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Biodiversity offsets in limestone quarries: Investigation of practices in Brazil

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ABSTRACT

In response to the increasing loss of biodiversity, several countries have adopted offsetting policies that seek to balance habitat destruction by restoring, enhancing and/or protecting equivalent values offsite. Such mechanisms are increasingly important in quarrying, where habitat loss may be unavoidable due to colocation of mineral resources and areas of biodiversity importance. Seeking to contribute to advance understanding of the current gaps and challenges, biodiversity offsetting required for environmental approval of three limestone quarries in compliance with Brazil's *Atlantic Forest Act*, a federal law that aims at protecting this biodiversity hotspot, were investigated. Both protection and restoration offsets were applied at area ratios from 1:1.1 to 1:5. Offset implementation costs ranged from ~3 to ~8% of quarry investment. The main difficulties reported by practitioners are finding suitable areas, lack of methods to calculate residual losses and uncertainties about the success of restoration. Internationally recommended best practices are partially followed with the highest adherence observed for the quarry whose environmental impact study was more detailed and provided a stronger basis for designing the offset. Results suggest that the quality of offset planning and implementation is directly related to the quality of the environmental impact assessment.

1. Introduction

The expansion of mining and quarrying to meet growing societal demands for minerals has the potential to directly and indirectly affect biodiversity. Direct impacts result arises from vegetation clear cut and earth and rock excavation, resulting in habitat loss and fragmentation. On the other hand, by providing infrastructure and access, as well as boosting economic and population growth, mining and quarrying can induce land-use changes in their areas of influence (Sonter et al., 2014), which, in turn, may result in more biodiversity loss.

Differently from other economic activities, notably industry, mining and quarrying feature locational constraints that often make biodiversity loss unavoidable if projects are to proceed. In addition, local communities benefiting from the services provided by biodiversity and ecosystems may also be adversely affected (Rosa and Sánchez, 2016), thereby exposing mining and quarrying projects to the attention of the general public (Careddu and Siotto, 2011).

Hence, mining and quarrying provide an appropriate setting for testing biodiversity-offsetting approaches. Evidence so far (Ekstrom et al., 2015; Rainey et al., 2015) suggests that despite the fact that conceptualization of offsets is arguably being strengthened and becoming more robust (Brownlie et al., 2013), and practical guidance is being developed (Ledec and Johnson, 2016), there are many practical challenges, a better understanding of which could shed more light on the theoretical debates about biodiversity offsets.

A growing number of countries have adopted offset policies that seek to balance the suppression of habitat by restoring, improving and / or protecting biodiversity values in response to the increasing loss of native vegetation and biodiversity (Brownlie and Treweek, 2016; Gordon et al., 2011; Morandeau and Vilaysack, 2012). Moreover, financial institutions have also been paying attention to the impacts and risks to biodiversity arising from the projects they finance, with the International Finance Corporation's Performance Standard 6 as a key reference (IFC, 2012).

Businesses, in turn, have also taken initiatives to mainstream biodiversity (and ecosystem services) in project decision-making and in operations management. The best known such initiative is the Business and Biodiversity Offset Program - BBOP, launched in 2004 by a group of large companies and international non-governmental organizations.

Biodiversity offset is defined as “measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken. The goal of offset is to achieve No Net Loss (NNL) or net gain (NG) of biodiversity after appropriate prevention and mitigation measures have been taken” (BBOP, 2012a, p. 13).

The basic approach to the concept of offset is to quantify the residual losses of biodiversity remaining after the implementation of

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measures to avoid and to reduce impacts (according to mitigation hierarchy) and then to assess the benefits to biodiversity resulting from offset activities (Doswald et al., 2012; IFC, 2012; ICMM and IUCN, 2012).

BBOP agreed on a number of principles of offsetting best practices. Under the "right" circumstances, the application of these principles is said to improve conservation outcomes from large-scale development projects and provide "much-needed funding for protected areas and similar conservation efforts" (Ledec and Johnson, 2016).

Despite the fact that offsetting is becoming a consolidated instrument in the environmental assessment process in several countries and in project financing, and evidence that the introduction of offsets has prevented biodiversity loss has been obtained (Gibbons, 2010), there are questions about the effectiveness and the capacity of offsets to actually counterbalance losses (ten Kate et al., 2004; Gordon et al., 2011). Such concerns include:

(i) The hypotheses, approaches, and methods of calculating biodiversity offsets are controversial. There is no single metric that objectively captures the full extent of biodiversity, which itself has no universal, unambiguous definition (Bull et al., 2013; Gelcich et al., 2017).
(ii) Barriers to the effective application of existing approaches, including problems of governance and lack of methods to assess the ecological equivalence between biodiversity losses and gains (Quétier and Lavorel, 2011).
(iii) Actual loss is accepted in the present in return for uncertain future gains. Uncertainty of future biodiversity outcomes arise from many factors that may affect the success of both ecological restoration and ecosystem protection (Folke et al., 2004). The assumption that restoration will achieve ecological equivalence is often not supported by evidence (Maron et al., 2012; Gordon et al., 2015).
(iv) Offset policies can favor, and facilitate, the loss of biodiversity (Walker et al., 2009; Bekessy et al., 2010), paving the way for a "license to trash" nature and legitimizing activities that would otherwise not to be approved (Hayes and Morrison-Saunders, 2007; Salzman and Ruhl, 2000).

Seeking to contribute to advance understanding of the current practice of biodiversity offsetting, this study investigated recent actions adopted for obtaining government approval of limestone quarries in compliance with Brazil's *Atlantic Forest Act* (2006), a federal law that aims at protecting this high biodiversity value biome, considered as a biodiversity hotspot (Myers et al., 2000). The act establishes that suppression of native vegetation for mining and quarrying can be approved only if no viable alternative exists, as demonstrated by an environmental impact study prepared in accordance with existing requirements (Fonseca et al., 2017). In those cases, an offset is required. The Act, thus, is guided by the mitigation hierarchy principle.

An explanation of methods used in the research is provided in Section 2, along with a short description of three cases which were reviewed in order to gather evidence of current practices. The results are summarized in Section 3 and discussed in Section 4. Conclusions follow in Section 5.

2. Material and methods

The research investigated the offset programs developed in three limestone quarries which expanded or opened for the production of cement, hydrated lime and aggregates for civil construction.

The research question, which guides the research objectives, is featured in Fig. 1, alongside the methods for collecting and analyzing data. The research is structured in four sequential steps, each with specific objectives, which are detailed below.

2.1. Step 1: Compilation of best practices

Environmental best (or good) practices "include, for each sector of activity, a set of procedures recognized by the main companies as economically viable to avoid or reduce the environmental impacts of activities, products and services" (Neri and Sánchez, 2010). To benchmark best practices of biodiversity offsets, our literature review included sources such as international financing agencies, government websites and publications, industry-sponsored or joint government-industry publications, in addition to scholarly papers (Table 2).

2.2. Step 2: Review of legal requirements

According to the *Atlantic Forest Act*, suppression of primary or secondary native vegetation in "intermediate" or "advanced" stages of regeneration in the Atlantic Forest biome can be authorized only if an applicant can demonstrate that no viable alternative exists. In such cases, an authorization will be issued only if an acceptable offset plan is submitted and approved. Regulation of practical modalities of offsets have been issued by both the federal and state governments and it varies across states.

In addition to that Act, other legislation applies. To understand how these requirements are organized, we undertook a general survey of legal and regulatory requirements not restricted to mining or quarrying. For searching legal norms, we used CAL® Software, a proprietary web system that identifies the legislation applicable to a project. Using the Portuguese key word "compensação" (meaning both "offset" and "compensation"), 98 legal rules were identified. Note that legal requirements differ according to jurisdiction and characteristics of each project (Table 3).

These legal norms were grouped in the following categories:

i. Monetary compensation: when a proponent must transfer or invest funds in biodiversity protection to comply with the National System of Protected Areas legislation (hereafter, SNUC, "Sistema Nacional de Unidades de Conservação");
ii. Forest offset: when a proponent has an obligation to protect or restore an area as a condition for authorizing the suppression of native vegetation;
iii. Speleological offset: legal provisions requiring offsetting or compensating for the loss of caves and other features of speleological interest;
iv. Environmental regularization of a property: a particular aspect of Brazilian legislation requiring conservation of a certain percentage of the surface of rural real estate (named "legal reserve"), riparian vegetation, and other "permanent preservation areas"; the formal steps to demonstrate and include such areas in real estate registers are known as "environmental regularization".

2.3. Step 3: Case study analysis

The cases were intentionally selected on the basis of availability of information and willingness of a cement company operating several quarries to provide access to documents and site visits. Preference was given to recent cases for supposedly representing the most recent practices. For selecting the cases, an initial check of document availability was conducted. Key documents include the environmental impact study (EIS) and any other document filed with the application for environmental approval (for the purpose of this research, in particular, forest inventories and the detail of the offset proposal, required after EIS approval). Site visits were conducted by the first author to get acquainted with the areas. Digital shapefiles featuring native vegetation fragments, current and expanded quarry pit and other components of the project's footprint, and offset areas were provided by the company and used to prepare maps using GIS software. Costs of planning, implementing and maintaining offsets were obtained from both public-