EGU2023
23 – 28 April 2023
Session HS2.1.4
EGU23-10173

Impacts of anthropogenic activity and climate change on water resources for the whole of Mongolia by using process-based eco-hydrology model

Tadanobu NAKAYAMA (e-mail : nakat@nies.go.jp), National Institute for Environmental Studies (NIES), Japan

EGU General Assembly 2023

1. Objective of This Study

In Mongolia, overuse and degradation of groundwater is a serious issue. The author has recently applied a process-based eco-hydrology model, NICE (National Integrated Catchment-based Eco-hydrology) to urban and mining hubs to explicitly quantify spatio-temporal variations in water availability (Nakayama et al., 2021a, 2021b). In this study, NICE was scaled up to the total of 29 river basins in the entire country (Ministry of Nature, Environment and Tourism, 2013) (Fig. 1). There are two basic science questions in this study: (i) How does past climatic change influence the water resources in each basin of the entire country ? (ii) How does anthropogenic activity such as livestock, irrigation, mining, industrial, and domestic water uses change the water availability there ?

Fig.1 Location of the total of 29 river basins in Mongolia.

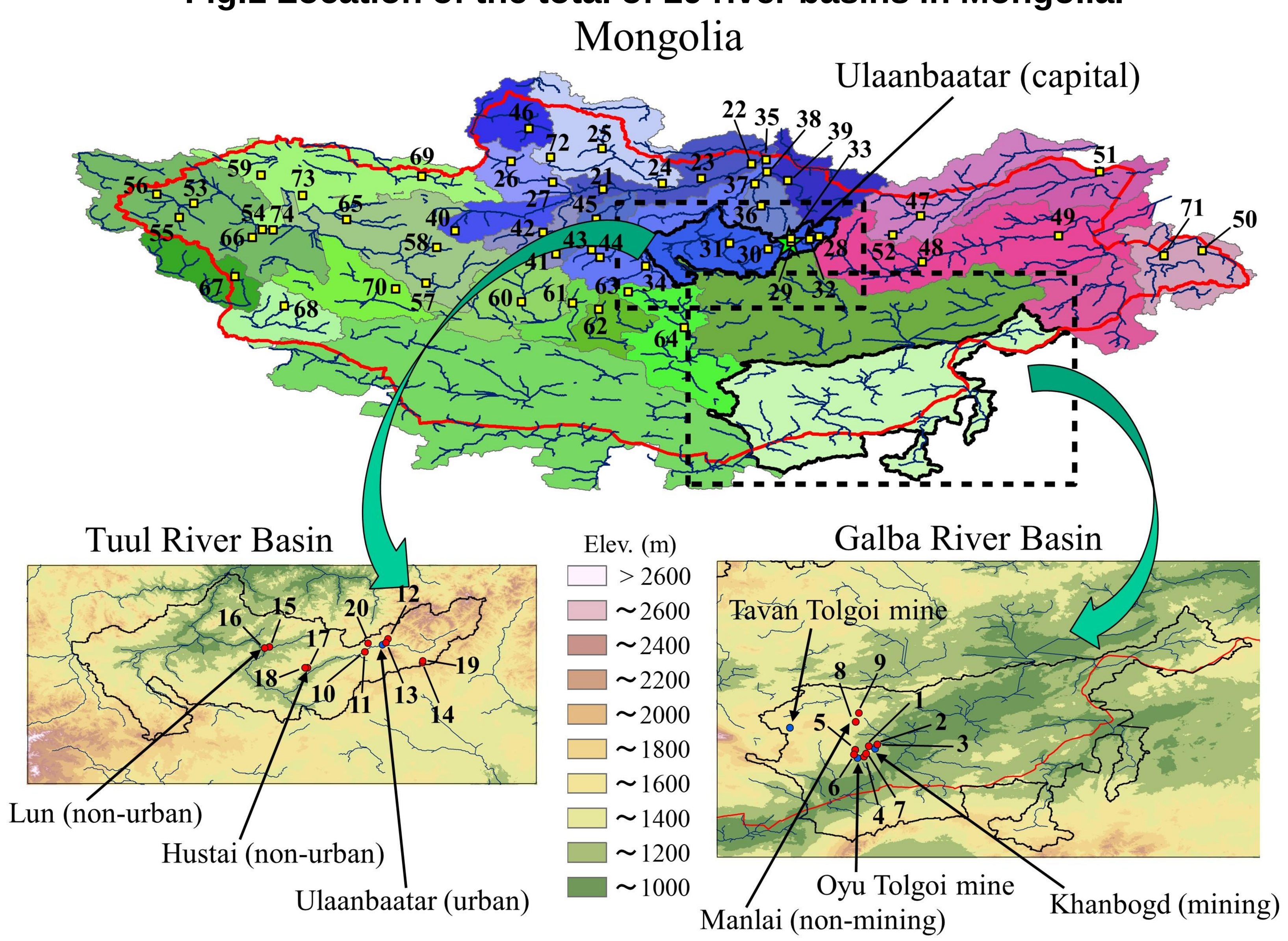
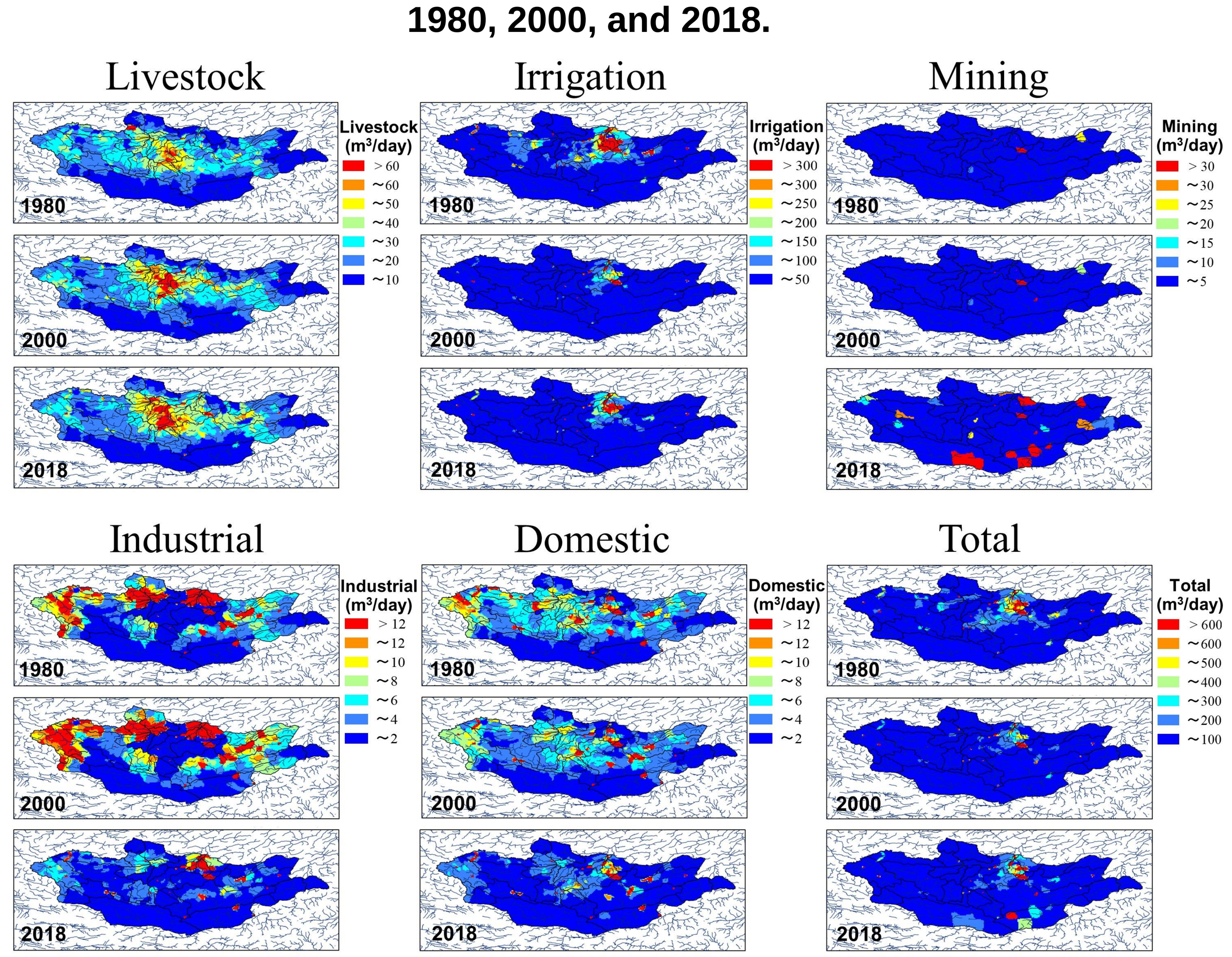


Fig.2 Estimated water use at 0.1° x 0.1° resolution in the entire Mongolia at 1980, 2000, and 2018.



2. Materials and Methods

A high-resolution of 0.1° x 0.1° gridded dataset representing water use for each water use was derived by combining a global dataset, statistical data, GIS data, observation data, and field surveys to input the NICE simulation in the extension of the previous studies (Fig. 2).

The simulation area was scaled up from Tuul and Garba River Basin in the author's previous studies (Nakayama et al., 2021a, 2021b) to all the 29 river basins including these basins of the entire Mongolia with 35.0° wide by 13.0° long in longitude-latitude coordinates (Fig. 1). There are a total of 2214 river channels in the simulation area, of which 1049 river channels are in the Mongolian basin.

3. Evaluation of Hydrologic Budget in the Entire Mongolia

The model reasonably reproduced the river discharge observed during the last 2 decades (NUM, 2018), and the discharge generally became maximal during the summer rainfall seasons. (Fig. 3). The simulated results in the forest area at site Nos. 22, 24, and 35 (in the downstream of Selenge, Eg, and Orkhon Rivers) were in good agreement in the observed values. In contrast, the simulated values were over-estimated than the observed values in the grassland and steppe regions at sites Nos. 49 and 54 (in the downstream of Kherlen and Khovd Rivers).

The model also simulated the annual-averaged hydrologic budget in 29 river basins of the entire Mongolia (Fig. 4). The result shows the effective precipitation and the water yield became smaller in the middle and southern country where the shorter grassland and desert are dominant. It is conceivable that the competition for water use among various sectors (Fig. 2) will become more intense there in the future unless some measures are taken.

Fig.3 Comparison of annual-averaged, and time-series of monthly-mean discharge discharges in 29 river basins .

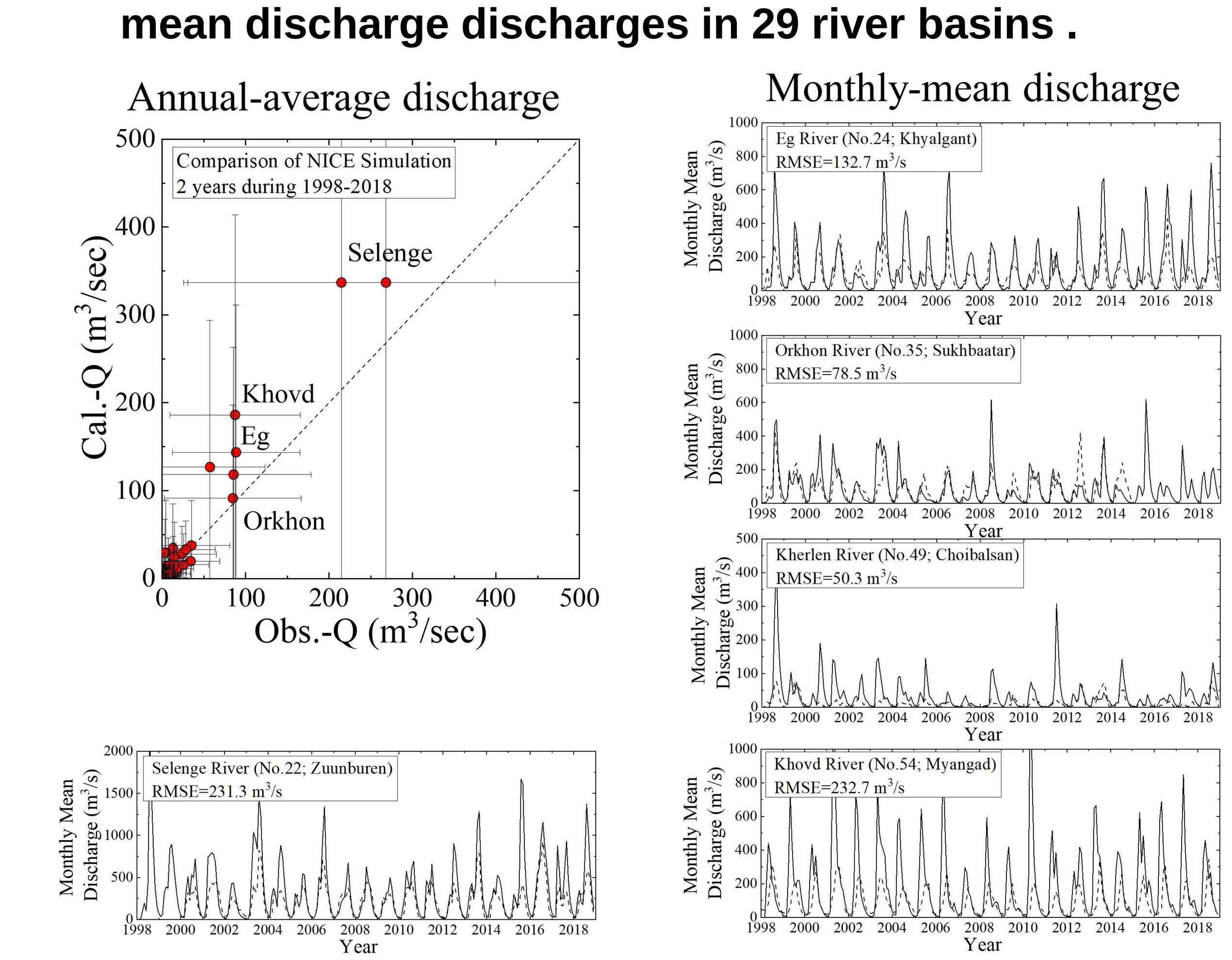
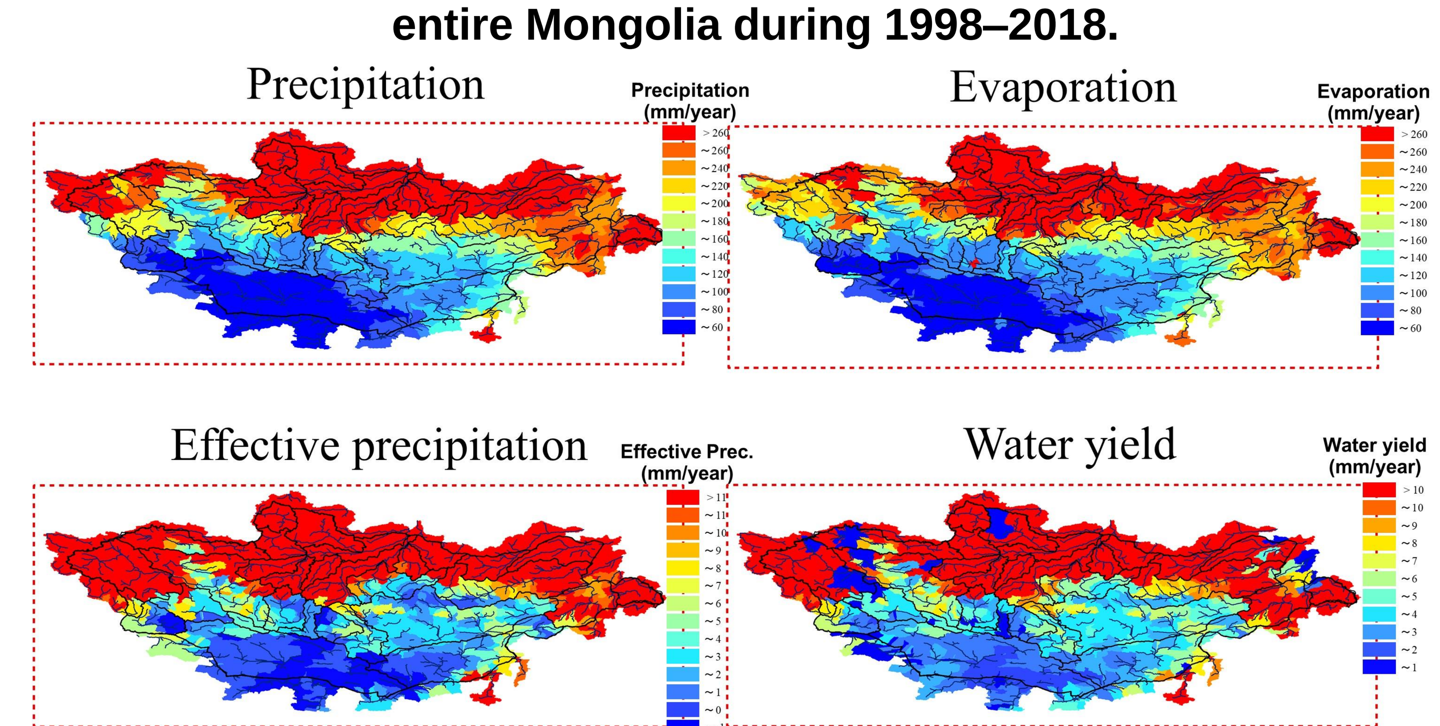


Fig.4 Simulated results of annual-averaged hydrologic budget in the entire Mongolia during 1998–2018.



4. Identifying Relative Contribution of Various Sources to Groundwater Degradation

The author analyzed the relative contribution of various water uses to groundwater level change in the entire country (Fig. 5). Generally, the contributions of industry and domestic water uses are relatively large in the northern basins (Tuul and Kharaa Rivers), whereas the contribution of mining water use increased suddenly after 2010 in the Gobi desert (Galba River).

The spatial distribution of relative contribution shows the dominant water uses and their ratios affected greatly the changes in groundwater level (Fig. 6). While the changes in precipitation had a large effect on changes in groundwater levels until 2000 (Fig. 5), the model clarified that human activities have recently come to have a large impact on groundwater level changes.

Fig.5 Relative contribution of various water uses to changes in groundwater level during 1980–2018.

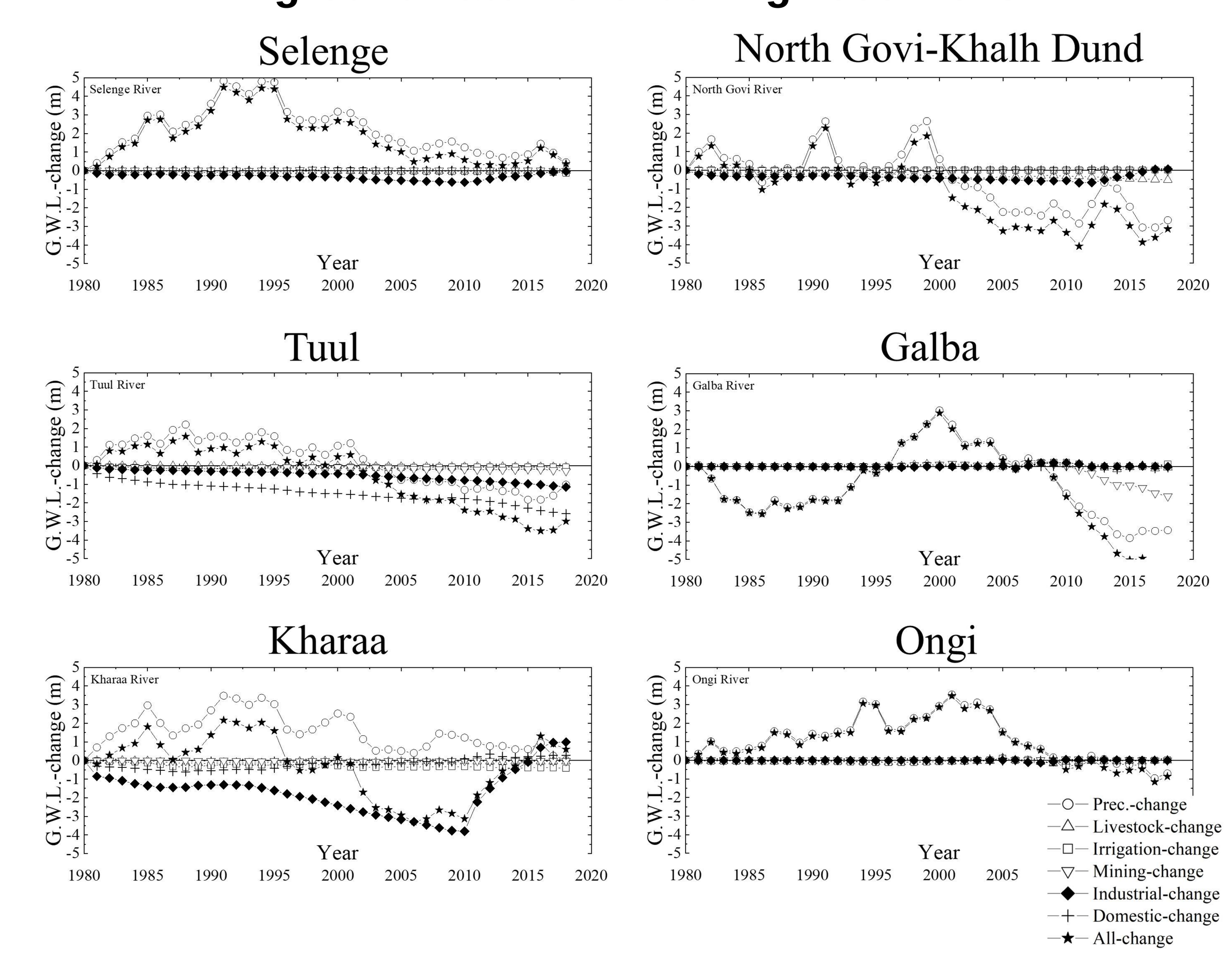
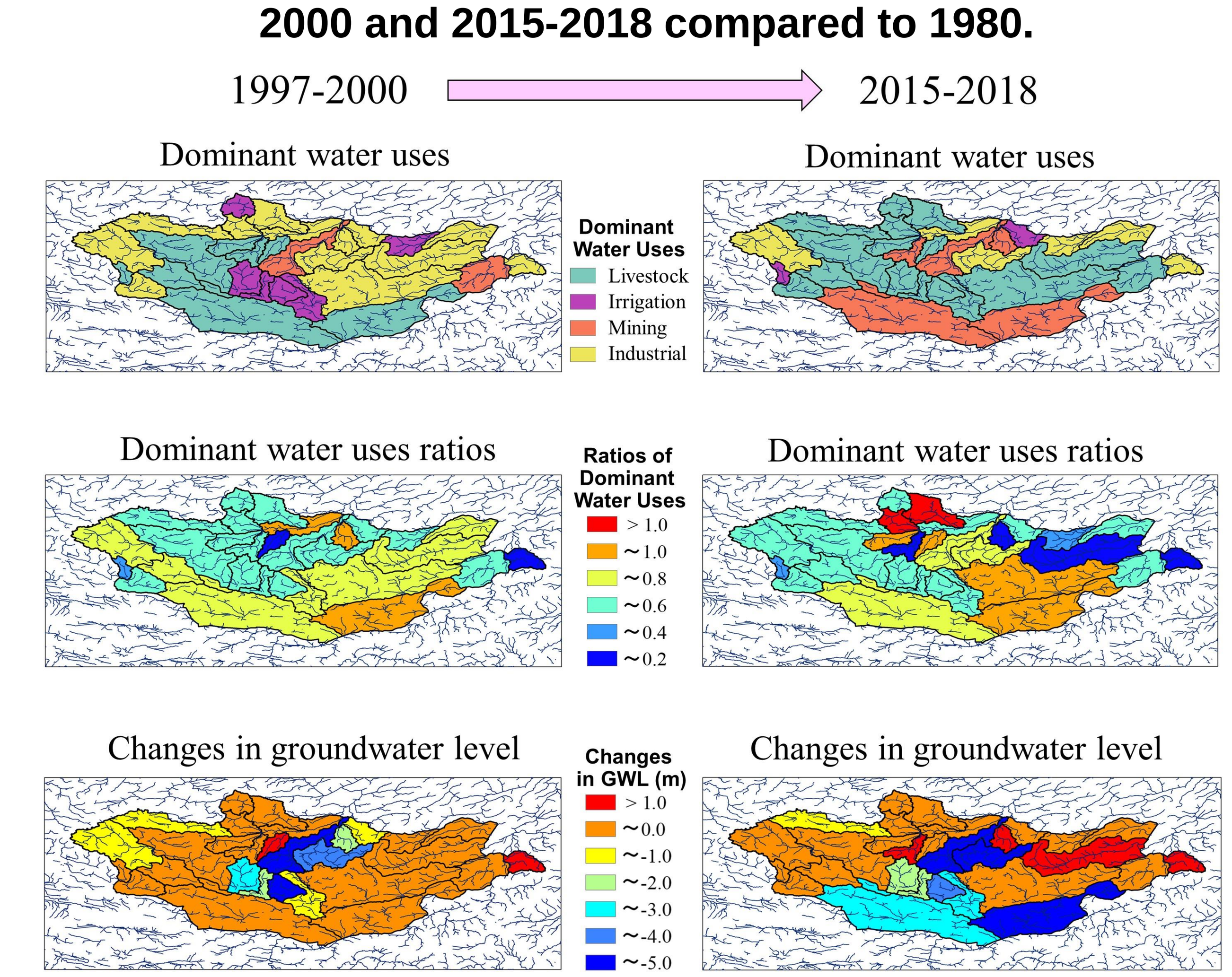


Fig.6 Spatial distribution of relative contribution averaged during 1997-2000 and 2015-2018 compared to 1980.



5. Conclusions

The process-based eco-hydrology model NICE was applied to the total of 29 river basins in Mongolia. The model simulated the effect of past climatic change and human activity on water resources during 1980-2018 in each basin.. This methodology is powerful to predict and resolve future competition for water resources that could potentially trigger conflicts between urban, mining companies, herders and local communities.