

# InVEST IN PRACTICE

## A Guidance Series on Applying InVEST to Policy and Planning

### Using InVEST to Conduct Strategic Environmental Assessments

InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) is a freely-available software tool developed by the Natural Capital Project – a partnership of Stanford University, The Nature Conservancy (TNC) and World Wildlife Fund (WWF) – and used in more than ten places around the world. InVEST can be a useful tool to help integrate ecosystem services into Strategic Environmental Assessment (SEA). This document provides guidance on how the current Tier 1 version of InVEST can be used at each typical step of an SEA.

SEAs are analytical and participatory approaches that aim to integrate environmental considerations into policies, plans, and programs<sup>1</sup>, and to evaluate the links with economic and social considerations (OECD, 2008). SEAs are broader in scope and enable earlier and more proactive consideration of environmental considerations than Environmental Impact Assessments (EIA), typically applied to projects (Finnveden, 2003). In both guidance and practice, the main sectors covered by SEA are spatial and land-use planning, water, waste, transport, and energy (Sadler, 2000). Integrating ecosystem services and their societal values into SEA can help demonstrate the social, economic and financial reasons for environmentally sustainable policies (Slootweg and van Beukering, 2008). Considering a broad range of ecosystem services helps ensure an SEA includes a comprehensive and balanced assessment of environmental impacts and considers the trade-offs of alternative options.

### InVEST and SEA

SEAs are increasingly institutionalized within government decision-making, particularly in developed countries (Sadler 2000). With this increasing global uptake, SEA provides an existing and powerful process for embedding the scientific results of InVEST analyses in planning and policy. InVEST can help support an SEA by identifying how policies, plans and programs can meet multiple goals and guiding selection of the best alternatives.

SEAs are flexible and adaptable; they can be applied to a variety of policy or planning contexts and can incorporate many analytical methods. Given the wide range of forms that SEA can take, the contributions InVEST can make will vary. Nevertheless, InVEST is better suited to certain steps of an SEA than others. Here, we provide initial guidance on how InVEST can be used at each typical step (Fig. 1). The aim is to give new InVEST users realistic expectations about when InVEST is – and is not – likely to be appropriate and helpful.

**Figure 1. InVEST Contributions to Typical SEA Steps**

Policy Step	InVEST Contribution
1. Screen whether SEA required	Identify likely ES impacts of policy or plan
2. Scope context and issues	Show current ES status
3. Assess baseline	Identify future ES provision without policy / plan
4. Identify alternatives	
5. Identify impacts of alternatives	Assess ES impacts of alternatives
6. Assess mitigation measures	1. Determine ES impacts requiring mitigation 2. Assess ES impacts of mitigation measures
7. Prepare report	
8. Consultation	Provide data and visual aids for discussion

Well-designed to inform  
May also be able to inform

<sup>1</sup> Policies are typically broad statements of intent. A plan is a more specific strategy for implementing a policy. A program consists of proposals for how, when and where specific actions will be carried out, often through individual projects.

## Further Details on InVEST Contributions to General SEA Steps

### **Step 1: Screening**

Screening determines whether a policy, plan or program is likely to have significant environmental effects, and therefore requires an SEA. The process for defining whether effects are 'significant' enough to warrant an SEA varies across countries and contexts, but is typically determined using criteria or rules of thumb that may be written in legislation, combined with expert judgment from designated authorities. In most cases, where data are not easily available and rule of thumb screening criteria are in place, an InVEST analysis is likely to be more time, resource and data intensive than is efficient for the screening stage of an SEA. However, if the input data required for InVEST are easily available and the standard process for screening (based on criteria and expert judgment) are giving ambiguous, conflicting or border-line recommendations, a low-resolution, simple InVEST analysis could be useful. This type of 'fast and dirty' InVEST analysis could predict, albeit with some uncertainty, the scale and location of the ecosystem service impacts of the policy, plan or program, helping to decide whether an SEA is warranted.

### **Step 2: Scoping**

Once it has been determined that a policy, plan or program requires an SEA, the next step is to scope issues, define boundaries and assess the context. This includes defining the relationship to other policies, programs, and plans, identifying objectives, targets, and indicators, as well as distinguishing issues, constraints, and opportunities for the SEA to address. As with screening, in most data-poor contexts an InVEST analysis is likely to be more time, resource, and data intensive than is efficient for the scoping stage of an SEA. However, if the input data required for InVEST are easily available, a low-resolution, simple analysis could be useful for gaining an understanding of the current status of ecosystem services, and how actions are likely to affect service provision.

### **Step 3: Baseline**

The next step of an SEA involves documenting the state of the environment and how it is likely to evolve without the policy, plan or program. This provides a baseline for comparing against potential alternatives. Baseline assessments typically include evaluations of ecosystem service trends, indirect and direct drivers affecting those trends, and whether environmental thresholds have been observed. InVEST is suitable at this step for

assessing a) the status of ecosystem services on the current landscape, and b) how ecosystem services will be affected under future land-use likely without the policy, plan or program. Additional analyses may be needed to complement InVEST if greater detail or certainty is required. InVEST does not currently generate baseline scenarios.

### **Step 4: Alternatives**

The next step is to identify feasible alternatives for the proposed policy, plan or program. These typically include a 'no action' option (the baseline – see Step 3), the proposed option (if one exists) and a number of feasible alternatives. Alternatives are typically developed in close engagement with stakeholders and require careful consideration of the objectives, context and scope of the proposed plan. Scenario development and modeling tools may be required to explore possible external drivers of land-use change. InVEST is not a scenario generation tool, and therefore cannot generate alternatives for an SEA. However, InVEST can be combined with optimization tools, such as Marxan, to identify efficient land-use arrangements for meeting ecosystem service supply goals. These optimizations could be used to develop policy alternatives.

### **Step 5: Impact Identification**

The next step of an SEA is to assess the likely environmental impacts of the alternatives specified in Step 4. This is a critical stage of the SEA, which typically involves a variety of modeling and analytical approaches to estimate how the policy, plan or program would affect environmental factors. InVEST can play a key role at this stage of an SEA. It can estimate the ecosystem service impacts of the alternatives, in both biophysical terms, such as tons of carbon sequestered, and first-estimates of economic value in dollar terms, using a variety of economic valuation techniques. As a GIS tool, InVEST can also estimate where ecosystem service impacts are likely to occur.

### **Step 6: Mitigation measures**

If there are likely to be significant adverse effects resulting from the selected policy, plan or program, the next step in the SEA is to outline measures for mitigating these impacts. The SEA must consider how to prevent, reduce or offset harmful impacts. Mitigation measures could include establishing protected areas, compensating stakeholders, or offsetting particular ecosystem service impacts through mitigation banking

schemes. InVEST's estimates of the impact of each alternative on each relevant ecosystem service (see Step 5) can help determine the type and magnitude of mitigation actions required and where ecosystem services are relatively distributed across the landscape, which could identify where mitigation or offset actions could be located. InVEST can also estimate the quantity and location of ecosystem service impacts of these mitigation measures (see Issue No 6 on offsets for more details.)

#### **Step 7: Report preparation**

Results and conclusions need to be prepared and written into a report, with a summary for public

consultation with diverse stakeholders. InVEST does not itself generate reports, but InVEST's outputs, with additional analysis, can provide data and visuals, such as ecosystem service maps and balance sheets.



#### **Step 8: Consultation**

The SEA report is typically disseminated to inform and consult with relevant authorities and the public. As responses are received, they are taken into account in the evolving plan through an iterative process. InVEST's ecosystem service maps can provide visual aids and scientific information for this consultation stage, generating dialogue and discussion.

### **Overarching Issues with Using InVEST for SEA**

**Policies vs. plans and programs:** It may be easier to use InVEST for SEAs of plans and programs than for high-level policies. Plans and programs are usually specific and spatially defined and therefore more tightly coupled to land-use change. Policies are typically broad statements of intent. Conducting an InVEST analysis of a policy may be difficult if it is hard to determine specific impacts on land-use. SEAs at the policy level often involve following checklists or seeking expert opinion, rather than conducting a detailed and analytical impact assessment.

**Ecosystem services included:** InVEST can model a range of services that are relevant to SEA: avoided reservoir sedimentation, hydropower production, carbon storage and sequestration, open-access harvest (includes non-timber forest products), timber production, water purification and crop pollination. In the future, InVEST will also include models for flood control, irrigation water for agriculture, and agricultural production. InVEST also has a simple biodiversity module, that estimates habitat integrity and rarity as a proxy for biodiversity.

**Geographic scale:** Many services in InVEST involve hydrologic processes that are best described at the sub-basin or larger scales. This may make InVEST inappropriate for Environmental Impact Assessments of single projects at a scale smaller than sub-basins. InVEST is appropriate for SEA of policies, plans and programs at the sub-basin level or larger, with discernible impacts on land-use.

**Relative vs. absolute values:** Without calibration, InVEST is most useful for identifying the relative supply of ecosystem services across the landscape. This makes InVEST useful for identifying where to focus policies, plans, programs or mitigation measures. If InVEST models are calibrated and there is good correlation between modeled results and observations, InVEST can estimate absolute values of services, which may be useful for comparing across social, economic and environmental impacts.

**Biophysical vs. economic terms:** InVEST can quantify ecosystem services in biophysical terms (e.g. tons of carbon). It can also estimate economic values using a range of techniques such as avoided damage or treatment costs and market valuation. Valuation can only be undertaken once the biophysical parts of the models are calibrated to time series data. Given the simplifications in the biophysical and economic models, economic value estimates should be treated as first estimates only, suitable for gaining support, but may not be appropriate for detailed cost-benefit analyses.

**Time and resources required:** The skill and data requirements needed to apply InVEST are relatively light. The scale, scope, and availability of data all affect the amount of time and capacity required. In general, it will take 1-3 people two months to a year to compile data and run the InVEST models. A full application of InVEST results within the context of SEA will take longer. The team would need someone with basic GIS proficiency and may also require a hydrologist. For more detail on data requirements, see the InVEST user manual.

**Temporal scale:** The current InVEST models only provide estimates of ecosystem services on an annual average basis. When monthly or seasonal patterns in ecosystem service provision are of interest, InVEST is not a useful assessment tool.

## Further reading on InVEST and SEA

The Natural Capital Project: [www.naturalcapitalproject.org](http://www.naturalcapitalproject.org)  
InVEST User's Guide: <http://www.naturalcapitalproject.org/InVEST.html>  
InVEST download: <http://invest.ecoinformatics.org>

DAC Guidelines and Reference Series. (2006). *Applying strategic environmental assessment: Good practice guidance for development co-operation*. OECD.

DAC Network on Environmental and Development Cooperation (ENVIRONET). (2008). *Strategic environmental*

Sadler, B. (2000). *A framework approach to strategic environmental assessment: Aims, principles, and elements of good practice*. Paper at the International Workshop on Public Participation and Health Aspects in Strategic Environmental Assessment, Szentendre, Hungary.

Slootweg, R., & van Beukering, P. (2008). *Valuation of ecosystem services and strategic environmental assessment: Lessons from influential cases*. Netherlands Commission for Environmental Assessment.

*InVEST in Practice* is a series of short introductory materials to show potential InVEST users how the currently available Tier 1 version of the InVEST tool can be applied to existing policy and planning processes. The guidance here is based on The Natural Capital Project's experiences developing and applying InVEST in more than ten places around the world. Each issue indicates how and when InVEST is likely to be helpful for each stage of a specific policy or planning context, and when it may be inappropriate. Our goal is to give users realistic expectations about the tool, based on the current understanding of its strengths and weaknesses. As more is learned about the tool through further testing, this guidance will be refined and updated. Every context is different. Experience thus far has shown that the applicability of InVEST to different decision contexts depends on the quality and availability of data and other ecosystem service tools, local modeling capacity, local institutional and governance structures and the policy time-frame. The guidance provided here should therefore be considered in light of the local context where InVEST may be applied. Additional tools and approaches will always be needed to complement InVEST when conducting SEA.



© Praveen Wignarajah

We are grateful for comments from Sabine Bergman and Christine Tam (Stanford University)

**For more information contact:** Emily McKenzie, [emily.mckenzie@wwfus.org](mailto:emily.mckenzie@wwfus.org) or +1 202 495 4378



STANFORD  
UNIVERSITY