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Preferences for forest benefits: are distributive justice principles reflected in values for Ecosystem Services?

by

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Thesis for the degree of Doctor of Philosophy

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Abstract

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Forest resources have an important role in supporting the livelihood strategies of rural communities in Malawi, especially for the poorest village members, and can have an important equalising effect. The management system of forest ecosystems determines how those resources are distributed to local users and therefore influences total societal welfare. The current management policies in Malawi are evolving toward a community-based management scheme, i.e. co-management policies, where local communities become responsible for all the harvesting activities. The committee-based configuration adopted in Malawi establishes new local institutions responsible for the management and the distribution of forest resources. The aim of this PhD is to assess how the implementation of CBM influences the welfare of the local forest users both by determining the level of personal consumption and the fairness of the overall distribution using rational choice theory and economic valuation methods. The relative importance of the fairness of the overall distribution depends also on the procedures used to allocate decision-making power over forest resources. Therefore, this PhD evaluates also whether individual's distributive behaviour is influenced by procedures, and its fairness. Finally, because the socio-ecological system is embedded in a broader ecological system this PhD performs an integrated assessment of the welfare impact of CBM policies on beneficiaries by quantifying the aggregate availability of forest resources given the ecological status of the forest and the total societal welfare according to how those resources are distributed to local users. This thesis demonstrates that the individual rational choices on how to distribute forest resources are determined both by self-interested preferences and societal values and that individuals are willing to forego some personal benefits to achieve a fairer outcome that benefit all community members. Indicating that individual's welfare is influenced both by the total amount of forest products that can be consumed at personal level but also by the magnitude of resources distributed to others. However, the relevance of fairness concerns for the individual when choosing how to distribute resources between village members depends on the fairness of procedures employed in defining the decision-making roles. Finally, the thesis shows that the current consumption patterns are not ecologically sustainable and that without intervention many sub-areas of the forest reserve would be completely degraded in 15 years. Introducing co-management policies to limit consumption within sustainable levels would overall benefit the population as indicated by the welfare effects gain. We also show that different distributional rules are found to influence greatly the total welfare gains and how our welfare analysis approach

can be used as a useful tool to inform decision-making when fairness and distributional rules are deemed as relevant for societal welfare.

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I declare that this thesis and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

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2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission

Signature: Date: 24/08/2019

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Definitions and Abbreviations

CBFM	Community-based forest management
CBM	Community-based management
DBH	Diameter at breast height
DCE	Discrete Choice Experiment
ES	Ecosystem services
FAO	Food and Agricultural Organization
FRIM	Forest research institute of Malawi
GIS	Geographic information system
HH	Household(s)
KII	Key informant interview
MEA	Millennium ecosystem assessment
SP	Stated preferences
TEV	Total economic value
WTP	Willingness to pay

Chapter 1 Introduction

1.1 Background and research problem

Rural communities in Malawi strongly rely on forest ecosystem services (ES) for their basic needs; forests provide food, fuelwood, water, soil nutrients, flood protection and socio-cultural benefits. Forest products are an important resource for income-generating activities and provide means to accumulate assets to promote economic development and poverty alleviation (Campbell, 1996; Fisher, 2004; Kamanga et al., 2009; Kayambazinthu and Locke, 2002). At the same time, the combination of high population growth, which increases pressures on forest ecosystems for agriculture development, and the lack of sustainable energy sources, leading to high biomass dependence (e.g. fuelwood and charcoal), poses challenges to the implementation of effective sustainable management systems of forest ecosystems (Place and Otsuka, 2001). Forest coverage in Malawi has been declining at a fast rate. Although the actual forest cover is not known with certainty, it has been estimated that the annual rate of deforestation ranges between 1% and 3.5% (Bekele, 2001; FAO, 2010; Zulu, 2010).

Sustainable development requires balancing the exploitation of natural resources for meeting present human needs and socio-economic development goals while guaranteeing the long-term ability of natural ecosystems to provide benefits to future generations (UN Assembly, 1987). Especially in low-income countries, where the socio-economic system is closely connected to, and dependent on ecosystems, the loss of natural capital is among the major threats to sustainable development. The degradation of forest ecosystems has strong effects on the welfare of rural population with disproportionate effects on the poorest people. Forest resources are in fact an important source of income for most rural households, have an important equalising effect and act as a safety-net preventing poor households falling deeper into poverty (Angelsen et al., 2014; Chilongo, 2014; Kamanga et al., 2009).

Forest management policies play a key role in ensuring the efficient use of forest resources and an equitable distribution of benefits. The forest management system in Malawi has evolved over the last decades from a centralized system to a community-based system (CBM). In a CBM system, local users are involved in the management of the natural resource with the aim to improve ecological outcomes and to facilitate access to all local users (Agrawal, 2001). The hypothesis underlying CBM is that local communities have the incentives and the knowledge to manage the forest ecosystem ensuring both ecological sustainability and the development of management rules according to all users' needs (Bowler et al., 2012; Ostrom et al., 1999). However, experiences across different countries have shown that CBM of forests (CBFM) has improved ecological sustainability and reduced unsustainable harvest, but its effectiveness in terms of equitable distribution of benefits and improved livelihoods is unclear (Ameha et al., 2014; Chomba et al., 2015; Lund and Treue, 2008; Vyamana, 2009). Collective action for natural resource management is more likely to generate efficient and equitable outcomes if local user groups can cooperate and coordinate their heterogeneous interests in forest uses (Varughese and Ostrom, 2001). The participation of all local forest users in the implementation of CBFM policies, especially during the decision-making phases, increases the probability of a positive joint outcome, i.e. reducing unsustainable harvest whilst guaranteeing benefits to all users (Persha et al., 2011). The hierarchy of the social relationships within the community and other local actors, and an unequal distribution of power, can limit the possibility for all members to actively participate and therefore the inclusion of the interests of the marginalised groups. Local elites and other powerful local actors can constrain the distribution of benefits among all users, exacerbate existing inequalities and generate negative social outcomes (Adhikari et al., 2014; Persha and Andersson, 2014; Yadav et al., 2015).

Forests are a common-pool resource characterized by a conflict among individual interests in harvesting the natural resource to maximise the utility derived from it, and societal interests in managing the resource sustainably to guarantee a long-term flow of benefits for all users (Perman et al., 2003). Therefore, individual preferences and behaviour regarding forest management may be driven by ethical and moral considerations, such as fairness concerns, in addition to the maximisation of individual preferences. This raises the question of how members of forest-adjacent communities would prefer to see such fairness considerations addressed in forest management and how their choices are influenced by it. Understanding and identifying the socio-economic values involved in those choices can highlight the role of individual distributive preferences for the allocation of forest resources in shaping the outcomes of CBM policies and the factors that may influence those preferences.

Rational choice theory can be used to model individual behaviour regarding public policies so to assess preferences for the provision of forest products under a specific management regime and to quantify the socio-economic values that the individual holds in such context (McFadden, 1999; TEEB, 2010). However, microeconomic theory often considers individual choices motivated by pure self-interest and may fail to adequately reflect the influence of social and moral values on preferences for forest ecosystems. To elicit a wider range of values that individuals attach to the environment, we need to apply a theoretical model of individual behaviour that can explain choices motivated by moral and social preferences.

This PhD firstly focuses on the influence of fairness concerns on individual preferences for forest ES, to understand whether the importance of equity considerations at a strategic policy level in a context of high poverty is reflected in local individual preferences. Specifically, individuals may hold social preferences motivated by fairness concerns, i.e. distributive preferences, regarding the distribution of forest benefits among community members (Johansson-Stenman and Konow, 2010). Individual distributive preferences involved in environmental decision-making are hypothesised to be influenced by general principles of distributive justice (Konow, 2001).[1] These norms can often be interpreted and applied by individuals in a self-serving manner and both the institutional setting where resources are (re-)distributed and the stakeholders' characteristics may render fairness concerns more or less salient (Konow, 2000). Analysing and modelling individual preferences for the distribution of forest benefits under a specific management regime enables the ex-ante evaluation of which factors play a role at individual level in determining distributional outcomes and, in turn, how the fairness of outcomes influence individual's welfare. The rational choice model of individual behaviour employed in economic empirical research, which assumes that the individual behaves such to maximise his own utility, has been complemented with many hypotheses regarding the role of fairness norms (Cappelen et al., 2007; Charness and Rabin, 2002; Fehr and Schmidt, 1999). However, the assumption that the individual may hold two different sets of preferences, i.e. self-interested and social, has rarely been tested in applied environmental economics research. Therefore, this PhD addresses this gap by analysing the role of individual distributive preferences for choices about forest management policies and contributing to an empirical understanding of the role of fairness preferences. Moreover, we examine whether certain characteristics of the institutional setting where forest resources are distributed have an influence on the relevance of these preferences and as such whether distributive behaviour of agents may change across different policy contexts.

The second issue addressed in this PhD thesis is that, if such fairness concerns are deemed important by communities, then the question that arises is how to address these in sustainable forest management, where extraction is capped by sustainable harvesting rates. There is a growing interest in research on ES, and their linkages with human well-being, and explicitly valuation and recognition of the benefits in the form of ES generated by sustainable ecosystem management could lead to better integration of development and environmental policies (MEA, 2005; TEEB, 2010). In Malawi, forest provisioning services are extensively used by the whole population and their consumption determines increasing pressures on the ecological functioning

[1] 'general principles of distributive justice' (Konow 2001) are also referred in the literature as 'fairness ideals' (Cappelen et al. 2007) and will be called 'fairness norm' throughout this thesis.

of forest ecosystems threatening the provision of regulating and cultural services as well as the long-term provision of provisioning services. Unsustainable harvesting of trees for fuelwood, charcoal production, construction materials and timber extraction together with land clearance for agricultural expansion have important consequences for the welfare of communities that are dependent on forest resources. The ecological sustainability of forest management policies, and ultimately the welfare of local forest users, depends on the balance between human demand for forest ES and ES supply (Chaplin-Kramer et al., 2019). Integrating ecological and welfare assessments lies at the core of ES research. However, the literature has mainly focused on developing methodologies for the ecological assessments of potential ecosystem services supply and little attention has been given to the integration of ES demand in the analysis taking in account the spatial mismatch between the production area, i.e. forest area, and where the reference population that consume the resources is located. Moreover, the ability of a population to consume ecosystem services is determined also by the institutional mechanism implemented for ES governance which determines how those services are distributed between different group of stakeholders and very little attention has been given to evaluate the welfare trade-offs arising from distributional rules.(Daw et al., 2011; Dawson et al., 2017).

1.2 Aims

The broad aim of this PhD is to understand whether and how fairness concerns influence individual incentives and welfare in the context of sustainable forest management through CBM systems in Malawi. Measuring individual and social preferences for forest ES using rational choice theory and assessing how the spatial variability of ES supply across the landscape influences total societal welfare can inform sub-national decision making in a low-income country context.

Specifically, this PhD aims to evaluate whether individual distributive preferences for forest ES can be elicited using discrete choice experiment (DCE) methods, and whether these preferences expressed in decisions on forest management reflect fairness norms. It puts forward that individuals hold two sets of preferences, i.e. self-interested and social preferences, and that individual choices may be influenced by both systems of preferences. Moreover, distributive preferences may be heterogeneous across the population depending on how individual apply fairness norms in specific distributive contexts.

The relative importance of each norm in individual decision-making may depend on information about the characteristics of the resources to be redistributed and the actors involved and as such different distributive contexts may activate a different distributive behaviour of agents. Individual distributive preferences can also be influenced by the procedures used to allocate decision-making power. Therefore, a second aim of this PhD is to test whether individual allocative choices are influenced by fairness norms and if the allocation of decision-making power influences how these norms are applied by individuals.

The final research aim of this PhD is to assess how current demand for provisioning ES affect the sustainability of forest ES use and how different rules used to distribute the sustainable flow of ES affect the total welfare of the population. In the economic models that are used at a starting point in this PhD, individual preferences determine individual demand, and distributive preferences mediate demand. However, the management of forest resources, as an outcome of choices of community members, regulates how much of demand is 'realised' by using the forest ES supply. Mapping ES demand, integrating its spatial variability and comparing it with potential supply of ES can highlight areas where ES provision is unlikely to meet beneficiaries' needs and future unsustainable patterns of use can take place and how constraining the distribution of resources to ecological sustainable levels can influence total societal welfare.

This PhD makes a novel contribution through using rational choice theory to assess empirically the relevance of fairness and distributive preferences for individual choices regarding the distribution of forest resources. First, it contributes to a broader debate about the role of fairness norms when eliciting preferences regarding distributional outcomes of public policies where there is a tension between individual and societal interests. Next, this PhD examines how the institutional setting of the distributive context, i.e. procedures used to allocate decision-making power, influences individual distributive behaviour, and examine in more detail the relationship between fairness concerns relative to both outcomes and procedures. It contributes to the literature by assessing whether perceptions of fairness about procedures shapes individual distributive behaviour and therefore determine the fairness of the agents' choices. Finally, by recognising that the socio-ecological system is embedded in a broader ecological system, this PhD integrates the estimated empirical model of individual behaviour in a distributive context with a biophysical assessment of aggregate availability of forest resources to provide a comprehensive overview of the welfare impact of CBM policies on beneficiaries. Through measuring empirically first what is the sustainable supply of provisioning ES that can be distributed to the relevant population and then evaluate how the population welfare is affected by hypothetical distributional scenarios of those ES, this thesis contributes to interdisciplinary ES research by providing an integrated assessment of the impact of ES governance.

1.3 Research questions

1. What are the marginal non-market forest ES benefits associated with a change in forest management?
   1.1. Are distributive preferences for ES benefit distributions reflected in the preferences that people have for local forest management options?

   Hypothesis: values for forest ES are influenced by fairness norms regarding the distribution of benefits to other members of the community.

2. Does the procedure through which decision-making power is assigned influence the final distribution of resources?

   Hypothesis: the perceived fairness of the procedure determines how fairness norms influence distributive choices of powerful individuals.

3. Does the potential ecosystem services supply fulfil the current demand of local population for provisioning forest ecosystem services?
   3.1. What are the welfare effects for the local population when the distribution of benefits is constrained at an ecological sustainable level?

   Hypothesis: societal welfare associated with CBM policies changes according to the distributional rules used for the allocation of forest resources.

1.4 Methodological approach

This PhD thesis is interdisciplinary and combines theory and methods of environmental economics together with spatial analysis and experimental economics. To answer the research question 1, I used economic valuation methods to quantify and monetise the contribution of non-marketed benefits, i.e. forest ES, to individual's welfare and more broadly to model individual's preferences regarding hypothetical policy scenarios. I employed a hypothetical choice experiment, i.e. DCE, to collect data about individual's preferences about co-management alternative scenarios. By exploring community members' preferences for co-management agreements and their distributional consequences, I measured how local users choose to redistribute forest resources and how they trade-off benefits accrued to themselves against benefits accrued to other members.

Monetary valuation of welfare changes provides a metric that can be used to assess how local forest users may benefit from the introduction of a policy and its specific configurations, e.g. the management plan and the distribution rules. By introducing a model of individual behaviour where individuals are assumed to be motivated by their own personal benefits and a concern for fairness, I assessed how different distributional outcomes affect individual welfare. The monetary valuation results can be used to provide policy makers with an assessment of total welfare effects of a policy change and to support the development of mechanisms of benefit distribution better aligned with the population's preferences.

Economic experiments with real monetary consequences have been successfully used to explore the influences of moral and social norms in individual choices. Importantly, more evidence is needed to understand whether and how different features of the distributive context influence individual's choices motivated by fairness concerns. The devolution of power to local members of the community creates new local elites that exert their control over how the allocation of limited resources will be realized in practice. The outcomes of community forestry can be shaped by personal interests of these powerful actors involved in the development and management of CBFM: their preferences may determine the distribution of benefits among all forest users (Schusser et al., 2015). Therefore, I employed an incentivised experimental method. i.e. dictator game, to answer the research question 2; a controlled experiment allowed the identification of the underlying link between procedures for the allocation of power and individual distributive choices without the confounding that may be present in ex-post analysis of case studies.

Finally, a positive outcome of a given resource management system is also related to the current ecological status and the availability of forest products and services. Over time, the potential supply of ES is determined by the biophysical structure of the natural ecosystem under management and the relationship with the anthropocentric pressures. Co-management policies introduce a new management regime that is expected to constrain the extraction of forest provisioning ES across the population according on the potential availability of forest resources across space. Therefore, to answer research question 3 I employed a spatial modelling method to map the overall availability of provisioning ES, to identify the population of beneficiaries that demand those ES and to quantify in biophysical terms the sustainable amount of provisioning ES that the population would be potentially able to access. Finally, I evaluated, using the monetary estimates from the DCE analysis, the consequences for the welfare of the total population of future policy scenarios which vary according to how provisioning ES are (re-distributed).

1.5 Thesis structure

This PhD thesis is presented following a "three-paper PhD" format. The overall research problem, aims and research questions are presented in this first chapter together with a brief overview of the methodological approach employed. The thesis that follows is divided into five sections: literature review, context, and case-study description, three results chapters (academic papers) and a final discussion chapter. This section provides a summary of each of these sections.

Literature review

In this chapter, I first discuss the broad theoretical framework used in this thesis, rational choice theory, and how concerns for fairness have been conceptualised within the consumer behavioural model. I also briefly discuss how the concept of fairness relative to natural resource management policies has been defined and discussed within the environmental justice literature. Next, I review the empirical applications of the rational choice model inclusive of hypothesis regarding the role of social preferences focusing first on DCE and then on incentivised experiments. This section reports a brief discussion of the research gap relative to the research questions of this PhD, but a focused literature review and discussion of the research gap are included in the results chapters to ensure a more logical flow. Finally, I briefly discuss the concept of ES and the relationship between ecological and socio-economic system with a focus on the need of employing spatial analysis to perform an integrated empirical assessment.

Context and case-study description

This chapter describes broadly the case-study area and the relative policy context, and it contextualises the research problem. Firstly, I discuss the role of forest ecosystems for the livelihoods of the rural communities through a literature review. Next, I present the results of the exploratory fieldwork performed in August 2016 and describe the practical implementation of CBM policies in the context using both technical documentation and the results of key informant interviews and focus groups. Finally, I describe the spatial sampling strategy used to select the sampled villages.

Results chapters

Chapter four, five and six each present the results of this PhD research in the format of a stand-alone journal articles. Two of them have been presented at international conferences (see Appendix A) and are finalised for submission to journals. The last (Chapter 6) needs to be finalised for submission. Each results chapter comprises of an introduction which is inclusive of a discussion of the research gap and motivation, a discussion of relevant literature, a detailed description of the methods used, results and discussion of the findings.

Chapter 4 addresses research question 1 and investigates the influence of fairness concerns on individual choices regarding the provision of forest benefits under a CBM policy using a DCE. The proposed DCE design enables the elicitation of both personal values (i.e. self-interested preferences) and "societal" values related to the distribution of these benefits to other individuals (i.e. social preferences). Briefly, the results show that individuals are not concerned solely by their personal interests, but they also associate utility gains with the amount of resources distributed to the other village members and with the overall fairness of the final allocation of resources.

Chapter 5 addresses research question 2 and investigates the effect of different procedures used for assigning decision-making roles on how the individual choose to distribute monetary resources using a dictator game. The experiment tests three role allocation procedures, namely random, meritocratic, and favouritism and provides insights into the relationship between procedural and outcome fairness. The findings show that individual choices motivated by outcome fairness are strongly dependent on the degree of procedural fairness. The dictators who obtain their role through unfair mechanisms transfer significantly less money to recipients than dictators exposed to fair procedures.

Chapter 6 addresses research question 3 and assesses the impact on total societal welfare of alternative CBM policies which varies according to benefit distribution rules. Spatial modelling methods have been used to integrate a biophysical assessment of the actual ability of forest ecosystems to provide benefits to the surrounding population and a monetary estimate of the population's welfare when governance shifts from centralised to CBM (Chapter 4). Briefly, the chapter shows that the spatial distribution of forest biomass is heterogeneous across the forest area and therefore the provision of forest benefits to the surrounding population is unequal in biophysical terms. Moreover, the chapter shows that in such context the impact of benefit distribution rules on societal welfare differs across areas and according to the scale of analysis.

Discussion and conclusion

Chapter 7 summarizes the conclusions of this thesis, discusses its novel contributions to knowledge, outlines its limitations and presents thoughts for future research and policy implications.

Chapter 2 Literature Review

The aim of this chapter is to provide a descriptive overview of the theory underpinning my research questions. I discuss the theoretical framework used to model individual's choices, i.e. rational choice theory, and its limitations when used in the context of natural resource management policies. Secondly, I discuss concepts of fairness and justice in economic theory, and their application to individual decision-making given its relevance in my study context (see Chapter 3). Next, I focus on empirical evidence of individual choices motivated by fairness and the influence of decision-making power on fairness concerns. Finally, I discuss methods for developing spatial mapping assessment of ES demand and supply to define possible applications in my research context.

2.1 Rational choice theory and the self-interest hypothesis

2.1.1 Microeconomic theory and the self-interest hypothesis

Microeconomic theory and the axioms underlying consumer behaviour can be used to assess and model individual behaviour regarding environmental management policies and evaluate how individuals are willing to trade-off different levels of provision of environmental goods and services. Individual choices are assumed to be the outcome of a utility maximisation process and reveal the most preferred bundle of environmental goods and services, i.e. which maximises individual welfare.

Microeconomic theory gives an axiomatic characterisation of consumer behaviour which is based on the rationality principle where the individual makes choices such to achieve outcomes aligned with their personal objectives (Hausman, 2011). The rational consumer optimises some choice function subject to some constraints. The consumer is assumed to behave as if he maximises his utility function, where utility represents the satisfaction yielded from the consumption of specific bundles of good.[2] The utility function is a measure of individual preferences that can be defined as a personal ranking of alternatives based on their relative desirability. The consumer faces a finite set of possible consumption bundles and he is assumed to have preferences that can be expressed in the form of "consumption bundle A is preferred or indifferent to consumption bundle B".

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[2] For simplicity, I use male pronouns when referring to individuals throughout the thesis.

Rationality and the preference axioms

To portray and model an individual who behaves rationally, i.e. who maximises his own utility function, microeconomic theory has defined axioms regarding the underlying preferences. The axiom of completeness establishes that any consumption bundle of the choice set can be compared and the individual holds preferences over all the bundles. The axiom of transitiveness establishes that if A is preferred to B and B is preferred to C, then A is preferred to C and the individual preferences can be ordered over a scale in a consistent way so that the "best" bundle can be identified. Finally, to represent preferences through a utility function, the axiom of continuity needs to be assumed; it establishes that if A is preferred to B, then any bundles close enough to A must also be preferred to B.

Maximisation hypothesis and consumer problem solutions

Once the existence of a continuous utility function is defined, rational choice theory posits that the consumer will choose its preferred bundle through a process of utility maximisation subject to a budget constraint. The budget constraint represents the possible combinations of goods and services that a consumer can choose given its income and actual prices. The consumer who behaves rationally solve his constrained optimisation problem and choose the optimal bundle. The relationship between the bundle chosen given the budget constraint and the individual utility function is represented by the consumer Marshallian demand correspondence. To be able to identify this relationship and the unique optimal bundle two other preference axioms needs to be assumed. The axiom of strong monotonicity states that a consumption bundle X with a unit more of some good compared to bundle Y is strictly preferred, and it implies that more commodities are preferred to less. Finally, the axiom of convexity of preferences is assumed, which represents the fact that individuals like diversity and usually prefer mixed and well-balanced bundles of goods and services instead of extremes, e.g. a bundle with just one good.

Empirical analysis of choices and rational choice theory

The model defined above provides a conceptual description of individual behaviour in consumption starting from its primitive unit of analysis: preferences. However, preferences are not directly observable and are considered as given, and the empirical focus is on the choices made as a measure of underlying preferences (McFadden, 2001). The theoretical model allows the analysis of hypotheses related to consumer behaviour and theoretical assumptions about behavioural rules, objectives, and constraints. To test empirically the validity of theoretical hypotheses and behavioural models, there is a need to reconcile observed demand, represented by choices, with the axiomatic characterisation. Revealed preference theory develops a link between theoretically defined functions based on fixed assumptions and the observed demand and allow to estimate parametric functions suitable for econometric and policy analysis.

Revealed preference theory assumes observed demand as the primitive unit of analysis and derives conditions under which the choices observed can arise from a population of utility-maximisers, i.e. there is a utility function that rationalises the observed behaviour. The weak and strong axiom of revealed preferences define which are the conditions that observed choices need to satisfy to define a utility function that achieve its maximum value at the chosen bundle. To define these two axioms, we first need to define when a chosen bundle is revealed preferred directly or indirectly. Assuming two bundles A and B both affordable by the individual, if A is chosen over a bundle B, then A is defined to be directly revealed preferred. We also define bundle A as indirectly revealed preferred over a bundle C, if A is directly revealed preferred to B and B is directly revealed preferred to C. Given these definitions, the weak axiom of revealed preference (WARP) establishes that if a bundle A is chosen over a bundle B when both are affordable, then, if in a different context a bundle B is chosen, bundle A must not be affordable. The strong axiom of revealed preference (SARP) ensures transitivity of preferences, if a bundle A is revealed (directly or indirectly) preferred over a bundle B and they are different, then bundle B cannot be revealed (directly or indirectly) preferred over A. A more general approach has been developed to analyse consistency of observed choices in the case where there may be more than one level of consumption that maximises utility and it is called Generalized Axiom of Revealed Preference (GARP). As shown by Varian (2014) consistency of observed choices with GARP requires that the hypothesis of convexity and monotonicity of preferences hold, together with the other axioms that guarantee a rational behaviour.

The theory of consumer behaviour and the theory of revealed preferences represent two different approaches for imposing conditions and representing a consumer who makes choices rationally. Rational behaviour is often identified as maximisation of a utility function pursuing individual self-interest, but as shown by the above discussion there is no evidence that the application of the rational principle requires the individual to be self-interested. We can instead regard the rationality of behaviour as condition for internal consistency, choices made under different conditions should relate to each other and be consistent with the maximisation hypothesis.

The hypothesis of self-interested preferences is a required condition for the existence of a general economic equilibrium and for deriving Pareto optimality, a fundamental theorem of welfare economics. The concept of self-interest is required to derive general equilibrium theorems, but it is not needed to guarantee consistency of choices and to retain the link between observed demand and consumer theory. Rational individuals are assumed to act as if they maximise their best interest as they perceive it, but there is no theoretical indication that we should assume self-interest as a motivation underlying individual preferences.

2.1.2 Limitations of rational choice theory for empirical analysis

Microeconomic theory developed a model for consumer choices, but people are also citizens embedded in a complex set of ethical, moral, and social norms (van den Bergh et al., 2000). The individual decision-making process around environmental resources involves a difference between individual and societal interests and is driven by ethical and moral considerations, together with the maximisation of self-interested preferences (Nyborg, 2000; Sagoff, 1998). The theoretical validity and ethical suitability of rational choice theory for modelling preferences about environmental resources is questioned by the existence of social values and different motivations underlying individual choices. Moreover, numerous assumptions of the neoclassical economic model of consumer theory have been questioned by other branches of economics and by other disciplines, especially psychology, with reference to the rationality of the choice process and the nature of preferences (Folmer and Johansson-Stenman, 2011).

Bounded rationality and constructed preferences

Rational choice theory assumes that the individuals engage a choice task with exogenously given, consistent and immutable preferences and will act to maximise only his personal satisfaction disregarding the consequences for the others. Choice behaviour is a complex process that is influenced by perceptions/beliefs, attitudes, affect, motives and preferences and their relationships (McFadden, 1999); when the decision-making process is complex, for example in the context of risk, uncertainty or with intertemporal implications, individual are constrained by cognitive limitations, imperfect information and short time availability and they may deviate from perfect rationality and use instead a satisficing process (Gsottbauer and van den Bergh, 2011). McFadden (1999) discusses the rational choice theory regarding three aspects: perception-rationality, preference-rationality, and process-rationality. Perception-rationality refer to how information is processed by individuals to form perceptions and beliefs; in the standard model agents are assumed to use strict Bayesian principles. However, individuals can be influenced by the way information are presented or interpret them based on their status quo position, i.e. context and reference point effects. Process-rationality regards the cognitive process guiding choices, which in the standard model is assumed to be preference maximisation. Complex choices and lack of information can lead individuals to process information and form beliefs by using heuristics or judgement bias due to a wrong interpretation of the context (McFadden, 1999). In unfamiliar or uncertain choice settings and where choice options are morally charged, research has demonstrated that people consider social expectations and relationships, use moral intuition, use relatively simple decision rules and heuristics, or try to avoid negative emotions (Menzel and Wiek, 2009). For example, people may employ different ethics to come to a decision: Greene et al. (2001) argue that whilst people use utilitarian ethics (favouring the greater good) and provide reasoned responses for impersonal actions, they refuse to make decision that elicit unpleasant emotions and defend that on deontological grounds (favouring individual rights). Affect and emotions act both as inputs and outcomes of choices. They influence the extent to which people process information, and how they expect to deal with emotional outcomes (Loewenstein et al., 2001). In complex decisions where losses are relevant, and emotions are negative, emotional reactions may overrule cognitive or reasoned assessments; people use a sense of affect as a heuristic to infer benefit evaluations (Slovic et al., 2007). However, Luce et al. (1997) find that the stronger the anticipated negative emotions, the more effort people invest into processing and considering alternatives and attributes. Perception-rationality and process-rationality are extensively questioned by findings in behavioural economics and social psychology and form the core of the bounded rationality concept. Bounded rationality assumes that individuals' behaviour is constrained by the availability of information, the cognitive limitations of their thinking capacity and the time available to make decisions (Simon, 1982).

With reference to the last aspect of rationality, preference-rationality, in the standard model preferences are assumed to be independent from the context, consistent and complete; evidence from behavioural decision research has shown that in some context, preferences are constructed and often dependent on the choice task (Slovic, 1995). Psychologists make a difference among attitudes and preferences, the formers are stable psychological tendencies to evaluate something, while the latter are constructed from attitudes in a specific process context-dependent (McFadden, 1999). The psychological view implies that preferences are volatile and changes every time that the choice task is reframed, and thus cannot represent the fundamental unit of microeconomic analysis. Bowles (1998) argues that preferences, seen as cultural traits or learned constraints on behaviour, are influenced by economic institutions through different type of effects. Markets and other economic institutions represent, in a social psychology sense, situations where the framing of the choice context may influence individual choices. The external context has an influence on intrinsic individual attitudes, motives and affects that inform their choices and could potentially induce a preference change.

Bounded rationality and constructed preferences can limit the ability to analyse individual choice behaviour following the standard model and limitations related to the adoption of the rationality principle in the specific context of natural resource management need to be taken in account.

However, as McFadden (1999) argues the evidence of claiming a failure of preference-rationality look circumstantial and bias found in the analysis of rational choices can be mainly related to cognitive limitations in perceptions and processes.

Social context and social values

Criticism to the theoretical axioms of consumer theory presented above and the application of the rational model in the context of natural resources point also at the need to recognise the relevance of the social context when the individual makes choices. The social and cultural context in which people are involved can influence individual choices through cultural norms that can drive rule-based choices (Kim et al., 2014). Postlewaite (2011) refers to a dual classification of preferences: deep and reduced-form preferences. Deep preferences represent the immediate satisfaction of basic needs as related to chemical brain reactions, stable preferences from which we can infer the utility function. Reduced-form preferences instead can be mutable and context-dependent and can be shaped by history or education and social influences. The standard model assumes that individuals choose following their deep preferences. However, observed choices can also be determined by reduced-form preferences and be influenced by the social consequences related to those choices (Postlewaite, 2011).

The political ecology literature has proposed a broader framework of values that individuals attach to environmental resources, which includes social and shared values (Irvine et al., 2016). Social values can be defined as normative and ethical principles that guide individual's action in a social context and that are shared by groups, communities, or societies (Kenter et al., 2015). Social values include transcendental values, i.e. general guiding principles based on ethical or moral norms, assumed to be part of people's system of values. They become contextual values when applied in a specific context. The idea of social and shared values that are part of individual's preferences has been embedded into the rational choice theory framework through the concept of social norms. A social norm as defined by Nyborg (2018, pp. 411) is a "*predominant behaviour pattern within a group, supported by a shared understanding of acceptable actions and sustained through social interactions within a group*". This definition incorporates social psychology view where social norms are rules that define both common and acceptable behaviour (Cialdini and Trost, 1998) and a game theory perspective where norms arise as a solution to coordinate interactions among individuals which have multiple equilibria (Young, 1998).

Finally, the choices, and underlying values and preferences, of an individual who is embedded in a broader social system, may also be influenced by the welfare of other (altruism). Altruism can be considered as a moral norm which arises from what the individual considers being an ethically appropriate behaviour and it is reinforced by the individual's inner feelings (Nyborg, 2018). Altruism and other moral values regarding the others' welfare that individuals may have in the context natural resources have been included within neoclassical consumer theory by using models of individuals with altruistic preferences (Curtis and McConnell, 2002).

2.1.3 Social preferences

The idea that the individual is influenced by the social context has been explored within the experimental economics literature with the aim of identifying motivations or intentions leading to "prosocial" choices. Prosocial choices are defined as choices that deviate from the expected pure self-interested outcome. A simple example of a prosocial choice is the decision by an agent to share money with another agent in a dictator game. In a standard dictator game, there are two agents, the dictator, and the recipient; the dictator is endowed with a certain amount of money and he decides how to split the amount between himself and the recipient. Following the standard self-interest assumption, the dictator will choose not to send any money to the recipient, but evidence shows that on average dictators send approximately 30% of their total endowment to recipients (Engel, 2011). The analysis of individual choices in behavioural games where individual decisions deviate from the expected self-interest outcome has generated evidence on possible motivations underlying prosocial choices and related modelling approaches (Fehr and Schmidt, 2006). Introducing the influence of social interactions into the standard model has been proven useful to explain prosocial behaviour, and many features of the social context have been found to be relevant for individual choices, such as fairness of the overall distribution, type and intentions of other agents, social image and social status.

Gsottbauer & van den Bergh (2011) provide a classification of prosocial behaviour and motivations that includes two distinct categories: social preferences and self-identity preferences. The former is related to the impact that the allocation of resources to the others has on agent's utility, while the latter refer to the individual concerns about self-signalling reputation and status. Self-signalling reputation has been modelled by Andreoni and Bernheim (2009) who introduced a concern for self-signalling a fair behaviour as explanation for the prevalence of equal splits in dictator game. Self-signalling reputation may be required by a social or a moral norm that apply to the given context (Bicchieri, 2005; Nyborg, 2018).

Social preferences instead refer to models where the individual's utility is assumed to be influenced by changes in the material resources that are accrued to other agents (Fehr and Schmidt, 2006). Individuals seem to be motivated by concerns over the total resources allocated (Andreoni and Miller, 2002; Engelmann and Strobel, 2004), i.e. efficiency concerns, fairness of the overall distribution of resources between agents (Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Fehr and Schmidt, 1999) and envy and spitefulness about the allocations to another agent (Bolton, 1991). The models presented above consider that the individual decision-making process is influenced only by the final allocation of resources, i.e. they are instrumentalists and they are not concerned with procedures leading to given outcomes. However, in many cases agents exhibit preferences which are indirectly affected by the information about the opponent's type, e.g. envious or altruistic (Levine 1998), or their intentions (Falk et al., 2008; Sobel, 2005). Two broad categories of social preferences can be distinguished: distributive preferences, as social preferences that regard outcomes, and reciprocal preferences, as social preferences which are influenced by the intentions of, or type of, the other agents (Croson and Konow, 2009).

Conclusion

Consumer theory establishes that an individual regarded in his role as consumer, makes choices rationally by maximising his utility function. The rational model has been interpreted often with a narrow sense of self-interest where the individual makes choices taking in account only the consequences on his own welfare. However, the principle of rational behaviour does not embed self-interest among the conditions required to guarantee internal consistency and to be able to infer the individual's utility function from the observed choice. Therefore, we can regard rational choices as individuals acting to maximise their interests without assuming self-interest as a required assumption. This is especially relevant for modelling choices regarding natural resources, which have the characteristics of public goods or common-pool resource where individual preferences can be influenced by underlying contextual and societal values. The fact that individuals can be motivated by a broad range of ethical values, such as altruism or concern for fairness, can be reconciled with the utilitarian framework through the theory of social preferences.

2.2 Fairness and individual choices

In the following, I discuss the inclusion of fairness concerns in individual decision-making through models of social preferences, i.e. individual preferences influenced by the amount of material resources allocated to other agents. The terms fairness, justice and equity are often used interchangeably across different disciplines (see Zalta, 2012) and I employ here a general definition from the Oxford English Dictionary which states that fairness is "*the quality of treating people equally or in a way that is reasonable*". I further distinguish between outcome fairness, i.e. distributive justice, and procedural fairness. Distributive justice concerns the moral principles adopted by a society for the redistribution of economic benefits and burdens across all members of that society (Lamont and Christi, 2016). As I discuss in Section 2.2.2, such principles may underly distributive preferences and the individual evaluates the fairness of outcomes accordingly. Procedural fairness instead regards the fairness of the processes that lead to a given outcome (Pascual et al., 2010). Procedures can be considered fair if they involve a set of transparent and impartial rules that ensure equal opportunities for all individuals to participate in the decision-making process (Bolton et al. 2005; Grimalda et al. 2016; Trautmann et al. 2016; Dold et al. 2017). Finally, I discuss briefly the concept of fairness regarding natural resource management policies focusing specifically on how power relationships and their role in determining outcomes has been conceptualised in the environmental justice literature.

2.2.1 Distributive preferences and utility theory

The influence of fairness concerns on distributive choices has been extensively examined as motivations underlying prosocial behaviour given the prevalence of an equal division in ultimatum game outcomes (Andreoni and Bernheim, 2009). In a standard ultimatum game, there are two agents, the proposer, and the respondent; the proposer is endowed with a sum of money and he proposes a split to the respondent. The respondent can either accepts the proposal, both players gain the money following the split proposal, or reject it, both players get nothing. The idea of aversion to inequality regarding distributional outcomes as a motivation for individual behaviour is also supported by neural evidence (Tricomi et al., 2010). When individuals make choices on how to allocate a certain amount of money between themselves and others, they seem motivated not only by self-interested material benefits but also by fairness norm such as efficiency, equality or maximin (Charness and Rabin, 2002; Engelmann and Strobel, 2004). Aversion to inequality is included in the modelling framework developed by Fehr & Schmidt (1999), where the reference point for evaluating if an allocation is fair the relative position of the agent compared to others. The inequality-averse agent shows altruistic behaviour if they are better off, motivated by aversion to advantageous inequality, but they appear envious if they are worse off, motivated by aversion to disadvantageous inequality. Bolton & Ockenfels (2000) developed a similar model where the agent evaluates his relative standing expressed as a proportion of the sum of players' payoffs. However, models of inequality aversion are derived from experiments where the choices available to agents do not allow disentangling a concern for equality from a concern for efficiency and/or maximin preferences (Engelmann and Strobel, 2004). A more complete model that accounts for the prevalence of other fairness norms, in addition to equality, is developed by Charness & Rabin (2002). They elicited three different types of distributive preferences that motivate choices: competitive distributive preferences, inequality averse preferences and social welfare preferences. If players exhibit competitive distributive preferences, then they prefer a payoff higher than the opponent; if players exhibit social welfare preferences, they prefer to increase the total sum of money available for both players but prefer more for himself when he is getting a lower payoff. Charness & Rabin (2002) formalize a model where concern for others is evaluated through a utilitarian social welfare function that enters the individual utility function and that is composed of two parts: one representing Rawlsian inequality aversion (the inequality benchmark is the welfare of the least well-off) and the other reflecting a desire to maximise social welfare. In addition, Engelmann & Strobel (2004) have found that individuals are influenced by norms such as efficiency and maximin, showing that inequality aversion measured as relative distance between players' payoff is not the only motivation that plays a role in distributive choices (Blanco et al., 2011).

2.2.2 Fairness norms in economic theory

Models for prosocial choices motivated by a concern for fairness usually assume that the individual compares the chosen allocation against a reference point that is "fair" (Kerschbamer, 2015). The models of social preferences presented above refer to a situation where the individual evaluates the fairness of a certain allocation from his individual point of view, therefore as an implicated stakeholder. A different but related set of questions instead has focused on the identification of what is considered a fair allocation by a stakeholder not implicated, with the aim to identify regularities in the perception of fairness expressed by individuals (Konow, 2003). Experimental evidence has shown that equality, as equal division of material resources, is not the only fairness norm used to evaluate fairness (Charness and Rabin, 2002; Engelmann and Strobel, 2004). The heterogeneity identified in distributive preferences, as measured in games involving choices over allocations depends on the pluralism of fairness norm motivating those choices (Cappelen et al., 2007; Konow, 2001).

Konow (2001) argues that most individuals hold views of distributive justice that can be related to three fairness norms: accountability, efficiency, and need. The accountability principle relates the perception of fairness to individual responsibility and proportionality; an allocation is considered fair if benefits are allocated to individuals proportionally to some variables that individuals' control, such as his effort to produce the total surplus to be redistributed (Konow, 2003). The efficiency principle is related to a utilitarian view of justice where just maximising the total output matters while inequalities in how the output is allocated are not relevant. Therefore, from an efficiency point of view an allocation is considered fair if benefits are allocated to individuals in a way that maximises the total surplus for the society. Finally, the need norm establishes that an allocation is considered fair if the allocation equalises basic needs of everyone in a society and it incorporates a concern for the least well-off in the society, i.e. maximin. The evaluation of fairness views held by individuals is dependent on subjective elements that influence the individual judgement, such as the economic status of the people involved in the distribution. However, unbiased stakeholders, sampled across a large population representative of many different countries, show a high degree of consensus in fairness judgements on different hypothetical distributive scenarios (Johansson-Stenman and Konow, 2010).

The identification of fairness norms held by unbiased stakeholder supports the idea that sharing in dictator games and other behavioural games involving choices about the allocation of resources is dependent on individual judgement of fairness. Engelmann and Strobel (2004) proposed an allocation game that involved 3 players and the decision-maker had to choose between different allocations affecting the other 2 players. They excluded the self-interested motivation by keeping the payoff constant for the decision-maker across the game. The authors identify inequality averse preferences, maximin preferences and efficiency-related preferences, confirming the idea that individuals hold different principles that resembles the need and efficiency principles empirically measured by Konow (2001).

2.2.3 Fairness in environmental justice literature

The concept of fairness in the context of natural resource management has been discussed by the environmental justice literature, where distributive justice is more often referred to as equity over outcome (McDermott et al., 2012). The discussion of the concept of equity regarding outcomes of natural resource management policies is not limited just to outcomes, and its fairness, but it applies also to the procedures employed to reach those outcomes, i.e. procedural fairness. Procedural fairness refers to the fairness of procedures used in the decision-making process to reach a certain outcome (Pascual et al., 2010). The environmental justice approach criticises that the assessment of equity and social outcomes generated by natural resource management policies usually focus on the distributive justice dimension and it ignores the origins of unequal outcomes. The unequal allocation of benefits and costs of a given policy among stakeholders may be related to the political process governing the policy implementation and execution (McDermott et al., 2012). Procedural equity requires the inclusion and active participation of all stakeholders that have an interest in managing the natural resource and may experience adverse consequences from the implementation of a given policy (Schreckenberg et al., 2016).

Power and equity in natural resource management

The unequal distribution of power is one element indicating that the procedures employed may not be considered fair and it has been highlighted by the environmental justice literature as the origins of unfair outcomes (Chinangwa et al., 2015; Persha and Andersson, 2014; Torpey-Saboe et al., 2015). A power relationship between two actors, A and B, is defined as a social relationship in which actor A can modify the behaviour of actor B without recognizing his will (Krott et al., 2014). In the context of natural resource management, the rules imposed and enforced by powerful members can constrain the choices of subordinate members, i.e. local users without decision-making power and control over the distribution of forest benefits (Cleaver, 2007). The actor-centred power framework proposed by Krott et al. (2014) proposes three distinct sources of power of actors involved in natural resource management policies: coercion, (dis-)incentives and dominant information. Local users responsible for forest management, as actors holding power, determine the distribution of forest resources among all local users. Through coercion and disincentives mechanisms, powerful members can enforce harvesting rules and monitoring activities that determine how the final outcomes are distributed among all users. Moreover, powerful actors may control dominant information exchanged at community level which can further limit access to forest benefits for subordinate members (Krott et al., 2014).

The definition of power as social relationships and the identification of sources of power at the individual level can be used for the empirical analysis of natural resource management policy implementation and facilitates understanding the influence of power on the realised outcomes (Schusser et al., 2015). The risk of elite capture in natural resource management has been extensively studied and numerous case studies have highlighted how local actors with increased decision-making power can constrain the distribution of benefits by pursuing their self-interest and fulfilling their own needs (Chomba et al., 2015; Iversen et al., 2006; Persha and Andersson, 2014). However, individual moral attitudes and underlying fairness norms could also lead to a more equitable distribution and a better targeting of poor and disadvantaged members of the community (Dasgupta and Beard, 2007). The distributive outcomes depend on individual choices and how motivations related to fairness norms interact with self-interest. Therefore, understanding how devolving decision-making power to selected members of the community influences their distributive choices could highlight how the implementation of CBFM policies will influence the overall distribution of forest resources in a community and its fairness.

2.3 Measuring distributive preferences

In the following, I review the empirical applications of the rational choice model which include an assessment of social preferences in a broad sense. I first focus on the DCE literature and how general concerns about the others and fairness have been tested empirically across different disciplines with the aim to identify a research gap within the applied environmental economics literature. Next, I review the experimental economics literature to evaluate what are the factors that influences distributive preferences and what is the relationship with fairness norms, both in low and high-income countries. Finally, I focus on the experimental studies that examine the influence of decision-making power on stated fairness norms and revealed behaviour in incentivised experiments.

2.3.1 Economic valuation of forest ecosystem services

The Total Economic Value (TEV) framework incorporates and defines the different categories of economic value which arises from natural resources (Perman et al., 2003). The values considered under the TEV are firstly disaggregated into use and non-use components. Non-use values relate to the satisfaction that individuals derive from knowing that other people in the present (altruistic value) or in the future (bequest value) can enjoy benefits from the natural resource, or from the mere existence of the resource (existence value) (Turner et al., 2001). Use values are categorised as consumptive use values, obtained by extracting products from nature (e.g. timber collection); indirect use values, obtained from non-removable nature's services (e.g. soil fertility); and option values, arising from potential future consumption of the natural resource (Figure 2.1). Direct use values can be associated with goods and services with characteristics of private goods, and where traded on the market their value is reflected in their market prices. Indirect use and non-use values are associated with goods and services that have characteristics of public goods for which there is no market; therefore, their economic value is not directly observable from market transactions.

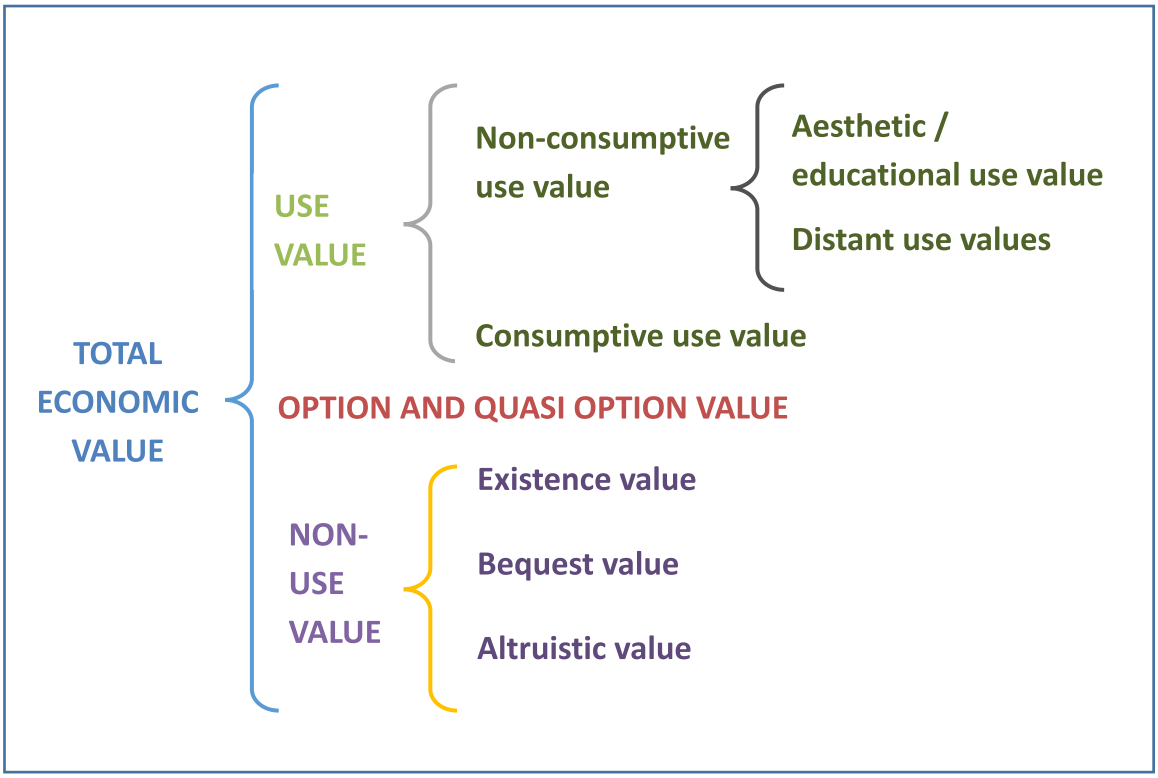

Figure 2.1 TEV and its components (Turner and Schaafsma, 2015)

In low-income countries, most forest products are not exchanged on markets. Price information is unavailable and the contribution of environmental resources to individual welfare can be assessed through the elicitation of preferences.

Economic valuation methods can be classified in two main categories: revealed preferences and stated preferences (TEEB, 2010). In addition, monetary estimates of non-marketed environmental goods and services (called ES henceforth) are obtained using cost-based approaches and analytical-deliberative valuation methods (Figure 2.2).

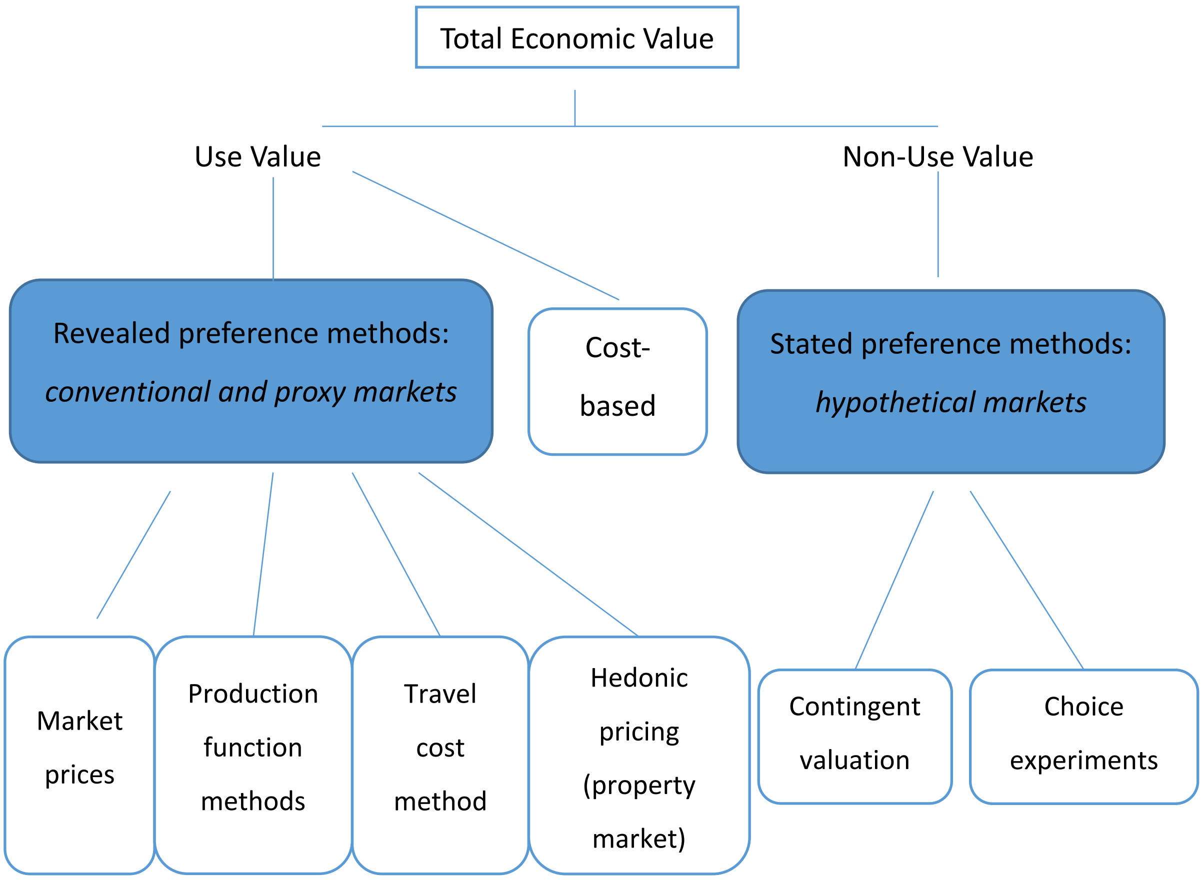

Figure 2.2 Environmental valuation methods (Turner and Schaafsma, 2015)

Revealed preferences include market price approaches, used to value ES traded on (proxy) markets, through observing prices. Production function methods assign a monetary value to ES by evaluating their contribution to an economic activity that is traded on markets. Travel-cost methods estimate a demand function that explains the choice to visit a specific natural sites and ES values are inferred from the travel cost that the individuals incur in. Finally, hedonic pricing approaches assume that the changes in price of marketed commodities, such as houses, is influenced by surrounding changes in environmental attributes and their value is estimated by inferring a demand function (TEEB, 2010).

Cost-based approaches assign values to specific of environmental services through estimating the costs for recreating natural ecosystem functions. The avoided cost method estimates costs that a population would have incurred in the absence of a certain ES. The replacement cost method basis monetary values on the costs of replacing an ES. The restoration cost method assumes that the value of ES is equal the costs of mitigation measures given its loss (TEEB, 2010).

Stated preference (SP) methods are used to elicit monetary values of resources that are not traded in formal markets. Individuals are asked to express their preferences on hypothetical markets, where it is possible to trade the quality or quantity of an environmental resource. SP approaches include contingent valuation, which uses direct questions to elicit willingness to pay

(WTP) for improvement in the provision, or to accept compensation for the loss, of ES. Another SP method is DCE, where an individual is presented with a hypothetical decision-making scenario described in terms of attributes of the environmental resource. Finally, analytical-deliberative valuation combines SP approaches and deliberation, a technique used in political disciplines, and provide to respondents a democratic context for group discussion prior to the individual choices.

Discrete choice experiments

In a DCE, respondents are presented with a hypothetical policy scenario describing different options for the provision of a (public) good and they are asked to indicate their preferred option. Every option is composed of a set of attributes that are assumed to yield utility to respondents following Lancaster (1966) model of consumer choice which proposes that the consumer's satisfaction from consumption of a good could be disaggregated into the good's attributes. The levels of these attributes randomly vary among choices to portray the trade-offs involved in alternative policy scenarios. Under the assumption that the respondent act as utility-maximiser the observed choices can be analysed using random utility theory and the individual utility for the policy under valuation can be estimated (McFadden, 2001). The probability of choosing a specific alternative can be used to infer the relative utility of attribute levels, and with the inclusion of a price and/or cost attribute the attributes, the utility coefficients can be translated in WTP estimates for those attributes.

Formally, the individual *n* faces a choice among *J* alternatives. The individual will choose alternative *j* if and only if $U_{nj} > U_{ni}$, i.e. the utility from alternative *j* is higher than the utility from alternative *i*. The utility function of the individual is not known by the analyst who can only observe the choice made, some of its attributes (x_{nj}), the characteristics of the individual (s_n) and model an indirect utility function (V_{nj}). The utility function therefore consists of two parts: the indirect utility function observed by the analyst and an error component including all the unobserved aspects of utility.

$$U_{nj} = V_{nj}(x_{nj}, s_n) + \varepsilon_{nj}$$

The probability of choosing alternative j is then given by $Prob(j|J) = Prob(V_{nj} + \varepsilon_{nj} > V_{ni} + \varepsilon_{ni})$.

Through assumptions imposed on the distribution of the error term (ε), a conditional logit model can be estimated (McFadden, 2001) and the indirect utility function can be parametrized. The conditional logit model or multinomial logit model assumes that the error term is independently and identically distributed extreme value (Train, 2009). Alternative assumptions on the distribution of the error term can be used and give rise to other type of logit/probit models for the assessment of choice probabilities (See Train 2009 for an overview)

$V_n = \beta x_{nj}$

The coefficients (β) are the relative contributions of the alternative characteristics (x_{nj}) to the individual utility for a given policy scenario.

Performing a DCE for valuation of non-marketed benefits requires the definition of the attributes composing the alternatives to be valued, their levels and range and the construction of choice sets through experimental design theory (Kanninen, 2006).

The final model estimates indicate the relative contribution to the individual utility of the attributes and can be used to estimate monetary values of the welfare effects of a policy change.

Limitations of DCE

The theoretical framework underlying SP methods is rooted in consumer theory which provides a modelling framework for individual choices in a market context. The application of the same theory in a hypothetical context has been criticised because there are no material consequences for respondents. Therefore, the individual does not have appropriate incentives to answer truthfully, engage in the choice task and display rational behaviour. If individual choices cannot be related to the rational model of consumer behaviour, then the results of statistical modelling will not accurately represent the underlying preferences and the resulting welfare estimates will be biased.

Proponents of SP methods argue that appropriate survey design and a credible policy scenario description can limit the hypothetical bias. The choices must be incentive-compatible, so that respondents are incentivised to reveal their “true” preferences and not to act strategically. Moreover, the options must be credible and mimic as much as possible the real policy context so that respondents believe that their choices are consequential (Hoyos, 2010). To calculate welfare estimates, all attributes that respondents perceive to be relevant need to be included so to avoid an omitted variable bias. Pre-survey activities such as interviews with local experts and focus groups with targeted populations can be used to determine the set of attributes and their levels. However, the number of attributes selected should be weighed against the need to limit the complexity of the choice set because the greater the choice complexity the higher the cognitive effort required to make a rational choice. The respondents’ ability to trade-off all attributes can be impaired, and they can employ decision-making heuristics and shortcuts instead of maximising their utility function (DeShazo and Fermo, 2002; McFadden, 1999). Moreover, when valuing complex ecological functions and services, the description of the attributes needs to be understood by respondents to avoid information and misspecification biases (Barkmann et al., 2008; Moseley and Valatin, 2013). The design of the policy scenario description must eliminate hypothetical bias, i.e. the respondents' belief that the choice will not have real consequences, but also reduce complexity. Moreover, the options' description must facilitate the adoption of compensatory behaviour, i.e. respondents make trade-offs among all attributes (Colombo et al., 2013).

In addition to careful design and extensive pre-test and piloting to avoid biases, tests of validity and reliability can be embedded into the survey instrument used for eliciting individual preferences (Rakotonarivo et al., 2016). Reliability tests are concerned with the consistency of valuation results and their replication across temporal scales and/or contexts. Validity tests refer to the degree to which the welfare estimates are consistent with the theoretical construct that the researchers wanted to measure. The analysis of stated choices assumes that the individuals maximise their utility function and choose the best option. Theoretical validity tests are used to verify that preferences inferred from choices comply with the axioms of consumer theory. The continuity axiom establishes that the individual has complete preferences to trade-off the attributes of the alternatives. If respondents do not pay attention to all attributes of the alternative when making choices, then the continuity axiom may be violated because respondents may not have chosen following compensatory behaviour. Colombo et al. (2013) show that when self-reported attribute non-attendance is taken in account, the welfare estimates differ greatly and are lower than in a model where all attributes are assumed to be traded off. Campbell et al. (2011) using a latent class model to determine attribute non-attendance found greater WTP for models where attribute non-attendance is not accounted, and respondents are assumed to engage in full compensatory behaviour. Therefore, attribute attendance and tests of compliance with continuity axioms integrated in the analysis provide a validity test.

As stated above, credibility of the scenario and perception of consequentiality are needed to avoid hypothetical bias and produce welfare estimates that are closer to "real" WTP. Tests of content validity aim to evaluate if respondents believe in the consequentiality of the survey, protests toward features of the scenario description and the degree of comprehension of the policy change under examination (Rakotonarivo et al., 2016). Content validity can be assessed through de-briefing questions after the choice task, comprehension ratings of the features of the choice and qualitative interviews to understand the motivation of respondents for making their choices. Protest responses, i.e. respondents reject (protest against) some aspect of the constructed market scenario, are sometimes treated as absence of WTP for the good or service valued (Meyerhoff et al., 2012). However, excluding protest beliefs from the analysis can bias the final values estimates, because protesters may hold values for the service, but they are not willing to reveal those given some feature of the survey (Meyerhoff et al., 2014). Protest behaviour arises both from respondent characteristics, e.g. demographic variables, and features of the survey, e.g. payment vehicle or question formats. Identifying sources of protest behaviour can improve welfare estimates and avoid self-selection problems, i.e. if protest answers follow a certain distribution in the targeted population, then their exclusion will bias the results by estimating WTP of a self-selected sub-sample (Meyerhoff et al., 2012). Therefore, accounting for protesting behaviour and motivations behind it can improve WTP estimates by identifying protest responses and correct the model used for the analysis of those choices.

Careful design, pre-tests and validity tests are important for applications in low and middle-income countries (Mangham et al., 2009; Rakotonarivo et al., 2016). In some low-income countries or areas of low market involvement of the population and high literacy rates are considered as limitations for the application of SP methods (Gibson et al., 2015; Whittington, 2010). Moreover, language barriers can complicate explaining the hypothetical policy scenario and increase the risk of hypothetical bias (Whittington, 2010). Low market involvement can influence the credibility of the scenario and the payment vehicle, with consequences on the number of protest responses and to zero-bids, i.e. respondents that states that are not willing to pay for the provision of the good. The use of non-monetary numeraires, such as working time, has been proposed to improve the validity of results (Gibson et al., 2015; Rai and Scarborough, 2012; Whittington, 2010). However, when respondents can choose between non-monetary and monetary payments, roughly 40% choose monetary payment (Gibson et al., 2015). Moreover, comparison of welfare estimates using both type of vehicle payments shows that the use of a non-monetary instead of a monetary numeraire does not significantly change the magnitude of coefficients and relative welfare estimates (Gibson et al., 2015). Therefore, DCE surveys using monetary vehicle payments can be regarded as feasible in low-income countries. For the application of SP methods, the most important stages are the design and the piloting phase: to carefully design the policy scenario and select attributes and their levels appropriately. By using local research assistants and interviews with local experts, issues of cultural and language barriers can be addressed. Finally, the inclusion of validity tests for detecting lack of comprehension, protest behaviour and compliance with axioms of rational behaviour allow to verify the validity of welfare estimates.

Using DCE to assess social preferences

The influence of social preferences in DCE has been studied mainly in the health and environmental economics literature (Table 2.1).

Table 2.1 Number of DCE papers including a DCE testing the influence of altruism and fairness

Topic	DCE without monetary attribute	DCE with monetary attribute
Health	9	6
Environment and climate change	2	6
Tax redistribution		2
Transport		2
Agriculture	1	
Total	**13**	**16**

Source: author's calculation

Fairness and altruism in health economics

In the field of health economics the influence of fairness and altruism has been extensively studied using DCE (Bosworth et al. 2009; Hurley & Mentzakis 2013; Itaoka et al. 2007; Erdem & Thompson 2014; Mirelman et al. 2012; Lim et al. 2012; Koopmanschap et al. 2010; Norman et al. 2013; Ratcliffe et al. 2009; Youngkong et al. 2010; Baltussen et al. 2007; Schuffam et al. 2010; Green & Gerard 2009; Johansson-Stenman & Martinsson 2008; Rodríguez & León 2004) and other choice settings such as best-worse scaling (Godager and Wiesen, 2013; Torbica et al., 2014). Some of these studies focused on identifying trade-offs between equity and efficiency by modelling choices framed either as personal or public about health care interventions with efficiency vs equity objectives (Erdem and Thompson, 2014; Green and Gerard, 2009; Johansson-Stenman and Martinsson, 2008; Koopmanschap et al., 2010; Lim et al., 2012; Mirelman et al., 2012; Norman et al., 2013; Ratcliffe et al., 2009; Schuffam et al., 2010; Youngkong et al., 2010). Other studies focused on determining the relevance of social preferences in individual choice settings and their relationship to self-interested preferences (Bosworth et al. 2009; Hurley & Mentzakis 2013; Itaoka et al. 2007; Rodríguez & León 2004).

Health care interventions

Erdem & Thompson (2014) used a DCE to examine public preferences for health service innovations in the UK, including factors such as the group of stakeholders targeted and their age class, characteristics of innovations and potential health benefits. They found heterogeneity in preferences driven by the characteristics of potential beneficiaries: some respondents preferred targeting young and adult populations but not the elderly, while others preferred to discriminate based on the health condition. Schuffam et al. (2010) examined preferences for health-care interventions among English and Australian respondents and assessed the relevance of equity by introducing the attribute “missing on treatment due to cost”. Both in Australia and UK the number of people missing on treatment negatively affected individual WTP, showing support for policies that reduce lack of access due to income inequalities.

Other health studies examined priorities and distributional consequences of health interventions from a societal point of view, i.e. without eliciting an individual WTP, targeting mainly health practitioners and policy-makers. Mirelman et al. (2012) conducted a DCE in Brazil, Cuba, Nepal, Norway, and Uganda among health practitioners to evaluate equity according to severity of disease, possibility to subsidise individuals and the age of beneficiaries. They found that Cuba’s practitioners preferred equity, reflected in distributional effects related to age, income and severity of disease, while the rest of the sample preferred interventions leading to higher cost-effectiveness and number of individuals reached, i.e. efficiency. Health care professionals in Thailand preferred interventions that, among others, target high risk groups (> 20 years with high risk behaviour, rather than younger people or all adults) and both genders (rather than only men or women) (Youngkong et al., 2010). Ratcliffe et al. (2009) found gender-based heterogeneity in pursuing objectives of efficiency and equity and among different practitioners in the UK. Females and staff of health institutions expressed preferences for targeting worst-off population compared to males and hospital managers. In the Netherlands healthcare professionals preferred equity objectives, identified as severity of disease, over higher costs, and cost-effectiveness (Koopmanschap et al. 2010). Trade-offs between gains in efficiency and equity in health care policies are also valued differently by the general population in South Korea, Nepal, and Australia (Lim et al., 2012; Norman et al., 2013). Lim et al. (2012) found that respondents in South Korea attached higher value to health care funding allocation to treatment of patients with higher disease severity and lower household income. Norman et al. (2013) examined distributional concerns toward specific groups of the population and estimated distributional weights for the aggregation of preferences. They found equity weights higher than one for some categories of beneficiaries, i.e. non-smokers, people with a healthy lifestyle, full-time carers, and people with low-income status. In a slightly different setting, ethical preferences of Swedish respondents dictated that they preferred to save the lives of younger people and pedestrians as a result of road safety investments more than of older people and motorists (Johansson-Stenman and Martinsson, 2008).

Altruism

Four studies assessed preferences for public health policies that may also benefit others and the influence of altruism on individual WTP. Itaoka (2007) found that in Japan respondents were willing to pay more for reduction of risk of illnesses related to air pollution when framed as public good provision than as a private service. The study asked respondents for the motivation underlying their WTP and found that altruistic values are higher for people with children. Bosworth et al. (2009) however did not find evidence of altruistic motivations for WTP for public interventions to reduce health risks affecting respondents' community. Hurley and Mentzakis (2013) studied the relevance of altruistic preferences for private provision of health care services in Canada. They found that respondents are willing to pay for treatment of others even if the individual is a stranger and there is no risk of contagion of the illness. Rodríguez and León (2004) studied preferences for public policy interventions to reduce health risks and other socio-economic interventions in a deprived area in Spain. They found negative WTP estimates for the implementation investments in education and leisure facilities. However, WTP was positive for the implementation of income supplement.

Fairness and altruism in environmental economics

In environmental economics only few studies have used DCE to evaluate preferences for environmental policies and the distribution of benefits and costs (Carlsson et al., 2013, 2011; Dietz and Atkinson, 2010; MacKerron et al., 2009). Two studies focused on the influence of morality in individual choices related to (Biel et al., 2011; Johansson-Stenman and Svedsäter, 2012). Other two studies focused on preferences for intergenerational equity without including an individual monetary attribute (Scarborough and Bennett, 2008; Spyce et al., 2012).

Environmental policies and distributive rules

MacKerron et al. (2009) asked respondents to pay for voluntary carbon offsets related to personal flights. The choices included co-benefits of human development and poverty alleviation, conservation and biodiversity, and technology and market development. They found that WTP for human development was higher than for technology but lower than for conservation. The attribute was explained as a fuel-efficient stove program that would improve health, lower fuel bills, and give poor people more to spend on other things. Using a sample of Sweden citizens, Carlsson et al. (2011) investigated preferences for effort-sharing rules in carbon emissions reduction policies among the EU, USA, Africa, and China. The DCE involved three rules, i.e. historical emission levels, current emission levels and equal emission levels per person, where payments were set based on these different efforts sharing rules. Respondents preferred the equal emissions rule, where emissions must be decreased according to per capita emissions so that all countries can emit an equal amount of CO2 per persons. They did not prefer a rule that was most beneficial to their own group (EU) but choose a rule more beneficial for Africa. Carlsson et al. (2013) performed a similar study involving citizens from USA and China adding a fourth rule that considers the capacity to pay based on income level. They found that for both samples, participants preferred the rule that is less costly for their country and that WTP is higher for Chinese citizen. This indicates that how mitigation costs are shared internationally is more important for Chinese than for Americans. Dietz and Atkinson (2010) studied preferences for distribution of benefits and costs for local air pollution and climate change policies in the UK. The choice set for both policy interventions consisted of a description of environmental improvements, average cost for the household, cost-sharing rules, and an indication of the ability to pay (discount for low-income households). The rules for cost-sharing were: everyone pays, the beneficiary pays, or the polluter pays[3]. They found that participants preferred the polluter-pays principle for both policy scenario, and the inclusion of a discount for low-income households. The latter was higher in the climate change scenario.

Morality

Johansson-Stenman & Svedsäter (2012) studied the willingness to contribute to moral goods in an environmental context to test the influence of hypothetical bias in choices with a moral dimension in Sweden. They found that choices to donate to WWF are higher in hypothetical contexts than in real-monetary payments, but this bias is not found in choices related to a-moral goods, i.e. restaurant voucher. Using a similar context, i.e. real-monetary donations to WWF, Biel et al. (2011) examined the influence of emotions associated with donations. They found that self-interested choices are characterised by strong emotional reactions, such as shame, regret, and disgust. Moreover, they showed that the differences between WTP and willingness to accept becomes statistically insignificant when emotions are accounted for. Unselfish choices therefore seemed motivated by moral norms that are traded-off against self-interests when a pecuniary benefit is part of possible gains derived from choices, but not when the choice does not have material consequences for respondents (hypothetical).

[3] For the global climate change scenario, the principle of beneficiary pays was not included.

Intergenerational equity

Intergenerational equity can be assessed through varying the provision of benefits over time, as in (Spyce et al., 2012). The results of this DCE showed that over a period of 100 years, respondents preferred options that deliver benefits in terms of local jobs, number of moose and fish catch rates. The results showed an estimated discount rate close to zero, which would indicate that respondents put a higher weight on future benefits. Scarborough and Bennett (2008) assessed preferences for intergenerational equity in outcomes over a period of 25 because of distribution of environmental resources with a DCE in Australia. They found that the social marginal rate of substitution was higher than one for new born and 25-age generation. However, the interaction term between age and preferences for benefits for those generations was negative, suggesting that older groups are less likely to prefer benefit distribution to younger groups.

The influence of fairness for supporting (re-)distributive, transport, and agricultural policies

Two studies addressed the redistribution of tax money across different groups in society and examined income inequality as a motivation for public support in Ireland and Switzerland (Fourati and O’Donoghue, 2009; Neustradt and Zweifel, 2010). Fourati and O’Donoghue (2009) investigated individual preferences for a state pension scheme using attributes such as the average level of contribution of low and high-income members, the magnitude of benefits redistributed, the eligibility age and the resulting change in poverty rate. They found that a decrease in poverty rate among elderly had a positive influence on the demand for state pension schemes, both for high and low-income respondents. Moreover, respondents’ income level, age, and attitudes toward inequality, measured through attitudinal questions, further affected individual preferences. The study included as payment vehicle a weekly contribution for the average wage, so WTP values may not reflect individual budget constraint. Neustadt & Zweifel (2010) showed that income redistribution as a percentage of personal income to benefit various disadvantaged groups in society (working poor, unemployed, old-age pensioners, families with children, and people with ill health) as well as to foreigners rather than national citizens, is currently higher than the level preferred by respondents. Swiss citizens preferred 21% of GDP redistributed as opposed to the current situation (25%) and the mean WTP was negative also for respondents who stated that government should reduce income inequality. The payment vehicle was a percentage of income tax.

Two studies assessed the role of fairness in preferences in the context of transport (Di Ciommo et al., 2013; Tilahun and Levinson, 2013). Di Ciommo et al. (2013) found that in Spain, (social) responsibility for environmental and safety issues of road use was not an important factor in road pricing acceptance among road stakeholders. However, consideration of different aspects of fairness was deemed to be important for acceptance. Tilahun & Levinson (2013) studied the influences of distribution of income and travel time across the population in individual choices for transport interventions. They found that individuals in USA are willing to pay for equalizing the distribution of income and of travel time, and that individuals were sensitive to different characteristics of the distribution of benefits such as the mean, variance, minimum and maximum. They were willing to forego some of their own well-being to allow for higher minimum incomes or reduced mean travel times: 95% in case of travel time, and 75% for income.

The distributional consequences of agricultural policies interventions have been examined by Rocamora-Montiel et al. (2014) through preferences for budget allocations. They found preference heterogeneity across groups where respondents having relatives working in the farming sector preferred allocations that increase payments to less favoured areas and quality of life interventions. Through a set of attitudinal questions, they also found that almost 60% of participants stated that they would prefer options where direct aid is reduced, and the total funds are allocated more equally. The experiment did not include a monetary attribute or individual payment.

Finally, another approach to assess preferences for fair distribution is presented in Chang and Lusk (2009), where respondents were asked to indicate on a scale from 0-10 how likely they were to buy organic bread under different profit distributions. They showed that respondents preferred buying goods when small farmers receive a larger proportion of the profits, and by applying the inequality-aversion model proposed by Fehr and Schmidt (1999) they show that inequality relative to small farmers explain WTP to pay a premium for organic food.

Conclusion

By reviewing the literature on fairness influences in DCE I found that distributional outcomes of public policies are relevant for different groups of stakeholders. There is evidence that individual preferences are affected by altruism and fairness of distributive outcomes. However, most of the studies aiming at evaluating distributional outcomes do not separate self-interested preferences and societal benefits. When clear individual benefits are identified or when real monetary payments are included, altruistic behaviour, as willingness to sacrifice personal benefits for increasing benefits for others, seems to be less dominant. Studies on the elicitation of fairness rules for the distribution of environmental policies benefits, have focused on the fairness in the distribution of costs, and less on benefit distribution. Finally, there are no studies performed in low-income countries that focus on valuation of fairness in environmental policies at community level.

In the context of environmental valuation, I argue that values related to forest ES include both personal values, i.e. expressions of self-interested preferences, and “societal” values related to the distribution of these benefits in the reference group of the individual, i.e. social preferences. The individual, when performing a choice, is influenced by both systems of preferences and makes trade-offs among them. Therefore, I propose to apply a model of social preferences for the analysis of discrete choice data to assess the influence of fairness concerns in choices related to the environment. By eliciting social preferences, I aim to incorporate moral values attached to environmental resources, disentangle them from individual values and contribute to the empirical understanding on how the individuals’ fairness concerns affect valuation of environmental resources in DCE.

2.3.2 Fairness norms and moral values in individual decision-making

Experimental economics methods are extensively used in the literature to understand how moral norms influence individual behaviour, and the empirical evidence forms the basis of theories of social preferences. The hypothesis underlying social preferences theories is that individual’s utility is determined both by self-interested preferences, i.e. a monetary payoff, and non-pecuniary moral costs or benefits associated with a choice (Bardsley, 2008; Levitt and List, 2007). The influence of moral costs and benefits on individual’s behaviour depends on subjective value judgements, such as fairness concerns, and some experimental economics literature has focused on identifying the origins of those judgements and the mechanisms influencing them. An abstract setting such as a dictator game can be used to analyse the influence of norms of altruism and fairness on individual choices, the motivations behind them and the factors that influence the application of these norms.

Moral norms and fairness concerns in dictator game

Fairness concerns represent, among others, a moral norm that seems to motivate individual behaviour and modify individuals’ incentives in distributive choices. Fairness concerns that influence individual allocative choices can be related to fairness norms as theorised in normative economics literature (Konow, 2003). Konow (2001) provides evidence of three fairness norms (accountability, efficiency and need) that the individuals may use to evaluate the fairness of distributional outcomes, and he argues that the contextual information, such as the wealth status of the other agents or their degree of contribution to the production of the surplus to be allocated matters for the (extent of) application of these norms. Dictator game, and its variations, is used to understand how fairness norms are employed in individual decision-making; by varying contextual features of the game environment, it is possible to test if such norms are relevant and to what degree individuals adhere to them (Levitt and List, 2007).

Konow (2010) performed an experiment with dictator game variations to examine different motivations leading to unselfish behaviour, i.e. when the dictator gives some money to the recipient. Specifically, he evaluated the relevance of unconditional altruism, warm-glow, impure altruism (a combination of unconditional altruism and warm glow) and fairness norms. Unconditional altruism is defined as a pure concern for others and assumes that the individual, in the role of dictator, prefers to give a certain amount of money to the recipient, because he derives utility from the final allocation to the recipient independently from any fairness norm. The warm glow theory instead establishes that the individual wants to give some money because he gets utility from the act of giving. Impure altruism (Andreoni, 1990) is a combination of pure altruism and warm glow, where the individual gains utility from both the final allocation to the recipient and the act of giving. Finally, conditional altruism assumes that fairness norms determine individual preferences for giving, and the dictator pursues the objective of realising a fair outcome in the distribution of resources. Konow (2010) found that the model of conditional altruism incorporating the principles of accountability and need better explain choices made by dictators than models of pure or impure altruism. The results are corroborated by a questionnaire on motivations administered after the choices, where respondents identified equity as main motivation for their choices. Korenok et al. (2012) employed a modified version of dictator game where also recipients are endowed with an initial amount of money to test the influence of inequality aversion motivations on dictator's giving with a sample of students. They found that increasing the initial endowment allocated to the recipient, while keeping constant the initial endowment of the dictator, significantly reduced the mean and median amount of money given by dictators confirming that inequality aversion, represented here by different unequal initial conditions, explain variations of giving in dictator games.

An individual's choice in a distributive situation is determined by his distributive preferences (β) and the fairness norm (η^k). Formally, following Cappelen et al. (2007), the utility function of the dictator can be expressed as:

$$V_i = \alpha y_i - \beta \, (y_j - \eta^k)$$

Where α is the weight assigned to self-interested preferences, β the individual's distributive preferences and η^k is the fairness benchmark which depends on the fairness norm that applies to situation k.

Cappelen et al. (2007), using a sample of students, employed a dictator game with a production function, where the common endowment to be redistributed by the dictator is generated by actions performed by the players and external factors imposed by the experimenter. Two players are paired and during the first phase, the production phase, both players decide how much to invest to generate gains for a joint endowment that will then be shared between the two players. The investment choice of players is interpreted as the degree of effort of the players, while the rate of return of the investment is an external, random factor down to luck. During the second stage, the distribution phase, one player is assigned the role of dictator and he is informed about the degree of effort exerted by the other player and his relative rate of return. This design allowed to examine the relevance of three different versions of the accountability norm: strict egalitarianism, liberal egalitarianism, and libertarianism. The strict egalitarian norm prescribes that every person should be allocated the same level of material goods and services independently from their contribution to the total production. The libertarian fairness norm means that an allocation is fair if every individual is allocated all the resources that he produces independently from exogenous factors, such as luck, that may have caused the inequalities in individuals' initial contribution. The liberal egalitarian norm identifies a fair allocation as the one that takes in account the individual effort in contributing to the total production but disregards the factors that the individual cannot control. Allocative choices in Cappelen et al. (2007) differed greatly among participants and individuals seemed to be motivated by these three different norms; almost half of the sample was motivated by strict egalitarianism while 38% was motivated by liberal egalitarianism.

Rodriguez-Lara and Moreno-Garrido (2012) performed a similar experiment with a sample of students in Spain where they tested for the relevance of strict egalitarian, liberal egalitarian, and libertarian principles. They found that dictator's choices deviated from the expected self-interested outcome and that there was heterogeneity in the fairness ideals employed by participants. At the same time, participants seemed to endorse self-serving views of fairness by choosing the norm that maximised their final payoff.

The accountability norm proposed by Konow (2001) and the liberal egalitarian principle norm by Cappelen et al. (2007) consider fair an allocation if individuals are distributed resources proportionally to the effort that they exerted and determined their contribution to the total surplus. However, the degree of contribution to the social surplus is determined also by the individual's productivity related to individual's innate talents. Cappelen et al. (2010) examined in more detail for which factors individual should be held responsible when determining a fair share in the final allocations. They performed an experiment where individual responsibility is determined by degree of effort exerted in a real-effort task (amount of time spent working) and productivity due to innate characteristics (better performance in the task). The final contribution to the joint endowment is determined also by the rate of reward for the completed task which is established by the experimenter and it is not controlled by participants, i.e. luck. Cappelen et al. (2010) found that almost half of the dictators (47%) held their opponents responsible for both the degree of effort and their productivity, i.e. they applied a meritocratic principle.

Effect of earned endowment and property rights in dictator-sharing games

As shown above, the application of different fairness norms by individuals in their distributive choices depends, among other factors, by the degree of contribution of players to the joint endowment to be redistributed. A set of different experimental study focused on understanding the effect of effort in settings where clear property rights over the initial endowment are defined.

Jakiela (2015) tests the influence of effort and luck in a dictator game in two different countries, USA, and Kenya, in combination with variations on the nominal ownership over the endowment. In the luck treatment, the initial endowment was determined just by one of the two players by rolling a die, while in the effort treatment one player performed a real-effort task. The dictator role was then assigned to the individual that generated the endowment, in the 'giving' treatment, or to another player that did not contribute to the production in the 'taking' treatment. Jakiela (2015) did not find significant variation in the mean amount sent by Kenyan dictators between effort and luck treatments, which indicates that the Kenyan villagers did not distinguish between earned and randomly assigned endowment. Moreover, the Kenyan villagers seemed motivated by the egalitarian principle and allocated more than 40% of the budget in the taking treatments, showing evidence that dictators respected the recipients' rights to retain the endowment that they had produced. The same did not apply to the USA students, who acted selfishly across all treatments: roughly 10% of the sample allocated equal splits except in the Effort-Taking treatment, where dictators seemed to respect the effort exerted by recipients and reduced the amount of money taken from them compared to the Luck-Taking treatment.

Barr et al. (2015) performed a 4-player dictator game in the UK and South Africa with three different groups: students, workers and unemployed. The initial allocation for every player was determined either randomly or based on performance in a task. The authors tested if dictators were influenced by the degree of effort exerted by participants across a sample with different socio-economic characteristics. The initial endowments varied across participants within each group, depending on their performance in the task, and dictators were allowed both to give and to take from recipients. Barr et al. (2015) showed evidence of an earned endowment effect in both countries among students and employed participants, while the unemployed (UK) and participants classifying themselves as low-income (South Africa) seemed to be influenced only by the initial allocation of the others but not by the difference between earned and random endowments.

Finally, Leibbrandt et al. (2015) studied the influence of giving and taking frames in rural villages in Bangladesh in combination with different budget amounts to be allocated to evaluate the influence of different size (high and low) of the initial endowment to be redistributed in dictator game giving. They found, similarly to Jakiela (2015), a significant framing effect: dictators allocated on average more than twice as much in the taking frame as in the giving frame. Moreover, under the taking frame, dictators chose an equal split more often (22% vs 9%) and a significant proportion (roughly 10%) allocated everything to the recipient under both budget conditions (high and low).

The characteristics of the decision environment i.e. features of the dictator game setting, where fairness norms are studied influences significantly the distributive behaviour of individuals (Dreber et al., 2013; List, 2007; Oxoby and Spraggon, 2008). In fact, as shown by the discussion above the definition of clear property rights affects individual's allocative choices. At the same time, the effect of effort and luck, two variables deemed as relevant to disentangle different fairness norms in allocative choices, are found to influence significantly dictator's choices across different countries and under different property rights treatments. These findings confirm the hypothesis that individual's notions of fairness influence individual's choices and dictator game is a useful experimental environment to test the relevance of these norms.

Fairness norms in low and high-income countries

Gowdy et al. (2003) played different rounds of dictator and ultimatum games with participants from rural villages in Nigeria. They found a mean amount of money sent in both games between 40% and 50%. Through de-briefing questions and focus groups, they identified as main motive altruism and fairness norms as opposed to strategic factors such as fear of retaliation. Cappelen et al. (2013) studied the relevance of fairness principles across students both from low-income countries, Uganda and Tanzania, and high-income countries, Norway, and Germany. They found that students from Uganda and Tanzania took in account the participants' degree of contribution to the joint endowment and 67.3% endorsed in a libertarian or liberal egalitarian fairness ideals, while the rest of the sample seemed motivated by the egalitarian principle. Moreover, they found that some individuals seemed motivated by a need concern, which is assumed to be relevant when the dictator was matched with a recipient from a low-income country. However, in the high-income sample the concern of recipient's income was totally dominated by a concern over the individual contributions, while 34% of the low-income participants assigned greater weight to need considerations.

Field experiments on sharing in low-income countries

Schüring (2014) performed a field experiment in Zambia using a dictator game design with n-participants, to study the performance of CBM targeting policies for social cash transfers. Participants were allocated to groups composed of 12 people and were asked to distribute a sum of money with the aim of reducing poverty of members of their group (including himself), in the first treatment, and members of another group, in the second treatment. Participants played two rounds to elicit individual and group decisions, and they were asked to choose the beneficiaries, the total amount of money to be redistributed to every beneficiary, and whether to make the transfer conditional for the recipient (i.e. requiring the recipient to spend the allocated money for specific services such as education or health). The results showed that participants choose to distribute the money equally among recipients in 30% of the cases; moreover, participants targeted very poor beneficiaries in 34% of the cases. Schuring (2014) also found evidence of self-interested allocations but mainly when the individual was very poor while there was no evidence of higher allocations to family members or community members with high social status.

D'Exelle et al. (2012) examined attitudes toward sharing of irrigation water in rural communities in self-regulated irrigation systems in Tanzania. The field experiment used a structure like a standard ultimatum game. Specifically, upstream users could choose how to allocate the water resources between themselves and downstream users. Choices had real monetary consequences both for upstream and downstream users. In addition, downstream users could choose a costly punishment to reduce the proposers' payoff. Upstream users were given a set of choices which varied in the amount of water that could be consumed by both types of users and their own payoff. Choices of more equitable sharing between upstream and downstream users reduced the total income while more unequal distributions increased the total payoff, i.e. efficiency-equality trade-offs. The modal choice in both treatments was equal share of water resources, despite the efficiency losses, which was chosen by roughly 30% of participants.

Power and fairness

Fairness norms act as a benchmark for individual fairness concerns when the individual makes choices over allocations. However, when the individual has a stake, i.e. the allocative choice has implications for himself, the fairness concern is traded-off against his own self-interest. The decision-making power assigned to the individual in a dictator game setting has been shown to enhance self-interest and modify the individual perceptions of what is a fair share (Rode and Le Menestrel, 2011). Decision-making power intrudes into ethical judgements and the application of fairness norms that determine the fairness benchmark for the allocation (Croson and Konow, 2009).

Rode et al. (2011) examined the influence of decision-making power in allocative choices in a dictator game setting. They found that changes in decision-making power influenced the perception of fairness: increased decision-making power generates a sense of entitlement over the joint produced endowment and increased both self-interested allocations and the amount stated as a fair share. They compared, in a dictator game setting with a production function with a real-effort task, the offers of dictators when they contributed to the production of the common endowment and when they did not. Actual allocations differed from fairness statements and there is evidence of a role-dependent self-serving bias: when the inactive participants were entitled with decision-making power, they reward themselves more than what they stated as fair.

Rustichini and Villeval (2015) found that decision-making power in different game settings (dictator game, ultimatum game and trust game) influenced fairness judgements of both the agents in the advantageous and disadvantageous position. After being exposed to actual decisions in the three games, passive recipients, i.e. recipients in the dictator and trust games, adjusted their fairness norm statement in favour of the stronger. Respondents in the ultimatum game were an exception, after playing the game they increased the amount of what they considered fair by 5%. Therefore, being exposed to the choices of players with decision-making power over an allocation influences the fairness judgement of the powerless players, who adjust his fairness norm in favour of the powerful players.

Rodriguez-Lara (2016) studied the influence of fairness norms in an ultimatum game and the no-veto-cost game[4] where participants earned the endowment by performing a real-effort task. The joint endowment is determined by the players' effort and an exogenous rate of reward for the task performance. The study found that the respondent's degree of effort was considered in the proposer's choices for both games, while a higher reward rate for the respondent's task reduced the mean amount offered in the no-veto-cost game. The respondent's demand of the joint produced endowment was influenced by the degree of effort and in the no-veto-cost game respondents demanded a higher amount than in the ultimatum game because of the increased bargaining power. The difference in bargaining power held by respondents between the two games was not a significant factor for proposers' choices but influenced respondents' distributive preferences and so they demanded a higher share of the joint endowment.

[4] The no-veto-cost game is a variant of ultimatum game where the rejection of the offer by the respondent will not affect his payoff, but the proposer will get 0.

Conclusion

Overall, the evidence summarised here shows that fairness norms are relevant in individual decision-making for allocative choices. Individual preferences over outcomes are influenced by fairness norms as identified by Konow (2001) and they may be internalized by individuals as norms guiding their distributive behaviour. Dictator game settings have been successfully used to explore the determinants of moral norms in individual distributive choices. Importantly, more evidence is needed to understand how different features of the distributive context influence individual's choices motivated by fairness concerns and how to extrapolate findings from laboratory experiments to other settings (Barr et al., 2015; Fong, 2007; List, 2007). I argue that the allocation of decision-making power between participants with different characteristics, such as the initial assigned endowments, influence the application of fairness norms in distributive choices. Moreover, the implementation of an artefactual field experiment with participants from rural villages can provide further evidence on how fairness norms influence individual decision-making outside the laboratory setting.

2.4 Spatial mapping of ecosystem services supply and demand

The demand for ES is determined by individual preferences and consumption choices that are mediated by local, regional, and national institutions responsible for the governance of natural ecosystems. Factors influencing ES supply are better analysed at the ecological scale of the reference ecosystem, which typically differs from the institutional scale where demand is realized (Burkhard et al., 2012; Willemen et al., 2012). Therefore, there is a need to integrate the spatial complexity that characterizes both ES supply and demand to evaluate the contribution of flows of ecosystems to human well-being (García-Nieto et al., 2013; Guerry et al., 2015; Serna-Chavez et al., 2014).

In the following, I first discuss the ES framework and how it can be applied in low-income countries in a context of high poverty. Next, I discuss the variables that can influence values for forest goods and services in low-income countries with the aim to identify factors that influence ES demand. Finally, I discuss how existing mapping approaches can be used to evaluate the relationships between demand and supply of ES in spatial terms.

2.4.1 The Ecosystem Services framework

ES have been defined by De Groot et al. (2002) as "*The capacity of natural processes and components to provide goods and services that satisfy human needs, directly or indirectly*". A more recent definition of ES by the UK National Ecosystem Assessment "*The benefits provided by* *the ecosystems that contribute to making human life both possible and worth living*" (UK NEA, 2011). The ecosystem cascade model provides a graphical representation of the linkages between the ecological and the socio-economic system (Figure 2.3).

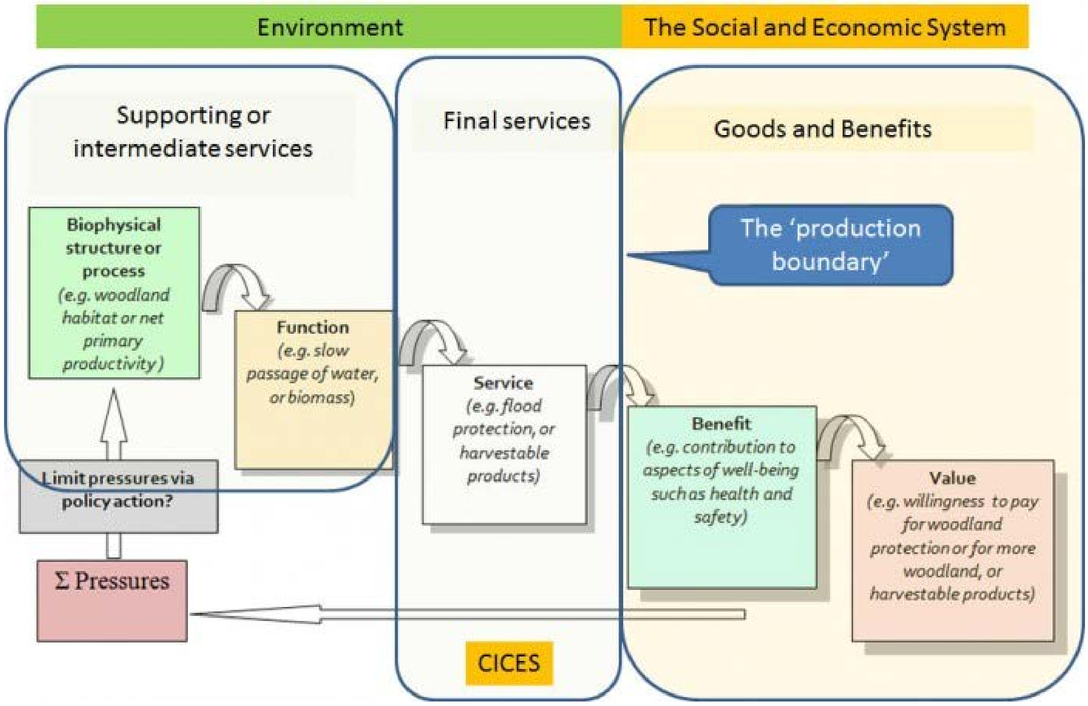

Figure 2.3 ES cascade model (Potschin and Haines-Young, 2011)

An ecosystem service is the capacity or potential of delivering goods and services based on the ecosystem structure and processes that contributes to human well-being when there is a population that benefits from it and attaches values to those services. The final benefits enjoyed by a certain population surrounding the natural ecosystem influence individual's well-being to varying degrees and this is reflected in different values that people attach to it.

ES have been classified into three main categories (Roy Haines-Young and Potschin, 2013):

- Provisioning services;
- Regulating and maintenance services;
- Cultural services.

Provisioning services are defined as material outputs provided by the natural ecosystem that can be directly consumed or used as input for human productive processes. For instance, a forest ecosystem provides woody and non-woody biomass such as timber, fuelwood, and grass. Regulating and maintenance services are defined as regulating functions that mediate and moderate the natural environment providing indirect products and services. For instance, a wetland ecosystem provides a water purification service by retaining pollutants and regulating the number of nutrients discharged in the surrounding groundwater and surface water sources. Finally, cultural services are defined as non-material outputs that affect physically, spiritually, and mentally individuals' welfare. An example of a cultural service is the use of forest ecosystems as a natural space for recreational activities. The provision of these different categories of services depends on the underlying biophysical structure and processes and anthropocentric pressures generates trade-offs in the provision of ES (Howe et al. 2014; Maes et al. 2012). For instance, the use of provisioning services modified greatly the biophysical structure and leads to the reduction of regulating services supply. Extensive human modifications of the natural landscapes for collection of provisioning services, e.g. animals for food or trees for timber, can also lead to a reduced provision of cultural services by reducing specific ecological features, e.g. high biodiversity.

Ecological trade-offs in ES supply, which occurs when the use of a certain service reduces the supply of another, influence the well-being of different groups of people that enjoy those benefits (Howe et al., 2014). Trade-offs in provision of ES depends also on the socio-economic system where a group of stakeholders may be facilitated and captures the flow of services reducing supply for other social groups. The ES cascade framework acknowledges the existence of these complex trade-offs, i.e. ecological and socio-economic, and it is a useful tool for understanding the relationships between natural resources and human well-being. Trade-offs in provision of ES determined by specific management options may have an impact on societal welfare by reducing the flow of services for specific categories of users and increasing for others.

2.4.2 Ecosystem services and poverty

For rural communities in low-income countries, natural ecosystems are particularly relevant because they provide in basic needs such as food, energy, water, and other services, such as soil nutrients, flood protection, and socio-cultural benefits (TEEB, 2010). At the same time, unsustainable use may be the only option available to poor households to fulfil their needs. Poor rural communities may be trapped in a vicious circle where their reliance on forest resources will prevent them to develop alternative livelihood strategies that could generate higher income, facilitate accumulation of assets and facilitate poverty reduction (Angelsen et al., 2014). At the same time forest resources prevent rural population falling deeper into poverty and act as safety net for the poorest segment of rural population (Angelsen et al., 2014; Wunder et al., 2014).

It has been argued that rural communities heavily dependent on forests may contribute to forest decline because they lack the assets, capital and income needed to provide in basic needs using alternative sources (Sunderlin et al., 2005). However, the share of environmental benefits that rural households can capture, and the pressure that they exert on the natural resource, differs greatly among different groups of rural stakeholders (Babigumira et al., 2014). Impacts on the ecological sustainability of forest areas and long-term ecological resilience depends on different types of forest uses. Individual livelihood strategies and degree of dependence on forests are determined by a complex set of socio-economic factors and biophysical characteristics. These factors include the availability of the resource both in physical terms, such as distance from forest, and in legal/institutional terms, such as rights to access the resource; moreover, individual characteristics such as asset ownership and availability of capitals will likely determine the degree of pressure on forest resources. For example, asset-rich households can develop activities that generate more income and that affects strongly the ecological structure of forests, such as charcoal production and timber collection, while households lacking capitals engage more in low-return activities with a lower pressure on the ecological functioning. Babigumira et al. (2014) showed that households with medium and high asset holdings are more likely to clear forests. This result is supported by Angelsen et al. (2014) who show that environmental income accounts for about 30% of total household income; the relative proportion is higher for the poorest households, indicating strong reliance, but the absolute environmental income is broadly five times higher in the highest quintile of the population than in the lowest.

Forest resources play a prevalent role in preventing poverty, especially for the poorest segment of the population (Angelsen et al., 2014; Wunder et al., 2014). Moreover, forest resources could also support pathways out of poverty for the well-endowed households that engage in activities generating high economic returns (Fisher et al., 2005). At the same time, the implementation of long-term conservation strategies, which limits the exploitation of direct forest products, may ensure a long-term flow of (indirect) benefits for the whole population and may also contribute to the well-being of people beyond local communities (externalities related to carbon sequestration, biodiversity, recreation, watershed protection). However, pursuing conservation objectives may conflict with economic development and poverty alleviation objectives.

Fisher et al. (2014) propose a framework for the analysis of linkages between ES and poverty alleviation. They highlight the need for disaggregated assessments to uncover the influence of different ES (provisioning, regulating and cultural) on human welfare. Provisioning services and related income-generating activities are more easily identifiable and quantified as environmental income. However, other ES contribute to other aspects of human well-being, e.g. physical security is primarily related to regulating services. Moreover, the analysis of ES contribution to human well-being should take in account the individual's ability to capture the flow of benefits from ecosystems and the conditions determining the access to those benefits. The contribution of forest ES to human well-being is constrained by the availability (supply) of ES and the ecological status of the natural ecosystem. However, higher availability will not necessarily lead to higher contribution to well-being or poverty alleviation, because its contribution will depend on the ability to get those ES. Various socio-economic factors, i.e. endowments and entitlements, capitals, preferences, and other sources of welfare, affect people's ability to appropriate and enjoy ES (Fisher et al., 2014). The institutional system determines rights and access to natural resources and, together with the informal social dynamics happening at local level, will mediate and influence individuals and collective ability to access and control the ES supply. Therefore, ecosystem policies that aim to balance economic development and environmental conservation objectives need to be analysed focusing both on the ecological and socio-economic dimensions of ES supply.

2.4.3 Spatial mapping of ES demand and supply

Spatial distribution of forest ES demand

The analysis of ES demand and its determinants is proposed as a useful tool to improve the operationalization of the ES concept in policy-making and natural resource management and planning (Baro et al., 2016; Villamagna et al., 2013; Wolff et al., 2015). ES demand is defined both as direct use and consumption of ES by beneficiaries located in a defined area (Burkhard et al., 2012) and the quantity preferred or required by beneficiaries to fulfil their needs (Villamagna et al., 2013). The latter definition regards demand as the required quantity of benefits by a population of beneficiaries which does not necessarily equate the current benefits extracted. Economic valuation of ES through SP methods is used to identify preferred demand for ES and model individual preferences.

Individual demand for ES is characterised by heterogeneity that depends both on socio-economic characteristics and on the characteristics of the good valued. In low-income countries, ES demand for forest provisioning services is likely to be influenced by the structure and the quality of forest. Forest quality, tree structure and tree composition are proxy variables across different zones of the same forested area and may influence individual preferences for forest ES through influencing cost of collection, demand, and availability of forest products. Schaafsma et al. (2014) studied the individual demand for forest provisioning services in Tanzania and its relationships with spatial variables such as forest availability and accessibility. They found that forest availability, i.e. a proxy representing availability of biomass, influenced individual demand for forest products, closed woodland. Specifically, higher presence of forest area in a 10 km buffer increased the probability of forest products collection while the availability of open woodland, as an indication of lower supply of biomass, in the surrounding reduced the probability of collection.

Location and accessibility also influence individual choices to collect forest products, where forests located in montane and sub-montane areas reduces the individual probability of engaging in the activity given the transport difficulty associated with steep slopes and the management regime, i.e. protected status. The availability of forest areas is strongly associated with an increase in environmental income, both in its cash value and in terms of subsistence use, indicating higher demand (Jagger et al. 2014). Also, the location of forest patches relative to the location of the household will influence their demand. Distance to the source of ES influences preferences for ES and the individual demand because higher distance to the providing location means higher costs to access and use the ES demanded (Albers and Robinson, 2013; Vollmer et al., 2016). In addition, other socio-economic variables, such as distance to main markets where it is possible to buy or sell timber and non-timber products or to main roads as a proxy for market involvement, will likely influence individual preferences for forest provisioning services (Albers et al. 2013). Schaafsma et al. (2014) found a negative relationship between firewood collection and distance to main roads in Tanzania.

The determinants of ES demand exhibit spatial variation and the evaluations of these variability in individual preferences for forest ES allow the spatial exploration of future patterns of consumption of forest provisioning services (Schägner et al., 2013; Wolff et al., 2015). The economic valuation literature is increasingly combining the use of SP methods and GIS tools to identify how spatial variations of drivers of ES demand impact individual preferences and stated WTP (Abildtrup et al., 2013; Baerenklau et al., 2010; Broch et al., 2013; Czajkowski et al., 2016; Nielsen et al., 2016; Termansen et al., 2013; Yao et al., 2014). Preferences for forest recreation activities are influenced by the characteristics of the forest area accessed by respondents, and spatial variations in biophysical variables may generate spatial sorting effects in individual demand (Abildtrup et al., 2013). Spatial sorting implies that individuals will access forest areas because of the presence and/or absence of certain characteristics. The quality of the forest area has been found to be a significant determinant of recreational values, and its variability across the area affects significantly WTP for forest management and conservation policies (Czajkowski et al., 2016). The size of forest cover is another factor that significantly affects values for recreation services (Nielsen et al., 2016; Yao et al., 2014). Moreover, the location of the forest relatively to the location of the household influences recreational values, as distance represents a proxy for transport costs (Bateman et al., 2006; Hanley et al., 2003; Termansen et al., 2013). Finally, another factor that is characterized by spatial variability and that influences values for environmental good of services is the availability of substitutes (Schaafsma & Brouwer 2013; Schaafsma et al. 2012).

Mapping forest ES supply

There are an increasing number of studies focused on mapping the provision of ES across different scales and with different purposes (Maes et al., 2012). Mapping approaches for ES supply can be divided into two broad categories: methods based on some primary data and methods based on proxies (Eigenbrod et al., 2010). Provisioning services can often be directly quantified using primary data when available and easily mapped across the relevant spatial scale. To quantify and map other categories of ES instead there is a need to use proxies because of the lack of primary data (Maes et al. 2012). Some authors classify the proxy-based methods category into two further typologies, i.e. land use/cover proxy and proxies based on combinations of likely causal variables (Lautenbach et al., 2011). ES assessment based on land cover data (Haines-Young et al., 2012; Kienast et al., 2009) is quite common due to the widespread availability of digital raster land cover maps. However, this kind of approach can introduce errors because it does not take in account many other factors such as the spatial variability of biophysical variables, different management practices and biotic responses (Lavorel et al., 2011). Other proxy-based approaches have incorporated into the analysis, together with land cover data, other relevant information on biophysical variables and causal relationships that affect the ES supply (Willemen et al., 2010).

Focusing on the African countries, the first mapping experience performed was the Southern African Millennium Ecosystem Assessment which had the objective to provide policy-maker valuable information on stocks and trends characterising ES in the region (van Jaarsveld et al., 2005). The assessment covered 19 sub-Saharan countries at different scales (national scale, basin-scale, and local scale) and key services such as water and food provision, wood-fuel provision, and biodiversity (van Jaarsveld et al., 2005). Other mapping experiences have been performed at national and regional scale across different ecosystems. However, the development of mapping approaches for semi-arid systems is still in its infancy, compared to the more analysed tropical and temperate areas (Egoh et al., 2012; Wangai et al., 2016). Most of the studies on mapping ES assessed provision of regulating services such as carbon storage (Batjes, 2008; Egoh et al., 2008, 2011; Leh et al., 2013), water flow regulation (Egoh et al. 2008; Egoh et al. 2011), soil accumulation and retention (Egoh et al., 2008, 2011; Leh et al., 2013). Other attempts focused on developing scenario analysis and related land use changes to evaluate future provision of ES (Haregeweyn et al., 2012; Petz et al., 2014; Swetnam et al., 2011) or provide an overall assessment of ES potential provision by using composite indicators (Rogers et al., 2010; Wendland et al., 2010).

Overall, the evidence of approaches for mapping ES provision in semi-arid ecosystems is scarce and forest provisioning services mapping exercises have not been performed[5]. The European experience of large-scale mapping of ES (Maes et al., 2018) could give some guidance on how to proceed for the development of a mapping approach suitable for provisioning services, and specifically raw materials provided by forest ecosystems in semi-arid ecosystems. However, lack of national forest inventories and reliable estimates of woody biomass claims for an approach that relies on indicators derived from remote sensing products. Changes in vegetation cover and tree canopy density data measured through remote sensing products, such as MODIS vegetation continuous fields (DiMiceli et al., 2011) or tree cover loss estimates (Hansen et al., 2013), could be useful for developing a mapping approach.

Conclusion

Mapping the spatial distribution of ES potential provision and demand can be used to identify the ecosystem service flows and highlight consequences for ecological sustainability of forest use and management (Baro et al., 2016). ES demand for forest provisioning services could potentially exceed ES provision in a specific area and generates future unsustainable patterns of consumption leading to degradation of forest areas with adverse long-term consequences for human well-being. The analysis of spatial drivers of ES demand and mapping approaches based on SP surveys are increasingly used in the ES literature, however their use in low-income countries is scarce. Moreover, developing indicators for mapping sources of potential supply of forest provisioning services and linking them with map of ES demand can be used to improve the assessment of ecological sustainability of forest resource consumption.

[5] Except for van Jaarsveld which performed a mapping of wood fuel supply and demand at a resolution of 5 km x 5 km

Chapter 3 Context and case-study description

The aim of this chapter is to provide a descriptive overview of the case-study area and to contextualize the research problem defined in the introduction in the policy context. I discuss the relationship between forest ES and livelihood strategies in Malawi and its relevance for poverty prevention. Next, I describe briefly the characteristics of co-management policies and discuss the information that I gathered from my exploratory fieldwork through key informant interviews and focus groups. Finally, I will describe the spatial sampling strategy used to select the sampled villages.

3.1 Forest resources, governance, and rural livelihoods

Rural livelihood strategies in Malawi include a mix of income-generating activities, including off-farm activities (remittances, craftwork, wage-work, etc.), agriculture, livestock rearing, and collection of forest products. Natural resource-based activities, including cultivated and natural habitats, are one of the main livelihood source and rural communities strongly rely on forest products and services (Chilongo, 2014; Kayambazinthu and Locke, 2002). Forests are the primary source of energy-related goods, i.e. firewood and charcoal and provide also important products such as construction materials, timber, wild food, and medicines (Campbell, 1996; Kamanga et al., 2009). Moreover, forests provide important indirect benefits such as flood protection and soil fertility, regulating the availability of water in streams during the dry season, and cultural benefits. Forest resources are an important source of income for most rural households, contributing about 10-20% of the household income on average, and have an important equalizing effect (Chilongo, 2014; Fisher, 2004). Finally, forest-related income may have a role in preventing rural households from falling deeper into poverty and act as a safety-net (Angelsen et al., 2014). The reliance on forest resources is especially high among vulnerable households as indicated by Chilongo (2014) who found that the highest forest dependence is associated with the lowest annual income.

At the same time, forest coverage in Malawi has been declining at a fast rate; although the actual forest cover is not known with certainty, it has been estimated that the annual deforestation rate ranges between 1% and 3.5% (Bekele, 2001; FAO, 2010; Zulu, 2010). FAO estimated a total forest cover of 3,237,000 ha in 2010 in Malawi (FAO, 2010); however, updated and reliable data on forest cover and rate of deforestation are not available because the last forest national assessment was performed in 1991 (FAO, 2010). FAO's estimates of forest cover are calculated by linear extrapolation of forest data for 1973 and 1991 and the estimated annual deforestation rate was 1% between 1990 and 2010. A report of the Forestry Outlook Study for Africa (Bekele, 2001) estimated forest cover using remote sensing images at 1,898,315 ha in 1992, with an annual deforestation rate of 2.8%. Zulu (2010) reported a forest cover of 1,988,500 ha in 2008 with an estimated annual deforestation rate of 3.5% based on the Malawi Biomass Energy Strategy (Marge, 2009). The estimated deforestation trends highlight the need to improve the management of forest resources and reduce adverse consequences of increase scarcity of forest products on local livelihoods (Kamanga et al., 2009).

3.1.1 Forest governance and community-based forest management (CBFM)

The management practices of forest areas in Malawi determine both the ecological status of the ecosystem and its ability to re-generate and rules for local users that wants to access and harvest forest products. The forest areas are located both on public and customary land and the management practices vary according to ownership status. Customary land is defined as "*all land which is held, occupied or used under customary law, but does not include any public land*" (GoM, 1965). Communities have property rights on forest located on customary land and they are usually managed by a traditional leader on behalf of the community. Public forests instead are owned and managed by the state and include forest reserves, national parks, and wildlife reserves, which cover approximately 1,526,487 ha (FAO, 2010). Forest reserves are managed by the Forestry Department and are mostly located in water catchments and mountainous areas, i.e. fragile environments. Wildlife reserves and national parks are managed by the Department of National Parks and Wildlife and are designated in areas with high biological diversity.

The management practices of public forests in Malawi are transitioning from a centralised management system to CBM, as established in the 1996 Forestry Policy and the 1997 Forestry Act (GoM, 1997, 1996). The National Forestry Programme developed in 2001 (GoM, 2001) as a framework to operationalize the previous acts has established, among its strategies, objectives such as strengthening local forest governance through decentralization and CBM in public owned forests and customary land (GoM, 2001). The development of CBM for forest reserves and customary forests as a mean to pursue effective forest ecosystem management is recognized as a priority by the forest department (GoM, 2016).

The implementation of CBFM systems in Malawi differs according to the type of land tenure (IFSMLP, 2010). CBFM implementation on customary land recognizes the ownership and harvesting rights of local communities traditionally in charge of land management. The forest department acts as facilitator in the development of the forest management plan. The local communities are facilitated through the process by public forest officers who help the communities to set the boundaries of the customary forest, identify relevant stakeholders and community needs, elect a Village Forest Committee (VFA) responsible for the coordination of activities, and draft a management plan to regulate the use of the common access forest.

3.1.2 Co-management in forest reserves

The implementation of CBFM policies in forest reserves is defined as co-management. A co-management policy involves the sharing of rights and responsibilities between government and local resources users over forest reserves (Berkes, 2009). Local communities are recognised as users with access rights and are involved by the forest department in the management of the resource and the decision-making process (GoM, 1996). The implementation process of a co-management policy follows the same steps as in forest areas on customary land (IFSMLP, 2010). However, from a legal point of view the forest department retains the ownership of the forest and grants usufruct rights to rural villages (GoM, 1996). The management partnership between local community and government becomes effective through a signed binding agreement between the forest department and the residents of the communities involved which are represented by a committee. Rural communities are then entitled with access rights and management duties, but the forest department is responsible for supervising the management outcomes and has the authority to revoke or terminate the agreement in case the communities fail in protecting and managing the forest areas.

The development of co-management schemes has started in 2002 with a pilot phase that has culminated in 2005 with the publication of guidelines for the implementation of co-management to be realised for all forest reserves (GoM, 2005). The document "Standards & Guidelines for Participatory Forestry in Malawi" defines guidelines and procedures for the promotion of co-management agreement as a mean to support poverty alleviation in Malawi. Specifically, a co-management scheme requires a participatory process to define a sustainable management plan for a forest reserve area, or part of it, according to community members' demand for forest resources and the ecological status of the forest. The first step of the process is about identifying of the forest reserve area and the local stakeholders to be involved in the agreement (communities within 5 km buffer around the forest reserve). The forested area is then divided in management blocks and, depending on local users' preferences about key products to be harvested, a management plan that ensure the long-term sustainability for the forest area is developed. The block is assigned at group village level and is divided in Forest Management Unit (FMU) where community members define key products to be harvested for each FMU, quantities that can be sustainably allocated, mechanisms of distribution and other management activities, e.g. fire breaking maintenance and monitoring.

The local users involved in co-management schemes can be classified in categories depending on their main forest uses:

- Collectors of non-timber forest products (NTFP), such as bamboo and thatching grass, for domestic uses
- Woody product collectors for domestic uses
- NTFP collectors for commercial uses
- Carpenters and builders
- Timber traders
- Firewood traders
- Beekeepers
- Craft workers

Different stakeholders may have different interests in defining key forest products for the forest management unit and their ability to participate and influencing the set of rules implemented will determine the possibility to access specific products under the future co-management regime. The management rules set for a specific block, i.e. area of a forest reserve co-managed, will determine the availability of forest products for the provision of basic needs and source of income and it will therefore influence the welfare of local users.

3.1.3 Co-management scheme: participation and benefit distribution

The effects on income of the rural communities involved in existing co-management projects in Malawi are unclear and differ across experiences (Jumbe and Angelsen, 2006; Mazunda and Shively, 2015). Co-management policies have different distributional implications depending both on rules developed by the local users and the practical implementation of those rules at community level. Jumbe and Angelsen (2006) found that participation in co-management programs increased forest income of local users in Chimaliro, while reduced it in Liwonde, where forest-based businesses are a main source of income. Mazunda and Shively (2015) extended Jumbe and Angelsen's work by analysing panel data from 2002 and 2009. They did not find a significant effect on total annual forest income, but they found evidence of a reduction of forest pressure in the whole area, including private and customary forests. Moreover, vulnerable categories of forest users, such as women-headed and low-income households, got relative smaller benefits from co-managed forest reserves compared to less vulnerable households, highlighting the need to improve the targeting of different categories of forest users (Jumbe and Angelsen, 2006).

The non-effectiveness of some co-management scheme in targeting vulnerable households may be related to how devolution of power and responsibility are transferred to the local communities. The lack of participation in decision-making activities of all categories of forest users in fact limits the ability of users to express their needs and preferences, orient the development of management plans and establish rules that can benefit all members. Chinangwa et al. (2015) analysed two co-management experiences in Malawi and found that non-committee village members are mainly involved in management activities, i.e. they provide effort inputs for the management of the forest reserve, but do not participate in decision-making activities and their access to forest resources is significantly lower than for committee members (e.g. 12.4% of ordinary members declare to have access to resources compared to 42.3% of committee members).

3.2 Exploratory fieldwork results

I performed an exploratory fieldwork in August 2016 with the aim to improve the understanding of the policy context through key informant interviews (KII) and focus groups (see Appendix B.1, B.2, B.3 and B.4). The main topic discussed during my exploratory fieldworks are:

- The relevance of forest resources for livelihood strategies in rural areas
- The implementation of CBFM system and impacts on benefit distribution
- Sustainable forest management and the importance of regulating ES (water flow regulation, soil fertility and landslides protection)

The information gathered through key informant interviews and focus groups have been used to refine the scope of my research questions and the hypothesis to be tested. The exploratory fieldwork informed the DCE design and the selection of the attributes relevant for the valuation of forest ES under co-management. As discussed by Johnston et al. (2017) qualitative pre-testing is required for the development of a questionnaire and a choice scenario that is understandable and credible for respondents.

3.2.1 Key informant interviews

I interviewed a diverse range of key informants: researchers affiliated with the Forest Research Institute of Malawi (FRIM), researchers of the University of Malawi, forest department staff at national, regional and district level and NGO's staff involved in forest management activities and projects (see Table B.1). The information collected through the KII that I performed gave me a very good understanding about current status of co-management implementation and effectiveness, the degree of community involvement and relative distribution of benefits, and the main research gap as identified by local experts.

Co-management policies have been introduced as an experimental policy in 1992 and formalized legally in 1996 and 1997 (GoM, 1997, 1996); effective implementation across forest reserve areas started in 2002 through a partnership with external donors. The Improved Forest Management for Sustainable Livelihoods Program (IFSMLP, 2010), funded by EU, started in 2006 and has extended co-management agreement in 12 forest reserves across the whole country following guidelines developed in a pilot phase. The results of the first and second phase of the project in terms of effectiveness differ greatly across experiences, but overall forest staff involved in the agreements have highlighted its effectiveness in ecological terms and reduction of pressures on forest resources with specific benefits in terms of higher availability of water in the dry season.

> "Co-management is a good concept if the community is doing a good work"
>
> **(FRIM researcher)**

However, lack of external funding has slowed down the implementation and monitoring activities and co-management agreements are still in their first stages of implementation in most areas.

> "Co-management policies are still under implementation and testing"
>
> **(Forest Department staff)**

The second main topic discussed with the key informant interviews regards the degree of community involvement in the rules-making process and benefit distribution rules. Co-management policy implementation follows a standard template developed during the pilot phase of the IFMSLP project. The standard guidelines developed by the forest department in partnership with external organizations requires a comprehensive assessment of community needs to identify their preferences and guide the development of management and rules. However, in practice the implementation of co-management agreements, due to time and financial constraints, is realized with a top-down approach that imposes management rules which will ensure ecological sustainability without taking in account social impacts of the governance system.

> "The government should evaluate how communities interact with the resource to develop management plans, but this is not part of the co-management practices"
>
> **(NGO's staff)**

The rules implemented determine the maximum annual sustainable harvest and the governance system is characterized by a formal license system with fixed prices for each type of resource to be harvested. The main problems identified by local experts with the current practices is that the key resources that determine the sustainable harvest plan might not match community's preferences and needs and the lack of access given the high price of licenses.

> "Everyone has formal access, but they have to go through the implemented system and the 1% of users can actually buy licenses"
>
> **(NGO's staff)**

Formally, there are regulations, rules and sanctions that will ensure a participation of all members of the community in managing the forest reserve. However, practically the exercise and enforcement of formal rules is scarcely realized, and the appointed local committee is entitled with discretionary power in determining the distribution of benefits.

> "Kacha (social norms) influence how the forest reserve is practically managed at community level"
>
> **(FRIM researcher)**

> "The licence prices in some co-managed area depend on the degree of participation in the activities, community members that help with the management buy licenses for less"
>
> **(Forest Department staff)**

Finally, among information gap highlighted by local experts regarding the co-management policies and its effectiveness there is a need to explore drivers of forest resource use at household level and how co-management policies affect those incentives. Moreover, senior researcher and forest department staff involved at national level pointed at the need to evaluate complementary interventions to co-management policies, such as implementation of payment for ES, to pursue conservation and poverty alleviation objectives.

3.2.2 Focus groups

I performed four focus groups in three different villages with the aim to gather information on views and perceptions of forest management policies (see Appendix B.3 and B.4). In two villages (Matandika and Lipongo), located within 5 km buffer around Liwonde forest reserve, co-management schemes are implemented while in one village (Kwitunji), located around Namizimu forest reserve, the forest is still managed by the state (Table 3.1).

Table 3.1 Focus group activities performed in Malawi during my exploratory fieldwork

Focus group activity	Description of the context
Matandika village – interview with members of the co-management committee (see Appendix B.3)	The village is in a 5 km buffer around Liwonde forest reserve (Machinga district) and the co-management policy is implemented (not effective)
Matandika village – focus group discussion with members of the community (see Appendix B.3)	
Lipongo village – focus group discussion with members of the community (see Appendix B.3)	The village is in a 5 km buffer around Liwonde forest reserve (Machinga district) and the co-management policy is implemented (effective)
Kwitunnji village – focus group discussion with members of the community (see Appendix B.4)	The village is in a 5 km buffer around Namizimu forest reserve (Mangochi district) and the co-management policy is not implemented

The focus groups involved 8 participants of both genders randomly sampled among community members. The main topic discussed were the community members' perceptions about the importance of forest resources, its benefits, and its relevance for their livelihoods. In addition, the focus groups allowed me to gather information on perceptions related to forest management and fairness of the actual system where the co-management is already implemented. In the following I will discuss the main findings of the focus groups discussions in the three villages.

Forest as a common good and the need of regulating its use

Participants perceive the importance of forest as collective resource and the relevance of forest products for the livelihood of the whole community. Community members harvest woody products from the forest reserve, and they make use of them for subsistence and income-generating activities.

> "In this village we entirely depend on the forest for livelihood"
>
> **(FG Lipongo village)**

However, community members also agree on the need to manage sustainably the forest such that indirect services and benefits, e.g. water retention and flood protection, can be also delivered.

> "Forests prevent soil erosion and improves water availability"
>
> **(FG Kwitunji village)**

Moreover, the need of regulating the use of forest products is recognized by participants and policies that limit forest exploitation are perceived as beneficial to maintain forest coverage and the provision of ES.

> "There is no willingness to harvest trees for charcoal burning and other uses because this will bring a lot of problems"
>
> **(FG Kwitunji village)**
>
> "Charcoal burners are the ones that cause deforestation. So, in this area we don't do that due to the co-management and that is why we have more trees"
>
> **(FG Lipongo village)**

The concept of CBFM policies is seen in a positive way from the participants' point of view and community members would like to be involved in co-management policies where they are not implemented yet. Participants from Lipongo, where co-management is implemented already, said:

> "The good thing about co-management is that we are having enough water throughout the year in rivers"
>
> **(FG Lipongo village)**
>
> "The sense of ownership"
>
> **(FG Lipongo village)**

A participant from a village where co-management policy is not implemented yet commented:

> "The forest should be divided in two parts and community members should be allowed to use a part"
>
> **(FG Kwitunji village)**

Overall, these results support the DCE design and show that the policy scenario proposed is credible and acceptable by respondents. Co-management policies are widely accepted, community members recognise the need to limit the use of forest resources and the development of new management rules is supported by the local users.

Co-management policies: forest committee, licenses, and payments

Access to forest products, both for forest reserves managed by the state or co-managed by the community, is regulated through a licensing system. In the case of forests managed by the state the only forest product that can be harvested is firewood, while in the case of co-managed forest also poles and timber can be collected. Communities recognize the need of limit forest products harvesting to protect the forest and agree that the licence payment is a useful mechanism for doing so.

In villages where co-management is implemented, access is guaranteed to everyone through the system of licenses, but respondents have highlighted the major role of the committee in the implementation and enforcement of management rules. Discussing of the rule definition process and license's prices a participant stated:

> "It's the committee that did that"
>
> **(FG Lipongo village)**

All participants were aware of the license system and prices to be paid to access the resource but few of them were involved in the discussion for the definition of those rules and they highlighted the importance of the committee in the coordination of forest management activities.

> "Forests are owned by foresters and block committee"
>
> **(FG Matandika village)**

When asked on who participated in the rule definition process a participant said:

> "The forest committee which was initiated by the government"
>
> **(FG Matandika village)**

Fees for obtaining the licenses to harvest forest products are recognised as needed to sustain the co-management policy and limit access to the forest resource.

> "The truth is, this helps to control the way forest is managed, there is less deforestation, so benefits outweigh disadvantages"
>
> **(FG Lipongo village)**

However, payments for obtaining access are considered a barrier for providing in basic needs. Discussing about licence payments related to co-management plan participants said:

"The co-management committee restricts us when we want firewood for sell when we don't have money for our livelihood"

(FG Lipongo village)

"We depend on forest for money so limit is somehow bad at such times"

(FG Lipongo village)

"People stopped to get licenses, they don't have money to be honest"

(FG Matandika village)

Finally, focusing on the fairness dimension of the policy and how the licence system could affect individual's welfare, participants in co-management policies claim for a more equitable system that incorporates measures for targeting the least advantaged.

"Some trees are too expensive, and the prices should depend on the wealth of people"

(FG Lipongo village)

"I am not really happy because the prices we pay for licenses are higher, sometimes, than the profits we get when we sell"

(FG Lipongo village)

3.2.3 Conclusion

Co-management policies are formally implemented through a participatory process with the aim to facilitate the coordination of different interests and needs. However, as discussed by key informants the actual implementation is mainly focused on developing sustainable management plans and the distributional implications are not strictly taken in account neither monitored during actual functioning of the co-management system.

At procedural level, the lack of participation of all members in the definition of rules and key products to be harvested may limit the ability of the scheme to include the interests of vulnerable households. The appointed local committee seems to be entitled with discretionary power over the distribution of resource and that in turn could affect the effectiveness of mechanisms of re-distribution of resources.

The license system in place does not take in account the members' ability to pay for it and this may generate an unequitable distribution of benefits, where forest products would be collected just by wealthier village members. Local members claim a more equitable system that could take in account their needs in terms of forest resources and ability to pay for accessing those resources.

3.3 Spatial sampling strategy

In the following, I provide a brief description of the case-study area and the methodology used to select the sample of villages used for Chapter 4 and Chapter 6. I discuss how the variables used to identify the strata are calculated, their distribution across the sample, the resulting strata and the final random sample selected.

3.3.1 Namizimu forest reserve

The case-study area selected for this PhD is Namizimu forest reserve which is in the Mangochi district in the Southern Region of Malawi. The reserve has an extension of 82,831 Ha, an altitude ranging between 500 and 1,800 m and is in the upper part of the shire river basin (Figure 3.1). I selected Namizimu forest reserve because co-management policies are not implemented yet, but the national government is planning to implement it as part of the Shire River Basin Management Program (Government of Malawi, 2013). According to key informants the forest reserve is still relatively intact but is characterised by increasing anthropocentric pressures, mainly due to timber collection and charcoal production to fulfil urban demand (Mangochi and Zomba).

For the main data collection of this PhD I selected the sample of participants from the villages surrounding Namizimu forest reserve. The reference population chosen for the analysis is the population of 110 villages in a 5 km buffer at the east side of Namizimu forest reserve (called east side villages henceforth, Figure 3.1). I focused on the east side to ensure a relatively homogeneous sample according to the village members' livelihood strategies. The villages on the west side were excluded because close to Lake Malawi and they are also highly dependent on fisheries for their livelihoods. The village selection was limited to those located within 5 km buffer from the forest reserve boundaries following guidelines for the implementation of co-management. The layer of villages has been retrieved from FRIM; it shows the spatial distribution of the main villages and it is the best approximation available.

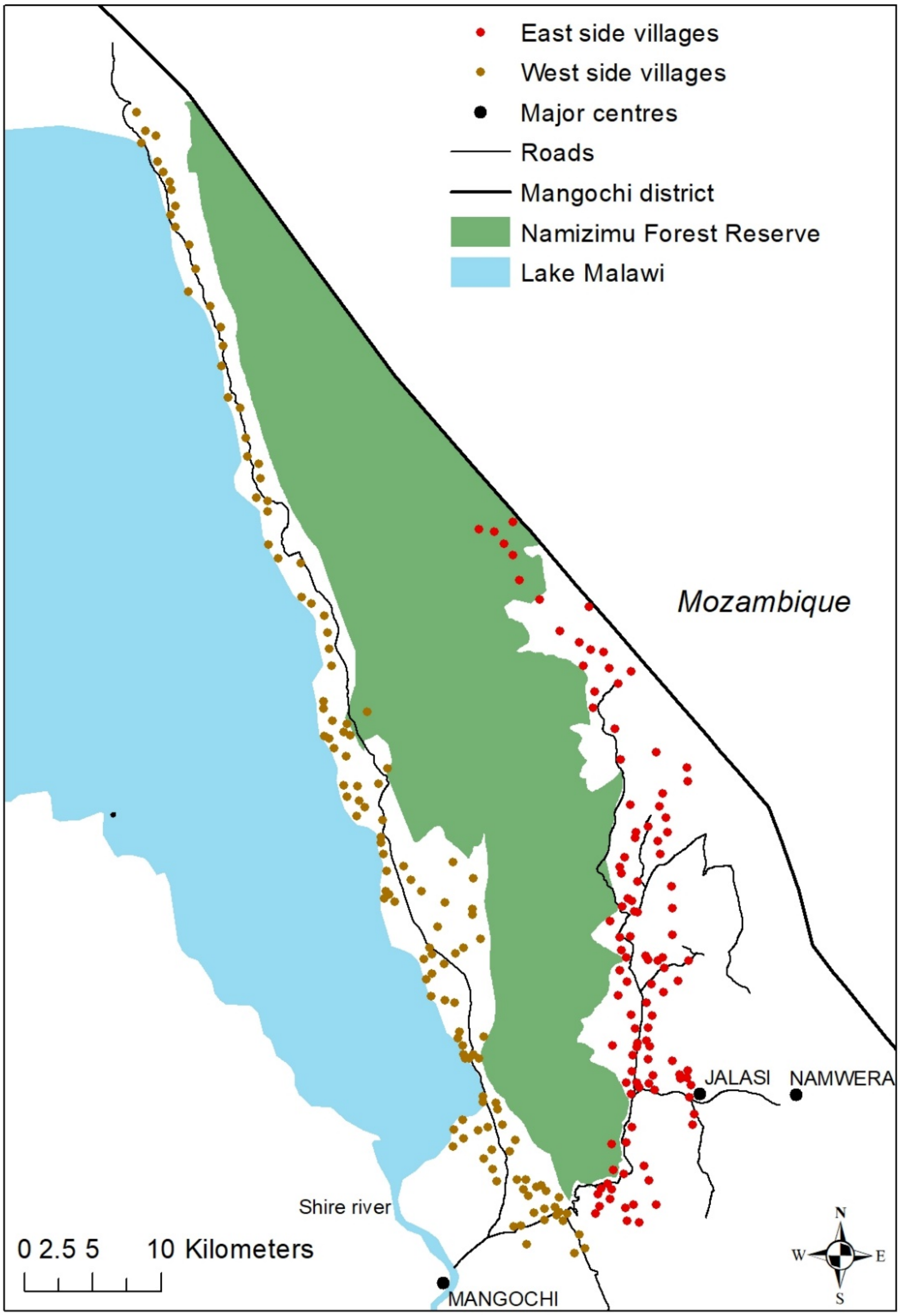

Figure 3.1 Case-study area

3.3.2 Stratified spatial sampling strategy

I employed a stratified spatial sampling strategy to take in account the spatial variability of factors that may influence demand for forest ES as discussed in Section 2.4.3. The factors examined for defining the strata are:

1) Forest quality expressed in terms of vegetation cover as a proxy of products availability
2) Distance from river proxy variable to represent regulating services
3) Distance from roads/trading centres as a proxy for market access and therefore profitability for forest products sale activities
4) Density of forest cover outside forest reserve as a proxy for the presence of substitutes
5) Distance from forest as a proxy for accessibility to forest products and therefore cost for collecting products

Forest quality

I examined forest quality in the forest reserve using the Land Cover map produced by FAO relative to the year 2010 (FAO, 2012). The FAO land cover map classify forest cover in 3 classes: dense, moderate, and sparse. The dense forest class includes areas with where trees cover more than 70%, the moderate forest class includes areas with tree coverage between 70% and 20% while the sparse forest class includes areas with tree coverage between 20% and 5%. I calculated an indicator of the quality/density of the forest area for each village considering the relative proportion of area covered by dense and moderate forest over the total area in a 10 km buffer around the village (to be noted that the variables are calculated just into the forest reserve boundaries and therefore forest coverage outside forest reserve is not considered). Table 3.2 presents the descriptive statistics of the variable calculated for every village.

Table 3.2 Descriptive statistics of the forest quality indicator (n=110)

	Mean	St. Dev	Minimum	1st Quant	Median	3rd Quant	Maximum
Forest quality/density in a 10 km buffer	0.29	0.10	0.12	0.19	0.29	0.34	0.51

Distance from river

Water availability in rivers during the dry season is considered an important regulating services supplied by the forest ecosystem according to key informants and pilot household survey. Therefore, I examined distance from rivers as a proxy for access to river and its relevance both for domestic and agricultural uses. The distance from rivers was calculated using the spatial location of east side villages and a layer representing rivers from the area. The river layer is derived from google earth images and compared with hydroSHEDS modelled rivers (Lehner et al., 2008). The two layers overlaid almost perfectly therefore the river layer produced using google earth images had been used for calculating the distance between the rivers and the villages. The distance was calculated using the Near tool in ArcGIS without including slope. Table 3.3 presents the descriptive statistics of the variable calculated for all villages.

Table 3.3 Descriptive statistics of distance to river (n =110)

	Mean	St. Dev	Minimum	1st Quant	Median	3rd Quant	Maximum
Distance to river (m)	2,492	1,589.9	92.78	1,229.7	2,211.7	3,648.5	6,202.6

I divided the variable in two classes, i.e. close and far, considering 2 km as threshold because the use of river diversion for agricultural uses is recommended up to 2 km (Smith et al., 2014).

Table 3.4 Frequencies of distance to river classes (n=110)

Distance to river	Frequency	Relative frequency (% villages)
Close	47	43%
Far	63	57%

Distance from roads and major centres

Distance from roads and major centres is a proxy for the availability of markets where forest products can be commercialised, and it may influence the demand for provisioning forest ES. I used the free available layer from OpenStreetMap (OpenStreetMap contributors, 2017) to calculate the distance between the villages and the roads. Table 3.5 presents the descriptive statistics for the variable calculated for the 110 villages.

Table 3.5 Descriptive statistics of distance to roads (n=110)

	Mean	St. Dev	Minimum	1st Quant	Median	3rd Quant	Maximum
Distance to roads (m)	1,721	2,291	7	280	744	1,448	14,817

I calculated distance from the major centres using a layer that has been retrieved from FRIM.

Table 3.6 Descriptive statistics of distance to major centres (n=110, in meters)

	Mean	St. Dev	Minimum	1st Quant	Median	3rd Quant	Maximum
Distance to major centres (m)	14,935	11,345	819	6,749	10,626	19,926	44,461

I divided the variable in two classes, i.e. close and far, considering 10 km as threshold according to the variable distribution (Median = 10,626).

Table 3.7 Frequencies of distance to major centres classes (n=110)

Distance to river	**Frequency**	**Relative frequency (% villages)**
Close	48	44%
Far	62	56%

Presence of substitutes – density of forest cover outside forest reserve

I examined forest cover outside the forest reserve using the Land Cover map produced by FAO for 2010 (FAO, 2012). Forest cover in the surrounding of villages is an indicator for the presence of substitutes for ES. The density of forest resources outside the forest reserve was estimated as a percentage of total area covered by moderate forest classes over the total area in an 850 m buffer around the village. The buffer of 850 m is chosen because is the average distance between the east side villages. Table 3.8 presents the descriptive statistics of the variable calculated for all villages.

Table 3.8 Descriptive statistics of presence of substitutes (n=110)

	Mean	**St. Dev**	**Minimum**	**1st Quant**	**Median**	**3rd Quant**	**Maximum**
Presence of substitutes	0.10	0.15	0	0.01	0.05	0.12	0.88

Distance from the forest reserve

Distance from the forest reserve is a proxy for the accessibility of forest products into the forest reserve. I used the administrative boundaries of the forest reserve retrieved from FRIM to calculate the distance between the villages and the forest boundaries. Table 3.9 presents descriptive statistics for the variable calculated for the 110 villages.

Table 3.9 Descriptive statistics of distance to forest (n=110)

	Mean	**St. Dev**	**Minimum**	**1st Quant**	**Median**	**3rd Quant**	**Maximum**
Distance to forest reserve (mt.)	2,075	1,453	0	823	1,817	3,278	4,832

I divided the variable in two classes, i.e. close and far, considering 2 km as threshold according the variable distribution (Median = 1,817 m).

Table 3.10 Frequencies of distance to forest reserve classes (n=110)

Distance to forest reserve	**Frequency**	**Relative frequency (% villages)**
Close	61	55
Far	49	45

3.3.3 Analysis of the correlations and selection of the variables for the strata

I analysed the correlations between the variables chosen to evaluate what are the most suitable variable to be used for stratification.

The variable distance to river did not correlate with any other variables so it was selected as first variable.

Distance to roads and major centres

The two variables showed strong and positive correlations ($r=0.72$, p-value < 0.05) therefore I used distance to major centres as a proxy for access to markets.

Density/quality of forest inside forest reserve

The variable representing forest quality inside forest reserve showed a moderate and positive correlation ($r=0.56$, p-value < 0.05) with distance to major centres. I used distance to major centres as stratifying variable.

Presence of substitutes

The variable presence of substitutes did not correlate with distance to major centres, but it correlated moderately ($r=0.37$, p-value <0.05) with distance to river. Moreover, the distribution of the variable is very skewed toward the left indicating that villages did not vary much according to presence of substitutes, so it was not used as stratifying variable.

Distance to forest reserve

The variable distance to forest reserve did not correlate with distance to river and distance to roads. I selected it as the 3rd stratifying variable.

The final variables selected for defining the strata (Table 3.11) are:

- Distance to river
- Distance to major centres
- Distance to forest reserve

Table 3.11 Strata composition (n=110)

Strata	Distance to major centres	Distance to forest reserve	Distance to river	N	%
1 – CCC	Close	Close	Close	2	2%
2 – CCF	Close	Close	Far	17	15%
3 – CFC	Close	Far	Close	13	12%
4 – CFF	Close	Far	Far	16	15%
5 – FCC	Far	Close	Close	26	23%
6 – FCF	Far	Close	Far	16	15%
7 – FFC	Far	Far	Close	6	5%
8 - FFF	Far	Far	Far	14	13%
	Total			**110**	**100%**

3.3.4 Final sample selection (after exploratory fieldwork)

I verified on the field that I could not select the sample based on the strata defined according to the three variables discussed above because the information about the river did not match reality on the ground. Through informal communications with village members during the pilot phase we found that most of the villages were located close to a river and that respondents accessed different rivers for their irrigation/drinking needs. Therefore, we could not define a unique criterion regarding river to define the strata. Using information on village member perception on water availability during the dry season we selected villages such that we had at least some variability regarding water availability across the four strata which were defined by distance to major centres and distance to forest reserve. Table 3.12 shows the final villages selected for the DCE study with the strata characteristics.

Table 3.12 Villages selected for DCE sample and strata characteristics

Village name	Distance from major centres	Distance from forest reserve	Strata	Water availability during dry season
Village 1	far	close	1 - FC	River goes dry
Village 2	far	close	1 - FC	River level goes low
Village 3	far	far	2 - FF	River goes dry
Village 4	close	close	3 - CC	River level goes low
Village 5	close	close	3 - CC	River level goes very low (paddles)
Village 6	close	far	4 - CF	River level goes very low (paddles)

The data collected from the sample of respondents that participated in the DCE have also been used for Chapter 6 (see Section 6.4.1 and Section 6.4.3). For each of the six villages presented in Table 3.12, respondents were selected based on a further stratified strategy which divided the village population in strata according to age, gender, and wealth status (see Section 4.3.2). The participants for the incentivised experiment (Chapter 5) had been selected from 18 villages randomly chosen from within a 5-km buffer around the Namizimu Forest Reserve, including the 6 villages used for the DCE study, but disregarding the spatial sampling criteria discussed in the above (see Section 5.3.2).

Chapter 4 Preferences for fair distributions in resource management: are distributive justice concerns reflected in values for forest ecosystem services?

4.1 Introduction

The design of management policies for forest resources involves balancing different, and sometimes conflicting objectives, such as environmental conservation and satisfaction of human needs (Guerry et al., 2015). Forest management policies that aim to guarantee ecologically sustainable exploitation need to define harvesting rules to limit the total amount of resources distributed to all users (Lund and Treue, 2008). Defining such limits has an impact on the forest users' consumption and potentially on the overall equity of the policy (Jumbe and Angelsen, 2007). Moreover, when management policies are likely to influence the rules for distributing resources among users, it becomes relevant to assess how those rules impact individual's welfare, both by limiting personal consumption but also through limiting the other users' consumption. A range of studies in environmental, health, behavioural and experimental economics has demonstrated that individual welfare is not only driven by personal gains, but also by fairness considerations (Gsottbauer and van den Bergh 2011; Nyborg 2000; Fehr and Schmidt, 2006). Individual utility is influenced both by the self-interested preferences, i.e. how much the individual gets for himself, and his social preferences, influenced by the benefits allocated to other individuals. The distributional outcomes of environmental policies influence individual WTP, and those values should be included in welfare analysis.

The purpose of this paper is to assess whether individual preferences regarding the management of forest resources are driven by altruism and fairness considerations in addition to, or instead of, the maximisation of self-interested preferences. SP method can be used for *ex-ante* evaluation of the impact of forest management policies on local users. We employ a DCE to elicit preferences of local forest users for CBM policies. The DCE method is based on consumer theory which establishes that an individual in his role as consumer makes choices rationally by maximising his utility function. This rational model has often been interpreted with a narrow sense of self-interest, where the individual makes choices taking in account only the consequences for his own welfare. We argue that values related to forest benefits under a CBM system include both personal values, i.e. expressions of self-interested preferences, and "societal" values related to the distribution of these benefits to other individuals, i.e. distributive preferences. Few valuation studies have elicited preferences for the distribution of benefits and costs of environmental change, including local air pollution and climate change policies (e.g. Carlsson et al., 2013, 2011; Dietz and Atkinson, 2010). We expand on this literature by developing a DCE design which enables disentangling self-interested and distributive preferences. Our design allows to identify whether choices of forest management policies are influenced by the benefits distributed to the others, i.e. social preferences, and whether these social preferences are motivated by underlying fairness norms. We employ fairness models developed in the experimental economics literature and apply these to a policy context where forest users need to choose how to distribute forest resources. We test whether choices for hypothetical forest management options reveal inequity aversion (modelled using the Fehr and Schmidt (1999) framework), and whether other fairness norms, such as efficiency (highest overall benefits) and maximin (most benefits to poorest), influence individual utility.

We find that individuals associate utility gains with the amount of resources distributed to the other village members, but the magnitude of self-interested preferences, i.e. the amount of resources available to the individual, is significantly higher than that of social preferences. Significant inequity aversion preferences are found, and inequity aversion relative to poorer village members appears more important than inequity relative to richer. We also find that, whilst efficiency is the most important fairness norm, respondents also state to gain utility from policy options that increase equality with respect to poorer people and allocate more trees to poorer people than to richer (maximin principle). The significance of distributive preferences in individual choices and the effect of these preferences on WTP for environmental resources have immediate relevance for the evaluation of public support for policies which have redistribution effects, as well as for cost-benefit analysis and the selection of social welfare functions.

In the next section, we review the literature on the influence of social preferences and fairness norms in individual decision-making. We then present the methods used in this study including a description of the case study and the DCE design, the econometric framework used for the analysis and our hypothesis. In Section 4.6, we present our results and in Section 4.7 we discuss overall relevance of results and avenues for future research.

4.2 Literature review

Individual choices on how to allocate material resources, i.e. money, between themselves and others is motivated both by self-interested preferences and by concerns regarding the fairness of the overall distribution (Fehr and Schmidt 1999; Bolton and Ockenfels 2000; Charness and Rabin

2002; Engelmann and Strobel 2004). Models of rational choice incorporating fairness assume that the individual is willing to give away some of his benefits to realise a fair outcome. The fairness of the outcome is judged according to norms of fairness, i.e. the reference point, and there is considerable heterogeneity on what are the fairness norms that motivate the agents' distributive preferences (Cappelen et al., 2007; Johansson-Stenman and Konow, 2010; Konow 2001). The experimental economics literature has highlighted that different people seem to be motivated by different fairness norms, such as equality (Fehr and Schmidt 1999; Bolton and Ockenfels 2000), i.e. a desire to distribute resources equally, efficiency (Andreoni and Miller 2002; Engelmann and Strobel 2004), i.e. a desire to maximise social welfare, and maximin (Charness and Rabin 2002; Engelmann and Strobel 2004), i.e. a desire to maximise welfare of the least well-off.

In the model developed by Fehr and Schmidt (1999), the equality norm is included as self-centred inequity aversion. The authors propose that the fair reference point of the agent depends on his relative position in the wealth distribution compared to the other agents. The inequity-averse agent experiences disutility both when he is better off than other agents, i.e. he is averse to advantageous inequity, and when he is worse off, i.e. he is averse to disadvantageous inequity. However, inequity aversion is not the only motivation that plays a role in distributive choices (Blanco et al., 2011). Charness and Rabin (2002) developed a more complete model that accounts simultaneously for other norms. They incorporate the maximin norm, where an allocation is considered fair if it maximises the welfare of the least well-off, and an efficiency norm, where an allocation is considered fair if it maximises the total of resources allocated at aggregate level. Engelmann and Strobel (2004) found that individuals are influenced by norms such as efficiency and maximin in addition to inequity aversion.

The influence of social preferences and fairness concerns on individual choices has also been examined in the DCE literature. Altruism, as a general concern about benefit accrued to the others, has been found to influence individual WTP for health care public programs (Bosworth et al. 2009; Hurley and Mentzakis 2013; Itaoka et al. 2007; Rodríguez and León 2004). Individual choices about public policies are also influenced by fairness concerns, i.e. how costs and benefits are distributed across all members of society. Several studies on health have elicited distributive preferences regarding health benefits distribution and found that fairness influences preferences for the allocation of benefits to different target groups (Erdem and Thompson 2014; Schuffam et al. 2010; Mirelman et al. 2012; Lim et al. 2012; Koopmanschap et al. 2010; Norman et al. 2013; Ratcliffe et al. 2009; Youngkong et al. 2010; Johansson-Stenman and Martinsson 2008; Green and Gerard 2009).

Fairness concerns have also been found to influence individual preferences in the context of transport and tax redistribution policies (Di Ciommo et al. 2013; Tilahun and Levinson 2013; Fourati and O'Donoghue 2009; Neustradt and Zweifel 2010). Di Ciommo et al. (2013) found that in Spain, road pricing acceptance was influenced by whether the toll is perceived as fair. Tilahun and Levinson (2013) studied the influences of distribution of income and travel time across the population and found that individuals in USA were willing to forego some of their own well-being to allow for higher minimum incomes or reduced mean travel times for everyone. Fourati and O'Donoghue (2009) investigated individual preferences for a state pension and found that a decrease in poverty rate among elderly had a positive influence on utility, both for high and low-income respondents.

However, within the environmental economics literature only a few studies have used DCE to evaluate if individuals are willing to pay for social and environmental benefits which will benefit the whole population (MacKerron et al. , 2009) and elicit preferences regarding the distribution of benefits and costs of environmental policies (Carlsson et al. 2011; Carlsson et al. 2013; Dietz and Atkinson 2010). MacKerron et al. (2009) assessed WTP for voluntary carbon offsets related to personal flights. They found that WTP for offsets financing human development and poverty alleviation was higher than for market development in low-carbon sectors, but lower than for biodiversity conservation. Using a sample of Sweden citizens, Carlsson et al. (2011) investigated preferences for effort-sharing rules in carbon emissions reduction policies among the EU, USA, Africa, and China. Respondents preferred rules that equalised per capita emissions, which was not so much beneficial to their own group (EU) as it would be to Africa. Carlsson et al. (2013) performed a similar study involving citizens from USA and China and found that participants preferred the rule that is less costly for their country, i.e. self-serving choice. Dietz and Atkinson (2010) studied preferences for distribution of benefits and costs for local air pollution and climate change policies in the UK. The results showed that participants preferred the polluter-pays principle, rather than having everyone or beneficiaries pay, as well as the inclusion of a discount for low-income households. However, none of these DCE studies focused on the distribution of benefits of environmental policies and clearly separated the effect of personal and societal values, i.e. distributive preferences. This motivated the design of our DCE.

4.3 Methods

We designed a DCE for eliciting individual preferences for the provision of forest benefits to village members under a specific management regime, i.e. co-management policies. We tested the influence of social preferences and fairness norms on choices regarding the distribution of environmental benefits and assessed trade-offs between social and personal benefits.

4.3.1 Case-study description

For a comprehensive overview of the role of forest resources for the livelihoods of rural communities, a description of co-management policies and of the case-study area the reader can refer to Chapter 3.

4.3.2 Survey design and data collection

In the DCE, the participants were presented with a hypothetical scenario describing a new management system for the forest reserve, i.e. a co-management policy option, and they were asked to choose their preferred alternative (see Appendix C.2 for the policy scenario description). The alternatives were described using attributes related to the provision of forest benefits to village members and the cost that the respondent had to pay to obtain those benefits (Table 4.1). The attributes and their levels were defined based on the results of focus groups organized with participants sampled from the targeted population and key informant interviews with local experts (forest department officials, researchers of the FRIM and a co-management expert from the third sector – see Appendix B and Section 3.2). The focus was on woody products considering their relevance for the participants' livelihoods; woody products such as firewood, poles and timber are used by village members both for subsistence and for generating income.[6] However, harvesting those products reduces the ability of the forest ecosystem to provide other indirect services that benefit the whole community such as water flow regulation, soil fertility and landslide protection. Therefore, in the DCE policy scenario we introduced an attribute describing the provision of collective benefits. We chose water supply in the dry season because the target population considered this the most important regulating service.

The policy options were described in terms of individual benefits for the respondent, i.e. the number of trees available to the household, collective benefits, i.e. water scarcity during the dry season, and individual benefits distributed to other village members, i.e. the number of trees available to worse-off and better-off households. The vehicle payment was described as an annual membership fee to access the co-management scheme and obtain permits to harvest the quantity of forest products specified in each alternative. Participants were informed that the revenues from the membership fee would be used to fund all required management activities (e.g. patrolling, tree planting) and that the scheme would be coordinated by a committee of village members elected by the whole village. Participants were informed that harvesting forest products

[6] Timber and other woody products that are obtained from trees have the characteristics of a normal good in the context of the analysis.

without the required permit would be punished with a monetary fine for the household (equivalent to 4 times the annual membership fee) and the confiscation of the collected forest products and the tools used.

Table 4.1 Attributes and its levels used for the definition of the choice tasks

Attributes	**Levels**			
Number of months with a low level of water in the river during the dry season	W	1	3	
Number of trees that your household will be allowed to harvest	T_s	0	8	15
Number of trees that another member of the village poorer than you will be allowed to harvest	T_p	0	8	15
Number of trees that another member of the village richer than you will be allowed to harvest	T_r	0	8	15
Membership fee (MKW)	*Price*	1000	6000	12000

The levels of the selected policy attributes were combined to describe different policy alternatives presented in the choice task. The choice sets were generated using a D-efficient design assuming null priors. The design was optimized so to estimate all main effects and two-way interactions between the trees available to the household and the trees available to poorer and richer members. The interactions that we specified for the experimental design allow to test all the hypothesis specified. The final design consisted of 18 unique choice sets which were divided into three blocks so that each respondent was asked to make six choices. Each choice set contained two hypothetical co-management options and a status quo alternative described as an opt-out option. In the opt-out option the current harvesting rates and the water shortage period were not specified because they were impossible to verify accurately. Under the current forest management regime tree cutting is forbidden but we verified during the pre-test period that idiosyncratic rules were set by the forest department, i.e. allowing some people some harvesting in some parts of the forest reserve at certain times. The period that streams run dry varies across villages too. To take in account this variability across participants and avoid increasing complexity of the exercise by specifying levels for the status quo that may not be credible for some of our respondents, we set the current situation as the opt-out option which implies no policy is chosen and utility for policy attributes for the status quo is assumed to be 0. An example of choice card is presented in Figure 4.1. To facilitate comprehension for all respondents we complemented the text description of the choice attribute in the card using images. We did not employ an image for the water attribute to limit the visual complexity of the choice task. The choice card design was finalized after a piloting phase of 2 weeks during which we interviewed about 80 participants. As choice card design may distort how respondents process the information on the choice task

(McFadden, 1999; White et al., 2001), we qualitatively verified that respondents did not only focus on trees for which images were included, but also considered also the water attribute in their choices.

The choice task was embedded in a household survey used to collect socio-economic characteristics of respondents, e.g. income, livelihood activities, gender, household size, literacy level, asset holding, and specific uses of forest resources under the current forest management (see Appendix C.1). Moreover, the household survey included questions to identify perceptions about the main features of the policy, e.g. the role of the village forest committee and potential interests in alternative forest uses as well as questions about the choice task, e.g. stated attribute attendance. The survey and all the choice cards were translated in Chichewa, the main language in Malawi.

	A	**B**	**C**
Number of trees that your household will be allowed to harvest	15 Trees	8 Trees	Number of trees that you can collect following the rules of the department of forestry.
Number of months with low level of water in the river	3 Months	1 Month	
Number of trees that another village member doing worse than you will be allowed to harvest	0 Trees	8 Trees	
Number of trees that another village member doing better than you will be allowed to harvest	8 Trees	15 Trees	
Annual membership fee (three-monthly fee)	MK 2.000 (MK 500)	MK 16.000 (MK 4.000)	
Which option do you prefer?	□ A	□ B	□ C

Figure 4.1 Example choice chard

We conducted the survey with a sample of adults (male and female, 18-65 years old) randomly selected from six rural villages in Mangochi District in Malawi. Participants for each village were chosen from a list of households compiled with the help of village members. We employed a stratified random sampling method at village level and selected people based on gender, age, and wealth status. The questionnaire was administered face-to-face by local research assistants over a three-week period in August 2017 and the average interview lasted approximately 50 minutes. We provided a monetary compensation of 200 MKW to each respondent and interviewed 288 people in total.[7]

4.4 Econometric framework

We used a random utility framework (McFadden, 1974) to analyse our choice data. The individual, who evaluates *J* alternatives within a choice task *t*, is assumed to choose the alternative that gives him the highest expected utility *U*. The individual utility function is not known by the researcher who can only observe the choice made, some of its attributes (x_{njt}) and the characteristics of the individual (s_n). The researcher specifies an indirect utility function (V_{njt}) which relates the observed factors to the individual's utility (U_{njt}). The unobserved factors of the individual utility are captured by a random error term (ε_{njt}). Individual utility is decomposed as:

$$U_{njt} = V_{njt}\left(x_{njt}, s_n\right) + \varepsilon_{njt} \qquad (1)$$

Indirect utility is usually specified as a linear in parameter function:

$$V_{nj} = \beta' x_{nj} \qquad (2)$$

where β' is a vector of parameters to be estimated. The individual will choose alternative *j* over any alternative *i* within the choice task *t* if $V_{njt} + \varepsilon_{njt} > V_{nit} + \varepsilon_{nit}$. The probability of choosing alternative *j* is given by

$$Prob(j|J) = Prob(V_{njt} - V_{nit} > \varepsilon_{nit} - \varepsilon_{njt}) \qquad (3)$$

We obtain the conditional logit model (McFadden, 1974; Train, 2009) under the assumption that the error term is independently and identically distributed (IID) extreme value:

$$Prob(j|J) = \frac{e^{V_{njt}}}{\sum_{i=1}^{J} e^{V_{nit}}} \qquad (4)$$

In a panel context, where an individual makes repeated choices, the IID assumption is unrealistic because it is likely that unobserved factors are correlated over choices. Moreover, the conditional logit model cannot accommodate random variation of marginal utility for policy attributes, i.e. the model imposes homogeneous preferences across respondents. Therefore, we employed a mixed

[7] 200 MKW = 1.20 USD PPP (purchasing power parity). The adjusted exchange rate is 172.42 MKW = 1 USD PPP which is the PPP conversion factor for private consumption for the year 2016 (World Bank, International Comparison Program database)

logit framework which can account for random taste variation across respondents and correlation of unobserved factors over repeated choices (Train, 2009).

The random parameter specification assumes that the preference parameters β' are heterogeneous across the sampled population and can be represented by a continuous distribution function, $f(\beta|\theta)$, where θ includes the parameters of the distribution. Following Train (2009), the probability that individual *n* chooses alternative *j* in choice task *t*, conditional on the parameter distribution (θ), is the integral of standard logit probabilities over the density of the preference (β') parameters:

$$Prob(j|J,\theta) = \int \frac{e^{V_{njt}}}{\sum_{i=1}^{J} e^{V_{nit}}} f(\beta|\theta) d(\beta) \qquad (5)$$

Finally, respondents may evaluate the status quo option systematically different from the hypothetical alternatives because the former is experienced while the latter are hypothetical. To account for the status quo effect, we also specified a random error component common to the hypothetical alternatives to accommodate the correlation across utilities of the two hypothetical alternatives (Scarpa et al. 2005). Specifically, the unobserved part of utility ε_{njt} is partitioned in two parts:

$$U_{nj} = \beta' x_{nj} + [\eta_{nj} + \varepsilon_{nj}] \qquad (6)$$

where ε_{nj} is the usual IID error term and η_{nj} is a random term which is normally distributed with zero mean and standard deviation one. The probability that individual *n* chooses alternative *j*, conditional on the parameter distribution (θ) and the random error component (η), is given by:

$$Prob(j|J,\theta) = \iint \frac{e^{V_{njt}+\eta_{njt}}}{\sum_{j=1}^{J} e^{V_{nit}+\eta_{nit}}} g(\eta|\sigma) f(\beta|\theta) d(\eta) d(\beta) \qquad (7)$$

We estimated the models specified below in preference space using a mixed logit framework via Simulated Maximum Likelihood (SML) (Train, 2009). We selected the parameters to be modelled as random based on the statistical significance of their standard deviation. The random parameters are assumed to follow a normal distribution except for the price parameter which is assumed to follow a log-normal distribution such that it is constrained on the negative domain (Hensher and Greene 2003). The D-efficient experimental design was generated using SAS 9.4 while the choice models were estimated using R.

4.5 Utility functions and hypotheses

We analysed the choice data using different models to test hypotheses regarding the relevance of social preferences and the influence of fairness norms as possible motivation underlying social preferences. We specified different models and re-arranged the same set of attributes because we cannot test all the hypothesis using a single model, but it has to be noted that the underlying data remains the same.

4.5.1 Social preferences

Model 1 (eq. 8) tests whether individuals are purely self-interested when making choices about forest management options or exhibit concerns about the magnitude of benefits distributed to the others, i.e. social preferences. The utility function of individual *n* depends on all the attributes included in the choice set:

$$V_{njt} = ASC_j + \beta_{ts}T_s + \beta_w W + \beta_{tp}T_p + \beta_{tr}T_r + \beta_p Price \quad (8)$$

where ASC_j is a constant included in the utility of the opt-out alternative to capture overall preference for the status quo (see Table 4.1 for the abbreviations of the other variables). We formulated two hypotheses regarding social preferences. If utility is influenced by the number of trees distributed to poorer and to richer village members:

H1a: $\beta_{tp} \neq 0$ and H1b: $\beta_{tr} \neq 0$

Specifically, if individuals are altruistic toward the poorer (richer) village members and gain utility from increasing the amount of resources distributed to them then β_{tp} (β_{tr}) > 0 whilst if individuals are envious toward poorer (richer) households then β_{tp} (β_{tr}) < 0.

4.5.2 Fairness norms

Individuals may hold social preferences and care about the amount of resources distributed to the other village members because they have a desire to realise a fair distribution of resources among all agents, i.e. agents hold distributive preferences. The experimental economics literature has identified general fairness norms that motivate social preferences (Fehr and Schmidt 1999; Bolton and Ockenfels 2000; Charness and Rabin 2002). It has also highlighted that individuals may be motivated by a plurality of norms (Cappelen et al., 2007; Engelmann and Strobel, 2004). We employ Model 2 (eq. 9) to tests whether individual's concerns regarding the number of trees allocated to other members of society are influenced by fairness norms and whether the importance of those norms is heterogeneous among respondents. Three fairness norms are selected: equality, efficiency and maximin. An individual who is influenced by the efficiency norm (η^e) wants to maximise the total surplus available to the society, i.e. the total number of trees distributed to the other members of society. An individual who is influenced by the equality norm (η^{ep} and η^{er}) wants an equal distribution of trees between himself and the other members of society disregarding any pre-existing inequalities in wealth status. An individual who is influenced by the maximin norm (η^m) wants to maximise the benefits distributed to the worse-off group, i.e.

maximise the number of trees distributed to the poorer members compared to the richer. As such, the indirect utility function of Model 2 becomes:

$$V_{njt} = ASC_j + \beta_w W + \beta_{ts} T_s + \beta_{eff} \eta^e + \beta_m \eta^m + \beta_{ep} \eta^{ep} + \beta_{er} \eta^{er} + \beta_p Price \quad (9)$$

Where efficiency is calculated as the sum of the trees distributed to the other village members and the other fairness norms are codified as dummy variables based on the comparison within alternatives (Table 4.2). A fairness norm dummy of value 1 indicates that the hypothetical distribution of woody forest products in each alternative (denoted with *j*) is considered fair according to that norm. The parameters β_m, β_{ep} and β_{er} are estimated for the dummy variables related to the fairness norms maximin, equality with poorer and equality with richer.

The variable for the efficiency norm (η^e) is calculated as the sum of the total number of trees distributed both to the poorer and richer village member:

$\eta^e = T_r + T_p$ The maximin dummy (η^m) is based on a comparison within a single alternative and takes the value 1 if the number of trees distributed to the poorer village members is higher than the number of trees distributed to the richer:

$\eta^m = 1$ if $T_p^j > T_r^j$

Equality with poorer (richer) village members η^{ep} (η^{er}) takes the value 1 if the number of trees distributed to the poorer (richer) members is the same as the number of trees distributed to the individual himself:

$\eta^{er} = 1$ if $T_s^j = T_r^j$

$\eta^{ep} = 1$ if $T_s^j = T_p^j$

The fairness norms variables are based on a combination of the tree-harvesting attributes (T_s, T_p, T_r), therefore we excluded the main effect relative to the number of trees distributed to poorer and richer (T_p, T_r) to avoid collinearity problems.

Formally, if respondents are motivated by the efficiency norm:
H2a: $\beta_{eff} > 0$

If they are motivated by the maximin norm then

H2b: $\beta_m > 0$

Finally, if they are motivated by the equality norm compared to poorer and richer village members then

H2c: $\beta_{ep} > 0$ and H2d: $\beta_{er} > 0$

These different motives can generate different distributional outcomes and we hypothesise, following Engelmann and Strobel (2004), that the relevance of these motives is heterogeneous across the sampled population.

Table 4.2 Choice card tree attributes and coding scheme for fairness rules model

	Choice card n. 15		Choice card n. 1	
	Alternative A	**Alternative B**	**Alternative A**	**Alternative B**
T_s	8	0	15	0
T_p	8	8	8	15
T_r	8	0	15	0
	Recoded variables			
T_s	8	0	15	0
η^e	16	8	23	15
η^m	0	1	0	1
η^{ep}	1	0	0	0
η^{er}	1	1	1	1

Model 2 can be considered as an extension of model 1 where in addition to testing for the relevance of self-interested preferences and social preferences, we also control for the equality and the maximin norm. A general desire to increase the number of trees distributed to the others, called efficiency here to indicate that we are interested in the aggregate increase of number of trees distributed to the others independently of their wealth status, may be actually influenced by a desire to have equal distributions among all members of society or to increase the allocation of the poorer village members. Participants may gain utility when the total number of trees distributed is increasing because they gain utility from the fact that the poorer get the same number of trees as them, equality with poorer, or that the poorer get more trees than the richer. Participants' utility may not be strictly monotonic increasing in the number of trees distributed to the others, altruism, but may increase up to when certain fairness conditions are met, e.g. equality with poorer. We therefore estimate model 2 to investigates the importance of those motives for distributional choices and whether the relevance of those motives is heterogeneous across the population.

4.5.3 Inequity aversion

The modelling framework proposed by Fehr and Schmidt (1999, henceforth F&S) incorporates the influence of the equality norm and it assumes that aversion to inequality differs depending on whether the agent is materially advantaged or disadvantaged. The agent is considered materially advantaged when he receives more resources than other village members and materially disadvantaged when he gets less resources than the others. We employ Model 3a (eq. 10) to tests whether choices for forest management are influenced by inequity aversion and whether such aversion differs according to the type of inequality, i.e. advantageous or disadvantageous, and across reference groups defined by their wealth status.

$$V_{njt} = ASC_j + \beta_w W + \beta_{dr} DR + \beta_{ar} AR + \beta_{dp} DP + \beta_{ap} AP + \beta_p Price \qquad (10)$$

The F&S variables (DR, AR, DP, and AP) are calculated as the difference between the number of trees distributed to richer or poorer village members and the individual (Table 4.3).

Like Model 2, the direct effects of the tree-harvesting attributes are excluded. DR and DP represent aversion toward disadvantageous inequity, where the respondent is allowed to harvest fewer trees than the richer or poorer village members respectively, and AR and AP represent aversion toward advantageous inequity, where the respondent is allowed to harvest more trees than richer or poorer village members respectively. The levels for the inequity aversion terms are calculated as follow:

$$DR = (T_r - T_s)\ if\ T_s < T_r\ and\ 0\ otherwise$$

$$DP = (T_p - T_s)\ if\ T_s < T_p\ and\ 0\ otherwise$$

$$AR = (T_s - T_r)\ if\ T_s > T_r\ and\ 0\ otherwise$$

$$AP = (T_s - T_p)\ if\ T_s > T_p\ and\ 0\ otherwise$$

Table 4.3 Choice card tree attributes and coding scheme for inequality aversion model

	Choice card n. 6		**Choice card n. 8**	
	Alternative A	**Alternative B**	**Alternative A**	**Alternative B**
T_s	15	8	8	8
T_p	8	15	15	0
T_r	0	0	15	0
	Recoded variables			
T_s	15	8	8	8
DR	0	0	7	0
AR	15	8	0	8
DP	0	7	7	0
AP	7	0	0	8

The F&S model assumes that the estimated inequity aversion coefficients β_{dr}, β_{ar}, β_{dp} and β_{ap} are less than or equal to zero, so that the agent either does not care or experiences disutility from being either better off or worse off than others. F&S also assume that disutility for disadvantageous inequity is greater than or equal to disutility for advantageous inequity, meaning that the agent has stronger negative preferences towards being allocated less trees than others than to being allocated more trees.

To test the model's predictions, we define the following hypotheses regarding comparisons with richer and poorer village members. If the respondents are averse to inequalities:

H3a (disadvantageous inequity with richer): $\beta_{dr} < 0$

H3b (disadvantageous inequity with poorer): $\beta_{dp} < 0$

H3c (advantageous inequity with richer): $\beta_{ar} < 0$

H3d (advantageous inequity with poorer): $\beta_{ap} < 0$

Next, if aversion to disadvantageous inequity is greater than aversion to advantageous inequity, then:

H3e: $|\beta_{dr}| > |\beta_{ar}|$ and H3f: $|\beta_{dp}| > |\beta_{ap}|$

Furthermore, we hypothesise that the effect of inequity aversion differs across the two reference groups, which in our study are defined by wealth status (poorer or richer village member).
H3g: $\beta_{dp} \neq \beta_{dr}$ and H3h: $\beta_{ap} \neq \beta_{ar}$

In Model 3a, utility is influenced only by the size of the inequalities between the respondent and the other village members and the absolute number of trees allocated to the respondents is disregarded. Model 3a tests empirically the F&S theoretical assumptions. However, in our design the number of trees distributed to the respondent and those distributed to the other village members vary simultaneously and therefore the effect on utility of the absolute number of trees distributed to the individual (T_s) can be identified independently from the inequity aversion terms.

Model 3b (eq. 11) also introduces a utility coefficient relative to T_s.

$$\mathrm{V_{njt}} = \mathrm{ASC_j} + \beta_{\mathrm{ts}}\mathrm{T_s} + \beta_{\mathrm{w}}\mathrm{W} + \beta_{\mathrm{dr}}\mathrm{DR} + \beta_{\mathrm{ar}}\mathrm{AR} + \beta_{\mathrm{dp}}\mathrm{DP} + \beta_{\mathrm{ap}}\mathrm{AP} + \beta_{\mathrm{p}}\mathrm{Price} \quad (11)$$

Here, the inequity aversion terms reveal the effect on utility of increasing inequalities either in the advantageous, β_{ar} and β_{ap}, or disadvantageous, β_{dr} and β_{dp}, domain.

Finally, we specify Model 3c to test for the existence of non-linear effects regarding disutility associated with inequity aversion. The experimental economics literature has highlighted that a preference for equalising outcomes may also be motivated by a desire to meet a person's basic need or comply with other moral obligations relative to giving (Konow, 2010; Korenok et al., 2012; Engelmann and Strobel, 2004). In Model 3c the inequity aversion terms β_{dr} and β_{ar} are multiplied by the total number of trees distributed to the richer members and the terms β_{dp} and β_{ap} are multiplied by the total number of trees distributed to poorer members. These interactions allow us to test whether inequity aversion is characterised by diminishing or increasing marginal disutility in the number of trees distributed to the other village members.

In table 4.4 we present a summary of all the hypothesis specified above.

Table 4.4 Summary of all hypothesis relative to the three models estimated

Hypothesis		**Description**
Social preferences model (model 1)		
H1a	$\beta_{tp} > 0$	The agent is not purely self-interested and his utility increases when the number of trees distributed to poorer village members
H1b	$\beta_{tr} > 0$	The agent is not purely self-interested and his utility increases when the number of trees distributed to richer village members
Fairness rules model (model 2)		
H2a	$\beta_{eff} > 0$	The agents gain utility when the number of trees distributed to the other village members (both poorer and richer member) increases
H2b	$\beta_{m} > 0$	The agents gain utility when the number of trees distributed to the poorer is higher than the number of trees distributed to the richer
H2c	$\beta_{ep} > 0$	The agents gain utility when the number of trees distributed to poorer is equal to the number of trees distributed to oneself
H2d	$\beta_{er} > 0$	The agents gain utility when the number of trees distributed to poorer is equal to the number of trees distributed to oneself
Inequality aversion model (model 3)		
H3a	$\beta_{dr} \leq 0$	The agents are averse to disadvantageous inequality with richer village members
H3b	$\beta_{dp} \leq 0$	The agents are averse to disadvantageous inequality with poorer village members
H3c	$\beta_{ar} \leq 0$	The agents are averse to advantageous inequality with richer village members
H3d	$\beta_{ap} \leq 0$	The agents are averse to advantageous inequality with poorer village members
H3e	$\lvert\beta_{dr}\rvert > \lvert\beta_{ar}\rvert$	The agents are more averse toward inequality with richer when they are in a disadvantageous position compared to when they are in an advantageous position
H3f	$\lvert\beta_{dp}\rvert > \lvert\beta_{ap}\rvert$	The agents are more averse toward inequality with poorer when they are in a disadvantageous position compared to when they are in an advantageous position
H3g	$\beta_{dp} \neq \beta_{dr}$	Aversion to disadvantageous inequalities differs depending on the wealth status of the other village member
H3h	$\beta_{ap} \neq \beta_{ar}$	Aversion to advantageous inequalities differs depending on the wealth status of the other village member

4.6 Results

4.6.1 Descriptive statistics

A summary of the descriptive statistics of household characteristics is provided in Table 4.5. A comparison of our respondents' characteristics with those from the fourth Integrated Household Survey (IHS4) conducted by the Malawi National Statistics Office (2017) in 2016-2017 for

Mangochi district (including urban areas) suggests that our sample is representative of the wider population. The average age of our participants is 36 years and households are composed of about five members on average, compared to an average household size of 4.2 according to IHS4 statistics. About 60% of our respondents owns livestock and the average land size is 1.47 acres (0.56 hectares), with the corresponding figures from IHS4 at 34% and 1.3 acres. The majority of participants stated that they considered all attributes when making their choices, 89%, and around 2% stated that they did not consider the water attribute.

Table 4.5 Descriptive statistics: characteristics of respondents (n=288)

Variable	**Mean**	**S.D.**
Female (1=female, 0=male)	0.53	0.50
Age (years)	35.50	10.58
Household size	4.63	1.87
Livestock ownership dummy (1=yes, 0 otherwise)	0.60	0.49
Land size (acres)	1.47	0.99
At least 5 years of schooling (1=yes, 0 otherwise)	0.63	0.48
Respondents that considered all attributes when choosing	0.89	0.31

4.6.2 Estimation results

Social preferences

The results of the mixed logit model (MXL) estimated for Model 1 (eq. 8) are shown in Table 4.6. Our results show that respondents hold social preferences and there are utility gains associated with resources distributed to other members of society (hypothesis H1a and H1b) but respondents' self-interested preferences outweigh their social preferences. The coefficient for the number of trees distributed to oneself, capturing the self-interested preferences, is positive (p-value < 0.01) indicating that an increase in the number of trees allocated to the respondents has a positive effect on utility. The coefficients of the attribute for the trees allocated to poorer and richer members have a positive sign (p-value < 0.01) indicating utility gains associated with material resources allocated to others. However, the magnitude of the coefficient for trees for oneself is significantly greater than the coefficients for trees for poorer and richer (p-value < 0.001 for both comparisons; the standard errors relative to the difference among coefficients is calculated using the Delta Method). We also found that the magnitude of the coefficient for trees for poorer and richer does not differ significantly (p-value = 0.61) indicating that the magnitude of utility derived from social preferences does not differ significantly when considering the wealth status. This indicates that respondents value trees distributed to themselves much higher than trees distributed to other village members.

The model is estimated with all parameters treated as random, except the ASC parameter which captures the utility associated to the status quo, i.e. no change in forest management policies. The significance of the standard deviation coefficients indicates that there is taste heterogeneity across respondents in all attributes except trees for poorer village members. The statistically significant coefficient for the error component shows that the variance of unobserved utility component is correlated across the two hypothetical alternatives and different from the status quo. The overall fit of the model is good (adjusted ρ^2=0.51).

Table 4.6 Model 1 results

	Mean		**Standard deviation**	
Water in the river[a] (W)	0.015	***	0.018	***
	(0.002)		(0.002)	
Trees for the respondent himself[a] (T_s)	0.211	***	0.187	***
	(0.032)		(0.034)	
Trees for poorer village members[a] ($\mathrm{T_p}$)	0.055	***	0.047	**
	(0.010)		(0.023)	
Trees for richer village members[a] ($\mathrm{T_r}$)	0.051	***	0.060	***
	(0.010)		(0.019)	
Price[b]	-1.905	***	1.038	***
	(0.126)		(0.068)	
Error component			2.145	***
			(0.741)	
$\mathrm{ASC_j}$	-8.341	***		
	(1.531)			
Model statistics				
Log-likelihood	-913.53			
Adjusted ρ^2	0.51			
Estimated parameters	12			
BIC	1917			

*** p<0.01, **p<0.05, * p<0.1. Standard errors in parentheses.

(a) normal distribution. (b) log-normal distribution

The number of respondents is 288; the number of observations is 1728

The coefficient for the price attribute is significant (p-value < 0.01) and has the expected negative sign. The coefficient for the water attribute, which indicates marginal utility for decreasing water scarcity in the dry season, has a positive sign. The ASC is statistically significant (p-value < 0.01) and the negative sign indicates that not changing the forest policy has a negative impact on utility.

Fairness norms

In Model 2 (eq. 9), we test whether fairness norms (efficiency, maximin, equality) affect choices about co-management policies, thereby providing further insights into the motivations underlying social preference and whether the relevance of these motives is heterogeneous across the population. The results in Table 4.7 show that the efficiency and equality norms examined are associated with utility gains (H2a, H2c, H2d) indicating that different fairness norms influence preferences for forest management policy option.

Table 4.7 Model 2 results (fairness rules)

	Mean		Standard deviation	
Water in the river[a] (W)	0.015	***	0.019	***
	(0.002)		(0.003)	
Trees for the respondent himself[a] (T_s)	0.211	***	0.202	***
	(0.031)		(0.036)	
Efficiency norm[a] (η^{e})	0.058	***	0.035	**
	(0.008)		(0.018)	
Maximin[a] (η^{m})	0.181		0.215	
	(0.008)		(0.018)	
Equality with poorer[a] (η^{ep})	0.639	***	1.102	***
	(0.172)		(0.301)	
Equality with richer[a] (η^{er})	0.199	*	0.054	
	(0.134)		(0.306)	
Price[b]	-2.038	***	1.491	***
	(0.134)		(0.078)	
ASC	-11.693	***		
	(2.644)			
Error component			4.345	***
			(1.004)	
Model statistics				
Log-likelihood	-901.4			
Adjusted ρ^2	0.52			
Estimated parameters	16			
BIC	1922			

*** p<0.01, **p<0.05, * p<0.1. Standard errors in parentheses.

(a) normal distribution. (b) log-normal distribution

The number of respondents is 288; the number of observations is 1728

As in model 1, the utility for trees distributed to oneself is found to be significant (p-value < 0.001) and of the same magnitude and the number of trees distributed to the others is associated as well with utility gains. The efficiency norm coefficient, which indicates a desire to increase total number of trees distributed to other village members, is also found to be positive and statistically significant (p-value < 0.001) but significantly lower than self-interested preferences (p-value < 0.001; Delta Method). Preferences for trees for oneself and for the others are characterised by heterogeneity as indicated by the significant standard deviation of the random parameter. The distribution parameters (mean and SD) of the random coefficients implies that collecting trees for himself is associated with negative utility for about 15% of our respondents while the efficiency norm implies that about 9% of the sampled population is negatively influenced by a norm that distributes more resources to other village members.

The equality rule with poorer village members is also associated with utility gains on average and is significantly higher than the coefficients for equality with richer and maximin norms (p-value < 0.05; Delta Method). This indicates that a distribution that equalizes the allocation between self and poorer village members is associated with additional utility gains whilst the total number of trees distributed to oneself and the others are kept fixed. However, the coefficient for equality for poorer is characterised by heterogeneity, as indicated by a significant standard deviation. The distribution of the estimated coefficient means that such equality is associated with disutility for 30% of the respondents. The coefficient for equality with richer members is marginally significant (p – value < 0.1) indicating that comparison with richer village members is a fairness motive that has very little relevance for our sample. Finally, the coefficient of the maximin norm, which indicates a distribution where the total number of trees allocated to poorer members is higher than to richer members, is not statistically significant indicating that respondents are not influenced by the relative distribution of trees among other village members but they are simply interested in increasing the overall number of trees distributed to the others. The overall fit of the model is good (adjusted ρ^2=0.51) and the coefficient for the price and water attributes and the ASC have the same sign and significance level as in Model 1.

Inequity aversion

Table 4.8 shows the estimated results for Models 3a (eq. 10), 3b (eq. 11) and 3c, which tests whether respondents are averse to unequal outcomes. The results of the three different specifications demonstrate that the unequal distribution of resources among village members is associated with utility losses. However, the magnitude of disutility is found to be different depending both on whether respondents compare themselves to poorer or richer members and whether they are materially advantaged or disadvantaged in such comparisons. Moreover, we find that the total absolute number of trees distributed matters and that the effect of inequity aversion is not linear in the absolute number of trees distributed to the others.

Table 4.8 Model 3 results (inequity aversion)

	Model 3a – inequity aversion (F&S)				Model 3b – inequity aversion (with TS)				Model 3c – inequity aversion with int.			
	Mean		Standard deviation		Mean		Standard deviation		Mean		Standard deviation	
Water in the river[a] (W)	0.011	***	0.014	***	0.014	***	0.017	***	0.013	***	0.017	***
	(0.001)		(0.002)		(0.002)		(0.002)		(0.002)		(0.002)	
Trees for self[a]					0.258	***	0.152	***	0.228	***	0.096	***
					(0.027)		(0.029)		(0.024)		(0.029)	
Disadvantageous inequity relative to richer members (DR)	-0.026	***			0.029	**			-0.142	***		
	(0.010)				(0.014)				(0.047)			
Disadvantageous inequity relative to poorer members (DP)	-0.082	***			-0.01				0.067			
	(0.012)				(0.013)				(0.056)			
Advantageous inequity relative to richer members (AR)	-0.015	*			-0.051	***			-0.066	***		
	(0.009)				(0.011)				(0.013)			
Advantageous inequity relative to poorer members (AP)	-0.08	***			-0.112	***			-0.119	***		
	(0.010)				(0.013)				(0.014)			
DR*Trees for richer									0.012	***		
									(0.003)			
DP*Trees for poorer									-0.005			
									(0.004)			
AR*Trees for richer									-0.012	**		
									(0.005)			
AP*Trees for poorer									0.01	**		
									(0.004)			
Price[b]	-2.522	***	1.319	***	-2.176	***	1.26	***	-2.269	***	1.427	***
	(0.119)		(0.063)		(0.142)		(0.095)		(0.124)		(0.071)	
ASC	-14.486	***			-8.347	***			-16.336	***		
	(2.445)				(1.539)				(3.353)			
Error component			6.257	***			1.276	*			8.269	***
			(1.187)				(1.076)				(1.709)	
Model statistics												
Log-likelihood	-997.7				-896.7				-884.7			
Adjusted ρ^2	0.47				0.52				0.53			
Estimated parameters	10				12				16			
BIC	2070				1883				1889			

*** p<0.01, **p<0.05, * p<0.1. Standard errors in parentheses.
(a) normal distribution. (b) log-normal distribution
The number of respondents is 288; the number of observations is 1728

Model 3a replicates the original F&S specification and we find support for most of our hypotheses. Three out of four inequity aversion coefficients, excluding advantageous inequity relative to richer members, are found to be negative and significant (p-value < 0.001) indicating that respondents are averse towards unequal final allocations: we accept H3a, H3b and H3d, but reject H3c.The inequality with poorer village members is associated with the same level of disutility both when the respondents is advantaged and when is disadvantaged therefore rejecting H3f (p-value > 0.1; Delta Method). The wealth status of the "other" village member matters when the agent is disadvantaged: having less than those richer has a significantly smaller effect on utility than having less than those poorer (p-value < 0.001; Delta Method), and we thereby accept H3g.

In Model 3b and 3c, we introduce a parameter for the individual's personal gain so that we can test the importance of inequity aversion while accounting for pure self-interested preferences. In Model 3c we also introduce non-linear inequity aversion terms to test whether utility associated with inequalities is influenced by the absolute number of trees distributed to the other village members. The overall fit of these two models is good (adjusted ρ^2=0.52). The coefficient for the price and water attributes and the ASC have the same sign and significance levels as in Models 1 and 2.

First, we evaluate the results for the disadvantageous domain. In Model 3b, the coefficient for disadvantageous inequity relative to richer members is statistically significant and positive and the coefficient for disadvantageous inequity relative to poorer members is insignificant. This would suggest that within the disadvantageous domain, respondents gain utility as inequity with richer members increases and thus that the hypothesis of inequity aversion toward richer is partly not verified. However, in Model 3c the same coefficient is negative and significant, suggesting that on average respondents are averse to disadvantageous inequity with richer members and that such aversion may depend on the number of trees distributed to the richer members given that the interaction term (DR*Trees for richer) is statistically significant and positive. The combination of these two coefficients indicate that on average respondents dislike inequity with richer village members when the number of trees distributed to those richer is relatively small, but they would be willing to accept to be "left behind" when richer members receive a high number of trees (the break-even point is 13 trees). When considering non-linear effects, we find support for H3a and evidence of aversion toward disadvantageous inequity relative to richer, while disadvantageous inequity relative to poorer members remains insignificant, rejecting H3b.

Next, in the advantageous domain, both coefficients for inequity relative to poorer and richer members are negative and statistically significant in both models (3b and 3c). Respondents appear to dislike unequal outcomes when either richer or poorer are receiving less trees than the respondent, supporting H3c and H3d. In addition, in Model 3c the interaction term (AP*Trees for poorer) is positive and statistically significant, indicating that such inequity is associated with disutility when poorer members are distributed less than 12 trees but when poorer village members are allocated more trees than the threshold then being in an advantageous position is acceptable. Non-linear effects are also found in preferences regarding advantageous inequity relative to richer members, but in the opposite direction. The negative coefficient for the interaction term (AR*Trees for richer) indicates that the disutility experienced for being in an advantageous position relative to richer members increases when the absolute number of trees allocated to them increases.

Finally, we find that the wealth status of the village members to whom the respondent is compared is relevant in the advantageous domain indicating that aversion to inequality relative to poorer is higher, supporting H3h, but not in the disadvantageous domain (H3g). The coefficient for advantageous inequity with the poorer is about twice as large as the coefficient relative to richer members and the difference is statistically significant (p – value < 0.001; Delta Method).

Willingness to pay calculations

In Table 4.9 we present the total willingness to pay (WTP) for 6 different distributional scenarios using the coefficients estimated with model 1 in US$.[8] The aggregate WTP is the sum of the mean WTP for each tree attribute according to the scenario whilst water is kept constant. MWTP provides a monetary measures of individual's welfare gain (or loss) for one unit increase in the relative attribute and it is calculated as the ratio of the attribute coefficient for trees for self and the price attribute coefficient:

$$MWTP_{ts} = -\beta_{ts}/\beta_p \qquad (12)$$

To simplify the WTP calculations we estimated a model where the price attribute was included as a fixed (non-random) parameter (Train and Weeks, 2005), while keeping the rest of the model specification equal to the model presented above, so that we avoided issues of indefinite moments when calculating the ratio of two distributions and difficulties in estimating the relative confidence intervals (Carson et al., 2019). The 95% confidence intervals of the WTP estimates are calculated using the estimated standard deviation for each attribute divided by the price attribute (Train and Weeks, 2005).

The WTP calculations presented in table 4.8 allow to better appreciate the role of social preferences and fairness motives for the individual welfare of our DCE participants when considering alternative distributional scenarios. The scenario that generates the highest welfare gains for the average individual is scenario A where the total number of trees distributed is high

[8] The adjusted exchange rate is 248.38 MKW = 1 US$ PPP (purchasing power parity) using the PPP conversion factor for private consumption for the year 2018 (World Bank, International Comparison Program database)

(30 trees) and they are all allocated to the respondent and someone poorer than him. Scenario B generates 33% less welfare compared to scenario A despite the total number of trees distributed in total is about the same. Comparing B to C reveal that a scenario where the number of trees distributed in total is much lower (about half) may generate little losses in welfare indicating that when ecological constraints require capping the total harvesting paying attention at how those trees are distributed may limit the welfare losses due to lower consumption.

Table 4.9 Total WTP for different distributional scenarios (US$)

	Distributional scenarios					
	A	**B**	**C**	**D**	**E**	**F**
T_s	15	8	8	8	0	8
T_r	0	15	0	8	8	15
T_p	15	8	8	0	15	0
Tot trees	30	31	16	16	23	23
η^{ep}	Yes	Yes	Yes	No	No	No
η^{er}	No	No	No	Yes	No	No
η^{m}	Yes	No	Yes	No	Yes	No
Total WTP	80.49 (-1.16-162.13)	53.47 (-4.80-111.73)	42.93 (-0.62-86.47)	38.47 (2.27-74.67)	24.52 (-11.82-60.86)	43.39 (0.32-86.45)
	T_s	T_p	T_r			
MWTP estimates	4.11 (0.56-7.65)	1.26 (-0.64-3.16)	0.70 (-0.28-1.68)			

4.7 Discussion and conclusion

We designed a DCE to elicit preferences for distributive outcomes of environmental policies. Our novel DCE design enables the estimation of separate effects of fairness concerns and self-interested preferences on individual utility. This is relevant within the field of SP for the valuation of environmental goods because equity-related preferences may affect WTP for changes in resource management. We implemented our DCE in a case study on forest co-management in Malawi, where respondents were asked to evaluate management options that related to three fairness norms: equality, maximin and efficiency. Our results demonstrate that respondents in DCE hold social preferences, where the magnitude of material benefits accrued to others significantly affects the utility derived from resource management, and unequal outcomes are associated with disutility. Moreover, our findings confirm studies from experimental economics showing that fairness norms affect individual choices, but individual preferences towards alternative fairness norms are subject to heterogeneity (Cappelen et al., 2007; Johansson-Stenman and Konow, 2010; Konow, 2001).

When we examine multiple fairness norms simultaneously (Model 2), we find that the magnitude of trees distributed to oneself is the most important factor in distributional choices but efficiency, i.e. increasing the total number of resources distributed to the others, is also an important factor. In addition we also found that equality with poorer is a fairness norm that influences distributional choices but both preferences for efficiency and equality with poorer norms are heterogeneous across the sampled population, i.e. equality with poorer village members generates disutility for about 1/3 of respondent. This suggests that there may be different sub-samples within the sampled population that are motivated by different fairness norms or a mixture of those. The desire to realise a distribution that equalises trees distributed to oneself and to richer village members is marginally significant while guaranteeing that the poorer village members receive a higher number of trees than richer members does not seem to affect choices for forest management options.

Self-centred equity, where the agent prefers to get the same amount of benefits as other village members, matters when comparing to both poorer and richer members, but equality with poorer members is relatively more important as shown by Model 3. This finding is also confirmed by Model 2, where all fairness norms are included: equality with poorer is significant (p – value < 0.001), while equality with richer is only marginally significant (p – value < 0.1). The fact that the inequity aversion preferences are found to be substantially different across these two different wealth groups may indicate that there are different motivations underlying inequity aversion. One explanation may be that inequity aversion relative to richer people is not driven by the equality norm but by a desire to comply with other local customary rules that apply to specific wealth categories, i.e. a wealth status effect. Such explanation would be consistent with the conditional altruism model proposed by Konow (2010) and the idea that there is a pluralism of norm underlying preferences for the benefits distributed to the others (Cappelen et al., 2007; Korenok et al., 2012).

Inequity aversion relative to poorer village members seems to be driven by fairness concerns, but it only appears relevant when respondents are in an advantageous position (Model 3). This seem to indicate a form of maximin concerns. In addition, advantageous inequity relative to poorer members becomes positive when a relatively high number of trees are distributed to the poorer members indicating that respondents are averse to unequal outcomes up to when poorer members are allocated a minimum number of trees (threshold). However, Model 2 shows that the maximin coefficient is not statistically significant and this indicates that inequity aversion relative to poorer is a stronger motive than a maximin norm when making choices about forest management options.

Our paper proposes a methodological innovation which can be applied when assessing preferences for common-pool resources and accommodates that individuals may hold two sets of preferences, those of consumers and citizens (Sagoff, 1998; Nyborg, 2000). Our design can capture the influence of social preferences in individual choices regarding the allocation of environmental resources. We further test whether these social preferences are motivated by fairness norms (Konow, 2003) through employing alternative model specifications. The relatively small size of the experimental design (18 degrees of freedom) does not allow us to specify models that can account both for the overall magnitude of benefits distributed to others and the relevance of fairness norms. The experimental design that we used for data collection ensures that some key interactions between number of trees distributed to oneself and number of trees distributed to others can be estimated whilst some others are confounded, e.g. the interactions between the amount of trees to poorer and richer. This limits the possibility to employ a more general model formulation (e.g. Charness and Rabin, 2002; Kerschbamer, 2015) that would allow to explore a wider range of patterns of substitution between self-interested and social preferences. However, the combination of different models allows to provide a comprehensive account of the different motivations behind choices for the distribution of environmental resources. Further research could investigate in more detail the interactions about different fairness motivations by employing a larger design (at least 22 degrees of freedom) inclusive of the two-way interaction between trees available to richer and poorer. With such a design it would be possible to estimate a model that includes all the different fairness motives whilst controlling for magnitude of benefits distributed to each village member (self, richer, poorer).The results are relevant to the wider debate on the devolution of forest management and the development of co-management regimes of common pool resources. Being able to elicit societal and personal values that people hold for environmental benefits under a specific management regime is especially relevant when results from SP applications are used for cost-benefit analysis and to orient public decision-making toward welfare-enhancing policies. The results of our DCE show that the importance of forest benefits to relatively poor members of forest-adjacent villages is recognised by village members, and they prefer progressive allocation regimes that reduce inequalities with those worse-off members. At the same time, while the strong preference for maximising resource use, both at the individual and the collective level, appear to contribute to local welfare, it is important to adequately monitor harvesting levels if long-term ecological sustainability objectives are to be met.

Chapter 5 Unfairness breeds self-interest: an experimental study of procedural and outcome fairness

5.1 Introduction

The influence of fairness as a norm guiding the allocation and distribution of scarce resources has been studied extensively in economics. Individual choices in (re-)distributive contexts are often influenced by outcome fairness, where the fairness of the final allocation is judged according to fairness norms (Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Fehr and Schmidt, 1999; Konow, 2000). Agents are not completely self-interested, and they are willing to forego personal benefits to achieve the societal objective of a fair distribution of resources. However, agents often interpret and apply fairness norms in a self-serving manner. Both the institutional setting where resources are (re-)distributed and the stakeholders' characteristics may render fairness concerns more or less salient for the agents. For instance, lower social distance between agents involved in (re-)distribution is found to decrease self-interested allocations (Hoffman et al., 1996), while the more the effort that the agent puts in "producing" the common resource, the higher is the amount he chooses to keep for himself (Cherry et al., 2002).

Procedural fairness regards the fairness of the processes that lead to a given outcome. Procedures can be considered fair if they involve a set of transparent and impartial rules that ensure equal opportunities for all individuals to participate in the decision-making process (Bolton et al. 2005; Grimalda et al. 2016; Trautmann et al. 2016; Dold et al. 2017). The study of procedural fairness in the experimental economics literature has focused on the influence of random procedures in ultimatum games and whether participants are more likely to reject outcomes when fairness norms at procedural level are violated. Most literature posits that agents react similarly to violations of either procedural or outcome fairness and they appear to be substitutes, i.e. the higher the perceived fairness of procedures is, the less likely it is that the agent cares about the fairness of outcomes and vice versa (Bolton et al. 2005; Krawczyk 2011; Grimalda et al. 2016). However, the literature's findings rely exclusively on ultimatum game settings where only the responder's reaction to unfair random procedures has been analysed. The model therefore cannot be used to explain distributive choices of proposers and how they are directly influenced by the fairness of procedures.

In this paper, we explore whether the degree of procedural fairness in assigning decision-making power in a distributive setting (i.e. dictator game) influences individual (i.e. dictator) choices. The degree of decision-making power of the agent has been found to increase self-serving views of fairness norms (Rode et al. 2011; Rustichini et al. 2015; Kittel et al. 2017), and this effect may be influenced by the power distribution mechanism and its fairness. To the best of our knowledge, this is the first study to investigate the role of procedural (un)fairness regarding distributive choices of agents endowed with full decision-making power. In addition, we manipulate the wealth status of the receiving agents to evaluate whether distributive choices are influenced by an income effect.

This paper provides two key contributions to the literature. Firstly, we study the influence of the procedures, and its fairness, for assigning decision-making power on individual choices in a redistributive setting. The procedure used to assign dictator role is experimentally manipulated to mimic three different mechanisms: random, meritocratic, and unfair. Importantly, our design expands that of Hoffman et al. (1994) by introducing an unfair procedure. Our unfair procedure is a mechanism that is not transparent, and it does not guarantee equal opportunity to all agents to access a powerful role. Moreover, we introduce treatments where the recipient’s initial endowment is varied to test whether the dictator’s choice to give is influenced by the stakeholder’s initial wealth status.

Second, we propose a novel framework that operationalises theoretical arguments (Bicchieri, 2005; Konow, 2000) and incorporates a concern for procedural fairness within outcome fairness models. In our model redistributive choices are assumed to be influenced by fairness norms and the agent trade-off a preference for own money with a preference for complying with fairness norms. The (un)fairness of a procedure facilitates self-serving manipulations of fairness norms relative to outcomes. This framework can be used to examine how the distributive behaviour of agents changes when they are exposed to institutional settings where social and moral norms are violated. It is therefore relevant for the analysis of (re-)distributive policies in which the outcome and its fairness depend on the choices of powerful agents.

In this paper, we use data from a lab-in-the-field experiment in Malawi. The management system of forest reserves in Malawi is evolving towards a CBFM. CBFM policies in Malawi involve the Government devolving the rights to access forest resources to local communities where newly established committees coordinate forest management and the distribution of the harvested resources. The procedures used for appointing the forest committee members varies across different forest reserves and includes both elections held at community level and top-down approaches such as nomination by forest department staff or the village chief (Chinangwa et al., 2015). The nomination mechanism may imply some form of favouritism, where the forest department staff or the village chief assign powerful roles to individuals because of social ties. Extensive literature has documented that CBM systems that lack transparency and impartiality at procedural level may exacerbate inequalities due to elite capture (Lund et al. 2008; Vyamana 2009; Ameha et al. 2014; Persha et al. 2014; Chinangwa et al. 2015; Chomba et al. 2015). Our experiment therefore aims to analyse how the institutional setting, specifically the procedures used to allocate decision-making power, and the recipients' wealth status affect agents' distributive behaviour and their distributive preferences. The rural communities living in the surrounding of forest areas strongly rely on the harvested resources for their basic needs (Fisher, 2004; Kamanga et al., 2009) and the distributional consequences of CBFM policies may affect total social welfare. Therefore, uncovering mechanisms that link procedures and outcomes could offer insight into how welfare-enhancing distributions can be achieved and thereby inform local policy design. Briefly, we observe that assigning decision-making power through an unfair procedure significantly reduces the amount sent by dictators compared to fair procedures and we hypothesise that procedural unfairness reduces the relevance of fairness norms relative to outcomes. Section 5.2 reviews previous literature followed by a description of the experimental design and procedures in Section 5.3. Section 5.4 discusses the analytical model, our hypotheses, and the empirical strategy while Section 5.5 presents our results. Section 5.6 discusses findings and concludes.

5.2 Literature review

Outcome fairness has often been proposed as the motive underlying distributive preferences in the literature (Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Fehr and Schmidt, 1999; Konow, 2000). Models of rational choice incorporating outcome fairness assume that the individual is willing to give away some of his benefits to realise a fair outcome. Such models assume that the agents judge fairness of a wealth distribution according to universal norms of fairness over outcomes, i.e. the reference point (Konow, 2001). Early theoretical developments identified efficiency, equality and maximin as fairness norms that motivate choices in distributive contexts (Fehr & Schmidt 1999; Bolton & Ockenfels 2000; Charness & Rabin 2002). Further experimental research has demonstrated that when the total wealth to be redistributed is a result of individuals' contributions, different fairness norms arise. For example, under accountability, a distribution is fair if wealth is redistributed proportionally to individual effort, and under libertarianism, wealth should be divided based on contribution without distinguishing among effort and luck (Cappelen et al., 2010, 2007; Konow, 2003).

The relative importance of fairness norms within individual choices is highly heterogeneous across agents and contexts (Hoffman et al. 1994; Konow 2001; Henrich et al. 2005; Engel 2011; Rode et al. 2011; Krupka et al. 2013; Rustichini et al. 2015). For instance, Cappelen et al. (2007) show that individuals involved in the same distributive situation seem motivated by different fairness norms and that the overall relevance of those norms is heterogeneous across participants. Konow (2001; 2003) explains the great variability of individual behaviour in distributive contexts by suggesting that fairness and the willingness to act on it is context-dependent. Context includes, for instance, varying degrees of social distance with the other agents that will benefit from redistribution (Charness et al. 2008), how the total wealth to be distributed has been obtained (Barr et al., 2015; Cappelen et al., 2010; Jakiela, 2015, 2011) or whether property rights over the total wealth have been defined (Cappelen et al., 2013; List, 2007).

The fact that the role of fairness norms is context-dependent and heterogeneous across agents is further demonstrated by comparing the results from standard labs experiment with students in high-income countries to artefactual field experiments in low-income countries where the sample is composed of non-standard subjects, e.g. villagers or workers from urban areas. Jakiela (2015) found that rural villagers from Kenya were mainly motivated by an egalitarian principle and sent on average about 40% of their endowment disregarding the role of individual effort and contribution to the endowment. Instead, the US students behaved much more selfishly, sending on average about 20% of total endowment, and seemed motivated by a meritocratic fairness norm and distributed money proportionally to effort. Similarly, Barr et al. (2015) found that non-standard lab subjects such as unemployed participants, both in UK and South Africa, behaved differently from students in a dictator game; whilst the latter acknowledged the role of effort and distributed money proportionally to individual's contribution, the sample of unemployed agents seem to be motivated just by an egalitarian principle. Finally, Cappelen et al. (2013) compared distributive choices of students from low-income countries, Uganda and Tanzania, and high-income countries, Norway and Germany and found that for all nationalities the accountability principle is the main norm that seems to motivate distributive choices whilst a need principle, which take in account of the wealth status of the participants and prescribes to give a higher amount to the less wealthy, seem to motivate some agent but just a minority.

Framed field experiments about sharing resources performed in low-income countries have also shown that agents' choices seem to be influenced by fairness norms such as the egalitarian and the need principles (D'Exelle et al., 2012; Schüring, 2014). Schüring (2014) assessed the performance of a community-based mechanism for targeting recipients for social cash transfer interventions aiming at reducing poverty. The study found that participants prefer egalitarian shares and distribute the amount of money available between all experiment participants in 1/3 of the cases whilst they target very poor beneficiaries 34% of the cases. The study also found evidence of selfish choices and individuals that choose to allocate the transfer to themselves, but just when such choice is justified by his wealth status indicating that the underlying motivation seem to be following a fairness principle, i.e. need. The high relevance of egalitarian principles when making choice about sharing resources between rural villages has also been found by D'Exelle et al. (2012). They performed a framed field experiment about sharing water resources between communities where more equitable choices resulted in lower gains for all participants, i.e. efficiency-equality trade-offs, and found that equal sharing of water resources was chosen by about 30% of participants despite the efficiency loss. An important aspect of the distributive context which has received little attention in the literature is the fairness of procedures and rules governing the decision-making process. The procedures through which a society makes choices about final allocations, and their fairness, influence individual utility, both as a moral value per se and in relation to the outcome (Bolton et al. 2005; Grimalda et al. 2016; Trautmann et al. 2016; Dold et al. 2017; Krawczyk 2011). The study of procedural fairness in the experimental economics literature has focused exclusively on random procedures where lotteries with equal probabilities have been considered the fair reference point for procedures.

Bolton et al. (2005) show that individuals have preferences for (fair) procedures in addition to preferences for (fair) outcomes. In an ultimatum game, responders' rejection rates are higher for unequal outcomes which have been determined by an unfair procedure, in this case a lottery assigning higher probability to the outcomes biased in favour of proposers, than by a procedure with equal probabilities. Bolton et al. (2005) extend the outcome-based model of Bolton et al. (2000) to incorporate procedural fairness; the model assumes that individual utility decreases if the final allocation deviates from the fair benchmark, which is defined either by the procedure or the outcome depending on which of the two is less biased. In this model, procedural and outcome fairness are considered two factors which act as substitutes. Grimalda et al. (2016) explore the role of random procedures, and their fairness, in determining initial roles in an ultimatum game. The probability of becoming the proposer, which the authors consider the advantageous position in the game, determines the degree of procedural (un)fairness, i.e. the higher the inequality of opportunities the more unfair the procedure. Results suggest that higher procedural unfairness lead to an increase of the minimum acceptable offer, i.e. responders demand more equal outcomes.

However, in ultimatum game designs the direct effect of procedural fairness on the proposer's choice is confounded with strategic considerations about the responder's reaction. The responder can, in fact, reject the proposer's offer preventing both participants to gain any money, and therefore the proposer's choice is in part determined by his beliefs about the responder's expectations. On the contrary, in dictator games, where dictators have unilateral power to decide on the final distribution, such concerns are not present. Past evidence suggests that procedures, other than random, used for assigning roles may reduce the relevance of outcome fairness and enhance self-interested allocations (Hoffman et al., 1994; Ku et al., 2013). Hoffman et al. (1994) find that when dictator roles are assigned based on merit, the average share sent to the other agent is lower compared to random assignment. Ku et al. (2013) designed an experiment where the advantaged or disadvantaged role translated into unequal initial endowments. The initial position was assigned using different procedures such as random, meritocratic, arbitrary, and rewarding uncooperative behaviour. The payoffs redistribution mechanism generated a trade-off between efficiency (i.e. an increase in total income available to both participants) and equality (i.e. an increase in income inequality relative the pair). The results show that the advantaged agents kept for themselves a statistically significant higher amount in the treatment when they were assigned the role based on their uncooperative attitude. However, the underlying motive is not easily identified as in their experimental design, self-interested choices were confounded with choices motivated by a desire to increase total efficiency.

More evidence is needed to understand how different features of the distributive context influence individual's choices and although previous research has shown that individuals are influenced by procedural fairness, the literature has almost exclusively focused on examining the effect of random (unfair) procedures on responder's reactions, but it has not explored directly how different procedures for allocating roles influence choices of agents endowed with full decision-making power. I argue that the allocation of decision-making power between participants with different characteristics, such as the initial assigned endowments, influence the application of fairness norms in distributive choices. Moreover, the implementation of an artefactual field experiment with participants from rural villages can provide further evidence on how fairness norms influence individual decision-making outside the laboratory setting.

5.3 Experimental design

We designed a lab-in-the-field experiment to investigate the effect of different procedures for assigning decision-making roles on the distributive choices of agents endowed with full decision-making power. Moreover, we manipulated the endowment provided to the recipients to evaluate whether the initial wealth status of stakeholders influences dictator's giving.

5.3.1 Treatments

We conducted six treatments of a dictator game that varied along two dimensions: the procedure for assigning the dictator's role and the initial endowment provided to recipients. In all treatments, each dictator made a single choice about how to divide a fixed amount of money, E_d, between himself and an anonymous recipient. Recipients made no decision and only received the amount that dictators allocated to them.

The role of dictator was assigned using three different mechanisms: random, earned and unfairly earned (called unfair henceforth). In the random treatment, the dictator role was assigned based on an identification number randomly picked at the beginning of the experimental session. The random treatment qualifies as a lottery with equal probabilities and therefore it is considered a fair procedure. In the earned treatment, the dictator role was assigned based on performance on a simple task, which consisted of sorting beans from a bag containing four different varieties of dried beans over a one-minute period, with a fixed number of beans from each variety (Barr et al., 2015; Jakiela, 2015). We ranked the participants from high to low based on the number of beans sorted. We then assigned the dictator role to participants in the top half of the ranking, while the remaining participants (in the lower half) were assigned the role of recipient. In the earned treatment we introduced an effort/talent component, but we provide all participants with equal opportunities, i.e. the same number of beans in each bag, and therefore it is considered a fair procedure. In the unfair treatment, the dictator role was assigned based on performance in a similar sorting task, where half the bags, which were distributed randomly to participants, contained fewer beans. The fixed, low number of beans prevented participants who received those bags from scoring high enough in the sorting task to become dictators. After the task, participants were informed that some bags contained fewer beans so players receiving those bags could not have become dictators irrespective of their effort. The bags were distributed to participants randomly and we do not know who got the "unfair" one.[9] The unfair treatment hence created an unfair procedure by employing a mechanism which was not transparent and that did not provide equal opportunities to participants.

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[9] The probability of getting the role of dictator in the unfair treatment depends both on effort exerted and number of beans in the bag. Potentially a participant which received the "unfair" bag could have become a dictator if they exerted a higher effort than all participants with the bags containing the higher number of beans. Yet, it is unlikely that such situation did happen as the number of beans in the "unfair" bags was lower than the average sorted in all other earned treatments, including the pilot. Moreover, even if such specific situation did happen, participants were not able to notice it because they were never informed about the total number of beans in their bags or their score. The unfairness of the procedure was conveyed through the instructions which informed dictators that they got their role because they had been favourably treated while the opposite held for recipients.

The second manipulation concerned the assignment of endowment to recipients. In a standard dictator game, only dictators receive an endowment which they can then split between themselves and recipients. In our experiment, similarly to Konow (2010) and Korenok et al. (2012) the recipient had a zero or a positive initial endowment, but dictators did not get any initial personal endowment. Dictators only received endowment E_d that they could split as they wanted with their recipients.

5.3.2 Lab-in-the-field setting and recruitment procedures

We conducted our lab-in-the-field experiment with a sample of adults aged 18-65 years selected from fourteen rural villages in Mangochi District in Malawi. The villages were randomly chosen from within a 5 km buffer around the Namizimu Forest Reserve. In each location, we conducted either two parallel sessions or one single session depending on the population size of the village. For single sessions, we invited 24 participants; in villages where we ran parallel sessions, we invited 48 participants who were assigned, on arrival, randomly to one of the two sessions. We ran a single treatment in each experimental session.

Table 5.1 Summary of experimental treatments and sample size

Treatment	Recipient's endowment	Dictator role	Number of pairs[a]
Random – zero	No	Random	34
Random – positive	Yes	Random	34
Earned – zero	No	Earned	34
Earned – positive	Yes	Earned	33
Unfair – zero	No	Unfair	32
Unfair – positive	Yes	Unfair	33
Total number of participants (dictators and recipients)			400

[a] For each session we invited 24 participants. Non-attendance was low: three sessions were attended by 24 participants; 14 sessions were attended by 22 participants and one session was attended by 20 participants.

We selected participants for every village from a list of households previously compiled with the help of village members. We employed a stratified random sampling method and selected people based on gender, age, and wealth status. One day prior to each experimental session, members of the research team visited the village chief and provided him with a list of individuals invited to the experimental session happening the day after, as well as a reserve list of names in case the invited participant was not available, and an invitation letter that included information about the study. Potential participants invited to take part in the study were informed of the time and venue, the duration of the session, the show-up fee (100 MKW) and the possibility of earning additional money.[10] In total, we ran 18 experimental sessions (3 per treatment) in 14 villages (Table 5.1). All the sessions were conducted in Chichewa, the main language in Malawi. The data were collected within a 3-weeks period in August 2017.

5.3.3 Experimental protocol

The experimental sessions were held in common spaces used by village members for communal activities, such as empty school classrooms or the outside area in front of the chief's house or church. Research assistants prohibited access to any non-participants and ensured participants' privacy and anonymity.

The experimental sessions consisted of two phases. In the first phase, participants were asked to pick an identification number from a bag and subsequently detailed instructions about the game and the role allocation mechanisms were read aloud (see Appendix D.5 and D.7). Participants were then divided into a dictator and a recipient group either randomly (random treatment) or based on performance in the bean sorting task (earned and unfair treatments). In the earned and unfair treatments, a member of the research team read aloud the bean sorting task instructions and demonstrated to participants how to perform the task by showing some of the content of the bag and the type of beans to be sorted. All participants of the same session were assigned either the dictator or recipient role. Players who did not become dictators in the role assignment phase were assigned the role of recipients. All interactions between participants were anonymous.

In the second phase, we sent dictators and recipients to separate locations and provided further instructions about the structure of the game (see Appendix D.5). We informed participants that they were paired with someone from the other group. The social proximity between dictators and recipients may influence the absolute level of giving but the focus of our paper is on analysing the relative differences across experimental treatments. Experimental instructions on the dictator's choice were presented orally, and the decision-making process was demonstrated using envelopes that were clearly labelled as YOU and OTHER PERSON (see Appendix D.7). The endowment (320 MKW) was split into 16 notes of 20 MKW (the smallest denomination of notes in Malawi), so that dictators could allocate any amount divisible by 20. Dictators were informed either that the recipient got no initial endowment (in the zero treatment) or that recipients got 80 MKW as initial endowment (in the positive treatment) and that this money would be part of the

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[10] 100 MKW = 0.60 USD PPP (purchasing power parity). The adjusted exchange rate is 172.42 MKW = 1 USD PPP using the PPP conversion factor for private consumption for the year 2016 (World Bank, International Comparison Program database)

recipients' final earnings independent of the amount they (i.e. the dictator) allocated to them. We then sent each dictator to a separate, secluded location to make their choice using the envelopes.

Once the second phase was completed by both groups, a researcher (who was not involved in phase one or two) collected all envelopes, labelled with the participants identification number, and calculated the final payments, while the participants were provided with refreshments and completed a short questionnaire (see Appendix D.6). The questionnaire included questions on socio-economic characteristics of respondents (i.e. age, education, livestock ownership, agricultural activities, and other income-generating activities), attitudes toward fairness and trust and feedback on game (e.g. fairness perception about role allocation). We placed the final payments in an envelope and distributed these to participants at the end of the experimental session, thereby ensuring complete anonymity about the dictator's choices (double blind dictator design) and reducing potential experimenter's demand effects (Hoffman et al., 1994). The experimental sessions, including refreshments and short questionnaires, lasted about two hours.

5.4 Conceptual framework

We develop a novel conceptual framework where both outcome and procedural fairness are incorporated, starting from the assumption that fairness norms influence dictators' choices. We build on the modelling framework proposed by Cappelen et al. (2007) where the dictator is assumed to experience disutility for making a choice that deviates from the fair reference point prescribed by a fairness norm. Formally, dictator *i* is assumed to maximise the following utility function when choosing how to distribute the endowment provisionally allocated to him:

$$V_i(y) = \alpha_i y - \beta_i (y - \eta^k)^2 \qquad (13)$$

where α_i is the marginal utility of income, capturing material self-interest, β is the weight attached to fairness considerations and *y* is the amount kept by the dictator. The parameter β represents an overall preference for fairness which is assumed to be an individual characteristic following Cappelen et al. (2007). The preference for fairness, β, is traded-off against utility derived from monetary income allocated to the agent, α. The dictator experiences disutility if he chooses to keep more or less of the fair share prescribed by the norm (i.e. $y - \eta^k \neq 0$), while the fairness term has a quadratic form that reaches its minimum when the dictator keeps the fair share, i.e. $y - \eta^k = 0$.

η^k identifies the content of fairness in situation k, i.e. the reference point that defines what is a fair share for the dictator (Cappelen et al., 2007; Konow, 2001). The situation k indicates a general and abstract distributional context able to accomodate different features that may modify what is perceived to be a fair share, e.g. contribution of each individual to produce the total wealth or wealth status of the agents. For instance, in a situation k where the agents produce the endowment that they subsequently need to distributed there are two norms that may be influence dictator choices: the egalitarian principle, i.e. distributing the endowment equally among players, and the accountability principle, i.e. distributing the endowment proportionally to the contribution of each player, are both relevant. In our dictator game where the player's endowment is provided by the experimenter, as opposed to be "produced" by participants, players will consider themselves equally deserving, and the only relevant fairness norm in our design is egalitarianism (Andreoni and Bernheim, 2009; Cappelen et al., 2007; Jakiela, 2011). As the egalitarian norm prescribes the equalisation of the final payoffs, the provision of an endowment to recipients influences the reference point (Konow, 2010; Korenok et al., 2012). Formally, given that the total available endowment (E) is the sum of the dictator's endowment (E_d) and the recipient's endowment (E_r), the fair share for the dictator prescribed by egalitarianism is:

$$\eta_E = (E_d + E_r)/2 \tag{14}$$

When the recipient is not given an initial endowment, E_r = 0, the fair share for the dictator is exactly half E_d.

Konow (2000) and Bicchieri (2005) propose theoretical frameworks that we can adapt to address procedural fairness. In Konow's (2000) model, the individual experiences a conflict between self-interest, i.e. the desire to keep the full endowment for himself, and fairness, i.e. the desire to keep only his fair share. This tension, defined as cognitive dissonance, is costly and the agent aims to reduce these costs by sending the amount that is fair. The fair share is identified by two distinct terms: the fairness norm and the individual's belief about what is a fair share. The latter is mediated by contextual factors. Konow's model prescribes that the agent reduces the level of disutility generated by cognitive dissonance through self-deception, i.e. changing what he believes is a fair share in a self-serving manner. Konow (2000) finds evidence that self-deceptive behaviour is highly relevant in dictator game interactions and that the agents' self-serving interpretation of fairness norms may be facilitated by contextual factors, which motivates why in our framework we assume that dictators change their beliefs about what is a fair share.

Bicchieri (2005) extends Konow's framework by including the role of expectations. She argues that individual choices are influenced by fairness norms if individuals prefer to comply with those norms. The preference to comply with a fairness norm in a distributive context is conditioned by the presence of empirical and normative expectations. When a fairness norm exists and is practiced in each population, the agent's empirical expectations arise from repeated past observations that a sufficient number of people will conform to the norm. The agent's normative expectations instead originate from the belief that others expect the individual to conform to the norm, either because the individual recognises the legitimacy of others' expectations or because non-conformity may be sanctioned by others. A fairness norm influences a choice if and only if both expectations are present; the individual prefers to comply with a norm if he believes that the others will comply (empirical expectations) and that the others expect him to do so too (normative expectations). Features of the distributive context may influence both types of expectations and generate ambiguity about the relevance of a fairness norm, thereby enhancing self-serving manipulations (Bicchieri and Chavez, 2010).

We incorporate the intuition of both theoretical models in our framework where agent *i* is assumed to maximise the following individual utility function:

$$V_i(y) = \alpha_i y - \beta_i \left(\frac{y-\delta_p \eta^k}{E_d}\right)^2 \qquad (15)$$

Here, the cost associated with the deviation from the fairness norm is given by β and is assumed to be stable within the context of a one-shot game. The procedures for the allocation of the dictator role can change what the dictator believes to be the fair share, and thus the magnitude of self-serving bias. Therefore, the procedure *p* modifies the weight (δ_p) that individuals assign to η^k, the fair share prescribed by the norm and exogenous to the model. The product $\delta_p \eta^k$ is the dictator's context-dependent belief about what is a fair share to keep for himself.

Assuming an interior solution, maximising *V* yields the optimal amount *y** for the dictator to keep:

$$y^* = \frac{\alpha_i}{2\beta_i} E_d^2 + \delta_p \eta^k \qquad (16)$$

where the procedure, *p*, is either random (R), earned (E) or unfair (U) and $\beta \geq 0$.

The dictator's optimal allocation is therefore related both to what is believed to be a fair share, $\delta_p \eta^k$, and to the weight attached to self-interest and fairness concerns, $\frac{\alpha}{2\beta}$.

5.4.1 Hypotheses

Under this modelling framework, we formulated two hypotheses about the effect of power-allocation procedures on the magnitude of self-serving bias (δ_p) in our experiment.

Hypothesis 1 - Entitlement hypothesis

H1: $\delta_{Earned} > \delta_{Random}$

The first hypothesis is derived from empirical evidence suggesting that dictators earning their position through winning a contest feel entitled to exploit their power and favour themselves because they believe to have earned a larger share (Hoffman et al., 1994).

Hypothesis 2 - Procedural fairness hypothesis

H2: $\delta_{Unfair} > \delta_{Random}$

Unfair procedures in allocating dictator roles reduce the dictator's perception on how much he ought to adhere to fairness norms compared to random procedures and increase the likelihood of self-serving manipulations of beliefs about what is a fair share. This follows from the framework developed by Bicchieri (2005), where exposing agents to a violation of fairness norms at procedural level modifies their empirical expectations.

5.4.2 Empirical strategy

We investigate whether the two factors manipulated in the experiment influence average allocations to recipients by estimating a linear regression model, using the amount sent to the recipient, $x = E_d - y$, as response variable. Model 1 includes all the main experimental variables:

$$x_i = a_0 + a_1 R_e + a_2 P_e + a_3 P_u \tag{17}$$

where P_e takes the value 1 if the participant *i* is a dictator in the earned treatment and 0 if not, P_u takes the value 1 if the participant is a dictator in the unfair treatment and 0 if not, and R_e takes the value 1 if the recipient has an initial (private) endowment and zero if they do not. The first hypothesis is that a dictator who earned his role is subject to an entitlement effect and keeps a larger share for himself so that $a_2 < 0$ (H1). The second hypothesis prescribes that dictators exposed to unfair procedures change their perception about how much they ought to adhere to a fairness norm and choose to keep more for themselves so that $a_3 < 0$ (H2). Finally, following our conceptual framework, if the individual reference point prescribed by the norm is influenced by the recipient's endowment and thereby reduces the overall amount sent to recipients, then $a_1 < 0$.

Furthermore, we fit an extended model with two-way interactions between the magnitude of endowment provided to recipients and the procedures used to allocate the dictator role. Model 2 is:

$$x_i = a_0 + a_1 R_e + a_2 P_e + a_3 P_u + a_4 R_e * P_e + a_5 R_e * P_u \tag{18}$$

Note that the baseline treatment is the random mechanism with no private endowment for recipients. We did not formulate hypotheses on the presence and the expected effects of the interaction terms given the lack of theoretical and empirical evidence.

5.5 Results

We first present the sample statistics, followed by a set of descriptive statistics of dictator allocation means and non-parametric tests across treatments. We then present the results of our regression analysis defined in equations (17) and (18).[11]

5.5.1 Descriptive statistics

A comparison of our dictators' characteristics (Table 5.2) with data available for the district suggests that our sample is representative of the wider population. The average age of our participants is 32 years and households are composed of about five members on average. The fourth Integrated Household Survey (IHS4) conducted by the Malawi National Statistics Office (2017) in 2016-2017 reports that the average household size for the Mangochi district (including urban areas) is 4.2. About 40% of our respondents owns livestock and the average land size is 1.38 acres (0.56 hectares) with the corresponding figures from IHS4 at 34% and 1.3 acres. More women than men participated (78% female respondents) due to local customs, i.e. in Malawi, women usually attend group activities at village level.[12] The amount of money provided to dictators was 320 MKW and the average payment for participants across the whole experiment was 280 MKW. The average daily household income calculated from our data is 296 MKW and if we assume that each family has on average at least two members earning income, then the estimated daily individual income is about 150 MKW so that the average payment to the participants was almost double their daily income.[13] Moreover, because of the high level of poverty and low opportunity costs, we are confident that the monetary incentives were sufficient for activating utility maximising behaviour. It is estimated that 73% of the population in the Mangochi district lives below the poverty line (IHS3, 2011) which is higher than the national average (about 50% in 2010, World Bank). The opportunity costs of participation can be considered low and stable because the data were collected during the dry season, when farm labour requirements of rain-fed agriculture are low, while alternative income activities are rarely undertaken.

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[11] In section D.1 of the appendix we also present the estimates of our structural choice model defined in equations (12)-(15). The results are consistent with the regression model therefore we did not include it in the main section (see Table D.2).

[12] In the appendix we provide descriptive statistics of gender distribution across treatments. We found that the random-positive treatment is particularly affected by this gender imbalance (see Table D.4) but that overall findings are robust once we exclude choices of the male sample (see Table D.5).

[13] The average annual household income calculated from the data is 70,950 MKW which implies a monthly income of 5,913 MKW and, assuming a week of 5 working days and a month with 4 weeks an average daily income of 295 MKW.

Table 5.2 Descriptive statistics: characteristics of dictators (n=200)

Variable	**Mean**	**S.D.**
Female (1=female, 0=male)	0.78	0.41
Age (years)	32.51	10.81
Household size	5.27	2.10
Livestock ownership dummy (1=yes, 0 otherwise)	0.42	0.49
Land size (acres)	1.38	1.05
At least 5 years of schooling (1=yes, 0 otherwise)	0.61	0.48

We classify the random and earned allocation mechanisms as a fair procedure while the unfair earned treatment as an unfair procedure because it does not provide equal opportunities to all participants. Such classification is supported by the subjective evaluations of dictators regarding the fairness of role allocation mechanisms as shown in Table 5.3. In the random treatment 90% of participants stated that the procedure was fair or very fair and the figure increases to 96% for the earned treatment. In the unfair treatment instead, the figure decreases to 32% and 52% of dictators who earned the role "unfairly" stated that the procedure was very unfair or unfair (P-value < 0.001, Fisher's exact test).[14]

Table 5.3 Contingency table of participants' perceived procedural fairness of role allocation mechanism

Role allocation mechanism	**Unfair or very unfair**	**Fair or very fair**	**Don't know**	**Total**
Random	0%	90%	10%	
	(0)	(61)	(7)	68
Earned	0%	96%	4%	
	(0)	(64)	(3)	67
Unfair	52%	32%	15%	
	(34)	(21)	(10)	65
Total				200

Notes: Number in parentheses is the number of respondents in each category.
P-value < 0.001, Fisher's exact test

5.5.2 Dictator's choices across treatments

Overall, the average allocation of dictators across experimental treatment is 33.4% of their total endowment (MKW=320) as shown in Table 5.4 - Panel A. The role allocation mechanisms

[14] The perceptions about procedural fairness is found to be the same for the female and male sample (see Table D.3)

significantly affect dictator's allocations.[15] In the random treatment dictators allocated 39.1% of their total endowment while this drops to 28.1% ($p < 0.001$)[16] in the unfair treatment and to 32.5% ($p = 0.05$) in the earned treatment. These results confirm both the entitlement effect (H1) and the procedural fairness (H2) hypotheses. Moreover, the percentage of dictators choosing to split their endowment in half decreases from 19.1% in the random treatment to 7.7% in the unfair treatment and 14.9% in the earned treatment, again providing support for H2 and suggesting that unfair procedures reduce the relevance of fairness norms and increase self-interested allocations.

Table 5.4 Mean amount sent by dictators to recipients across role allocation mechanisms and recipients' endowment

Panel A: allocations by procedure and recipient's endowment

		Role allocation			Endowment	
	Pooled sample	**Random**	**Earned**	**Unfair**	**Zero**	**Positive**
Mean allocation to recipient (MKW)	107 (98-116)	125 (110-140)	104 (89-118)	90 (75-106)	119 (107-131)	95 (82-108)
Mean allocation to recipient (% of dictator endowment)	33.4%	39.1%	32.5%	28.1%	37.2%	29.7%
Frequency (%) of dictators allocating 50% of their endowment	14.0%	19.1%	14.9%	7.7%	23.0%	5.0%
Number of observations (dictators)	200	68	67	65	100	100

Panel B: allocations by treatment

	Random - Zero	**Random - Positive**	**Earned - Zero**	**Earned - Positive**	**Unfair - Zero**	**Unfair - Positive**
Mean allocation to recipient (MKW)	131 (109-152)	120 (99-141)	127 (110-144)	80 (59-101)	98 (76-119)	84 (60-107)
Mean allocation to recipient (% of dictator endowment)	40.9%	37.5%	39.7%	25.0%	30.6%	26.3%
Frequency (%) of dictators allocating 50% of their endowment	32.3%	5.9%	26.5%	3.0%	9.4%	6.1%
Number of observations (dictators)	34	34	34	33	32	33

Notes: 95% confidence interval in parentheses

[15] We rule out the hypothesis that the effect of the earned treatment may depend on the fact that the most competitive/productive participants in the bean-sorting task, i.e. those who get the role as dictators, may also be more selfish because the correlation between the dictator's allocation and their performance in the task. Correlations is very weak and not statistically significant ($r = 0.09$, p-value = 0.45)

[16] All reported test results in this section for the differences between treatment means are based on a non-parametric two-side Mann-Whitney U test with alpha=0.05. The significance of differences between treatments means were also tested using T-tests with unequal variances and Kolmogorov-Smirnov tests. These tests provided the same results.

As expected, providing an additional endowment to recipients reduces the average amount sent by dictators. In the zero-endowment treatment, the average amount sent is 37.2%, significantly higher than the amount sent (29.7%) in the positive-endowment treatment ($p = 0.002$). Similarly, the relative frequency of dictators allocating half of their endowment decreases by 18 percentage points compared to the baseline. Finally, the modal amount sent (22% of dictators) in the positive private endowment treatment is 120 MKW, i.e. half of the sum of dictator's and recipient's endowments.

Table 5.4 - Panel B presents disaggregated results for each treatment. In the zero-endowment treatments, the unfair procedure significantly decreases the average share by about 10% compared the random procedure ($p = 0.007$), but there is no significant difference between the random and earned procedure ($p = 0.71$). Yet, the number of dictators choosing to split their endowment in half in the unfair procedure (9.4%) is significantly lower than those in the random (32.3%) and earned (26.5%) treatments. Therefore, when recipients do not receive an endowment, the null hypothesis for H1 cannot be rejected and only the procedural fairness hypothesis H2 is confirmed.

In the positive-endowment treatments, however, the amount sent in the random treatment (37.5%) is significantly higher compared to both the earned (25%, $p = 0.006$) and the unfair procedure (26.3%, $p = 0.009$). Therefore, across positive treatments both hypotheses are confirmed, implying that earning the role of dictator fairly or unfairly significantly reduces the amount sent to recipients.

The endowment reduces the mean allocation to recipients for the earned treatment by 14.7 percentage points (p-value < 0.001). However, the corresponding differences in the random and unfair treatments are much smaller at 3.4 and 4.3 percentage points, respectively, and not statistically significant ($p=0.23$; $p=0.26$ resp.). The number of dictators who split their endowment in exactly half is much lower in the positive treatments ($E_r>0$) than in the zero treatments ($E_r=0$), again showing that the fair (egalitarian) reference point is influenced by the recipient's endowment.

5.5.3 Regression analysis

Table 5.5 reports the results of the ordinary least squares (OLS) regression models, where the response variable is the dictator's allocation to the recipient expressed as percentage of dictator's endowment. The results of Model 1 (eq. 16) show that the earned procedure reduces the amount sent by about 7%, while the unfair procedure decreases the average amount by almost 11% compared to the random procedure. Both effects are statistically significant, confirming our two hypotheses. The recipient endowment has a negative (-7.5%) and significant ($p < 0.001$) effect, showing that the average allocation to recipients decreases when an endowment is provided. Results for Model 2 (eq. 17) show that, controlling for interaction effects, the effect of the unfair procedure remains significant and reduces the average amount sent by about 10%, indicating that unfair procedures have an effect on dictator's choices (H2). In the earned procedure, the average amount sent decreases significantly only in the positive treatment (E_r>0), as indicated by the significant interaction effect with endowment. This suggests that the entitlement effect hypothesis (H1) is weakly supported by the empirical results.

Table 5.5 OLS regression results: average amount sent by dictators to recipients (% of E_d)

	Model 1 - main effects		**Model 2 - main and interaction effects**		**Model 1a – model 1 and socio-economics**		**Model 2a – model 2 and socio-economics**	
Constant	42.8	***	40.8	***	62.2	***	62.9	***
	(2.652)		(3.225)		(7.391)		(9.125)	
Earned treatment	-6.7	**	-1.1		-5.5	*	-1.5	
(1=Yes, 0 otherwise)	(3.252)		(4.561)		(3.184)		(4.566)	
Unfair treatment	-10.8	***	-10.3	***	-9.9	***	-12.4	**
(1=Yes, 0 otherwise)	(3.277)		(4.632)		(3.287)		(4.861)	
Recipient endowment	-7.5	***	-3.1		-9.5	***	-7.4	
(1=Yes, 0 otherwise)	(2.672)		(4.561)		(2.659)		(4.646)	
Recipient endowment X Earned			-11.4	*			-9.3	
			(4.596)				(6.489)	
Recipient endowment X Unfair			-1.0				4.6	
			(4.596)				(6.796)	
Gender (1=female, 0=male)					-12.1	***	-13.0	***
					(3.225)		(3.381)	
Total number of household members					0.0		0.2	
					(0.623)		(0.666)	
Livestock ownership dummy (1=yes, 0 otherwise)					5.0	*	5.2	*
					(2.719)		(2.742)	
Land size (Acres)					0.1		0.3	
					(1.301)		(1.325)	
Age (years)					-0.0		-0.0	
					(0.137)		(0.136)	
Observations	200		200		191		191	
Adjusted R2	0.075		0.083		0.134		0.146	

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses. We excluded nine individual's choice for model 1a and 2a estimation because of missing values for age and household size. Dependent variable: percentage of dictator's endowment allocated to the recipient

Models 1a and 2a include controls for dictators' socio-economic characteristics and show that the effect of the unfair procedure remains statistically significant and reduces the average amount sent. In model 1a we find that both the unfair procedure and the provision of an endowment to the recipients reduces the average amount sent by about 9-10% ($p < 0.01$), while the effect of the earned procedure is smaller (-5.5%) and only marginally significant ($p < 0.1$). Participants who own livestock, which can be considered as an indicator of wealth, are found to send a higher average amount (5%; $p < 0.1$). Gender also significantly reduces the average amount sent (12.1%).[17] In Model 2a, which includes interactions between the two experimental factors, the effect of the unfair procedure is negative (-12.4%) and statistically significant, while the other experimental factors do not have significant effects. As in Model 1a, gender and livestock have significant effects.

5.6 Discussion and conclusion

The experiment explored how procedures for defining roles with decision-making power influence choices on how to distribute resources. Our study builds on previous empirical findings that show that distributive choices are motivated by a desire to be fair but that fairness norms are often interpreted and applied by the agent in a self-serving manner. The results of our experiment confirm that procedures employed in a distributive context may facilitate self-serving biases. The most striking result is that unfair procedures strongly increase self-interested allocations. We define a procedure as fair if it provides equal opportunities to all participants to become dictators and therefore the random and earned mechanism are classified as fair while the unfairly earned is classified as an unfair procedure. It could be argued that the earned procedure does not provide equal opportunities, and hence it cannot be considered a fair procedure, because the procedural mechanism rewards participants based on a personal talent, i.e. their ability to perform in the task, which may be distributed unequally in the sampled population. Cappelen et al. (2010) has shown that a meritocratic principle is part of the fairness principles employed by individuals to judge the fairness of an outcome and that individuals consider a final distribution that reward individual talents as fair. We therefore argue that the same principle may be applied to judge fairness of procedures as supported also by the participants' perception on procedural fairness: 96% of our dictators considered the earned allocation mechanism fair or very fair.

Our results contribute to a growing literature which shows that procedural fairness matters for the acceptance of (un-)equal outcomes and that procedural and outcome fairness may act as

[17] The regression findings hold also within a female sub-sample, whose size is large enough to allow robust estimation (see Table D.5).

(imperfect) substitutes (Bolton et al. 2005; Grimalda et al. 2016). We expand on this by showing that the fairness of procedures influences the incentives of agents endowed with full decision-making power in distributive contexts. Agents who are assigned a powerful role through an unfair mechanism do not compensate for this injustice by choosing a fairer outcome but instead choose a more unequal, self-interested final allocation.

In our analytical framework, we defined two hypotheses on the role of procedures: an entitlement effect and a procedural fairness effect. We found strong support for our procedural fairness hypothesis; dictators which have been allocated a powerful role through an unfair procedure strongly reduces the amount sent to recipients. The results of the estimated structural model suggest that the fairness of the procedure modifies individual behaviour through changing expectations about how much the individual ought to adhere to a fairness norm. However, an explanation based solely on the fair-unfair dichotomy would ignore the entitlement effect hypothesis confirmed weakly in the earned treatments of our experiment. The allocation of power through a mechanism that rewards merit and thereby creates a sense of entitlement is, in fact, found to influence average dictator shares although the effect is only marginally significant. Previous findings on the magnitude of entitlement effect have shown that individuals acknowledge earned entitlements but there is substantial heterogeneity across participants (Jakiela 2011; Jakiela 2015; Barr et al. 2015). A meritocratic fairness norm has been found to be relevant for relatively more educated subjects in a Kenyan sample (Jakiela, 2015) and relatively wealthier in a South African sample (Barr et al., 2015). Our study contributes to this literature by showing that meritocratic procedures may activate an entitlement effect and influence fairness norm relative to outcome, but further research is needed to evaluate whether this effect is mediated by individual characteristics, such as the wealth status of participants.

The assumption that the provision of an endowment to recipients influences the fair reference point is also supported by our results. The results show that the difference in the amount dictators sent between the zero and the positive treatments is statistically significant. In our theoretical framework, dictator choices are motivated by fairness norms. We hence interpret this result as a shift in the fair reference point prescribed by the egalitarian norm similarly to Korenok et al. (2012) and Konow (2010).

We selected two procedural mechanisms which are the most relevant for our policy setting, meritocracy and random unfair, and we defined fair procedures based on the degree of equality of opportunity provided to participants. However, such proxy may not ensure a clear classification of procedural fairness and further research should investigate alternative proxies. Individuals hold a pluralism of fairness norm regarding distributional outcomes and it is plausible that those same principle apply to procedures employed to determine outcomes or to allocate power positions. Further research should also investigate the mechanism underlying the relationship between procedures and final choices. Here we hypothesise that the fairness of procedures modifies the degree of compliance with fairness norms through influencing expectations and lowering the cost of self-deception. However, it could be argued that unfair procedures reduce the overall relevance of fairness concerns in such a context and, through comparison of dictators with the behaviour of non-implicated stakeholders, further insights on the mechanism underlying procedural and outcome fairness relationship could be gathered.

Our findings are relevant to natural resource management institutions and offer initial evidence that the mechanism through which the decision-making positions are assigned has a strong effect on how individuals will behave in distributing resources. However, given the abstract nature of the experiment and the lack of reference to the forest management context, e.g. labelling the resources to be distributed as trees may influence the utility weight associated with fairness norms (Martin et al., 2019), the results are purely indicative of possible mechanisms that can influence individual behaviour in a distributive context but cannot be extrapolated to the real context (Levitt and List, 2007). Further research could focus on enhancing external validity of the experiment by introducing explicit references to the forest resource management context in the game instructions and labelling the money to be distributed as forest products (Cardenas, 2009). To enhance external validity and allow extrapolation of the results to the policy context, it would also be useful to combine the experimental data with data about “real” distributive behaviour where co-management is implemented elicited through survey or observational qualitative studies (Bouma and Ansink, 2013; D’Exelle et al., 2012). Yet, the experiment provide evidence that in a context where forest management is delegated to local village elites and the managers control the distribution of forest benefits across all village members, the procedures employed to appoint the committee members are important because the fairness of final distribution of those benefits is often determined by choices of the village members selected for the coordination of the resource use. Our findings suggest that a mechanism which does not favour anyone because of merit, effort or other characteristics beyond individual control would result in the most equal outcome. This translates into a call for more transparency in selection procedures for forest management committees and in payment mechanisms.

Chapter 6 Mapping demand and supply for forest ecosystem services to assess the impact of distributional rules on societal welfare

6.1 Introduction

Identifying the actual contribution of nature to human well-being requires an understanding of the demand for 'ecosystem services' and how this demand is connected to the potential supply of those services across space (Ala-Hulkko et al., 2019; Bagstad et al., 2013; Syrbe and Walz, 2012; Vallecillo et al., 2019). ES are the direct and indirect benefits that natural ecosystems provide to people and thereby contribute to human well-being (De Groot et al., 2002). Uncovering the links between natural ecosystems and human well-being requires both quantifying the capacity of the natural ecosystem to provide services and evaluating the ability of human populations to consume those goods and services (Chaplin-Kramer et al., 2019). The potential flow of ES depends on the structure and the ecological processes of the natural ecosystem and is characterised by spatial variation (Barò et al., 2016; Burkhard et al., 2012; Syrbe and Walz, 2012). Potential flow becomes an actual ES if there is a population that benefits from it and hold values for it (Potschin and Haines-Young, 2011).

Quantifying how much of the potential flow of ES is effectively captured and enjoyed by the population is especially relevant when analysing ES in low-income countries. Rural communities of low-income countries are strongly reliant on natural ecosystems for their basic needs such as food, energy, and water, as well as for soil nutrients, flood protection, and socio-cultural benefits. A global study which evaluated households' reliance on the natural environment in 24 different low-income countries has found that environmental income accounts for 28% of total household income, and 77% of this comes from forest products and services (Angelsen et al., 2014). Moreover, the relative proportion of environmental income is higher for the relatively poorest households, highlighting a possible role for ES in alleviating poverty (Angelsen et al., 2014; Fisher et al., 2014; Guerry et al., 2015).

This role motivates why it is important to understand whether different social groups benefit differently from ES and what are the institutional mechanisms that determine which group can benefit (Daw et al., 2015, 2011; Ryan et al., 2016). The individual's ability to capture the potential ES flow depends on the spatial connection between the supply and demand area and the institutional mechanisms implemented for ES governance (Fisher et al., 2014; Syrbe and Grunewald, 2017).

In low-income countries, CBM is a widespread institutional mechanism for managing natural resources such as forest and fisheries (Agrawal et al., 2008; Sunderlin et al., 2008). In CBM, local users are involved in the management of the natural resource with the aim to improve ecological outcomes and to facilitate access to all local users (Agrawal, 2001). The hypothesis underlying CBM is that local communities have the incentives and the knowledge to manage sustainably the natural ecosystem and develop management objectives according to all users' needs (Bowler et al., 2012; Ostrom et al., 1999).

However, experience across different countries has shown that CBM has improved ecological sustainability and reduced unsustainable harvesting, but its effectiveness in terms of achieving an equitable distribution of benefits and improved livelihoods is unclear (Chomba et al., 2015; Lund and Treue, 2008; Persha and Andersson, 2014). An analysis of the relationship between forest conservation and livelihoods outcomes across 84 case studies in low-income countries has shown that the probability of joint positive outcomes depends on the degree of participation of all local forest users (Persha et al., 2011). The lack of active participation of forest users can limit the development of equitable rules and the inclusion of interests of the marginalized groups and exacerbate existing inequalities through elite capture (Adhikari et al., 2014; Chomba et al., 2015; Yadav et al., 2015). Local elites and other powerful local actors with power and control over forest resources can constrain the benefit distribution and generate negative social outcomes. As such, CBM may generate trade-offs in the well-being of different social groups, which may in turn reinforce or negatively compromise ES governance (Dawson et al., 2017).

The integration of environmental justice within ES assessments has been proposed as an approach to recognise and evaluate distributional patterns arising from ES governance (Howe et al., 2014; Sikor et al., 2014). Distributive issues are one of multiple environmental justice concerns, with the other dimensions focusing on procedural justice, i.e. the political processes used to define distributional outcomes, and recognition of all stakeholders and their values (Martin et al., 2014; Schlosberg, 2013; Sikor et al., 2014). Despite an increasing emphasis on integrating environmental justice concerns within ES assessments, few studies have performed disaggregated analyses and evaluated distributive trade-offs among stakeholders (Chaudhary et al., 2018; Dawson et al., 2017). While Chapters 5 and 6 focused on understanding the influence of the procedural and distributive justice on choices and thus individual welfare, this chapter investigates how distributive justice can be realised within the constraints of ES supply.

This chapter provides two main key contributions to the current literature. Firstly, we implement a novel methodological approach that combine current biophysical estimates of ES supply, i.e. availability of biomass in the forest reserve, and current estimated demand, i.e. total biomass consumed by household. The novelty of the approach relies on the fact that both supply and demand are empirically estimated using data from the ground, as opposed to modelling approaches mainly used in the ES literature (Willcock et al., 2019). Moreover, we develop a modelling approach to simulate the spatial connectivity between production and consumption areas through which we can identify the actual flow and we can identify unsustainable patterns by keeping in account spatial heterogeneity.

Second, for the first time we employ a DCE to perform a welfare analysis of a policy change that take in account the effects of distributional rules across group of stakeholders embedded in forest management. We used the results of the current situation analysis together with the DCE results from chapter 4 to show how the DCE can become an operative tool able to support decision-making processes when distributional rules and fairness are deemed as relevant.

6.2 Methodological approach

In this chapter, we assess the welfare trade-offs between social groups that may arise from alternative scenarios of CBM policies that determine the distribution of provisioning ES. First, we quantify the actual flow of provisioning ES, i.e. woody biomass used for different purposes, by using a supply and demand approach that considers spatial variability and possible spatial mismatches between supply and demand. Next, we assess the contribution of the ES flow to the population's welfare by estimating and monetising individual's preferences for provisioning ES because of a shift in governance from centralised to CBM. Finally, we evaluate how total welfare changes across different distributional scenarios.

The first step of our analysis is mapping and quantifying woody biomass supplied by forest ecosystems to assess the potential flow of ES. The development of approaches for mapping and quantifying ES in semi-arid systems, such as African woodlands, is still in its infancy compared to the more frequently analysed tropical and temperate areas (Egoh et al., 2012; Wangai et al., 2016; Willemen et al., 2018). Most of the studies on mapping ES have assessed the provision of regulating services such as carbon storage (Batjes, 2008; Egoh et al., 2011; Leh et al., 2013), water flow regulation (Egoh et al., 2008), soil accumulation and retention (Egoh et al., 2011; Leh et al., 2013). Mapping and quantifying woody biomass provided by forest ecosystems, when lacking primary data such as national forest inventories, relies on indicators derived from remote sensing data combined with ground observations (DeFries et al., 2007; Ryan et al., 2012). We therefore employed high resolution remote sensing images that measure changes in vegetation cover, combined with biomass estimates from ground observations to quantify total biomass supplied by the forest ecosystem under examination.

The second step of our analysis is quantifying and mapping current human demand for biomass to identify the actual flow of ES that reaches people. We quantified current demand using the results of a household survey administered to the population living in the surrounding of the forest ecosystem. The forest area, which supplies the ES, and the villages area, which demand ES, are not spatially overlapping and therefore there is not a clear spatial connection between demand and supply. Therefore, we used accessibility analysis to determine the potential link between the service providing area and the reference population (Ala-Hulkko et al., 2019; Syrbe and Grunewald, 2017). Through simulating the spatial connectivity between supply and demand, we identified the actual flow of ES and we evaluated where demand could exceed ES provision. This revealed where the supply of ES would not be able to meet demand in the future and harvesting could become ecologically unsustainable.

The third step of our analysis is assessing the contribution to welfare of ES provisioning services under alternative distributive scenarios using WTP analysis. We used a DCE, an economic valuation method, to elicit individual preferences for different level of biomass supply under a CBM policy (Villamagna et al., 2013; Wolff et al., 2015). Our DCE (see Chapter 4) measured also preferences for different distribution of biomass across better-off and worse-off village members and therefore it can be used to assess total welfare impacts of different distributive scenarios and to evaluate welfare impacts for each wealth status group. By using one metric, WTP, we can assess trade-offs between social groups which arise because of different institutional arrangements that generates alternative benefit distribution scenarios.

6.3 Case study: Namizimu forest reserve

For a comprehensive overview of the role of forest resources for the livelihoods of rural communities, a description of co-management policies and of the case-study area the reader can refer to Chapter 3. In the following I report a summary of the main steps involved in developing co-management schemes.

Developing a co-management scheme requires to identify interested communities and evaluate their needs and demands, carry on an ecological assessment of the forest reserve areas to evaluate potential supply, and develop a sustainable management plan. The communities involved are located within 5 km buffer from the forest reserve and are grouped at the administrative level of group village. Each of these group of stakeholders is responsible for managing a forest reserve sub-area, known as block, which is identified based on the ecological status of the forest area and the traditional group village boundaries. Once the block area has been identified, its current ecological status is assessed, and the potential availability of forest products is estimated. Finally, a sustainable forest block management plan is developed taking in account the local users' demand for forest products and the potential supply of the forest block. The management partnership between local community and government becomes effective through a signed binding agreement between the forest department and the residents of the communities involved which are represented by a committee.

6.4 Methods and data

6.4.1 Defining the population and forest area

As discussed in Section 3.3.1, the reference population chosen for the analysis is the population of 110 villages in a 5 km buffer at the east side of Namizimu forest reserve (called east side villages henceforth) (Figure 6.1).

In absence of information about the customary boundaries of group village forest areas, we selected the forest area for all 110 villages of interest for the analysis based on the walking distance from the villages whilst accounting for accessibility (Albers and Robinson, 2013; Uchida and Nelson, 2008). The walking distance between villages and harvesting locations in the forest represents a cost for the individual who collects forest products (Schaafsma et al., 2012). The main assumption underlying our modelling approach is that the higher the distance, and so the higher the cost, the less likely is that the individual will reach the harvesting location. Using cost distance analysis tools from ArcGIS, we developed an accessibility map that assigns a foot-based travel time to each possible harvesting location (grid cell 30m x 30m) in Namizimu forest reserve considering the 110 selected villages as starting point. The travel time by foot is assumed to be 4 km/h on flat terrain and it is weighted by the slope expressed in gradients, extracted from the 30 arc-second elevation product SRTM30, following the van Wagtendonk and Benedict (1980) formula.[18] We defined the forest area of analysis (called harvesting area henceforth) by including all harvesting locations that can be reached by walking a maximum of 180 minutes, following the household survey data on walking time to collect forest products (mean=76 minutes, mode=120 minutes; 96% of the sampled households declare to walk 180 minutes or less). To account for the fact that the population of the villages located on the west side of the forest would also harvest

[18] $V = V_0 e^{-3s}$ where V is the foot-based speed over the sloping terrain, V_0 the base speed of travel over flat terrain (4 km/h in this case) and s is the slope expressed in gradient

forest products from Namizimu forest, we calculated a travel time map for both the west and the east side villages and assigned the pixels that overlay to the group of villages for which the walking time is lower. We obtained a harvesting area map for the east side villages that covers 31,752 ha of the Namizimu forest reserve.

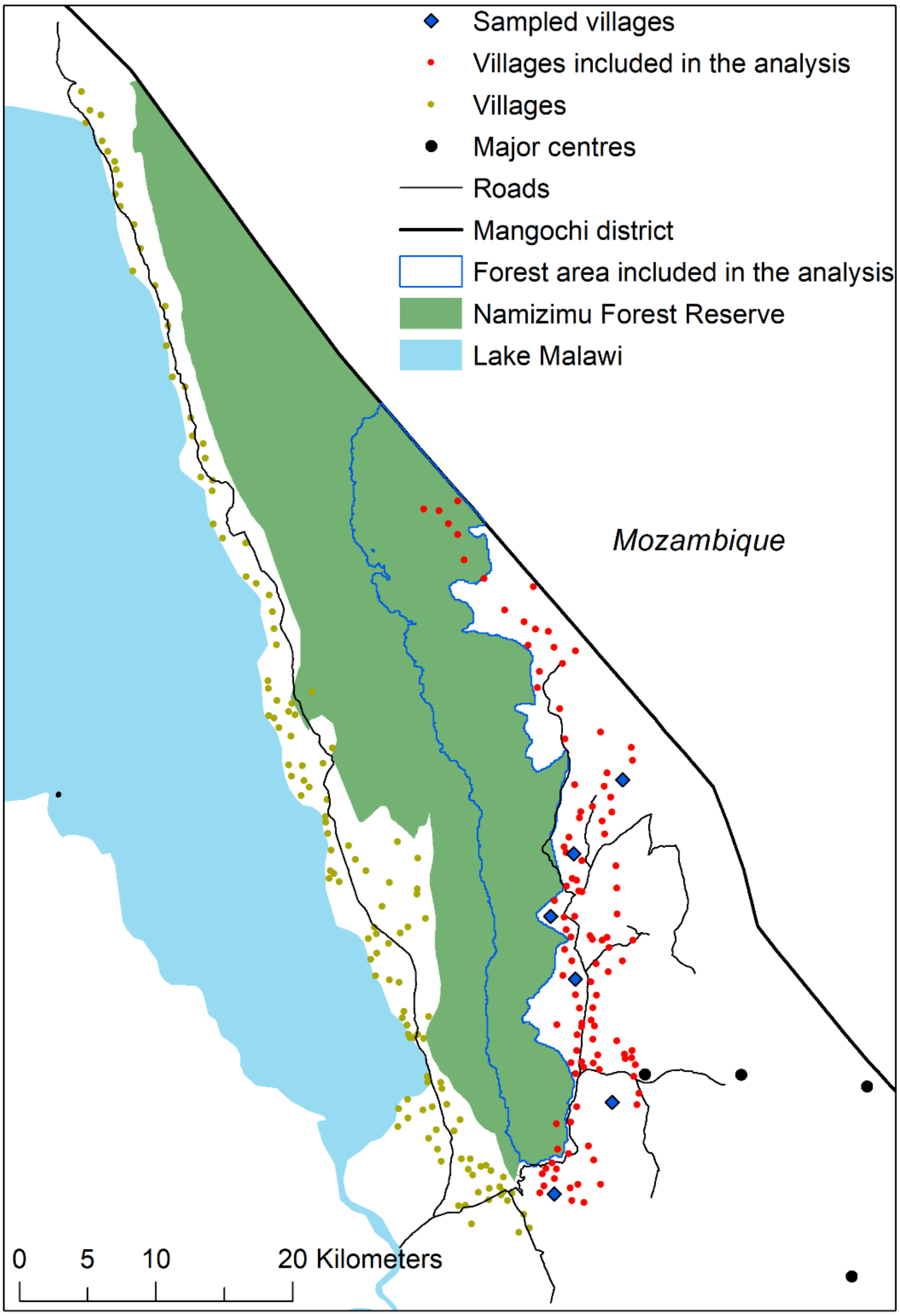

Figure 6.1 Case-study area[19]

[19] The sampled villages are randomly shifted from the original location to minimise the risk of identification and ensure anonymity of participants

6.4.2 Evaluate current forest degradation

We first assessed the current ecological condition of Namizimu forest reserve using a degradation index (Baumann et al., 2014).[20] Information on the current forest stocks and monitoring changes over time are essential for sustainable management of forest resources, but accurate ground data for such analysis are often lacking in low-income countries (Mitchell et al., 2017). In Malawi, the assessment of forest biomass stock in forest reserves is based on estimates which employ data from the two forestry inventories carried out in 1973 and in 1991 (FAO, 2010). The lack of more recent field-based assessments and periodic field measurement in permanent plots necessitates the use of satellite data for the assessment of the current forest status and for monitoring changes over time (Mitchell et al., 2017). However, changes in biomass stocks due to forest degradation occurring at small-scale are difficult to quantify accurately when relying on optical remote sensing images because of the cloudy nature of the tropics, which increases the risk of measurement errors (DeFries et al., 2007; Hirschmugl et al., 2018; Ryan et al., 2012). We therefore employed a categorical approach based on a disturbance index to provide an overall assessment of degradation patterns within the study area for the period 2013 to 2018.

The disturbance index is a spectral index calculated using a tasselled cap-based transformation (Healey et al., 2005). The approach used by Neil (2018) reduces the Landsat reflectance bands to three distinct tasselled components (Brightness, Wetness and Greenness) and evaluates how much these components differ compared to a chosen threshold which is completely disturbed; the comparison is used to classify each pixel in the area as disturbed or undisturbed (Healey et al., 2005). For each year from 2013 to 2018, the area covering the Namizimu forest reserve was classified in disturbed and undisturbed pixels using Landsat-8 images at 30m resolution collected at the end of the wet season (Neil 2018). The yearly disturbance index maps were then combined over the chosen time period to obtain an overall disturbance index according to the number of years in which the pixel was disturbed (Table 6.1).

Table 6.1 Disturbance index classification

Number of years of disturbance	Disturbance category
0	Intact
1 to 2	Low disturbance
3 to 4	Medium disturbance
5 to 6	High disturbance

[20] The pre-processing and processing of remote sensing images to produce NDVI and DI index maps has been performed by Clive Neil (2018) as part of his masters' dissertation. I collected the output in the form of maps and performed the analysis presented in this chapter myself.

We employed the overall disturbance index to evaluate (a) spatial patterns of degradation in the harvesting area and (b) whether patterns of degradation were associated with human presence by performing proximity analysis.

6.4.3 Quantifying current biomass supply and demand

Current supply

We quantified the current biomass stock in the Namizimu forest reserve using a combination of remote sensing data and forest biomass measurements performed on the ground. We thereby produced a map of biomass supply expressed in tonnes, i.e. 1000 kg of dry biomass, at 30m resolution for the whole Namizimu forest reserve area.

The field inventory data were extracted from a forest biomass survey conducted in Malawi in 2011 by FRIM. The biomass survey was part of the Forest Preservation Programme funded by the government of Japan which aimed to develop a monitoring, reporting and verification (MRV) system for the reduction of carbon emission in the forestry sector. The survey covered 17 priority forest reserves across the three regions of Malawi which were selected by the Department of Forestry as pilot sites for the implementation of REDD+ programmes. For the Namizimu forest reserve, 53 sample plots were randomly selected through overlaying grid points at a 4 km interval on the whole forest area. Each grid point was associated with GPS coordinates which were used to determine the centre of a circular plot of a size of 0.1 ha. For each plot, all trees with diameter at breast height (DBH) greater than or equal to 20 cm were included in the dataset, the trees species names were recorded and the DBH, tree height (HT), clear length and crown diameter were measured.

The above-ground dry biomass (AGB) of each sampled tree in the plots was estimated using the allometric biomass model (eq. 18) developed for miombo woodlands in Malawi (Kachamba et al., 2016). The carbon content is assumed to be 47% of the dry biomass (Kachamba et al., 2016).

$$AGB = 0.103685 * DBH^{1.921719} * HT^{0.844561} \quad (19)$$

The total AGB value for each plot was calculated by summing up the AGB estimates for each tree in the plot.

Next, we estimated a regression model of the relationship between AGB estimates for each plot with the Normalized Difference Vegetation Index (NDVI), so that we could apply the estimated regression model to the study area and interpolate the biomass value stock across the Namizimu area to produce a map of total biomass supply. To do so, we used a map of NDVI at 30m resolution processed by Neil (2018) who used Landsat-8 images collected at the end of the wet season for 2013. The year 2013 was chosen because the images were cloud-free over the Namizimu area, and therefore less prone to measurement error. The NDVI is a spectral vegetation index which is derived from remote sensing images by combining algebraically the values of the spectral reflectance in the red and in the near infrared (Beck et al., 2011). The NDVI index ranges between 0 and 1 where a very low value corresponds to bare areas while high values indicates a high prevalence of vegetation. The spectral index is found to be associated to biophysical variables such as Leaf Area Index, biomass, and productivity (Beck et al., 2011; Gizachew et al., 2016).

To link the AGB data with the NDVI data, we first had to spatialize the AGB estimates. We did this by creating a circular buffer centred on the UTM coordinates of each field plot, using the plot radius reported in the field measurement dataset. We then overlaid the AGB map with the NDVI map and calculated the average NDVI value for each plot to be used as independent variable in the regression model. We masked the NDVI map using the FAO dominant landscape map at 30 arc-second resolution (Latham et al., 2014) and selected the area classified as forest; this allowed us to exclude areas which are included within the reserve boundaries but that have been deforested (e.g. tea plantations areas). We explored the relationship between AGB and NDVI statistically through calculating the Spearman's rank correlation coefficient (ρ) and visually by analysing the scatter plot of AGB against NDVI. The scatter plot (see Appendix E.1) suggested a linear relationship, so we estimated a linear regression model and used the Bonferroni outlier test (together with visual analysis of the scatter plot) to detect and exclude outliers (Fox, 2016). We then interpolated the biomass estimates across the whole Namizimu forest area using the estimated regression model and assigned value zero to each pixel that had a negative biomass value.

Current demand

To estimate the current demand for dry biomass by the 110 villages of interest, we used the data obtained through a household survey administered in six villages selected from the 110 villages located in the east side of the forest reserve (see Chapter 3 – Section 3.3.2).[21] The six villages were selected using a random spatial sampling strategy and the households to be interviewed within each village were selected using a stratified random sampling strategy based on gender, age and wealth status (see Chapter 4 - Section 4.3.2).

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[21] We assume that people from Mozambique do not cross the boundary to collect forest products as confirmed by key informant interviews and focus groups in the selected villages.

We quantified the woody biomass extracted by households based on the sample median yearly consumption of four different forest products: firewood, poles, timber, and charcoal. The quantities extracted for each product were recorded using customary measurement units, e.g. headloads for firewood. These were translated into dry biomass expressed in tonnes using conversion factors adopted by FRIM, available in the literature (Marge, 2009) or information provided in the original survey. The data collected through household surveys suffer from some limitations which are common in data collection on natural resource uses (Schaafsma et al., 2012). The data were collected within a 3-week period and required respondents to recall how much forest products they collected over a certain time period which may be inaccurate. Moreover, collecting forest products from Namizimu forest reserve is illegal if not licensed by the forest department, but some harvesting is done without a license and therefore classified as illegal. Even though we put great care in guaranteeing anonymity to our respondents and obtained information on illegal harvesting from some respondents, it is likely that our data are characterised by underreporting especially for poles and timber collection.

6.4.4 Scenario analysis

Unit of analysis: village clusters and co-management blocks

To perform our scenario analysis, we simulated a hypothetical co-management scheme where single villages are grouped together and are allocated a sub-area of the forest reserve for harvesting activities. When co-management policies are implemented, the demarcation of the co-management blocks is negotiated on a case-by-case basis depending on the ecological assessment of the area, the needs of the adjacent communities and the traditional group village boundaries. In Namizimu forest reserve, co-management is not implemented yet and we lack information on both the ecological status, because there is no updated national forest inventory, and the administrative information about how villages are organised into group villages. Therefore, we used a priori rules to define which villages are grouped together in one co-management group using Euclidean distance, and the harvesting area for each group based on walking distance weighted by accessibility.

We defined the group of villages using a clustering algorithm which aims to minimise the distance between village points within the group and maximise the distance between village points across the different groups. The underlying assumption is that villages which are closer to each other are all close to the same forest sub-area and are also more likely to have aligned interests regarding management objectives. We used the Partitioning Around Medoids (PAM) clustering method which, given the chosen number of clusters (k), finds the optimal partition of the objects contained in the dataset in *k* clusters (Kaufman et al., 1987). We chose the number of *k* clusters assuming that each forest management block would be allocated to a group of 5 villages, following interviews with experts from the forest department; this means that the 110 villages had to be clustered into 22 groups.

Next, we defined the harvesting area for each cluster of villages using the same walking distance approach employed for defining the overall forest area to be used for the analysis. We produced an accessibility map that assigns a foot-based travel time to each possible harvesting location for each village. Then, we produced a single travel time map for each cluster by taking the average values of the travel maps relative to the villages within the cluster. We defined the cluster harvesting area by including all harvesting locations that can be reached within 180 minutes. Finally, we assigned each harvesting location exclusively to one cluster by assigning it either to the cluster that can reach the location or, when the harvesting location falls into two or more cluster harvesting areas, to the cluster that can reach it in the lowest walking time.

The distance-based processing generated 22 clusters of villages which include five villages on average (SD 2). Six clusters were not allocated a forest harvesting area because their entire harvesting area always overlaid another cluster's area with a lower cost distance, i.e. the other village cluster was closest to the forest area. These six clusters (28 villages) were excluded from further analysis of the hypothetical co-management policy scenarios. The average distance from the forest edge of the excluded villages was 3,568 m, compared to 1,437 m for the remaining villages. Given the importance of accessibility for harvesting (Albers and Robinson, 2013), excluding the six furthest clusters seems reasonable. The algorithm employed for the clustering exercise (PAM) is usually sub-optimal and the clusters produced by it may vary depending on which are the chosen *k* starting points from the dataset (Fowler et al., 1981). Therefore, to evaluate the sensitivity of our modelling approach we ran the algorithm several times specifying a different random set of *k* starting points and verified that the algorithm produces a stable set of clusters, i.e. either the same exact clusters or with very minimal differences (just one village gets allocated to a different cluster). The GIS processing was done using ArcGIS (Version 10.6.1).

Business as usual scenario

We developed a business-as-usual scenario to evaluate the future ecological sustainability of current management practices and consumption patterns by comparing biomass supplied and biomass demanded for each co-management block. The base year is 2015 and we analysed the scenario over a horizon of 15 years, until 2030, with yearly steps assuming an annual population increase.

We calculated the biomass supplied by each block for each year by adding to the current estimated biomass the mean annual increment per ha estimated by Green et al. (2016) for Malawi miombo woodlands and by subtracting the estimated current consumption scaled up for the total population of the east side villages. To scale up the biomass demand estimates to the total population, we estimated the proportion of people collecting each forest product using our households' survey data and assumed that this sample proportion is the same across all villages. We estimated the total population of each cluster using the gridded population map of Malawi for 2015 version 2.0 produced by WorldPop (Tatem, 2017) at a 100m resolution, which reports the total number of people for each pixel. We used the modelled gridded population because it is more representative of the spatial distribution of the population across the area compared to the administrative unit counts. We used the Thiessen polygon tool in ArcGIS, from the proximity toolset, to partition the population map in unique polygons with one village point at its centre. The population of each cluster was calculated as the sum of the population within all villages' polygons of the cluster. We also calculated the population for each cluster by partitioning the population map using a circular buffer around each village point, but this provided estimates which were less close to the 2008 Malawi population and housing census than the polygon-based approach. We calculated the number of households assuming a mean household size of four members following our household survey data. Finally, we estimated the population for each year using the UN world population average exponential rate of growth for Malawi estimated over a period of 5 years of 2.66% (medium fertility variant, UN DESA, 2019).

Co-management scenario

We developed a co-management scenario to evaluate welfare impacts of the co-management policies for the rural population surrounding the forest reserve. Under co-management the quantity of biomass that can be extracted from each block would be limited to the ecologically sustainable amount, i.e. such that the productive capacity of the forest is maintained (Luckert and Williamson, 2005). To simulate a sustainable management plan, we assumed that the annual sustainable harvest rate for each block is equal to 80% of the AGB growth (Otuoma et al., 2011). The AGB growth is approximated by the mean annual increment per ha modelled by Green et al. (2016) who found that on average Miombo woodlands in Malawi provide a yearly biomass supply of 1.639 t/ha. We calculated the total quantity of biomass that can be extracted under a sustainable management regime by multiplying each block area by the modelled mean annual increment.

Then, we developed a set of distributional rules to allocate the sustainable biomass amount available for each cluster to its population. We converted the total biomass supply expressed in tonnes in number of trees using an average quantity of biomass per tree calculated from our field inventory dataset. We analysed 15 different distributional scenarios where the available biomass is distributed in different proportions among better-off ("rich") and worse-off ("poor) village members in each cluster (Table 6.2). We calculated the total number of rich and poor households using the proportion of people that define themselves as relatively rich and relatively poor in our household sample (31% and 69% respectively).

Table 6.2 Distribution rule for scenarios

	Rich	**Poor**
	Trees/household	**Trees/household**
A1	11-15	0-15
A2	6-10	0-10
A3	1-5	0-5
A4	0-15	11-15
A5	0-10	6-10
A6	0-5	1-5
	% of total trees	**% of total trees**
B1	50%	50%
B2	10%	90%
B3	20%	80%
B4	30%	70%
B5	40%	60%
B6	60%	40%
B7	70%	30%
B8	80%	20%
B9	90%	10%

In the A scenarios, one of the wealth status categories is prioritised over the other, and a high (A1 and A3), medium (A2 and A4) or low (A3 and A6) level of harvesting is guaranteed for each member of such category, if there is enough biomass supplied by the forest block, then the remaining biomass available is distributed to village members of the other wealth status category. In the B scenarios, we chose to redistribute the total number of trees available in each cluster according to a pre-determined proportion: equal to both groups (B1) or in favour of one of the two wealth status categories. The maximum number of trees available for each household under all scenarios is capped to 15 per year. To take in account variability in forest users' needs we applied our distributional scenarios considering that total biomass is distributed to: (1) the total population, (2) the proportion of people who stated to be interested in harvesting forest products in our sample (97%), (3) the proportion of people interested in harvesting poles and timber (55%) and (4) the proportion of people interested in harvesting timber (21%) (see Appendix E.2).

Next, we assessed the welfare impact of co-management policies by using WTP estimates from our DCE survey (see Chapter 4). Our DCE survey assessed the contribution to individual welfare of different levels of biomass provision under a co-management policy and of the distributional rules used to allocate the biomass to other village members identified based on a wealth status category, i.e. rich and poor village members.

As described in Chapter 4, in our DCE respondents were asked to choose among co-management options described as a hypothetical distribution of biomass, identified by the number of trees, among the respondent, a village member poorer than them and a village member richer than them. Formally, the individual is assumed to maximise their utility function, i.e. an additive function including all the different characteristics of the co-management policies on offer:

$$V_{njt} = ASC_j + \beta_{ts}T_s + \beta_w W + \beta_{tp}T_p + \beta_{tr}T_r + \beta_p Price \tag{20}$$

The marginal WTP for each of the DCE attributes (MWTP) provides a monetary measure of individual's welfare gain (or loss) for a one unit increase of biomass, here described using trees as a proxy. The MWTP associated with allocating one additional tree to a village member poorer than the respondent is calculated as the ratio of the biomass (trees for self) attribute coefficient and the price attribute coefficient:

$$MWTP_{tp} = -\beta_{tp}/\beta_p \tag{21}$$

We used the estimated MWTP relative to the biomass attributes to calculate the monetary welfare changes associated with the different distributional scenarios. Water availability is assumed to be constant across the scenarios, primarily because a suitable hydrological model coupled with forest cover was unavailable for the type of biome of the Namizimu forest.

The individual WTP values for a poor and a rich village member for cluster 1 are calculated as:

$$\mathrm{MWTP}_{\mathrm{P\_1}} = \mathrm{MWTP}_{\mathrm{self}} * \mathrm{Trees}_{\mathrm{poor\_1}} + \mathrm{MWTP}_{\mathrm{tp}} * \mathrm{Trees}_{\mathrm{poor\_1}} + \mathrm{MWTP}_{\mathrm{tr}} * \mathrm{Trees}_{\mathrm{rich\_1}} \tag{22}$$

$$\mathrm{MWTP}_{R\_1} = \mathrm{MWTP}_{\mathrm{self}} * \mathrm{Trees}_{\mathrm{rich\_1}} + \mathrm{MWTP}_{\mathrm{tp}} * \mathrm{Trees}_{\mathrm{poor\_1}} + \mathrm{MWTP}_{\mathrm{tr}} * \mathrm{Trees}_{\mathrm{rich\_1}} \tag{23}$$

where $\mathrm{Trees}_{\mathrm{rich\_1}}$ and $\mathrm{Trees}_{\mathrm{poor\_1}}$ are the number of trees allocated to rich and poor village members in cluster 1 following the rules of the distributional scenarios. $\mathrm{MWTP}_{\mathrm{self}}$ does not differ between rich and poor respondents.

According to the utilitarian framework, the societal welfare value, i.e. the welfare effects of a policy change for the whole population, is obtained as the sum of the individual WTP. The total WTP aggregated over the population for cluster 1 is calculated as:

$$WTP_{TOT\_1} = \mathrm{MWTP}_{\mathrm{P\_1}} * Pop_{\mathrm{poor\_1}} + \mathrm{MWTP}_{R\_1} * Pop_{\mathrm{rich\_1}} \tag{24}$$

We used total WTP estimates to evaluate which distributional scenarios maximises total societal welfare, the societal welfare of the poor and of the rich population, both for each cluster and for the total forest area, calculated as the sum of the total WTP of all clusters.

6.5 Results

6.5.1 Forest degradation in Namizimu forest reserve

Figure 6.2 shows the aggregated disturbance index map for the period 2013-2018 which approximates the intensity of disturbance in the reference area used for the analysis.

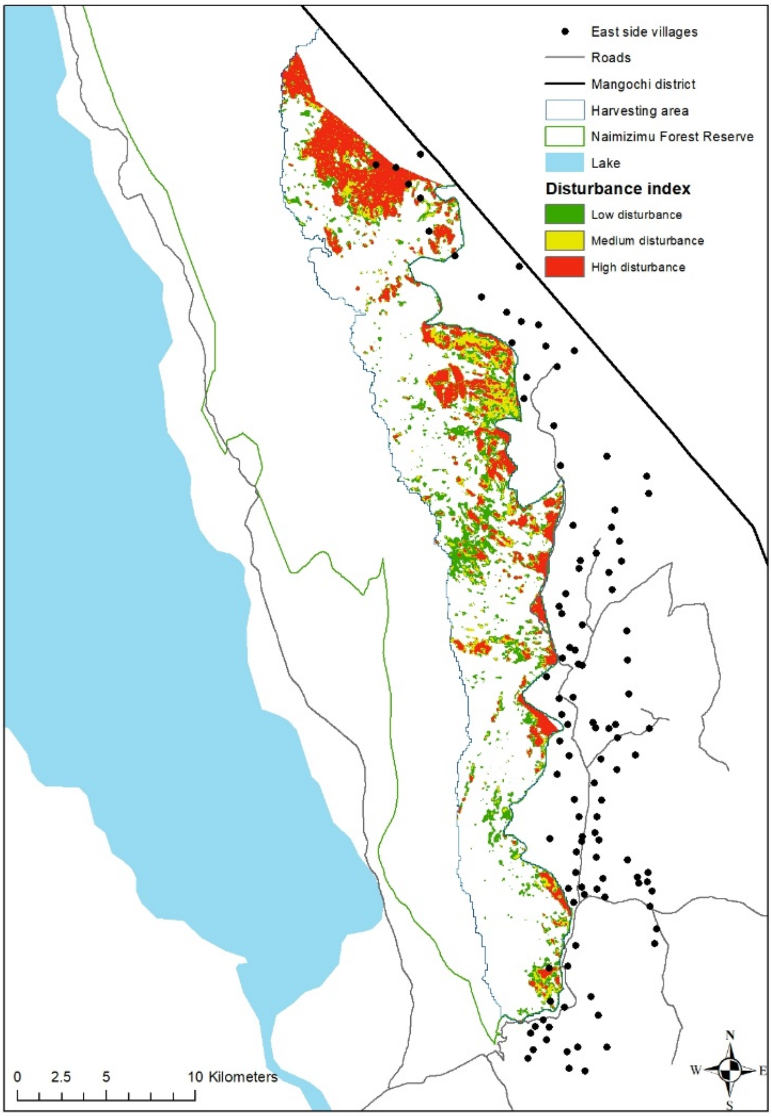

Figure 6.2 Degradation index[22]

[22] The area within the forest boundary that is not coloured corresponds to pixels that have not been classified as disturbed and so can be considered as intact forest.

The pixels classified as highly disturbed are 48% of the total number of disturbed pixels, while the low and medium disturbed ones are respectively 32% and 20%. The average distance from low and medium disturbed pixels to the east side villages is about 3.5 km, while the average value for high disturbed pixels is 2.6 km indicating that areas closest to human population are more likely to be highly degraded. The average biomass per hectare of the highly disturbed areas is 38 tonnes, while the average biomass for the entire harvesting area is 59 tonnes. This shows that the pattern of forest disturbance shown by the index captures a decline in biomass available in the area according to the biomass data that we estimated (see Section 6.5.2), confirming that degradation occurs and that the stock of biomass available declined over time especially in areas closest to human settlements.

6.5.2 Quantify current biomass supply and demand

Current supply

We excluded 4 plots from the forest inventory sample because there were no data recorded and we further excluded 2 other plots because they were identified as outliers using the Bonferroni outlier test. The dataset used for the regression analysis hence included the total AGB estimated for 47 plots of 0.1 ha; for each plot there are on average 9 trees (SD 5 trees) and the mean estimated AGB is 6.49 tonnes of dry biomass (SD 4.03; mean biomass per hectare 62 tonnes).

Table 6.3 shows the regression model estimates used to interpolate biomass values across the whole Namizimu forest reserve. The linear relationship between estimated AGB and NDVI is positive and statistically significant. We used this model to produce a biomass supply map for the year 2013 (Figure 6.3). Following Gizachew et al. (2016) we evaluated model performance using the root mean square error (RMSE) expressed as the percentage of the mean AGB estimated from the field inventory and the absolute bias. The RMSE% is 53% and the absolute bias is 0.0001 t/ha suggesting that the model's accuracy is comparable with previous work that used a similar approach (Gizachew et al., 2016).

Table 6.3 OLS regression results: total biomass expressed in tonnes relative to 0.1 ha plots

Intercept	-7.1	**
	(3.523)	
NDVI	19.5	***
	(5.0)	
Observations	47	
Adjusted R2	0.26	
Spearman's rank correlation coefficient (ρ)	0.53	***

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses.

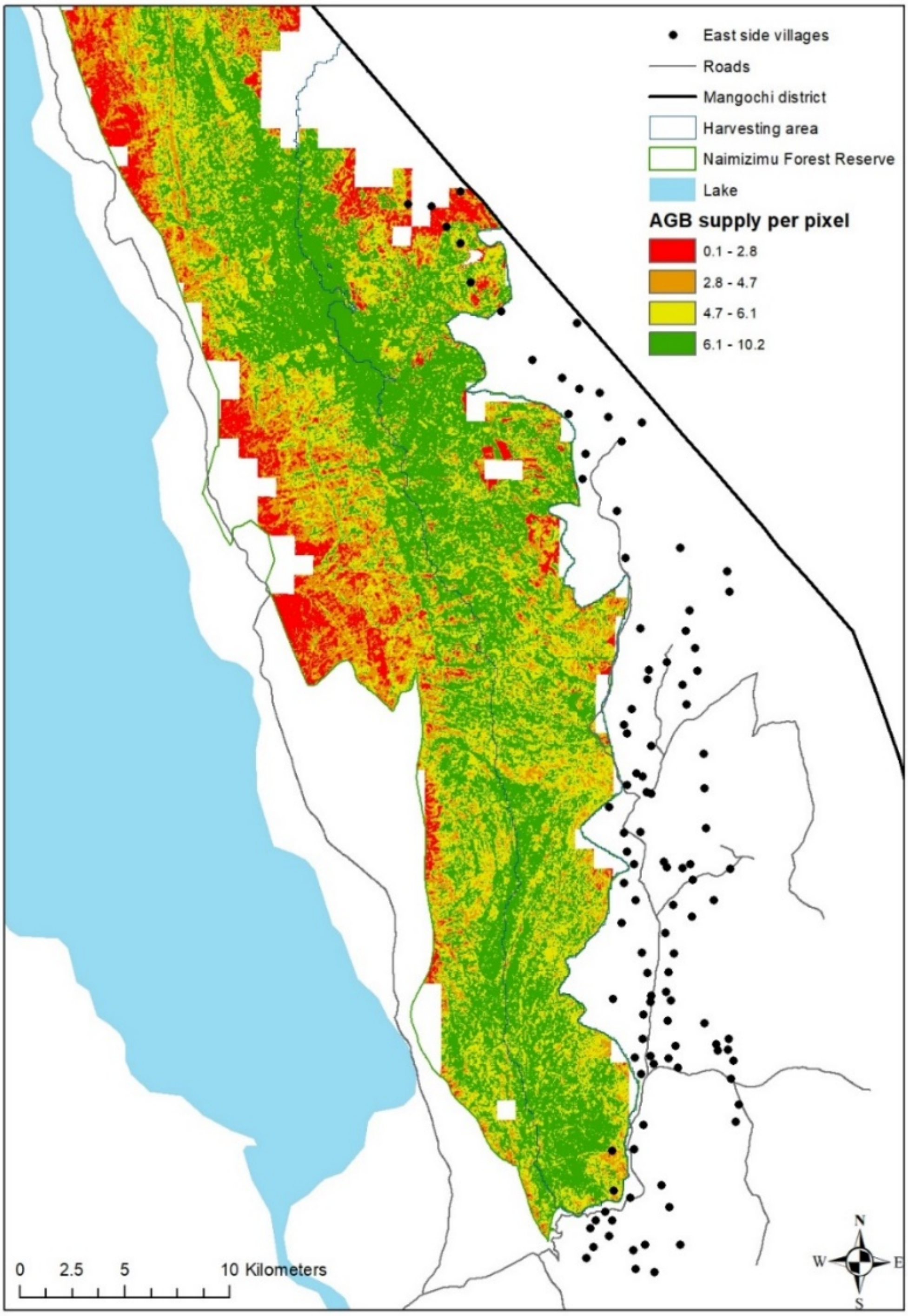

Figure 6.3 Biomass supply[23]

Current demand

Table 6.4 presents the estimated median quantities harvested per household per year, along with the relative frequency of households harvesting trees for those products disaggregated at village

[23] The map presents the AGB estimated for each pixel of 30m x 30m size (0.09 ha) and therefore the order of magnitude of the estimates differs from the standard measure of biomass expressed in t/ha.

level. We interviewed a total of 288 households across 6 villages which vary in their distance to forest and distance to major centres (Table 6.4). In terms of socio-economic characteristics our sample of respondents is representative of the district population (see Section 4.4.1). Overall, about three out of every four households collect firewood from Namizimu forest reserve while 13% of our respondents collect poles. Trees harvesting for timber and charcoal production is done by 1% and 5% of our sampled households, respectively. The number of people collecting the various forest products does not differ significantly across the villages (P-value > 0.10 for each forest product, Fisher’s exact test), therefore we can consider our estimated demand representative of the whole sub-population located in the east side of the forest reserve. The estimated median quantity of dry biomass extracted for firewood is 4.8 tonnes a year which is very similar to the estimated annual consumption of firewood (4.6 tonnes) for communities living in the surrounding of Chimaliro and Liwonde forest reserve (Jumbe & Angelsen, 2011 Energy economics).

Table 6.4 Descriptive statistics of current biomass demand disaggregated by village and product

	Median yearly quantity (t)	**Relative (absolute) frequency of households harvesting trees**						
		All villages	**Village 5**	**Village 1**	**Village 2**	**Village 6**	**Village 4**	**Village 3**
Firewood	4.8	76%	70%	85%	63%	80%	83%	70%
		(218)	(38)	(45)	(22)	(43)	(35)	(35)
Poles	4.4	13%	11%	23%	6%	9%	10%	16%
		(37)	(6)	(12)	(2)	(5)	(4)	(8)
Timber	6.3	1%	0%	0%	6%	0%	2%	2%
		(4)	(0)	(0)	(2)	(0)	(1)	(1)
Charcoal	8	5%	9%	4%	3%	4%	5%	4%
		(14)	(5)	(2)	(1)	(2)	(2)	(2)
Total	23.5	(288)	(54)	(53)	(35)	(54)	(42)	(50)
Distance from forest (m.)			1,083	223	293	3,085	379	3,669
Distance from major centres (m.)			4,496	14,894	11,373	6,777	8,079	17,825

Notes: Number in parentheses is the number of respondents in each category.

6.5.3 Scenario analysis

Business as usual scenario

The average size of the co-management blocks is 1,984 ha but it varies greatly across clusters (SD 1,821 ha – Table 6.5). As discussed above the definition of co-management areas is negotiated on a case by case basis according to multiple criteria therefore there are no standards against which we can compare our simulated co-management blocks. However, actual co-management policies implemented in Liwonde forest reserve located in southern Malawi (area of 26,991 ha) shows that there is great variability in block forest size ranging from 357 Ha to 2721 Ha. The total above-ground biomass supplied by each co-management block expressed in t/ha ranges between 31.15 and 69.47. The range translated in carbon content (14.64-32.65 tC/ha) is in line with the range of 13-30 tC/ha estimated by Shirima et al. (2011) for a Miombo area in Tanzania and the average of 21.2 tC/ha estimated by Ryan et al. (2011) for a Miombo area in Mozambique.

Table 6.5 Current situation in the base year (2015) for each cluster

Cluster n.	Number of villages	Co-management block size (ha)	Population (HH)	Biomass (t/ha)	Number of trees/HH
1	3	3,070	148	66.70	56
2	4	6,957	895	31.15	21
3	5	2,738	1,028	63.80	7
4	3	1,804	193	68.33	25
5	4	120	434	59.07	1
6	7	511	1,165	68.38	1
8	7	1,003	1,563	65.65	2
9	9	1,430	1,114	69.47	3
10	8	1,093	1,840	58.57	2
14	3	4,381	599	61.29	20
15	2	1,506	789	57.35	5
16	3	93	1,135	45.32	0
17	9	420	2,394	52.80	0
18	3	3,613	362	61.83	27
20	7	1,042	706	62.23	4
21	5	1,969	738	59.79	7
Total	**82**	**31,752**	**15,102**	**59.48**	
Excluded clusters	**28**		**5,964**		

The number of households (HH) assigned to each co-management block is also characterised by great variability ranging from 148 households in cluster n. 1 to 2,394 households in cluster n. 17. Such spatial variability determines a different initial distribution of forest resources to each household depending on the size and the ecological status of each co-management block. The last column reports the absolute number of trees that can be sustainably harvested by each household according to their co-management block size and shows that there are great inequalities across co-management blocks in the amount of biomass that can be extracted. Specifically, cluster n. 1, 2, 4, 14 and 18 can potentially extract a high quantity of biomass and would certainly be able to satisfy firewood demand for each household, which corresponds to an average quantity of 10 trees according to our households' descriptive statistics. The households assigned to the clusters n. 5, 6, 16 and 17 are instead in great disadvantage given the small size of their co-management block. The remaining clusters are also characterised by a low number of trees that could be harvested sustainably by each household implying that not everyone would be able to obtain the current demanded quantities

The analysis of changes over time (see Figure 6.4) shows that the current consumption patterns are unsustainable and that the forest harvesting area would be highly degraded by 2030. The average amount of biomass provided per ha in 2015 is 59.48 t/ha while by 2030 would be about 31.40 t/ha, assuming that all households continue harvesting and, when their co-management block is completely degraded, either harvest from a different co-management block or start trading with other areas. Figure 6.4 shows the average quantity of biomass supplied per ha by each co-management block for the years 2015, 2020, 2025 and 2030. The white co-management blocks do not provide above ground tree biomass, i.e. the area is degraded and deforested. It further shows that the co-management blocks located in the south area are more prone to degradation due to the higher population density and a lower availability of forest ha per person. In the areas located in the north part instead the biomass supply is stable over time; due to a lower population density the biomass supply and demand budget is positive, and forest can potentially re-generate.

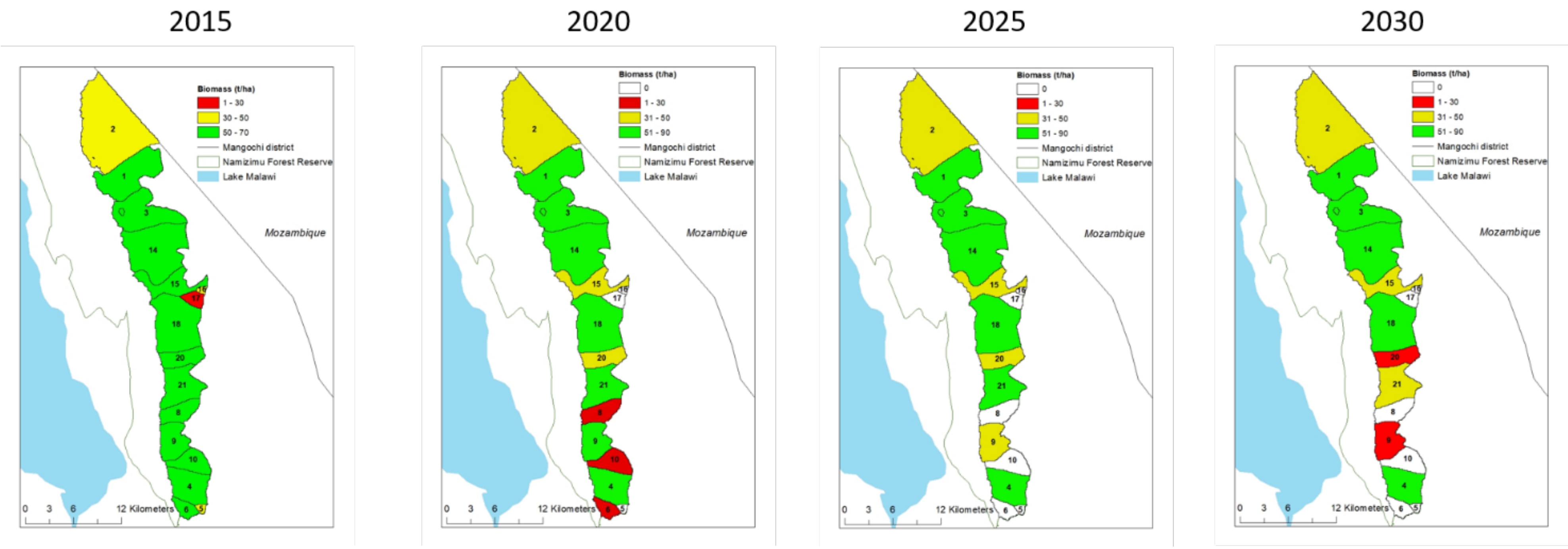

Figure 6.4 Scenario analysis (BAU)Co-management scenario

In Table 6.6 we present the average distribution of trees between rich and poor households for each scenario, the total WTP for the whole forest area in US$ and the total benefit gained for each tonne of carbon stored in above-ground biomass.[24]

Table 6.6 Average distribution of trees and total WTP estimates across distributional scenarios

Scenarios	Trees/HH (poor)	Trees/HH (rich)	Total WTP	Total WTP (poor)	Total WTP (rich)	Carbon (tC)
	Rich gets more					
A1	2.66	6.09	354,455 (-19,701 – 711,552)	200,568 (-19,829 – 406,124)	153,887 (128 – 305,428)	13,769
A2	2.39	4.35	282,620 (-15,923 – 570,353)	169,818 (-14,556 – 344,976)	112,801 (-1,367 – 225,376)	11,079
A3	2.04	3.75	242,598 (-13,662 – 489,496)	145,477 (-12,532 – 295,497)	97,121 (-1,130 – 193,999)	9,507
B5	4.02	4.91	399,205 (-23,018 – 812,976)	264,046 (-17,498 – 538,962)	135,159 (-5,519 – 274,014)	15,895
B6	3.08	6.27	386,089 (-21,612 – 777,192)	225,502 (-20,707 – 457,406)	160,586 (-905 – 319,786)	15,069
B7	2.36	6.83	359,845 (-19,727 – 718,550)	191,035 (-21,724 – 385,401)	168,810 (1,997 – 333,149)	13,850
B8	1.62	7.24	328,468 (-17,578 – 649,901)	154,644 (-22,330 – 649,901)	173,824 (4,752 – 340,289)	12,442
B9	0.82	7.65	293,003 (-15,172 – 572,629)	114,565 (-22,881 – 572,629)	178,438 (7,709 – 346,429)	10,860
	Poor gets more					
A5	2.99	1.59	231,239 (-13866 - 478361)	177,461 (-7030 - 364594)	53,778 (-6,835 – 113,767)	9,457
A6	2.66	2.13	228,459 (-13461 - 469284)	164,377 (-8333 - 336802)	64,082 (-5,128 – 1324,82)	9,232
B2	4.94	1.79	355,303 (-21,585 – 738,923)	285,558 (-9,170 – 587,749)	69,745 (-12,415 – 151,174)	14,662
B3	4.63	3.36	386,850 (-22,900 – 796,131)	283,251 (-13488 - 580806)	103,599 (-9412 - 215325)	15,682
B4	4.33	4.23	395,991 (-23,106 – 810,251)	274,501 (-15,763 – 561,516)	121,490 (-7,342 – 248,734)	15,895
	Equal share					
A4	2.18	2.18	201,186 (-11,725 – 411,459)	138,819 (-8,090 – 283,907)	62,368 (-3,635 – 127,552)	8,069
B1	4.30	4.30	396,312 (-23,097 – 810,523)	273,455 (-15,937 – 559,261)	122,857 (-7,160 – 251,262)	15,895

Notes: The highest WTP value for each population group is in red. 95% confidence intervals are in parentheses

The confidence intervals for each scenario are calculated using the lower and the upper 95% bound for the mean WTP for trees for self, poorer and richer member. The scenario that

[24] The adjusted exchange rate is 248.38 MKW = 1 US$ PPP (purchasing power parity) using the PPP conversion factor for private consumption for the year 2018 (World Bank, International Comparison Program database)

maximises total WTP for the total population is B5, where the rich village members would be allocated about 5 trees while the poor would get about 4 trees.

In the Figures 6.5-6.7 we provide a graphical representation of the trade-offs that emerges from the WTP analysis at aggregate level. Figure 6.5 shows the relationship between the relative distribution of biomass between rich and poor and their relative gains in WTP, calculated using the average individual WTP. The 45-degree orange line represents the hypothetical situation where distributional rules do not matter for the individual and for the aggregate social welfare so that a higher tree allocation to rich or poor would result in an equivalent increase in their WTP. Scenarios A4 and B1, where each household gets the same number of trees irrespective of their wealth, fall onto this line; to the left of this line are the scenarios where poor households get more trees per household, and to the right are the scenarios where rich households get more trees. The B5 scenario, which maximises total societal WTP, is not on the 45-degree line and produces a gain in total WTP of 2,893 US$ compared to B1 while the total biomass extracted is the same. However, further prioritising the rich households, i.e. moving from left to right along the x-axis, does not produce an equivalent gain in welfare for the rich group and there are diminishing marginal WTP values for the rich group as the relative allocation of trees to them increases.

Figure 6.5 Relationship between relative inequality in terms of trees and relative inequality in terms of welfare

We represent the social trade-offs in welfare determined by the distributional scenarios in the two radar charts in Figure 6.6 and Figure 6.7 which shows the value of total WTP for the whole population, the poor and the rich group. Both the A scenarios (Figure 6.6) and the B scenarios (Figure 6.7) are scaled between 0 and 1 using a minmax normalization. Each axis corresponds to a scenario and the higher is the value scored on the axis the greater is the contribution to the population's welfare of that scenario. The A scenarios are almost all suboptimal compared to the B scenarios as shown by the smaller area covered by the relative WTP shapes. Moreover, all the A-scenario WTP shapes largely overlap indicating that the A scenarios do not involve many trade-offs between total WTP, WTP of the rich and of the poor group.

In contrast, the B scenarios WTP figures cover a larger area because many B scenarios lead to relative high welfare, and the shapes relative to the three different criteria do not overlap fully, i.e. the scenarios involve trade-offs among these three criteria. The scores for total WTP and WTP for the poor group of the B3 and B4 scenarios are very close, showing that these distributional scenarios do not involve a trade-off between those two criteria. However, as shown by the green shape, the rich group WTP is penalised under such scenarios and gains very little. The three criteria shapes overlap mostly around the B1, B5 and B6 scenarios which is also where the distance between WTP of the poor and of the rich group is minimised. Finally, the lack of overlap in correspondence of the most extreme scenarios, i.e. B7, B8, B9 and B2, shows that even though those scenarios maximise the WTP of one of the two wealth status groups, they fail to maximise total WTP.

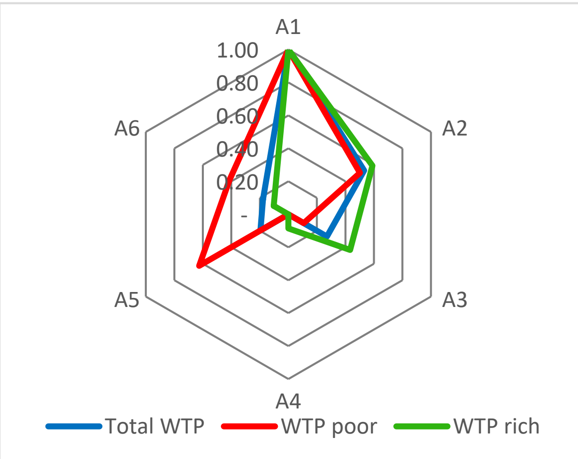

Figure 6.6 Radar chart A scenarios

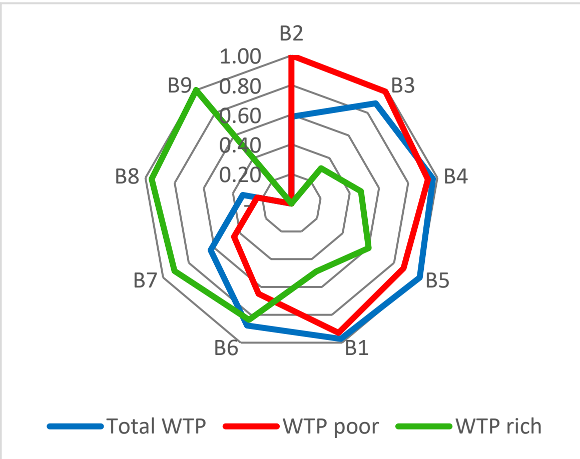

Figure 6.7 Radar chart B scenarios

To understand if the scenarios that maximise the WTP sums at the aggregated level also maximise them for each cluster, we perform a disaggregated analysis of the B scenarios (the A scenarios are sub-optimal and not further analysed). Figure 6.8 shows which distributional scenarios maximise total WTP (blue), WTP of the poor group (red) and WTP of the rich group (green) for each cluster.

For the clusters 1, 2, 4, 14, and 18, many scenarios are optimal according to these three criteria, including the scenarios that are considered optimal at aggregate level (B2 and B5), except for the B9 scenario. These clusters have a high availability of biomass with an average number of available trees per person of at least 20 trees and under many distributional rules each village member would be allowed to harvest the maximum number of trees per year (15 trees). For the remaining clusters, where biomass supply is more limited, the B9 scenario is found to maximise total WTP and WTP for the rich group in many cases, while the B2 scenario is found to be optimal for the poor group as at the aggregate level.

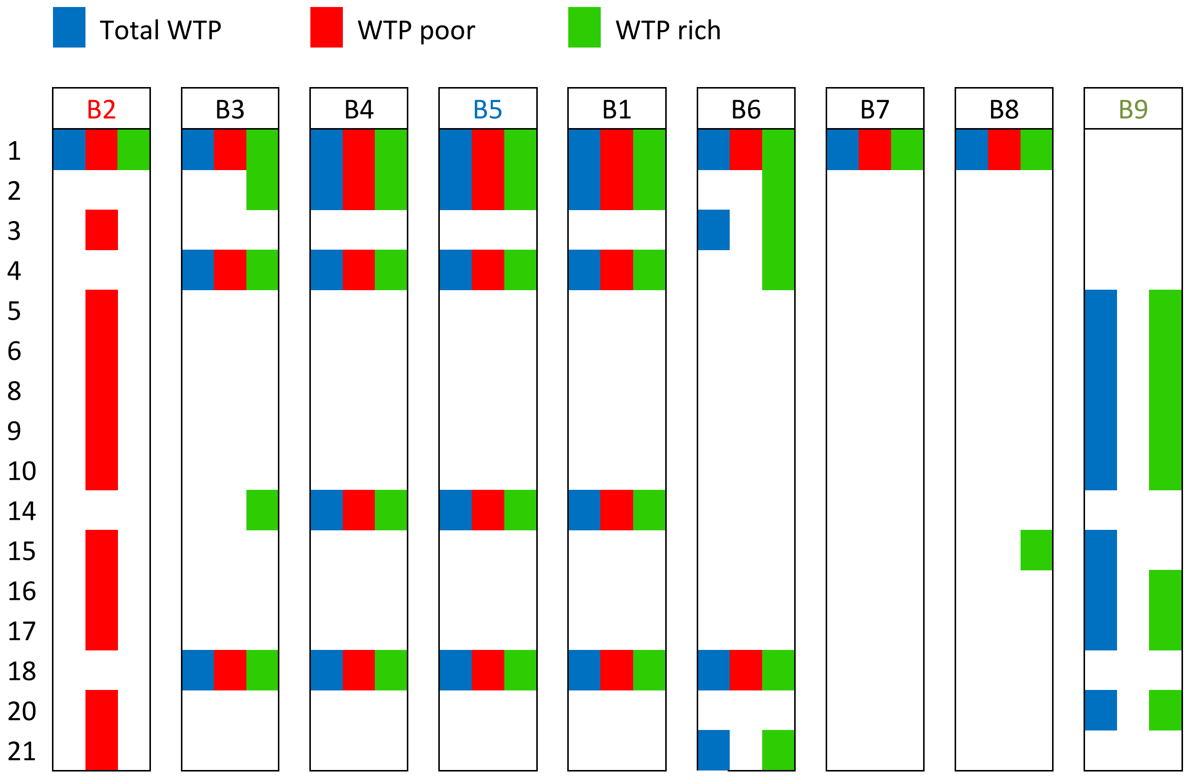

Figure 6.8 Distributional scenarios that maximise the three WTP criteria across clusters

In Appendix E.2, we provide results of the disaggregated analysis where the total biomass is distributed just to the proportion of people that stated to have interest in harvesting specific forest products as elicited in our household survey. We found that lower is the number of people among which forest products has to distributed and higher is the convergence of the three criteria toward one scenario, i.e. trade-offs are minimised. Yet, there is high variability across clusters on what are the scenarios that maximise the three WTP sums indicating that the "optimal" distributional scenario depends on the combination of many factors. Finally, we examine in more detail three clusters which differ according to biomass availability to assess what are the social welfare trade-offs involved in these three cases. Figure 6.9 shows the mean individual WTP for a poor and a rich village member and their average WTP scaled between 0 and 1 using a minmax normalization. Cluster 2 has a high initial supply of biomass (21 trees per person) while cluster 3 has a medium supply level (7 trees) and cluster 6 a low level (1 tree). When there is a high availability of biomass (cluster 2), the scenarios B4, B5 and B1 (equal share) are all optimal according the three criteria and trade-offs can be minimised. Yet, choosing a distributional rule which polarizes the distribution of biomass in favour of one of the wealth status groups will also reduce total welfare. For cluster 3 (medium) the optimal scenario in terms of total WTP is the B6 scenario where the rich group gain a higher WTP compared to the poor group but the distance

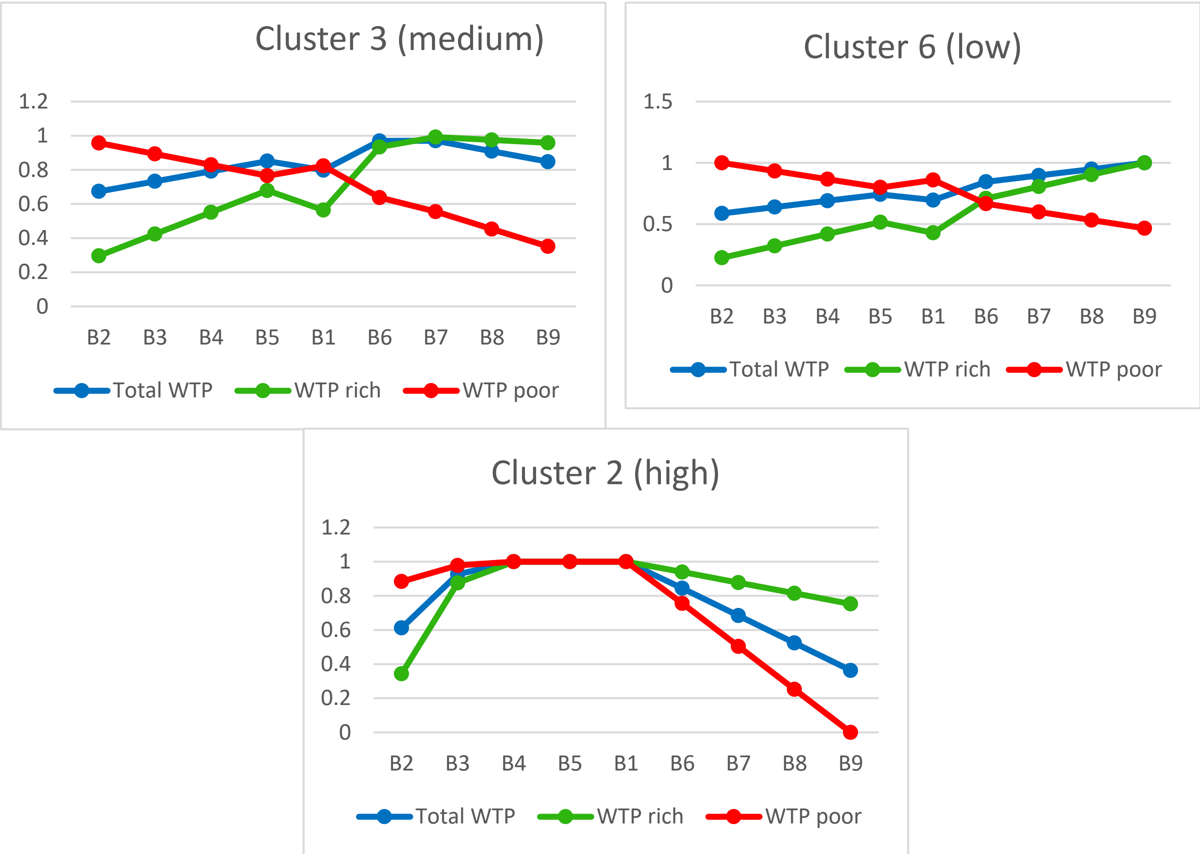

Figure 6.9 Trend of the three WTP criteria for cluster n. 2, 3 and 6

between the two groups is moderate; the B5 scenario minimises this distance but lowers total WTP for the whole population compared to B6. Finally, when the number of trees to be distributed is low, as in cluster 6, the trade-offs between WTP of the poor and the rich group is the most extreme – as can be seen by the opposite trend of the green and the red line – and the WTP of one wealth status group can only be maximised at the expense of the other. As shown by Figure 6.9, WTP of the rich is maximised under scenario B9 that polarizes the distribution of biomass in favour of that group, and the same applies for the poor group (scenario B2). In this cluster, the total WTP is also highest under the B9 scenario implying that a polarised distribution when resources available are low may lead to a higher total welfare.

6.6 Discussion and conclusion

We propose a methodology to evaluate how the institutional mechanism used for the governance of forest ES affects the contribution of provisioning ES to societal welfare taking in account the welfare trade-offs between social groups. We quantified the potential supply of provisioning forest ES, i.e. woody biomass, and link it to the current human demand to identify the amount of ES effectively captured by the population. We then assessed the effect on total welfare of the beneficiaries of different hypothetical distributional scenarios arising from a CBFM policy. We show that, due to the spatial mismatches between demand and supply, the distribution of provisioning ES to the rural population across the whole harvesting area is unequal in biophysical terms (see Table 6.5). By coupling biophysical modelling with WTP analysis, we then provide an assessment of total welfare gained by the population. Our WTP analysis captures the effect of distributional rules on individual's welfare at the aggregate level, i.e. for the total population and the whole forest harvesting area, and at disaggregate level, i.e. for the two wealth status groups and for each cluster. We contribute to the literature by combining a biophysical assessment of ES potential availability and actual flow with a welfare assessment that integrates the impact of distributional outcomes (Chaudhary et al., 2018; Daw et al., 2011; Dawson et al., 2017; Fisher et al., 2014).

The biophysical assessment reveals that the current patterns of consumption are ecologically unsustainable and demand for ES exceeds sustainable supply in many co-management blocks leading to forest degradation. The disturbance index shows that the areas closer to human settlements have been highly disturbed during the 2013-2018 period. The comparison of supply and demand shows that the distribution of biomass is unequal across the whole harvesting area (see Table 6.5) and therefore not all demand can be met whilst guaranteeing that forests would re-generate. We found that only in five co-management blocks, which account for 15% of the reference population, forests would be able to support the estimated current biomass demand. The unsustainable consumption patterns that meeting demand would generate under the business as usual scenario affects mainly the south area of the forest, where the population density is higher, indicating that in the future the current degree of inequalities in the distribution of biomass across space may increase further (see Figure 6.4).

The WTP analysis shows that the distributional scenario that maximises total societal welfare in monetary terms across the harvesting area is the scenario that distributes 40% of biomass to the rich group while the remaining 60% is allocated to the poor group (see Table 6.6). However, this scenario (B5) does not maximise total WTP for all clusters (see Figure 6.9). Whilst at the aggregate level an (almost) egalitarian distribution of biomass between poor and rich is found to be increasing the welfare for the whole population, at disaggregated level a distribution polarised towards the rich maximises total WTP in many clusters where biomass availability is low. Forest benefits are especially relevant for the poorest village members, and therefore a policy maker could opt to develop institutional mechanisms that maximise the welfare of the poor group on normative grounds, instead of maximising total welfare. In such situations, our analysis shows that the scenario that maximises WTP for the poor group at aggregate level (B2) produces a total WTP almost equivalent to B5, but it also maximises the difference between welfare of the rich and the poor at the aggregate level (see Figure 6.7).

Our methodology relies on coupling multiple models used to estimate both biophysical and monetary quantities; such estimations required a set of simplifying assumptions. To quantify the biomass available, we relied on remote sensing images, given that we lacked an updated forest inventory dataset, but our estimates are characterised by a relative predictive error of about 50% and uncertainty related to measurement errors. Using SAR (synthetic aperture radar) remote sensing technologies, which overcome the problem of clouds, may improve the predictive ability of the regression model used (Mitchell et al., 2017). Moreover, quantifying the uncertainties and simulating confidence intervals through bootstrapping procedures would provide a measurement of the magnitude of error of the biophysical estimates (Ryan et al., 2012). We kept in account part of the uncertainty associated with the final welfare estimates by providing 95% confidence intervals for the aggregated monetary estimates (Table 6.6). Furthermore, to link the potential supply and potential demand, we simulated the spatial connectivity through developing an accessibility map which included walking distance weighted by slope. Such accessibility map could be complemented by other factors deemed as relevant for forest products collection, such as quality of forest area as a proxy of products availability or distance to market and information on possible substitutes which may increase or reduce the likelihood to harvest from the forest reserve (Albers and Robinson, 2013).

We demonstrated how our methodology can account for trade-offs between wealth status groups both at the aggregate and disaggregate level using a single indicator (WTP) and how it serves as a useful tool to inform decision-making about welfare distribution issues for ex-ante valuation of ES governance policies. Important improvements upon earlier assessments of our methodology is that it considers the contribution to human well-being of the actual ES flow, as opposed to potential, and incorporates spatial heterogeneity in the analysis (Bagstad et al., 2014; La Notte et al., 2017). Moreover, we developed a tool for disaggregated assessments which can account for the differential ability of social groups to capture the flow of ES (Daw et al., 2011; Fisher et al., 2014) and evaluate the trade-offs involved in ES governance ex-ante instead of evaluating them ex-post (Chaudhary et al., 2018b; Dawson et al., 2017).

Chapter 7 Discussion and conclusion

7.1 Introduction

Forest resources have an important role in supporting the livelihood strategies of rural communities in Malawi, especially for the poorest village members, and can have an important equalising effect (Chilongo, 2014; Fisher, 2004). The management system of forest ecosystems determines how those resources are distributed to local users and therefore influences total societal welfare. The management policies regarding forest reserves in Malawi is evolving toward a CBFM, i.e. co-management policies. In a co-management scheme, the government devolves forest management responsibilities and access rights to the local communities which, in partnership with the forest department, develop detailed management plans and assign coordination responsibilities to a local committee. The committee-based CBFM configuration as adopted in Malawi establishes new local institutions responsible for the management and the distribution of forest resources.

The aim of this PhD is to assess how the implementation of CBM influences the welfare of the local forest users through understanding how fairness concerns influence individual incentives and behaviour. The distributional outcome of CBM policies affect individual's welfare both by determining the level of personal consumption and the fairness of the overall distribution; the individual may be willing to sacrifice his personal consumption to realise a fair outcome, but such assumption has rarely been tested in the context of CBM policies. Moreover, the relative importance of the fairness of the overall distribution may depend also on the procedures used to allocate decision-making power over forest resources. Therefore, this PhD evaluates also whether individual's distributive behaviour is influenced by procedures, and its fairness. Finally, the socio-economic system is embedded in a broader ecological system and performing an integrated assessment of the welfare impact of CBM policies on beneficiaries requires assessing the ability of the ecosystem to provide forest ES. The final aim of the PhD is to quantify the aggregate availability of forest resources given the ecological status of the forest and the total societal welfare according to how those resources are distributed to local users.

The research questions underlying this PhD are:

1. What are the marginal non-marketed forest ES benefits associated with a change in forest management?
    1.1. Are distributive preferences for ES benefit distributions reflected in the preferences that people have for local forest management options?

        Hypothesis: values for forest ES are influenced by fairness concerns toward other members of the community

2. Does the procedure through which decision-making power is assigned influence the final distribution of resources?

    Hypothesis: the perceived fairness of the procedure determines how fairness norms influence distributive choices of powerful individuals

3. Does the potential ecosystem services supply fulfil the current demand of local population for provisioning forest ecosystem services?
    3.1. What are the welfare effects for the local population when the distribution of benefits is constrained to a sustainable level?

        Hypothesis: societal welfare associated with CBM policies changes according to the distributional rules used for the allocation of forest resources

This thesis makes a novel contribution by providing an empirical analysis of individual distributive behaviour using rational choice theory where the individual is assumed to be influenced by fairness norms. It integrated a hypothetical experiment, i.e. DCE, used to assess how distributional outcomes of forest management policies, and their fairness, are associated with individual's utility and an incentivised experiment used to evaluate how the institutional setting of the distributive context, i.e. procedures used to allocate decision-making power, interacts with fairness norms relative to outcomes. As such, this thesis provides a comprehensive model of individual behaviour in a natural resource redistributive context where it first demonstrates that the fairness of the distributional outcomes arising from CBM policies matters for the individual and then shows how those distributive preferences are influenced by the institutional setting. Finally, the estimated empirical model of individual behaviour has been used to simulate the ex-ante welfare impacts of CBM policies for the total population surrounding the Namizimu forest reserve. Through assessing first what is the sustainable supply of provisioning ES that can be distributed to the relevant population and then evaluate how the population welfare is affected by hypothetical distributional scenarios of those ES, this thesis contributes to interdisciplinary ES research by providing an integrated assessment of the impact of ES governance.

This thesis combines rational choice theory for the empirical analysis of individual behaviour with a biophysical assessment of forest provisioning ES supply to evaluate welfare implications of CBM policies. Chapters 4 and 5 focus on understanding the influence of fairness norms at the individual level to answer research question 1 and 2 using primary data. Chapter 6 integrates the primary data collected for question 1 with a set of spatially explicit biophysical secondary data to examine the ability of the broader ecological system to support human demand and answer research question 3.

In the following, I first discuss the key findings of this thesis and their contribution to the knowledge, I then discuss possible limitations and implications for further research and draw the overall conclusions and implications for policy.

7.2 Key findings

7.2.1 The overall fairness of forest management policies distributional outcomes contributes to individual's welfare

Chapter 4 addresses research question 1 and examines whether individuals have preferences regarding the distributional outcomes of forest management policies. I applied a theoretical model of choice behaviour where the individual is willing to trade-offs the benefits distributed to him with benefits distributed to other village members so to realise a fair outcome. I asked respondents to make choices regarding forest resource management options which were described as alternative hypothetical distribution of forest products between the respondent and other village members, a relatively worse-off member and a relatively better-off one. The proposed design allows to estimate the separate effect of social and self-interested preferences on individual utility within the context of forest resource management. In addition, I tested whether choices for forest management policies option can be reconciled with three underlying fairness norms: equality, efficiency and maximin (Johansson-Stenman and Konow, 2010; Konow, 2001). The results show that individuals hold social preferences regarding the amount of forest products distributed to other village members and that they are averse to unequal outcomes corroborating the hypothesis that fairness concerns influence individual welfare. I also found evidence of preference heterogeneity regarding fairness norms confirming findings from experimental economics literature which have highlighted that there are multiple fairness norms which may motivate distributive choices (Cappelen et al., 2007). Individuals gain utility according to the magnitude of benefits distributed to the others, i.e. they hold social preferences, but the marginal utility relative to the benefits distributed to themselves, i.e. self-interested preferences, is significantly higher (Model 1 - Section 4.6.2). Social preferences are motivated by underlying fairness norms such as equality, efficiency and maximin (Model 2 - Section 4.6.2). My results show that efficiency, i.e. increasing the amount of benefits distributed to all village members, is the most important fairness norm followed by equality with poorer village members. The relevance of both norms is heterogeneous across the population and equality with poorer is associated with disutility for about 30% of our respondents. I investigated the equality norm further using the Fehr and Schmidt (1999) inequity aversion model which assumes that disutility associated with inequalities differs depending on whether the individual is in an advantageous or disadvantageous position compared to the “other” (Model 3 - Section 4.6.2). I found that individuals are averse to unequal outcomes in the advantageous position when comparing to both better-off and worse-off households. In the disadvantageous position they are averse to unequal outcomes comparing with richer people, but they are indifferent to inequality with poorer.

By using a set of different models to explore the preferences for CBM distributional rules, I provided a comprehensive account of different motivations underlying those preferences. A concern for fairness in the form of aversion to relative unequal outcomes seems to be the most relevant motivation, as suggested by the fact that it has the best model fit, however further observations can be made. The distribution of forest resources to poor village members is always associated with positive utility as shown by the non-significant standard deviation in Model 1 and seems to be associated to a maximin norm, i.e. maximising the welfare of the least well-off, as shown by the positive coefficient in Model 2. Moreover, the inequity aversion coefficients are characterised by non-linearities in the absolute number of trees distributed to the other village members indicating that aversion to unequal outcomes changes according to how much the other member gets. Individuals who are in an advantageous position compared to poorer experiences disutility until when the poorer is distributed a minimum number of resources (12 trees). Moreover, the individual dislikes inequality with richer in the disadvantageous position when the number of trees distributed to the others is relatively low but he is willing to be “left behind” when the number increases. A possible explanation is that the comparison with the richer is not driven by the equality norm but by a desire to comply with other local customary rules that applies to wealth status categories.

This novel DCE design ensures that social values can be disentangled and that the effect of the social context in which the individual is included, the village community in this case, can be separated from his own personal interest, i.e. harvesting the resource. The DCE design shows that rational choice theory can accommodate and measure two different sets of preferences, i.e. self-interested and social, when modelling behaviour regarding common-pool resources such as forests. Monetary valuation has often been criticised regarding its ability to accommodate the fact that the individual can make choices both as a consumer, i.e. self-interested preferences, and as a citizen, i.e. social preferences (Nyborg, 2000; Sagoff, 1998; Spash, 2008). Individuals may make choices and express preferences that regard what society ought to do, instead of maximising their individual utility, and this conflicts with the basic assumption of rational choice theory and may invalidate results of the assessment (Howley et al., 2010; Ovaskainen and Kniivila, 2005).

The ability to disentangle the two types of values is especially relevant for aggregation purposes to evaluate alternative projects under cost-benefit analysis and to orient decision-making toward welfare enhancing policies. The existence of values attached to the magnitude of resources distributed to others poses problems for the aggregation of those values across the population, because it violates general equilibrium assumptions and it may imply some double counting (Diamond and Hausman, 1994; Nyborg, 2000). Flores (2002) shows that whilst a selfish individual is a condition required for the existence of general economic equilibrium and deriving Pareto optimality, this condition does not fully generalise to the benefit-cost analysis: individual values about other's welfare may legitimately be used to evaluate societal welfare. Finally, if individual welfare is driven also by the overall fairness of how costs and benefits are distributed across all society members then fairness has implications for social welfare (Johansson-Stenman and Konow 2010). Therefore, I argue that the values that depend on the magnitude of resources distributed to others should be considered for inclusion in cost-benefit analysis, and their impact on policy decisions should be explored and evaluated.

7.2.2 Using unfair procedures to allocate decision-making power leads to more self-interested distributive choices

In Chapter 5, I complemented the DCE with an incentivised experiment which tests how procedures for assigning decision-making power influence distributive choices. The experimental economic literature has highlighted that distributive choices are motivated by underlying fairness norms, but the individual interprets and applies those norms in a self-serving way, and contextual features, such as the degree of decision-making power, may facilitate such biases (Kittel et al., 2017; Konow, 2000; Rode and Le Menestrel, 2011; Rustichini and Villeval, 2015). Therefore, I examine whether three different allocation mechanisms to assign decision-making power, namely random, meritocratic and favouritism, affect distributive choices in a dictator game setting. I hypothesised that the procedure modifies what is believed to be a fair share as prescribed by the egalitarian fairness norm and may enhance self-serving biases. The earned procedure, which mimics the meritocratic mechanism, is assumed to influence dictator's choices through an entitlement effect (Hoffman et al., 1994), whilst the procedure that mimics favouritism, i.e. the unfairly earned procedure, is assumed to modify expectations about how much the individual ought to adhere to a fairness norm (Bicchieri and Xiao, 2009).

The link between procedural and outcome fairness has been rarely explored within experimental economics using rational choice theory. Although the literature has highlighted that individuals have preferences for (fair) procedures in addition to (fair) outcomes, most of the current empirical analysis has focused on the reaction of recipients (Bolton et al., 2005; Grimalda and Kar, 2016). I therefore contributed to the literature by examining the role of procedural (un)fairness on the distributive choices of agents endowed with full decision-making power. A procedure can be considered fair if it involves a set of transparent and impartial rules that ensure equal opportunities for all individuals to participate in the decision-making process (Dold and Khadjavi, 2017; Krawczyk, 2011; Trautmann and van de Kuilen, 2016). According to this definition the random and earned allocation procedure are considered fair, while the unfairly earned one is considered an unfair procedure. The earned procedure may be considered unfair because rewards individuals based on effort and personal talent; the latter may not be distributed equally in the sampled population and therefore be qualified as unfair. However, a meritocratic fairness norm that rewards personal talent has been shown to be perceived as fair when applied to outcomes (Cappelen et al., 2010). Therefore, I argue that it could similarly apply to procedures. The classification about fair and unfair procedures is also confirmed by the perception of the participants to the dictator game (see Table 5.4 - Section 5.6.2).

I found strong support for the procedural fairness hypothesis. The unfair procedure, in the form of favouritism, strongly reduces the relevance of fairness norms and increases self-interested allocations (see Table 5.5 – Section 5.5.3 and Table D.2). I also found weak evidence of an entitlement effect. While the average share distributed by the dictators is significantly lower in the earned treatment compared to the random (see Table 5.4 – Section 5.5.2), the significant effect disappears when socio-economic controls are included in the regression analysis (see Table 5.5 – Section 5.5.3). Previous literature that has studied the magnitude of entitlement effect and how a meritocratic fairness norm applies to outcomes has found that individuals acknowledge earned entitlements but there is substantial heterogeneity across participants (Barr et al., 2015; Jakiela, 2015, 2011). Participants with a relatively higher wealth status in South Africa acknowledged earned entitlements (Barr et al., 2015), as did educated subjects in a Kenyan sample (Jakiela, 2015). Although meritocratic procedures may activate an entitlement effect and interact with fairness norms relative to outcomes, further research is needed to evaluate whether this effect is mediated by individual characteristics.

The fair reference point relative to the egalitarian norm, which is the salient norm in our design, is influenced by the provision of an endowment to the recipients. The results show that the difference in the amount dictators sent between the zero and the positive endowment treatments is statistically significant (see Table 5.4 – Section 5.5.2). We introduced variation in endowment to test whether distributive choices are influenced by a wealth status concern and we verified that the lower the wealth of the recipient the higher is the share of the dictator, on average, indicating some form of maximin concern (Konow, 2010; Korenok et al., 2012).

The controlled lab-in-the-field experiment of Chapter 5 tests a rational choice model that incorporates the influence of fairness norms relative to both outcomes and procedures. The model can be used to examine how the distributive behaviour of individuals changes when they are exposed to institutional settings where social and moral norms are violated. The results are relevant for the development of natural resource management institutions in Malawi. Mechanisms for the distribution of benefits in CBM policies across different countries can be reconciled with fairness norms. For instance, community forest users in Nepal have developed rules that ensure an equal distribution of benefits across all members, while other experiences are based on a need approach that aims at improving the welfare of the poorest members (McDermott et al., 2012). Our findings suggest that if the benefit distribution mechanism depends on the choices of the village members selected for the coordination of the resource use, then to ensure compliance with fairness norms relative to outcomes those selected individuals should be appointed using a mechanism which does not favour anyone because of merit, effort or other characteristics beyond individual control.

7.2.3 The societal welfare derived from CBM policies changes according to the norm chosen for the distribution of forest provisioning ES

Finally, in Chapter 6 I examined the future welfare impacts of the distributional outcomes of community-based ES management by performing a scenario analysis. The main aim of the chapter is to provide an overall assessment of future welfare impacts of CBM implementation in the case study area, Namizimu forest reserve. First, I mapped and quantified the potential provisioning ES supply of the forest area, i.e. biomass, and assessed whether potential supply can fulfil current demand by modelling the spatial connection between them. Next, I integrated the results of Chapter 4 and calculated total WTP, i.e. a monetary measure of individual welfare, using a model that can capture the welfare impacts of different distribution of biomass across better-off ("rich") and worse-off ("poor") village members. Finally, I developed different scenarios to distribute the biomass that can be sustainably harvested among the two wealth groups and evaluated the total welfare impacts of those scenarios using WTP analysis. The distributional scenarios range from a pure egalitarian, where half of the available biomass is distributed both to the poor and the rich group, to an extremely polarised distribution that favours one the two groups. These scenarios can be considered representative of possible CBM outcomes considering that in some case an egalitarian rule is chosen while in others a pro-poor rule may be preferred (McDermott et al., 2012) or benefits are mainly distributed to the wealthier because of elite capture (Chinangwa et al., 2015). The analysis contributes to the broader literature by quantifying potential supply and demand and by using accessibility analysis to model their spatial connectivity so to identify the actual flow of benefits that can actually be captured by the human population (Bagstad et al., 2013; La Notte et al., 2017; Syrbe and Grunewald, 2017; Wolff et al., 2015). Chapter 6 further contributes to the literature by evaluating the welfare impacts of CBM policies at aggregate level as well as trade-offs among different social groups (Chaudhary et al., 2018; Daw et al., 2011; Dawson et al., 2017; Fisher et al., 2014).

The biophysical assessment shows that over the period 2013-2018 the forest has been degraded in the areas closest to human settlements and in those areas the amount of biomass available is lower than the average from the whole forest. The total biomass supply of the forest area examined is lower than the current estimated demand, therefore all demand cannot be met, and unsustainable patterns of consumption are likely to arise. As shown by the scenario analysis over time (see Figure 6.4 – Section 6.5.3), if current demand is stable over time many areas would be highly degraded by 2030 and the total biomass provided by the whole area would be about half (from 59.48 t/ha in 2015 to 31.40 t/ha in 2030). This degradation is characterised by spatial variability, the southern area of Namizimu forest is likely to be highly degraded by 2030 due to high population density and easy access, while the northern areas may be able to meet all demand of the adjacent population while re-generating.

The welfare assessment shows that a scenario which provides 40% of biomass to the rich group and 60% to the poor maximises the total societal WTP at aggregate level indicating that a slightly unequal distribution maximises social welfare according to the individual preferences elicited with the DCE. However, the same result does not hold at disaggregated level and a scenario that distributes most of the benefits to the rich is found to increase total WTP in many co-management blocks where the sustainable amount of biomass available is low. Forest provisioning ES are especially relevant for the poor community members and therefore the policy objective may be to maximise WTP of the poor group instead of maximising total social welfare. The scenarios that produce a high WTP for the poor group are also generating a relatively high total WTP (as indicated by the overlap of the shapes in Figure 6.7 – Section 6.5.3) indicating that at aggregate level maximising the welfare of the poor does not lead to costly trade-offs. However, when looking at disaggregated level where total biomass available is low, choosing the distributional scenario that maximise WTP of the poor would also minimise total WTP indicating that trade-offs between the two social groups are very high in those situations and there is no win-win that can be achieved (see cluster 6 in Figure 6.9 – Section 6.5.3).

The integrated assessment shows that the institutional mechanism employed for the ES governance, which determines the ability of local users to enjoy provisioning ES, has different effects on total societal welfare depending on how much ES is available. By taking in account the spatial variability of forest ES supply and the demand of the surrounding population, I performed an ex-ante welfare assessments of ES governance which can be used to orient decision-making toward welfare-enhancing policies.

7.3 Limitations and reflections

This thesis used experimental methods, i.e. a DCE and a dictator game, to test whether individual choices are influenced both by self-interested and social preferences. Both methods suffer from some limitations related to their ability to measure actual behaviour in the real policy context, i.e. issues of external validity and hypothetical bias, but they provide advantages in terms of their ability to isolate the effects of interest without confounding.

The DCE relies on the assumption that the individual will make a choice to maximise his utility given his budget constraint (McFadden, 2001). However, the choices that the individuals make do not have real immediate consequences, especially regarding the monetary payment, and there is a risk of hypothetical bias, one form of external validity (Rakotonarivo et al., 2016). The bias can be defined as a difference in actual and hypothetical choices and leads to overestimate of the marginal WTP for the policy attributes. This risk may be particularly relevant when making choices with a moral component because of a desire to appear fair (Johansson-Stenman and Svedsäter, 2012). I cannot completely rule out hypothetical bias in the experiment but the results of the incentivised experiment, i.e. the dictator game, confirm that the sampled population hold social preferences and are willing to distribute resources to other village members, being either hypothetical forest benefits or real money. Moreover, both experiments show that self-interested preferences outweigh social preferences. In fact, in the DCE the coefficient relative to individual gains is significantly higher than those for the resources distributed to the others while in the dictator game the mean amount that participants kept for themselves is about 67%.

It is important to note that DCE has the strength of measuring choice behaviour in a real policy context frame while retaining a certain degree of experimental control so that distributive behaviour can be explored, and various hypothesis can be tested. However, the incentivised experiment whilst reducing the risk of hypothetical bias still suffers from external validity problems given its abstract context (List, 2007). In the dictator game design, respondents are asked to choose how to distribute money with an anonymous partner and there is no reference to the management of the forest reserve. As highlighted in Chapter 2 and Chapter 5 there is a gap in the literature of how perceptions of fairness regarding procedures interact with norms of fairness relative to outcomes when individuals are endowed full decision-making power. Therefore, to define a clear link between procedures and distributive choices we relied on a fully controlled experimental setting which requires an abstract setting to measure the hypothesised relationship (Kagel and Roth, 2016). However, complementing the abstract setting with some information relative to the policy context, e.g. providing the policy context and frame the distributional trade-off as a choice to distribute trees (e.g. D'Exelle et al., 2012; Schüring, 2014), could enhance the external validity of the experiment. As highlighted by Martin et al. (2019), preferences regarding fairness norms elicited under a monetary frame differ from those elicited under an environmental resource frame.

The two experiments have been used to answer two different research questions and they complement each other by providing evidence that can be incorporated within rational choice theory. Further research that would look at integrating those two methods with the aim of providing a more complete picture of distributive behaviour in a natural resource management context may make use of deliberative choices experiments (Schaafsma et al., 2018), field experiments (Carpenter and Cárdenas, 2008) and eliciting fairness judgements through surveys (Konow, 2000; Rustichini and Villeval, 2015). Specifically, a deliberative DCE which includes treatments resembling different political processes for defining a distribution of benefits within CBM policies may be used to complement the current DCE results on fairness norms relative to outcomes and test further hypotheses on the influence of procedures. Similarly, complementing the abstract setting of dictator game with a policy context frame and a clear link with the distribution of forest resources, instead of money, would be useful to evaluate whether the different frame activates different fairness norms. As discussed in Chapter 5, fairness norms relative to outcomes have been found to be heterogeneous across distributive contexts and further evidence regarding heterogeneity of fairness norms regarding procedures is needed. Finally, further insights on the mechanisms linking procedural and outcome fairness could be gained through comparing actual behaviour of dictators with fairness statements and real choices of non-implicated stakeholders, i.e. individuals that would be rewarded independently from the distributive choice that they make.

The results presented in Chapter 6 aims at integrating the findings from Chapters 4 and 5 and scale it up across the whole forest area of interest so to integrate the broader ecological system. To perform this analysis in Malawi, where the data needed for ES modelling and mapping are scarce (Willcock et al., 2019; Willemen et al., 2018), I relied on coupling multiple models and required a set of simplifying assumptions. Most assumptions regarding biophysical models, and possible improvements are discussed in the chapter, but it has to be noted that the quantification of the actual flow is uncertain, and the degree of uncertainty is not quantified. The potential quantity of biomass supply which has been estimated may propagate a measurement error of up to 50% of the average biomass while the potential demand estimated may suffer from limitations due to under-reporting of illegal activities. Even though these limitations call for an extremely cautious approach when discussing actual quantities of biomass supplied and demanded the trend of degradation highlighted by the BAU scenario analysis is in line with the current trend of degradation measured (2013-2018). Finally, we focused on one single provisioning ES, woody biomass, and on trade-offs involved in the allocation of those products among two social groups without considering trade-offs among different ES, and eventually who will benefit from different types of ES (Howe et al., 2014). Given the relative importance of water quantity regulating services in the area, as discussed briefly in Chapter 3 and Chapter 4, a possible avenue of research would be to integrate trade-offs between harvesting biomass, and so reducing forest cover, and conserving biomass, so to increase water availability in the streams during the dry season.

7.4 Conclusions and implications for policy

To assess the equity dimension of decentralised natural resource management policies, I focused on understanding whether specific distributional and procedural aspects of the policy influence individual preferences and what is the total societal welfare that would be determined by these preferences and the ecological status of the area.

The answer to the first research question (Chapter 4) is that individuals hold distributive preferences and their welfare is influenced by the magnitude of benefits distributed to other community members and the fairness of the overall distribution. The fact that the individual welfare depends, partly, on how benefits arising from forest are distributed to other village members is relevant for the implementation of public policies which aim to enhance total societal welfare. Rural village members living in the surrounding of forest reserves prefer a progressive distributive mechanism that reduces inequalities with worse-off village members. Equity considerations which are considered important at policy level (Sustainable Development Goal 10 – reduce inequality within and among countries, UN 2015) are also part of preferences of the local users, and vice versa. This is an important finding in support of pro-poor forest regulations.

The answer to the second research question (Chapter 5) shows that the relative importance of fairness norms relative to outcomes for the individual and how much he is willing to trade off his own personal benefits for the sake of a fairer outcomes diminishes when fairness norms are violated at procedural level. Chapter 5 highlights that to ensure an equitable distribution of benefits when forest management is delegated to elites of local users, the procedures employed to distribute such roles should avoid favouring anyone because of merit or other characteristics beyond individual control. This translates into a call for more transparency in selection procedures for forest management committees and in payment mechanisms that needs to be enforced and monitored by local government and international organizations responsible for setting up co-management programs. To achieve the Sustainable Development Goal number 16 the Forest Department in Malawi, together with NGO's and external donors, need to promote and ensure accountable and inclusive institutions for local forest management.

The answer to the third research question (Chapter 6) shows that when there is a limited amount of biomass available and sustainable management requires constraining the distribution of forest products then to maximising social welfare requires developing different benefit distribution mechanisms across different areas. Higher availability of forest products, both at individual and the collective level, appear to contribute to local welfare, but at the same time the current level of biomass demand is likely to generate unsustainable consumption patterns and lead to future degradation. Given the strong reliance on biomass, in addition to improved monitoring and enforcement of forest management policies, there may be a need to compensate local population for restrictions on harvesting. Payment for ecosystem service schemes, such as REDD+ initiatives (Shyamsundar et al., 2019), may be considered in addition to CBM policies to realise joint positive outcomes, i.e. social equity, and ecological sustainability.

This thesis demonstrates that the individual rational choices are determined both by self-interested preferences and societal values and that individuals are willing to forego some personal benefits to achieve a fairer outcome that benefit all community members. This is especially relevant for forest-reliant communities which will be responsible for the management of their collective forest resources under a CBM policy. However, it must be noted that the relevance of fairness concerns for the individual depends on the fairness of procedures employed in defining decision-making roles, therefore to ensure fair outcomes the policy set-up must guarantee fair procedures as well. The aggregate availability of forest biomass is found to increase total societal welfare if individuals can harvest, however it is important to adequately monitor harvesting levels if long-term ecological sustainability objectives are to be met.

Appendix A Achievements during the PhD

A.1 Conferences

Chapter four and five have been selected through a peer-review process to be presented at various discipline-specific international conferences.

I presented Chapter 4 as:

1) **Dreoni, I**, Schaafsma M., Mentzakis E., 2019. Preferences for fair distributions in resource management: are distributive justice concerns reflected in values for forest Ecosystem Services?, paper presented at International Choice Modelling Conference, Kobe, 19-21 August 2019.
2) **Dreoni, I**, Schaafsma M., Mentzakis E., 2019. Preferences for equitable distribution in resource management: are distributive justice concerns reflected in values for forest Ecosystem Services?, paper presented at envecon: Applied Environmental Economics Conference, London, 15th of March 2019.

I presented Chapter 5 as:

3) **Dreoni, I,** Mentzakis E., Schaafsma M., 2019. Favouritism breeds self-interest: an experimental study of procedural and outcome fairness, paper presented at BIOECON: inequality and poverty in biodiversity conservation and natural resource management, Wageningen, 11-13 September 2019.

I. Dreoni conceived of, collated the data, conducted the analysis, and wrote the paper. Co-authors provided input into the design and data analysis and comments on manuscript draft.

Appendix B Exploratory fieldwork

B.1 Key informant interviews

Table B.1 List of key informant interviews performed in Malawi

Key Informant Interviews (KII) (see Appendix B.2)	Summary of information retrieved
Mr Willie Sagona – researcher at Forest Research Institute of Malawi (FRIM) specialized in forest restoration and plantations	- Issues related to management of forest resources and overview over the policy context - Support in identifying relevant key informants for my project and related contacts - Suggestions on possible relevant case-study areas - Relationships between conservation of forest resources and ES
Mr Tembo Chanyenga – director of FRIM	- Issues related to management of forest resources and overview on the policy context - Introduction on the work performed by the institute and its policy objectives - Implementation of co-management policies - Strengths and weaknesses of co-managed systems across different forest reserves - Participation of rural communities in co-management policies and relationship with the district forest department - Alternative policies implemented in the context to support sustainable forest management - Main information gap related to forest resource management - Relationships between forest resources and ES - Secondary data: availability within FRIM and possible sources - Support in identifying relevant key informants for my project and related contacts - Suggestions on possible relevant case-study areas
Mr Gerald Meke – researcher at FRIM specialized in indigenous forest and involved in implementation of co-management policies	- Relevance of forest resources for rural communities - Comprehensive description of steps for the implementation of co-management policies with a focus on relationship between rural communities and forest department and factors that promote the participation of rural communities - Strengths and weaknesses of co-managed systems across different forest reserves - Main information gap related to co-management policies

	- Support in identifying relevant key informants for my project and related contacts - Suggestions on possible relevant case-study areas and procedures to be introduced in the communities
Dr Richard Mussa – researcher at Department of Economics Chancellor College specialized in macroeconomic analysis of poverty and inequities	- Sources of secondary data - Suggestions on household survey and questions related to poverty and identification of wealth groups
Dr Dennis Kayambazinthu – senior researcher and ex deputy director of department of forestry	- Overview over the policy context from an historical and legal point of view - Implementation of co-management policies - Strengths and weaknesses of co-managed systems across different forest reserves - Main policy gaps identified in the context and related information gap supporting the implementation of policies - Relationships between conservation forest resources and ES and indication of relevant literature analysing Malawi forest resources and related ES - Discussion of policy relevance of my study - Support in identifying relevant key informants for my project and related contacts
Mr Muhosha – District Forest Officer (DFO) for Machinga District	- Issues related to management of forest resources and practical overview over the context - Description of practical implementation of co-management policies in Liwonde forest reserve - Overview over the administrative aspects of the policy implementation and coordination among different local authorities and committee at community-level - Evaluation of effectiveness to date and identification of relevant factors influencing the enforcement of the policy - Collection of secondary data and general information on actual co-management implemented (forest management plan and sustainable livelihood analysis) - Support in identifying relevant contacts for being introduced in the communities
Forest Extension Officer – Machinga District	- Description of practical implementation of co-management policies in Liwonde forest reserve
Mr Ralph Kamvazatha – Wildlife and Environment Society of Malawi (WESM).	- Introduction on the work performed by the society and its objectives - Overview of conservation policies applied to forest reserves, national parks, and game reserves - Relevance of natural resources for rural communities - Overview on relationship between rural communities and the forest department

	- Participation of rural communities in community-based natural resource management system - Alternative policies implemented in the context to support sustainable natural resource management - Support in identifying relevant key informants for my project and related contacts
Co-management expert	- Overview over the policy context from an historical and legal point of view - Implementation of co-management policies - Strengths and weaknesses of co-managed systems across different forest reserves - Main policy gaps identified in the context and related information gap supporting the implementation of policies - Discussion of policy relevance of my study - Support in identifying relevant key informants for my project and related contacts - Suggestions on possible relevant case-study areas and procedures to be introduced in the communities - Relationships between conservation of forest resources and ES
Mr Lettons Mkandawire – National Smallholder Farmers' Association of Malawi (NASFAM)	- Introduction on the work performed by the association and its objectives - Relationship between conservation of natural resources and ES related to agriculture - Support in identifying relevant key informants for my project and related contacts
District Forest Officer (DFO) for Mangochi District	- Issues related to management of forest resources and practical overview over the context - Support in identifying relevant contacts for being introduced in the communities
Forest Extension Officer – Mangochi District	- Issues related to management of forest resources and practical overview over the context
Mr Henri Utila – researcher at FRIM	- Relevance of forest resources for rural communities - Relationships between conservation forest resources and ES and technical suggestions on how to quantify those relationships to develop my design - Support in identifying relevant contacts for being introduced in the communities and collect secondary data related to management plans in Mangochi district

B.2 Questionnaire guide for key informant interview

Before beginning the interview, please ensure that you have read the accompanying consent form and participant information sheet.

If you have any questions or concerns regarding these forms or the project, then please raise these before the start of the interview.

Questionnaire Checklist for different key informant groups

Semi-structured interviews with key informants – guided questions/topics

Objective: to understand status of the community-based management system in the area, policies and management systems implemented and the relationship with the social context.

Questions/Topics	Possible follow up questions
Could you briefly describe your role and work within your organisation?	
What is your role regarding community-based management system?	Can you tell me about the development process of community-based management system in Malawi? How does the implementation of this type of management system differ from State-owned and customary land forest areas?
What is the importance of forest resources for rural communities?	
How does implementation of protected forest areas affect livelihood strategies of the surrounding rural communities?	
Do you have any experience in implementing co-management initiatives in Zomba Malosa forest reserve?	Can you tell me how the process has been implemented? Can you recommend any further participants for this study?
Which are the stakeholders involved in the implementation of community-based management system on state-owned forest?	How is the process coordinated among different local community/village institutions and other institutions involved?
Can you tell me if and how local communities are empowered to effectively lead and participate in forest conservation and management?	Who in the communities typically takes part in the forest committees that are involved in the CBFM?
How is the community/village participation in this type of program promoted?	What are the factors contributing to participation of rural population in forest management initiatives?
What are the strengths of the implementation of community-based forest management system on state-owned forest?	
What are the most serious problems to date in implementing community-based forest management system on protected forest areas?	How can they be resolved? Are there any existing programs or management strategies in place to address these issues?

What has happened to forest cover since the introduction of CBFM?	
Has the implementation of CBFM had any impact on the distribution of forest benefits?	Are there in place any mechanisms for the poorest member of community? For instance, free licenses
Are there any payments associated with forest use currently?	How was the level of those payments determined? Where does the money go? How participants prefer to pay?
What do you think the main information gaps in the implementation of community-based management policies are?	
Possible list of probes if needed: *Can you explain that further? Can you say more? Could you give an example?* *I am sorry I do not understand. Please describe what you mean. Is there anything else? Tell me more about that* *Can you give me more detail?*	

B.3 Questionnaire guide for focus groups in villages where the forest reserve is co-managed

Objectives: understanding relevance of forest resources for livelihood strategies, explore if current management activities are in place and which type of benefit are extracted, understand the licencing mechanism and its pricing.	
Questions/Topics	**Instructions moderator**
Which forests are available? What is the quality of the forested areas surrounding your communities? Are there many big trees?	Assess which forests surround the community and their quality
Who owns these forests?	Try to understand which type of ownership characterize forests. Probe: are they on customary land, private land or state land (forest reserve)?
Can you access around your community? Is access free? If access is not free, how they can collect products from the forest? Is it different based on the type of forest (customary, forest reserve, private)?	Assess if they can harvest forest products following some rules or otherwise which system is in place for different forests.
Who decides on access? What do you have to do to get access?	Try to understand if different rules apply to different forests.
Which kind of products do you extract from forest? How do you use these products? Which activities do you carry out?	Try to understand if these products are used domestically (for cooking, for building houses and fences) or if they are sold or used for other activities (brick burning, charcoal production)
Do you see any benefits of forest other than the woody products?	Try to understand if they recognize any other benefit which is not tangible (e.g. water, protection from mudslides)
We now want to focus on forest reserves in particular. Do you have any agreement in place with the department of forestry for managing the forest reserve?	Assessing how’s their understanding of the agreement that they have with the forest officer
Who in the village is involved in the discussions? What are the main good and bad things about it?	Assess how the program was implemented and what they think about the program.

Do you have to have licences to extract products? Do they differ based on type of products?	Assess how they access to products and how the license system works.
What do you have to do to get a licence? Who decides on that?	Focusing on procedure for getting the licence.
Are there any people from your community that cannot get a licence? Why not?	Understand if the licence system is used by everyone and if not WHY not?
Are there forest guards? Who are they, who do they work for? Do they get paid? Do you have to pay them to get access? What happens if you don't have a licence?	Assess how the forest rules are enforced and how the harvesting of products is harvested.
Do you think this list of criteria is suitable for identify better-off and worse-off? Would you add some criteria? Following these criteria, how many households can be considered better-off and poor in your village?	Show them the wealth-ranking criteria trying to understand if they agree with the definition and the criteria and if people can actually collocate themselves in these two different categories.

B.4 Questionnaire guide for focus groups in villages where the forest reserve is managed by the state

Objectives: understanding relevance of forest resources for livelihood strategies, explore if current management activities are in place and which type of benefit are extracted, understand the licencing mechanism and its pricing. Understand which type of natural risks related to degradation of forest impact the community	
Questions/Topics	**Instructions moderator**
Which forests are available? What is the quality of the forested areas surrounding your communities? Are there many big trees?	Assess which forests surround the community and their quality
Who owns these forests?	Try to understand which type of ownership characterize forests. Probe: are they on customary land, private land or state land (forest reserve)?
Can you access around your community? Is access free? If access is not free how they can collect products from the forest? Is it different based on the type of forest (customary, forest reserve, private)?	Assess if they can harvest forest products following some rules or otherwise which system is in place for different forests.
Who decides on access? What do you have to do to get access?	Try to understand if different rules apply to different forests.
Which kind of products do you extract from forest? How do you use these products? Which activities do you carry out?	Try to understand if these products are used domestically (for cooking, for building houses and fences) or if they are sold or used for other activities (brick burning, charcoal production)
Do you see any benefits of forest other than the woody products?	Try to understand if they recognize any other benefit which is not tangible (e.g. water, protection from mudslides)
We now want to focus on forest reserves in particular.	
How do you get access? Do you have licenses to extract products?	Assess how they access to products and how the license system works.
Who gives out licences? What do you have to do to get a licence? Who decides on that?	Focusing on procedure for getting the licence.
Are there any people from your community that cannot get a licence? Why not?	Understand if the licence system is used by everyone and if not WHY not?
We now want to focus on natural risks in the area	
Have you experienced mudslides in the last 3 years during the rainy season? If yes, what's the frequency? What's the damage? Did damage crops? Did damage houses? Did you suffer any long-term loss?	Assess the frequency of landslide and the intensity of damage
What are your sources of drinking water? What are your sources of irrigation water? What's the distance from your village to these sources?	Try to assess for different uses (domestic and irrigation)

Have you experienced water scarcity in the last 3 years during the dry season? Have you had less water in the streams? Have you had less water in boreholes? If yes for how many days/weeks/months have you experienced water scarcity?	Try to assess the degree of water scarcity in the context

Appendix C Supplementary information Chapter 4

C.1 Household questionnaire

Name of village		Respondent UID	
Date		Consent obtained	□Yes □No
Start time		Name of interviewer	
End time			
Completed	□Yes □No		

[provide the following introduction] **In this survey, we will ask you questions about you and your household, your livelihood activities with a specific focus on forest resources and activities.**

1. Farming, livestock and other activities

To start this interview, we begin with questions on your farming activities

1.1 How many plots (including gardens/homesteads) did you use to cultivate crops? *[if none, go to 1.10]*

……………… Plots

[do question 1.2-1.8 first for plot 1, leave some rows open in between plots – put each crop per plot in a separate row. Then again for plot 2, etc. include the responses in the table below]

[1.2] Plot no.	[1.3] Ownership	[1.4] What is the size of each of these plots? *[THICK LAND SIZE CRITRIA IN WEALTH-RANKING CARD]*		[1.5] Which crops did you plant in each of this plot?	[1.6] How much did you harvest per crop since August 2015		[1.7] Sales: did you sell any crops since August 2015, if yes, how much?		[1.8] Revenue from sales (in price or total)	
	1 Owned by household 2 Rented 3 Borrowed	number	Unit (code) 1. Acre 2. Hectare 3. Square meters 4. Other (specify)		Qt	Unit	Qt	unit	Price per unit in MKW	Total revenue in MKW

1.9 For how many months did your farm produce enough to feed your family excluding the food that you bought? *[Put 12 if they still have food from the last harvest]*

…….. months

1.10 Did you also buy food in addition to your own produced?

1. Yes
2. No *[go to 1.12]*

1.11 For how many months did the food that you bought feed your family?

…….. months

Appendix C

We would like to know about your livestock and what you did with from August 2015 to August 2016.

1.12 Do you own livestock?

1. Yes
2. No *[go to 1.16]*

1.13 Which type of animals do you own?	1.14 How many animals do you own now (of each type)?	1.15 How much cash did you receive by selling livestock products or live animals over the last harvesting season?
1. cows 2. chicken 3. goats 4. donkey 5. pigs 6. other, (specify)		In MKW

We would like to know if your household had any other source of cash/income over the last year.

1.16 Did your household receive cash/income from any other sources or activities?

[*IF THE ANSWER IS NO, PROBE TO BE SURE THAT THEY DO NOT ENGAGE IN OTHER ACTIVITIES OTHER THAN SELLING CROPS OR LIVESTOCK]*

3. Yes
4. No *[go to 1.19]*

1.17 Where does your household get that from? [*IF THEY DO NOT MENTION ANY FOREST-BASED ACTIVITIES PROBE ON THAT AND ASK IF THEY ENGAGE IN ANY ACTIVITY THAT PRODUCES INCOME THAT MAKE USE OF FOREST PRODUCTS*]

Forest-based activities

1. Roof thatching
2. Brick burning
3. Sales of firewood/bamboo
4. Pit-sawing
5. Charcoal production
6. Charcoal sales
7. Timber sales
8. Other, ……..

Non-forest based activities

9. formal employment, for the government or a company/enterprise
10. ganyu/casual labour
11. public works program
12. bicycle and radio repairs
13. selling products other than farm/forest goods (e.g. clothes, prepared food or drinks, sand mining)
14. transfers from relatives living elsewhere / remittances
15. social program run by the government
16. social program run by an NGO
17. Other, …….

1.18 How much income did your household get from each of those activities since August 2015 until now (one year)?

MK…………………… for ……………….………….. *[fill in activity from 1.17]*

MK…………………… for …………………………….. *[fill in activity from 1.17]*

MK…………………… for …………………………….. *[fill in activity from 1.17]*

1.19 Has anyone in your household requested a loan over the past 2 years?

1. Yes
2. No *[go to 1.22]*

1.20 If yes, from who *[Multiple options possible]*?

1. Neighbours/friends
2. Village banks
3. Other institutions, specify…

1.21 Did your household have enough money to pay for important services, such as health and education?

1. Yes
2. No

I would now like to know more about your household composition.

[1.22] How many people live in your household in total?	[1.23] Please specify the **gender** of each member of your household	[1.24] Please specify the **age** of each member of your household	[1.25] Who is the **head** of your household?	[1.26] What is the highest level of **education** that each of your family members has completed?
Household member	1 Male 2 Female	Age in years	1 Yes 2 No	1. None at all 2. 1 year (Standard 1) 3. 5 years (Standard 5) 4. Primary school (Standard 8) 5. Secondary school 6. Post-secondary 7. Others (specify)
Respondent				
Member 2				
Member 3				
Member 4				
Member 5				

1.27 Where do you get your domestic water from? *[multiple options possible]*

1. Piped into dwelling
2. Borehole
3. Piped to plot
4. Spring
5. Public tap/standpipe
6. River/stream [if chosen go to 1.28]
7. Open well in plot
8. Pond/lake
9. Open public well
10. Rainwater
11. Protected well in plot
12. Tanker truck
13. Protected public well
14. Other, ….

1.28 Where do you get water for agriculture from?

1. Well in plot
2. Borehole
3. Piped to plot
4. Pond/lake
5. Rainwater
6. River/stream
7. Other, ….

1.29 Is there a river close to your village?

1. Yes [go to 1.29]
2. No [go to 1.32]

1.30 How far is this river away from your home? [Distance: walking time one way]

……. hours, …….. min

1.31 Is the river without water during the dry season?

1. Yes [Go to 1.31]
2. No [Go to 1.32]

1.32 If yes, for how many weeks/months per year?

……………………………..

1.33 Are you a member of any of committee?

1. Yes [Go to 1.33]
2. No [Go to 2]

1.34 If yes, which committee?

Committee	[Thick if yes]
Village Natural Resource Committee	
Village Development Committee	
[WATER-RELATED GROUP]	
[HEALTH-RELATED GROUP]	
[SAVING SCHEME]	
[FARMER GROUP]	

2. Forests

Now, we would like to ask some questions about forest areas surrounding your community

[Do questions for the first forest area, then for the next; for all forests. For every forest reserve ask 2.7 and 2.8 - leave some rows open in between forest areas - put each product collected in a separate row.]

[2.1] **Do you collect goods and products from forest?**	[2.2] **What kind of products do you collect?** *[put each product collected in a separate row and then ask 2.3, 2.4, 2.5, 2.6 for each product]*		[2.3] **How many of these products do you collect?**		[2.4] **Did you sell any of the products you collected since July 2016?** **If yes, how much money did you get – per unit or in total?** *[if no, put zero]*		[2.5] **How much do you pay the permit for extracting these products?**		[2.6] **We know would like to know from which forest you get these products?** *[record quantity of each product for each forest]*	
1 Yes 2 No [Go to 2.8]	1 Firewood 2 Charcoal 3 Timber 4 Poles 5 Fruits 6 Fodder	7 Fertiliser 8 Medicine 9 Grasses 10 Animals (hunting) 11 Other, specify	Quantity and unit (e.g. 3 bundles)	Time unit (e.g. in a year, in a month, in a week)	Per unit in MKW	In total in MKW	Price MK	Unit (e.g. for a trip, for a bundle)	Forest name	Quantity

2.7 We would like to know how far are these forests away from your home [*name/point forests from household map*]**?**

Forest name	**Distance: walking time one way** **… hours, .. min** *[only use km if time is not possible]*

2.8 In addition to products that you collect, what other effects do the forests around your community have on your livelihood, either positive or negative?

1. Water provision
2. Crop diseases
3. Flood protection
4. Shade
5. Fertile soils
6. Fresh air
7. Pests
8. Dangerous animals
9. Shelter from wind
10. Other, specify

3. Choice Experiment

In this section, we would like you to express your opinion about the options presented

read out Introduction of the policy problem to respondent

3.1 How is the quality of the forests around your community?

	Forest 1	Forest 2	Forest 3
1. Good			
2. Medium			
3. Poor			
4. Don’t know			

read out Policy scenario to the respondent

3.2 Are you interested in collecting any of these products?

a.	Firewood	1. Yes 2. No
b.	Timber	1. Yes 2. No
c.	Poles	1. Yes 2. No
d.	Other products?	1. Yes, specify....... 2. No

3.3 How much quantity of these products do you expect to get from 1 tree?

a.	Firewood	.... bundles
b.	Timber	.... planks
c.	Poles	.... bundles

3.4 Do you understand how the new management system will work?

1. Yes
2. No [explain again]

read out Policy options to the respondent - show attribute card

read out Example choice card to the respondent – show example choice card

3.5 Do you understand how the licenses will be distributed among members of the group village?

1. Yes
2. No [Explain again]

read out opt-out option to the respondent – show example choice card

3.6 Which option do you prefer?

1. A [skip 3.6 and 3.7]
2. B [skip 3.6 and 3.7]
3. C [go to 3.6]

3.7 Why did you choose C?

…………………………………………..

3.8 Are you sure that you will be able to afford the payment for the option you choose?

1. Yes, I am sure I can pay [Yes]
2. I think I can find the money [Maybe]
3. No, it will be too difficult for me to pay [No]

You will now see 6 of these choice cards. These are all different situations, not additional. Please at each card, choose the option that you believe would be the best option to improve the livelihood of you and your household.

- *Note down version.*
- *show first card to respondent.*
- *Ask which option s/he would choose.*
- *ask 'why do you choose this option' if choice = opt-out*
- *Go to the next card.*
- *Do not go back and forth between cards. Do not compare cards in your explanation*

VERSION:…………..								
CARD	**Which option do you prefer?**			*[if respondent chose C]* **Why did you choose C?**	**CARD**	*[For a random card]* **Are you sure that you will be able to afford the payment for the option you choose?**	
Card 1	3.9	□ A □ B □ C	3.10		Card 1	3.11	□ Yes □ Maybe □ No
Card 2	3.12	□ A □ B □ C	3.13		Card 2	3.14	□ Yes □ Maybe □ No
Card 3	3.15	□ A □ B □ C	3.16		Card 3	3.17	□ Yes □ Maybe □ No
Card 4	3.18	□ A □ B □ C	3.19		Card 4	3.20	□ Yes □ Maybe □ No
Card 5	3.21	□ A □ B □ C	3.22		Card 5	3.23	□ Yes □ Maybe □ No
Card 6	3.24	□ A □ B □ C	3.23		Card 6	3.26	□ Yes □ Maybe □ No

4. Feedback on exercise

Thank you. We would like to know what you thought about the choices that you were asked to make.

4.1 When were you making your choices where there any attribute that you never looked at? [POINT AT ONE CARD WHILE ASKING THIS QUESTION]

	Tick if it's mentioned	Why didn't you consider it?
Number of trees available for your households		
Number of trees available for the worse-off households		
Number of trees available for the better-off households		
The availability of water in the river		
Co-management fee		

4.2 When you were making your choices did you consider the differences in the number of trees between better-off and worse-off households?

Yes

No [go to 4.4]

4.3 Why did you choose a certain distribution of number of trees between better-off and worse-off households?

I wanted to give more trees to the rich because they can take better care

I wanted to give more trees to the poor because they need them

I wanted an equal number of trees among each other

Other reasons, specify…………

4.4 How many people do you think are poorer than you in this village?

Many people are poorer than I

About half of the people are poorer than I

Few people are poorer than I

4.5 Do you think that the forest will improve with the new management agreement? If not, why?

1. Yes
2. No, because………

4.6 Do you think that the members of community will respect the rules set by the whole village more than the current rules?

1. Yes
2. No

4.7 Do you think that the committee can be trusted with the implementation of the new management agreement?

1. Yes
2. No, because……………………………………………………………

5. Statements

[READ OUT THE TEXT ON CARD STATEMENTS. INCLUDE THE RESPONSES IN THE TABLE BELOW]

		agree with left	Neither	Agree with right	
	Vehicle payment				
A	It is my right to collect trees from the forest reserve without paying anything	1	2	3	I believe is right paying a fee for access the forest so that people do not cut too much trees
	Trust toward scenario				
B	I believe that the community, with the support of the forestry department, will be effective in managing the forest and it will improve	1	2	3	I don't believe that co-management will be effective and that the forest will improve
C	I believe that the money collected will not be used for improving our forest	1	2	3	I believe that the money collected will be used by the committee for better managing our forest
D	Forests brings benefits for the whole community so we should all invest in it	1	2	3	Those who are interested in harvesting products from the forest should pay for its management
	Fairness				
E	The members of the group village that are not doing well shouldn't pay for collecting trees	1	2	3	Everyone should pay for collecting trees because we all harvest products from the forest
F	We should agree on how to divide the number of trees that we can collect	1	2	3	If we all pay the same fee we should be allowed to collect the same number of products

Closing interview

Thank you very much for your participation.

Is there anything else that you would like to know about this survey or the project?

……………………………………………

……………………………………………

The information that you have given us is very valuable to our project. Remember that the information you gave will be treated confidentially and you will remain anonymous. The choices we have discussed are for research purposes only, and our work is not related to any project currently planned for your village.

6. **Quality of interview**

6.1 Do you believe that the respondent understood the CE well?

- □ Understood very well
- □ Understood well
- □ Understood a little
- □ Did not understand
- □ Did not understand at all

6.2 Did the respondent pay attention throughout the interview?

- □ Paid attention constantly
- □ Paid attention mostly, only sometimes distracted
- □ Was distracted often, paid little attention
- □ Was distracted often, walked away

6.3 Did the respondent paid attention to all CE cards?

- □ Paid attention to all
- □ Paid attention to some (at the beginning)
- □ Didn't pay attention to the cards

6.4 Do you think that the respondent answered the questions truthfully?

- □ Yes
- □ No, I think s/he did not complete part ………………….. truthfully
- □ No, I think s/he provided socially desirable responses.
- □ No, I think s/he did not understand the questions sufficiently to be able to respond truthfully

6.5 Is there anything else you want to add about how the interview went?

……….

C.2 Scenario description

Introduction of the policy problem

Currently Namizimu forest reserve is managed by the state. You, or other members of your household and your village, can harvest trees and collect other forest resources within the rules set by the forest department.

These rules are not always observed by people. Cutting trees without any limit reduces the quality of the forest, and therefore also the quantity and the quality of trees that you can collect in the future.

Cutting too much trees affects also the streams, so that there is less water available in the streams during the dry season.

The government is discussing the implementation of another way to manage Namizimu forest to improve the current situation.

Policy scenario

We now want to discuss with you a possible new way of managing Namizimu forest. We are doing this research to understand your personal opinion, and we will ask many other people to give their opinion too.

The new management agreement will allow members of your village to harvest trees for timber, poles and firewood. But the quantity that all members of the village every year can collect has to be limited. In this way, the forest reserve can improve.

The forest reserve will be divided in management blocks and all the members of the village will be responsible for the management of a specific block. The members of the village will decide how many trees can be harvested by every household per year. The forest department will help the village to set the harvesting rules so that the forest can improve.

Under the new agreement, people that wish to access the forest reserve and collect products will be asked to contribute by paying an annual membership fee. The fee can be paid in 4 instalments per year. The fee will give you permits to collect a certain number of trees for timber, poles and firewood in a year. Collection of fruits, mushrooms, fibres, thatch grass, bamboos and three bundles a week of firewood from dead, dry and diseased trees per household will be allowed without any limit.

A new committee composed of village members and elected by the whole village will be responsible of the collection of the fees and distribution of the permits.

The total amount of fees collected by the committee will be used for funding all the management activities. This will include boundary marking, firebreak maintenance, patrolling, tree planting and management of permits for collecting trees.

If you are caught harvesting woody products in the forest reserve without holding a permit, you have to pay a penalty of four times the annual fee. Moreover, the forest products collected, and the tools used will be confiscated.

Policy options

Now we are going to ask you a few questions. In each question, you will see different options and you need to choose the option you prefer most.

These are options for the management of the forest block assigned to your village.

[POINT AT RELEVANT PICTURES IN ATTRIBUTE CARD]

Every option includes the number of trees that you, or other members of your household, could harvest in a year.

With the implementation of the new harvesting rules the forest will improve and there will be more water available in the stream in the dry season. Therefore, each option includes the number of months in which the river will have water at low level but still flowing.

Under this agreement, the quantity of trees that can be collected every year by each village members are limited. Therefore, it has to be decided who will be allowed to harvest and how much trees can be collected by every village member. The village members will decide the rules for distributing the limited number of trees between worse-off and better-off households.

Everyone who wants to collect forest products will pay the same fee that will be used for the management of the forest. But the number of permits distributed to every household will be different based on their wealth status. Therefore, every option includes the number of trees that will be available to households who are doing worse than you and the number of trees that will be available to households that are doing better than you.

The option that the majority of the village members choose will be adopted. It is therefore important that you express which of the options you prefer most.

Example choice card [SHOW EXAMPLE CHOICE CARD]

Now we will show you a card with two options. As you can see, the options are different. We ask you to choose which option you prefer for the management of your village block

[SHOW EXAMPLE CHOICE CARD]

In option A, your household could collect in total 15 trees in a year

Your village will experience 3 months with low level of water in the river but still flowing.

The distribution of permits between members of the village will be different. The households doing worse than you will get permits for harvesting 0 tree per year, and the households doing better than you will get permits that allow to harvest 8 trees per year.

In option B, your household could collect in total in a year 8 trees.

Your village will experience 1 month with low level of water in the river but still flowing.

In a year, the households of the village doing worse than you will get licences for harvesting 8 trees and the household doing better then you will get licenses that allow to harvest 15 trees.

Please be assured that there are no correct choices, we just want your opinion.

Opt-out option

It is possible that you are not interested in implementing this new management agreement. In that case, you can choose Option C. This option means that you prefer to keep things as they are in the current situation. The forest reserve continues to be managed by the state and you will collect forest products following the rules of the department of forestry. When you make your choices, please keep in mind how much you are able to pay, given your annual cash income and the income you would get from the forest products. If you cannot afford to pay the annual membership fee than you will not have access to the forest reserve to harvest trees for forest products.

Please be assured that there are no correct choices, we just want your opinion.

We are going to show you 6 of these cards. We ask you to choose your preferred option every time. The cards are not related. So, you cannot go back to change the choice you first made, and you would only pay the fee once, not for all the cards you choose together

C.3 List of references

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N.J., Bauch, S., Börner, J., Smith-Hall, C., Wunder, S., 2014. Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. World Dev. 64, S12–S28.

Barr, A., Burns, J., Miller, L., Shaw, I., 2015. Economic status and acknowledgement of earned entitlement. J. Econ. Behav. Organ. 118, 55–68.

Bouma, J., Ansink, E., 2013. The role of legitimacy perceptions in self-restricted resource use: A framed field experiment. For. Policy Econ. 37, 84–93.

Cappelen, A.W., Hole, A.D., Sorensen, E., 2007. The Pluralism of Fairness Ideals: An Experimental Approach. Am. Econ. Rev. 97, 818–827.

Cappelen, A.W., Moene, K.O., Sørensen, E., Tungodden, B., 2013. Needs versus entitlements-an international fairness experiment. J. Eur. Econ. Assoc. 11, 574–598.

Cardenas, J.C., 2009. Experiments in Environment and Development. Annu. Rev. Resour. Econ. 1, 157–182.

Charness, G., Rabin, M., 2002. Understanding social preferences with simple tests. Q. J. Econ. 117, 817–869.

D’Exelle, B., Lecoutere, E., Van Campenhout, B., 2012. Equity-Efficiency Trade-Offs in Irrigation Water Sharing: Evidence from a Field Lab in Rural Tanzania. World Dev. 40, 2537–2551.

Jakiela, P., 2015. How fair shares compare: Experimental evidence from two cultures. J. Econ. Behav. Organ. 118, 40–54.

Kerschbamer, R., 2015. The geometry of distributional preferences and a non-parametric identification approach: The Equality Equivalence Test. Eur. Econ. Rev. 76, 85–103.

Konow, J., 2001. Fair and square: The four sides of distributive justice. J. Econ. Behav. Organ. 46, 137–164.

Levitt, S.D., List, J.A., 2007. What Do Laboratory Experiments Measuring Social Preferences Reveal About the Real World? J. Econ. Perspect. 21, 153–174.

Martin, A., Kebede, B., Gross-Camp, N., He, J., Inturias, M., Rodríguez, I., 2019. Fair ways to share benefits from community forests? How commodification is associated with reduced preference for equality and poverty alleviation. Environ. Res. Lett. 14, 064002.

McFadden, D.L., 1999. Rationality for economists? J. Risk Uncertain. 19, 73–105.

Schüring, E., 2014. Preferences for Community-based Targeting - Field Experimental Evidence from Zambia. World Dev. 54, 360–373.

Train, K., Weeks, M., 2005. Applications of Simulation Methods in Environmental. Appl. Simul. Methods Environ. Resour. Econ. 1–16.

White, P.C., Bennett, A.C., Hayes, E.J., 2001. The use of willingness-to-pay approaches in mammal conservation. Mamm. Rev. 31, 151–167.

Willcock, S., Hooftman, D.A.P., Balbi, S., Blanchard, R., Dawson, T.P., O'Farrell, P.J., Hickler, T., Hudson, M.D., Lindeskog, M., Martinez-Lopez, J., Mulligan, M., Reyers, B., Shackleton, C., Sitas, N., Villa, F., Watts, S.M., Eigenbrod, F., Bullock, J.M., 2019. A Continental-Scale Validation of Ecosystem Service Models. Ecosystems.

Appendix D Supplementary information Chapter 5

D.1 Structural choice model

We estimate the parameters of the utility function defined in (14) using a random utility framework (McFadden, 1974). In the random utility framework, the total individual utility (U_n) is assumed to be the sum of a deterministic part (V_n) and a random error term (ε):

$$U_n(y) = V_n(y) + \varepsilon_i \qquad (25)$$

Given our set-up the dictator chooses the optimal allocation from a discrete set of *Y* values ranging between 0 (where he gives everything to the recipient) to 320 (when he keeps everything for himself) in intervals of 20. Out of the 16 possible values, the individual chooses alternative *j*, i.e. a specific *Y*, over any alternative *i* if $U_n(y^*) \geq U_n(y)$. The probability of choosing alternative *j* is then given by:

$$Prob(j|J) = Prob(V_{nj} - V_{ni} > \varepsilon_{ni} - \varepsilon_{nj})$$

By assuming that the error term, ε_i, follows a type I extreme value distribution we derive McFadden's conditional logit model (Train, 2003), where the probability of choosing the alternative that maximises the dictator's utility is given by:

$$Prob(j|J) = \frac{e^{V_{nj}}}{\sum_{i=1}^{J} e^{V_{ni}}} \qquad (26)$$

The model is estimated through maximum likelihood, with the parameter β representing the importance attached to fairness consideration, and the procedure-specific parameters δ_R, δ_E and δ_U denoting the magnitude of self-serving bias. The fair share prescribed by the norm, η^k, is exogenous to the model and calculated as in (13).

For β = 0 the individual is completely selfish while for β > 0 the individual is willing to forego some of his income to be fair. The amount that is believed to be fair in each context depends on δ_p and we can distinguish different "type" of fair behaviour. For $\delta_p = 1$ the dictator believes that he should keep exactly the amount prescribed by the fairness norm for himself and he is fully compliant with the relevant fairness norm. If $\delta_p > 1$ the dictator believes that he should keep more than the fair share prescribed by the norm while if $\delta_p < 1$ the dictator believes that he should keep less.

The model estimation results presented in Table D.2 show that all parameters are statistically significant. Following our theoretical framework, we hypothesized that the procedure-specific parameter, δ, for the earned and unfair procedure is higher than when a random procedure is employed. The δ parameter for the random procedure is higher than 1 indicating that on average dictators in the random treatment believe that is fair to keep for themselves more of what is the fair (egalitarian) share. The δ parameter for the earned procedure is higher than for the random procedure (p-value < 0.05), indicating support for the first hypothesis (H1), i.e. being allocated the dictator role because of merit increases what is believed to be a fair share for the dictator, so that the dictator keeps a higher amount for himself. As described in equation 15, the optimal choice for dictator is influenced by what is believed to be a fair share, $\delta_p \eta^k$.

Table D.2 Estimates of the conditional logit model

β	2.3589	***
	(0.1428)	
δ_{Random}	1.0743	***
	(0.0514)	
δ_{Earned}	1.2408	***
	(0.0567)	
δ_{Unfair}	1.3272	***
	(0.0614)	
Log-likelihood	-495.24	
Number of observations	200	
Post-estimation calculations		
$\delta_R - \delta_E$	-0.1665	**
	(0.0755)	
$\delta_R - \delta_U$	-0.2529	***
	(0.0787)	
$\delta_E - \delta_U$	-0.0864	
	(0.0802)	

Note: *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses.

The second hypothesis (H2) is also supported by the model estimation results. The δ parameter for the unfair procedure is higher than for the random procedure (p-value < 0.01), meaning that unfair procedures decreases the relevance of the fairness norms and dictators keep more for themselves compared to a random procedure. Using the delta method, we tested whether the difference between the δ parameter for the earned procedure is significantly different from the δ parameter for the unfair procedure. We find that the difference is not significantly different from zero (p-value=0.28). The procedural fairness hypothesis assumes that being exposed to a violation of fairness norms, e.g. unfair procedures in the assignment of decision-making roles, influences self-serving bias and increases the amount kept by dictators compared to a situation where procedures are perceived as fair. Our results support this hypothesis when comparing unfair procedures to random.

D.2 Sorting task and perception of fairness across gender categories

The literature has highlighted that gender matters for performance in competitive tasks within experimental setting (Gneezy et al. 2003). Moreover, females could potentially be facilitated when asked to perform a sorting task compared to males, due to the familiarity of the task which females perform daily at home.

We verified during our pilot that males did not perform worse than females. Moreover, given that the endowment provided to the dictators is fixed and does not depend on performance, a difference across gender would be problematic just if it affected procedural fairness perceptions. As shown in Table D.3 both males and females perceived the unfair allocation mechanism as unfair while the random and earned procedure was perceived as fair.

Table D.3 Contingency table of perceived procedural fairness of participants across role allocation mechanisms

	Male sample				**Female sample**			
Role allocation mechanism		**Unfair or very unfair**	**Fair or very fair**	**Total**		**Unfair or very unfair**	**Fair or very fair**	**Total**
Random	Random	9%	91%		Random	4%	96%	
		(1)	(10)	11		(2)	(54)	56
Earned	Earned	0%	100%		Earned	14%	86%	
		(0)	(17)	17		(7)	(44)	51
Unfair	Unfair	88%	13%		Unfair	61%	39%	
		(14)	(2)	16		(30)	(19)	49
Total				44				156

D.3 Gender composition of sample

Table D.4 shows the gender composition across treatments. Overall, females participated more often than males: 78% of participants are female. The difference in participation of women and men across villages varies across treatments. The treatments most affected by this sampling imbalance are the random-high and unfair-low treatments, where the total number of females is much lower compared to the other treatments (respectively 58.8% and 65.6%).

Table D.4 Distribution of males and females across treatments

Gender	Treatment						Total
	Random – zero	Random – positive	Earned – zero	Earned - positive	Unfair - zero	Unfair - positive	
Males	8.8%	41.2%	8.8%	24.2%	34.4%	15.2%	22.0%
	(3)	(14)	(3)	(8)	(11)	(5)	(44)
Females	91.2%	58.8%	91.2%	75.8%	65.6%	84.8%	78.0%
	(31)	(20)	(31)	(25)	(21)	(28)	(156)
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	(34)	(34)	(34)	(33)	(32)	(33)	(200)

In the regression analysis (presented below) we explore the impact of this gender imbalance on the treatment effects.

D.4 Regression analysis with female sub-sample

Table D.5 reports the results of the ordinary least squares (OLS) regression model, where the response variable is the dictator's allocation to the recipient. The experimental sessions in each village were attended on average by more females (78% of our sample). The low number of males prevented us from verifying if the gender effect in Model 1a and 2a (Section 5.5.3) is a result of a sampling bias or if there is a true underlying effect. Therefore, we estimated the same regression models using the female sub-sample (Models 1, 2, 1a and 2a) to verify the robustness of the experimental factors. The significance of the influence of the unfair procedures on average allocations is also found in the female sub-sample together with a significant effect of the recipient's endowment. Therefore, we conclude that the unfair procedure has a strong effect on the amount dictators sent, which is robust across the endowment variations and to the inclusion of socio-economic variables. Finally, the earned procedure appears insignificant with the female sub-sample indicating that it may be linked to a gender effect, however given the low number of males it may also be an effect due to data noise.

Table D.5 OLS regression results: average amount sent by dictators to recipients

	Model (1) – female only		Model (2) – female only		Model (1a) – female only		Model (2a) – female only	
Constant	40.0%	***	40.9%	***	36.7%	***	37.5%	***
	(2.750)		(3.201)		(6.069)		(6.592)	
Earned treatment	-4.1%		-3.2%		-4.4%		-3.1%	
(1=Yes, 0 otherwise)	(3.465)		(4.527)		(3.620)		(4.982)	
Unfair treatment	-8.8%	***	-16.2%	**	-9.4%	**	-14.0%	**
(1=Yes, 0 otherwise)	(2.901)		(5.038)		(3.942)		(5.645)	
Recipient endowment	-11.1%	***	-11.2%	***	-9.4%	**	-10.8%	**
(1=Yes, 0 otherwise)	(3.615)		(5.112)		(3.034)		(5.425)	
Recipient endowment x Earned			-1.7%				-2.7%	
			(4.596)				(7.616)	
Recipient endowment x Unfair			-9.8%				8.1%	
			(7.253)				(7.876)	
Total number of household members					-0.6%		-0.7%	
					(0.920)		(0.945)	
Livestock ownership dummy (1=yes, 0 otherwise)					2.1%	**	2.1%	**
					(0.994)		(1.018)	
Land size (Acres)					-0.1%		-0.2%	
					(1.605)		(1.617)	
Age (years)					2.1%		0.2%	
					(0.994)		(0.173)	
Observations	156		156		148		148	
Adjusted R2	0.109		0.115		0.114		0.116	

Notes: *p<0.1; **p<0.05; ***p<0.01. Standard errors in parentheses. We excluded nine individual's choice from the dataset when estimating model 1a and 2a because we had no information on age or household size. Dependent variable: percentage of dictator's endowment allocated to the recipient

D.5 Experiment instructions

Game introduction and task [All group]

[TO BE READ ONCE THE GROUP OF PARTICIPANTS IS FORMED]

Thank you for coming here today and participating in this study. It will approximately last [TIME]

It is important that you do not talk to any of other participants until the experiment is over. Thank you very much!

Now I am going to explain how the game will work and you can decide afterwards, if you want to keep participating. You are free to withdraw at any time and you will receive as a minimum compensation 100 MK.

This is a game on making choices. In addition to the 100 MK for participation you will have the opportunity to earn more money depending on your choices and the choices of the others.

When you came in today, each of you draw a piece of paper. The piece of paper has a number. Please keep this piece of paper with you because we will use it during the game. You will also need it at the end of the study to claim your money.

Now, this exercise is about sharing money between you and your partner. The money that you are receiving today comes from the University of Southampton in the UK.

Any money you get will be paid privately and in cash at the end of the game after answering a short questionnaire. If you decide to leave before you will receive just the show-up fee.

Each of you will be paired with a player from this group and you will form a pair. But you will never know who he/she is, you will not know who you are paired with.

The pairing will be performed by [RESEARCHER] by drawing numbers from these two cups [RA EXTRACTS NUMBERS AND MAKE THE PAIR]. This is how the pairing will be done. The researcher will do the pairing far away from you and record the pairs on a sheet that we will use at the end for calculating the payments. No one except the research team will know who is paired with who.

Do you understand how you will be paired with another person?

Any question?

Your pair will be allocated a sum of money and one member of the pair will be asked to decide how to divide this amount of money between him/herself and his/her partner.

[RANDOM TREATMENT] We will assign you a role based on chance depending on the number of the piece of paper that you picked when you arrived. Since the role of choosing how to divide the money is assigned randomly everyone has an equal chance to get the role.

[EARNED TREATMENT] We will assign you a role based on your performance in a sorting task. The players that sort more beans in one minute will earn the role to decide how to divide the money.

[UNFAIR TREATMENT] We will assign you a role based on your performance in a sorting task. The players that sort more beans in one minute will earn the role to decide how to divide the money.

You can now decide whether you want to continue with the experiment by accepting your role and the rules or you can leave with the show-up fee.

Important: participation is voluntary!

Are you all happy to keep participating in the experiment?

Now we will divide you in two groups.

[RANDOM TREATMENT]

If you drew numbers from 1 to 12 please go with [Name of RA].

If you drew numbers from 13 to 24 please go with [Name of RA]

[EARNED TREATMENT]

Now I will give you the material to perform the task. [Explain the task]

[TIME FINISHED]

[RA GOES AND COUNT BEANS AND MAKE A RANKING]

Now we will divide you in two groups.

[FIRST 12 CALLED BY NUMBER] please go with [Name of RA].

[LAST 12 CALLED BY NUMBER] please go with [Name of RA]

[UNFAIR TREATMENT]

Now I will give you the material to perform the task. [Explain the task]

[TIME FINISHED]

[RA GOES AND COUNT BEANS AND MAKE A RANKING]

[UNFAIR TREATMENT] Now we will divide you in two groups based on how many red and white beans you sorted. But the bags that you got to sort were not equal, some bags contained more beans than others. So, you did not all have the same opportunity to gain the role of the person who decides.

[FIRST 12 CALLED BY NUMBER] please go with [Name of RA].

[LAST 12 CALLED BY NUMBER] please go with [Name of RA]

Instructions for group of dictators

Your pair will be allocated 320 kwacha.

We ask each of you to choose how you want to divide this money between you and your partner.

This “fake” money represents the 320 kwacha that are allocated to your pair. Every note is worth 20 kwacha.

[PUT THE MONEY IN THE MIDDLE BETWEEN THE TWO ENVELOPES]

You have received 0

[SHOW THE BROWN ENVELOPE EMPTY]

Your partner in the other group has received 0/80

[SHOW THE WHITE ENVELOPE EMPTY]

Now each of you must decide how much of the money that your pair has [320] you want to send to your partner and you can do this by placing money in the white envelope [PUT SOME OF THE 200 IN THE WHITE ENVELOPE], and how much you want to keep for yourself by placing money in the brown envelope [PUT MONEY IN THE BROWN ENVELOPE]. You can choose to send any amount you want, anything from nothing to all the money. Please remember that this is just your choice and there is no wrong or right choice.

The money placed in the envelopes will be given to you and your partner in cash at the end of the exercise.

[RA make demonstration with notes and envelopes]

Do you have any question?

Each of you will go one-by-one to the [PLACE]. There, no one can see what you choose. There, you choose how much money you want to give to your partner by putting it in the white envelope and how much you want to keep for yourself by putting it in the brown envelope. You will then put the envelopes in this bigger envelope and give it to me and at the end of the game you will earn the money that you choose to keep for yourself, and your partner will get the money that you decided to give to him. You will never know who the person to whom you send the money to, and he/she will never know your identity; they will never know who they got the money from.

Appendix D

Do you have any question?

[PARTICIPANTS MAKE A CHOICE ONE BY ONE]

Instructions for recipients

Your pair will be allocated 320 kwacha.

Your partner will then choose how he/she wants to divide this money between him/herself and you.

This “fake” money represents the 320 kwacha that are allocated to your pair. Every note is worth 20 kwacha.

[PUT THE MONEY IN THE MIDDLE BETWEEN THE TWO ENVELOPES]

You have received 0/80

[SHOW THE EMPTY WHITE ENVELOPE]

Your partner has received 0

[SHOW THE EMPTY BROWN ENVELOPE]

Now your partner will decide how much of the money that he has [320] he/she wants to send to you, and how much he/she wants to keep for him/herself. [DEMONSTRATE WITH FAKE MONEY]

The choice that he/she makes determines how much you and your partner will be given in cash at the end of the experiment.

[RA demonstrates with notes and envelopes]

We want to know, independently from the choice that your partner is making, what do you think will be a fair division of money.

Each of you will come with me in a place where no one can listen what you say, and you will tell me what you think your partner should give to you as a fair share.

Do you have any question?

Please notice that this will not affect your earnings from the choice that your partner is making.

[RA goes in the designed place and every participant goes there to answer the question]

Appendix D

Closing instructions

We have now finished!

Thank you very much for your participation!

Please come all with me to [DESIGNATED PLACE] where refreshments are available, and you can collect your earned money in cash after answering a quick questionnaire.

Many thanks!

D.6 Post-experiment questionnaire

Name of village		Respondent number	
Date		Experimental session number	
Name of interviewer		Completed	□Yes □No

Questionnaire

Household composition and village activities

I would like to know more about your household composition.

	[1.1] Gender	[1.2] Age	[1.3] Head of household	[1.4] What is the highest level of **education** that you have completed?
	1 Male 2 Female	Age in years	1 Yes 2 No	8. None at all 9. 1 year (Standard 1) 10. 5 years (Standard 5) 11. Primary school (Standard 8) 12. Secondary school 13. Post-secondary 14. Others (specify)
Respondent				

How many people have your household? [total number of people including respondent and children]

…………………………..

How many children, i.e. below 18 years old, have in your household? [Children that live in the house]

…………………………….

1.5 Have you lived in this village since when you were born?

1. Yes, I am from this village [go to 1.8]
2. No, but I am from this area and/or nearby village
3. No, my family and I are from a different area

1.6 How many years ago did you move?

………………… Years

1.7 Is anyone in your household a member of any of the village organisations or committees?

1. Yes
2. No [go to 1.10]

1.8 If yes in which committee/group are you involved?

Committee	[Thick if yes]
1. Village Natural Resource Committee	
2. Village Development Committee	
3. Water-related committee	
4. Health-related committee	
5. Saving scheme	
6. Farmer group	

Farming activities and other income-generating activities

Now we would like to know about your farming activities and other livelihood activities.

1.9 How many plots (including gardens/homesteads) did you use to cultivate crops? *[if none, go to 1.156]*
……………… Minda

[do question 1.13 for all plots but put each crop in a separate row. Ask 1.13 and 1.14 for each crop]

[1.10] Plot no.	[1.11] What is the size of each of these plots?		[1.12] Which crops did you plant in each of this plot?	[1.13] Sales: did you sell any crops since August 2015, if yes, how much?		[1.14] Revenue from sales (in price or total)	
	number	Unit (code) 1. Acre 2. Hectare 3. Square meters 4. Other (specify)		Qt	Unit	Total revenue in MK	Price per unit in MK

We would like to know about your livestock and what you did with from July 2016 to July 2017

1.15 Do you own livestock?

1. Yes
2. No *[go to 1.19]*

1.16 Which type of animals do you own?	1.17 How many animals do you own now (of each type)?	1.18 How much cash did you receive by selling livestock products or live animals over the last harvesting season?
1. cows 2. chicken 3. goats 4. donkey 5. pigeons 6. other, (specify)		In MK

We would like to know if your household had any other source of cash/income over the last year.

1.19 Did your household receive cash/income from any other sources or activities?

1. Yes
2. No *[go to 1.22]*

1.20 Where does your household get that from?

Forest-based activities

1. Roof thatching
2. Brick burning
3. Sales of firewood/bamboo
4. Pit-sawing
5. Charcoal production
6. Charcoal sales
7. Timber sales
8. Other, ……..

Non-forest activities

9. formal employment, for the government or a company/enterprise
10. ganyu/casual labour
11. public works program
12. bicycle and radio repairs
13. selling products other than farm/forest goods (e.g. clothes, prepared food or drinks, sand mining)
14. transfers from relatives living elsewhere / remittances
15. social program run by the government
16. social program run by an NGO
17. Other, …….

1.21 How much income did your household get from these other activities since July 2016 until now (one year)

MK…………………… for ………………………….... *[fill in activity from 1.11]*

MK…………………… for ……………………………. *[fill in activity from 1.11]*

MK…………………… for ……………………………. *[fill in activity from 1.11]*

1.22 Has anyone in your household requested a loan over the past 2 years?

1. Yes
2. No *[go to 1.24]*

1.23 If yes, from who?

1. Neighbours/friends
2. Village banks
3. Other institutions, specify…

1.24 How many people that you can rely on in times of need do you think you have in this village?

1. 0
2. 1-2
3. 3-5
4. 5-7
5. 8-10
6. 11 or more

1.25 Did your household have enough money to pay for important services, such as health and education?

1. Yes
2. No

1.26 On a scale from 1 to 5 how much do you think that people in this village would try to be fair?

	People would try to take advantage				**People would try to be fair**
	1 Pang'ono Kwambiri	2 Pang'ono	3 Pakatikati	4 Kwambiri Pang'ono	5 Kwambiri!
Tick the rating chosen					

1.27 On a scale from 1 to 5, how much do you think people in your village can be trusted?

	People can't be trusted and need to be very careful				**Most people can be trusted**
	1 Pang'ono Kwambiri	2 Pang'ono	3 Pakatikati	4 Kwambiri Pang'ono	5 Kwambiri!
Tick the rating chosen					

Feedback on game

Now we would like to know what you thought about the game.

2.1 During the game, you were paired with someone from the other group to who you gave money to/from who you got money [DEPENDING IF DICTATOR OR RECIPIENT]. Did you know any participants in this other group?

1. Yes
2. No [go to 2.3]

2.2 If yes, how do you know them? *[Multiple options possible]*

1. Family of wife
2. Family of husband
3. Respondents' family
4. Neighbours
5. Members of committee/group I take part in
6. Friends
7. The same village
8. Others, specify……

2.3 [Depending if dictator or recipient] Did you think about those people when you were making your choice/when you were answering the question in the game?

9. Yes
10. No

2.4 In the game you became a recipient/dictator based on chance/winning the sorting game/winning the sorting game when there was an unequal number of beans in the bags. On a scale from 1 to 5 how fair do you think the process was by which you got your role?

	Very unfair				**Very fair**
Tick the rating chosen	1 Pang'ono Kwambiri	2 Pang'ono	3 Pakatikati	4 Kwambiri Pang'ono	5 Kwambiri!

Thank you very much for your participation. Here's your final monetary reward.

You gained [ ] as a show-up fee plus

[FOR DICTATORS] the amount that you choose to keep for yourself

[FOR RECIPIENTS] the amount that your partner has chosen to send you

Thank you very much for your participation!

D.7 Experiment protocol (Pictures)

Figure D.1 Recipients and dictators received their instructions separately

Figure D.2 Dictator's choices: demonstration with envelopes

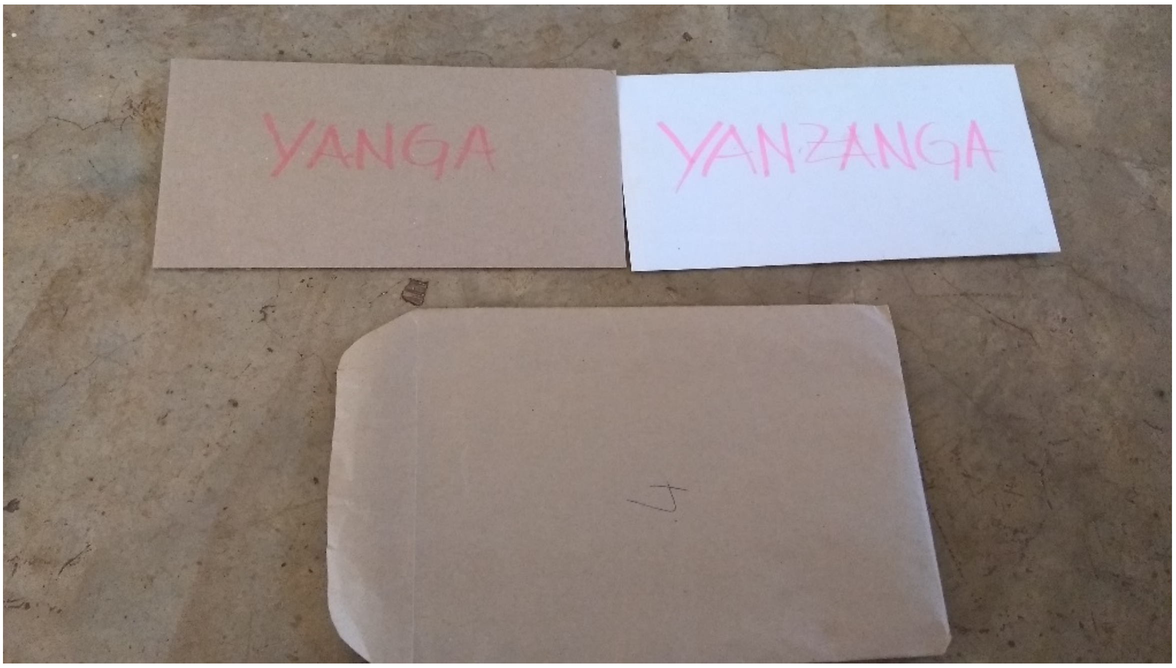

Figure D.3 Envelopes used for dictator's choices (Yanga means “YOU” and Yanzanga means “OTHER”)

Figure D.4 Envelopes used for dictator's choices (fake Malawian Kwacha - local currency)

Figure D.5 Bags with beans used for the sorting task

Figure D.6 Research assistants administering exit questionnaires

D.8 List of references

Ameha, A., Nielsen, O.J., Larsen, H.O., 2014. Impacts of access and benefit sharing on livelihoods and forest: Case of participatory forest management in Ethiopia. Ecol. Econ. 97, 162–171.

Andreoni, J., Bernheim, B.D., 2009. Social Image and the 50-50 Norm: A Theoretical and Experimental Analysis of Audience Effects. Econometrica 77, 1607–1636.

Barr, A., Burns, J., Miller, L., Shaw, I., 2015. Economic status and acknowledgement of earned entitlement. J. Econ. Behav. Organ. 118, 55–68.

Bicchieri, C., 2005. The grammar of society: The nature and dynamics of social norms. Cambridge University Press.

Bicchieri, C., Chavez, A., 2010. Behaving as expected: Public information and fairness norms. J. Behav. Decis. Mak. 23, 161–178.

Bolton, G.E., Brandts, J., Ockenfels, A., 2005. Fair procedures: Evidence from games involving lotteries. Econ. J. 115, 1054–1076.

Bolton, G.E., Ockenfels, A., 2000. ERC: A Theory of Equity , Reciprocity , and Competition. Am. Econ. Rev. 90, 166–193.

Cappelen, A.W., Hole, A.D., Sorensen, E., 2007. The Pluralism of Fairness Ideals: An Experimental Approach. Am. Econ. Rev. 97, 818–827.

Cappelen, A.W., Nielsen, U.H., Sørensen, E., Tungodden, B., Tyran, J.R., 2013. Give and take in dictator games. Econ. Lett. 118, 280–283.

Cappelen, A.W., Sørensen, E., Tungodden, B., 2010. Responsibility for what? Fairness and individual responsibility. Eur. Econ. Rev. 54, 429–441.

Charness, G., Gneezy, U., 2008. What's in a name? Anonymity and social distance in dictator and ultimatum games. J. Econ. Behav. Organ. 68, 29–35.

Charness, G., Rabin, M., 2002. Understanding social preferences with simple tests. Q. J. Econ. 117, 817–869.

Cherry, T.L., Frykblom, P., Shogren, J.F., 2002. Hardnose the Dictator. Am. Econ. Rev. 92, 1218–1221.

Chinangwa, L., Sinclair, F., Pullin, A.S., Hockley, N., 2015. Can co-management of government forest reserves achieve devolution? Evidence from Malawi. For. Trees Livelihoods 8028, 1–17.

Chomba, S., Treue, T., Sinclair, F., 2015. The political economy of forest entitlements: Can community based forest management reduce vulnerability at the forest margin? For. Policy Econ. 58, 37–46.

Dold, M., Khadjavi, M., 2017. Jumping the queue: An experiment on procedural preferences. Games Econ. Behav. 102, 127–137.

Engel, C., 2011. Dictator games: A meta study. Exp. Econ. 14, 583–610.

Fehr, E., Schmidt, K.M., 1999. A Theory of Fairness, Competition, and Cooperation. Q. J. Econ. 114, 817–868.

Fisher, M., 2004. Household welfare and forest dependence in Southern Malawi. Environ. Dev. Econ. 9, 135–154.

Grimalda, G., Kar, A., 2016. Procedural fairness in lotteries assigning initial roles in a dynamic setting. Exp. Econ. 19, 819–841.

Grimalda, G., Kar, A., Proto, E., 2016. Procedural fairness in lotteries assigning initial roles in a dynamic setting. Exp. Econ. 19, 819–841.

Henrich, J., Boyd, R., Bowles, S., Camerer, C.F., Fehr, E., Gintis, H., McElreath, R., Alvard, M., Barr, A., Ensminger, J., Henrich, N., Hill, K.R., Gil-White, F., Gurven, M., Marlowe, F.W., Patton, J.Q., Tracer, D., 2005. “Economic man” in cross-cultural perspective: behavioral experiments in 15 small-scale societies. Behav. Brain Sci. 28, 795–815; discussion 815-55.

Hoffman, E., McCabe, K., Shachat, K., Smith, V., 1994. Preferences, Property Rights, and Anonymity in Bargaining Games. Games Econ. Behav.

Hoffman, E., McCabe, K., Smith, V.L., 1996. Social distance and other-regarding behavior in dictator games. Am. Econ. Rev. 86, 653–660.

Jakiela, P., 2015. How fair shares compare: Experimental evidence from two cultures. J. Econ. Behav. Organ. 118, 40–54.

Jakiela, P., 2011. Social preferences and fairness norms as informal institutions: Experimental evidence. Am. Econ. Rev. 101, 509–513.

Kamanga, P., Vedeld, P., Sjaastad, E., 2009. Forest incomes and rural livelihoods in Chiradzulu District, Malawi. Ecol. Econ. 68, 613–624.

Kittel, B., Kanitsar, G., Traub, S., 2017. Knowledge, power, and self-interest. J. Public Econ. 150, 39–52.

Konow, J., 2010. Mixed feelings: Theories of and evidence on giving. J. Public Econ. 94, 279–297.

Konow, J., 2003. Which is the fairest one of all? A positive analysis of justice theories. J. Econ. Lit. 41, 1188–1239.

Konow, J., 2001. Fair and square: The four sides of distributive justice. J. Econ. Behav. Organ. 46, 137–164.

Konow, J., 2000. Fair Shares: Accountability and Cognitive Dissonance in Allocation Decisions. Am. Econ. Rev. 90, 1072–1091.

Korenok, O., Millner, E.L., Razzolini, L., 2012. Are dictators averse to inequality? J. Econ. Behav. Organ. 82, 543–547.

Krawczyk, M.W., 2011. A model of procedural and distributive fairness. Theory Decis. 70, 111–128.

Krupka, E.L., Weber, R.A., 2013. Identifying social norms using coordination games: Why does dictator game sharing vary? J. Eur. Econ. Assoc. 11, 495–524.

Ku, H., Salmon, T.C., 2013. Procedural fairness and the tolerance for income inequality. Eur. Econ. Rev. 64, 111–128.

List, J.A., 2007. On the Interpretation of Giving in Dictator Games. J. Polit. Econ. 115, 482–493.

Lund, J.F., Treue, T., 2008. Are We Getting There? Evidence of Decentralized Forest Management from the Tanzanian Miombo Woodlands. World Dev. 36, 2780–2800.

Persha, L., Andersson, K., 2014. Elite capture risk and mitigation in decentralized forest governance regimes. Glob. Environ. Chang. 24, 265–276.

Rode, J., Le Menestrel, M., 2011. The influence of decision power on distributive fairness. J. Econ. Behav. Organ. 79, 246–255.

Rustichini, A., Villeval, M.C., 2015. Moral hypocrisy, power and social preferences. J. Econ. Behav. Organ. 107, 10–24.

Trautmann, S.T., van de Kuilen, G., 2016. Process fairness, outcome fairness, and dynamic consistency: Experimental evidence for risk and ambiguity. J. Risk Uncertain. 53, 75–88.

Vyamana, V.G., 2009. Participatory forest management in the Eastern Arc Mountains of Tanzania: who benefits? Int. For. Rev. 11, 239–253.

Appendix E Supplementary information Chapter 6

E.1 Scatter plot of AGB against NDVI

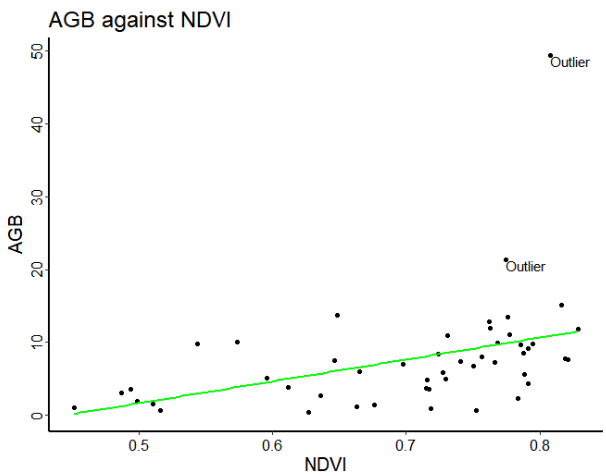

Figure E.7 Scatter plot of AGB against NDVI

E.2 Disaggregated analysis at cluster level

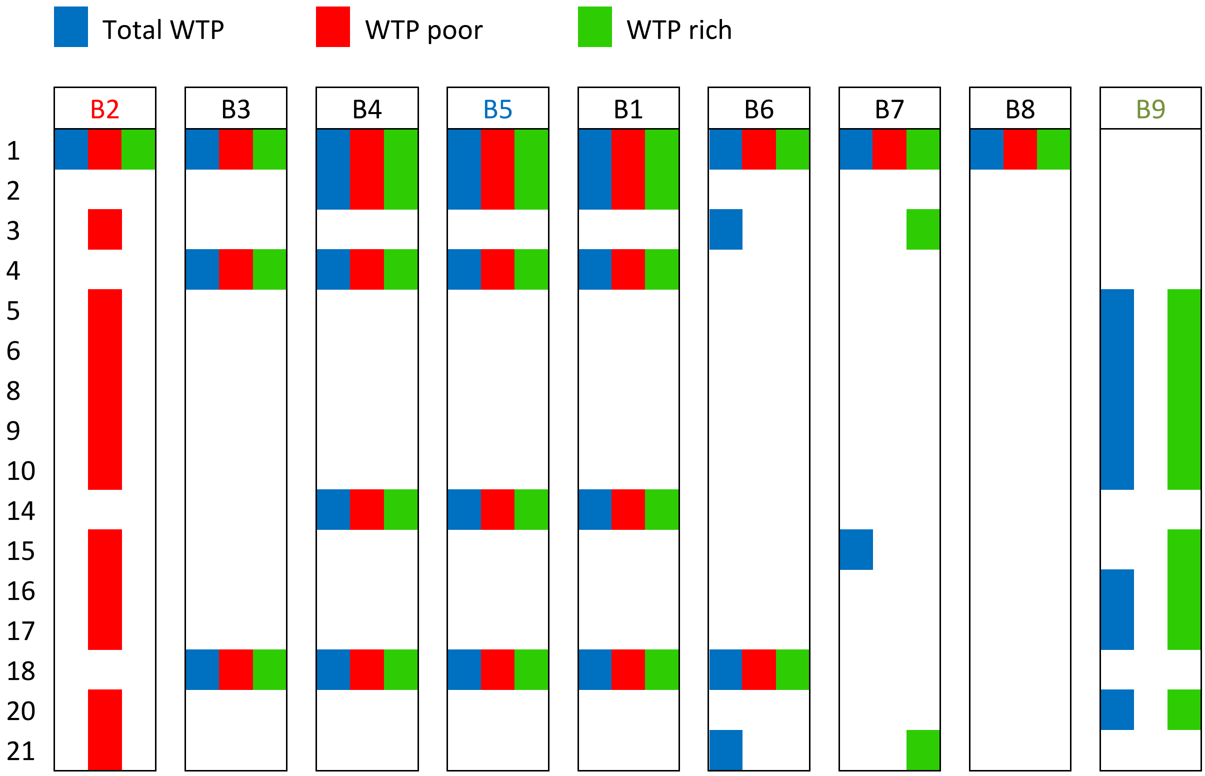

Figure E.8 - Distributional scenarios that maximise the three WTP criteria across clusters (population size 97% of total population)

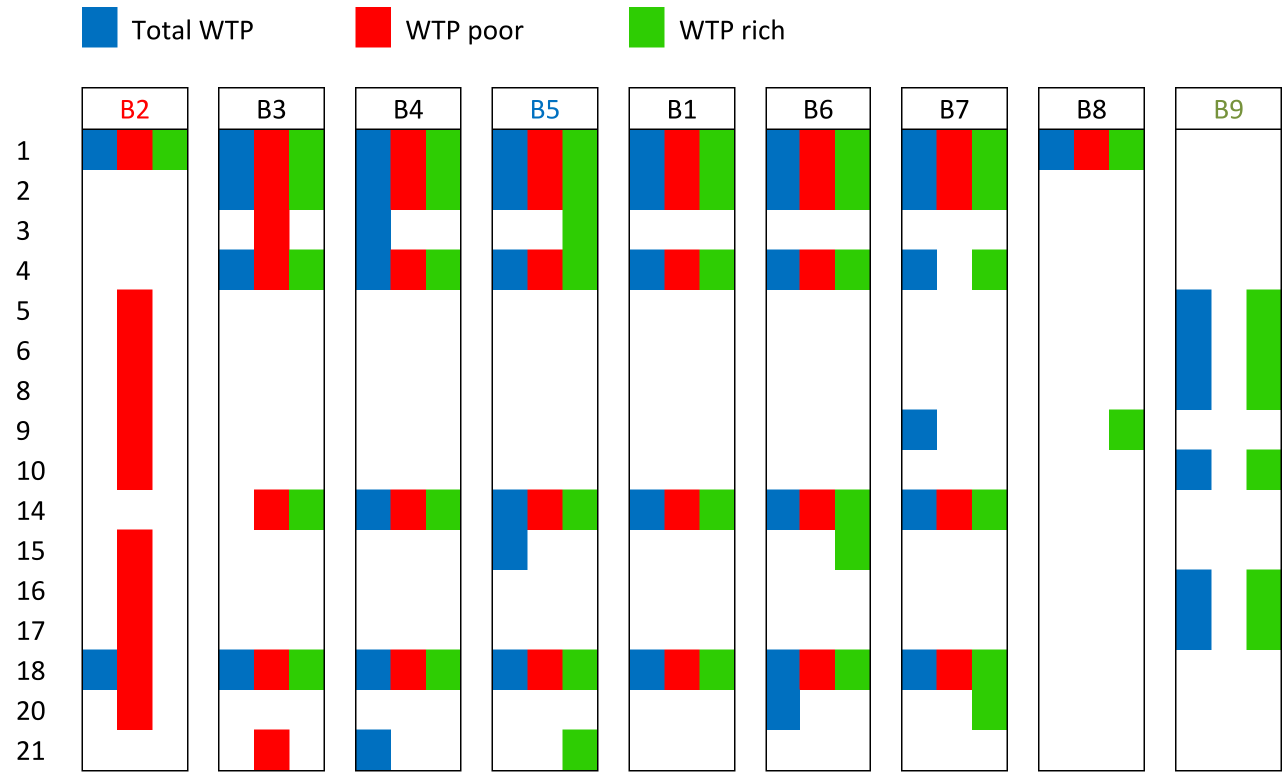

Figure E.9 - Distributional scenarios that maximise the three WTP criteria across clusters (population size 55% of total population)

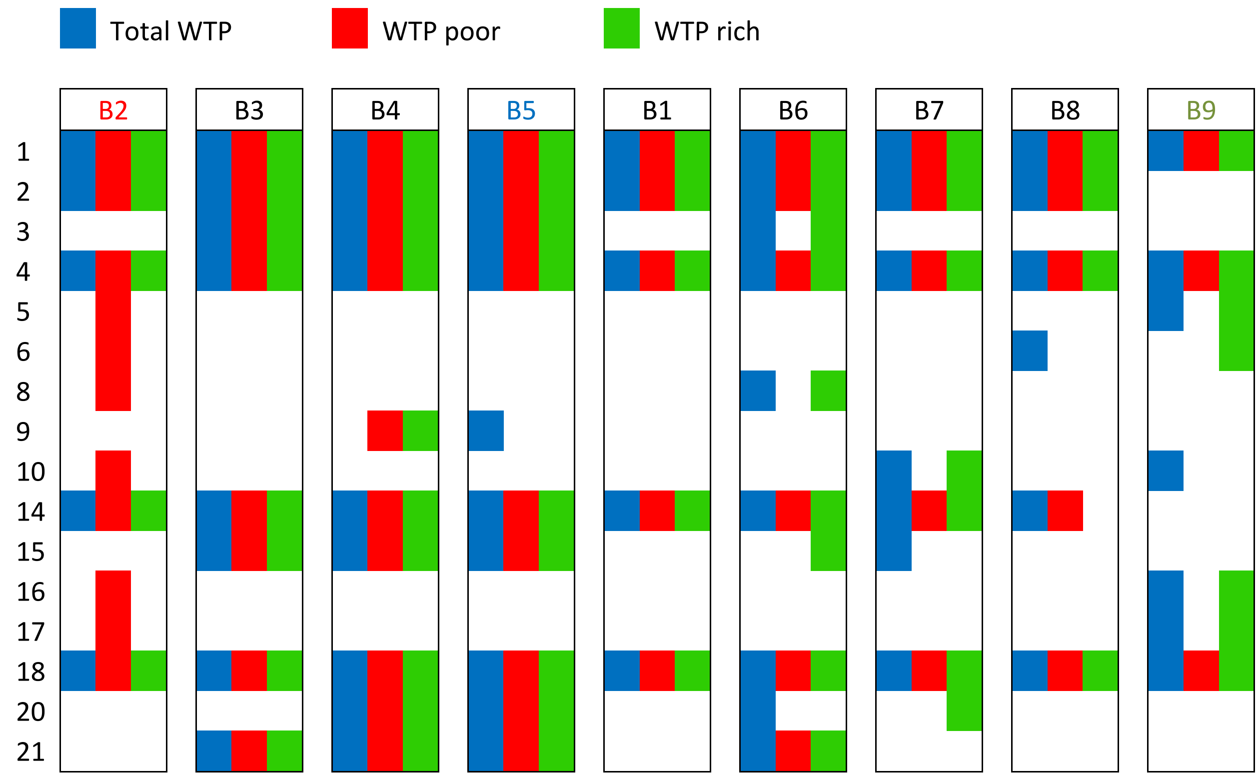

Figure E.10 - Distributional scenarios that maximise the three WTP criteria across clusters (population size 21% of total population)

E.3 List of references

Adhikari, S., Kingi, T., Ganesh, S., 2014. Incentives for community participation in the governance and management of common property resources: The case of community forest management in Nepal. For. Policy Econ. 44, 1–9.

Agrawal, A., 2001. Common property institutions and sustainable governance of resources. World Dev. 29, 1649–1672.

Agrawal, A., Chhatre, A., Hardin, R., 2008. Changing governance of the world's forests. Science (80-.). 320, 1460–1462.

Ala-Hulkko, T., Kotavaara, O., Alahuhta, J., Hjort, J., 2019. Mapping supply and demand of a provisioning ecosystem service across Europe. Ecol. Indic. 103, 520–529.

Albers, H.J., Robinson, E.J.Z., 2013. A review of the spatial economics of non-timber forest product extraction: Implications for policy. Ecol. Econ. 92, 87–95.

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N.J., Bauch, S., Börner, J., Smith-Hall, C., Wunder, S., 2014. Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. World Dev. 64, S12–S28.

Bagstad, K.J., Semmens, D.J., Waage, S., Winthrop, R., 2013. A comparative assessment of decision-support tools for ecosystem services quanti fi cation and valuation. Ecosyst. Serv. 5, 27–39.

Bagstad, K.J., Villa, F., Batker, D., Harrison-Cox, J., Voigt, B., Johnson, G.W., 2014. From theoretical to actual ecosystem services: Mapping beneficiaries and spatial flows in ecosystem service assessments. Ecol. Soc. 19.

Barò, F., Palomo, I., Zulian, G., Vizcaino, P., Haase, D., G??mez-Baggethun, E., 2016. Mapping ecosystem service capacity, flow and demand for landscape and urban planning: A case study in the Barcelona metropolitan region. Land use policy 57, 405–417.

Batjes, N.H., 2008. Mapping soil carbon stocks of Central Africa using SOTER. Geoderma 146, 58–65.

Baumann, M., Ozdogan, M., Wolter, P.T., Krylov, A., Vladimirova, N., Radeloff, V.C., 2014. Landsat remote sensing of forest windfall disturbance. Remote Sens. Environ. 143, 171–179.

Beck, H.E., McVicar, T.R., van Dijk, A.I.J.M., Schellekens, J., de Jeu, R.A.M., Bruijnzeel, L.A., 2011. Global evaluation of four AVHRR-NDVI data sets: Intercomparison and assessment against Landsat imagery. Remote Sens. Environ. 115, 2547–2563.

Bowler, D.E., Buyung-Ali, L.M., Healey, J.R., Jones, J.P.G., Knight, T.M., Pullin, A.S., 2012. Does community forest Management provide global environmental benefits and improve local welfare? Front. Ecol. Environ. 10, 29–36.

Burkhard, B., Kroll, F., Nedkov, S., Müller, F., 2012. Mapping ecosystem service supply, demand and budgets. Ecol. Indic. 21, 17–29.

Chaplin-Kramer, R., Sharp, R.P., Weil, C., Bennett, E.M., Pascual, U., Arkema, K.K., Brauman, K.A., Bryant, B.P., Guerry, A.D., Haddad, N.M., Hamann, M., Hamel, P., Johnson, J.A., Mandle, L., Pereira, H.M., Polasky, S., Ruckelshaus, M., Shaw, M.R., Silver, J.M., Vogl, A.L., Daily, G.C., 2019. Global modeling of nature's contributions to people. Science (80-.). 366, 255–258.

Chaudhary, S., McGregor, A., Houston, D., Chettri, N., 2018a. Environmental justice and ecosystem services: A disaggregated analysis of community access to forest benefits in Nepal. Ecosyst. Serv. 29, 99–115.

Chaudhary, S., McGregor, A., Houston, D., Chettri, N., 2018b. Environmental justice and ecosystem services: A disaggregated analysis of community access to forest benefits in Nepal. Ecosyst. Serv. 29, 99–115.

Chomba, S., Treue, T., Sinclair, F., 2015. The political economy of forest entitlements: Can community based forest management reduce vulnerability at the forest margin? For. Policy Econ. 58, 37–46.

Clive, N., 2018. Applying tasselled cap transformation to landsat time-series data for rapid forest degradation assessment towards improving REDD+ reporting in data-deficient areas. University of Southampton.

Daw, T.M., Brown, K., Rosendo, S., Pomeroy, R., 2011. Applying the ecosystem services concept to poverty alleviation: The need to disaggregate human well-being, UEA.

Daw, T.M., Coulthard, S., Cheung, W.W.L., Brown, K., Abunge, C., Galafassi, D., Peterson, G.D., McClanahan, T.R., Omukoto, J.O., Munyi, L., 2015. Evaluating taboo trade-offs in ecosystems services and human well-being. Proc. Natl. Acad. Sci. 112, 6949–6954.

Dawson, N., Grogan, K., Martin, A., Mertz, O., Pasgaard, M., Dawson, N.M., Rasmussen, L.V., 2017. Environmental justice research shows the importance of social feedbacks in ecosystem service trade-offs. Ecol. Soc. 22.

Dawson, N.M., Grogan, K., Martin, A., Mertz, O., Pasgaard, M., Rasmussen, L.V., 2017. Environmental justice research shows the importance of social feedbacks in ecosystem service trade-offs 22.

De Groot, R.S., Wilson, M.A., Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecol. Econ. 41, 393–408.

Dearing, J.A., Wang, R., Zhang, K., Dyke, J.G., Haberl, H., Hossain, M.S., Langdon, P.G., Lenton, T.M., Raworth, K., Brown, S., Carstensen, J., Cole, M.J., Cornell, S.E., Dawson, T.P., Doncaster, C.P., Eigenbrod, F., Flörke, M., Jeffers, E., Mackay, A.W., Nykvist, B., Poppy, G.M., 2014. Safe and just operating spaces for regional social-ecological systems. Glob. Environ. Chang. 28, 227–238.

DeFries, R., Achard, F., Brown, S., Herold, M., Murdiyarso, D., Schlamadinger, B., de Souza, C., 2007. Earth observations for estimating greenhouse gas emissions from deforestation in developing countries. Environ. Sci. Policy 10, 385–394.

Egoh, B., Reyers, B., Rouget, M., Richardson, D.M., Le Maitre, D.C., van Jaarsveld, A.S., 2008. Mapping ecosystem services for planning and management. Agric. Ecosyst. Environ. 127, 135–140.

Egoh, B.N., O'Farrell, P.J., Charef, A., Josephine Gurney, L., Koellner, T., Nibam Abi, H., Egoh, M., Willemen, L., Farrell, P.J.O., Charef, A., Josephine, L., Koellner, T., Nibam, H., Egoh, M., Willemen, L., O'Farrell, P.J., Charef, A., Josephine Gurney, L., Koellner, T., Nibam Abi, H., Egoh, M., Willemen, L., 2012. An African account of ecosystem service provision: Use, threats and policy options for sustainable livelihoods. Ecosyst. Serv. 2, 71–81.

Egoh, B.N., Reyers, B., Rouget, M., Richardson, D.M., 2011. Identifying priority areas for ecosystem service management in South African grasslands. J. Environ. Manage. 92, 1642–1650.

FAO, 2010. Global Forest Resources Assessment 2010 - Malawi.

Fisher, J.A., Patenaude, G., Giri, K., Lewis, K., Meir, P., Pinho, P., Rounsevell, M.D.A., Williams, M., 2014. Understanding the relationships between ecosystem services and poverty alleviation: A conceptual framework. Ecosyst. Serv. 7, 34–45.

Fowler, R.J., Paterson, M.S., Tanimoto, S.L., 1981. Optimal packing and covering in the plane are NP-complete. Inf. Process. Lett. 12, 133–137.

Fox, J., 2016. Applied Regression Analysis and Generalized Linear Models, Third edit. ed. Sage.

Gizachew, B., Solberg, S., Næsset, E., Gobakken, T., Bollandsås, O.M., Breidenbach, J., Zahabu, E., Mauya, E.W., 2016. Mapping and estimating the total living biomass and carbon in low-biomass woodlands using Landsat 8 CDR data. Carbon Balance Manag. 11.

Green, E.L., Eigenbrod, F., Schreckenberg, K., Willcock, S., 2016. Modelling tree growth to determine the sustainability of current off-take from miombo woodland: A case study from rural villages in Malawi. Environ. Conserv. 44, 66–73.

Guerry, A.D., Polasky, S., Lubchenco, J., Chaplin-Kramer, R., Daily, G.C., Griffin, R., Ruckelshaus, M., Bateman, I.J., Duraiappah, A., Elmqvist, T., Feldman, M.W., Folke, C., Hoekstra, J., Kareiva, P.M., Keeler, B.L., Li, S., McKenzie, E., Ouyang, Z., Reyers, B., Ricketts, T.H., Rockström, J., Tallis, H., Vira, B., 2015. Natural capital and ecosystem services informing decisions: From promise to practice. Proc. Natl. Acad. Sci. 112, 7348–7355.

Healey, S.P., Cohen, W.B., Zhiqiang, Y., Krankina, O.N., 2005. Comparison of Tasseled Cap-based Landsat data structures for use in forest disturbance detection. Remote Sens. Environ. 97, 301–310.

Hirschmugl, M., Sobe, C., Deutscher, J., Schardt, M., 2018. Combined use of optical and synthetic aperture radar data for REDD+ applications in Malawi. Land 7, 1–17.

Howe, C., Suich, H., Vira, B., Mace, G.M., 2014. Creating win-wins from trade-offs? Ecosystem services for human well-being: A meta-analysis of ecosystem service trade-offs and synergies in the real world. Glob. Environ. Chang. 28, 263–275.

Kachamba, D.J., Eid, T., Gobakken, T., 2016. Above- and belowground biomass models for trees in the miombo woodlands of Malawi. Forests 7.

Kaufman, L., Hopke, P.K., Rousseeuw, P.J., 1987. Using a parallel computer system for statistical resampling methods. Technische Universiteit Delft.

La Notte, A., Maes, J., Dalmazzone, S., Crossman, N.D., Grizzetti, B., Bidoglio, G., 2017. Physical and monetary ecosystem service accounts for Europe: A case study for in-stream nitrogen retention. Ecosyst. Serv. 23, 18–29.

Latham, J., Cumani, R., Rosati, I., Bloise, M., 2014. Global Land Cover SHARE (GLC-SHARE) database Beta-Release Version 1.0. Food Agric. Organ. United Nations (FAO), Rome, Italy 1–39.

Leh, M.D.K., Matlock, M.D., Cummings, E.C., Nalley, L.L., 2013. Quantifying and mapping multiple ecosystem services change in West Africa. Agric. Ecosyst. Environ. 165, 6–18.

Luckert, M.K., Williamson, T., 2005. Should sustained yield be part of sustainable forest management? Can. J. For. Res. 35, 356–364.

Lund, J.F., Treue, T., 2008. Are We Getting There? Evidence of Decentralized Forest Management from the Tanzanian Miombo Woodlands. World Dev. 36, 2780–2800.

Marge, 2009. Malawi Biomass Energy Strategy, Consultancy Study for Government of Malawi and EU Partnership Dialogue Facility. Marchéage et Gestion de l'Environnement 1–107.

Martin, A., Gross-Camp, N., Kebede, B., McGuire, S., Munyarukaza, J., 2014. Whose environmental justice? Exploring local and global perspectives in a payments for ecosystem services scheme in Rwanda. Geoforum 54, 167–177.

Mitchell, A.L., Rosenqvist, A., Mora, B., 2017. Current remote sensing approaches to monitoring forest degradation in support of countries measurement, reporting and verification (MRV) systems for REDD+. Carbon Balance Manag. 12.

Ostrom, E., Burger, J., Field, C.B., Norgaard, R.B., Policansky, D., 1999. Revisiting the commons: local lessons, global challenges. Science (80-.). 284, 278–282.

Otuoma, J., Odera, J., Bodo, E., Ongugo, P., Oeba, V., Kamondo, B., 2011. Annual allowable cut for merchantable woody species in a community managed forest in western Kenya. For. Ecol. Manage. 262, 2281–2286.

Persha, L., Agrawal, A., Chhatre, A., 2011. Social and Ecological Synergy: Local Rulemaking, Forest Livelihoods, and Biodiversity Conservation. Science (80-.). 331, 1606.

Persha, L., Andersson, K., 2014. Elite capture risk and mitigation in decentralized forest governance regimes. Glob. Environ. Chang. 24, 265–276.

Potschin, M.B., Haines-Young, R.H., 2011. Ecosystem services: Exploring a geographical perspective. Prog. Phys. Geogr. 35, 575–594.

Ryan, C.M., Hill, T., Woollen, E., Ghee, C., Mitchard, E., Cassells, G., Grace, J., Woodhouse, I.H., Williams, M., 2012. Quantifying small-scale deforestation and forest degradation in African woodlands using radar imagery. Glob. Chang. Biol. 18, 243–257.

Ryan, C.M., Pritchard, R., McNicol, I., Owen, M., Fisher, J.A., Lehmann, C., 2016. Ecosystem services from Southern African woodlands and their future under global change Citation for published version: Ecosystem services from southern African woodlands and their future under global change. Philos. Trans. R. Soc. B Biol. Sci. 371, 20150312.

Ryan, C.M., Williams, M., Grace, J., 2011. Above- and belowground carbon stocks in a miombo woodland landscape of mozambique. Biotropica 43, 423–432.

Schaafsma, M., Brouwer, R., Rose, J.M., 2012. Directional heterogeneity in WTP models for environmental valuation. Ecol. Econ. 79, 21–31.

Schlosberg, D., 2013. Theorising environmental justice: The expanding sphere of a discourse. Env. Polit. 22, 37–55.

Shirima, D.D., Munishi, P.K.T., Lewis, S.L., Burgess, N.D., Marshall, A.R., Balmford, A., Swetnam, R.D., Zahabu, E.M., 2011. Carbon storage, structure and composition of miombo woodlands in Tanzania's Eastern Arc Mountains. Afr. J. Ecol. 49, 332–342.

Sikor, T., Martin, A., Fisher, J., He, J., 2014. Toward an Empirical Analysis of Justice in Ecosystem Governance. Conserv. Lett.

Sunderlin, W.D., Hatcher, J., Liddle, M., 2008. From Exclusion to Ownership? Challenges and Opportunities in Advancing Forest Tenure Reform, From exclusion to ownership Challenges and opportunities in advancing forest tenure reform.

Syrbe, R., Grunewald, K., 2017. Ecosystem service supply and demand – the challenge to balance spatial mismatches. Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. 13, 148–161.

Syrbe, R.U., Walz, U., 2012. Spatial indicators for the assessment of ecosystem services: Providing, benefiting and connecting areas and landscape metrics. Ecol. Indic. 21, 80–88.

Tatem, A.J., 2017. WorldPop, open data for spatial demography. Sci. Data 4, 2–5.

Uchida, H., Nelson, A., 2008. Agglomeration Index: Towards a New Measure of Urban. World Dev. Rep. Reshaping Econ. Geogr. 19.

UN DESA, 2019. World population prospects 2019, United Nations. Department of Economic and Social Affairs. World Population Prospects 2019.

Vallecillo, S., La Notte, A., Zulian, G., Ferrini, S., Maes, J., 2019. Ecosystem services accounts: Valuing the actual flow of nature-based recreation from ecosystems to people. Ecol. Modell. 392, 196–211.

van Wagtendonk, J.W., Benedict, P.R., 1980. Travel time variation on backcountry trails. J. Leis. Res. 2, 99–106.

Villamagna, A.M., Angermeier, P.L., Bennett, E.M., 2013. Capacity, pressure, demand, and flow: A conceptual framework for analyzing ecosystem service provision and delivery. Ecol. Complex. 15, 114–121.

Wangai, P.W., Burkhard, B., Muller, F., 2016. A review of studies on ecosystem services in Africa. Int. J. Sustain. Built Environ. 5, 225–245.

Willemen, L., Crossman, N.D., Quatrini, S., Egoh, B., Kalaba, F.K., Mbilinyi, B., de Groot, R., 2018. Identifying ecosystem service hotspots for targeting land degradation neutrality investments in south-eastern Africa. J. Arid Environ. 159, 75–86.

Wolff, S., Schulp, C.J.E., Verburg, P.H., 2015. Mapping ecosystem services demand: A review of current research and future perspectives. Ecol. Indic. 55, 159–171.

Yadav, B.D., Bigsby, H., MacDonald, I., 2015. How can poor and disadvantaged households get an opportunity to become a leader in community forestry in Nepal? For. Policy Econ. 52, 27–38.

List of References

Abildtrup, J., Garcia, S., Olsen, S.B., Stenger, A., 2013. Spatial preference heterogeneity in forest recreation. Ecol. Econ. 92, 67–77.

Adhikari, S., Kingi, T., Ganesh, S., 2014. Incentives for community participation in the governance and management of common property resources: The case of community forest management in Nepal. For. Policy Econ. 44, 1–9.

Agrawal, A., 2001. Common property institutions and sustainable governance of resources. World Dev. 29, 1649–1672.

Agrawal, A., Chhatre, A., Hardin, R., 2008. Changing governance of the world's forests. Science (80-.). 320, 1460–1462.

Ala-Hulkko, T., Kotavaara, O., Alahuhta, J., Hjort, J., 2019. Mapping supply and demand of a provisioning ecosystem service across Europe. Ecol. Indic. 103, 520–529.

Albers, H.J., Robinson, E.J.Z., 2013. A review of the spatial economics of non-timber forest product extraction: Implications for policy. Ecol. Econ. 92, 87–95.

Ameha, A., Nielsen, O.J., Larsen, H.O., 2014. Impacts of access and benefit sharing on livelihoods and forest: Case of participatory forest management in Ethiopia. Ecol. Econ. 97, 162–171.

Andreoni, J., 1990. Impure Altruism and Donations to Public Goods: A Theory of Warm-Glow Giving. Econ. J.

Andreoni, J., Bernheim, B.D., 2009. Social Image and the 50-50 Norm: A Theoretical and Experimental Analysis of Audience Effects. Econometrica 77, 1607–1636.

Andreoni, J., Miller, J., 2002. Giving According to GARP : An Experimental Test of the Consistency of Preferences for Altruism. Econometrica 70, 737–753.

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N.J., Bauch, S., Börner, J., Smith-Hall, C., Wunder, S., 2014. Environmental Income and Rural Livelihoods: A Global-Comparative Analysis. World Dev. 64, S12–S28.

Babigumira, R., Angelsen, A., Buis, M., Bauch, S., Sunderland, T., Wunder, S., 2014. Forest Clearing in Rural Livelihoods: Household-Level Global-Comparative Evidence. World Dev. 64, S67–

S79.

Baerenklau, K.A., González-Cabán, A., Paez, C., Chavez, E., 2010. Spatial allocation of forest recreation value. J. For. Econ. 16, 113–126.

Bagstad, K.J., Johnson, G.W., Voigt, B., Villa, F., 2013. Spatial dynamics of ecosystem service flows: A comprehensive approach to quantifying actual services. Ecosyst. Serv. 4, 117–125.

Bagstad, K.J., Semmens, D.J., Waage, S., Winthrop, R., 2013. A comparative assessment of decision-support tools for ecosystem services quanti fi cation and valuation. Ecosyst. Serv. 5, 27–39.

Bagstad, K.J., Villa, F., Batker, D., Harrison-Cox, J., Voigt, B., Johnson, G.W., 2014. From theoretical to actual ecosystem services: Mapping beneficiaries and spatial flows in ecosystem service assessments. Ecol. Soc. 19.

Baltussen, R., Ten Asbroek, A.H.A., Koolman, X.H.E., Shrestha, N., Bhattarai, P., Niessen, L.W., 2007. Priority setting using multiple criteria: Should a lung health programme be implemented in Nepal? Health Policy Plan. 22, 178–185.

Bardsley, N., 2008. Dictator game giving: Altruism or artefact? Exp. Econ. 11, 122–133.

Barkmann, J., Glenk, K., Keil, A., Leemhuis, C., Dietrich, N., Gerold, G., Marggraf, R., 2008. Confronting unfamiliarity with ecosystem functions: The case for an ecosystem service approach to environmental valuation with stated preference methods. Ecol. Econ. 65, 48–62.

Barò, F., Palomo, I., Zulian, G., Vizcaino, P., Haase, D., G??mez-Baggethun, E., 2016. Mapping ecosystem service capacity, flow and demand for landscape and urban planning: A case study in the Barcelona metropolitan region. Land use policy 57, 405–417.

Barr, A., Burns, J., Miller, L., Shaw, I., 2015. Economic status and acknowledgement of earned entitlement. J. Econ. Behav. Organ. 118, 55–68.

Bateman, I.J., Day, B.H., Georgiou, S., Lake, I., 2006. The aggregation of environmental benefit values: Welfare measures, distance decay and total WTP. Ecol. Econ. 60, 450–460.

Batjes, N.H., 2008. Mapping soil carbon stocks of Central Africa using SOTER. Geoderma 146, 58–65.

Baumann, M., Ozdogan, M., Wolter, P.T., Krylov, A., Vladimirova, N., Radeloff, V.C., 2014. Landsat remote sensing of forest windfall disturbance. Remote Sens. Environ. 143, 171–179.

Beck, H.E., McVicar, T.R., van Dijk, A.I.J.M., Schellekens, J., de Jeu, R.A.M., Bruijnzeel, L.A., 2011. Global evaluation of four AVHRR-NDVI data sets: Intercomparison and assessment against Landsat imagery. Remote Sens. Environ. 115, 2547–2563.

Bekele, M., 2001. Malawi - Forest Outlook, Forestry Outlook Studies in Africa.

Berkes, F., 2009. Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. J. Environ. Manage. 90, 1692–1702.

Bicchieri, C., 2005. The grammar of society: The nature and dynamics of social norms. Cambridge University Press.

Bicchieri, C., Chavez, A., 2010. Behaving as expected: Public information and fairness norms. J. Behav. Decis. Mak. 23, 161–178.

Bicchieri, C., Xiao, E., 2009. Do the Right Thing : But Only if Others Do So. J. Behav. Decis. Mak. 22, 191–208.

Biel, A., Johansson-Stenman, O., Nilsson, A., 2011. The willingness to pay-willingness to accept gap revisited: The role of emotions and moral satisfaction. J. Econ. Psychol. 32, 908–917.

Blanco, M., Engelmann, D., Normann, H.T., 2011. A within-subject analysis of other-regarding preferences. Games Econ. Behav. 72, 321–338.

Bolton, G.E., 1991. A comparative model of bargaining: Theory and evidence. Am. Econ. Rev. 81, 1096–1136.

Bolton, G.E., Brandts, J., Ockenfels, A., 2005. Fair procedures: Evidence from games involving lotteries. Econ. J. 115, 1054–1076.

Bolton, G.E., Ockenfels, A., 2000. ERC: A Theory of Equity , Reciprocity , and Competition. Am. Econ. Rev. 90, 166–193.

Bosworth, R., Cameron, T.A., DeShazo, J.R., 2009. Demand for environmental policies to improve health: Evaluating community-level policy scenarios. J. Environ. Econ. Manage. 57, 293–308.

Bowler, D.E., Buyung-Ali, L.M., Healey, J.R., Jones, J.P.G., Knight, T.M., Pullin, A.S., 2012. Does community forest Management provide global environmental benefits and improve local welfare? Front. Ecol. Environ. 10, 29–36.

Bowles, S., 1998. Endogenous Preferences : The Cultural Consequences of Markets other Economic Institutions. J. Econ. Lit. 36, 75–111.

Broch, S.W., Strange, N., Jacobsen, J.B., Wilson, K.A., 2013. Farmers' willingness to provide ecosystem services and effects of their spatial distribution. Ecol. Econ. 92, 78–86.

Burkhard, B., Kroll, F., Nedkov, S., Müller, F., 2012. Mapping ecosystem service supply, demand and budgets. Ecol. Indic. 21, 17–29.

Campbell, B.M., 1996. The Miombo in Transition: Woodlands and Welfare in Africa, Cifor.

Campbell, D., Hensher, D.A., Scarpa, R., 2011. Non-attendance to attributes in environmental choice analysis: a latent class specification. J. Environ. Plan. Manag. 54, 1061–1076.

Cappelen, A.W., Hole, A.D., Sorensen, E., 2007. The Pluralism of Fairness Ideals: An Experimental Approach. Am. Econ. Rev. 97, 818–827.

Cappelen, A.W., Moene, K.O., Sørensen, E., Tungodden, B., 2013. Needs versus entitlements-an international fairness experiment. J. Eur. Econ. Assoc. 11, 574–598.

Cappelen, A.W., Nielsen, U.H., Sørensen, E., Tungodden, B., Tyran, J.R., 2013. Give and take in dictator games. Econ. Lett. 118, 280–283.

Cappelen, A.W., Sørensen, E., Tungodden, B., 2010. Responsibility for what? Fairness and individual responsibility. Eur. Econ. Rev. 54, 429–441.

Carlsson, F., Kataria, M., Krupnick, A., Lampi, E., Löfgren, Å., Qin, P., Sterner, T., 2013. A fair share: Burden-sharing preferences in the United States and China. Resour. Energy Econ. 35, 1–17.

Carlsson, F., Kataria, M., Lampi, E., Löfgren, Å., Sterner, T., 2011. Is fairness blind? The effect of framing on preferences for effort-sharing rules. Ecol. Econ. 70, 1529–1535.

Carpenter, J.P., Cárdenas, J.C., 2008. Behavioural Development Economics: Lessons from Field Labs in the Developing World. J. Dev. Stud. 44, 311–338.

Chang, J.B., Lusk, J.L., 2009. Fairness and food choice. Food Policy 34, 483–491.

Chaplin-Kramer, R., Sharp, R.P., Weil, C., Bennett, E.M., Pascual, U., Arkema, K.K., Brauman, K.A., Bryant, B.P., Guerry, A.D., Haddad, N.M., Hamann, M., Hamel, P., Johnson, J.A., Mandle, L., Pereira, H.M., Polasky, S., Ruckelshaus, M., Shaw, M.R., Silver, J.M., Vogl, A.L., Daily, G.C., 2019. Global modeling of nature's contributions to people. Science (80-.). 366, 255–258.

Charness, G., Gneezy, U., 2008. What's in a name? Anonymity and social distance in dictator and ultimatum games. J. Econ. Behav. Organ. 68, 29–35.

Charness, G., Rabin, M., 2002. Understanding social preferences with simple tests. Q. J. Econ. 117, 817–869.

Chaudhary, S., McGregor, A., Houston, D., Chettri, N., 2018. Environmental justice and ecosystem services: A disaggregated analysis of community access to forest benefits in Nepal. Ecosyst. Serv. 29, 99–115.

Cherry, T.L., Frykblom, P., Shogren, J.F., 2002. Hardnose the Dictator. Am. Econ. Rev. 92, 1218–1221.

Chilongo, T., 2014. Livelihood strategies and forest reliance in Malawi. For. Trees Livelihoods 23, 188–210.

Chinangwa, L., Sinclair, F., Pullin, A.S., Hockley, N., 2015. Can co-management of government forest reserves achieve devolution? Evidence from Malawi. For. Trees Livelihoods 8028, 1–17.

Chomba, S., Treue, T., Sinclair, F., 2015. The political economy of forest entitlements: Can community based forest management reduce vulnerability at the forest margin? For. Policy Econ. 58, 37–46.

Cialdini, R.B., Trost, M.R., 1998. Social influence: social norms, conformity, and compliance. In: Gilbert, D.T., Fiske, S.T., Lindzey, G. (Eds.), The Handbook of Social Psychology, Vol. 2. McGraw-Hill, New York, pp. 151–192.

Cleaver, F.D., 2007. Understanding agency in collective action. J. Hum. Dev. 8, 223–244.

Clive, N., 2018. Applying tasselled cap transformation to landsat time-series data for rapid forest degradation assessment towards improving REDD+ reporting in data-deficient areas. University of Southampton.

Colombo, S., Christie, M., Hanley, N., 2013. What are the consequences of ignoring attributes in choice experiments? Implications for ecosystem service valuation. Ecol. Econ. 96, 25–35.

Croson, R., Konow, J., 2009. Social preferences and moral biases. J. Econ. Behav. Organ. 69, 201–212.

Curtis, J. a, McConnell, K.E., 2002. The citizen versus consumer hypothesis: Evidence from a contingent valuation survey. Aust. J. Agric. Resour. Econ. 46, 69–83.

Czajkowski, M., Budziński, W., Campbell, D., Giergiczny, M., Hanley, N., 2016. Spatial Heterogeneity of Willingness to Pay for Forest Management. Environ. Resour. Econ. 1–23.

D'Exelle, B., Lecoutere, E., Van Campenhout, B., 2012. Equity-Efficiency Trade-Offs in Irrigation Water Sharing: Evidence from a Field Lab in Rural Tanzania. World Dev. 40, 2537–2551.

Dasgupta, A., Beard, V.A., 2007. Collective Action and Community Driven Development in Rural and Urban Indonesia. Dev. Change 38, 229–249.

Daw, T., Brown, K., Rosendo, S., Pomeroy, R., 2011. Applying the ecosystem services concept to poverty alleviation: The need to disaggregate human well-being. Environ. Conserv. 38, 370–379.

Daw, T.M., Coulthard, S., Cheung, W.W.L., Brown, K., Abunge, C., Galafassi, D., Peterson, G.D., McClanahan, T.R., Omukoto, J.O., Munyi, L., 2015. Evaluating taboo trade-offs in ecosystems services and human well-being. Proc. Natl. Acad. Sci. 112, 6949–6954.

Dawson, N., Grogan, K., Martin, A., Mertz, O., Pasgaard, M., Dawson, N.M., Rasmussen, L.V., 2017. Environmental justice research shows the importance of social feedbacks in ecosystem service trade-offs. Ecol. Soc. 22.

De Groot, R.S., Wilson, M.A., Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecol. Econ. 41, 393–408.

Dearing, J.A., Wang, R., Zhang, K., Dyke, J.G., Haberl, H., Hossain, M.S., Langdon, P.G., Lenton, T.M., Raworth, K., Brown, S., Carstensen, J., Cole, M.J., Cornell, S.E., Dawson, T.P., Doncaster, C.P., Eigenbrod, F., Flörke, M., Jeffers, E., Mackay, A.W., Nykvist, B., Poppy, G.M., 2014. Safe and just operating spaces for regional social-ecological systems. Glob. Environ. Chang. 28, 227–238.

DeFries, R., Achard, F., Brown, S., Herold, M., Murdiyarso, D., Schlamadinger, B., de Souza, C., 2007. Earth observations for estimating greenhouse gas emissions from deforestation in developing countries. Environ. Sci. Policy 10, 385–394.

DeShazo, J.R., Fermo, G., 2002. Designing choice sets for stated preference methods: The effects of complexity on choice consistency. J. Environ. Econ. Manage. 44, 123–143.

Di Ciommo, F., Monzón, A., Fernandez-Heredia, A., 2013. Improving the analysis of road pricing acceptability surveys by using hybrid models. Transp. Res. Part A 49, 302–316.

Diamond, P.A., Hausman, J.A., 1994. Contingent Valuation - Is Some Number Better Than No Number? J. Econ. Perspect. 8, 45–64.

Dietz, S., Atkinson, G., 2010. The Equity-Efficiency Trade-off in Environmental Policy: Evidence from Stated Preferences. Land Econ. 86, 423–443.

DiMiceli, C.M., Carroll, M.L., Sohlberg, R.A., Huang, C., Hansen, M.C., Townshend, J.R.G., 2011. Annual Global Automated MODIS Vegetation Continuous Fields (MOD44B) at 250 m Spatial Resolution for Data Years Beginning Day 65, 2000 - 2010.

Dold, M., Khadjavi, M., 2017. Jumping the queue: An experiment on procedural preferences. Games Econ. Behav. 102, 127–137.

Dreber, A., Ellingsen, T., Johannesson, M., Rand, D.G., 2013. Do people care about social context? Framing effects in dictator games. Exp. Econ. 16, 349–371.

Egoh, B., Reyers, B., Rouget, M., Richardson, D.M., Le Maitre, D.C., van Jaarsveld, A.S., 2008. Mapping ecosystem services for planning and management. Agric. Ecosyst. Environ. 127, 135–140.

Egoh, B.N., O'Farrell, P.J., Charef, A., Josephine Gurney, L., Koellner, T., Nibam Abi, H., Egoh, M., Willemen, L., Farrell, P.J.O., Charef, A., Josephine, L., Koellner, T., Nibam, H., Egoh, M., Willemen, L., O'Farrell, P.J., Charef, A., Josephine Gurney, L., Koellner, T., Nibam Abi, H., Egoh, M., Willemen, L., 2012. An African account of ecosystem service provision: Use, threats and policy options for sustainable livelihoods. Ecosyst. Serv. 2, 71–81.

Egoh, B.N., Reyers, B., Rouget, M., Richardson, D.M., 2011. Identifying priority areas for ecosystem service management in South African grasslands. J. Environ. Manage. 92, 1642–1650.

Eigenbrod, F., Armsworth, P.R., Anderson, B.J., Heinemeyer, A., Gillings, S., Roy, D.B., Thomas, C.D., Gaston, K.J., 2010. Error propagation associated with benefits transfer-based mapping of ecosystem services. Biol. Conserv. 143, 2487–2493.

Engel, C., 2011. Dictator games: A meta study. Exp. Econ. 14, 583–610.

Engelmann, D., Strobel, M., 2004. Inequality Aversion, Efficiency, and Maximin Preferences in Simple Distribution Experiments. Am. Econ. Rev. 94, 857–869.

Erdem, S., Thompson, C., 2014. Prioritising health service innovation investments using public preferences: a discrete choice experiment. BMC Health Serv. Res. 14, 360.

Falk, A., Fehr, E., Fischbacher, U., 2008. Testing theories of fairness-Intentions matter. Games Econ. Behav. 62, 287–303.

FAO, 2010. Global Forest Resources Assessment 2010 - Malawi.

FAO, 2012. Atlas of Malawi, land cover and land cover change, 1990-2010.

Fehr, E., Schmidt, K.M., 1999. A Theory of Fairness, Competition, and Cooperation. Q. J. Econ. 114, 817–868.

Fehr, E., Schmidt, K.M., 2006. The economics of fairness, reciprocity and altruism–experimental evidence and new theories. In: Handbook of Reciprocity, Gift-Giving and Altruism. pp. 615–691.

Fisher, J.A., Patenaude, G., Giri, K., Lewis, K., Meir, P., Pinho, P., Rounsevell, M.D.A., Williams, M., 2014. Understanding the relationships between ecosystem services and poverty alleviation: A conceptual framework. Ecosyst. Serv. 7, 34–45.

Fisher, M., 2004. Household welfare and forest dependence in Southern Malawi. Environ. Dev. Econ. 9, 135–154.

Fisher, M., Shively, G.E., Buccola, S., 2005. Activity Choice, Labor Allocation, and Forest Use in Malawi. Land Econ. 81, 503–517.

Flores, N.E., 2002. Non-paternalistic altruism and welfare economics. J. Public Econ. 83, 293–305.

Folmer, H., Johansson-Stenman, O., 2011. Does Environmental Economics Produce Aeroplanes Without Engines? On the Need for an Environmental Social Science. Environ. Resour. Econ. 48, 337–361.

Fong, C.M., 2007. Evidence from an experiment on charity to welfare recipients: Reciprocity, altruism and the empathic responsiveness hypothesis. Econ. J. 117, 1008–1024.

Fourati, Y.A., O'Donoghue, C., 2009. Eliciting individual preferences for pension reform, CESifo working paper, CESifo working paper.

Fowler, R.J., Paterson, M.S., Tanimoto, S.L., 1981. Optimal packing and covering in the plane are NP-complete. Inf. Process. Lett. 12, 133–137.

Fox, J., 2016. Applied Regression Analysis and Generalized Linear Models, Third edit. ed. Sage.

García-Nieto, A.P., García-Llorente, M., Iniesta-Arandia, I., Martín-López, B., 2013. Mapping forest ecosystem services: From providing units to beneficiaries. Ecosyst. Serv. 4, 126–138.

Gibson, J.M., Rigby, D., Polya, D.A., Russell, N., 2015. Discrete Choice Experiments in Developing Countries: Willingness to Pay Versus Willingness to Work. Environ. Resour. Econ.

Gizachew, B., Solberg, S., Næsset, E., Gobakken, T., Bollandsås, O.M., Breidenbach, J., Zahabu, E., Mauya, E.W., 2016. Mapping and estimating the total living biomass and carbon in low-biomass woodlands using Landsat 8 CDR data. Carbon Balance Manag. 11.

Godager, G., Wiesen, D., 2013. Profit or patients' health benefit? Exploring the heterogeneity in physician altruism. J. Health Econ. 32, 1105–1116.

GoM, 1965. Malawi Land Act.

GoM, 1997. Forestry Act.

GoM, 2001. National Forestry Programme Priorities for Improving Forestry and Livelihoods.

GoM, 2005. Standards & Guidelines for Participatory Forestry in Malawi 146.

GoM, 2016. Malawi Government National Forest Policy 60.

Government of Malawi, 1996. National Forest Policy of Malawi.

Government of Malawi, 2013. Shire river basin management programme (Phase I) project - final environmental and social assessment report.

Gowdy, J.M., Iorgulescu, R., Onyeiwu, S., 2003. Fairness and retaliation in a rural Nigerian village. J. Econ. Behav. Organ. 52, 469–479.

Green, C., Gerard, K., 2009. Exploring the social value of health-care interventions: a stated preference discrete choice experiment. Health Econ. 18, 951–976.

Green, E.L., Eigenbrod, F., Schreckenberg, K., Willcock, S., 2016. Modelling tree growth to determine the sustainability of current off-take from miombo woodland: A case study from rural villages in Malawi. Environ. Conserv. 44, 66–73.

Greene, J.D., Sommerville, R.B., Nystrom, L.E., Darley, J.M., Cohen, J.D., 2001. An fMRI Investigation of Emotional Engagement in Moral Judgment. Science (80-.). 293.

Grimalda, G., Kar, A., 2016. Procedural fairness in lotteries assigning initial roles in a dynamic setting. Exp. Econ. 19, 819–841.

Gsottbauer, E., van den Bergh, J.C.J.M., 2011. Environmental Policy Theory Given Bounded Rationality and Other-regarding Preferences. Environ. Resour. Econ. 49, 263–304.

Guerry, A.D., Polasky, S., Lubchenco, J., Chaplin-Kramer, R., Daily, G.C., Griffin, R., Ruckelshaus, M., Bateman, I.J., Duraiappah, A., Elmqvist, T., Feldman, M.W., Folke, C., Hoekstra, J., Kareiva, P.M., Keeler, B.L., Li, S., McKenzie, E., Ouyang, Z., Reyers, B., Ricketts, T.H., Rockström, J., Tallis, H., Vira, B., 2015. Natural capital and ecosystem services informing decisions: From promise to practice. Proc. Natl. Acad. Sci. 112, 7348–7355.

Haines-Young, R., Potschin, M., Kienast, F., 2012. Indicators of ecosystem service potential at European scales: Mapping marginal changes and trade-offs. Ecol. Indic. 21, 39–53.

Hanley, N., Schläpfer, F., Spurgeon, J., 2003. Aggregating the benefits of environmental improvements: Distance-decay functions for use and non-use values. J. Environ. Manage. 68, 297–304.

Hansen, M.C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S.A., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R., Kommareddy, A., Egorov, A., Chini, L., Justice, C.O., Townshend, J.R.G., 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. Science (80-.). 342, 850–854.

Haregeweyn, N., Fikadu, G., Tsunekawa, A., Tsubo, M., Meshesha, D.T., 2012. The dynamics of urban expansion and its impacts on land use/land cover change and small-scale farmers living near the urban fringe: A case study of Bahir Dar, Ethiopia. Landsc. Urban Plan. 106, 149–157.

Hausman, D.M., 2011. Preference, Value, Choice, and Welfare. Cambridge University Press, Cambridge.

Healey, S.P., Cohen, W.B., Zhiqiang, Y., Krankina, O.N., 2005. Comparison of Tasseled Cap-based Landsat data structures for use in forest disturbance detection. Remote Sens. Environ. 97, 301–310.

Henrich, J., Boyd, R., Bowles, S., Camerer, C.F., Fehr, E., Gintis, H., McElreath, R., Alvard, M., Barr, A., Ensminger, J., Henrich, N., Hill, K.R., Gil-White, F., Gurven, M., Marlowe, F.W., Patton, J.Q., Tracer, D., 2005. “Economic man” in cross-cultural perspective: behavioral experiments in 15 small-scale societies. Behav. Brain Sci. 28, 795–815; discussion 815-55.

Hensher, D.A., Greene, W.H., 2003. The Mixed Logit model: The state of practice. Transportation (Amst). 30, 133–176.

Hirschmugl, M., Sobe, C., Deutscher, J., Schardt, M., 2018. Combined use of optical and synthetic aperture radar data for REDD+ applications in Malawi. Land 7, 1–17.

Hoffman, E., McCabe, K., Shachat, K., Smith, V., 1994. Preferences, Property Rights, and Anonymity in Bargaining Games. Games Econ. Behav.

Hoffman, E., McCabe, K., Smith, V.L., 1996. Social distance and other-regarding behavior in dictator games. Am. Econ. Rev. 86, 653–660.

Howe, C., Suich, H., Vira, B., Mace, G.M., 2014. Creating win-wins from trade-offs? Ecosystem services for human well-being: A meta-analysis of ecosystem service trade-offs and synergies in the real world. Glob. Environ. Chang. 28, 263–275.

Howley, P., Hynes, S., O’Donoghue, C., 2010. The citizen versus consumer distinction: An exploration of individuals’ preferences in Contingent Valuation studies. Ecol. Econ. 69, 1524–1531.

Hoyos, D., 2010. The state of the art of environmental valuation with discrete choice experiments. Ecol. Econ. 69, 1595–1603.

Hurley, J., Mentzakis, E., 2013. Health-related externalities: Evidence from a choice experiment. J. Health Econ. 32, 671–681.

IFSMLP, 2010. Putting PFM into Practice Manual in Malawi.

Irvine, K., O’Brien, L., Ravenscroft, N., Cooper, N., Everard, M., Fazey, I., Reed, M., Kenter, J.O., 2016. Ecosystem services and the idea of shared values. Ecosyst. Serv. 1–10.

Itaoka, K., Krupnick, A., Saito, A., Akai, M., 2007. Morbidity Valuation with a Cessation Lag: Choice Experiments for Public- and Private-Goods Contexts in Japan. Resour. Futur. Discuss. Pap.

Iversen, V., Chhetry, B., Francis, P., Gurung, M., Kafle, G., Pain, A., Seeley, J., 2006. High value forests, hidden economies and elite capture: Evidence from forest user groups in Nepal's Terai. Ecol. Econ. 58, 93–107.

Jakiela, P., 2011. Social preferences and fairness norms as informal institutions: Experimental evidence. Am. Econ. Rev. 101, 509–513.

Jakiela, P., 2015. How fair shares compare: Experimental evidence from two cultures. J. Econ. Behav. Organ. 118, 40–54.

Johansson-Stenman, O., Konow, J., 2010. Fair air: Distributive justice and environmental economics. Environ. Resour. Econ. 46, 147–166.

Johansson-Stenman, O., Martinsson, P., 2008. Are some lives more valuable? An ethical preferences approach. J. Health Econ. 27, 739–752.

Johansson-Stenman, O., Svedsäter, H., 2012. Self-image and valuation of moral goods: Stated versus actual willingness to pay. J. Econ. Behav. Organ. 84, 879–891.

Johnston, R.J., Boyle, K.J., Adamowicz, W., Bennett, J., Brouwer, R., Cameron, T.A., Hanemann, M.W., Hanley, N., Ryan, M., Scarpa, R., Tourangeau, R., Vossler, C.A., 2017. Contemporary Guidance for Stated Preference Studies. J. Assoc. Environ. Resour. Econ. 4, 319–379.

Jumbe, C.B.L., Angelsen, A., 2006. Do the poor benefit from devolution policies? Evidence from Malawi's forest co-management program. Land Econ. 82, 562–581.

Kachamba, D.J., Eid, T., Gobakken, T., 2016. Above- and belowground biomass models for trees in the miombo woodlands of Malawi. Forests 7.

Kagel, J.H., Roth, A.E., 2016. The handbook of experimental economics, Volume 2. Economics Books 2.

Kamanga, P., Vedeld, P., Sjaastad, E., 2009. Forest incomes and rural livelihoods in Chiradzulu District, Malawi. Ecol. Econ. 68, 613–624.

Kanninen, B., 2006. Valuing environmental amenities using stated choice studies. Springer.

Kaufman, L., Hopke, P.K., Rousseeuw, P.J., 1987. Using a parallel computer system for statistical resampling methods. Technische Universiteit Delft.

Kayambazinthu, D., Locke, C., 2002. Forest management and diverse livelihoods in Malawi, Ladder.

Kenter, J.O., O'Brien, L., Hockley, N., Ravenscroft, N., Fazey, I., Irvine, K.N., Reed, M.S., Christie, M., Brady, E., Bryce, R., Church, A., Cooper, N., Davies, A., Evely, A., Everard, M., Fish, R., Fisher, J.A., Jobstvogt, N., Molloy, C., Orchard-Webb, J., Ranger, S., Ryan, M., Watson, V., Williams, S., 2015. What are shared and social values of ecosystems? Ecol. Econ. 111, 86–99.

Kerschbamer, R., 2015. The geometry of distributional preferences and a non-parametric identification approach: The Equality Equivalence Test. Eur. Econ. Rev. 76, 85–103.

Kienast, F., Bolliger, J., Potschin, M., De Groot, R.S., Verburg, P.H., Heller, I., Wascher, D., Haines-Young, R., Haines-young, D.W.R., De Groot, R.S., Verburg, P.H., Heller, I., Wascher, D., Haines-Young, R., 2009. Assessing landscape functions with broad-scale environmental data: Insights gained from a prototype development for Europe. Environ. Manage. 44, 1099–1120.

Kim, J., Rasouli, S., Timmermans, H., 2014. Hybrid Choice Models: Principles and Recent Progress Incorporating Social Influence and Nonlinear Utility Functions. Procedia Environ. Sci. 22, 20–34.

Kittel, B., Kanitsar, G., Traub, S., 2017. Knowledge, power, and self-interest. J. Public Econ. 150, 39–52.

Konow, J., 2000. Fair Shares: Accountability and Cognitive Dissonance in Allocation Decisions. Am. Econ. Rev. 90, 1072–1091.

Konow, J., 2001. Fair and square: The four sides of distributive justice. J. Econ. Behav. Organ. 46, 137–164.

Konow, J., 2003. Which is the fairest one of all? A positive analysis of justice theories. J. Econ. Lit. 41, 1188–1239.

Konow, J., 2010. Mixed feelings: Theories of and evidence on giving. J. Public Econ. 94, 279–297.

Koopmanschap, M.A., Stolk, E.A., Koolman, X.H.E., 2010. Dear policy maker: Have you made up your mind? A discrete choice experiment among policy makers and other health professionals. Int. J. Technol. Assess. Health Care 26, 198–204.

Korenok, O., Millner, E.L., Razzolini, L., 2012. Are dictators averse to inequality? J. Econ. Behav. Organ. 82, 543–547.

Krawczyk, M.W., 2011. A model of procedural and distributive fairness 111–128.

Krott, M., Bader, A., Schusser, C., Devkota, R., Maryudi, A., Giessen, L., Aurenhammer, H., 2014. Actor-centred power: The driving force in decentralised community based forest governance. For. Policy Econ. 49, 34–42.

Krupka, E.L., Weber, R.A., 2013. Identifying social norms using coordination games: Why does dictator game sharing vary? J. Eur. Econ. Assoc. 11, 495–524.

Ku, H., Salmon, T.C., 2013. Procedural fairness and the tolerance for income inequality. Eur. Econ. Rev. 64, 111–128.

La Notte, A., Maes, J., Dalmazzone, S., Crossman, N.D., Grizzetti, B., Bidoglio, G., 2017. Physical and monetary ecosystem service accounts for Europe: A case study for in-stream nitrogen retention. Ecosyst. Serv. 23, 18–29.

Lamont, J., Christi, F., 2016. Distributive Justice. Stanford Encycl. Phylosophy.

Lancaster, K.J., 1966. A New Approach to Consumer Theory. J. Polit. Econ. 74, 132–157.

Latham, J., Cumani, R., Rosati, I., Bloise, M., 2014. Global Land Cover SHARE (GLC-SHARE) database Beta-Release Version 1.0. Food Agric. Organ. United Nations (FAO), Rome, Italy 1–39.

Lautenbach, S., Kugel, C., Lausch, A., Seppelt, R., 2011. Analysis of historic changes in regional ecosystem service provisioning using land use data. Ecol. Indic. 11, 676–687.

Lavorel, S., Grigulis, K., Lamarque, P., Colace, M.P., Garden, D., Girel, J., Pellet, G., Douzet, R., 2011. Using plant functional traits to understand the landscape distribution of multiple ecosystem services. J. Ecol. 99, 135–147.

Leh, M.D.K., Matlock, M.D., Cummings, E.C., Nalley, L.L., 2013. Quantifying and mapping multiple ecosystem services change in West Africa. Agric. Ecosyst. Environ. 165, 6–18.

Lehner, B., Verdin, K., Jarvis, A., 2008. New global hydrography derived from spaceborne elevation data. Eos, Trans. Am. Geophys. Union 89, 93–94.

Leibbrandt, A., Maitra, P., Neelim, A., 2015. On the redistribution of wealth in a developing country: Experimental evidence on stake and framing effects. J. Econ. Behav. Organ. 118, 360–371.

Levitt, S.D., List, J.A., 2007. What Do Laboratory Experiments Measuring Social Preferences Reveal About the Real World? J. Econ. Perspect. 21, 153–174.

Lim, M.K., Bae, E.Y., Choi, S.E., Lee, E.K., Lee, T.J., 2012. Eliciting public preference for health-care resource allocation in South Korea. Value Heal. 15, S91–S94.

List, J.A., 2007. On the interpretation of dictator giving. J. Polit. Econ. 115, 482–493.

Loewenstein, G., Hsee, C.K., Weber, E.U., Welch, N., 2001. Risk as Feelings. Psychol. Bull. 127, 267–286.

Luce, M.F., Bettman, J.R., Payne, J.W., 1997. Choice processing in emotionally difficult decisions. J. Exp. Psychol. Learn. Mem. Cogn. 23, 384–405.

Luckert, M.K., Williamson, T., 2005. Should sustained yield be part of sustainable forest management? Can. J. For. Res. 35, 356–364.

Lund, J.F., Treue, T., 2008. Are We Getting There? Evidence of Decentralized Forest Management from the Tanzanian Miombo Woodlands. World Dev. 36, 2780–2800.

MacKerron, G.J., Egerton, C., Gaskell, C., Parpia, A., Mourato, S., 2009. Willingness to pay for carbon offset certification and co-benefits among (high-)flying young adults in the UK. Energy Policy 37, 1372–1381.

Maes, J., Paracchini, M.L., Zulian, G., Dunbar, M.B., Alkemade, R., 2012. Synergies and trade-offs between ecosystem service supply, biodiversity, and habitat conservation status in Europe. Biol. Conserv. 155, 1–12.

Maes, J., Teller, A., Erhard, M., Grizzetti, B., Barredo, J., Paracchini, M., Condé, S., Somma, F., Orgiazzi, A., Jones, A., Zulian, A., Vallecilo, S., Petersen, J., Marquardt, D., Kovacevic, V., Abdul Malak, D., Marin, A., Czúcz, B., Mauri, A., Loffler, P., BastrupBirk, A., Biala, K., Christiansen, T, W.B., 2018. Mapping and Assessment of Ecosystems and their Services: An analytical framework for ecosystem condition. Luxembourg.

Mangham, L.J., Hanson, K., McPake, B., 2009. How to do (or not to do)...Designing a discrete choice experiment for application in a low-income country. Health Policy Plan. 24, 151–158.

Marge, 2009. Malawi Biomass Energy Strategy, Consultancy Study for Government of Malawi and EU Partnership Dialogue Facility. Marchéage et Gestion de l'Environnement 1–107.

Martin, A., Gross-Camp, N., Kebede, B., McGuire, S., Munyarukaza, J., 2014. Whose environmental justice? Exploring local and global perspectives in a payments for ecosystem services scheme in Rwanda. Geoforum 54, 167–177.

Martin, A., Kebede, B., Gross-Camp, N., He, J., Inturias, M., Rodríguez, I., 2019. Fair ways to share benefits from community forests? How commodification is associated with reduced preference for equality and poverty alleviation. Environ. Res. Lett. 14, 064002.

Mazunda, J., Shively, G., 2015. Measuring the forest and income impacts of forest user group participation under Malawi's Forest Co-management Program. Ecol. Econ. 119, 262–273.

McDermott, M., Mahanty, S., Schreckenberg, K., 2012. Examining Equity: a multidimensional framework for assessing equity in payments for ecosystem services. Environ. Sci. Policy.

McFadden, D.L., 1974. The measurement of urban travel demand. J. Public Econ. 3, 303–328.

McFadden, D.L., 1999. Rationality for economists? J. Risk Uncertain. 19, 73–105.

McFadden, D.L., 2001. Economic Choices. Am. Econ. Rev. 91, 351–378.

MEA, 2005. Ecosystems and Human Well Being: Synthesis. Island Press, Washington DC.

Menzel, S., Wiek, A., 2009. Valuation in morally charged situations: The role of deontological stances and intuition for trade-off making. Ecol. Econ. 68, 2198–2206.

Meyerhoff, J., Bartczak, A., Liebe, U., 2012. Protester or non-protester: A binary state? On the use (and non-use) of latent class models to analyse protesting in economic valuation. Aust. J. Agric. Resour. Econ. 56, 438–454.

Meyerhoff, J., Mørkbak, M.R., Olsen, S.B., 2014. A Meta-study Investigating the Sources of Protest Behaviour in Stated Preference Surveys. Environ. Resour. Econ. 58, 35–57.

Mirelman, A., Mentzakis, E., Kinter, E., Paolucci, F., Fordham, R., Ozawa, S., Ferraz, M., Baltussen, R., Niessen, L.W., 2012. Decision-making criteria among national policymakers in five countries: A discrete choice experiment eliciting relative preferences for equity and efficiency. Value Heal. 15, 534–539.

Mitchell, A.L., Rosenqvist, A., Mora, B., 2017. Current remote sensing approaches to monitoring forest degradation in support of countries measurement, reporting and verification (MRV) systems for REDD+. Carbon Balance Manag. 12.

Moseley, D., Valatin, G., 2013. Insights from behavioural economics for ecosystem services valuation and sustainability.

Neustradt, I., Zweifel, P., 2010. Is the Welfare State Sustainable? Experimental Evidence on Citizens' Preferences for Redistribution, MPRA.

Nielsen, E.A.S., Lundhede, T.H., Jacobsen, J.B., 2016. Local consequences of national policies - A spatial analysis of preferences for forest access reduction. For. Policy Econ. 73, 68–77.

Norman, R., Hall, J., Street, D., Viney, R., 2013. Efficiency and equity: a stated preference approach. Health Econ. 22, 568–581.

Nyborg, K., 2000. Homo Economicus and Homo Politicus: interpretation and aggregation of environmental values. J. Econ. Behav. Organ. 42, 305–322.

Nyborg, K., 2018. Social Norms and the Environment 405–426.

OpenStreetMap contributors, 2017. Planet dump retrieved from https://planet.osm.org .

Ostrom, E., Burger, J., Field, C.B., Norgaard, R.B., Policansky, D., 1999. Revisiting the commons: local lessons, global challenges. Science (80-.). 284, 278–282.

Otuoma, J., Odera, J., Bodo, E., Ongugo, P., Oeba, V., Kamondo, B., 2011. Annual allowable cut for merchantable woody species in a community managed forest in western Kenya. For. Ecol. Manage. 262, 2281–2286.

Ovaskainen, V., Kniivila, M., 2005. Consumer versus citizen preferences in contingent valuation: Evidence on the role of question framing. Aust. J. Agric. Resour. Econ. 49, 379–394.

Oxoby, R.J., Spraggon, J., 2008. Mine and yours: Property rights in dictator games. J. Econ. Behav. Organ. 65, 703–713.

Pascual, U., Muradian, R., Rodríguez, L.C., Duraiappah, A., 2010. Exploring the links between equity and efficiency in payments for environmental services: A conceptual approach. Ecol. Econ. 69, 1237–1244.

Perman, R., Ma, Y., McGilvray, J., Common., M., 2003. Natural resource and environmental economics. Pearson education.

Persha, L., Agrawal, A., Chhatre, A., 2011. Social and Ecological Synergy: Local Rulemaking, Forest Livelihoods, and Biodiversity Conservation. Science (80-.). 331, 1606.

Persha, L., Andersson, K., 2014. Elite capture risk and mitigation in decentralized forest governance regimes. Glob. Environ. Chang. 24, 265–276.

Petz, K., Glenday, J., Alkemade, R., 2014. Land management implications for ecosystem services in a South African rangeland. Ecol. Indic. 45, 692–703.

Place, F., Otsuka, K., 2001. Population, tenure, and natural resource management: The Case of customary land area in Malawi. J. Environ. Econ. Manage. 41, 13–32.

Postlewaite, A., 2011. Social Norms and Social Assets. Annu. Rev. Econom. 3, 239–259.

Potschin, M.B., Haines-Young, R.H., 2011. Ecosystem services: Exploring a geographical perspective. Prog. Phys. Geogr. 35, 575–594.

Rai, R.K., Scarborough, H., 2012. Economic value of mitigation of plant invaders in a subsistence economy: incorporating labour as a mode of payment. Environ. Dev. Econ. 18, 225–244.

Rakotonarivo, O.S., Schaafsma, M., Hockley, N., 2016. A systematic review of the reliability and validity of discrete choice experiments in valuing non-market environmental goods. J. Environ. Manage. 183, 98–109.

Ratcliffe, J., Bekker, H.L., Dolan, P., Edlin, R., 2009. Examining the attitudes and preferences of health care decision-makers in relation to access, equity and cost-effectiveness: A discrete choice experiment. Health Policy (New. York). 90, 45–57.

Rocamora-Montiel, B., Colombo, S., Salazar-Ordóñez, M., 2014. Social attitudes in southern Spain to shape EU agricultural policy. J. Policy Model. 36, 156–171.

Rode, J., Le Menestrel, M., 2011. The influence of decision power on distributive fairness. J. Econ. Behav. Organ. 79, 246–255.

Rodríguez, M.X. V, León, C.J., 2004. Altruism and the economic values of environmental and social policies. Environ. Resour. Econ. 28, 233–249.

Rodriguez-Lara, I., 2016. Equity and bargaining power in ultimatum games. J. Econ. Behav. Organ. 130, 144–165.

Rodriguez-Lara, I., Moreno-Garrido, L., 2012. Self-interest and fairness: Self-serving choices of justice principles. Exp. Econ. 15, 158–175.

Rogers, H.M., Glew, L., Honzák, M., Hudson, M.D., 2010. Prioritizing key biodiversity areas in Madagascar by including data on human pressure and ecosystem services. Landsc. Urban Plan. 96, 48–56.

Roy Haines-Young, Potschin, M., 2013. Common International Classification of Ecosystem Services (CICES , Version 4 . 3). Rep. to Eur. Environ. Agency 1–17.

Rustichini, A., Villeval, M.C., 2015. Moral hypocrisy, power and social preferences. J. Econ. Behav. Organ. 107, 10–24.

Ryan, C.M., Hill, T., Woollen, E., Ghee, C., Mitchard, E., Cassells, G., Grace, J., Woodhouse, I.H., Williams, M., 2012. Quantifying small-scale deforestation and forest degradation in African woodlands using radar imagery. Glob. Chang. Biol. 18, 243–257.

Ryan, C.M., Pritchard, R., McNicol, I., Owen, M., Fisher, J.A., Lehmann, C., 2016. Ecosystem services from Southern African woodlands and their future under global change Citation for published version: Ecosystem services from southern African woodlands and their future under global change. Philos. Trans. R. Soc. B Biol. Sci. 371, 20150312.

Ryan, C.M., Williams, M., Grace, J., 2011. Above- and belowground carbon stocks in a miombo woodland landscape of mozambique. Biotropica 43, 423–432.

Sagoff, M., 1998. Aggregation and deliberation in valuing environmental public goods: A look beyond contingent pricing. Ecol. Econ. 24, 213–230.

Scarborough, H., Bennett, J., 2008. Estimating intergenerational distribution preferences. Ecol. Econ. 66, 575–583.

Scarpa, R., Ferrini, S., Willis, K., 2005. Performance of Error Component Models for Status-Quo Effects in Choice Experiments, in: Scarpa, R., Alberini, A. (Eds.), Applications of Simulation Methods in Environmental and Resource Economics. Springer Netherlands, Dordrecht, pp. 247–273.

Schaafsma, M, Brouwer, R., Rose, J.M., 2012. Directional heterogeneity in WTP models for environmental valuation. Ecol. Econ. 79, 21–31.

Schaafsma, M., Bartkowski, B., Lienhoop, N., 2018. Guidance for Deliberative Monetary Valuation Studies. Int. Rev. Environ. Resour. Econ. 12, 267–323.

Schaafsma, M., Brouwer, R., 2013. Testing geographical framing and substitution effects in spatial choice experiments. J. Choice Model. 8, 32–48.

Schaafsma, Marije, Morse-Jones, S., Posen, P., Swetnam, R.D., Balmford, A., Bateman, I.J., Burgess, N.D., Chamshama, S.A.O., Fisher, B., Green, R.E., Hepelwa, A.S., Hern??ndez-Sirvent, A., Kajembe, G.C., Kulindwa, K., Lund, J.F., Mbwambo, L., Meilby, H., Ngaga, Y.M., Theilade, I., Treue, T., Vyamana, V.G., Turner, R.K., 2012. Towards transferable functions for extraction of Non-timber Forest Products: A case study on charcoal production in Tanzania. Ecol. Econ. 80, 48–62.

Schägner, J.P., Brander, L.M., Maes, J., Hartje, V., 2013. Mapping ecosystem services' values: Current practice and future prospects. Ecosyst. Serv. 4, 33–46.

Schlosberg, D., 2013. Theorising environmental justice: The expanding sphere of a discourse. Env. Polit. 22, 37–55.

Schreckenberg, K., Franks, P., Martin, A., Lang, B., 2016. Unpacking Equity for Protected Area Conservation. Parks 22.

Schuffam, P.A., Whitty, J.A., Taylor, M., Saxby, R.C., 2010. Health System Choice - A Pilot Discrete-Choice Experiment Eliciting the Preferences of British and Australian Citizens. Appl. Health Econ. Health Policy 8, 573–580.

Schüring, E., 2014. Preferences for Community-based Targeting - Field Experimental Evidence from Zambia. World Dev. 54, 360–373.

Schusser, C., Krott, M., Yufanyi Movuh, M.C., Logmani, J., Devkota, R.R., Maryudi, A., Salla, M., Bach, N.D., 2015. Powerful stakeholders as drivers of community forestry - Results of an international study. For. Policy Econ. 58, 92–101.

Serna-Chavez, H.M., Schulp, C.J.E., Van Bodegom, P.M., Bouten, W., Verburg, P.H., Davidson, M.D., 2014. A quantitative framework for assessing spatial flows of ecosystem services. Ecol. Indic. 39, 24–33.

Shirima, D.D., Munishi, P.K.T., Lewis, S.L., Burgess, N.D., Marshall, A.R., Balmford, A., Swetnam, R.D., Zahabu, E.M., 2011. Carbon storage, structure and composition of miombo woodlands in Tanzania's Eastern Arc Mountains. Afr. J. Ecol. 49, 332–342.

Shyamsundar, P., Ahlroth, S., Kristjanson, P., Onder, S., 2019. Supporting pathways to prosperity in forest landscapes – A PRIME framework. World Dev. 125, 104622.

Sikor, T., Martin, A., Fisher, J., He, J., 2014. Toward an Empirical Analysis of Justice in Ecosystem Governance. Conserv. Lett.

Simon, H.A. (Herbert A., 1982. Models of bounded rationality. MIT Press.

Slovic, P., 1995. The construction of preference. Am. Psychol. 50, 364–371.

Slovic, P., Finucane, M.L., Peters, E., MacGregor, D.G., 2007. The affect heuristic. Eur. J. Oper. Res. 177, 1333–1352.

Smith, M., Muñoz, G., Alvarez, S.J., 2014. Irrigation Techniques for Small-scale Farmers: Key Practices for DRR Implementers, A Field Guide for Disaster Risk Reduction in Southern Africa: Key Practices for DRR Implementers.

Sobel, J., 2005. Interdependent Preferences and Reciprocity. J. Econ. Lit. 43, 392–436.

Spash, C.L., 2008. Deliberative Monetary Valuation and the Evidence for a New Value Theory. Land Econ. 84, 469–488.

Spyce, A., Weber, M., Adamowicz, W., 2012. Cumulative Effects Planning: Finding the Balance Using Choice Experiments. Ecol. Soc. 17, 68–78.

Sunderlin, W.D., Belcher, B., Santoso, L., Angelsen, A., Burgers, P., Nasi, R., Wunder, S., 2005. Livelihoods, forests, and conservation in developing countries: An overview. World Dev. 33, 1383–1402.

Swetnam, R.D., Fisher, B., Mbilinyi, B.P., Munishi, P.K.T., Willcock, S., Ricketts, T., Mwakalila, S., Balmford, A., Burgess, N.D., Marshall, A.R., Lewis, S.L., 2011. Mapping socio-economic scenarios of land cover change: A GIS method to enable ecosystem service modelling. J. Environ. Manage. 92, 563–574.

Syrbe, R., Grunewald, K., 2017. Ecosystem service supply and demand – the challenge to balance spatial mismatches. Int. J. Biodivers. Sci. Ecosyst. Serv. Manag. 13, 148–161.

Syrbe, R.U., Walz, U., 2012. Spatial indicators for the assessment of ecosystem services: Providing, benefiting and connecting areas and landscape metrics. Ecol. Indic. 21, 80–88.

Tatem, A.J., 2017. WorldPop, open data for spatial demography. Sci. Data 4, 2–5.

TEEB, 2010. The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Earthscan, London and Washington.

Termansen, M., McClean, C.J., Jensen, F.S., 2013. Modelling and mapping spatial heterogeneity in forest recreation services. Ecol. Econ. 92, 48–57.

Tilahun, N., Levinson, D., 2013. Selfishness and altruism in the distribution of travel time and income. Transportation (Amst). 40, 1043–1061.

Torbica, A., De Allegri, M., Belemsaga, D., Medina-Lara, A., Ridde, V., 2014. What criteria guide national entrepreneurs’ policy decisions on user fee removal for maternal health care services? Use of a best-worst scaling choice experiment in West Africa. J. Heal. Serv. Res. Policy 19, 208–15.

Torpey-Saboe, N., Andersson, K., Mwangi, E., Persha, L., Salk, C., Wright, G., 2015. Benefit Sharing Among Local Resource Users: The Role of Property Rights. World Dev. 72, 408–418.

Train, K.E., 2009. Discrete choice methods with simulation. Cambridge University Press.

Trautmann, S.T., van de Kuilen, G., 2016. Process fairness, outcome fairness, and dynamic consistency: Experimental evidence for risk and ambiguity. J. Risk Uncertain. 53, 75–88.

Tricomi, E., Rangel, A., Camerer, C.F., O’Doherty, J.P., 2010. Neural evidence for inequality-averse social preferences. Nature 463, 1089–1091.

Turner, R.K., Bateman, I.J., Adger, W.N., 2001. Economics of coastal and water resources: valuing environmental functions. Springer Science & Business Media.

Uchida, H., Nelson, A., 2008. Agglomeration Index: Towards a New Measure of Urban. World Dev. Rep. Reshaping Econ. Geogr. 19.

UK NEA, 2011. The UK National Ecosystem Assessment Technical Report.

UN Assembly, 1987. Report of the world commission on environment and development: Our common future.

UN DESA, 2019. World population prospects 2019, United Nations. Department of Economic and Social Affairs. World Population Prospects 2019.

Vallecillo, S., La Notte, A., Zulian, G., Ferrini, S., Maes, J., 2019. Ecosystem services accounts: Valuing the actual flow of nature-based recreation from ecosystems to people. Ecol. Modell.

392, 196–211.

van den Bergh, J.C.J.M., Ferrer-i-Carbonell, A., Munda, G., 2000. Alternative models of individual behaviour and implications for environmental policy. Ecol. Econ. 32, 43–61.

van Jaarsveld, A.S., Biggs, R., Scholes, R.J., Bohensky, E., Reyers, B., Lynam, T., Musvoto, C., Fabricius, C., 2005. Measuring conditions and trends in ecosystem services at multiple scales: the Southern African Millennium Ecosystem Assessment (SAfMA) experience. Philos. Trans. R. Soc. Lond. B. Biol. Sci. 360, 425–441.

van Wagtendonk, J.W., Benedict, P.R., 1980. Travel time variation on backcountry trails. J. Leis. Res. 2, 99–106.

Varian, H.R., 2014. Intermediate Microeconomics: A Modern Approach: Ninth International Student Edition. WW Nortong & Company.

Varughese, G., Ostrom, E., 2001. The contested role of heterogeneity in collective action: Some evidence from community forestry in Nepal. World Dev. 29, 747–765.

Villamagna, A.M., Angermeier, P.L., Bennett, E.M., 2013. Capacity, pressure, demand, and flow: A conceptual framework for analyzing ecosystem service provision and delivery. Ecol. Complex. 15, 114–121.

Vollmer, D., Ryffel, A.N., Djaja, K., Grêt-Regamey, A., 2016. Examining demand for urban river rehabilitation in indonesia: Insights from a spatially explicit discrete choice experiment. Land use policy 57, 514–525.

Vyamana, V.G., 2009. Participatory forest management in the Eastern Arc Mountains of Tanzania: who benefits? Int. For. Rev. 11, 239–253.

Vyrastekova, J., Huisman, J., Mosha, I., Smits, J., 2014. Mothers more altruistic than fathers, but only when bearing responsibility alone: Evidence from parental choice experiments in Tanzania. PLoS One 9.

Wangai, P.W., Burkhard, B., Muller, F., 2016. A review of studies on ecosystem services in Africa. Int. J. Sustain. Built Environ. 5, 225–245.

Wendland, K.J., Honzák, M., Portela, R., Vitale, B., Rubinoff, S., Randrianarisoa, J., 2010. Targeting and implementing payments for ecosystem services: Opportunities for bundling biodiversity conservation with carbon and water services in Madagascar. Ecol. Econ. 69, 2093–2107.

Whittington, D., 2010. What Have We Learned from 20 Years of Stated Preference Research in Less-Developed Countries? Annu. Rev. Resour. Econ. 2, 209–236.

Willcock, S., Hooftman, D.A.P., Balbi, S., Blanchard, R., Dawson, T.P., O'Farrell, P.J., Hickler, T., Hudson, M.D., Lindeskog, M., Martinez-Lopez, J., Mulligan, M., Reyers, B., Shackleton, C., Sitas, N., Villa, F., Watts, S.M., Eigenbrod, F., Bullock, J.M., 2019. A Continental-Scale Validation of Ecosystem Service Models. Ecosystems.

Willemen, L., Crossman, N.D., Quatrini, S., Egoh, B., Kalaba, F.K., Mbilinyi, B., de Groot, R., 2018. Identifying ecosystem service hotspots for targeting land degradation neutrality investments in south-eastern Africa. J. Arid Environ. 159, 75–86.

Willemen, L., Hein, L., Verburg, P.H., 2010. Evaluating the impact of regional development policies on future landscape services. Ecol. Econ. 69, 2244–2254.

Willemen, L., Veldkamp, A., Verburg, P.H., Hein, L., Leemans, R., 2012. A multi-scale modelling approach for analysing landscape service dynamics. J. Environ. Manage. 100, 86–95.

Wolff, S., Schulp, C.J.E., Verburg, P.H., 2015. Mapping ecosystem services demand: A review of current research and future perspectives. Ecol. Indic. 55, 159–171.

Wunder, S., Angelsen, A., Belcher, B., 2014. Forests, Livelihoods, and Conservation: Broadening the Empirical Base. World Dev. 64, S1–S11.

Yadav, B.D., Bigsby, H., MacDonald, I., 2015. The relative distribution: An alternative approach to evaluate the impact of community level forestry organisations on households. Land use policy 42, 443–449.

Yao, R.T., Scarpa, R., Turner, J.A., Barnard, T.D., Rose, J.M., Palma, J.H.N., Harrison, D.R., 2014. Valuing biodiversity enhancement in New Zealand's planted forests: Socioeconomic and spatial determinants of willingness-to-pay. Ecol. Econ. 98, 90–101.

Young, H.P., 1998. Social norms and economic welfare 42, 821–830.

Youngkong, S., Baltussen, R., Tantivess, S., Koolman, X.H.E., Teerawattananon, Y., 2010. Criteria for priority setting of HIV/AIDS interventions in Thailand: a discrete choice experiment. BMC Health Serv. Res. 10, 197-197 1p.

Zalta, E.N., 2012. The Stanford Encyclopedia of Philosophy. The Metaphysics Research Lab, Stanford.

Zulu, L.C., 2010. The forbidden fuel: Charcoal, urban woodfuel demand and supply dynamics, community forest management and woodfuel policy in Malawi. Energy Policy 38, 3717–3730.