The structure and content of the GIS 'Hydrological and environmental safety of the Selenga river basin'

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Scientific challenge

- Global climate change has substantially affected hydrological processes in the Baikal Lake basin.
- The runoff of Selenga river is the key factor for the stability of the Baikal ecosystem, since it gives up to 50% of water runoff and more than 50% of chemical runoff to the lake.
- An important feature of the Selenga river basin is its transboundary position, since two thirds of the basin area is located in Mongolia.

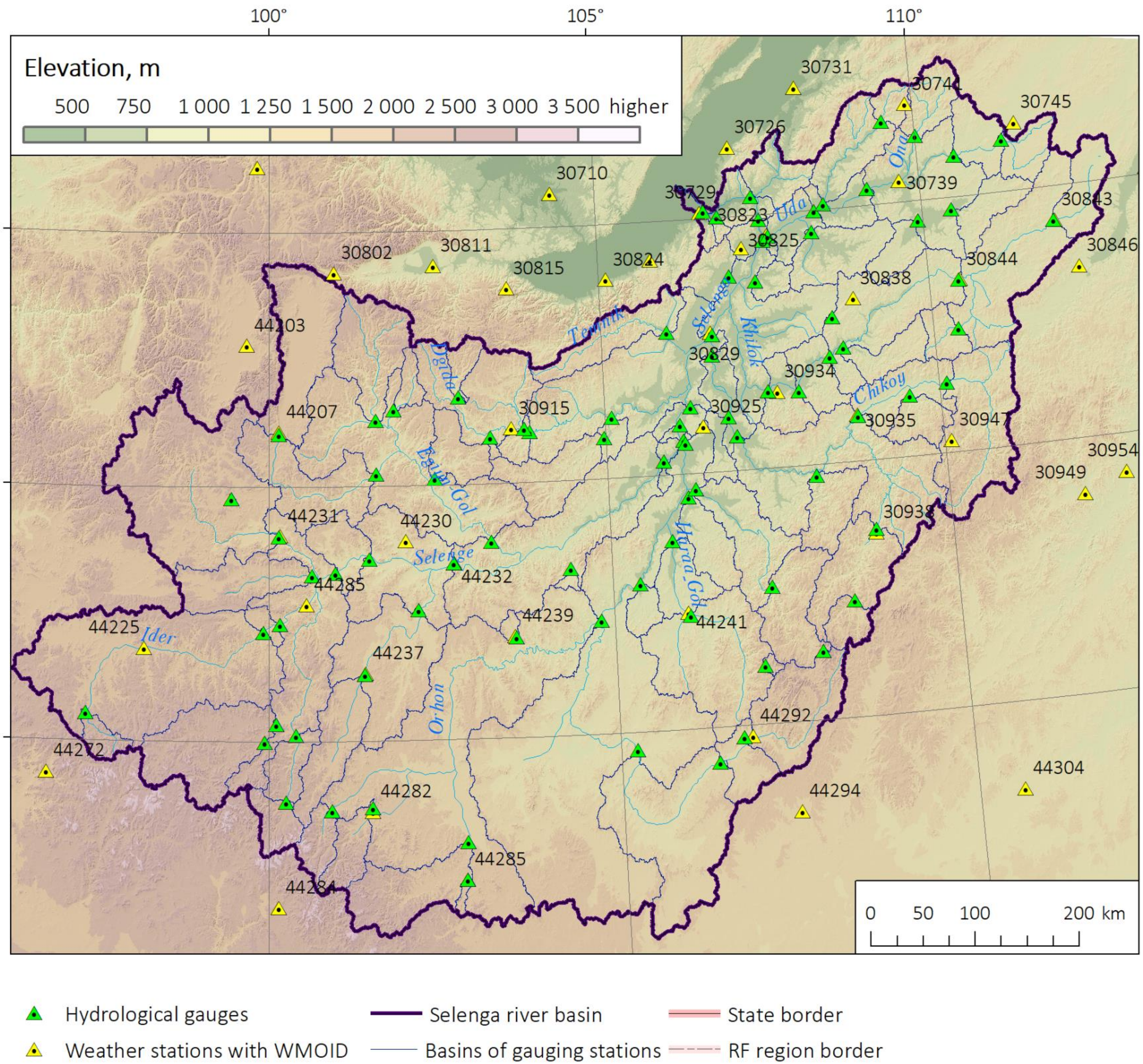
Aims of the study

- Develop a web-GIS that integrate the data of long-term hydrological and environmental observations in Selenga river basin, publish it in user-friendly interface and improve the its analysis
- Provide GIS-based support both scientific research and decision making in this area.

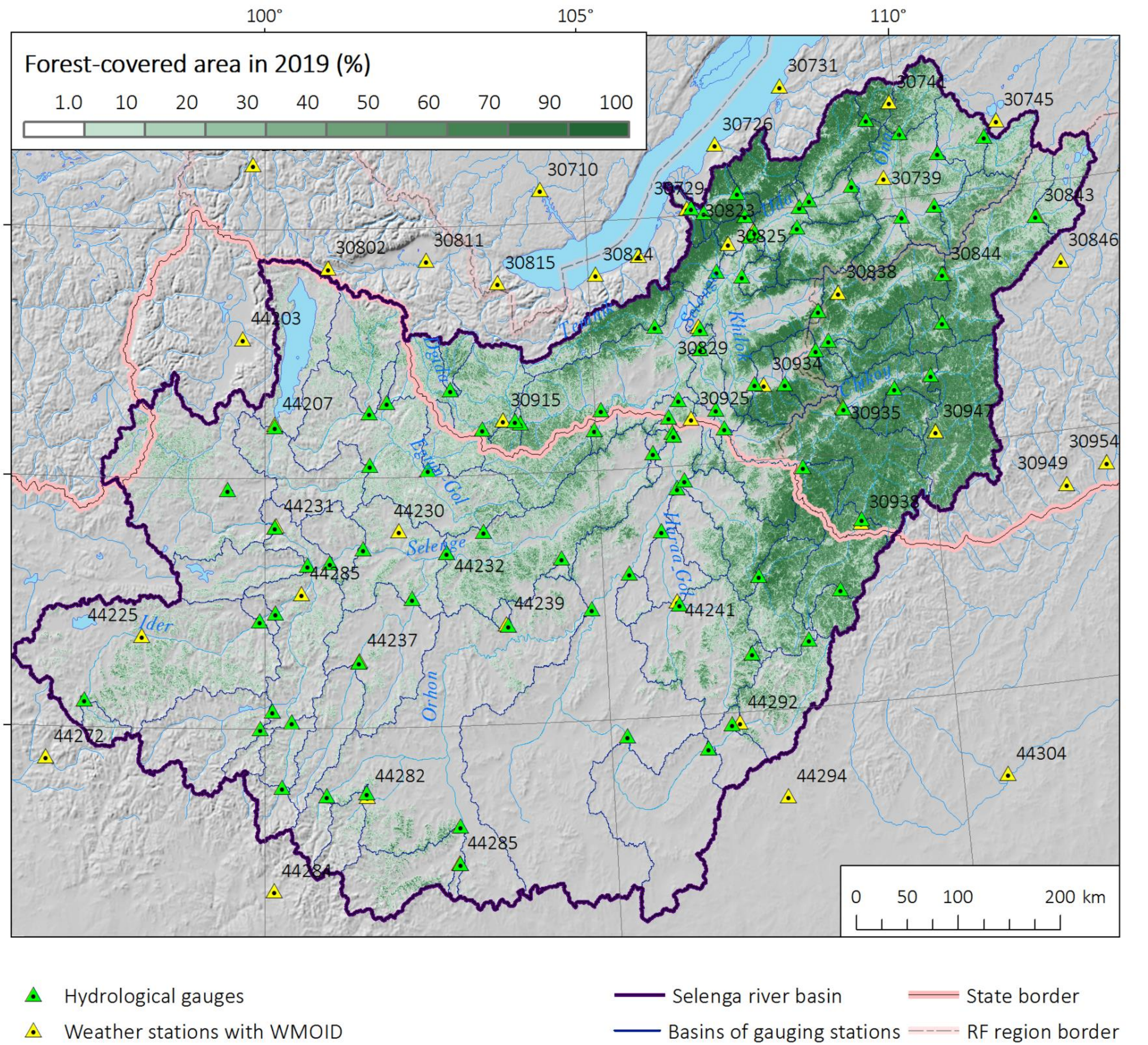
Structure of the online web map service

- The structure of the online web map service will include three main thematic sections
- Climatic characteristics (average and extreme)
- Hydrological characteristics (according to long-term observations data)
- Hazardous hydrological events and their impact on the settlements and infrastructure (database of hazardous hydrological events, related channel processes, and flooded areas delineated based on high-resolution DEMs).

Selenga river basin (DEM, and observation network and basins of gauging stations)



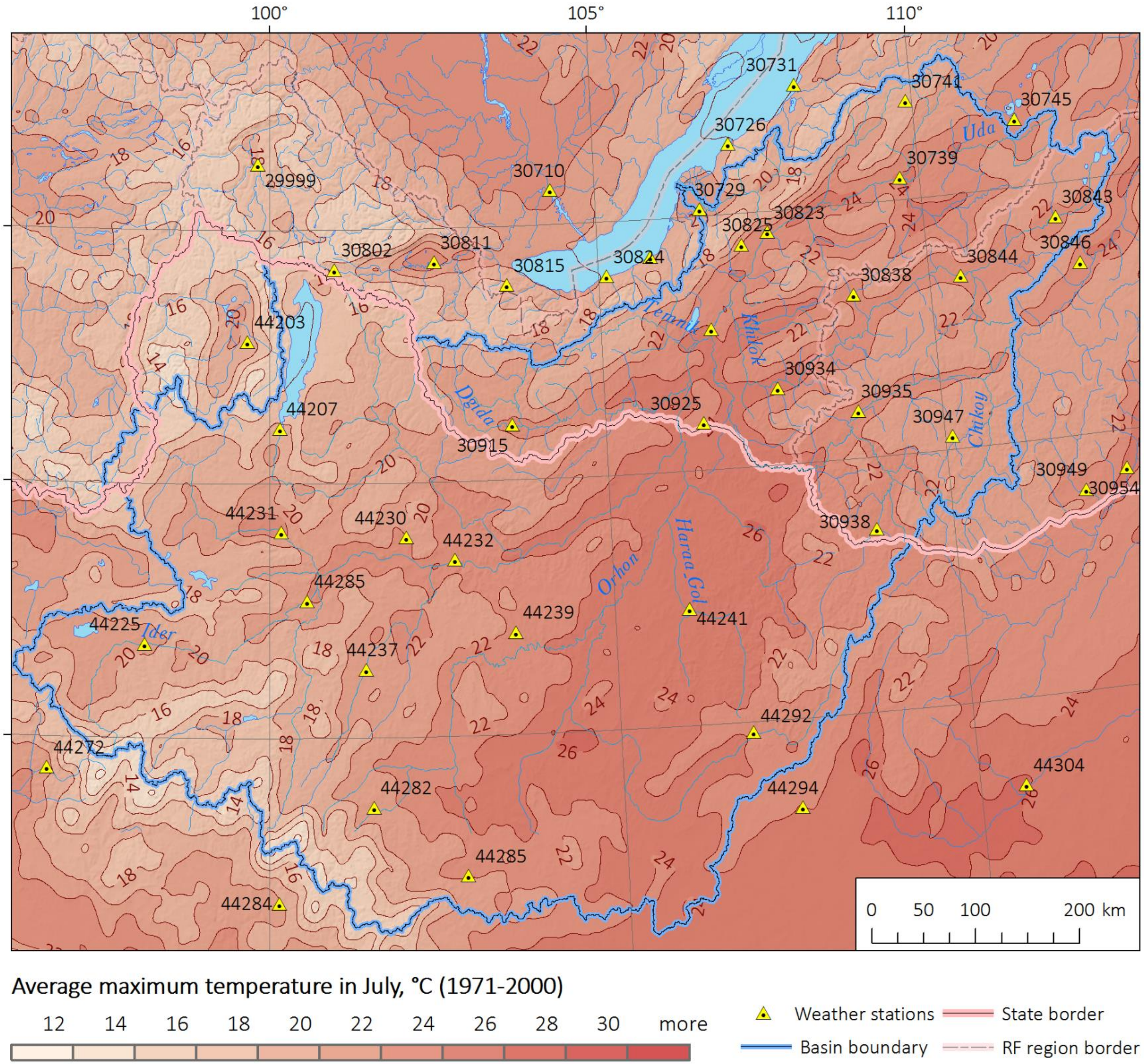
Selenga river basin (forest-covered area in 2019 according to Global Forest Change dataset)



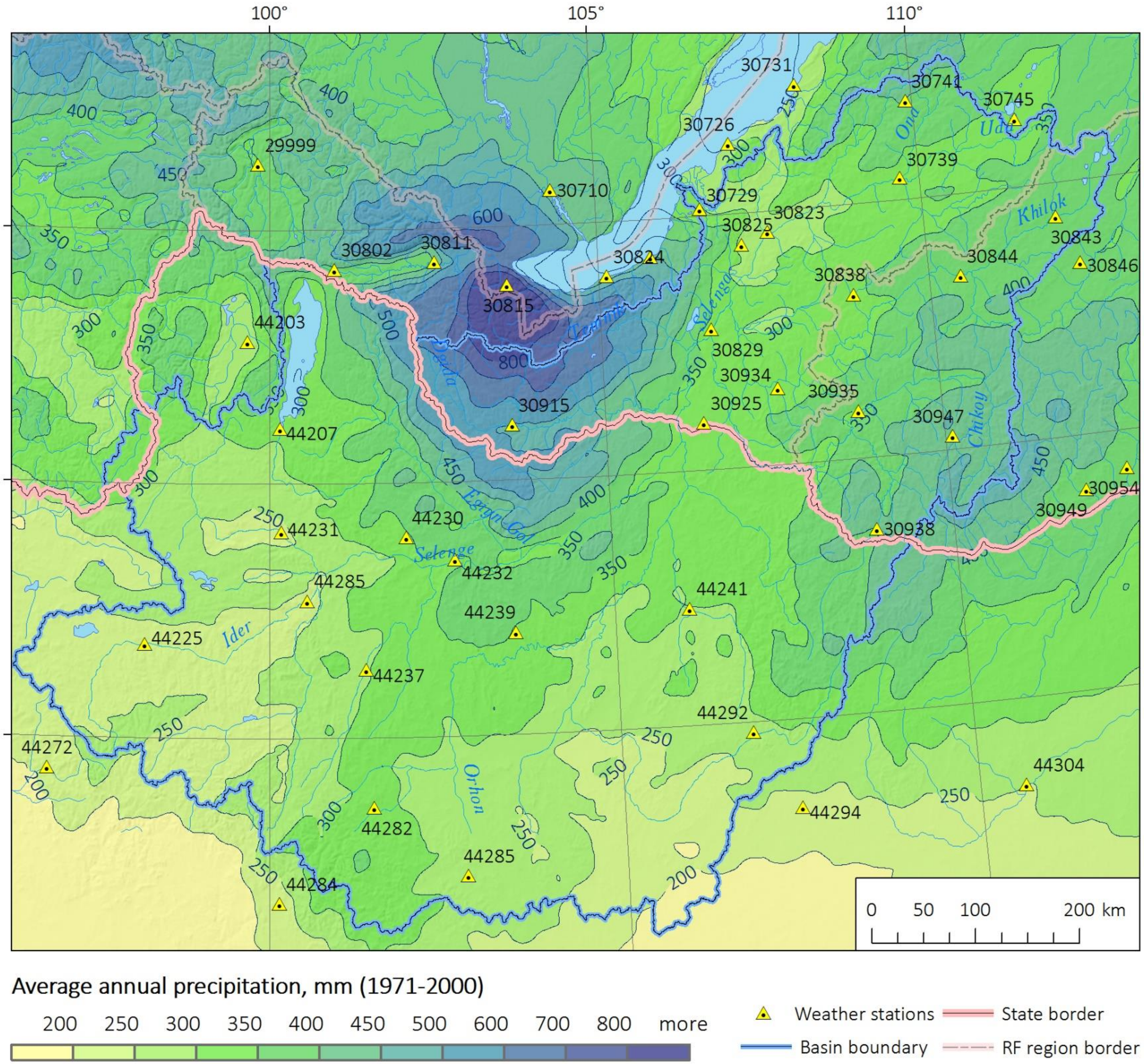
Climate data

- Historical climate data (mean values for 1971-2000) – solar radiation, min/max air temperature and humidity, precipitation, wind speed, bioclimatic variables – with 30’’ (~1 km) spatial resolution
- Historical monthly weather data (min/max air temperature, precipitation) for 1960-2018 with 2,5’ (~5 km) spatial resolution
- Temperature and precipitation extremes (indices) – the data for the entire observations period, maps for 1961-1990
- Full data from basic (climatic) weather stations of Roshydromet (temperature, precipitation, wind speed, cloud cover, snow cover, hazardous events) – only for Russian part of the basin

Average annual temperature in July according to Worldclim data)

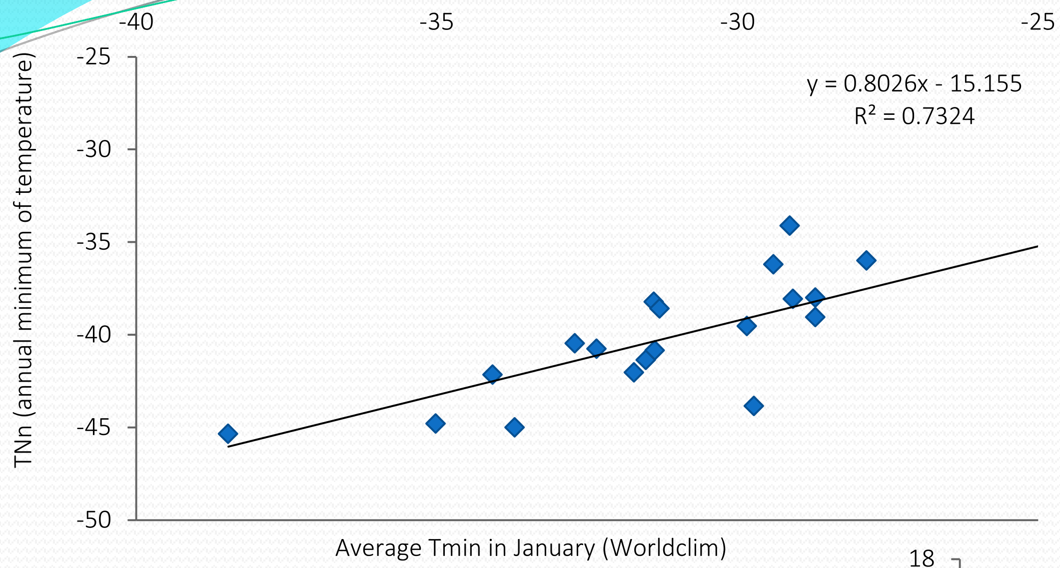


Average annual precipitation amount according to Worldclim data)



Climate extremes mapping

- CLIMDEX, Global Historical Climatology Network Daily dataset (53 weather stations located within Selenga river basin and outside it) has been used as input. The data are complete only for 1961-1990.
- No data available for most of weather stations in Mongolia
- Two methods have been implemented to interpolate the data
- Interpolation with single variable regression. Average climatic values (T_{min} in January, T_{max} in July, precipitation amount in summer months) calculated from WorldClim2.0 data were independent variables
- Multiple linear regression. Latitude, longitude, elevation and average values of temperature and precipitation (calculated from WorldClim2.0 data have been used as independent variables.

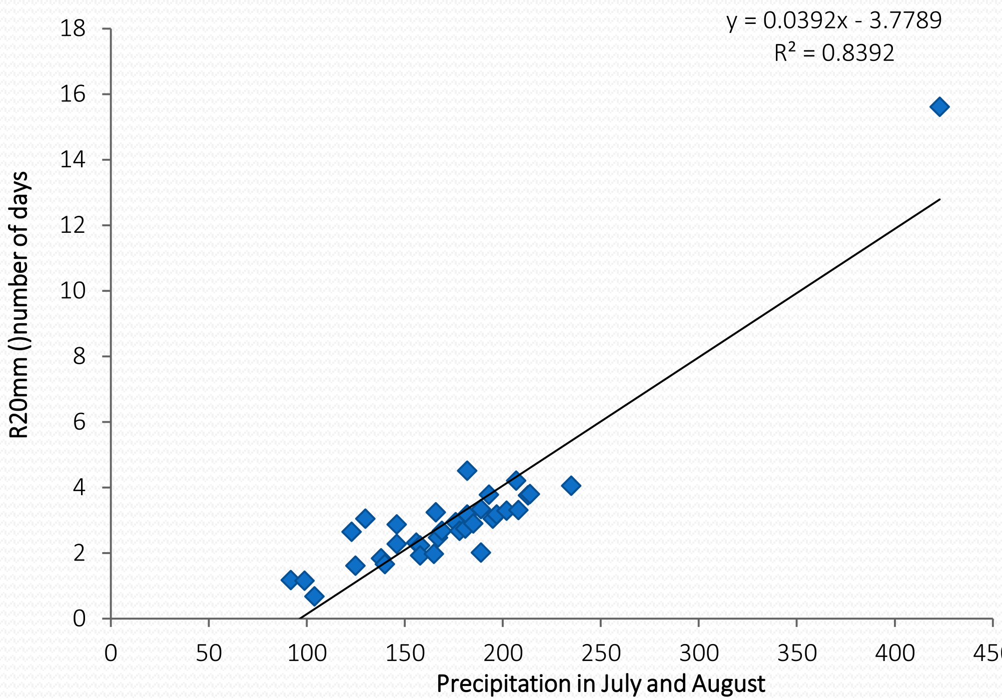


Single variable regression

Spline interpolation first, then add relationship with climatic variable

- The interpolation method is described in Shikhov A.N., Abdullin R.K., Tarasov A.V. Mapping temperature and precipitation extremes under changing climate (on the example of The Ural region, Russia). GES. 2020;13(2):154-165. https://doi.org/10.24057/2071-9388-2019-42

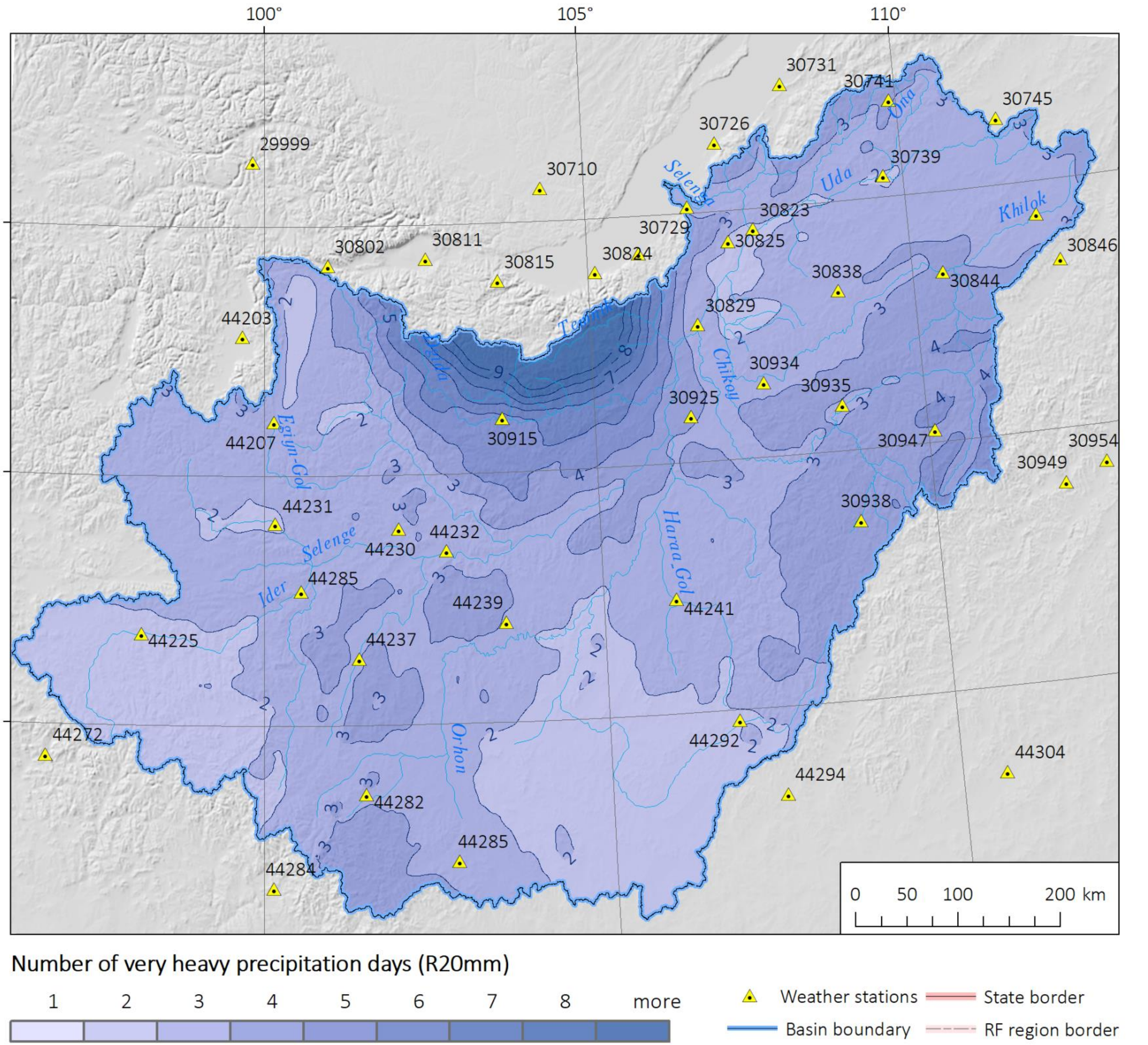
on the example of Ural region



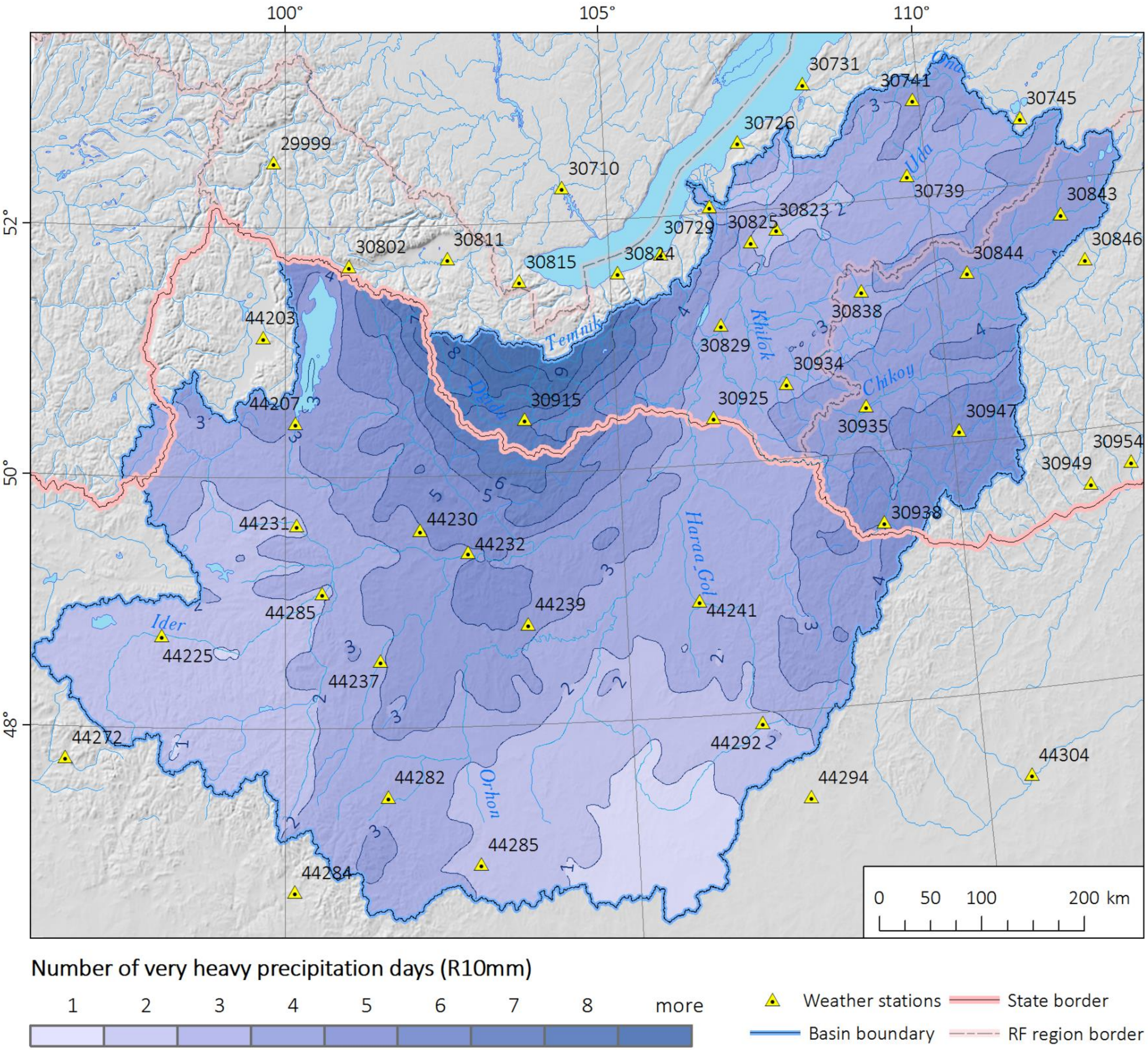
Multiple linear regression (MLR)

- MLR method has been used for interpolation only if multiple R was ≥0.9
- MLR-based interpolation was applied only for two climatic extreme indices (R_{10mm} and R_{20mm})
- Latitude, longitude and related climatic characteristic (average temperature for temperature extremes and average precipitation for precipitation extremes) were most suitable independent variables
- Substantial difference between the results of interpolation with the use of single variable regression and multiple linear regression

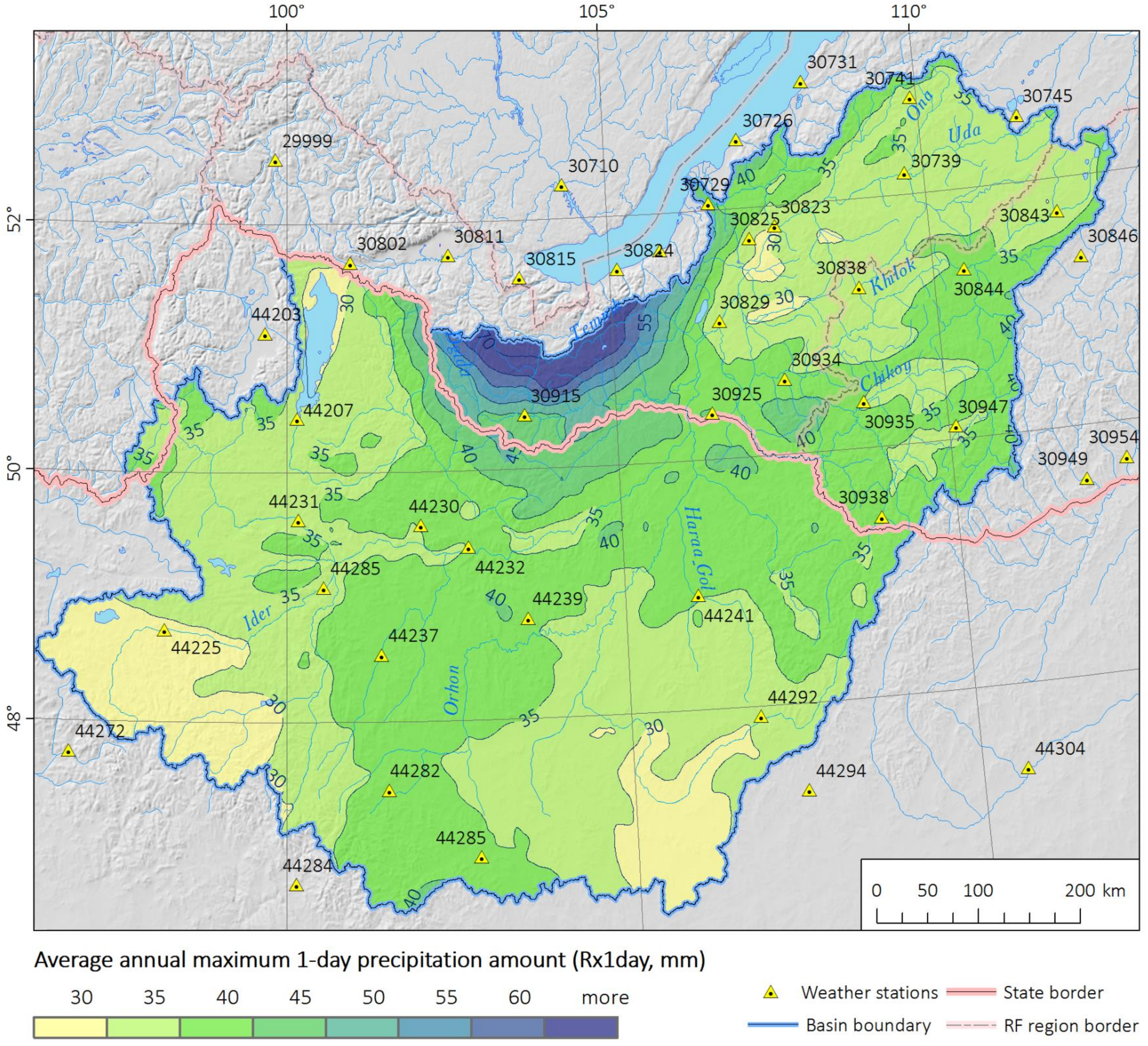
Number of very heavy precipitation days (R20mm), calculated with the use of single variable regression



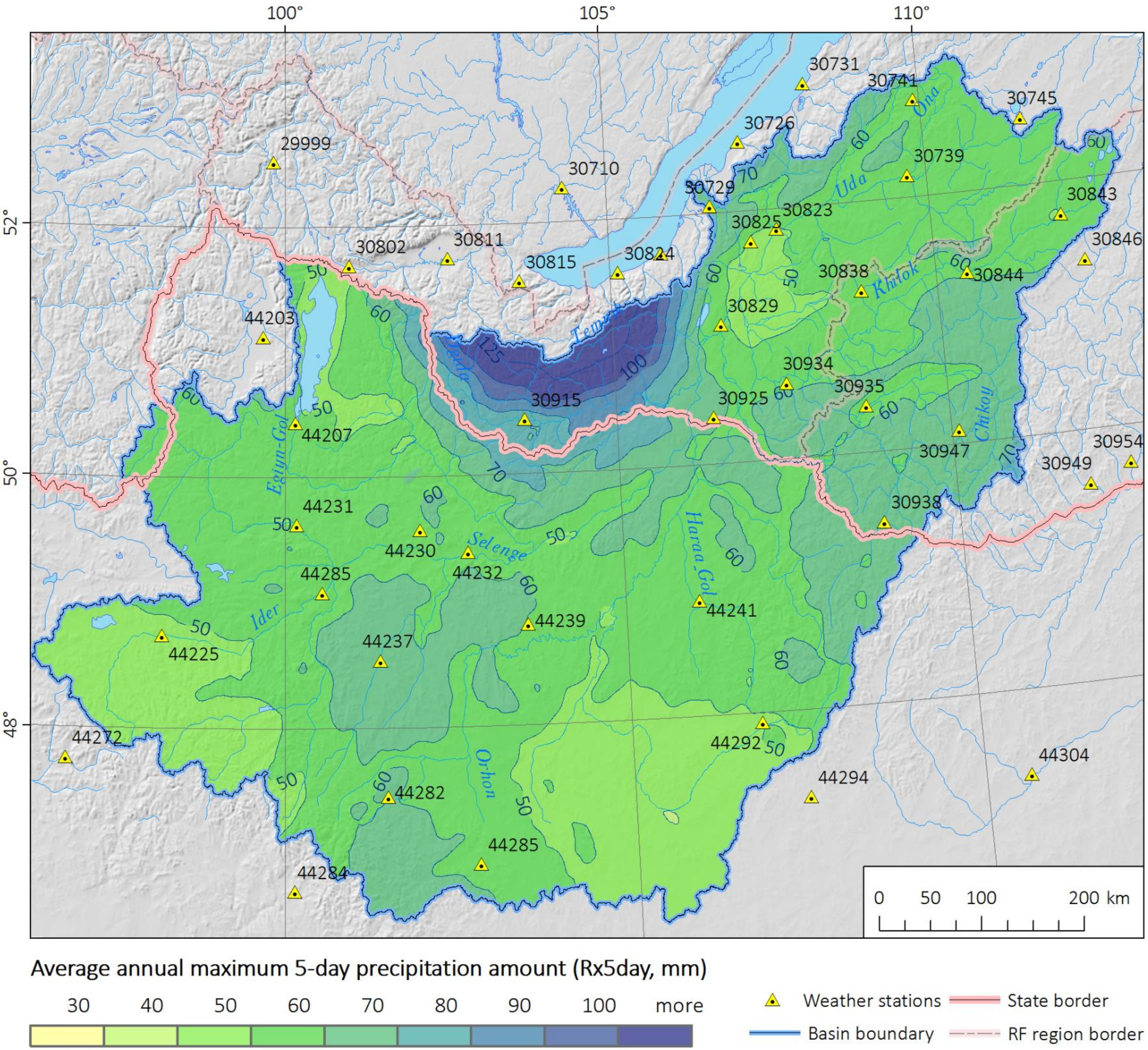
Number of very heavy precipitation days (R20mm), calculated with the use of multiple linear regression



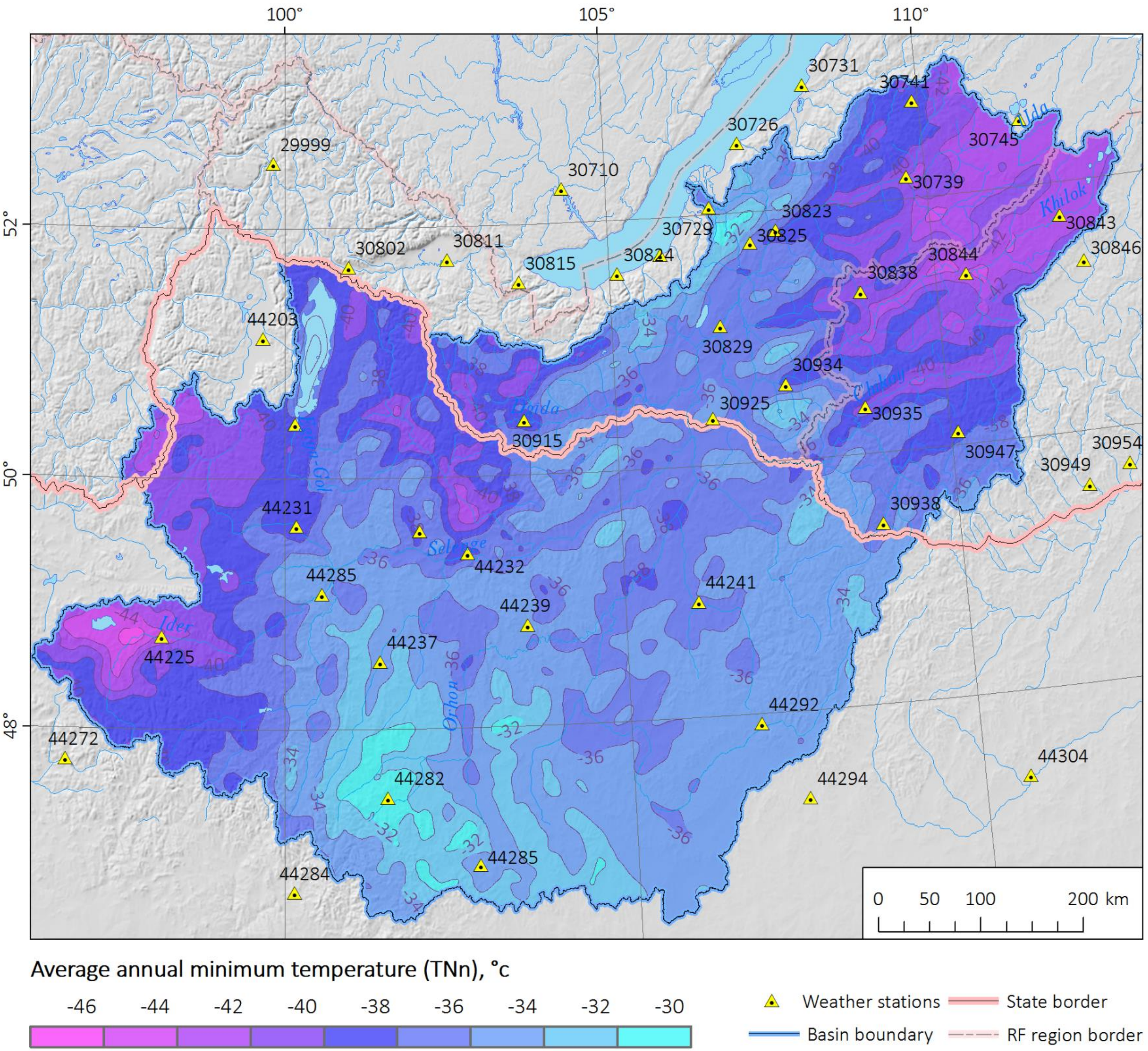
Average annual maximum of daily precipitation amount (RX1day), calculated with the use of single variable regression



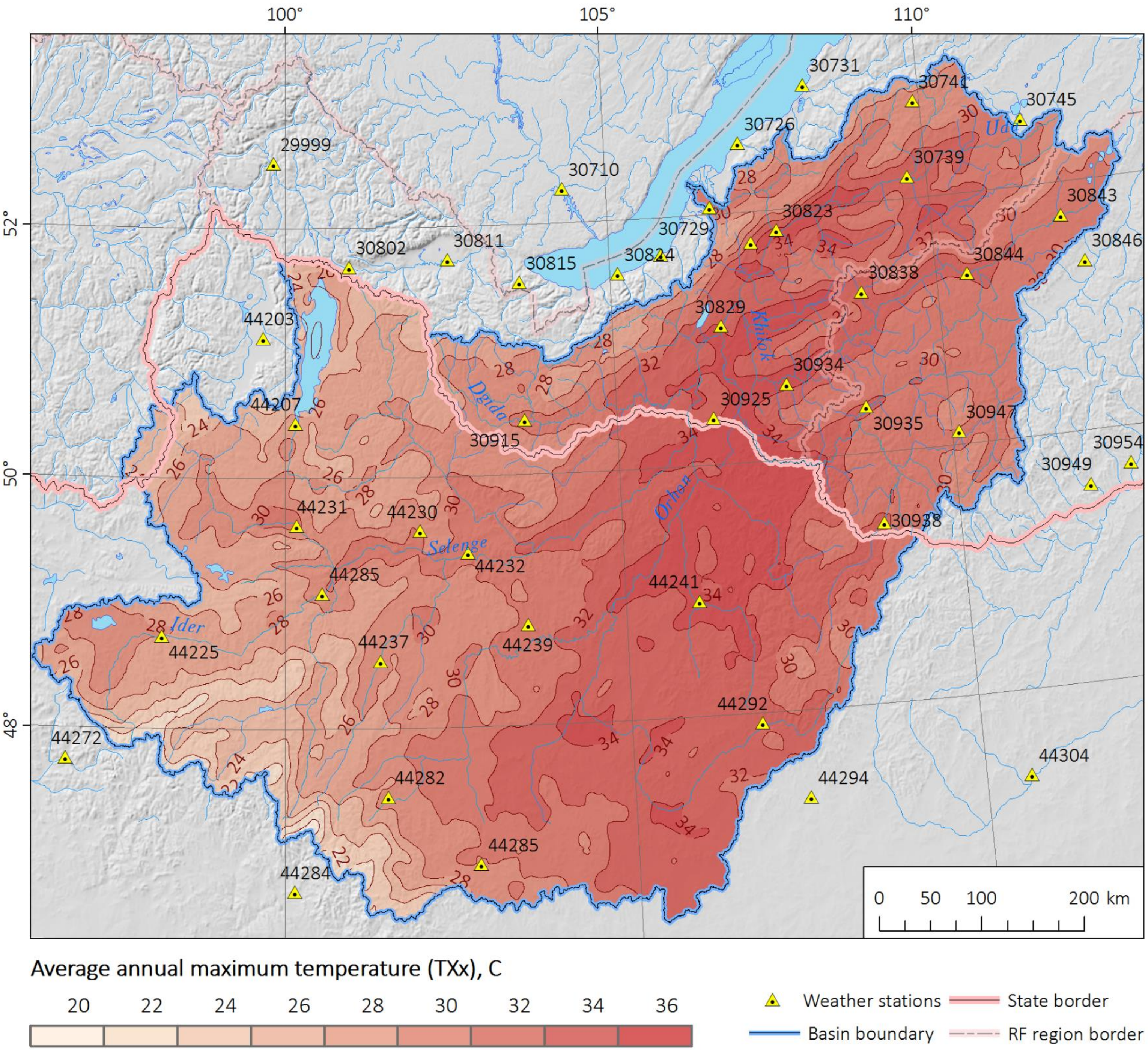
Average annual maximum of 5-day precipitation amount (RX5day), calculated with the use of single variable regression



Average annual minimum of temperature (TNn), calculated with the use of single variable regression



Average annual maximum of temperature (TXx), calculated with the use of single variable regression

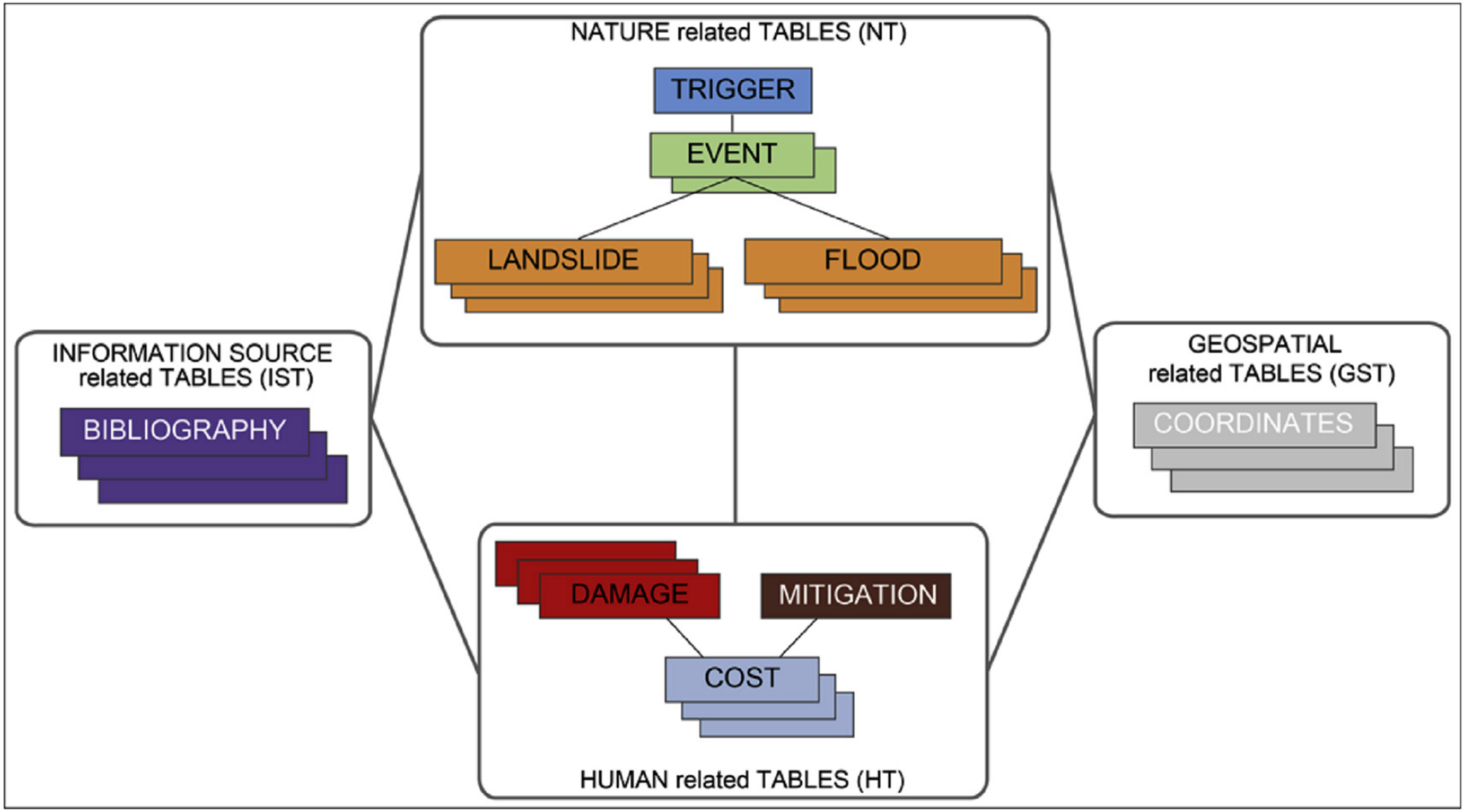


Hydrological data

- The data from 85 gauging stations for the entire observation period will be used for mapping of average and extreme hydrological characteristics
- The main attributes of river basins: average, max and min altitude, slope. Forest-covered area in 2000 and 2019, land use types distribution according to GlobCover dataset and high-resolution GlobaLand30 map
- The main characteristics of river flow (average and extreme), flow of suspended sediments, water levels
- Channel processes and mudflows

Hazardous hydrological events

- The GIS database of hazardous hydrological events will be developed based on modified LAND-DeFeND database structure, proposed by (Napolitano et al., 2018)



Conclusion

- The structure of the online web map service of hydrological and ecological safety of Selenga river basin will include three main thematic sections.
- Average and extreme climatic characteristics and their trends estimated on the basis of weather stations network, as well as the WorldClim 2.0 and ClimDEX (GHCN-Daily) datasets.
- The maps of long-term hydrological characteristics based on the data from hydrological gauges.
- The database of hazardous hydrological events developed with the use of the innovative structure LAND-DeFeND. Also it will contain the areas affected by landslides, mudflows and river coasts collapse, and the flooding zones in settlements estimated with HEC-RAS software tool and high-resolution topographic maps.

Thank you for your attention

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