Land-based carbon offsets with InVEST

Integrated Valuation of Environmental Services and Tradeoffs (InVEST) can help in the design and implementation of land-based carbon offsets, guiding selection of the best project alternatives. Land-based carbon projects often provide 'co-benefits' in addition to carbon sequestration, like biodiversity conservation, erosion control, diversification of agriculture, or ecotourism opportunities.[1] InVEST can help identify how and where these co-benefits can be maximized by analyzing and comparing tradeoffs among a variety of ecosystem services (ES). InVEST can assess ES provided under current and future scenarios in the project area, help guide the selection of projects for investment, and improve project efficiency. This brochure focuses on offsets that provide co-benefits, following the standards of the Climate, Community and Biodiversity Alliance (CCBA).
Outlined below are InVEST's key contributions to carbon offset projects:

Planning step	How InVEST can help
1. Scope carbon markets	*N/A*
2. Secure stakeholder support	Provide visual aids for discussion
3. Conceptualize project design	*N/A*
4. Assess current conditions	Show current ES status
5. Project and assess baseline	Estimate how ES may change under future baseline
6. Assess and develop capacity	*N/A*
7. Assess legal status and property rights	*N/A*
8. Determine net impacts for climate, communities, biodiversity	Estimate how carbon storage, ES, and biodiversity may change with offsetting activities.
9. Identify sustainable finance	Identify ES beneficiaries
10. Monitor climate, community, and biodiversity impacts	Inform design of monitoring program, analyze monitoring data
11. Adaptive Management	Assess ES returns of project adaptations

InVEST In Practice

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.

Carbon markets involve the buying and selling of carbon credits[2] by nations, organizations and individuals to offset greenhouse gas (GHG) emissions and mitigate global climate change. Land-based offsets can involve activities such as reforestation, agroforestry or reduced deforestation; forest carbon projects reduce GHG emissions by sequestering carbon in particular locations, e.g. peat swamps. These credits can be used in compliance markets (e.g. cap-and-trade), be part of broader land-use policies using national funds such as REDD+, or enable participation in the voluntary carbon market.[3] For more information on project planning and market requirements, for example in relation to carbon credit additionality, see Forest Trends' website.

1: Scope carbon market requirements

What are the relevant standards and regulations?

Scope the requirements of the CCBA. Other guidelines such as the Verified Carbon Standard (VCS), or those stipulated by the UNFCCC or the Clean Development Mechanism (CDM), may also be relevant.

2: Secure stakeholder support for offset project

Who are the relevant stakeholders, and how will they be involved in the project?

Identify stakeholders and engage them in offset evaluation, siting, implementation, and monitoring. InVEST can identify where ES are supplied and delivered, indicating which stakeholders will be affected by proposed projects. InVEST ES maps also provide information for stakeholder engagement.

3: Begin conceptualizing project design

What are the project's objectives and activities?

Create a preliminary definition of activities, potential project scales, areas, and boundaries. Project design is an ongoing process, and InVEST outputs from Steps 4-9 will help delineate specific activities and inform implementation.

4: Assess current conditions in project area

Where are carbon storage and sequestration currently distributed throughout the landscape, and which other ES are delivered?

Collect and analyze data on biophysical parameters, such as vegetation types, levels of biodiversity, and ES provision. Collect local socio-economic data and identify areas of critical local importance or cultural significance. Use InVEST to estimate the amount and distribution of carbon storage and sequestration, other ES, and biodiversity in the project landscape. Additional measurements e.g. field data, remote sensing or more sophisticated models for individual ES may be required.

5: Project and assess baseline

How will ES be supplied and delivered in the future?

Describe the expected future conditions of the project area in the absence of the offset project, and project a future land-use scenario to represent this 'baseline'. This a reference point to estimate the likely relative returns from the project. Scenario models and tools, like InSEAM [4] and NatCap's upcoming scenario generator tool, can help here. See the InVEST Scenarios Guide [5] for more information. Once a scenario map is created, InVEST can be used to estimate impacts on carbon and other ES.

6: Assess and develop capacity

Who will implement and sustain the project?

Assess any need for capacity building; ensure that the project team has skills in community engagement, biodiversity assessment, and carbon measurement and monitoring.

7: Assess legal status and property rights

Which legal and regulatory requirements affect project viability?

Assess local property and use rights for land and ES. Assess any land tenure or illegal resource extraction issues.

8: Determine net impacts for climate, communities, and biodiversity

How will ES change under the offset program?

Use InVEST to estimate net changes in carbon stocks and GHG emissions (equal to the difference between carbon stock change with and without the project). Quantify and mitigate any activities that might result elsewhere and increase GHG emissions (e.g. carbon leakage) or impact biodiversity.

To meet CCBA standards, ensure that the project generates net positive impacts on local socio-economic well-being, and that costs and benefits are equitably distributed. Any negative impacts on the well-being of stakeholders outside the project area must be mitigated. InVEST can quantify ES that contribute to well-being, such as water yield for hydropower and irrigation, crop pollination, flood control, erosion control and non-timber forest products. InVEST can also assess ES impacts outside the project area, to determine that the project will not negatively impact surrounding communities. Additional analyses are likely to be required, e.g. to evaluate how the project may affect local economies and employment.

9: Identify sustainable finance

How will the offset project be financed?

Use InVEST to assess where ES are delivered, helping determine the location of stakeholders who might have an interest in financing the offset for its co-benefits. Supplement this with socio-economic data and direct discussions with potential financiers.

10: Monitor climate, community, and biodiversity impacts

How can the sustained delivery of ES be ensured?

Monitor changes in carbon pools, GHG emissions, biodiversity, and local well-being resulting from the project. Also monitor leakage throughout the project's lifetime. InVEST is not a real time monitoring tool, but can be used to inform monitoring design and analyze monitoring data.

11: Adaptive Management

How can the project be adapted to improve performance?

As the project is evaluated, adapt it to fit changing economic and environmental conditions and ensure compliance with market standards. InVEST can be used to evaluate ES impacts of alternative adaptations of the project, informing adaptive management.

Key Issues for land-based carbon offsets

Applicable ecosystem services

In the context of carbon offsets, InVEST is most effectively used to indicate tradeoffs between carbon storage and sequestration and other services, and model ES that provide co-benefits. These include sediment retention/erosion control, forage products (including NTFPs), crop pollination, water purification, habitat quality and timber production. In the future, InVEST will include models for flood control, irrigation water for agriculture, and agricultural production. A model for blue carbon designed for marine vegetation (wetlands, marsh, sea grass, mangroves) is in internal testing. This model complements the terrestrial version, addressing differences in marine environments (e.g. carbon accumulation in sediment pools). See the InVEST User's Guide for more information.

Temporal scale

The current version of InVEST provides ES estimates on an annual average basis, and is thus not a useful assessment tool for seasonal (i.e., monthly) patterns in hydrologic service provision (e.g. sediment/nutrient retention). A future release will address seasonal water yields. In addition, InVEST's carbon model assumes a linear model of sequestration over time, although in reality trees may sequester more carbon early in their life cycle. This has implications for carbon accounting, as benefits may not accrue evenly throughout a project. See the User's Guide for more information.

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 (>1km^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's hydrologic models are most useful for identifying where to focus carbon offsets based on relative contributions of ES across the landscape. If the hydrologic models are calibrated and there is good correlation between modeled results and direct observations, InVEST may help inform offset processes based on absolute values. The carbon model and other non-hydrologic InVEST models (e.g. habitat quality, NTFPs) typically do not require calibration.

Alternative measures for InVEST outputs

InVEST can quantify ES in biophysical terms (e.g. mTs of carbon sequestered), which can help target offsets across landscapes. It can also estimate economic values, in dollar terms, using a range of techniques such as avoided damage or treatment costs and market valuation. For hydrologic models, valuation can only be completed once the biophysical parts of the models are calibrated to time series data. Given the simplifications in the biophysical/economic models, economic value estimates should be treated as first estimates only, for example, for gaining support for offset projects.

Uncertainty

Uncertainty simulations have recently been incorporated in InVEST's carbon model. These simulations depend on the quality of data. For sparse datasets, even relative estimates from InVEST may have high degrees of error. Therefore, the InVEST outputs should be interpreted cautiously – see the InVEST User's Guide for more information.

Time and resources required

On the lower end, it will take 1-3 people one month 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. 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 carbon projects and offsets, the team will require a team-member with intermediate GIS proficiency, and may also require a hydrologist, biodiversity specialist, or social scientist depending on the project. For more detail on data requirements, see the InVEST User's Guide.

InVEST in Practice: Example Applications


© Fletcher & Baylis/WWF-Indonesia

Prioritizing carbon projects: Sumatra

In 2010, InVEST supported district and provincial policy makers in conducting ecosystem-based spatial planning to balance development and conservation goals in central Sumatra, Indonesia.[6] Planners applied InVEST models to assess the quantity and location of high quality habitat, carbon storage, annual water yield, erosion control, and water purification under contrasting land-use scenarios. This included a *carbon project analysis*, which quantified possible gains and losses to carbon stock based on potential government plans and resulting land uses, and identified areas and districts with high potential for investments in offsets/payments for forest carbon under compliance markets, voluntary projects, and overseas aid programs (see Figure below). A 2012 report led by the Natural Capital Project provided recommendations for forest carbon project opportunities (including forest restoration and best management practices), many of which involve co-benefits for water quality, sediment retention, and erosion control, as well as improved habitat for biodiversity. Indonesian government ministries considered the report's findings in key planning decisions.[7]
www.naturalcapitalproject.org/where/sumatra.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

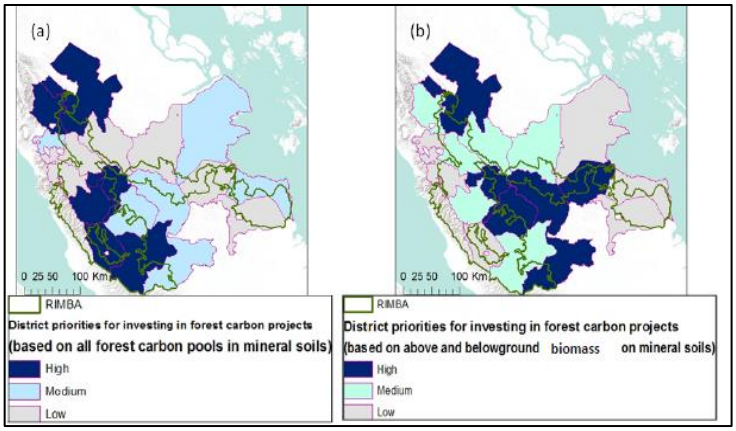

Figure: Priority districts for investing in forest carbon projects on mineral soils – Sumatra, Indonesia

We are grateful for comments from Kate Hamilton (Forest Trends), Steve Panfil & Joanna Durbin (CCBA), and Jason Funk (Environmental Defense Fund)

[1] CCBA. (2008). Climate, Community, & Biodiversity Project Design Standards, 2nd ed. CCBA.

[2] A carbon credit is a permit that allows the holder to emit 1mT of CO2.

[3] REDD+ stands for Reducing Emissions from Deforestation and Forest Degradation. For more information see the UN-REDD website.

[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] Bhagabati, N., Barano, T., Conte, M., Ennaanay, D., Hadian, O. McKenzie, E., Olwero, N., Rosenthal, A., Suparmoko, Shapiro, A., Tallis, H., and Wolny, S. (2012). A Green Vision for Sumatra: Using ecosystem services information to make recommendations for sustainable land use planning at the province and district level. The Natural Capital Project, WWF-US, and WWF-Indonesia

[7] Ruckelshaus, M., McKenzie, E., Tallis, H., Guerry, A., Daily, G., Kareiva, P., Polasky, S., Ricketts, T., Bhagabati, N., Wood, S. A., Bernhardt, J. (2013). Notes from the field: Lessons learned from using ecosystem service approaches to inform real-world decisions. *Ecological Economics*, Available online 23 August 2013

Stanford Woods Institute for the Environment · WWF · The Nature Conservancy · Institute on the Environment, University of Minnesota, Driven to Discover