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To what extent have the links between ecosystem services and human well-being been researched in Africa, Asia, and Latin America?

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Abstract

Most studies to date assume that there are multiple relationships between ecosystem services and human well-being, but there are few studies that quantify these relationships. Our objectives were: (1) to investigate the trends and understudied areas within ecosystem services and well-being research; and (2) within these general trends, to analyze to what extent the linkages between ecosystem services and well-being presented in empirical research in Africa, Asia, and Latin America were part of a tested hypothesis and to assess which conceptual frameworks were used in understanding this interface. The results of this study highlighted that most publications assumed that ecosystem services and well-being were interlinked but did not analyze their relationship as part of the hypothesis to test. While different frameworks on well-being were adopted by empirical research, only one out of the 29 post-Millennium Ecosystem Assessment (MEA) conceptual frameworks that illustrate the linkages between ecosystem services and well-being was documented, and most case studies adopted the MEA. Finally, trade-offs and synergies between ecosystem services and disaggregated well-being were understudied. Considering these knowledge gaps in future studies will help empirical ecosystem services research to simultaneously contribute to improved well-being and environmental sustainability when applied at multiple policy or institutional levels.

Keywords: Africa, Asia, conceptual framework, ecosystem services, human well-being, Latin America, systematic review

1. Introduction

Human well-being is a multidimensional concept with objective dimensions that include social and material attributes, and subjective dimensions that comprise a person’s assessment of their own conditions (King, Renó and Novo 2014; Summers, Smith, Case et al. 2012). It includes different social, environmental, physical, spiritual, and emotional components associated with how people function and
how they feel. Summers Smith Case et al. (2012: 328) emphasized that in order to have well-being it is necessary that ‘basic needs are met, that individuals have a sense of purpose, and that they feel able to achieve important personal goals and participate in the society.’ Although there is a substantial body of literature on the indicators of human well-being (e.g. Cummins, Eckersley, Pallant et al. 2003; Gasper 2007; Prescott-Allen 2001), the benefits that humans receive from the environment are not well understood within the well-being literature (Summers, Smith, Case et al. 2012). However, the interconnectedness between well-being and the benefits provided by ecosystems to humans is increasingly gaining recognition among scientists, who are progressively exploring conceptual and methodological frameworks for conducting socio-ecological analysis (King, Renó and Novo 2014).

A foundational piece known as the Millennium Ecosystem Assessment (MEA, 2005) illustrates the multiple links between ecosystem services and human well-being. Indeed, ecosystems, through the benefits they provide, are essential for safeguarding the multiple dimensions of human well-being, such as the provision of goods and services (e.g., food, timber, fuelwood, freshwater provision) that are needed for human survival. Along with the rapid increase of ecosystem services literature after the publication of the MEA (Gómez-Baggethun, De Groot, Lomas et al. 2010), numerous frameworks have emerged that attempt to conceptualize the dynamics and complexity of the links between ecosystem services and human well-being (e.g. Díaz, Demissew, Carabias et al. 2015; EPA 2012; Fisher, Patenaude, Giri et al. 2014; Rounsevell, Dawson and Harrison 2010; TEEB 2010). For instance, Blundo Canto, Cruz-Garcia, Sachet et al. (in preparation) found a total of 29 frameworks describing the relationship between ecosystem services and human well-being that emerged after the publication of the MEA. Although these frameworks propose various economic, social, political, and ecological perspectives for understanding the interactions between these two concepts, it is unclear how far empirical research has advanced in demonstrating and measuring these theoretical linkages, combining perspectives from different disciplines and in different contexts. Exploring the connections between human well-being and ecosystem services at different scales and contexts, and using a systemic analysis where different perspectives (e.g. social justice, poverty eradication, environmental sustainability) and disciplines are combined, will help to identify the actions required to simultaneously enhance human well-being and ecological stability, which will contribute to achieving the Sustainable Development Goals (Balvanera, Siddique, Dee et al. 2014; Carpenter, Mooney, Agard et al. 2009; Duraïappah 2011; Raworth 2012; Reyers, Roux, Cowling et al. 2010).

Although research on ecosystem services and human well-being is increasing exponentially, little is known about the extent to which empirical research has studied the nature of their linkages. For instance, 81% of the case studies on ecosystem services and food security (a component of human well-being) conducted in Africa, Asia and Latin America assumed they are linked, while few had tested their links empirically (Cruz-Garcia, Sachet, Vanegas et al. 2016). There is no systematic review that examines to what extent the connection between ecosystem services and human well-being has been theoretically assumed as part of the study justification or empirically researched by including this connection as part of the study hypothesis. Such an analysis is necessary to provide useful directions for future empirical studies in the way that they contribute to an understanding how trade-offs and synergies between ecosystem services and well-being can simultaneously ensure environmental sustainability and improved livelihoods. This is particularly important for Africa, Asia and Latin America, where improving social progress, economic and human development is imperative. They include countries where social progress indices range from very low to middle. Their lower social progress indices compared to North America, Europe and Australia, are not clearly correlated with country income; instead, they are related to low attainments in multiple dimensions of human well-being (including environmental indicators), basic need satisfaction and social opportunities (Porter, Stern and Green 2016). Such a socioeconomic challenging context is paired with growing environmental concerns. For instance, between 1990 and 2015, the greatest forest loss occurred in sub-Saharan Africa, South-Eastern Asia and Latin America, accounting for almost 16,000
The hypothesis underlying this study is that most of the many studies on ecosystem services and human well-being assume that there are multiple relationships between these two concepts, but there are few research studies that examine these relationships. This paper aims to evaluate to what extent these links have been empirically analyzed in scientific studies. The objectives were: (1) to investigate the trends and understudied areas within ecosystem services and human well-being research (temporally, spatially and by topic); and (2) within these general trends, to analyze to what extent the linkages between ecosystem services and human well-being presented in empirical research in Africa, Asia, and Latin America were part of a tested hypothesis or were assumed to be part of the study justification, and to assess which conceptual frameworks were used to understand this interface. This empirical evidence, when applied, will contribute to synergistically improve environmental sustainability and human well-being as part of policies, strategies and initiatives related to the attainment of the Sustainable Development Goals.

2. Methods

A systematic literature review was conducted using the methodological rules of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) designed for indexed publications. According to PRISMA, a systematic review is “a review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyze data from the studies that are included in the review” (Moher, Liberati, Tetzlaff et al. 2010: 336).

All indexed peer reviewed publications including ecosystem services and human well-being (or wellbeing or well being) in title, abstract and keywords, published in English before 2015, were searched using the Scopus®, Web of Science™ and ScienceDirect® databases. This review focused on scientific research based on a peer review process, which aims to ensure the scientific rigor of publications. The choice to omit gray literature was a response to the need to have a rigorous search of the established databases, systematic identification of scientific publications and eligibility criteria (procedures and standards). The Booleans AND, which ensures the presence of both terms, and OR, which allows the presence of either term (or both), were used using the keyword combination “ecosystem services” AND (“human well-being” OR “human well-being” OR “human well being”) in the search. The keywords of the query were entered in Scopus’ and ScienceDirect’s ‘title-abstract-keywords’ field option, where there is no difference between author and indexed keywords (Tancoigne, Richard, Barbier et al. 2014). The keywords of the query were entered in Web of Science’s ‘topic’ field option that includes searching in: title, abstract, author keywords, and indexed keywords fields. The literature search yielded a total of 474, 63, and 142 publications found in Scopus®, Web of Science™, and ScienceDirect®, respectively. Duplicate articles were manually deleted. Publications that were found during the search that did not include the search terms in title, keywords or abstract, publications that were not written in English or were not accessible online, and non-peer reviewed books, were manually excluded. This yielded a total of 462 publications establishing the first database (Fig. 1), which was used for addressing objective 1 of the study (i.e. understanding the general trends in ecosystem services and human well-being research).
Fig. 1. Flow diagram of the selection process of publications for databases 1 and 2, based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) rules and templates (Moher, Liberati, Tetzlaff et al. 2010).

To evaluate to what extent the linkages between ecosystem services and human well-being have been empirically analyzed as part of scientific research conducted with rural and urban communities in Africa, Asia and Latin America (objective 2), a subset of case studies was selected from database 1. A case study is defined as an empirical enquiry that requires a scientifically rigorous research design, using one or more types of research methods (qualitative and/or quantitative) for data collection and analysis (adapted from Yin 2013). The selection criteria for inclusion were based on paper coverage and the continent where the study was conducted. In addition, case studies should have been conducted with rural or urban communities. Accordingly, the first step was to select original research publications, excluding review papers from database 1. Then, experimental research publications (based on field or laboratory experiments) and case studies that did not adhere to the criteria (two articles) were excluded. This generated a total of 145 case study publications globally. Finally, case studies that were not conducted in Africa, Asia and Latin America were excluded, yielding a total of 49 case studies from Africa, Asia and Latin America, which constituted database 2.
The quantitative analysis of publications from database 1 was based on: type of publication (e.g. journal article, book chapter, conference paper, letter, editorial and commentary), year of publication, subject area (according to Scopus 2011), type of study area, and geographical scope (e.g. continent, country, scale). The publications from database 2 were classified into two groups: (a) case studies that analyzed the linkages between ecosystem services and human well-being as part of the hypothesis to test and designed the research methodology on this basis; and (b) case studies that assumed that these linkages existed as part of the study justification and based on this assumption, proposed a hypothesis. The final database included two variables: ‘link tested’ (for articles classified in group a) and ‘link assumed’ (for articles classified in group b). These case studies were analyzed in relation to their research methods, citation or application of a conceptual framework, dimensions or indicators of well-being used, category and type of ecosystem services included, and whether issues related to trade-offs and gender were included.

This paper followed the ecosystem service categories and the ecosystem services types from the MEA (Millennium Ecosystem Assessment 2005), The Economics of Ecosystems and Biodiversity or TEEB (McVittie and Hussain 2013; TEEB 2015), and the Common International Classification of Ecosystem Services or CICES (Biodiversity Information System for Europe 2016; European Environment Agency 2016). Data were analyzed using Microsoft Excel®.

3. Results

3.1. Global trends in ecosystem services and human well-being research

A total of 462 publications on ecosystem services and human well-being (corresponding to database 1) included journal articles (83%), book chapters (9%), conference papers (7%), editorials (1%), letters (0.2%) and commentaries (0.2%). The first article was published in 1999 and the number of publications was about 20 per year up to 2009 (Fig. 2). Since 2010, the total number of publications has exponentially increased, reaching a maximum of 109 in 2014. The first case study was published in 2004, and the total number of case studies did not show a substantial increase until 2011.
The number of publications on ecosystem services and human well-being differed in terms of their geographical scale and scope, presenting research conducted from global (5%), continental or subcontinental (9%), national or subnational (29%), to city or community scale (7%). In addition, two publications were at farm scale, and another two were at oceanic scale. Only 2% of the publications presented multiple scales, and for almost half of the papers (47%) scale was not applicable given that they were review papers. Most research took place on Europe (17% of all publications), followed by North America encompassing US and Canada (8%), Asia (8%), Africa (7%), Latin America (6%), and Oceania (3%).
Although 59% of all publications did not specify the country (or it was not applicable, i.e. they were at a global scale or were review papers), research was conducted in a total of 92 countries, with only 7% of publications taking place in multiple countries. The most researched country was the US (7%). Australia, Spain and South Africa covered 3% of all publications each, and the remaining countries were included in 2% or less of publications.

Remarkably, more than two-thirds (68%) of all case studies (n=145) were conducted at national or subnational scale, followed by city or community scale (17%), and continental or subcontinental scale (11%). Most case studies were conducted in Europe (39%), whereas 19% took place in North America, 14% in Africa, 13% in Asia, 13% in Latin America, and 6% in Oceania. Three case studies took place in more than one continent. Most case studies also took place in the US (15%), followed by Spain (9%) and Germany (7%) (Fig. 4).

![Geographical distribution of all articles presenting case studies on ecosystem services and human well-being worldwide (n=145 articles, with 17 studies occurring in multiple countries), indicating which countries included case studies with communities in Africa, Asia, and Latin America (n=49). Note: The case study conducted at a global scale was not illustrated in the map. A scale of gray indicates the number of case studies covered in each country, and countries from Africa, Asia, and Latin America with selected case studies with stripe lines on the top of the color. Categories are nonexclusive, thus a publication might be found in several countries.](image)

3.2. Ecosystem services and well-being: case studies from Africa, Asia and Latin America

The presence of case studies on rural and urban communities in Africa, Asia and Latin America (n=49, corresponding to database 2) is recent, with the first ones published in 2006. Their total number, however, has remained below 20 up to 2014 (Fig. 2). The most important subject area was environmental policy and management (n=18), followed by environmental economics (n=9), environmental and earth sciences (n=7), and ecological and biological sciences (n=7) (Fig. 3). Landscapes (n=8) and livelihoods (n=7) were the most common focus of study, whereas fisheries, grasslands and wetlands were the least common (with one or two case studies each). All selected case studies were journal articles, with the exception of two conference papers.
Following the same trends as all case studies, 67% of selected case studies for Africa, Asia and Latin America were conducted at national or subnational level, followed by city or community level (29%), and continental or subcontinental level (4%). Some 37% of the selected case studies were conducted in Latin America, 37% in Africa and 27% in Asia. The most researched countries were China and South Africa (with 14% of all selected case studies each), followed by Chile (12%) (Fig. 4). Three case studies occurred in multiple countries.

All ecosystem service categories were covered by 18% of the publications, whereas 39% included three or two categories. Provisioning services was the most common ecosystem service category included in the articles, with almost half of the case studies (45%), followed by regulating services (39%), cultural services (20%) and supporting services (16%). There were no articles focusing only on supporting services, and the most popular study area among provisioning, regulating and cultural services was landscape ecology. Ecosystem service categories were not specified in 22% of the articles.

A total of 57 different types of ecosystem services were included. Biological control, food, freshwater and recreation were the only ecosystem services that were the focus of one publication, whereas 92% of case studies presented multiple ecosystem service types – up to 32 services in a single article. Provisioning services presented 15 different types of ecosystem services, and the most common ones were food and freshwater, which were included in almost half of the case studies. Regulating services encompassed 19 ecosystem service types in relation to soil, water, air, and organisms, among others. Cultural services included 14 types of ecosystem services, and supporting services presented nine. Fig. 5 presents the most common types of ecosystem services included in the case studies.
Trade-offs were only addressed in 35% of case studies, mainly in those on environmental policy and management (n=6), and at national or subnational scale (n=9). Authors, for example, evaluated the trade-offs between conservation goals and improvement of livelihoods (Bremer, Farley, Lopez-Carr et al. 2014), or between environmental and economic aspects (e.g. Brancalion, Cardozo, Camatta et al. 2014; Dai, Ulgiati, Zhang et al. 2014; Jogo and Hassan 2010). The trade-offs between different types of ecosystem services were also included as part of the research (e.g. Geneletti 2013; Silvestri, Zaibet, Said et al. 2013).

Most (90%) of case studies did not include gender issues as part of the research. Gender was only present in case studies conducted in Costa Rica, Ghana, India, Kenya and Madagascar; and the most popular subject area was environmental policy and management (60% of case studies that included gender).

Interestingly, most studies that included gender (four out of five) also evaluated trade-offs between social and environmental issues, for instance, using participatory assessments (e.g. Abunge, Coulthard and Daw 2013; Berbés-Blázquez 2012).

3.3. Empirical analysis of the linkages between ecosystem services and well-being, in case studies from Africa, Asia, and Latin America

In terms of the analysis of the linkages between ecosystem services and human well-being among case studies with rural and urban communities in Africa, Asia and Latin America (n=49, corresponding to database 2), 71% of publications assumed that they existed as part of the study justification and, based on this assumption, proposed a hypothesis (referred to as ‘link assumed’ from now onwards). The first article that analyzed linkages between ecosystem services and human well-being as part of the hypothesis to test (referred to as ‘link tested’ from now onwards) did not appear until 2010 when Jogo and Hassan published a case study on the analysis of the linkages among economic well-being, ecological security and policy. The increase in publications analyzing these linkages started in 2013 (with five articles, and six in 2014). For example, Delgado, Sepúlveda and Marín (2013) evaluated how much ecosystem services, particularly wood from native forests and clean water, contributed to the well-being of rural populations of the Aysén watershed in northern Chilean Patagonia. Celentano et al. (2014) proposed an interdisciplinary research framework to evaluate the linkages between ecological sustainability, social needs, and traditional ecological knowledge to design riparian forest restoration strategies. Abunge Coulthard and Daw (2013) investigated the relations between well-being and ecosystem services from the perspective of coastal fisheries stakeholders in Kenya. However, there has also been a recent increase of articles that assume that these linkages exist as part of the study justification (with 11 in 2014).

Although the linkages were tested across all ecosystem service categories, it mainly occurred for provisioning and regulating services. The links between ecosystem services and human well-being were tested at least in one publication for 74% of the ecosystem service types, but none of the most popular types of ecosystem services (i.e. these assessed in more than 10% of case studies) encompassed more publications testing the links rather than assuming them in the research hypothesis (Fig. 5). Only six case
Sixty four percent of the case studies that tested the links between ecosystem services and human well-being did it by applying one research method, whereas four used two different methods, and one used three methods. The most common method was interviewing (n=5), using semi-structured and in-depth interviews, followed by focus group discussions (n=2). Scientific modelling and questionnaires were applied in two articles each; whereas photo-voice, transect walk, participatory well-being assessment, DPSIR analysis (driving force, pressure, state, impact and response), agrarian diagnosis, secondary data analysis, and trade-off analysis were only used in one case study each. For example, Berbés-Blázquez (2012) used a combination of photo-voice, focus group discussions and transect walks in order to analyze how a community assessed their environmental services in Costa Rica, highlighting the potential of photo-voice for documenting the interactions between people and ecosystems. Jogo and Hassan (2010) developed an ecological-economic model to evaluate the impacts of alternative policy regimes on economic well-being and wetland functioning in Limpopo, Southern Africa. Outeiro and Villasante (2013) used a combination of household surveys and scientific modelling to analyze the synergies and trade-offs caused by the salmon industry on ecosystem services and their effect on human well-being in Chiloe, southern Chile. In addition, Shameem Momtaz and Rauscher (2014) combined qualitative and quantitative data collected through household surveys and in-depth interviews to understand how major stresses and hazards shaped the vulnerability of people’s livelihoods in socio-ecological coastal systems in the southwest of Bangladesh.

3.4. Conceptual frameworks used in empirical research from Africa, Asia and Latin America

Out of ten frameworks on ecosystem services and human well-being reported by the case studies, 55% of publications presented one conceptual framework, 12% presented two frameworks, and 33% did not include any framework. Of the publications that presented a framework, 52% only cited it, 42% applied it for the case study, and two both cited and applied frameworks. Most articles that tested the link (79%) applied a conceptual framework; whereas most articles that assumed the link did not use a framework (46%) or just cited it (40%). Frameworks were mainly applied in case studies that focused on provisioning or regulating services (five and four articles, respectively), and six studies applied a framework but did not specify the ecosystem service category. The ecosystem services that were more common in terms of applying conceptual frameworks were freshwater and food, with 13 and 11 publications, respectively.

The most popular conceptual framework was the MEA, which was cited in 55% and applied in 27% of the publications that presented a framework (Millennium Ecosystem Assessment 2003, 2005). The first case study including the MEA was in 2006, and this number did not increase until 2013 (n=7) and 2014 (n=9). The MEA was applied across the continents (Table 1). The Sustainable Livelihoods Framework (Scoones 1998) was applied in two publications and cited in one, and the Cascade Model for Ecosystem Services (Haines-Young and Potschin 2010) was applied in two publications (Table 2). These case studies were published in 2013 and 2014. Additionally, the linkages between ecosystem services and human well-being were part of the hypothesis to test in 33% of the publications that used the MEA (five articles applied and four cited the MEA), in all articles that used the Sustainable Livelihoods Framework, in all articles that applied the Cascade Model for Ecosystem Services, and, as expected, in the two author frameworks. The two publications that proposed their own frameworks for analyzing their case studies were Delgado, Sepúlveda and Marín (2013), and Jogo and Hassan (2010).

The frameworks that were applied in one case study were: A multi-scale conceptual framework on nature, the productive base of societies and human well-being (Duraiappah, Asah, Brondizio et al. 2014),
Maslow’s Pyramid of Self-Actualization (Maslow 1954), and Multidimensional Poverty Assessment Tool (Cohen 2009); whereas the frameworks only cited in one case study were Costanza et al.’s valuation of ecosystem services and natural capital (1997), and the Gross National Happiness (Gross National Happiness Commission 2013).

Table 1. Matrix of publications presenting case studies with communities in Africa, Asia and Latin America (n=49). The matrix compares the usage of conceptual frameworks in the case studies in relation to ecosystem service categories and continent, indicating if a framework was only cited or also applied by the study. No articles were conducted in more than one continent. Some articles use different frameworks and/or assess more than one ecosystem service category.

<table>
<thead>
<tr>
<th>Conceptual frameworks</th>
<th>Ecosystem service categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Provisioning</td>
</tr>
<tr>
<td>Author’s framework</td>
<td>Af: 16(a)</td>
</tr>
<tr>
<td>Valuation of ecosystem services and natural capital (Costanza 1997)</td>
<td>As: 32(c)</td>
</tr>
<tr>
<td>A multi-scale conceptual framework on nature, the productive base of societies and human well-being (Duraiappah, Asah et al. 2014)</td>
<td>La: 23(a)</td>
</tr>
<tr>
<td>Cascade Model for Ecosystem Services (Haines-Young and Potschin 2010)</td>
<td>Af: 28(a)</td>
</tr>
<tr>
<td>Gross National Happiness (Gross National Happiness Commission 2013)</td>
<td>As: 17(c)</td>
</tr>
<tr>
<td>Maslow’s Pyramid of Self-Actualization (1954)</td>
<td>As: 9(a)</td>
</tr>
<tr>
<td>Millennium Ecosystem Assessment (2003, 2005)</td>
<td>Af: 2(c); 12(c); 18(c); 24(c); 28(c)</td>
</tr>
<tr>
<td>Multidimensional Poverty Assessment Tool (Cohen 1998)</td>
<td>Af: 18(c); La: 6(a)</td>
</tr>
<tr>
<td>Sustainable Livelihoods Framework (Scoones 1998)</td>
<td>Af: 18(a); La: 36, 37, 42, 44</td>
</tr>
</tbody>
</table>


Abbreviations for whether an framework was cited or applied: (c): cited, (a): applied

References. 1. (Abunge, Coulthard and Daw 2013); 2. (Ahmed, Saleh, Abdelkadir et al. 2009); 3. (Berbés-Blázquez 2012); 4. (Bodin, Tengö, Norman et al. 2006); 5. (Brancalion, Cardozo, Camatta et al. 2014); 6. (Bremer, Farley, Lopez-Carr et al. 2014); 7. (Celentano, Rousseau, Engel et al. 2014); 8. (Cilliers, Cilliers, Lubbe et al. 2013); 9. (Dai, Ugliati, Zhang et al. 2014); 10. (De Freitas, Schütz and De Oliveira 2007); 11. (Delgado, Sepúlveda and Marín 2013); 12. (Egoh, Reyes, Rouget et al. 2011); 13. (Figueroa and Pasten 2014); 14. (Garrard, Kohler, Wiesmann et al. 2012); 15. (Hou, Zhou, Burkhard et al. 2014); 16. (Jogo and Hassan 2010); 17. (Kubiszewski, Costanza, Dorji et al. 2013); 18. (Leauthaud, Duvail, Hamerlynck et al. 2013); 19. (Marin, Gelcich and Castilla 2014); 20. (Mhango and Dick 2011); 21. (Newton, del Castillo, Echeverría et al. 2012); 22. (Ouédraogo, Nacouлина, Hahn et al. 2014); 23. (Outeiro and Villasante 2013); 24. (Reyers, O’Farrell, Cowling et al. 2009); 25. (Ribeiro Palacios, Huber-Sannwald, García Barrios et al. 2013); 26. (Sandhu and Sandhu 2014); 27. (Samer, Montaz and Rauscher 2014); 28. (Silvestri, Zaitet, Said et al. 2013); 29. (Sitas, Prozesky, Esler et al. 2014); 30. (Su, Fu, He et al. 2012); 31. (Xu, Tan, Chen et al. 2014); 32. (Xu, Yu and Yue 2010); 33. (Yang, Dietz, Liu et al. 2013); 34. (Boafo, Saito and Takeuchi 2014); 35. (Bonzatowski, Braga and Vitule 2014); 36. (Geneletti 2013); 37. (Hack 2010); 38. (Joshi and Negi 2011); 39. (Kari and Korhonen et al. 2013); 40. (Karp, Judson, Daily et al. 2014); 41. (Khan, Page, Ahmad et al. 2012); 42. (Lindegren, Vigliano and Nilsson 2012); 43. (Matete and Hassan 2006); 44. (Mendenhall, Archer, Brenes et al. 2013); 45. (Mugwiza, Yalew, Van Der Kwast et al. 2014); 46. (Odada, Ochola and Olago 2009); 47. (Wang, Li and Paulussen 2010); 48. (Wendland, Honzák, Portela et al. 2010); 49. (Weyland and Laterra 2014).
<table>
<thead>
<tr>
<th>Conceptual frameworks</th>
<th>General description</th>
<th>Number of publications that cited (c) or applied (a) the framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millennium Ecosystem Assessment (2003, 2005)</td>
<td>The MEA constitutes a broadly applied foundational framework that links four categories of ecosystem services (provisioning, regulating, supporting and cultural) with five components of well-being (security, basic material for good life, health, good social relations and freedom of choice and action). It has been criticized that it has limited potential for the analysis of these links, and neglects issues related to social differentiation and political economy (Fisher, Patenaude, Meir et al. 2013).</td>
<td>18 (c), 9 (a)</td>
</tr>
<tr>
<td>Sustainable Livelihood Framework (Scoones 1998)</td>
<td>The SLF is an influential framework that conceptualizes livelihoods based on five components: contexts, conditions and trends; livelihood resources; institutional processes and organizational structures; livelihood strategies; and sustainable livelihood outcomes. Livelihood resources include natural, economic or financial, human and social capital, among others. However, the focus of the framework is on livelihoods, rather than well-being.</td>
<td>1 (c), 2 (a)</td>
</tr>
<tr>
<td>Cascade Model for Ecosystem Services (Haines-Young and Potschin 2010)</td>
<td>This framework illustrates the cascade relationship between four components: biophysical structures or processes (including biodiversity), ecosystem function, services, and benefits (values) for human well-being. It differentiates intermediate products, which encompass the first three components, and final products that include the last three components. Then function and service are both intermediate and final products.</td>
<td>2 (a)</td>
</tr>
</tbody>
</table>

The publications listed either indicators or dimensions of well-being (broader components of well-being encompassing one or more indicators). Only 35% of all case studies listed the indicators or dimensions of well-being used, and these belonged to different conceptual frameworks. A total of 117 different indicators or dimensions were reported, and case studies on average presented 7.3 indicators or dimensions (SD=5), with a maximum of 21 and a minimum of two. Most indicators or dimensions (97%) were used in one case study only. Indicators related to health, income, employment, poverty, education, security, social relations, demography, housing, food, access to resources, land and assets, inclusion and inequality, among others. Health was the most commonly used dimension of well-being (mentioned in four case studies), followed by good social relations (mentioned in three case studies), whereas education was mentioned in two publications. These dimensions, with the exception of education, were listed in the MEA framework (Millennium Ecosystem Assessment 2005). However, at least one dimension of each framework was used, and some dimensions were common to the application of more than one framework. Finally, the links between ecosystem services and human well-being were tested in at least one publication for 72% of well-being indicators or dimensions.
4. Discussion

4.1. General trends and understudied areas in ecosystem services and well-being research

The results of this study showed that research on ecosystem services and human well-being is growing not only in general, but also in relation to empirical case studies. In addition, this growth has been very recent: (a) the number of publications started to increase in 2009 with more than 20 per year (n=462); (b) the number of case studies (in general for the world) did not show a major increase until 2011 (n=145); (c) the number of case studies with communities from Africa, Asia and Latin America was below 20 per year up to 2014 (n=50). After the publication of the Millennium Ecosystem Assessment (2005) the use of the term ‘ecosystem services’ in research showed a substantial increase (Gómez-Baggethun, De Groot, Lomas et al. 2010). Although the conceptualization, research and measurement of human well-being has existed for more than 2,000 years (Stoll 2014), the use of the terms human development and well-being became more popular following the work of Amartya Sen (e.g. 1981; 1993).

The first case study was published in 1999, but case studies were not conducted in Africa, Asia or Latin America until 2006. Unquestionably, research on ecosystem services and human well-being in these regions is not only very recent, but also scanty. For instance, this study showed that the most common regions for research were Europe and North America (US and Canada), where 35% of all case studies were conducted (n=145). In addition, only 14 case studies from indexed scientific publications conducted in Africa, Asia and Latin America analyzed the linkages between ecosystem services and human well-being as part of the hypothesis to test. It is necessary to increase empirical research on these continents, which are characterized by a socioeconomic challenging context alongside environmental problems (Jahan 2015; Porter, Stern and Green 2016; United Nations 2016; Vörösmarty, McIntyre, Gessner et al. 2010). For instance, Balvanera, Uriarte, Almeida-Leñero et al. (2012) highlighted that in Latin America research is needed on the links between ecological processes, ecosystem services delivery, and related values, especially in understanding the vulnerabilities of different stakeholders and their cultural diversity. In addition, the MEA scenarios identified hot spots of rapid decline in ecosystem services per capita in sub-Saharan Africa, the Middle East and South Asia (Corvalan, Hales and McMichael 2005).

For the geographical scale of research, the most popular was national or subnational; whereas city or community scale was neglected among publications in general, and continental or subcontinental scale was understudied not only in general but also among case studies conducted in Africa, Asia and Latin America. Both constitute a research gap in ecosystem services and human well-being research.

Urban, marine and agricultural environments were the most popular in ecosystem services and human well-being research globally, whereas forest ecosystems, which is a cornerstone for well-being (Santoso, Thompson and Wreford 2009), was neglected (only present in 6% of all case studies). For case studies conducted in Africa, Asia and Latin America, fisheries, grasslands and wetlands were research gaps, with just two or less case studies each. This is unexpected, given that these three ecosystems are crucial for ensuring the well-being of rural and urban communities (see Charles, Allison, Chuenpagdee et al. 2012; Heidenreich 2009; Horwitz and Finlayson 2011; Millennium Ecosystem Assessment 2005).

Food and freshwater were the types of ecosystem services that received most attention in the case studies conducted in Africa, Asia and Latin America. Unquestionably, food, which includes agricultural and livestock products, fish, fruits, bushmeat, among others, is a basic means to achieve well-being (Millennium Ecosystem Assessment 2005). To achieve food and nutrition security, food availability, or a sufficient supply of food, economic and physical access to food (including entitlements), the nutrients and energy required for a healthy life, and stability during lean months and periods of instability (FAO 1996)
Crossman, Burkhard, Nedkov et al. (2013) explained that supporting and cultural ecosystem services remain understudied because these services are not as well understood or defined as provisioning and regulating services, and, consequently, are more difficult to measure. This study showed that supporting ecosystem services, such as genetic resources, nutrient cycling, soil formation and primary production, constitute an understudied area of research among case studies conducted in Africa, Asia and Latin America on ecosystem services and human well-being, reflecting the same trends observed in ecosystem services and food security research (Cruz-Garcia, Sachet, Vanegas et al. 2016), and ecosystem service trade-offs studies (Howe, Suich, Vira et al. 2014). However, these services constitute the underlying basis for provisioning and regulating ecosystem services, which were well represented among the case studies. In addition, the reduced presence of cultural services is aligned to what has been previously discussed in the cultural ecosystem services literature (Chan, Guerry, Balvanera, Uriarte, Almeida-Leñero et al. 2012; Chan, Satterfield and Goldstein 2012; Daniel, Muhar, Arnberger et al. 2012). For instance, it has been argued that ecosystem service research gives less attention to nonmaterial values, including cultural services, given that they are not suitable for monetization and cannot be easily linked to certain socio-ecological changes. Cultural benefits are related to cultural services and to different types of ecosystem services (Chan, Guerry, Balvanera et al. 2012). Different authors have proposed frameworks that may facilitate the integration of cultural services into the ecosystem services approach (e.g. Chan, Guerry, Balvanera et al. 2012; Daniel, Muhar, Arnberger et al. 2012). However, this has not been free of criticism; for instance it has been claimed that it is not possible to incorporate pivotal cultural values of nature, including symbolic meanings, into the ecosystem services framework. For instance, Kirchoff (2012: 1) explained that although “ecosystems produce the plants and animals that we perceive as parts of landscapes, the object ‘cultural landscape’ is a product of a specific way of seeing within the cultural framework of symbolic experience”.

4.2. To what extent have the links between ecosystem services and human well-being been empirically researched?

The analysis of the linkages between ecosystem services and human well-being is necessary to help us to understand how human well-being is affected by ecosystem composition and functioning, and how ecosystems are transformed by humans’ choices about the ways ecosystem services should be managed in order to increase their benefits in terms of human well-being (McMichael, Scholes, Hefny et al. 2005). The research findings, however, show that the majority of case studies presented in indexed scientific publications from Africa, Asia and Latin America assumed the existence of linkages between ecosystem services and well-being as part of the study justification and, based on this assumption, proposed a hypothesis. Only 29% of case studies analyzed the linkages between ecosystem services and human well-being as part of the hypothesis to test and, on this basis designed the research methodology and selected the variables that were investigated. Furthermore, the focus of analysis on these linkages from an empirical perspective only started in 2010.

Recently published conceptual frameworks could be useful for disaggregating well-being and ecosystem services to analyze their multiple interactions, i.e. Daw, Brown, Rosendo et al. (2011), and to consider equity (Pascual, Phelps, Garmendia et al. 2014). While their disaggregation is a priority for understanding the synergies and trade-offs between ecosystem services and human well-being for different groups in a
Understanding who benefits or is disadvantaged in terms of the use and access to ecosystem services, and how this affects their well-being is imperative given that different segments might derive different benefits from ecosystem services according to their contexts and needs. Therefore, the study of trade-offs and synergies plays a key role in understanding the interface between ecosystem services and human well-being.

The analysis of case studies that tested the linkages between ecosystem services and human well-being mainly focused on provisioning and regulating services. Certainly, as mentioned before, these ecosystem service categories are more tangible and amenable to quantification, whereas cultural and supporting services are more difficult to measure. The research findings showed that the study of trade-offs and synergies plays a key role in understanding the interface between ecosystem services and human well-being. However, the research findings showed that the trade-offs in the intersection between ecosystem services and human well-being have been neglected in scientific publications conducted with rural and urban communities from Africa, Asia and Latin America: Only 43% of the case studies that analyzed the links between ecosystem services and human well-being evaluated their trade-offs. Certainly, it has been highlighted that the trade-offs between ecosystem services and human well-being are understudied in ecosystem services research (Howe, Suich, Vira et al. 2014).

4.3. Empirical use of conceptual frameworks in the interface of ecosystem services and human well-being

Most case studies reported a conceptual framework as the basis of the research conducted with rural and urban communities in Africa, Asia and Latin America. These frameworks were cited but not applied in more than half of the case studies, while their application was mainly reported in publications that analyzed the linkages between ecosystem services and human well-being as part of the hypothesis to test. Conceptual frameworks contribute to interdisciplinary analysis in ecosystem services research and assist the assessment of complex and dynamic situations (Fisher, Patenaude, Meir et al. 2013). According to the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), frameworks are a 'concise summary in words or pictures of relationships between people and nature' (Díaz, Demissew, Carabias et al. 2015: 3), not only representing social and ecological components, but also the relations between them,
providing a common structure and terminology to the variables that are central to the socio-ecological system.

Nonetheless, the analysis of frameworks among case studies showed that: (a) only ten different frameworks were reported (cited or applied) by the case studies; (b) 80% of the frameworks were applied (the other 20% were only cited); and (c) 70% of the frameworks were applied only once. Comparing these results with the review of post-MEA frameworks (Blundo Canto, Cruz-Garcia, Sachet et al. in preparation), we were surprised to see that although 29 frameworks on ecosystem services and well-being were published up to December 2014, only one (Duraiappah, Asah, Brondizio et al. 2014) was applied in a case study. This shows that the diversity of frameworks used for the study of the interface between ecosystem services and human well-being was very low – 82% of the articles including a framework used the one proposed by the MEA (2003, 2005) and the remaining frameworks were not applied. In addition, whereas frameworks such as the Sustainable Livelihoods Framework (Scoones 1998), Maslow’s Pyramid of Self-Actualization (Maslow 1954), the Multidimensional Poverty Assessment Tool (Cohen 2009), and the “Gross National Happiness (Gross National Happiness Commission 2013), which have not been framed within an ecosystem services and well-being approach, were used in case studies, ecosystem services frameworks such as The framework for ecosystem service provision (Rounsevell, Dawson and Harrison 2010) and The Economics of Ecosystems and Biodiversity (TEEB) framework (TEEB 2010) were not cited or applied in any of the case studies. Most frameworks that were developed to aid the understanding of the interface between ecosystem services and human well-being have not been applied in empirical research conducted in Africa, Asia and Latin America. This reflects a lack of application of theory in practice within ecosystem services research, and that there might be too many frameworks emerging faster than are potentially applicable, and are not necessarily innovative compared to the ones that are already available.

The MEA framework (2003, 2005), which was used in most case studies has been criticized not only for oversimplifying the relationships between nature and well-being (Lele, Springate-Baginski, Lakerveld et al. 2013), but for overlooking issues related to social differentiation and the political economy (Daw, Brown, Rosendo et al. 2011; Fisher, Patenaude, Meir et al. 2013). Fisher Patenaude, Meir et al. (2013) also argued that it neglects social trade-offs in ecosystem management strategies. On one hand, social differentiation and inequality (related to rights, access and entitlements) are underlying causes of poverty (Sen 1981). Poverty is related to environmental degradation (Raworth 2012) and its eradication is part of the Sustainable Development Goals. On the other hand, the role of institutions in the governance of the relationships between people and ecosystem services, and among different social groups, should become a crucial component of ecosystem services and human well-being research (Butler and Oluoch-Kosura 2006; Díaz, Dumas, Garcia, Sachet et al. 2015).

4.4. Recommendations for future systematic literature reviews on ecosystem services and human well-being

While this review mainly focused on empirical research on ecosystem services and human well-being in Africa, Asia and Latin America, future reviews could expand the geographical scope. Future studies could also incorporate environmental services as part of the search in order to capture articles published before the 1990s. Likewise, the search could be expanded beyond human well-being, including e.g. poverty, quality of life, livelihoods, among others. Additionally, future reviews could also consider gray literature.

5. Conclusions
The outcomes of this study based on the review of scientific indexed publications of research conducted with rural and urban communities in Africa, Asia and Latin America demonstrated that the analysis of the linkages between ecosystem services and human well-being as part of a hypothesis to test remained largely neglected. This analysis mainly focused on provisioning and regulating services, but addressing cultural and supporting services is increasingly important. The study showed that there are various understudied areas in the empirical literature on the relationships between ecosystem services and human well-being, which constitute future research opportunities for further empirical research in these continents; for example, in relation to fisheries, grasslands and wetlands.

The application of conceptual frameworks is a useful tool in helping us to understand the links between ecosystem services and human well-being, but most existing frameworks have not yet been applied in empirical research as most case studies that presented a framework used the one proposed by the MEA. Moreover, important issues, such as those related to social inequality, disaggregated needs and outcomes, and governance, are often overlooked within such frameworks. It is also imperative to have a better understanding of trade-offs and synergies, not only between different types of ecosystem services, but also between ecosystem services and disaggregated human well-being. Social differentiation, including gender approaches, should be considered as part of the analysis of the interface between ecosystem services and well-being. Considering these recommendations will certainly help empirical ecosystem services research to synergistically contribute to improved well-being and environmental sustainability when applied at multiple policy or institutional levels, thereby advancing the achievement of the Sustainable Development Goals.

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Tables

Table 1. Matrix of publications presenting case studies with communities in Africa, Asia and Latin America (n=49). The matrix compares the use of conceptual frameworks in the case studies in relation to ecosystem service categories and continent, indicating if a framework was only cited or also applied by the study. No articles were conducted in more than one continent. Some articles use different frameworks and/or assess more than one ecosystem service category.

Table 2. Description of the conceptual frameworks used by two or more case studies (n=49).
Figures

**Fig. 1.** Flow diagram of the selection process of publications for databases 1 and 2, based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) rules and templates (Moher, Liberati, Tetzlaff *et al.* 2010).

**Fig. 2.** Number of publications on ecosystem services and human well-being published in English before 2015, using the Scopus®, Web of Science™ and ScienceDirect® databases indicating chronological trends for all publications (n=462), all case studies (n=145), and selected case studies for communities in Africa, Asia, and Latin America (n=49).

**Fig. 3.** Subject area of research on ecosystem services and human well-being for all publications (n=462), all case studies (n=145), and selected case studies for communities in Africa, Asia, and Latin America (n=49).

**Fig. 4.** Geographical distribution of all articles presenting case studies on ecosystem services and human well-being worldwide (n=145 articles, with 17 studies occurring in multiple countries), indicating which countries include case studies with communities in Africa, Asia, and Latin America (n=49). The case study conducted at global scale was not illustrated in the map. A scale of gray indicates the number of case studies covered in each country, and countries from Africa, Asia, and Latin America with selected case studies have stripe lines on the top of the color. Categories are nonexclusive, thus a publication might be found in various countries.

**Fig. 5.** Number of publications for ecosystem service types assessed in more than 10% of the selected case studies (n=49). The ten articles that did not specify the type of ecosystem service were not included in the table. The letters between parentheses mean: P = provisioning service, R = regulating service, C = cultural service and S = supporting service. The bars also indicate for each type of ecosystem service the proportion of publications that analyzed the linkages between ecosystem services and human well-being as part of the hypothesis to test (link tested) in relation to the publications that assumed that these linkages exist as part of the study justification and, based on this assumption, proposed a hypothesis (link assumed).