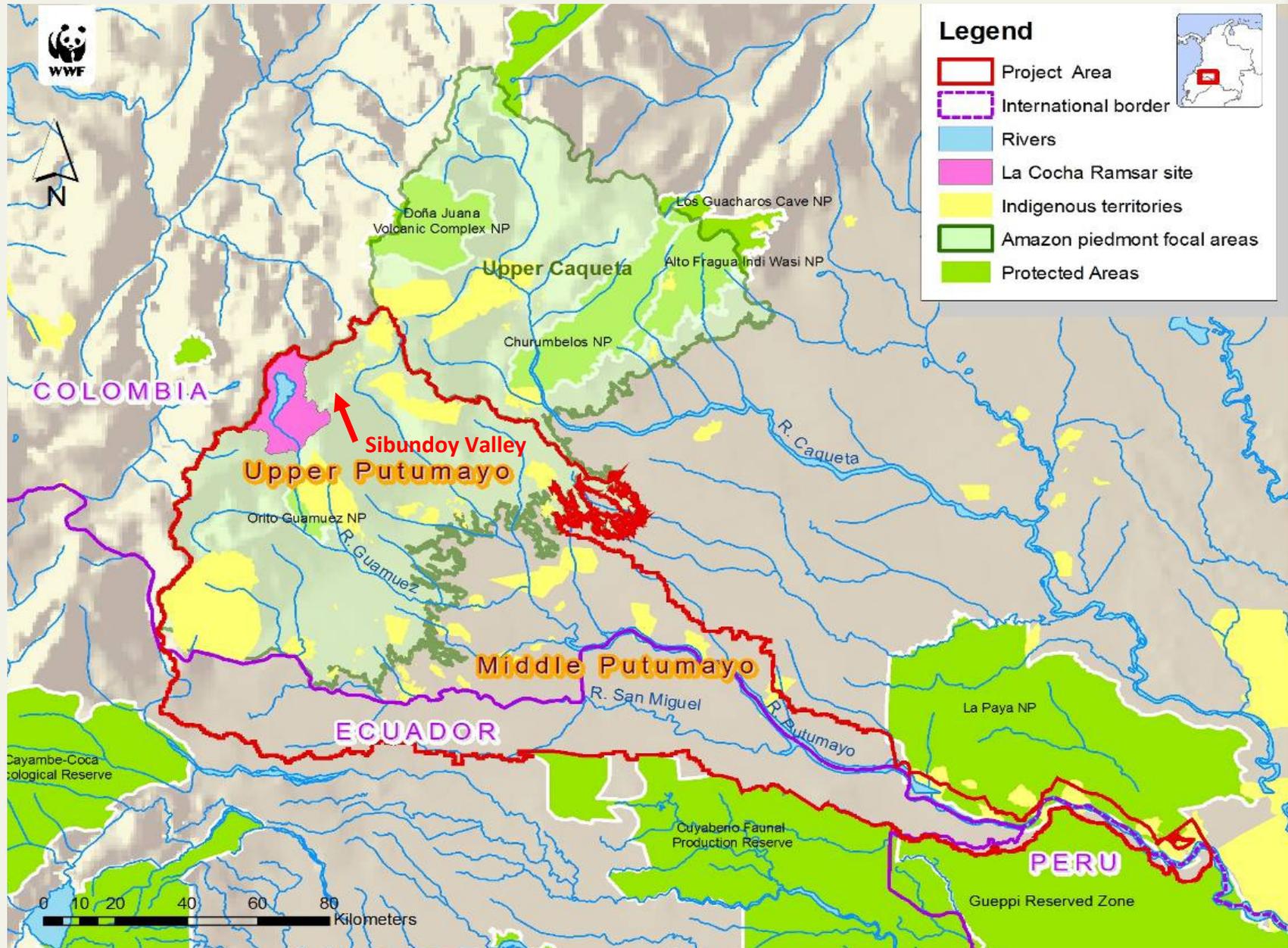


Spatial mapping as a tool for mainstreaming biodiversity values

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Seeking solutions to prevent further biodiversity loss in the upper Putumayo basin

The cloud forests of Colombia's Upper Putumayo region are threatened by advancing agriculture, ranching, and infrastructure development.

These activities can have adverse effects on the benefits nature provides, including water supply and quality, prevention of soil erosion, carbon capture and sequestration, and biodiversity.

The impacts of climate change intensify these effects, which is likely to have serious consequences for future development.



Developing a scheme of compensation and rewards for ecosystem services

WWF, Corpoamazonía (the regional environmental regulatory agency), and CIPAV (Foundation Center for Sustainable Agricultural Systems), joined efforts to identify areas in the Upper Putumayo basin with especially high ecosystem service value, for incorporation into a compensation and rewards for ecosystem services (CRES) scheme.

A CRES scheme involves creating contracts for compensation or providing incentives for ecosystem stewards to protect and enhance ecosystem services, or reduce their degradation, for the benefit of users.

CRES schemes differ from payments for ecosystem services (PES) schemes in that no market is set up to facilitate the payment transfers. Ecosystem service providers may pay compensation to beneficiaries to offset a decline in ecosystem services. Alternatively, ecosystem service beneficiaries may pay compensation to providers to reduce economic activities that degrade ecosystem services.



Assessing Ecosystem Services in the Upper Putumayo Basin

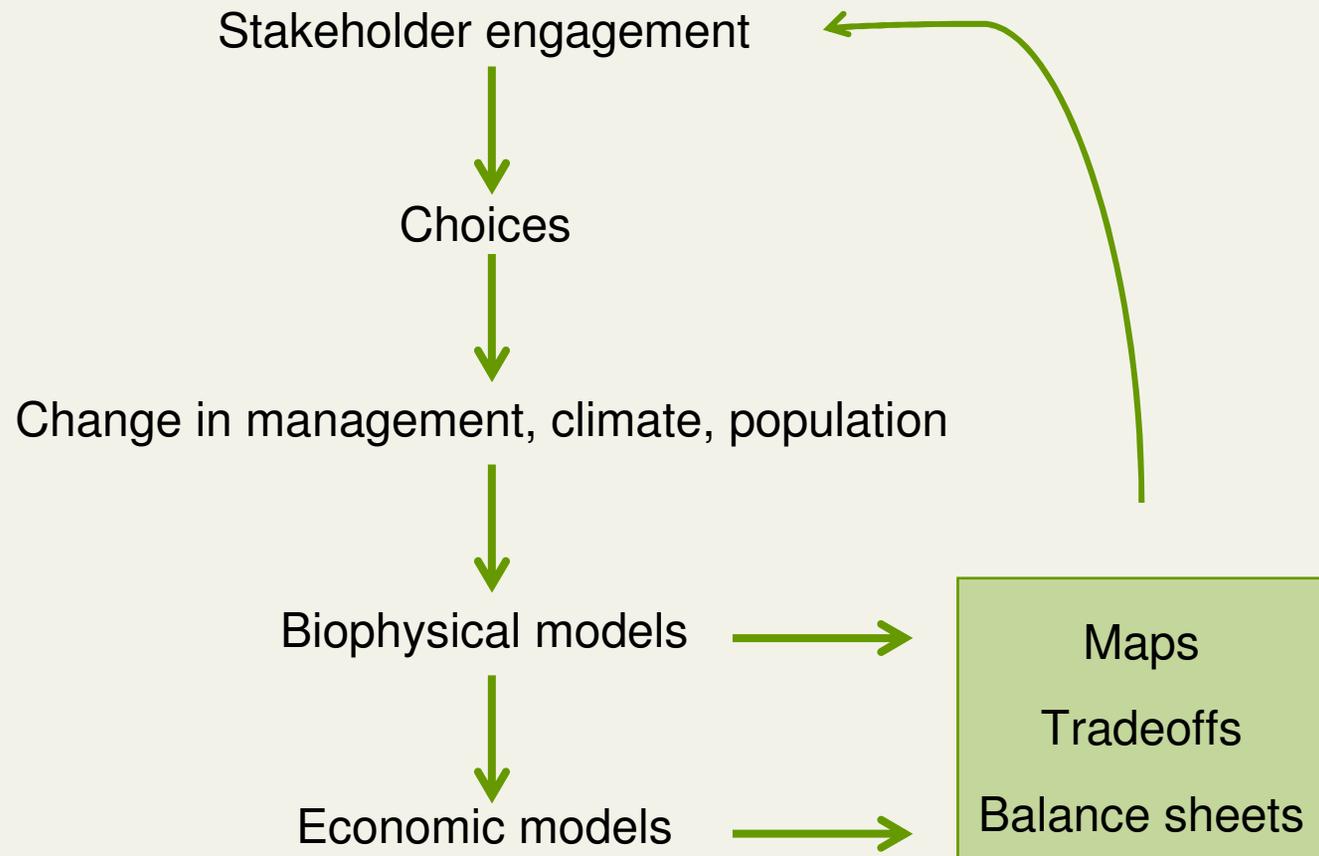
Establishing a CRES scheme for alternative livestock production systems required assessing how cattle ranching would affect :

- agricultural revenues
- drinking water quality to local aqueducts
- erosion control
- carbon sequestration, and
- biodiversity

InVEST: Integrated Valuation of Ecosystem Services and Tradeoffs

- Where do ecosystem services originate and where are they consumed?
- How does a proposed forestry management plan affect timber yields, biodiversity, water quality and recreation?
- Which parts of a watershed provide the greatest carbon sequestration, biodiversity, and tourism values?
- Where would reforestation achieve the greatest downstream water quality benefits while maintaining or minimizing losses in water flows?
- How will climate change and population growth impact ecosystem services and biodiversity?

InVEST is embedded in a decision-making process:



Using InVEST for decision making

- InVEST can estimate the amount and value of ecosystem services that are provided on the current landscape or under future scenarios.
- InVEST models are spatially-explicit, using maps as information sources and producing maps as outputs.
- InVEST returns results in either biophysical terms (e.g., tons of carbon sequestered) or economic terms (e.g., net present value of that sequestered carbon).
- The spatial resolution of analyses is also flexible, allowing users to address questions at the local, regional or global scale.
- Using InVEST in an iterative process: the stakeholders may choose to create new scenarios based on the information revealed by the models until suitable solutions for management action are identified.

InVEST has a tiered design

TIER 1 Models	TIER 2 Models	TIER 3 Models
Simplest models; ignore certain real processes	Incorporate more real processes	Most complex; dynamic, process-based models
Least data required	More data required	Most data required
Annual average time step, no temporal dynamics	Daily to monthly time step, some temporal dynamics	Daily to monthly time step, temporal dynamics with feedbacks and thresholds
Appropriate spatial extent ranges from sub-watershed to global	Appropriate spatial extent ranges from parcel to global	Appropriate spatial extent ranges from parcel to global
Low precision estimates best for identifying areas of high & low ecosystem service production	More precise estimates of ecosystem service delivery	More precise estimates of ecosystem service delivery
No ecosystem service interactions	Some ecosystem service interactions	Sophisticated ecosystem service interactions with feedbacks and thresholds
Produce either absolute values or relative indices	Produce absolute values	Produce absolute values

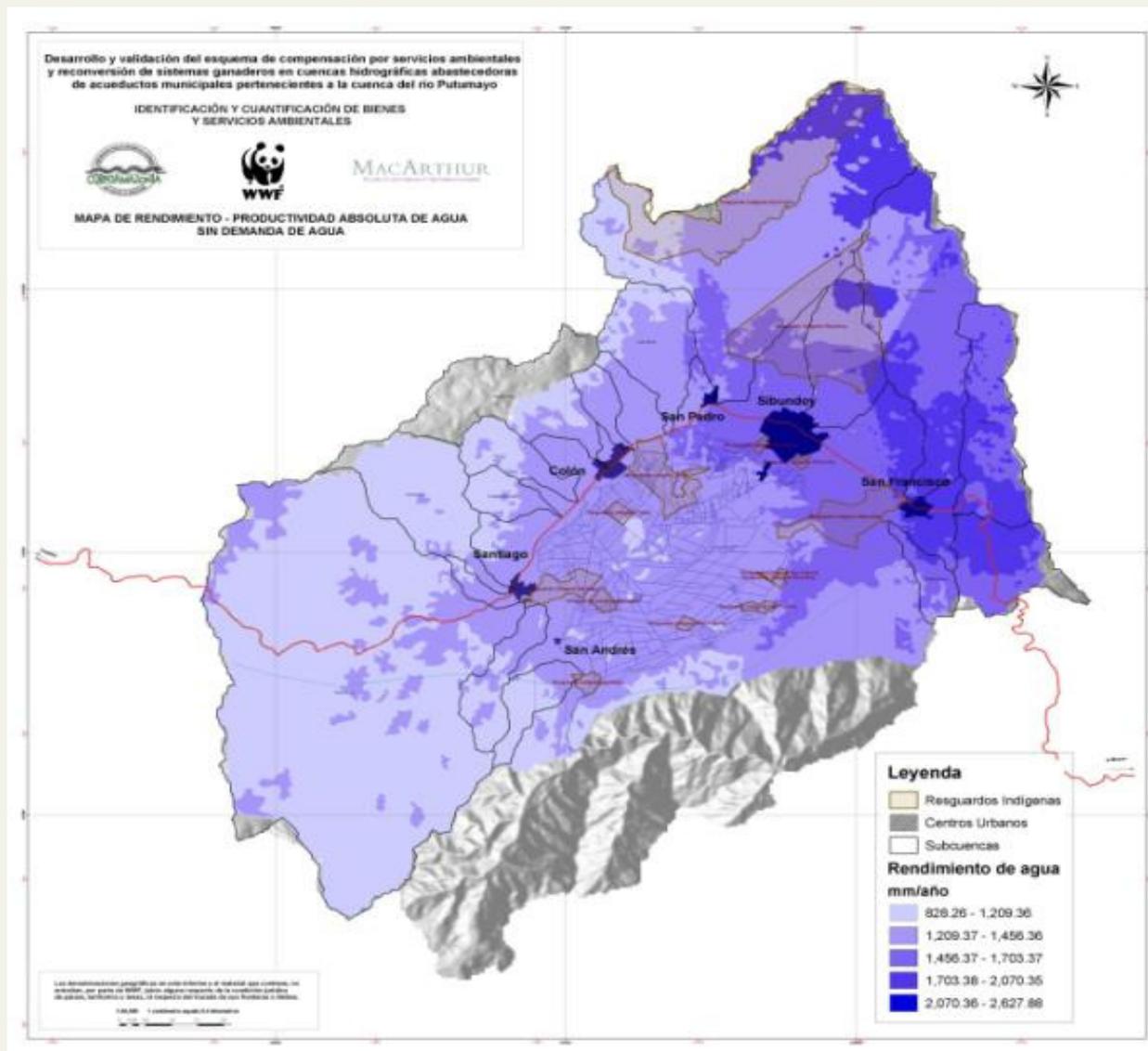


Quantifying and mapping ecosystem services in the Upper Putumayo

- Water: where are the most important areas to maintain the current water cycle?
- Carbon: which parts of a watershed maintain the largest carbon stocks?
- Biodiversity: which parts of a watershed provide the best quality habitat?
- Sediment retention: where will most of the potential soil losses occur under current land use and land cover patterns?
- Erosion: which parts of the landscape are more important to prevent soil loss?
- Nutrient retention: Which parts of the landscape are more important in keeping pollutants out of waterways?



Annual Average Water Yield





Contributions by type of land cover

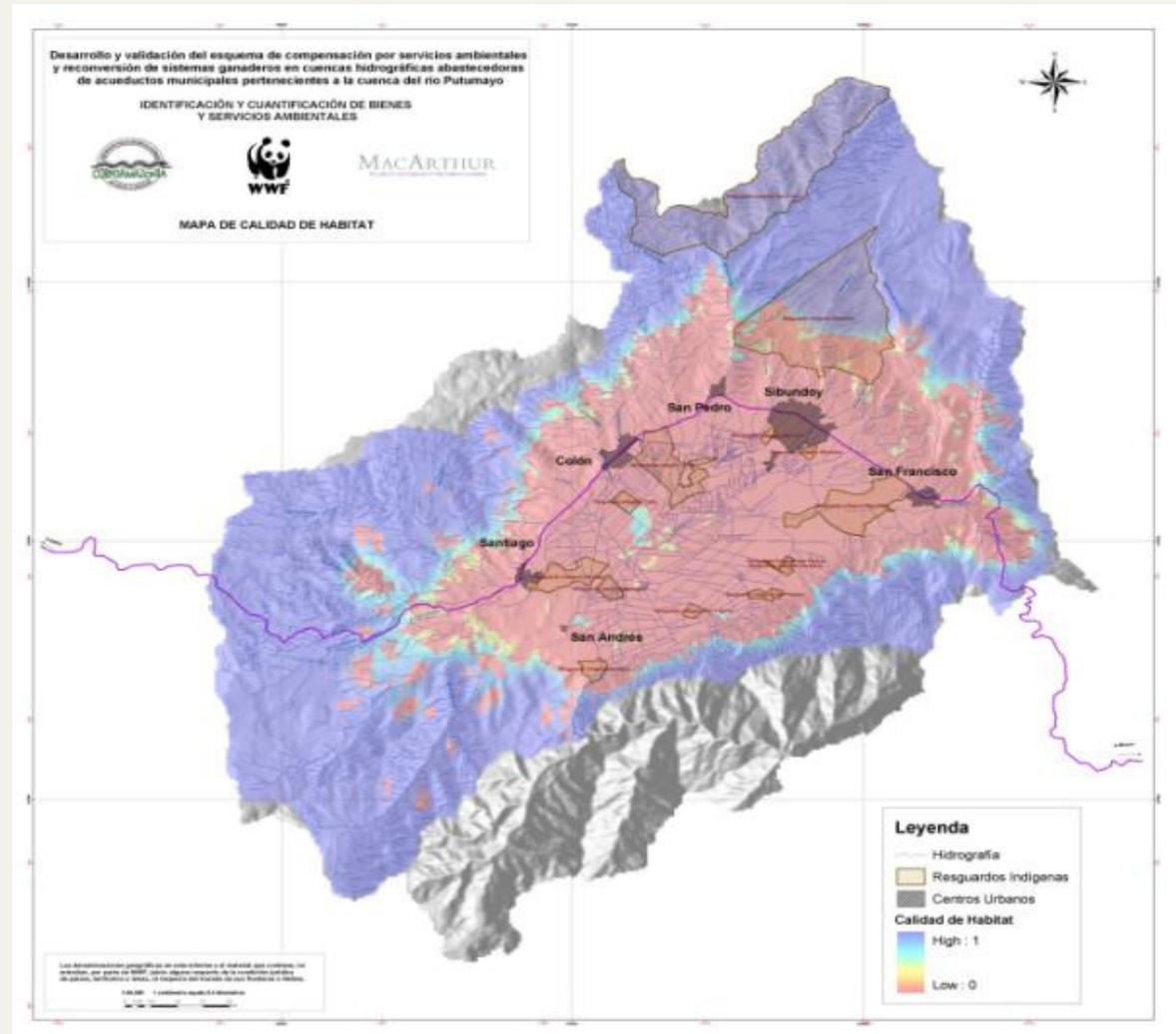
Component	Putumayo		Hidráulica	
	Vol m ³	%	Vol m ³	%
Primary forest	17,947,620	53.2	6,804,630	28.2
Secondary forest	9,161,190	27.1	831,719.70	3.45
Wetlands	-	-	0	0
Agricultural systems	4,659,822	13.8	11,050,650	45.9
Paramo grasslands	-	-	2,325,753	9.65
Urban areas	-	-	335,887.20	1.39
Natural pastures	2,000,016	5.92	2,742,930	11.4



Biodiversity –habitat quality

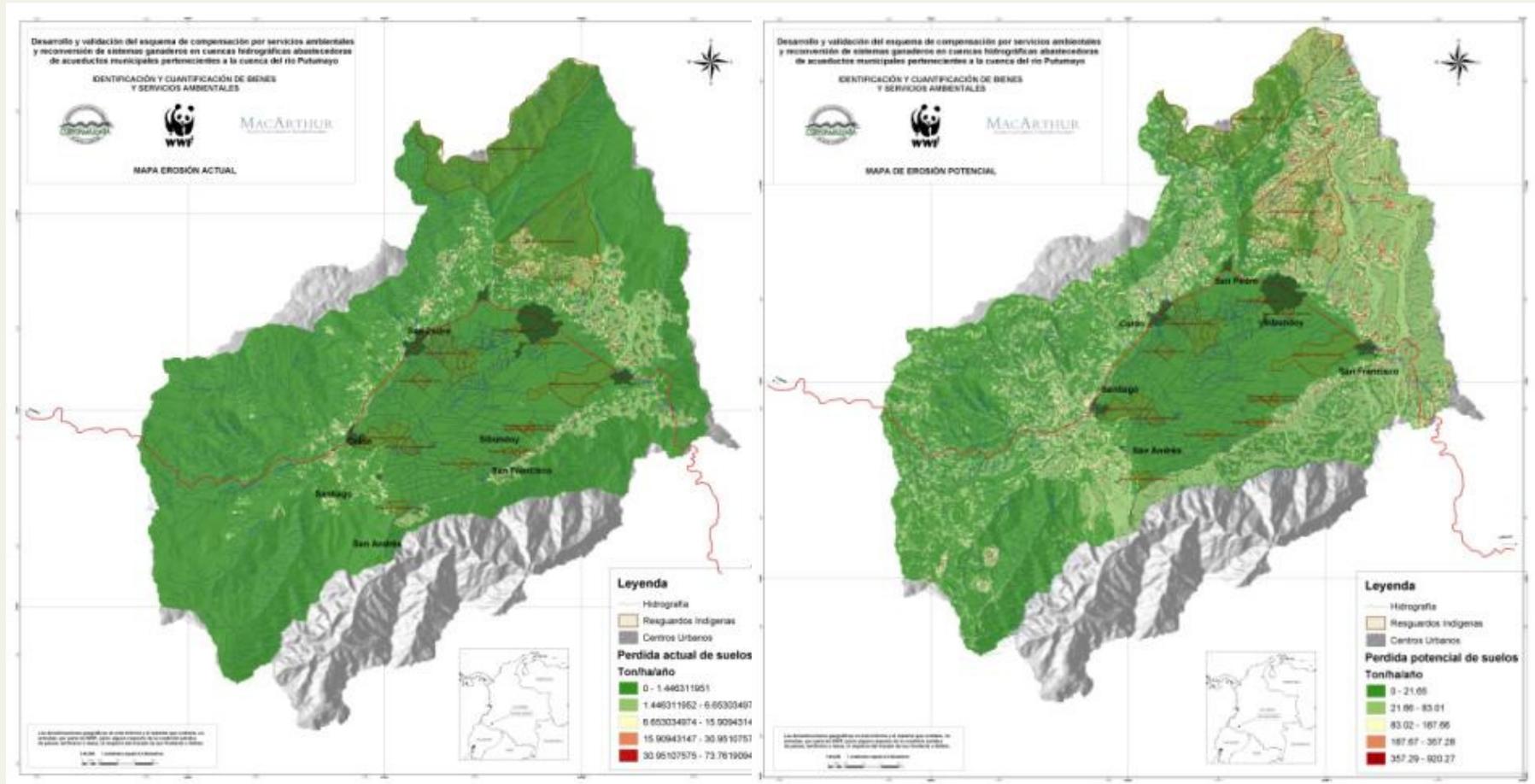
Modifiers (Threats):

- Land use conflicts
- Road distance
- Town distance
- Current land use





Sediment Retention

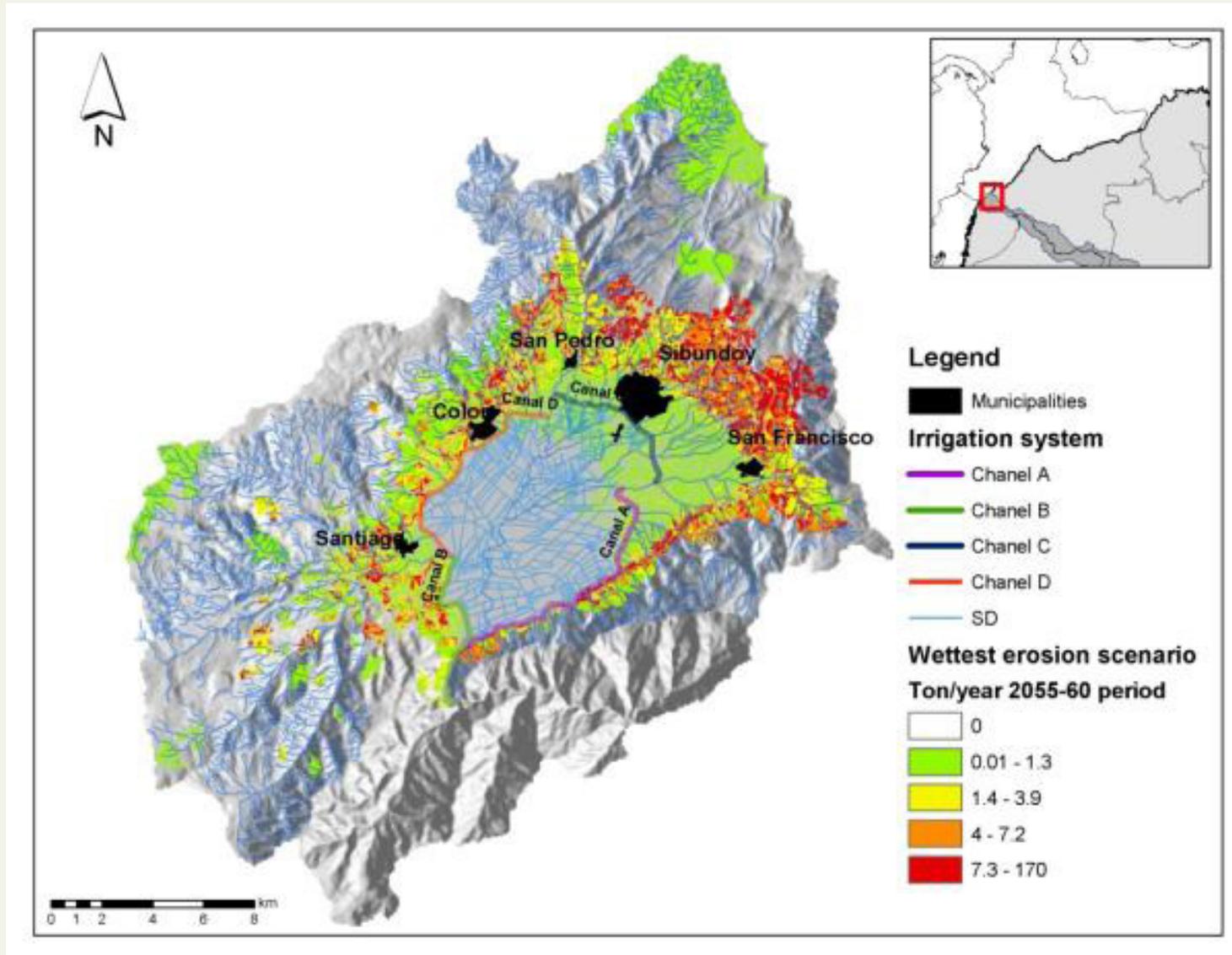


Current soil loss calculation

Potential soil loss calculation



Ecosystem services and climate change





Concluding remarks

- The results identified the areas most important in terms of carbon sequestration capacity, water yield, nutrient retention, and erosion control.
- The most biodiverse areas were located at higher elevations, which were farther away from roads and infrastructure development.
- Locations with the highest concentrations of services, the greatest risk of loss from incompatible activities, or potential to increase services provide the greatest amount of benefits to ecosystem stewards and beneficiaries, making the sites good candidates for compensation schemes.
- WWF Colombia and its partners have selected pilot locations for silvopastoral systems, using InVEST to identify where there is potential for enhancing ecosystem services in degraded areas and for conservation in areas with high concentration of services.



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