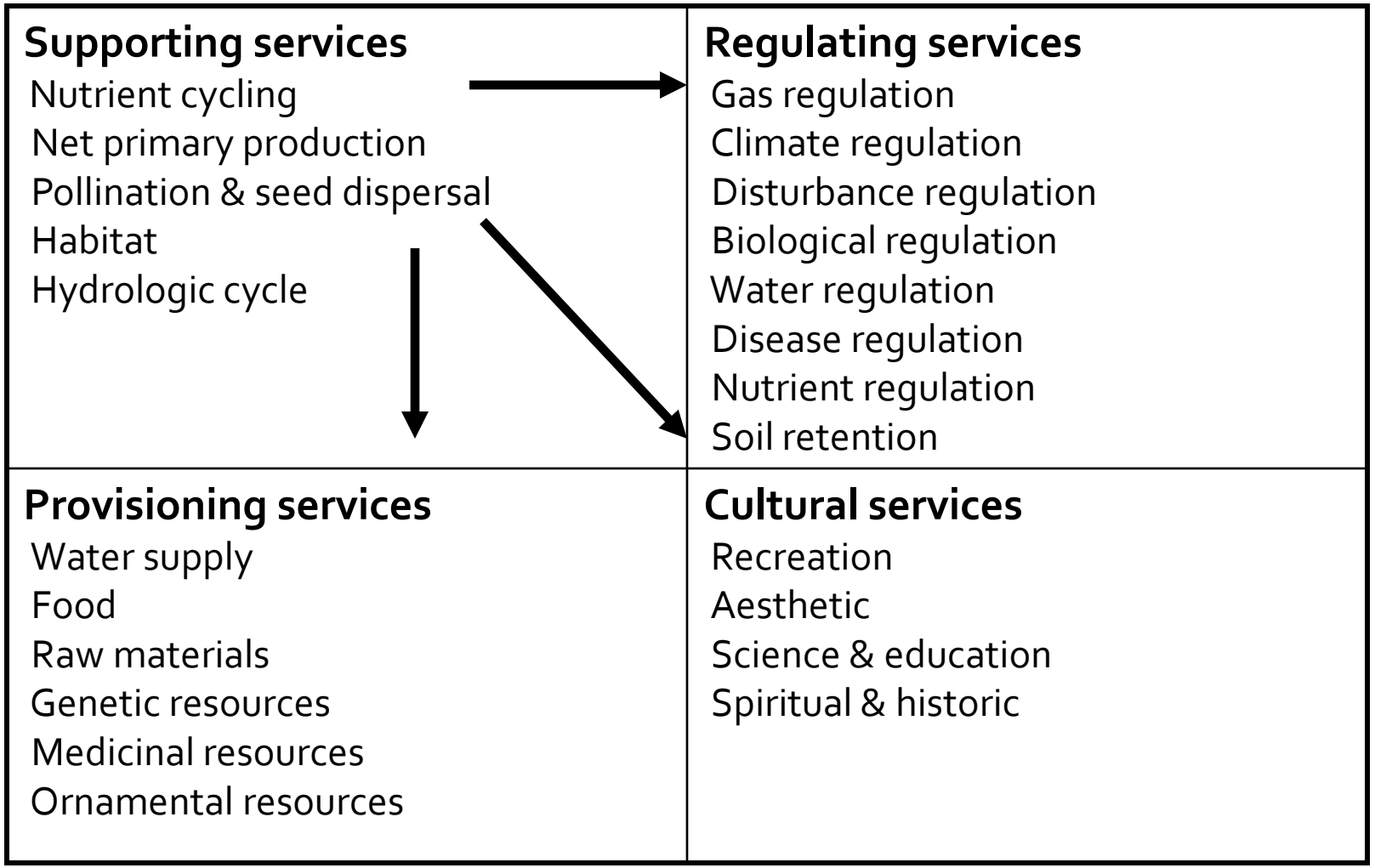
INTEGRATED ASSESSMENT MODEL

RACC ANNUAL MEETING

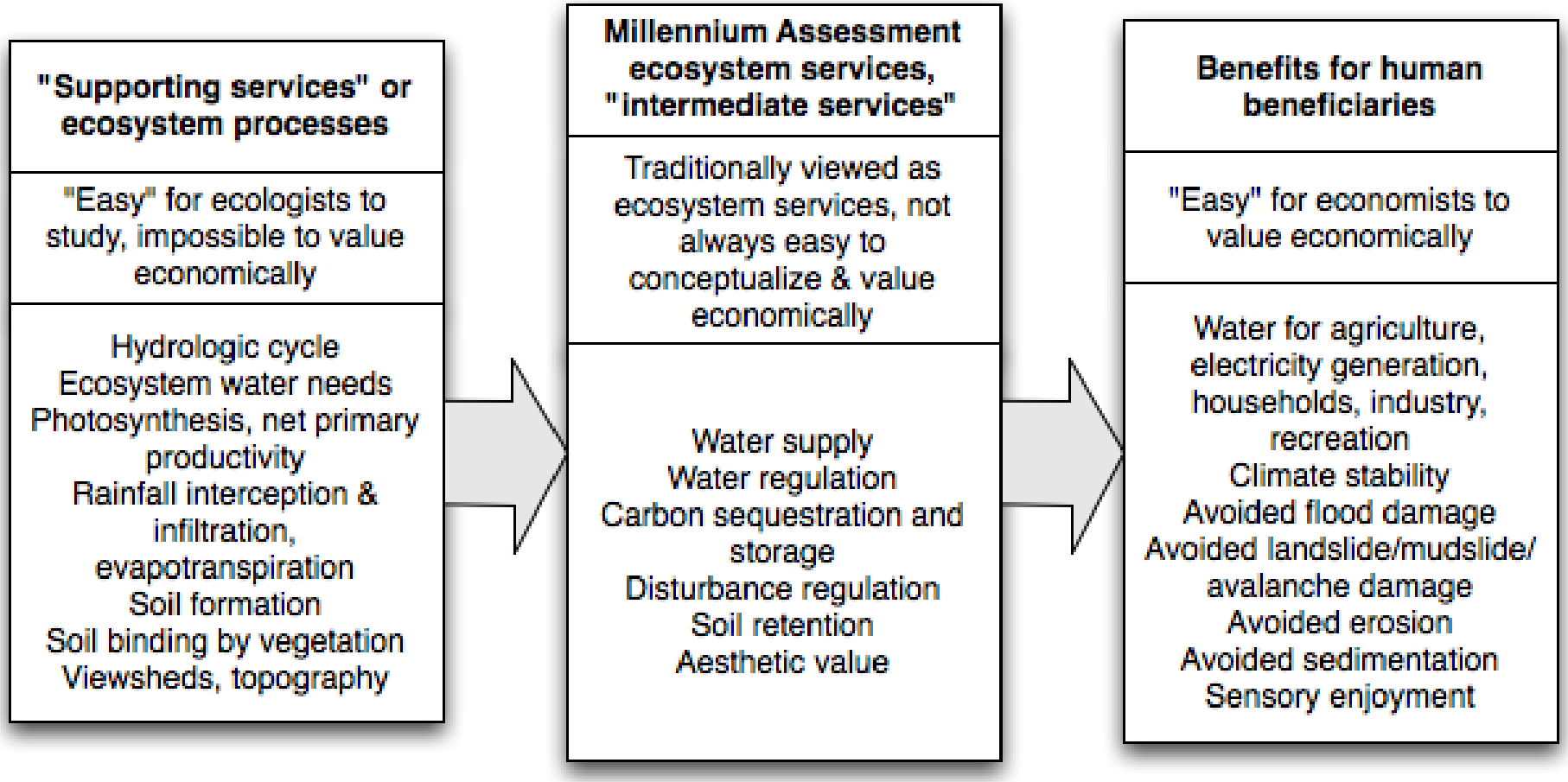
16 MAY 2013

Dr. Brian Voigt
University of Vermont

Ecosystem Service Types



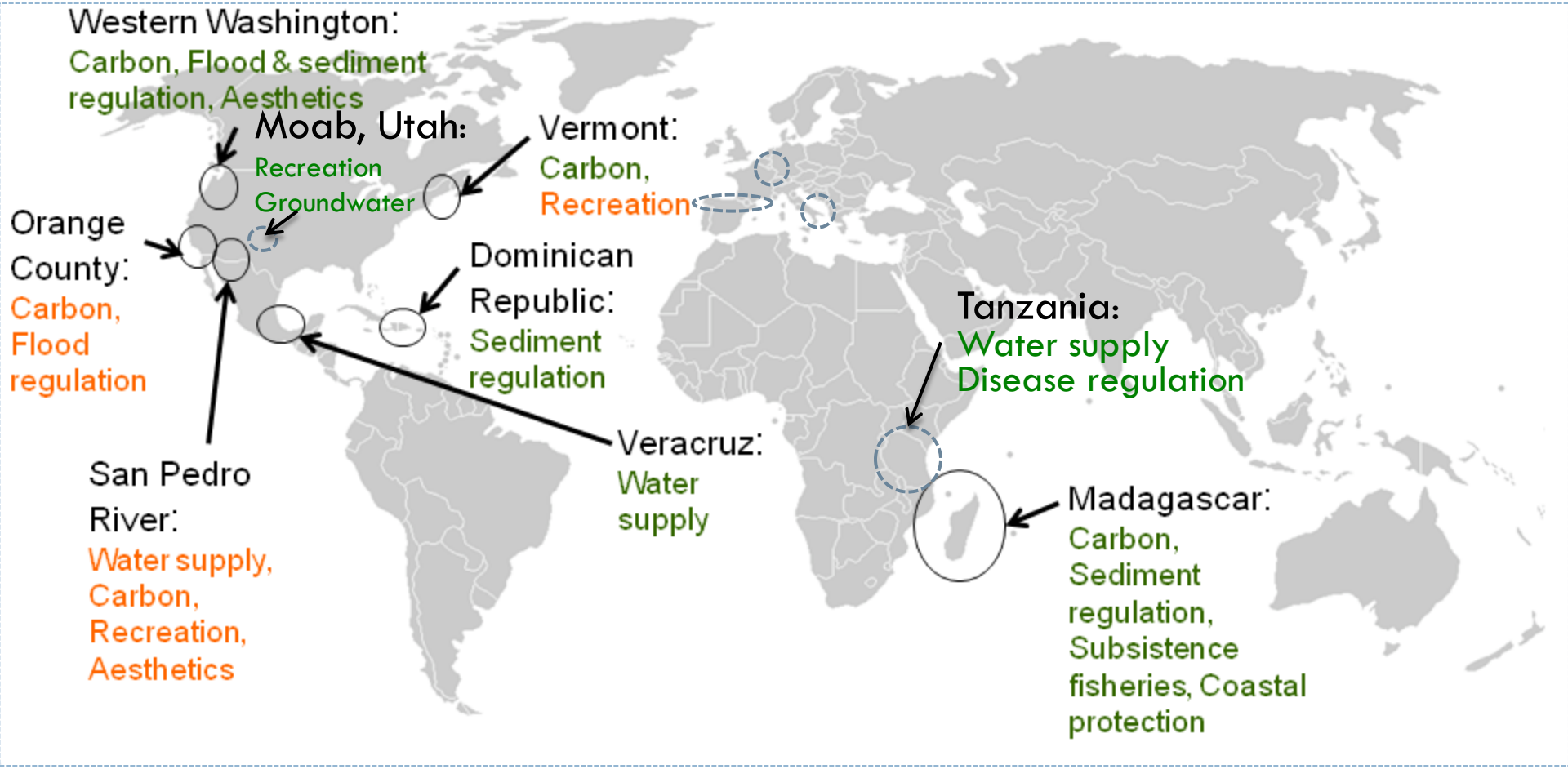
A Quantitative Framework for ES



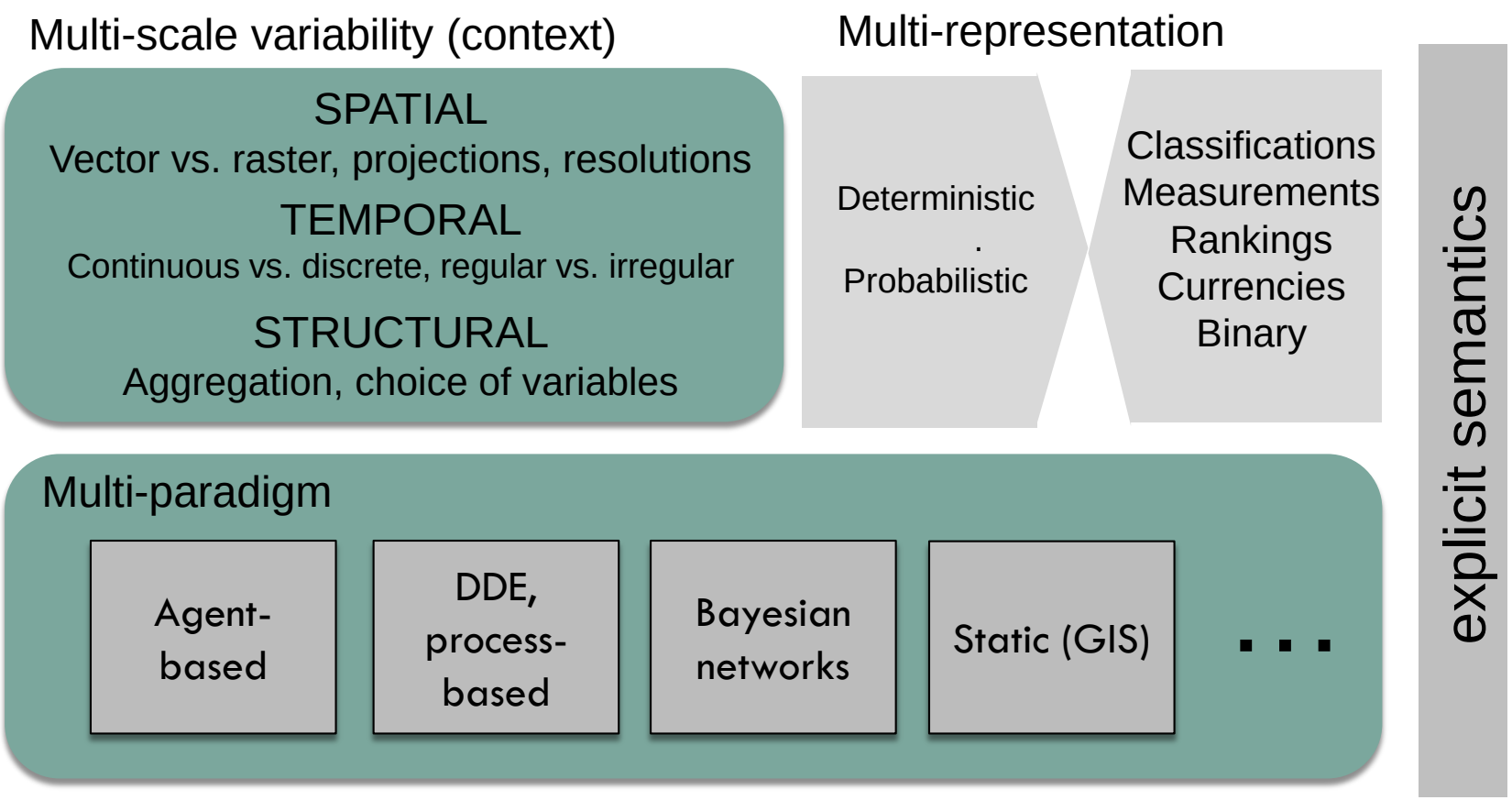
ARIES: A Brief Overview

- ***AR***tificial ***I***ntelligence for ***E***cosystem ***S***ervices
- A rapid assessment toolkit for ecosystem services (ES) 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 look at provision.
- Probabilistic models inform decision-makers of likelihood of all possible outcomes; users can explore effects of policy changes and external events.
- Customizable for specific user groups, geographic areas and policy goals

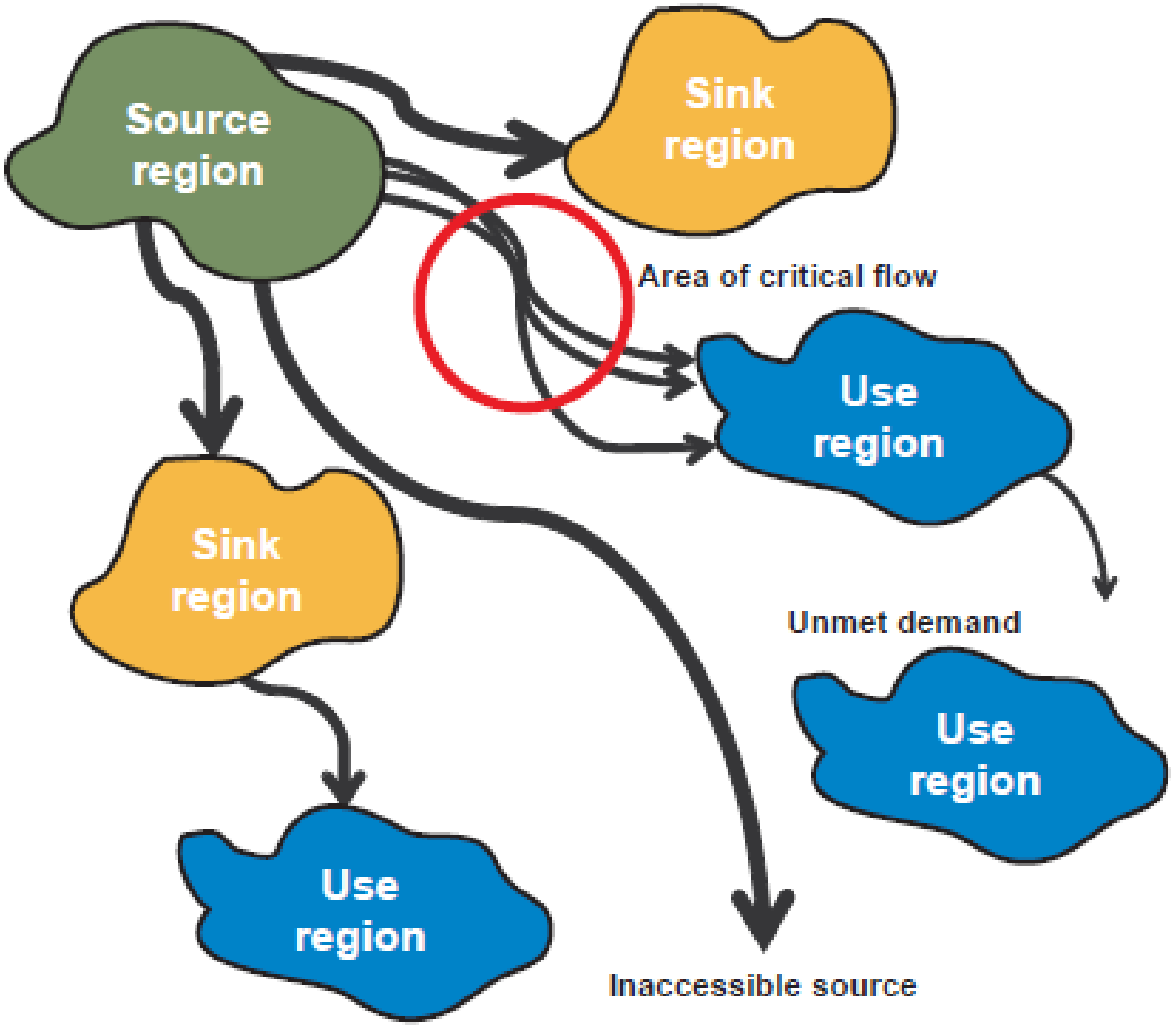
Case Study Sites



The Integrated Modeling Platform



ARIES Conceptual Model



ARIES Model Outputs

- Result maps are produced in pairs, describing both the natural sources and the human beneficiaries of the service

- How much service is available and is there room for improvement?

  - *Theoretical*: maps show the maximum values that could be produced under ideal conditions, assuming that all services produced are able to reach people

  - *Actual*: maps depict the amount of a service that actually reaches the users in a useful form after accounting for supply (source locations), rival use and natural deposition (sink locations), and connectivity (flow paths)

  - Theoretical value > Actual value: room for some type of policy intervention to improve or restore service delivery

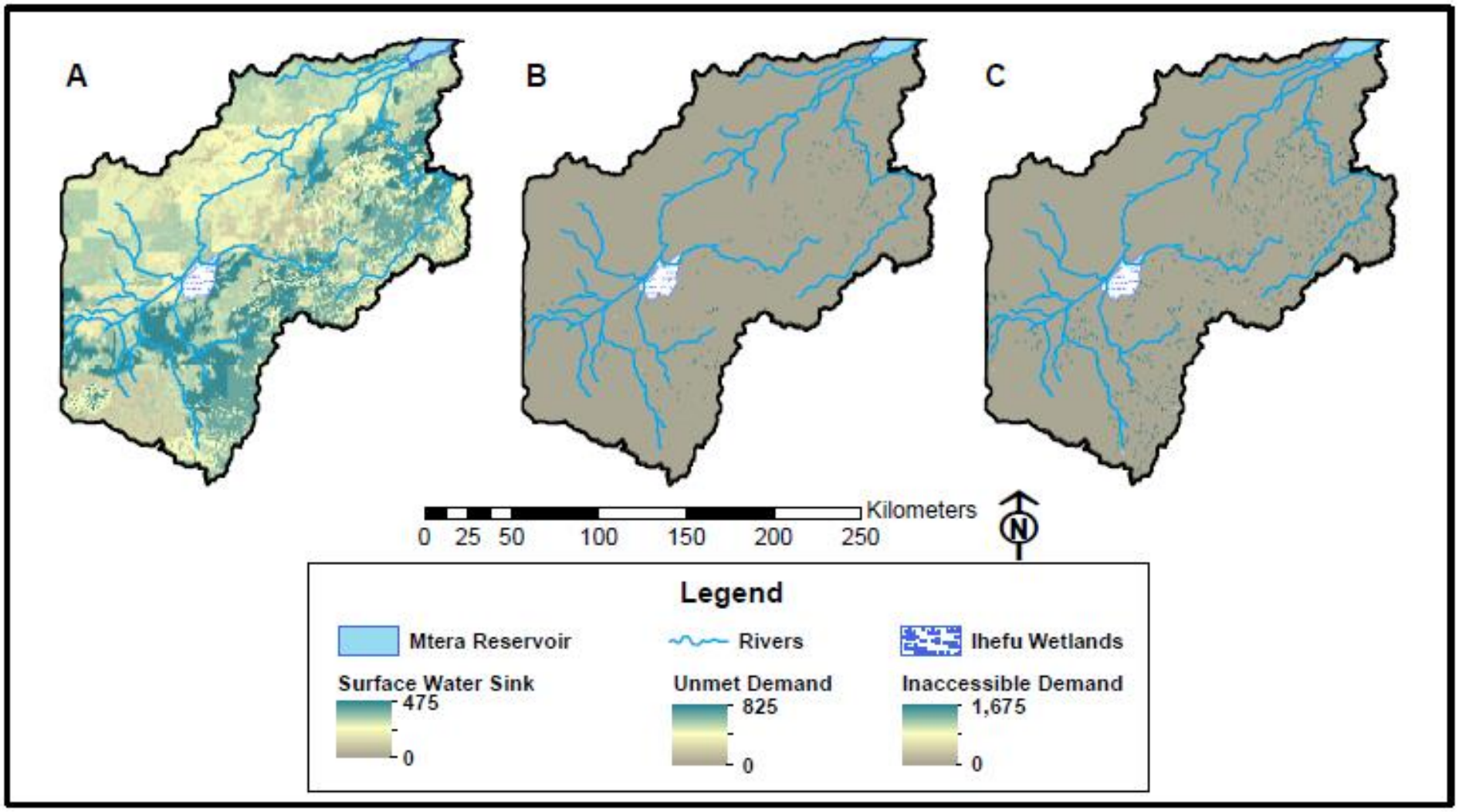
ARIES Model Outputs

- Identifying problem areas in need of intervention

- *Blocked*: maps show the value that is produced by the ecosystem but cannot get to humans, because of policy-controlled issues such as pollution or flow diversions resulting from infrastructure or natural landscape features
  - *Blocked Demand* map shows the location and amounts of unmet demand for a specific group of beneficiaries
  - *Blocked Supply* map shows the areas that produce views that are "wasted" to natural phenomena or depleted by anthropogenic landscape features beyond the point of usability
  - values can be used to prioritize areas where human intervention may restore service delivery

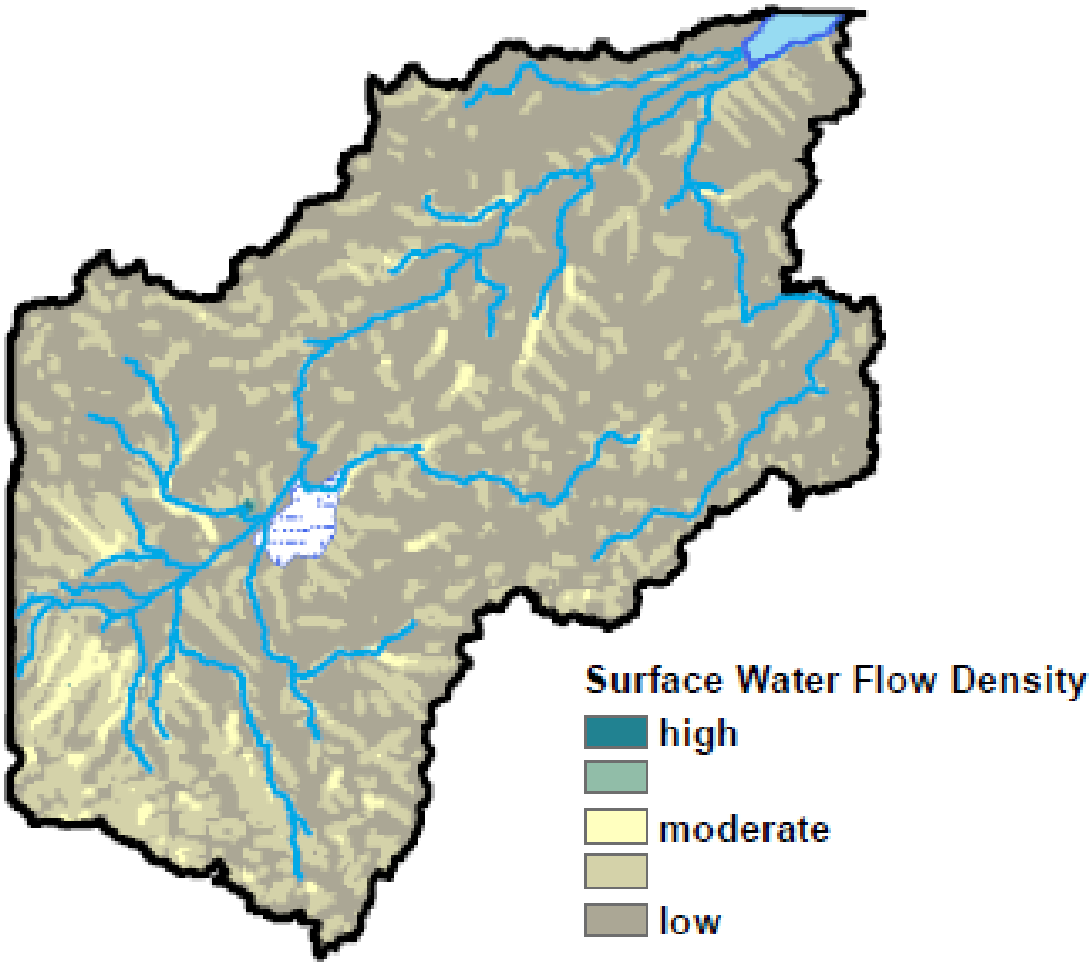
- *Inaccessible*: maps show the value that is produced by the ecosystem but cannot be accessed by humans due to a lack of connectivity between source and use locations
  - values highlight those areas where service production may be under-utilized

Water Supply Sink & Demand Profiles



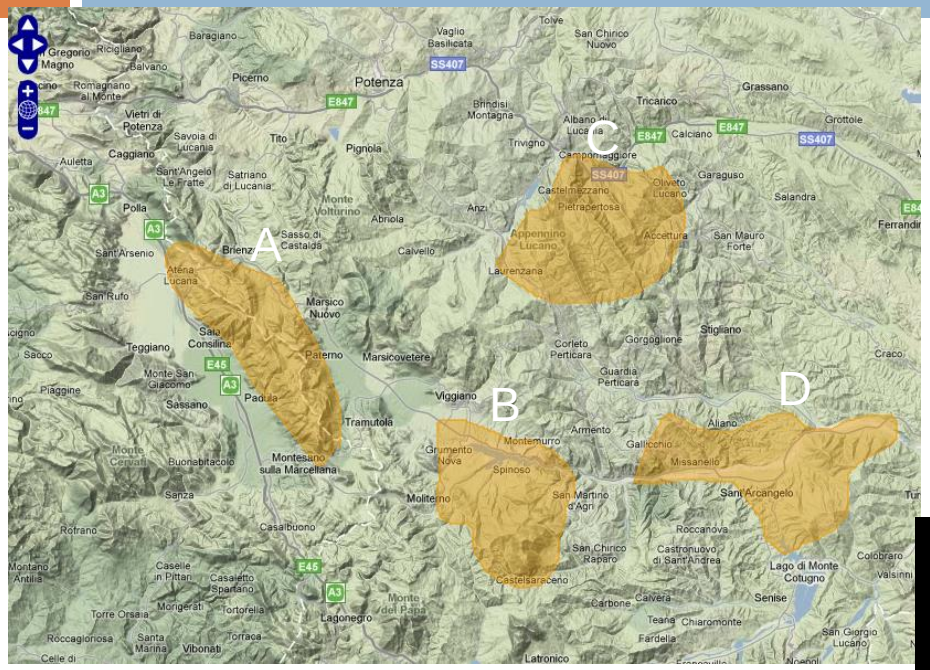
Villa, Voigt & Erickson, in review

Flow Model Outputs



Villa, Voigt & Erickson, in review

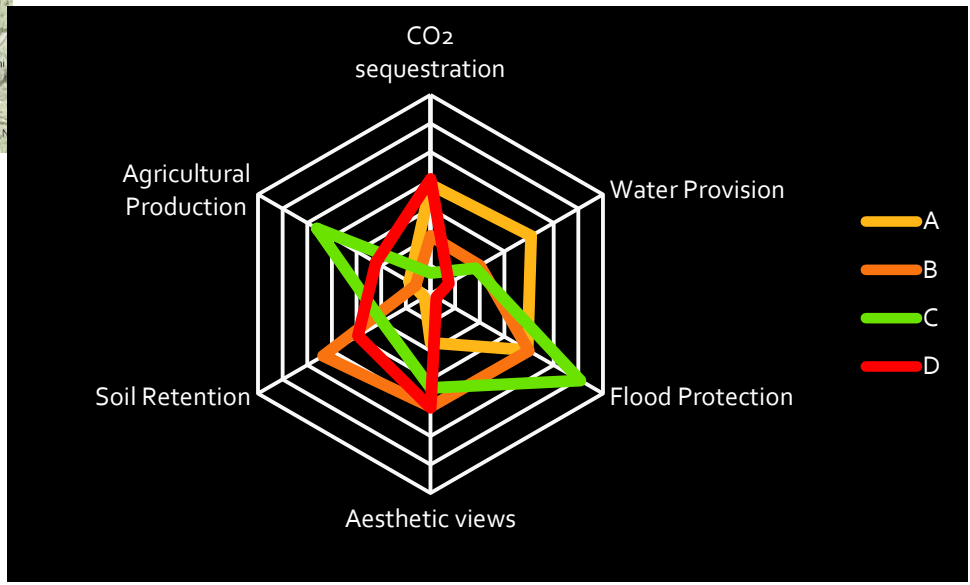
Multiple Criteria Analysis



ARIES can produce a full ES profile for a set of potential development locations and evaluate changes in ES delivery (to specific beneficiary groups).

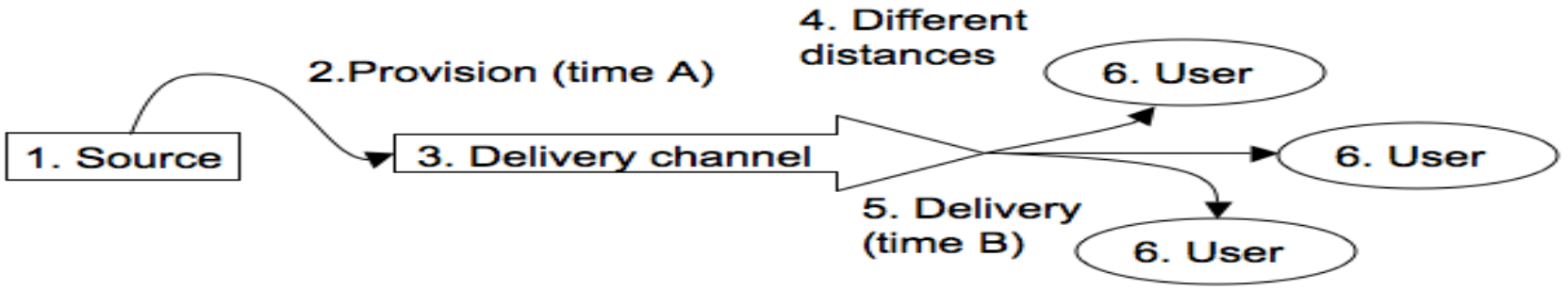
Such profiles help selection of areas and documentation of ES offsets.

Multiple Criteria Analysis allows customizing the ES profiles to pre-existing priorities or legal constraints.



Mapping ES in ARIES

1. Collect spatial data
2. Identify beneficiaries
3. Develop models for source, sink, and use
4. Develop flow models to connect ecosystems to people



Ruhl et al. 2007

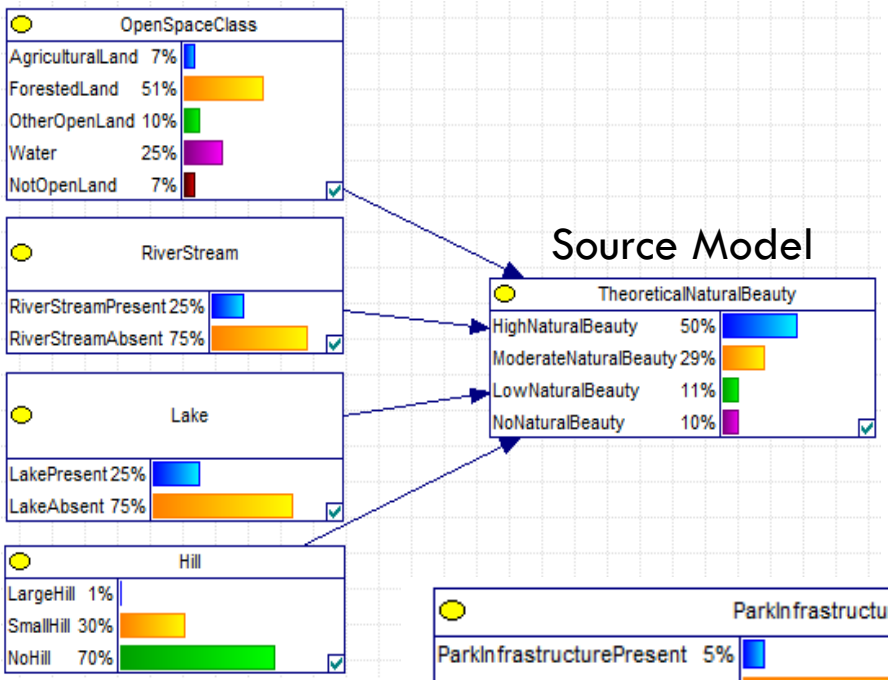
1. Collecting spatial data

- GIS data for as many components as possible to map source, sink, and use
- Local data where possible for case studies, otherwise use global data
- Where no data exists, use Bayesian prior probabilities and patterns learned from parts of the world where full dataset exists
- Progress: GIS data library assembled during 2012 – 2013

2. Identifying beneficiaries

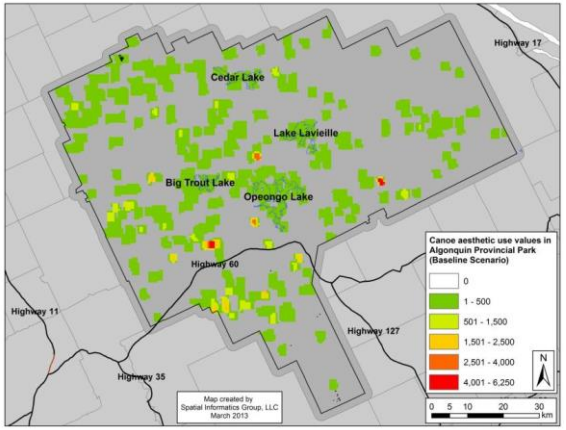
Ecosystem Services	General Beneficiary Class	Specific Beneficiary Group
Carbon sequestration & storage	Groups vulnerable to climate change	Coastal populations, snowmelt dependent populations, farmers, etc.
	Users of atmospheric CO_2 absorption	Greenhouse gas emitters
Aesthetics	Scenic views	Homeowners with scenic views
	Proximity to open space	Homeowners near open space
Recreation	Residents	Population within the region
	Tourists	Visitors to the region
	Businesses	Tourism operators, hotels, restaurants
Soil retention	Non-eroded systems	Farmers on erodible land
	Areas benefiting from sedimentation	Some floodplain farmers
	Non-sedimented systems	Some farmers, fishermen, hydro utilities, etc.
Disturbance regulation	Flood protection	Floodplain residents, farmers, public & private property owners
	Storm surge protection	Same groups as above
	Mudslide/avalanche protection	Same groups as above

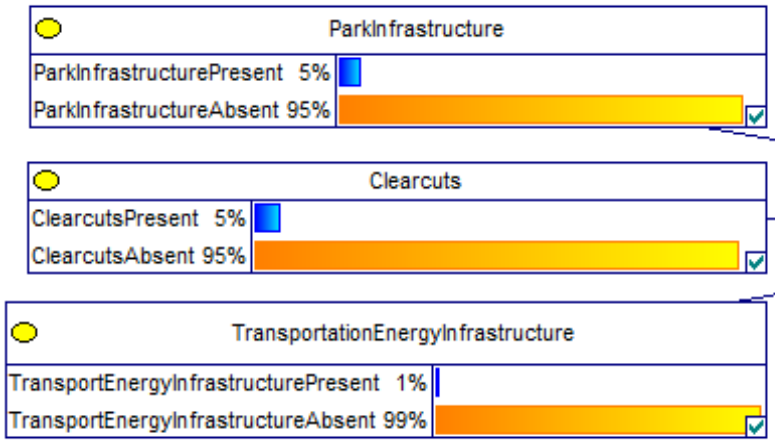
3. Source, Sink & Use Models



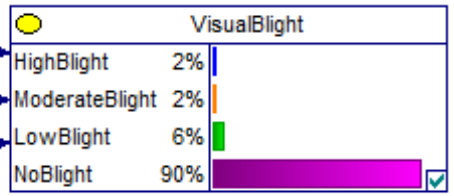
Use Model

GIS data and Recreation Survey

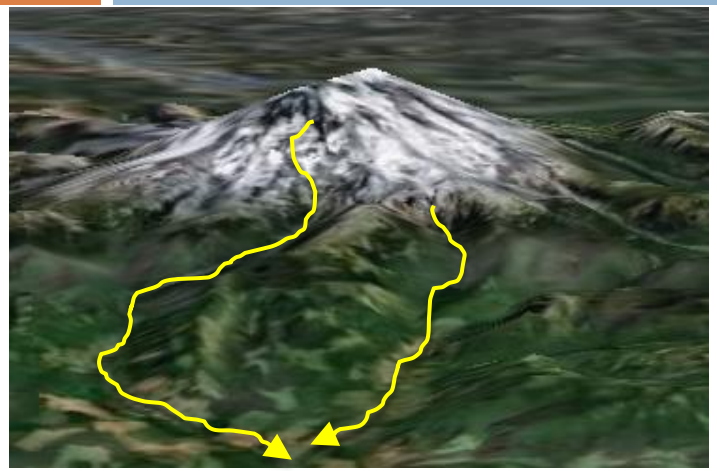




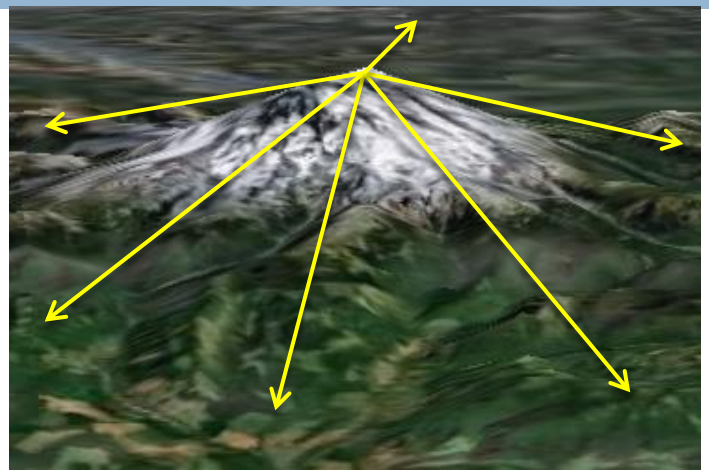
Sink Model



4. Flow Models

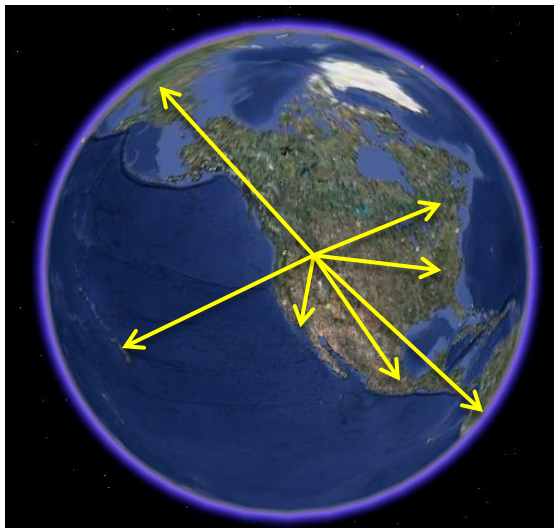


Hydrologic services



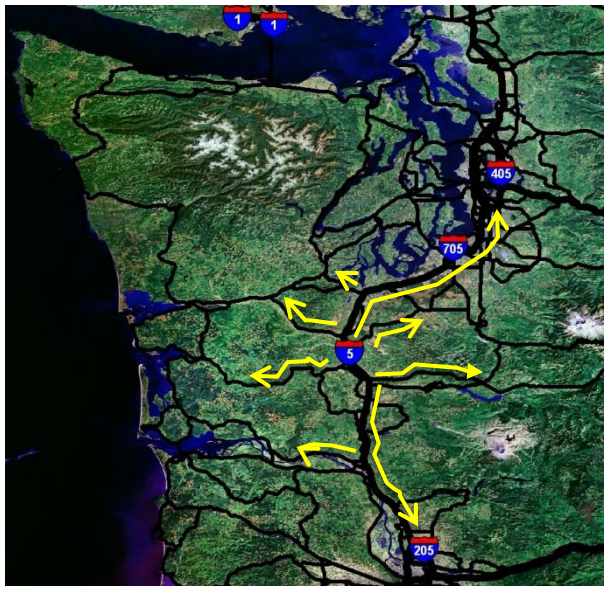
Aesthetic viewsheds

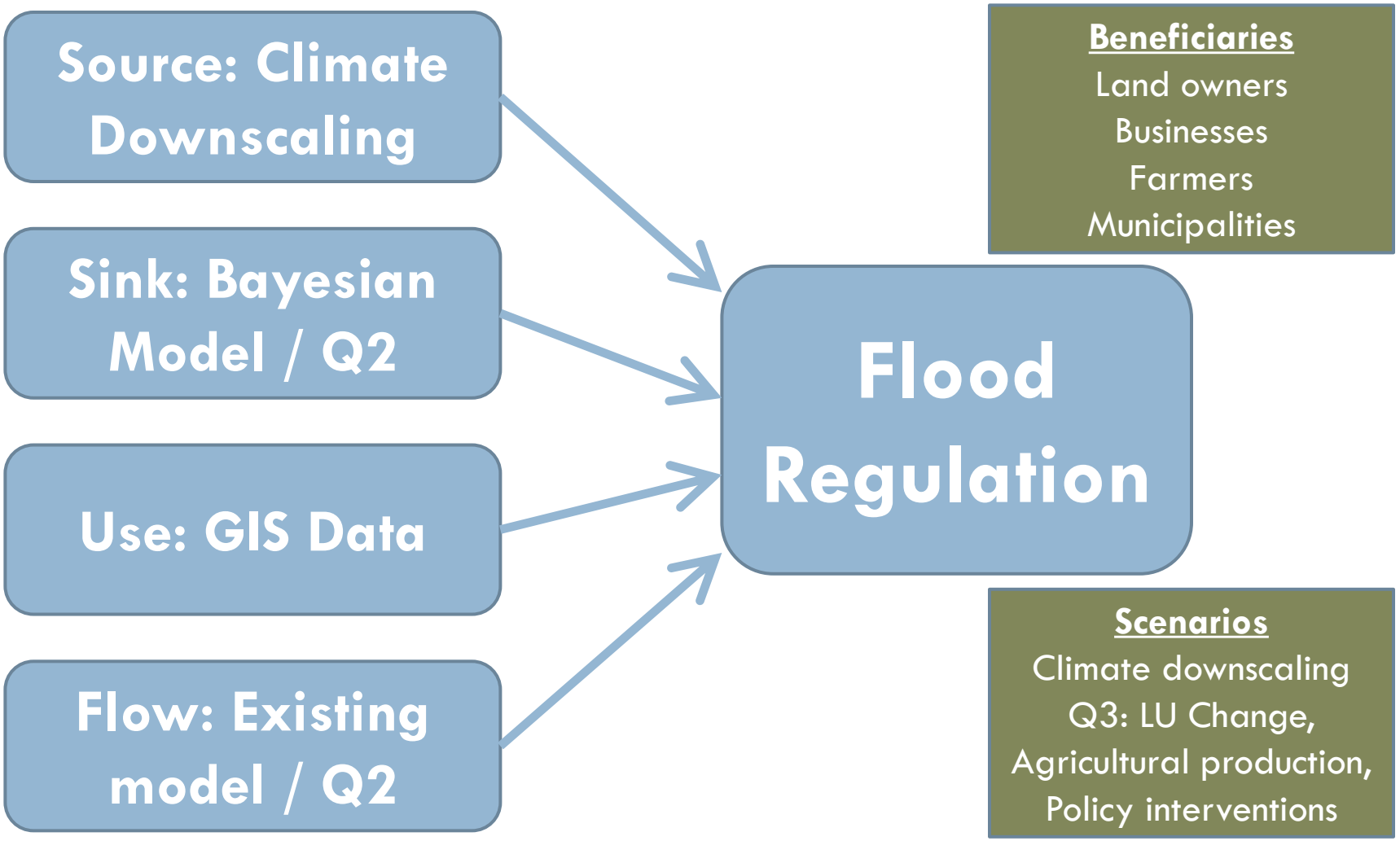
Recreation, flood regulation, many ecosystem goods

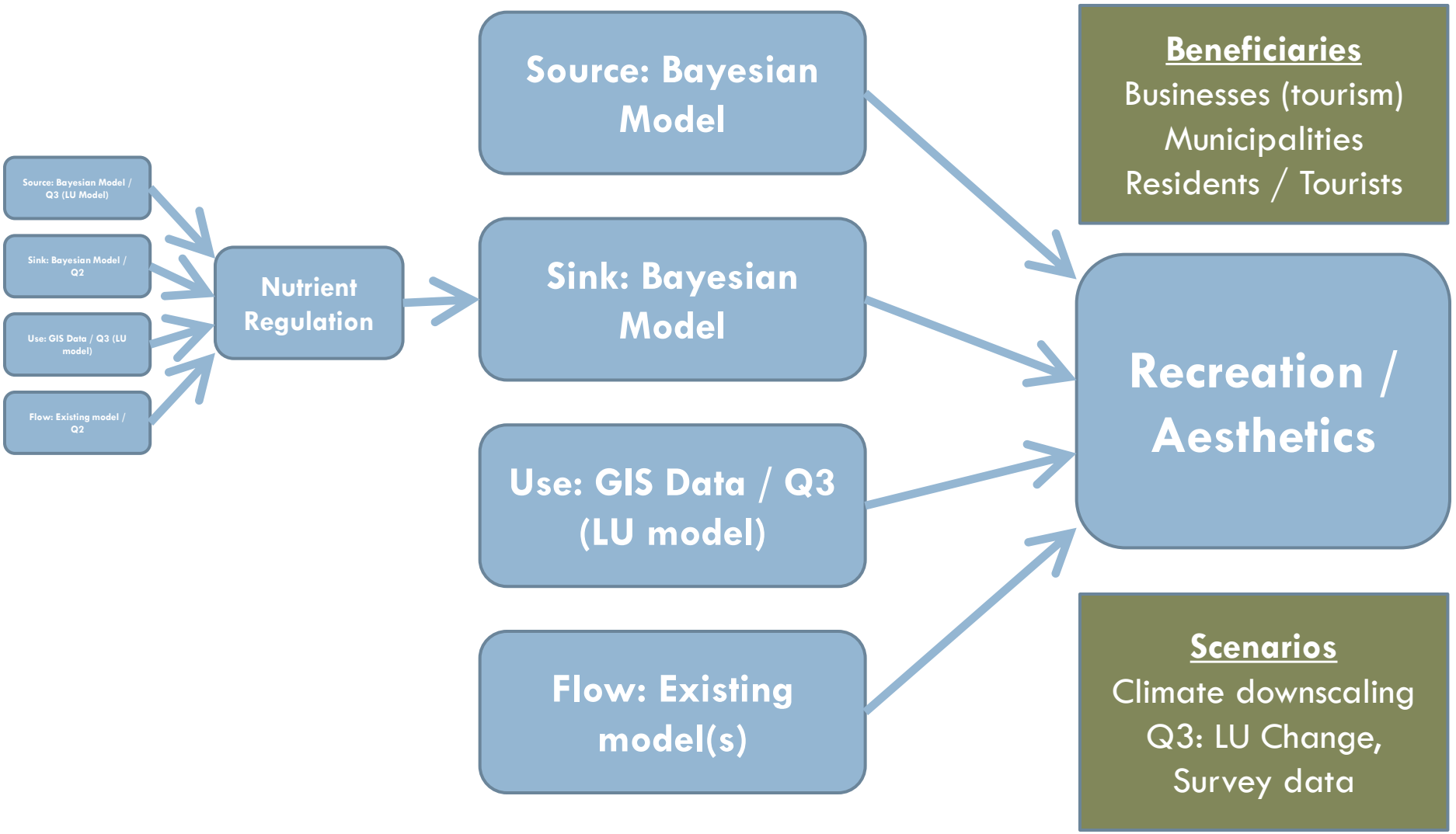


Carbon sequestration, some cultural values

Recreation, aesthetic proximity, some cultural services




Source: Climate Downscaling
Sink: Bayesian Model / Q2
Use: GIS Data
Flow: Existing model / Q2
Flood Regulation
Beneficiaries
Land owners
Businesses
Farmers
Municipalities
Scenarios
Climate downscaling
Q3: LU Change, Agricultural production, Policy interventions


Source: Bayesian Model / Q3 (LU Model)
Sink: Bayesian Model / Q2
Use: GIS Data / Q3 (LU model)
Flow: Existing model / Q2
Nutrient Regulation
Source: Bayesian Model
Sink: Bayesian Model
Use: GIS Data / Q3 (LU model)
Flow: Existing model(s)
Beneficiaries
Businesses (tourism)
Municipalities
Residents / Tourists
Recreation / Aesthetics
Scenarios
Climate downscaling
Q3: LU Change,
Survey data

Next Steps

- Work with collaborators to identify and assemble additional data and models
- Develop scoping models to address priority ecosystem services (i.e. flood & nutrient regulation, water provision, recreation, carbon sequestration) and priority beneficiaries (i.e. homeowners, businesses, farmers)
- Preliminary integrated modeling framework
- Identify scenarios with policy / management relevance

Acknowledgements

- ARIES Team: Ferdinando Villa, Ken Bagstad, Gary Johnson
- Q1, Q2, & Q3 teams