Offsetting and compensating biodiversity and ecosystem services losses in mining

Josianne Rosa, Gady Novachi, Luis E. Sánchez
University of São Paulo
lsanchez@usp.br

1. Introduction

Biodiversity offsets (BO) designed for a major mining project in Brazil are reviewed, enquiring as to their potential to achieve no net loss (NNL) of biodiversity and compensating for impacts on ecosystem services (ES). The focus is on in-kind compensation mechanisms, i.e. compensation that follows the concept of strong sustainability (Neumeyer, 2010). This concept does not accept exchange of human-made for natural capital and other forms, such as financial compensation, are not discussed here.

BO aims to reach NNL and preferably a net gain of biodiversity regarding species composition, habitat, structure and ecosystem function (BBOP, 2012; Gordon et al., 2011). An offset can be based either on replacing affected habitats or on restoring disturbed habitats. Therefore, there are two types of biodiversity offsets: protection offsets and restoration offsets (ICMM, 2013). Protection offsets ensures conservation of existing biodiversity values that otherwise could be threatened, but do not add to the stock of existing areas, thus not sufficient to achieve NNL. Conversely, restoration offsets can promote biodiversity gains by restoring an area larger than the disturbed area and by establishing ecological connections, provided the restoration process is effective as evaluated against a non-degraded, reference ecosystem. However, several studies demonstrate a widespread failure to fully restore biodiversity (Bullok et al., 2011; Maron et al., 2012; Mens et al., 2013). Consequently, it seems that the ideal approach would be a combination of restoration and protection offsets.

Planning of BO should be based on four conditions: (i) equivalence, i.e. losses and gains of biodiversity are comparable; (ii) additional gain; (iii) gains are permanent and; (iv) it represents ecological viability, conservation significance and human uses (Virah-Sawmy et al., 2014).

2. Key legal requirements

Several countries now feature BO requirements, often triggered by environmental impact assessment of development projects. Brazilian legislation pertaining to offsets is essentially focused on replacing habitat loss. The most common offset mechanism is the creation of new protected areas (in public or private lands). Initiatives to restore degraded areas and to enrich vegetation diversity are also accepted.

The basic metrics is hectare-habitat. Although limited because it takes little account of the quality of the affected habitat, this approach is simple and is used for mining (Virah-Sawmy et al., 2014). When using habitat-area metrics, the amount of offsetting is defined by applying an area ratio of at least 1:1 or, preferably, higher. In addition, it is required that the conservation status of the newly protected area be similar to the status of the affected area.

Any project interfering in certain types of protected ecosystems or species is required to offset habitat loss. No offset is mandatory for unprotected ecosystems. The legislation is not comprehensive in terms of biodiversity, although it follows some criteria of best international practice (BBOP, 2012), including applying the mitigation hierarchy, quantifying residual impacts (in in terms of vegetation hectares lost), and selecting offset areas featuring ecological equivalence aimed at permanent protection.

The mining project whose offsets are reviewed is subject to offsets required under the Atlantic Rainforest Act, requiring in-kind offset after application of the mitigation hierarchy, and implemented through restoration or protection, including the acquisition of land inside previously designated protected areas. A second type of offset applies when a project interferes in an "area of permanent protection", as defined by the Forest Code, such as river and creek margins, steep hillslopes and hilltops. Offsets for this kind of intervention must be based on restoration of equivalent areas in the same watershed.

3. Offset in a large mining project

The reviewed case is a greenfield iron mining project in Southeastern Brazil. Operations started in late 2014. Government approval required the assessment of environmental impacts and the design of an environmental management plan that included offsetting for habitat loss in accordance with the abovementioned requirements. The project affects a high biodiversity value territory recognized as a Biosphere Reserve in 2005 and featuring sensible ecosystems as Atlantic rainforest and montane savanna (ferruginous rocky outcrops). The latter ecosystem is characterized by endemism - less than 5% of plant species have widespread distribution. This rare ecosystem: covers only few hundred square kilometers in the Southeastern and in the Northern regions (Jacobi and Carmo, 2012). This ecosystem is associated with iron ore deposits, and it is difficult to find available areas to offset mining impacts, particularly if the offset area is to have ecological equivalence.

The offsets analyzed here refer to the current project phase, which includes an open pit, a tailings dam, two waste rock dumps, a water pipeline, and ancillary installations (Figure 1). The project footprint is about 2,000 hectares, out of which 20% represents ferruginous rocky outcrops, and 10% Atlantic rainforest, the remainder comprises anthropic uses. The authorized pit allows for 10 years of mining. Extension for about 20 additional years is currently under consideration. The project affects about 402 hectares of land that triggers a biodiversity offset (Table 1). Required offset areas amount to 642 hectares, which will be converted into protected areas. Required protection offsets represent more than 65% of the total offset area and restoration include converting pasturelands into forests (about 1%) and enriching degraded forest fragments with native tree species. This type aims at increasing species diversity by planting seedlings of key species in remaining forest stands that feature some degree of degradation, typically areas in an intermediate stage of regeneration.

Additional voluntary offset amounts to 1,509 hectares, resulting in a total proportion of ~30-70% protection and restoration offsets respectively (Figure 1).

Choosing the location of offset areas followed two regulatory criteria: (i) similarity of vegetation type, as assessed by the phytophyisiognomy, and (ii) proximity (same watershed). The approach used by the mining company to meet legal offsetting requirements is briefly described and discussed.

The first criterion, dubbed "economic", relates to the cost of land acquisition. Next, three locational criteria based on government guidelines were applied: watershed, zone assessed as a priority for conservation purposes (as defined in other studies) and proximity to the intervention area. Then, the company adopted additional criterion called here “ecological”, resulting from a rapid landscape analysis and aiming at connecting patches of conserved vegetation.

Table 1: Suppression and legally required offset areas for phases I and II of the mining project

Affected ecosystem	Affected area (ha)	Offset area	
		In PPA (ha)	Out of PPA (ha)
Forest offset (Atlantic rainforest)			
Forest	119.22	141.04	97.32
"Candeial"	69.89	10.20	129.57
Rock field	50.97	0.17	101.78
Subtotal		151.41	328.67
Total	240.08	480.08	
Offset to intervene in permanent protection areas (PPA)			
Forest	83.36	37.82	45.44
Anthropic use	79.38	2.76	76.62
Subtotal		40.58	122.13
Total	162.74	162.75	
Total offset area		642.83	

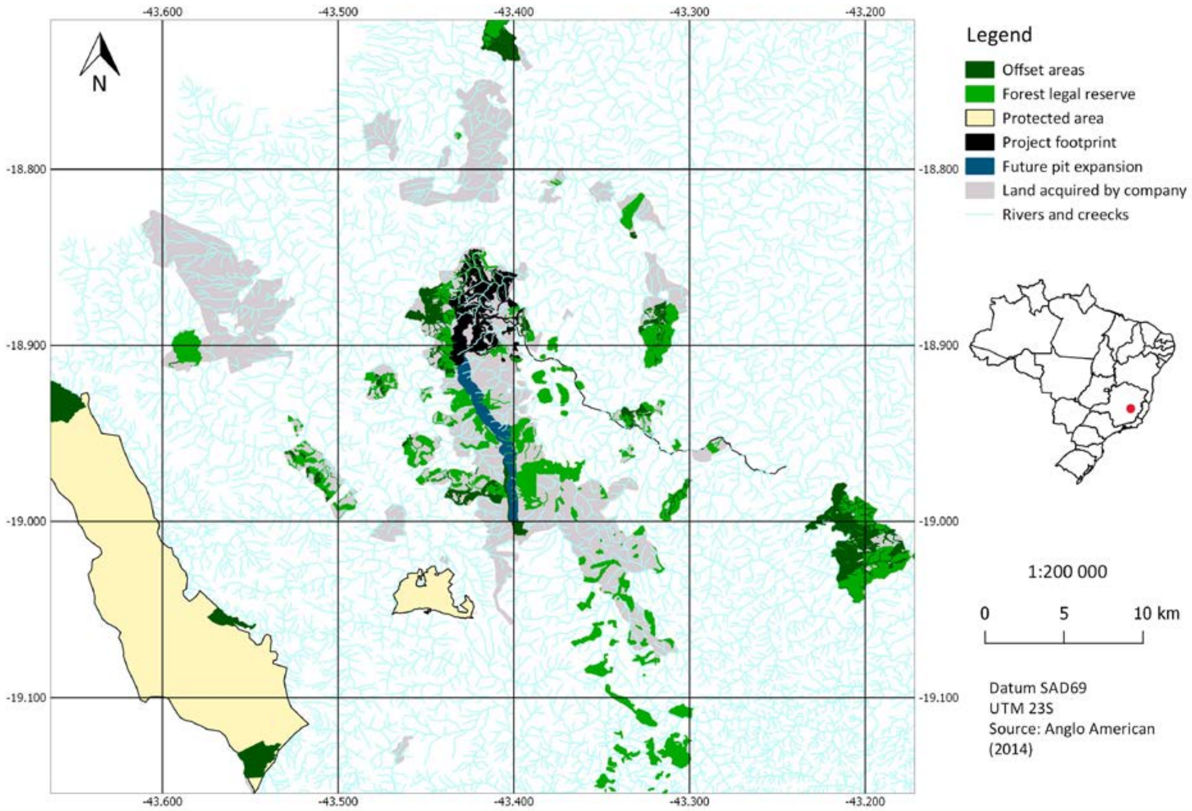

Figure 1: Project location and offset areas

Although offsetting in land owned by the company was the first criterion, acquisition was partly driven by offset planning itself and guided by the abovementioned studies. Additionally, the company acknowledged that informal advice provided by the environmental agency, itself grounded on knowledge of ecological values of the area, influenced land acquisition for offsetting purposes. The environmental agency and the mining company considered several farms featuring vegetation stands of good conservation status, which could be used for offsetting. This strategy aimed at both achieving the best practicable conservation outcomes and avoiding speculation of land prices. Thereafter, the farms acquired were chosen following the criterion of: (1) vegetation type, and (2) location in the same watershed.

Government guidelines, such as the location of priority areas for conservation and proximity to protected areas, were also used as criteria to choose the most appropriate offset areas. However, the small scale of the maps available for this analysis was not adequate as they did not allow differentiation of potential areas under each criterion. As a practical solution, offset areas were chosen from among the stock of land acquired by company which were located closest to permanent protected areas and legal forest reserves.

Interviews were conducted with representatives from the environmental agency and from the mining company to enquire about the main difficulties found when implementing offsets. Results are compared with the literature (Table 2).

Table 2: Main difficulties faced by the company and the environmental agency in comparison with the literature

Major difficulties in offset planning	***Literature (BBOP, 2012)***	***Mining company***	***Environmental agency***
Uncertainties about the success of restoration	√	√	√
Finding similar areas to offset	√	√	√
Finding suitable no fragmented areas		√	√
High price of land		√	
Choice of method to calculate residual losses	√		√

Potential to achieve No Net Loss

At this stage of offsets implementation, it is not possible to evaluate actual outcomes. However, as in rehabilitation of mined land (Neri and Sánchez, 2010), by evaluating planning, implementation and management of offsetting it is possible to estimate the chances of successful outcomes.

The project was subjected to legally required environmental impact assessment (EIA), consequently, the project impacts and legal framework for offset were reviewed, and the mitigation hierarchy was applied. By analyzing the alternatives presented in the EIS, it was determined that the suppression of 185 hectares of Atlantic rainforest was avoided by selecting the location of one waste rock dump. However, evidence documented in the environmental impact study (EIS) showed that alternative consideration for other major project structures (particularly the tailings dam) did not avoid natural vegetation loss.

Although stakeholder and affected communities were consulted as part of the EIA process, the BO design does not require any kind of involvement (Table 3). Therefore, the second step recommended by BBOP (2012) was not performed. Methods to calculate losses and gains of biodiversity are defined by the legislation. Residual impacts and needs for offsetting are determined by a habitat-hectare metric. The metric is not in accordance with recommendations (Virah-Sawmy et al., 2014; BBOP, 2012), because it does not represent key biodiversity components (step partly performed). As shown in Figure 1, the company acquired several potential offset areas and reviewed these under policy and ecological criteria for designing BO. Therefore, Step 5 was considered as totally performed. Step 6 was performed simultaneously with Step 5, but, as the habitat-hectare metric was used, it was considered as only partly meeting recommendations.

Table 3: Interim evaluation of the biodiversity offset design adopted in the reviewed case

Main steps of biodiversity offset design (BBOP, 2012)	***Steps implemented in the reviewed case***		
	Totally performed	***Partly performed***	***Not performed***
1. Review project and legal framework for biodiversity offset	√		
2. Stakeholder involvement and consult with experts			√
3. Assess impacts and apply mitigation hierarchy		√	
4. Assess residual impacts and determine needs for offset based on calculation of biodiversity losses		√	
5. Review potential offset locations	√		
6. Calculate offset gain and select appropriate offset areas		√	
7. Implement, adapt and improve offset	not assessed (in progress)		
8. Monitor to achieve no net loss or net gain and maintain it	not assessed (in progress)		

As for monitoring (Step 8, Table 3), neither the company nor the environmental agency developed or proposed methods that could allow it to be demonstrated that the BO plan to has potential to achieve NNL. However, it can be argued that the plan does have this potential, as most steps of BO design were implemented (Table 3), even partly. In addition it is suggested that the project does have this potential in view of the following factors: (i) there are currently only two protected areas in the region (Figure 1); (ii) the high biodiversity value of affected ecosystems, and thus potentially of the offset areas; (iii) the resulting protected/affected areas ratio (Table 2); (iv) the balance 65-35% of legally required protection/restoration offsets (Table 3); (v) the balance 30-70% of additional voluntary protection/ restoration offsets.

Potential to compensate for ecosystem services losses

The project was found to affect 9 priority ecosystem services - 6 provisioning, 2 regulating and one cultural service – out of 17 affected services (Rosa and Sánchez, 2016). Affected beneficiaries are local communities not involved in the design of BO. Therefore, offsetting did not consider the most important services affected by the project according to the perspectives of the beneficiaries.

The BO strategies adopted in the case will certainly not compensate impacts on provisioning and cultural services, because all offset areas become protected areas, with strong restrictions to community access. In addition, the areas are located far away from affected communities. On the other hand, offset areas will ensure the supply of regulating and supporting services, especially to regional beneficiaries. Therefore, compensating impacts on ES depends on which category of services is mostly impacted and the scale of affected beneficiaries. According to Quétier et al. (2014), replacing natural capital by delivering identical ES is a way to achieve NNL and it is in accordance to the concept of strong sustainability. However, if the focus is changed from BO to compensating ES, it is hard to assure that biodiversity will be protected (Ridder, 2008).

4. Conclusions

Biodiversity offsets were conceived as a means of neutralizing the impacts of development projects. The concept is being promoted at international level, but evidence of actual success is still scarce. This paper reviewed a mining project and provided evidence of potential achievement of no net loss in the long-term. It also showed that biodiversity offsets do not result in compensation to local communities for loss or impairment of ecosystem services. Compensating for adverse impacts on ecosystem services requires a specific approach that is different from offsetting biodiversity losses.

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