

Artificial Intelligence for Ecosystem Services: A tool for spatially explicit ecosystem services assessment, planning, and valuation

ARIES is a web-based tool designed as a decision aid for land management and environmental decision making, which enables rapid ecosystem service assessment and valuation. *Ecosystem services* are the economic benefits that nature provides to people. They can be used to more inclusively frame costs, benefits, and tradeoffs in conservation and economic development. Examples of ecosystem services include water supply, flood and coastal storm regulation, nutrient regulation, and carbon sequestration and storage. ARIES helps users map and value ecosystems and the benefits they provide to specific human beneficiary groups across specific geographies. ARIES was initially funded by a grant from the National Science Foundation to the University of Vermont, Conservation International, and Earth Economics beginning in 2007. Since that time additional partner originations and funders from the public, private, academic, and NGO sectors have contributed to ARIES' ongoing development.

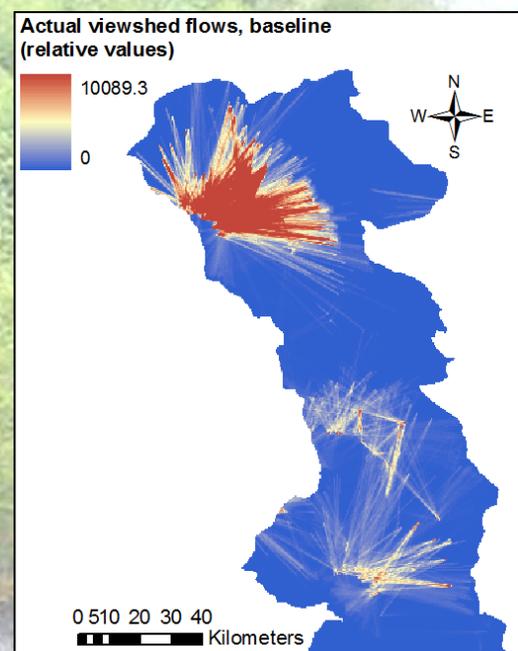
How it works

ARIES contains an extensive database of spatial data and ecosystem service models across local to global scales. Data are “tagged” with relevant concepts so that ecosystem service models automatically call on, transform, and integrate the needed data into each model for a region’s ecological and socioeconomic context. The open-source ARIES modeling language assembles, transforms, and processes data automatically for each ecosystem service. Results are returned to the user during an online ARIES session. While full reporting of results takes place online, the user can also export results for use with external GIS software for further display and analysis.

ARIES maps the location of people or groups who are the beneficiaries of ecosystem services, and quantifies their demand for each service (Figure 1). For instance, ARIES separately considers cases for flooding on rivers, and in coastal zones, and their impacts on residents, infrastructure, and cropland. Regulation of each of these disturbances depends on different processes and patterns of water flows. Different beneficiary groups are explicitly identified (e.g., crops, housing, lives at risk, privately-owned structures or public infrastructure), as each of these groups value the benefit differently.

Figure 1: Line-of-sight flows between property owners and high-quality views (e.g., mountains, water bodies) for the San Pedro River watershed in southeast Arizona. Flow maps show the precise beneficiaries of ecosystem services and support more accurate economic valuation.

Researchers have long recognized that the ecosystems that provide benefits to people and the beneficiaries of these services are not always in the same locations. ARIES is the first modeling tool to account for this. ARIES uses models to map provision, use, and sinks (features that deplete or transform an ecosystem service carrier as it moves across the landscape) of ecosystem services. We then model movement of a carrier for each service (e.g., tons of carbon dioxide, tons of sediment, kg of fish, or abstract units of view) across the landscape according to service-specific flow paths (e.g., through atmospheric mixing, hydrologic flows, transportation networks, or lines of sight). While most past ecosystem services mapping tools and projects have simply mapped the potential provision of ecosystem services, ARIES maps actual *provision, use, and flows* of services by accounting for flow paths and rival use or *sink* regions (Figure 2).



ARIES can use several approaches to economically value ecosystem services. After modeling the ecosystem services of interest, multiple services can be paired with user priorities in a multiple criteria analysis to produce maps of agreement between existing service values and those desired by the user. Such maps can give “abstract” service values. Alternatively, ecosystem service flows can be used to transfer values from past economic studies to the new study region of interest. This is done by generating a transfer function that aggregates values of past economic valuation studies for ecosystem services with the help of a system that identifies most likely candidates for value transfer based on ecological and economic similarities between source and destination areas.

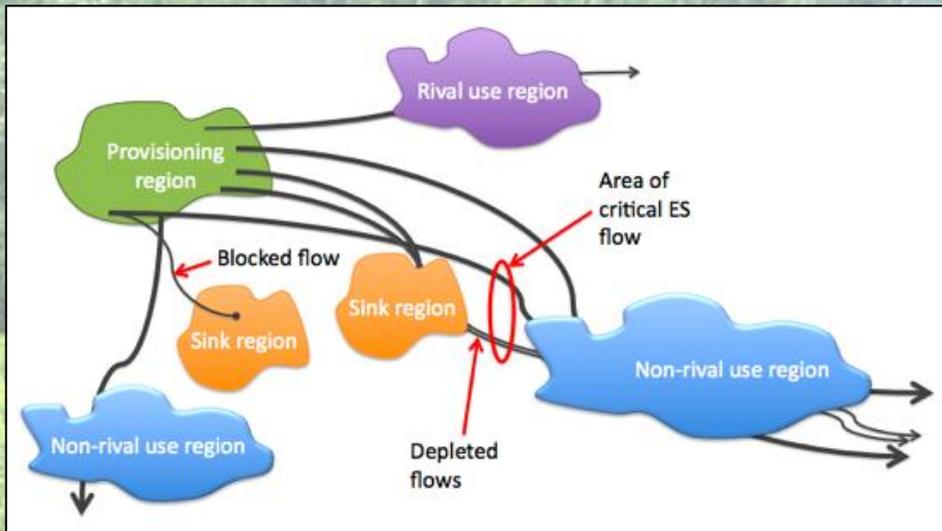


Figure 2: Ecosystem services have value when people can access a benefit provided by nature. We can model ecosystem service flows by considering the locations of ecosystems that supply value and people who demand for particular benefits provided by nature.

Colorado: An ARIES case study region

Colorado’s Rocky Mountains provide well-recognized benefits including water supply to the Platte, Arkansas, Rio Grande, and Colorado Rivers and recreational visits to millions of acres of public lands. Key management challenges include fire management after almost a century of fire suppression, outbreaks of mountain pine beetle, and the impacts of climate change on snowpack and water resources. By mapping ecosystem service provision and beneficiaries, we can better illustrate management tradeoffs in these valued ecosystems.

Past work has been conducted to map social values for ecosystem services using the SolVES tool - spatially explicit survey information showing places where people directly value the landscape for certain cultural services. In this case study, we are comparing the places that people recognize as important locations and areas that are predicted to provide key services such as water supply, control of sediment delivery to reservoirs, carbon sequestration, and the value of scenic views for property owners.

For additional information

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