Ecosystem Services Across Landscapes: Prioritizing conservation and assessing trade-offs

Delta Science Program Brown Bag Seminar
May 23, 2010

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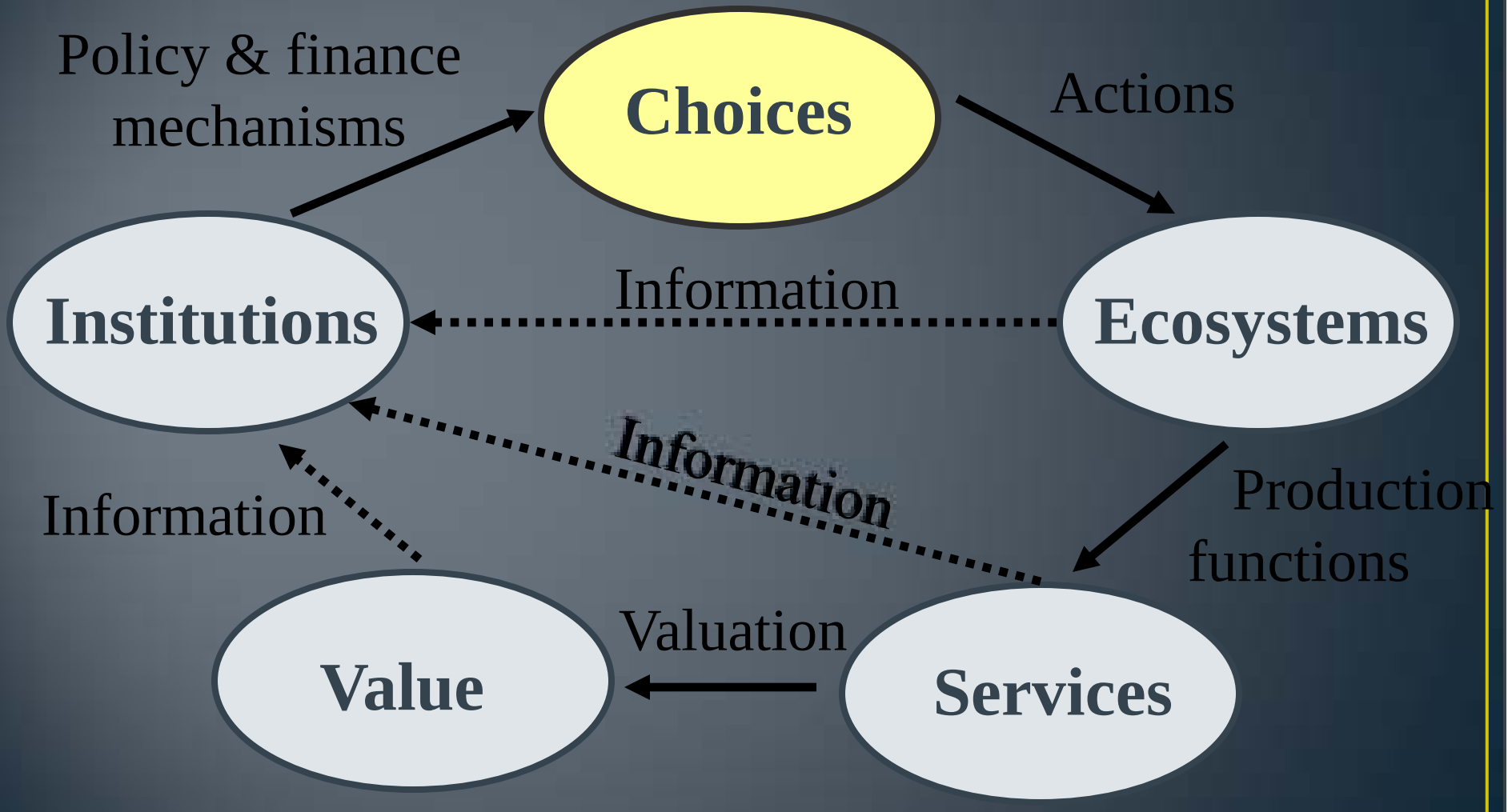
The Natural Capital Project

The Nature Conservancy

WWF

Woods Institute for the Environment
Stanford University

Conceptual Approach



Polasky et al.

Decisions Today

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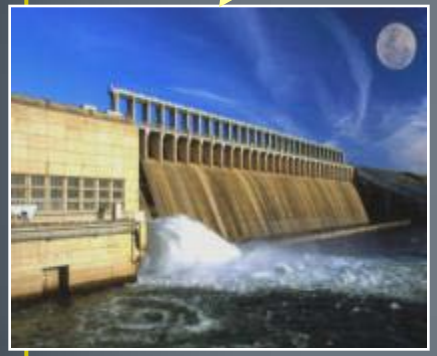

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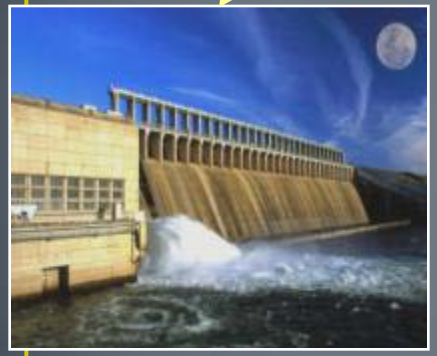
Ecosystem Based Management Decisions

$13 million loss



$2 million loss

5 species lost

$1 million loss

$5 million gain

InVEST:
Integrated Valuation of Ecosystem Services and Tradeoffs

Steve Polasky, Peter Kareiva, Taylor Ricketts, Erik Nelson, Guillermo Mendoza, Jim Regetz, Rebecca Shaw, Robin Naidoo, Kai Chan, Vic Adamowicz, Eric Lonsdorf, Dick Cameron, Neil Burgess, Andrew Balmford

How things fit together

Scoping opportunities

↓

Mapping

↓

Valuation

↓

Policies & payments

InVEST = **In**tegrated **V**aluation of **E**cosystem **S**ervices and **T**radeoffs
(software tool for mapping & valuation of ES)

Existing Tools

- Complex and data intensive
- No way to integrate
- Often place-specific
- Usually biophysical or economic

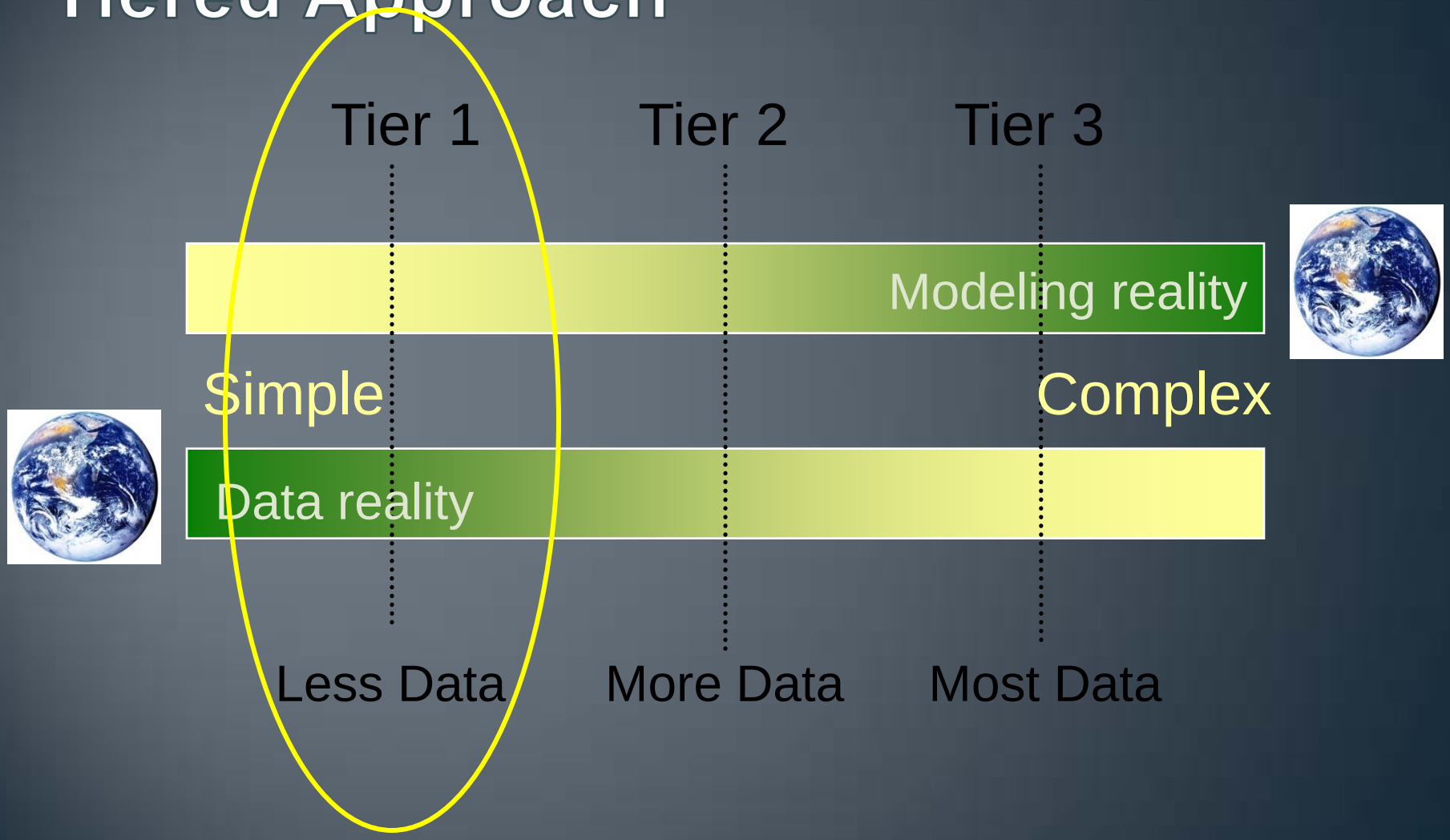
InVEST: key features

- Biodiversity and Multiple services
- Biophysical or economic results
- Spatially explicit (mapped)
- Tiered design: simple or complex
- Driven by management scenarios
- Ready to use
- Flexible and transferable
- Use common terms ($$ and other)

Multi-service, Multi-sector

- Biodiversity
- Ecosystem services
  - Carbon sequestration
  - Drinking water
  - Flood control
  - Hydropower
  - Agricultural crop production
  - Irrigation water (for ag)
  - Native pollination (for ag)
  - Commercial timber production
  - Non-timber forest products
  - Real estate value
  - Recreation and tourism
  - Cultural and aesthetic values

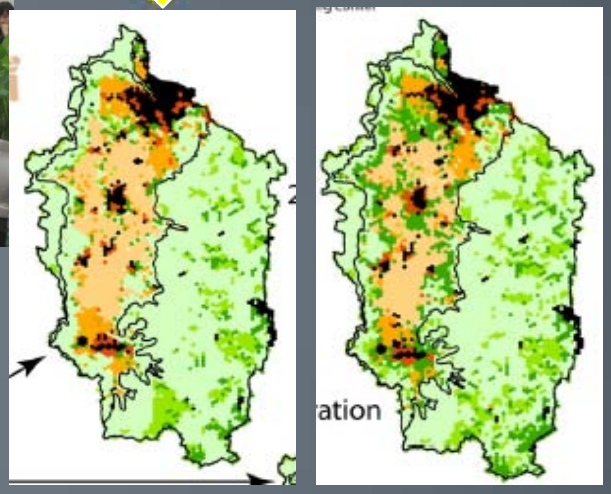
Tiered Approach



Driven by management scenarios

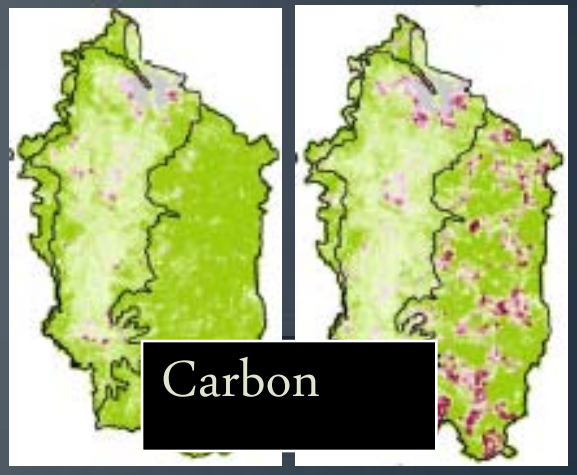
Stakeholders

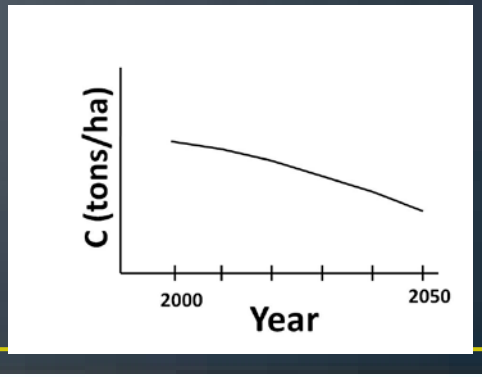
Policy input



Land use scenarios

Mapping with InVEST





Policy implementation

Demonstration Sites

Test and apply tools in real-world conservation priorities

Integrating Ecosystem Services and Biodiversity Conservation in the Sierra Nevada, California

Dick Cameron, Rebecca Shaw,
Holly Davis, Guillermo Mendoza

Sierra Nevada

Biodiversity:

- Vertebrates: 26 Endemic, 190 threatened
- Plants: 405 endemic, 218 threatened, ½ California's 7000 vascular plants

Ecosystem services

- Water: 25% of power, 65% of water supply
- Recreation and tourism
- Grazing and forage production
- Carbon storage
- Timber production

CALIFORNIA REPUBLIC

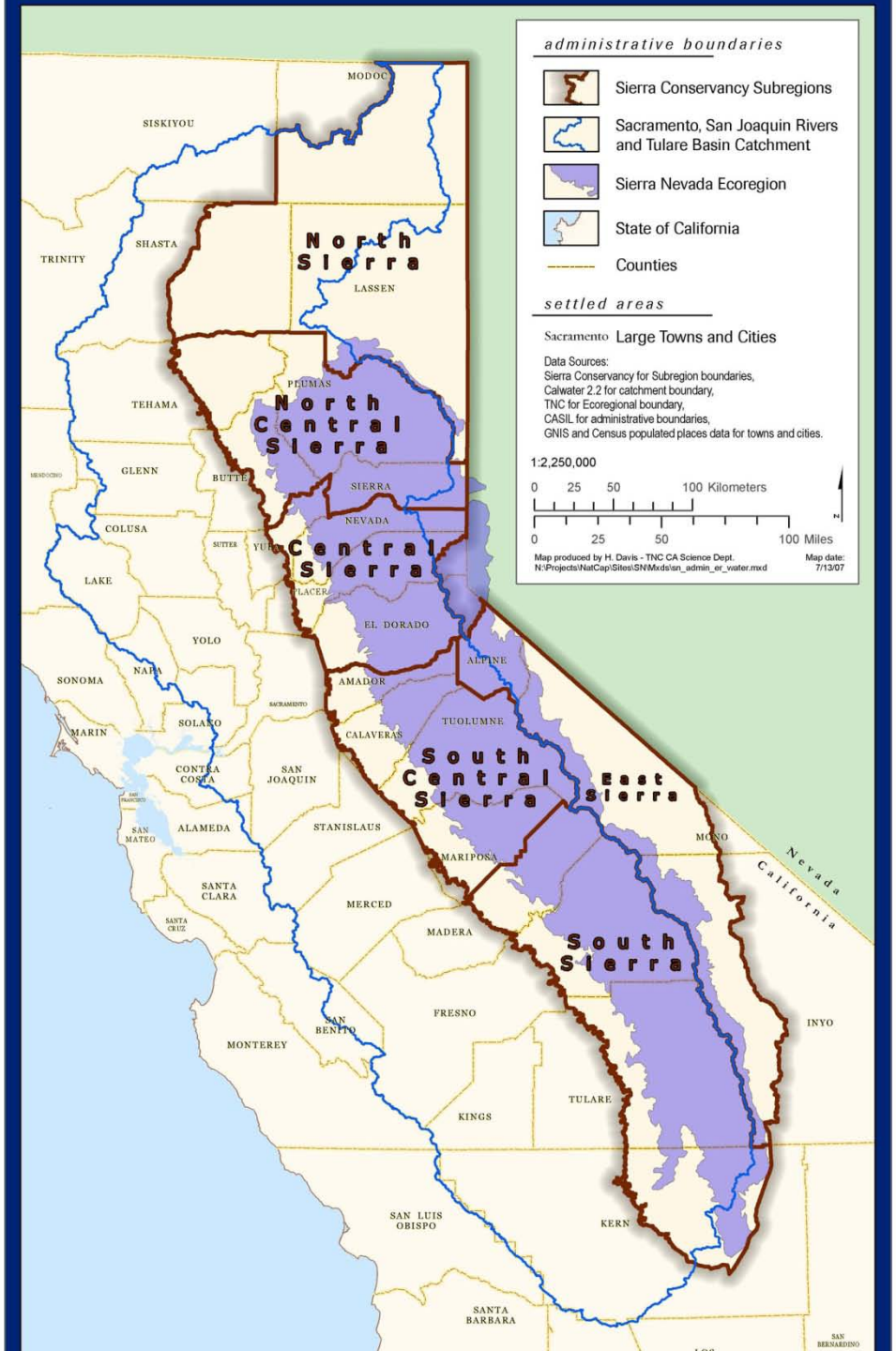
Sustainable Conservation

RESOURCES LEGACY FUND

SIERRA BUSINESS COUNCIL

SIERRA NEVADA ALLIANCE

THE UNIVERSITY OF CALIFORNIA 1868


administrative boundaries
Sierra Conservancy Subregions
Sacramento, San Joaquin Rivers and Tulare Basin Catchment
Sierra Nevada Ecoregion
State of California
Counties
settled areas
Sacramento Large Towns and Cities
Data Sources:
Sierra Conservancy for Subregion boundaries,
Calwater 2.2 for catchment boundary,
TNC for Ecoregional boundary,
CASIL for administrative boundaries,
GNIS and Census populated places data for towns and cities.
1:2,250,000
0 25 50 100 Kilometers
0 25 50 100 Miles
Map produced by H. Davis - TNC CA Science Dept.
N:\Projects\NatCap\Sites\SN\Mxds\sn_admin_er_water.mxd
Map date: 7/13/07
North Sierra
North Central Sierra
Central Sierra
South Central Sierra
East Sierra
South Sierra
MODOC
SISKIYOU
TRINITY
SHASTA
LASSEN
PLUMAS
TEHAMA
GLENN
BUTTE
SIERRA
NEVADA
COLUSA
SUTTER
YUBA
PLACER
LAKE
EL DORADO
YOLO
ALPINE
NAPA
SONOMA
AMADOR
SACRAMENTO
SOLANO
TUOLUMNE
MARIN
CALAVERAS
CONTRA COSTA
SAN JOAQUIN
SAN FRANCISCO
SAN MATEO
ALAMEDA
STANISLAUS
MONO
MARIPOSA
SANTA CLARA
MERCED
SANTA CRUZ
MADERA
FRESNO
INYO
SAN BENITO
MONTEREY
TULARE
KINGS
SAN LUIS OBISPO
KERN
SANTA BARBARA
SAN BERNARDINO
Nevada
California

Sierra Nevada site: Primary objectives

1. Map and value the Sierra Nevada's natural capital (what is there, who is benefiting from it, and what is it worth?)

- Understand policy and market options at broad scales
- Characterize the flows of services at regional scale
- Develop applied, local demonstration project

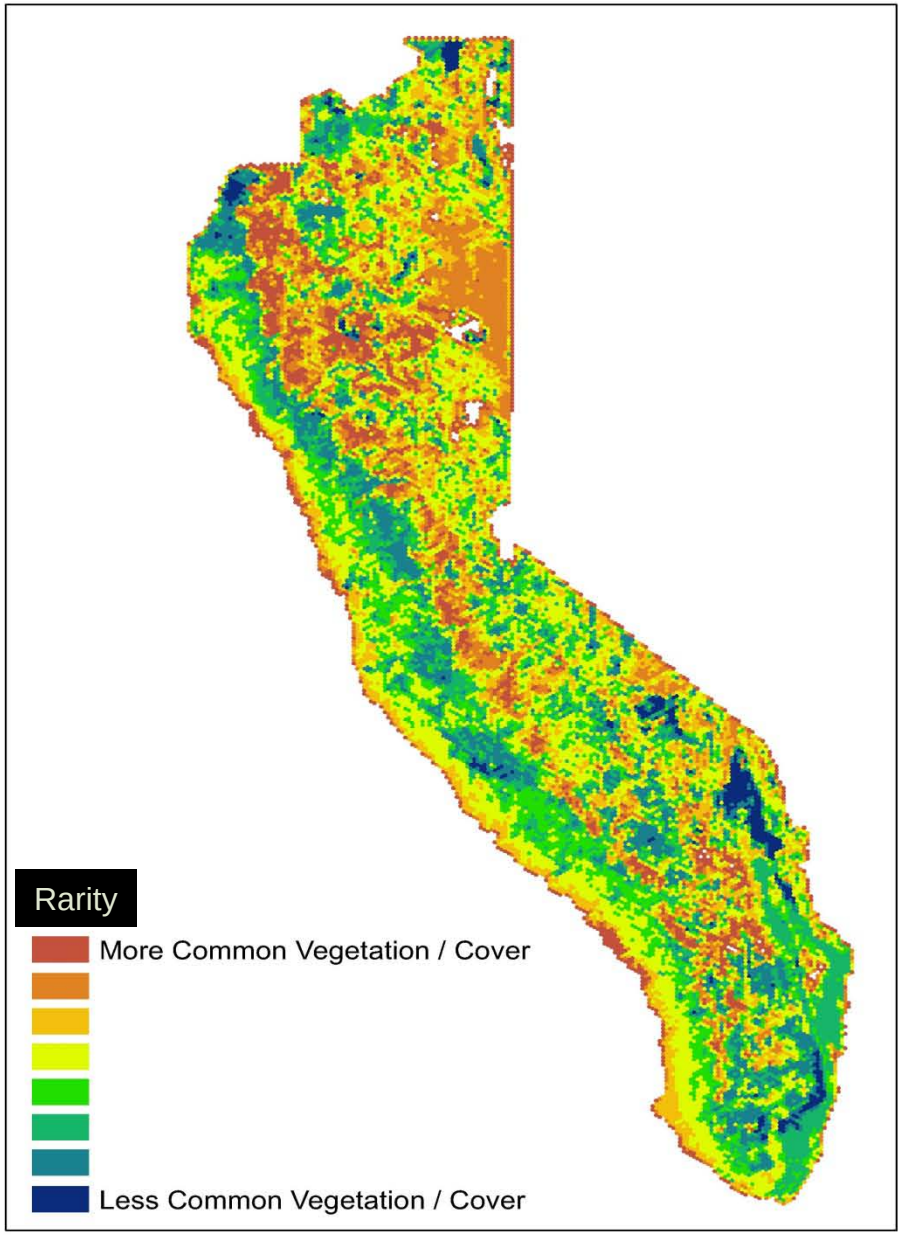
Mapping the Services

Biodiversity – Tier 1

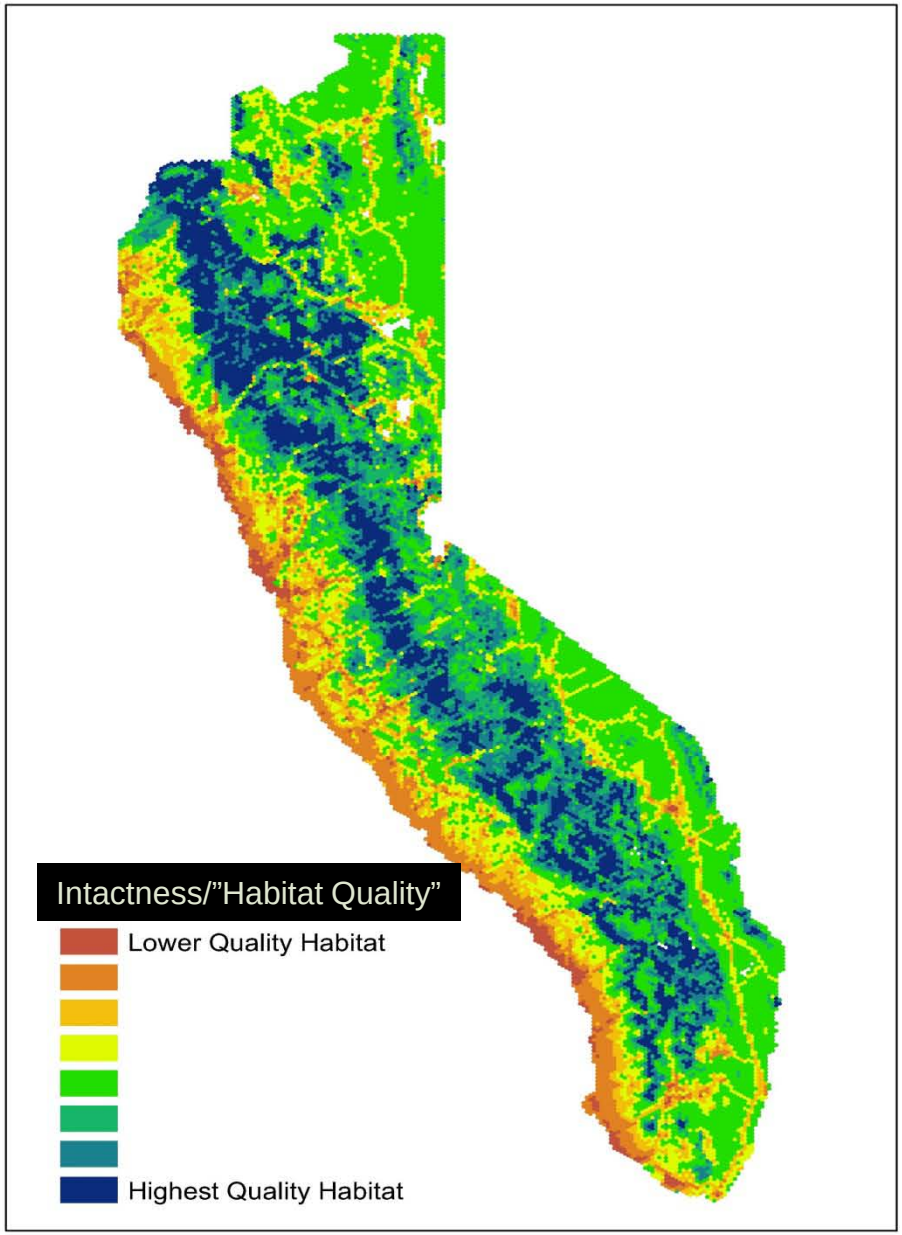
Objective: Develop methods to estimate components of biodiversity using broad, globally available data

Rarity – *How common is this vegetation type or species in the region? Simple RWRI for NDDB weighting* (data: USFS Calveg using WHR classification, CA NDDB)

Intactness – *What is the relative level of human-caused land use change? Intactness is a function of developed area, intensive agriculture, road density, sensitivity of vegetation types to disturbance* (data: USFS Calveg using WHR classification, TIGER roads, CDF Multi-source land cover data)



June 2007



Biodiversity DRAFT Tier 1: Rarity and Habitat Quality

Sierra Nevada Demonstration Site

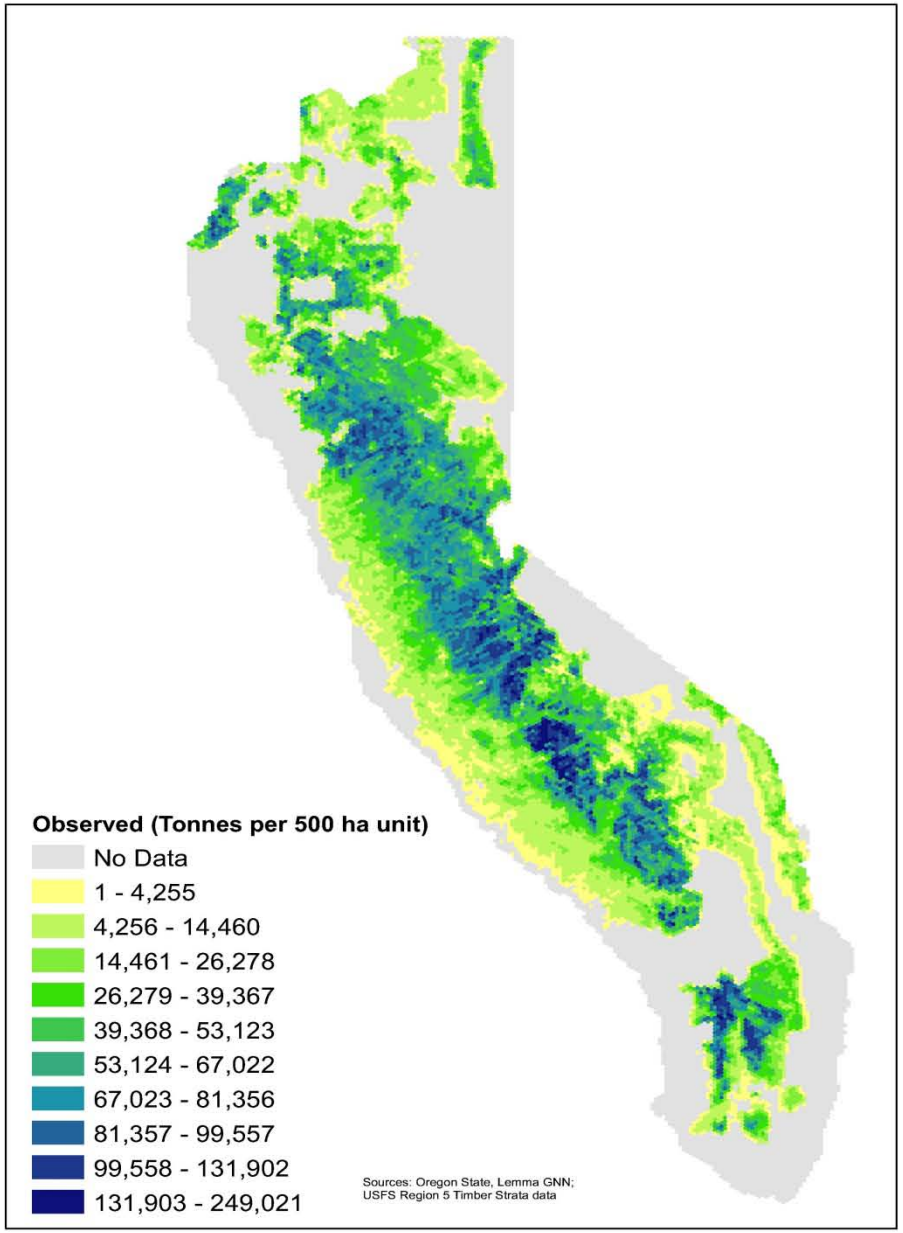
Mapping the Services

Carbon Storage

How much carbon is currently being held in the forest? What is the carbon sequestration potential?

Method 1: "Fake Age" Estimated biomass based on stand size class for forest cover based on USFS (Smith et al. 2005) estimates for other pools (standing dead wood, understory, dead and down wood, forest floor, soil) (data: USFS Calveg using WHR classification)

Method 2: "Observed" based on stand survey and interpolation and same estimates for other pools (data: USFS R5 Strata Grid, LEMMA program Oregon State Univ.)



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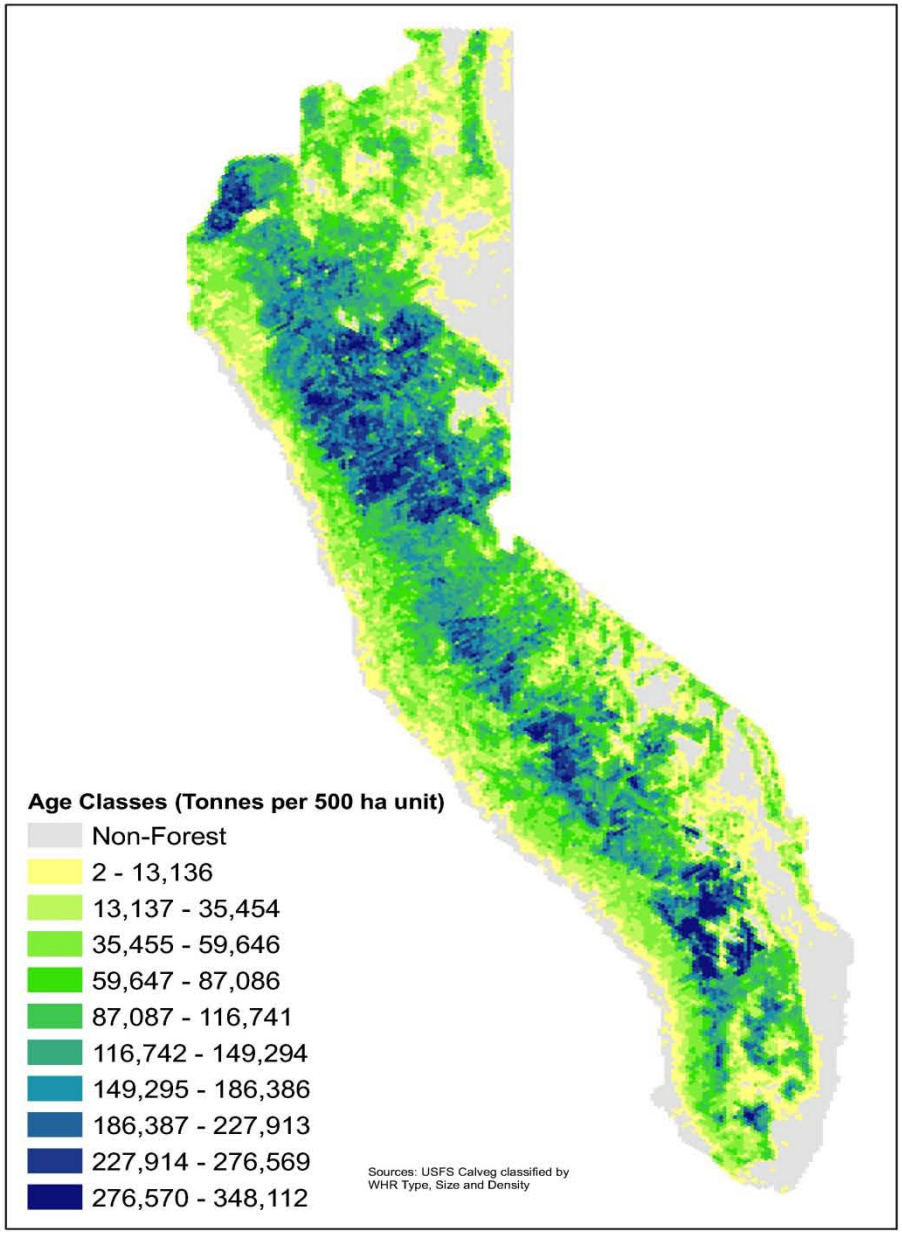


Current Carbon Storage DRAFT Tier 2: Estimated Forest Carbon and Associated Pools

Sierra Nevada Demonstration Site

biophysical production of services

Water Yield

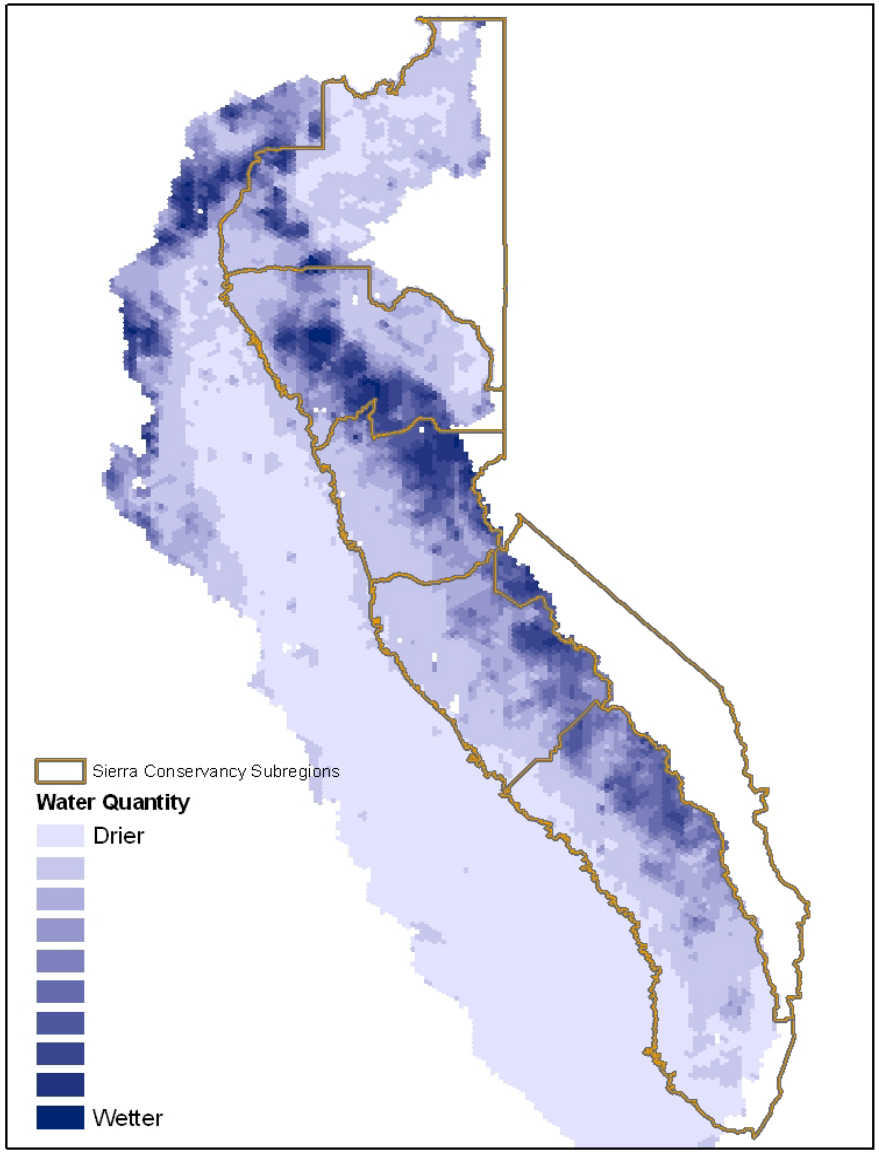
Accounting for ecosystem processes, how much water will be available as runoff or recharge for groundwater?

(data: PRISM data for precipitation, monthly temperature, Root depth and LAI look-up tables- various sources, STATSGO soil depth and available water content)

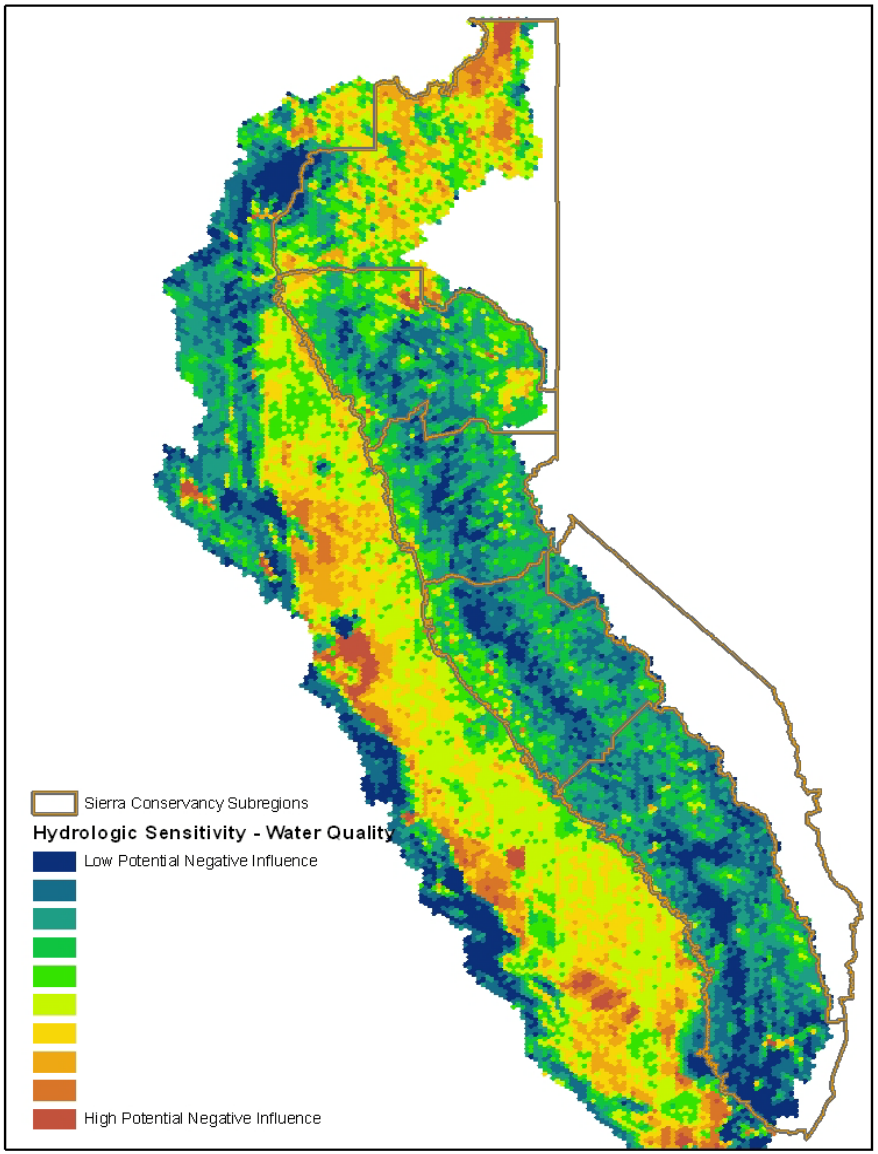
Water Quality

What areas will saturate first and potentially contribute to degraded water quality?

(data: USGS National elevation dataset- derived slope and drainage area, STATSGO soil depth)



July 2007



Water Quantity and Hydrologic Sensitivity : DRAFT

Sierra Nevada Demonstration Site

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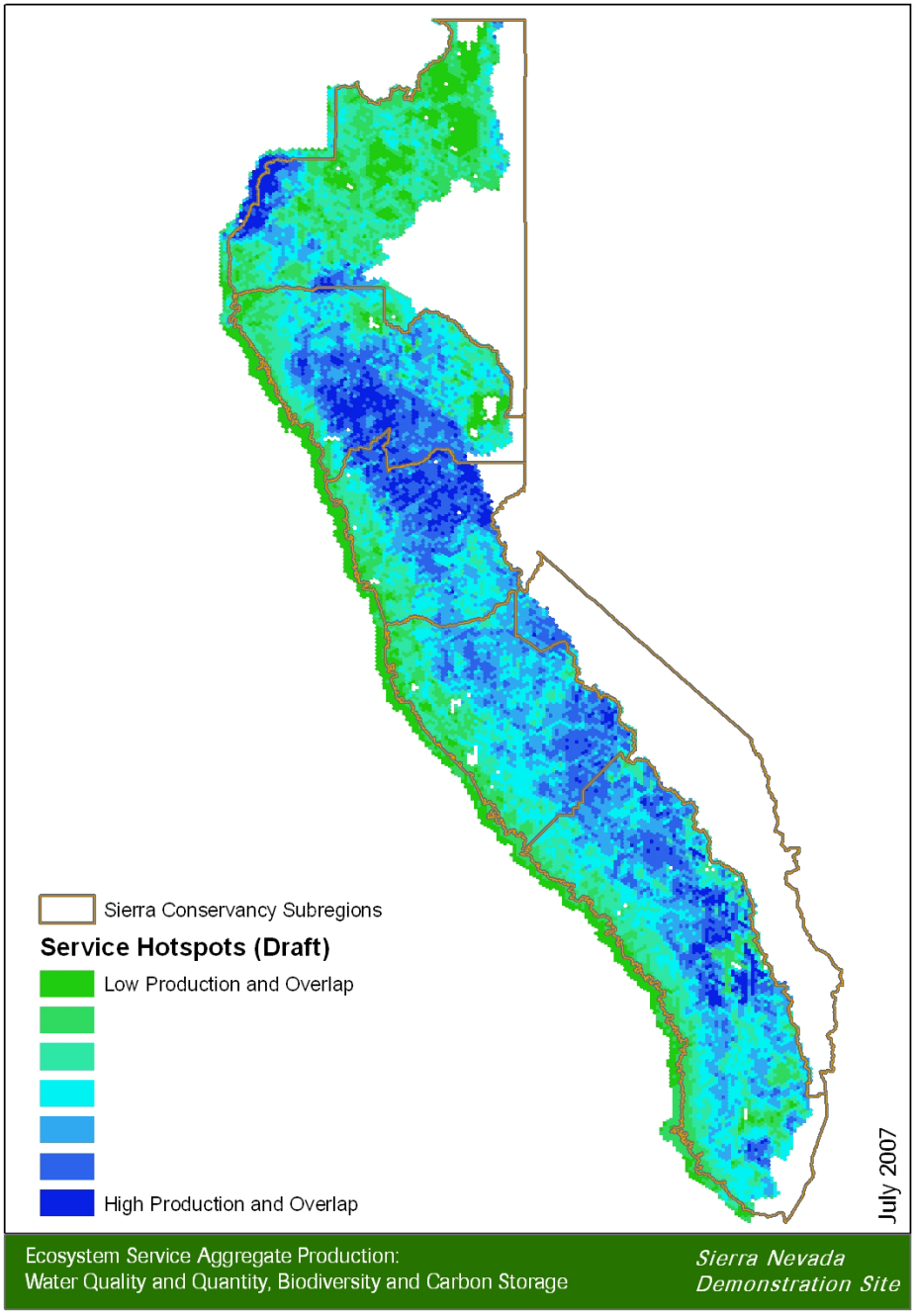

Sierra Conservancy Subregions
Service Hotspots (Draft)
Low Production and Overlap
High Production and Overlap
July 2007
Ecosystem Service Aggregate Production:
Water Quality and Quantity, Biodiversity and Carbon Storage
Sierra Nevada
Demonstration Site

land use change scenarios

Given potential threats from development and fire, how will service production change?

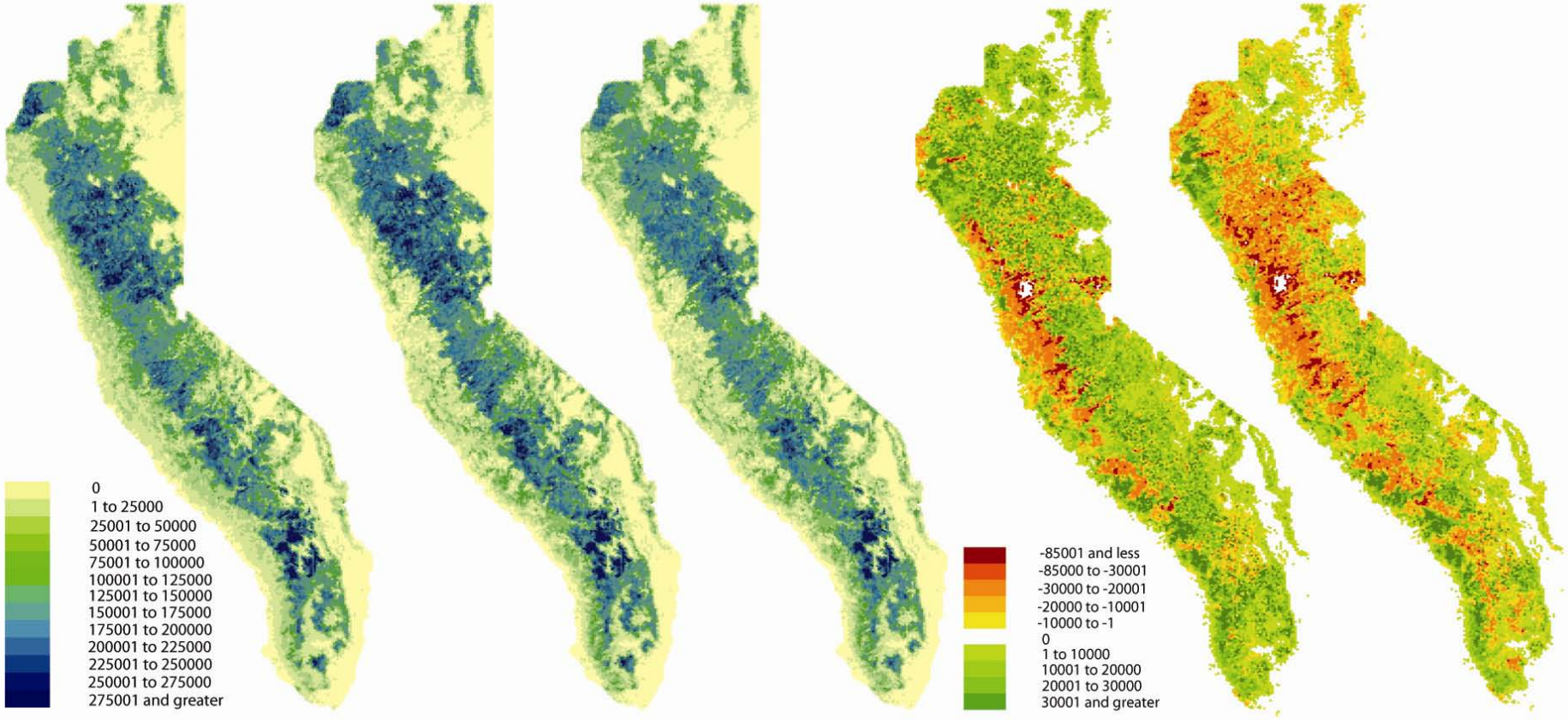
Current Landscape

Potential Future Landscapes

Urbanization *Urbanization + Fire*

Difference Across Current and Future Landscapes

Urbanization *Urbanization + Fire*



Carbon Storage (Metric Tons of Carbon per Hexagon)

Carbon Sequestration (Change in the Metric Tons of Carbon per Hexagon)

natural capital PROJECT

LATIN AMERICAN WATER FUNDS PARTNERSHIP

The Nature Conservancy
Protecting nature. Preserving life.

FUNDACIÓN FEMSA

IDB Water and Sanitation Initiative

Optimizing Investments in Natural Capital
RIOS tool for Water Funds

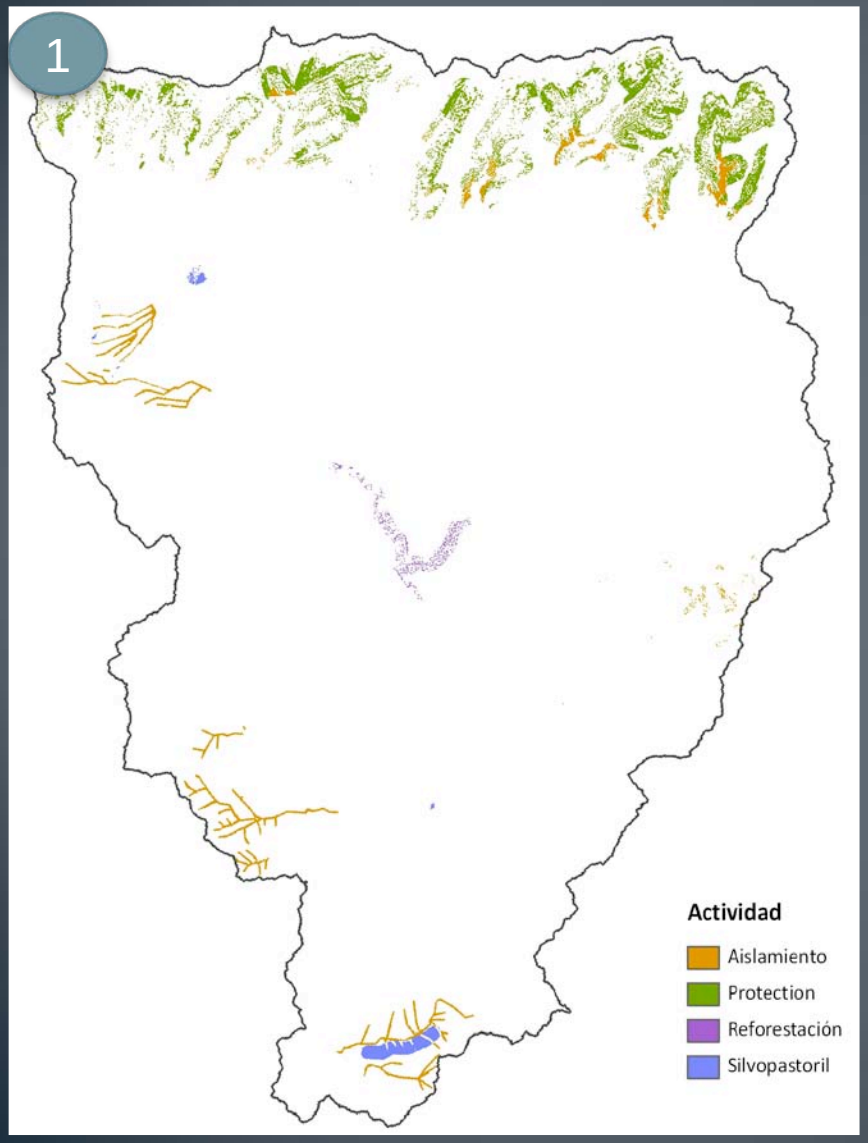
Latin American Water Funds Platform

Water Fund Investment Prioritization

The Birth of RIOS

- Water Funds Workshops
  - Dominican Republic, Fall 2011
  - Mexico, April 2012
- RIOS: Resource Investment Optimization System
- Goal is to provide guidance on ***what*** activities to invest in, and ***where***

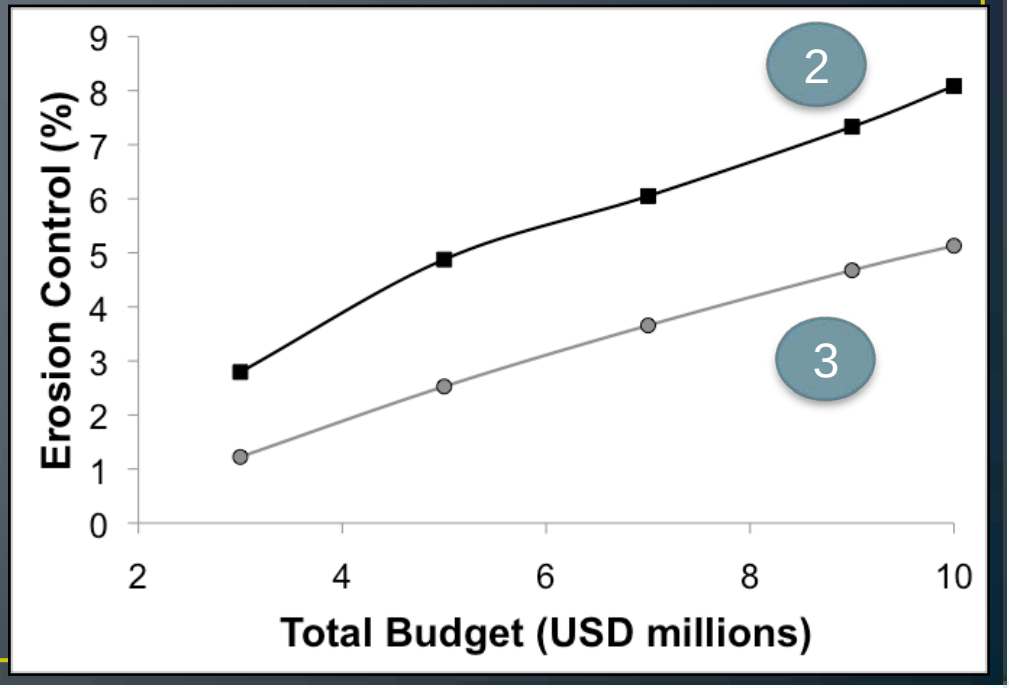
RIOS Outputs



1 Investment Portfolio
(Objectives, Activities, Budget, Diagnostic Screen, Priority Areas)

2 Estimated Return on Investme
(Estimate Returns)

3 Estimated Value of Science
(Business case for approach)



Output I – Diagnostic screening

Objectives

What are the fund's objectives?

Diagnostic Screening

Land Use Change

- Which land use transitions do you want to cause?
- Will some be more effective than others?
- Will some factors be more important than others in determining the impact of each transition?

Activities

- Which activities can be used for each land use transition? Do you prefer some over others?
- Where can each activity be done?
- How much does each activity cost?

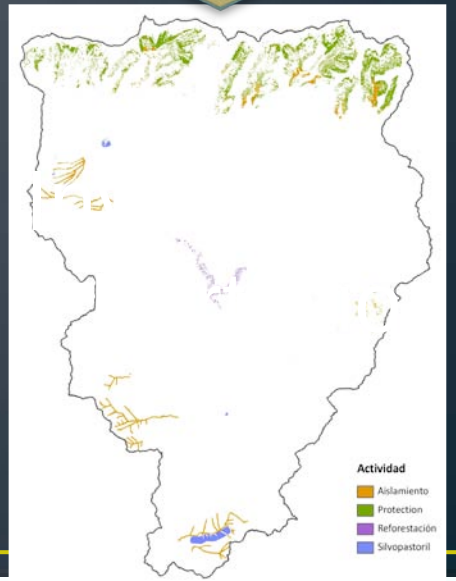
Priority Area Selection

Budget

- What is the budget?
- How do you want to spend it?

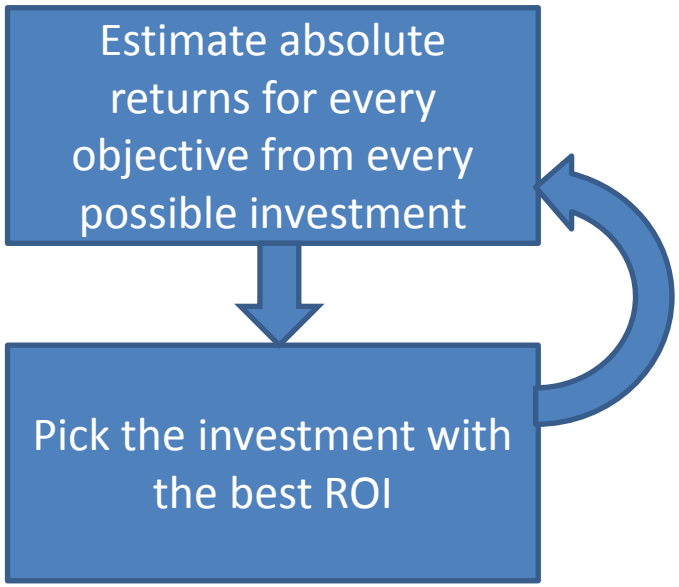
Activities

- How much does each activity cost?

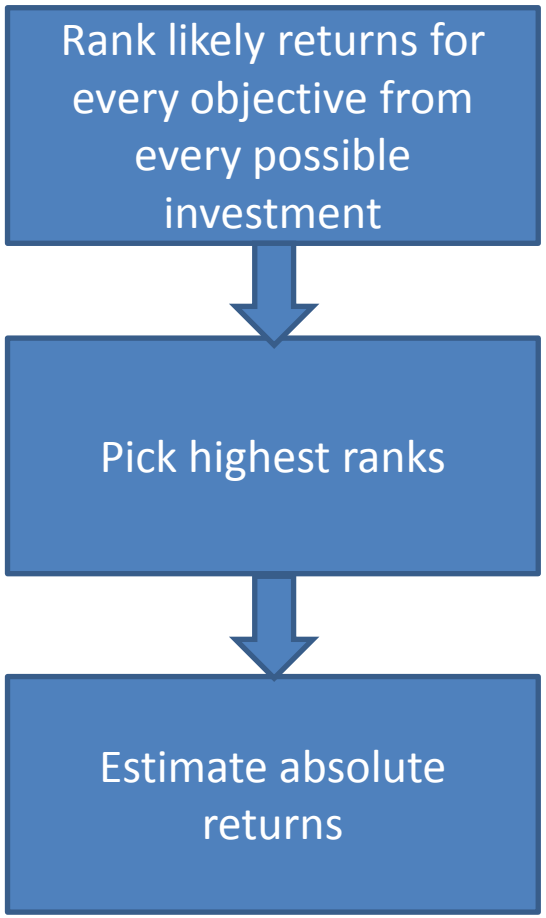


Diagnostic Screening Approach

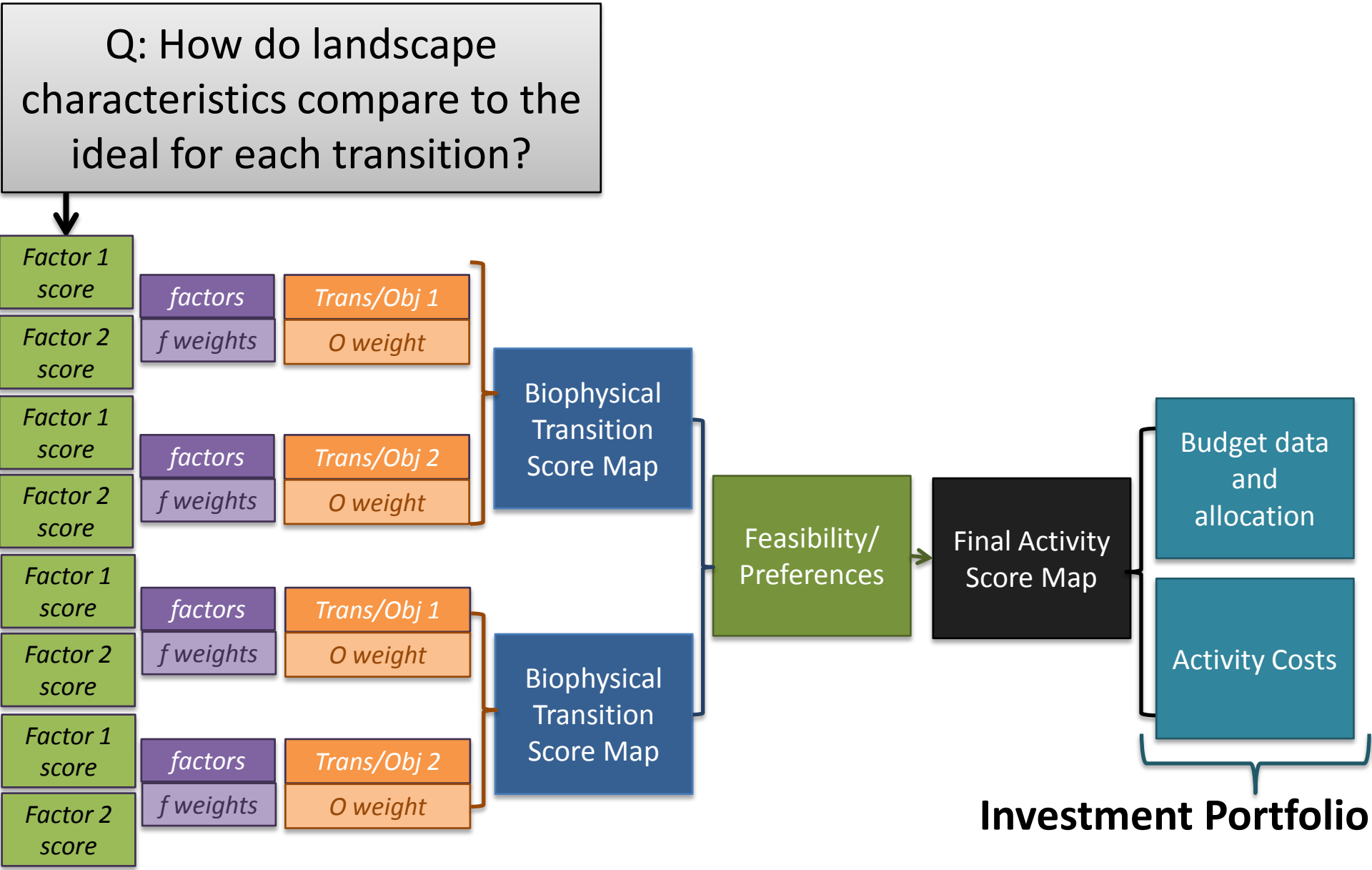
Dynamic Landscape Optimization



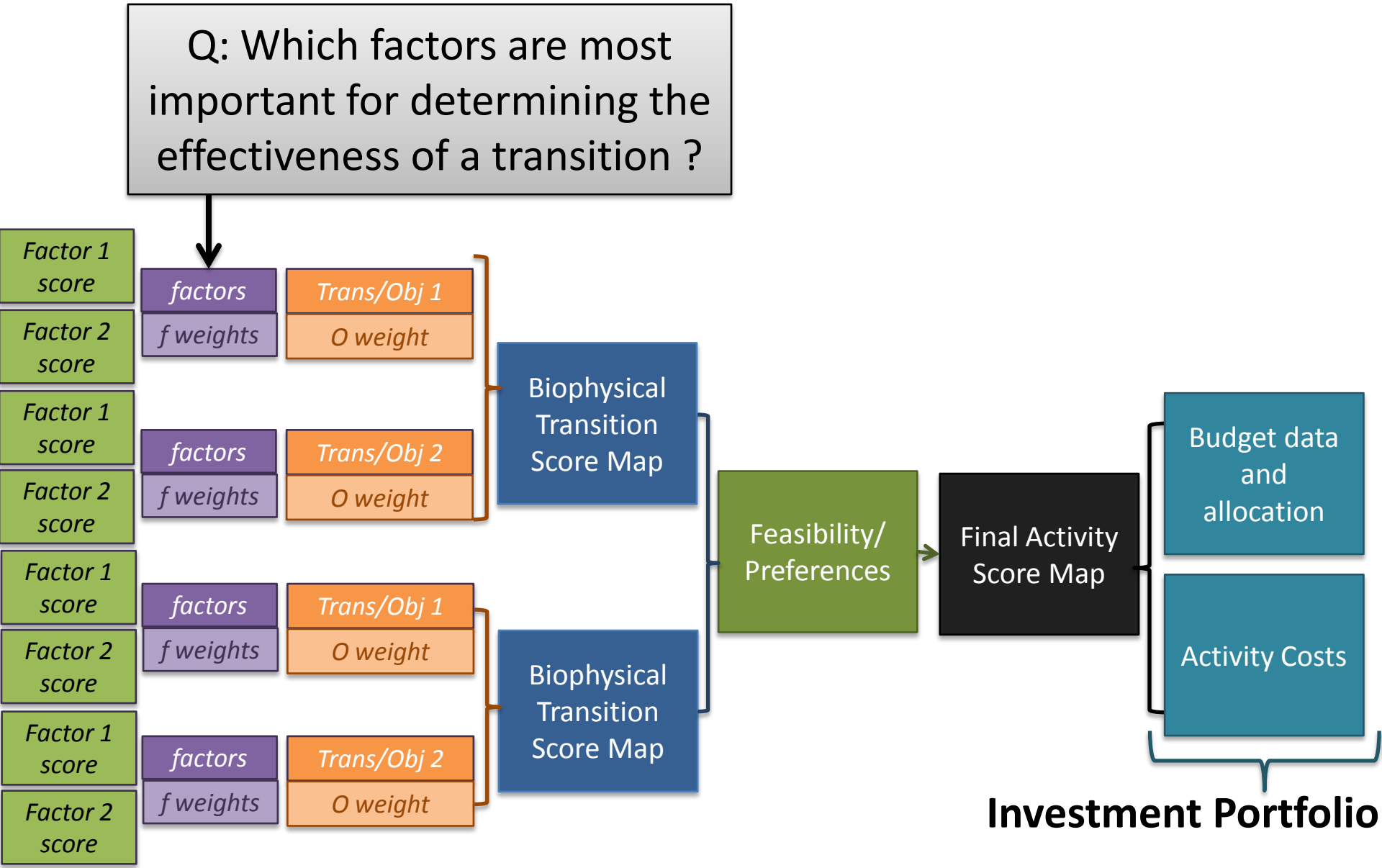
Ranking Model Optimization



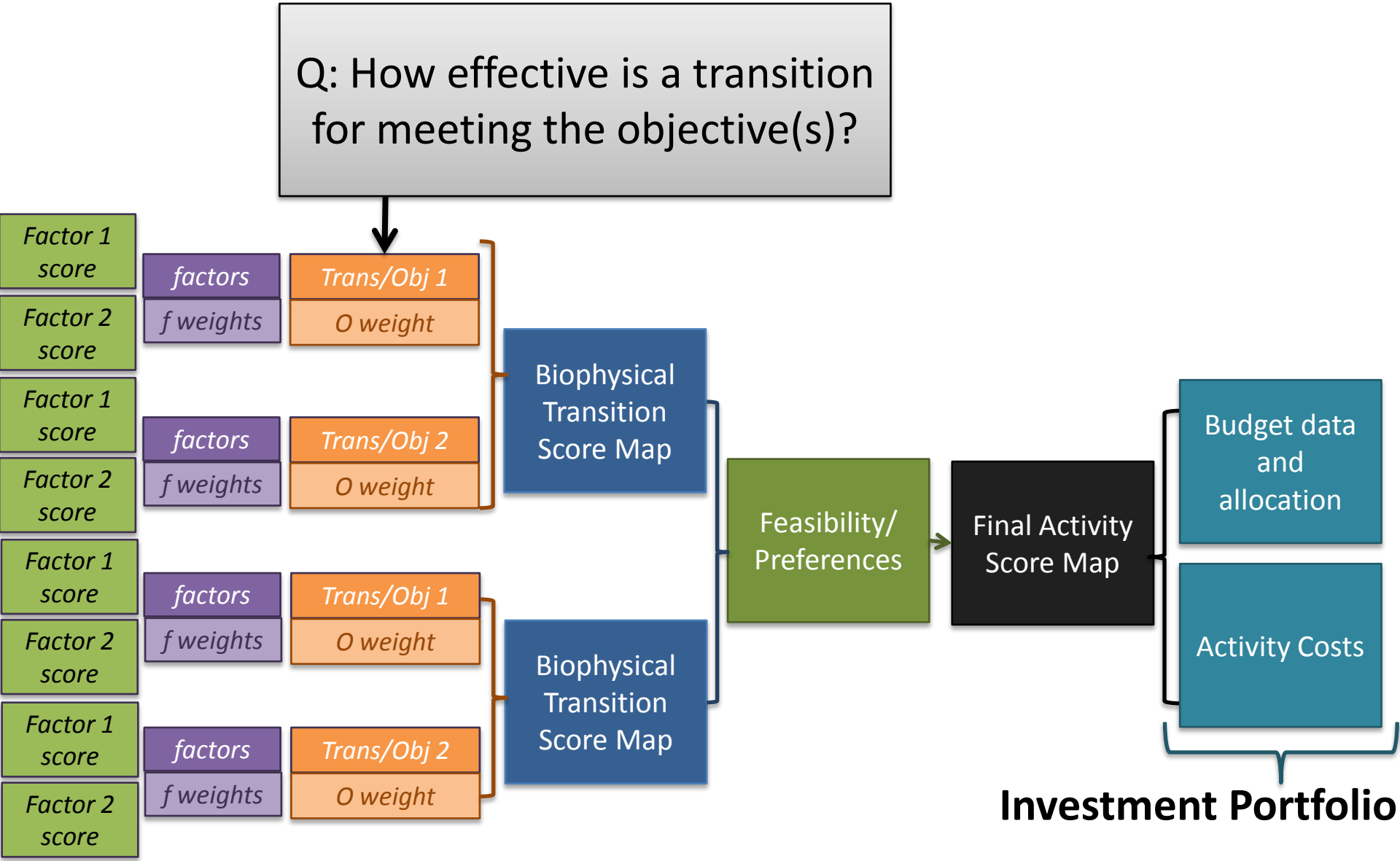
Ranking Approach



Ranking Approach



Ranking Approach



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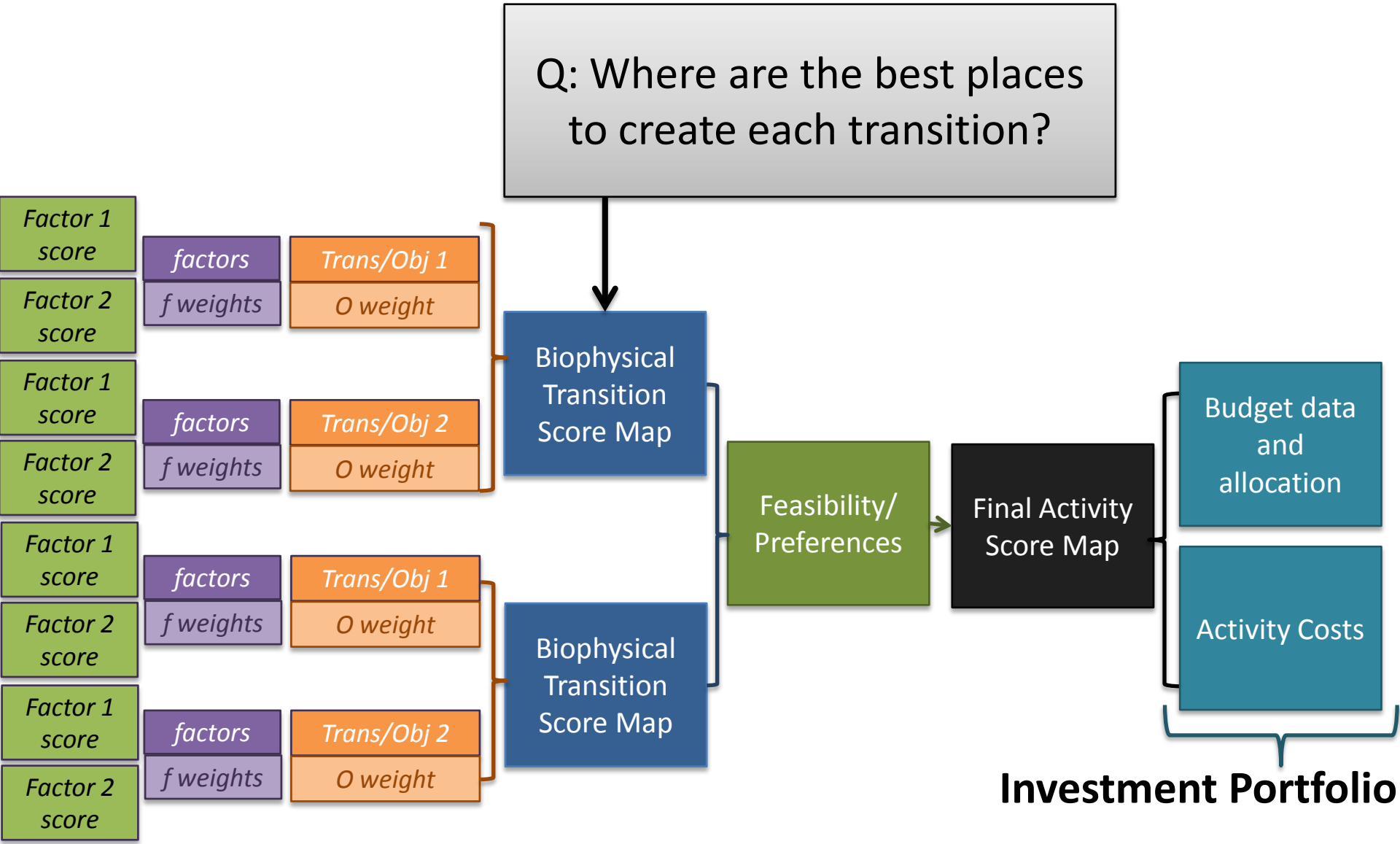

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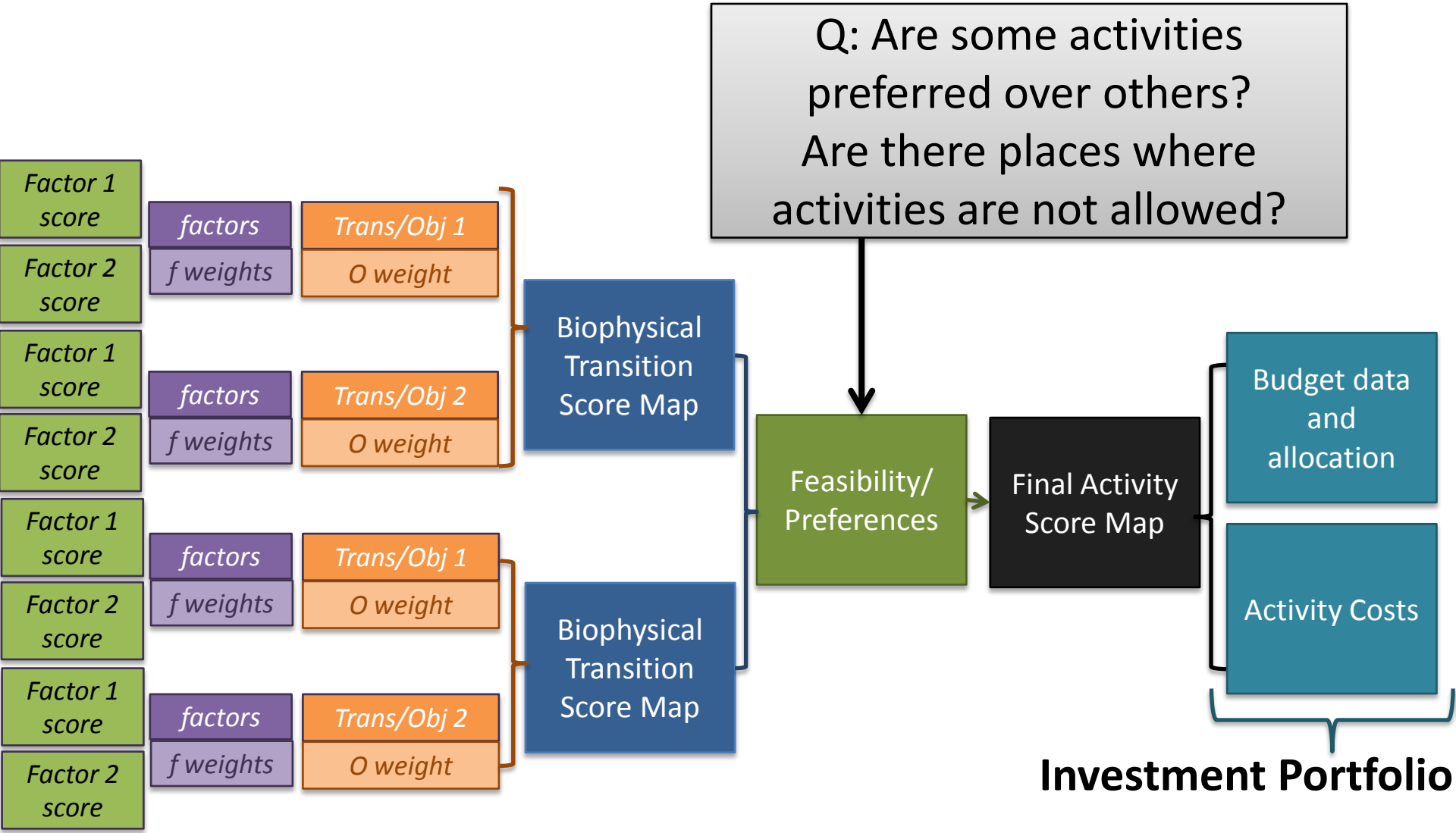
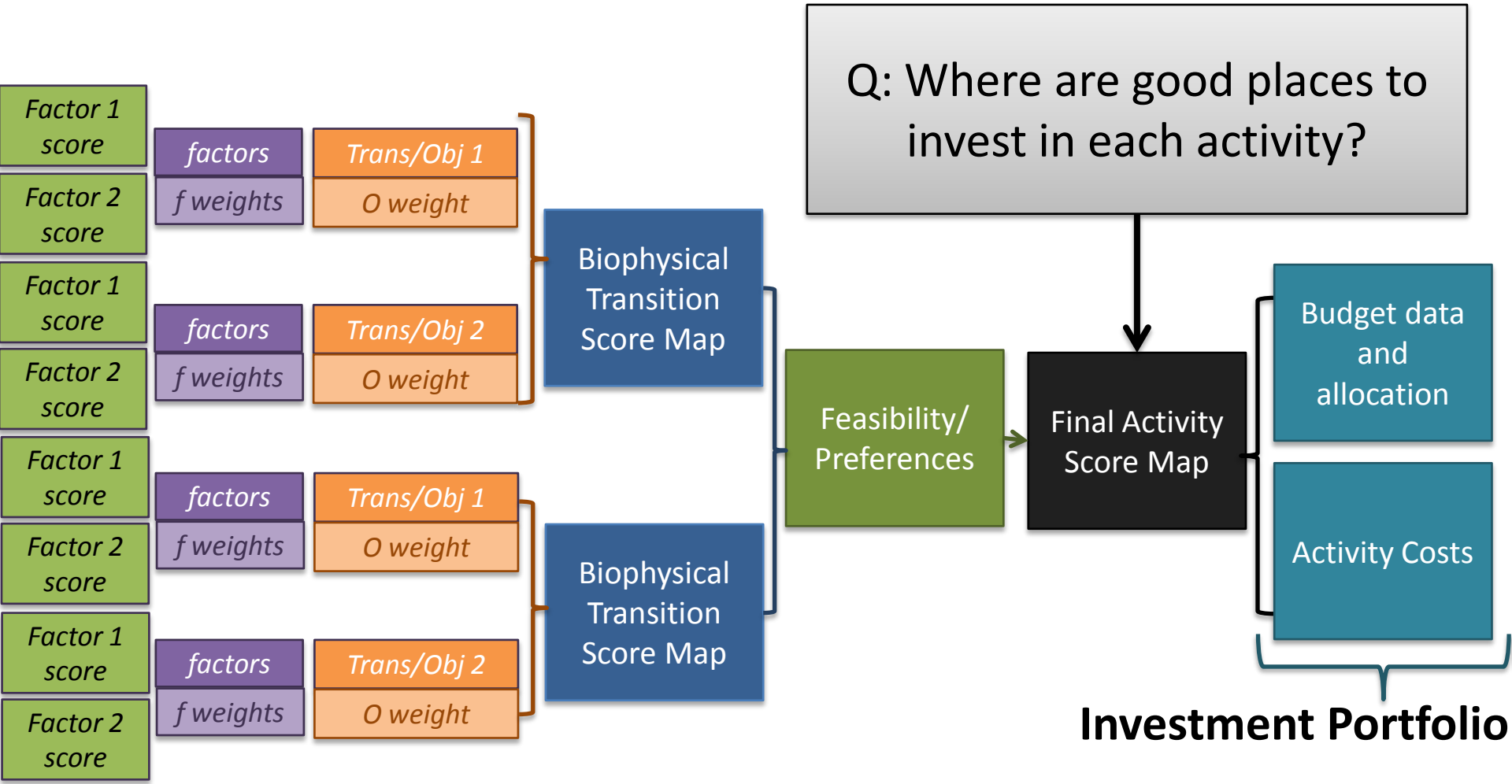
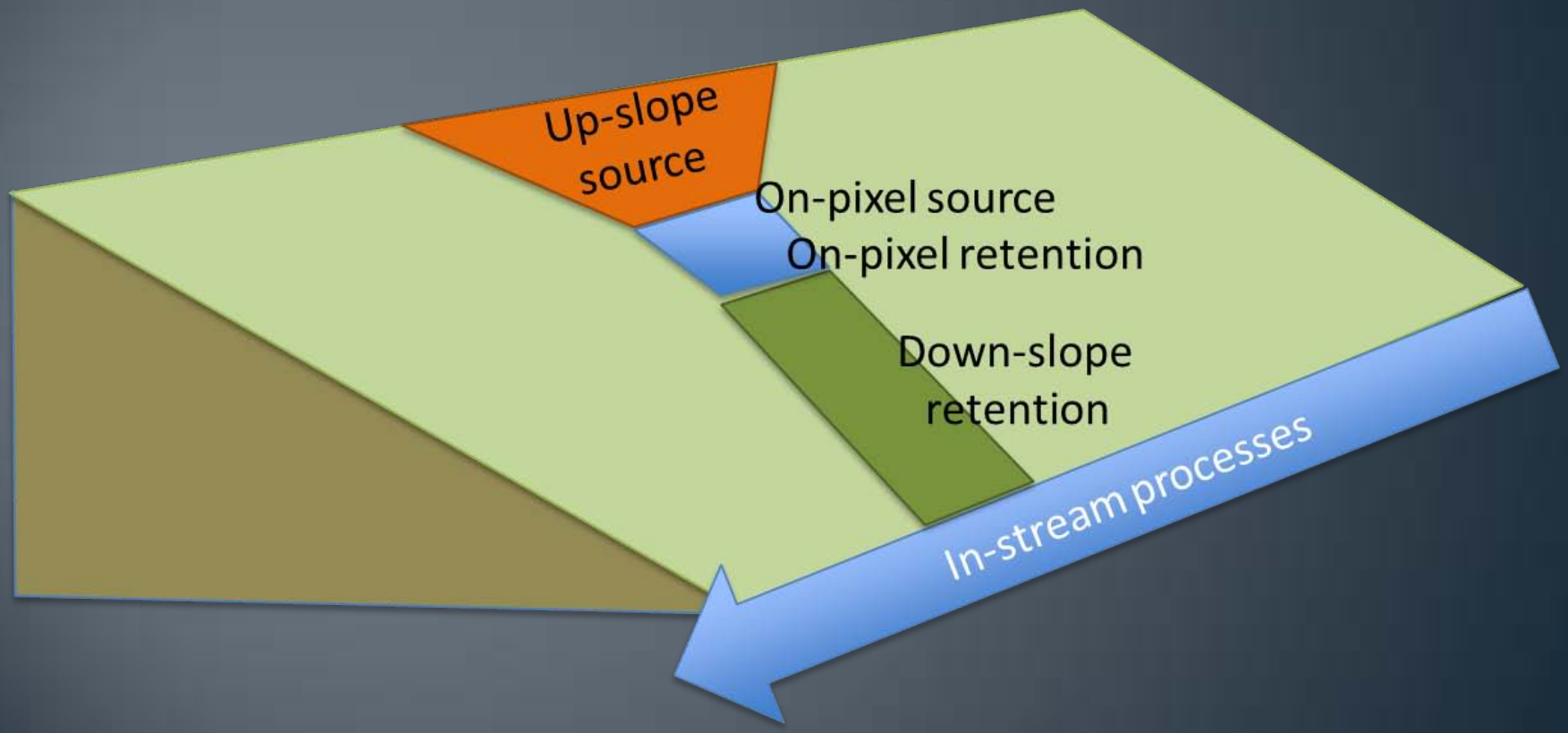


Ranking Approach



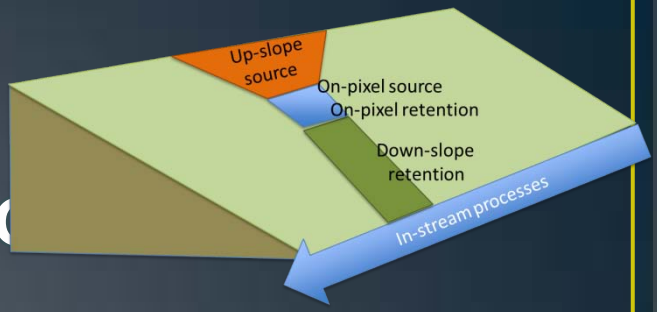
Key Components



Objectives in RIOS v0.1.0

- Erosion Control for Reservoir Maintenance
- Erosion Control for Drinking Water Quality
- Nutrient Retention (Nitrogen and Phosphorus)
- Flood Mitigation
- Groundwater Recharge Enhancement

Factors – Erosion Contr



Up-slope Source

- Slope
- Retention + Source Factors
- Source area

On-pixel

Source:

- Rainfall erosivity
- Soil erodibility
- Soil Depth
- Export (USLE C factor)

Retention:

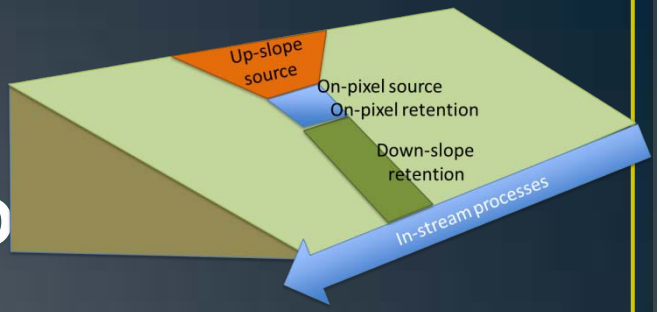
- % Sediment Retention
- Riparian Continuity

Downslope Retention

- Slope
- Sediment Retention
- Flow length to stream

Beneficiaries

Factors – Flood Mitigatio



Up-slope Source

- Slope
- Retention + Source Factors
- Source area

On-pixel

Source:

- Rainfall depth
- Vegetative cover
- Soil texture
- Slope

Retention:

- Vegetation Roughness (n)
- Riparian Index

Downslope Retention

- Slope
- Vegetation Roughness (n)
- Flow length to stream

Beneficiaries

Future Directions

- Biodiversity and Social Objectives
- Refining Ranking Model
- Dynamic Landscape Optimization
- Quantify ROI with InVEST Tier 1 model(s)
- Compare science-informed vs. ad-hoc approach to conservation