.

southwest Rwanda and four villages at one site bordering Gishwati Forest in the northwest (Fig. 2). The three research sites were selected based on their relative levels of infrastructure, access to transport, trade links and employment opportunities, ranging from a well-connected site alongside a main highway to a very remote site with no paved road, no public transport, four hours walk to the nearest small market and no tourism infrastructure. Villages within the three sites were selected so as to incorporate the ethnic and socio-economic variation present in that administrative sector. As villages in the moderately remote site were ethnically and socio-economically distinct, four villages were selected at that site so as not to overlook that variation.

Within each of the eight villages, three methods were employed: 1) focus groups; 2) semi-structured interviews, and; 3) more ethnographic methods of participant observation and informal key informant interviews to allow observation of local practices, resource and land use.

One focus group was conducted per village with between five and seven participants, including both men and women. Participants were asked “what is important to be able to live well in this village?” Instruction was given to the facilitator not to prompt or give examples but to encourage elaboration until participants felt the list was complete. The phrasing and translation of questions to elicit wellbeing priorities can be very influential with material concerns often emphasised at the expense of non-material concepts (Abunge et al., 2013), though in this case the question was interpreted broadly.

Semi-structured interviews were used to assess wellbeing, the influence of different changes and the contribution of various ecosystem services to wellbeing. Interviews incorporated open questions to enable the respondent to discuss areas of wellbeing perceived as important to the individual and their own subjective values, including their thoughts about the importance of culture, important social relations influencing their wellbeing and values and their individual experiences and

aspirations which indicated their agency. However interviews also contained a set of questions to record more objective and quantifiable resources at the household level (including land, livestock, housing, formal education levels, occupation and possession of assets) and also their ability to meet the basic needs detailed above. But while quantitative data were recorded to reflect differences in socio-economic status of participating households and their ability to meet basic needs, this did not represent a standard socio-economic or food security survey. Those questions which were common to each interview are presented in Appendix A. However interviews were intended to function as conversations guided by the respondent with no established order to questions, and there was also considerable scope within interviews to add questions in order to explore issues which were raised by the respondent in greater detail.

Interviews were completed with a minimum of 10% of households in each village (between 15 and 30 households per village), giving a total of 165 interviews. 42% of respondents were male and 58% were female (19% of households had only a female head of household). Respondents for semi-structured interviews were selected at random from lists of inhabitants held by local officials. Focus group respondents were in turn selected randomly from this subset of households. Interviews took place with either an adult male or female from each household and lasted between 1.5 and 4 h. Focus groups and interviews were all conducted in Kinyarwanda, the first language of all respondents. Notes were taken in Kinyarwanda during focus groups and interview responses were translated directly into English and recorded in written notes. Coding and thematic analysis of these qualitative data were performed in Nvivo 9 (QSR, 2010), to classify responses by ecosystem service category and by the sub-concepts included with the wellbeing framework presented in Fig. 1.

For analysis of differences between households, we employ three main variables: location (study site), socio-ethnic group, and socio-

economic status. The latter was defined through a hierarchical cluster analysis of four types of resources identified by villagers themselves during focus groups as being priorities for their wellbeing. Land, livestock, housing and opportunities to earn money were the quantifiable resources put forward in at least seven of the eight villages. Clustering was agglomerative using between-group linkages and squared Euclidean distances with standardised values to account for the different scales of the four variables used in the analysis.

In the remainder of the paper a comprehensive assessment of wellbeing is not presented. Rather both quantitative and qualitative data are used illustratively to address each of the five common shortcomings of ecosystem service research listed in the Introduction section. The emphasis of this study design and analysis was on participants' perceptions of what it meant to them to live well, how satisfied they were with their quality of life, how ecosystem services contributed to their wellbeing, and how and why they felt each of these things was changing. The field work therefore afforded considerable time and regard to developing trust and mutual understanding with participants and village leaders, to ensuring participants understood the motivations for the research, the independence of the researchers, procedures regarding anonymity and that they consented to take part. Ethical approval was gained through the researchers' host university. As part of this approach participant observation and key informant interviews took place continually over the course of the fieldwork both inside the village and in the various habitats surrounding the villages.

3. Results

3.1. Consideration of Different Types of Values

When asked “what is important to be able to live well in this village?” focus group respondents revealed very consistent ideas across all eight villages. The responses shown in Table 2 were agreed as being important in six or more of the eight focus groups conducted.

The seven responses in Table 2 include economic, natural, human, social and cultural resources, supporting the idea that a multidimensional definition of wellbeing is necessary to comprehend how ecosystem services support wellbeing. The list of wellbeing components is similar to other qualitative studies in rural Rwanda, with authority, land, health and shelter playing an important role in the lives of villagers, even to the extent that education receives limited mention (Abbott and Wallace, 2012; Ingelaere, 2014).

Household interviews revealed considerable differences in the way resources were valued. Here we focus on the variety of values relating

Table 2
Factors considered by participants to be important to their wellbeing and rationale provided.

Component of wellbeing	Rationale provided
Land and livestock	To produce food to satisfy basic needs and to grow crops to secure regular income
Having adequate shelter for the family	Many houses are very basic constructions and small spaces for accommodating a large family
Infrastructure, particularly paved roads and transport networks	Linked to opportunities for both trade and work
Access to work opportunities	Enables people to exploit different income streams among the diverse rural economy
Good health	To be able to act effectively to produce food and to earn an income
Social relations and sharing between households	To maintain good relations and help those in need
The freedom for people to be able to make their own decisions about how to act to achieve wellbeing	Currently centrally designed rules regarding agriculture, housing standards and even personal appearance impose too many constraints on villagers

to land use to illustrate differences in how people “think and feel about what they have and can do.” Land was not only valued as an economic resource to provide food and income. Rather these material values were interrelated with traditional knowledge, cultural norms and identities which had developed separately and distinctly for the three socio-ethnic groups.

The majority of people interviewed were long-term residents who prioritised growing multiple crops with their land. The common type of farming practised by this group in each of the study sites was a complex polyculture producing a multitude of different crops with different tolerances and timings, often grown on numerous plots with varied soils, slope, shade and moisture. This practice of agricultural production appears to be inseparable from the cultural meaning that is attached to land, livestock, agricultural inputs and associated human resources. In other words, provisioning and cultural ecosystem services are connected. Indeed these systems of land management are intertwined with the culture and social systems, labour markets and trade patterns of people inhabiting this mountainous landscape, having developed over centuries to minimise the risk of having nothing to eat, as a response to extreme topography and climate (Pottier and Nkundabashaka, 1992). Crops grown by those interviewed included potatoes, sweet potatoes, beans, maize, bananas of several varieties, taro, cassava, squashes, peas, wheat, sugar cane, avocado, cabbage and many others. In the west of the country, the 2008 national agricultural survey revealed that farmers grew sixty different types of edible crops, with 95% of farmers using traditional polyculture at that time (NISR, 2010).

The same basis for valuing land was not shared by all households. Many of the returnees from DRC left Rwanda in the 1960s or were born in DRC, where land was far more abundant, soil more fertile and climate less extreme. They were placed in communities in Rwanda in the mid-1990s rather than making their own choice of where to settle and each household was provided with at least 1 ha of land on which to farm. However this group had not developed the same material or cultural attachment to polyculture systems and of the 28 households of returnees, 21 had changed from growing crops to trade milk, or to grow trees or tea.

In further contrast, the culture for local Twa had only begun to change quite recently due to their removal and exclusion from the forests. In focus groups they emphasised finding work as the most important resource for wellbeing rather than land. Twa made little progress in turning to agriculture for their livelihoods and instead most became dependent on labouring opportunities and were willing to migrate to different areas to find work. Those who received plots from the government in the past readily sold their land soon after, even though they possessed many of the human resources required to manage that land. From interviews, cultural links to the protected forest were far more evident than for the other two groups. Twa respondents talked at length about the significance of forest goods to their wellbeing, as the two following examples reveal:

“We pygmy have our proper culture that is different to ordinary people, because we have a different history. Ours was of hunting and gathering in the forest. So when we were taken from the forest we had no choice but to adapt to a culture different to our own, finding other livelihoods.”

“Our culture is starting to disappear. Like knowing how to look for different types of honey, our children no longer know how that is done.”

3.2. Disaggregation of People

Households were found to be differentiated along several lines in respect to their wellbeing and how they valued ecosystem services. “What people have” and “what they can do,” (Fig. 1) differed considerably

between households in terms of socio-economic status, socio-ethnic group, and, to a lesser extent, geographic location. In order to establish socio-economic differences the objective indicators put forward as being important in focus groups were used to formulate variables for a hierarchical cluster analysis. Land size, livestock, employment and shelter were attributed to between three and six categories (Table 3).

As a result of the cluster analysis 34% of households could be classed as labourers with no land or only very small plots, a further 38% as resource poor workers, leaving only 28% who could be classed as belonging to two relatively wealthy groups (Table 4). One household could not be grouped with any of the four clusters, being professionals whose land had been lost to a government reforestation project without compensation. Analyses of variance revealed that each of the four main groups were statistically significantly different from one another at the 1% level, with the exception of the relatively wealthy professionals without livestock, because their lack of livestock was, unsurprisingly, similar to the landless labourers.

Poverty was widespread among participating households and provisioning ecosystem services played a considerable role in the meeting of basic needs for many. Those most commonly sought included: food production from subsistence agriculture; firewood for fuel; grasses for livestock (primarily to produce milk or manure); wood, earth and rope for housing; and medicinal plants for health. Land holdings were generally very small at all sites, but there was also considerable inequality (Table 4). More than half of sample households farmed only for subsistence. The landless labourers were reliant on sporadic labouring opportunities which yield uncertain and very small wages. These households were unable to access the means to meet not just one, but multiple basic needs: 89% collected firewood illegally (making them vulnerable to fines), 55% had no medical insurance (another 32% were reliant on the government to pay for them) and 75% suffered food scarcity, having to go at least an entire day a month with no food at all (Table 5). In the absence of employment opportunities few could afford to buy sufficient food from markets and, due to strict forest protection, hunting and gathering were very rarely employed as an alternative.

Demand for some provisioning services increased with wealth. As open grazing of livestock on public land was forbidden in Rwanda and cattle must be kept inside sheds, demand for fodder and bedding had greatly increased. This demand came primarily from the relatively wealthy minority (36% of our sample, Table 3) who own cows, although a further 14% of households borrowed cows from wealthier owners. The provisioning services sought (illegally) from protected natural forests did not appear to be related to basic needs either. When asked what resources were missed from the now protected forest, respondents' specified meat, honey and gold, all of which were primarily sold for income. Mining for gold and other minerals was still frequently recorded in Nyungwe NP by forest rangers and 40% of incidents in 2011 occurred in the vicinity of one of our study sites, representing approximately 78 mines at that site in one year alone (Rwanda Development Board, unpublished data). Although no respondents openly admitted to mining during interviews, participant observation and informal interviews in that study area revealed mining to be very widespread around the forest edge and involved some of the wealthiest respondents in the sample. Similarly hunting, still prevalent in Nyungwe NP (Martin et al., 2014)

and also occurring in Gishwati Forest (Nyandwi, 2008), was considered to be carried out by specific individuals who may travel long distances and sell meat for money rather than being a common subsistence activity (Mulindahabi and Ndikubwimana, 2010).

The material wellbeing and socio-economic status of households was strongly related to their socio-ethnic group (Table 3, Fig. 3). Two households suffered particularly low levels of material wellbeing: 88% were classed as landless labourers (Fig. 3), 94% endured food scarcity at least one day per month and all were dependent upon illegal firewood collection (Table 5). In stark contrast returnee households were on average able to achieve higher income-earning occupations than other groups, with less than 10% classified as landless labourers (Fig. 3), in part because they were provided with disproportionately large areas of land, often appropriated from long-term residents without compensation (Bruce, 2007). Female headed households were slightly skewed towards lower occupation categories, accounting for 26% of the 27 poorest households compared to 20% of the entire sample.

Benefits from tourism came in the form of jobs, a government revenue sharing scheme and NGO-distributed benefits in the form of water supply, education facilities and farming inputs. They were geographically skewed towards the two sites with tourism centres and concentrated among the wealthier households in specific villages within these sites where up to 67% of households perceived benefit (Table 3). In the two villages in the most remote area, furthest from National Park headquarters, not a single household perceived any benefit (Table 3).

3.3. Power Relations

The contribution of ecosystem services to the wellbeing of forest-adjacent populations was clearly mediated by power relations. Here we give two examples of how social and political processes may restrict benefits or impose costs on groups whose social status is relatively marginalised.

Although firewood did not appear to be a limited resource in the landscape, an analysis of basic needs and changing ecosystem service availability revealed a local scale trade-off with important implications for the poorest households and for ecosystem management. Only 18% of households were able to acquire firewood from their own land and alternatives such as charcoal were unaffordable for all but the wealthiest villagers, so the majority of households collected firewood in government owned or private forests of non-native trees (Table 5). This informal access had persisted for many years, allowing the poor to benefit from firewood available in the landscape. However, this group were unable to protect their resource access as timber and charcoal became an increasingly marketised commodity and as those with property rights excluded informal access through formalisation of land tenure. This was exacerbated by increasingly strict protection of native forest. The result has been an increasing risk associated with firewood collection with many respondents complaining of greater frequency of financial or physical punishment. Plans for the commercial utilisation of publicly owned forest buffer zones threaten to further limit access to essential firewood, particularly for the poorest (Gross-Camp et al., 2015).

As described above, forests had come under increased protection to preserve biodiversity and to allow for generation of tourism revenue.

Table 3

Categories of land size, livestock, shelter and occupation used for hierarchical cluster analysis (based on interview data for 165 households).

Group	Land size	Livestock	House type	Occupation
1	<0.1 ha (18%)	No livestock (33%)	Basic: earth and sticks (25%)	Agricultural labour only (17%)
2	0.1 to 0.25 ha (23%)	Small livestock/borrow 1 cow (31%)	3 rooms or less, made of large adobe or concrete blocks (42%)	Other labouring (e.g. tea labour, building, charcoal or brewing) (25%)
3	0.26 to 0.5 ha (22%)	Own one cow (22%)	Larger houses of concrete or manufactured bricks (33%)	Own trade such as crops and shop owners (36%)
4	0.51 to 1 ha (19%)	Own two cows or more (14%)		Professionals (builders, teachers, administrators etc., 12%)
5	1.1 to 2.5 ha (14%)			
6	>2.5 ha (4%)			

Table 4
Results of hierarchical cluster analysis displaying different groups identified from 165 households in rural Rwanda (1 household could not be grouped).

	Landless labourers (34%)	Resource poor workers (38%)	Relatively wealthy, diversified farmers (24%)	Relatively wealthy professionals without livestock (3%)
Land (hectares)	Negligible, average 0.13 ha	Small, average 0.56 ha	Relatively large, average 2 ha	Relatively large, average 2.25 ha
Livestock	Majority have none, 7% own a cow	29% own a cow	93% own cows	No livestock. All grow trees commercially
Occupation	Labourers earning 40p to £1 per day	Regular, low-paid work. 43% trade crops	Run own business or earn off-farm income. 68% trade crops	All are professionals
Housing	Small and basic houses	70% small or medium	Relatively large houses	All have large houses

Increased forest protection had undoubtedly had negative impacts on local livelihoods and these impacts had been particularly acute for those Twa, whose livelihoods, and in many cases homes, had been dependent on native forest habitats. But in addition to their lack of formal or informal access to forests, prejudice and discrimination were still common experiences for Twa. Their ability to succeed in finding resources to meet basic needs and alternative livelihoods to forest use had been considerably hindered by social exclusion and also repeated examples of exploitation. Cooperatives had failed due to corrupt leadership, considerable amounts of labouring wages were misappropriated, and donations to Twa redirected, all by people from other socio-ethnic groups.

“Most of our problems we have now can be solved by finding regular work... In the past there were no jobs either but at that time we could find a livelihood from the forest, we didn't need a project then. When we go to ask for jobs in the tea project they refuse to give them to us. The job that provides a good wage, they don't give that work to us Twa.... Having a decent job doesn't require just education, your ethnicity is a factor.”

Such occurrences were not restricted to the Twa. Some of the poorest households from other socio-ethnic groups found themselves unable to benefit from livestock distribution schemes aimed at helping them, due to corruption.

“The local leaders call it the distributor's juice and that goes into their pocket. Here it costs 15,000 (Rwandan francs, c.UK£15) to get what is entitled to you. You have to pay rather than go without the cow! We have no choice about that.”

3.4. Multiple Land use Types: Exploring the Contribution of Ecosystem Services to Wellbeing at the Landscape Scale

Prior to strict forest protection, Rwanda's tropical forests provided a large number of provisioning ecosystem services to the surrounding populations, including timber products, fruits, grazing and medicines (Hill et al., 2002). However, interviews and observation of local practices revealed that the goods which households required to meet basic needs could all be acquired from habitats outside of native forest. For example all firewood collected and building timber observed consisted of non-native trees common in private plantations, fields or protected area buffer zones. The valuation of ecosystem services from native forests was therefore mediated by the availability of substitutes.

Only a single regulating service was widely perceived to be of benefit to participants: 81% of all households regarded the influence of forests on climate as beneficial for agriculture (through rainfall and frosts creating soil moisture), and also for health (the cold creating unfavourable conditions for malarial mosquitos, Table 5). Climate regulation was a key factor explaining the presence of dense human populations at the forest edge in Rwanda's mountains (Roose and Ndayizigiye, 1997; Van Hoyweghen, 1999). And fear of disrupting local rainfall patterns was the major reason that many people supported forest protection despite the loss of ecosystem services due to strict conservation. However a much lower proportion of respondents (60%) perceived benefit from

climate regulation in the study site with greater infrastructure and trade opportunities, where the meeting of basic needs was less intimately linked to cultivation (Table 5).

Unexpectedly, not a single household felt that native forests provided any benefit in terms of erosion regulation, soil fertility or water provision. Inhabitants felt that these functions were just as easily performed by non-forested habitats such as grasslands or non-native forests. This perspective is particularly surprising given that the deforestation of Gishwati, next to which half of those interviewed had lived, was widely considered to be an ecological disaster which caused severe landslides and deaths. However many pointed to the fact that they live on deforested slopes without any forest on their peaks, yet have no problems of water provision and may use alternative means to stabilise their soil such as channels and terracing.

3.5. Changes Over Time and Their Drivers at Multiple Scales

A number of different changes were having profound effects on the wellbeing of respondents. Improved health and education services, improved security, population increase, rising costs of living and increased forest protection all had important influences on people's wellbeing and behaviour regarding ecosystem services. However, the most important change put forward by respondents related to government policies to promote productivity growth in Rwandan agriculture. The Rwandan government, supported by international donors, implemented a National Land Policy in 2004 stipulating that the government may choose to reallocate it if not used effectively (ROR, 2004). A subsequent nationwide crop intensification programme set strict production targets for six approved crops and made available subsidised seeds and chemical fertilisers (MINAGRI, 2008). The policies effectively dictated that smallholders cease practising polyculture and plant only approved crops in each of the two growing seasons, changes which affected study sites from 2010. The ability of smallholders to benefit from increasing yields was limited by ability to participate in credit schemes for seeds and fertiliser. Only 37% of households in this study actually traded crops for income, and these households were very unlikely to take credit and use subsidised inputs. Only 32% of all households did so. In response to open questions (e.g. “How have the crops you grow changed over the years?” 68 of the 165 people interviewed felt that they had been negatively impacted by recent agricultural policies whereas only six felt that they had benefitted. Perceived negative effects included reduced land tenure security, creating an incentive for the poorest households to sell their land.

“We go to buy seeds at the sector but they can't provide them to us unless we can afford to buy fertiliser too. Myself, I am not buying seeds from them because of that. In summary, I am not allowed to mix my crops anymore and the result is that we are starving here. The consequence of this is that we are suffering in poverty now.”

4. Discussion

Ecosystem service research has, so far, played a limited role in the management of ecosystems for joint social and ecological objectives, and due to poor integration of social science with ecological or economic

Table 5 Basic needs, ecosystem services and socio-economic indicators across socio-economic, ethnic groups and study site.

	Socio-economic groups			Socio-ethnic groups			Geographic locations			Average (range) by village (n = 165)	
	Landless labourers (n = 56)	Resource-poor workers (n = 63)	Relatively wealthy, diversified farmers (n = 40)	Relatively wealthy professional without livestock (n = 5)	Long term residents (n = 120)	Returnees from DRC (n = 28)	Twa (n = 17)	Connected to markets with employment (n = 50)	Remote, some infrastructure (n = 75)		Very remote, lack of infrastructure (n = 40)
Average land size in hectares (standard error)	0.13 (0.02)	0.56 (0.05)	2.00 (0.30)	2.25 (0.45)	0.68 (0.09)	1.73 (0.36)	0.22 (0.06)	0.61 (0.12)	0.74 (0.11)	1.20 (0.30)	0.81 (0.3–1.8)
Food scarcity, at least once per month	75%	27%	13%	20%	28%	54%	94%	32%	37%	53%	39%
Collect firewood illegally	89%	54%	43%	0%	58%	54%	100%	50%	57%	83%	61%
Without health insurance	55%	35%	28%	0%	43%	25%	29%	34%	48%	28%	39%
Perceive benefit from climate regulation	77%	78%	98%	40%	77%	93%	94%	60%	89%	93%	81%
Perceive benefit from tourism	27%	33%	30%	40%	23%	43%	59%	36%	43%	0%	30%

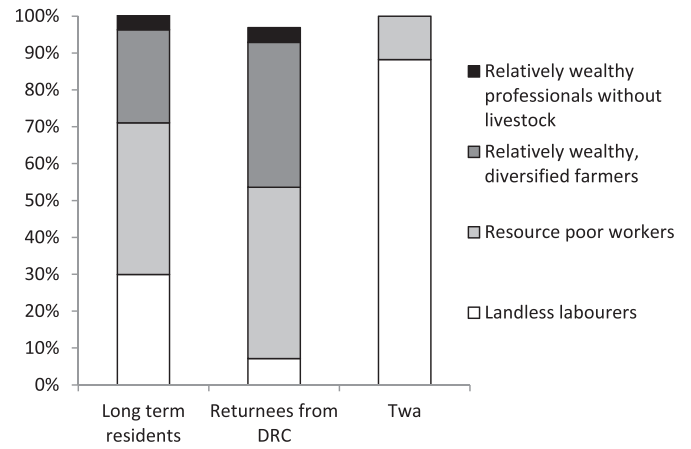


Fig. 3. Proportion of households of each socio-ethnic group displayed by socio-economic categories.

studies, has resulted in correspondingly limited progress in understanding socio-ecological complexity (Reyers et al., 2011; Lele et al., 2013). One suggestion to improve this situation is to incorporate social data based on the capability approach, to enrich understanding of how people use and value ecosystem services (Polishchuk and Rauschmayer, 2012; Forsyth, 2015). This research has explored the utility of this approach by identifying and analysing a set of five categories of socio-ecological reductionism which commonly occur in ecosystem service research and ecosystem management (summarised in Table 1): a failure to consider different types of values; aggregation of people across large scales; oversight of power relations; a focus on single land use types (commonly biodiversity-rich habitats); and lack of attention to changes occurring in people's lives and their drivers. Even given the limited scope of this study, which focuses only on perspectives of forest-adjacent villagers, we believe it provides new insights that go well beyond the socio-economic data commonly relied upon by natural resource managers for the purposes of ecosystem management. We also suggest that they help to reveal possibilities for jointly addressing conservation and development objectives that are not obvious through more reductionist analysis.

Studies using monetary proxies to represent ecosystem service values such as contribution to income, cost-benefit or contingent valuation may overlook the importance of non-material benefits or the crucial contribution ecosystem services make to meeting basic human needs (Pagiola et al., 2002; Kroeger and Casey, 2007; Jax et al., 2013). In this case study, through both quantitative and qualitative data presented, the focus was on conceptions of what it means to live well in the local context and on the values, preferences and perceptions of rural inhabitants themselves. Although land and material wealth played a role, the use of ecosystem services and the ways in which they were valued was strongly mediated by social relations, cultural norms, historical and political factors. The freedom to manage land utilising cultural knowledge was an important element of wellbeing. It should not be expected that freedoms are valued any less by the rural poor (Sen, 1999) and freedom of decision making has also emerged as an important component of wellbeing in similar ecosystem service studies (Abunge et al., 2013). Lack of recognition of people's values and practices, and limited influence over decision making may lead to claims of injustice in environmental management and lack of compliance with tenure regimes imposed (Martin et al., 2013).

Definitions of cultural ecosystem services have proven difficult to incorporate into research (Daniel et al., 2012). While provisioning and cultural services are defined as being quite distinct in most ecosystem service work (MA, 2005), our empirical findings, based on an experiential approach to identifying and categorising services, supports the view that definitions must recognise an overlap between provisioning and

cultural ecosystem services (Chan et al., 2012) and should additionally be considered to be interrelated with regulating services. This can be easily explained by considering the widely-accepted view that the knowledge required by smallholder farmers to manage land effectively under environmental constraints and uncertainty may have developed over many generations and represents a cultural resource (Berkes et al., 2000; Leach and Fairhead, 2000b). Indeed much of what people consider to be part of their culture involved the use or consumption of material things and oversight of these links can lead to unrecognised impacts of policies. The cultural ecosystem services identified in this study had little to do with worship, recreation or inspiration among local people, which comprise the somewhat restrictive definition put forward in the Millennium Ecosystem Assessment (MA, 2005).

By aggregating populations over large scales and using averages to characterise them, many of the important distinctions between local resource users may be overlooked and the situation of some of the poorest and most disadvantaged groups can be ignored or misinterpreted. Indeed the aggregation of both people and their values by decision makers may cumulatively and counterproductively contribute to increased discrimination of marginalised people whose status differs from the average and whose values contrast with the hegemonic view. The disaggregation of rural populations is extremely relevant to the pursuit of development goals alongside biodiversity conservation and arguably essential to be able to measure either positive or adverse effects upon wellbeing or poverty. Where people struggle to meet multiple basic needs and few alternatives exist beyond natural resources, demand will undoubtedly arise for provisioning ecosystem services (Barrett and Swallow, 2006). Conversely, despite the prevalence of acute poverty in this study, the ecosystem services most dependent upon native tropical forests were more common to relatively wealthy households. In practical terms the specific nature of the basic need or want, the particular habitat and ecosystem service which can satisfy it and the types of people who rely on that ecosystem service are pertinent details for the design of interventions to mitigate negative impacts or to maximise co-benefits.

Differences in power between stakeholder groups influence which values are recognised in policies governing natural resources, in the negotiation of trade-offs and consequently in the contribution of ecosystem services and disservices to the wellbeing of local people. Throughout the developing world, benefits of conservation have tended to accrue to distant rather than local stakeholders (Fearnside, 2003; West et al., 2006). Local perspectives played little part in shaping the natural resource management in this study and the few benefits derived from conservation activities by local stakeholders (such as tourism) were most often captured by relatively wealthy households and concentrated in specific locations with high levels of infrastructure. Many local users, and particularly the indigenous Twa whose links to the forest have never received official recognition in Rwanda (Lewis, 2006), suffered considerably from the almost complete deforestation of Gishwati Forest and from subsequent protectionist policies. Most Twa respondents, many of whom inhabited tropical forest until the early 1990s and some even after 2000, maintained their cultural links to the forest despite strict protection having turned it into “only a poster,” for them. Their removal from the forests, subsequent denial of access to forest products together with laws restricting ethnic recognition have attracted criticism from human rights groups as cultural assimilation (Beswick, 2011).

Social differentiation and relative power also have a strong influence on the negotiation of access and trade-offs at the local scale. The relative position of the most disadvantaged among local populations, their agency and ability to negotiate and participate in both formal and informal decision-making processes is therefore particularly important to consider in research which seeks to promote social as well as ecological outcomes (Edmunds and Wollenberg, 2001). Research has revealed in similar contexts that material redistribution alone is unlikely to achieve intended social and behavioural outcomes as poverty can be reproduced through power inequalities (Cleaver, 2005).

The multiple habitats which make up landscapes should be considered in order to derive conservation and development solutions to ecosystem service trade-offs (de Groot et al., 2010). The availability of alternatives in the landscape to the ecosystem services provided by highly biodiverse habitats and the impact on values attributed to them receives scant attention in the ecosystem service literature. Many of the services important to households neighbouring Nyungwe and Gishwati were not specific to those native forests (which were already strictly protected). Rather wellbeing was strongly influenced by access to alternatives in the surrounding landscape, including resources from fields, wetlands and non-native forests. The prominence of alternatives to native forest ecosystem services was not restricted to provisioning services but also included regulating services. For example soil retention services can be provided even by pasture land as has been shown in areas around Gishwati forest, even on quite severe slopes (Mukashema, 2007).

Primary forest conservation is key to maximising biodiversity and ecosystem service provision to wider populations, nationally and beyond (Barlow et al., 2007). In western Rwanda the potential for non-native forest habitats to provide alternative, vital resources to local populations provides a clear opportunity for conservation. Positive outcomes for both the wellbeing of local populations and forest conservation (through reduced or averted illegal use of primary habitats) could be achieved in this region through a more integrated governance of the matrix of habitats outside of native forests. Provision of public lands for agreed multiple, low-impact uses alongside afforestation and with specific attention to marginalised groups, may be well aligned with the needs and practices of local stakeholders. However such opportunities are not being reflected in current policy trends. Increasing forest protection and state regulation have had restrictive impacts on local resource use and further restrictions within such highly utilised landscapes on which people's wellbeing is so crucially dependent are unlikely to induce the desired behavioural changes for sustainable ecosystem management. Market-based solutions to enhance regulating services, such as payments for environmental services or REDD+ schemes, most often seek to maintain or increase restrictions on land use (Mahanty et al., 2012) and may therefore also be unsuitable in this context. Such schemes rely primarily upon financial compensation for restricted use, which is rarely sufficient for households to afford alternatives (Jindal et al., 2012).

Alongside other economic, social and environmental changes, the lives of rural inhabitants were dramatically affected by extensive national policies. Rwandan agricultural policies have arisen from a narrative which views traditional practices of food production as archaic causes of land degradation and these policies severely affected certainty over land tenure and the ability of people to produce sufficient food to subsist or earn an income, with negative impacts disproportionately incurred by the poorest groups (Pritchard, 2013; Van Damme et al., 2014). Increased landlessness and poverty among the forest-adjacent population may have considerable implications for the demand for ecosystem services.

The definition of wellbeing utilised in this study places importance on a plurality of experiences and perspectives alongside power imbalances and does not privilege specific knowledge or points of view. Its combination with ecosystem services in the framework presented provides a basis to interpret local perceptions and needs, and therefore to contribute to more equitable outcomes for local inhabitants alongside sustainability goals. This consideration to local ways of thinking and acting may serve to close the gap between: the dominant approaches to the study of ecosystem services and poverty, and; the practical issues of social wellbeing and human rights increasingly being pursued in joint development and conservation initiatives.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <http://dx.doi.org/10.1016/j.ecolecon.2015.06.018>.

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