Emerging ecosystem services into cumulative impact assessment scoping

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Cumulative impact assessment (CIA) is one of the most complex impact assessment (IA) processes to undertake, requiring methodological innovations to move beyond weak understanding and limited practice. Integrating the Ecosystem Services (ES) approach into IA processes has often been suggested and, in terms of CIA, may have the potential to improve practice. We explore how an ES approach might be used to improve CIA scoping to focus on delivering environmental outcomes that matter to affected populations. Since 2003, Brazil has applied a type of CIA named the Integrated Environmental Assessment (IEA) to evaluate the cumulative impacts of proposed hydropower projects in watersheds before the environmental impact assessment for each project takes place. Using one example of IEA undertaken in the Brazilian Amazon for hydropower planning, we adapted a procedure previously tested in other IA contexts based on documentary and primary data analysis (interviews and surveys with local and affected populations). The results suggest that integrating an ES approach to CIA scoping can deliver CIA more focused on the values of affected populations. Applying the ES approach into the first steps of CIA scoping can present some benefits and limitations compared with a generic CIA process.

1. Introduction

Cumulative impact assessment (CIA) is defined CIA as "*a systematic procedure for identifying and evaluating the significance of effects from multiple sources/activities and for providing an estimate on the overall expected impact to inform management measures*" Judd et al. (2015, p. 254).

CIA focuses on the effects of multiple environmental stressors on particular components (Duinker et al., 2013) that simultaneously impacting geographical locations it creates an additional challenge of establishing scale and temporal boundaries (Therivel and Ross, 2007). This led Canadian researchers to focus on the role of Valued Environmental Components (VECs), generally described as components of the physical, biological or socio-economic environment, as the focus of CIA (Duinker et al., 2013). "*Valued ecosystem component (VEC) selection is a core component of cumulative effects assessment (CEA) and gives direction to impact analysis, mitigation and monitoring. Yet little is known about CEA VEC selection practices*" (Olagunju and Gunn, 2015, p.207). The process of scoping VECs is highly subjective and lacking in scientific inputs and knowledge concerning how to include cumulative effects (Olagunju and Gunn, 2013; Roudgarmi, 2018) and an absence of VEC selection guidance hampers the full potential of the CIA process (Olagunju and Gunn, 2015).

Baker et al. (2013) suggested the Ecosystem services (ES) approach as another means of overcoming the time and space issues of cumulative effects in IA because the bundled nature of ES allows their consideration to cross environmental stressors and to represent a more holistic framing of effects, helping to focus the assessment.

We hypothesize that using an ES approach can improve its efficiency by bundling environmental stressors which reduces the number of causal predictions that need to be made. Thus, this work aims to explore whether integrating ES and CIA approaches represents a better way of performing the scoping stage of CIA. In order to achieve this aim, an existing CIA case study is identified as this then forms the benchmark (and evidence) against which a combined ES and CIA scoping approach can be evaluated.

2. Methods

2.1. Developing an integrated ES and CIA scoping framework

The integration approach adopted in this research was based on the Ecosystem Services Review (ESR) for IA framework, comprising sequential steps, proposed and tested by Landsberg et al. (2011 and 2013) as this framework has been successfully used by other researchers to integrate ES into other IA instruments (e.g., EIA – Rosa and Sánchez, 2016 and SEA – Partidário and Gomes, 2013). The EC processes combine into the six steps presented in Figure 1 which also presents the main important steps for undertaking scoping in CIA.

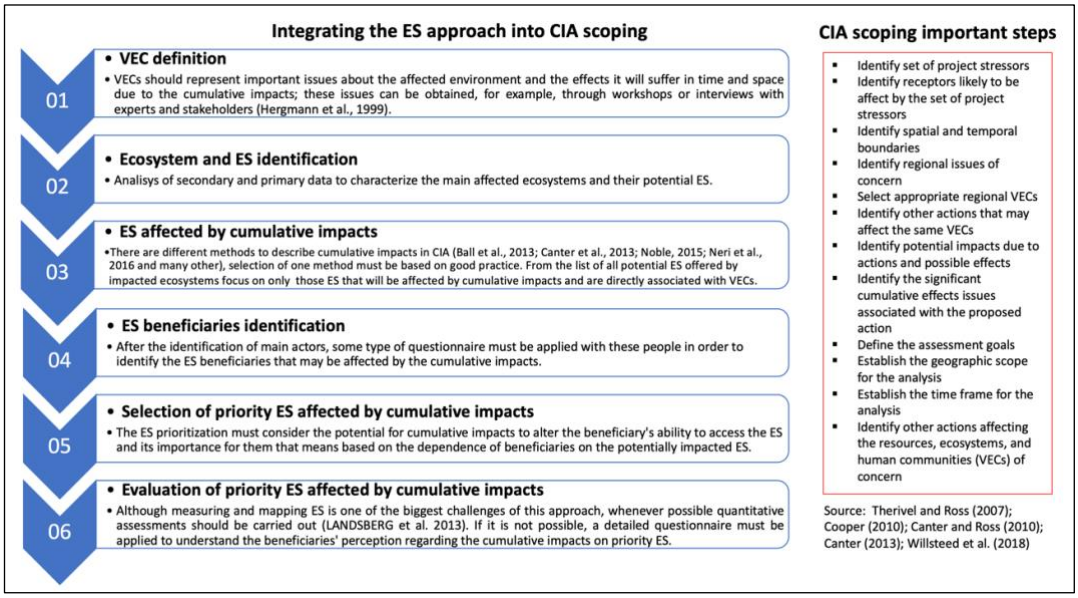

Figure 1 – Integrated VEC and ES Framework for conducting CIA.

2.2. Testing the ES framework for CIA scoping

An assessment tool named the Integrated Environmental Assessment (IEA) is applied in the Brazilian hydropower planning before the environmental impact assessment (EIA) for each hydroelectric plant. An IEA is a type of CIA focussed on the socioenvironmental implications of a set of hydropower plants on river basins (Westin et al., 2014). From 2007 to 2014, 15 IEAs were prepared for Brazilian watersheds, with nine being prepared for Amazonian river-basins, we chose the Teles Pires watershed IEA for developing this work. The Teles Pires watershed covers an area of 141,279 km², encompassing 35 municipalities in the states of Mato Grosso and Pará (EPE, 2009), in the Amazon and Cerrado biomes. According to the IEA of the Teles Pires watershed (EPE, 2009), the energy potential was 3,697 MW (EPE, 2009), distributed across six large hydropower plants (HPP) and seven small hydropower (SHP) plants.

To test the ES framework, we combine documentary (EPE, 2009) and primary data. The focus of the analysis is mainly to reveal whether and how potential gains attributed to the use of the ES approach in IA can also be achieved for the CIA scoping stage. The primary data collection (interviews and surveys) was then aimed at gathering essential data on ES approach that was not included in the IEA, following the established framework. Figure 2 presents the approach considering its application to the IEA Teles Pires case study.

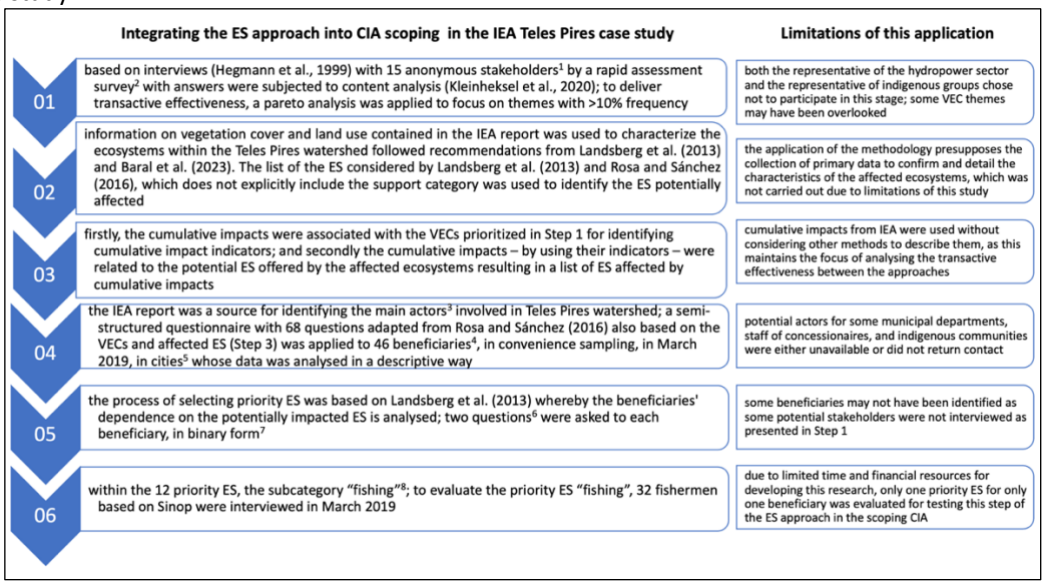

Figure 2 – Application of the ES framework to the IEA Teles Pires case study and the limitations in each step.

3. Results

Figure 3 presents the main results of the six steps of the framework for integrating ES into CIA scoping outlined in Figure 2 in the context of the Teles Pires watershed.

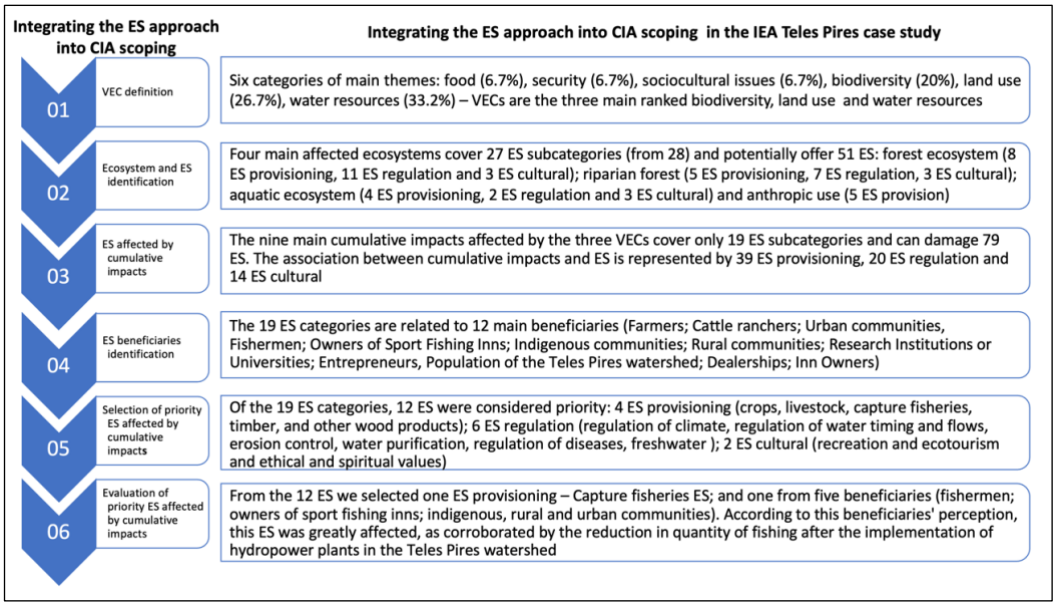

Figure 3 – Results from the application of the ES framework to the IEA Teles Pires watershed case study.

From Figure 3, considering the Brazilian case study application, the themes that represented the three main VECs were evaluated for the four different ecosystems that are in the planning area of influence. In this way, the identified ES (27 ES) represent a wide range of interactions between the affected environment and the proposed actions. In the subsequent stage, the ES are narrowed down to only those that will be affected by the cumulative impacts, ensuring focus and rigor in the CIA scope.

So, of the 19 ES affected by relevant cumulative impacts in the Teles Pires watershed, 12 ES were considered priority, that is, crucial for the subsistence, health, safety, or culture of some or all the beneficiaries. Provisioning services are the ES most affected by cumulative impacts in the Teles Pires watershed. These ES are crucial to different types of Amazonian communities due to the lack of infrastructure, basic sanitation, and employment opportunities as revealed by the affected beneficiaries. One or more groups of the 12 identified beneficiaries may be harmed by the reduction of supply in one or more of the 12 identified ES. According to the perception of one group of potential beneficiaries (fishermen), one of the main ES, the “capture fisheries”, was greatly affected, as corroborated by the reduction in quantity of fishing after the implementation of hydropower plants in the Teles Pires watershed. These results align with those observed by Lees et al. (2016) who highlight that hydropower plants can alter connectivity, cause fragmentation, and interfere with the reproduction, size, and variety of fish populations, causing loss of species along with the ES they provide. These findings reinforce that the ES approach is accurately identifying the most critical ES that can be affected through cumulative impacts and give guidance for better identifying spatial and temporal boundaries. The ES do not have replacement alternatives, according to the perception of the beneficiaries of these services. The priority ES which will be affected by cumulative impacts stand out.

This ES approach for CIA scoping details both the ES that will be most affected by the cumulative impacts and provides evidence to identify beneficiaries that will be most harmed by the cumulative impacts. These results show that adding ES to the scoping CIA allows it to focus on the local effects of cumulative impacts. This allows a better understanding of the effects of cumulative impacts not only for the most affected ES, but also on the groups that rely most on these ES. After applying the ES framework to the IEA Teles Pires watershed case study presented in Figure 3, Figure 4 shows how these results converge with the main steps of CIA scoping discussed in the literature.

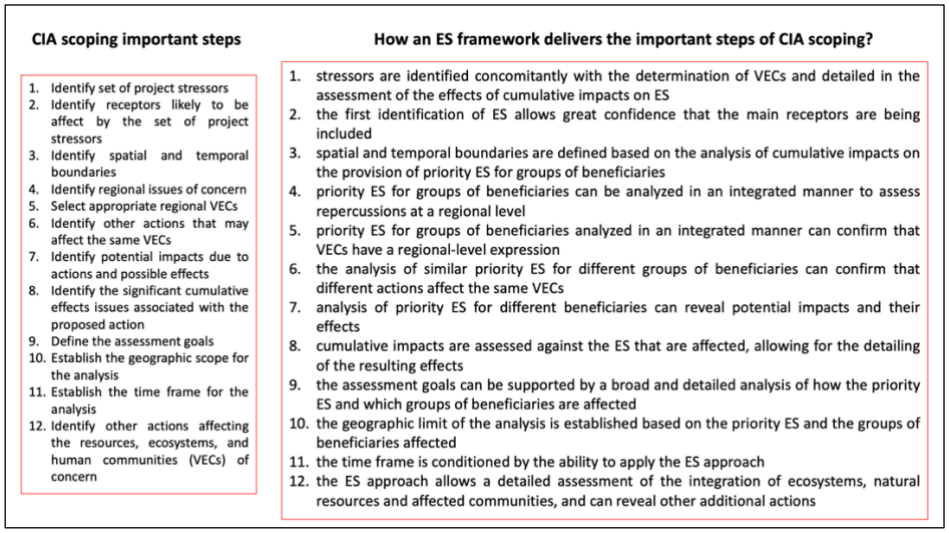

Figure 4 – CIA scoping important steps applied to the IEA Teles Pires watershed case study.

Figure 4 reveals that the ES approach achieves all the steps of CIA scoping and confirms how they can be achieved. The integrated approach organizes successive and combined procedural stages in which the ES, and their associated aspects, are at the centre of the assessment. This analysis embedded in the ES approach identifies the beneficiaries accurately. The focus of the analysis is achieved in its final stage in which the assessment is centred on the priority ES, thus validating the VECs within the scope of CIA scoping. The ES approach allows for the addition of local values and specific aspects of the environment, more targeted public participation with the inclusion of more vulnerable groups, among other potential issues to make the CIA scoping stage more efficient.

4. Discussion

The discussion of the results presents how the ES approach can be more efficient compared to usual models of carrying out CIA scoping framed by transactive effectiveness. Based on the analysis of the case study, Figure 5 presents some potential benefits and limitations of taking an ES approach to CIA scoping.

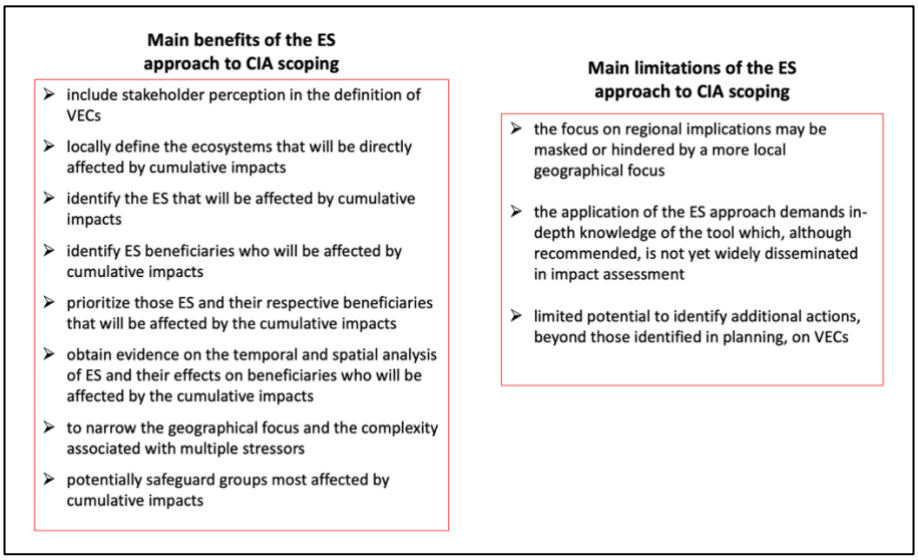

Figure 5 – Main benefits and limitations of taking the ES approach to CIA scoping.

5. Conclusions

The test of the ES approach by using the Integrated Environmental Assessment (IEA) – a typology of cumulative impacts assessment for planning the Brazilian hydropower sector – highlighted opportunities for improving the focus of CIA scoping beyond the tested context. The restriction to VECs

and specific ESs supporting local beneficiaries help to focus the CIA scoping such that it becomes a less daunting undertaking for agencies and/or developers tasked with them.

All important steps to build the CIA scope are achieved using the ES approach. From the potential benefits derived from the ES approach, the advantages of its adoption lie in an integrated view of the environment and associated communities in the face of the effects of cumulative impacts.

The ES approach allows the vision of interested parties, especially the most vulnerable and ES-dependent communities, to be better considered in planning. Thus, affected ecosystems and their ES can be considered in an integrated way in planning to better highlight how cumulative impacts will temporally and spatially affect environmental resources in the area affected by multiple projects.

The ES approach makes it possible to add more tangibility to the characteristics of cumulative impacts at the scoping stage, which can further facilitate their management over time and provide feedback to processes that must consider this type of impact for decision-making.

The approach taken in this paper was facilitated by the existence of IEA reports which have already undertaken a form of CIA. The next step in the development of an efficient and useful CIA approach is to test this approach in other contexts, so that more generic guidance can be developed that also includes the initial identification of cumulative effects.

Acknowledgements

The authors gratefully acknowledge FAPESP (the State of São Paulo Research Foundation) – grant #2023/14497-6, São Paulo Research Foundation (FAPESP) and CNPq grant #306419/2023-8 for their support to this research.

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