

Environmental & Social Impact Assessments

Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) can be used to design analytically-rigorous environmental and social impact assessments (ESIAs) by quantifying the expected losses and gains of ecosystem services (ES) from development proposals. InVEST enables spatially-explicit evaluations of project alternatives and realistic mitigation plans. Using a “serviceshed” approach, which maps areas providing specific ES to specific beneficiaries,¹ InVEST users can also compare changes in ES access among different communities.

The Natural Capital Project (NatCap) is developing a tailored software tool that draws on InVEST models to incorporate ES into ESIAs and impact-offset decisions. A beta tool is expected in mid-2014.

Outlined below are the key contributions of InVEST to ESIAs:

Planning step	How InVEST can help
1. Review project scope	N/A
2. Review legal & policy context	N/A
3. Design ESIA process and stakeholder engagement	Determine where ES is supplied and delivered, provide data and visual aids for discussion
4. Assess impact	Show current ES status, estimate how ES will change under different project options
5. Identify potential mitigation portfolio	Assess ES returns of potential offsets and compare offset options
6. Prepare report and management plan	Provide data and visual aids for discussion
7. Monitoring and evaluation	Inform design of monitoring program, and analyze monitoring data to compare to ES goals
8. Adaptive management	Assess ES returns of alternative offset portfolios



The InVEST in Practice Series outlines the InVEST software’s applicability to policy and planning processes. This guidance is based on our experiences developing and applying InVEST in more than 20 places around the world.

The applicability of InVEST depends on the quality and availability of data, modeling capacity, local institutional and governance structures, and the policy time frame. The guidance should be considered in context of local social, environmental, and institutional conditions where InVEST is used.



Environmental impact assessments (EIAs) involve processes to identify, predict, evaluate and mitigate the negative biophysical and social impacts of development plans.² Social impact assessments focus specifically on measuring development’s impact to human communities.³ EIAs tend to be more project-based than strategic environmental assessments (SEAs), and may call for mitigation efforts, such as compensation for losses of biodiversity, following a mitigation hierarchy designed to avoided, minimize, and offset harmful impacts.

1: Review project scope

What is the purpose of the development project?

Assess the type, location, timeframe and frequency of activities likely to take place throughout the project. Assess project plans in consultation with developers and regulators. InVEST is not suitable here.

2: Review legal and policy context

Which policies and regulations govern ESIA requirements?

Review relevant regulations, including policies of national and local government, financial institutions and companies. Are ESIA or offsets required for projects in certain sectors, project densities or habitats? InVEST will not be useful in answering these questions.

3: Design ESIA process and stakeholder engagement

Does the ESIA consider previous research on ecosystem services and social conditions?

Review any relevant studies to the area of development, and collect additional environmental and social information if necessary. InVEST can support initial review with a coarse ES assessment, including where they are supplied and delivered. A finer-scale analysis with field data can provide a baseline for comparison.

Identify relevant stakeholders and establish a process for their participation. InVEST outputs describing ES provision across a landscape can help identify these actors. To ensure ESIA reflect environmental and social realities, involve stakeholders in every stage of the process, including the selection, design, and implementation of offsets. ES maps produced with InVEST can provide visual aids to discuss stakeholder preferences.

4: Assess impact

What are the expected changes in ES flows?

Use InVEST to assess the location and magnitude of the project's ES impacts. InVEST can compare alternative future scenarios – for example, a project scenario and 'without project' scenario – and compare these to current levels of ES provision. Alternative scenarios are sometimes developed with stakeholders, and often employ scenario development or optimization modeling tools. Scenario development tools, like InSEAM⁴ and NatCap's upcoming scenario generator, will be useful here. Please see the [InVEST Scenario Guide](#)⁵ for more information.

InVEST can measure ES impacts in biophysical terms, such as tons of carbon sequestered, and if desired, in economic terms, such as the dollar value of timber production. It can also indicate communities with changed access to ES, using the Servicedshed Mapper.⁶

Step 5: Identify potential mitigation portfolio

How and where can projects' negative impacts be offset?

Using InVEST, rank different project options based on their changes in ES and impact to stakeholders. Spatially-explicit outputs can target areas that achieve the highest ES or biodiversity returns and minimize or avoid undesirable impacts. If the preferred option still creates harmful impacts after avoidance and minimization, identify potential offset activities. Use regional plans to identify available areas for offsetting and use InVEST to compare these areas to the affected site.

InVEST outputs informing mitigation plans should be calibrated with local time series data and reviewed by local experts. Alternative models and collection of field-based observations may also be required. Consult National Biodiversity Strategies and Action Plans to identify conservation priorities, and use economic and social information to assess how offsets may affect the distribution of benefits among stakeholders.

6: Prepare report & management plan

How can results be communicated to stakeholders?

In a report or management proposal, describe the likely impacts of the project and identify mitigation options with feasible offset locations. Specify potential biodiversity and ES losses and gains for different stakeholders, and the fit of the recommended option with regulatory and policy requirements. InVEST does not generate reports, but it can provide data and spatially-explicit data, such as ES maps and balance sheets, to support ESIA findings.

7: Monitoring and evaluation

Is the ESIA successfully meeting objectives?

Monitor relevant and measurable indicators to ensure that ES are actually delivered by offset activities. InVEST is not a real-time monitoring device; it is not a substitute for field measures of delivery towards objectives. However, InVEST can help determine where to place monitoring stations, thereby improving the efficiency of the monitoring design. After monitoring has been conducted, field data inputs describing ES provision can be used in InVEST to determine if goals have been met.

8: Adaptive management

How can managers modify development plans and implemented offsets to improve environmental outcomes?

As offsets are monitored and evaluated, they can be modified to improve performance and adapt to changing economic and environmental conditions. As in Steps 4 and 5, InVEST can evaluate and quantify ES impacts. This process can inform evolving mitigation programs.

Key Issues for Environmental and Social Impact Assessments

■ Biodiversity

InVEST offers simple models for assessing habitat quality in terrestrial and marine environments. The tool is designed to measure ecosystem service changes in order to complement biodiversity impact and mitigation assessments. InVEST includes a simple biodiversity module, which can estimate habitat integrity and rarity as a proxy for biodiversity. As a result, the InVEST toolbox can be easily integrated with existing approaches for assessing impacts to biodiversity.



■ Geographic scale

InVEST has been applied to decisions made at the global, national, provincial, district, basin, and sub-basin levels. The most appropriate spatial scale for InVEST models depends on the ecosystem services modeled, the resolution of the available data, and the decision context. In general, hydrological models are best interpreted at the sub-watershed level ($>1\text{km}^2$), since the processes they represent are better understood at that scale, rather than at the pixel level. Results from other non-hydrological models (e.g., carbon, pollination, habitat quality) or from RIOS may be adequately interpreted at the pixel level, keeping in mind that the quality and resolution of input data relative to the size of the area of interest will still impact these results.

■ Relative vs. absolute values

Without calibration to on-the-ground data, InVEST models are most useful for identifying where to mitigate and offset project impacts based on relative contributions of ecosystem services across the landscape. However, if InVEST models are calibrated and there is good correlation between modeled results and observations, InVEST can be used to compare social, economic and environmental impacts with absolute values. InVEST non-hydrologic models (such as carbon, habitat quality, and NTFPs) typically do not require calibration.

■ Alternative measures for InVEST outputs

InVEST can quantify ecosystem services in biophysical terms (e.g., cubic meters of water), which can be useful for understanding relative impacts. It can also estimate economic values, in dollar terms, using a range of valuation methods, such as market valuation or the costs of avoided damage (e.g., costs of water treatment). For InVEST's hydrologic models, valuation can only be completed once the biophysical parts of the models are calibrated to time series data. Given the simplifications in InVEST models, economic valuations should be treated as first estimates only. The values are suitable for targeting relative offset values, but not for determining specific payments.

■ Time and resources required

On the lower end, it will take 1-3 people two months to a year to compile data and run InVEST; the scope of the project, models used and availability of data will affect the amount of time required. For example, the team may use global datasets for initial estimates of ES values, or work with partners to compile detailed local data for a complete application of InVEST within the context of ESAs and offsets. In our experience, data collection, scenario development and iteration (re-running the models with better data) tend to take the most time. The team's familiarity with InVEST will also be relevant here, since experienced InVEST users may be able to complete analyses more quickly. In the context of ESAs, the team will require a team-member with intermediate GIS proficiency. For more detail on data requirements, see the [InVEST User's Guide](#).



InVEST in Practice: Example Applications

Equity and road-building in the Peruvian Amazon



NatCap used InVEST and the serviceshed approach to analyze the social equity implications of road-building and associated deforestation in the Peruvian Amazon. InVEST was used to examine potential impacts on services like clean drinking water, climate regulation, and provision of wild food and medicine for nearly 250,000 people in 107 cities and towns.⁷ The analysis approximated the best locations for mitigation (protection and restoration) considering feasibility, land tenure, and optimization of natural capital gains. These activities helped decision-makers understand for which services full mitigation was and was not possible, and identify the mitigation approaches that would result in the lowest net losses for communities. <http://www.naturalcapitalproject.org/decisions/permitting.html>

Further Resources

The Natural Capital Project

naturalcapitalproject.org

InVEST User's Guide

naturalcapitalproject.org/InVEST.html

InVEST download

naturalcapitalproject.org/download.html

InVEST Toolbox

naturalcapitalproject.org/toolbox.html

InVEST and Scenarios

naturalcapitalproject.org/decisions/scenarios.html

Contact

Emily McKenzie

EJMcKenzie@wwf.org.uk

Mitigating environmental impacts: Colombia

In 2011 InVEST was applied in Colombia to support the Ministry of the Environment in incorporating ecosystem services into impact assessments and permitting decisions. Scientists used InVEST models to evaluate the impacts of new and proposed coal mine permits on water quality regulation services in the Cesar Department of northern Colombia. [InVEST analyses](#) evaluated the potential to mitigate mining impacts to communities through protection and restoration activities, and identified areas where full mitigation was not possible. www.naturalcapitalproject.org/where/colombia.html

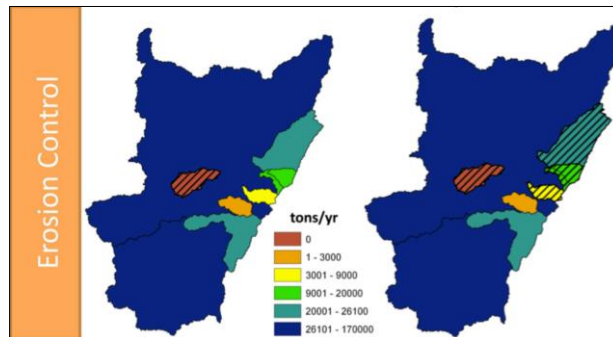


Figure: ES benefits from protecting the biodiversity portfolio of sites in Colombia's Cesar Department. Hatched servicesheds indicate that benefits of protection are not big enough to offset the impacts from proposed mining development

¹ Tallis, H., Wolny, S., Lozano, J.S., Benitez, S., Saenz, S., Ramos, A. (2012). Working Paper: "Servicesheds" Enable Mitigation of Development Impacts on Ecosystem Services. The Natural Capital Project and the Woods Institute on the Environment, Stanford University, The Nature Conservancy.

² Senecal, P., Goldsmith, B., Conover, S., Sadler, B., Brown, K. (1999). Principles of Environmental Impact Assessment Best Practice. International Association for Impact Assessment and Institute of Environmental Assessment, UK.

³ Becker, H. A. (2001). Social impact assessment. *European Journal of Operational Research*, Volume 128, Issue 2, pp. 311-321. [http://dx.doi.org/10.1016/S0377-2217\(00\)00074-6](http://dx.doi.org/10.1016/S0377-2217(00)00074-6).

⁴ InSEAM is an online interactive mapping tool. The current version is a prototype in internal testing, with a public release planned for 2014.

⁵ McKenzie, E., A. Rosenthal et al. (2012). Developing scenarios to assess ecosystem service tradeoffs: Guidance and case studies for InVEST users. World Wildlife Fund, Washington, D.C.

⁶ See [NatCap's serviceshed page](#). A Serviceshed Mapper is in development, although [RIOS](#) software can map servicesheds for hydrological services.

⁷ Mandle, L., Tallis, H., Vogl, A., Wolny, S., Touval, J., Sotomayor, L., Vargas, S., Rosenthal, A. (2013). Can the Pucallpa-Cruzerio Do Sul Road be developed with no net loss of natural capital in Peru? USAID, The Nature Conservancy, The Natural Capital Project.