

PUTTING InVEST INTO PRACTICE: IMPACT ASSESSMENT & MITIGATION

Natural Capital Project Annual Meeting & Training
March 28, 2014

EXERCISE OBJECTIVES

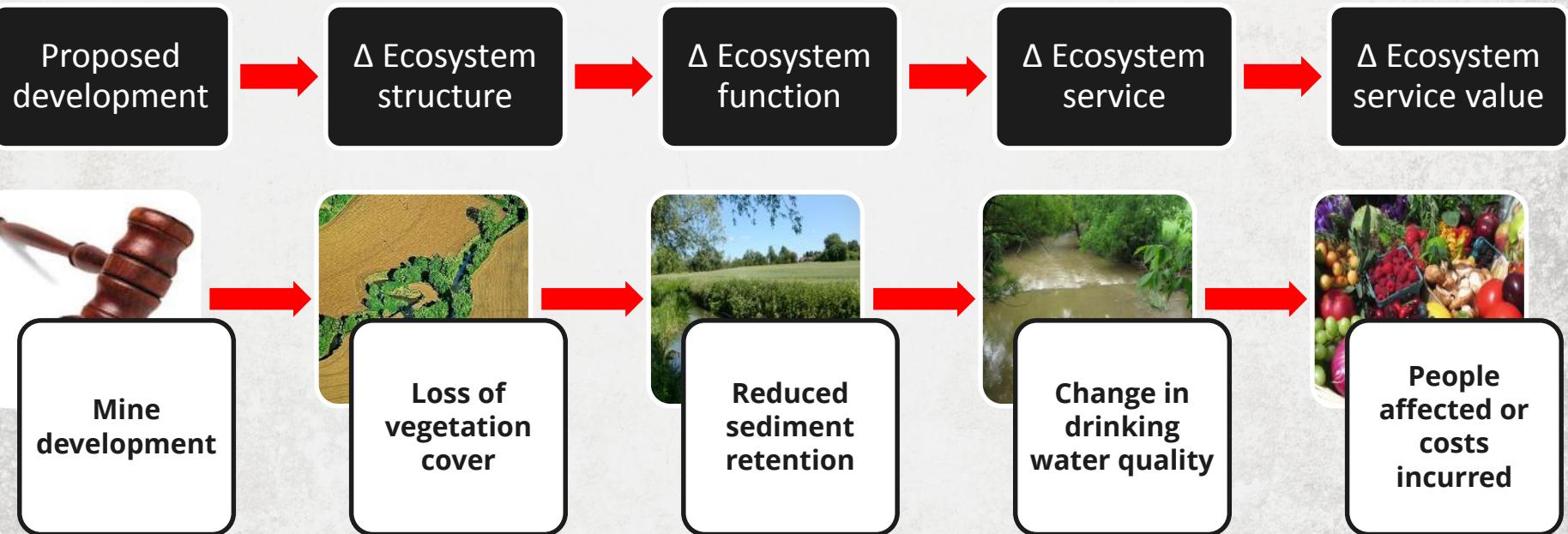
- Quantify the impacts of a proposed mine on ecosystem services and evaluate whether the offset plan is likely to mitigate ecosystem service losses
- Gain experience using the InVEST carbon, nutrient retention and sediment retention stand-alone models
- Apply the concept of servicesheds to an analysis
- Get experience interpreting InVEST outputs and communicating results

BACKGROUND

Production Functions & Servicesheds

PRODUCTION FUNCTIONS

CHANGE IN ENVIRONMENT → CHANGE IN BENEFITS

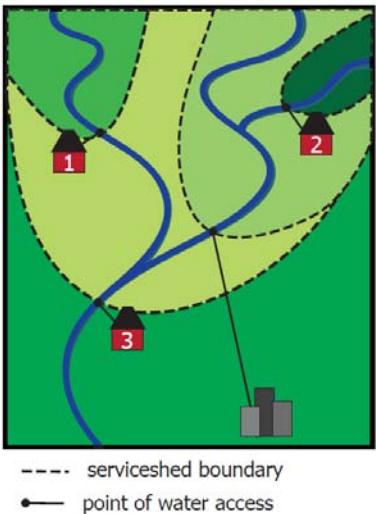


SERVICESHEDS

TRACKING IMPACTS TO PEOPLE

Serviceshed: Area with potential to provide an ecosystem service to a specific beneficiary

Supply + Physical access + Institutional access



Water



Carbon

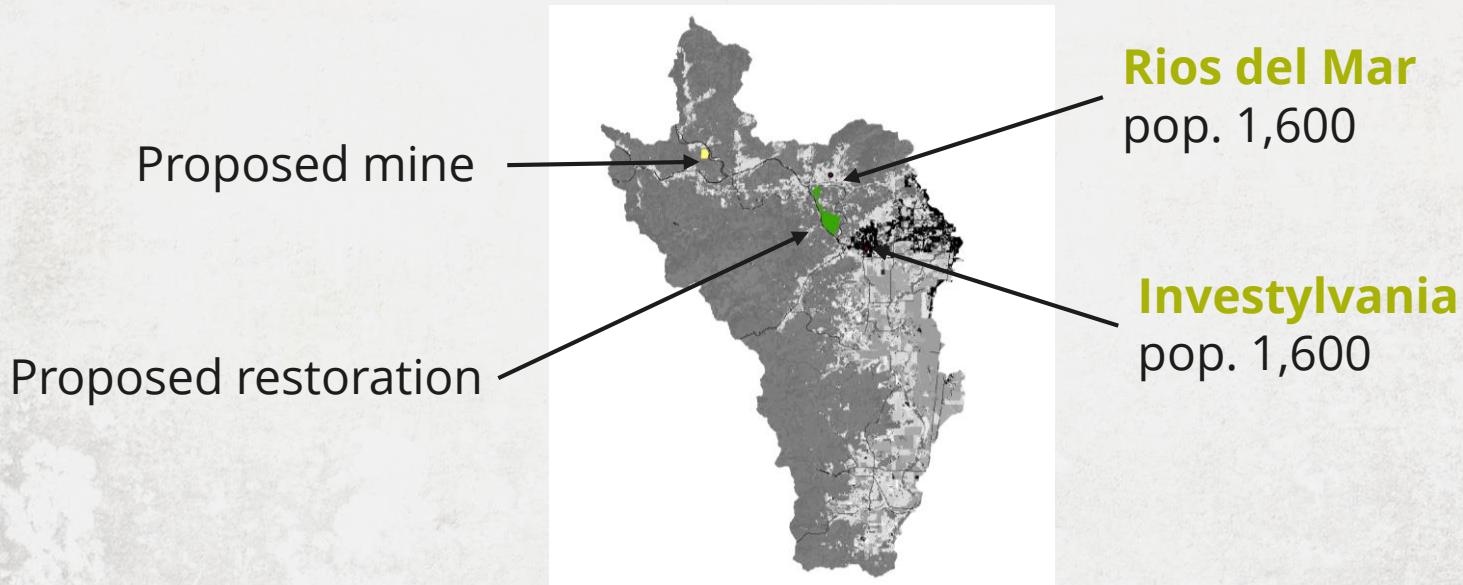
HANDS-ON EXERCISE

Assessing the net impacts of mining on water quality and carbon storage

NATCAPTORIA WANTS TO KNOW:

WHAT ARE THE IMPACTS OF GEM MINERAL LTD'S PROPOSED MINE?

WILL THEIR RESTORATION PLAN OFFSET ECOSYSTEM SERVICE LOSSES?



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Services



Climate regulation

Models

Carbon

Water quality regulation

Nutrient retention (nitrogen)

Sediment retention



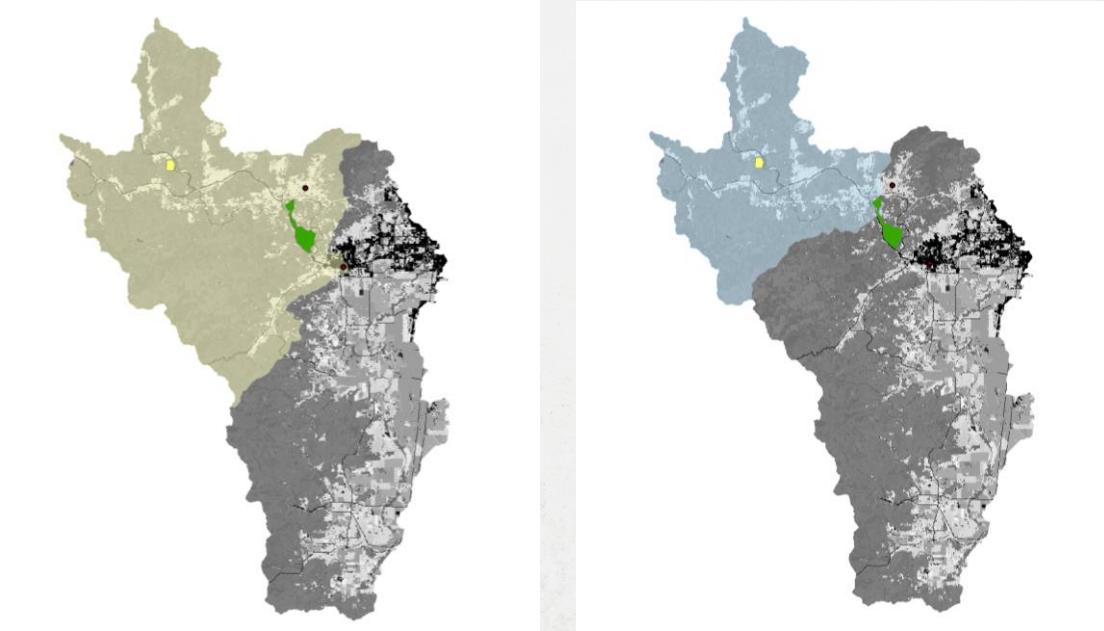
InVEST

integrated valuation of
environmental services
and tradeoffs

NATCAPTORIA WANTS TO KNOW:

WHAT ARE THE IMPACTS OF GEM MINERAL LTD'S PROPOSED MINE?
WILL THEIR RESTORATION PLAN OFFSET ES LOSSES?

Servicesheds for water-related services



Investylvania

Rios del Mar

YOUR TASK:

- Quantify the mine's impacts on three services to the two cities
- Evaluate the restoration plan's ability to offset ecosystem service losses
- Prepare a presentation of your results for NatCaptoria's Ministry of Natural Resources

SNEAK PEEK: A New Tool For Incorporating Ecosystem Services Into Impact Assessment & Offset Selection

Lisa Mandle & James Douglass
Natural Capital Project
lmandle@stanford.edu | jdouglass@stanford.edu

OUR APPROACH

ECOSYSTEM SERVICES IN IMPACT ASSESSMENT & MITIGATION DECISIONS

Servicesheds



1) Estimate impacts



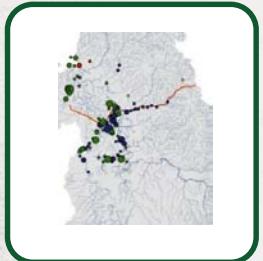
2) Assess mitigation options



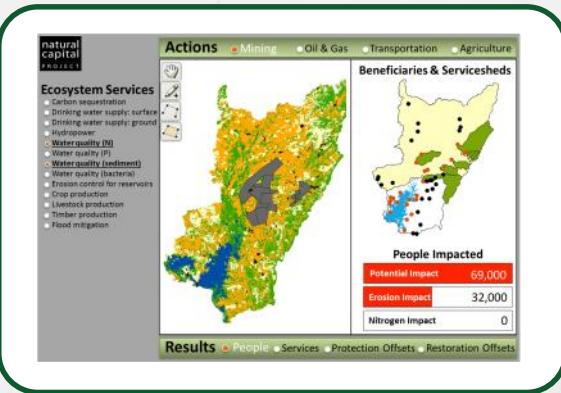
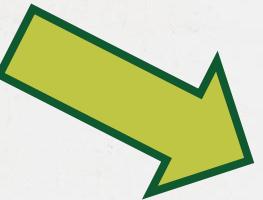
3) Determine net offset potential

CREATING A USER-FRIENDLY TOOL

A WORK IN PROGRESS!



Road permitting
in Peru



Impact assessment & offset
design tool for Colombia



Coal mine
permitting
in Colombia



Flexible tool for application
across contexts

TOOL OVERVIEW

QUANTIFYING IMPACTS AND ASSESSING MITIGATION OPTIONS

Inputs:

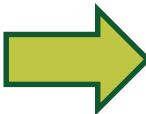
Project footprint

(+ optional inputs for added flexibility)

Using **static maps** generated from earlier InVEST runs across all of Colombia to speed up process:



Estimate impacts



Assess mitigation options:

Search for offset sites and calculate their value



Outputs:

Determine net offset potential:

List of possible offset parcels

Interactive tables for selecting offset portfolio

Balance sheet for exploring results



Changes in ecosystem services:

- Δ carbon, sediment & nitrogen total and by serviceshed

Changes in biodiversity:

- Δ hectares per ecosystem type

TOOL INTERFACE

The screenshot shows a software interface with a toolbar at the top and a main configuration area below. The configuration area contains several input fields with descriptions and arrows pointing to them.

Input Field	Description
Workspace	invest-natcap.permitting/adept_workspace
Project Footprint	footprints/Example_mining_projects.shp
Impact type	Bare ground/Mine
Area of Influence	/dataocolombia_tool_data/sample_aoi.shp
<input checked="" type="checkbox"/> Use custom ecosystems map	a_tool_data/ecosys_dis_nat_comp_fac.shp
Threat map (optional)	
Species richness map (optional)	
Avoidance areas (optional)	
Conservation portfolio (optional)	
Previously granted impacts (optional)	
Previously selected offsets (optional)	
Custom static map (optional)	a_tool_data/sample_static_impact_map.tif

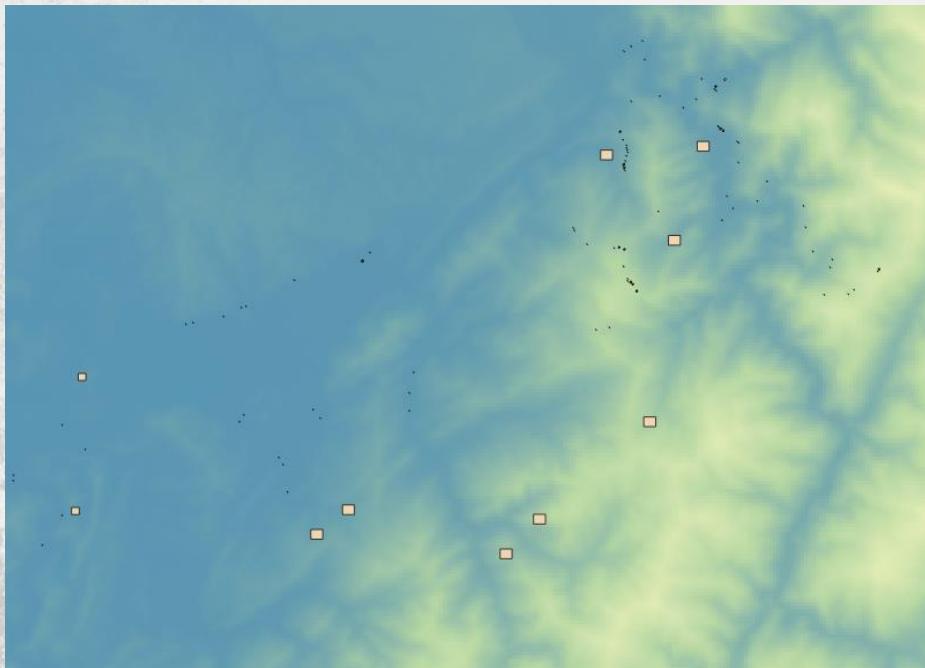
Annotations with arrows explain the purpose of some fields:

- Project Footprint: Shapefile of impact site
- Impact type: Select impact type: bare ground or paved
- Area of Influence: Boundary of search for offset sites
- Use custom ecosystems map: Override embedded LULC map
- Threat map (optional), Species richness map (optional), Avoidance areas (optional): Limit to parcels of equal or better quality
- Conservation portfolio (optional), Previously granted impacts (optional), Previously selected offsets (optional): Check if impact site intersects with designated avoidance areas
- Conservation portfolio (optional), Previously granted impacts (optional): Prioritize areas within conservation portfolio
- Custom static map (optional): Exclude areas that will be developed, or are already part of an offset portfolio

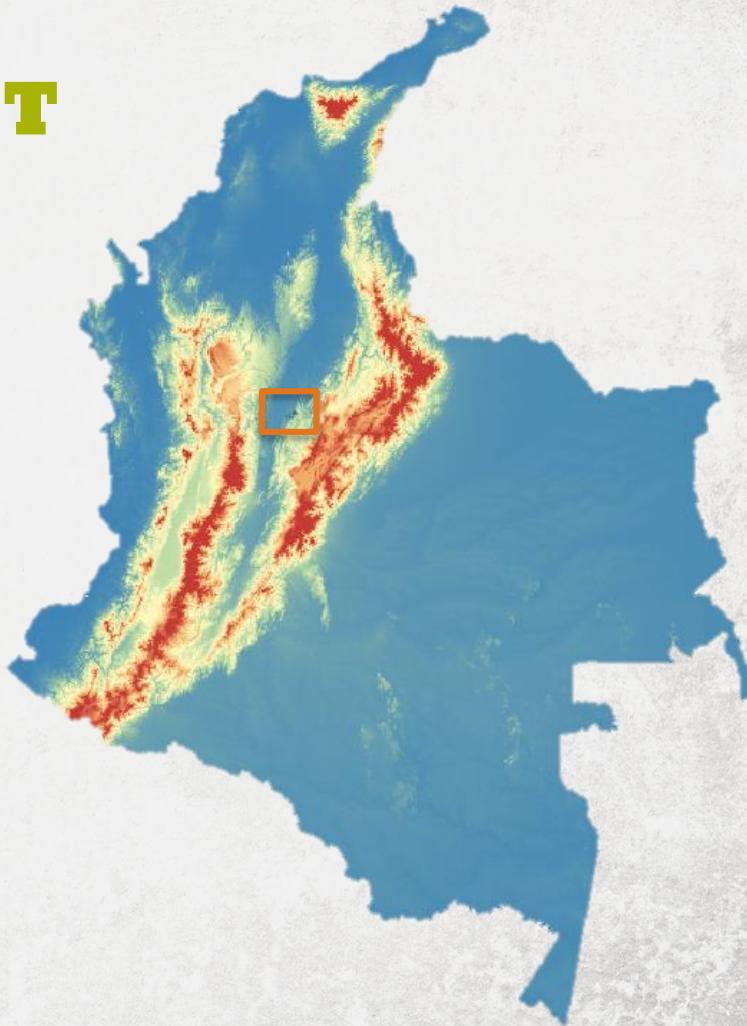
Buttons at the bottom include: Reset, Quit, and Run.

PROJECT FOOTPRINT

WHERE ARE WE BUILDING?

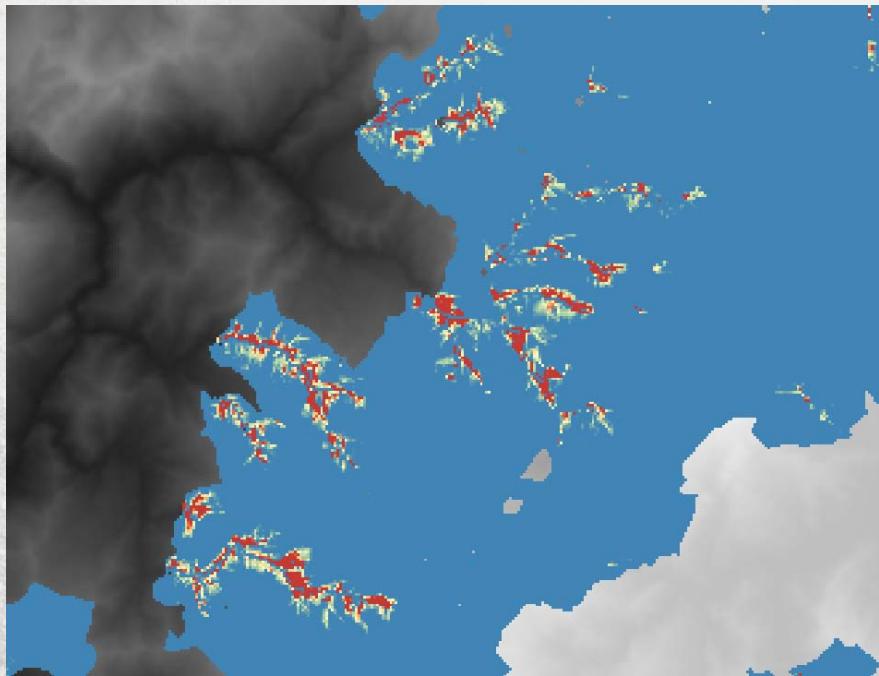


22 Km



ESTIMATING IMPACTS

STATIC IMPACT MAPS

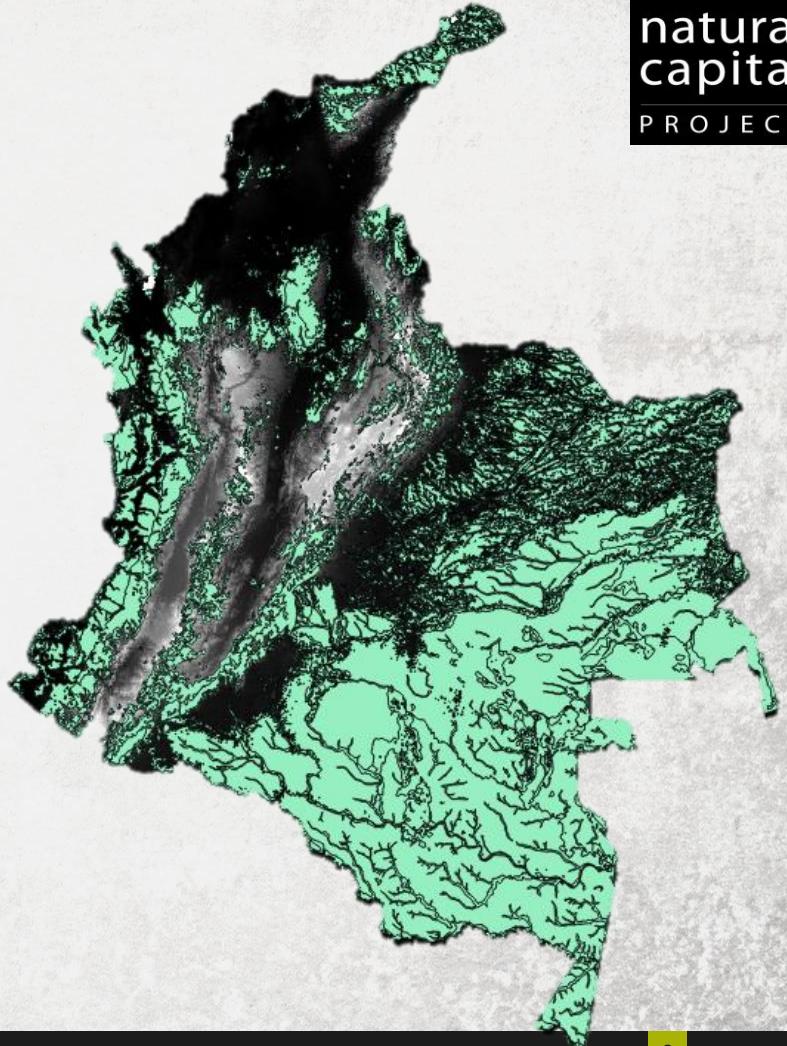
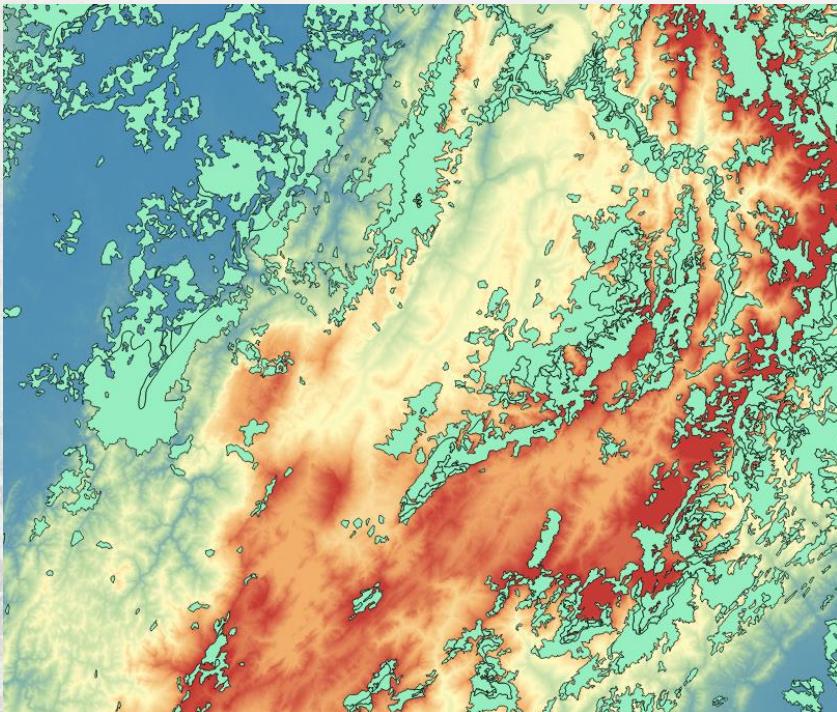


Paved impact map (**Low** **Med** **High**)



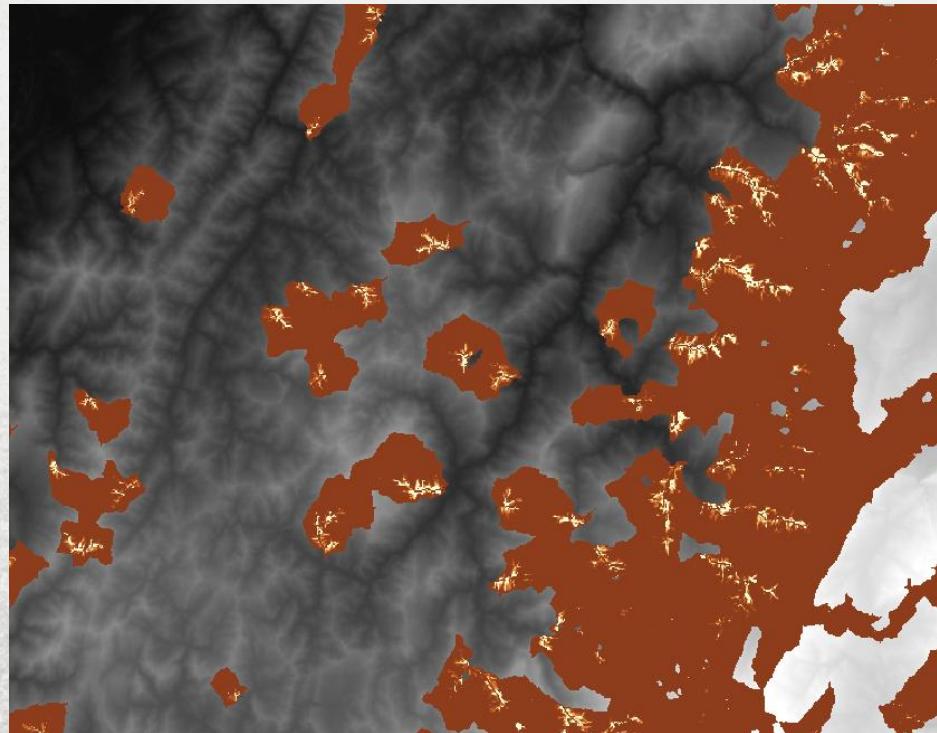
OFFSET PARCELS

WHAT AREAS CAN BE PROTECTED?



VALUE OF PROTECTION

STATIC PROTECTION MAP

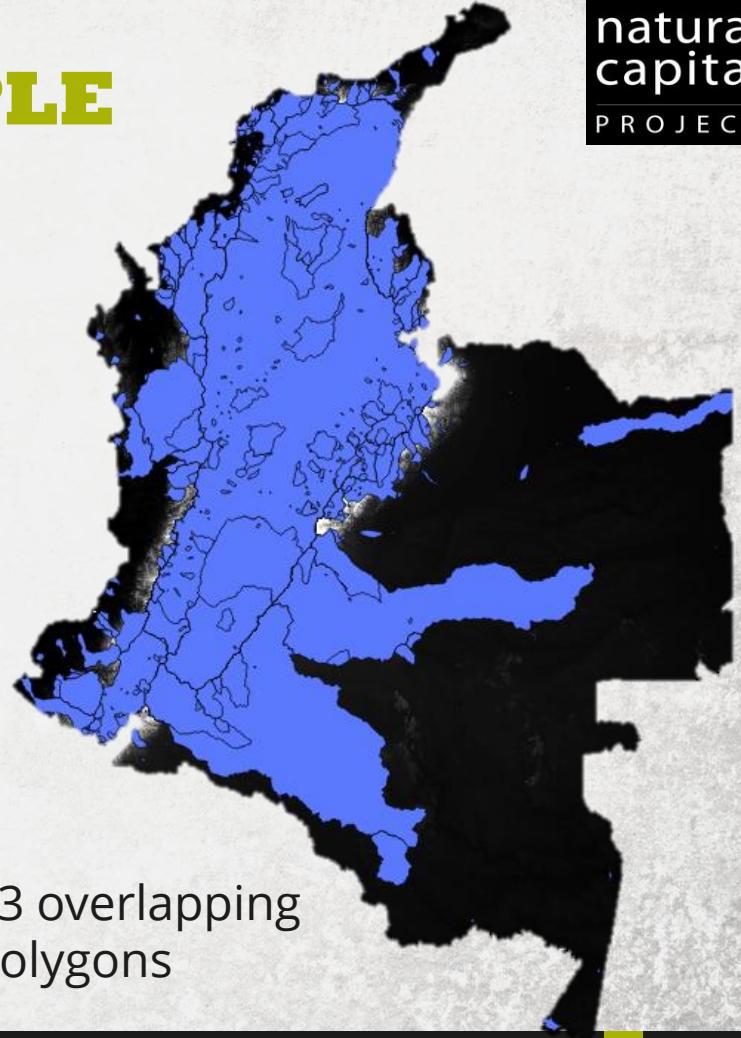


IMPLICATIONS TO PEOPLE

AGGREGATION BY SERVICESHEDS



13 overlapping
polygons



VISUALIZING BENEFITS

TOOL OUTPUTS

Adept Test Report

file:///Users/jdouglass/workspace/invest-natcap.permitting/tests/adept_smok...

Impact Site Summary

Impact Type: An impact type!

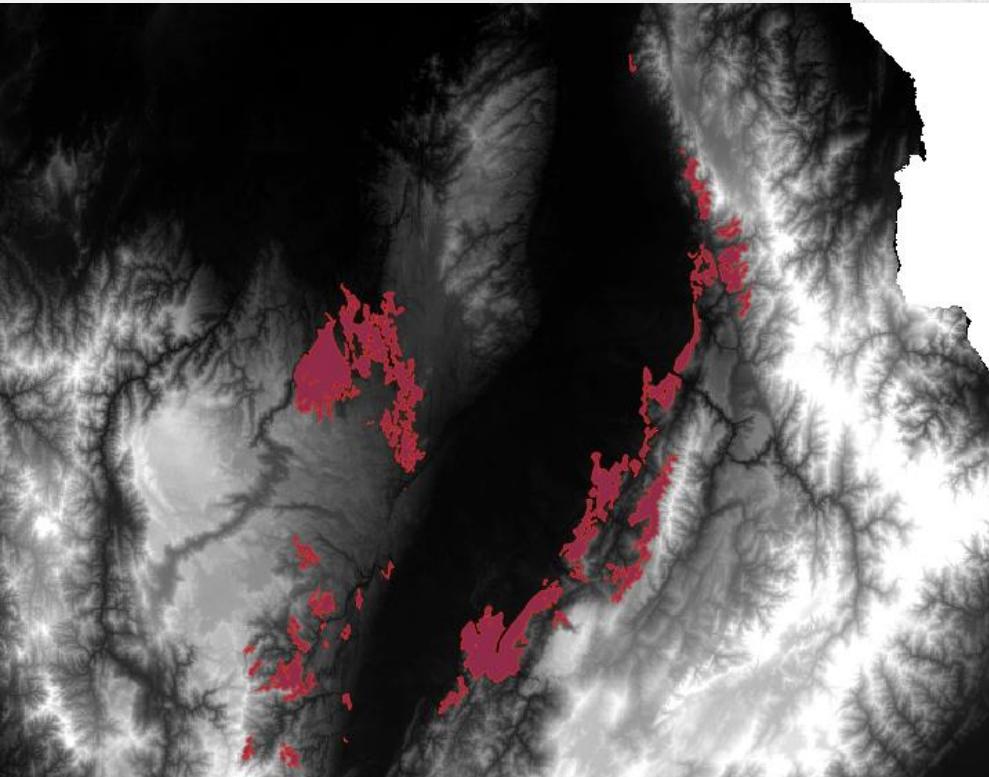
Site Shapefile	Select	Carbon Storage Impact Amount	Sediment Impact Amount	Nitrogen Impact Amount	Custom Ecosystem Service Impact Amount	Bosques naturales del orobrama bajo de los Andes en NorAndina Montano_Valle_MaOrobiomas bajos de los Andes AREA (ha)	Bosques naturales del orobioma bajo de los Andes en NorAndina Montano_Valle_MaOrobiomas bajos de los Andes AREA (area * fact)
Example_mining_projects.shp	<input type="checkbox"/>	n/a	1234567	n/a	1	32.39	
	Selected Total	--	--	--	--	--	--
	Total	--	--	--	--	--	--

Impact Mitigation

Possible offset sites

GIS Vector with all selected offset sites: [output/selected_offsets.shp](#)

parcel_id	Select	Sediment	Nitrogen	Phosphorous	% Impact (Sediment)	Area	Ecosystem type	distance
0	<input type="checkbox"/>	1732392.0	0	0	140.32	24769554.72	Bosques naturales del orobioma...	105299.13
1	<input type="checkbox"/>	129957.0	0	0	10.53	1382784.06	Bosques naturales del orobioma...	114203.53
2	<input type="checkbox"/>	105822.0	0	0	8.57	1167536.7	Bosques naturales del orobioma...	114146.51
3	<input type="checkbox"/>	829172.0	0	0	67.16	11592039.49	Bosques naturales del orobioma...	114579.06
4	<input type="checkbox"/>	2899472.0	0	0	234.86	39053053.69	Bosques naturales del orobioma...	111860.44



REPORT DEMO

TOOL OVERVIEW

QUANTIFYING IMPACTS AND ASSESSING MITIGATION OPTIONS

Inputs:

Project footprint

Estimate impacts

Assess mitigation options:
Search for offset sites and calculate their value

Outputs:

Determine net offset potential:

List of possible offset parcels

Interactive tables for selecting offset portfolio

Balance sheet for exploring results

InVEST

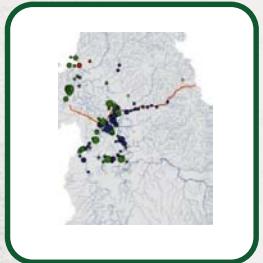
Integrated valuation of environmental services and tradeoffs

Changes in ecosystem services

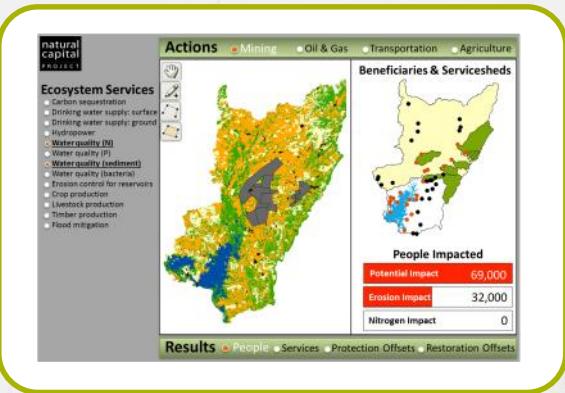
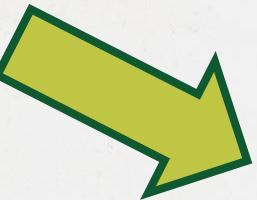
Changes in biodiversity

CREATING A USER-FRIENDLY TOOL

A WORK IN PROGRESS!



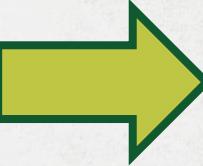
Road permitting
in Peru



Impact assessment & offset
design tool for Colombia
Spring 2014



Coal mine
permitting
in Colombia



Flexible tool for application
across contexts

QUESTIONS? COMMENTS?

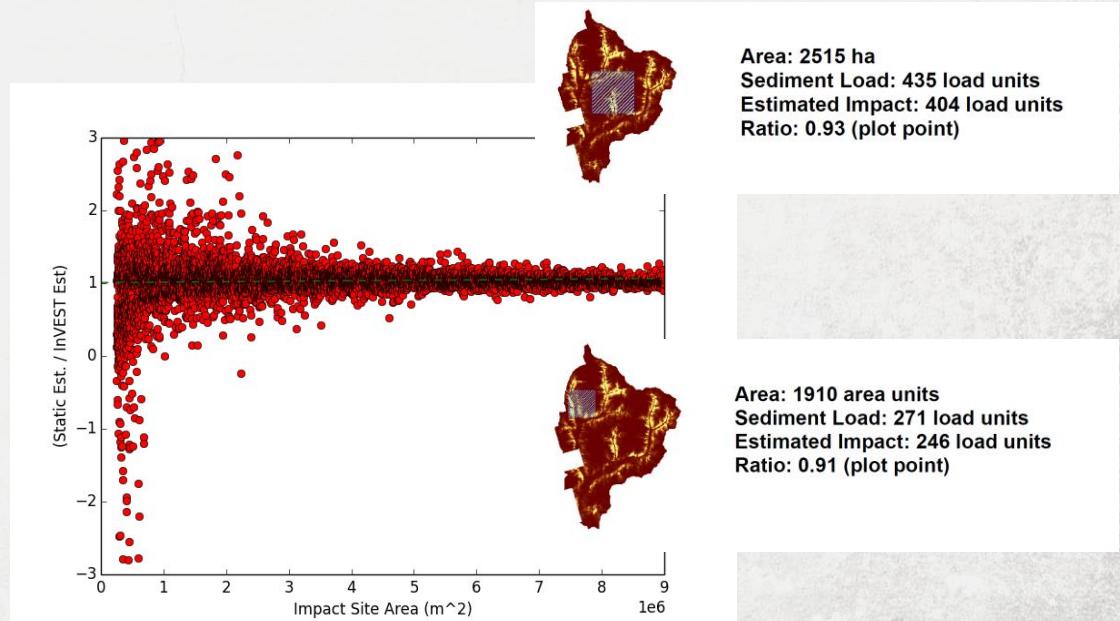
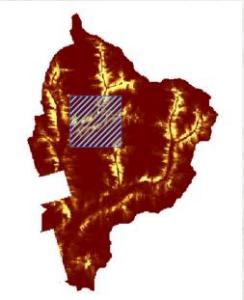
Do you see a use for this tool in your own work?
How could we make it more useful for you?

RAPIDLY ESTIMATING IMPACTS

A 'STATIC MAP' APPROACH

Static map is difference in per-pixel sediment retention between base and completely converted LULC map

Estimate impact by summing static map values under project footprint





Infrastructure and dependencies

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rmgriff@stanford.edu



WOODS INSTITUTE
FOR THE ENVIRONMENT
STANFORD UNIVERSITY



The Nature Conservancy



INSTITUTE ON THE
ENVIRONMENT
UNIVERSITY OF MINNESOTA
Driven to Discover™

Infrastructure and impacts - EIS and EIA

Report and recommendations of the Environmental Protection Authority

Environmental and water assessments relating to mining and mining-related activities in the Fortescue Marsh management area

Advice of the Environmental Protection Authority to the Minister for Environment under Section 10(6) of the Environmental Protection Act 1989



ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE N17 TOLL ROAD

PROPOSED REHABILITATION AND UPGRADING OF THE N17 FROM SPRINGS TO ERMELO AND PROPOSED CONSTRUCTION OF NEW SECTIONS BETWEEN LEANDRA AND LEVEN STATION, AT TRICHARDT AND BETHAL

FINAL ENVIRONMENTAL IMPACT REPORT

EnviroPlanners Ltd.



ANTALYA- TURKEY POWER PLANT

ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Conducted by

ERI-CEV

ENERGY AND ENVIRONMENTAL INVESTMENT AND CONSULTING LIMITED COMPANY ANKARA-TURKEY

October 2006



Environmental impact statement: 103 km highway corridor in the State of Durango

Actavis Priority-2000

Project study for the construction of a new highway in the State of Durango. This project will be built in high priority areas to allow for better access to basic services. The highway will facilitate high speed traffic and will have infrastructure, bridges, crossings for roads, railways, pedestrian and bicycle and other drainage works. The area impacted by the project is 103 km and it will affect 10 municipalities and 100,000 inhabitants. The project has major social, economic, environmental and cultural issues and requires detailed and well informed analysis. There are several areas of concern: flora and fauna, soil and water resources, air quality, noise, traffic, climate and public health.

The Environmental Impact Assessment (EIA) for this project was prepared in accordance with Mexican environmental legislation. When it was carried out, the project was in its planning phase.

INTRODUCTION

The project to build the environmental impact of a new highway in the State of Durango. This project will be built in high priority areas to allow for better access to basic services. The highway will facilitate high speed traffic and will have infrastructure, bridges, crossings for roads, railways, pedestrian and bicycle and other drainage works. The area impacted by the project is 103 km and it will affect 10 municipalities and 100,000 inhabitants. The project has major social, economic, environmental and cultural issues and requires detailed and well informed analysis. There are several areas of concern: flora and fauna, soil and water resources, air quality, noise, traffic, climate and public health.

The project to build the highway will join two Mexican Highways (Hwy 100 and Hwy 10) These two highways neighboring the area that has been proposed as a route of installation. On one side of the project is the state of Coahuila and on the other side is the state of Durango. The project has been proposed as a route of installation because it is the most direct route between the two states.

See Topic 5
IAEP Site Selection
Resource Manual



U.S. Environmental Protection Agency
Office of Civil Rights
Title VI Program
40 CFR Part 190.200
1200 Pennsylvania Avenue, NW, Suite 3000, Washington, DC 20460
Telephone: (202) 564-2000
Facsimile: (202) 564-2001
Email: TitleVI@epa.gov
Web site: www.epa.gov/titlevi

EPA
Evaluation Of Ecological Impacts From Highway Development



EnviroPlanners Ltd.

THE ENVIRONMENTAL IMPACT ASSESSMENT FOR HIGHWAY 2000, THE MOUNT ROSSER BYPASS, LINSTEAD TO MONEAGUE

DATE: 2007 August

GUEST: Burlington Public Utilities Branch

WORK DONE BY: EnviroPlanners Limited
26 West King's House Road
Kingston 10

PUBLICATION NO. PPLA-A100004

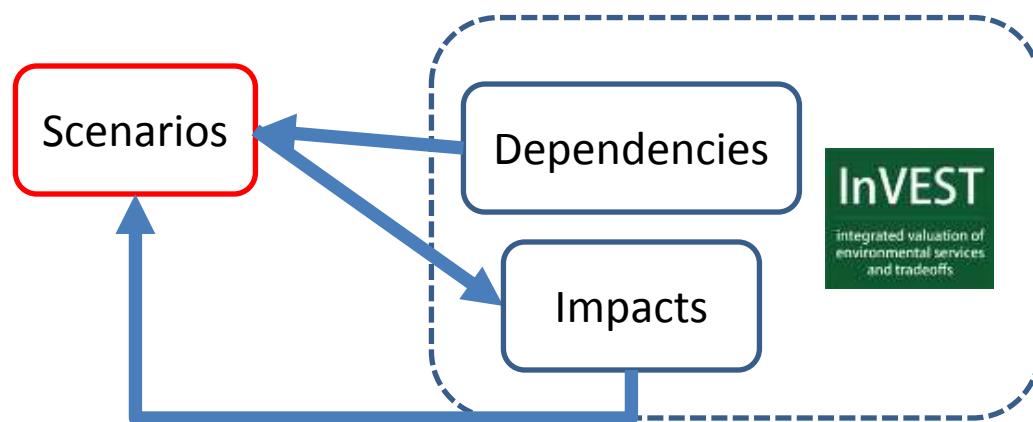
PRINTED ON JULY 2007 BY THE GOVERNMENT OF JAMAICA. 2007 © GOVERNMENT OF JAMAICA

Infrastructure - Impacts and Dependencies

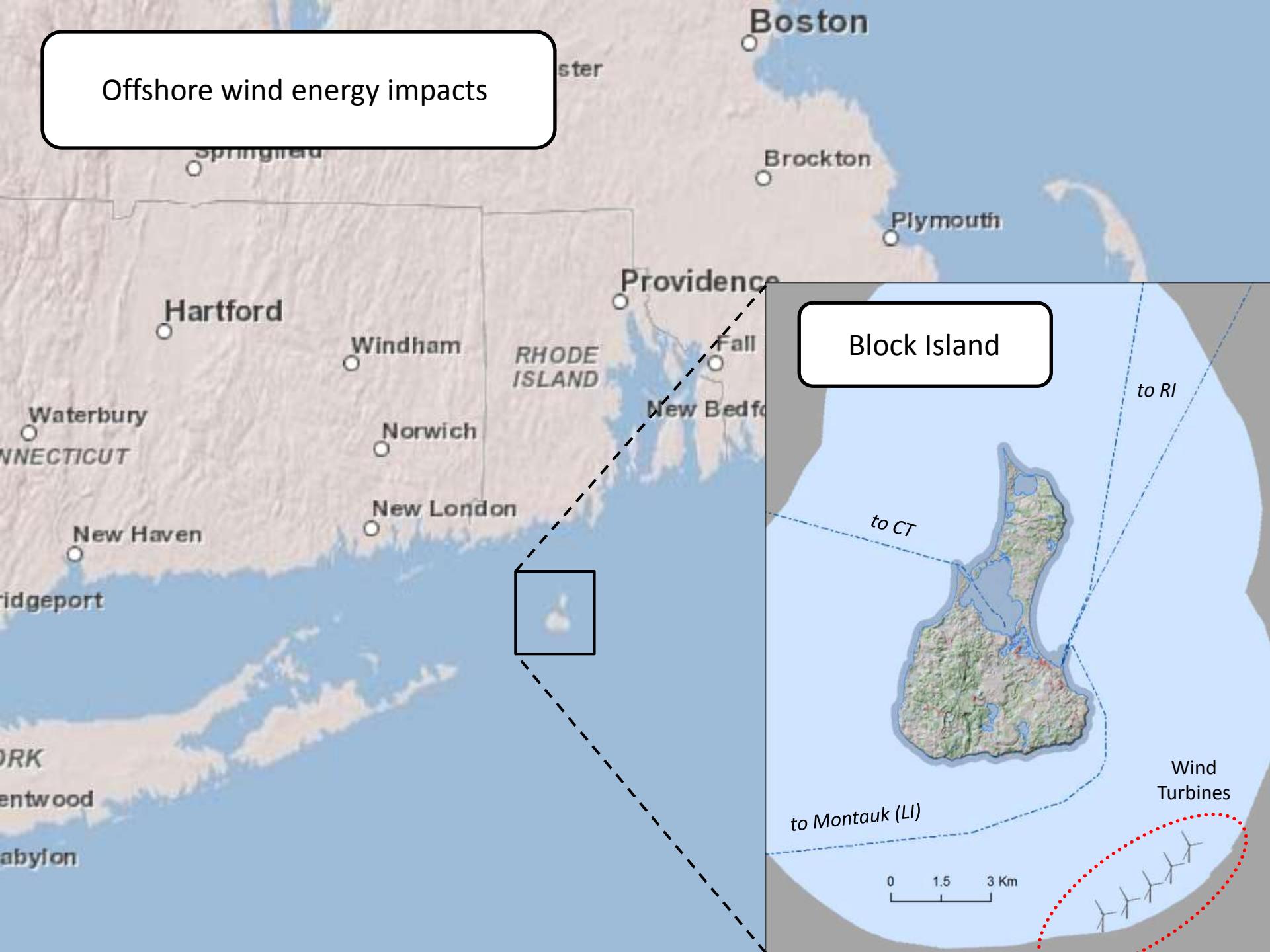
Framed by the affected party and direction of effects. In the context of infrastructure:

Impacts – Effects (\uparrow , foreseen or unforeseen) of infrastructure on the well-being of relevant parties

Dependencies – Effects (\downarrow , foreseen or unforeseen) of relevant external conditions on infrastructure



Offshore wind energy impacts



InVEST

integrated valuation of
environmental services
and tradeoffs

Offshore
Wind Energy



Block Island



Turbines

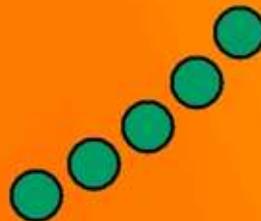


Lo



Hi

Wind NPV



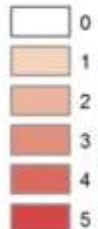
0 0.5 1 Km

InVEST

integrated valuation of
environmental services
and tradeoffs

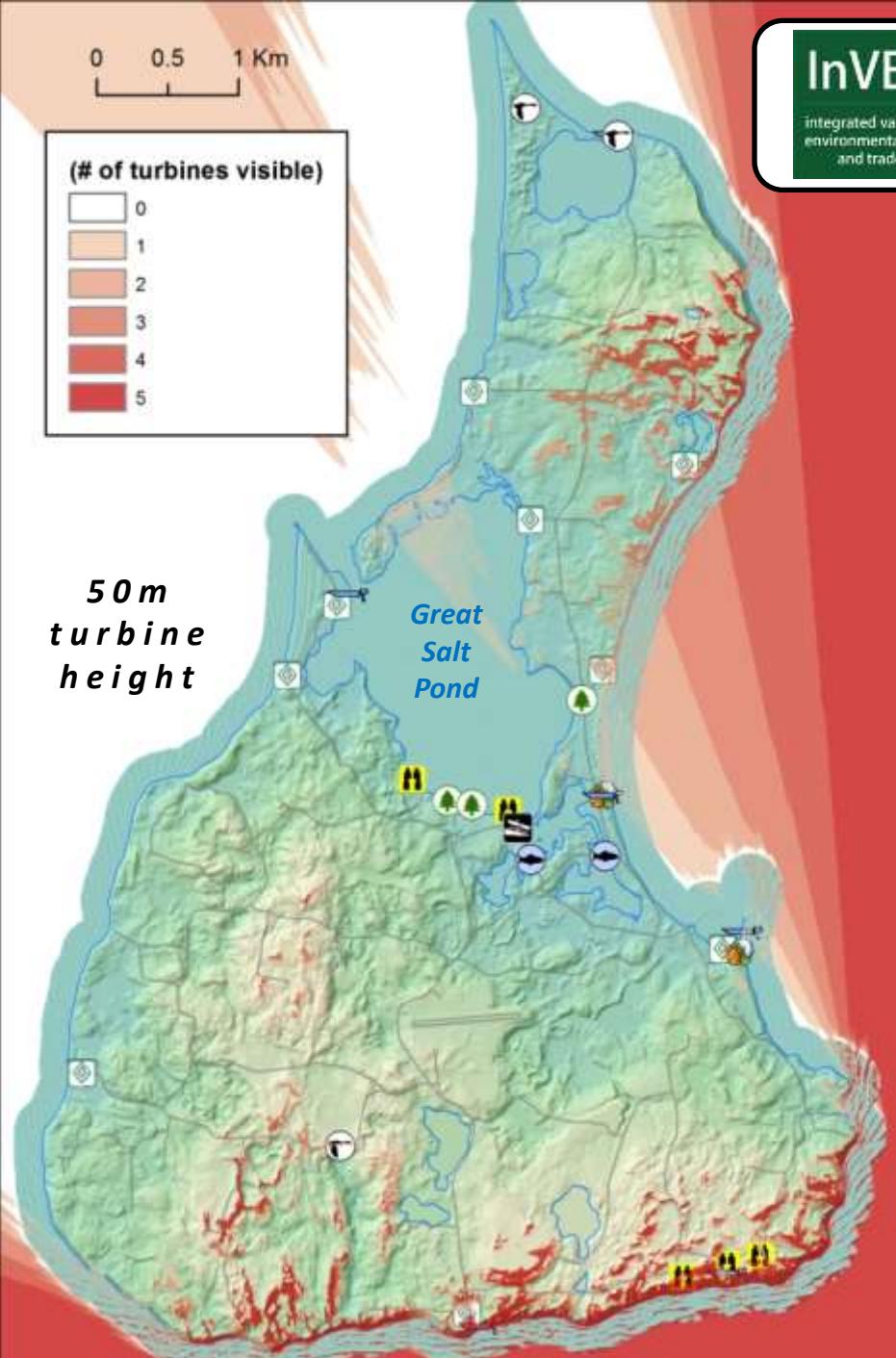
Aesthetic Quality

(# of turbines visible)



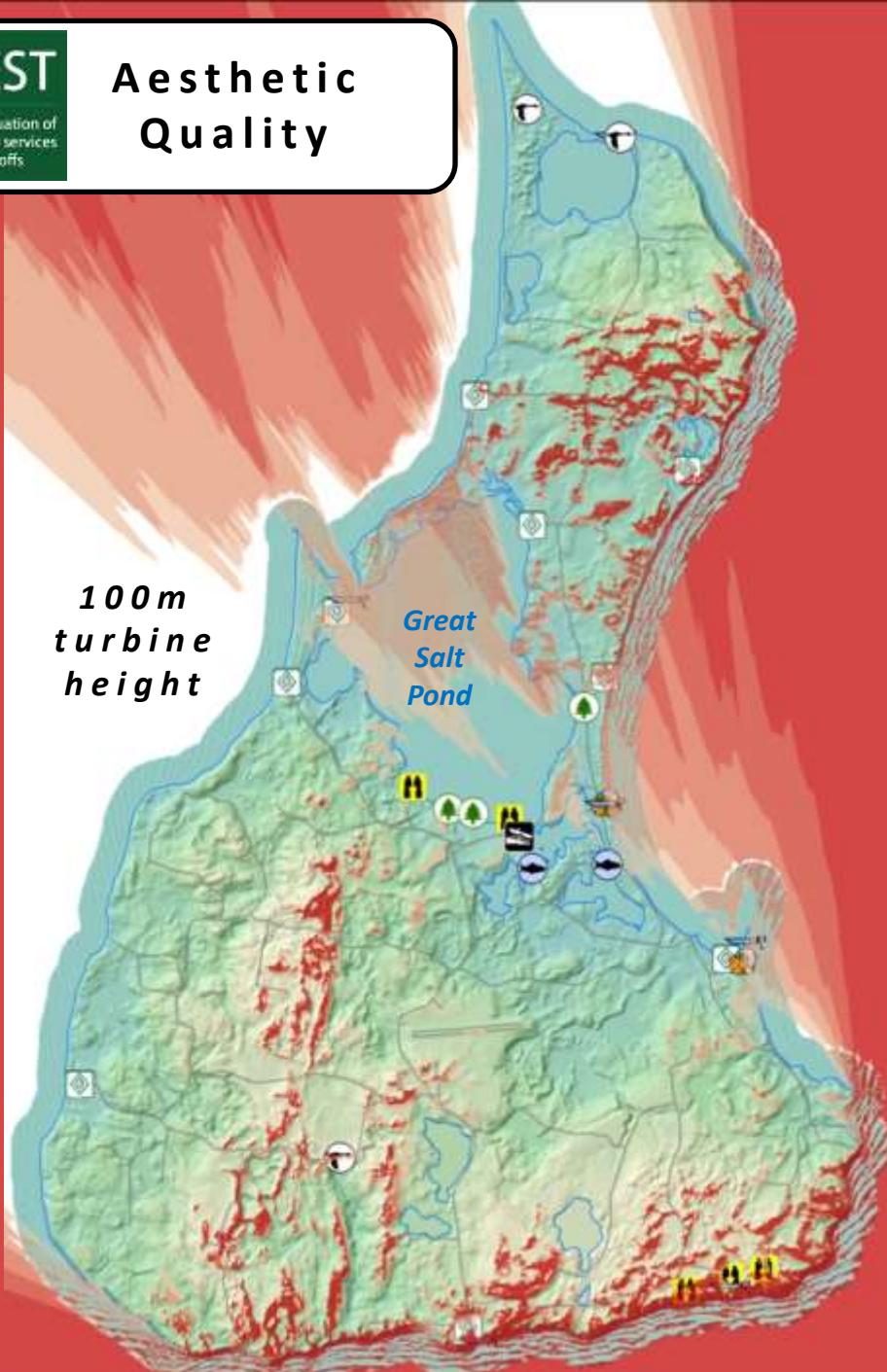
50 m
turbine
height

Great
Salt
Pond

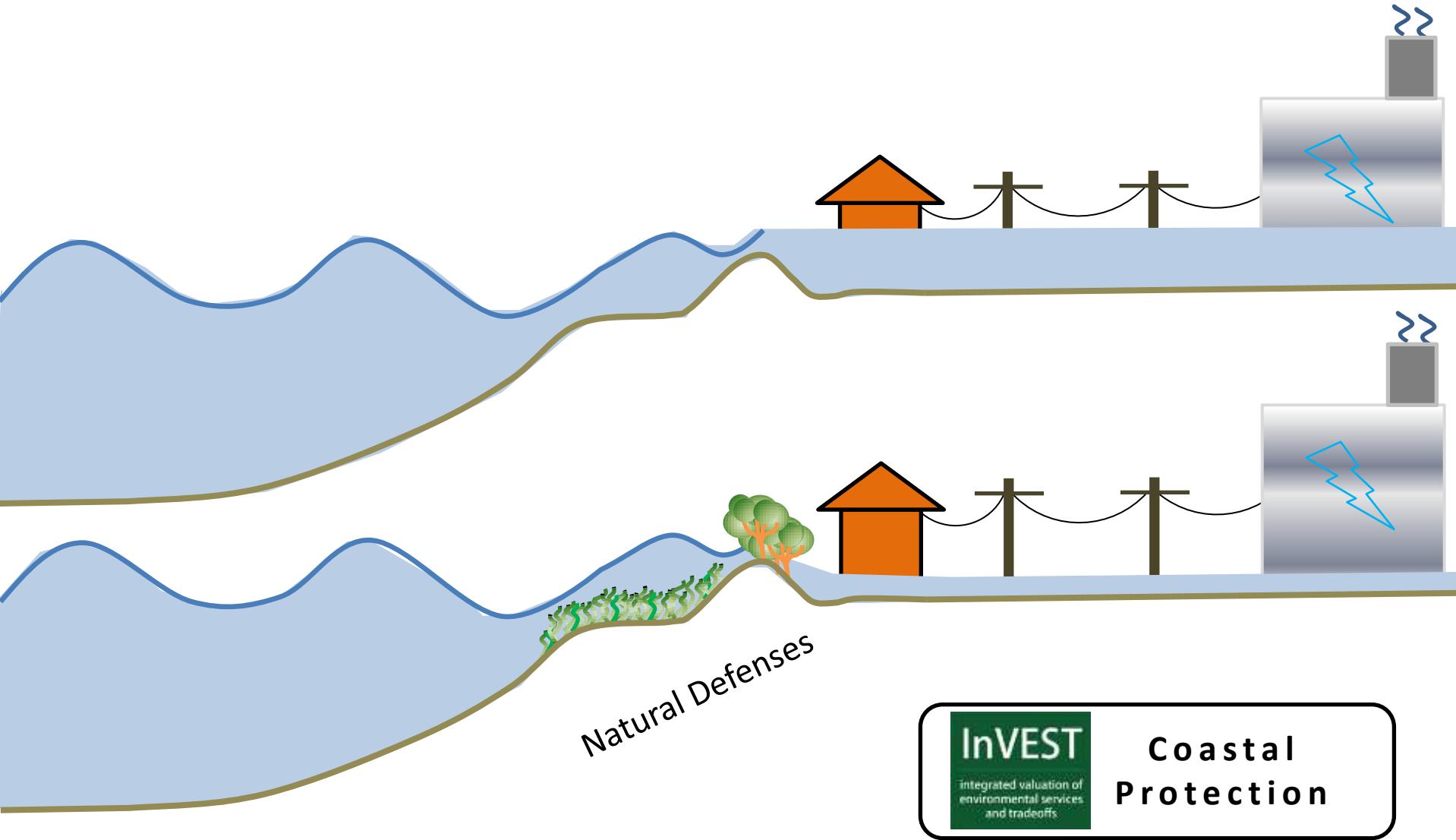


100 m
turbine
height

Great
Salt
Pond

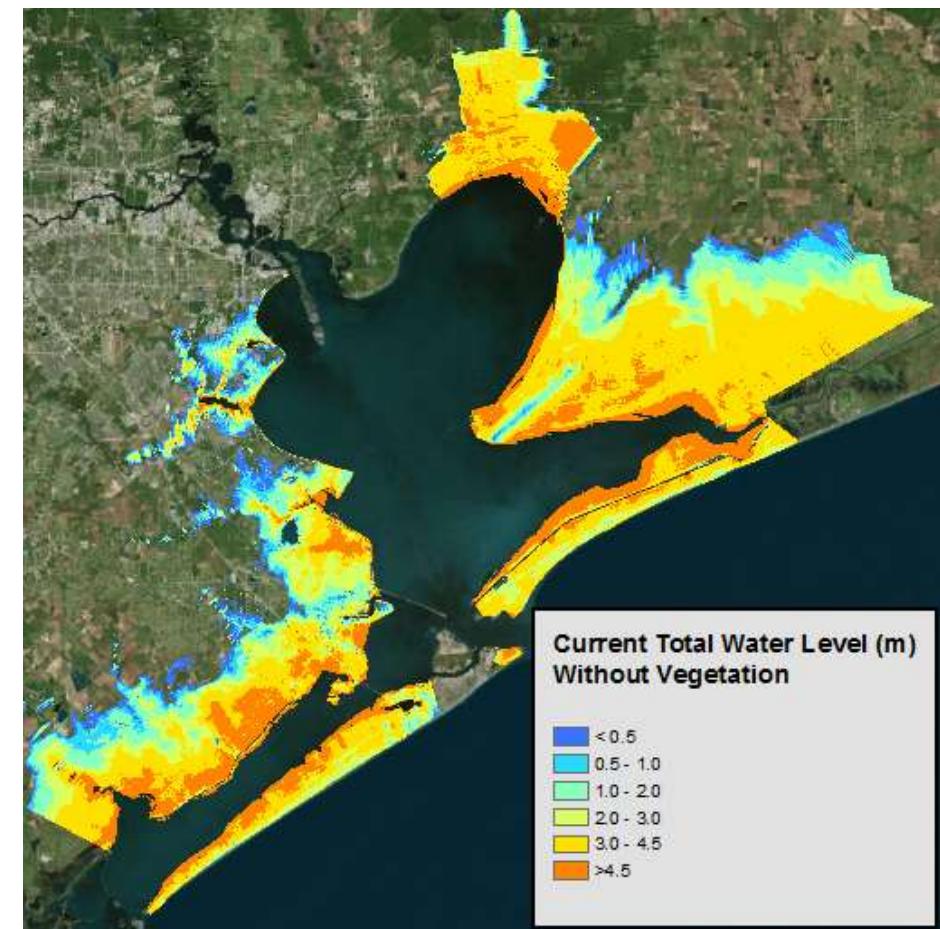


Infrastructure and dependencies

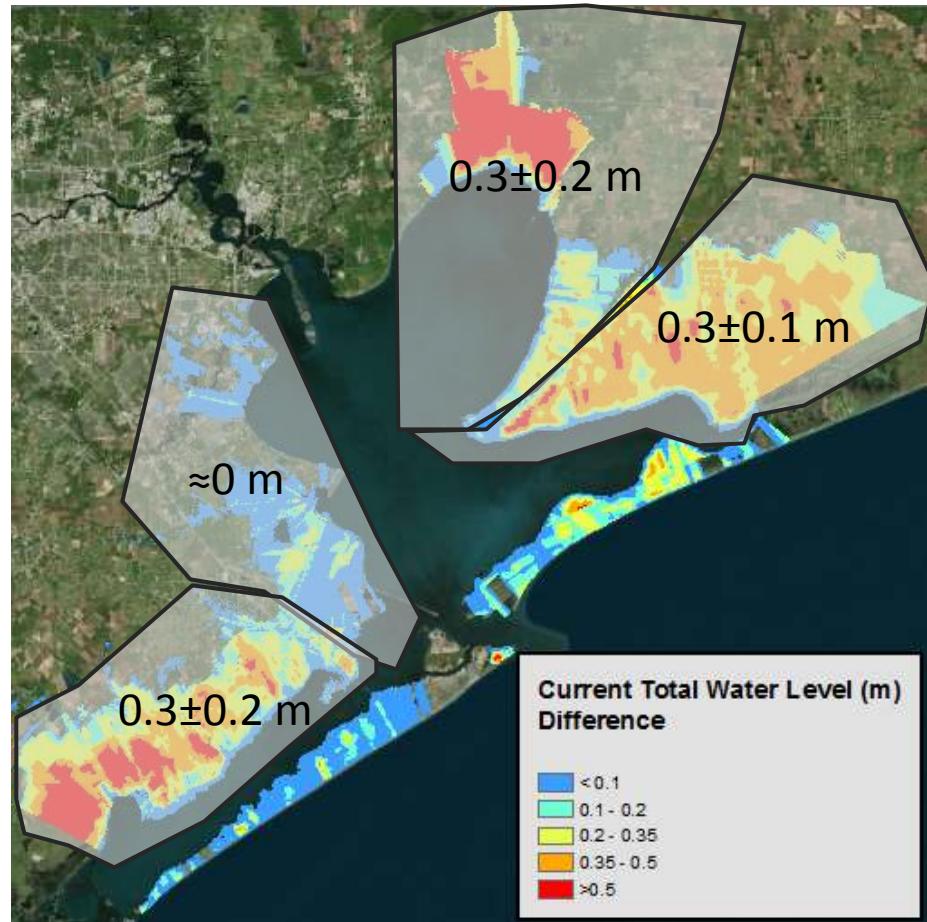


Natural Defenses in Galveston, TX

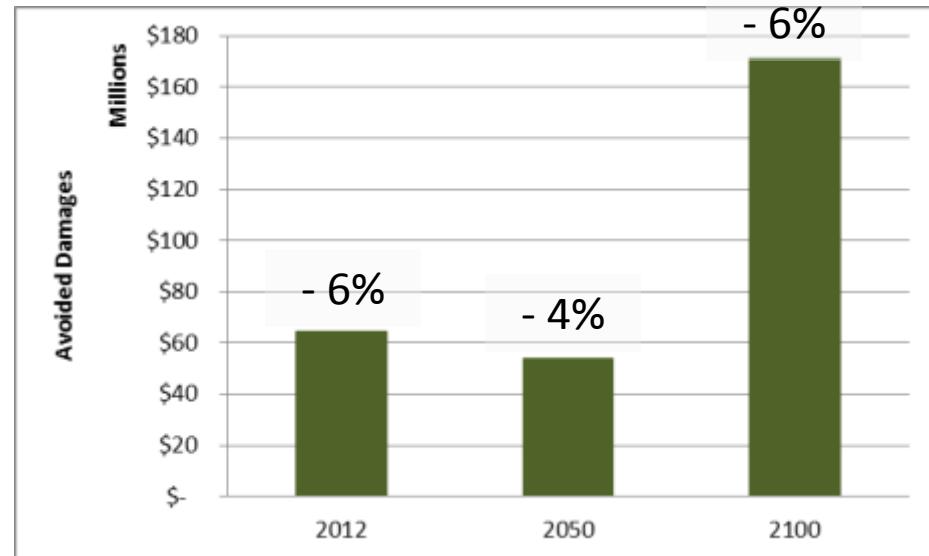
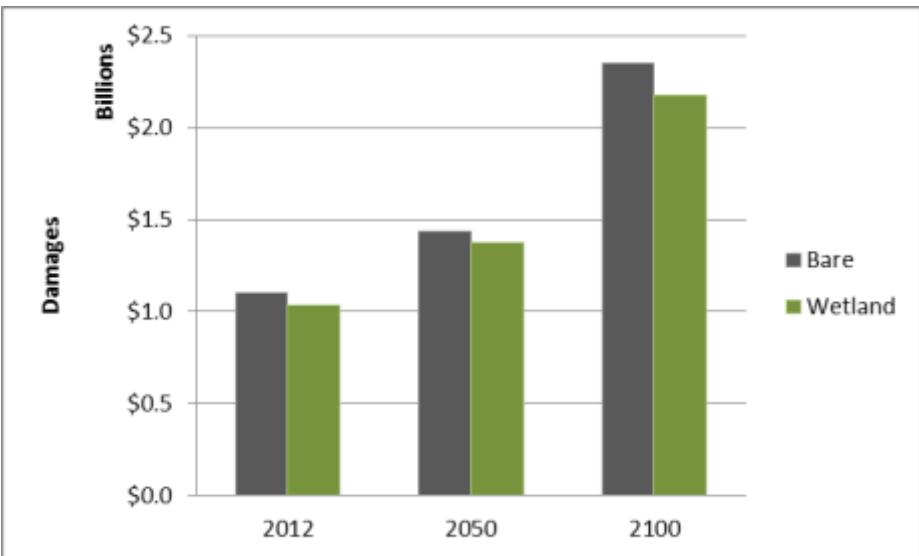
Bare



Marsh Present



Natural Defenses in Galveston, TX



- Damages will increase as sea level rises
- Wetlands reduce damages by ~5%

Transport



Impacts



View

Dependencies



Coastal
Protection



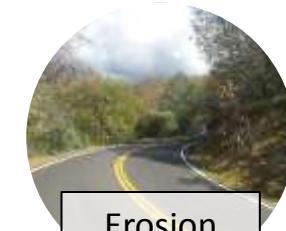
Carbon
Storage



Flood
Control



Flood
Control

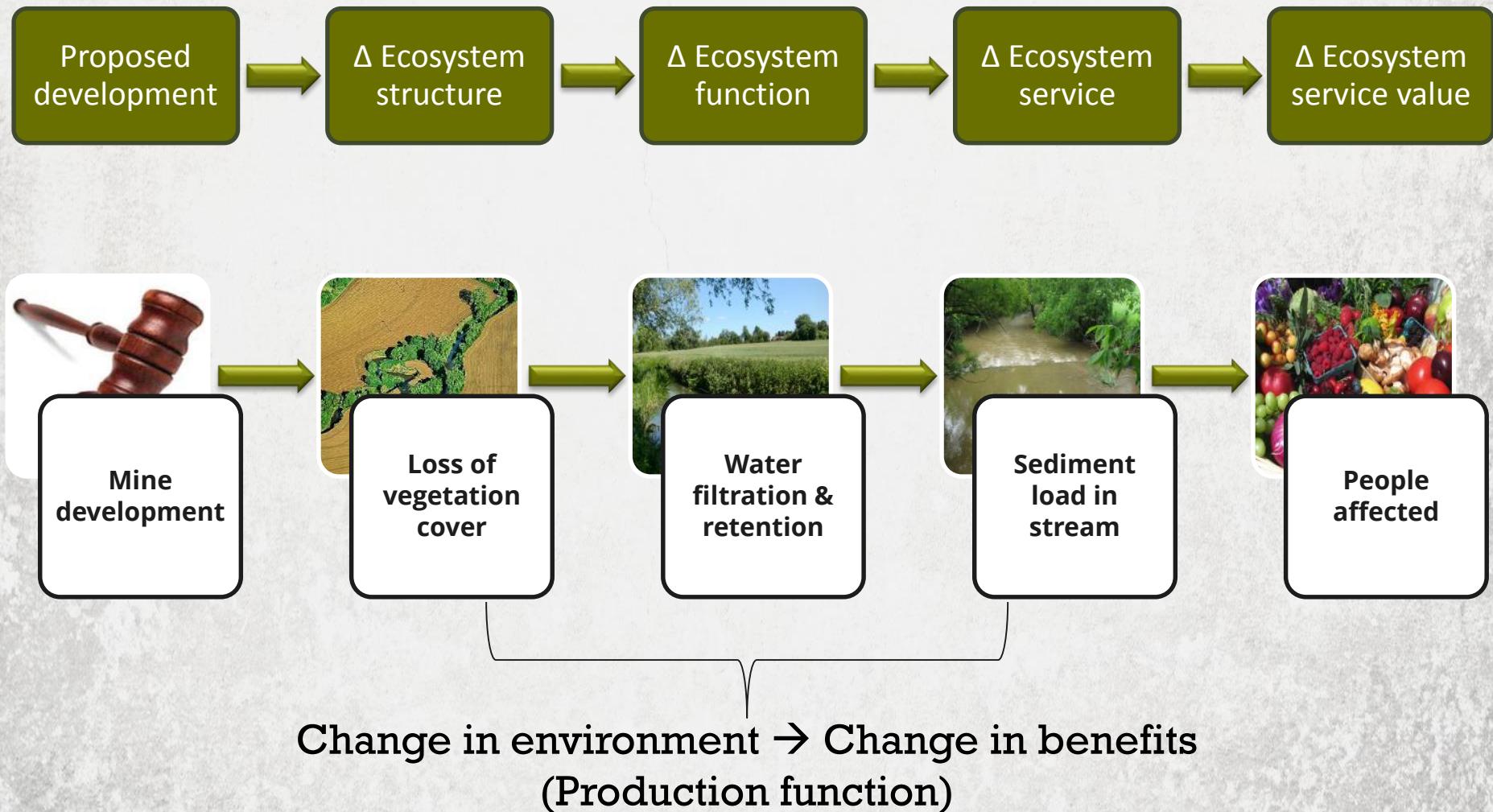


Erosion
Control

ECOSYSTEM SERVICES IN A MITIGATION HIERARCHY

Adrian L. Vogl
avogl@stanford.edu

AN ECOSYSTEM SERVICES APPROACH



THE MITIGATION HIERARCHY

BIODIVERSITY

Avoid &
minimize

Reduce

Compensate

ECOSYSTEM SERVICES

Avoid &
minimize

Reduce

Compensate

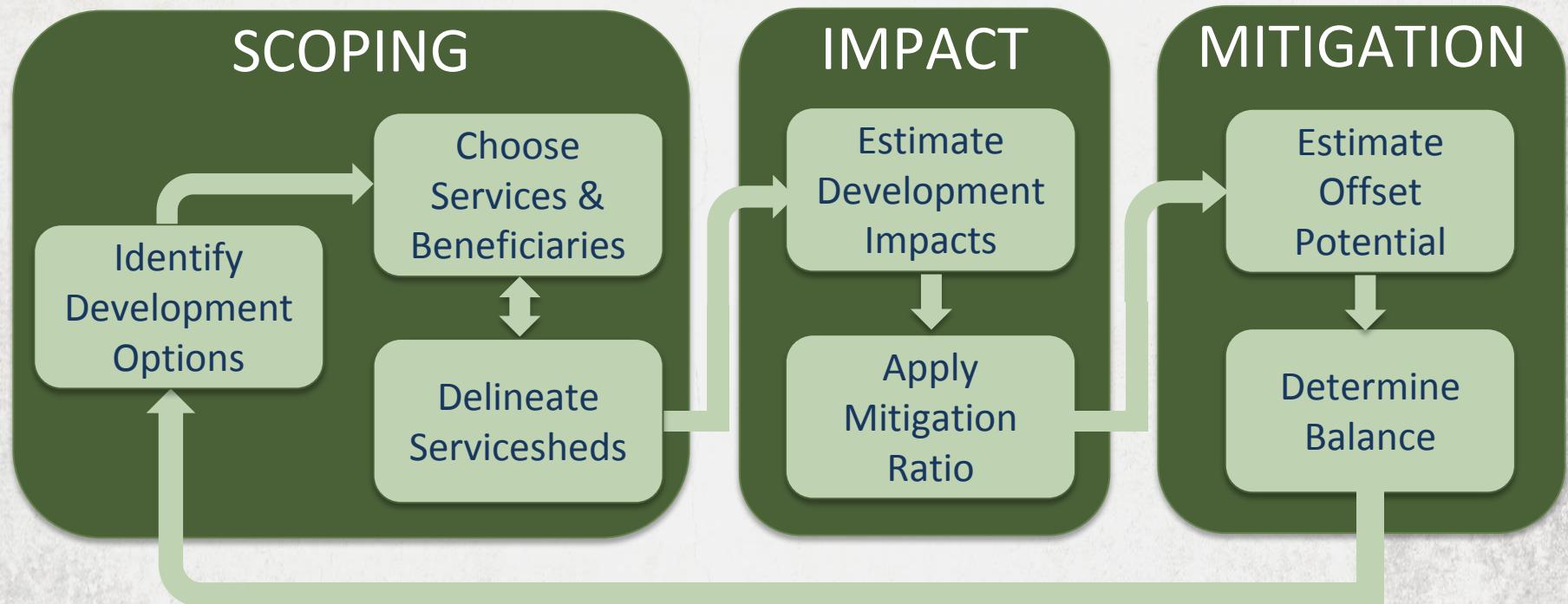
Challenges of ecosystem service mitigation

- Services are not always species or habitat specific – can't use simple area-based impact and offsetting
- The same habitat in different locations can provide different levels of service
- Problem with redistributing benefits around landscape

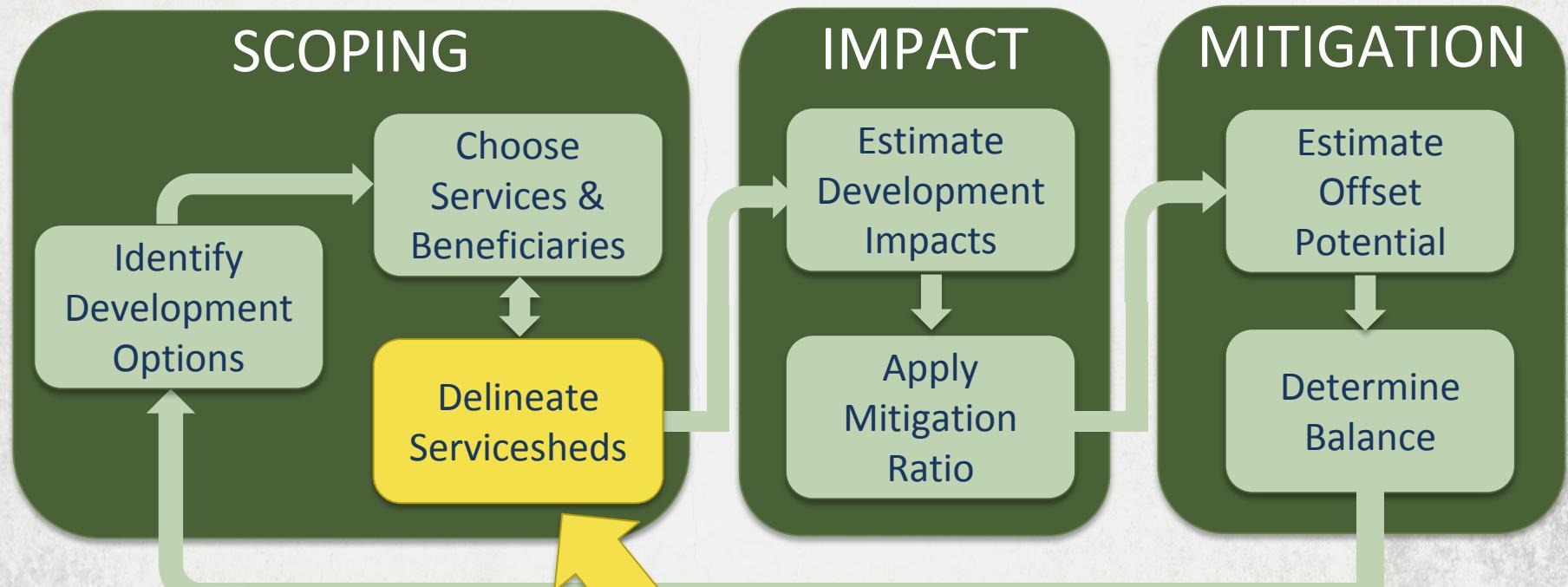


Need for an ecosystem services approach

GENERAL FRAMEWORK

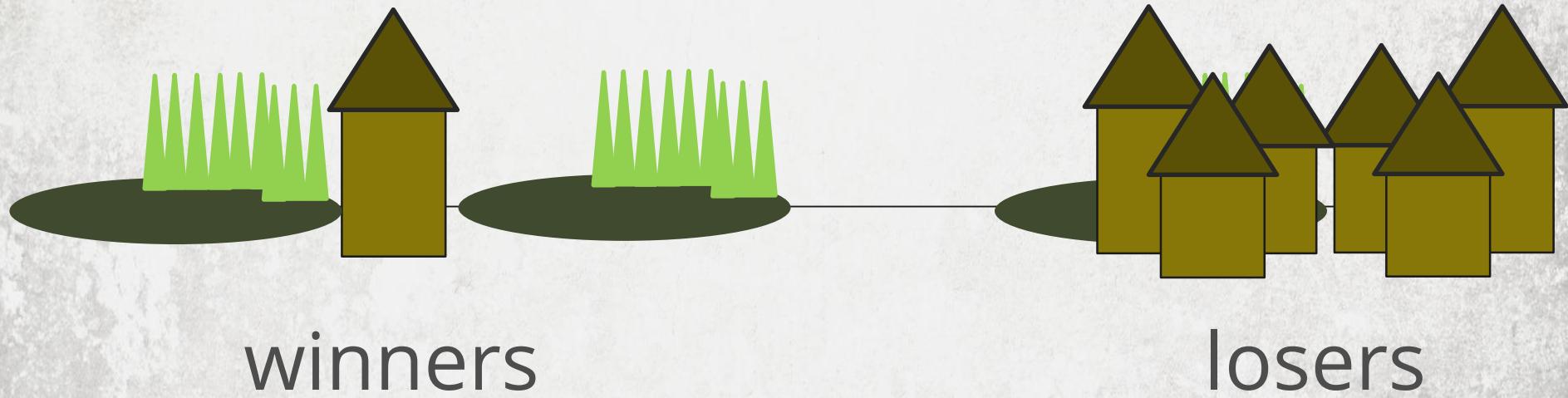


GENERAL FRAMEWORK



Deals with
redistribution and
social equity

WITHOUT CONSIDERING PEOPLE...



...mitigation can redistribute nature's benefits

SERVICESHEDS

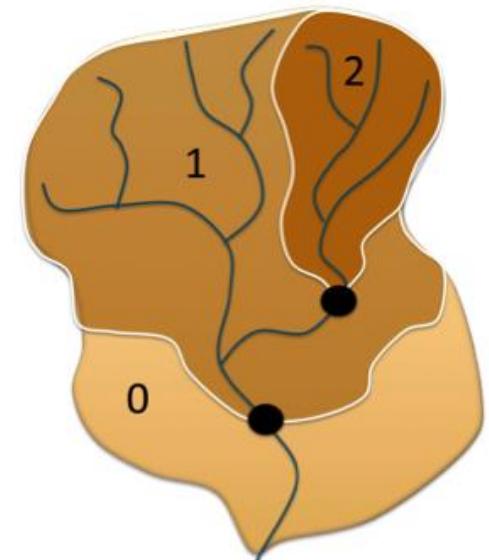
Serviceshed: area with potential to provide a particular ecosystem service to a specific beneficiary

Carbon

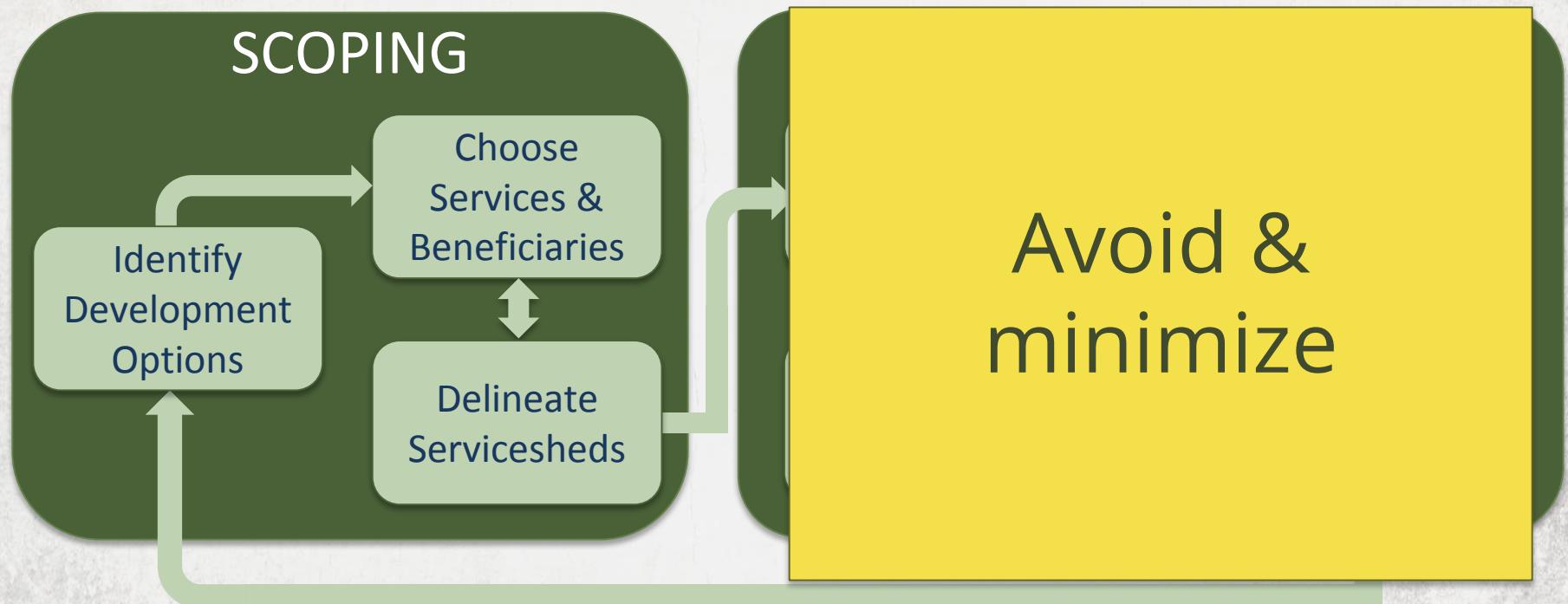


Supply
Physical access
Institutional access

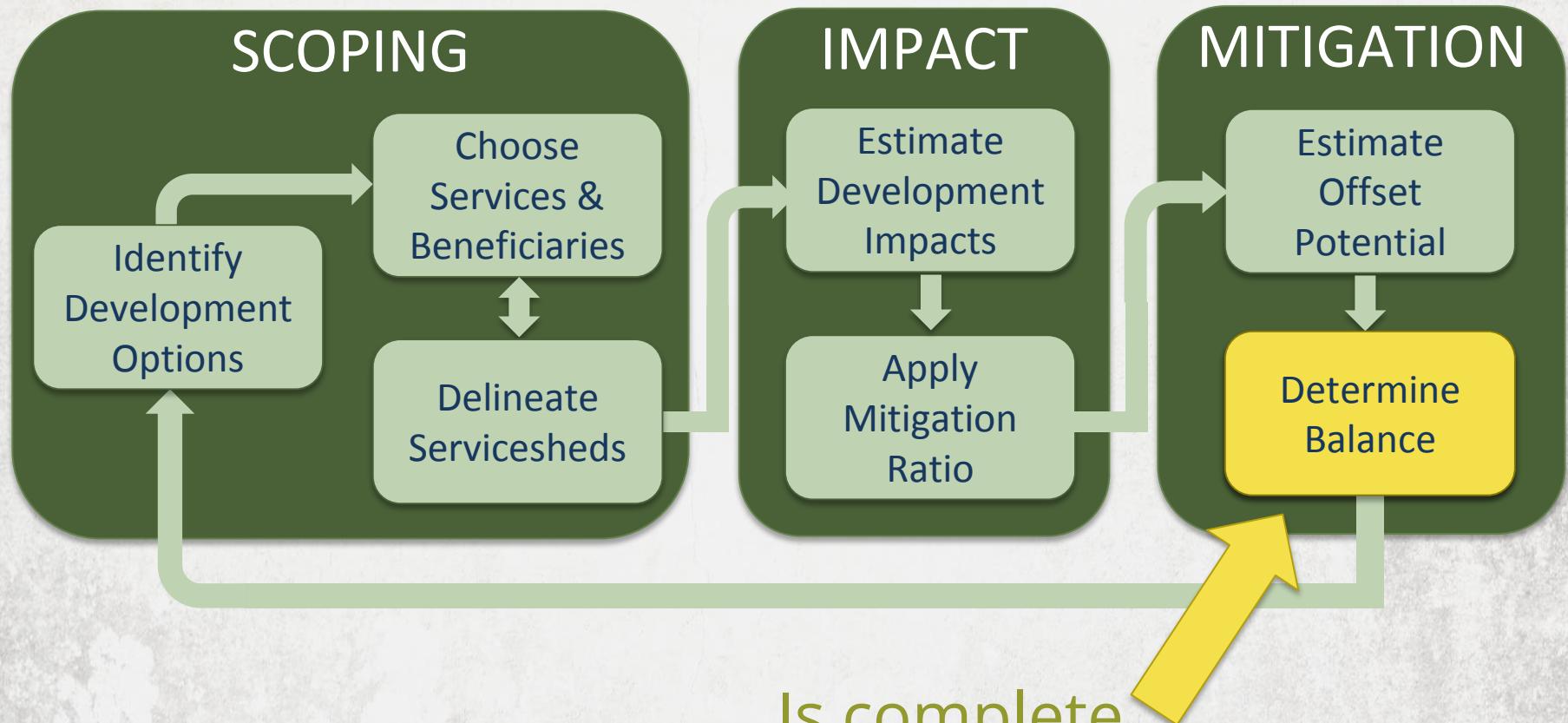
Water



GENERAL FRAMEWORK



GENERAL FRAMEWORK



Is complete
mitigation
possible?

Case Study

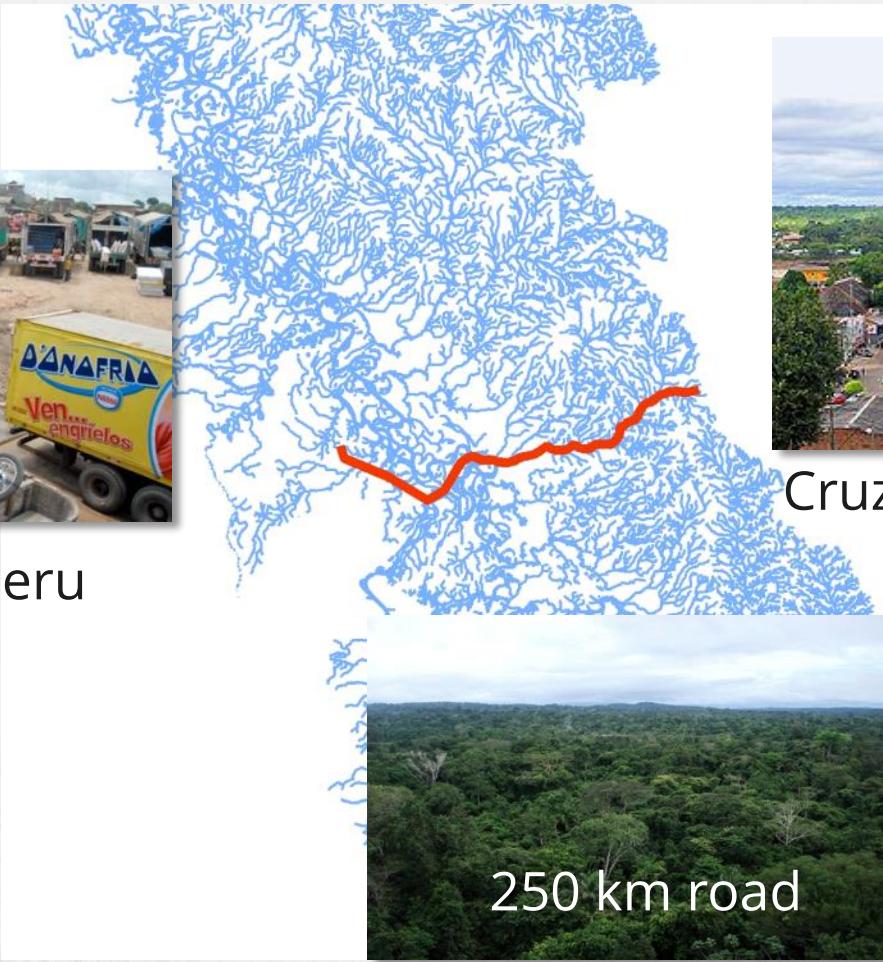


ROAD CONSTRUCTION - PERU

Peruvian Amazon



Pucallpa, Peru

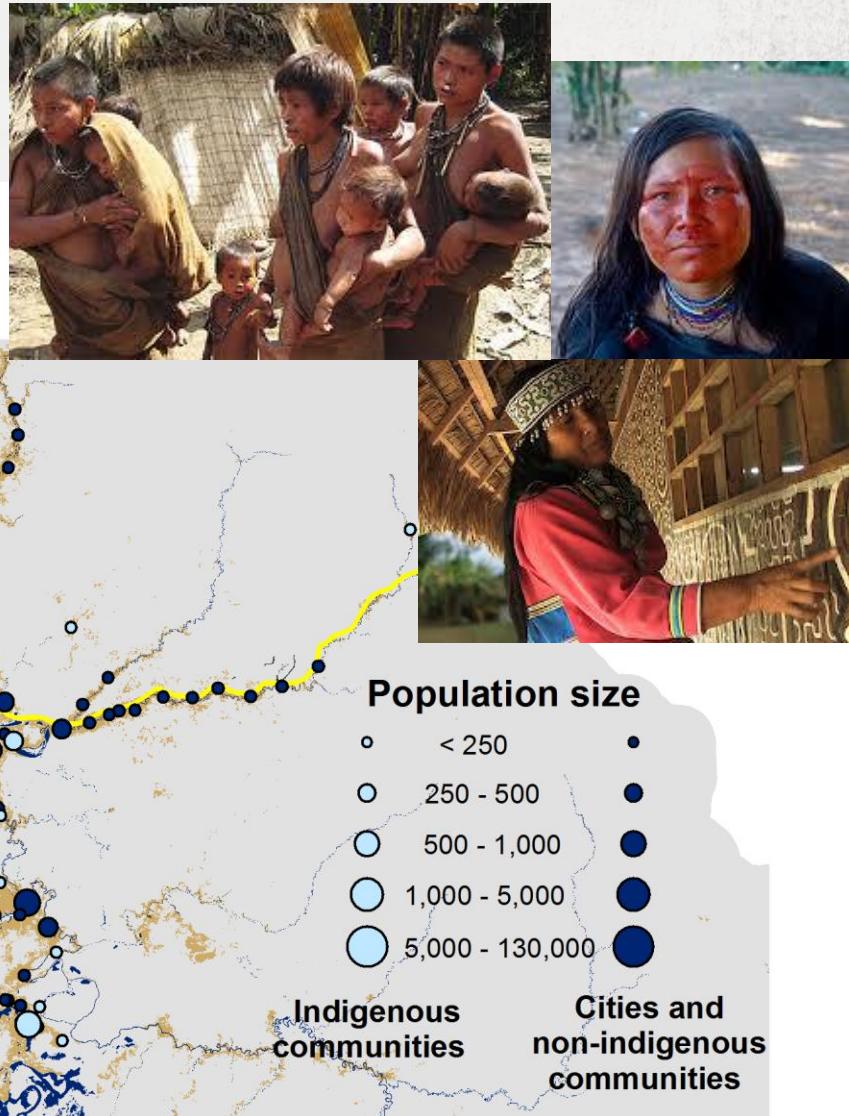


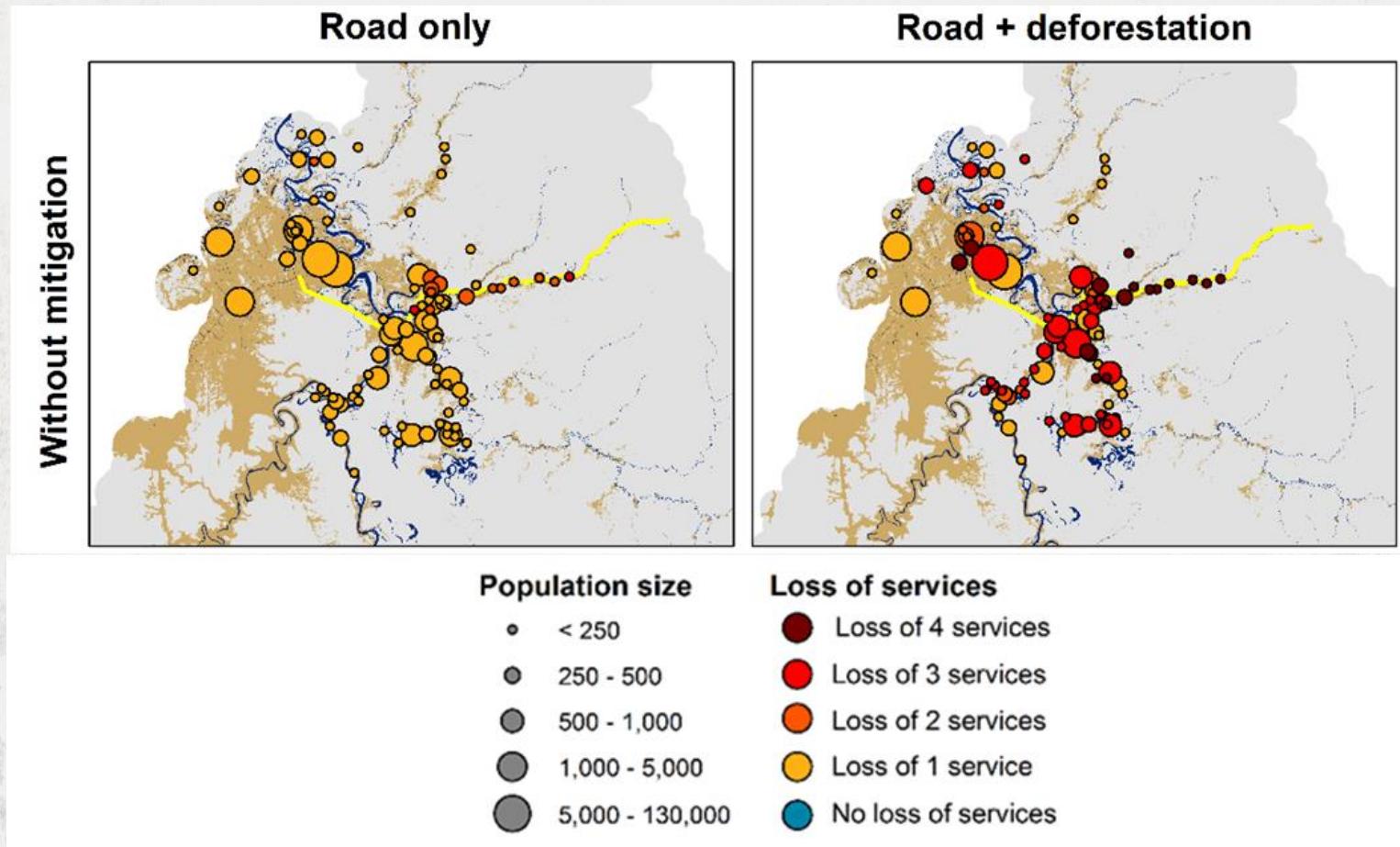
Cruzeiro do Sul, Brazil

Services: erosion control, N & P regulation for drinking water quality; carbon storage for climate regulation

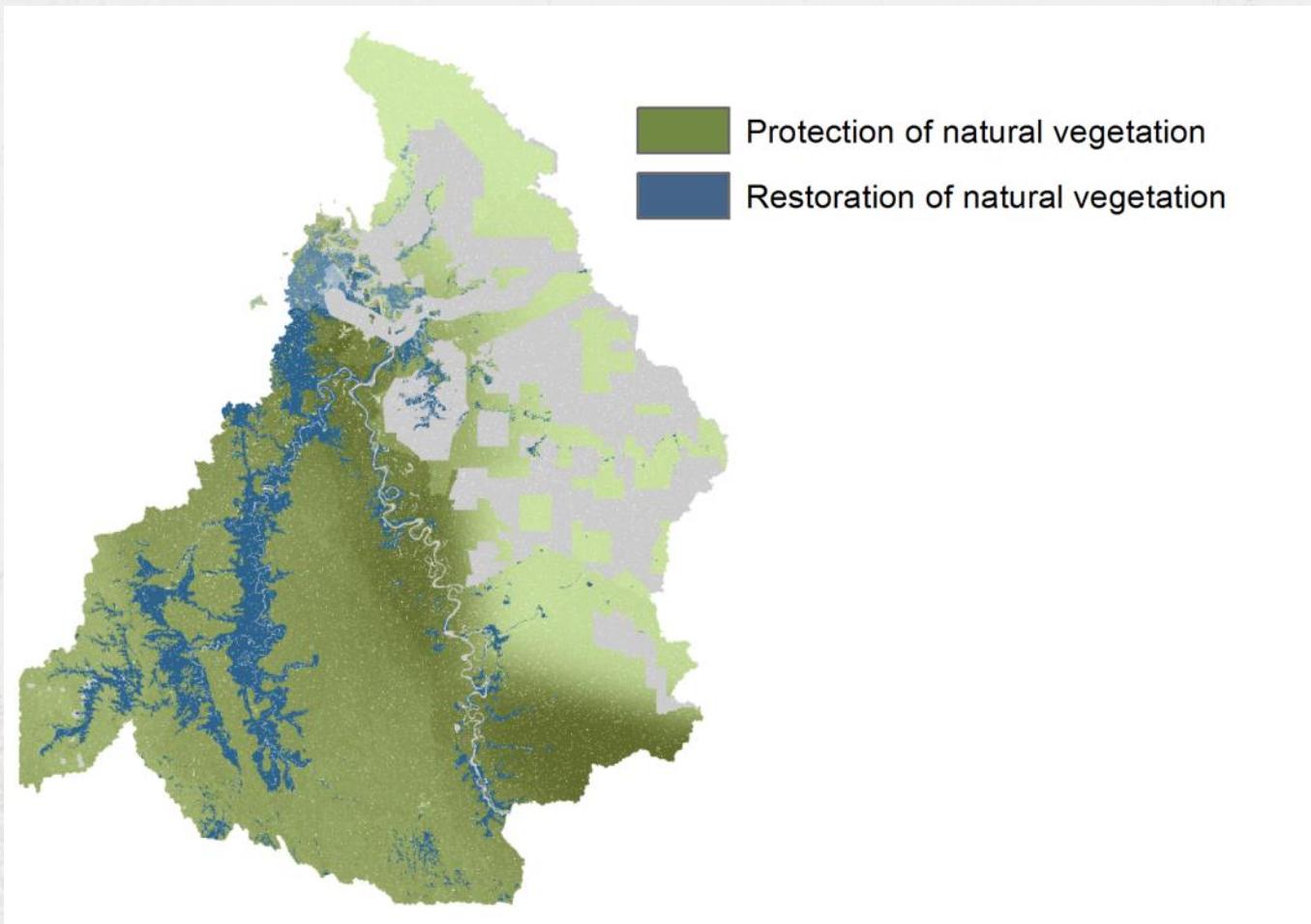
Beneficiaries: population centers

~230,000 people





Use InVEST models to determine areas impacted by proposed road development



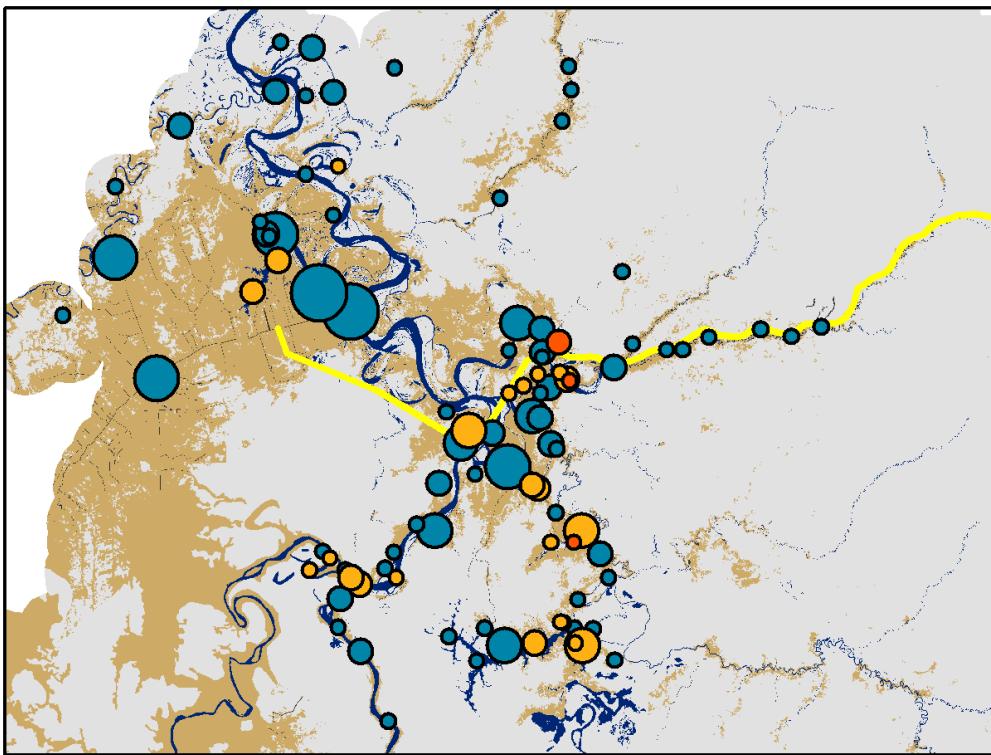
Determine areas likely to be good for ecosystem services recovery

Selected best 15% of landscape

Impacts remaining after mitigation:

Population size

- < 250
- 250 - 500
- 500 - 1,000
- 1,000 - 5,000
- 5,000 - 130,000



Loss of services

- Loss of 3 services
- Loss of 2 services
- Loss of 1 service
- No loss of services

THE MITIGATION HIERARCHY

BIODIVERSITY

Avoid &
minimize

Reduce

Compensate

ECOSYSTEM SERVICES

Avoid &
minimize

Reduce

Compensate

ACKNOWLEDGEMENTS



KATIE ARKEMA



LISA MANDLE



JUAN SEBASTIAN
LOZANO

THE GORDON AND BETTY MOORE FOUNDATION