Payments for Watershed Services & Water Funds

Both Integrated Valuation of Environmental Services and Tradeoffs (InVEST) and RIOS (Resource Investment Optimization System) can be used to design cost – effective payments for watershed services (PWS) and water funds. InVEST models can quantify the supply, location, and value of water-related ecosystem services (ES) and identify desired levels of their provisioning. RIOS can help target investments in management activities (e.g. restoration or protection) to meet multiple goals, and select among options based on ES returns. Together, the tools' key contributions to PWS development include baseline ES assessment, identification of ES buyers and providers, creation of feasible management alternatives, and adaptation of PWS to changing environmental conditions. Outlined below are InVEST/RIOS's key contributions to PWS and water funds:

Planning step	How InVEST can help
1. Scoping	Explore how ecosystem services interact
2. Engage Stakeholders	*N/A*
3. Develop governance structure	*N/A*
4. Define indicators and thresholds	Assess how marine use may affect ES
5. Assess existing conditions	Assess current ES status
6. Develop future scenarios	Develop future scenarios based on possible alternatives
7. Assess future scenarios	Assess impacts of future scenarios
8. Develop spatial management plan	Inform plan (based on previous steps)
9. Identify sustainable finance	Identify ES beneficiaries
10. Implementation	Identify ES providers/beneficiaries for enforcement plan
11. Monitoring and evaluation	Inform design of monitoring plans
12. Adaptive management	Assess returns of management plans; inform adaptation

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 and other NatCap tools 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 the tools are used.

PWS is a type of payment for ecosystem services (PES) scheme that incentivizes restoration and protection activities to sustain or improve watershed services (e.g. flood and erosion control, water regulation and purification). PES programs are contractual and voluntary transactions where a 'buyer' agrees to provide payment to a 'seller' conditional on delivery of an ES, or on the implementation of management practices likely to secure that service (e.g. wetland restoration).[1] Establishing PWS often takes years, requiring extensive stakeholder engagement and ES research. Water funds are a type of PWS in which financing is administered based on an independently governed trust fund, which enables a long-term horizon for activities.[23] The Natural Capital Project works with water funds across Latin America.

1: Secure government/ institutional support for PWS program

Use InVEST to show how PWS/water fund-induced land-use change could affect quantity, value, and location of target and non-target services. InVEST ES maps can help demonstrate the benefits of a PWS scheme to build stakeholder support, inform dialogue and build political momentum for pursuing a PWS program.

2: Conduct biophysical assessment

Use InVEST to establish a baseline of ES provisioning, and structure the PWS scheme based on relative contributions of ES supply at sub-basin or larger scales. Use RIOS' prioritization tool to identify areas of high potential impact for investments. This tool ranks areas according to biophysical data (e.g. topography), social information (e.g. legal limitations) and economic data (e.g. activity costs) to determine where investments are feasible and which activities will provide the highest returns. Both InVEST and RIOS can assess avoided sedimentation and hydropower production. RIOS can also prioritize areas for PWS activities based on seasonal base flow, flood, and groundwater recharge enhancement.

3: Develop governance mechanism

Establish a governing body to secure up-front financing, coordinate payments, and monitoring. This is largely a political and administrative process.

4: Identify service buyers

Use InVEST to identify potential buyers by locating areas where, for example, water treatment plants could reduce costs by investing in upstream watershed management. Supplement InVEST analysis with discussions with potential financiers.

5: Identify service providers

Use InVEST to assess where ES are supplied on the landscape. Use InVEST and RIOS to estimate how changes in land-use would affect ES, and identify potential management practices. Supplement InVEST analyses with stakeholder and property rights assessments to determine whether potential service suppliers will participate in the program. A long-term dialogue with potential providers is usually required.

6: Develop water fund portfolio alternatives

Use RIOS to produce an investment portfolio based on activity costs and budget; assess relative return on investment (ROI) for potential fund activities. RIOS can account for pre-allocated funds to priority areas and determine if there are enough funds to meet user goals. The investment portfolio can present a series of investments across several years and identify tradeoffs between priorities. Once a portfolio is chosen, use InVEST models to estimate the ES changes that could result from implementation.

7: Set prices or payments

Price setting for ES is primarily a negotiation between buyers and providers. However, InVEST can provide estimates of services' economic values to society (e.g. through avoided water treatment or dredging costs). These values may inform price negotiations, though payment levels are often based on costs of management practices and opportunity costs faced by ES providers. Values from InVEST should **not** be directly applied as prices for ES in a PWS scheme.

8: Conduct institutional assessment, develop capacity

Assess the regulatory and land ownership framework to determine the viability of PWS. Reforms could be necessary (e.g., defining the property rights of ES suppliers and legal frameworks to enable payments). Identify entities to support the PWS program, to connect buyers and sellers, or verify ES delivery. Develop mechanisms to support their capacity.

9: Establish success criteria

Establish criteria (e.g. efficiency, equity) with stakeholders. InVEST analysis from the biophysical assessment step can be helpful here. 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.

10: Determine and implement contract & payment types

Define the timing of payments and their type (e.g. financial or in-kind payments to support community goals). Establish a contractual mechanism through an MOU, legal contract or less formal 'handshake' agreement.

11: Monitoring and evaluation

Use InVEST to assess relevant, measurable ES indicators both before and after implementation. InVEST is not a real-time monitoring device; it models how ES are expected to alter under land-use arrangements. InVEST can inform the siting of monitoring stations, thereby improving the efficiency of the monitoring design. Field data inputs regarding ES provision can be plugged into InVEST to determine whether goals have been met.

12: Adapt and scale-up

As the PWS program is monitored and evaluated, adapt practices to fit changing economic and environmental conditions. As in previous steps, use RIOS and InVEST to evaluate ES impacts of alternative adaptations of the program. RIOS and InVEST can also identify areas where future PWS programs may be beneficial and help them expand to a broader scale.

Key Issues for payments for watershed services and water funds

Applicable ecosystem services

InVEST can model three hydrological services for PWS: avoided reservoir sedimentation, hydropower production and water purification. In the future, InVEST will include models for flood control, seasonal water yield, irrigation water for agriculture, and agricultural production. RIOS can prioritize PWS investments for erosion control, nutrient retention (N and P), flood mitigation, groundwater recharge enhancement, dry season baseflows, biodiversity, and other (user-defined) objectives. Other tools are likely to be needed to assess water supply-related services when groundwater is a significant component of yield, or when ES impacts will greatly affect groundwater or the ground/surface water balance.

Temporal scale

The current versions of InVEST and RIOS consider ES provision on an annual average basis, although future releases will address seasonal (i.e., monthly) water yields. When seasonal patterns in service provision for sediment or nutrient retention are of interest (e.g. for programs that increase or maintain water supplies during the dry season), alternative models and/or field observations will be required.

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 and RIOS are most useful for identifying where to focus PWS based on relative contributions of ES across the landscape. However, if InVEST models are calibrated and there is good correlation between modeled results and direct observations, InVEST can be used for PWS decisions based on absolute values, such as informing price negotiations. In addition, some individual components of RIOS do not require calibration (such as the prioritization tool).

Alternative measures for InVEST outputs

RIOS prioritizes areas for PWS based on relative scoring of potential ES impacts, which can help target payments across landscapes. InVEST can quantify ES in biophysical terms (e.g. cubic meters of water), which can help to identify service providers and beneficiaries. It can also estimate economic values, in dollar terms, using a range of techniques e.g. avoided damage or treatment costs and market valuation. Valuation can only be completed once the biophysical parts of the models are calibrated to time series data. Given the simplifications in the biophysical and economic models, economic values should be treated as first estimates only, e.g. for gaining support for PWS.

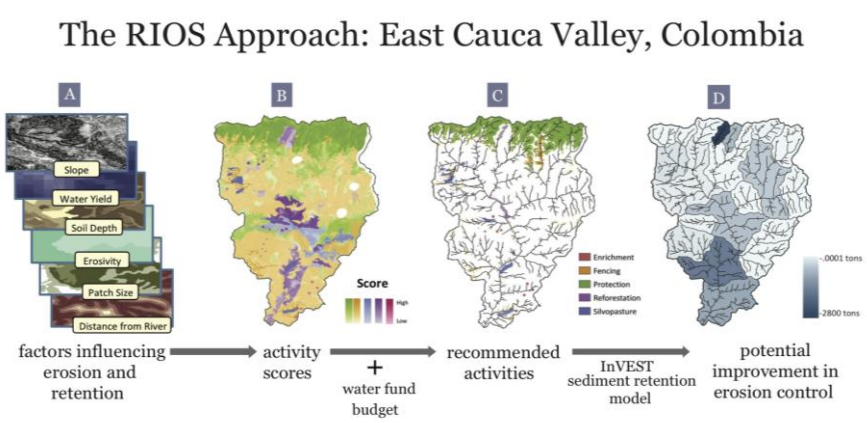
Time and resources required

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, using only the RIOS prioritization tool can be quicker than a complete application of InVEST in the context of PWS. In addition, the team may use global datasets for initial estimates of ES values, or work with partners to compile detailed local data (which can be time consuming). 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 and RIOS will also be relevant here. In the context of PWS, the team will require a hydrologist and someone with intermediate GIS proficiency. For more information, see the InVEST User's Guide.

InVEST in Practice: Example Applications

Cauca Valley, Colombia

The Natural Capital Project's approach for optimization of water fund investments in the East Cauca Valley of Colombia laid the foundation for developing RIOS. Early applications of RIOS in the Cauca Valley resulted in watershed investments up to six times more effective than typical investment approaches.
http://www.naturalcapitalproject.org/where/colombia.html



Water Producer Program, Cantareira Water Supply, Brazil

The Water Producer Program (WPP) provides financial compensation to farmers living in critical water production areas in return for reforestation of degraded areas, protection of existing forests, and soil conservation practices. The WPP applied the InVEST sediment retention model to identify priority erosion areas and to estimate the benefit that could be achieved through the program's activities in areas at high risk of erosion.

Ongoing work

RIOS and InVEST are currently being used to inform PWS design for the Monterey Water Fund in Mexico, the Ayampe Water Fund in Ecuador, for climate adaptation planning in Nicaragua, and for improving targeting of watershed conservation actions in Himachal Pradesh, India.

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

RIOS Toolbox and download
naturalcapitalproject.org/RIOS.html

RIOS and Water funds
naturalcapitalproject.org/pubs/WaterFunds_Brochure.pdf

We are grateful for comments from Sarah Lynch (WWF), Tracy Stanton (Forest Trends) & Christine Tam (Stanford).

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

[2] Goldman-Benner, R. L., Benitez, S., Boucher, T., Calvache, A., Daily, G., Kareiva, P., Kroeger, T. and Ramos, A. (2012). Water funds and payments for ecosystem services: practice learns from theory and theory can learn from practice. *Fauna & Flora International*, Oryx, 46(1), 55–63.

[3] Wunder, S. and Alban, M. (2008). Decentralized payments for environmental services: the cases of Pimampiro and PROFAFOR in Ecuador. *Ecological Economics*, 65, 685–698.

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