XLII International School of Hydraulics
20 - 23 May 2025 • Radocza • Poland

Sediment yields estimation under climate change and land use impact of the upper catchment of the Tuul River Basin in Mongolia

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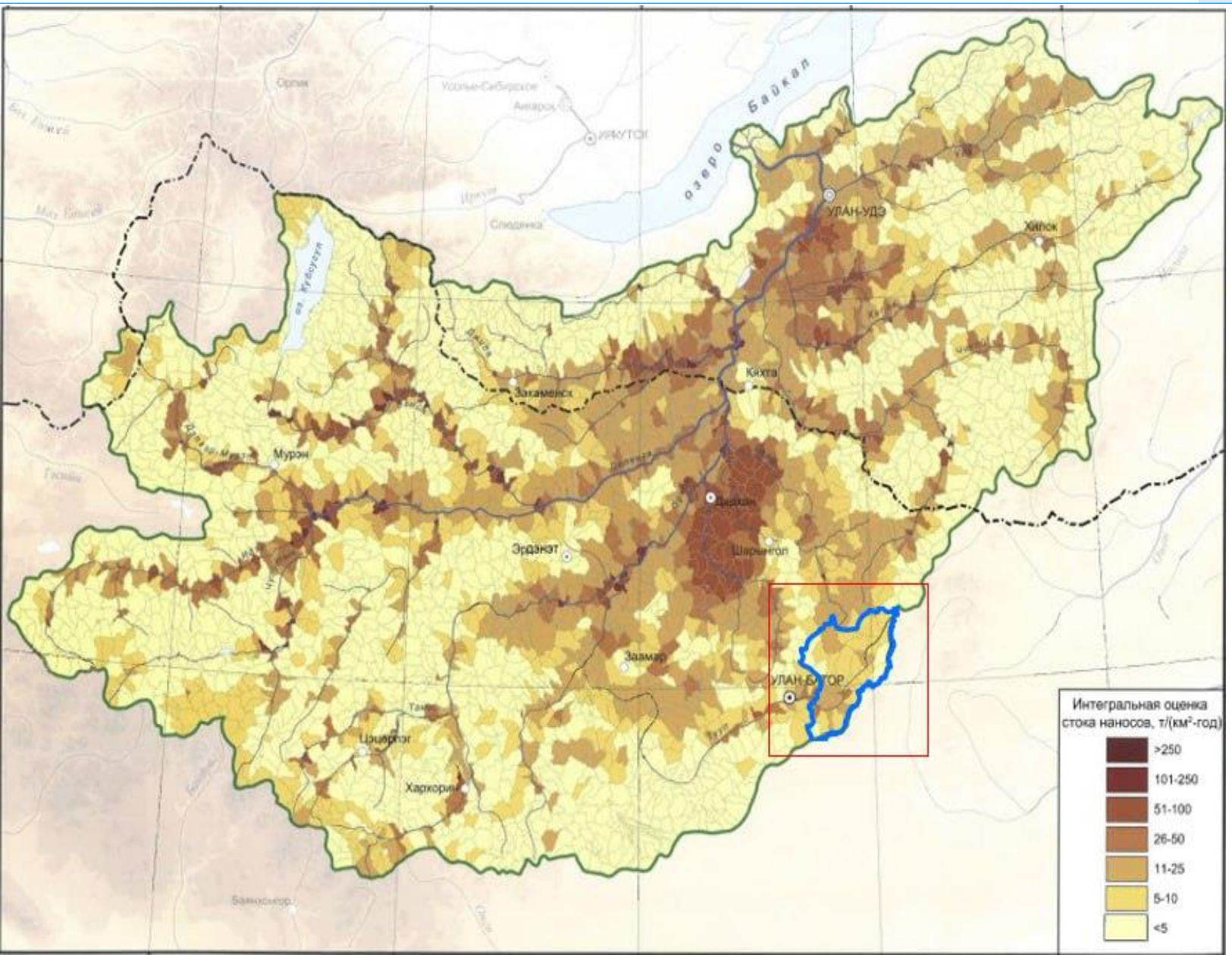
Introduction/Motivation

- The upper Tuul River Basin (TRB) is vital for Mongolia, hosting over half the population and accounting for over 60% of GDP.
- Climate change and land use shifts pose significant threats to the basin's sustainability and ecological health.
- Sediment yield (SY) is critical as increased sediment transport affects water quality, ecosystem health, and watershed management.

Introduction/Motivation

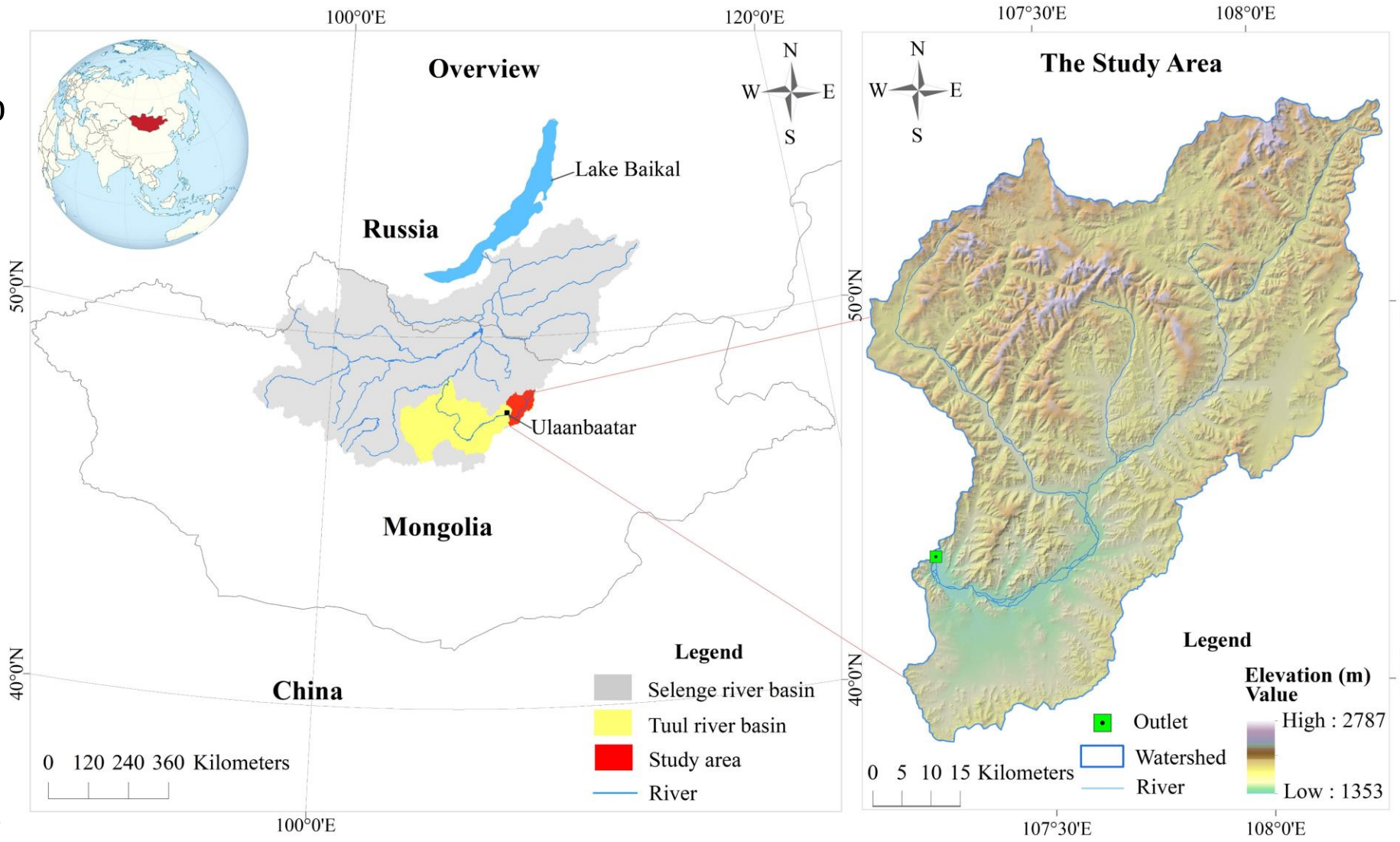


- Previous studies report sediment yield varying between 5 and 50 t/km^2/year, highlighting the need for precise estimations.

(Kasimov, et al., 2019)

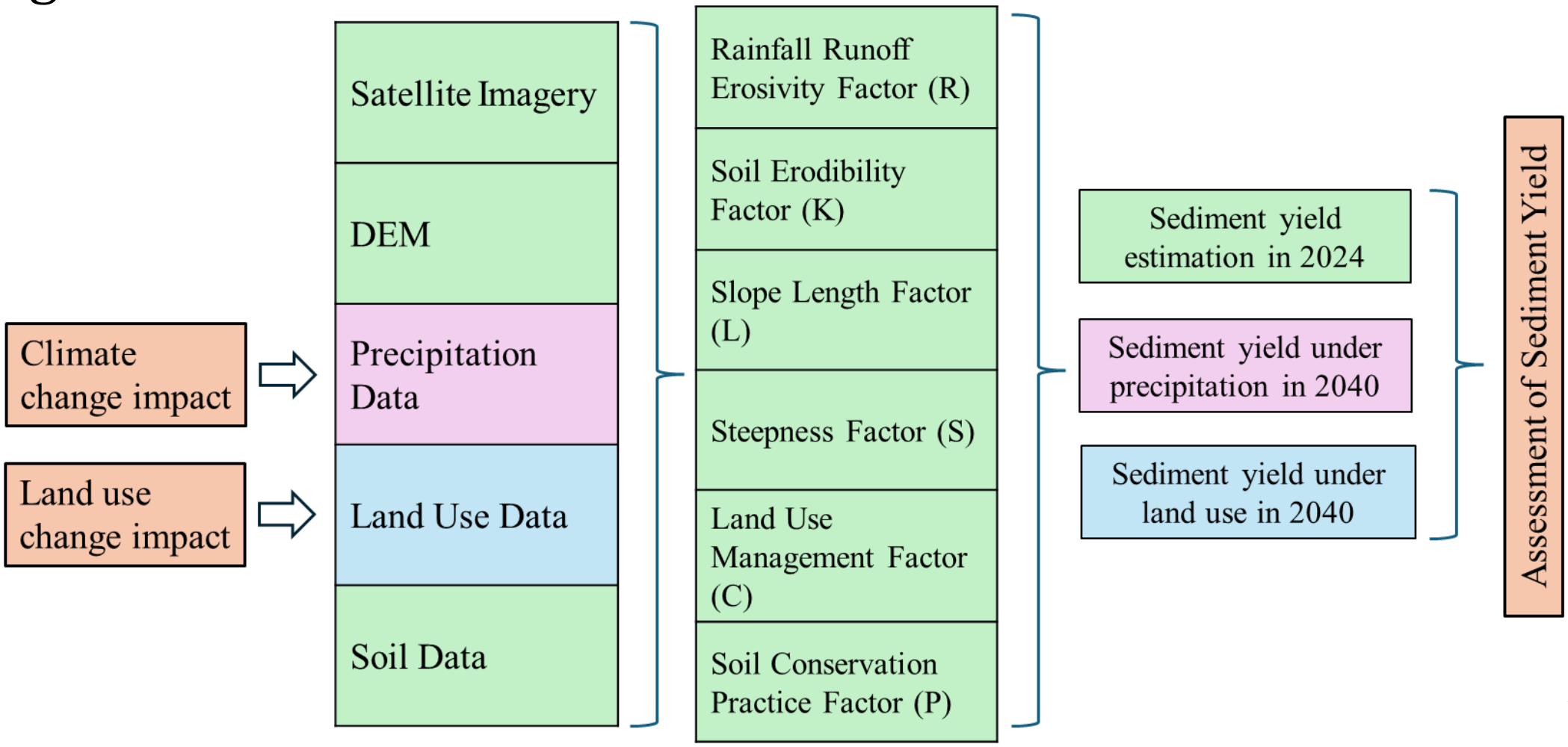
The study area

- 5,319 km²
- Origin of runoff: 69% rainfall, 25% groundwater, 6% snowmelt.
- summer rainfall-driven hydrological regime.
- Gorkhi-Terelj National Park and Khan Khentii Strictly Protected Area.
- traditional livestock grazing, tourism, and forest reserves.



Methods

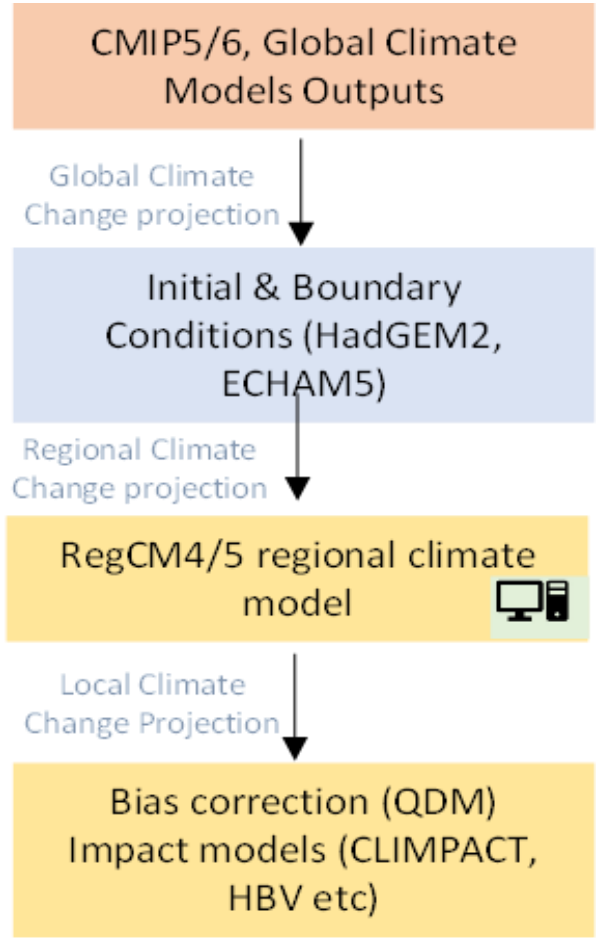
- Utilized the Revised Universal Soil Loss Equation (RUSLE) model integrated with GIS: $A = R \times K \times LS \times C \times P$



Methods

- Climate change impacts derived from CMIP5/6 models, regional climate models (RegCM4)

Stages of downscaling for future climate change projections



Regional climate model
Statistical model
Estimating climate extremes

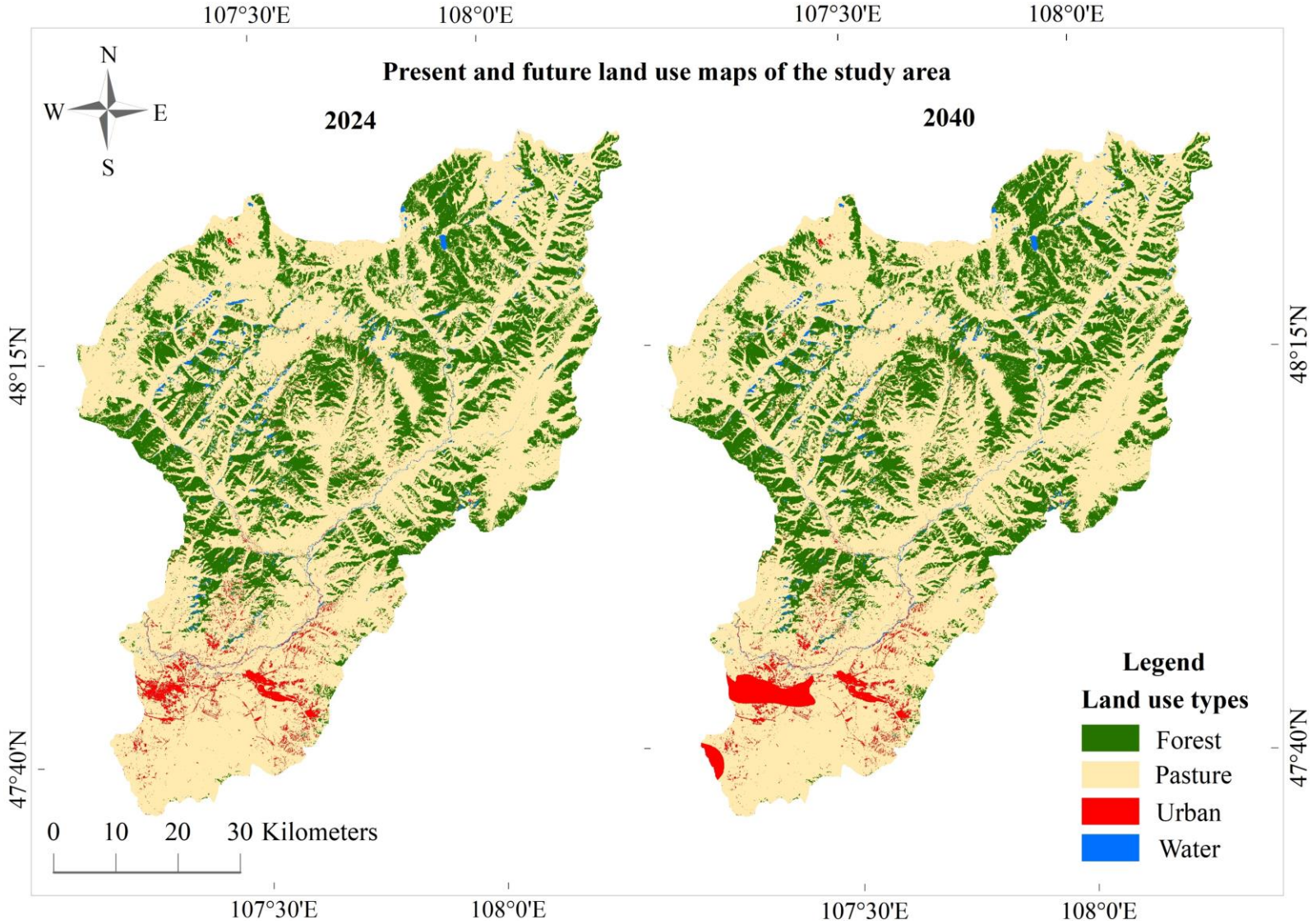
Data

- Data sources: DEM, soil data, land cover maps, and rainfall data from meteorological stations and satellite imagery.

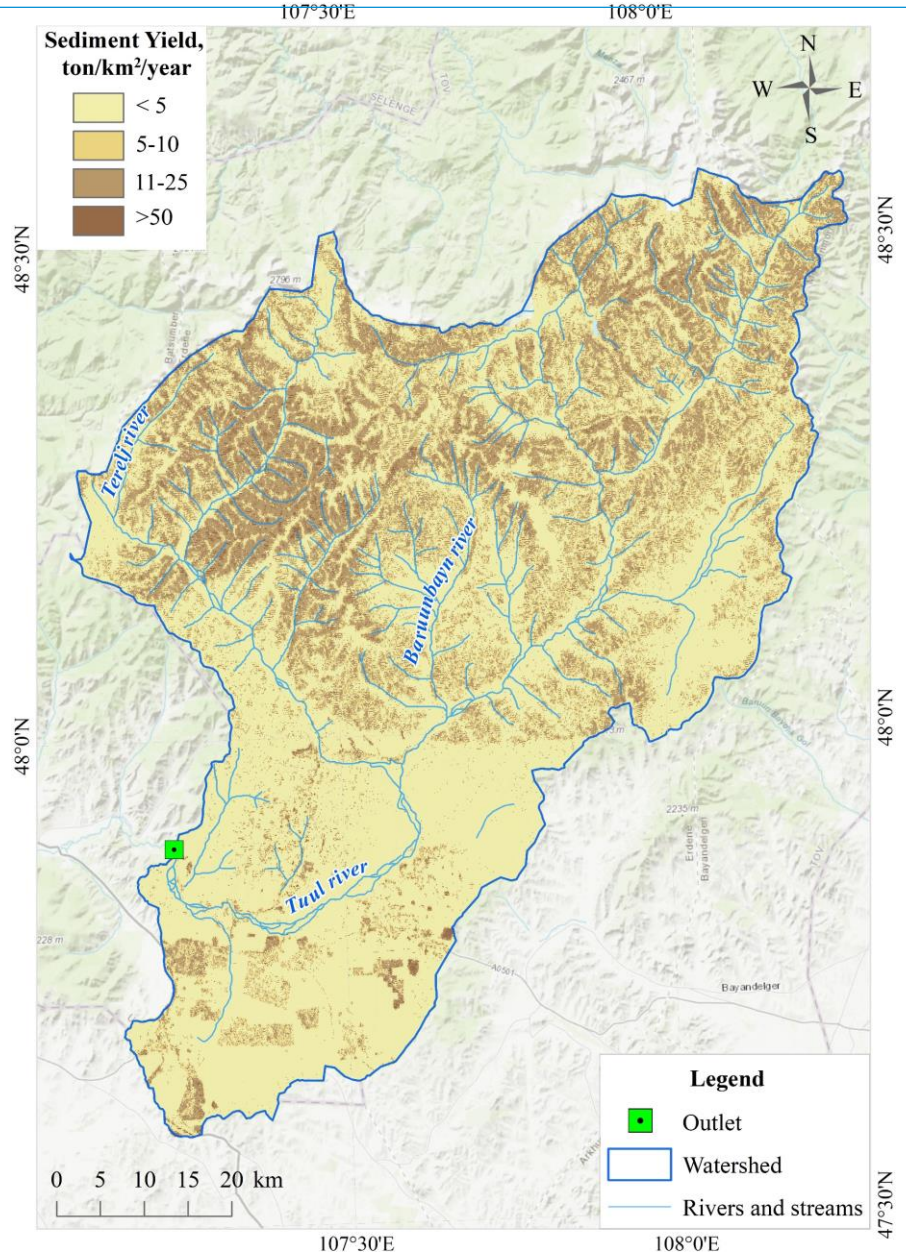
Data	Date	Resolution	Source
DEM	2024	30 m × 30 m	https://earthexplorer.usgs.gov/
Soil	2024	1 km × 1 km	https://www.fao.org/soils-portal/data-hub/soil-maps-and-databases/harmonized-world-soil-database-v20/en/
Land cover	2024	10 m × 10 m	https://livingatlas.arcgis.com/landcover/
Rainfall	2024	30 m × 30 m	Using data from regional meteorological stations, Dr. G. Davaa calculated the amount of precipitation in the Tuul River Basin using the HadGEM.RegCM4 model.

Data

- Land cover changes (Dolgorsuren, et al., 2024)

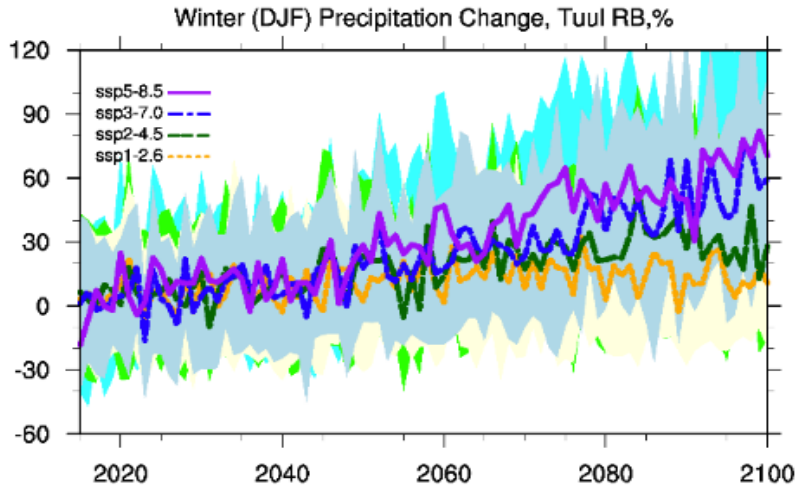


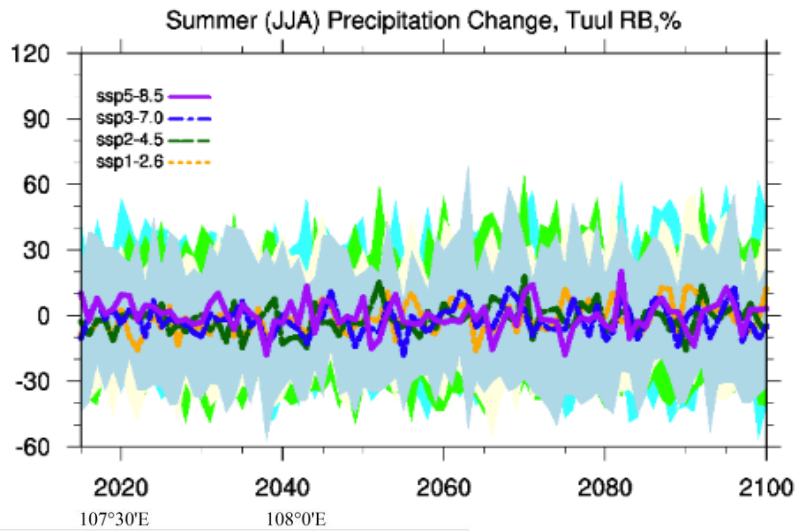
Results – Current SY

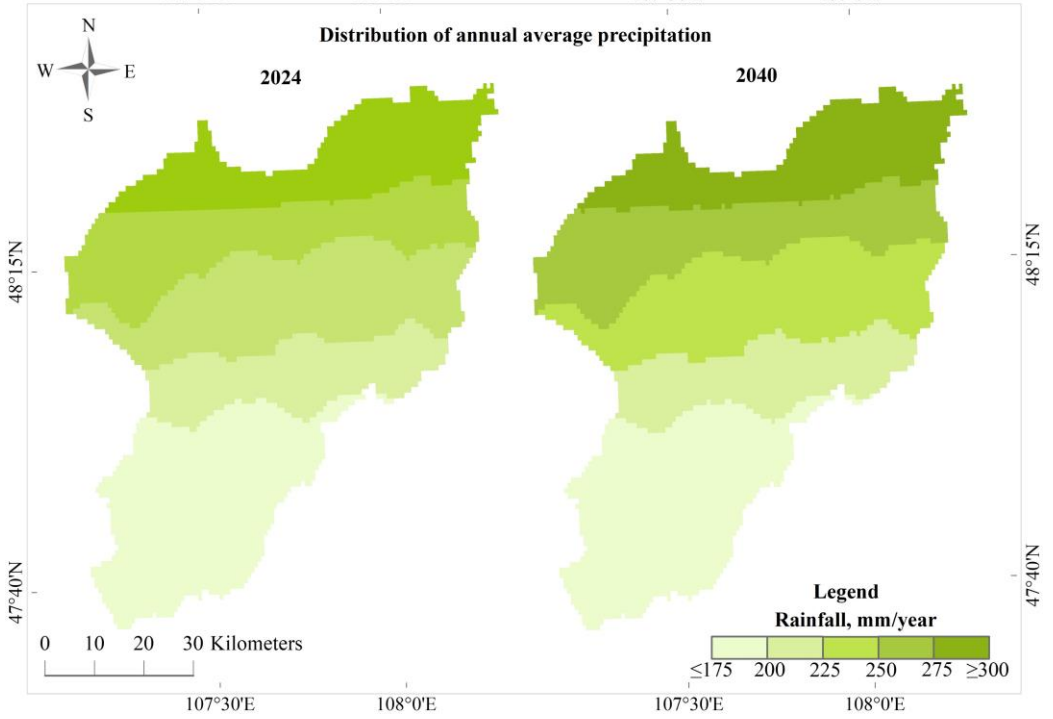


- Sediment yield (SY) range:
  - 52.8% area: 0~5.1 t/km²/year
  - 39.3% area: 5.1~17.8 t/km²/year
  - 7.9% area: 17.8~70.5 t/km²/year
- Spatial averaged SE: 9.4 t/km²/year
- Results align with regional estimates (5~50 t/km²/year).

Results | CC Impact by 2040

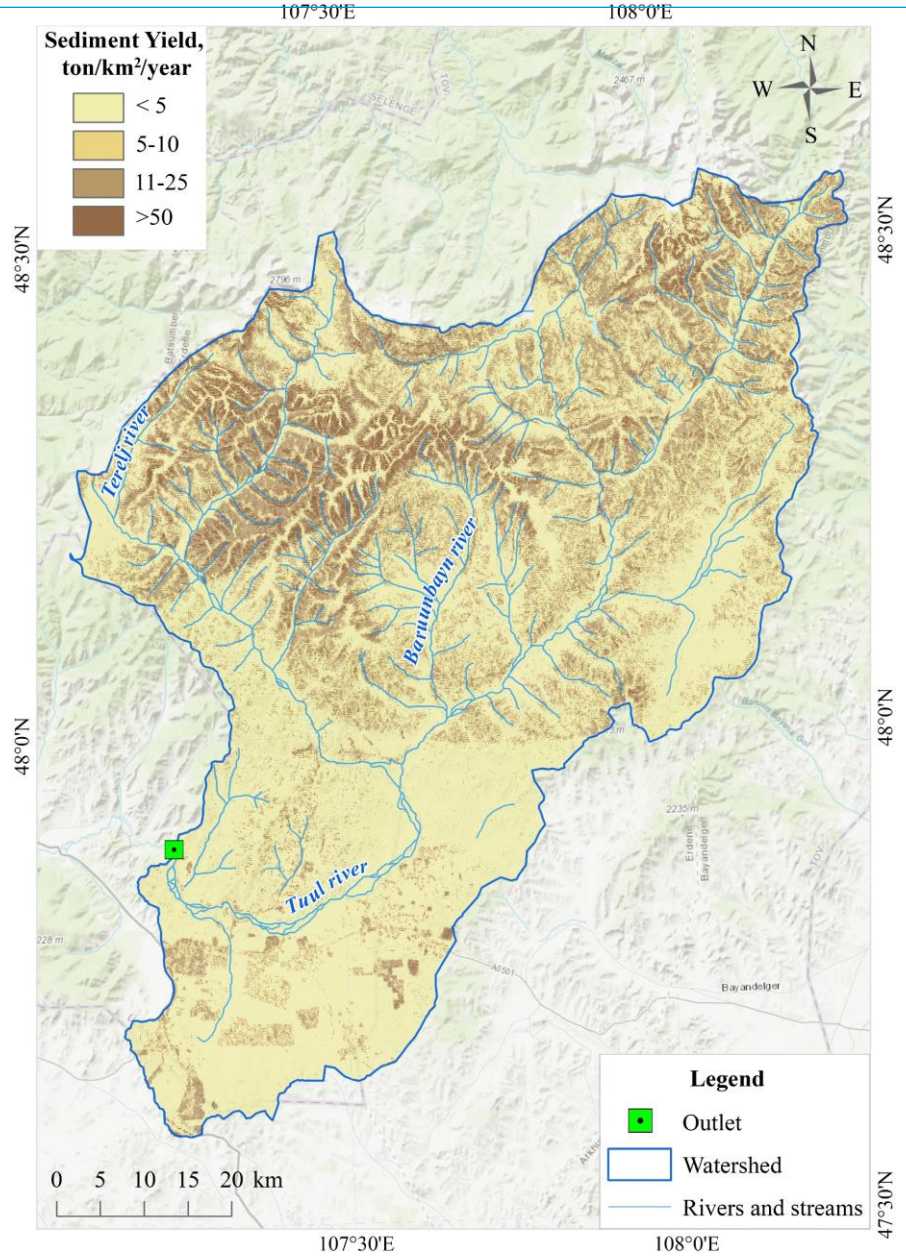






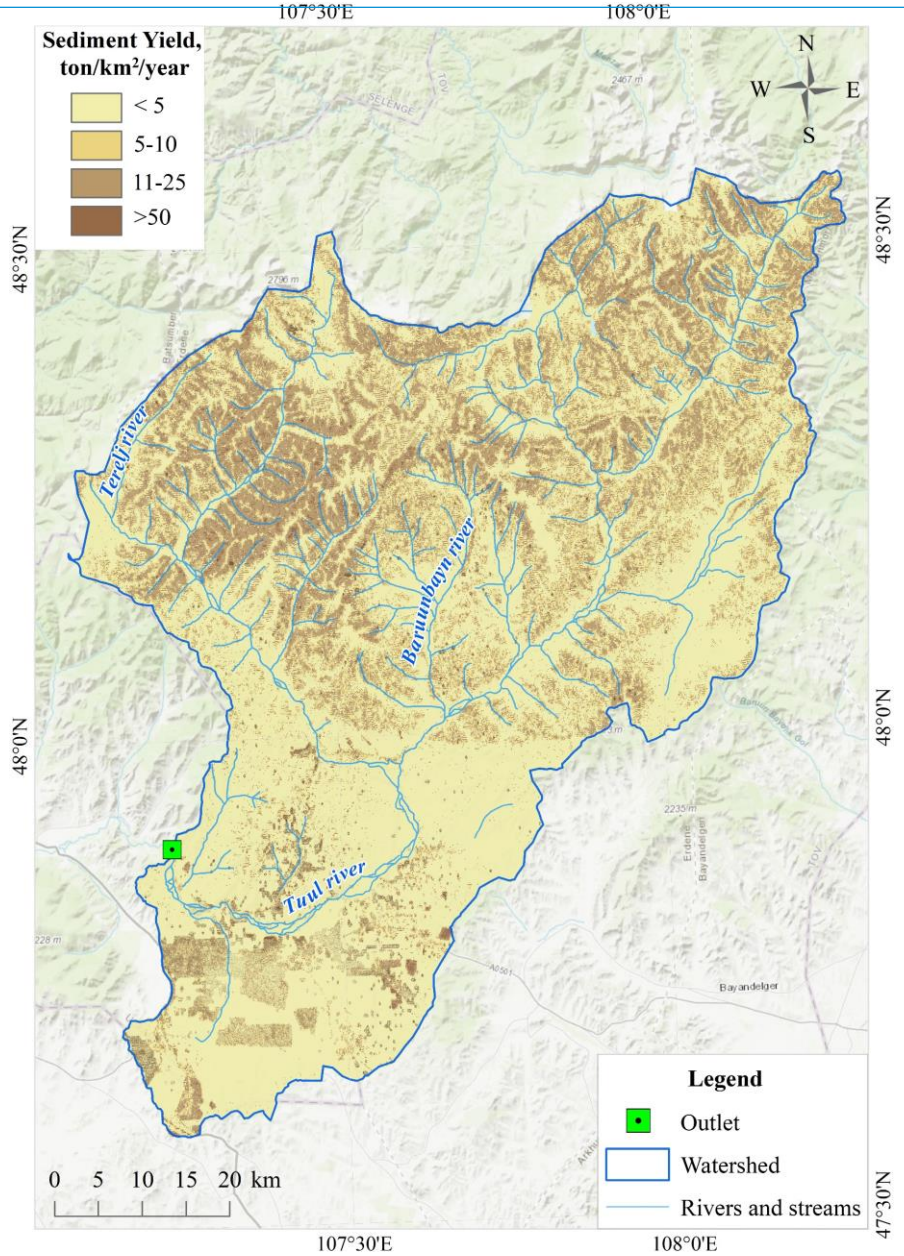
- Projected precipitation changes by season:
  - Winter: +60.0%
  - Spring: +25.9%
  - Autumn: +27.8%
  - Summer: decrease up to 5.3% or increase by 2.3%
- Overall precipitation increase projected between 33~37%.
- Increased intensity of rainfall expected to enhance erosion significantly.

Results | CC Impact by 2040



- Sediment yield range:
  - 50.6% area: 0~5.8 t/km²/year
  - 41.4% area: 5.8~20.2 t/km²/year
  - 8.0% area: 20.2~117.0 t/km²/year
- Spatial averaged sediment yield: 12.3 t/km²/year

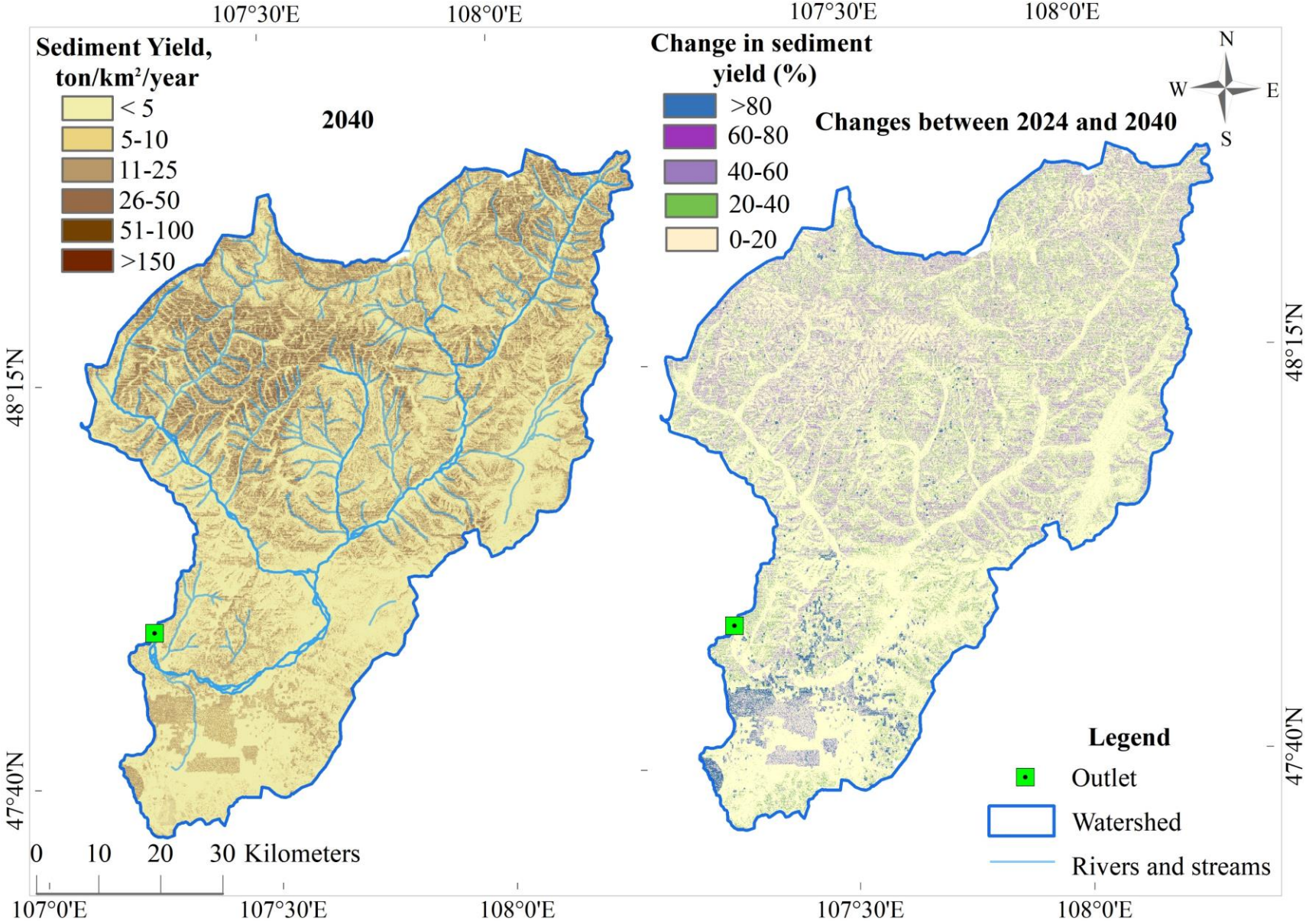
Results | LU Impact by 2040



- Sediment yield range:
  - 54.8% area: 0~5.9 t/km²/year
  - 37.2% area: 5.9~25.8 t/km²/year
  - 8.0% area: 25.8~157.0 t/km²/year
- Spatial averaged sediment yield: 14.8 t/km²/year

Results | CC + LU impacts

Title: Sediment yields estimation under climate change and land use impact of the upper catchment of the Tuul River Basin in Mongolia



- Sediment yield range:
  - 55.1% area: 0~6.2 t/km²/year
  - 36.7% area: 6.2~27.3 t/km²/year
  - 8.2% area: 27.3~168.0 t/km²/year
- Spatial averaged sediment yield: 16.5 t/km²/year

Discussions|CC + LU impact

- Significant implications for water resource management, ecological integrity, and urban planning.
- Critical areas include urban expansion zones and tourist-driven developments, especially near sensitive ecological zones.
- Increased precipitation variability and intensity demand adaptive water management strategies.

Factor of Changes	2024	2040	Percent of changes, %
	9.4		
Precipitation changes		12.3	31
Land use changes		14.8	57
Combined impact		16.5	76

Conclusions

- Sediment yield expected to significantly increase by 2040 due to climate change and land use intensification.
- Highest risk driven by urban expansion and increased rainfall intensity.
- Recommendations:
    - Implement comprehensive land and water management plans.
    - Enhance vegetative cover, establish green spaces, enforce paving standards.
    - Address gully erosion, protect vulnerable regions proactively.

Questions are appreciated.

Thanks for your attentions!