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Methodological and Ideological Options

Trade-off decisions in ecosystem management for poverty alleviation

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ABSTRACT

The academic literature on trade-offs in ecosystem management has paid relatively little attention to justice and poverty reduction objectives. The aim of this paper is to highlight the multiple dimensions of trade-offs in ecosystem services management for poverty alleviation, and to support decision-makers in planning for the almost inevitable trade-offs arising from environmental interventions. The paper brings together different dimensions or lenses through which to analyse trade-offs in ecosystem management for poverty alleviation in a low-income country context. Following a literature review of trade-off decisions, the paper introduces the Balance Sheets Approach to structure trade-off analysis and appraise decisions. We apply the Balance Sheets Approach to analyse five case studies set in very different social-ecological systems where trade-offs were pertinent and undermined poverty alleviation. We show how the combination of 'positive' approaches, often used at strategic level, with 'value' approaches which analyse multiple values, multi-scale governance, power and capacity, is necessary to analyse complex trade-offs. Based on the case studies we identify four lessons for future trade-off analysis in the context of ecosystem management for poverty alleviation in low-income settings.

1. Introduction

Both poverty alleviation and the avoidance of ecosystem services (ES) degradation have become legitimate policy targets, not least through their integration in the Sustainable Development Goals (SDGs). However, the multiple objectives of more sustainable ecosystems management and human wellbeing may not be compatible and attainable at the same time and place (Spaiser et al., 2019, Schaafsma and Bartkowski, 2020). Recent analyses suggest that trade-offs between poverty alleviation and sustainable ecosystem management are already apparent at a global scale; trends over the last decades suggest natural capital is in decline, yet human wellbeing is increasing and absolute poverty is decreasing (Raudsepp-Hearne et al., 2010; Chaplin-Kramer et al., 2019). However, it is questionable that this global trend of reduced poverty will continue, as such trends do not reflect delayed impacts on wellbeing of ecosystem degradation over longer timeframes (Dearing et al., 2012; Roe et al., 2014). Recent rises in undernourishment as well as pandemic-related absolute poverty caution assumptions about the future continuation of these trends (FAO et al., 2019; World Bank, 2020).

The relationship between sustainable ecosystem management and poverty alleviation is debated (Cavendish, 2000; Adams et al., 2004; Gray and Moseley, 2005). Although studies have identified a diversity of interventions that have the potential to deliver both (e.g. Porro et al., 2015; Baumert et al., 2016; Mudombi et al., 2018), evidence also shows that this potential is often not realised. Experience with a range of environmental and conservation interventions has shown that combining ecologically sustainable ecosystem management and poverty alleviation is problematic if not unachievable in many cases (Cinner et al., 2014, Ferraro and Hanauer, 2014, Dawson and Martin, 2015, Bidaud et al., 2017, Bluwstein, 2016, Dawson et al., 2016, Wunder et al., 2018). Drawing on evidence from over 100 research projects, Mace et al. (2018) conclude that trade-offs between ecological sustainability and

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poverty alleviation are ubiquitous.

In places characterised by both high poverty rates and high levels of ecosystem and biodiversity threats, addressing trade-offs effectively is particularly important for achieving the SDGs. Lele et al. (2013) identify the omission of trade-offs as one of the weaknesses of ES frameworks, and relatively few ES studies address trade-offs empirically (Lautenbach et al., 2019). A considerable body of literature has addressed trade-offs in ecosystem management over time and space, between or within individuals and groups, and within and between ecological and social outcomes (Howe et al., 2014, Finkbeiner et al., 2018, see section 2). In part of this literature, co-occurrence of positive and negative impacts have sometimes been labelled as trade-offs even in the absence of evidence for causality (Schaafsma and Bartkowski, 2020), whilst others use the term trade-offs for making values commensurable (Kohler et al., 2019). Here, we define trade-offs as a situation where achieving one desirable outcome must come at the expense of the achievement of another desirable outcome, occurring at the production possibility frontier[1] of a system and recognising that this frontier is set by societal and ecological boundaries that may change over time (Schaafsma and Bartkowski, 2020). Of particular interest to the paper are any ecosystem management decisions that come at the expense of poverty alleviation goals.

The identification of trade-offs in strategic decisions, whether for future policies or in past events, has been considered an important aspect of evidence-based policy support, although to what extent it is 'better' to make trade-offs explicit is disputed (Tetlock et al., 2017). The term 'trade-off' is political, and opponents argue it is used to justify losses based on a technocratic and rational decision ('hard choices are unavoidable') (e.g. Holland, 2002; Myers et al., 2018) and should first and foremost be avoided (Valencia, 2014). Conversely, proponents contend that one of the main advantages of being explicit about trade-offs is that it makes all aspects of a decision transparent, through analysis, deliberation or negotiation (Vira et al., 2012; Campbell et al., 2010), allowing it to be evaluated by external parties (Keeney, 1982).

Despite the political nature of trade-offs, much of the existing ES research on trade-offs has focused on the supply-side, i.e. of ES production (Howe et al., 2014; Turkelboom et al., 2018). As a result, the social and governance aspects of trade-offs often remain understudied (Ellis et al., 2019; Lautenbach et al., 2019). Trade-offs between ES often involve trade-offs between different beneficiaries (Lele et al., 2013; Mace et al., 2018), where there is a conflict of interest. Firstly, consideration of the social structures in which trade-offs are embedded could help to pre-empt or avoid conflicts and choices in cases where relationships between groups in society are unequal or the social context or sets of values are ignored (Hirsch et al., 2011). Disagreements and conflicts about trade-off decisions result from diverging needs, aspirations, visions, ideas about 'best' strategies, and motivations and value judgements of different actors (Kowarsch et al., 2017; Martín-López et al., 2019). Trade-off analysis therefore needs to pay attention to the diverse meanings and values of this social context, which motivate changes in governance and management, and in wellbeing and behaviour. Secondly, it is increasingly recognised that the governance and intervention systems that generate trade-offs are characterised by injustices and power imbalances (Martín-López et al., 2019; Menton et al., 2020).

Analysing the social and governance aspects of trade-offs requires a multiscale approach (Scholes et al., 2013), because the drivers and pressures on social-ecological systems, as well as the actors and the social processes they affect operate at different scales (Nunan, 2018). The actors' needs, values, priorities, interests, power and capabilities may differ, leading to implicit or explicit disagreements and conflicts within and across scales.

The overall goal of this paper is to provide recommendations to reveal and deal with the multiple dimensions of trade-offs in ecosystem management for poverty alleviation in a low-income country context. We do so in a way that addresses the social and governance aspects and reveals injustices in outcomes and processes of interventions. The paper thereby addresses the knowledge gap in the literature on trade-offs regarding the complexity of these trade-off decisions, amplified by the multi-level governance context and inequalities in wealth, interests and power between multiple actors. We achieve this via (a) a literature review identifying the challenges for trade-off analysis in ecosystem management for poverty alleviation; and (b) the application of the Balance Sheets Approach to achieve a critical synthesis of findings from five research projects conducted in different social-ecological systems in low-income countries where such trade-offs emerged. In doing so, we highlight the utility of the Balance Sheet Approach as an organising framework for decision-making at all levels in identifying and planning for the almost inevitable trade-offs arising from environmental intervention, and towards identifying options that better align different interests in space and time. Thereby, we provide a framework for steering trade-off decisions towards ecosystem management that fosters poverty alleviation.

Section 2 reviews the literature on trade-off analysis in ecosystem management for poverty alleviation, categorised into the so-called "positive" dimension of modelling and measuring, and the "value" dimension that considers values and moral choices, and just trade-off decisions (Robert and Zeckhauser, 2011). This categorisation is useful because although models provide trade-off **analyses**, normative trade-off **decisions** remain necessary due to uncertainty and true unknowns about future drivers and outcomes (Carpenter et al., 2006). Section 3 outlines the case studies and methodology. Section 4 demonstrates how the positive and value dimensions feature in the different trade-off analyses, and identifies emerging lessons for future trade-off analysis and decision-support for ecosystem management for poverty alleviation.

2. Framing trade-offs in ecosystem services management for poverty alleviation: a literature review

2.1. Dimensions of trade-off analysis

The question of whether to manage ecosystems for poverty alleviation is normative and debated extensively, around questions such as: what is possible, what is right, what is fair and whose values should count and be prioritised. Such normative choices are typically wicked or hard, involving value trade-offs (Hadari, 1988; Kooiman and Jentoft, 2009). Robert and Zeckhauser (2011) distinguish two complementary dimensions in normative trade-off analysis: the **positive dimension** and the **value dimension**. The explicit recognition of these two dimensions is important because it highlights the limited perspective of ES supply trade-off analyses constrained to the positive dimension that dominate the literature.

The aim of positive analysis is to support decision-making through decomposing the problem and issues at stake, and reducing it to a manageable format, largely through rationalisation and quantification using a range of models. Such analyses provide insight into the impacts of changes in drivers and pressures of social-ecological systems, and guide the design of interventions. However, they tend to ignore values, principles and emotions often associated with hard choices (Holland, 2002, McShane et al., 2011). Section 2.2 exposes the focus, strengths and shortcomings of this approach.

The value dimension engages with the social and governance aspects of trade-offs, recognises value plurality and is a key element of normative trade-off analysis, as described in Section 2.3. It inherently recognises that the legitimacy of trade-off decisions depends on the possibility of bringing value dimensions together in a way that is acceptable to

[1] The production possibility frontier (PPF) is a curve that shows the highest amount of two goods that can be produced if all resources are efficiently used, and is regularly used in trade-off analyses (e.g. Cavender-Bares et al., 2015; Strauch et al., 2019).

stakeholders (Gregory, 2002; Kooiman and Jentoft, 2009). It posits that rational, quantitative models are not morally or cognitively superior to other models, including strategies to avoid or redefine value conflicts (Tetlock et al., 1996; Turner et al., 2015).

2.2. Positive dimension: modelling trade-offs

A rapidly growing body of literature uses quantitative models for positive analysis of trade-offs, which are also called interactions between ES (reviewed in Seppelt et al., 2013, Mouchet et al., 2014, Lee and Lautenbach, 2016, Saidi and Spray, 2018, Agudelo et al., 2020). This literature focuses on identifying patterns of spatial and – less commonly – temporal (e.g. Renard et al., 2015) co-occurrence of ES supply (natural capital), demand (e.g. Bagstad et al., 2017), realised ES, and ES flows. Key approaches here include identification of hotspots, where two or more ES have high relative values (Lee and Lautenbach, 2016), and ES bundle analysis where sets of ES appear together repeatedly (Bennett et al., 2009; Saidi and Spray, 2018).

These trade-off analyses are useful for identification of temporal and spatial dynamics of the distributions of ES, with the most sophisticated models able to identify causal processes of ES supply and hence future trajectories of supply under scenarios of land use and climate change (e.g. Qiu et al., 2020). However, relationships between ES supply and poverty alleviation remain understudied, masking trade-offs in space and time. Temporal variation in ES supply and environmental shocks, as well as in political, social and economic conditions, may translate into poverty dynamics, and transitions in- and out of poverty (Dorward, 2009; Barrett and Constas, 2014; Adams et al., 2016). Current poverty assessments tend to provide a snapshot in time. Temporal differences in poverty status and severity between seasons or years require a move away from static measures of poverty and vulnerability in impact measurement (both for the baseline and the observed changes) (Hutton et al., 2018). Similarly, spatial intra-community differences are concealed by aggregate figures.

Risk in terms of negative impacts on wellbeing, in combination with dependence on ES, further influences poverty outcomes of ES management options that may increase benefits but also involve higher exposure to climatic, ecosystem or market dynamics (Barrett and Constas, 2014). The ability to deal with such temporal variation depends on safety nets (in the form of social or natural capital), assets and income security, available mobility and diversification options, exposure to hazards, rules of access to various resources, etc. (Adams et al., 2016). For example, to deal with decreasing fisheries incomes and lean seasons, fishermen face a choice of adaptation strategies: exit fisheries, diversify or remain fishing (Coulthard, 2012). These adaptation strategies differ in the way they reduce risk and vulnerability, but involve costs (lower wellbeing): they involve trade-offs in income, job satisfaction from fishing and self-actualisation. Fishermen remain fishing and cope with the lean seasons whilst their households endure poverty (ibid.). Models can help to reveal the trade-offs over time to wellbeing of different groups in society associated with different ES management options by explicitly identifying how management may change supply. However, due to the coupled nature of all social-ecological systems, and feedbacks between ES supply and human behaviours, prediction of future livelihood outcomes linked to changing ES dynamics remains extremely challenging (Brown et al., 2019).

2.3. Value dimension of trade-off decisions

2.3.1. Normative trade-offs, commensurability and justice

Ethics, emotions, complexity and uncertainty influence which decision-making strategy is chosen, and which trade-offs are deemed acceptable (Loewenstein et al., 2001; Menzel and Wiek, 2009). To better understand how people will respond to trade-off decisions, it is necessary to understand which values motivate the decisions of stakeholders at different levels in the analysis of trade-offs. Trade-offs involving incommensurable values, such as acute poverty versus irreversible ecosystem loss, can elicit resistance, and intense emotional and cognitive reactions such as moral outrage (McGraw and Tetlock, 2005; Daw et al., 2015).

Normative trade-off decisions regarding ecosystem management for poverty alleviation also require an evaluation about what is fair and just, in terms of values, procedures and outcomes, to understand which decisions are acceptable for stakeholders. Environmental justice has been defined along three dimensions: distributional justice (principles and processes for sharing costs and benefits), procedural justice (who makes decisions and how – see Section 2.3) and recognition (power and respect of cultures and knowledges) (Martin, 2013; Martin et al., 2016). Justice scholars have discussed how these dimensions intertwine and overlap, and how recognition is foundational to issues of procedural and distribution justice (Schlosberg, 2004). McDermott et al. (2013) have added the idea of contextual equity which emphasises that people's different assets, capabilities and systemic injustices affect equity outcomes. For the analysis of distributional outcomes, Daw et al. (2011) argue for disaggregation to demonstrate the value implications for marginalised groups and to make trade-off analyses in ecosystem management relevant to poverty alleviation. Disaggregation may start a discussion about which principles of justice to apply, whose benefits to prioritise (for example by putting higher weight on impacts on disadvantaged groups) and losses to accept (Atkinson et al., 2000, Kristrom, 2005), and what level of inequality to accept.

2.3.2. Measuring wellbeing and poverty

Findings relating to the contribution of ecosystem management for poverty alleviation may depend on how poverty and progress towards poverty alleviation objectives are measured. More holistic assessments of wellbeing may reveal further trade-offs. It is now well recognised that poverty is a multi-dimensional concept, which is not necessarily defined in the same way in different places, across time and between people (Cavender-Bares et al., 2015; Schleicher et al., 2017). Based on the principle of value pluralism, trade-off analyses would consider as many wellbeing dimensions as possible and deemed relevant by those whose wellbeing is measured. This would include the diverse ways in which people attribute meaning and wellbeing to the natural environment. However, the mainstream global poverty indicators such as GDP per capita, often used in possibility-frontier studies for trade-off analysis (e.g. Cavender-Bares et al., 2015; King et al., 2015), do not recognise such nature-inclusive or nature-dependent wellbeing conceptualisations. In practical assessments, such wellbeing elements may be excluded due to budget restrictions (Baulch, 1996), political power (who gets to decide what is measured?), or the purpose of poverty measurement (Palmer Fry et al., 2017).

Recognition (Section 2.3.1) is linked to poverty and wellbeing but rarely considered in empirical analyses of trade-offs. Gross-Camp (2017) finds that the ability to control resources and access (the ability to exclude non-community members) gives a sense of prestige and recognition of conservation efforts, and motivates the support for community-based forestry management regimes in Tanzania even in the absence of major tangible benefits. Similarly, Coulthard et al. (2011) find a trade-off between the individual costs of insufficient fisheries income and unreliable livelihood, and positive benefits of Padu membership (customary marine tenure system) in India, in the form of social prestige, collective power and the ability to have privileged access to the best fisheries. These studies demonstrate that the values associated with ecosystem management are much broader than positive trade-off analyses often assume, and that the value dimensions of trade-off analysis can reveal a wider range of trade-offs and lead to a better understanding of the diversity of stakeholders' decisions (Pasgaard and Dawson, 2019).

2.4. Multi-level decision-making

The value dimension of trade-off analysis also recognises the process of decision-making and the governance systems in which trade-off

decisions are embedded. Governance of both natural resources and poverty alleviation takes place at multiple levels, and typically sits in different ministries and sectors. Governance is defined by the rules and processes that control resources and rights and by which decisions are made, as well as the distribution and exercise of power and the inclusion and participation of multiple stakeholders (Nunan, 2018). Governance hence influences trade-off decisions and shapes who wins and who loses, whose values are considered legitimate, accounted for and acknowledged.

Decisions to employ particular policy instruments for ecosystem management have different effects on incomes, equity and environmental status (e.g. Persha et al., 2011; Ferraro and Hanauer, 2014). These instruments change *de jure* or de facto property rights and access rules, or the benefits that accrue from existing property rights. Whether by design or unintentional, they often embody different distributional principles and therefore result in different wellbeing outcomes (Pascual et al., 2010). The negotiation and selection of these instruments may hence be driven by interests of more powerful stakeholders who can silence or exclude groups (Chilvers, 2009). Where trade-off decision-making processes reproduce existing power imbalances and fail to address vested interests, they (re-)enforce disparities in ecosystem benefit distribution (Vira et al., 2012).

This complexity of social-ecological systems and governance creates a challenge for effective ecosystem interventions towards the dual objectives of alleviating poverty and ecological sustainability. A lack of shared objectives and prioritisation of these objectives across decision-makers may lead to ecosystem management that fails to achieve poverty alleviation. This literature review has highlighted that including the diverse values held by stakeholders, and the adherence to principles for multi-level governance may help to achieve these objectives.

3. Methodology

3.1. Case studies

To exemplify the multiple dimensions of trade-offs in ecosystem management for poverty alleviation in a low-income country context, we analyse five interdisciplinary research projects funded by the Ecosystem Services for Poverty Alleviation (ESPA) programme. The selected case studies focused on five different social-ecological systems in low-income countries, dealing with different ecosystem interventions to alleviate poverty, and using a range of methods to understand values held by different stakeholders at multiple levels. Their diversity provides an opportunity to demonstrate trade-offs, supported by the Balance Sheets Approach to examine the value dimension of trade-offs and the multi-level governance systems in which policies are embedded. The studies in Bangladesh, Malawi and Eswatini (formerly known as Swaziland) focused on trade-offs in more agricultural landscapes, while the studies in Kenya and Rwanda explored trade-offs in the use of natural mangroves and forests, respectively. A detailed description of the case studies is included in Appendix A.

The case study in Bangladesh used a systems-approach to investigate the effects of policy decisions in the complex Ganges-Brahmaputra-Meghna Delta system on poverty and ecosystems. The project analysed rice intensification and the expansion of saline aquaculture through conversion of rice fields to shrimp farms, as well as the potential of agricultural modernisation (e.g. hybrid or genetically modified crop varieties, irrigation, diversification).

The Eswatini case study investigated the impacts of agro-industrial development on ES and human wellbeing in the northern lowveld. It focused on the area around a large sugarcane plantation, surrounded by irrigated sugarcane smallholders organised in independently operating associations. The smallholder sugarcane sector was set up through extensive land consolidation and irrigation development, resulting in several thousand farmers scattered along the banks of the Komati river.

The Malawi case study focused on the potential of climate smart agriculture (CSA) as an alternative to traditional maize farming to enable smallholder farmers to increase yields and cope better with climate change. It analysed the compatibility of CSA with integrated catchment management, which aims for a balance between economic, social and environmental objectives, under different economic and climatic scenarios.

The Kenya study supported the formation of a Payments for Ecosystem Services (PES) scheme by generating data on the carbon storage potential of the mangrove forest and a baseline study of the social and economic situation of two villages in Gazi Bay. The project also supported the formation of a Community Forest Association, supporting the community-based organisation 'Mikoko Pamoja' in securing legal status and ability to receive funds from international carbon trading.

The Rwanda study examined the ability of PES to contribute to the national conservation and development goals of the country. The project focused on a sample of communities living adjacent to the strictly protected Afromontane forest of Nyungwe National Park, and evaluated the effects of a pilot-PES scheme on forest use and relationships with park authorities.

Multiple qualitative and quantitative research methods were used in the case studies to provide a broad picture of the different stakeholders and their interests, covering both the positive and value dimensions of trade-off analysis (Table 1). The Bangladesh project relied primarily on a system dynamic model and quantitative scenario analysis using household survey and secondary data – as an example of the positive dimension of trade-off analysis (Section 2.2). The Kenya project relied

Table 1
Main research methods and approaches used in the five case studies.

Project	Macro/national	Meso/district or region	Micro/local
Bangladesh	- system dynamic modelling - scenario analysis - actor network analysis	- system dynamic modelling - scenario analysis	- downscaled system dynamic modelling - literature review - secondary data analysis - household survey
Eswatini	- literature review - key informant interviews - institutional analysis	- land use mapping - carbon stock assessment - biomass survey and soil analysis	- focus group discussions - household survey
Malawi	- policy document review - key informant interviews	- scenario analysis in participatory workshop - trade-offs matrix - key informant interviews	- choice experiments - multi-criteria analysis - group deliberations
Kenya	- ethnography - governance workshop	- ethnography - key-informant interviews - governance workshops	- key-informant interviews - focus group discussions - household survey
Rwanda		- negotiation of PES	- interviews - community meetings - social activity monitoring - household survey - ecological surveys

much more on qualitative approaches to evaluate motivations and attitudes, fitting the value dimension of trade-off analysis (Section 2.3). The Rwanda project focused primarily on micro-level decisions, even if the negotiations of the final PES programme took place at meso-level. The projects in Malawi, Kenya and Eswatini employed methods to collect primary datasets at both micro- and meso-level, while using policy documents and key informants to better understand macro-level interests.

As poverty alleviation was a main, but often compromised objective in each of the case studies, we considered the following five questions regarding trade-off decisions at each of the macro-, meso- and micro-levels in the case study analysis:

1. Which objectives were pursued by different actors?
2. Which trade-offs were identified (between ES, stakeholders, in space and time)?
3. What motivated decisions? Which principles and values played a role?
4. Who was involved in the decision-making process?
5. Who had power to influence decisions?

Whereas the first two diagnostic questions engage with the presence of trade-offs, the latter three questions explore the social and governance aspects and origins of those trade-offs. We also evaluated the permanence of the decisions, interventions and outcomes to identify policy recommendations for avoiding or mitigating trade-offs.

The authors first convened a one-day meeting to discuss trade-offs in the context of ecosystem management for poverty alleviation, and specifically within the case studies. After this meeting, in combination with the literature review in Section 2, we developed the list of questions above. With the exception of the Malawi case, the research projects were not designed to focus on trade-offs analysis. Therefore, each of the authors involved in one of the case studies reflected on the range of outputs, activities and experiences of their respective projects, which was collected using a template with the questions (and sub-questions, plus further guidance) (see Appendix A). This served as the data for this paper. If studies did not explicitly address a particular question, then authors either used their expert knowledge of the case study sites to infer the answers, or highlighted the gap as a limitation. Each case study and its supporting documentation was probed by at least one other author to ensure a consistent approach across the cases.

3.2. Balance sheets approach

Various tools and methods exist for the analysis of the positive and value dimensions of trade-offs in ecosystem management, that can provide evidence and inform trade-off decision-making processes (e.g. Cord et al., 2017); Table 1 demonstrates this variety in our five cases. One way of organising these methods and linking them to policy-relevant social, economic and ecological principles (or decision-making criteria) is the Balance Sheets Approach (Turner et al., 2015, Turner, 2016, Fig. 1). This approach is a decision-support system, providing process and method guidance, which was originally developed for public sector decision-makers for evidence-based decision-making in uncertain and contested policy contexts, but could be adopted by, and adjusted to, any level of decision-making and employed by different stakeholders.[2] It brings together a range of broad principles, assessment methods and techniques, to organise (but not aggregate) different types of evidence.

Current applications of the Balance Sheets Approach are limited to marine environments in the Global North (Scharin et al., 2016; Turner and Schaafsma, 2015); this paper presents a novel application focused on the Global South, where budget limitations that force choices between different development options are often more severe than in the Global North. We have expanded the social principles beyond fairness and ethical rules, to include governance evaluation principles of inclusiveness, legitimacy, transparency and accountability. These were not only explicitly added because the design and implementation processes of policies and interventions should adhere to these in order to be effective (Bennett and Satterfield, 2018; Nunan, 2018), but also because they speak to issues of power imbalances (Section 2.4).

The Balance Sheets Approach starts with a strategic analysis in Sheet 1 of the policy objectives at national level, primarily within the positive dimension of trade-off analysis (Section 2.2). Here, to move beyond efficiency towards justice and equity criteria, the social principles emphasise the need to disaggregate findings across stakeholders and diagnose inequalities at the start of policy processes to legitimately and effectively design implementation strategies (Section 2.3). The implicit aim of highlighting distributional inequalities in outcomes is to start conversations and analyses of 'acceptable' inequalities in outcomes, feasible actual compensation and compromise options, and causes of inequality or limited poverty alleviation. The methods and techniques in this sheet are applicable in contexts of relatively slow and simple environmental change and provide headline figures and trends for strategic analysis (Fig. 1, blue arrow).

The meso-micro level policy analysis addresses regional economic effects, social-cultural conditions and values, as well as systemic effects at the scale of the ecosystem or landscape (Sheet 2). Methods and techniques in Sheet 2 tend to provide more insight into regional differences and dynamics, and impacts on sectors and households. While methods for Sheet 1 and 2 fall more so in the positive trade-off dimension, Sheet 3 most clearly addresses the value dimension of trade-offs (Section 2.3), with ethical criteria that reflect collective and cultural values or intrinsic values, which require non-monetary trade-off analysis (Section 2.3). Moreover, it highlights the importance of critical and irreplaceable natural capital and threshold effects underpinning ecological sustainability. Sheet 3 is thus crucial for policy design to ensure ethically defensible and culturally inclusive design and appraisal of ecosystem policies for poverty alleviation, and adherence to the social and governance principles (Section 2.4). Sheet 3 is suited to complex and dynamic environments with wicked, hard choices between value-laden, conflicting goals; its methods and approaches are suitable for multidimensionality and plural values. Participatory and deliberative approaches are most prominent in Sheet 3, but stakeholder engagement and participation in combination with technical expert input would increase the legitimacy and effectiveness of trade-off analysis in any of the sheets.

Through these complementary and sequentially linked but overlapping steps, operating at different levels of governance and complexity, the Balance Sheets Approach is useful to systematically analyse trade-offs. First, it forms a decision-support tool that can be utilised fully or partially, i.e. focusing on one particular sheet conditioned by the environmental or policy contexts at issue, where the choice of techniques should be adapted to the context. Decision-makers may reject Sheet 1 and move directly towards Sheet 3, if the values, dynamics and stakes involved are highly complex. Alternatively, decision-makers may start with analysing complex choices in Sheet 3, and then feed this back into regional or national policy analysis in Sheets 2 and 1. Second, the Balance Sheets Approach includes an explicit acceptance of the notion of plural values, and social, ecological and economic principles for the design and evaluation of decisions. Third, it explicitly highlights the importance of identification of inequality and emphasises actual compensation.

In the context of ecosystem management for poverty alleviation, the Balance Sheets Approach supports decision-makers to address the complexities of incommensurate values in resource allocation and allows for trade-off decisions to be revealed and analysed. For example, it

[2] It should be noted that the Balance Sheets Approach does not cover procedures and rules of decision-making, such as procedures for organisational integration or set-up (Nilsson and Weitz, 2019).

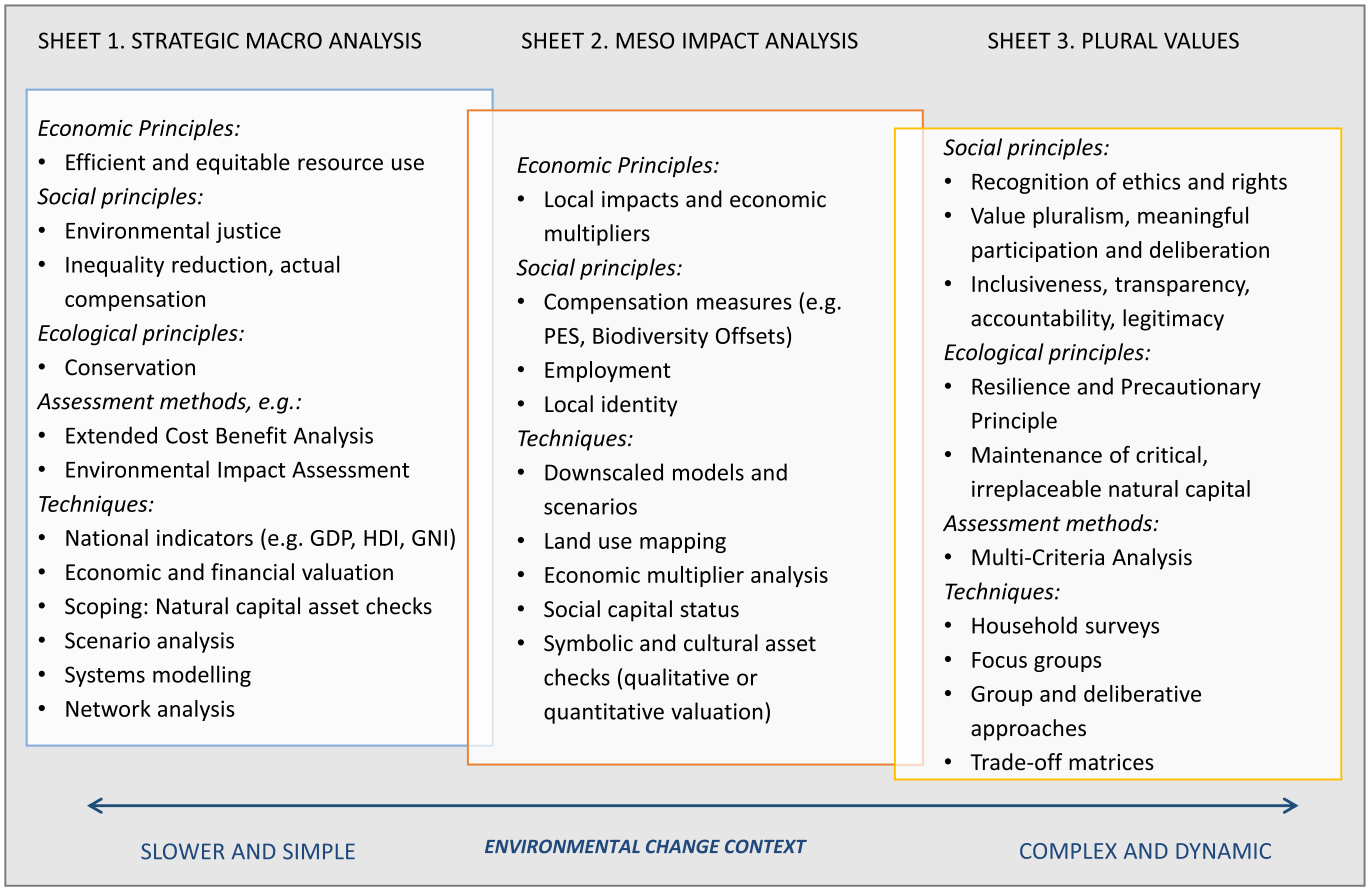

Fig. 1. Balance Sheets Approach. Adapted from Turner (2016).
Notes: GDP = Gross Domestic Product, HDI=Human Development Index, GNI = Gross National Income, PES=Payments for Ecosystem Services.

can be used to identify competing claims such as macro-level objectives of economic growth by governments and nature conservation by conservationists (Sheet 1), and meso- and micro-level objectives to create employment and incomes for different groups through natural capital exploitation (Sheets 2 and 3). For all these values and claims, different techniques are suitable (lists in Fig. 1 are by no means comprehensive) and method choices can become part of a participatory process. Therefore, the assessment techniques include not only natural capital and ES modelling and accounting, but also a diversity of monetary and non-monetary valuation methods based on deliberative and group processes. Comparing the methods in Table 1 to the Balance Sheets Approach (Fig. 1) reveals that the methods used at micro-level in particular are suitable for assessment of plural values (Sheet 3), whereas some of the techniques employed at macro and meso-level fit on Sheets 1 and 2.

The Balance Sheets Approach can be applied in ex-ante assessments to steer processes of decision-making; and specifically for trade-off analysis, map the interactions between different objectives and forecasted impact assessments, to then inform negotiations among actors with different goals (Nilsson and Weitz, 2019). In this study, the Balance Sheets Approach is applied ex-post as a diagnostic tool to structure the diverse evidence base and better understand how decisions were made and which perspectives, knowledge, values or priorities were recognised or ignored. The Balance Sheets Approach explicitly evaluates the evidence against not only guiding economic principles of efficient and equitable resource use but also social principles of justice and inequality reduction. The Approach thereby prompts the first two diagnostic questions for our case studies (see Section 3.1), as well as a discussion about the distributional outcomes and environmental justice, already in Sheet 1 and even more strongly as one moves towards Sheet 3, and the underlying processes involving power and influence where some win and others lose, prompting the remaining three questions.

In Section 4 we apply the Balance Sheets Approach to structure the analysis and evidence of some of the main trade-offs emerging in our five case studies.

4. Results and discussion

In this section, we draw on our five case studies to discuss the extent to which policy objectives were shared and aligned across different stakeholders and different governance levels (Section 4.1), and what the main trade-offs identified between poverty alleviation and other policy objectives were (Sections 4.2 and 4.3.1). Subsequently, we analyse where these trade-offs originated, linking this to social and governance principles (Section 4.3). In Section 4.4, we reflect on the emerging lessons learned in our trade-off analyses relating these to the reviewed literature (Section 2) and the principles included in the Balance Sheets Approach, and on the use of the Balance Sheets Approach to highlight important aspects of trade-off analysis.

4.1. Objectives of ecosystem management at different levels

Responses to the first question showed that the objectives of stakeholders varied across levels in all case studies, with micro-level motivations often deviating from meso- and macro-level interests (Table 2).

The macro- and meso-level stakeholders in Bangladesh and Eswatini were primarily interested in economic growth and generating foreign exchange through agricultural development and stimulating rural livelihoods through cash crops. In Bangladesh, macro-level policy focused on rice intensification and conversion of rice fields to shrimp farms, and

Table 2
Primary objectives of stakeholders at different levels in five case studies, with secondary objectives in brackets.

Project	Macro	Meso	Micro
Bangladesh	National government: Economic growth for poverty alleviation through agricultural intensification and coastal defence	Regional government: Economic growth through agricultural development and efficiency	Local households: Secure livelihoods
Eswatini	National government: Rural development and poverty alleviation, Economic growth	Royal Swaziland Sugarcane Corporation: Stabilisation and maximisation of sugarcane production	Smallholders: Income (Food security)
Malawi	National government: Economic growth and national food self-sufficiency	District government: Food security (forest conservation)	Local households: Food security
Kenya	National government: Conservation (Livelihoods, Government revenues)	County government: Conservation (Livelihoods, Government revenues)	Mikoko Pamoja Community Organisation; local office of Kenya Marine & Fisheries Research Institute; local communities: (Sustainable) forest use for livelihoods (Conservation)
Rwanda	Rwanda Development Board: Conservation, Poverty alleviation	Nyungwe National Park Authority; Forest/biodiversity conservation, (Do no harm to people)	Local communities: Education, housing, fuel, food, (Conservation)

at the meso-level on progressive farming and agricultural efficiency, through subsidies, micro-credits and hydrological engineering (Lázár et al., 2015). At micro-level, the farmers in Bangladesh emphasised the security of their livelihoods, which traditional farming offers to some extent (Adams et al., 2016).

In Eswatini, the sugarcane sector received strong support from the government, which has traditionally viewed sugarcane as an agent of national and rural development considering its large contribution to GDP (macro-level). The largest plantations used to be state-owned, and smallholder mobilisation and irrigation development happened through dedicated agencies. Government provided support through infrastructure development (including for irrigation), economic incentives to producers, technical support to smallholders and strong government involvement (Terry and Ogg, 2017). These supporting mechanisms sought to stabilise the sugarcane sector and maximise sugarcane production at meso-level. At micro-level, households were primarily interested in generating income. Households were more likely to get involved in sugarcane production if they lived closer to rivers (and were thus pre-selected), but practically all households decided to engage in the sector due to readily available irrigation, access to credit (via institutions such as sugarcane associations) and perceived higher economic gains (Mudombi et al., 2018; von Maltitz et al., 2019).

The main national agricultural policy in Malawi focuses on farmer input subsidies, dominated by fertiliser input for maize, with the aim of reducing poverty through national food self-sufficiency. Priorities at meso-level were harder to identify. Other than farm subsidies, many projects are funded through, and executed by, international donors who have multiple objectives around poverty alleviation and sustainable ecosystem management. The role of the district becomes one of approving suitable projects. District officials who participated in the workshop prioritised food security (Schaafsma et al., 2018). At micro-level, farmers were also primarily concerned about their family's food security when considering CSA adoption (Schaafsma et al., 2019). Wider landscape impacts were not explicitly considered, but some farmers stated that they were willing to adopt CSA for the long-term benefits for their children. Another factor motivating adoption was concern about the wellbeing impact of environmental risks, such as floods and droughts.

Whereas in Kenya and Rwanda the meso- and macro-level stakeholders involved in the PES projects were primarily interested in forest conservation, the primary goal of local stakeholders was to secure their livelihoods and ensure their education, housing and fuel. For local stakeholders, forest conservation was secondary to being able to access forests to obtain ES to fulfil basic needs in the short-term. In Kenya, the main motivation at meso- and macro-level for the PES programme was forest conservation, with limited efforts to truly devolve power over forest resources to local communities (Kairu et al., 2018). The secondary motivation was to support livelihoods and generate revenues for the forest department and the government. Although local communities have similar conservation objectives, there is more interest in future mangrove use for local livelihoods and short-term local revenue for community development from carbon trading.

The PES scheme in Rwanda was based on the simple premise that paying the 'right' amount (as compensation) to communities would negate illicit use of park resources. The Rwanda Development Board developed the payment method: deposits were paid into a savings and cash cooperative, with the aim of increasing money savings so that households would become eligible for loans (Martin et al., 2014). While the meso-level institutions were afraid that payments would be used poorly or create perverse incentives, the communities partly earmarked funds to improve housing, education, food security and alternative fuel sources.

The cases show that, at the national level, strategic objectives of growth and national development dominated decisions relating to the interventions studied in Bangladesh, Kenya and Malawi, which fits economic principles of Sheet 1 (Fig. 1). These top-down strategies were implemented at meso-level where objectives related to employment, and stable sector development (Sheet 2). The meso- and macro-level objectives of the forest policies studied in Kenya and Rwanda adhered to ecological principles (conservation), but allowed for resource use to raise government revenue. In all cases, these did not clearly match local/micro-level objectives, which focused primarily and by necessity on basic needs and security.

4.2. Main trade-offs with poverty alleviation

The activities undertaken by different stakeholders at micro-, meso- and macro-levels to achieve their disparate objectives led to trade-offs between poverty alleviation at micro-level and other objectives (summarised in Table 3). The outcomes of the studied interventions are frequently in conflict with social principles of the Balance Sheets Approach, related to rights, distributional effects and inclusiveness, as well as ecological principles of conservation and long-term resilience.

The interventions studied in Bangladesh, Eswatini and Malawi ultimately led to trade-offs between on the one hand economic growth through promoting efficiency and cash crops, and on the other poverty alleviation through providing access, livelihood security, basic needs and securing rights. The interventions were only accessible to some, often wealthier, actors at micro-level. In Bangladesh, economic growth-oriented policies to stimulate rice intensification or conversion to shrimp farming, which whilst financially more efficient, employ substantially less labour than traditional rice production (Amoako Johnson et al., 2016) and primarily benefited larger landowners and outside investors sometimes through bribery and forced land acquisition (Adams et al., 2016). However, a range of conditions including new restrictions on ecosystem access meant that marginalised actors could not benefit from agricultural development programmes (Adams et al., 2016). Meso-level modelling of scenarios of agricultural intensification suggested higher

Table 3
Trade-offs and potential risks and impacts.

Trade-offs	Risks / Impact	Case study
Efficiency (agriculture) vs. debt, access (to resources and technology)	Adoption inequality, increased poverty	Malawi, Bangladesh, Eswatini
Cash crops vs. security, basic needs and rights	Food insecurity, energy insecurity, forced migration, land dispossession	Bangladesh, Eswatini
Economic growth/rural development and provisioning services vs. sustainable regulating services	Lower resilience, poverty, water conflicts, food insecurity	Bangladesh, Eswatini
Longer-term conservation objectives vs. short-term costs of conservation, low compensation	Lack of local support	Kenya, Rwanda

incomes for farmers, but also higher exposure to climate and market volatility, and lower resilience and potentially higher dependence on high-interest loans or other assistance, compared to traditional farming techniques (Lázár et al., 2015). The micro-credit schemes in Bangladesh to incentivise adoption of rice intensification were supported and controlled by the government, but private loans were not. Thus the adoption of progressive farming techniques was low, largely due to the high initial costs. Overall, agricultural intensification resulted in siltation and a loss of productivity, and increased debts, reduced access to land, capital and farm jobs for poor people, ultimately resulting in forced migration for those who could afford to do so and further impoverishment for those who could not (Hutton et al., 2018).

The Malawi case study suggested similar effects of wealth-related access and adoption inequalities if limited government funding were used to support CSA instead of for continuing fertiliser subsidies. In line with findings by Scott (1977) on peasants' choices of techniques, CSA adoption is often not possible for farmers with very small land holdings who cannot experiment with new techniques without jeopardising their household food security (Schaafsma et al., 2019). Many CSA techniques in Malawi were perceived to have higher costs than benefits in the short-term, due to their higher labour requirements, lack of manure and higher risk. This discouraged many farmers from adopting CSA. CSA adoption may increase when accompanied by financial incentives, but penalties for farmers not meeting the requirements of this incentive form a barrier for poorer households.

This lack of inclusiveness also transpired in the expansion of industrial cropping in Eswatini through large private plantations, which sometimes came with involuntary population movement (despite some compensation), while the smallholder-driven expansion was very selective, creating major differences within communities. For example, only households close to the Komati River were provided with assistance to grow sugarcane (i.e. to access water, allow formation of farmer associations and market stabilisation), which precipitated differentiated access to freshwater within communities, causing a series of tensions (Terry and Ogg, 2017; von Maltitz et al., 2019). Government support made sugarcane more profitable than other productive uses of land. Households involved in sugarcane, whether as plantation workers or as sugarcane growers, were consistently better off across multiple measures and dimensions of wellbeing and more food secure than control groups (Mudombi et al., 2018). Consequently, the sugarcane smallholders have a much better access to credit than non-sugarcane farmers, which has further multiplier effects (von Maltitz et al., 2019).

Regarding the ecological principles, the Bangladesh modelling results showed that the emphasis of the government on economic growth and provisioning services from agriculture and aquaculture would likely have a negative and irreversible effect in the longer-term on the supply of regulating services, including water quality and quantity, and soil stability (Hossain et al., 2016). The degradation of regulating ES may undermine long-term poverty alleviation and resilience improvements, and furthermore lead to water conflicts across the delta. Such changes in the delivery of provisioning and regulating ES following landscape conversion were also observed in the sugarcane areas of Eswatini. In this case, sugarcane areas were established in former agricultural and forest land, affecting the provision of food crops (decline), sugarcane (increase) and carbon storage (increase), and possibly in water use due to irrigation and intensification (Gasparatos et al., 2018; Romeu-Dalmau et al., 2018).

The studies in Kenya and Rwanda showed similar trade-offs between long- and short-term goals, with longer-term conservation benefits at the expense of shorter-term poverty alleviation or perceived household benefits. In Rwanda, the initial funds were primarily used to invest in infrastructure, the development of the payment mechanism (imposed by authorities), and a number of tree and bamboo nurseries (Martin et al., 2014). Not only do these plantations have a considerable time lag before becoming productive, households also felt that they did not benefit from the project, where they could not use the forest but also received no compensation or alternative source of energy and materials. Such time lags may also become a burden on the Kenyan communities who have to keep out of an area of mangrove forest for a period of 25 years, foregoing forest benefits such as firewood and timber, in exchange for annual income and an improved mangrove forest for the future (Huxham et al., 2015). But the amount of income going to the community is quite small and it could be challenging to maintain the interest and motivation of the community over such a long period of time. In both cases, the lack of compensation or gains for local communities is likely to affect the local support for the conservation projects. The Kenyan local government office has been key in raising awareness and providing support and encouragement, but this will continue to be needed for years to come.

4.3. Social and governance aspects of trade-offs with poverty alleviation

In all case studies, there are clear trade-offs with poverty alleviation. These trade-offs originated through different mechanisms and at different governance levels of the trade-off analysis and decision-making process (Section 2).

4.3.1. Recognising trade-offs

In most cases, the trade-offs outlined in Section 4.2 are rather complex and not explicitly recognised, acknowledged or addressed in policy and legislation at all levels, generating both opportunities and challenges for implementation (Diz and Morgera, 2018). That is, the overall strategic objectives (Sheet 1), often focused on efficiency, result in trade-offs at meso- and micro-level to the detriment of the poor.

For example, Kenyan policies in coastal zone mangrove forests pursue conservation aims whilst also providing livelihoods and generating revenue for the government (Nunan et al., 2016). The incompatibility of objectives of decision-makers also meant that conservation objectives are traded off against revenue generation: the forest department sells timber licences, but does not strictly monitor or control the amount of timber extraction. As described in Section 4.2, the design of the payment schemes in Rwanda and Kenya failed to recognise the temporal trade-offs experienced at micro-level.

The meso-level trade-off analysis in Malawi forced policy-makers in a participatory scenario workshop to think about the compatibility of the objectives of river basin management and CSA over wider time and spatial scales (Schaafsma et al., 2018). The results showed that tree-planting and conservation agriculture would be the most promising CSA techniques. But under scenarios of severe climatic change and

negative economic growth, even these techniques would have trade-offs with yield maximisation, poverty alleviation, equity and environmental management objectives, mainly because the government would lack budgets to implement projects to acceptable standards and address such trade-offs. Participants also saw lack of coordination between agriculture, forestry, climate or water departments as a barrier to effective implementation of techniques.

The trade-offs and value conflicts over time and between sectors and ES in the Bangladesh case were revealed by the systems model that showed the results of very complex processes by which the poorest and most vulnerable people lose out (Hutton et al., 2018).

These examples suggest the difficulty of anticipating and integrating trade-offs in policies and local interventions, especially considering the lack of local capacity (see Section 4.3.4). In both the Malawi and Bangladesh studies, the use of trade-off analysis methods (modelling, matrices, scenarios) helped to reveal conflicting objectives.

4.3.2. Process of decision-making

In cases of complexity and lack of policy coherence (Section 4.3.1), improving the transparency and inclusiveness of trade-off decision-making processes may help improve social equity outcomes (Law et al., 2018, Sheet 3 – social principles). Nonetheless, different opinions about the fairness of outcomes may remain (Section 2.4). As highlighted by McDermott et al. (2013) for PES schemes, in any intervention it is important to understand who defines what constitutes equity (if it has even been considered).

In Rwanda, the involvement and power of the park management and District level authorities meant that these actors could influence the design of the PES scheme, and thereby directly influence the emergence of trade-offs. For example, park management wanted to reduce the amount that was paid as cash to households rather than communities, as well as the amount paid to the highest users of forest resources. The rationale was two-fold: (1) the park authority viewed payment to the highest forest users as a perverse incentive and (2) funnelling the money to community-level activities was aligned with District Level development objectives, i.e. creation of infrastructure and communal services like schools or maternity wards. The decision of how to distribute the money was made in a series of village level community meetings that were carefully designed in an iterative process and were relatively well attended. However, despite attempts to ensure meaningful participation, it may be that the outcomes were steered by local government authorities influenced by demands from the park and District level authorities. In the end, this led to some discontent with the project in relation to the low household-level payments, but not necessarily with community processes of decision-making.

In the Rwanda and Malawi studies, the transparency and modalities of the payments were prioritised over the amount disbursed. The deliberative methods in Malawi revealed that farmers would only accept an effort-based incentive for CSA adoption if transparency could be ensured, but they preferred a flat rate in case of lack of transparency. There was little support among farmers for pro-poor payments to support elderly, less-abled or single mothers. Such concerns over the transparency of allocating funds may originate in farmers' experience with fertiliser subsidy distribution, where social norms within communities create trade-offs: older members and those well acquainted with the chief tend to receive higher fertiliser subsidies than younger farmers. Participants in the study wanted to avoid replicating such non-transparent processes. In Rwanda, the authorities imposed the payment mechanism, assuming that the transparency of household saving accounts would enhance support for the conservation project and reduce illicit activities in the park. However, the costs of this mechanism reduced the pay-out to communities and households.

The case of Eswatini shows this interplay and possible tensions between inclusiveness, transparency and fairness (Sheet 3). One of the conditions for smallholders to receive irrigation (and thus the ability to grow sugarcane) was to organise in farmer organisations that operate as community enterprises with equal sharing of dividends between farmers (von Maltitz et al., 2019). This equal division increased transparency, the negotiating power with mills and input providers, and the ability to access credit, but has also created tension (Terry and Ogg, 2017). Some of the households that provided larger plots of land during the consolidation process perceived the equal share of dividends, as mandated by the government to enhance inclusiveness to the benefits of irrigation and sugarcane production, as inherently unfair.

4.3.3. Power and control

Some of the trade-offs between policy objectives originate in unbalanced power relationships between organisations at different levels that prohibit meaningful participation (Ellis et al., 2019, Martín-López et al., 2019, Sheet 3).

For example, the devolution of power from national to county governments in Kenya may affect natural resource governance, especially in cases of unclear allocation of roles and power between officers employed by national and county government. Even more so, the manner in which participatory forest management is implemented limits effective participation. Revenue from timber extraction licences is kept by the government rather than shared with Community Forest Associations (Mogoi et al., 2012), reflecting the reluctance of the government to share power and resources (Kairu et al., 2018). The policy being implemented reflects a trade-off between the need to involve resource users and the reluctance to share too much power or resources, or to cede control. As such, how well participatory forest management is supported and is perceived to perform remains unclear.

Unequal power also resulted in the emergence of trade-offs in some cases. For example, the power and control held by the Rwandan park authority meant that they unilaterally decided on the type of payment and the payment mechanism. These decisions did not directly involve the local communities. Only when the university partner negotiated that communities should have a say in the allocation of funds was a process set up to negotiate PES contracts.

Finally, top-down processes affected different types of trade-offs. In particular, the land- and associated water- development projects for cash crops in Bangladesh and Eswatini were top-down processes to achieve national economic growth and rural development. In Bangladesh, growth strategies came at the detriment of the poorest: land evictions, forced either by the government or by wealthy investors, affected poor households disproportionately (Haque, 2018). In Eswatini, the top-down decisions of the government parastatal coordinating the development of irrigation and sugarcane production included the selection of project beneficiaries (i.e. households close to the river) and benefit-sharing mechanism (i.e. equal dividends regardless of land allocation) (Terry and Ogg, 2017; von Maltitz et al., 2019). This created unequal power and control over water resources within local communities, with the legitimacy of the arrangement being contested by other community members, and catalysing many tensions over water, especially during the 2015–2016 droughts. Such inequality-raising decisions hence lead to trade-offs at micro-level that may undermine long-term efficiency and sustainability.

4.3.4. Sustained policy implementation, capability and commitment

Effectiveness of ecosystem management for poverty alleviation depends on the capability of governance actors to implement the interventions and adhere to good governance principles in order to avoid or mitigate trade-offs jeopardising poverty alleviation (Lockwood et al., 2010; Nunan, 2018).

The Kenyan case showed that prolonged local government support was needed to set up and support the community organisation Mikoko Pamoja. Indeed, devolving power to local resource managers may require investment in social capital, e.g. adult literacy and leadership training to effectively take command of resources (Leach et al., 1999). Without such investment, prevention of extraction of forest products from the mangrove forests will become harder, due to challenges in

maintaining monitoring of the forests, the operation of the community organisation and wider community support.

In Bangladesh, a key reason why policies are not implemented or taken-up at micro-level is the lack of investment or effort from local and regional governments for implementation on the ground, for example, to address indebtedness. Without such support, changing farming practices is simply too costly and risky for farmers in the short-term. Other support that could have built the capacity of farmers to benefit from agricultural intensification, such as government investment at macro- and meso-level in education, enforcement of land rights, law and order, and the funding of extension workers were also limited, if not absent.

Similarly, the large-scale adoption and sustained use of CSA practices is unlikely to take off in Malawi as long as the majority of the agricultural budget is directed to fertiliser subsidies. The 2016 National Agricultural Policy includes a section on CSA, but only sets yield objectives and does not foresee any funding to support CSA. Districts can effectively only attract and approve donor-funded CSA projects, and have little capacity to mitigate any trade-offs between CSA's positive and negative social or environmental outcomes.

On the other hand, the case study in Eswatini shows that with sufficient government support and buy-in from other major players, the large-scale promotion of irrigation and sugarcane production was able to improve the livelihoods of many local community members (Mudombi et al., 2018; von Maltitz et al., 2019). This required long-term and large-scale efforts and coordinated actions between the national government, traditional local authorities, international funders and not least the private sector. A key factor that facilitated this process was that the development of the project was overseen by a parastatal agency, which helped achieve buy-in from all major actors (Terry and Ogg, 2017). Overall, the project enabled many smallholders to benefit from the growth strategy, but nonetheless did not overcome water conflicts in times of drought.

4.4. *Lessons for trade-off analysis and decisions in ecosystem management for poverty alleviation*

The analysis of our case studies suggests a number of lessons for trade-off analysis relating to the positive and value dimensions of trade-off analyses (Section 2), the principles for multi-level governance evaluation, and the use of the Balance Sheets Approach.

Firstly, trade-off analysis needs to consider longer temporal scales, to make sure that the negative effects of environmental degradation on poverty are considered (Rodríguez et al., 2006, Section 2.2). Only through taking a longer-term view did the case study in Bangladesh reveal the looming threshold for regulating services (section 4.2). Positive trade-off analysis methods, such as systems-models and scenario analyses, can be helpful in revealing such feedback and dynamics (Schlüter et al., 2012). Some of the trade-offs, and the mechanisms through which they emerged, demonstrated lack of capability and capacity among micro- to meso-level actors to benefit from measures that would be sustainable and beneficial in the longer term. Many of the trade-off decisions to promote ecologically sustainable methods (e.g. conservation, CSA, conventional farming) would simply not generate sufficient income or benefits to alleviate poverty, by monetary standards as well as by broader measures such as food and energy security. Climate and market risks and delayed benefits are particularly hard to overcome (Barrett and Constas, 2014). In such contexts, further support is necessary (Porras and Asquith, 2018). Where funding, whether from government, donors or market-based instruments, does not provide adequate compensation for short-term costs (including opportunity costs and foregone benefits), then the distribution of outcomes may become unjust (Green et al., 2018).

The second lesson, related to the value dimension of trade-offs, is that trade-off analysis needs to understand the underlying motivations of decision-makers at all levels, and recognise their claims to benefits, ownership or rights, i.e. recognition justice (Martin et al., 2016, Section 2.3.1). In many of our case studies, conflicts between micro- and meso/macro-level motivations resulted in outcomes at the expense of increasing wellbeing of the poorest in the case study communities. Motivations and preferences at micro-level were not always considered, acknowledged, reflected or addressed in policies developed at macro-level, while considerations at macro-level were not supported at micro-level. In turn, this can lead to negative feedbacks in behaviour and outcomes (i.e. conflicts), and ultimately, policy failure (Dawson et al., 2017).

Thirdly, trade-off analysis is inherently an issue of distributional equity and fairness (Section 2.3.1). Some of our case studies demonstrated unequal distributions between meso- and micro-level forest revenues, and between those able to take up cash crops or new farming techniques and those who did not participate, often due to lack of access to various capitals (Section 4.2).

Fourthly, and linked to the second lesson, trade-off analysis needs to consider inclusiveness, transparency and fairness in governance and decision-making processes including the influence of power and control on which decisions are made and on which alternatives people prefer (Section 2.4). Local stakeholder groups were frequently not involved in negotiation of modalities, access and trade-offs associated with different interventions, and did not have the power to influence rule- and decision-making. Powerful actors were generally reluctant to transfer that power and instead used it to increase their benefits by manipulating the process of decision-making. Conversely, actors without power preferred solutions with high transparency, sometimes at the cost of lower distributive outcomes for themselves. Understanding such power struggles helps to understand existing barriers to poverty alleviation, and addressing these may increase the effectiveness of interventions (Nunan et al., 2018). Synergies between ecosystem management and poverty alleviation are more likely to occur where such processes manage to consider meaningfully all benefits and costs to different stakeholders (Howe et al., 2014). The involvement and buy-in of multiple stakeholders can help to support the trade-off decision-making process, recognise multiple values, and develop a shared understanding and reveal effects that are morally undesirable (and therefore sometimes actively or passively ignored or neglected) (Galafassi et al., 2017; Zia et al., 2011).

In such contexts, decision support systems such as the Balance Sheets Approach that emphasise methods to foster deliberation and discussion to pre-empt potential conflict and increase actors' perception of legitimacy of the governance system, can be particularly useful in ex-ante processes. Applied ex-post, such as in this paper, the Balance Sheets Approach provides a tool to diagnose the presence and origin of trade-offs. Moreover, the approach sets out different social, economic and environmental principles to evaluate trade-off decisions and their outcomes. The analysis in Section 4.3 showed that many of the trade-offs could be traced back to violations of the social and governance principles in the Sheets. Section 4.3 results showed that ecosystem management strategies for poverty alleviation formulated at macro-level (Sheet 1) quickly become complex, with multiple conflicting values and trade-offs, at meso- and micro-level. The Balance Sheets Approach provides for such contexts through the approaches in Sheet 3 with the aim of understanding, pre-empting and addressing complexity and inherent trade-offs.

Finally, we acknowledge that although the selected studies focused on a wide array of interventions and associated trade-offs in ecosystem management for poverty alleviation, they lacked a jointly developed and consistent research design to trade-off analysis. As a result, the main trade-offs, underlying mechanisms/dimensions and lessons learned outlined in this paper were extracted following the critical analysis of the project findings. This also limits the extent to which we can ensure the comparability of findings and evaluate the suitability of the different methods for analysing the trade-offs emerging in multi-level governance of ecosystems for poverty alleviation. There is a need, therefore, for the development of consistent and comparable studies spanning across multiple contexts and using lenses related to both the positive and value

approaches to trade-off analysis. The application of the Balance Sheets Approach to structure the analysis and synthesise the findings of such studies can further ensure this comparability and generate new insights to guide research on trade-off analysis in the context of ecosystem management for poverty alleviation.

5. Conclusions

This paper addresses the knowledge gap in the literature on trade-offs regarding the complexity of these trade-off decisions, amplified by the multi-level governance context and inequalities in wealth, interests and power between multiple actors. The paper has highlighted the multiple dimensions of trade-off analysis in ecosystem management and governance for poverty alleviation and has demonstrated approaches to support analysis and appraise decisions. In this policy context, trade-offs are regularly inevitable. The novelty of the paper is that it comprehensively brings together different dimensions or lenses through which to analyse trade-offs in ecosystem management for poverty alleviation in a low-income country context, links trade-offs to environmental justice, and provides recommendations to reveal and deal with trade-offs. More specifically, it shows how the combination of 'positive' approaches, often used at strategic level, with 'value' approaches to analyse multiple values, multi-scale governance, power and capacity that underlie such complex trade-offs, is necessary to analyse trade-offs.

In highlighting different areas where trade-offs may originate and occur, we implicitly took the position that such transparency, whilst increasing complexity, may improve evidence-based decision-making and help avoid unintended consequences. Analysing trade-offs is a first step in negotiating trade-offs, which is often a messy, incremental process that inevitably takes place in a context of power and relations. Participation and deliberation processes may increase the comprehensiveness of trade-off analyses (Hamilton et al., 2019), increase legitimacy and inclusion (Forsyth and Sikor, 2013), and lead to better quality of decisions (Chilvers, 2009), especially for the construction of moral choices (Roux et al., 2006) involved in ecosystem management for poverty alleviation.

We demonstrated the application of the Balance Sheets Approach, as a way of structuring policy appraisal at multiple governance levels and for different complexities, to support decision makers and stakeholders in addressing the different dimensions of trade-offs in ecosystem management for poverty alleviation. By highlighting social and governance principles, in particular those related to environmental justice and legitimacy, it encourages thinking beyond efficiency towards social justice and ecological sustainability. This approach also suggests a set of complementary methods to reveal trade-offs between incompatible values and objectives, which the set of case study questions provided further support for. The evaluations showed that emerging trade-offs and failure to achieve poverty alleviation objectives originated in decision-making processes and governance structures, linked to principles for effective multi-level governance included in the Sheets. The Balance Sheets Approach proved to be sufficiently flexible for application to our diverse set of studies, and therefore seems a suitable framework for future studies, and more importantly, for actual decision-making and implementation of interventions to manage ecosystem services for poverty alleviation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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