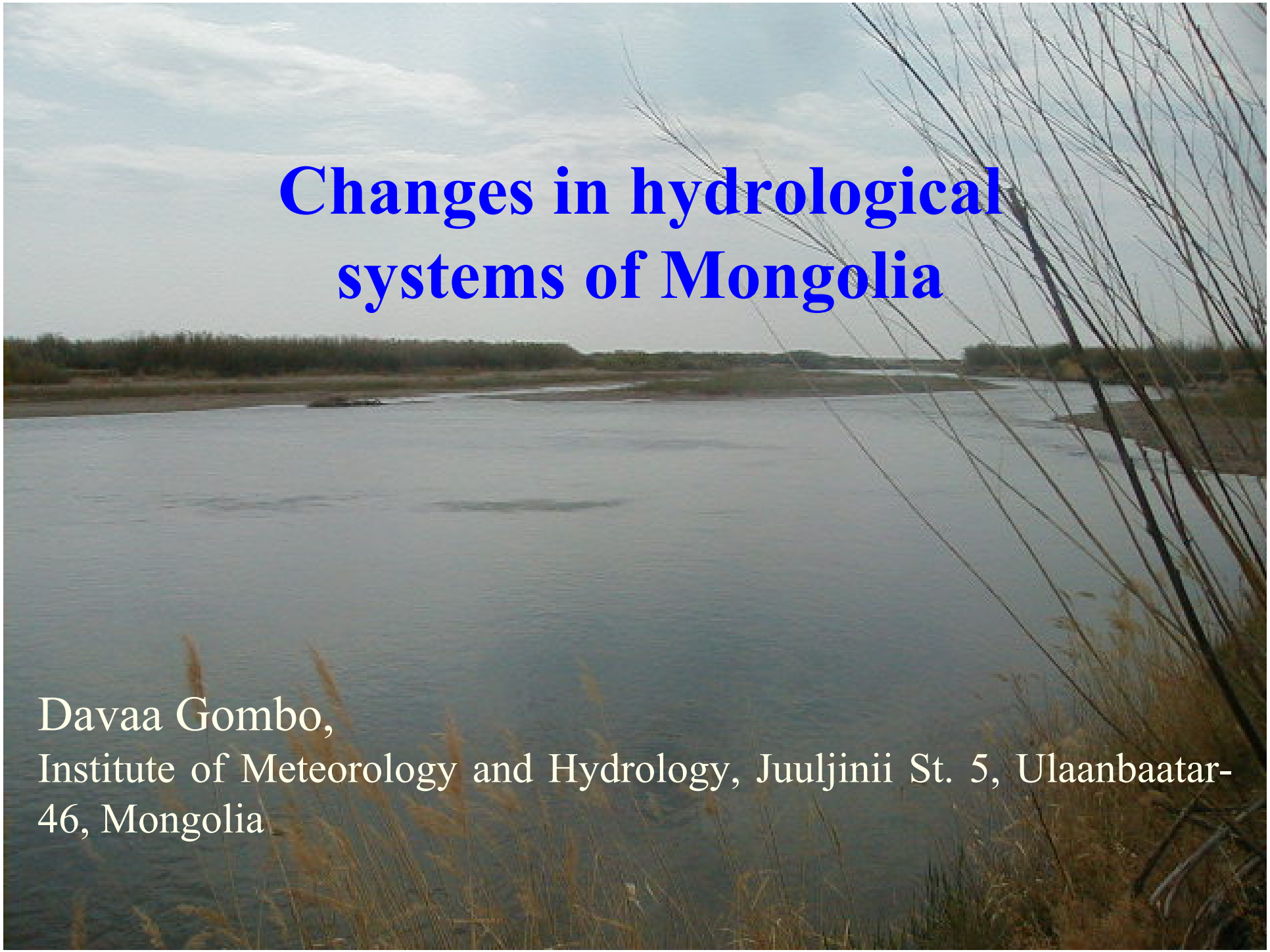
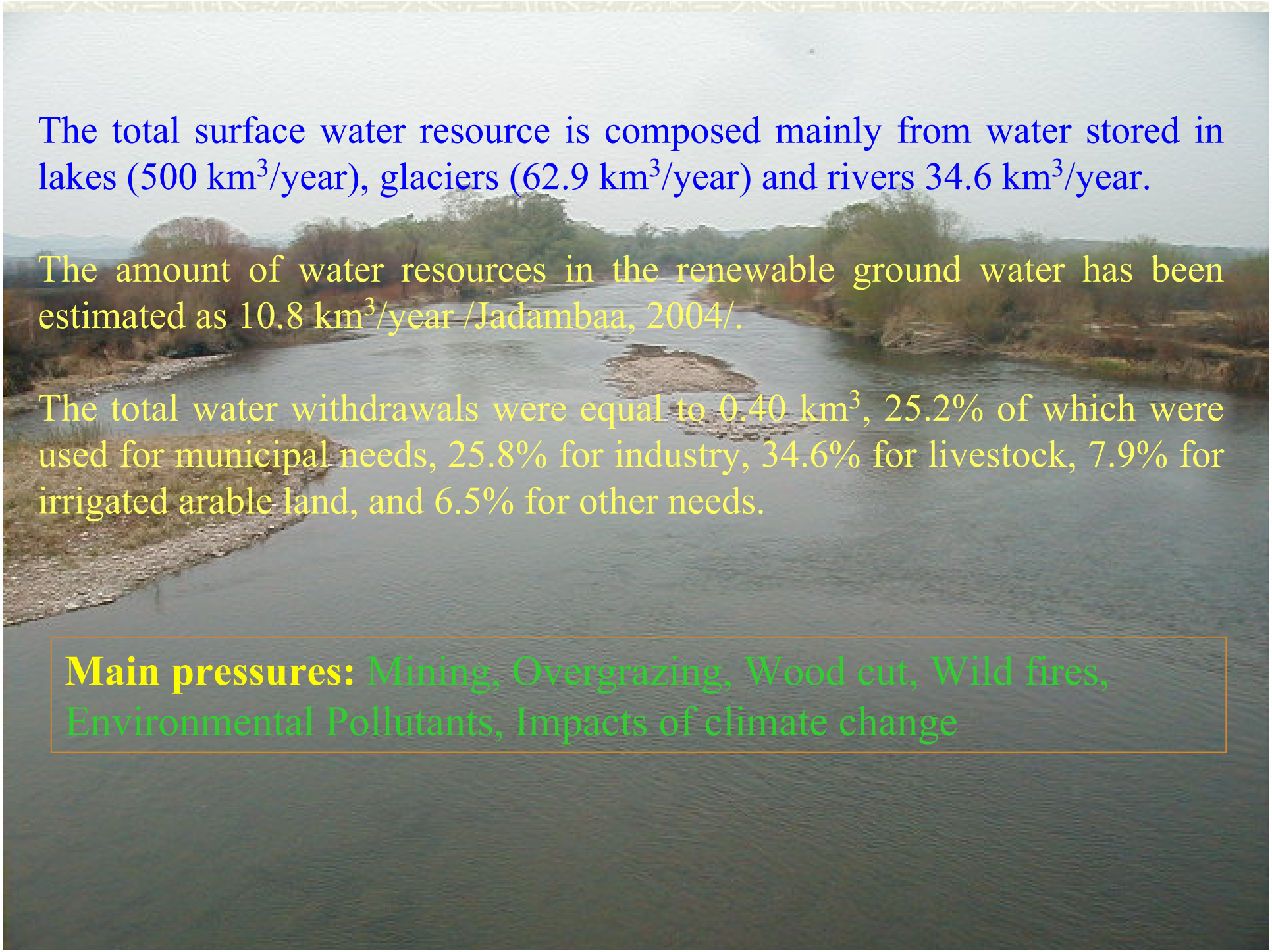


Changes in hydrological systems of Mongolia

Davaa Gombo,
Institute of Meteorology and Hydrology, Juuljinii St. 5, Ulaanbaatar-46, Mongolia

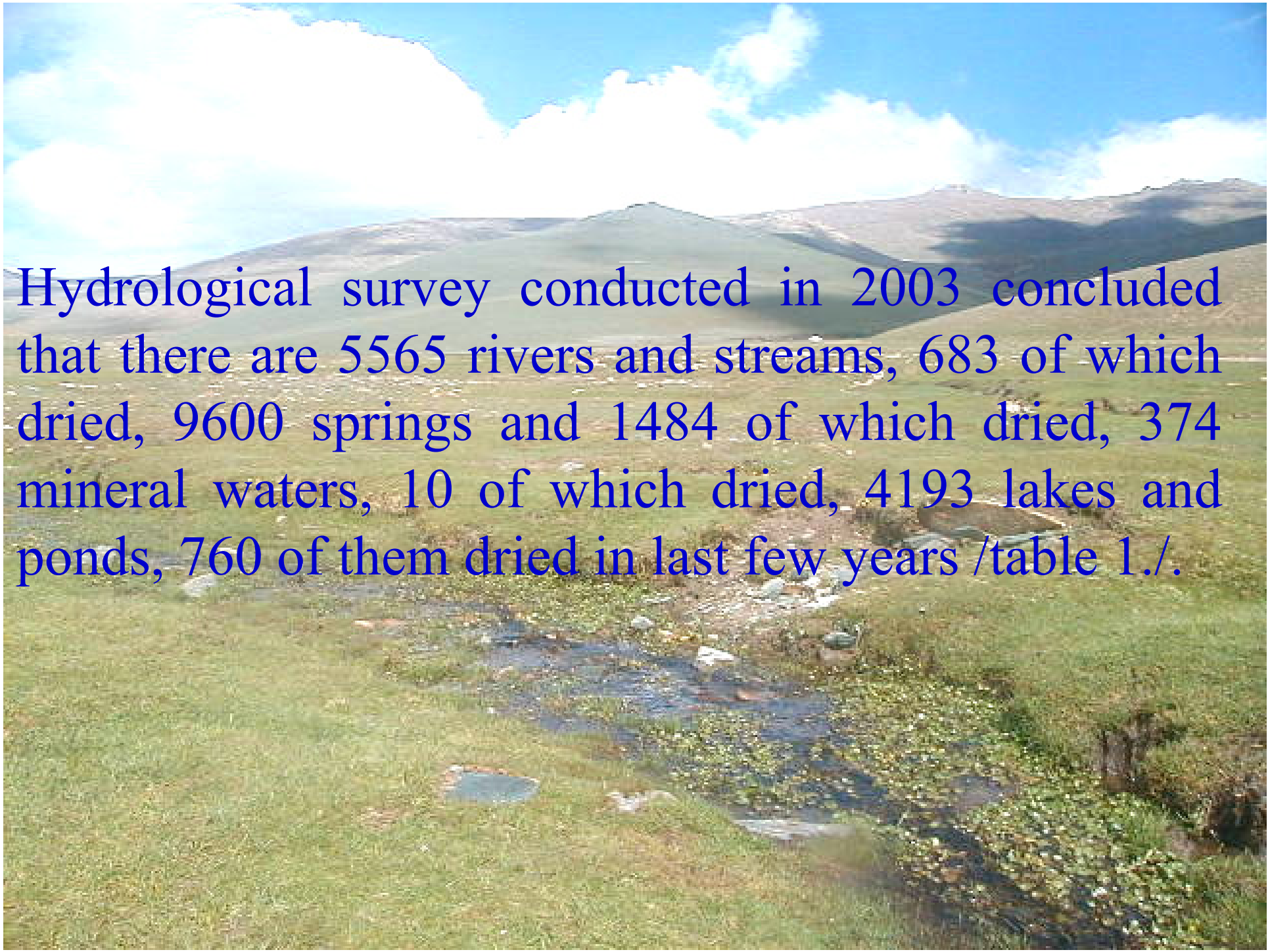


The total surface water resource is composed mainly from water stored in lakes (500 km^3/year), glaciers (62.9 km^3/year) and rivers 34.6 km^3/year.

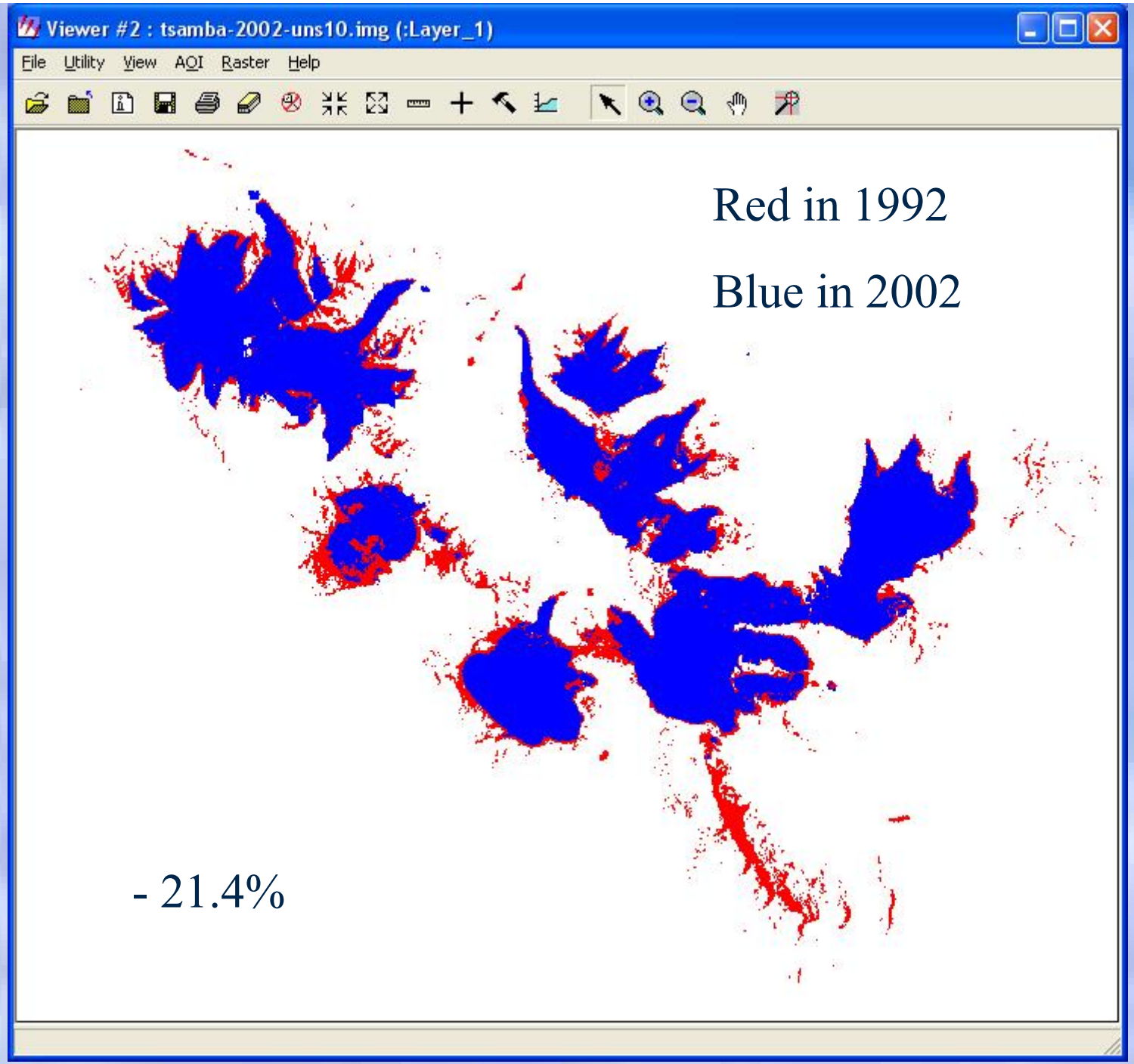
The amount of water resources in the renewable ground water has been estimated as 10.8 km^3/year /Jadambaa, 2004/.

The total water withdrawals were equal to 0.40 km^3, 25.2% of which were used for municipal needs, 25.8% for industry, 34.6% for livestock, 7.9% for irrigated arable land, and 6.5% for other needs.

Main pressures: Mining, Overgrazing, Wood cut, Wild fires, Environmental Pollutants, Impacts of climate change



Hydrological survey conducted in 2003 concluded that there are 5565 rivers and streams, 683 of which dried, 9600 springs and 1484 of which dried, 374 mineral waters, 10 of which dried, 4193 lakes and ponds, 760 of them dried in last few years /table 1./.


Viewer #2 : tsamba-2002-uns10.img (:Layer_1)
File Utility View AOI Raster Help
Red in 1992
Blue in 2002
- 21.4%

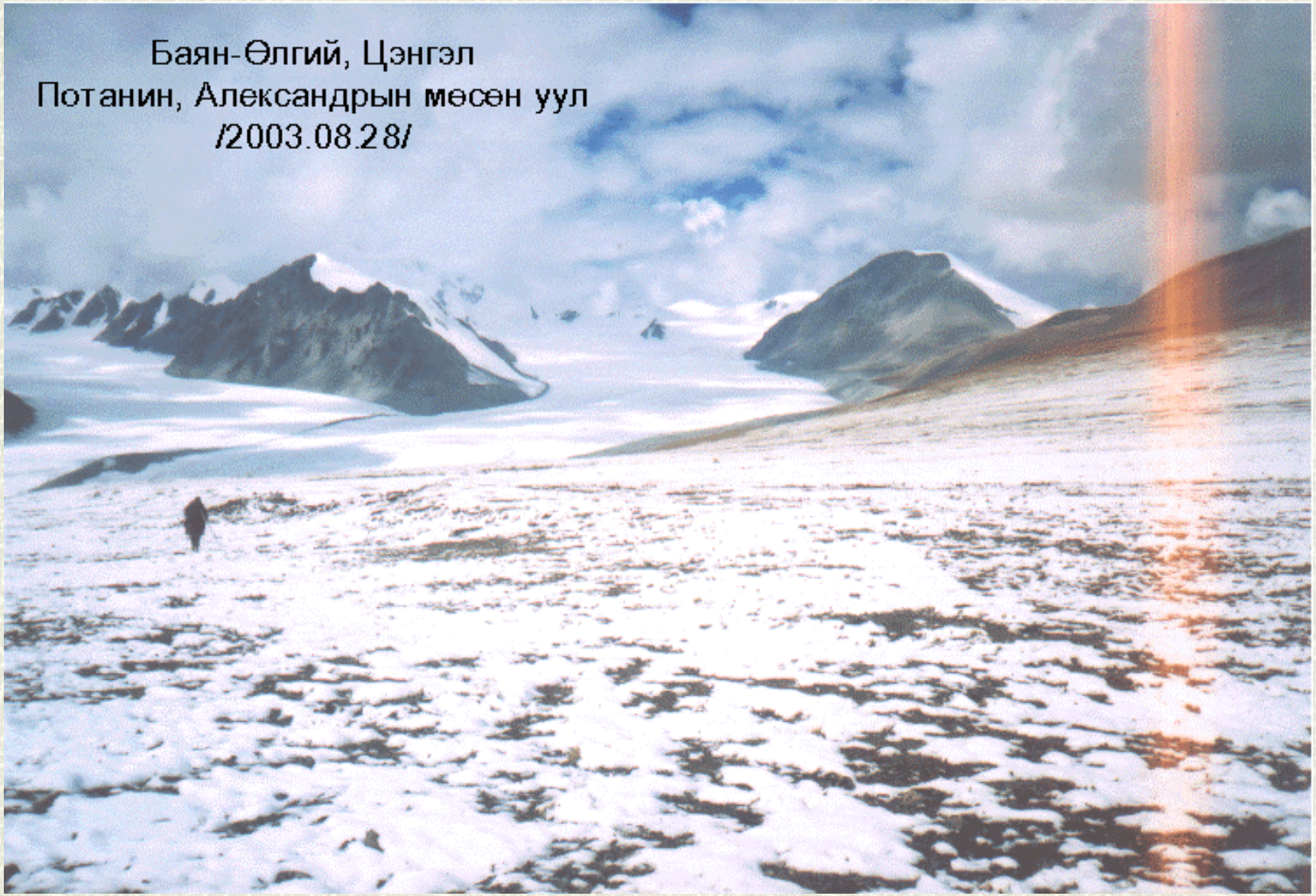
Changes in glacier areas, sq.km

Glacier	1940-th map	25 June, 1992	10 Sep. 2000	8 Aug. 2002
Kharkhiraa	43.02	-	36.08	31.29
Turgen	50.13	-	34.74	33.83
Munkhkharhan	-	36.96*	-	27.42
Tsambagarav	105.09	90.98	74.8	71.52
Sair	-	11.51	-	6.62

Changes in glacier areas, % in comparison with area of 1940-th

Glacier	1940-th	25 June, 1992	10 Sep. 2000	8 Aug. 2002
Kharkhiraa	0.0	-	16.1	27.3
Turgen	0.0	-	30.7	32.5
Tsambagarav	0.0	13.4	28.8	31.9

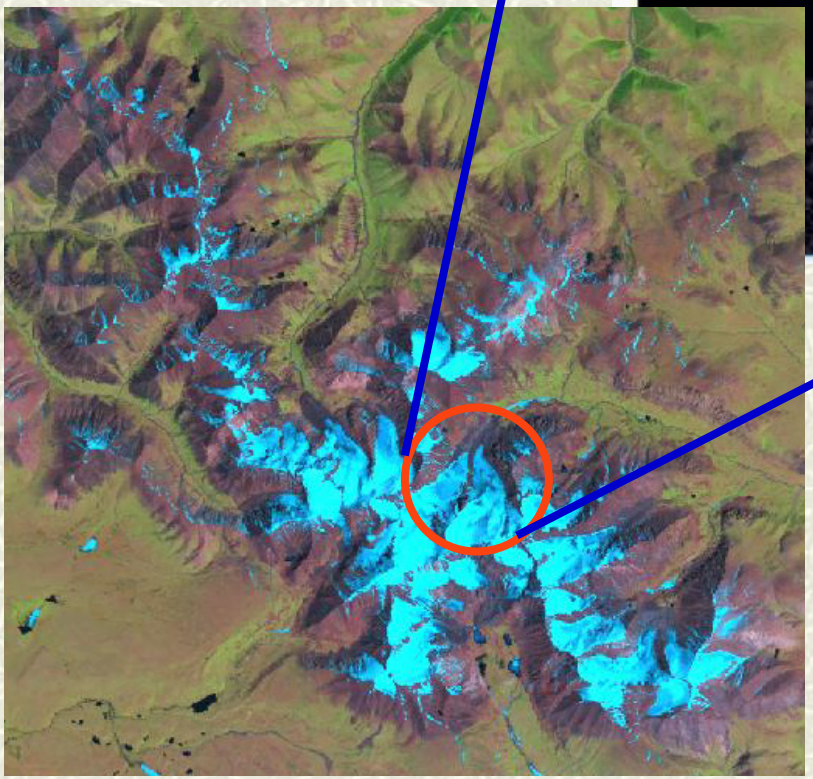
Glacier monitoring



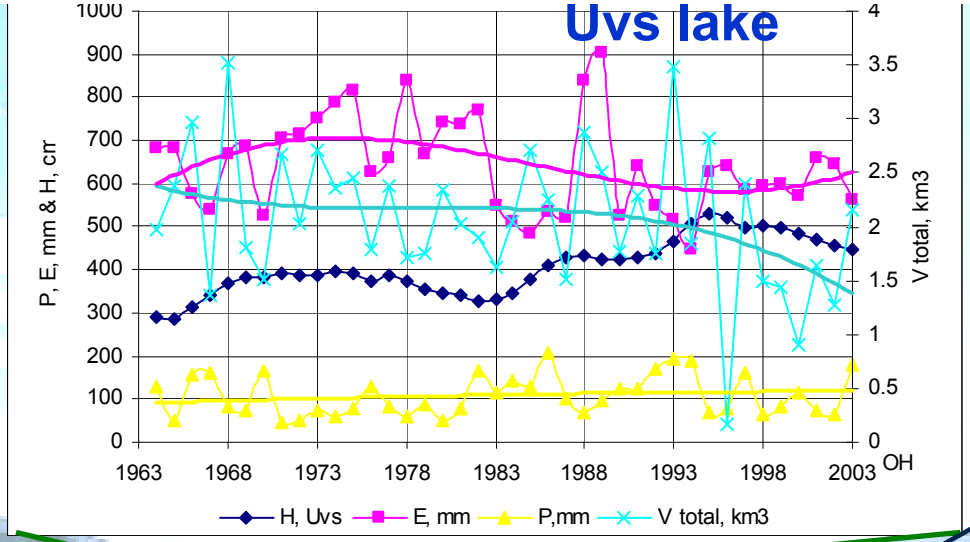
Glacier monitoring

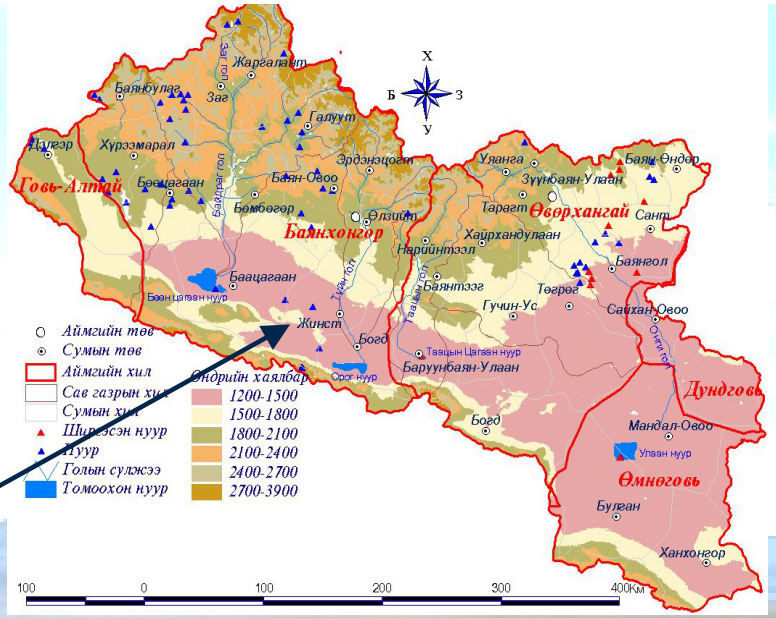
Цамбагарав уулын мөстөл судлалын өртөө байгуулах хэсгийн байршил, 2003-08-09

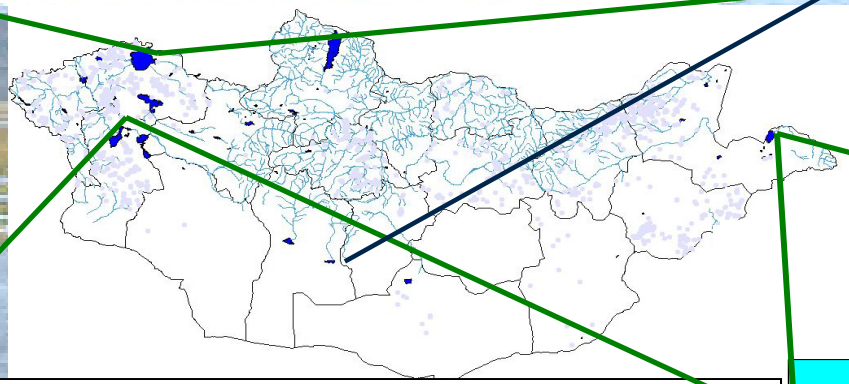
Turgen Mts.

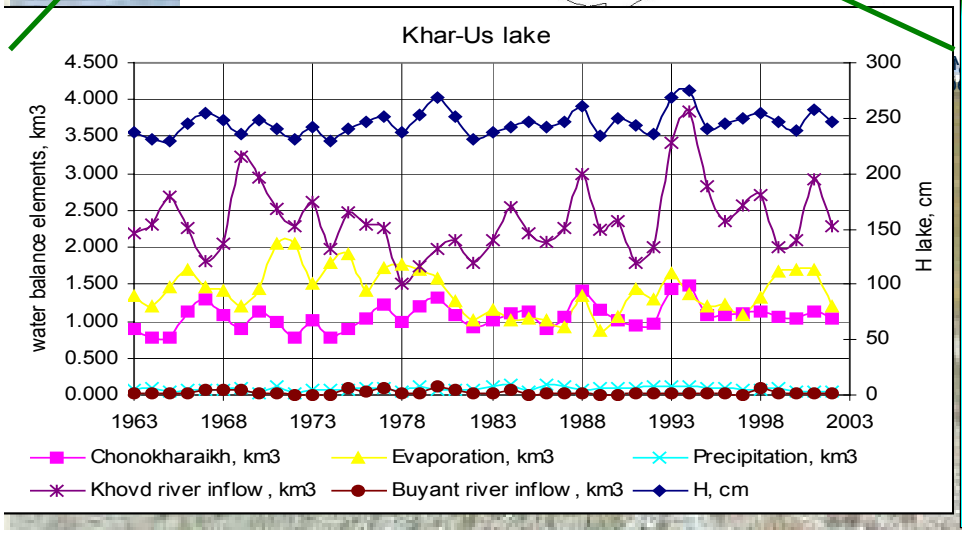


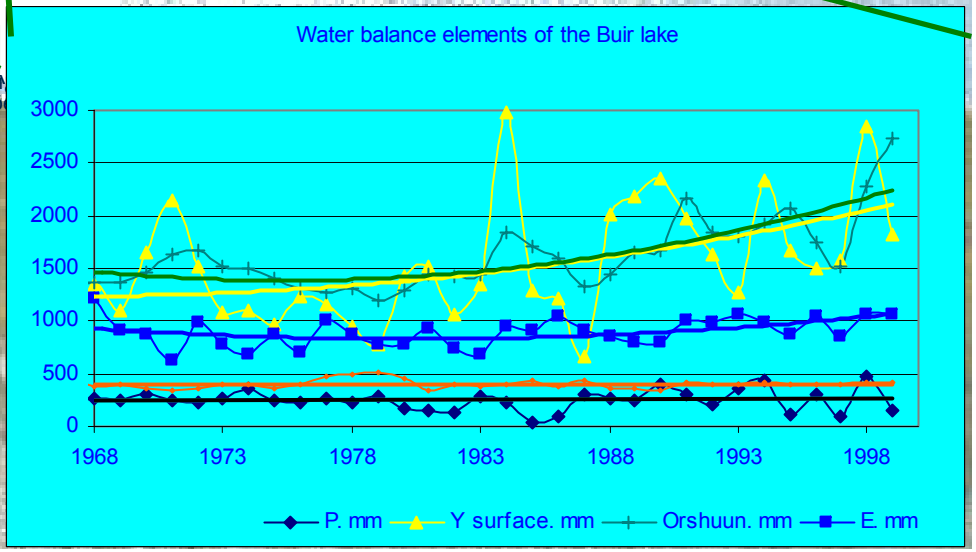
One of observation sites.


Uvs lake
P, E, mm & H, cm
V total, km3
OH
1963
1968
1973
1978
1983
1988
1993
1998
2003
H, Uvs
E, mm
P,mm
V total, km3


Говь-Алтай
Баянхонгор
Өвөрхангай
Дундговь
Өмнөговь
Аймгийн төв
Сумын төв
Аймгийн хил
Сав газрын хил
Сумын хил
Шилэнсэн нуур
Нуур
Голын сулжээ
Томоохон нуур
Онцгойлон хамгаалах газар
1200-1500
1500-1800
1800-2100
2100-2400
2400-2700
2700-3900
100
0
100
200
300
400км




Khar-Us lake
water balance elements, km3
H lake, cm
1963
1968
1973
1978
1983
1988
1993
1998
2003
Chonokharaikh, km3
Evaporation, km3
Precipitation, km3
Khovd river inflow , km3
Buyant river inflow , km3
H, cm

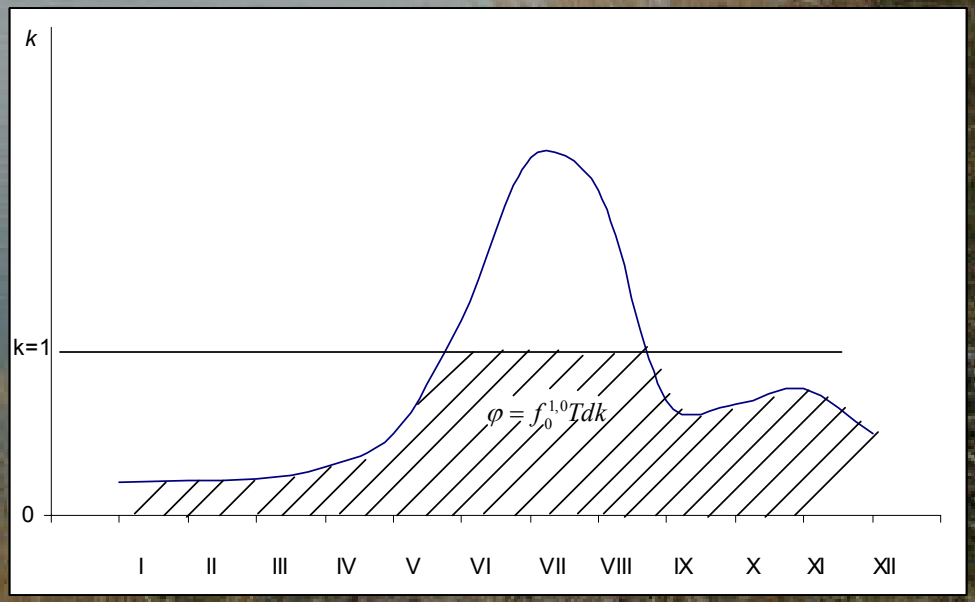

Water balance elements of the Buir lake
1968
1973
1978
1983
1988
1993
1998
P. mm
Y surface. mm
Orshuun. mm
E. mm

Methods and data

1. Annual storage ratio /φ/ series of the basin, expressed as ratio of area of hydrograph below annual average discharge to the total area of annual hydrograph indicates water regime regulating capability of the basin and it's overall changes with time and space.

$$\varphi = \int_{k=0}^{k=1} T dk \qquad /1/$$

where: T is days, k is the ratio of daily average discharge to yearly average discharge.



2. Runoff coefficient /C/ expressed as ratio of runoff depth to the basin average precipitation, indicates changes in elements of water balance in the basin.

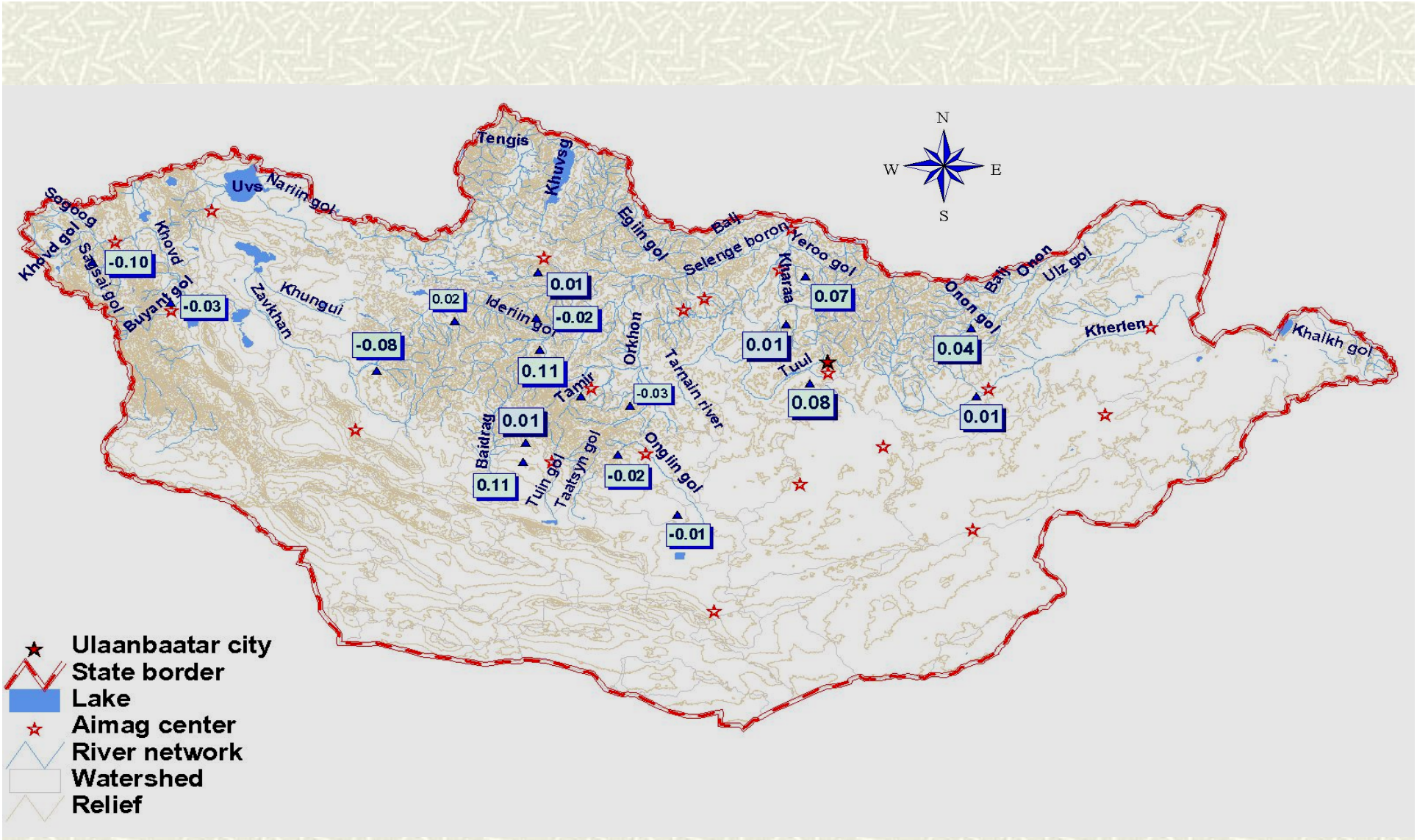
$$C_{natural} = \frac{h_{naturalregime}}{P_{basin}}$$

where, $C_{natural}$ is runoff coefficient in the period of natural flow regime, $h_{natural}$ is annual runoff depth, mm, P_{basin} is annual and basin average precipitation, mm in the same period.

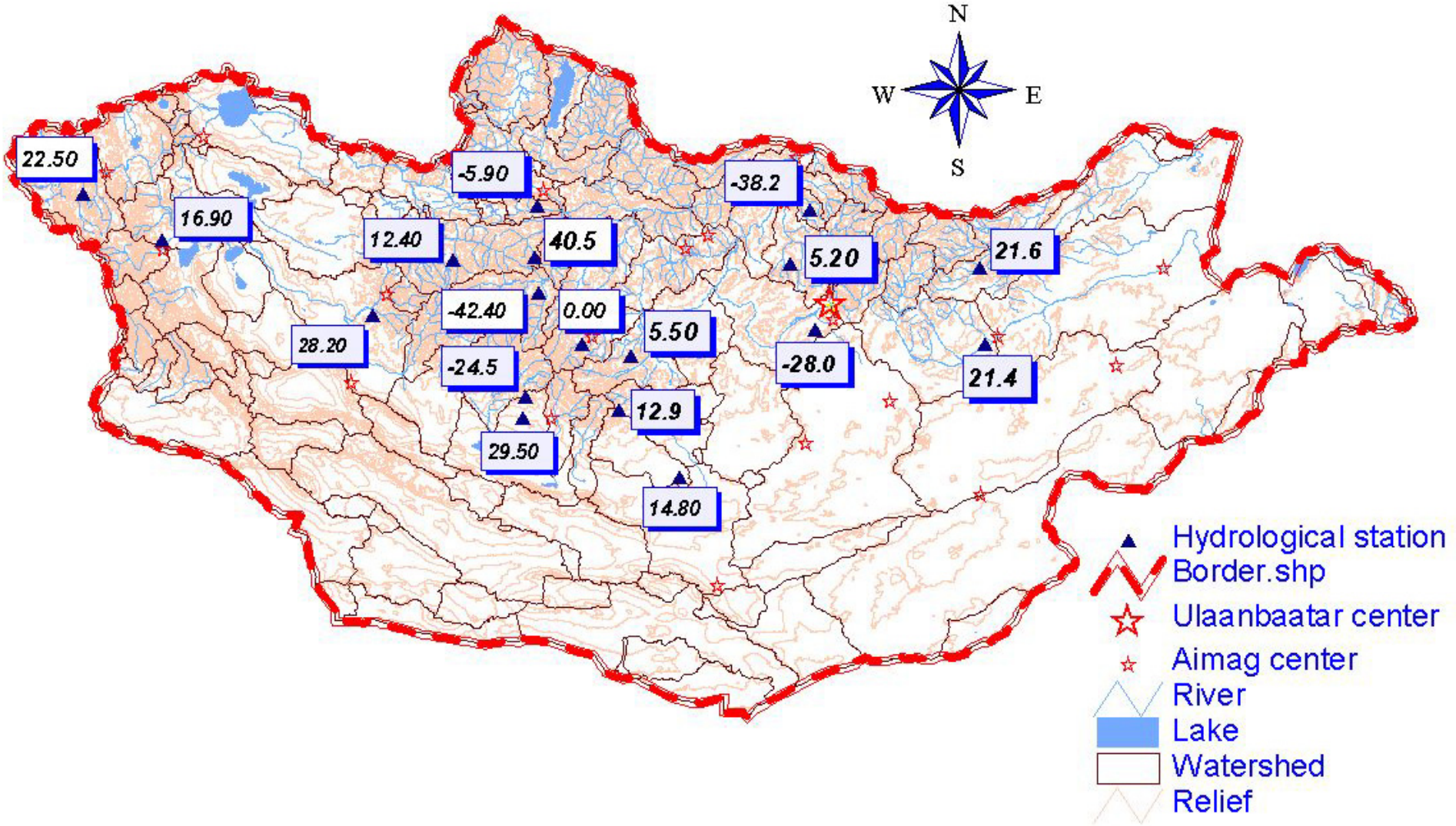
$$h_{\text{natural in anthropogenic period}} = C_{natural} P_{\text{anthropogenic period}}$$

Then, change in runoff will be the difference runoff in the period of natural flow regime /$h_{\text{natural in anthropogenic period}}$/ and runoff, observed in the period of increased anthropogenic pressures $h_{\text{anthropogenic period}}$:

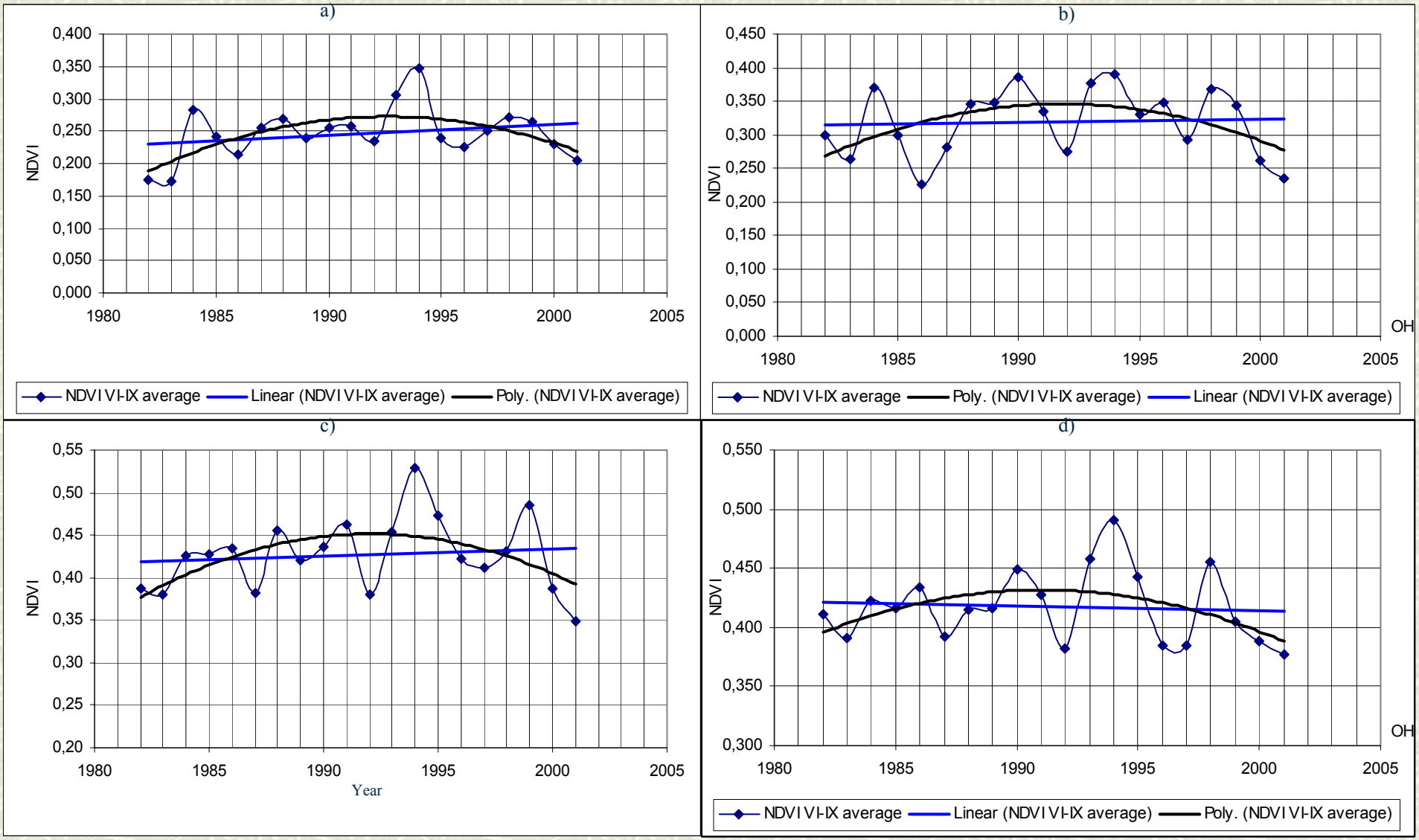
$$\Delta h = h_{\text{natural in anthropogenic period}} - h_{\text{anthropogenic period}}$$



Changes of runoff coefficients in river basins

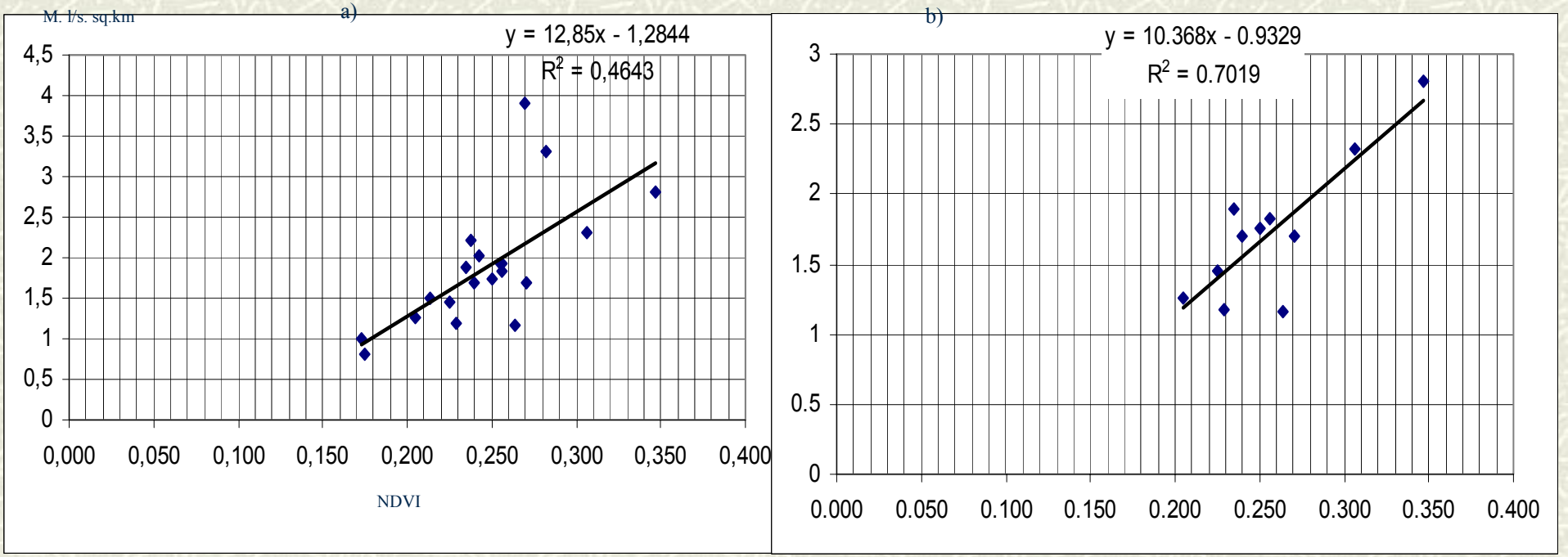


Changes of evapotranspiration in river basins

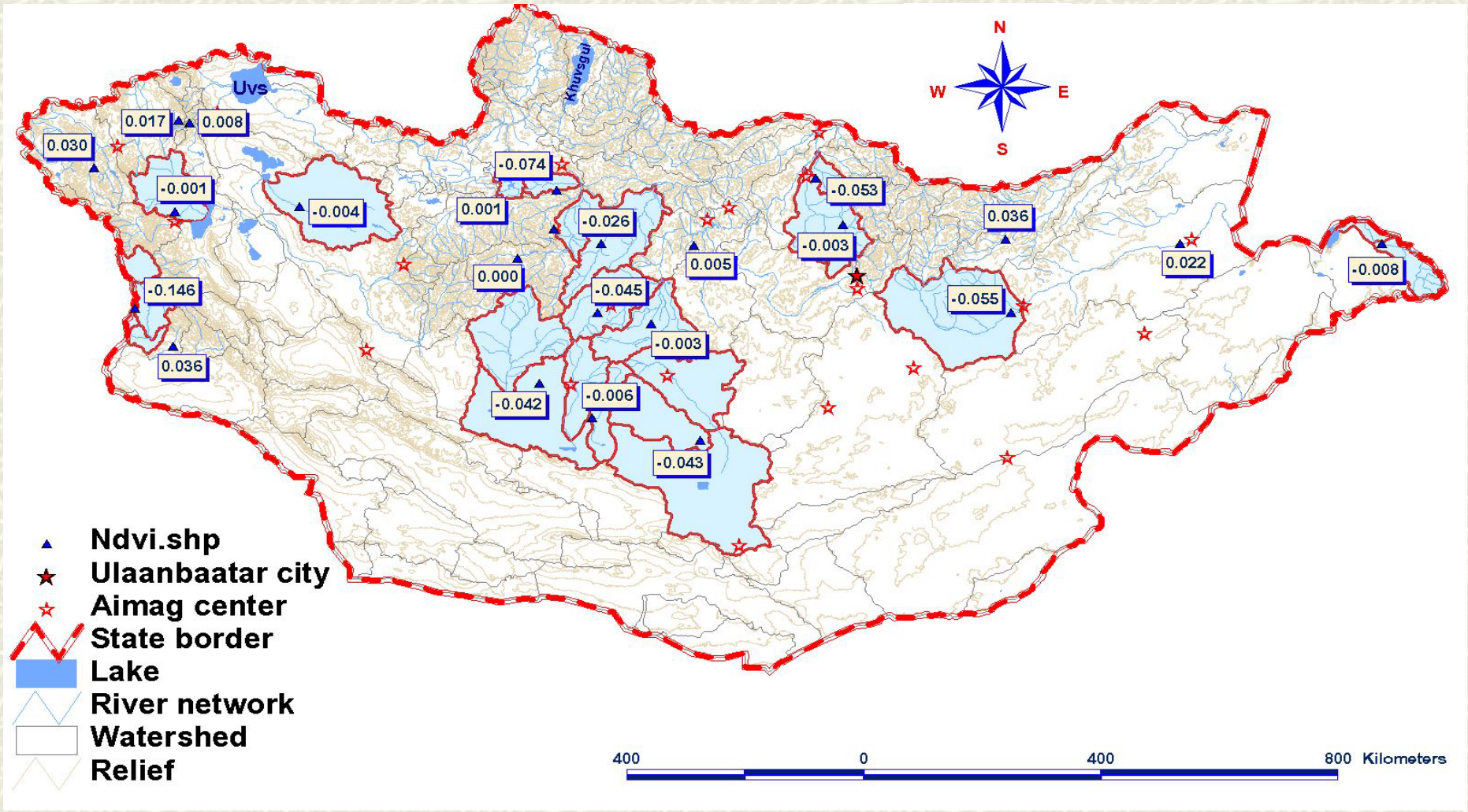


Dynamics of average values of NDVI in June-August period and in river basins of various region

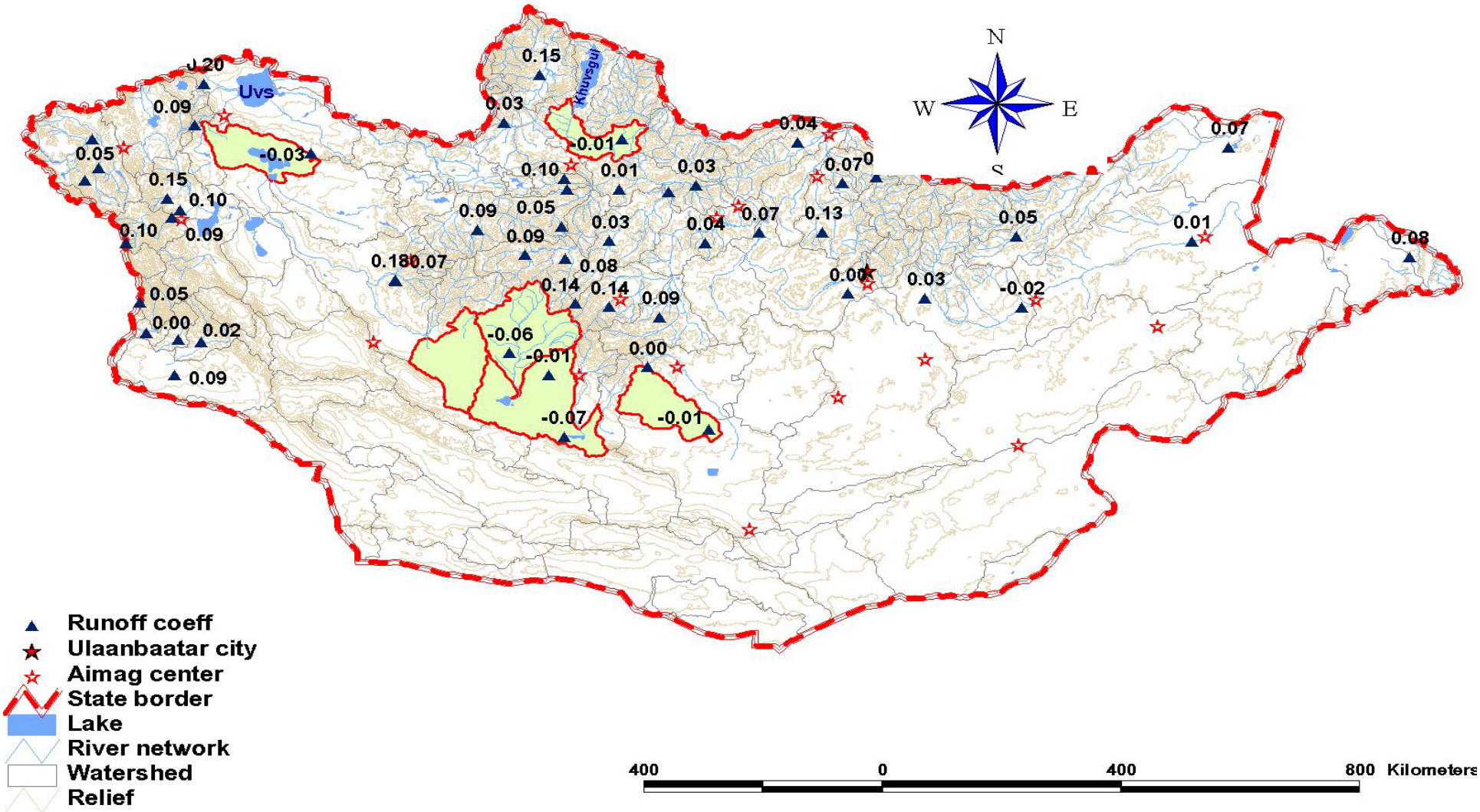
a- Bulgan river at Bulgan soum, b- Khalkh river at Sumber soum, c-Kherlen river at Undurkhaan, d-Ider river at Zurkh bag



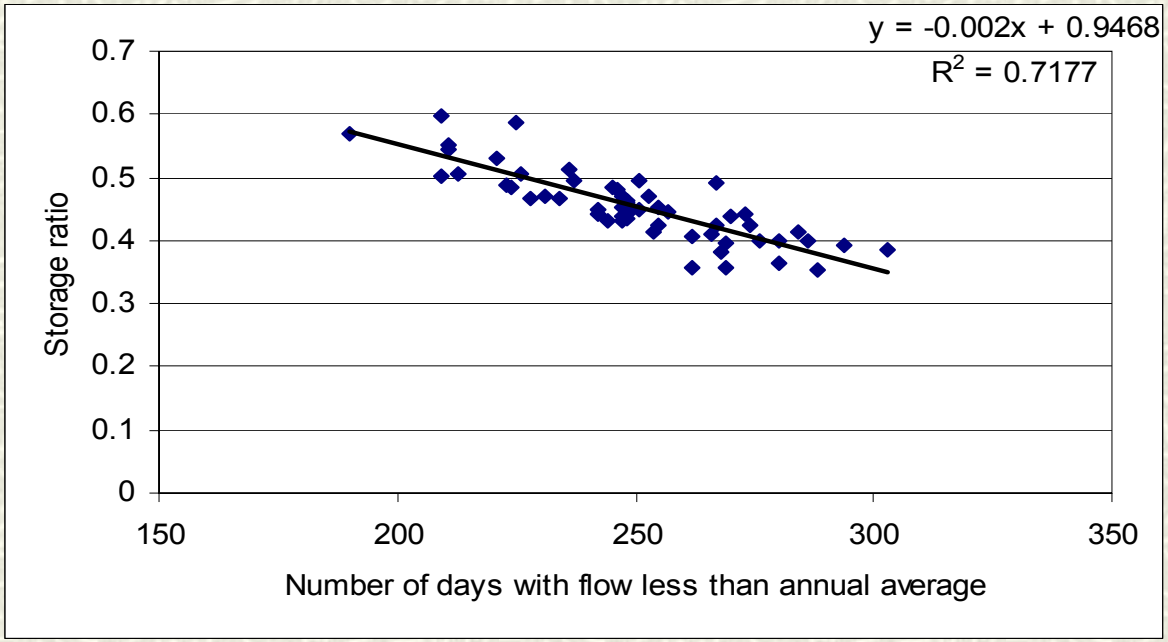
The relationship between average values of NDVI in June-August and annual average of specific discharge of the river Bulgan at Bulgan soum in 1982-2001, *a- in 20 years, b- after 1991*

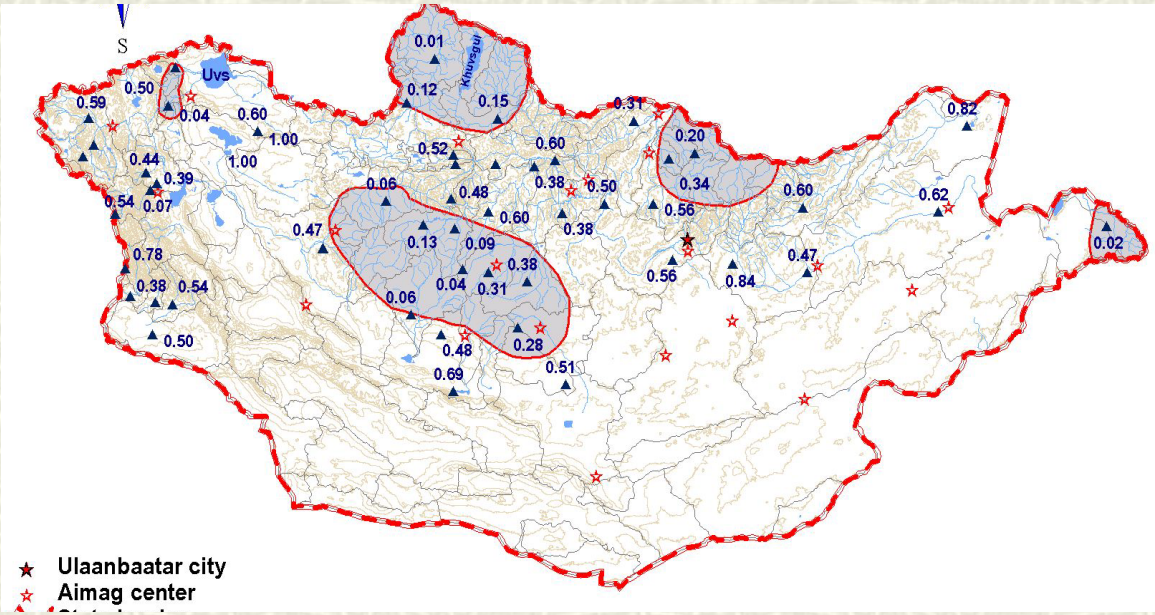


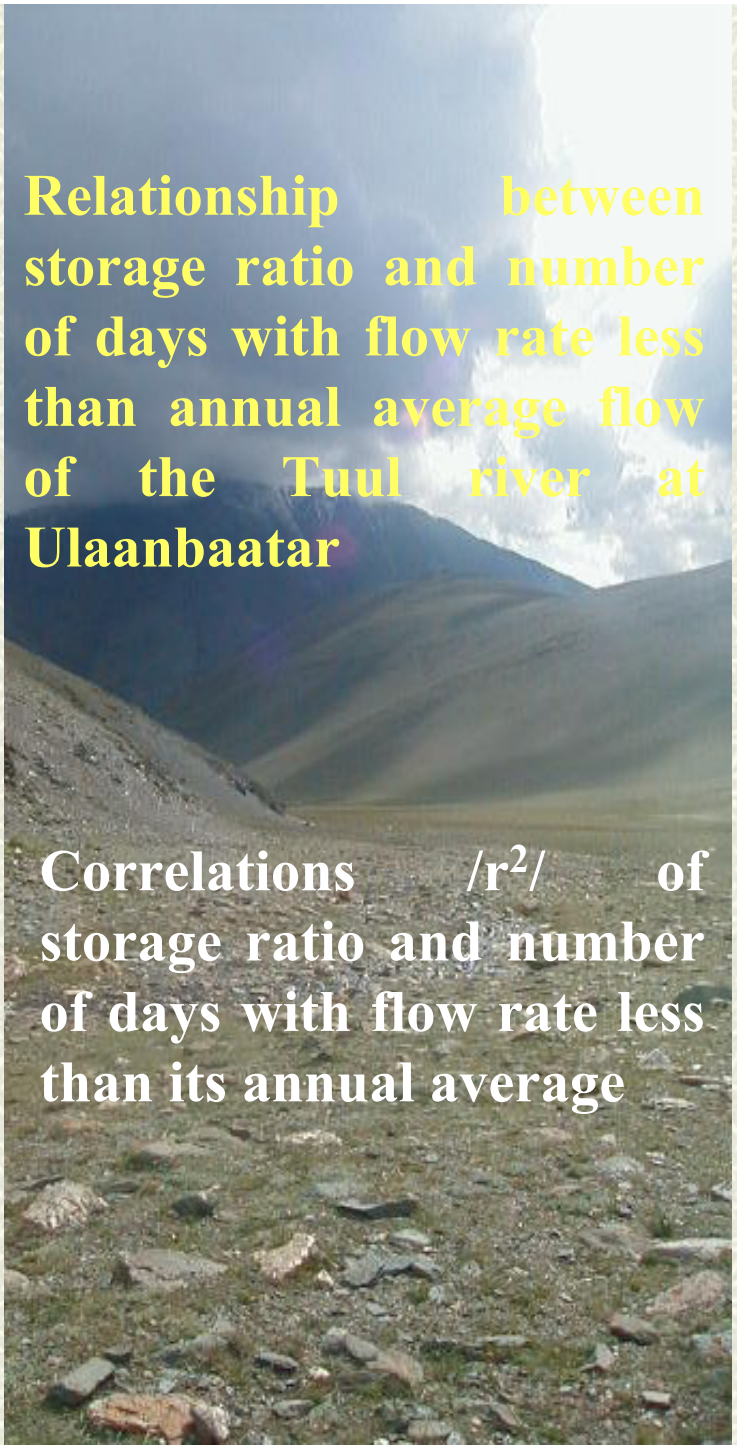
Changes in average values of NDVI during the period of June-August in 30-60 years



Changes in storage ratio indicating water regulating capability in 1982-2001 period

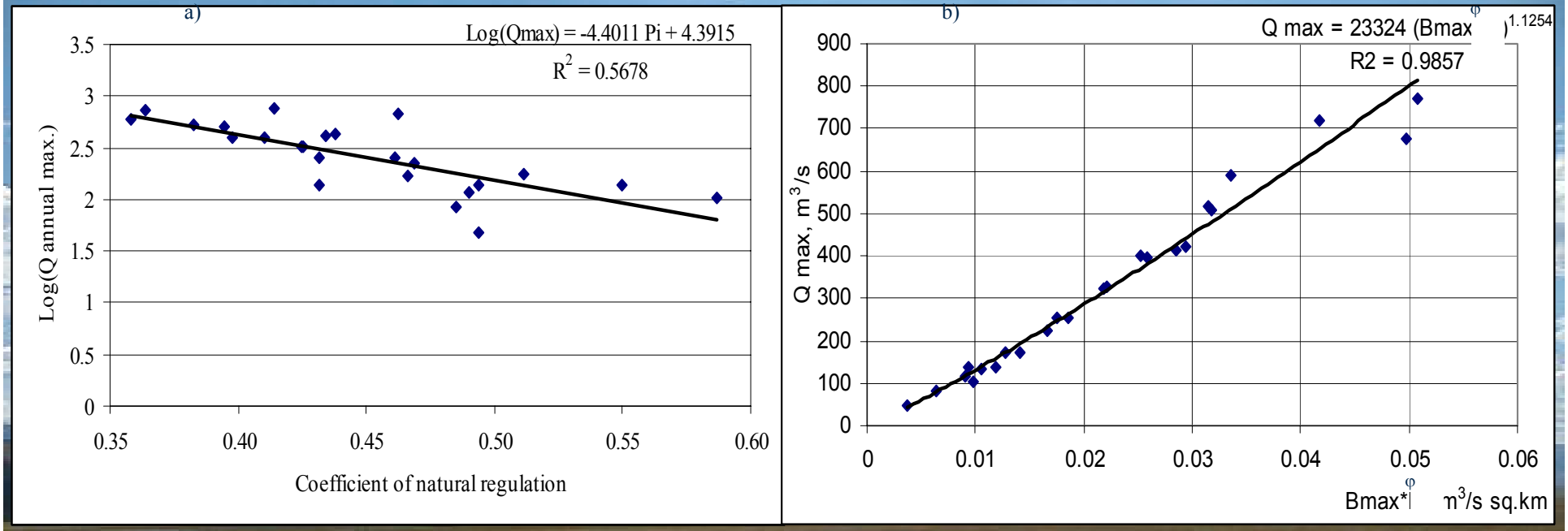






Relationship between storage ratio and number of days with flow rate less than annual average flow of the Tuul river at Ulaanbaatar

Correlations /r^2/ of storage ratio and number of days with flow rate less than its annual average



Relationships between annual maximum discharge and storage ratio (a), and specific discharge (b) for Tuul river at Ulaanbaatar

For the Tuul river, Q_{max} can be estimated by following empirical equation:

$$Q_{max} = 23324 \cdot (B_{max} \cdot \varphi)^{1.1254}$$

where, Q_{max} is annual maximum discharge, cub.m/s, B_{max} is specific discharge, which is function of climate variables, cub.m/s sq.km, φ is storage ratio of the Tuul River.

Future challenges

Glaciers are retreating due to climate change.

Analysis of water balance elements of lakes and storage ratio and runoff coefficient series of river basins show that water regime changes occurring in river basins of Mongolia. Changes in natural components such as forest, vegetation and soil cover leading to predominantly changes in hydrological regime. However, more detailed studies are urgent issues for Mongolia.


THANK'S ALL