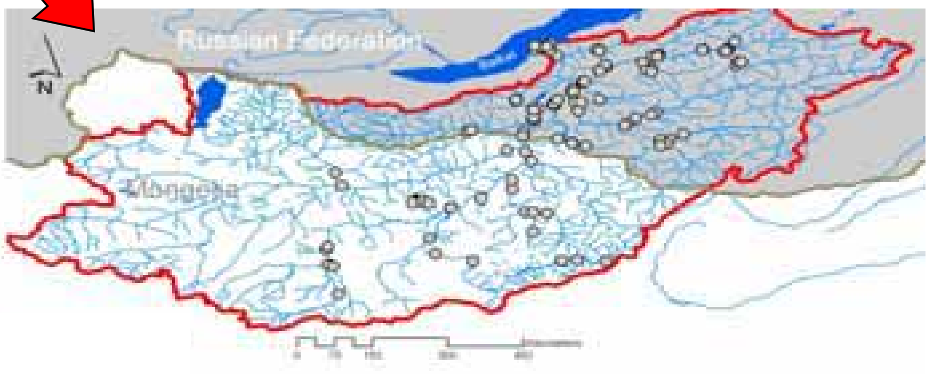
Faculty of Geography Lomonosov Moscow State University (Russia)
Russian-Mongolian biological expedition RAS-MAS (Russia)
Helmholtz Centre for Environmental Research (Germany)
Institute of Geography, Mongolian Academy of Sciences (Mongolia)
Baikal Institute of nature management (Russia)
Stockholm University (Sweden)

Monitoring and modelling of sediment transport in Selenga transboundary river system

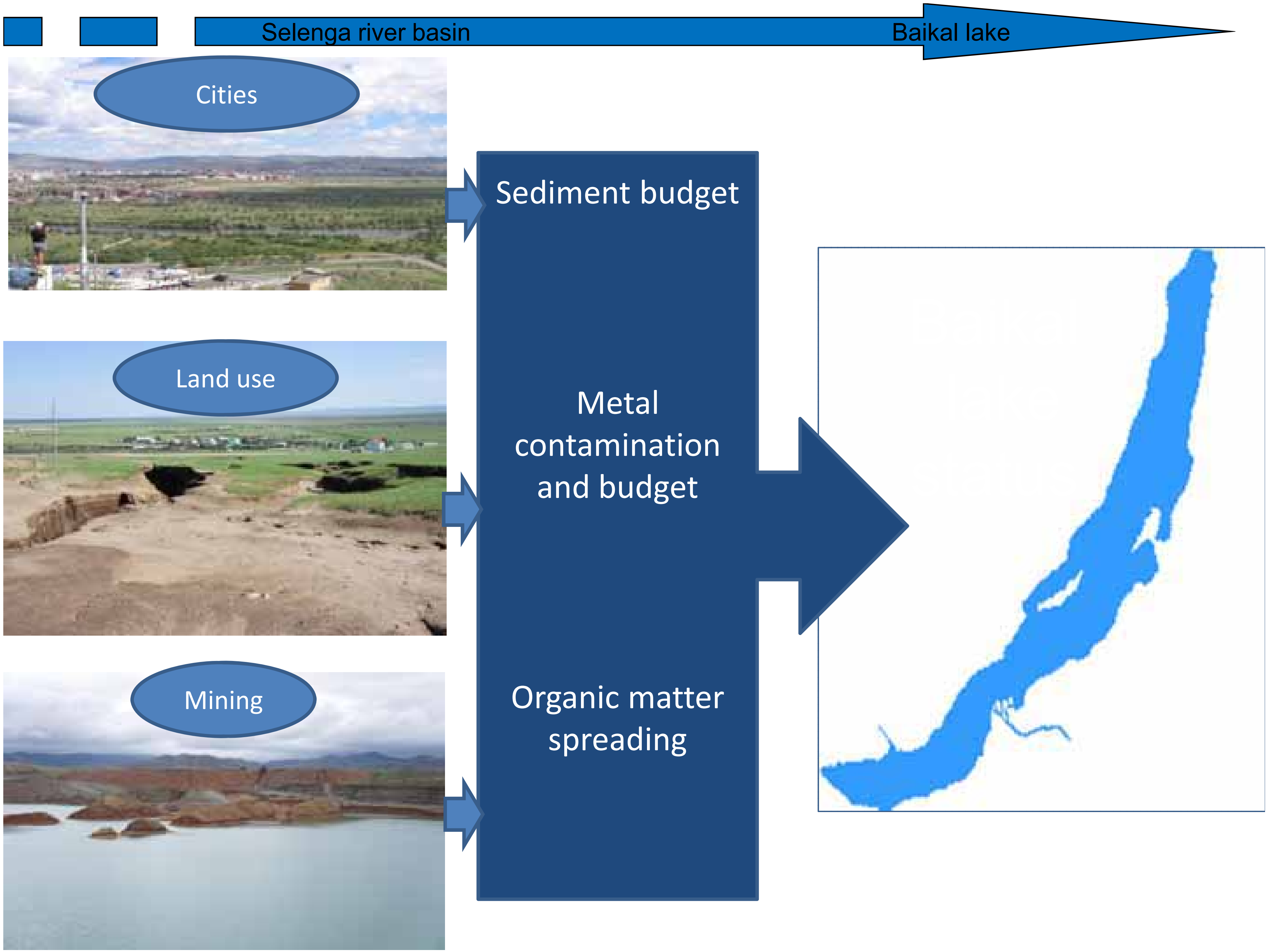
Sergey R. Chalov,
Nikolay I. Alexeevsky,
Ekaterina V. Belozerova,
Phillip Theuring,
Daniel Karthe,
Endon Garmaev

Transboundary rivers of Russia

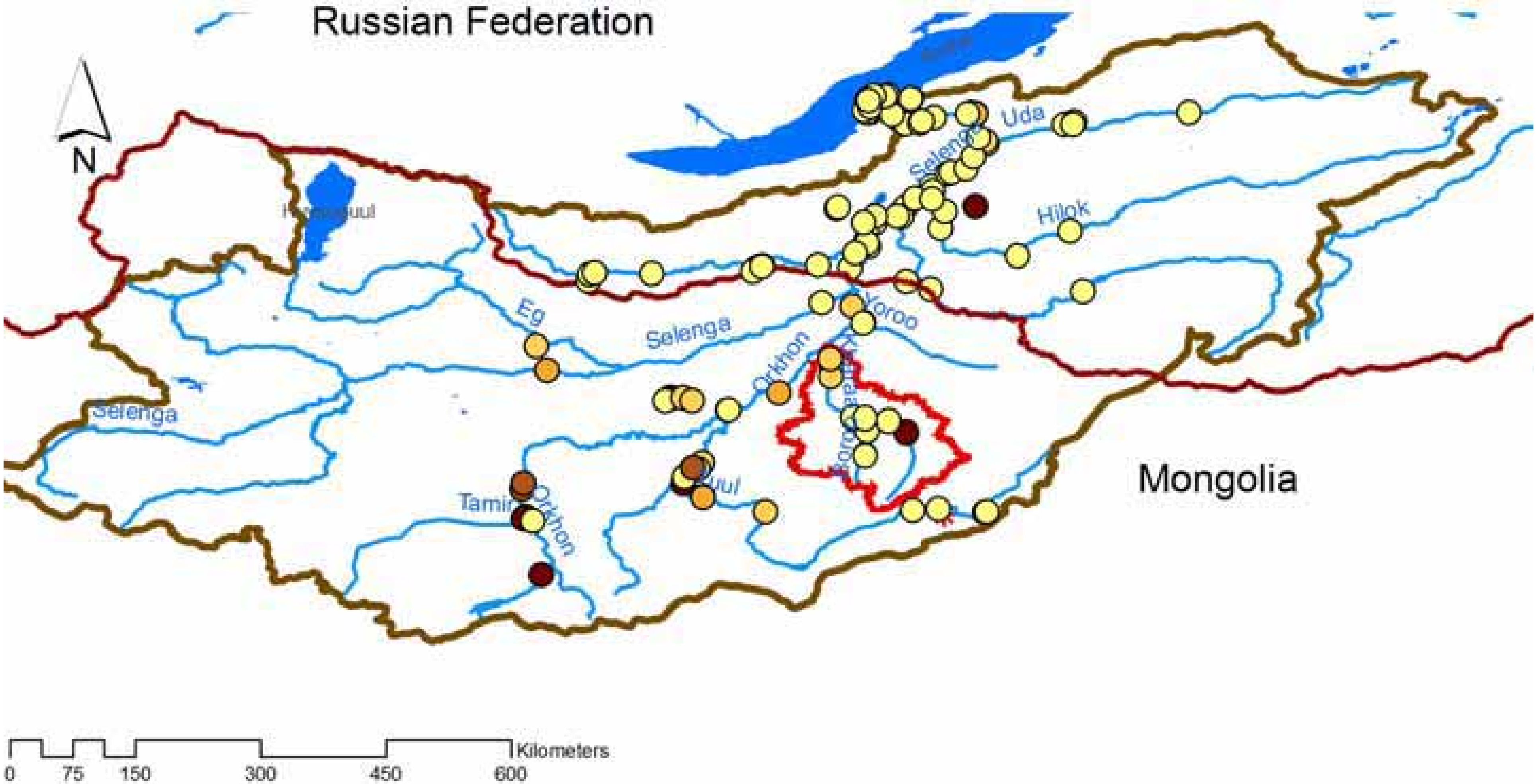
Foreign parts of Russian transboundary rivers

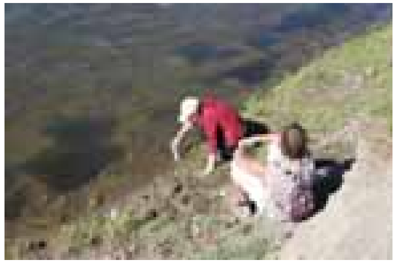


Selenga-Baikal drainage area case study


Selenga river basin
Baikal lake
Cities
Land use
Mining
Sediment budget
Metal contamination and budget
Organic matter spreading

Field campaigns 2011-2012

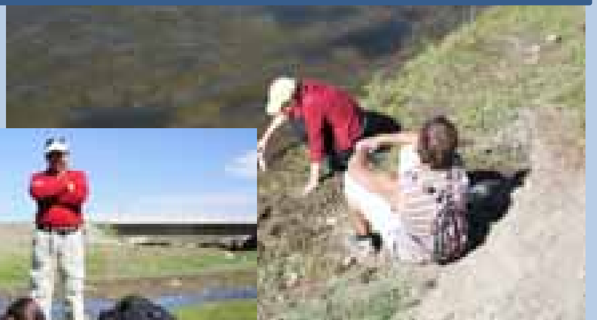


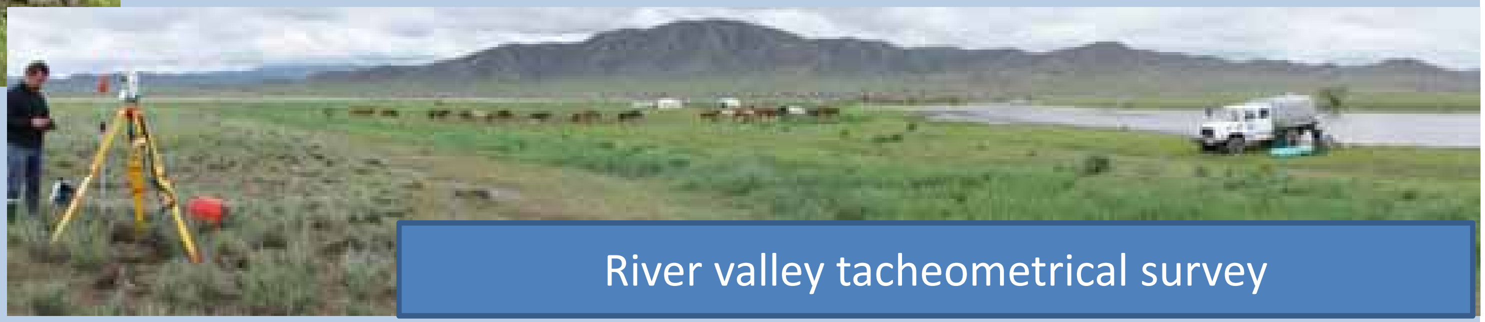



Flow measurements

Suspended and bed load measurements

Geochemical studies

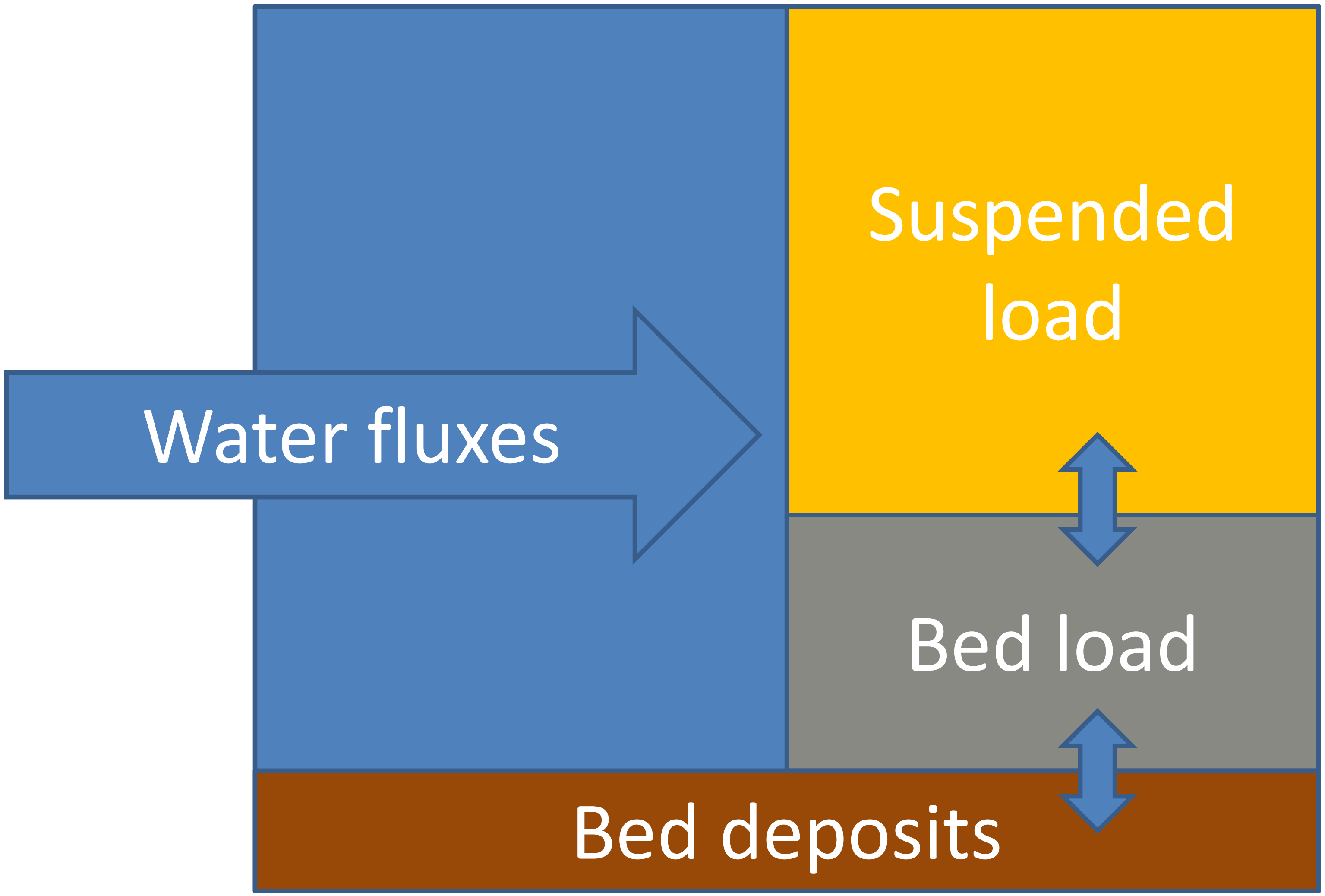




Vertical compose suspended sediments determination

River valley tacheometrical survey

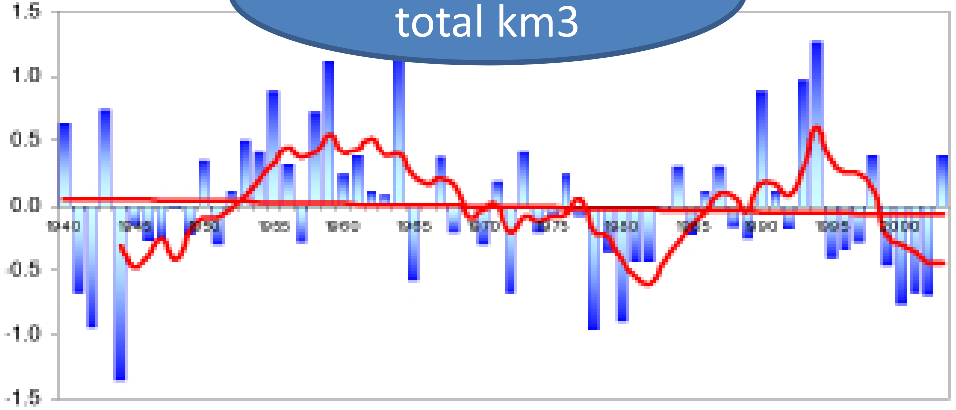
Principal approach to field campaigns



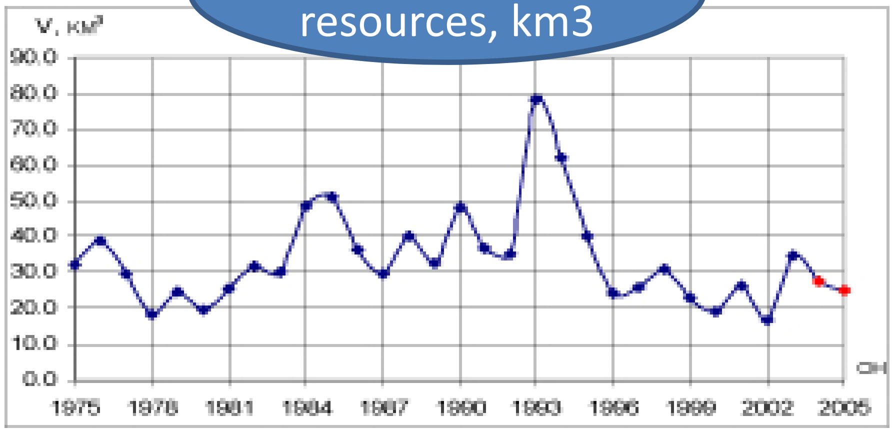
Hydrological conditions

over Mongolia

Precipitation total km3



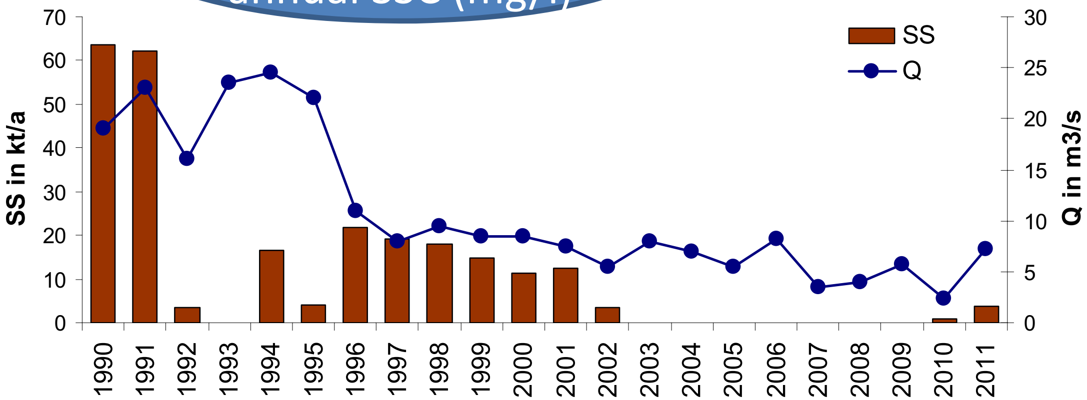
Surface water resources, km3



Batsukh et.al, 2008

Kharaa basin

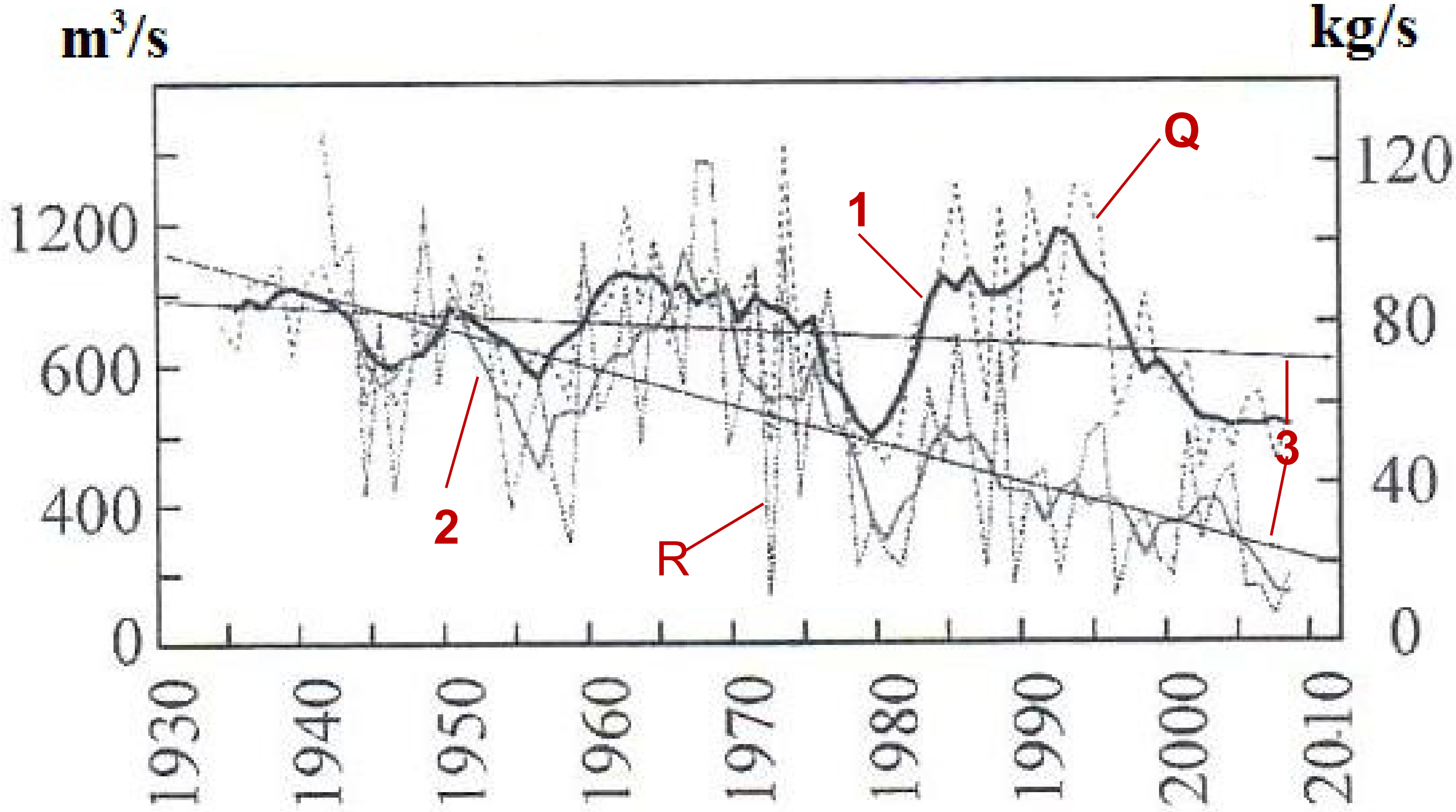
Surface water runoff (km3) and annual SSC (mg/l)



Hydrological conditions

over Russia

(by Potemkina, 2011)

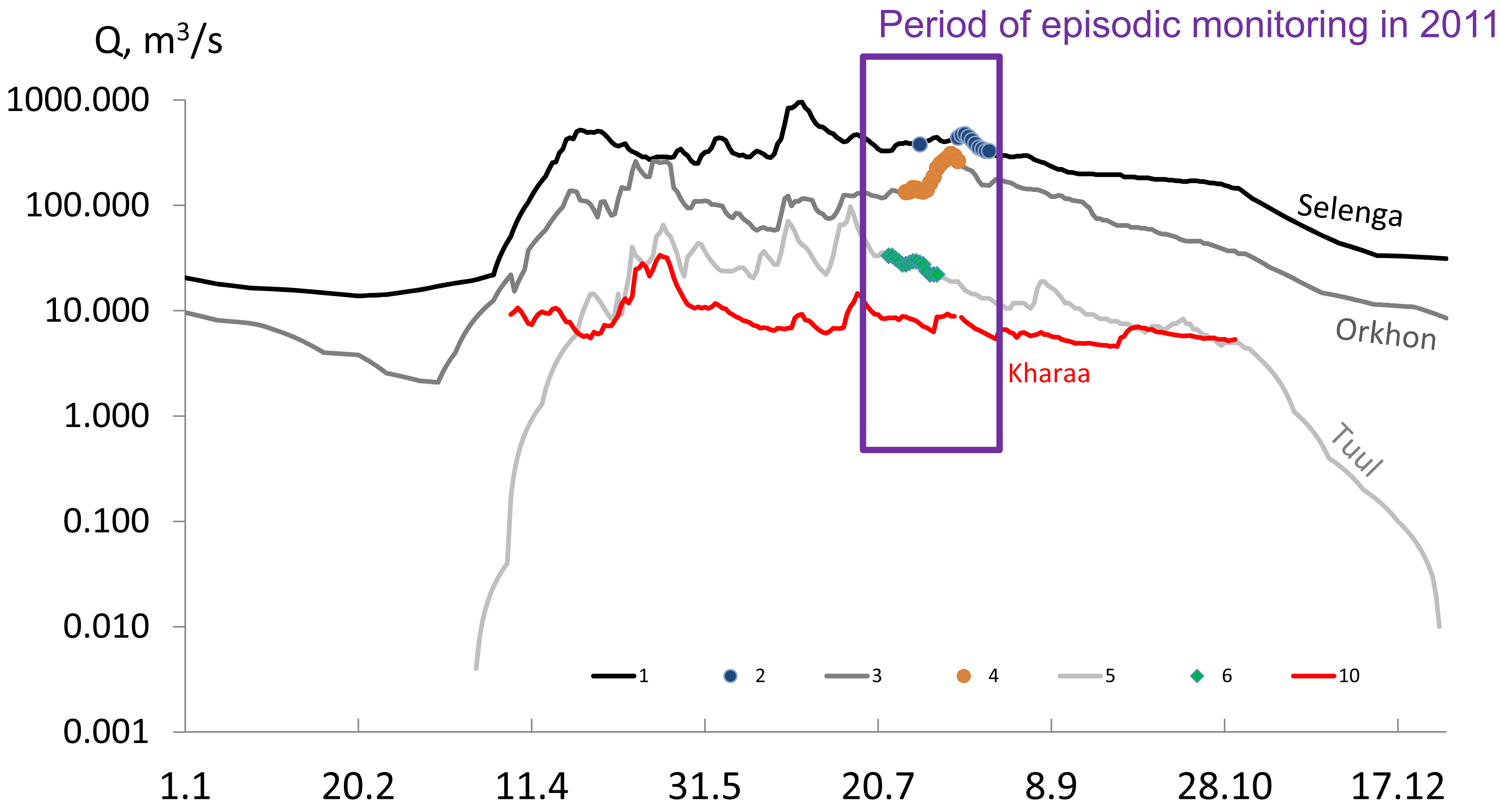


Q – water discharge
1 – average for 5 years

R – suspended sediment load
2 – average for 5 years

3 – linear trends

Integrating continuous meso-scale (red) and episodic large-scale monitoring

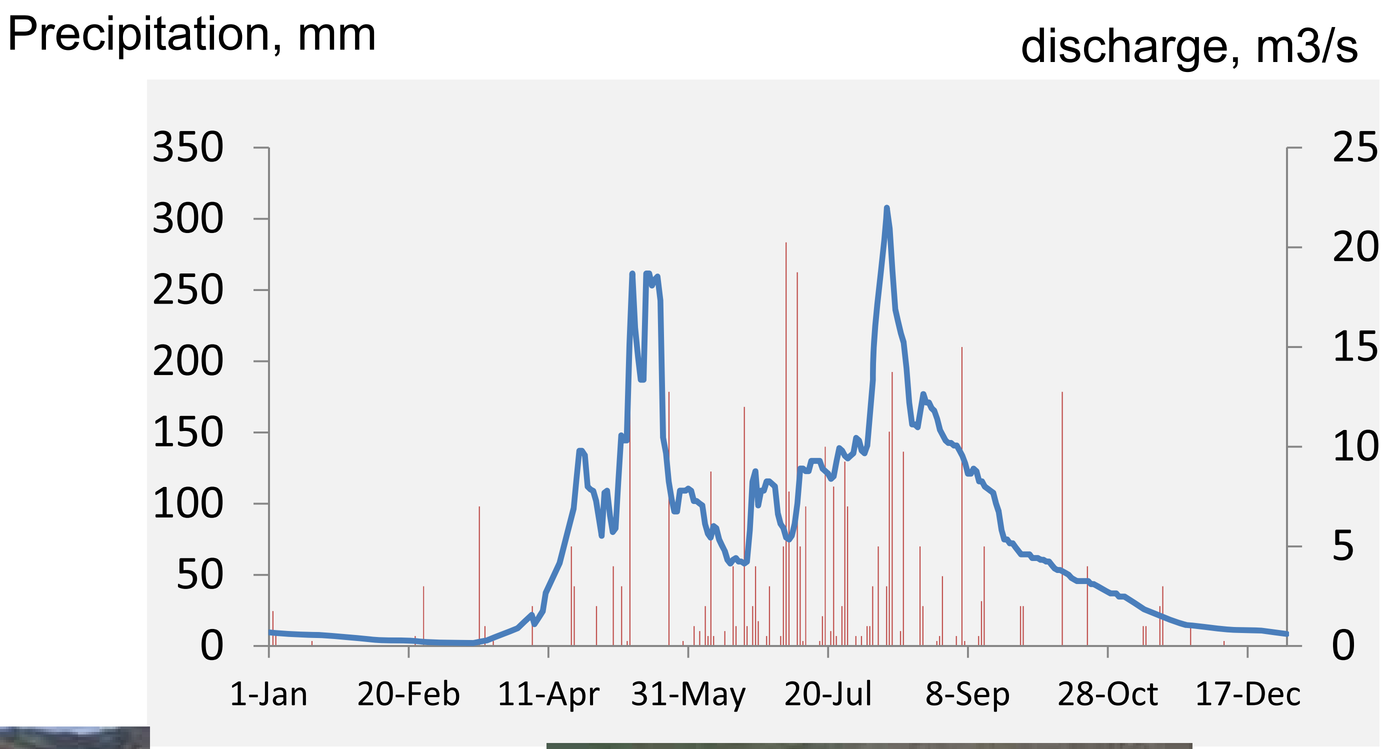


Human impacts: pollution and water consumption

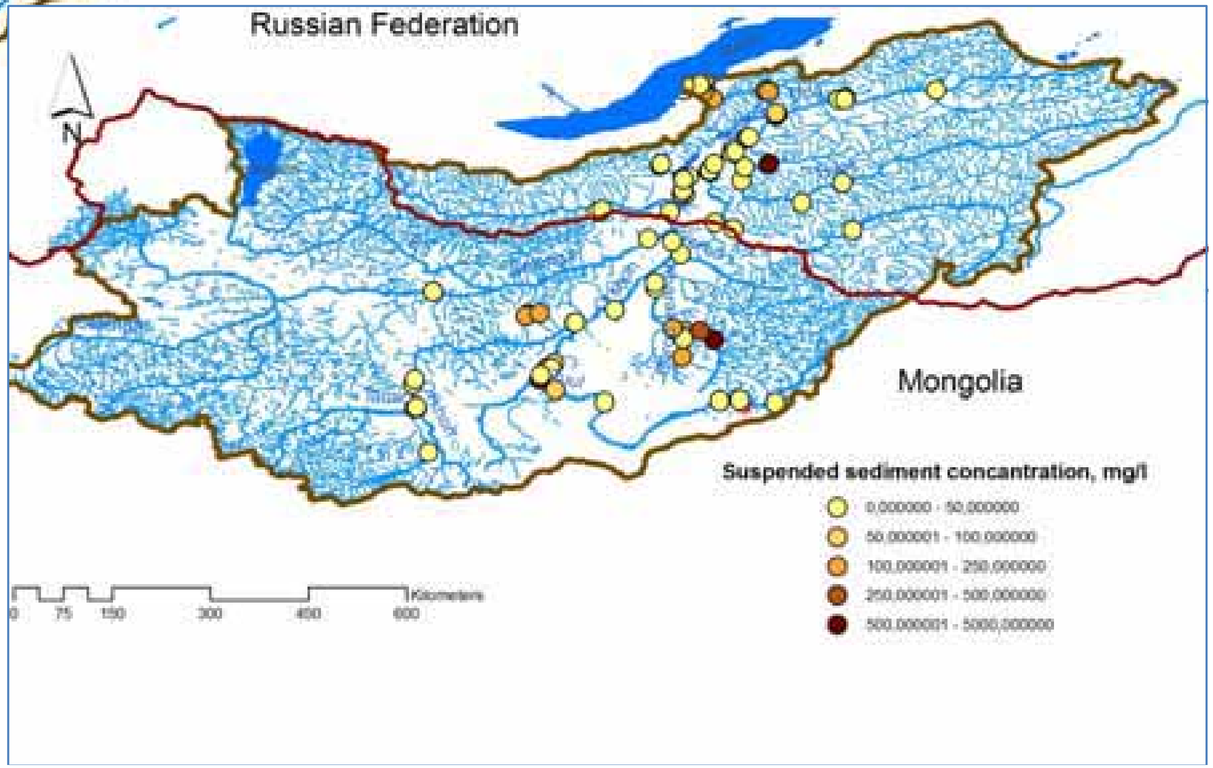
Sectors that use water and associated total water use (million m3)	
1. Drinking water supply	71.35
2. Agricultural water	
Livestock	71.00
Crop irrigation	52.28
3. Exploitation industry	
Extractive mining industry	35.8
Industrial water supply, Energy production,	93.8
Energy production, Power plants	27.6
Hydro Power Plant	80.0
3. Tourism water supply (excl. spa resorts)	1.68
4. Green area	0.27
Total:	**433.78**

Batsukh et. al, 2008

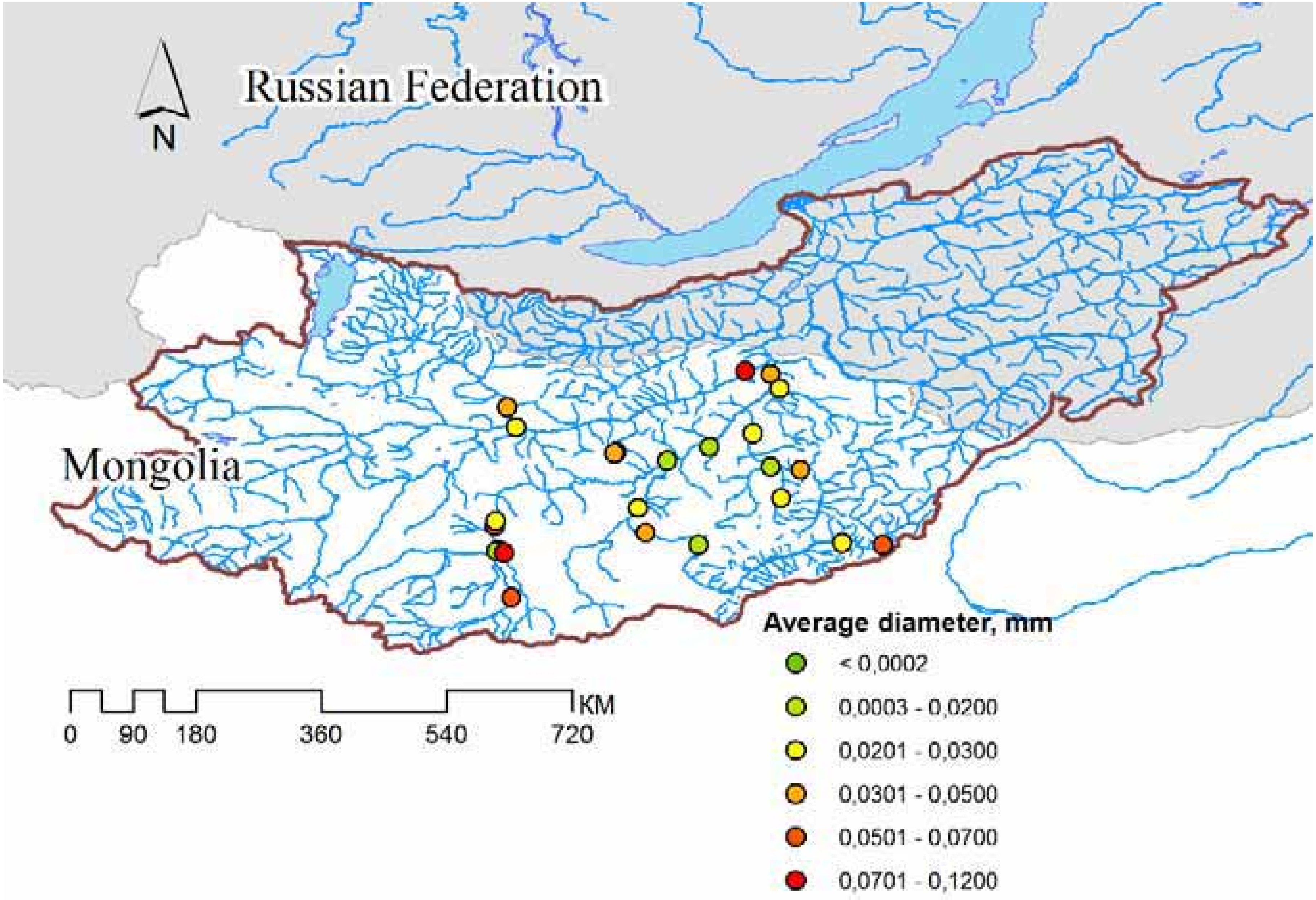
Climate-induced drivers of water and pollutants dynamics



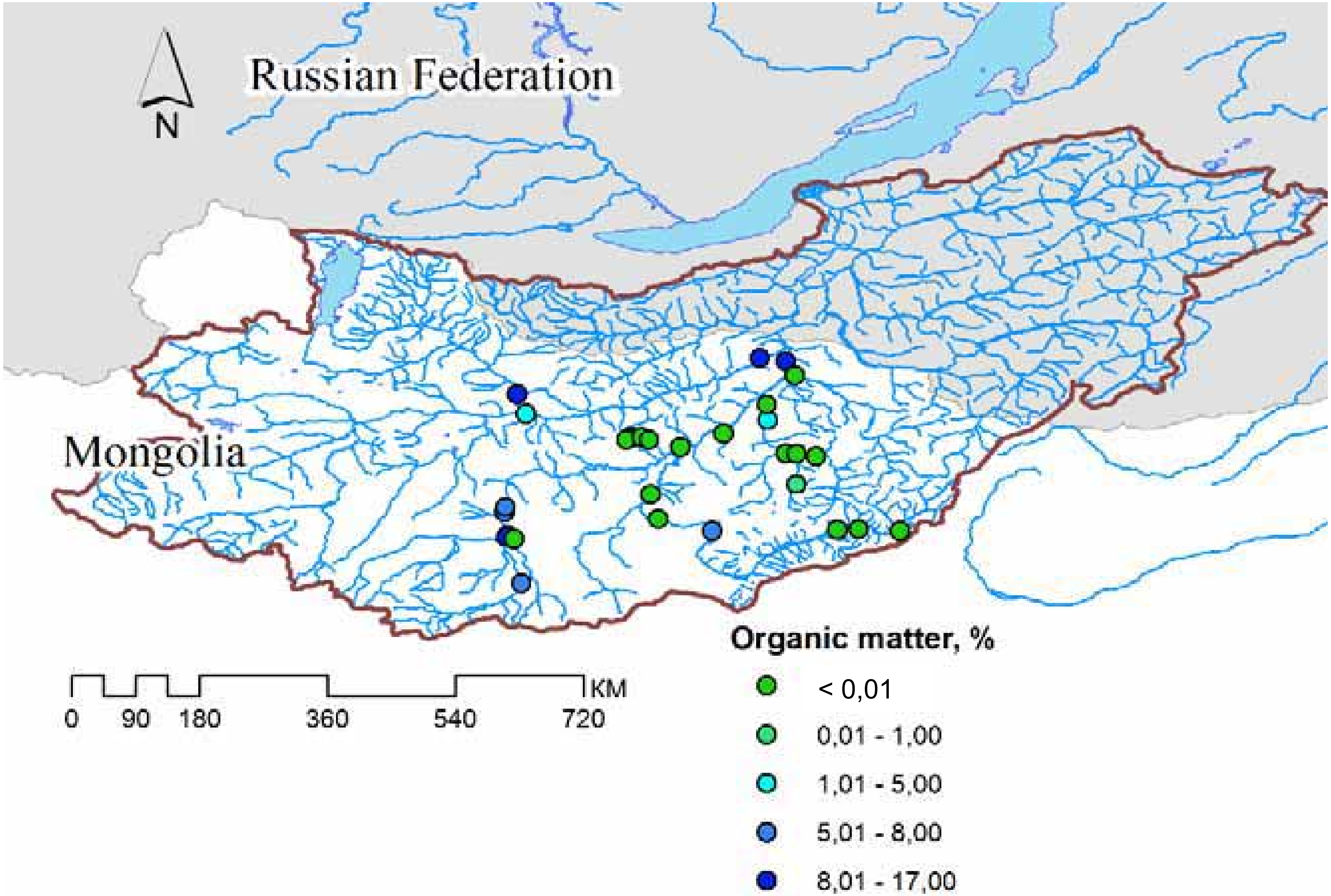
Suspended sediment concentration (SSC) assessment



Suspended sediment grain size



Organic matter content

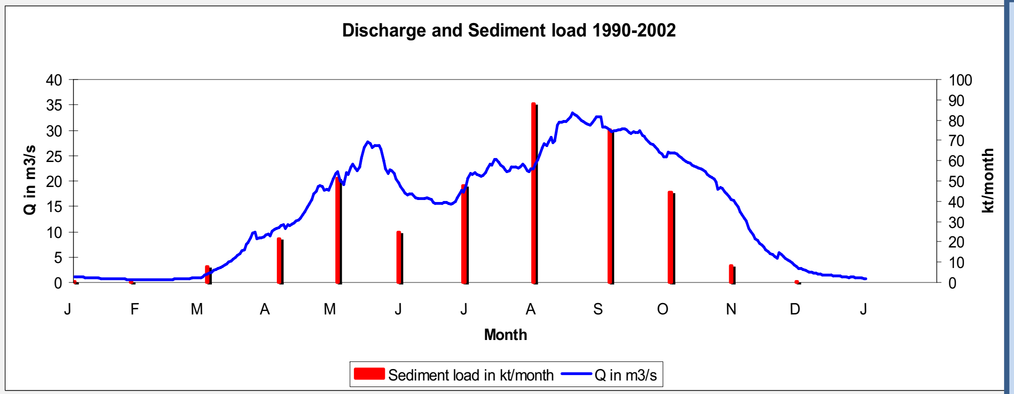


Reliability for annual sediment yield for Selenga river basin (2011)

Daily sediment discharges SL → Monthly sediment load → Annual yield

Wi = SL * number of days

W = Wi * monthly rating



monthly rating = total sediment yield / monthly sediment load

Example for Kharaa basin

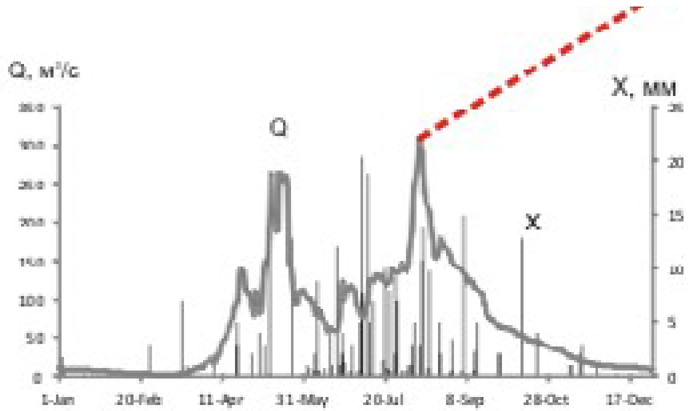
4350 t/year

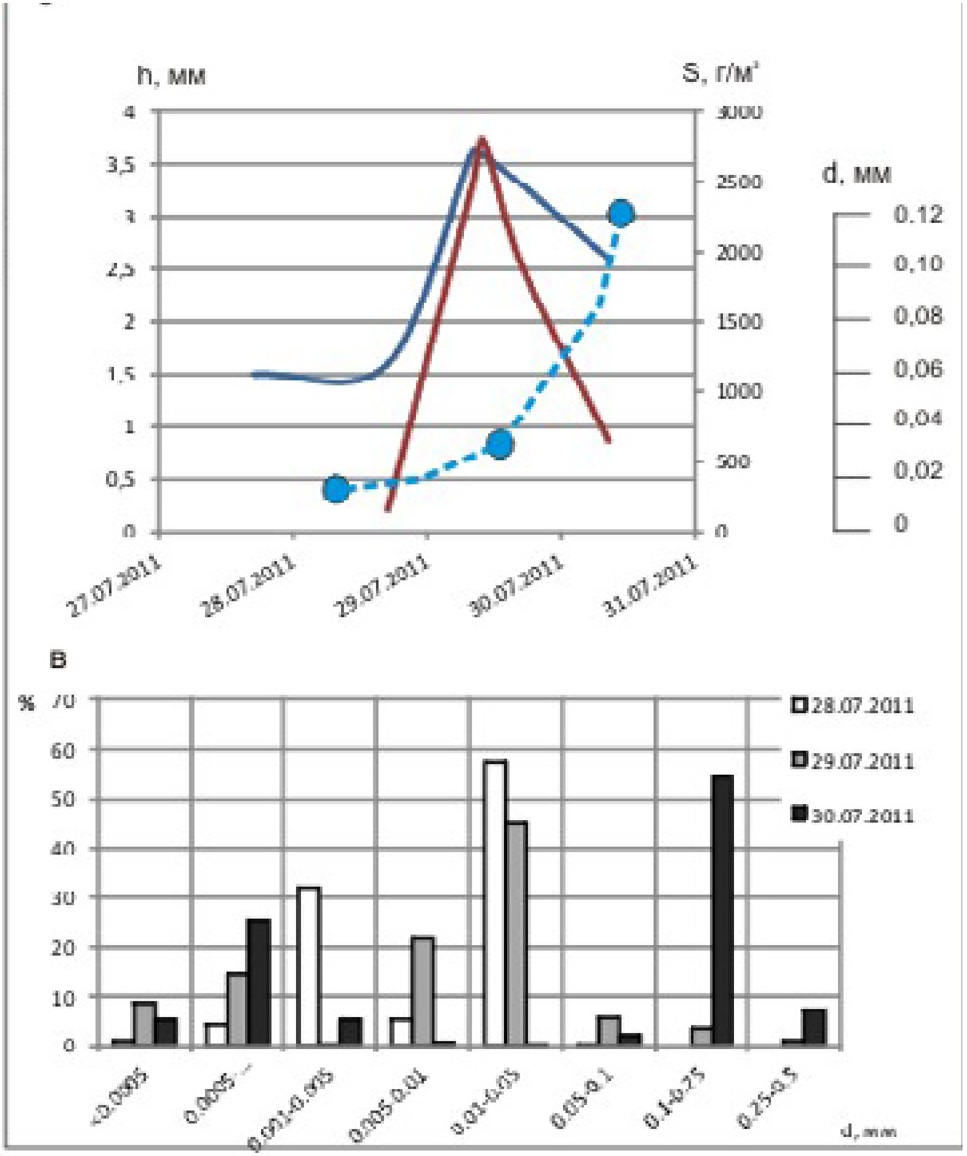
Single measurements in 2011

28600 t/year

continuous monitoring in 2011

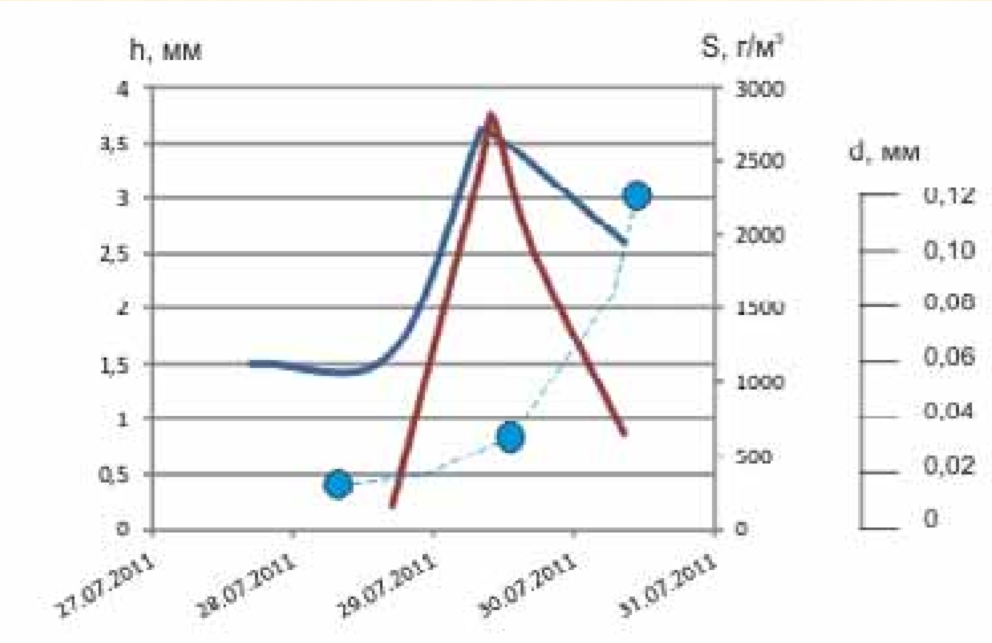
Contribution of storm events

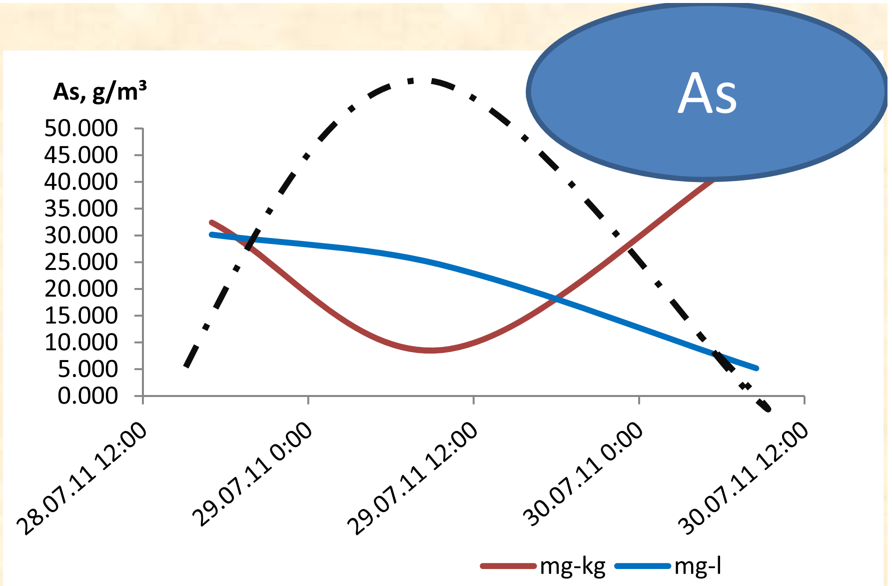


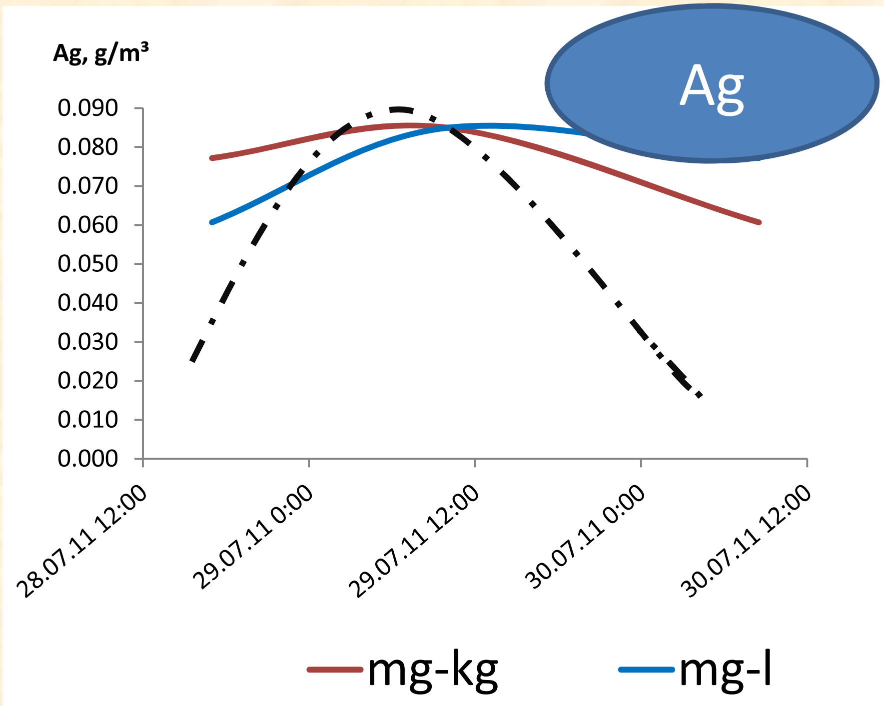


1 – water levels
2 - suspended sediment load
3 – grain size

Storm events signatures in pollutants transport

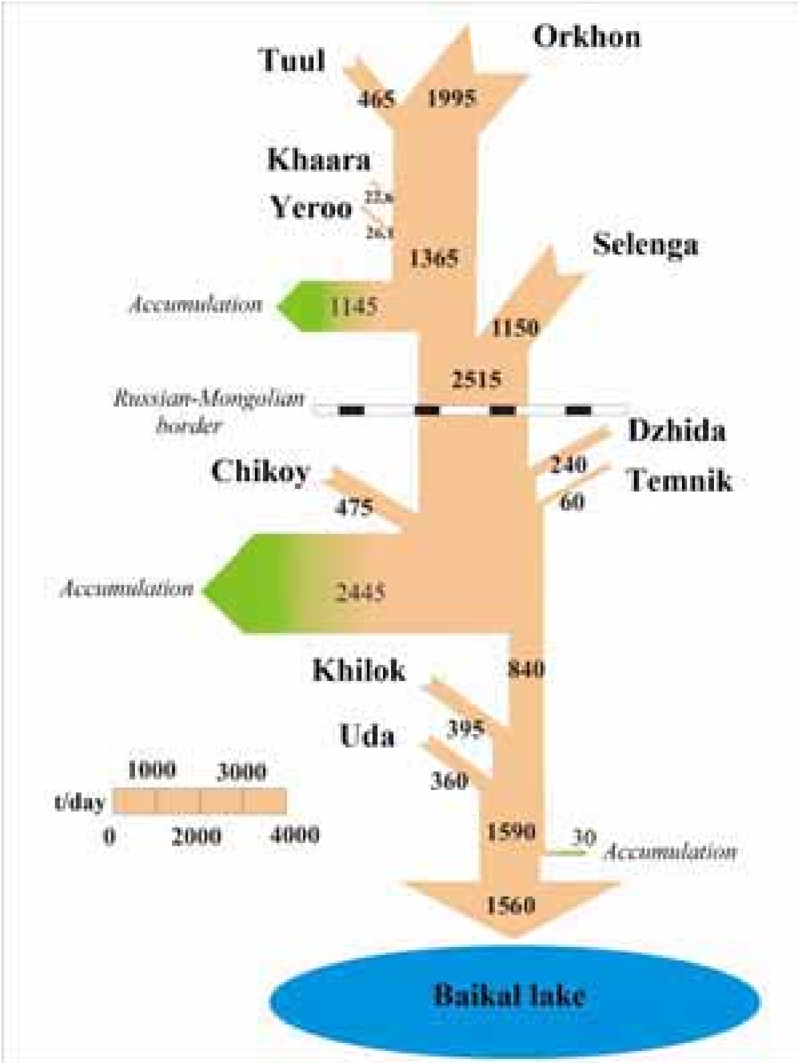






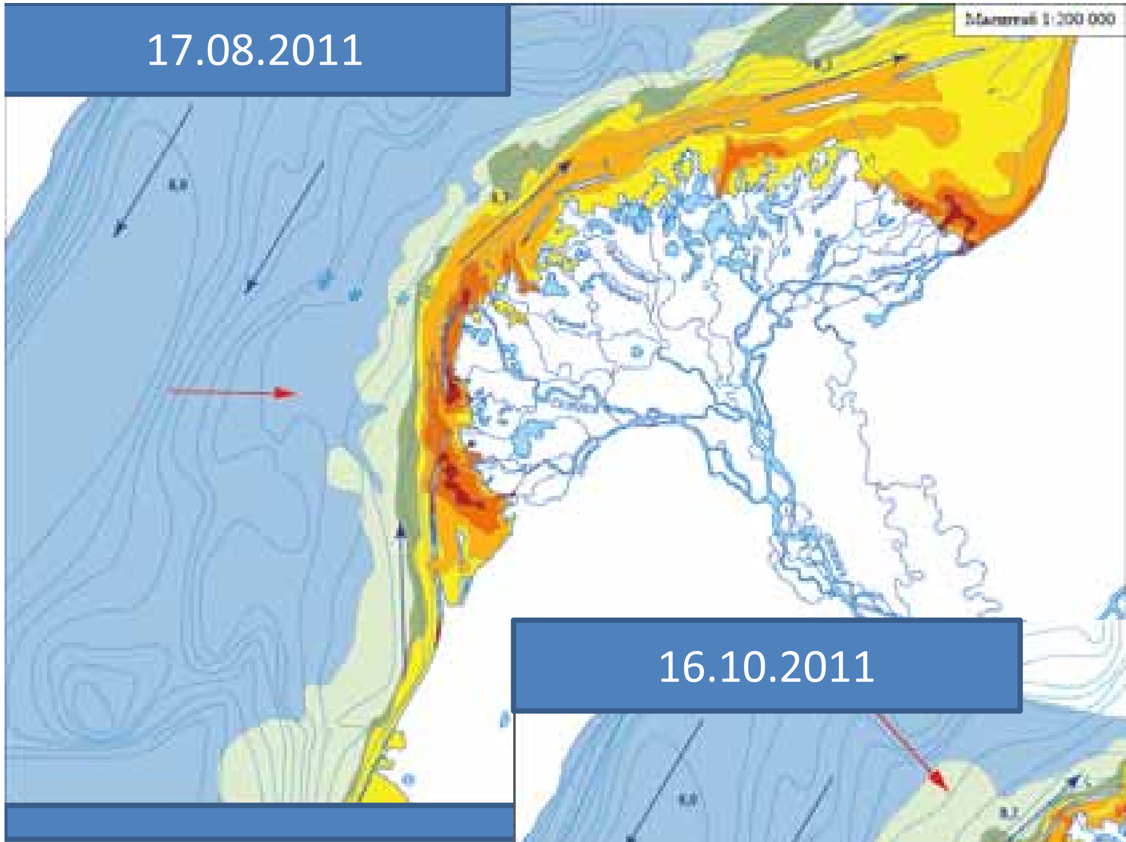
Daily sediment budget calculations for Selenga river basin (2011)

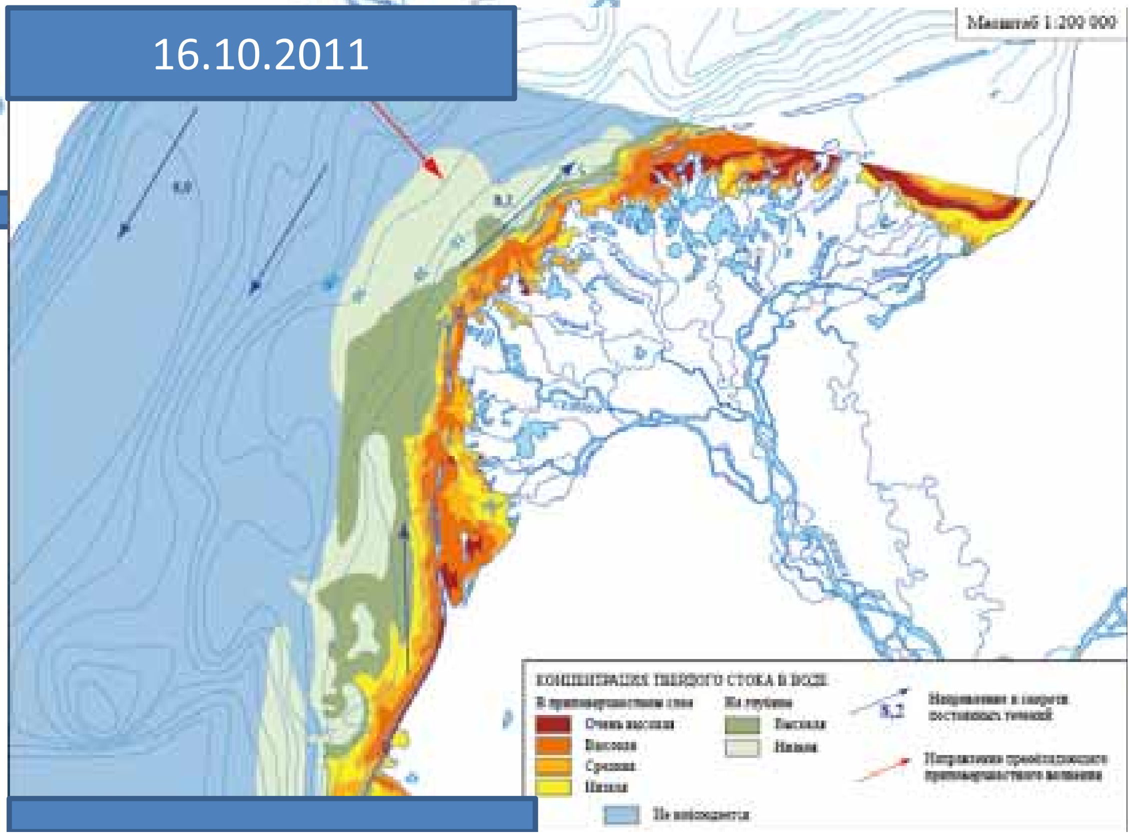
Grain size	Tuul river	Orkon river, middle	Orkon river, low	Selenga
Sandy (>0,05 mm)	7,3 (3,2 %)	237,8 (9,7 %)	265 (19,5 %)	302,3 (26,3 %)
Silt 0,001 – 0,05 mm	210,3 (92,9 %)	1869,6 (76 %)	1048 (76,7 %)	720,9 (62,7 %)
Clay < 0,001 mm)	8,8 (3,88 %)	352,2 (14,3 %)	51,7 (3,79 %)	125,8 (10,95 %)
Total t/day (100%)	226,4	2460	1365	1149



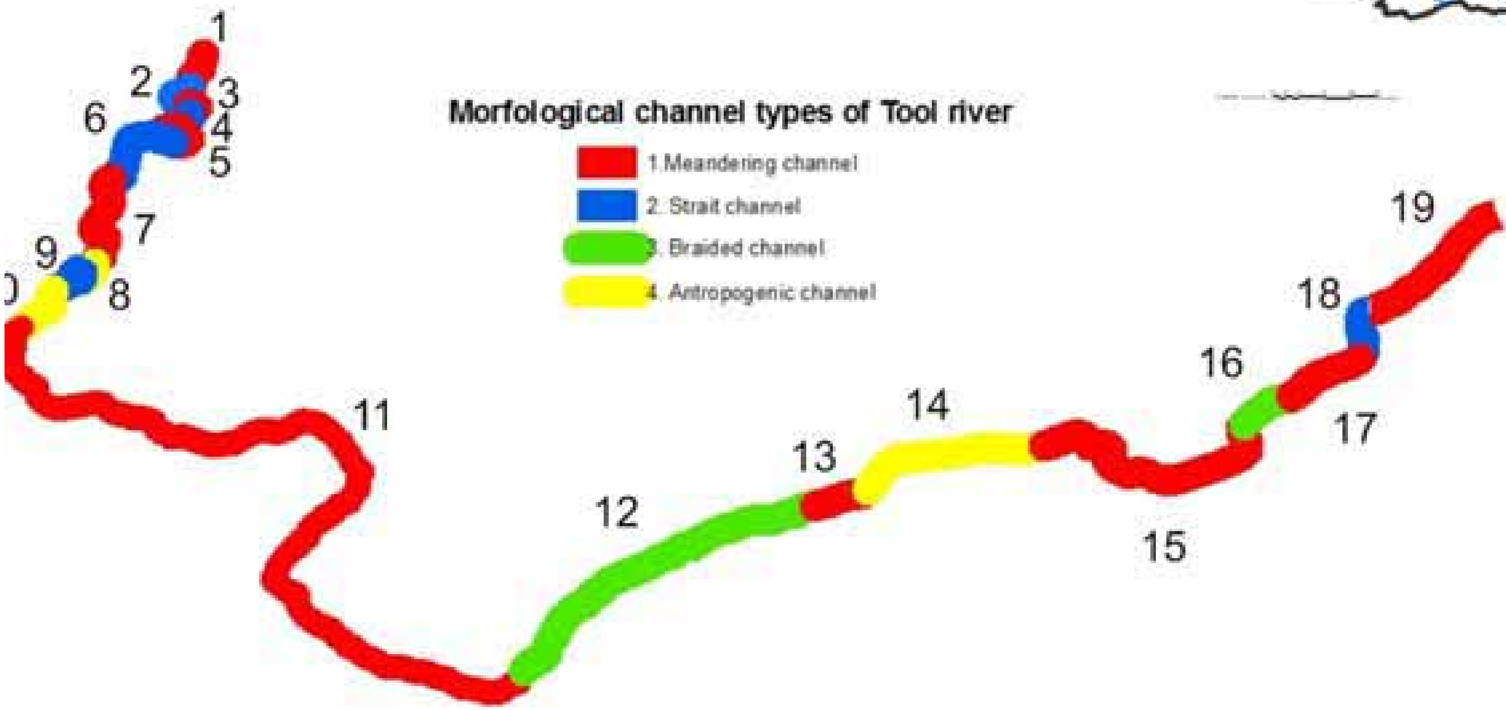
Calculation of sediment load for various grain size classes

Sediment delivery into Baikal lake: Remote sensing application

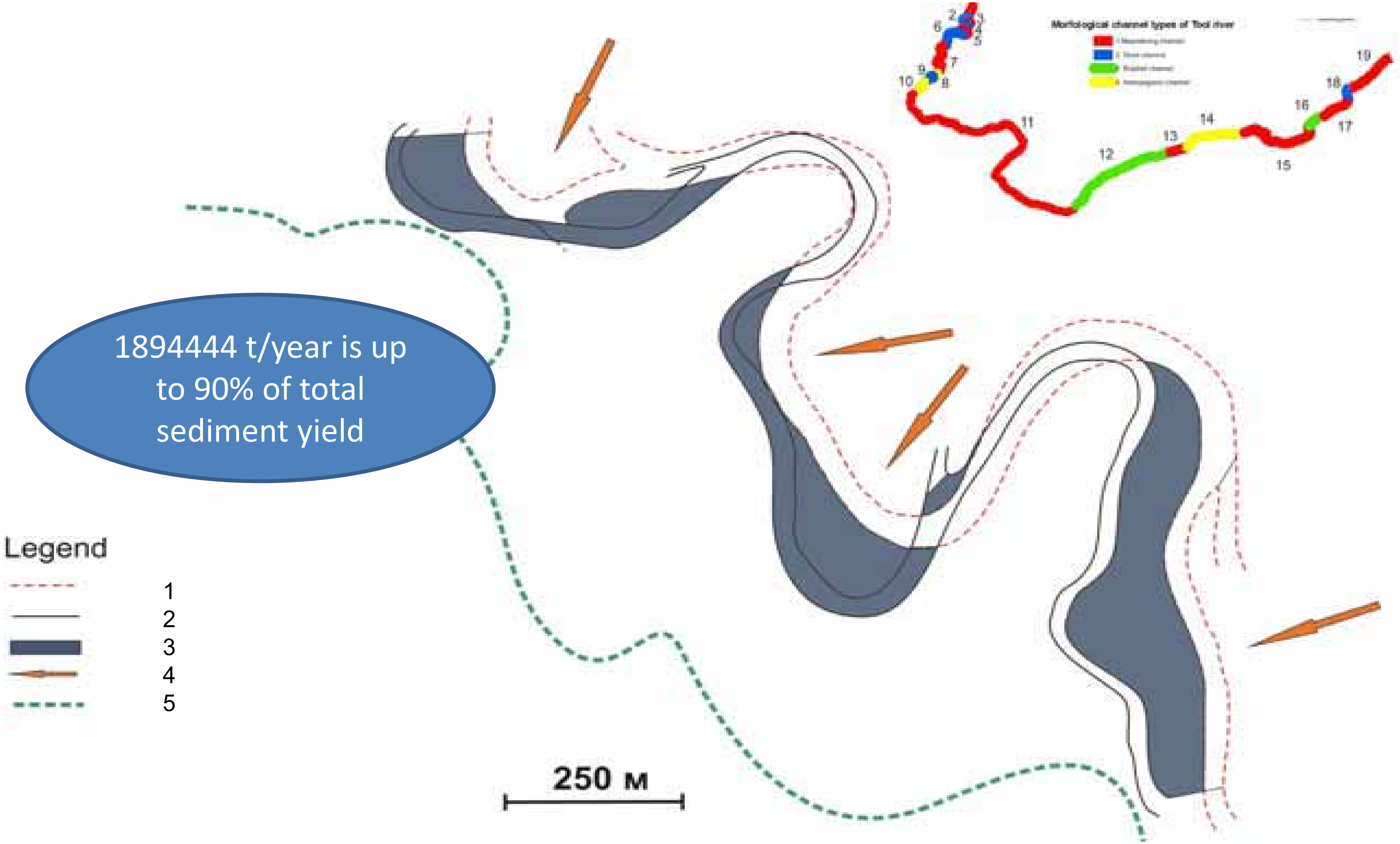




ntribution of channel erosion



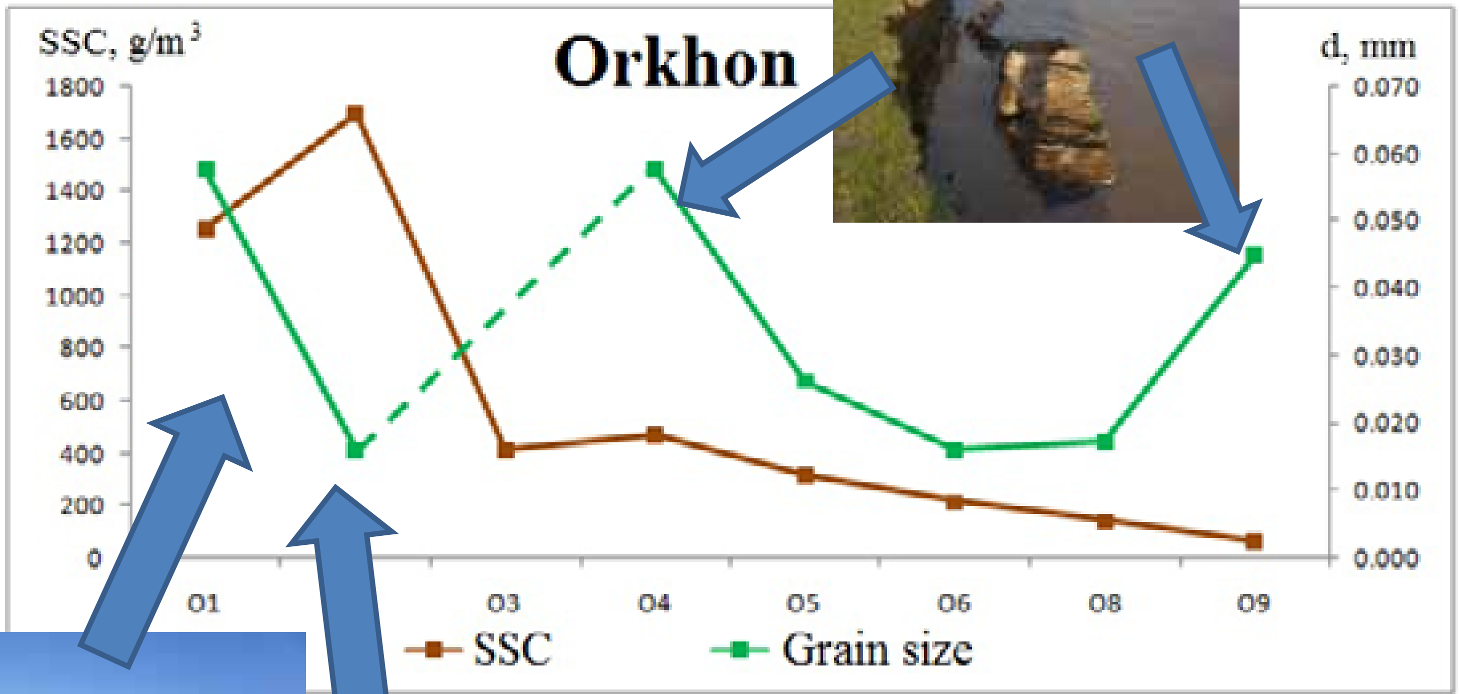
Contribution of channel erosion: Tuul river



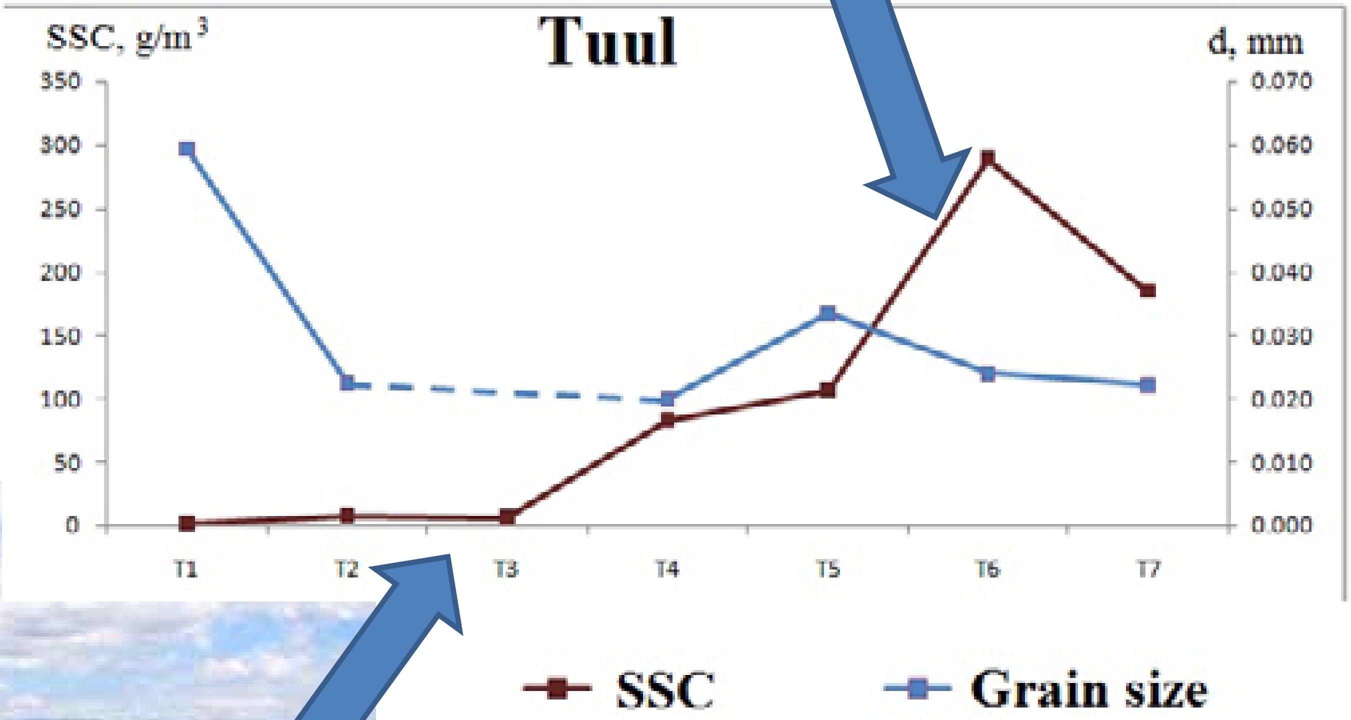
1894444 t/year is up to 90% of total sediment yield

1 – channel in 1970; 2 – channel in 2006; 3 – channel deformations;

Flood at kharkhorin

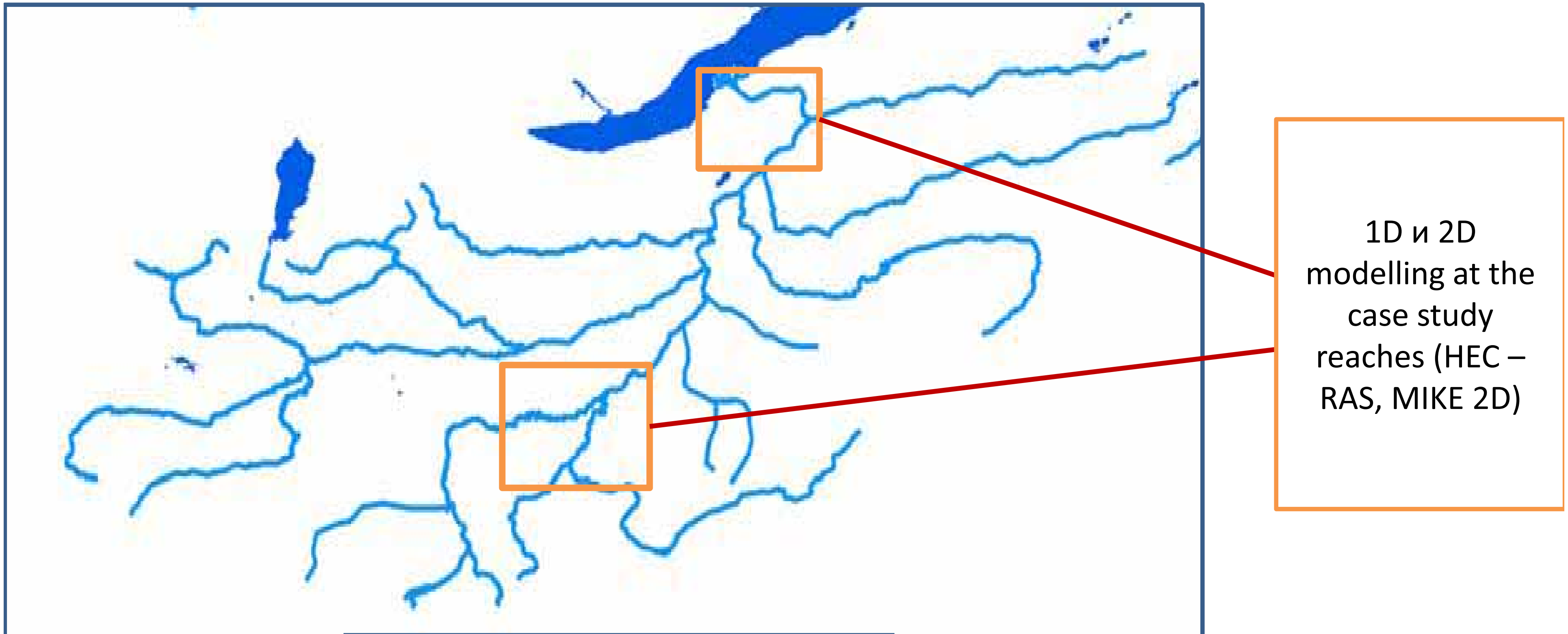


Zaamar gold mining



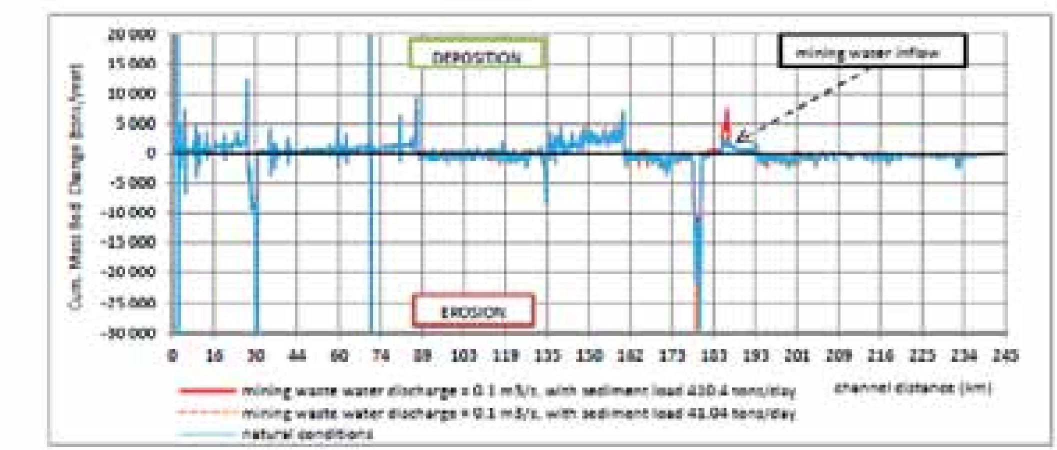
Ulaanbaator

Sediment transport modelling

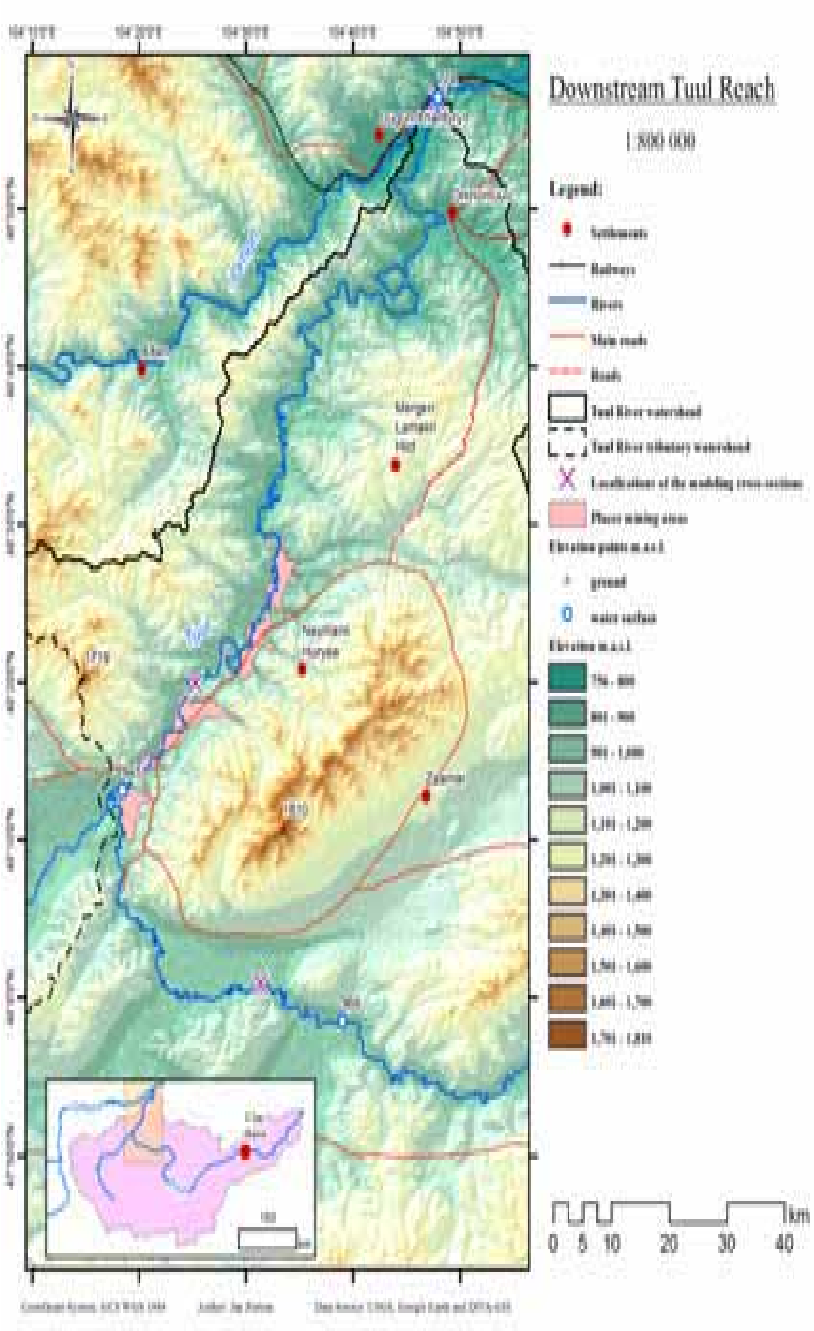


Decision-support system (0D-modelling)

Case study results



Zaamar Goldfield primarily impacts the closest (within couple kilometers from the mines) environments. However, contaminated sediments that are deposited in the vicinity of the goldfield can move much further downstream during peak flow events.
Also during slowly descending flow conditions, the mining waste may continue to be transported, to the Orkhon River and its downstream areas.



Thank you for your attention