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Climate Change and Shifts in Water Related Ecosystem Services in the Tualatin and Yamhill River basins



Oregon Water Conference
Corvallis, May 24, 2011

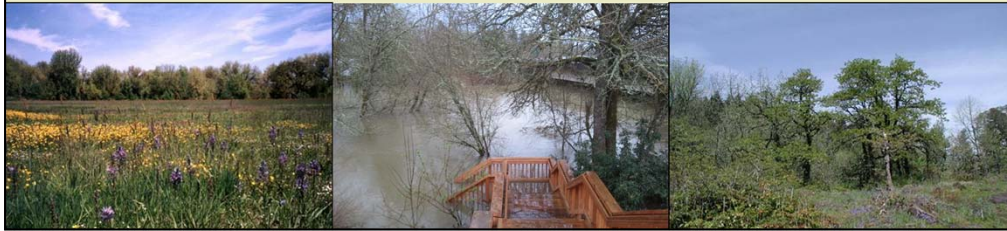


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Ecosystem Services

- Ecological characteristics, functions, or processes that directly or indirectly contribute to human well-being.
- In short, the benefits we receive from “natural capital”
- Market services (e.g., food, energy, timber)
- Nonmarket services (e.g., pollution filtering, temperature regulation, biodiversity habitat, aesthetics)



Humans benefit from a multitude of resources and processes that are supplied by natural [ecosystems](#). Collectively, these benefits are known as **ecosystem services** and include products like clean [drinking water](#) and processes such as the [decomposition](#) of wastes.

Types of Ecosystem Services

1. **Provisioning** (e.g., food, timber, water)
2. **Regulating** (e.g., flood control, carbon sequestration, pollination)
3. **Cultural** (e.g., recreation, aesthetics, cultural identity)
4. **Supporting** (e.g., soil formation, nutrient cycling, habitat provision - indirectly affect human benefits by facilitating provisioning, regulating and cultural services).

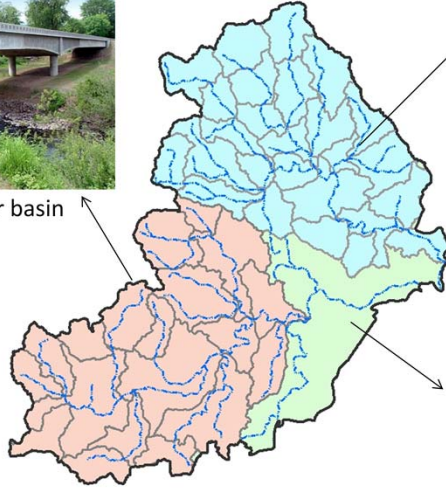


Source: Millennium Ecosystem Assessment (2005)

Study Area



Yamhill River basin



Tualatin River basin

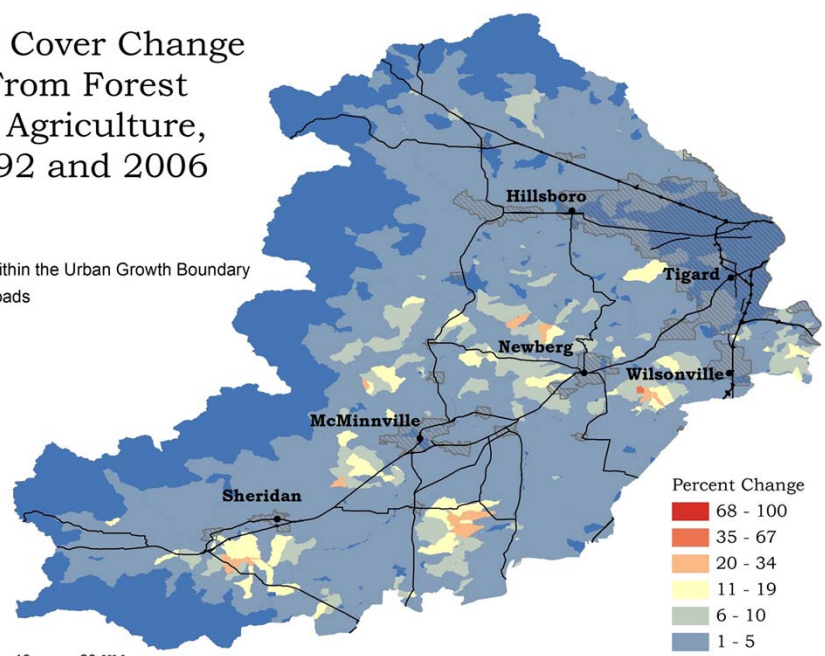


Lower Willamette and tributaries



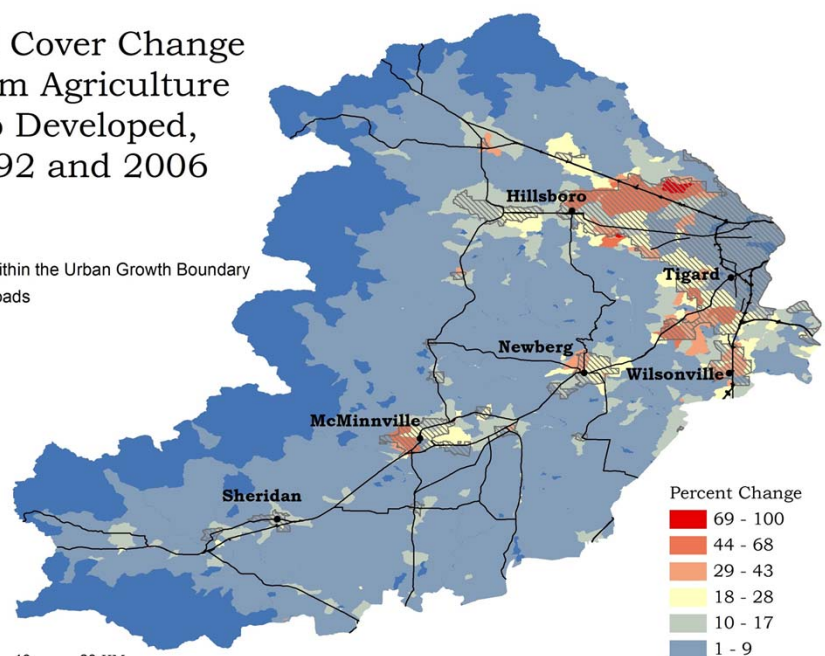
Land Cover Change From Forest to Agriculture, 1992 and 2006

▨ Areas Within the Urban Growth Boundary
— Major Roads

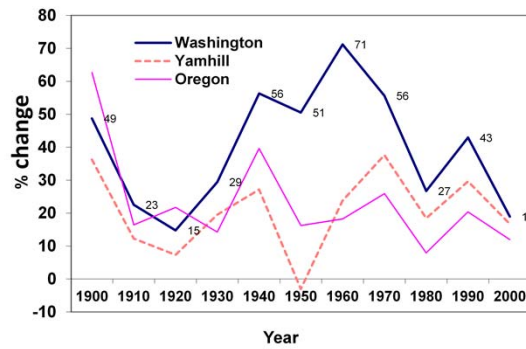
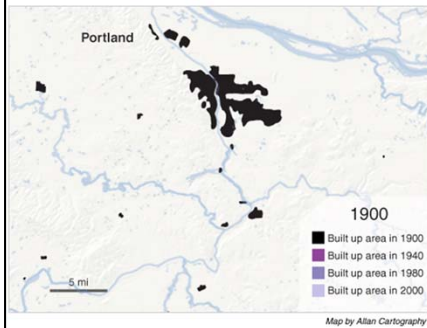
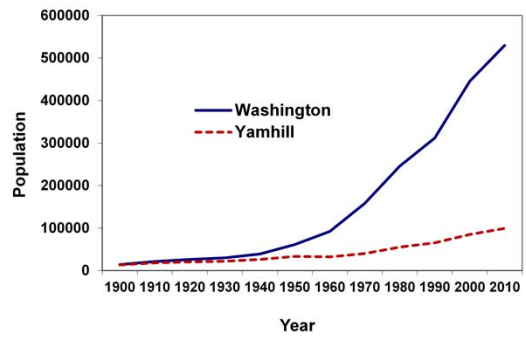


Land Cover Change From Agriculture to Developed, 1992 and 2006

▨ Areas Within the Urban Growth Boundary
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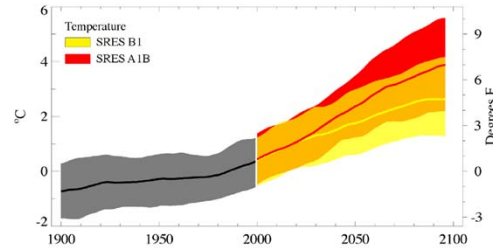
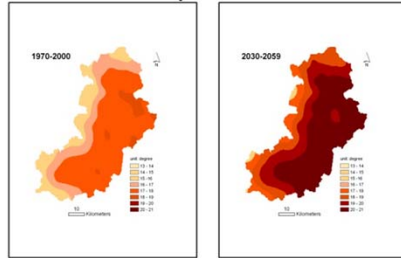


Population Change, 1900-2010

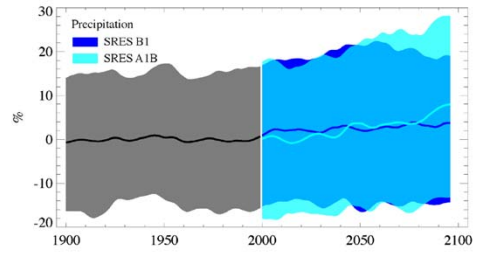
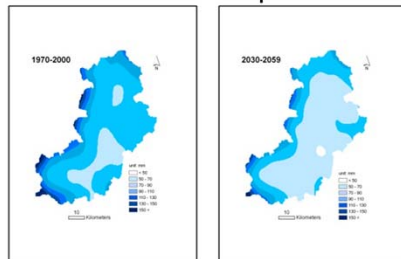


Climate Change, 1900-2100

Temperature



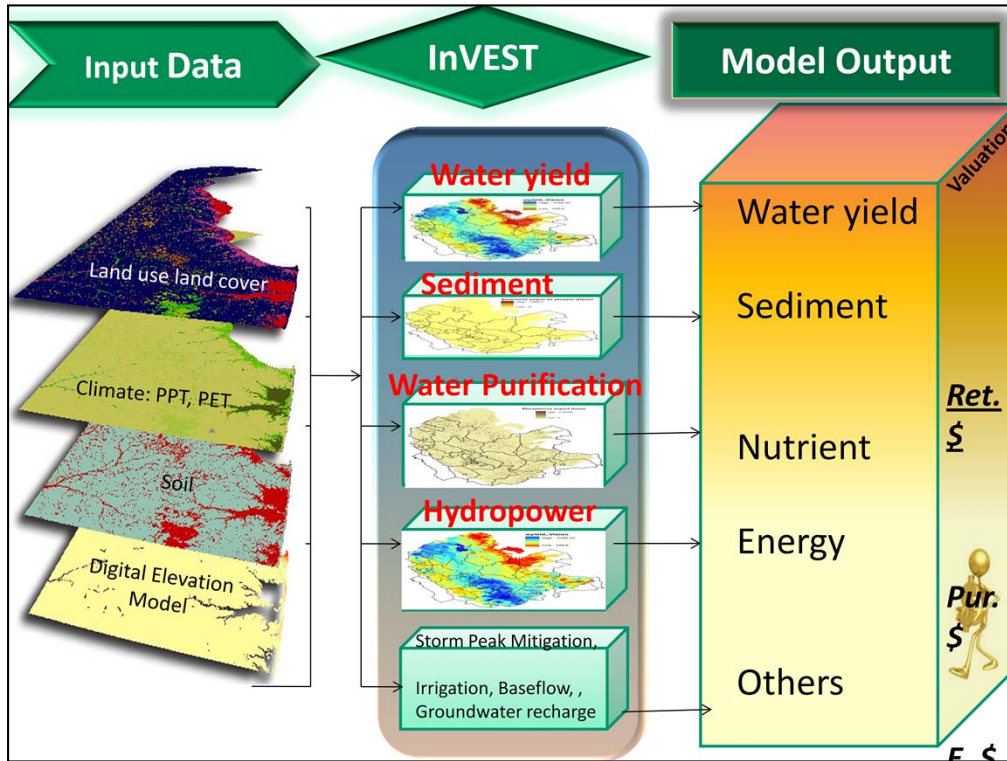
Summer Precipitation



Source: Mote and Salathe (2010) *Climatic Change*

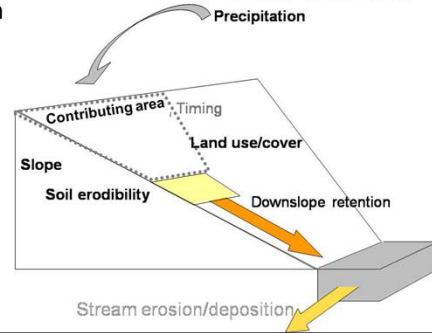
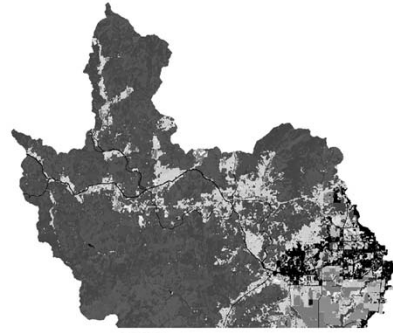
Research Questions

1. What is the effect of climate change on water-related ecosystem services (water yield, N, P, Sediment retention)?
2. Which parts of the basin provide the greatest water yield, sediment and nutrient retention?
3. Do spatial patterns persist regardless of different climate regimes?
4. How do we bundle these multiple ecosystem services together?



InVEST Water Models' Objectives

- **VALUE OF EACH PARCEL ON THE LANDSCAPE**
- Need to determine contribution (production function) of each parcel in ecosystem service of interest
- Where are the sources of nutrients/sediment?
- Where are the nutrients/sediment retention areas?
- How much is retained?
- What is the value of this retention?



Datasets

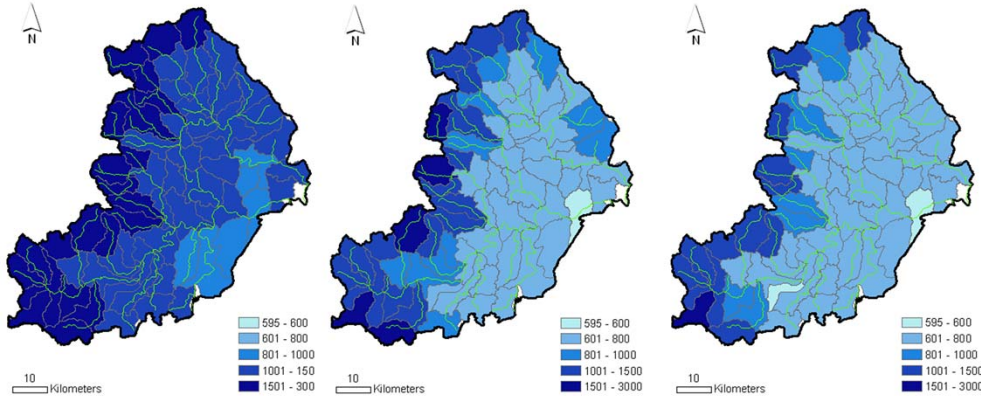
	Land Use/ Land Cover	Climate/ Weather	Streamflow
<i>Current-Wet</i>	USGS NLCD	NOAA 1995-1999	USGS/OWRD
<i>Current-Norm</i>	USGS NLCD	NOAA 2002-2006	USGS/OWRD
<i>Current-Dry</i>	USGS NLCD	NOAA 1988-1992	USGS/OWRD
<i>Future</i> – Dev (2050)	PNWERC or EPA ICLU	IPCC AR 5 th	SWAT model output
<i>Future</i> – Cons (2050)	PNWERC or EPA ICLU + TNC Synthesis map	IPCCAR 5 th	SWAT model output

Water Yield

Wet year

Normal year

Dry year



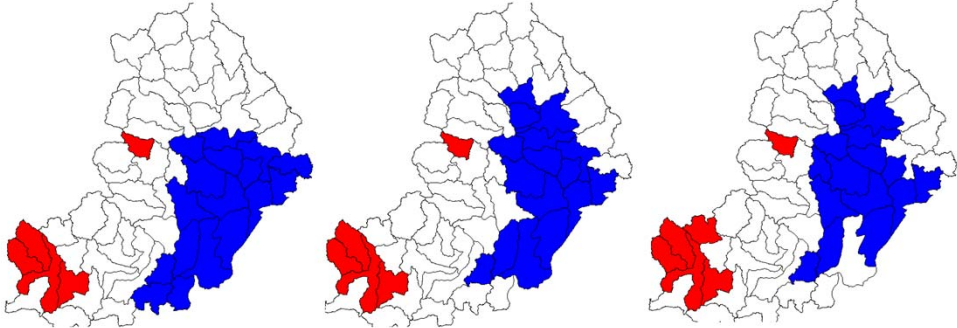
(unit: m^3)

Water Yield

Wet year

Normal year

Dry year



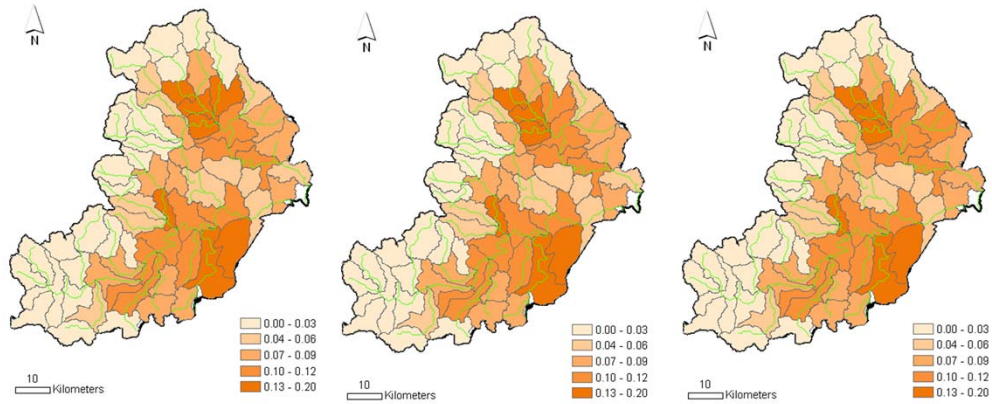
High-High Low-Low

Phosphorous retention

Wet year

Normal year

Dry year



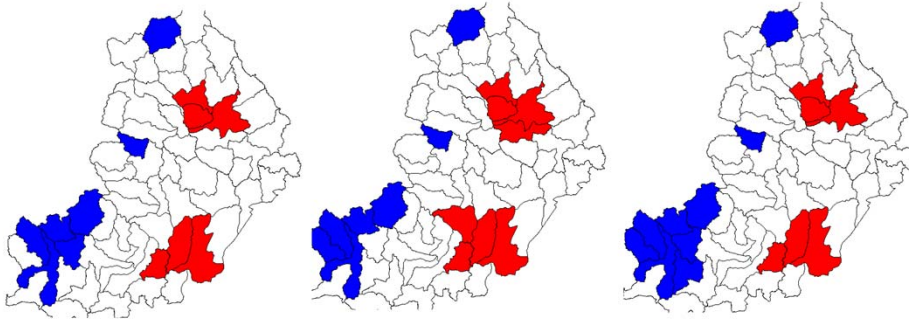
(unit: kg)

Phosphorous Retention

Wet year

Normal year

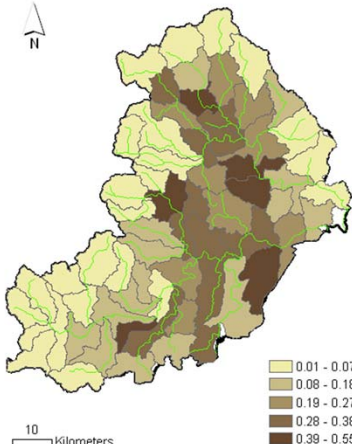
Dry year



■ High-High ■ Low-Low

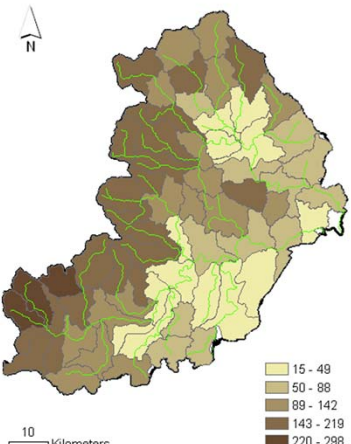
Sediment (Normal year)

Sediment (load)



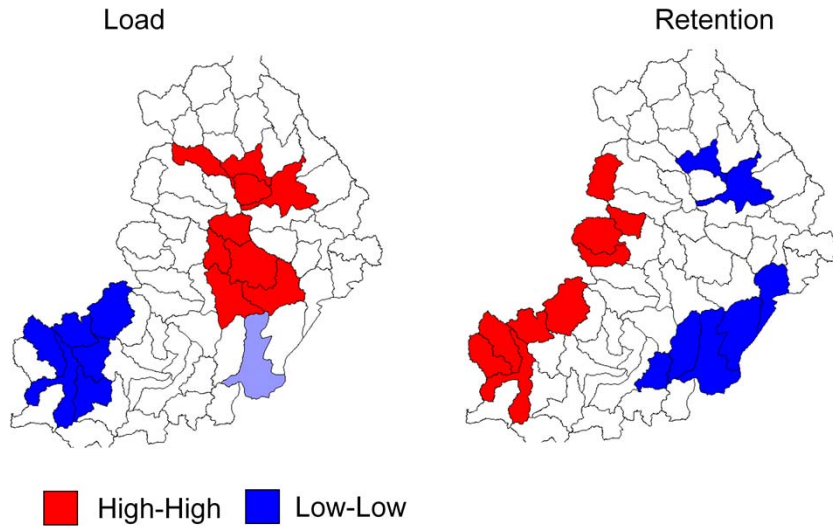
(unit: tons)

Sediment (retention)

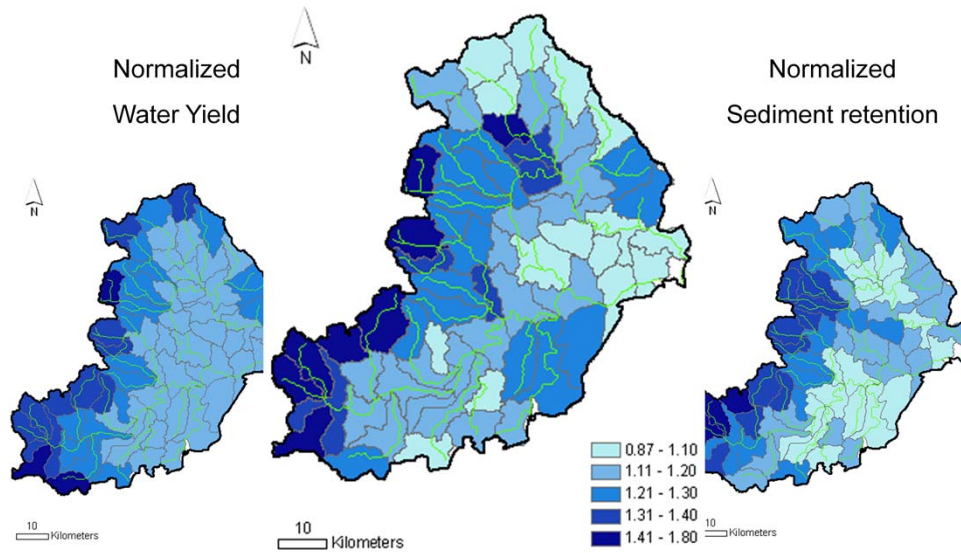


(unit: tons)

Sediment Export



Bundled Process (Normal year)



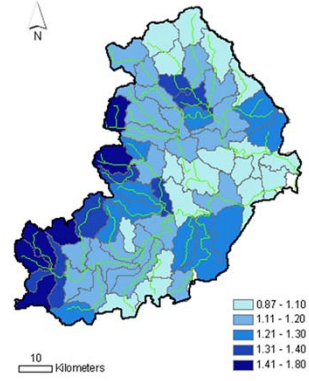
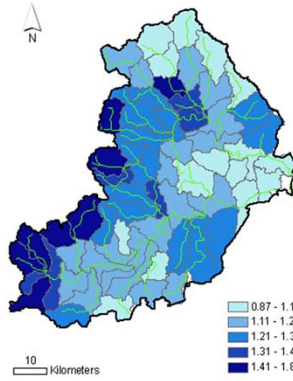
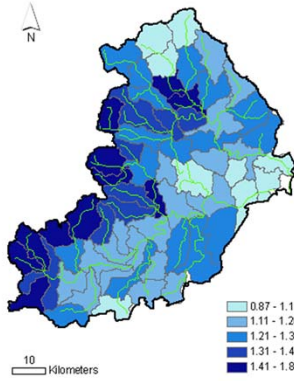
Bundled results

(water yield + P retention + Sediment retention)

Wet year

Normal year

Dry year

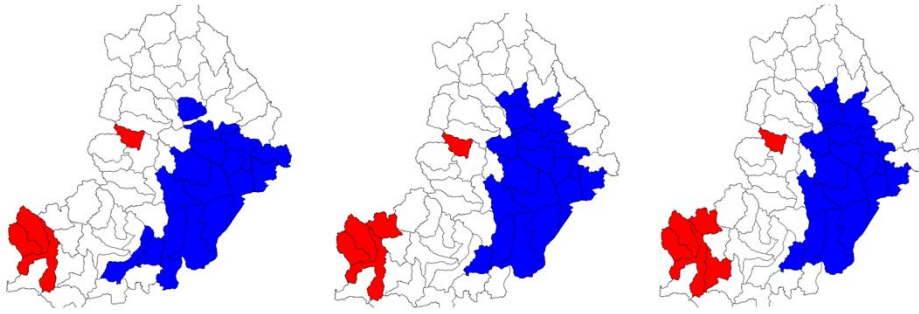


Bundled Services

Wet year

Normal year

Dry year



■ High-High ■ Low-Low

Stakeholder involvement



Stakeholder involvement

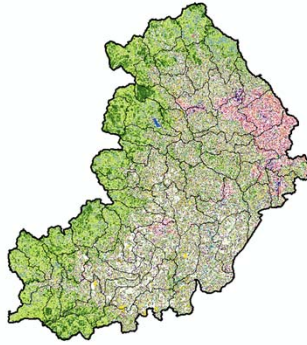


Future land cover scenarios (2040)

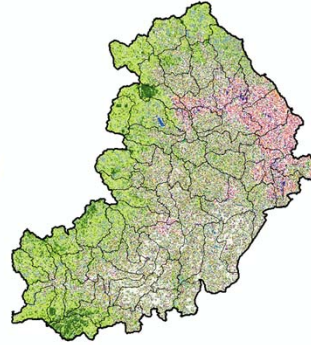
Plan trend



Conservation



Development

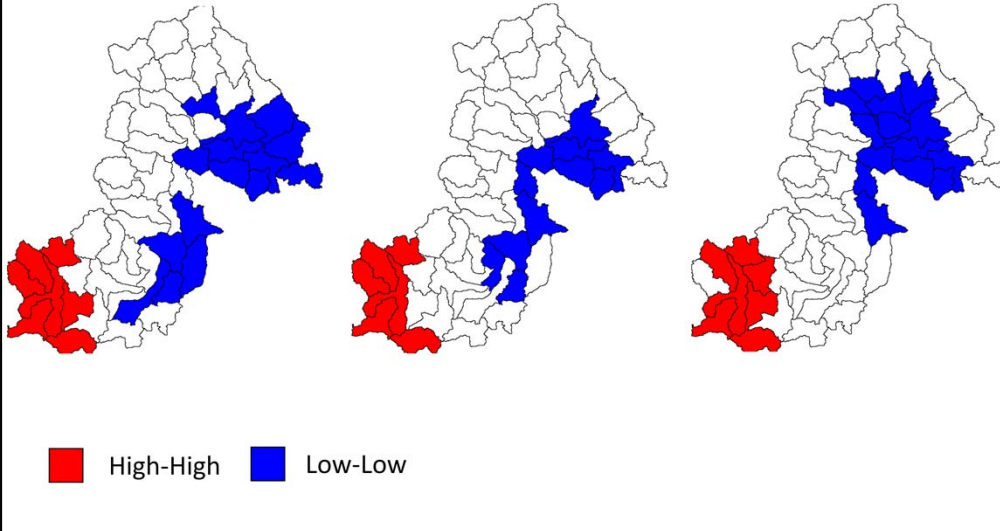


Water Yield (2040s, Development)

Wet year

Normal year

Dry year



Conclusions

1. Upper Yamhill sub-basins provide the most water yield and sediment retention, while lower valley areas have the highest phosphorus retention.
2. Climate change has either reduce or increase water yield and phosphorus retention depending on the direction of precipitation change.
3. Spatial patterns generally persist regardless of different climate regimes.
4. Bundling is a complex sociopolitical process and may not necessarily in line with biophysical modeling results.

Acknowledgements



Questions or comments: contact
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