

ARIES

ARtificial Intelligence for Ecosystem Services

WDPA datasets in modelling Ecosystem Service
Flows from Nature to society: coastal and marine

THE ARIES CONSORTIUM

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ECOINFORMATICS
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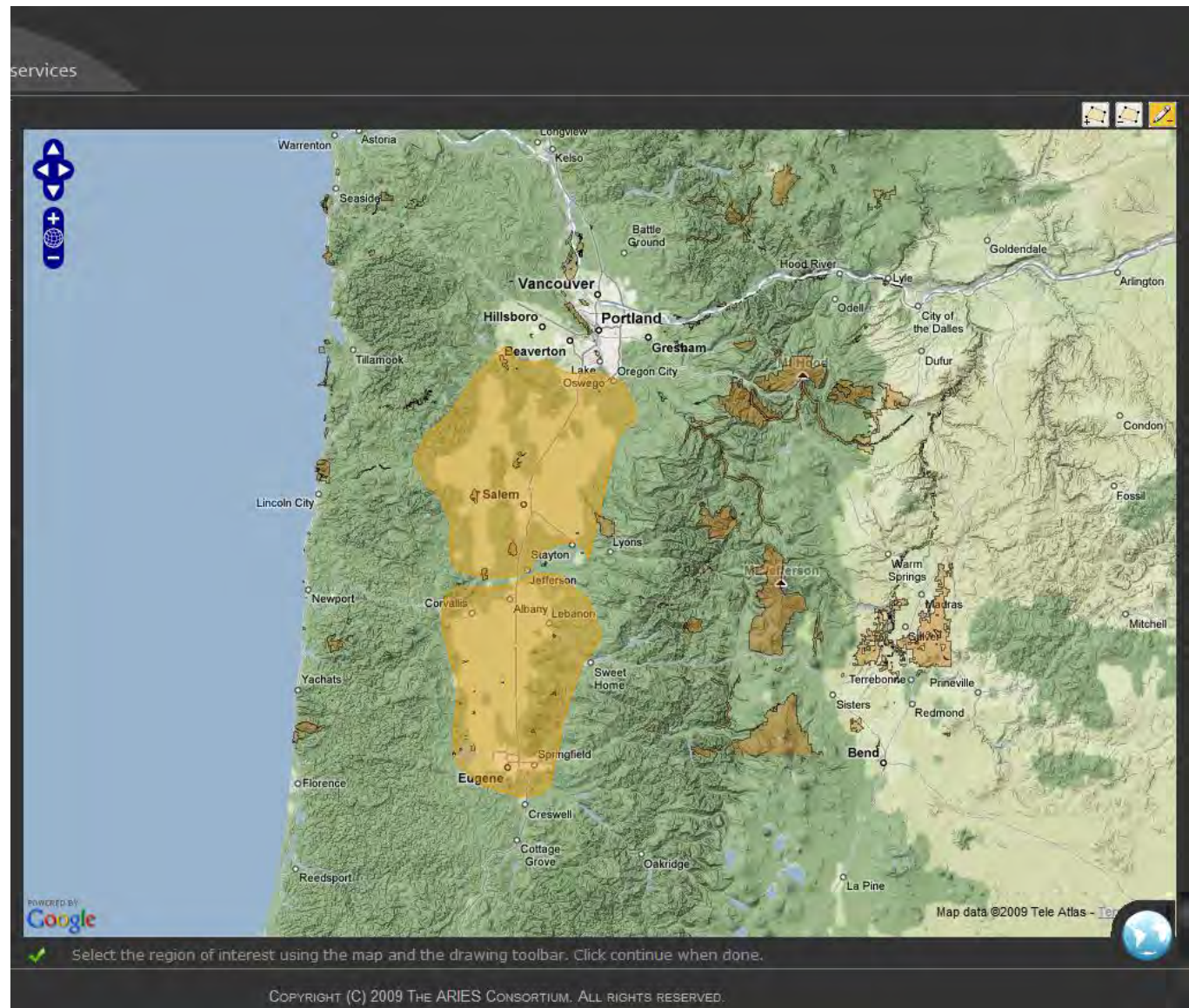
A web-accessible ES explorer

Rapid assessment toolkit for ecosystem services, biodiversity and their values

Integration with WDPA data: service analysis to and from biodiversity rich areas

Integrated ES valuation produces maps of **provision**, **use** and **flow** of ES

UNEP-WCMC supports the extension to marine and coastal environments



The three elements of ES modeling in ARIES

1. provisionsheds



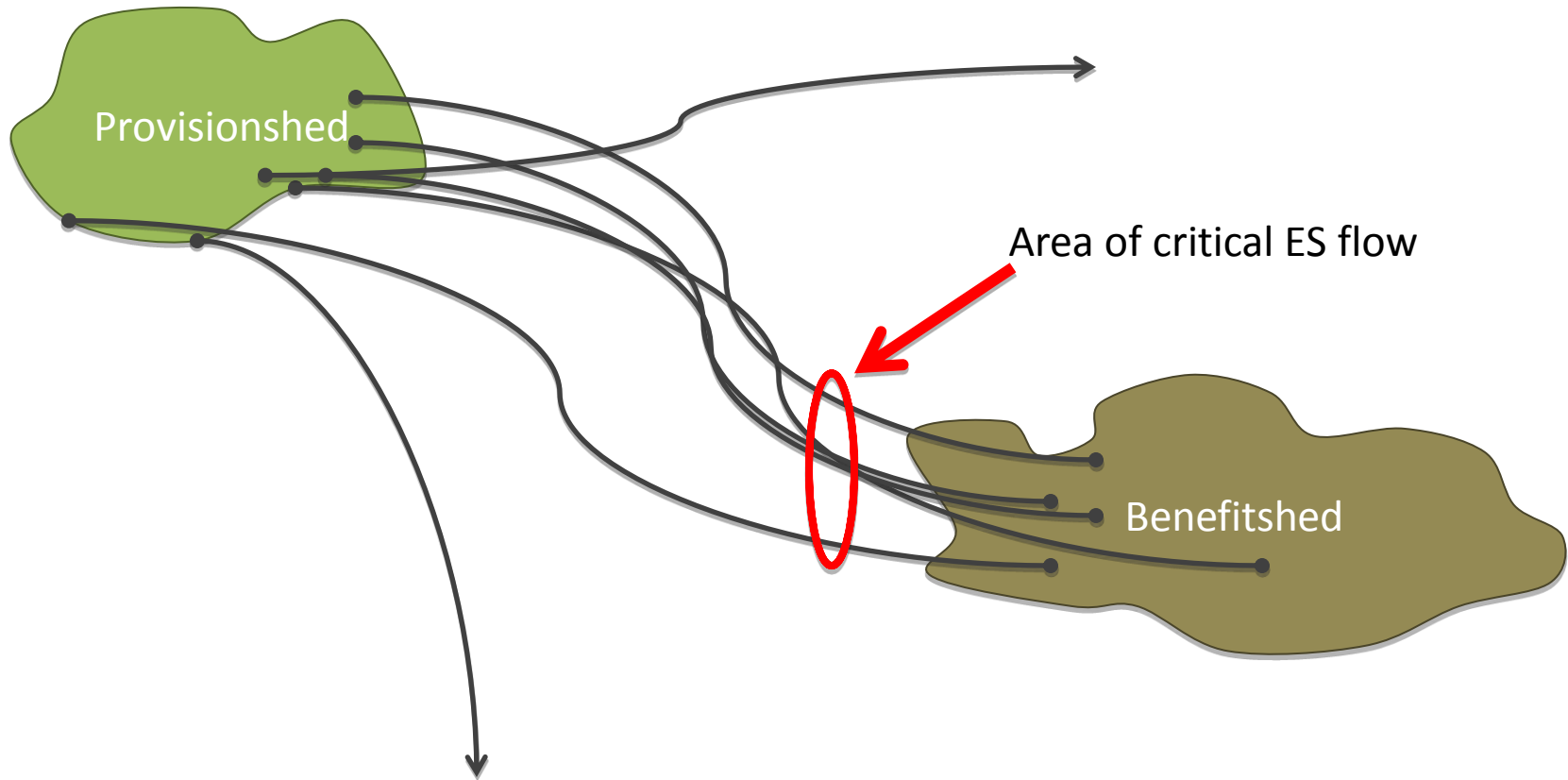
2. benefitsheds

1. Areas of provision of ES and biodiversity

3. Flow paths between areas of provision and areas of use

2. Areas of use of ES and biodiversity where beneficiaries are located

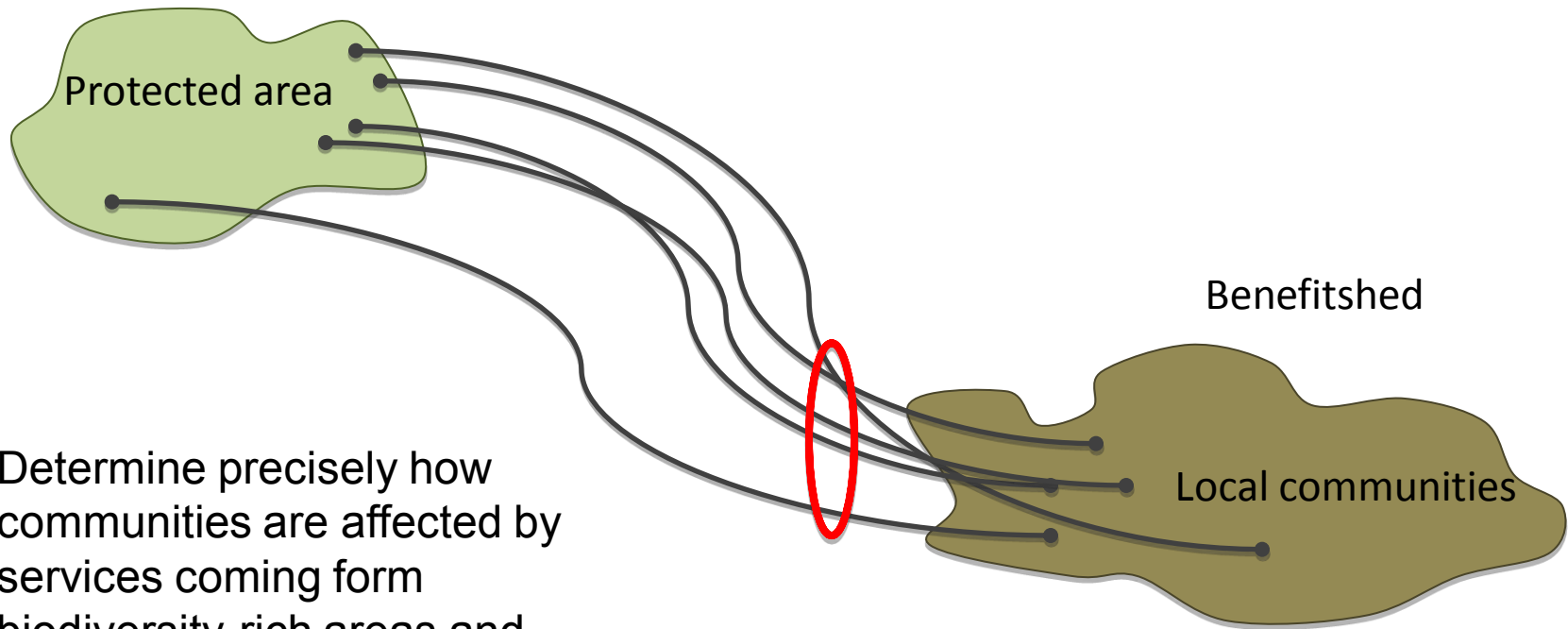
ES flow analysis in ARIES



ARIES and BIODIVERSITY

Ecosystem Services flow **FROM** protected areas

Provisioned

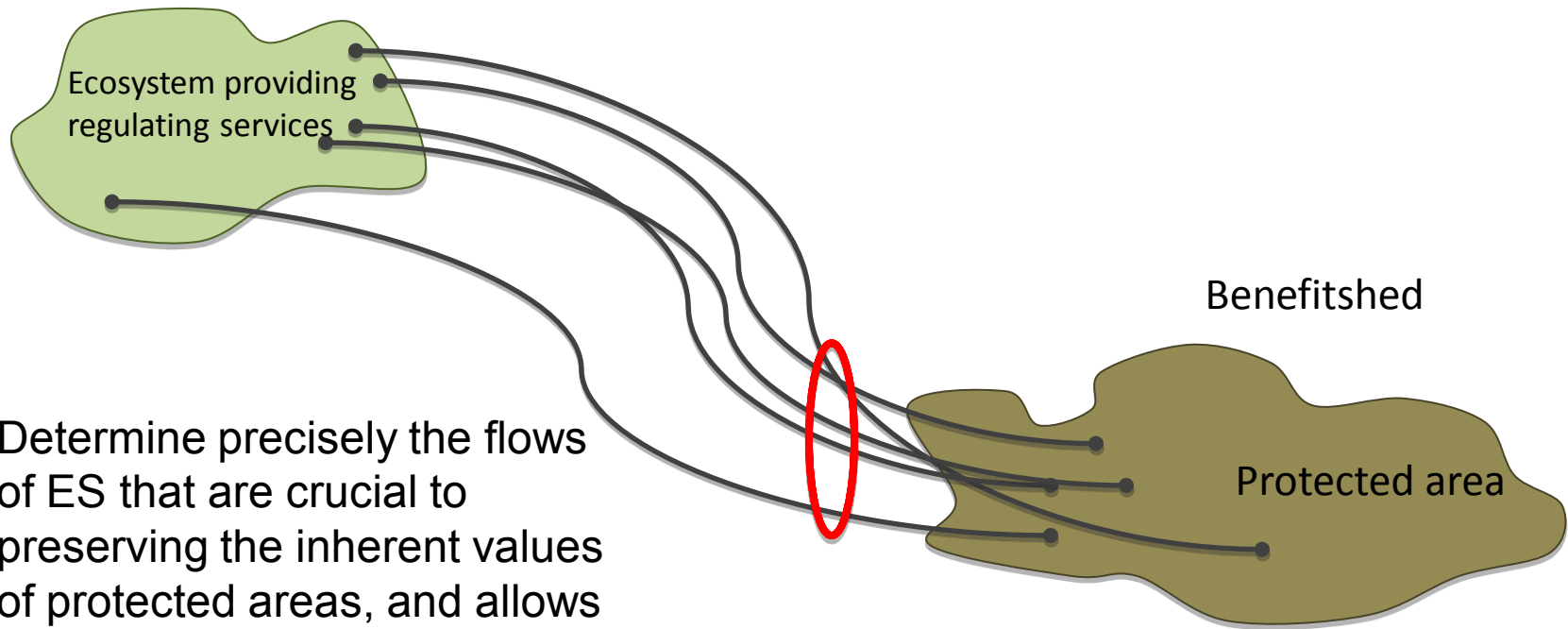


Determine precisely how communities are affected by services coming from biodiversity-rich areas and allows targeting protection to the areas providing the most important ES

ARIES and BIODIVERSITY

Ecosystem Services flow **TO** protected areas

Provisioned



Determine precisely the flows of ES that are crucial to preserving the inherent values of protected areas, and allows targeting conservation and enhancement intervention to areas critical to ES flow.

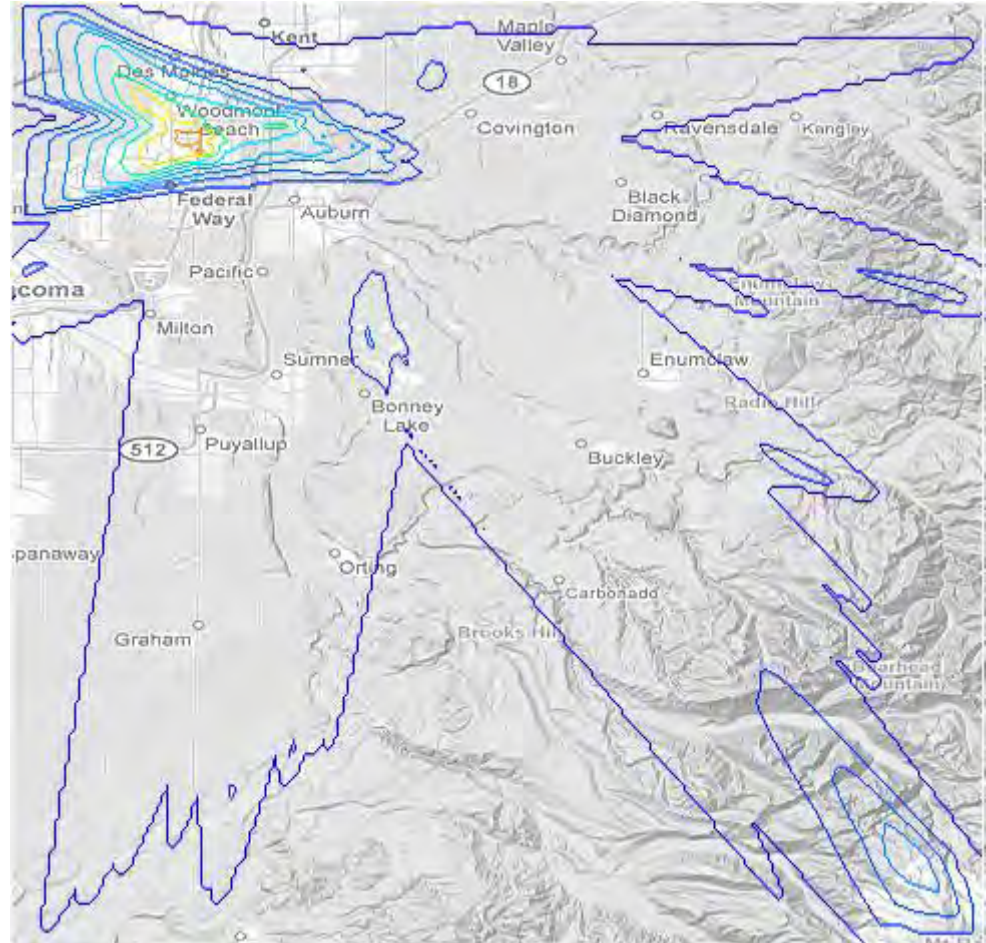
Novel SERVICE FLOW information

Example results: critical flow contours

The critical flow contours tell the user what areas are the most critical for the propagation of the service to the intended beneficiaries.

Armed with such knowledge, it is much easier to plan intervention on the territory. Areas of high criticality should be protected or enhanced, the others are OK for development.

Scenario analysis can compute the effects of possible changes to land configuration on flows.



ARIES in a nutshell

- A rapid assessment toolkit for ecosystem services and their values; not a single model but an intelligent system that customizes models to user goals.
- Demonstrate a mapping process for ecosystem service provision, use, and flow where most ES assessments only looks at provision.
- “Honest” probabilistic models inform decision-makers of likelihood of all possible outcomes; users can explore effects of policy changes and external events.

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ECOSYSTEM SERVICES in the MILLENNIUM ASSESSMENT

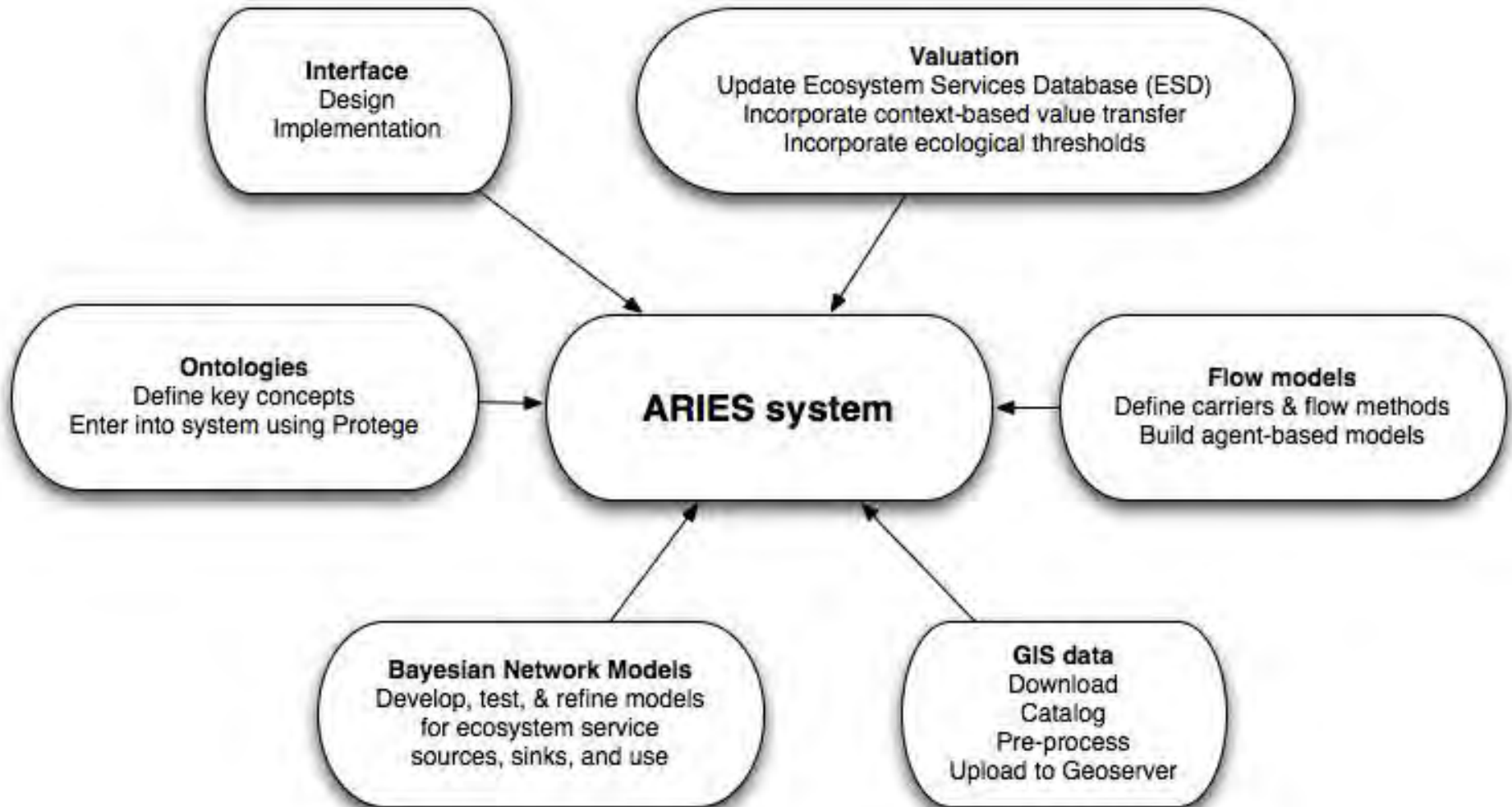
Optimal for communication, raising awareness

Supporting services <ul style="list-style-type: none">-Nutrient cycling-Net primary production-Pollination & seed dispersal-Hydrologic cycle...	Regulating services <ul style="list-style-type: none">-Climate regulation-Disturbance regulation-Water regulation-Nutrient regulation...
Provisioning services <ul style="list-style-type: none">-Water supply-Food-Raw materials...	Cultural services <ul style="list-style-type: none">-Recreation-Aesthetic-Spiritual & historic...

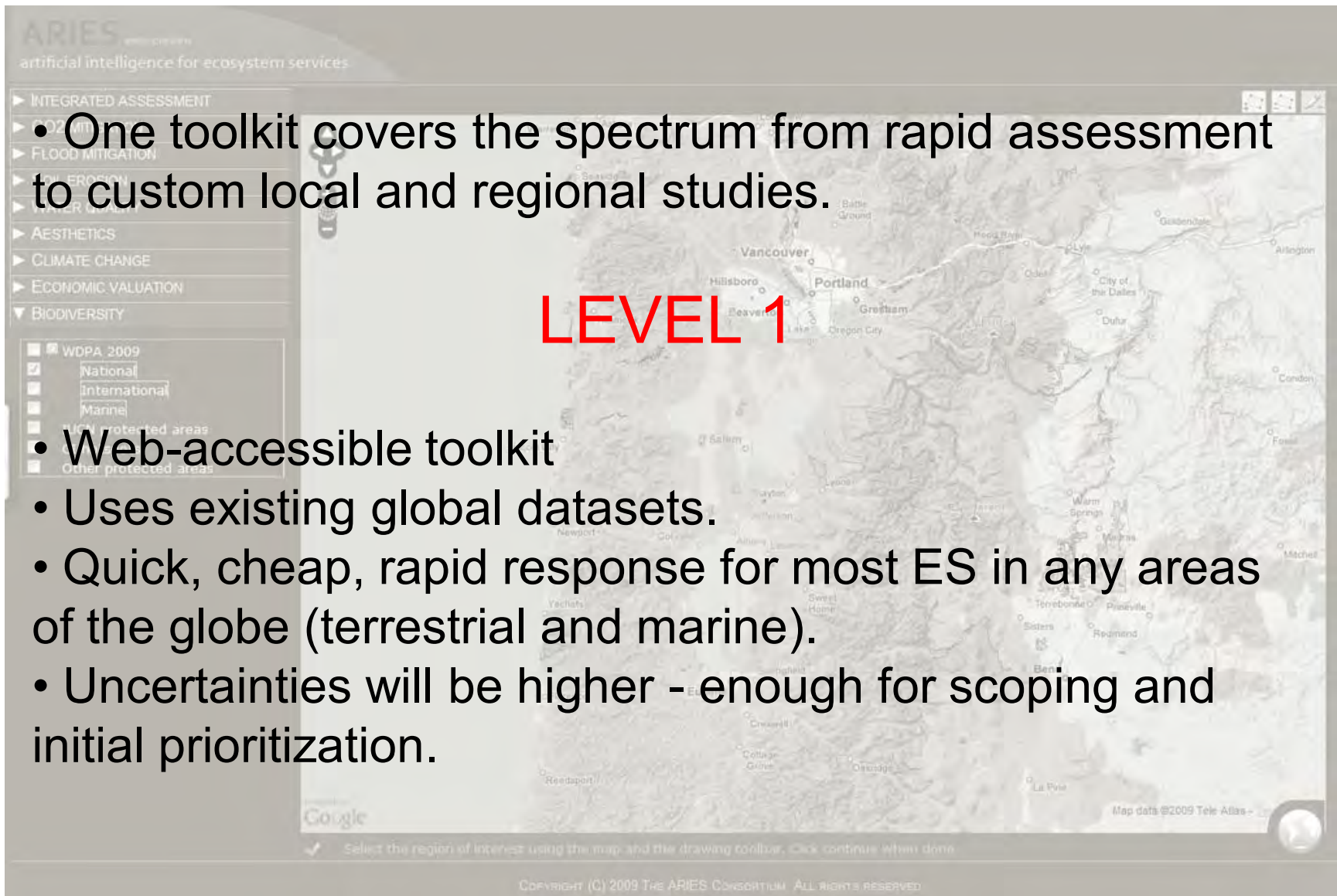
Ecosystem Services are a multiple-scale problem where provision and use have different scales and flow across the landscape in different manners.

Quantitative assessment and valuation require a systematic definition

Components of the ARIES system



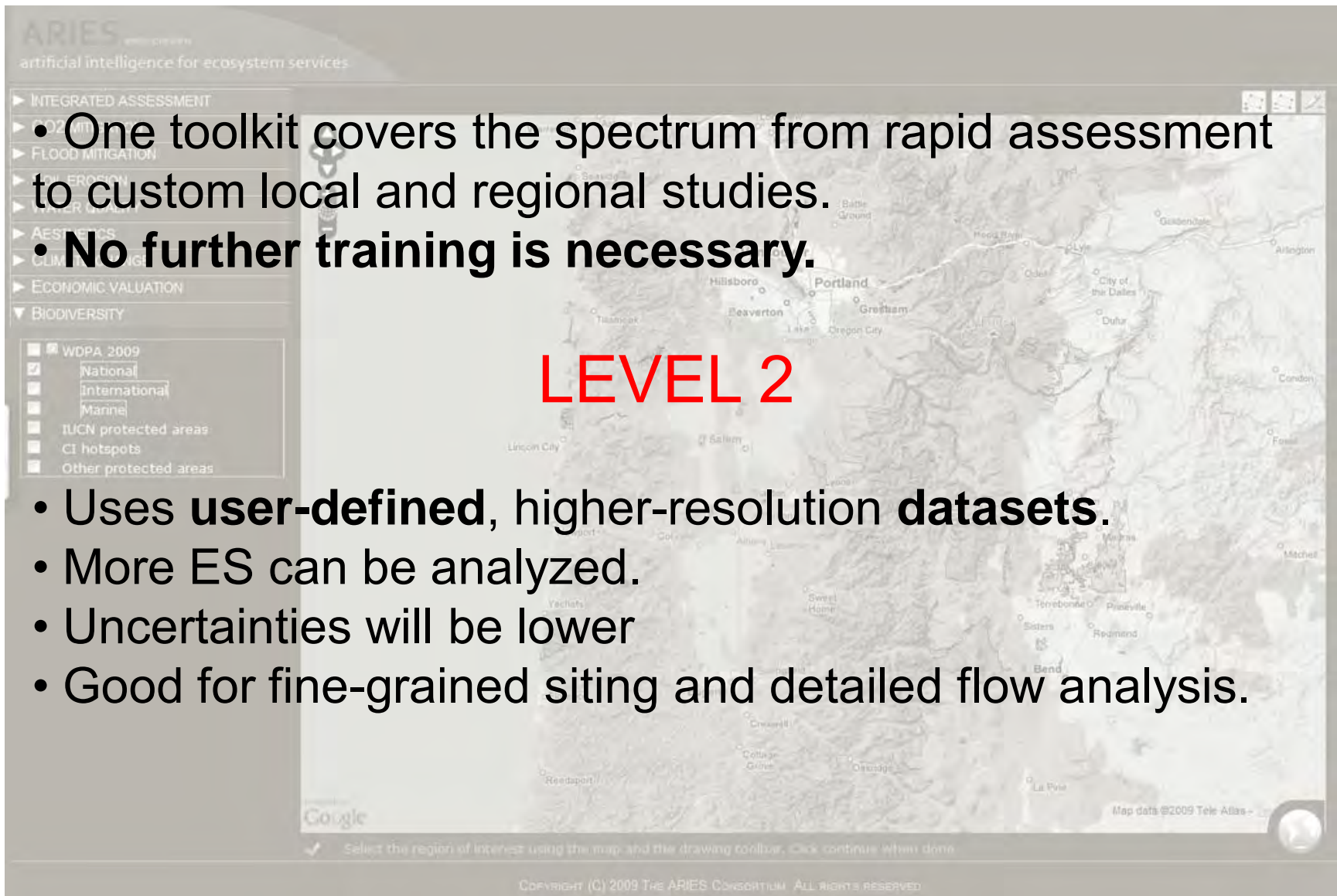
Three use levels, one tool



The screenshot shows the ARIES web application interface. The title bar reads 'ARIES artificial intelligence for ecosystem services'. On the left, there is a navigation menu with categories: INTEGRATED ASSESSMENT, CO2, FLOOD MITIGATION, SOIL EROSION, WATER QUALITY, AESTHETICS, CLIMATE CHANGE, ECONOMIC VALUATION, and BIODIVERSITY. Under BIODIVERSITY, there are sub-options for WDPA 2009 (National, International, Marine), IUCN protected areas, and Other protected areas. The main area is a map of the Pacific Northwest, showing cities like Vancouver, Portland, and Seattle. A red text overlay 'LEVEL 1' is positioned over the map. At the bottom, there is a Google logo and a copyright notice: 'COPYRIGHT (C) 2009 THE ARIES CONSORTIUM ALL RIGHTS RESERVED'.

- One toolkit covers the spectrum from rapid assessment to custom local and regional studies.
- Web-accessible toolkit
- Uses existing global datasets.
- Quick, cheap, rapid response for most ES in any areas of the globe (terrestrial and marine).
- Uncertainties will be higher - enough for scoping and initial prioritization.

Three use levels, one tool



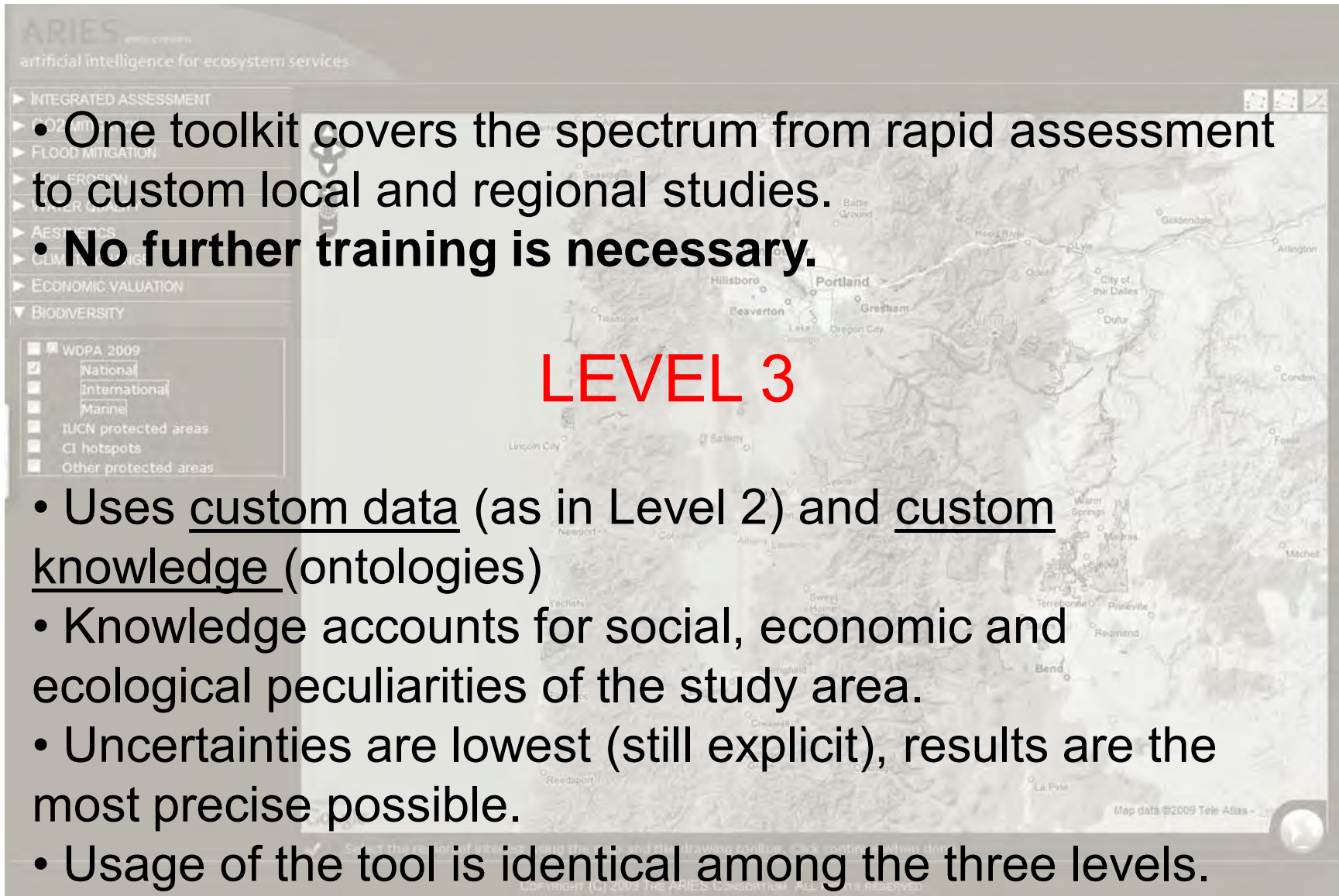
The screenshot shows the ARIES (artificial intelligence for ecosystem services) software interface. On the left, there is a navigation menu with categories: INTEGRATED ASSESSMENT, CO2 MITIGATION, FLOOD MITIGATION, SOIL EROSION, WATER QUALITY, AESTHETICS, CLIMATE CHANGE, ECONOMIC VALUATION, and BIODIVERSITY. Under BIODIVERSITY, there is a legend for WDPA 2009 with sub-categories: National (checked), International, Marine, IUCN protected areas, CI hotspots, and Other protected areas. The main area is a map of Oregon with various cities labeled, including Portland, Beaverton, Gresham, and Bend. The text 'LEVEL 2' is overlaid in red on the map. At the bottom, there is a Google logo and a copyright notice: 'COPYRIGHT (C) 2009 THE ARIES CONSORTIUM ALL RIGHTS RESERVED'.

- One toolkit covers the spectrum from rapid assessment to custom local and regional studies.
- **No further training is necessary.**

LEVEL 2

- Uses **user-defined**, higher-resolution **datasets**.
- More ES can be analyzed.
- Uncertainties will be lower
- Good for fine-grained siting and detailed flow analysis.

Three use levels, one tool



The image shows a screenshot of the ARIES (Artificial Intelligence for Ecosystem Services) software interface. The interface includes a sidebar with a menu of assessment categories: INTEGRATED ASSESSMENT, CO2, FLOOD MITIGATION, SOIL EROSION, WATER QUALITY, AESTHETICS, CLIMATE, ECONOMIC VALUATION, and BIODIVERSITY. Under BIODIVERSITY, there is a legend for WDPA 2009 with checkboxes for National, International, Marine, IUCN protected areas, CI hotspots, and Other protected areas. The main area displays a topographic map of Oregon with various cities and towns labeled, including Portland, Beaverton, Gresham, and Salem. The text 'LEVEL 3' is overlaid in large red letters on the map. The bottom of the interface shows a copyright notice: 'COPYRIGHT (C) 2009 THE ARIES CONSORTIUM. ALL RIGHTS RESERVED.'

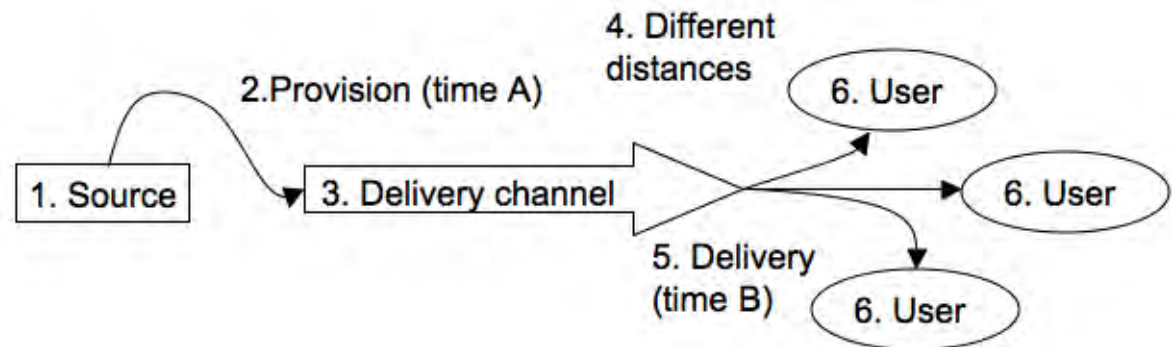
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LEVEL 3

- Uses custom data (as in Level 2) and custom knowledge (ontologies)
- Knowledge accounts for social, economic and ecological peculiarities of the study area.
- Uncertainties are lowest (still explicit), results are the most precise possible.
- Usage of the tool is identical among the three levels.

Mapping ES in ARIES

- 4-step process:
 1. Identify beneficiary groups & carriers of each ES (matter, energy, or information)
 2. Develop conceptual models of ES provision, sinks, and use; turn models into Bayesian Networks
 3. Collect spatial data for contributors to Bayesian Network models
 4. Develop flow models to move ES from ecosystems to people, with possible sink dynamics along the way

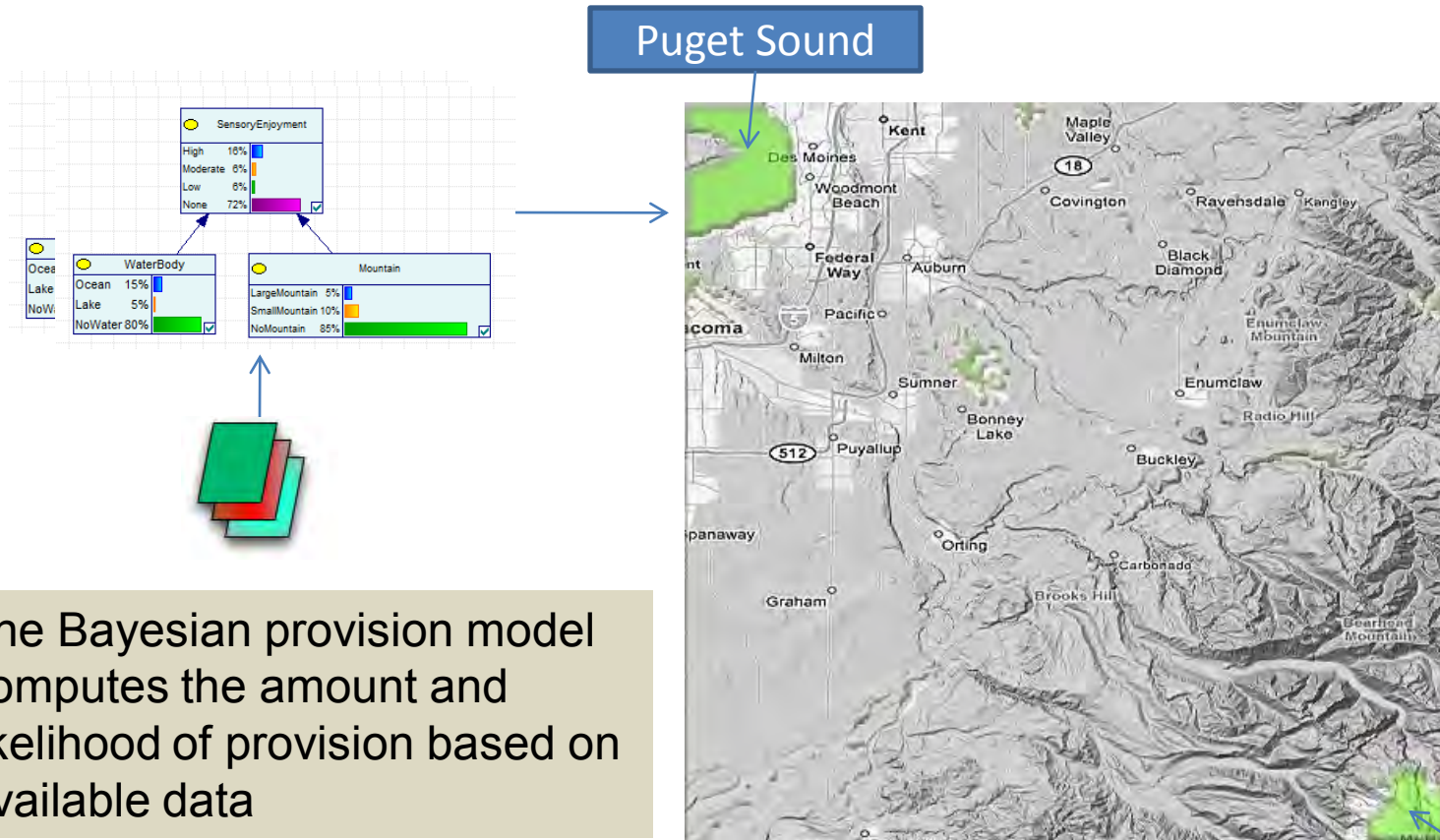


Ruhl et al. 2007

Ruhl et al. 2007

Example: Puget Sound “viewshed” analysis

Provisionshed

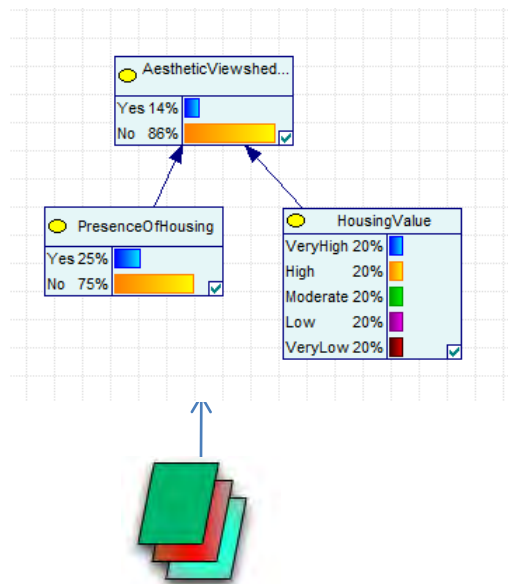


The Bayesian provision model computes the amount and likelihood of provision based on available data

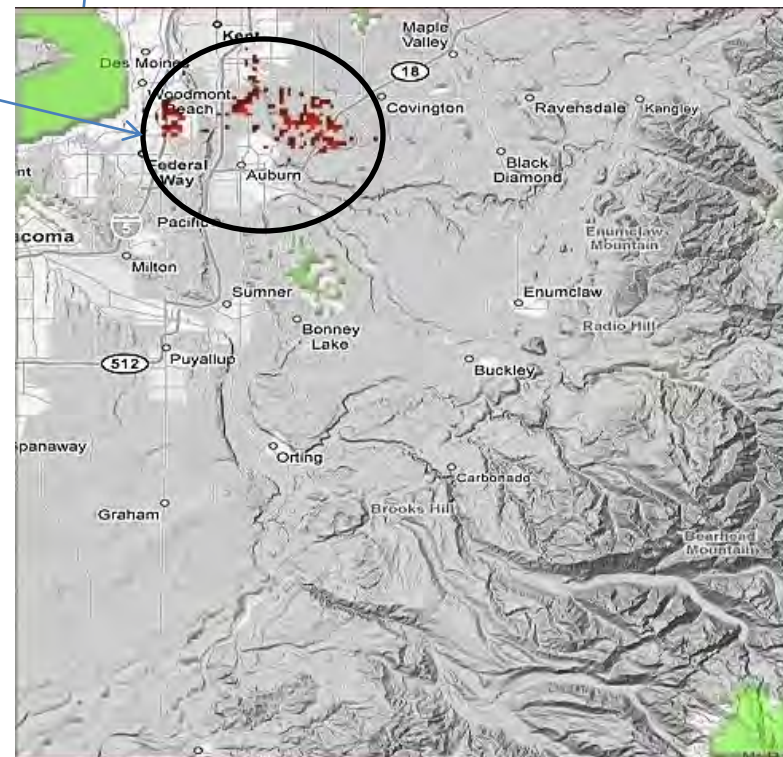
Mount Rainier

Example: Puget Sound “viewshed” analysis

Benefitshed



Puget Sound



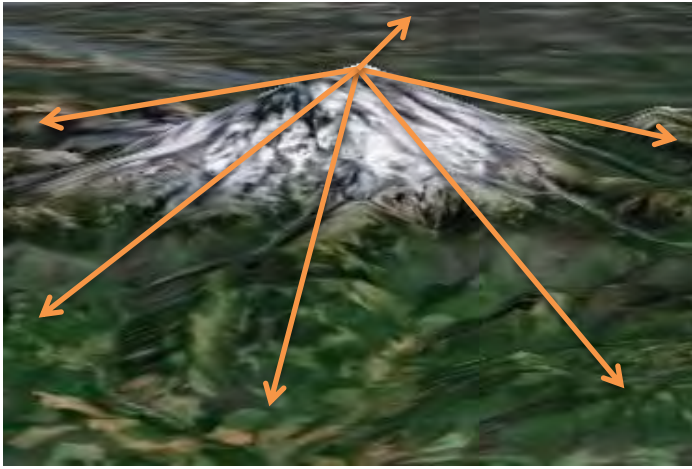
Mount Rainier

The Bayesian use model computes the amount and likelihood of use based on housing value and population data (only Kent municipality)

Identifying carriers & flow paths

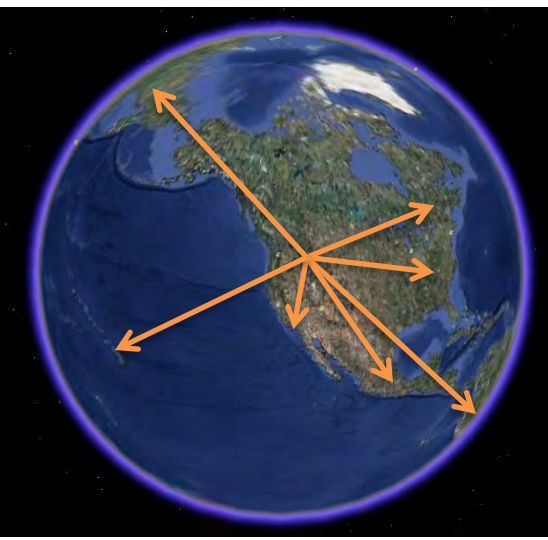


Hydrologic services



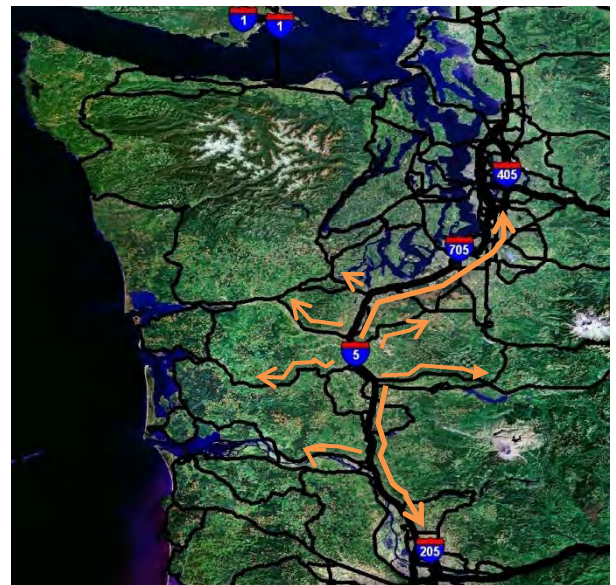
Aesthetic viewsheds

Recreation, flood regulation, many ecosystem goods



Carbon sequestration, some cultural values

Recreation, aesthetic proximity, some cultural services



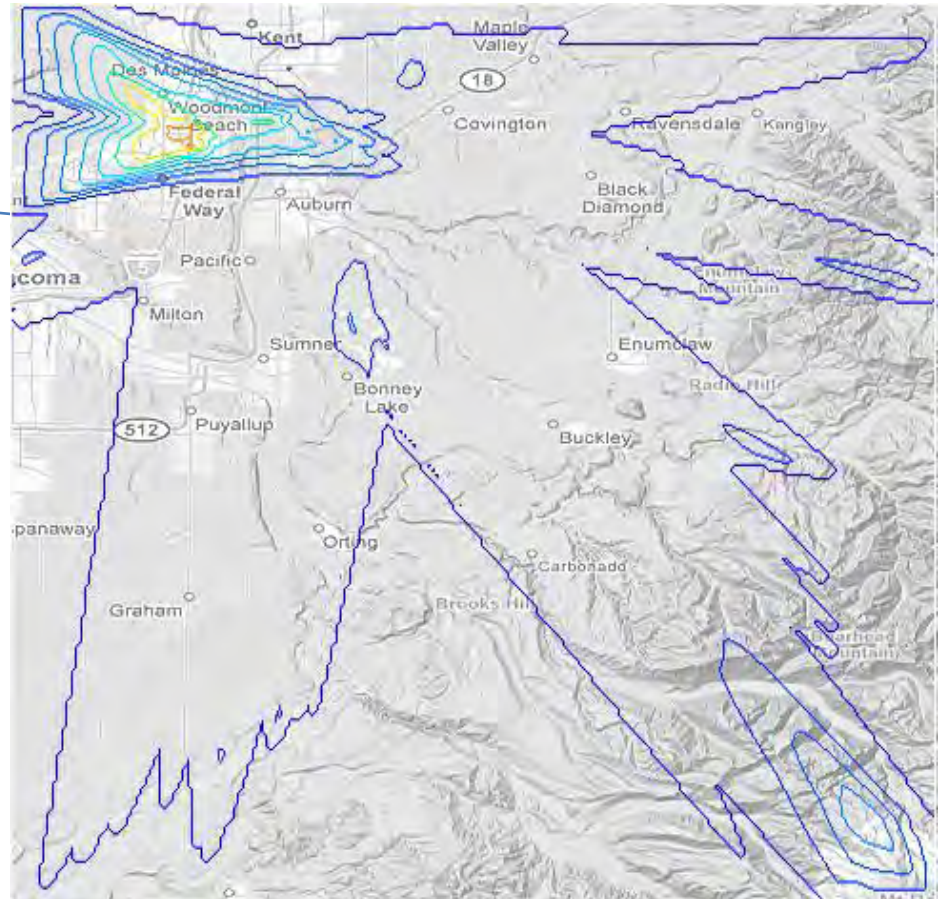
Example: Puget Sound “viewshed” analysis

Critical flow contours

The critical flow contours tell the decision maker what areas are the most critical for the propagation of the service to the intended beneficiaries.

Armed with such knowledge, it is much easier to plan intervention on the territory. Areas of high criticality should be protected or enhanced, the others are OK for development.

Scenario analysis can compute the effects of possible changes.



Puget Sound “viewshed” analysis

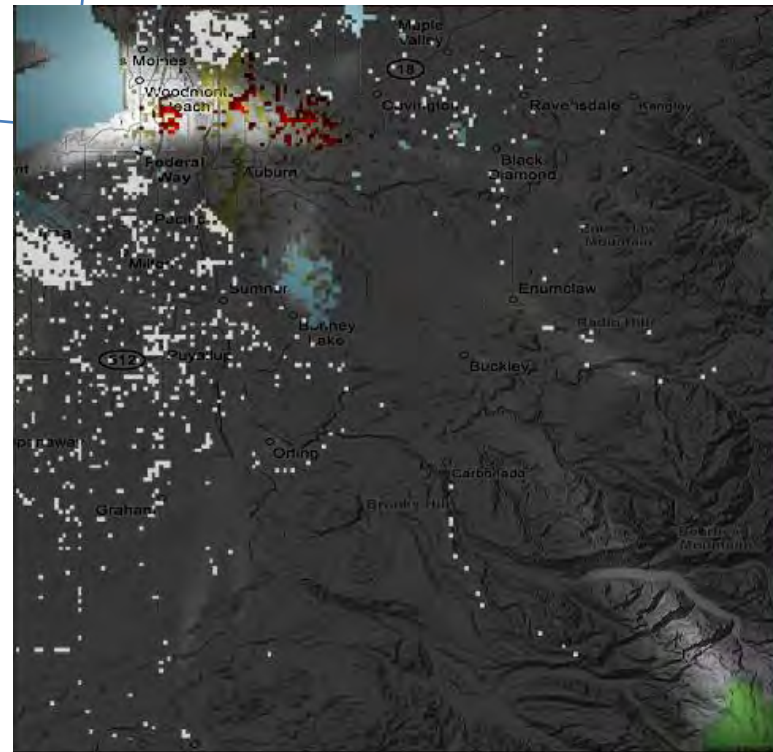
More example results: inaccessible service sink

Puget Sound

The white dots are the “negative” areas (service sinks) that do not detract from service provision to the intended beneficiaries.

This tells a decision-maker that development in these areas will not affect service provision to this group of beneficiaries.

Many such maps can be produced from the results of flow analysis.



Mount Rainier

The web-accessible ES analyzer

ARIES will be delivered in different ways, all with intuitive web interfaces. The prototype shown here also contains an ES valuation database and a biodiversity explorer toolkit.

Users select areas interactively and ES provision, use and flows are calculated automatically. Each service module has different scenario options to explore.

Case studies and specific users have custom interfaces built to suit their needs.

ARIES early preview
artificial intelligence for ecosystem services

- ▶ INTEGRATED ASSESSMENT
- ▶ CO2 MITIGATION
- ▶ FLOOD MITIGATION
- ▶ SOIL EROSION
- ▶ WATER QUALITY
- ▶ AESTHETICS
- ▶ CLIMATE CHANGE
- ▶ ECONOMIC VALUATION
- ▼ BIODIVERSITY

WDDPA 2009

- National
- International
- Marine
- IUCN protected areas
- CI hotspots
- Other protected areas

Map data ©2009 Tele Atlas

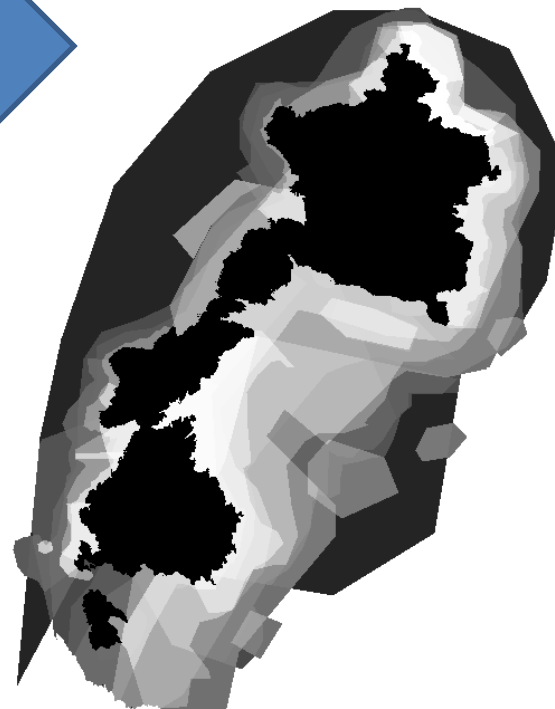
SELECT THE REGION OF INTEREST USING THE MAP AND THE DRAWING TOOLBAR. CLICK CONTINUE WHEN DONE.

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ARIES and valuation: non-economic

abstract valuation = concordance between benefit flows
and stakeholder priorities

	C	F	W	R	Value
Climate	1	9	9	9	377
Flood		1	9	3	455
Water			1	2	51
Raw mat				1	51



Relative importance values for benefits
are input by users

Overall value map is recalculated to
reflect stated priorities in each scenario
of management

Concordance values are the equivalent of
value to stakeholders, and vary between 0
(no value) to 1 (complete concordance)

ARIES and economic valuation

- Primary valuation:
 - WTP surveys, hedonics, travel cost, consumer expenditures, avoided/replacement cost
- Secondary valuation:
 - “Value transfer”: apply values from elsewhere to your site of interest
 - Function transfer
 - Traditional multiple regression
 - Bayesian multiple regression
 - Artificial Intelligence mediated
 - Flow-based
 - Point transfer
- Ecological-economic modeling

THANK YOU

For more information:

- E-mail: ecoinformatics@uvm.edu
- Web site (incomplete!):
<http://ecoinformatics.uvm.edu/aries>
- YOUTUBE video:
<http://www.youtube.com/watch?v=5yHnUTPADMw>

ARIES 1.0 will be public in Summer 2010; alpha and beta releases will start appearing in October 2009; a proof of concept marine and coastal tool is expected in January 2010.