Estimating the 'Return on Investment' in natural infrastructure:

Rio Camboriú watershed, Santa Catarina State, Brazil

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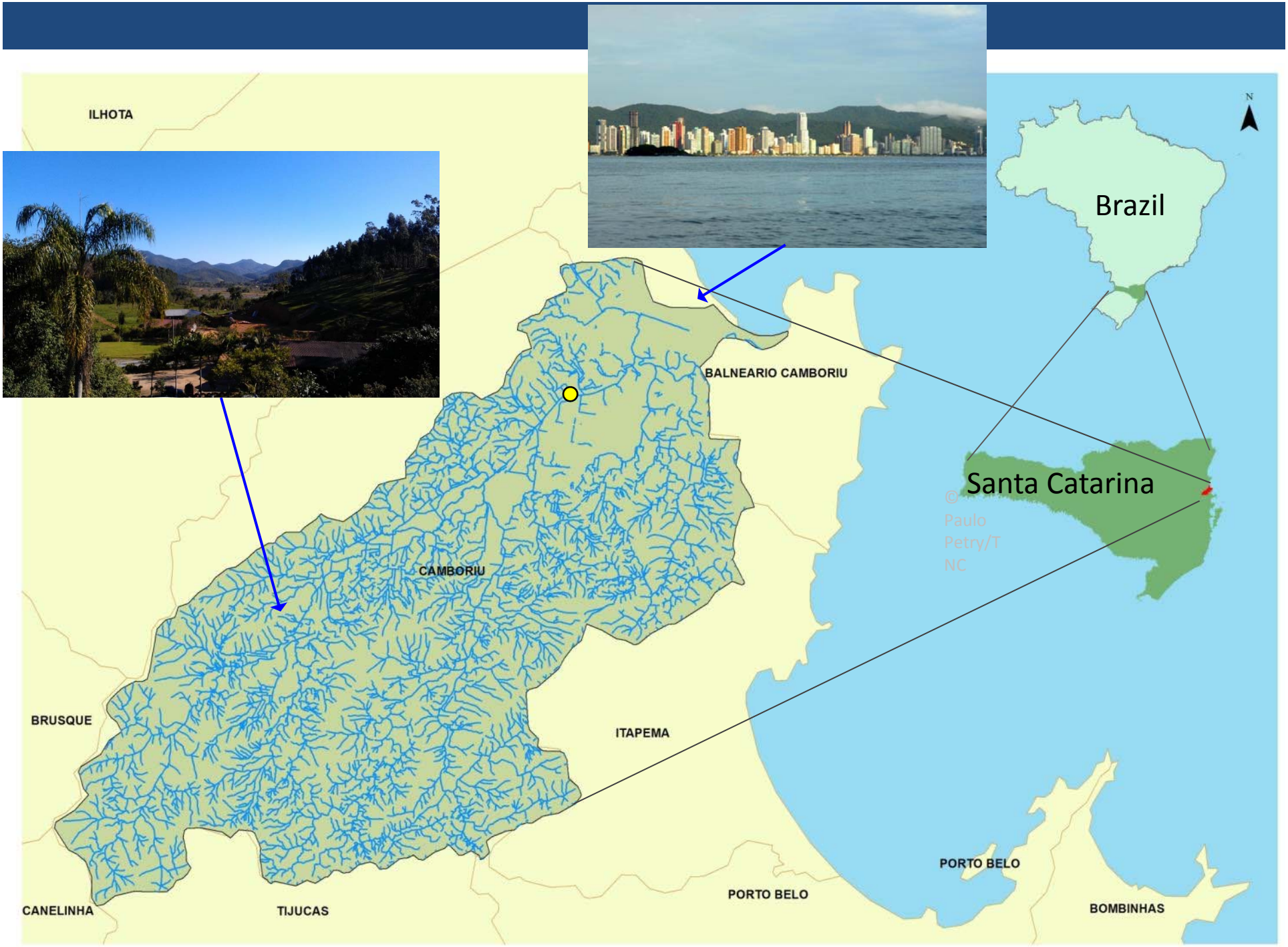
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BOMBINHAS
Brazil
Santa Catarina
N

Pop: 170,000 year-round

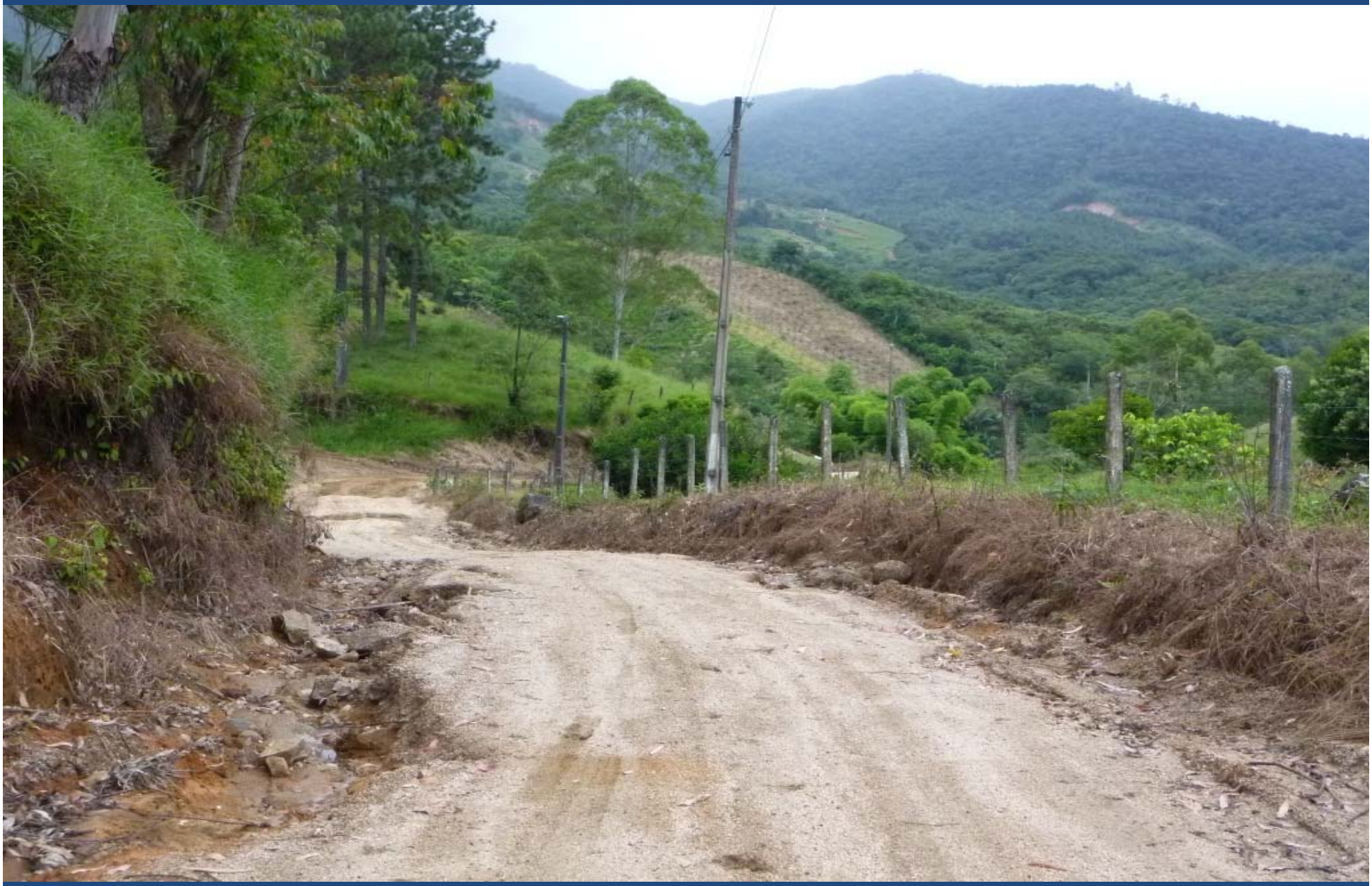
High season (New Year-Feb): Pop >800,000

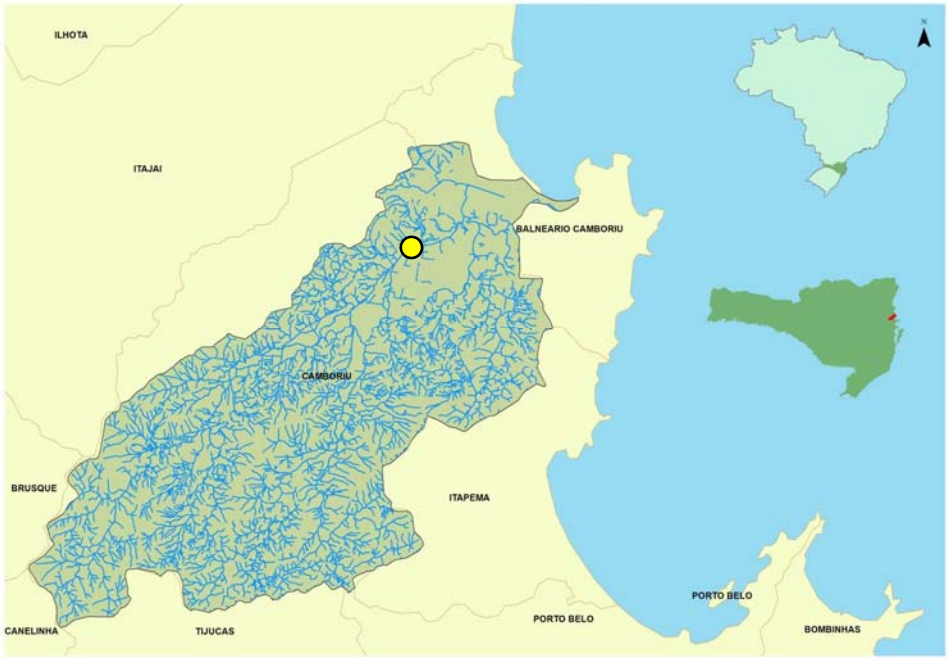
The Situation

- No large-scale water storage in watershed
- High water loss for frequent filter and pipe flushing at treatment plant, due to high sediment levels
- Expected near-future water supply shortfalls during high demand
- Flooding; low base flows during dry spells

Problem Nº 1: Livestock entering river

Problem Nº 2: Dirt roads

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Watershed Conservation Program

Created 2009; interventions since 2012.

Foci:

- Water quality (sediment)

  → reduce treatment cost & increase supply

- Flow regulation

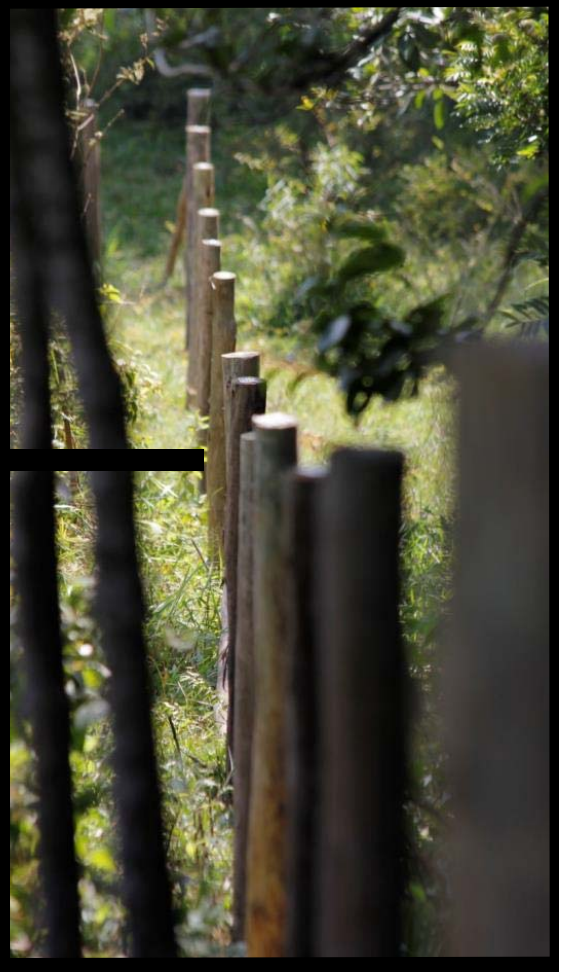
  → avoid alternative measures

- Conservation of threatened Atlantic Forest (highly biodiverse; ~10% of historic extent left in Brazil)

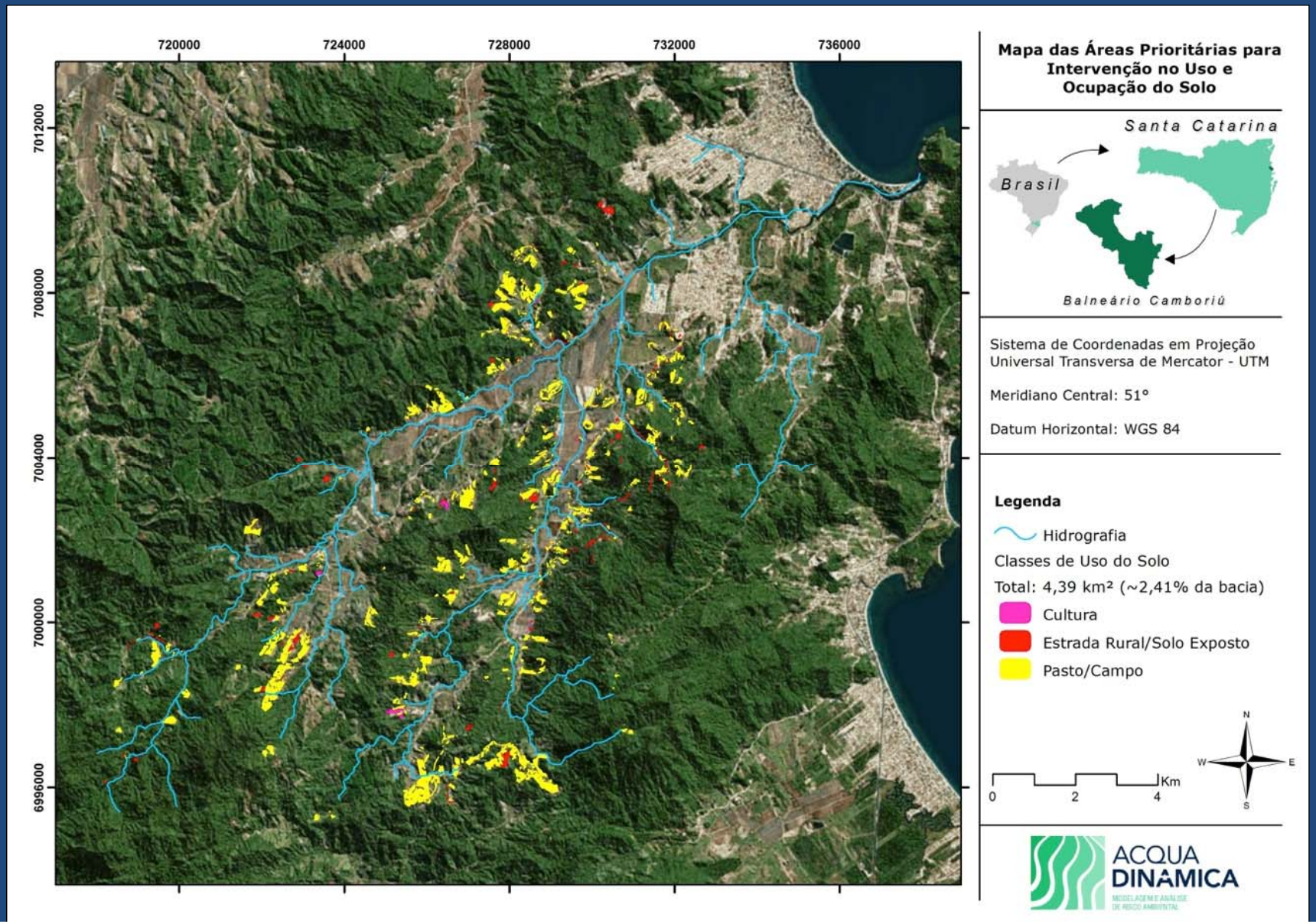
Interventions

- Fencing: riparian areas and conserved/ restored forest
- Active forest restoration
- Dirt road BMPs
- Pasture terracing



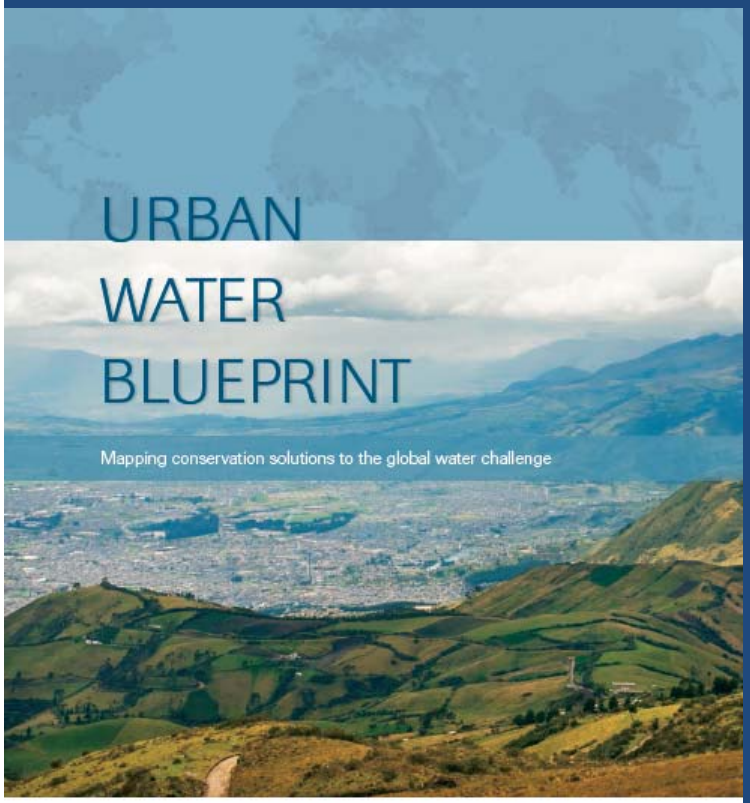



Priority areas



Why ROI analysis?

- Limited conservation budgets
- Making the business case
- Scale up



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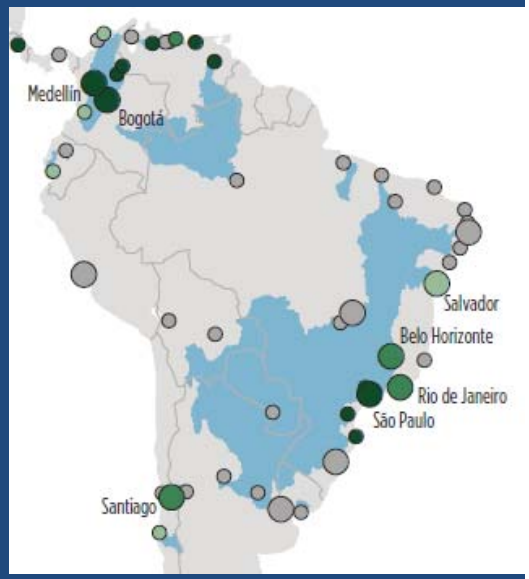
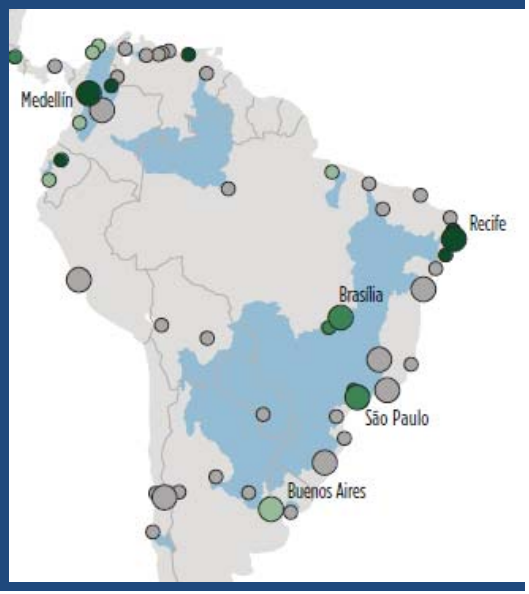
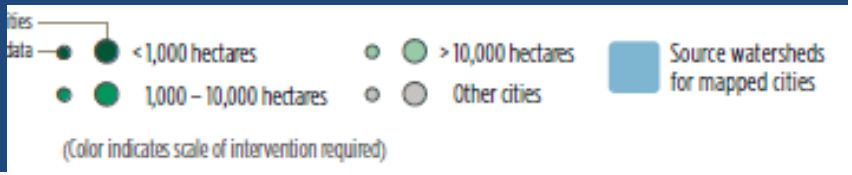
WHERE REFORESTATION CAN REDUCE SEDIMENT BY 10 PERCENT



WHERE RIPARIAN CONSERVATION CAN REDUCE SEDIMENT BY 10 PERCENT



CONSERVATION AREA



ROI of PWS programs

>280 PWS programs (active & in development)

BUT:

- Only 10 “credible” valuation studies (Ferraro et al., 2012)
- Only 5 credible ROI analyses

…for forest hydrologic services projects in developing countries

This is a problem!

Camboriu ROI analysis

- 2 ROI measures:

1) $$\frac{Sediment\ reduction\ at\ intake\ point}{Watershed\ conservation\ cost}$$

= Cost-effectiveness of PWS w.r.t sediment ("tons/$" or "gm TSS/L /$")

2) $$\frac{Avoided\ water\ treatment\ cost}{Watershed\ conservation\ cost}$$

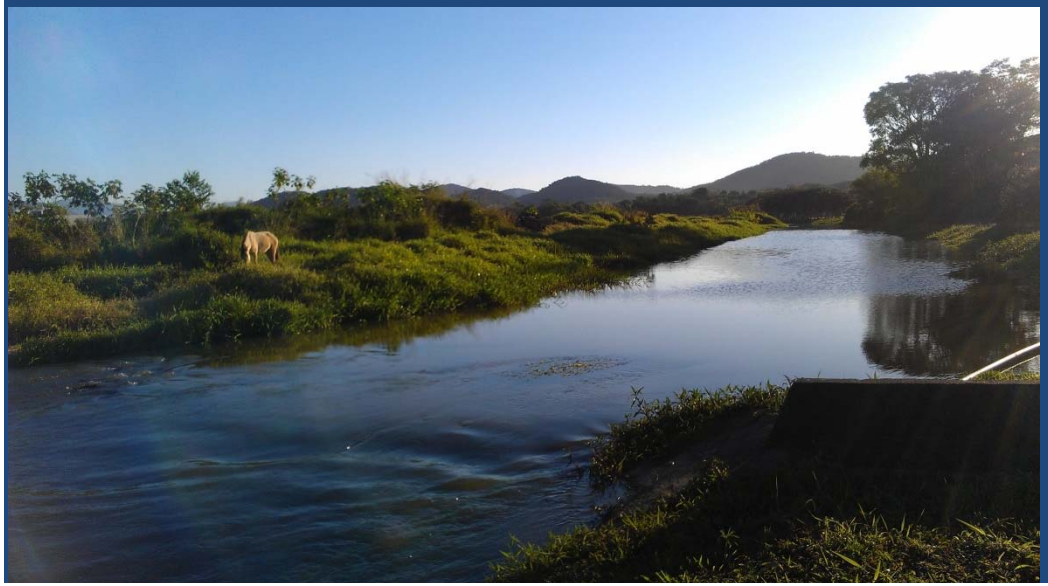
= ROI of PWS w.r.t. sediment ("$/$")

- Predictive analysis

Methodology

“Credible” ROI analysis:

Counterfactual thinking/ Attribution !



Intervention

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Ecosystem Structure

↓

Ecosystem Functions

↓

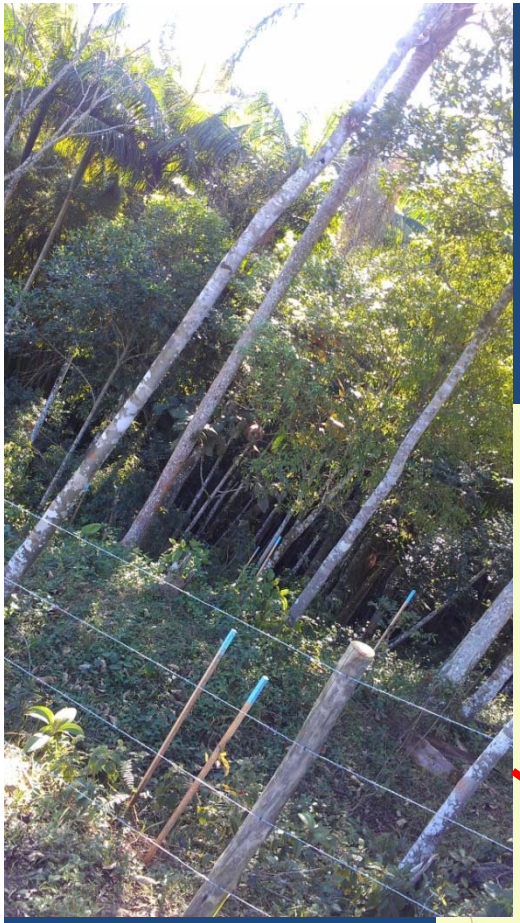
Ecosystem Services

↓

Benefits

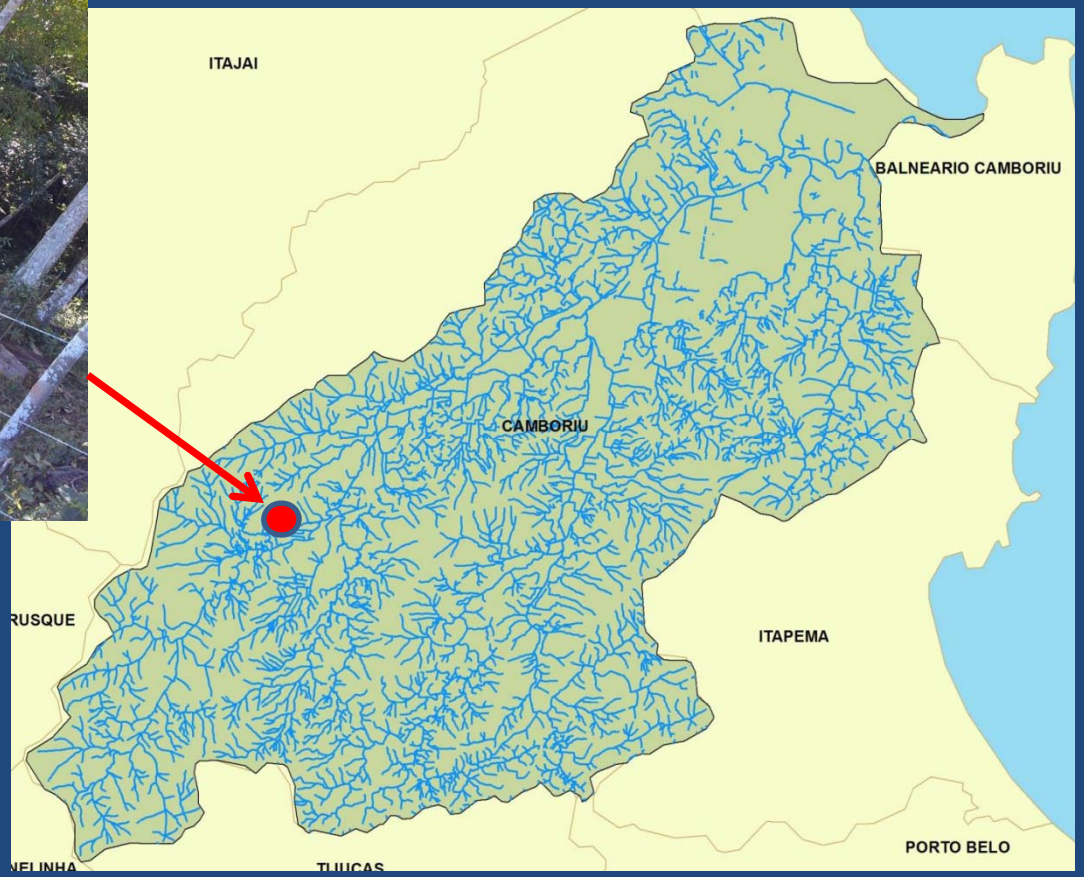
↓

Values



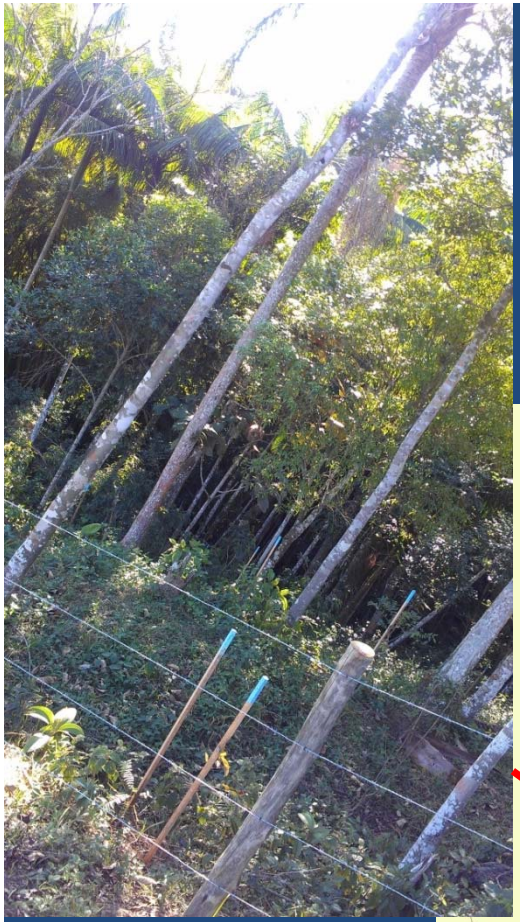
Credible ROI analysis

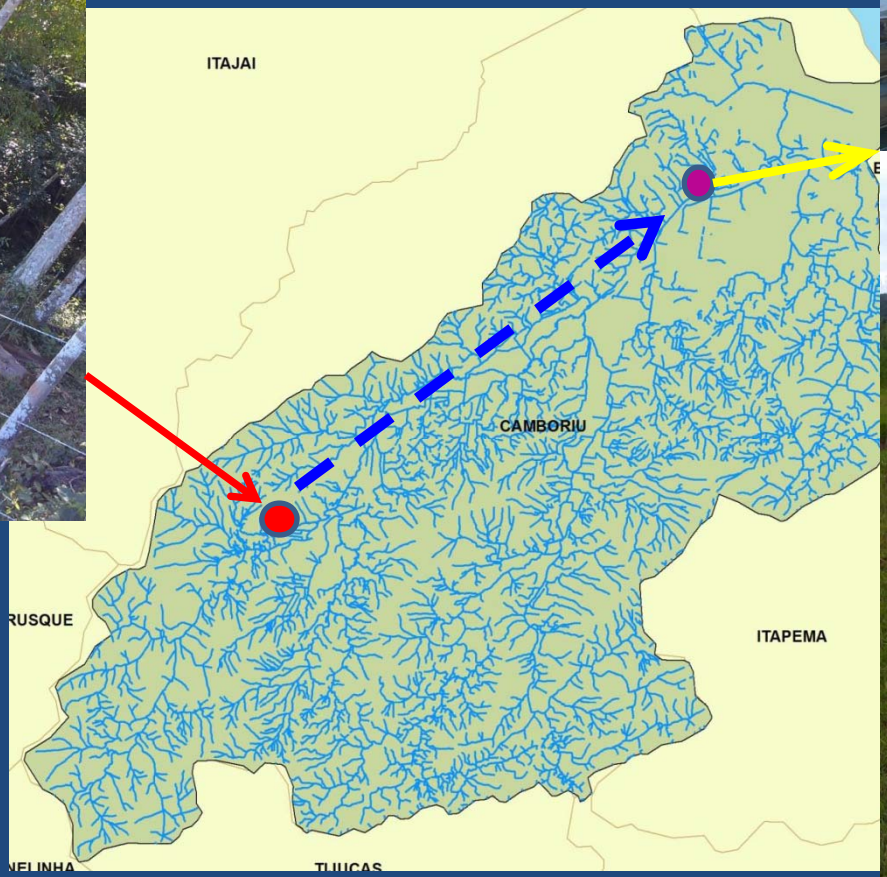
Intervention → Ecosystem Structure → Ecosystem Functions



Credible ROI analysis

Intervention → Ecosystem Structure → Ecosystem Functions → Ecosystem Services **→ Benefits → Values**





Camboriu ROI analysis

Empirical observation & modeled land cover change (w/ program & counterfactual)

ES production function (SWAT)

Empirical water treatment cost analysis

Intervention

↓

Ecosystem Structure

↓

Ecosystem Functions

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Ecosystem Services

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Benefits

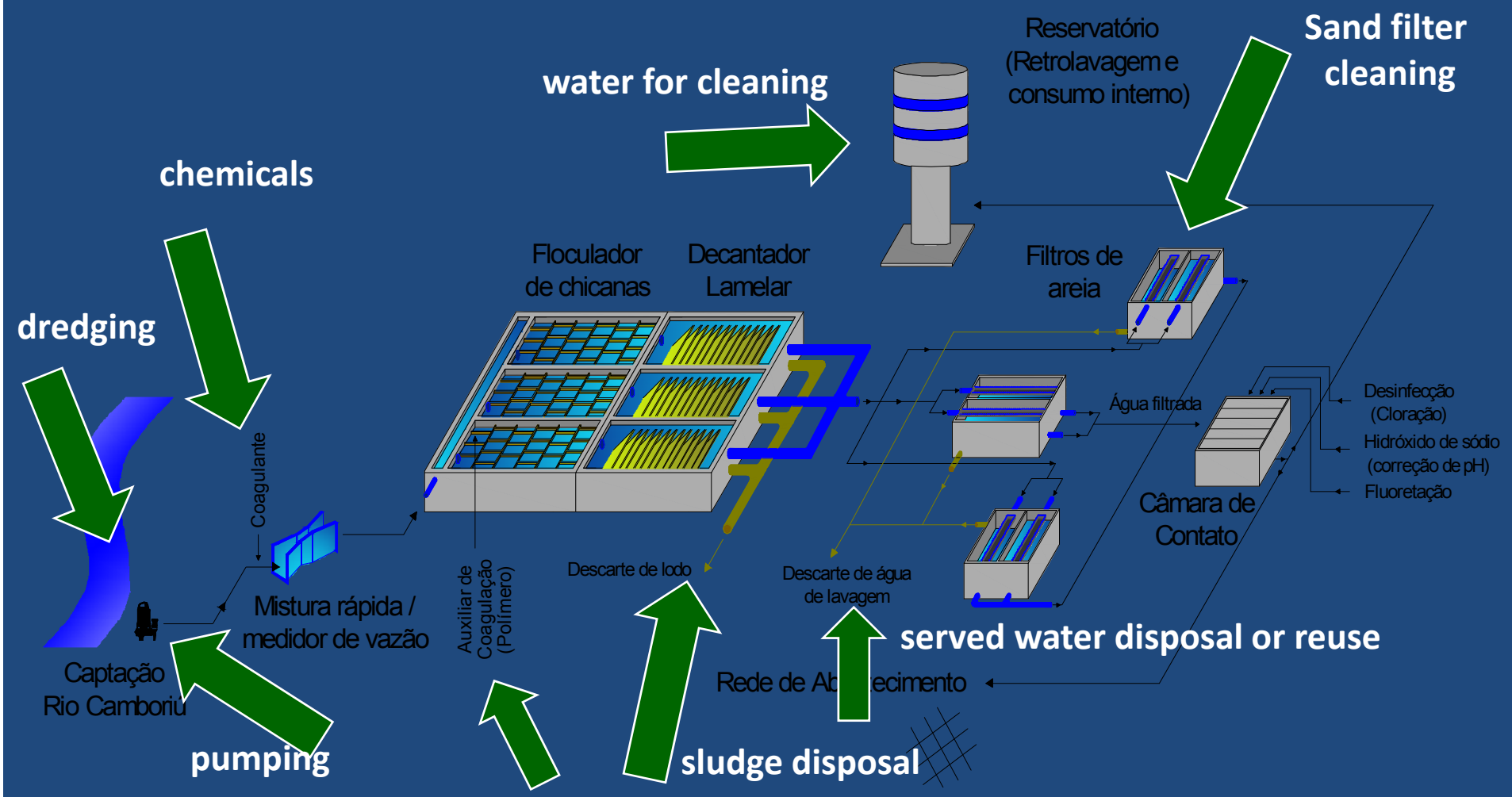
↓

Values

Compare to Program costs

Camboriu ROI analysis

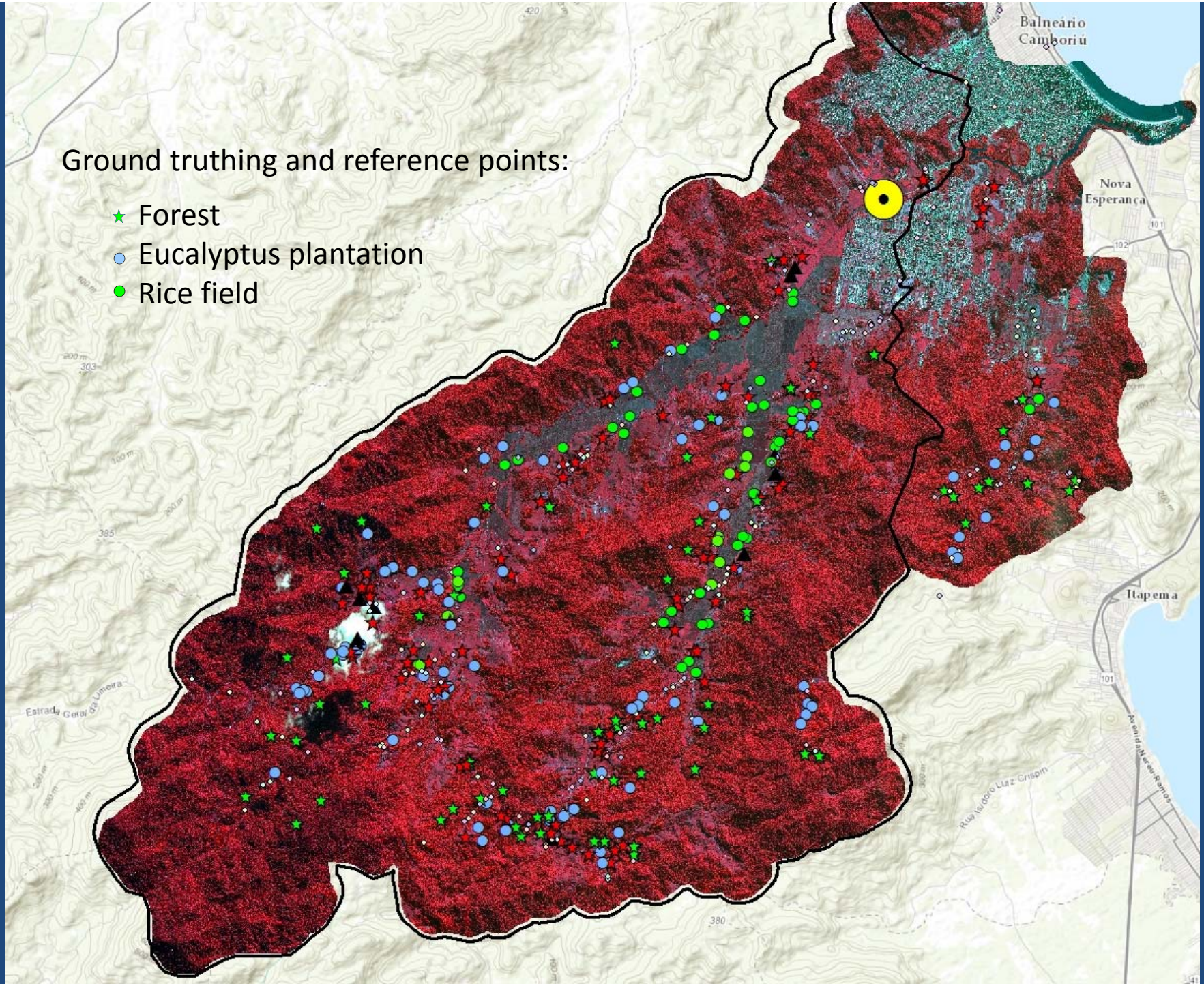
Q: How do reduced sediment loads affect water treatment?

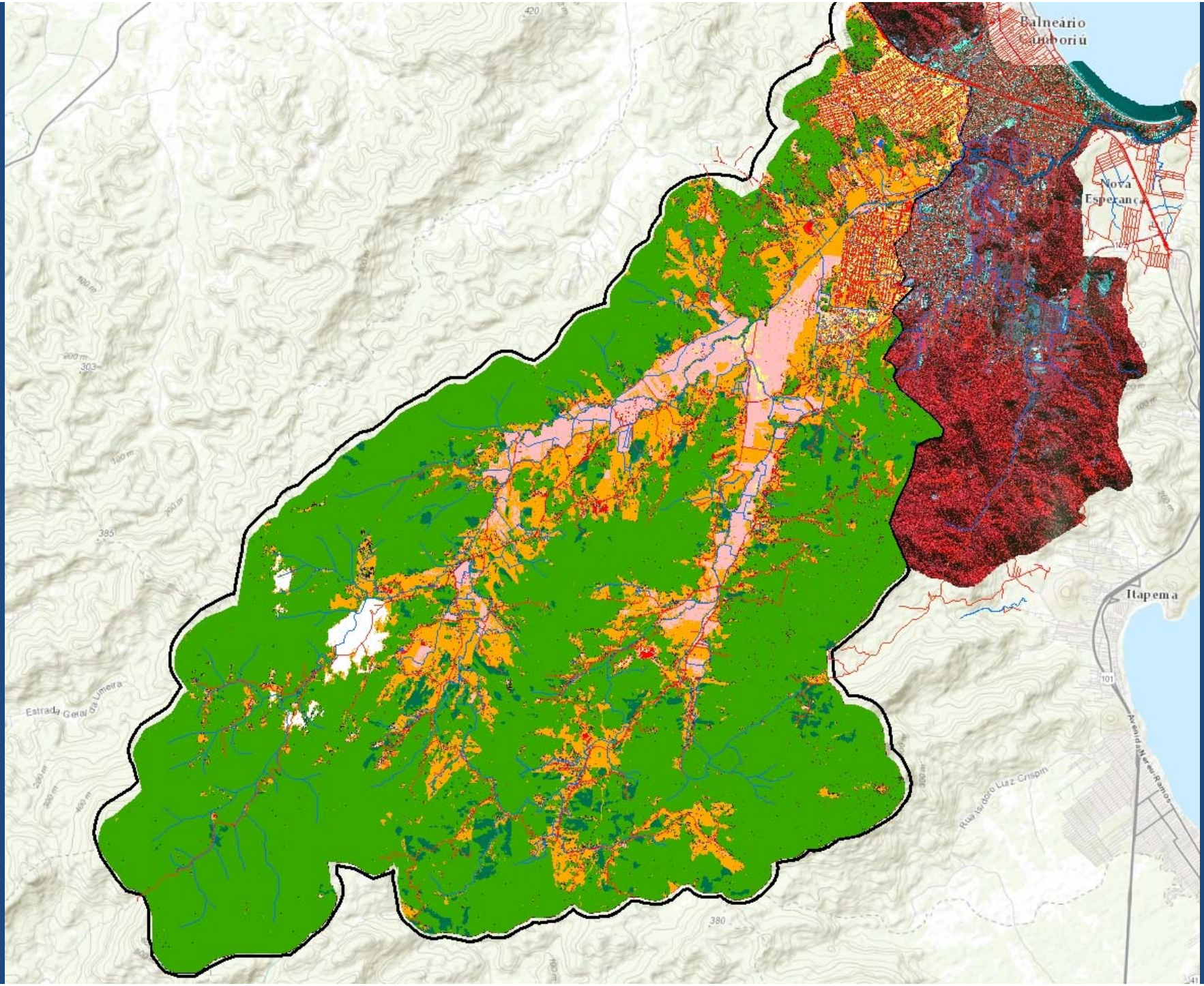


Ecosystem structure: Land cover

Map past and current land cover

- 2003, 2008, 2012 (2 m resolution)
- Cover classification based on SWAT needs and data availability (e.g., sediment export coefficients)
- Used very fine detail imagery – 60 cm Pan-sharpened multispectral
- 6 Land-cover Classes


Ground truthing and reference points:
Forest
Eucalyptus plantation
Rice field
Balneário Camboriú
Nova Esperança
Itapema


Balneário
Camboriú
Nova
Esperança
Itapema
Estrada Geral da Limeira
Rua Isidoro Luiz Crispim
Avenida Nereu Ramos
101
420
303
385
380

Estimate land cover change model

- Idrisi Land Change Modeler (LCM for ArcGIS 2.0)
  - Train model on 2008 and 2012 covers; (~~2003~~)
  - Iterative estimation thru 2025 to capture impact of LCC and conservation on neighboring parcels
  - Variables included (besides land covers):

Distance from (new) urban
Distance from agricultural lands
Distance from roads
Distance from any kind of conversion

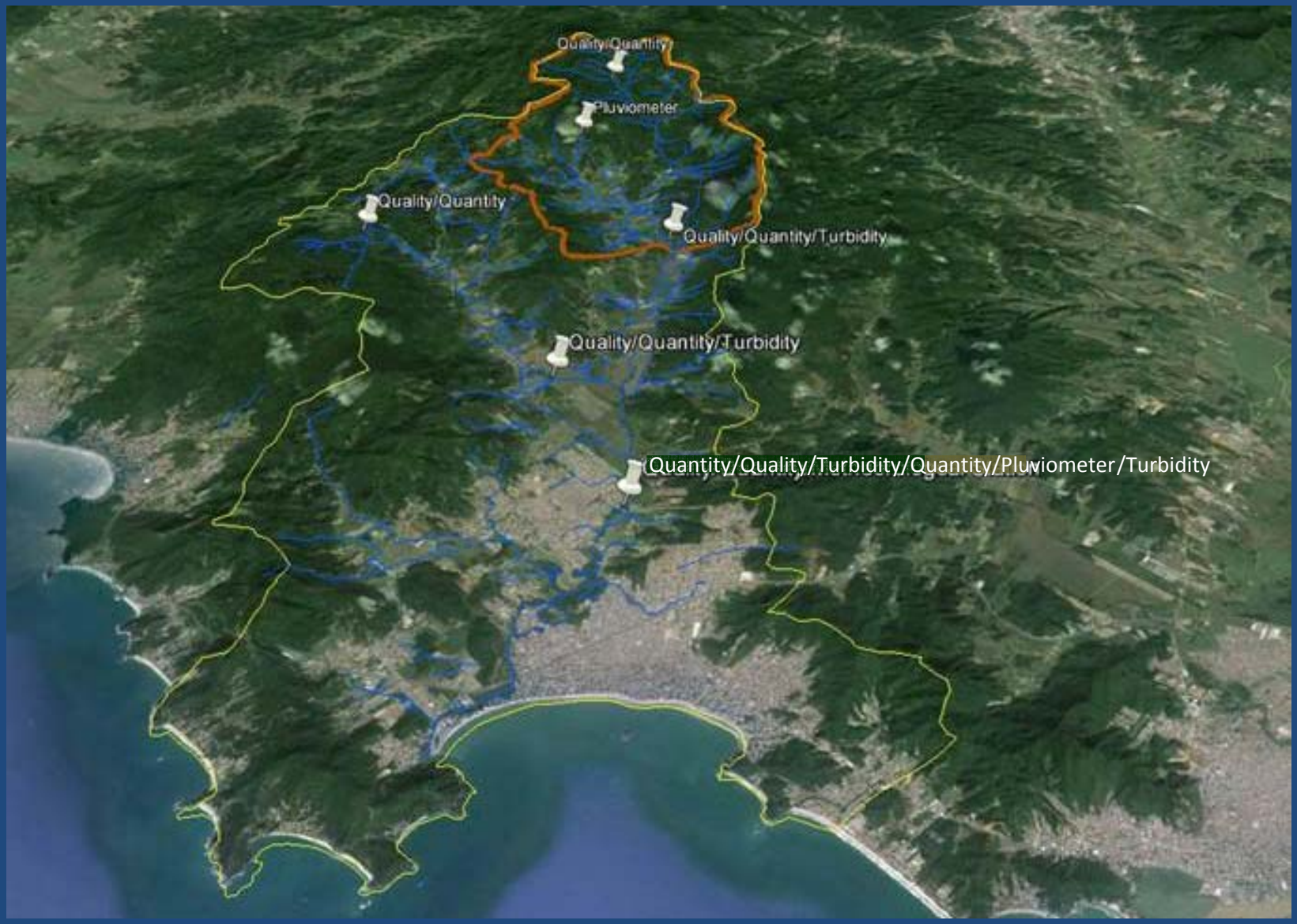
Elevation
Slope
Evidence likelihood of change

Recalculated dynamically

Predict land cover in 2025

- Without conservation program
  - Assume recent past land cover changes will continue
  - Set disturbed variables as dynamic (2018, 2021, 2025)
- With conservation program
  - Add protection constraints/conservation incentives
  - Incorporate timing of interventions

SWAT modeling



SWAT modeling

- SWAT version 2012
- Calibration using existing and new monitoring infrastructure
- Run on high-resolution land covers (2 m)
- For PWS and counterfactual land cover scenarios
  - Difference in sediment concentrations attributed to PWS

Valuation of service gains

- Benefits dominated by reduced sludge disposal and water loss
- Approx. 15 % of treated water is lost in the treatment process

Volume used for cleaning the system	m^3/yr	2.800.000
Volume used for filter cleaning	m^3/yr	***2.500.000***
Sludge generated	tons/yr	217.000
Dredging	$/yr	8.700
Pumping (power)	$/yr	610.000
Chemicals	$/yr	276.000
Water used for cleaning the system	$/yr	780.000
Sludge disposal	$/yr	5.650.000

Source: EMASA

- Working with water plant staff to estimate avoided costs from estimated sediment reductions (compared to counterfactual)

The Team

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THANK YOU!

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