Innovative Approaches to Quantify and Rank Impacts for EIA Scoping

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Abstract

The criteria and indicators used to determine the significance of environmental impacts in environmental and social impact assessments (ESIAs) vary by country and region. In most cases, the procedures for identification and analysis of impacts are based on professional judgments of government officers or consultants and generally use subjective qualitative criteria. This paper explores economic valuation methodologies to quantify and rank the impacts of environmental assessments using common and well-established metrics to determine the significance of environmental impacts of investment projects in low and middle-income countries. Methodologies to quantify and rank environmental impacts using welfare economic valuation have been used in various low- and middle-income countries (LMICs), where it has helped to identify priority environmental health problems and inform interventions that can be implemented to address them. Economic valuation techniques can provide actionable tools in promoting a Just Transformation, help making the world free of poverty on a livable planet.

1. Introduction

The world urgently needs to address the triple environmental crises of climate change, biodiversity loss, and pollution and to do so in a socially acceptable and equitable manner (UNEP, 2021). Environmental and Social Impact Assessment (ESIA)[1] is an indispensable tool to address these crises as it enables decision-makers and other relevant stakeholders to assess the potential environmental and socioeconomic- risks and impacts of investment projects and open governmental decision-making to public scrutiny (Abracosa et al., 1987; Ortolano et al., 1987). Additionally, ESIA can potentially contribute to a Just Transition[2] by identifying environmental priority challenges, providing a vehicle for stakeholder engagement, and designing interventions to improve environmental sustainability, economic welfare, enhance social inclusion, and foster green jobs.

This paper describes the methodologies used for scoping impacts in ESIAs, determining the significance of environmental impacts, and ranking those impacts. It also discusses how economic valuation provides an actionable tool and evidence of its use in promoting a Just Transformation.

2. Rationale for Enhancing EIA Scoping in LMICs.

In 1970, the United States (US) enacted the National Environmental Policy Act (NEPA). It requires federal agencies to integrate environmental considerations into their planning and decision-making processes and to engage in comprehensive environmental reviews for proposed projects[3]. Many low and middle-income countries (LMICs) have adopted requirements for environmental assessments of public and private investment projects. However, in LMICs, ESIAs have been used primarily to identify the best available measures to avoid, minimize, mitigate, and compensate for environmental and social impacts of investment projects.

[1] Also referred to as environmental impact assessment (EIA), environmental and social impact assessment (ESIA) is the preferred term as it stresses the explicit examination of social issues.

[2] https://climatepromise.undp.org/news-and-stories/what-just-transition-and-why-it-important

[3] https://www.epa.gov/nepa/national-environmental-policy-act-review-process

A key criterion for EIA effectiveness and efficiency is to ensure that the assessments focus on significant impacts. To meet this criterion, most countries have adopted two important steps in their EIA process. The first step, screening, refers to the process "to determine whether or not a proposal should be subject to EIA and, if so, at what level of detail" (IAIA 1999). One of the screening procedures used around the world is a typology list that defines the types of projects that require an EIA. The lists are often too rigid, which limits their ability to filter out the actions that would not generate significant environmental effects, and thus, a wide range of actions must complete the analysis. Otherwise, the lists are too prescriptive, and thus, many investments that could generate significant effects get filtered out as they don't meet the criteria stated in the typologies.

Scoping, the second step, is the process of identifying the environmental and social issues that are likely to be significant and relevant to address in the EIA and eliminating the issues that are of little concern (Rathi, 2021). The scoping phase aims to distinguish the impacts of a specific action likely to be significant from those that are not. Glasson et al. (1999) define scoping as "determining, from all a project's possible impacts and from all the alternatives that could be addressed, those that are key, significant ones," which should be subject to further assessment.

3. Methodologies for Scoping and Assessing Environmental Impacts

Screening and scoping of EIA varies by country. In many cases, the EIA scoping is based on generic terms of reference or terms of reference prepared by governmental officers that could include nonsignificant impacts or filter out the most significant environmental and social impacts of investment projects. Several scoping methods have been developed since the 1970s, including the following.

The **Checklist Technique** includes lists that usually cover all possible significant impacts of investment projects. The checklists usually take the form of questionnaires to elicit the necessary information about investment projects. Some checklists include a list of environmental and social impacts per type of project.

The **Matrix Technique** includes checklists and summaries of impacts assessed. The matrices link a particular environmental aspect to a specific action of the development project and, in a way, explain the nature of the impact. The Leopold Matrix (Leopold et al., 1971) consists of a matrix that weights each particular environmental and social aspect to the specific actions or activities of the development project and explains the nature of the resulting impact. The procedure is centered around a large matrix containing 8800 cells; the horizontal axis has 100 columns for development characteristics representing activities that might cause positive or negative environmental impacts.

The **Network Technique** includes determining interrelationships among the different aspects of the affected environment and identifying the flow of energy or impact throughout the environment resulting from investment projects. There are different types of networks, such as sequence diagrams, directed diagrams, or impact trees. The networks can be used to show both temporal and spatial flows of impacts.

In Overlay Techniques, now supported with the Geographic Information System (GIS) software, individual impacts, such as the effects on soil, water, settlements, and noise, are individually summarized and clearly highlighted by mapping over the area using choropleths (shaded zones) to indicate the relative intensity of the impact. By this technique, the individual maps are transferred onto transparencies, which are then

laid over one another to produce a composite effect. Thus, the individual effects are summed up to show the total impact of the project.

Qualitative environmental and social impact assessment methods based on professional judgment valuation. These methodologies focus on the evaluation of the impacts by assigning importance values (based on professional judgment) to the environmental and social parameters and quality scores. Robu (2003) defines the importance units for the selected environmental components to be considered with values changing between 0 and 1 according to the number of environmental impact parameters in the category of the selected environmental component (Robu, 2003; Robu et al., 2007).

Usati et al. (2013) introduce the method where environmental quality categories are assigned to each environmental quality class with the definition of the actual state of the environmental component/element. Following the determination of the quality classes for each parameter of the environmental component/element, the environmental element quality scores are determined as the summation of the quality scores. The scores are based on professional judgment estimates of environmental status from 1 to 6. Status 1 is given when an activity or project is not influencing the environment, while status 6 corresponds to an environment degraded and not suitable for preserving flora and fauna (Usati et al. ,2014).

Ortiz et al. (2018) use a multi-criteria decision analytic (MCDA) approach for environmental impact assessment, which relies on impact prioritization (with input from stakeholders' views) divided into four main phases: (1) creating the stakeholders' platform; (2) making a preliminary identification and assessment of impacts; (3) categorizing impacts; and (4) assessing and prioritizing negative impacts using MCDA. Ramos-Quintana et al. (2018) tailored the Driving Force, Pressure, State, Impact, and Response method (DPSIR) to construct a causal pathway of environmental impacts and responses.

The criteria and indicators used to determine the significance of environmental impacts in ESIAs at the screening and scoping stages vary by country and region. Assessing the significance of environmental impacts in ESIAs in low and middle-income countries can be challenging due to various factors, including limited regulations that define maximum thresholds for acceptable changes (resettlement, biodiversity loss, dam safety, accidents, and others) and availability and quality of baseline data. **Economic analysis of environmental impacts**

Economic analysis translates the multiple effects of a project into monetary values, which allows for the comparison of disparate impacts using a common, well-established metric. Through different methodologies, economic analysis can quantify the environmental impacts of investment projects, including human health (mortality and morbidity), ecological improvements (market products, recreation activities, and aesthetics), or reduced material damages (EPA 2016).

Monetization enables the comparison of economic values in a common unit, facilitating the identification of significant impacts in ESIA scoping. At the core of economic valuation lies the concept of welfare economic valuation, which involves assigning monetary values to the impacts on human well-being and overall societal welfare caused by environmental changes. This approach allows for a more nuanced and quantitative assessment of damage associated with environmental impacts of projects.

Several methods for economic valuation are based on people's_behavior. Below, we describe some of these methods.

- Hedonic Pricing examines the impact of environmental quality on market prices, particularly in the real estate and labor markets. By analyzing property values in relation to environmental characteristics (e.g., air quality, water quality, natural amenities, or land contamination) or the differences in wages of people exposed to different environmental and occupational risks, the implicit prices people are willing to pay for specific environmental amenities or the compensation value for increased environmental health risks in the workplace can be estimated.

- Averting and mitigating behavior is based on the premise that people acknowledge the existence of a risk and take measures to mitigate it. This approach infers the value of environmental quality from an individual willingness to pay for avoiding, preventing, or mitigating the effects of negative environmental changes.

- The travel cost method is mainly applied to ecosystem services contributing to recreational activities and assumes that the valuation of an ecosystem service site is directly linked to the price an individual is willing to pay to visit a recreational site. This method is different from the contingent valuation described below, as people's behavior is observed in real markets rather than hypothetical situations. Stated-preference techniques, including contingent valuation and choice modeling, involve estimating the willingness to pay individuals for a specific environmental improvement.

- Contingent Valuation Method involves asking hypothetical questions about environmental outcomes and the highest amounts individuals would be willing to pay to reveal the monetary value placed on environmental quality.

- Choice modeling requires respondents to choose and rank their preferred options from a set of alternatives made up of a combination of attributes that describe an environmental outcome. Implicit prices are estimated for each attribute, reflecting the people's willingness to pay for them (Baker & Ruting, 2014).

Other techniques include:

- Damage Cost Avoided methodologies estimate the economic value of preventing or mitigating environmental damages. They estimate the costs that would be incurred if the environmental damage were not addressed.

- Restoration cost estimates the cost of restoring the environment to its original state after it has been damaged. While like the Damage Cost Avoided approach, this method focuses on the expenses involved in restoration efforts rather than costs to avoid environmental damage.

- Benefit Transfer involves applying economic values derived from existing studies to similar environmental impacts in different contexts and geographical areas. It allows for the estimation of values when original primary data is not available.

Using estimates of the value of statistical life, economic valuation has led to estimates of the global cost of health damages associated with air pollution of about $8.1 trillion every year, which is equivalent to 6.1 percent of global GDP. Economic valuation of lead exposure impacts and cadmium exposure on human health resulted in estimates that amount to $10.35 trillion every year and from $2.8 to $5 trillion per year respectively. These estimates underscore the potential to use economic valuation to quantify and rank the environmental impacts of activities.

4. Conclusions

In many LMICs, the identification of significant impacts in EIA scoping currently relies on the professional judgment of those preparing and approving the ESIAs. Economic valuation of impacts makes it possible to quantify and rank the environmental impacts of investment projects. By assigning monetary values to environmental impacts, economic analysis can complement other methodologies and approaches used to assess the significance of a project's impacts. The quantification of environmental impacts is an evolving process that may require iterative adjustments based on new data, feedback, and changing project conditions.

Economic analysis has several advantages, including an extensive body of theoretical and empirical advice to support it and its potential to provide economic valuation associated with goods and services that are traded in the market (e.g., extraction of natural resources or paid recreational services), as well as non-market goods and services (e.g., health and ecosystem services). Economic analysis can further provide insights into distributional impacts among different stakeholders, including the poor and vulnerable groups. Further, expressing environmental impacts in monetary terms can lead to more effective communication among stakeholders as impacts may become easier to understand, particularly for those affected communities. This information can help understand the potential effects of a proposed project and its contribution to a Just Transition and a livable planet.

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