Committing to Net Gain in the Colombian High Mountain Ecosystems: Raising the Bar

IA has been key in determining the effects on biodiversity due to projects and its activities. Implementing further efforts in local characterization, tailored and measured ecosystem variables and computer modeling have paid off in understanding biodiversity in the territories. Results are encouraging, using multi-temporal ecological integrity analysis as one of the biodiversity measurements, the territory speaks for itself and shows consultants and promoters where strategic efforts, management plan implementation and investment will not only balance negative effects but have a net positive outcome. Extensive connectivity and fragmentation modeling, as well as analysis of ecological integrity in the Colombian high mountain andean ecosystems provide meaningful information for committing to biodiversity net gain.

General Discussion

Colombia's geography offers the country the opportunity to be one of the most biodiverse countries in the world. Unique and diverse ecosystems cover its territory, of special interest due to the wide range of ecosystem services they provide, high-mountain ecosystems have attracted attention in the last decades. However the remainder is exposed to anthropic activities that threaten their conservation. Within this type of ecosystem the “Paramo” ecosystem is of most interest, as it is considered a “water factory”, thus the source of water for millions across the country. Located in altitudes nearing 3000 m.a.s.l and ranging up to 3.600 m.a.s.l they cover over 1.900 ha, out of which a third is protected under National Parks (1).

Agriculture, cattle grazing, uncontrolled tourism, infrastructure and mining are some of the socio-economic activities that pressure these ecosystems. While most activities do not require special permits or licensing, infrastructure and mining projects do and must comply with rigorous studies and impact assessment (IA) that demonstrate no impact, when there is an impact a compensation or off-set plan must be presented for approval. The plan must comply with the “Biotic Compensation Manual” which is a tool that makes part of Colombia's Biodiversity and Ecosystem Services Integrated Management Policy (PNGIBSE) and helps project promoters and environmental authorities quantify impacts on ecosystem, where to apply the off-set plan and finally how to apply the plan (2). While the tool has served its purpose to prevent impacts and effectively manage mandatory compensation plans, today´s needs and interest demand net gain and not just off-sets that compensate project or activity impacts (no-net loss).

Consultancy related to IA in Colombia has acquired extensive experience related to biodiversity off-set plans, specifically in high-mountain ecosystems, mainly due to the need to build infrastructure related to main urban areas or where resources are available. Local authorities, communities and stakeholders plea for conservation of the surrounding ecosystem, even though they are currently under pressure and have historically suffered uncontrolled intervention. The need to demonstrate that projects not only compensate for their impacts but guarantee a net gain is imperative specially for locals, environmental authorities and conservation policies.

Detailed studies using ecosystem integrity indices overproject or activity area of influence (and beyond) have demonstrated useful to evaluate project impacts, off-set plan and maximize effectiveness of the latest towards biodiversity net gain.

Case Study

Over the last decades different tools, concepts and approaches have been used to measure biodiversity. While there is no specific and unified methodology several concepts have been applied worldwide. As the consultancy and IA demand detailed studies that surpass the area of influence of activities and projects, a consistent methodology to measure biodiversity, quantify impacts and predict biodiversity net gain has been developed and applied in development of environmental and social impact assessment studies in Colombia.

The methodology relies on the EII (Ecological Integrity Index) calculated by overlapping ecosystem conditions and characteristics over a wide area or territory, usually one that surpasses the area of influence of a project or activity.

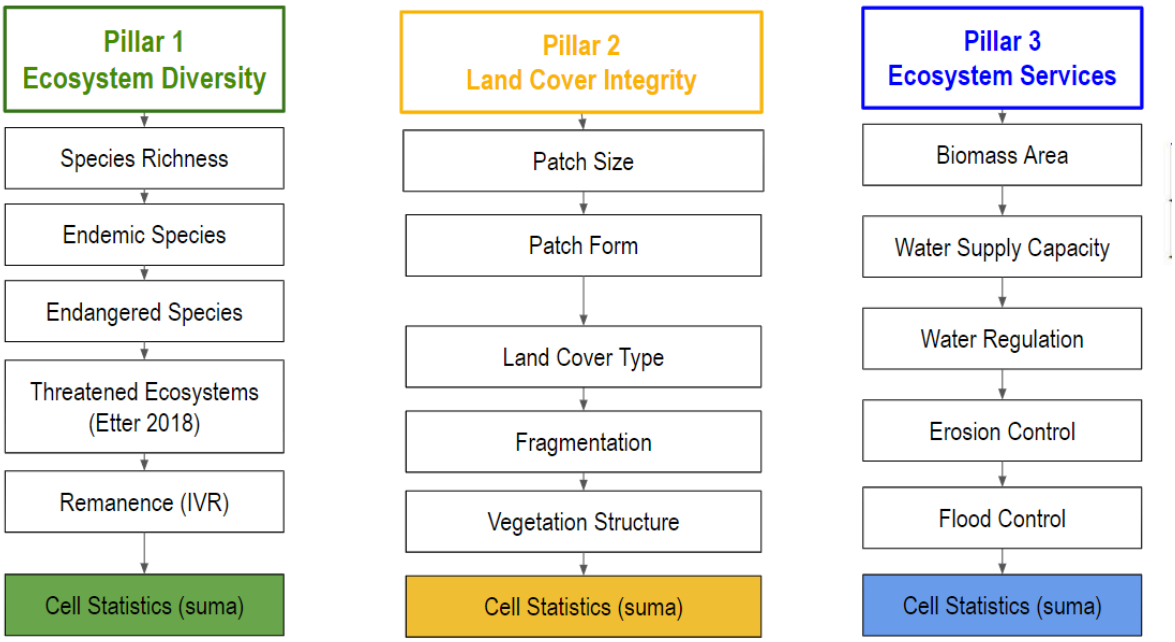

Figure 1. Ecological Integrity Index
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Adopting biodiversity and ecosystem services concepts used worldwide, 15 attributes are arranged within three biodiversity pillars: Ecosystem Diversity Attributes, Land Cover Attributes and Ecosystem Services Attributes.

According to the conditions and characteristics of each attribute a number between 1 to 5 is assigned to each attribute within a cell. Using GIS (Geographic Information Systems) attributes under a pillar are added; the three pillars are then added resulting in an overall value to determine the Ecological Integrity Index (EII). Even though implementing the methodology requires a considerable amount of effort and resources to obtain an adequate and detailed baseline, using the EII has proven feasible and appropriate. It offers a standardized, repliocable and quantifiable means to compare results over different site conditions, time (past, present and

future) and alternatives for implementation of off-set plans. The same methodology has been applied over the national territory with consistent results.

Analyzed over different scenarios, Ecological Integrity Index is a useful tool to determine impacts caused by a project, quickly compare impacts of alternatives for a project or activity, compare alternatives for off-set implementation, determine historical effects of activities in the territory among others.

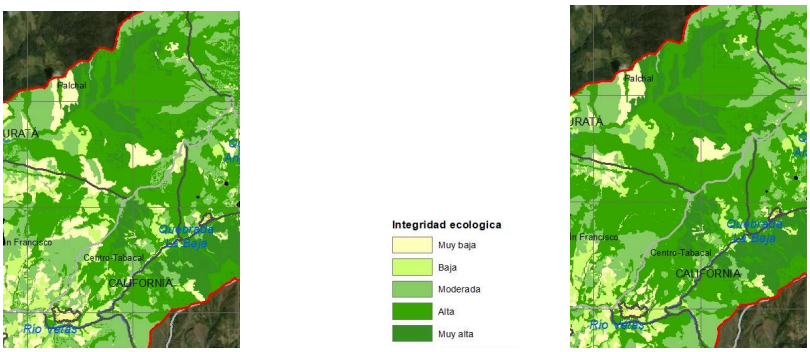
Four scenarios are considered mandatory for a particular project (3), however additional scenarios can be helpful:

a. Past scenario: using historical data, aerial or satellite images, and historical biodiversity related monitoring, past scenarios can be considered into the overall ecosystem analysis. This scenario is useful to obtain changes or tendencies in the territory prior to any project activity
b. Present Scenario: considered as the baseline scenario it is usually the scenario that has the most information and one that allows project promoters in evalauating project design alternatives. This is considered base scenario for analyzing project impacts
c. Project Scenario: this scenario takes into account the most critical activities, project footprint and operations activities. It can be subdivided into scenarios related to the construction, operation and closure phases of the project. These scenarios determine project impacts, magnitude and aid in determining area of influence
d. Post Project Scenario (post-closure): this scenario is predictive and is considered of importance since it is the base scenario to determine the effectiveness of the project compensation or offset plan. It considers all project activities finished and off-set plan has been implemented. When compared to the baseline scenario it becomes the key to determining plan effectiveness and if such a plan will result in Biodiversity Net Gain (BNG).

Implementing other intermediate scenarios aid in impact assessment and formulation of off-set plans. Scenarios related to compensation plan progress while the project is still active in any phase or scenarios that study the positive (or negative) effects of conservation measures or activities can prove useful.

Figure 2 illustrates sections of maps resulting from the results of an EII analysis developed for a capital investment project in high mountain ecosystem territory and neighboring “páramo” ecosystem. The corresponding Environmental Impact Assessment Study supplemented the EII analysis with detailed studies related to fragmentation, connectivity, critical habitat and extensive fauna and flora monitoring.

The two extracts allow for the comparison between two modeling scenarios: Scenario B - project implementation with no off-set and Scenario D - project implementation with off-set. Results show and increase in EII in project neighboring areas, however and most important, EII increase in key and strategic fauna conenctivity corridors. The analysis and comparison between scenarios demonstrate that off-set, strategically located, increase ecosystem health and increase mobility of species along high-mountain ecosystems neighboring project implementation sites.



Scenario B- EII no off-sets Scenario D- EII with Off-sets

Figure 2. EII Map Extracts - Comparison Between Scenarios
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After considering several scenarios, the use of EII proved to be useful in:

- Determining how past and current socio-economic activities have exercised high pressure on high mountain ecosystems over the last decades
- Impact prevention by early identification of biodiversity strategic areas and avoiding activities in such areas
- Determining and spatializing impacts on project neighboring ecosystems
- Assisting in selecting optimum location for conservation and compensation activities and creating a wide portfolio of areas in case specific sites were not available
- Identifying most sensitive and critical areas either to prevent or minimize project related activities or maximize and focalize conservation efforts

As a supplement to Ecological Integrity Index analysis, studies can be coupled with fragmentation and functional connectivity studies. By selecting representative “umbrella” local species and analyzing critical habitats and mobility corridors over EII results for different scenarios, it can be demonstrated that there is a direct correlation between increased EII and connectivity of species.

Applied over a wide range of projects in Colombia's geographical territory and over a wide range activities and projects (highways, power substations, renewable energy generation, power transmission lines, mining, among others) the Methodology for Modeling Ecological Integrity Index for Biodiversity has been used to demonstrate off-set effectiveness as well as Biodiversity Net Gain (BNG). Besides, it has also proven to be an important supplement to connectivity, fragmentation and compensation analysis to determine impacts and effectiveness of biodiversity conservation activities.

Conclusions

Measuring biodiversity is one of the challenges when demonstrating Biodiversity Net Gain (BNG), while there is no unique and sole methodology for calculating biodiversity, different concepts are commonly applied and referenced as a way to qualify and quantify biodiversity in a given area or territory.

Applied over a diverse set of types of projects, activities and territories in Colombia (including high-mountain ecosystems), the consultancy has adopted a process and methodology (based on measuring EII - Ecological Integrity Index) that allows measuring biodiversity under different scenarios and predicting results related to off-set and other conservation measures applied in a territory. Results gathered from different studies consistently demonstrate that using EII as a basis for measuring biodiversity provides an opportunity, among others, to predict BNG when selecting off-set location strategically.

Applied case studies uncover other benefits of using EII as a measure of biodiversity:

- Effects on biodiversity from project activities can be predicted
- If involved in the project decision phase, designers can be alerted as to better alternatives for location of project related infrastructure (mitigation hierarchy)
- Selection of sites for conservation measures can be more effective, as comparative simulations can be implemented for different alternate sites
- Off-set implementation can be studied and predicted over time, sites with the best effectiveness can be prioritized
- The methodology allows for “calibration” of models over time with real data once the project reaches its implementation stage and conservation strategies are implemented
- Prediction of BNG can be better supported and can be demonstrated over time

Overall EII (as described previously) incorporates and integrates diverse attributes related to biodiversity and can be considered as an index that can be used as a method for comparison of different scenarios. It is replicable over time, can be applied over different types of projects and in practically any territory.

For project promoters, the methodology and process described previously, provide a basis for committing to off-set implementation and better securing effectiveness and value for their investment. When analysis as those described are included in IA, results can be used to demonstrate to authorities, stakeholders and other decision makers impact extent as off-set and conservation activities effectiveness.

References

1. Ministry of Environment (Colombia): https://savia.minambiente.gov.co/ecosistemas-de-alta-montana/
2. Ministry of Environment (Colombia): Manual de Compensaciones del Componente Biótico (2018)
3. Methodology for Ecological Integrity Modeling for Biodiversity. INGETEC. 2023