Ecosystem Services 12 (2015) 137–147

Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

Ecosystem services and poverty alleviation: A review of the empirical links

Helen Suich [a,b,*,1], Caroline Howe [a,2], Georgina Mace [a,2]

[a] ESPA, 1 Roxburgh Street, Edinburgh EH8 9TA, Scotland, UK
[b] Environmental Change Institute, School of Geography and the Environment, University of Oxford, South Parks Road, Oxford OX1 3QY, UK

ARTICLE INFO

Article history:
Received 13 February 2014
Received in revised form
21 January 2015
Accepted 22 February 2015
Available online 26 March 2015

Keywords:
Ecosystem services
Poverty alleviation
Evidence
Impacts

ABSTRACT

We present the results of a review of the empirical evidence and of the state of knowledge regarding the mechanisms linking ecosystem services and poverty alleviation. The review was undertaken to determine the state of current knowledge about the scale and nature of these linkages, and focus the future research agenda. Research has, to date, focussed largely on provisioning services, and on just two poverty dimensions concerning income and assets, and food security and nutrition. While many papers describe links between ecosystem services and dimensions of poverty, few provide sufficient context to enable a thorough understanding of the poverty alleviation impacts (positive or negative), if any. These papers contribute to the accumulating evidence that ecosystem services support well-being, and perhaps prevent people becoming poorer, but provide little evidence of their contribution to poverty alleviation, let alone poverty elimination. A considerable gap remains in understanding the links between ecosystem services and poverty, how change occurs, and how pathways out of poverty may be achieved based on the sustainable utilisation of ecosystem services.

1. Introduction

The ecosystem services literature has been expanding at a rapid rate (Abson et al., 2014; Raffaelli and White, 2013); an accumulation of research which covers conceptual and theoretical papers, review papers, those identifying gaps in the literature and opportunities for further research, descriptions of tools and methods, as well as empirical papers on particular places and ecosystems.

While early conceptual studies largely focussed on ecosystem functions and processes, following the Millennium Ecosystem Assessment (2005) the literature increasingly frequently addresses the links between ecosystem services and human well-being (Carpenter et al., 2009; Raudsepp-Hearne et al., 2010), recognising that social and ecological components must be understood jointly (as opposed to in isolation) and taking into account the feedbacks (Chan et al., 2012; Miller et al., 2012; Milner-Gulland, 2012) and trade-offs (Howe et al., 2014) between them. Much of this literature now proposes systems of classification for (elements of) the linkages between ecosystem functions and well-being, as well as critiques and developments of these conceptualisations (Bateman et al., 2010; Fisher et al., 2014, 2013). Reviews focusing on specific geographical regions have also begun to emerge (Balvanera et al., 2012; Perevochtchikova and Oggioni, 2014).

The provision of ecosystem services (ES) are widely assumed to contribute to poverty alleviation, particularly in rural areas of developing countries and consequently the degradation of these services is also assumed to result in negative effects on human-well-being (Tallis et al., 2008), or to undermine efforts to reduce poverty (Sjostedt, 2012). Indeed, much of the research into ES and well-being focuses on developing countries; perhaps arising from observations that declines in wellbeing have been associated with increases in dependence on ES (e.g. Shackleton and Shackleton, 2012), and because the livelihoods of the poor appear to rely most directly on the provision of ES.

However, arguments remain about the direction of causality – whether poverty creates or is a result of environmental degradation (Sandker et al., 2012). Beyond large scale correlative studies mapping global patterns of wealth, biodiversity and environmental change (Turner et al., 2012), little attention has been paid to understanding the ways in which ES actually do contribute to poverty alleviation, or even if is possible in practice.

* Correspondence to: Crawford School of Public Policy (Bldg No. 132), Lennox Crossing, ANU, Canberra 0200, ACT, Australia. Tel.: +61 2 6125 1497.
E-mail address: helen.suich@anu.edu.au (H. Suich).
[1] Present address: Crawford School of Public Policy, Australian National University, Canberra 0200, ACT, Australia.
[2] Present address: Centre for Biodiversity and Environment Research, Department of Genetics, Evolution and Environment, University College London, Gower Street, London WC1E 6BT, UK.

http://dx.doi.org/10.1016/j.ecoser.2015.02.005

Many of the empirical studies purporting to deal with ES and poverty or wellbeing are really valuation studies, for example, demonstrating some kind of (usually monetary) value of ecosystem services or of their utilisation (Costanza et al., 1997; Ninan and Inoue, 2013), of their contribution to national economies (Lange and Jiddawi, 2009) or the distribution of costs and benefits of ecosystem service degradation or restoration (De Groot et al., 2013; Srinivasan et al., 2008). Few studies have examined relationships at anything less than a macro or aggregate level and most ignore the distribution of impacts, and are therefore inadequate for determining which groups actually benefit (and whether the poor are among the beneficiaries). Additionally many studies also focus only on income, rather than taking a multidimensional approach to poverty.

Consequentially, questions remain about the nature of the links between ES and the multiple dimensions of poverty, and about the mechanisms and consequences of changes in ES provision on different aspects of well-being (Fisher et al., 2013). Determining these causal pathways is particularly important with respect to developing appropriate and effective policies to achieve both the sustainable management of ES and poverty alleviation (Ash et al., 2010; Liebenow et al., 2012).

The purpose of this paper is therefore to review the empirical evidence regarding the state of knowledge of the links and mechanisms between ES and poverty alleviation, in order to improve knowledge about the scale and nature of these linkages, and focus the future research agenda. The specific questions we aim to address are:

1. Where, and under what circumstances have linkages between ES and poverty alleviation been studied? This includes consideration of the physical and social circumstances and context in which ES and poverty alleviation links have been identified and examined.
2. What are the actual linkages described and/or measured? This incorporates what aspect(s) of poverty have been addressed, which ES contributed and whether patterns can be identified across case studies.
3. Whether – and under what circumstances – the provision of ES contributes to the alleviation of poverty.

From this analysis, we hope to determine whether any generalisations can be made about the mechanisms that link multiple ES with multiple dimensions of poverty, and set this understanding into the broader area of where ES might be important for poverty alleviation (i.e. whether ecosystem-based pathways out of poverty exist), as well as identifying gaps in the evidence and where the focus of future research efforts should be.

The conceptual framework used for conducting this review is described below, and draws on a similar literature utilised for – and incorporates the range of indicators identified in – the conceptual frameworks relating specifically to the analysis of ecosystem services and poverty alleviation (see for example, ESPA, 2013; Fisher et al., 2014; 2013; Howe et al., 2013). The way in which this framework was operationalised is described in Section 2.

Poverty is recognised as being multidimensional, and is understood to have moved beyond a focus on income alone. Many dimensions of poverty have been identified including – but not limited to – food security and nutrition, health, income and assets, education and skills, property rights, etc. These are best understood in the context of surrounding social institutions, and as being driven by social processes.

Ecosystem services are the benefits that people derive from ecosystems (Millennium Ecosystem Assessment, 2005) but more specifically in our study are assumed to include the constituents, process and products of ecosystems that provide benefits for human well-being (ESPA, 2013; Mace et al., 2012). That is, the framework includes the consideration of a range of services that have been categorised as provisioning, regulating, cultural and supporting services (UKNEA, 2011).

This review focus on bundles of ES (Reyers et al., 2013) and on multiple dimensions of poverty, because determining net poverty alleviation outcomes from ES provision (or a change in ES management) requires the examination of how these ES bundles impact directly and indirectly on multiple dimensions of poverty, and an understanding of the existence and nature of any feedback and interactions between these multiple elements. This is in contrast to much conceptual and empirical work which simply illustrates the connections between each group of ES and each dimension of poverty described (e.g. between provisioning services and food security or between regulating services and security), and does not address the mechanisms by which these elements are connected.

In terms of poverty alleviation, the review initially restricted evidence to an interpretation of ES contributing actively to an improving household situation. However, the dearth of empirical evidence regarding poverty outcomes led us to include both poverty prevention and poverty reduction (Angelsen and Wunder, 2003; Daw et al., 2011). This framework recognises the importance of social differentiation and of the key factors affecting differentiation (called 'mediating factors' here) in any analysis of these relationships. This has also been highlighted in the development of conceptual frameworks developed for the analysis of ecosystem services and poverty alleviation (Fisher et al., 2014).

2. Methods

A literature search of the Web of Knowledge was carried out between March 2012 and February 2013, using all possible combinations of the terms in Table 1. These terms were selected on the basis of their likelihood of returning empirical evidence regarding the actual and specific contribution of ES to poverty alleviation. The search terms were considered sufficiently broad and general to capture different, though comparable, definitions of ES and poverty alleviation.

Only peer-reviewed publications in English were considered, as we were only interested in evidence that had been subjected to the peer-review process. The year 2000 was chosen as the start date for the literature search, as it represents the start of the Millennium Ecosystem Assessment and a relatively consistent use of the terms ecosystems and ecosystem services. 398 papers remained in the database once duplications and non-peer reviewed publications had been removed.

2.1. Classification

Phase I determined the relevance of each paper to the questions posed in the introduction to this study, based on a read-through of the abstract. Papers were classified as relevant when the abstract discussed ES, poverty, and the links between them. In order to maximise

Table 1
Search terms used.

Ecosystem		Poverty
Ecosystem services Ecosystem service* Environmental services Environmental service*	AND	Anti-poverty Poverty alleviation Poverty elimination Poverty eradication Poverty reduction

Each term was surrounded by double quotes " … "

Table 2
Variables coded in Phase II of the classification process.

Variable	Definition
Location	Country of study
Spatial scale of the study	Micro (village-level or small-scale) Meso (provincial/state or sub-national) Macro (national) Multi-national Multi-scale
Ecosystem type being considered	The system reporting categories used in the Millennium Ecosystem Assessment were adopted for this study. The 10 system categories are marine, coastal, inland water, forest, dryland, island, mountain, polar, cultivated and urban (Millennium Ecosystem Assessment, 2005)
Ecosystem service type	The ecosystem service types were adopted from the UKNEA, as was the categorisation in to supporting, provisioning, cultural and regulating services (see Fig. 2 for details) (UKNEA 2011)
Dimensions of poverty	The classification of poverty dimensions were self-defined—specific dimension(s) of poverty being examined were extracted from each paper during Phase I coding, and expanded during Phase II where necessary
Study type	This category originally attempted to distinguish between papers describing an ES or a poverty alleviation intervention. However, during Phase II coding, available categories had to be expanded to deal with studies that didn't deal with a specific intervention, but that examined the drivers of change at a particular location, or simply described a relationship between ES and poverty
Time scale of study	It was assumed that studies would analyse (historic) changes over time (i.e. in response to the ES or PA intervention). However, this categorisation was expanded to take account of more static (cross-sectional) data analyses, and of the few papers that considered future impacts (short, medium or long-run)
Impacts/outcomes	Where described, impacts were coded as being either direct or indirect. A direct impact was coded where a quantitative or qualitative description of the 'first round' of impacts or outcomes arising from an activity undertaken (i.e. that was directly attributable that activity) An indirect impact was coded where an impact or outcome was mediated/transmitted through another outcome, which were usually later in time and/or further removed in distance Poverty and ES impacts using these categories were coded separately Impacts were also coded according to whether they were unquestionably positive or negative (whether described or measured). Indeterminate impacts were not coded—for example, increased workloads (unless further elaborated) have an indeterminate impact; returns to the increased workload may be sufficient to generate a positive impact, or if not remunerated, are likely to generate negative impacts
Mediating factors	These were interpreted as intervening factors that could change the impact of one thing on another (e.g. institutions, power relations, polices, trade-offs etc.). These were self-defined, and were coded if and when mentioned in the paper
Social differentiation	Given the importance of understanding the distribution of impacts within and amongst communities, papers were coded where they undertook a disaggregated data analysis (e.g. according to wealth, ethnicity, gender, etc.) (see also Daw et al., 2011)

the comprehensiveness of the data analysis, where the discussion of links was implied, papers were classified as relevant and put forward for Phase II analysis. Papers also needed to imply or refer specifically to the analysis of primary data (as opposed to only conceptual discussion). Where insufficient information was provided in abstracts, papers were included in the second phase of categorisation in order to minimise the possibility of excluding relevant papers. During Phase I coding, 140 papers were rejected as not meeting the abovementioned criteria.

Phase II involved reading the whole paper, classifying its relevance and finally coding for important variables. Papers were classified as not relevant and excluded during this phase if they did not include both an analysis of primary data and of the links between ES and poverty alleviation in some form. Where they were classified as relevant, the variables described in detail in Table 2 were coded in each paper.

It was anticipated that the empirical evidence would demonstrate that a range of ES impact on a range of poverty dimensions, and the point of this research was to explore the full range of these links and mechanisms. The means by which payments for ecosystem services (PES) schemes link ES and poverty are thought to be very specific, relating almost exclusively to the delivery (current or future) of income as reward or compensation for the implementation of certain land management practices. Given the historical focus in the literature on income and poverty, it was felt that this mechanism was relatively well understood, and did not add to knowledge about the range of links between bundles of ES and other dimensions of poverty. Thus, where papers considered PES schemes, they were excluded from further consideration (17 papers were coded as PES in Phase I and a further 15 in Phase II).

Many papers were excluded during Phase II because they dealt with ES impacts as a result of land use change (e.g., the conversion of forest to agriculture or forest degradation associated with agroforestry) but did not link these with impacts on different dimensions of poverty, or describe how the provision of discussed services aid or prevent poverty alleviation. A large number of papers were also excluded that described the direct consumption of certain natural resources, but provided no analysis of how this consumption – or any change to it – impacted on poverty.

In order to determine the consistency of paper classification (i.e. relevant and not relevant), Cohen's kappa scores were formally compared between two of the authors involved in classification (HS & CH). A Kappa analysis determines the level of agreement between a number of people over and above that to be expected by chance (Edwards et al., 2002). The Kappa value was calculated as being 0.52, which is considered to be within the range considered as fair to good agreement (Viera and Garrett, 2005).

Following the classification processes, 39 papers remained and were coded (listed in Appendix A). Of these, not all papers could be coded for each different category, and in some cases papers were given more than one coding per category, so in the results presented below, not all totals add to 39.

2.2. Composite figure

A composite figure was constructed (see Section 3.3), using the papers describing ES, poverty or other interventions—based on the assumption that this group of papers would be most likely to (empirically) examine the mechanisms and links of interest. Of these, six papers dealt with some aspect of water resource management, and so could reasonably be compiled. The figure illustrates the direct and indirect impacts on different ecosystem services and dimensions of poverty that are described in each paper. The links

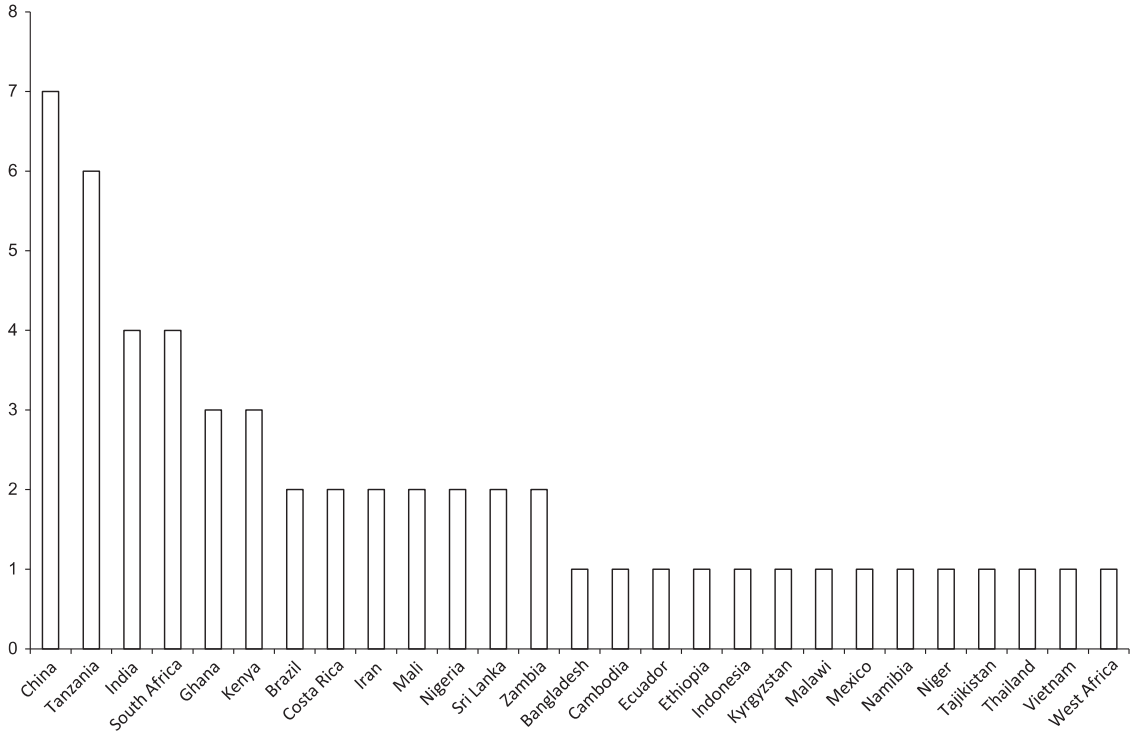

Fig. 1. Countries studied in empirical ecosystem services for poverty alleviation literature (this review).

described in those papers and coded during Phase II also demonstrate how systematically (frequently) each of these is considered.

3. Results

3.1. Overview of ecosystem service and poverty studies

Studies dealing with ES and poverty alleviation have been spread across the developing world (Fig. 1). A larger number of studies have been undertaken in sub-Saharan Africa, and relatively fewer in Latin America.

Virtually all of the case studies in the reviewed papers were conducted at a relatively small scale (93% at a micro or meso level). Only three papers discussed cases at a macro or multi-national scale, and no papers used multi-scale cases.

More than half of the papers reviewed analysed or described an historical change over time (21), while 11 papers conducted cross-sectional analyses, using a single point in time. Of the papers that dealt with future outcomes (either by prediction or using scenario development), most examined the short term future (up to 10 years) (7). Only one paper analysed a medium term future (10–50 years), and none looked at the future in the long term (more than 50 years) (see also Fig. 4).

The majority of cases covered described more than one ecosystem type; just in excess of one half of papers dealt with cultivated systems (54%), and 38% dealt with forests or inland water. Relatively less frequently covered were coastal (13%), dryland (10%), urban (5%), mountain (8%) and island (3%) ecosystems. No papers covered marine or polar systems. The most common combinations of ecosystem types were cultivated and forest (9 papers), cultivated and inland water (6 papers) and forest and inland water (5 papers).

The ES considered are illustrated in Fig. 2. Most papers considered only a single ES (21). Of those that considered more than one, they considered an average of three different ecosystem services (up to seven). The most commonly considered pairs were crops, livestock, fish with water supply (6), with trees, standing vegetation, peat (5) and with hazard regulation (5). These combinations emphasise the focus on provisioning services, particularly agricultural systems, in this literature.

When ecosystem types were compared with ecosystem services considered, the pairs most often jointly considered were wild species diversity and cultivated systems (11), wild species diversity and forests (10), as well as water supply and inland water (10) and water supply and cultivated systems (8).

Each paper considered, on average, three dimensions of poverty, with a range of one to seven. Fig. 3 demonstrates the emphasis given income and assets. Indeed, income and assets were included in five of the of the six most frequent pairs of poverty dimensions, considered jointly with food security (11 papers), with employment (7), health, time and vulnerability (considered by five papers each). Health and food security were also considered by five papers. This concentration of research on few poverty dimensions is further emphasised in Table 3, which also demonstrates the strong focus of research efforts to date on income and assets in combination with wild species diversity, with crops, livestock and fish, and water supply.

17 papers recognised the need for disaggregating analyses according to impacts on different groups and individuals within those groups, though not all actually undertook such analyses. The reasons for selecting certain groups for disaggregated analysis was not always fully explained, but broadly, disaggregation was done on the basis of wealth or income, gender, ethnicity, location, or participation or non-participation in an intervention.

3.2. Mediating factors between ES and poverty

Perhaps most surprising is the small number of papers examining the impacts of specific interventions to manage ES or alleviate poverty (Fig. 4). Only three papers were classified as examining poverty alleviation interventions that were designed to also improve ES management.

The most frequently discussed drivers related to environmental change were habitat conversion or modification (60%) and the over-exploitation, unsustainable or illegal use of resources (53%). With

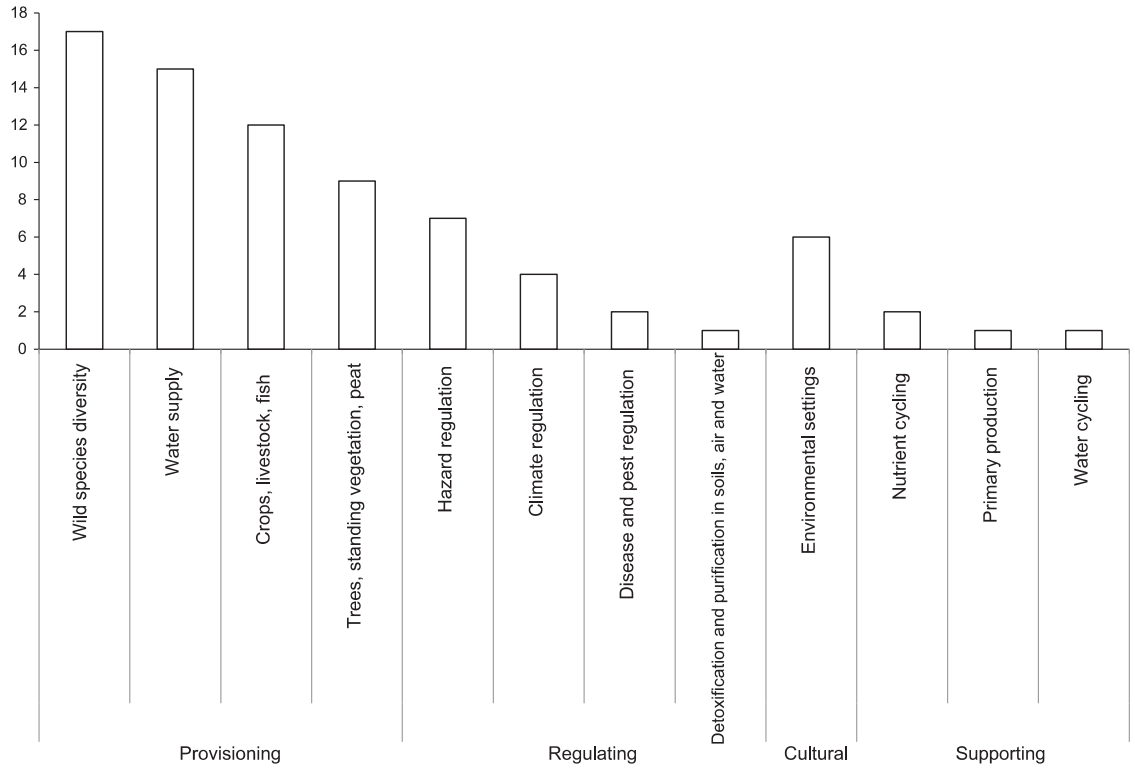

Fig. 2. Ecosystem services considered in reviewed papers (frequency).

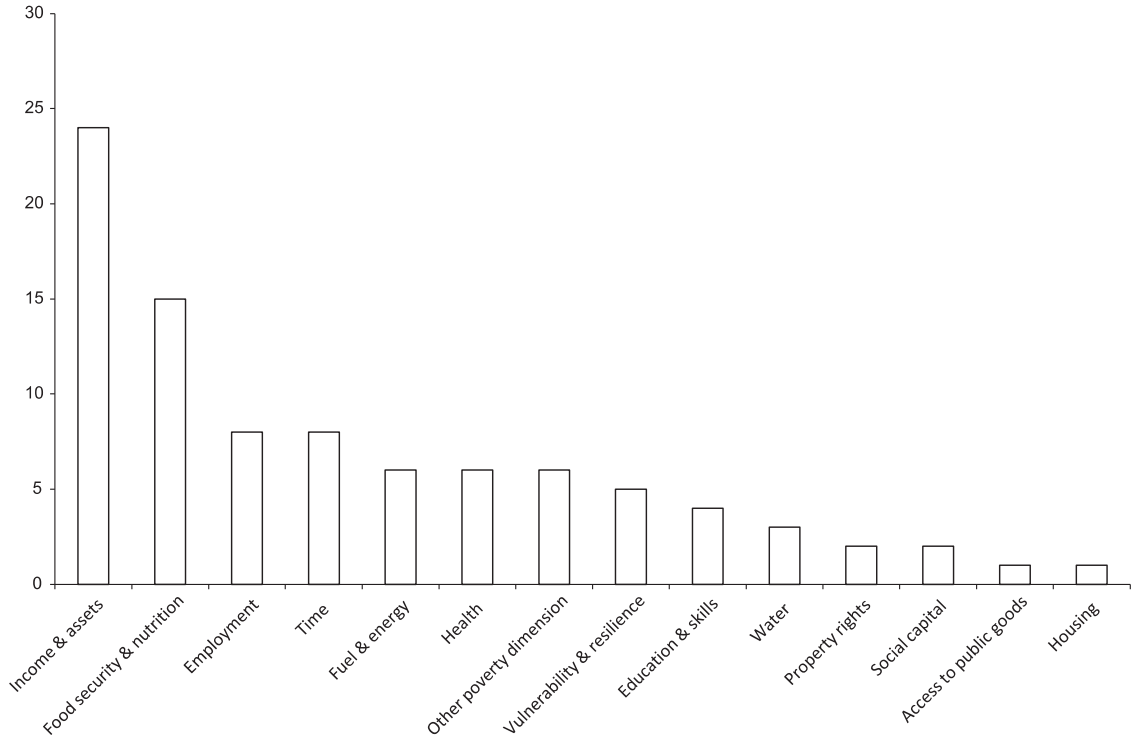

Fig. 3. Poverty dimension considered in reviewed papers (frequency).

respect to habitat conversion, papers most frequently described the conversion of forest to agriculture or pastoral uses, but also described inland and coastal waterway modification. Other drivers of change included population changes, climatic factors, pollution and poor land use planning and enforcement.

Descriptions of relationships between ES and poverty alleviation in the reviewed papers were wide and varied. Broadly, they included such topics as how farmers' choices about their practices shaped surrounding landscapes, how environmental degradation denies communities livelihood opportunities, descriptions of the current and historical use of a resource(s) and the impacts on that resource and on users' livelihoods, as well as relationships between biodiversity (preservation, conservation and disappearance) and livelihoods. Given their highly context specific nature,

Table 3
Ecosystem services by poverty dimension.

	Access to public goods	Education & skills	Employment	Food security & nutrition	Fuel & energy	Health	Housing	Income & assets	Other poverty dimension	Property rights	Social capital	Time	Vulnerability & resilience	Water
Crops, livestock, fish	–	1	2	5	2	3	–	9	3	–	2	2	3	1
Trees, standing vegetation, peat	–	1	1	3	3	1	–	7	3	–	–	2	2	1
Water supply	–	4	–	6	2	4	–	9	3	1	1	4	4	3
Wild species diversity	1	1	6	5	–	1	–	10	1	1	–	2	1	1
Climate regulation	–	–	3	3	–	2	–	3	–	–	–	–	–	–
Detoxification and purification in soils, air and water	–	–	1	–	–	–	–	1	–	–	–	–	–	–
Disease and pest regulation	–	–	–	2	1	1	–	1	–	–	–	1	1	1
Hazard regulation	–	1	1	2	1	2	1	5	1	–	1	1	2	1
Environmental settings	–	–	1	3	–	2	–	4	1	–	–	1	2	1
Nutrient cycling	–	–	–	1	–	–	–	1	–	–	–	1	–	–

NB: noise regulation, pollination, primary production, soil formation and water cycling are excluded as no papers were jointly coded for these ES and poverty dimensions.
– indicates no papers were jointly coded for this combination of ES and poverty dimensions.

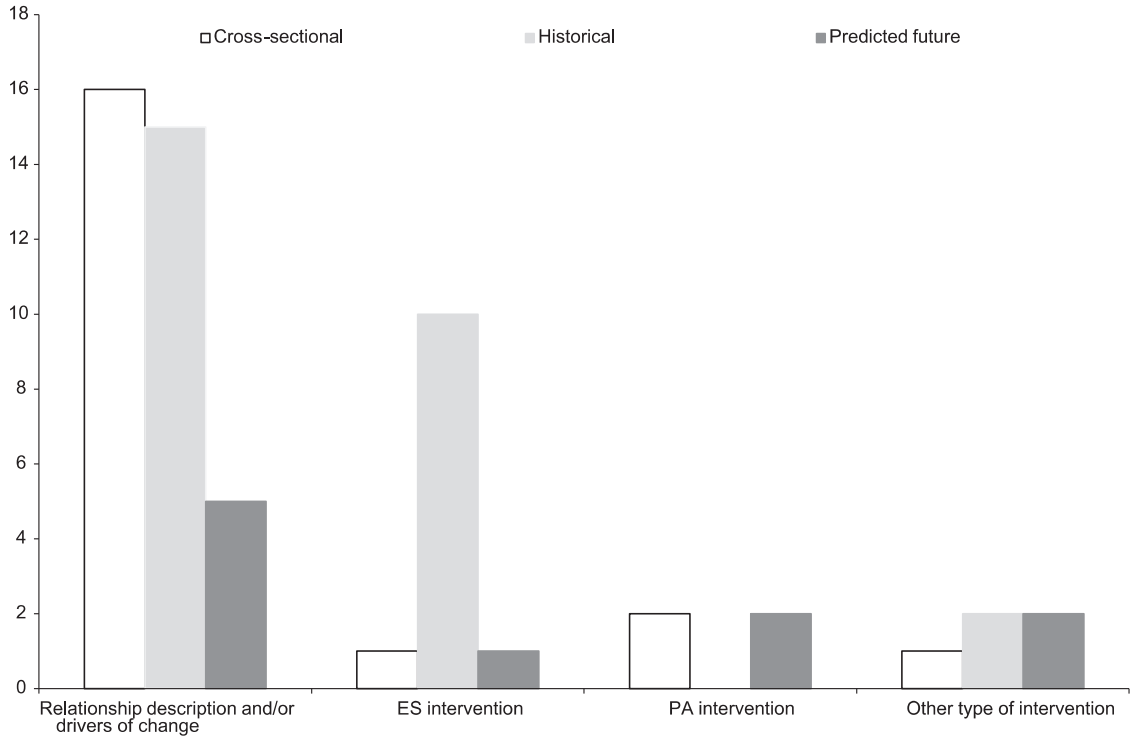

Fig. 4. Temporal scale and types of intervention considered in reviewed papers.

they could not easily be grouped in to categories for deeper analysis.

Mediating factors (e.g. issues of governance, power relations and trade-offs) of the links between ES and poverty are critically important to the extent and distribution of benefits and costs arising from changes, and to the mechanisms by which changes in ES or poverty affect the rest of the socio-ecological system. 26 of the papers (66%) incorporated some consideration of such mediating factors, however, they were not systematically considered. Given the diversity of studies under consideration, the mediating factors considered were highly varied; some were relevant only in very specific contexts, while others are more generalisable. The factors raised were land and resource rights and inheritance rules (impacting on access to land and/or resources); issues related to gender and participation; the rule of law; access to (and imperfect functioning of) markets; access to information; macroeconomic conditions; power imbalances; the presence or absence of appropriate institutions and governance quality.

3.3. Linkages reported

Despite not being the most frequently addressed ES, hazard regulation was coded with the widest variety of poverty dimensions (12), followed by water supply, wild species diversity and

crops, livestock and fish (with 11 each) and trees, standing vegetation and peat (10). Health was dealt with in only six papers; however, it was considered in conjunction with a relatively large number of ES (8). The intersection of studies related to water supply and crops, livestock and fish, as well as food security can be explained by the focus of the literature on irrigation (and therefore improved agricultural production). The relative lack of attention given to the intersection of water supply and either health or access to clean water and sanitation can also be explained by this focus on irrigation.

Few papers comprehensively analysed both the direct and indirect impacts on ES and poverty – the vast majority of papers reviewed considered only direct impacts on dimensions of poverty or on ES (Table 4). Relatively few papers considered any indirect or interaction effects, so understanding of the dynamics of the linkages both between and within ES and poverty impacts is necessarily limited.

Many of the papers measured one aspect of the impacts of ES and described (but did not measure) poverty impacts, or alternatively measured poverty impacts, but only described ES impacts. Further, of the 31 papers that considered both direct ES and direct poverty impacts, only 15 included descriptions that were able to be coded as unequivocally positive or negative impacts on ES or poverty (impact frequency, Table 4).

Fig. 5 presents the composite illustration – the purpose of which was to elucidate the actually measured or described linkages and pathways. It was compiled from six papers, by overlaying illustrations of the direct and indirect linkages and relationships described between ES and poverty in each of the papers. Though the illustration suggests a relatively comprehensive coverage of ES and poverty impacts, each element illustrated was described only once, with the exception of reduced erosion, which was identified in two papers (illustrated with double lines). No lines link the different elements illustrated,

Table 4
Joint consideration of impacts on ecosystem services and on poverty.

	Direct poverty impacts		Indirect poverty impacts	Overall (net) poverty impacts
Direct ES impacts	31		17	0
Indirect ES impacts	13		10	0
Overall (net) ES impacts	0		0	0
Impact frequency (sources coded)	Negative poverty impact	Positive poverty impact		
Negative ES impact	20 (5)	4 (1)		
Positive ES impact	9 (3)	30 (8)		

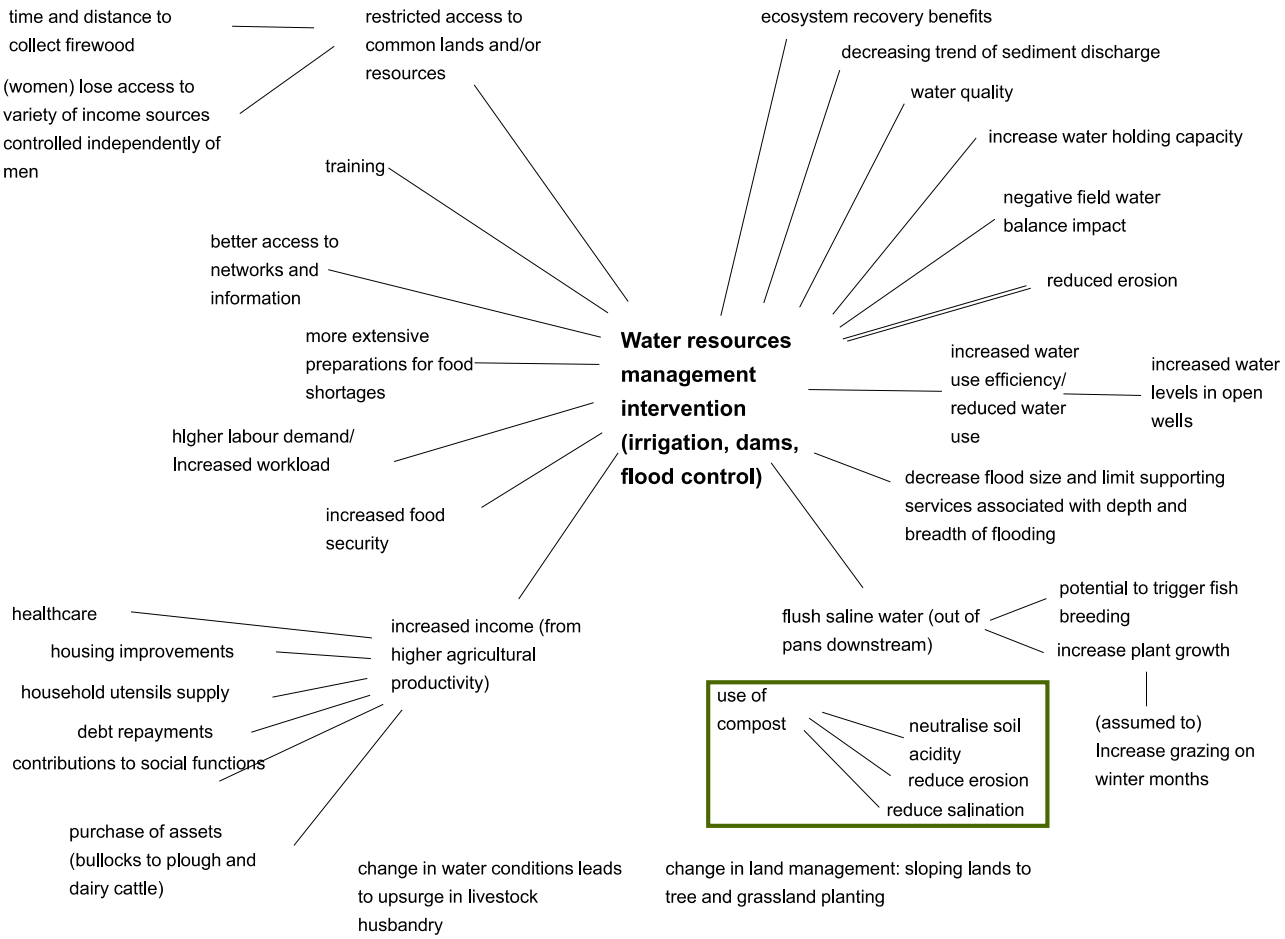

Fig. 5. Composite illustration of the direct and indirect links between ecosystem services and aspects of poverty in cultivated systems arising from water resource management interventions. *Sources*: Agoramoorthy et al. (2012); Enfors and Gordon (2008); Huang et al. (2012); Kerr (2002); Lankford et al. (2011); Qiang (2003).

which demonstrates the lack of consideration of indirect and interaction effects both within and between the ecological and social elements of the system. While researchers may be increasingly considering both social and ecological systems, this figure illustrates that they are not yet being integrated, though this may be partly related to the early stage of methods development to deal with these types of complexities.

4. Discussion and conclusion

Adopting an ecosystem services approach typically entails the consideration of multiple ecosystem services and of how changes in these services impact on multiple dimensions of poverty. The approach also encourages the examination of both direct and indirect impacts, feedback and interactions between and within ES and poverty dimensions; engaging with the complexity of natural and social systems, rather than looking at single aspects in a linear manner. An improved understanding of these links, and the mechanisms by which change is affected should also assist in the identification of pathways out of poverty.

This review demonstrates that researchers are adopting more wide-ranging approaches more frequently, and that the links between particular ES and specific dimensions of poverty are being identified. However, much of the published research simply describes observed relationships, rather than providing evidence for causal links. Much research also still fails to examine bundles of ES, and regulating services remain underrepresented. Further, while the multidimensionality of poverty is increasingly recognised, analyses to date remain heavily focussed on income and assets, rather than in combination with non-income dimensions of poverty.

The final analysis included a rather small number of papers, making conclusions difficult to draw, but emphasising the weak evidence base for the widely discussed linkages between ES and poverty alleviation. A large number of the papers initially identified in the paper search were excluded from the detailed analysis in this review, many because they attempted to quantify single services or functions (or species) and their relationships with single dimensions of poverty (e.g. research examining the direct contribution of wild harvested resources to livelihoods). Where such papers were excluded, it was because they did not consider the relative importance of these resources to household livelihoods (i.e. compared with other livelihood activities), or their contribution to poverty alleviation. A number of papers were also excluded because, while the research was undertaken in developing countries and amongst poor people, it failed to make any explicit connection with human well-being. For example, several papers looked at the impact of farming systems on ES, but failed to make any connection between the change in farming systems and farmers' poverty levels. Such research contributes little to the understanding the dynamic interactions between and among different ES and aspects of poverty.

It is possible that the consideration of empirical evidence regarding the links between ES and poverty alleviation has been limited due to the terms used to search the literature, and research from the bodies of literature that have not commonly used the ES language (e.g. the disaster risk reduction literature) may not have be incorporated into this review as a result. However, it is likely that these bodies of literature would have the same shortcomings as the papers both included (and excluded) from this review in terms of non-bundled approaches to ES, and few or single dimensions of poverty being examined.

Of the papers that were included, it is surprising that relatively few papers addressing the impacts of specific ES and/or poverty interventions were found to be relevant within the classifications of this review – particularly the small number of poverty alleviation interventions. However, this should not be interpreted as implying that that poverty alleviation interventions do not consider environmental impacts, as it is likely to be related to the language of the search terms used.

Even in the absence of specific ES or poverty interventions, papers can and do describe the relationships between resource utilisation and livelihoods. For example, Brooks et al. (2008) examine the historical development and current implications of aquatic snake harvests in Tonle Sap, Cambodia, as well as the role of harvesting in livelihoods, the factors threatening snake populations and the potential for management interventions. The paper analyses data on snake population dynamics and harvest composition and the drivers of change in perceived resource availability over time (across a range of resources), in order to improve understanding of snake hunting changes spatially and temporally. This paper also undertook a disaggregated analysis of the contribution of harvesting to total household income across four wealth categories, and compared snake fishing and non-snake fishing households (see Section 4.2).

4.1. Impacts and linkages

Generally, the provision of ES is widely assumed to contribute to poverty alleviation, particularly in rural areas of developing countries. However, the means by which these contributions are generally achieved remains unclear. A range of ecosystem services are important to the poor – even when only consumptive outputs (e.g. food, fuel, etc.) are considered. The patterns of direct contributions of ES to households described (e.g. from direct consumption of natural resources) tend to sustain livelihoods and/or prevent households from falling further in to poverty, rather than actively contribute to a steadily improving situation for the household, as these ES are insufficient in themselves to lift people out of poverty (Barrett et al., 2011). This contribution may be viewed as a contribution to the reduction of vulnerability rather than to poverty reduction, as greater dependence on ecosystem services often indicates more vulnerable households. However, this is a matter of interpretation, as poverty alleviation can be understood as including both poverty prevention and poverty reduction (Angelsen and Wunder, 2003; Daw et al., 2011).

As has been demonstrated, determining whether – and under what circumstances – the provision of ES contributes to the alleviation of poverty, is currently impossible given the lack of data from which generalisations can be made. Thus, there is still a poor understanding of ecosystem-based pathways out of poverty, if indeed they exist. Further, the discussion of impacts in the papers reviewed generally have a number of shortcomings, including incomplete analyses, the incomplete identification of linkages between ES and poverty, and a focus on description rather than measurement of impacts.

The assessment of poverty impacts in the reviewed papers were often based on incomplete analyses. For example, many papers that presented results focussed on impacts on income and assets gave no information regarding the relative importance of those impacts in terms of other livelihood activities, or whether time spent on the analysed activity could have been used more profitably, etc. Papers that discussed changes in labour requirements rarely followed up with analyses of the relative returns (i.e. compared to other activities), or whether these additional requirements produced constraints or bottlenecks for other livelihood activities.

From the papers reviewed, it is difficult to tell whether the linkages between certain ES and particular dimensions of poverty have been comprehensively identified (i.e. including all the linkages that exist) or were simply those that were possible to study or were of interest for some other reason. It is likely the latter, as we expected to see a number of linkages that are either absent from, or under-represented in Table 3. Expected linkages include, but are not limited to, those between: pollination and food security and

nutrition (perhaps also with human health); water supply (and water cycling) and access to clean water and sanitation; and pest and disease regulation and health (and potentially also food security and nutrition).

The review results suggest strong correlations between negative ES impacts and negative poverty impacts, and between positive ES impacts and positive poverty impacts (Table 4). However, it is probable that these correlations appear because of the incomplete range of impacts studied, particularly given that the majority of papers dealt with single rather than bundled ES, and the limited number of empirical studies identified.

An additional shortcoming is that many impacts are described rather than measured, so it is impossible to determine 'net' outcomes – whether overall benefits outweigh costs, or vice versa. Where disaggregated analyses are available, they demonstrate mixed successes – the presence and extent of impacts differs across social groups and individuals within those groups (Section 4.2). For example, Deng et al. (2010) found that perceptions of benefits derived from the establishment of a nature reserve in China differed depending on wealth, with more benefits appearing to go to the well-off. In their examination of a forestry project in Bangladesh, Muhammed et al. (2008) concluded the programme being studied was a financial success as a plantation raising strategy, however landless and poor people were not being selected to participate, and gender equity issues were also identified.

This review also clearly demonstrates the gaps remaining in the joint study of ES and poverty alleviation, with certain ES and dimensions of poverty more comprehensively studied than others (Table 3). However the small number of studies examining these combinations mean that generalisable knowledge with respect to ES and poverty alleviation is limited. One of the most surprising results from Table 3 is that, despite the focus of these studies on water supplies, so few also considered household access to clean water and sanitation (in addition to irrigation water supplies).

The interaction effects – both within and between different dimensions of poverty and ES provision – are also understudied, as demonstrated in Table 4 and illustrated in Fig. 5. One study that did examine interaction effects and long term sustainability impacts was Shackleton and Gambiza (2008), which examined the potential impacts of the removal of an alien invasive plant from communal grazing lands in South Africa. They found that the direct impact on the poorest would be positive (they would be paid to remove the plant), but that in the longer term, indirect effects would include additional time required for fuelwood collection and/or additional expenditure on alternative fuel sources. The authors also highlighted the importance of understanding the drivers of the invasion in order to successfully combat it with appropriate institutional and management responses over the long term (see also Section 4.3).

In another example, Enfors and Gordon (2008) investigated strategies amongst smallholders in a catchment of the Kilimanjaro region (Tanzania) for coping with drought, and whether access to small-scale irrigation (*Ndiva*) improved coping capacity. Landscape-scale management strategies were important, particularly given the reliance on provisioning services in times of need (to provide food and generate income during drought), which highlights the need to recognise links between food production, other ES and the livelihoods of rural poor. With respect to indirect and interaction effects, the authors noted that reliable agricultural output could reduce the need to engage in illegal logging (to produce charcoal) and to expand fields further, which could limit subsequent land degradation over the longer term.

4.2. Social differentiation and disaggregation

That 17 of the papers reviewed discussed social differentiation in some form is important, because the aggregation of information about well-being across groups limits its ability to inform about poverty alleviation (Daw et al., 2011). Despite the identification of social differentiation and the factors affecting differentiation (classified in this review as mediating factors, discussed below) as being key to understanding relationships and interlinkages (Fisher et al., 2014), while the papers reviewed here noted their importance, not all undertook disaggregated analyses.

Of those that did, analyses were most frequently disaggregated by income or wealth indicators, or by focussing on a particular marginalised group – most commonly women, or ethnic groups. For example, Lawson et al. (2012) examined the empirical evidence on poverty–environment linkages in the coastal zone of Ghana, focussing on women in coastal communities, and Agoramoorthy et al. (2012) focussed on tribal women in India. Liebenow et al. (2012) examined whether ecosystem services influence household wealth in semi-arid rural Mali, disaggregated by asset-based wealth measures. They noted that 'understanding how ecosystems influence wealth requires attention to complex relationships between household structure, production capacity and household well-being. Household size, cultural practices and differential access to markets and resources are likely to confound simple assessments of well-being and must be accounted for in comparative analyses' (p. 34).

4.3. Mediating factors

Mediating factors are critically important to the ways in which changes in ES or poverty affect the rest of the socio-ecological system. Despite this, the papers included in this review did not systematically or consistently consider them, meaning it is not possible to determine the conditions under which ES utilisation is most likely to contribute to poverty alleviation.

However, several papers provide examples of strong emphases on the role of mediating factors in affecting poverty and environmental outcomes. Kerr (2002) focuses attention on the institutional arrangements of a watershed development intervention, and the experience in managing implications for, and trade-offs between poverty alleviation and resource management in Maharashtra, India. The paper incorporates an analysis of institutional arrangements that can mediate the impacts of changes in ES on poverty alleviation. The specific institutional arrangements discussed include the restriction of access to resources on common lands – which benefits some groups, but negatively affects others who lose access to those resources. In addition to examining differential impacts, Kerr also describes the knock-on impacts different aspects of poverty, such as the increased time and agricultural labour required to compensate for the lost access to commons resources.

Goldin et al. (2008) also addresses institutions and power issues in a case study of the practical application of integrated water resource management in Mpumalanga, South Africa. The authors discuss the rules developed to encourage participation in the scheme and the requests channelled through the institution to facilitators and funders and how these affected project outcomes (e.g. for materials, training, etc.), and note that 'enhanced capabilities contribute not only to improved human development, but also to improved management of the ecosystem' (Goldin et al., 2008, p. 345).

4.4. Future research

In addition to the range of gaps in the empirical knowledge discussed above, several additional – and significant – gaps identified as part of this review relate to the relative dearth of research regarding dryland and urban ecosystems. This is a significant oversight given that approximately 41% of the Earth's land surface is covered by drylands, and approximately 90% of the more than two billion people inhabiting them are in developing countries (MA, 2005), many with poor human development indicators (Maestre et al., 2012).

Additionally, urban residents are important drivers of land use change and ecosystem degradation, a situation likely to be exacerbated without appropriate interventions for sustainable utilisation (DeFries and Pandey, 2010; Elmqvist et al., 2013; Nelson et al., 2010).

Further research should also address knowledge gaps regarding ecosystem disservices and costs (see for example Dunn, 2010; Lyytimäki et al., 2008; Zhang et al., 2007) and continue the increasing attention given to the trade-offs between and within ecosystem services and poverty alleviation (Power, 2010; Rodríguez et al., 2006; Vira et al., 2012).

In order to gain a comprehensive understanding of the nature and extent of linkages between ES and poverty, and whether and how changes in ES provision can alleviate poverty, research that examines bundles of ES, multiple dimensions of poverty and explores both direct and indirect linkages between these elements is necessary. Future studies will also need to look at the feedback mechanisms both within and between the dimensions of poverty and the bundles of ES under examination, at the full range of (expected and unexpected) costs and benefits to determine net outcomes, and how these outcomes are distributed between and within social groups. Finally, this review demonstrates that further research is required not only on the mechanisms, but also on the direction of causality.

In conclusion, this review has highlighted the considerable range and variety of knowledge gaps that remain regarding the mechanisms by which ES and their management may contribute to poverty alleviation. Existing research has focused on a relatively few ecosystem types, on provisioning services, and overwhelmingly on the income dimension of poverty, indicating wide scope for future research. Generalisations cannot, as yet, be made about where and under what circumstances linkages exist, nor have causal pathways between ES and poverty alleviation been identified. However, if systematically and comprehensively addressed, such research could help to answer these questions and contribute to the development of policies for the appropriate management of ES and effective poverty alleviation.

Acknowledgements

This work was funded with support from the Ecosystem Services for Poverty Alleviation (ESPA) Programme [NE/ESPA/010001]. The ESPA programme is funded by the UK Department for International Development, the Economic and Social Research Council and the Natural Environment Research Council. We would like to thank three anonymous referees for their useful comments and suggestions.

Appendix A. Papers included in Phase II of this data analysis

See references citation of appendix

Agoramoorthy et al. (2012), Aluko (2004), Berbes-Blazquez (2012), Bergquist (2007), Börner et al. (2007), Brooks et al. (2008), Dahmardeh et al. (2009), DeClerck et al. (2011), Deng et al. (2010), Enfors and Gordon (2008), Fang (2009), Ferraro et al. (2011), Förster et al. (2011), Giliba et al. (2010), Gilioli and Baumgaertner (2007), Goessling (2003), Goldin et al. (2008), Hengsdijk et al. (2007), Kerr (2002), Kideghesho (2008), Kideghesho et al. (2005), Kumar et al. (2011), Kusimi and Dika (2012), Lankford et al. (2011), La Rovere et al. (2005), Lewis et al. (2011), Lawson et al. (2012), Liebenow et al. (2012), Madulu (2005), Montagnini et al. (2008), Muhammed et al. (2008), Ottaviani et al. (2003), Qiang (2003), Shackleton and Gambiza (2008), Sellamuttu et al. (2011), Sheppard et al. (2010), Tallis et al. (2008), Villasante et al. (2012), Wang et al. (2012).

References

Abson, D.J., von Wehrden, H., Baumgärtner, S., Fischer, J., Hanspach, J., Härdtle, W., Heinrichs, H., Klein, A.M., Lang, D.J., Martens, P., Walmsley, D., 2014. Ecosystem services as a boundary object for sustainability. Ecol. Econ. 103, 29–37.
Agoramoorthy, G., Hsu, M.J., Shieh, P., 2012. India's women-led vegetable cultivation improves economic and environmental sustainability. Scot. Geogr. J. 128, 87–99.
Aluko, M.A.O., 2004. Sustainable development, environmental degradation and the entrenchment of poverty in the Niger Delta of Nigeria. J. Hum. Ecol. 15, 63–68.
Angelsen, A., Wunder, S., 2003. Exploring the Forest-Poverty Link: Key Concepts, Issues and Research Implications, CIFOR Occasional Paper.
Ash, N., Blanco, H., Brown, C., Garcia, K., Henrichs, T., Lucas, N., Raudsepp-Hearne, C., Simpson, R.D., Scholes, R., Tomich, T.P., Vira, B., Zurek, M., 2010. Ecosystems and human *well-being, A Manual for Assessment Practitioners. Island Press, Washington, D.C.
Balvanera, P., Uriarte, M., Almeida-Leñero, L., Altesor, A., DeClerck, F., Gardner, T., Hall, J., Lara, A., Laterra, P., Peña-Claros, M., Silva Matos, D.M., Vogl, A.L., Romero-Duque, L.P., Arreola, L.F., Caro-Borrero, Á.P., Gallego, F., Jain, M., Little, C., de Oliveira Xavier, R., Paruelo, J.M., Peinado, J.E., Poorter, L., Ascarrunz, N., Correa, F., Cunha-Santino, M.B., Hernández-Sánchez, A.P., Vallejos, M., 2012. Ecosystem services research in Latin America: the state of the art. Ecosyst. Serv. 2, 56–70.
Barrett, C.B., Travis, A.J., Dasgupta, P., 2011. On biodiversity conservation and poverty traps. Proc. Natl. Acad. Sci. 108, 13907–13912.
Bateman, I., Mace, G., Fezzi, C., Atkinson, G., Turner, K., 2010. Economic analysis for ecosystem service assessments. Environ. Resour. Econ. 48, 177–218.
Berbes-Blazquez, M., 2012. A participatory assessment of ecosystem services and human wellbeing in rural Costa Rica using Photo-voice. Environ. Manage. 49, 862–875.
Bergquist, D.A., 2007. Sustainability and local people's participation in coastal aquaculture: regional differences and historical experiences in Sri Lanka and the Philippines. Environ. Manage. 40, 787–802.
Börner, J., Mendoza, A., Vosti, S.A., 2007. Ecosystem services, agriculture, and rural poverty in the Eastern Brazilian Amazon: interrelationships and policy prescriptions. Ecol. Econ. 64, 356–373.
Brooks, S.E., Reynolds, J.D., Allison, E.H., 2008. Sustained by snakes? Seasonal livelihood strategies and resource conservation by Tonle Sap fishers in Cambodia. Hum. Ecol. 36, 835–851.
Carpenter, S.R., Mooney, H.A., Agard, J., Capistrano, D., DeFries, R.S., Díaz, S., Dietz, T., Duraiappah, A.K., Oteng-Yeboah, A., Pereira, H.M., Perrings, C., Reid, W.V., Sarukhan, J., Scholes, R.J., Whyte, A., 2009. Science for managing ecosystem services: beyond the Millennium Ecosystem Assessment. Proc. Natl. Acad. Sci. 106, 1305–1312.
Chan, K.M.A., Guerry, A.D., Balvanera, P., Klain, S., Satterfield, T., Basurto, X., Bostrom, A., Chuenpagdee, R., Gould, R., Halpern, B.S., Hannahs, N., Levine, J., Norton, B., Ruckelshaus, M., Russell, R., Tam, J., Woodside, U., 2012. Where are cultural and social in ecosystem services? A framework for constructive engagement. BioScience 62, 744–756.
Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253–260.
Dahmardeh, M., Dahmardeh, M., Yazdani, S., Piri, E., 2009. The socio-economic effects of Hamoon Lake in Sistan region of Iran. J. Food Agric. Environ. 7, 799–802.
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.
De Groot, R.S., Blignaut, J., Van Der Ploeg, S., Aronson, J., Elmqvist, T., Farley, J., 2013. Benefits of investing in ecosystem restoration. Conserv. Biol. 27, 1286–1293.
DeClerck, F.A.J., Fanzo, J., Palm, C., Remans, R., 2011. Ecological approaches to human nutrition. Food Nutr. Bull. 32, S41–S50.
DeFries, R., Pandey, D., 2010. Urbanization, the energy ladder and forest transitions in India's emerging economy. Land Use Policy 27, 130–138.
Deng, X., Wang, Y., Li, B., An, T., 2010. Poverty issues in a national wildlife reserve in China. Int. J. Sustainable Dev. World Ecol. 17, 529–541.
Dunn, R.R., 2010. Global mapping of ecosystem disservices: the unspoken reality that nature sometimes kills us. Biotropica 42, 555–557.
ESPA, 2013. ESPA Knowledge Strategy, Paper Prepared for ESPA. ESPA, Edinburgh.
Edwards, P., Clarke, M., DiGuiseppi, C., Pratap, S., Wentz, I.R., 2002. Identification of randomized controlled trials in systematic reviews: accuracy and reliability of screening records. Stat. Med. 21, 1635–1640.
Elmqvist, T., Fragkias, M., Goodness, J., Güneralp, B., Marcotullio, P.J., McDonald, R.I., Parnell, S., Schewenius, M., Sendstad, M., Seto, K.C., Wilkinson, C., 2013. Urbanisation, Biodiversity and Ecosystem Services: Challenges and Opportunities. Springer.
Enfors, E.I., Gordon, L.J., 2008. Dealing with drought: the challenge of using water system technologies to break dryland poverty traps. Global Environ. Change 18, 607–616.
Fang, B., 2009. Poverty and biodiversity in rural areas based on two investigations in Pujiang County, China. J. Environ. Manage. 90, 1924–1932.
Ferraro, P.J., Hanauer, M.M., Sims, K.R.E., 2011. Conditions associated with protected area success in conservation and poverty reduction. Proc. Natl. Acad. Sci. U.S.A. 108, 13913–13918.
Fisher, J.A., Patenaude, G., Meir, P., Nightingale, A.J., Rounsevell, M.D.A., Williams, M., Woodhouse, I.H., 2013. Strengthening conceptual foundations: analysing

frameworks for ecosystem services and poverty alleviation research. Global Environ. Change 23, 1098–1111.
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.
Förster, H., Pachova, N.I., Renaud, F.G., 2011. Energy and land use in the Pamir-Alai mountains. Examples from five social–ecological regions. Mt. Res. Dev. 31, 305–314.
Giliba, R.A., Lupala, Z.J., Mafuru, C., Kayombo, C., Mwendwa, P., 2010. Non-timber forest products and their contribution to poverty alleviation and forest conservation in Mbulu and Babati Districts -Tanzania. J. Hum. Ecol. 31, 73–78.
Gilioli, G., Baumgaertner, J., 2007. Adaptive ecosocial system sustainability enhancement in Sub-Saharan Africa. Ecohealth 4, 428–444.
Goessling, S., 2003. Market integration and ecosystem degradation: is sustainable tourism development in rural communities a contradiction in terms? Environ. Dev. Sustainability 5, 383–400.
Goldin, J., Rutherford, R., Schoch, D., 2008. The place where the sun rises: an application of IWRM at the village level. Int. J. Water Resour. Dev. 24, 345–356.
Hengsdijk, H., Wang, G., Van den Berg, M.M., Wang, J., Wolf, J., Lu, C., Roetter, R.P., Van Keulen, H., 2007. Poverty and biodiversity trade-offs in rural development: a case study for Pujiang county, China. Agric. Syst. 94, 851–861.
Howe, C., Suich, H., van Gardingen, P., Rahman, A., Mace, G.M., 2013. Elucidating the pathways between climate change, ecosystem services and poverty alleviation. Curr. Opin. Environ. Sustainability 5, 102–107.
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. Global Environ. Change 28, 263–275.
Huang, L., Shao, Q., Liu, J., 2012. Forest restoration to achieve both ecological and economic progress, Poyang Lake basin, China. Ecol. Eng. 44, 53–60.
Kerr, J., 2002. Watershed development, environmental services, and poverty alleviation in India. World Dev. 30, 1387–1400.
Kideghesho, J.R., 2008. Co-existence between the traditional societies and wildlife in western Serengeti, Tanzania: its relevancy in contemporary wildlife conservation efforts. Biodivers. Conserv. 17, 1861–1881.
Kideghesho, J.R., Roskaft, E., Kaltenborn, B.P., Tarimo, T.M.C., 2005. 'Serengeti shall not die': can the ambition be sustained? Int. J. Biodivers. Sci. Manage. 1, 150–166.
Kumar, R., Horwitz, P., Milton, G.R., Sellamuttu, S.S., Buckton, S.T., Davidson, N.C., Pattnaik, A.K., Zavagli, M., Baker, C., 2011. Assessing wetland ecosystem services and poverty interlinkages: a general framework and case study. Hydrol. Sci. J.—J. Sci. Hydrol. 56, 1602–1621.
Kusimi, J.M., Dika, J.L., 2012. Sea erosion at Ada Foah: assessment of impacts and proposed mitigation measures. Nat. Hazard. 64, 983–997.
La Rovere, R., Hiernaux, P., Van Keulen, H., Schiere, J.B., Szonyi, J.A., 2005. Co-evolutionary scenarios of intensification and privatization of resource use in rural communities of south-Western Niger. Agric. Syst. 83, 251–276.
Lange, G.-M., Jiddawi, N., 2009. Economic value of marine ecosystem services in Zanzibar: implications for marine conservation and sustainable development. Ocean Coast. Manage. 52, 521–532.
Lankford, B., Pringle, C., Dickens, C., Lewis, F., Mander, M., Chhotray, V., Goulden, M., Nxele, Z., Quayle, L., 2011. Hydrological modelling of water allocation, ecosystem services and poverty alleviation in the Pongola floodplain, South Africa. J. Environ. Plann. Manage. 54, 1237–1260.
Lawson, E.T., Gordon, C., Schluchter, W., 2012. The dynamics of poverty-environment linkages in the coastal zone of Ghana. Ocean Coastal Manage. 67, 30–38.
Lewis, D., Bell, S.D., Fay, J., Bothi, K.L., Gatere, L., Kabila, M., Mukamba, M., Matokwani, E., Mushimbalume, M., Moraru, C.I., Lehmann, J., Lassoie, J., Wolfe, D., Lee, D.R., Buck, L., Travis, A.J., 2011. Community Markets for Conservation (COMACO) links biodiversity conservation with sustainable improvements in livelihoods and food production. Proc. Natl. Acad. Sci. 108, 13957–13962.
Liebenow, D.K., Cohen, M.J., Gumbricht, T., Shepherd, K.D., Shepherd, G., 2012. Do ecosystem services influence household wealth in rural Mali? Ecol. Econ. 82, 33–44.
Lyytimäki, J., Petersen, L.K., Normander, B., Bezák, P., 2008. Nature as a nuisance? Ecosystem services and disservices to urban lifestyle. Environ. Sci. 5, 161–172.
Mace, G.M., Norris, K., Fitter, A.H., 2012. Biodiversity and ecosystem services: a multilayered relationship. Trends Ecol. Evol. (Personal edition) 27, 19–26.
Madulu, N.F., 2005. Environment, poverty and health linkages in the Wami River basin: a search for sustainable water resource management. Phys. Chem. Earth 30, 950–960.
Maestre, F.T., Salguero-Gomez, R., Quero, J.L., 2012. It is getting hotter in here: determining and projecting the impacts of global environmental change on drylands Introduction. Philos. Trans. R. Soc. London, Ser. B—Biol. Sci. 367, 3062–3075.
Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, D.C.
Miller, B.W., Caplow, S.C., Leslie, P.W., 2012. Feedbacks between conservation and social–ecological systems. Conserv. Biol. 26, 218–227.
Milner-Gulland, E.J., 2012. Interactions between human behaviour and ecological systems. Philos. Trans. R. Soc. London, Ser. B—Biol. Sci. 367, 270–278.
Montagnini, F., Islas, A.S., Araujo Santana, M.R., 2008. Participatory approaches to ecological restoration in Hidalgo, Mexico. Bois et Forets des Tropiques, 5–20.
Muhammed, N., Koike, M., Haque, F., Miah, M.D., 2008. Quantitative assessment of people-oriented forestry in Bangladesh: a case study in the Tangail forest division. J. Environ. Manage. 88, 83–92.
Nelson, E., Sander, H., Hawthorne, P., Conte, M., Ennaanay, D., Wolny, S., Manson, S., Polasky, S., 2010. Projecting global land-use change and its effect on ecosystem service provision and biodiversity with simple models. PLoS One 5, e14327.
Ninan, K.N., Inoue, M., 2013. Valuing forest ecosystem services: what we know and what we don't. Ecol. Econ. 93, 137–149.
Ottaviani, D., Ji, L., Pastore, G., 2003. A multidimensional approach to understanding agro-ecosystems. A case study in Hubei Province, China. Agric. Syst. 76, 207–225.
Perevochtchikova, M., Oggioni, J., 2014. Global and Mexican analytical review of the state of the art on ecosystem and environmental services: a geographical approach. Investigaciones Geográficas, Boletín del Instituto de Geografía 85, 47–65.
Power, A.G., 2010. Ecosystem services and agriculture: tradeoffs and synergies. Philos. Trans. R. Soc. London, Ser. B: Biol. Sci. 365, 2959–2971.
Qiang, Z., 2003. Rainwater harvesting and poverty alleviation: a case study in Gansu, China. Int. J. Water Resour. Dev. 19, 569–578.
Raffaelli, D., White, P.C.L., 2013. Ecosystems and their services in a changing world: an ecological perspective. In: Guy, W., Eoin, J.O.G. (Eds.), Advances in Ecological Research. Academic Press, pp. 1–70.
Raudsepp-Hearne, C., Peterson, G.D., Tengö, M., Bennett, E.M., Holland, T., Benessaiah, K., MacDonald, G.K., Pfeifer, L., 2010. Untangling the environmentalist's paradox: why is human well-being increasing as ecosystem services degrade? BioScience 60, 576–589.
Reyers, B., Biggs, R., Cumming, G.S., Elmqvist, T., Hejnowicz, A.P., Polasky, S., 2013. Getting the measure of ecosystem services: a social–ecological approach. Front. Ecol. Environ. 11, 268–273.
Rodríguez, J.P., Beard, T.D., Bennett, E.M., Cumming, G.S., Cork, S.J., Agard, J., Dobson, A.P., Peterson, G.D., 2006. Trade-offs across space, time, and ecosystem services. Ecol. Soc., 11.
Sandker, M., Ruiz-Perez, M., Campbell, B.M., 2012. Trade-offs between biodiversity conservation and economic development in five tropical forest landscapes. Environ. Manage. 50, 633–644.
Sellamuttu, S.S., de Silva, S., Nguyen-Khoa, S., 2011. Exploring relationships between conservation and poverty reduction in wetland ecosystems: lessons from 10 integrated wetland conservation and poverty reduction initiatives. Int. J. Sustainable Dev. World Ecol. 18, 328–340.
Shackleton, C.M., Gambiza, J., 2008. Social and ecological trade offs in combating land degradation: the case of invasion by a woody shrub (Euryops floribundus) at Macubeni, South Africa. Land Degrad. Dev. 19, 454–464.
Shackleton, S.E., Shackleton, C.M., 2012. Linking poverty, HIV/AIDS and climate change to human and ecosystem vulnerability in southern Africa: consequences for livelihoods and sustainable ecosystem management. Int. J. Sustainable Dev. World Ecol. 19, 275–286.
Sheppard, D.J., Moehrenschlager, A., McPherson, J.M., Mason, J.J., 2010. Ten years of adaptive community-governed conservation: evaluating biodiversity protection and poverty alleviation in a West African hippopotamus reserve. Environ. Conserv. 37, 270–282.
Sjostedt, M., 2012. Ecosystem services and poverty reduction: how do development practitioners conceptualize the linkages? Eur. J. Dev. Res. 24, 777–787.
Srinivasan, U.T., Carey, S.P., Hallstein, E., Higgins, P.A.T., Kerr, A.C., Koteen, L.E., Smith, A.B., Watson, R., Harte, J., Norgaard, R.B., 2008. The debt of nations and the distribution of ecological impacts from human activities. Proc. Natl. Acad. Sci. U.S.A. 105, 1768–1773.
Tallis, H., Kareiva, P., Marvier, M., Chang, A., 2008. An ecosystem services framework to support both practical conservation and economic development. Proc. Natl. Acad. Sci. U.S.A. 105, 9457–9464.
Turner, W.R., Brandon, K., Brooks, T.M., Gascon, C., Gibbs, H.K., Lawrence, K.S., Mittermeier, R.A., Selig, E.R., 2012. Global biodiversity conservation and the alleviation of poverty. BioScience 62, 85–92.
UKNEA, 2011. The UK National Ecosystem Assessment: Synthesis of the Key Findings. UNEP-WCMC, Cambridge.
Viera, A.J., Garrett, J.M., 2005. Understanding interobserver agreement: the Kappa statistic. Fam. Med. 37, 360–363.
Villasante, S., Rodriguez, D., Antelo, M., Quaas, M., Osterblom, H., 2012. The global seafood market performance index: a theoretical proposal and potential empirical applications. Mar. Policy 36, 142–152.
Vira, B., Adams, B., Agarwal, C., Badiger, S., Hope, R.A., Krishnaswamy, J., Kumar, C., 2012. Negotiating trade-offs. Choices about ecosystem services for poverty alleviation. Econ. Polit. Wkly 67, 67–76.
Wang, C., Yang, Y., Zhang, Y., 2012. Rural household livelihood change, fuelwood substitution, and hilly ecosystem restoration: evidence from China. Renewable Sustainable Energy Rev. 16, 2475–2482.
Zhang, W., Ricketts, T.H., Kremen, C., Carney, K., Swinton, S.M., 2007. Ecosystem services and dis-services to agriculture. Ecol. Econ. 64, 253–260.