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Research article

Advances and challenges of incorporating ecosystem services into impact assessment

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ABSTRACT

An ecosystem services approach (ESA) to assess the environmental and social impacts of projects is a conceptual innovation that contributes to overcome two widely acknowledged deficiencies of impact assessment (IA): integration of knowledge areas and participation of affected communities. This potential was demonstrated through a practical application to a large mining project, showing evidence of advances in relation to current practice and identifying challenges. Data was obtained from the environmental impact study of the reviewed project and its supplements; additional data to fulfill the needs of the ESA were collected using rapid appraisal techniques. Results show that the ESA provides: (i) a more effective scoping; (ii) a contribution to delimitate the study area; (iii) a more detailed identification of impacts; (iv) a determination of significance inclusive of the perspective of affected communities; (v) a design of mitigation focused on human well-being. The challenges of using the ESA fall into two groups: the limitations inherent to the concept and those that can be overcome by furthering research and advancing practical applications. This research added evidence to previous studies showing that incorporating ecosystem services into IA can improve practice.

1. Introduction

Assessing the environmental and social impacts of large projects remains a challenge after more than four decades of practice (Morgan, 2012). Innovation in this field can be of two kinds: conceptual (such as the integrated assessment of biophysical and social impacts) and technical (such as advances in computational modeling). One recent conceptual innovation is the assessment of impacts on ecosystem services (ES). Although the notion of ES can be traced back to the 1990s (de Groot, 1992; Costanza et al., 1997) it became more widespread after the release of the Millennium Ecosystem Assessment (MEA) report (Hassan et al., 2005).

The literature suggests that incorporating ES in the assessment of environmental and social impacts of projects (in this paper, referred to as the ecosystem services approach – ESA) can lead to several improvements as compared to current practice, including: (1) making scoping more effective, by prioritizing ES (Baker et al., 2013); (2) facilitating an integrated approach to collect baseline information inclusive of local knowledge (Baker et al., 2013); (3) identifying and understanding cumulative impacts (Baker et al., 2013; Landsberg et al., 2013; Slootweg and Mollinga, 2010); (4) providing a more detailed identification (Honrado et al., 2013; Rosa and Sánchez, 2015) and a more complete analysis of social impacts (Slootweg et al., 2003), due to its ability to demonstrate the social consequences of biophysical changes (Landsberg et al., 2013); (5) translating biophysical effects into impacts on human well-being (Slootweg and Mollinga, 2010), thus facilitating communication with stakeholders and decision-makers (Fisher et al., 2009); (6) strengthening determination of impact significance (Baker et al., 2013; Rosa and Sánchez, 2015); (7) bringing a new perspective to the design of mitigation, aiming at enhancing or at least maintaining the well-being of affected beneficiaries (Landsberg et al., 2013) and enlarging the focus of mitigation from avoidance, minimization or offsetting to enhancement, a much needed shift if impact assessment (IA) is intended to be a proactive agent in sustainable development (João et al., 2011).

The ESA is inspired by the so-called ecosystems approach, adopted by the Convention of Biological Diversity (CBD, 2004) and strengthened after the publication of the International Finance Corporation's Performance Standards (PS) on Environmental and Social Sustainability (IFC, 2012a). PS 6 (Biodiversity Conservation and Sustainable Management of Living Natural Resources) requires

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that "where a project is likely to adversely impact ecosystem services, as determined by the risks and impacts identification process, the client will conduct a systematic review to identify priority ecosystem services".

Pathways to incorporate ES into IA have been proposed since the CBD approved its "Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment" in two Conferences of the Parties - The Hague and Curitiba (CBD, 2006). Hanson et al. (2008) presented a methodology to review ES under a perspective of business risk and opportunities, for companies to develop strategies to manage their dependence and impacts on ecosystems. Rounsevell et al. (2010) and Slootweg and Mollinga (2010) proposed approaches aiming at integrating social and biophysical assessments, while Landsberg et al. (2011, 2013) and IFC (2012b) published specific guidance about how to assess impacts on ES.

In principle, "considering" ES in IA can be done under at least two different perspectives. Firstly, ES can be considered as another issue or topic to be dealt with in the assessment of a project, like noise or air quality. Hence, ES could be handled by specialist studies and added to other specialist studies. Arguably, such an approach deserves criticism for not promoting integration, thus not fulfilling the potential of the concept, as observed by Rosa and Sánchez (2015) in recent impact assessments prepared to meet the IFC requirements. An alternative is to embed ES into the sequential tasks of planning and carrying on an assessment as to produce an integrated analysis of social and environmental impacts. In this second perspective, the concept is part of each major step of the IA process, from scoping to mitigation and follow-up (Landsberg et al., 2013; Slootweg and Mollinga, 2010).

However, evidence of its actual benefits is so far limited and this paper investigates how the concept could advance the practice of IA. The research started by describing the key tasks and information needs to apply the ESA (section 2). The approach was applied to a large mining project (previously submitted to a legally required environmental impact assessment), briefly described in section 3. The results, featured in section 4, were compared with current practice, allowing for the identification of the advances and practical challenges of adopting the ESA (section 5). A discussion on how to overcome these challenges in order to take advantage of this conceptual innovation follows and leads to the conclusions (section 6).

2. Methods: incorporating ecosystem services into IA

The research steps, depicted in Fig. 1, are built on the grounds laid by IFC (2012b), Landsberg et al. (2013) and Slootweg and Mollinga (2010). The list of ES from Landsberg et al. (2013) was adopted, with the exception of the supporting services which, being related to the integrity of ecosystems (Burkhard et al., 2012), are indirectly included when other categories are analyzed (Fisher et al., 2009).

Data was collected through document review using the Environmental Impact Study (EIS) of the project as the key source of information (Table S1 shows a synopsis of the baseline content), in addition to its supplements and the review report prepared by the responsible environmental agency. Additional data was collected in the field through rapid appraisal techniques (USAID, 2010), using questionnaires, interviews and direct observation (Meyer, 2011).

Step 1: Identifying affected ecosystems. A land cover map (1:70,000) alongside a land use description, both from the EIS, were the main sources to identify the affected ecosystems, an approach also utilized in similar applications (Geneletti, 2003; Cooper, 2010). Treweek (1999), nevertheless, warns about the importance of using appropriate scales (e.g. 1:20,000–1:50,000) for this identification.

Step 2: Identifying potentially impacted ecosystem services and their beneficiaries. Based on the drivers of change, adopted by the MEA, the relationships between project activities and the provisioning of ES were analyzed to identify all services that the project could affect (Table 1). A census-based survey of local residents (Diversus, 2011) and direct observation were the primary source of information to identify the beneficiaries. Having found that the affected communities feature similar livelihoods and can be considered homogeneous for the purpose of this research, the saturation concept (Guest et al., 2006) was used to determine the number of questionnaires and interviews (applied in February 2013 and 2014) to be conducted in order to characterize the affected communities of beneficiaries.

Step 3: Prioritizing ecosystem services. Priority ES are: "(i) those services on which project operations are most likely to have an impact and, therefore, which result in adverse impacts to affected communities (…)." (IFC, 2012a). The prioritization process followed the decision tree (Fig. 2). Steps 1 and 2 provided information to answer to the first and second questions of this tree. Information to answer to the latter was acquired by interviewing local population and asking: (a) Are there other ecosystems at a viable distance, which could provide the same services? (b) Are beneficiaries able to access these ecosystems?

The summarization of priority ES and their beneficiaries results in the delimitation of a study area for conducting baseline studies, aiming at measuring, as far as practical, the supply of priority services. This task, however, was not performed in this research, which relied upon information provided in the EIS (Table S1) as a means of exploring how the ES concept could improve current IA practice.

Step 4: Assessing impacts on ecosystem services. The significance of impacts was assessed using a combination of criteria recommended by Landsberg et al. (2013), criteria generally recommended for good practice in IA (Briggs and Hudson, 2013; Lawrence, 2007) and criteria used by recent projects whose impacts on ES were assessed (Rosa and Sánchez, 2015). Significance was assessed by a combination of vulnerability of beneficiaries and magnitude of impacts (Fig. 3).

The vulnerability of beneficiaries was assessed in turn as a combination of:

1. Intensity of service use (daily, weekly or less);
2. Level of dependence on the service (high, moderate or low);
3. Relative importance of the service to affected beneficiaries (high, medium or low).

The magnitude of impacts was qualitatively established by:

1. Intensity;
2. Duration (permanent or temporary);
3. Reversibility (irreversible or reversible).

Step 5: Analyzing mitigation for impacts on ecosystem services. In order to verify to what extent mitigation usually proposed in the IA would also encompass mitigation of impacts on ES and their beneficiaries, measures described in the EIS were analyzed under two perspectives. Firstly, presence or absence of mitigation related to equivalent impacts identified both in the EIS and under the ESA. Secondly, a critical review of mitigation as described in the EIS in order to judge whether it is comprehensive enough to mitigate impacts on ES.

3. The project and its environmental assessment

The project is an iron ore mine in Minas Gerais State, part of an undertaking of US$ 8.8 billion aimed at extracting and concentrating ore and transporting it through the biggest slurry pipeline in