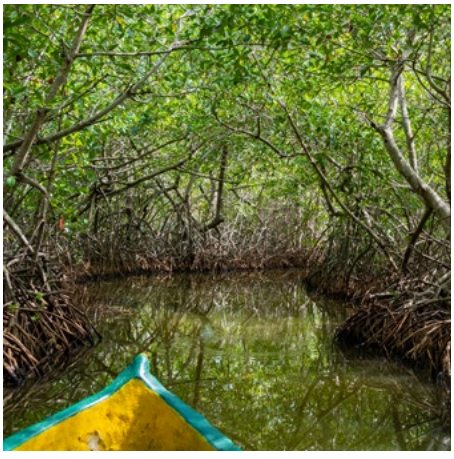
A powerful tool to map and value ecosystem services

Natural capital refers to the Earth's lands, waters, and biodiversity.

Ecosystem services are the benefits people obtain from ecosystems, such as timber and water purification from forests, recreation and cooling from city parks, and honey and crop pollination from bees.



InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) is a suite of free, open-source software models used to map and value the goods and services from nature that underpin economic activities and human well-being. InVEST currently includes 20 ecosystem service models, covering terrestrial, freshwater, coastal and marine, and urban contexts. InVEST was designed by scientists and software engineers at the Natural Capital Project and has been used in over 185 countries worldwide and in over 600 peer-reviewed scientific publications.

InVEST models are spatially explicit, using maps as information sources and producing maps and summary metrics as outputs. InVEST generally returns results in biophysical terms (e.g., tons of sediment pollution avoided, tons of carbon sequestered), which can then be translated into metrics on their value, such as monetary values (e.g., net present value of avoided sediment pollution or carbon sequestration) or the number of people who benefit (e.g., number of households with improved access to clean water, number of lives saved from heat-related deaths in cities). The spatial extent and resolution of analyses is flexible, allowing users to address questions at local, regional, or global scales.

InVEST is a scenario-based tool, allowing users to evaluate ecosystem services under current conditions, historic baselines, or potential future conditions. InVEST can therefore be used to consider the impacts of investments in restoration or protection of ecosystems, the risks of further environmental degradation, or the effects of climate change on ecosystem services—and the associated risks and opportunities to companies and financial institutions.

Using InVEST within TNFD's LEAP approach

InVEST is well-suited to support companies and financial institutions using the LEAP approach[1], the suggested risk and opportunity assessment approach from the Taskforce on Nature-related Financial Disclosures (TNFD)[2]. The LEAP approach includes four phases:

Locate your interface with nature;

Evaluate your nature-related dependences and nature impacts;

Assess your nature-related risks and opportunities; and

Prepare to respond and report.

InVEST is especially relevant to the *Locate*, *Evaluate*, and *Assess* phases.

Locating the interface with nature

InVEST can be used to generate maps of natural capital hotspots, showing areas of high ecosystem service value to society broadly, or to a particular company's activities. These maps can be overlaid with maps of a company's physical assets or operational locations to produce TNFD's suggested outputs from the Locate phase[3]. Maps from InVEST can highlight priority areas where a company may be impacting important ecosystem services, as well as areas where a company may depend on ecosystem services produced elsewhere in the landscape, so that these areas can be evaluated further.

Global maps of natural capital hotspots generated with InVEST can be found online at the Natural Capital World Viewer[4], and in several scientific publications[5]. They have also been integrated into the Swiss Re Institute's Biodiversity and Ecosystem Services Index[6].

Evaluating nature-related impacts and dependencies

With InVEST, users can map and quantify both impacts to and dependencies on ecosystem services for a company's operations as part of the Evaluate phase of LEAP. For example, a beverage bottling company that relies on surface water can use InVEST to identify where and to what extent environmental assets contribute to maintaining the clean, reliable water

1 https://framework.tnfd.global/leap-the-risk-and-opportunity-assessment-approach/
2 https://tnfd.global/
3 https://framework.tnfd.global/leap-the-risk-and-opportunity-assessment-approach/locate/
4 https://naturalcapitalproject.stanford.edu/software/natural-capital-world-viewer
5 Chaplin-Kramer, R., Sharp, R. P., Weil, C., Bennett, E. M., Pascual, U., Arkema, K. K., ... & Daily, G. C. (2019). Global modeling of nature's contributions to people. Science, 366(6462), 255-258. https://www.science.org/doi/abs/10.1126/science.aaw3372

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6 https://www.swissre.com/media/press-release/nr-20200923-biodiversity-and-ecosystems-services.html

Ecosystem services that can be modeled in InVEST:

Terrestrial & freshwater

- Carbon storage and sequestration
- Crop pollination
- Crop production
- Nature-based recreation
- Scenic quality
- Annual and seasonal water yield
- Sediment retention
- Water purification

Coastal & marine

- Coastal risk reduction
- Coastal blue carbon
- Offshore wind energy
- Wave energy

Urban

- Urban cooling
- Urban stormwater retention
- Urban flood risk mitigation
- Urban nature access

supply on which the company depends. A company with operations along the coast could use InVEST to evaluate the impacts a loss of coastal habitats would have on the risks posed by coastal storms to local communities and the company's operations.

PHOTO CREDIT: Antonio Busiello/WWF (coral reef, bird in nest, fishing boat)

Assessing nature-related risks and opportunities

In the Assess phase of the LEAP process, the use of scenarios in InVEST can be an especially powerful tool for understanding and planning to manage risks and opportunities. For example, an agricultural company could use InVEST to answer questions such as how their adoption of agricultural best management practices could reduce water pollution from the company's fields, and thereby mitigate reputational or regulatory risks. Or they might ask, what could enhancements to pollinator habitat in and around fields do to boost yields? How could investments in conservation or restoration of ecosystems in the source watershed for a company's water supply help secure a clean, reliable source of water?

Considerations when using InVEST

InVEST can be run on Mac OS and Windows computers as a desktop application, integrated into other business applications through its Python API, and easily deployed to servers with a provided Docker container. Additional geospatial software such as QGIS or ArcGIS is needed to prepare input data and to view and analyze results. Outputs can also be visualized in interactive dashboards such as Tableau.

To run InVEST, users must provide model-specific input data, which commonly includes maps of ecosystem locations, climate data, and information on the properties of ecosystems (such as the ability to retain sediments or ability to attenuate waves). The InVEST User's Guide[7] provides detailed information on locating and preparing input data.

The Natural Capital World Viewer provides global maps from InVEST for a select set of ecosystem services, allowing users to identify ecosystem service hotspots at global, national, and regional scales. These maps can be viewed and summrized without any specialized software at https://naturalcapitalproject.stanford.edu/software/natural-capital-world-viewer.

7 https://naturalcapitalproject.stanford.edu/software/invest

natural capital PROJECT

InVEST Integrated Valuation of Ecosystem Services and Tradeoffs

About the Natural Capital Project

The Natural Capital Project is an interdisciplinary team of researchers, software engineers, and other professionals working to make valuing natural capital easier and more accessible to everyone. With our global hub at Stanford University, the Natural Capital Project is a collaboration among academic partners including the Chinese Academy of Sciences, the Royal Swedish Academy of Sciences, the Stockholm Resilience Centre, and the University of Minnesota, with core implementing partners including The Nature Conservancy and World Wildlife Fund.

For more information about InVEST

Learn more and download InVEST for free at https://naturalcapitalproject.stanford.edu/software/invest or connect with our active community of InVEST users and experts at https://community.naturalcapitalproject.org/

See examples of InVEST in action on our Projects page at https://naturalcapitalproject.stanford.edu/projects

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