

Conservation as a mitigation maneuver to freshwater ecosystem services degradation: An InVEST modeling approach examining social ecological system (SES) boundaries



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Background

Portneuf River watershed as a semi-arid basin is fragile to climate change and agricultural activities:

- Irrigation consumes 94.5% of water.
- Climate warming alters the distribution and quality of water SES.
- The cap of Conservation Reserve Program (CRP), the largest federal program for conservation regarding private land retirement, is declining.

Research question

What are the “boundaries” imposed by climate and anthropogenic changes to freshwater ecosystem services in the study area?

Methods

InVEST toolset used to spatially model ecosystem services, i.e. water yield, total phosphorus (TP) export, total nitrogen (TN) export, and total suspended sediment (TSS) export.

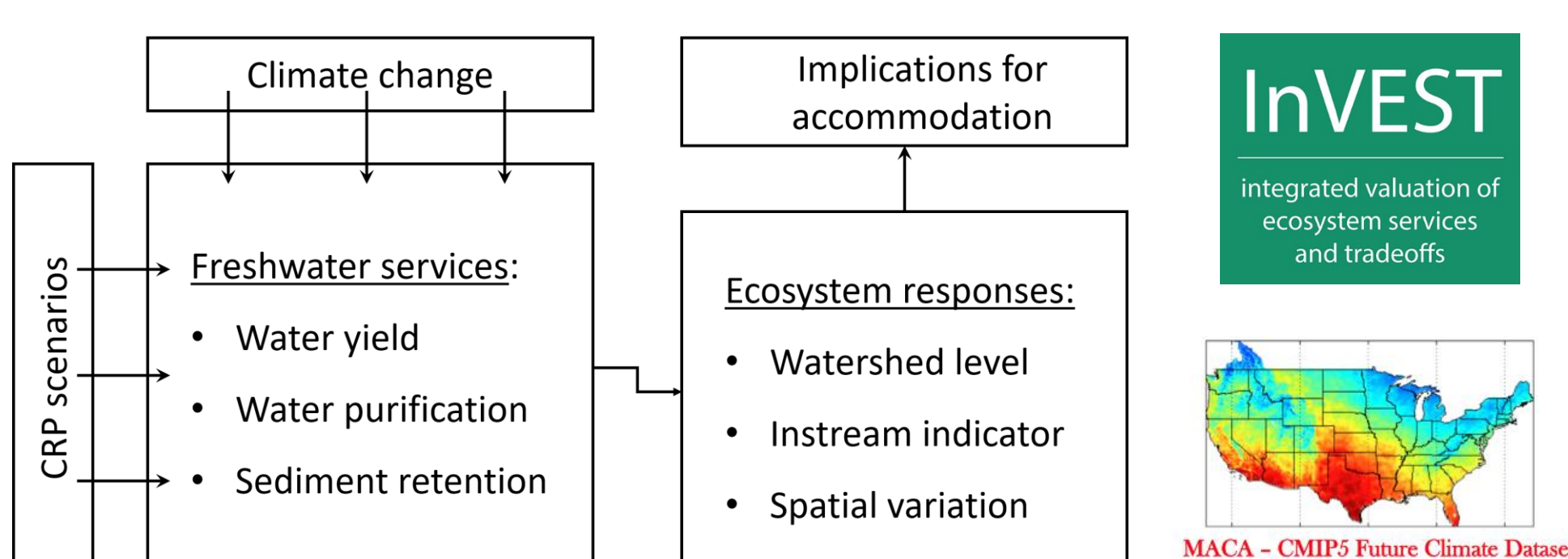


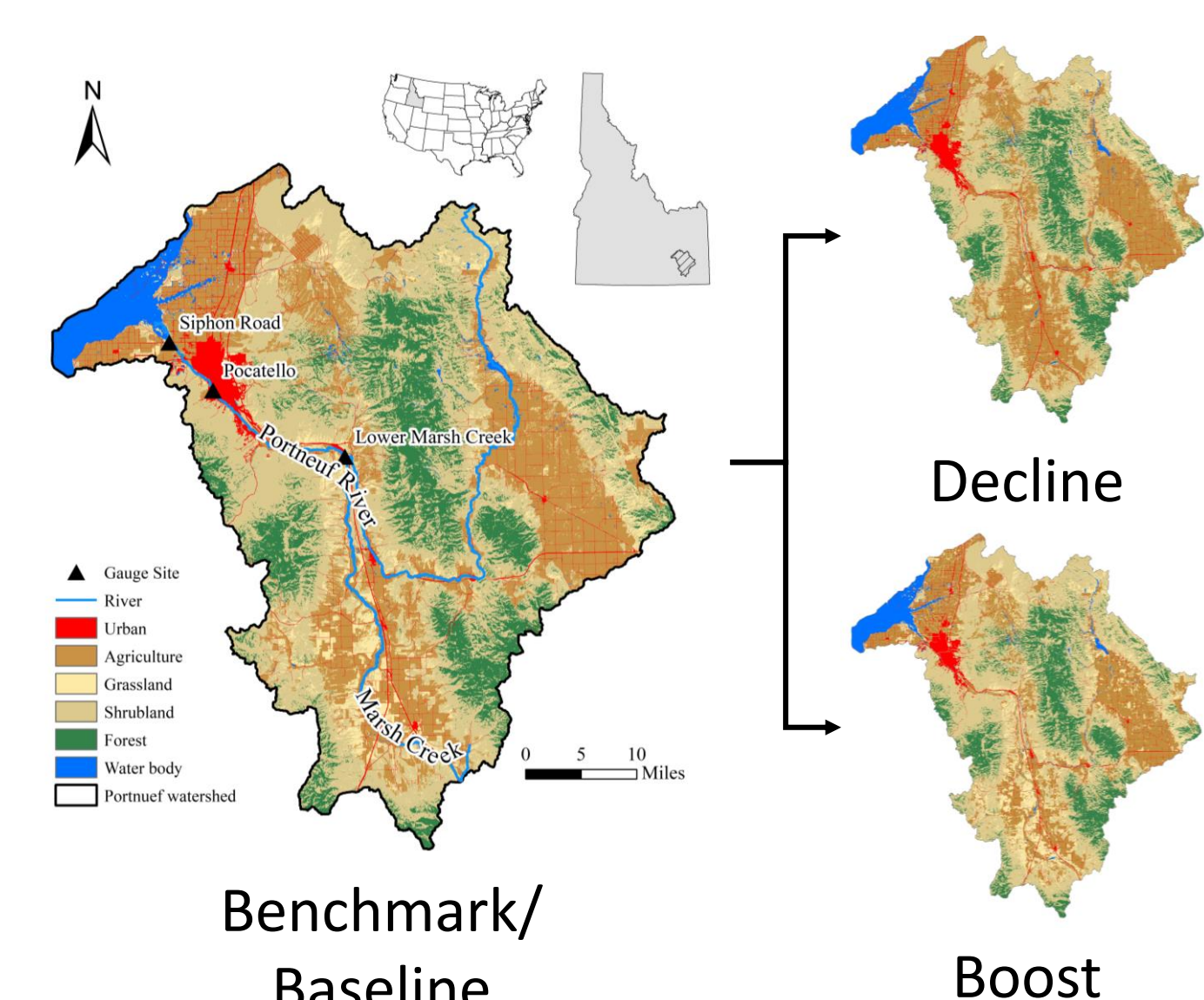
Fig. 1 Assessment framework

Results

Table. 1 Instream indicator in scenarios

CRP Scenario	Climate data	Conservation acres	Flow rate, ft ³ /s	TP export, lb/day	TN export, lb/day	TSS export, ton/day
Benchmark	1986-2015	92,217	229.7	236.7	2364.3	74.4
Baseline	2036-2065	92,217	-68.2%	11.6%	17.1%	60.3%
Decline	2036-2065	65,239	-37.4%	-0.2%	-0.2%	11.3%
Boost	2036-2065	122,895	-19%	-10.3%	-11.1%	-17.6%

*In boost scenario, the CRP enrollment is assumed to increase and riparian protection is implemented along 30 meters buffer of streams.

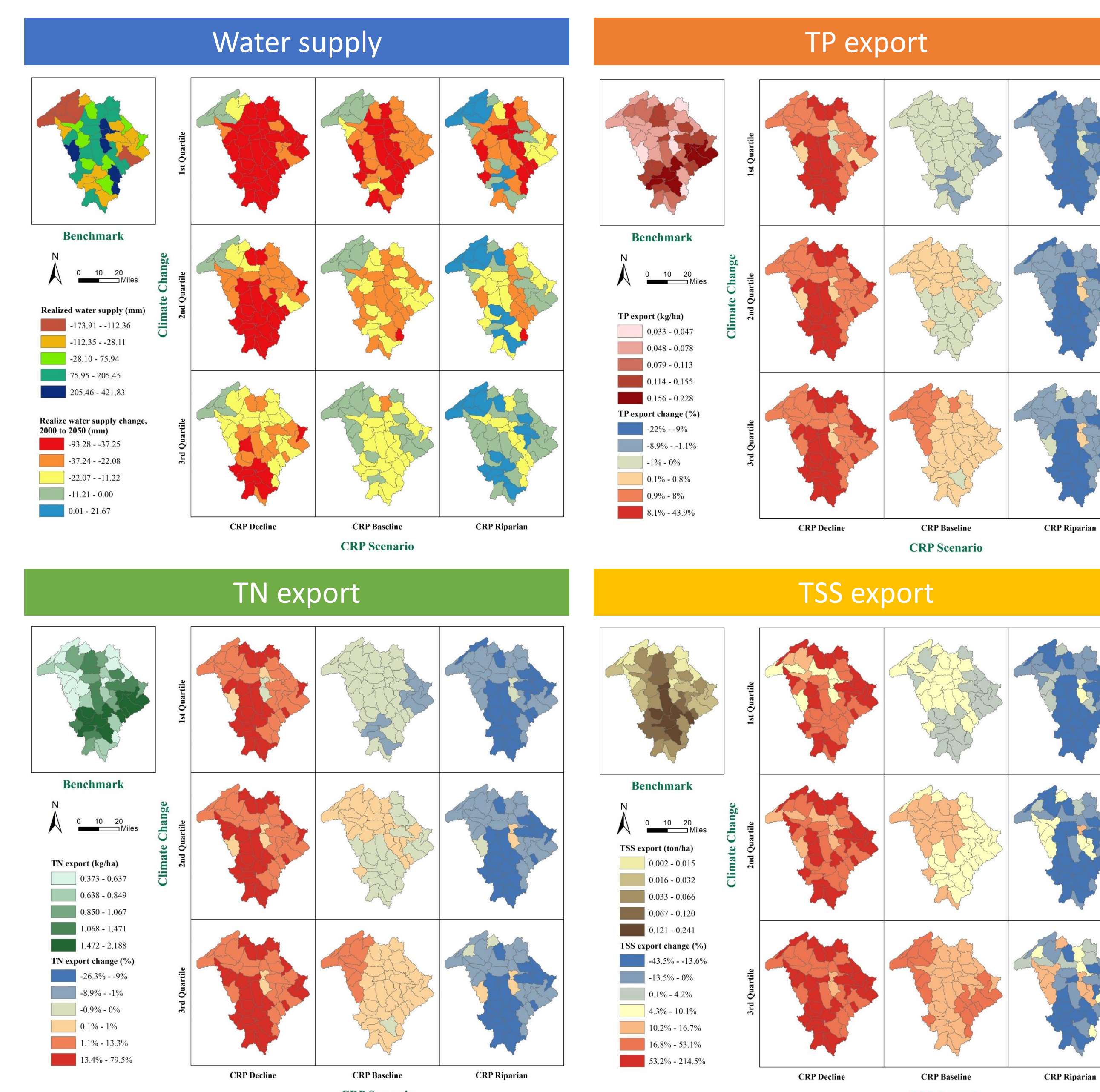


- Climate change alone will intensify water scarcity and turbidity due to more runoff and evapotranspiration.
- Environmental degradation could be accommodated by promoting croplands conservation and riparian protection.

Fig. 2 Land use cover in scenarios

- Water supply and sediment retention are spatially sensitive to both factors.
- Nutrient retention services are sensitive to conservation only.
- “Hot spots” are observed in southwest basin along Marsh Creek.

Fig. 3 Spatial distribution of freshwater ecosystem services



Conclusions

Climate change will impose harsher “boundary” to humans' well-being and survival.

The choice of conservation or exploitation land use policy will exert different effects on the “boundary” change and form new “domains of SES” over space and time for sustainable development.

Water scarcity will be a multiplier factor because it concentrates nutrients and sediments in streams.

Areas with intensive anthropogenic activities are less resilient to climate and land use change, especially for the region along Marsh Creek.

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Contact information

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