

INVEST IN PRACTICE

A Guidance Series on Applying InVEST to Policy and Planning

Using InVEST to Establish Payments for Watershed Services

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 for informing the design of payments for watershed services (PWS). This document provides guidance on how the current Tier 1 version of InVEST can be used at each typical step of a PWS program.

PWS are a type of payments for ecosystem services (PES) that focus on hydrological services, such as flood control, regulation of water supply, water purification, and erosion control. PES are contractual and voluntary transactions where a ‘buyer’ agrees to provide ‘payment’ to a ‘seller’ conditional on delivery of an ecosystem service, or implementation of a land use or management practice likely to secure that service (Wunder, 2005). PWS create financial incentives to protect, restore, or sustain ecosystem services provided by watersheds. Establishing PWS often takes years, requiring extensive stakeholder engagement to build trust and commitment. Classic cases of PWS include the system established by New York City (USA) in the Catskills Mountains and the Quito Water Fund (FONAG) in Ecuador. Activities subsidized by PWS can include restoring wetlands and maintaining native vegetation.

InVEST and PWS

While there is still debate on whether PES are an efficient way to improve or maintain ecosystem services and biodiversity (Wunder, 2005), interest in establishing PES is growing rapidly. InVEST can help support the design and implementation of PWS programs by identifying whether and how payments can meet multiple goals, determining where to distribute payments or establish new programs, and improving the efficiency of investments. In some cases, InVEST can also help select among management options, based on the ecosystem service returns.

PWS programs vary in the type and number of buyers and sellers, the institutional arrangements for payments, and the ecosystem services included. Given the wide range of formulations PWS programs can take, the contributions InVEST can make will vary. Nevertheless, InVEST is better suited to certain steps of PWS design and implementation 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 PWS Steps

Policy Step	InVEST Contribution
1. Secure Government or Institutional Support	Demonstrate potential economic efficiencies and social benefits of PWS
2. Conduct Biophysical Assessment	1. Show current ES status 2. Identify where to distribute payments 3. Predict how ES will change under PWS 4. Prioritize significant land management alternatives
3. Develop Governance	
4. Identify Service Buyers	Identify where ES are delivered
5. Identify Service Providers	1. Identify geographic areas of current ES provision 2. Identify geographic areas of potential ES provision 3. Assess ES returns of management options
6. Set Prices or Payments	Provide ES values as base for negotiation
7. Institutional Assessment	
8. Assess and Develop Capacity	
9. Define Success	Inform ES target levels
10. Determine Contract and Payment Types	
11. Monitoring and Evaluation	Inform design of monitoring program
12. Adapt and Scale Up	1. Assess potential ES returns of alternative management plans 2. Identify where to focus new PWS programs

Well-designed to inform
May also be able to inform

Further Details on InVEST Contributions to General PWS Steps

Step 1: Secure government and institutional support for PWS program

Some PWS programs directly rely on government for finance. Others that rely on private payments may still require some government support for administrative and institutional arrangements. To build government and public support for a payment scheme, it may be necessary to demonstrate that the net benefits to society are greater than alternatives. Land management practices subsidized by PWS programs are likely to affect many ecosystem services beyond those directly targeted. For example, a PWS scheme that involves wetland restoration may target flood mitigation, but also provide water purification and groundwater recharge benefits. InVEST can be used at this step to demonstrate how the land-use changes encouraged by a proposed PWS program would affect the quantity, value and location of both targeted and non-target services. InVEST ecosystem service maps can provide visual aids to raise awareness about the importance of ecosystem services, generate and inform stakeholder dialogue and build political momentum towards large-scale PWS.

Step 2: Conduct biophysical assessment

Biophysical assessments may be undertaken to gain an understanding of: a) the current status of ecosystem services targeted by a PWS program, b) the potential for these ecosystem services to be restored and maintained via the program, and c) the land management practices that could achieve ecosystem service delivery most efficiently. InVEST can be used for all three of these goals. InVEST can be particularly useful to identify how to distribute payments, based on the relative contribution of ecosystem service supply at sub-basin or larger scales. InVEST can assess a number of hydrological services that may be relevant to PWS schemes: avoided reservoir sedimentation, hydropower production, and water purification through nutrient retention. In upcoming releases, InVEST will also model flood control and irrigation water for agriculture. However, 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 Tier 1 is not a useful assessment tool. For example, PWS programs that increase or maintain water supplies during the dry season rely on seasonal information. In its current simple Tier 1 version, InVEST cannot predict the ability of a payment program to influence dry-season water flows. Alternative models and additional analyses, including collection of field-based observations and model calibration, will be required to ground-truth

InVEST results and provide information with greater detail and certainty needed to establish PWS contracts around the delivery of some services.

Step 3: Develop governance structure

This step involves establishing a strong governing body that can secure up-front financing, coordinate payments, and monitor effectiveness. This is a largely political and administrative process that InVEST does not contribute to, although InVEST outputs can inform the governing body about various issues involved in PWS programs.

Step 4: Determine potential service buyers

This crucial step involves identifying individuals, organizations, governments or companies who are willing and able to pay for ecosystem service provision. Buyer issues are often paramount for PWS design. Buyers therefore need to be involved from the outset. InVEST can identify where ecosystem services are delivered, giving the first piece of information needed for identifying potential buyers. For example, InVEST can identify reservoirs whose upstream watersheds retain more sediment, keeping dredging costs low. Similarly, InVEST can identify water treatment plants that could reduce water treatment costs by investing in upstream watershed management. These analyses provide a general indication of potential service buyers. However, there may be other common-sense ways to identify potential ecosystem service buyers. InVEST analysis will need to be supplemented with direct discussions with potential buyers to determine whether they are able and willing to participate in a PWS program.

Step 5: Determine service providers

The goal of PWS programs is to provide incentives to ecosystem service 'providers', who can manage land in ways that improve or maintain the delivery of services. An essential step in the design of PWS programs is to identify potential ecosystem service providers. InVEST can identify where ecosystem services are supplied on a landscape, which can identify broad areas where PWS may be feasible and where to focus payments. InVEST can also be used to estimate how major changes in land-use or management would affect watershed services, thereby helping to determine, at a general level, what practices could be implemented to restore, maintain or enhance service supply. In practice, site specific conditions can be highly variable, making this step complex. InVEST analyses will need to be complemented with stakeholder and property rights assessments to determine whether potential service suppliers are able and willing to participate in the PWS program. A long-term dialogue with potential providers is usually required.

Step 6: Set prices

Price setting for ecosystem services is primarily a negotiation between buyers and sellers. However, InVEST can provide lower-bound estimates of the economic values to society of ecosystem services such as water purification (via avoided treatment costs), sediment retention (via avoided dredging costs) or provision of irrigation water (via marginal crop values). These values may inform price negotiations, although in many cases, payment levels are based on the capital costs of desired management practices and opportunity costs faced by ecosystem service providers. Values from InVEST should **not** be interpreted as 'prices' for PWS. Negotiations typically depend on the level of trust and confidence among providers and buyers.

Step 7: Conduct institutional assessment

This step involves assessing the existing policy, regulatory and land ownership framework to see if PWS are viable and, if not, what reforms are required. Reforms could include strengthening the property rights of ecosystem service suppliers or developing the legal framework to enable payments to take place. Legal and policy expertise are required here..

Step 8: Conduct capacity assessment

PWS programs require supporting entities, such as intermediary organisations that can verify service delivery or reduce transaction costs by connecting buyers and sellers. This step involves identifying and, if necessary, developing the capacity to provide these services.

Step 9: Establish success criteria

A PWS scheme typically establishes criteria to evaluate success (e.g. efficiency, equity). These criteria are determined by stakeholders, but information from the biophysical assessment can help to identify them. For example, an InVEST analysis of how land-use change is likely to affect erosion control could help set a target for efficient delivery of that service.

Step 10: Determine contract & payment types

Several contract types and payment mechanisms can be used in PWS programs, such as Memoranda of Understanding, legal contracts or 'handshake' agreements. Contracts lay out the type and timing of payments, the length of the contract and requirements that must be met by suppliers. PWS can involve direct financial payments but may also take the form of in-kind payments or finance for projects that support community goals such as building schools or strengthening land rights. InVEST is not suitable here.

Step 11: Monitoring and evaluation

Ultimately, the long-term sustainability of a PWS program requires that services are actually delivered in return for payments. Determining service delivery requires monitoring of relevant, reliable and measurable indicators that enable evaluation of the effectiveness of PWS. InVEST is not a real-time monitoring device; it models how ecosystem services are expected to alter on an average annual basis under land-use arrangements, and is therefore not useful for directly assessing the performance of subsidized management practices. Hydrological monitoring is necessary to track actual changes in ecosystem service provision. However, InVEST can be used to determine where to place monitoring stations thereby improving the efficiency of the monitoring design.

Step 12: Adaptation

As PWS programs are monitored and evaluated, they can be adapted to improve performance, and to fit changing economic and environmental conditions. Just as in Step 2, InVEST can be used to evaluate the ecosystem service impacts of alternative possible adaptations of the scheme and thereby inform evolving PWS programs. InVEST can also identify areas where ecosystem services are supplied for future PWS, as programs are taken to a broad scale.

Overarching Issues with Using InVEST for PWS

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

Geographic scale: Many ecosystem services in InVEST involve hydrologic processes that are best described at the sub-basin or larger scales. This makes InVEST inappropriate for PWS programs at a small watershed scale (500-5000 ha). However, InVEST can be used to identify sub-basins that will likely return greater benefits from investments, for large scale PWS or scaling up small-scale pilot PWS. Often government financed programs are larger in scale than user-financed schemes (Wunder et al, 2008).

Relative vs. absolute values: Without calibration, InVEST is most useful for identifying where to focus PWS, 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 for PWS decisions based on absolute values, such as informing price negotiations.

Biophysical vs. economic terms: InVEST can quantify ecosystem services in biophysical terms (e.g. cubic meters of water), which can be useful for targeting payments 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. Valuation can only be done once the biophysical parts of the models are calibrated to observed data. Given the simplifications in the biophysical and economic models, economic value estimates should be treated as first estimates only, for gaining support for PWS schemes and informing price negotiations. Values from InVEST should **not** be interpreted as 'prices' for PWS.

Time and resources required: The skill and data requirements needed to apply InVEST are relatively limited. The scope and availability of data all affect the amount of time and capacity required. Based on past experience, it takes 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 PWS will take longer. This may be less if only one or two hydrological services are being considered. For informing PWS, the team would need someone with basic GIS proficiency and a hydrologist. For more on data required, see the User's Guide.

Temporal scale: The current InVEST Tier 1 models only provide estimates of ecosystem services on an annual average basis. When monthly or seasonal patterns in ecosystem service provision are important for PWS, InVEST is not a useful assessment tool.

Further reading on InVEST and SEA

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

Engel, S., Pagiola, S., & Wunder, S. (2008). Designing payments for environmental services in theory and practice: An overview of the issues. *Ecological Economics*, 65, 663-674.

Forest Trends and The Katoomba Group. (2008). Payments for ecosystem services. Getting started: A primer. *Forest Trends, The Katoomba Group and UNEP*.

Smith, M., de Groot, R., Perrot-Maitre, D., Bergkamp, G. (2006). Pay: Establishing payments for watershed services. IUCN, Water and Nature Initiative.

Wunder, S. (2005). Payments for environmental services: Some nuts and bolts. CIFOR Occasional Paper #42.

Wunder, S., Engel, S., Pagiola, S. Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries. *Ecological Economics*, 65, 834-852.

InVEST in Practice is a series of short introductory materials to show potential InVEST users how the current InVEST Tier 1 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 establishing PWS programs.

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