UNIVERSITÄT BAYREUTH

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Bayreuth Center of Ecology and Environmental Research

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Land use and land cover change in mountainous watersheds: Consequences for ecosystem services of water yield and water quality

SWAT 2015

PULA / SARDINIA / ITALY

Background

Mountain landscapes & ecosystem services

- Mountains provide a wide range of services
- As “water towers” they ensure the supply of fresh water
- Headwater catchments are key elements for supply

The “Flying Dragon” waterfalls in the Seoraksan National Park, South Korea

Background

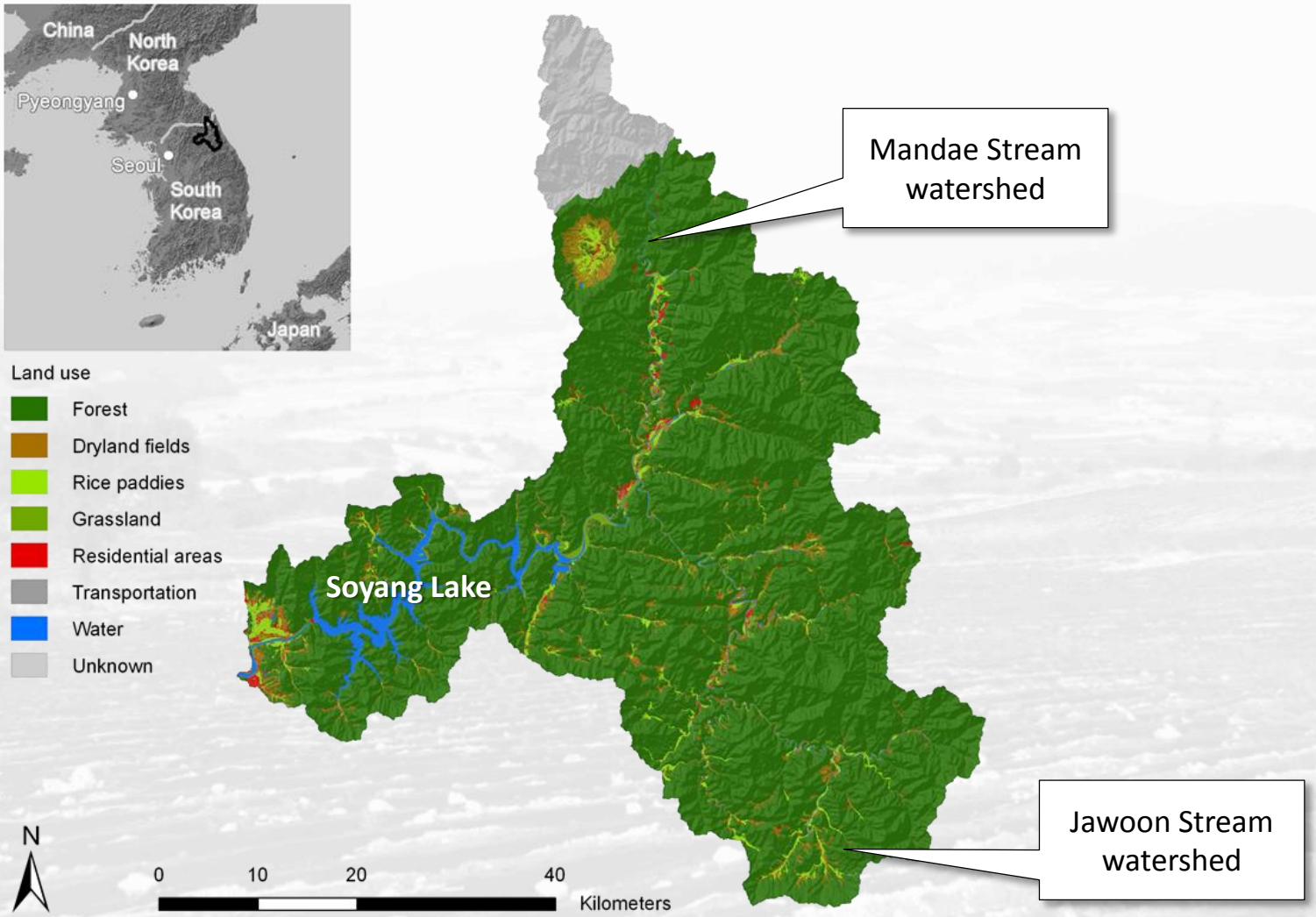
Mountain landscapes & ecosystem services

- Land use and land cover change alter the provision of services
- Urbanization, deforestation, and agricultural expansion degrade water regulation capacity
- Headwater catchments convert to water pollution “hotspots”

Highland cash crop cultivations are major sources of water quality degradation

Background

Mountain landscapes & ecosystem services



Land use & land cover change

Land use & land cover change

Population density

Conservation & protected areas

Distance & neighborhood

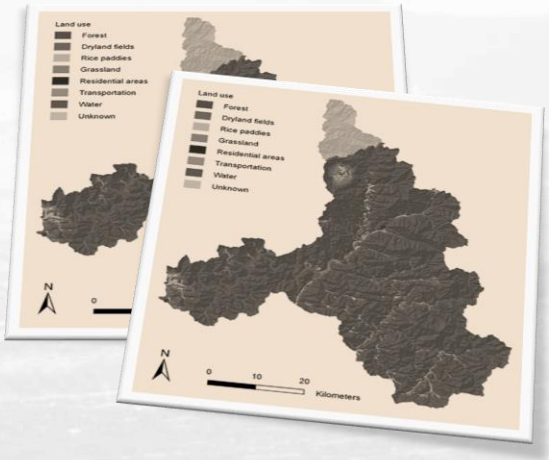
Terrain & climate data

Historical land cover maps

Economy & environ. policies

CA + LR

Land use & land cover change



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Water yield & water quality

Land use & land cover change

Environmental policy scenarios

- **No policy:** Current development trend without political interventions
- **Forest protection:** Restriction of forest conversion on high slope areas
- **Forest restoration:** Reforestation on high slope and elevation areas
- **Protection & restoration**

Dryland agriculture and rice paddies are primarily affected by environmental policies

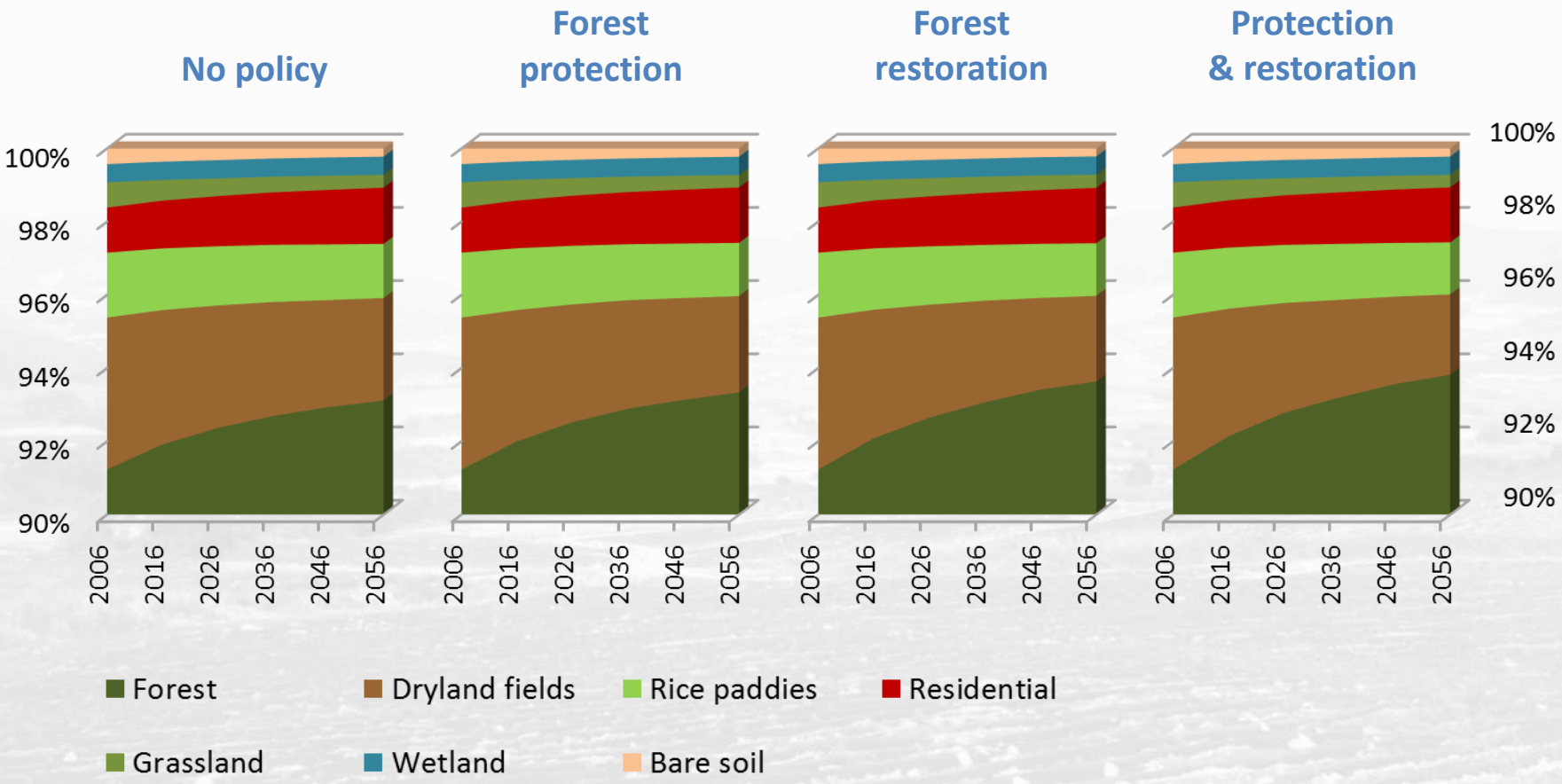
Land use & land cover change

Soyang Lake watershed

Land cover	Area 2006 (km^2)	Area 2056 (km^2)			
		No policy	Forest protection	Forest restoration	Protection & restoration
Forest	2333.0	2381.1	2386.8	2394.5	2399.2
Dryland fields	106.2	71.7	67.3	59.8	56.0
Rice paddies	45.4	37.9	37.2	36.8	36.4
Residential	31.4	39.2	38.7	38.6	38.4
Others	41.3	27.4	27.2	27.5	27.2

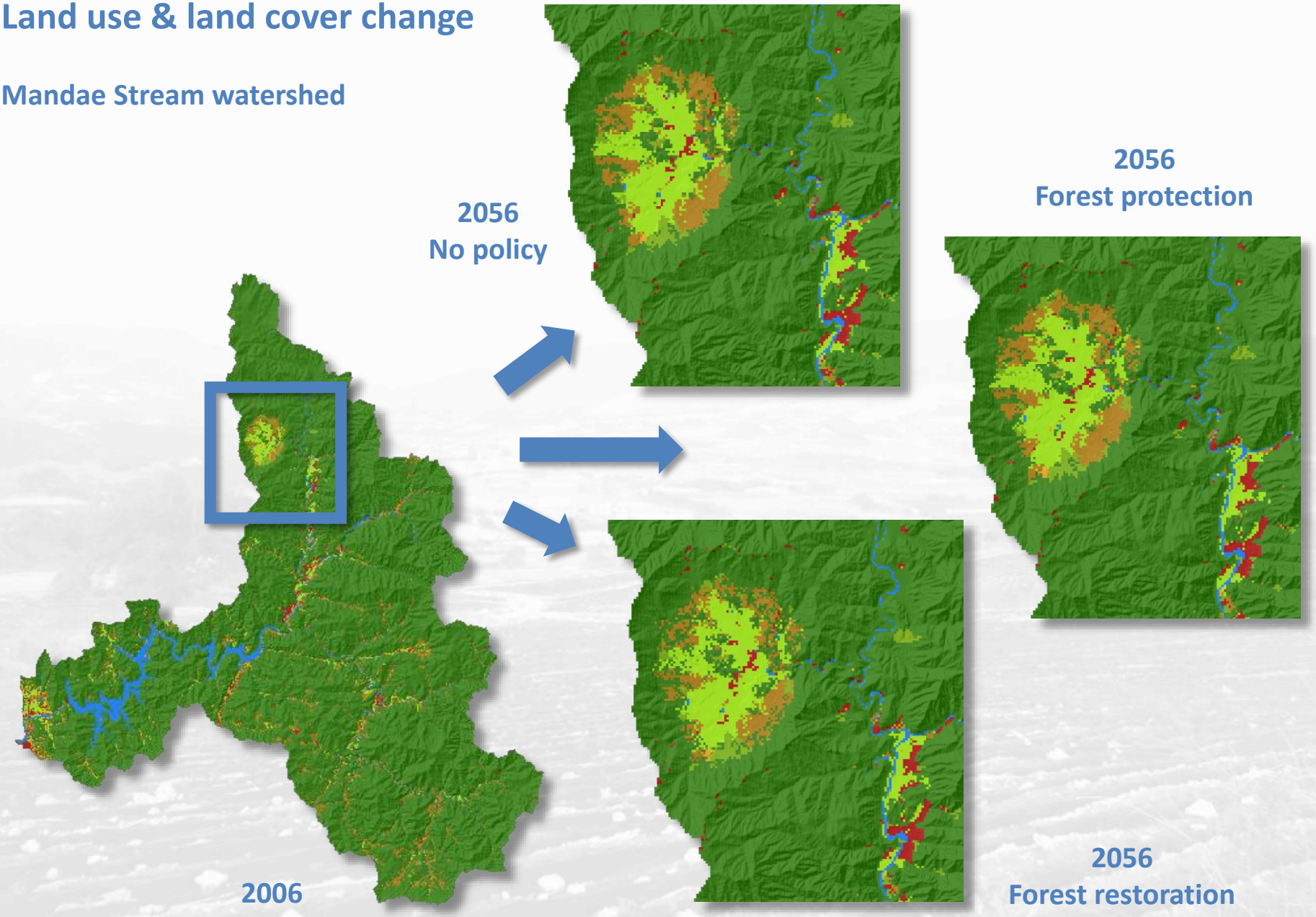
Land use & land cover change

Soyang Lake watershed



Land use & land cover change

Mandae Stream watershed



Water yield & water quality

Water yield & water quality

Economy & environ. policies

CA + LR

Land use & land cover change

Biophysical data

Climate

Topography

Soils

Land use & management

SWAT

Water yield & water quality

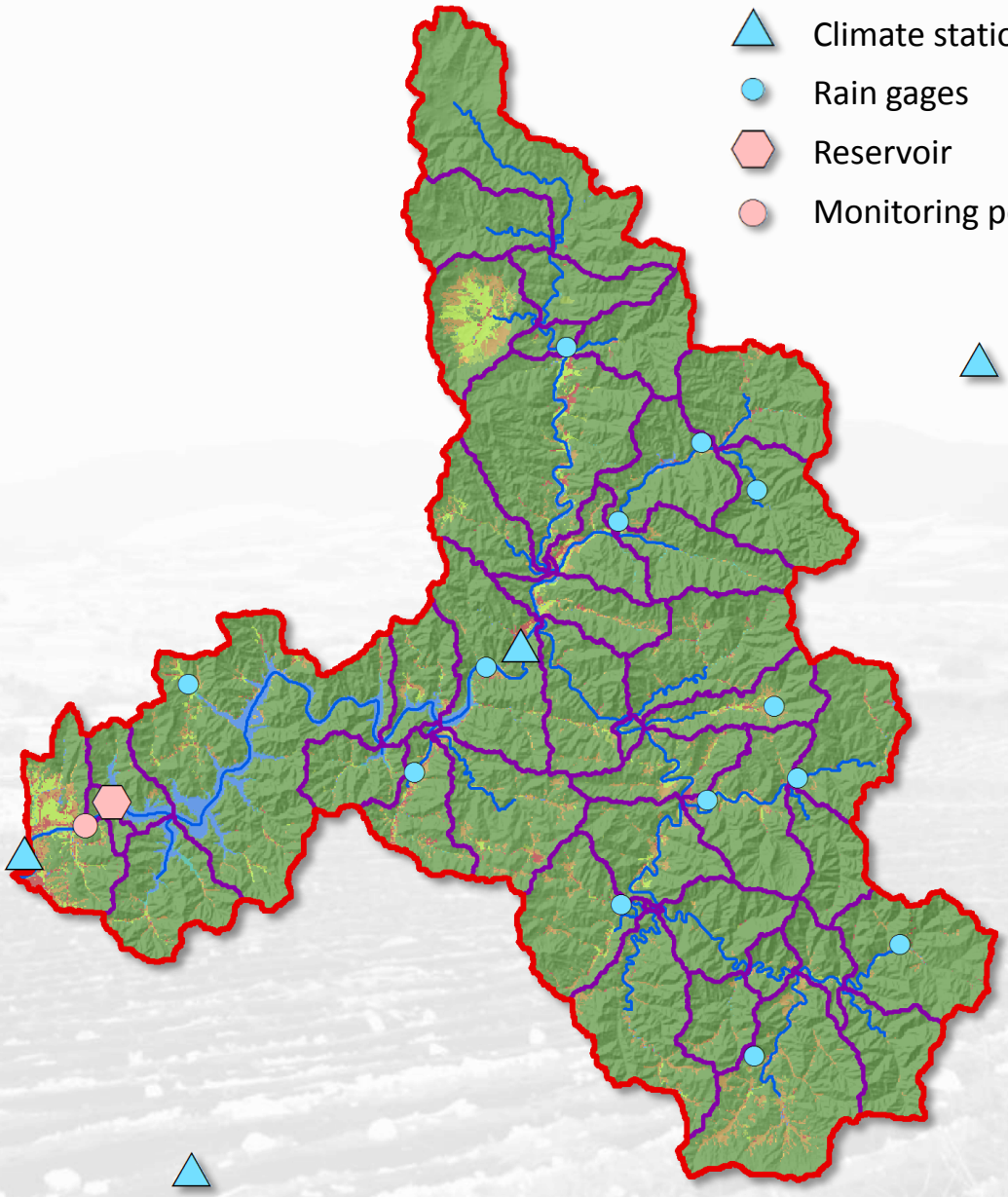
Water yield & water quality

Model setup

- 45 subbasins and ca. 3100 HRUs
- 6 climate stations and 19 rain gages
- 2 water monitoring sites

Simulation period

- 5 years with 2 years warmup
- Baseline 2005-2007



Water yield & water quality

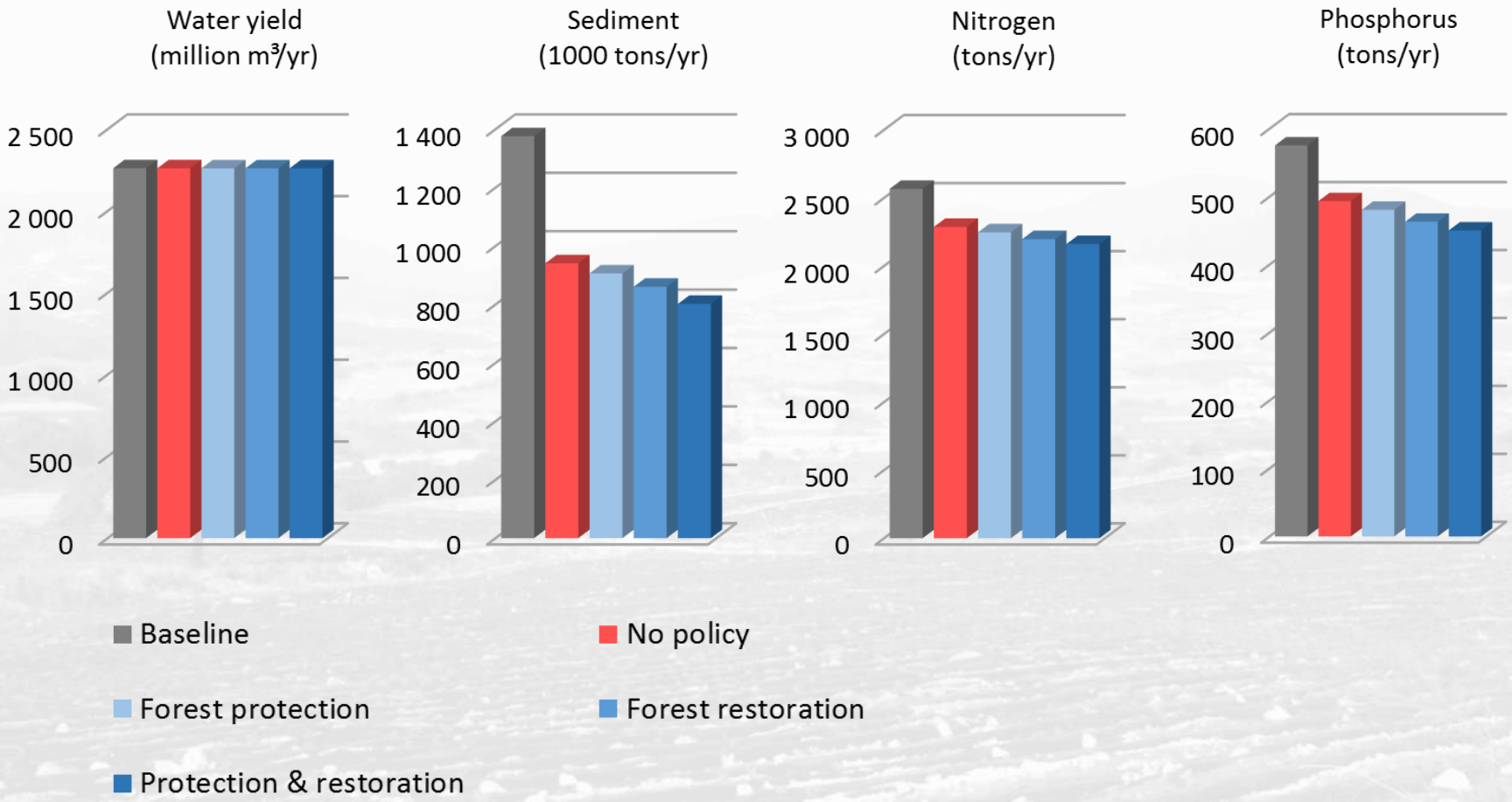
Calibration & validation

Parameter	Calibration (2005-2006)		Validation (2007)	
	P-factor	R-factor	P-factor	R-factor
Streamflow	0.73	0.30	0.77	0.34
Sediment	0.69	0.38	0.73	0.82
Total nitrogen	1.00	0.96	0.98	1.45
Total phosphorus	0.69	0.90	0.81	2.91

Typhoon “Ewiniar” approaching Japan and South Korea (Source: NASA)

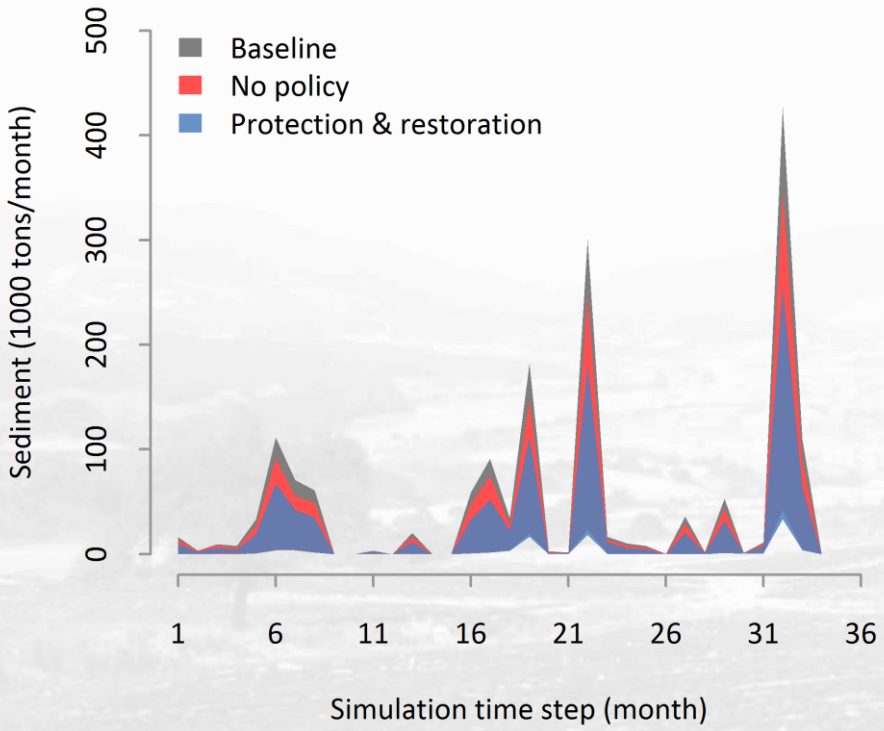
Water yield & water quality

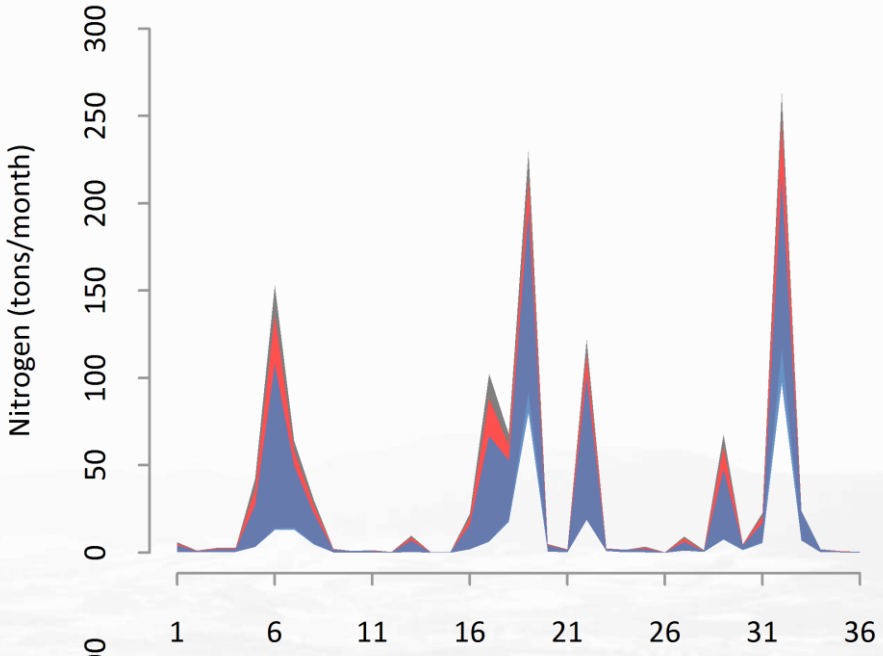
Soyang Lake watershed

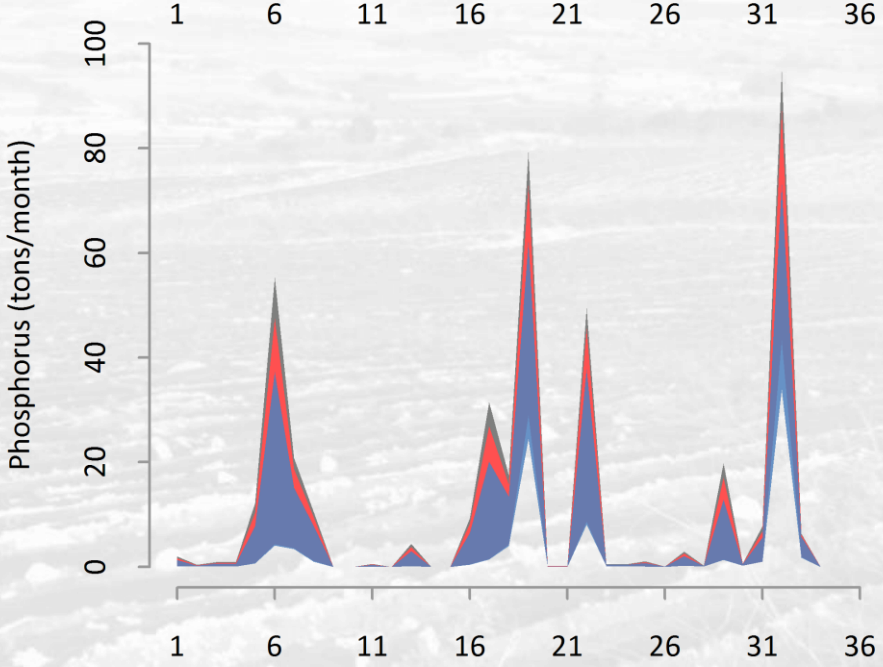


Water yield & water quality

Mandae Stream watershed







Conclusions & outlook

Land use & land cover change

- Urbanization and forest regeneration occur at the expense of agriculture
- Environmental policies strongly accelerate forest regeneration

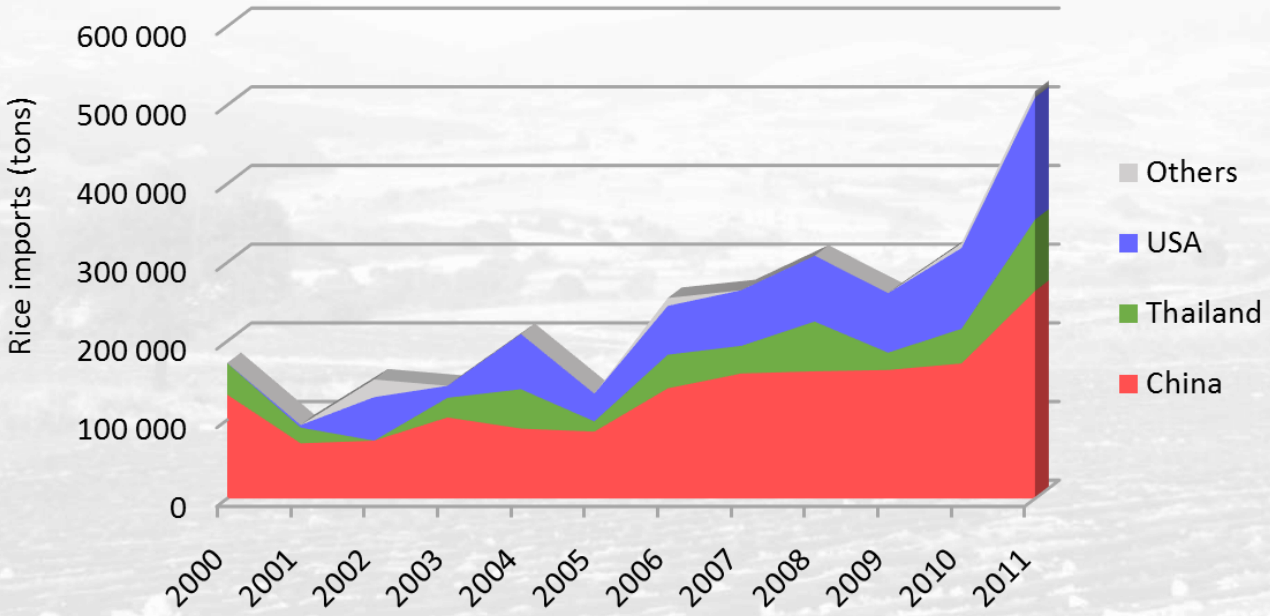
Water yield & water quality

- Streamflow and water supply remain stable under all policy scenarios
- Sediment, nitrogen, and phosphorus loads decrease considerably

Conclusions & outlook

Potential side effects

- Decline of agricultural production will lead to increasing imports of crop products
- Imports will translocate production and pressure on the environment to other regions

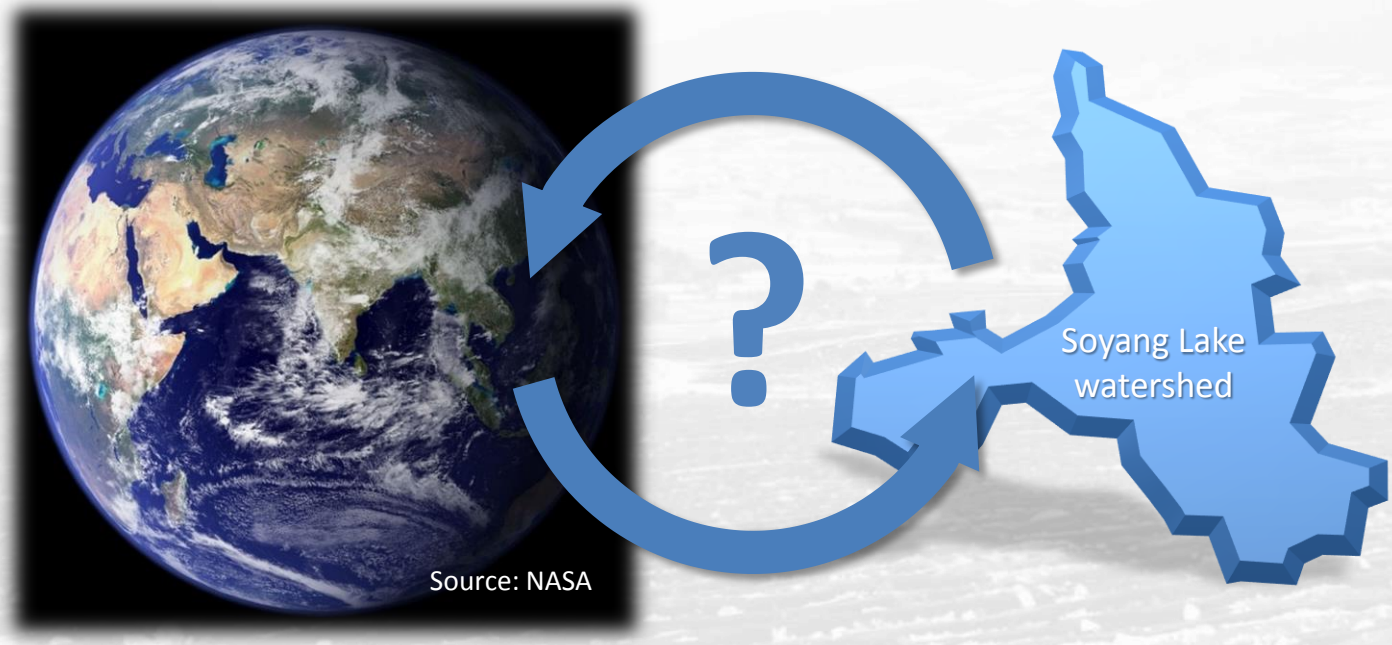


South Korean rice imports by country (Source: FAOSTAT)

Conclusions & outlook

Further questions

- How do policies displace land use and land cover change through global trade?
- How do displacements impact the provision of ecosystem services elsewhere?



Thank you !!!

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