Lomonosov Moscow State University
Faculty of Geography

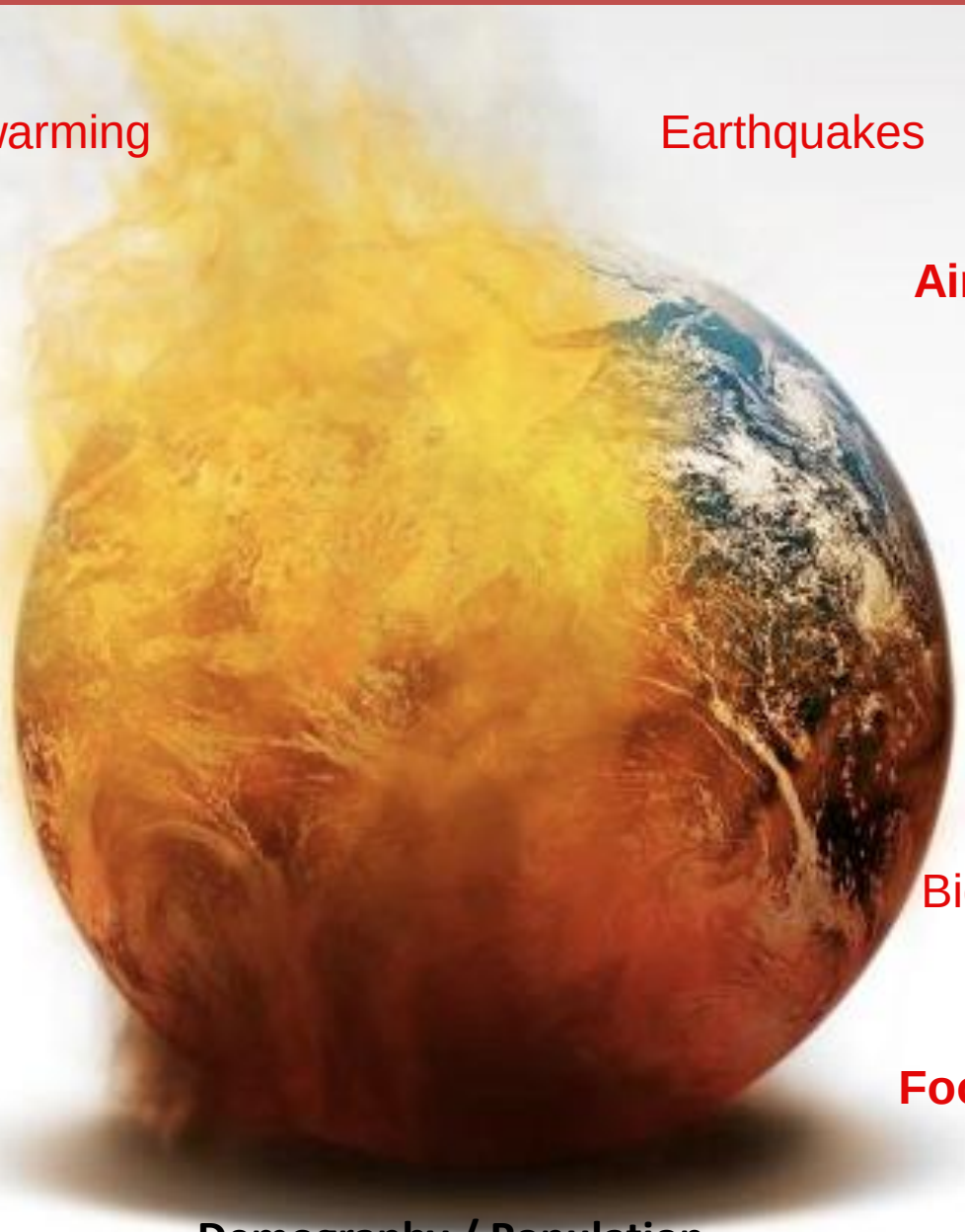
FACULTY OF GEOGRAPHY
Lomonosov Moscow State University

Russian strategy in meteo, hydro, atmospheric composition and ecosystems monitoring

Sergey Chalov

November 18, 2021

Background: Scope of Global Grand Challenges



Global warming

Earthquakes

Climate change

Air quality

Fresh water

Volcanoes

Ocean acidification

Energy

Deforestification

Epidemic diseases

Biodiversity loss

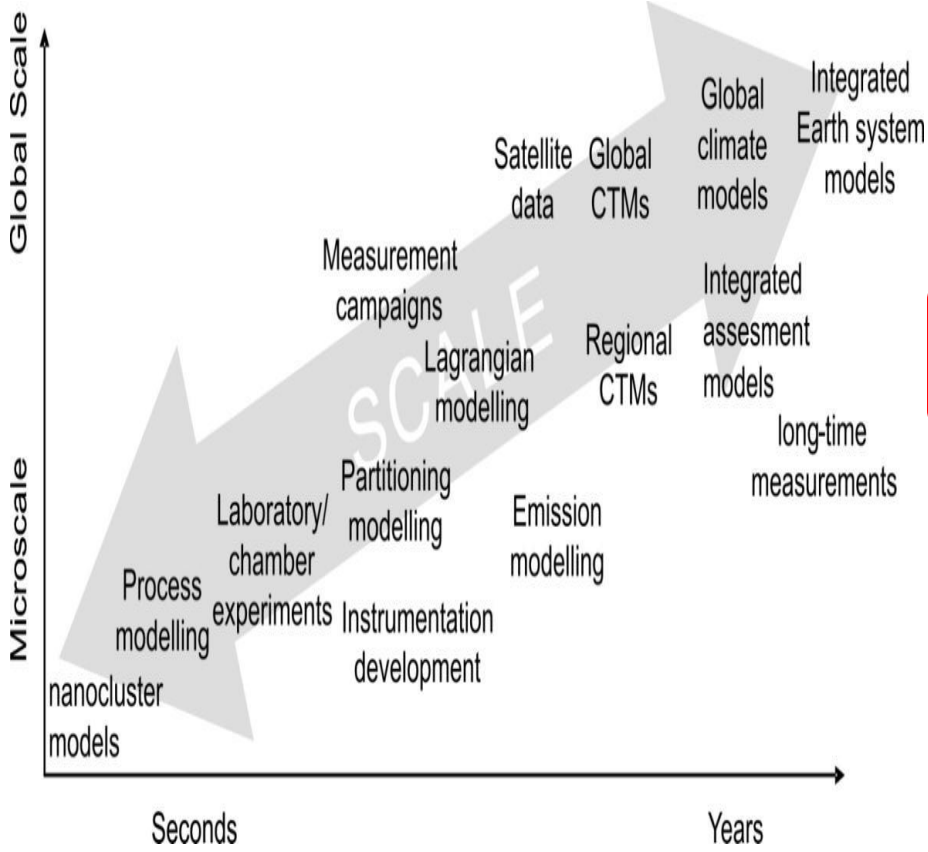
Food supplies

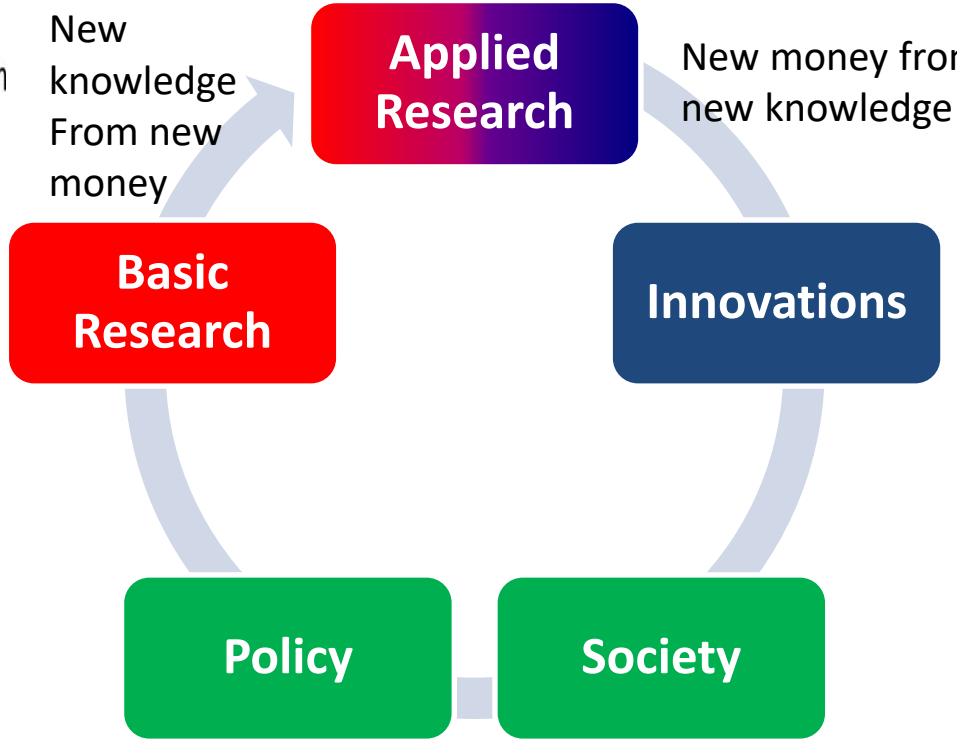
Chemicalisation

Demography / Population

Grand Challenges: How to answer

- ✓ clear and ambitious vision / from deep understanding to practical solutions
- ✓ empirical and experimental / modelling and new theories
- ✓ multidisciplinary (physics, chemistry, biology, meteorology, economy, social sciences etc)
- ✓ from research to innovations; new SMEs





Climate c
and enha
analyses

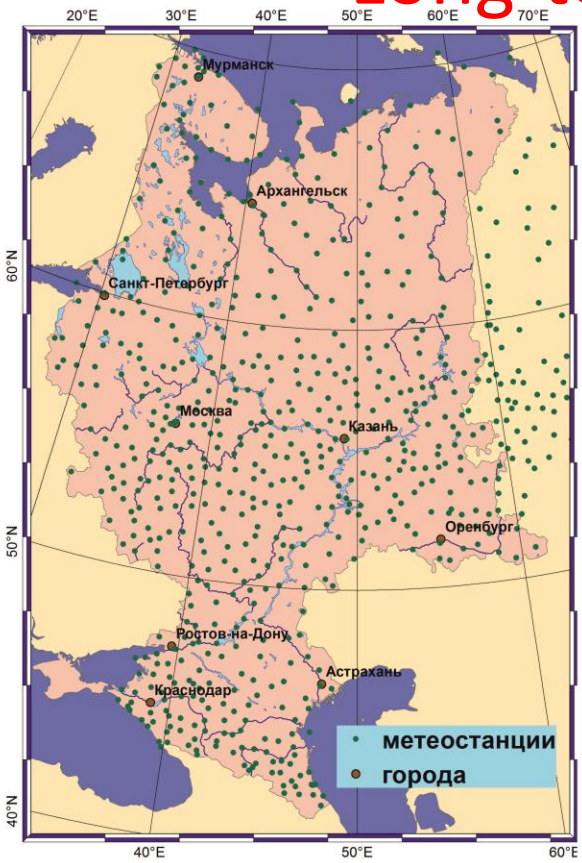
Stationarity Is Dead: Whither Water Management?

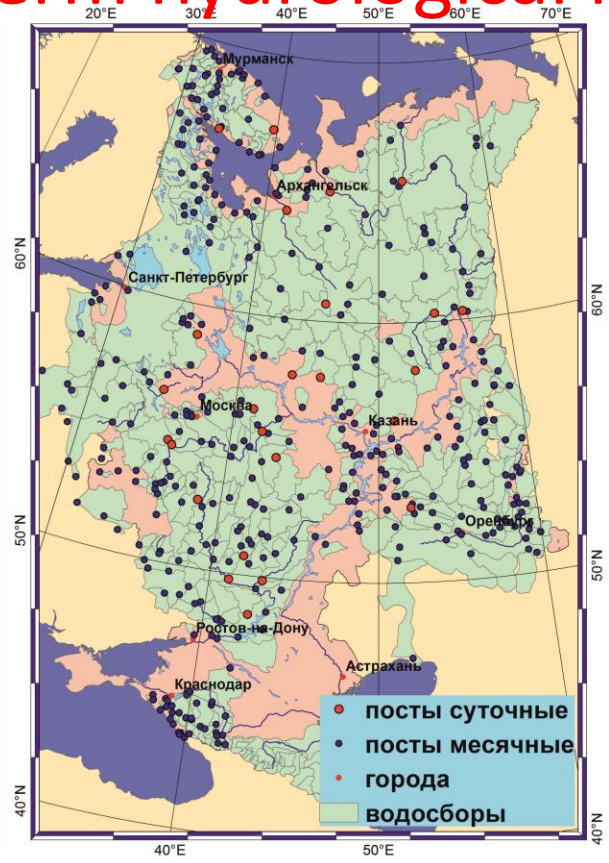
P. C. D. Milly,[1]* Julio Betancourt,[2] Malin Falkenmark,[3] Robert M. Hirsch,[4] Zbigniew W. Kundzewicz,[5] Dennis P. Lettenmaier,[6] Ronald J. Stouffer[7]

Systems for management of water throughout the developed world have been designed and operated under the assumption of stationarity. Stationarity—the idea that natural systems fluctuate within an unchanging envelope of variability—is a foundational concept that permeates training and practice in water-resource engineering. It implies that any variable (e.g., annual streamflow or annual flood peak) has a time-invariant (or 1-year–periodic) probability density function (pdf), whose properties can be estimated from the instrument record. Under stationarity, pdf estimation errors are acknowledged, but have been assumed to be reducible by additional observations, more efficient estimators, or regional or paleohydrologic data. The pdfs, in turn, are used to evaluate and manage risks to water supplies, waterworks, and floodplains: annual global invest-

An uncertain future challenges water planners.

Long-term hydrological monitoring

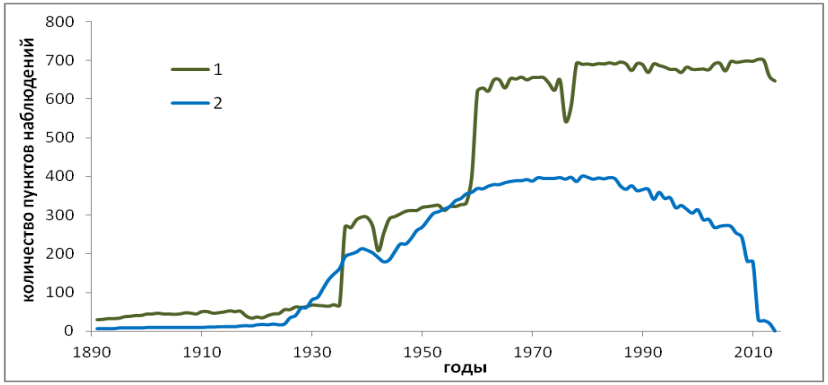




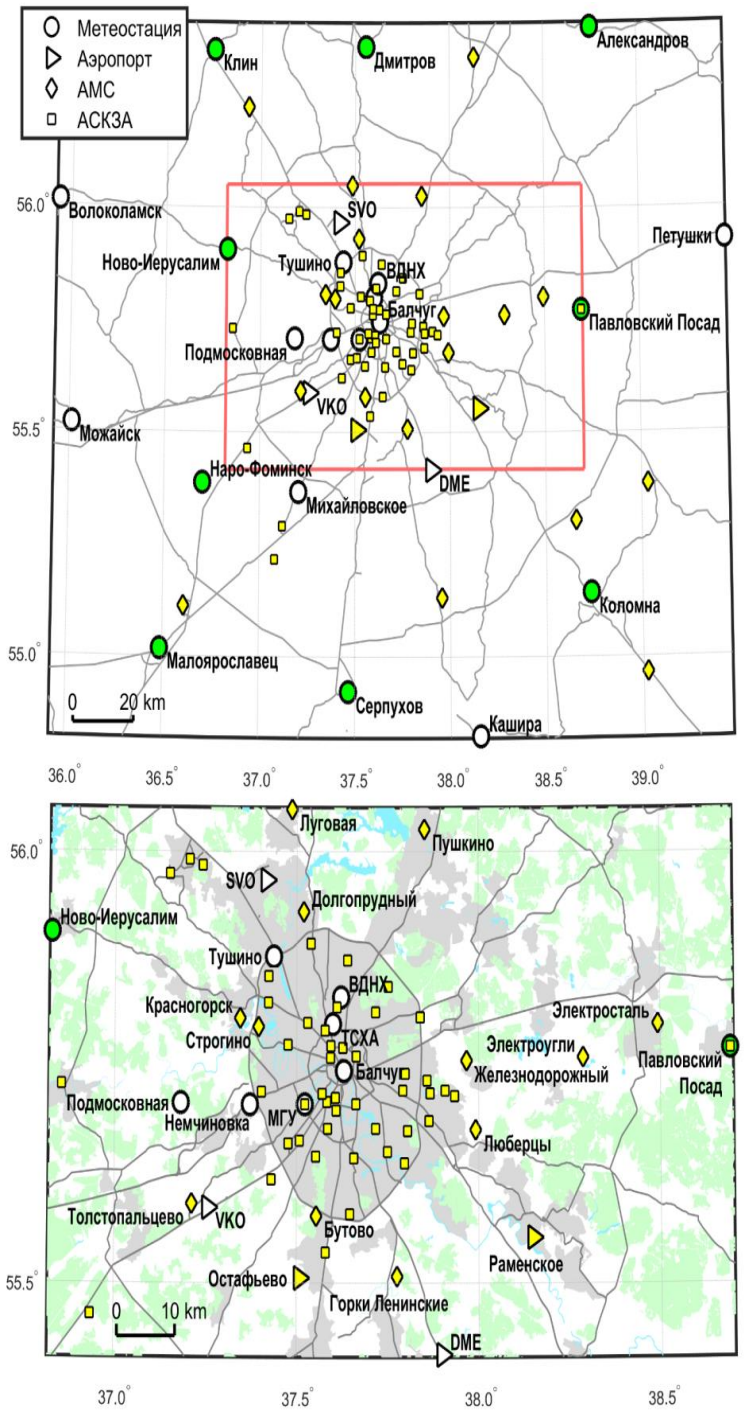
630 meteostations – temperature, precipitation datasets since 1966.

- **350 hydrological gauges** – monthly discharges
- 27 hydrological gauges – daily discharge datasets

1- meteostations, 2- hydrological gauges



GROUND-BASED monitoring in Moscow



Meteorological observations in the Moscow region

The scheme of location of weather stations, and Mosecomonitoring automatic stations for atmospheric pollution (AKZA) for the Moscow region and separately highlighted in red rectangle region around Moscow.

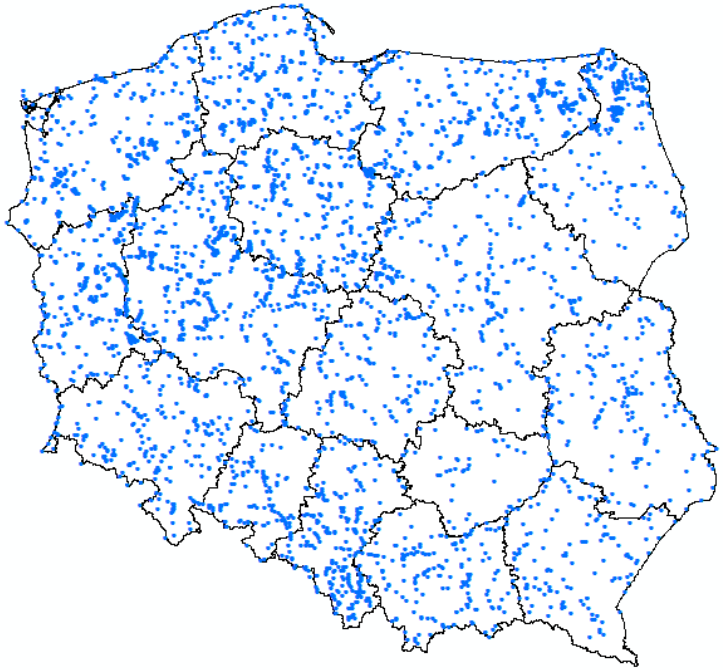
Green circles represent the weather station used to calculate the "background" temperature, yellow – "new" points of measurements which have appeared in recent years.

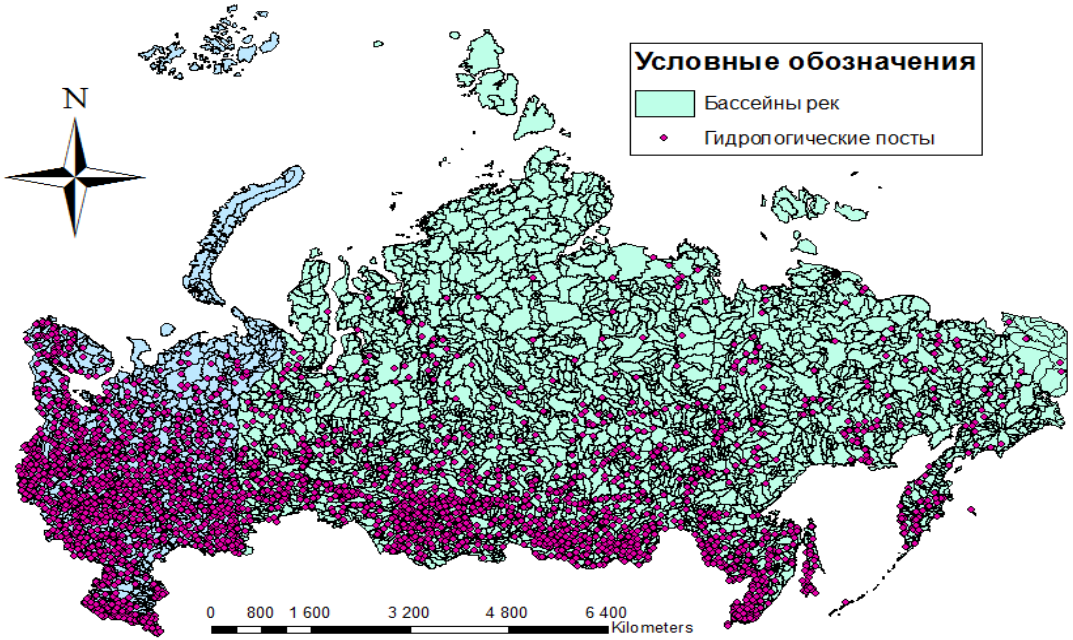
MONITORING

Joint dataset

Slide from N. Chubarova, 2017

Gauging network (hydro): Russian vs EU conditions

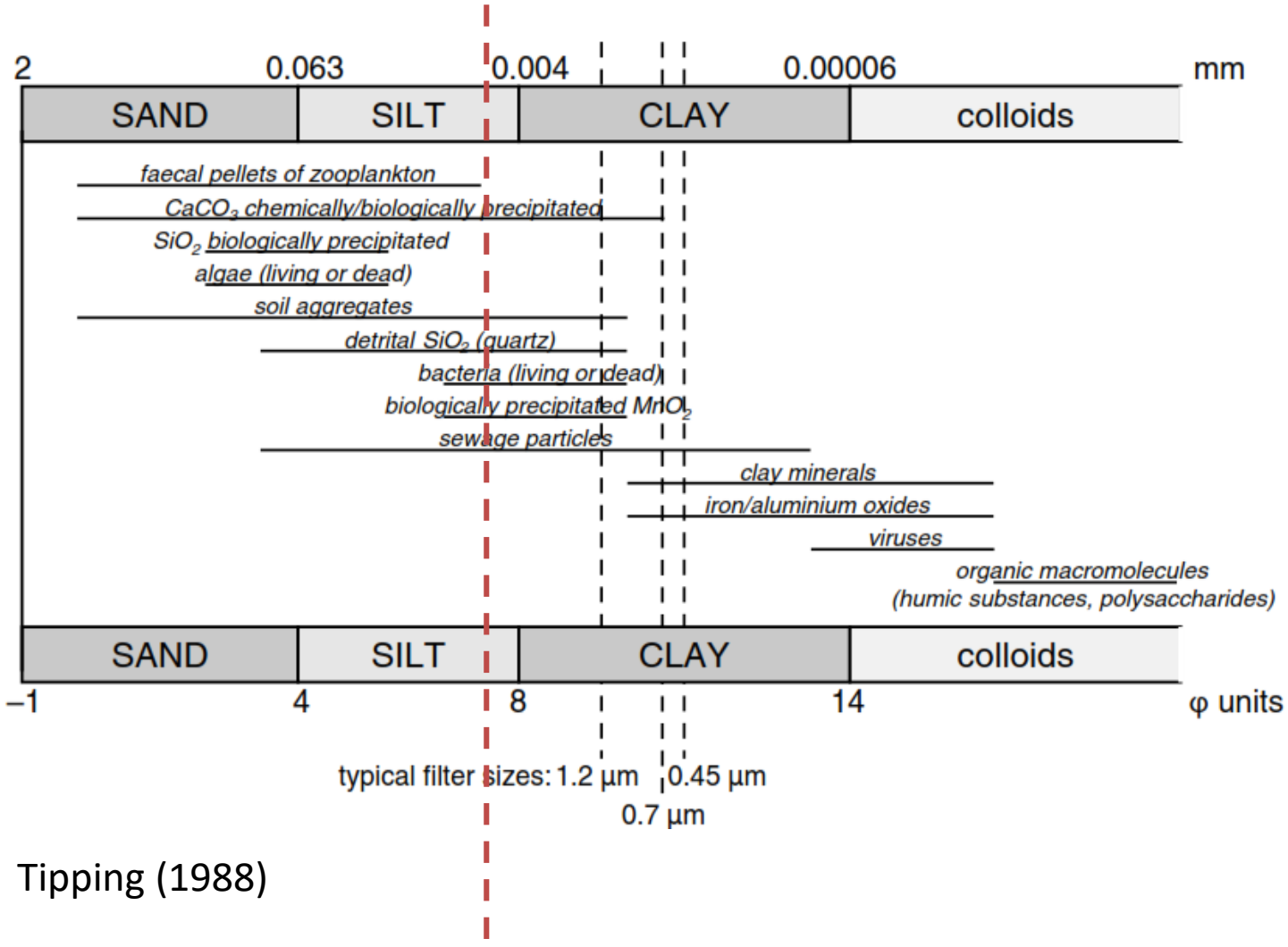




- Poland: 3195 sediment monitoring gauges
- Country area: 312 679 км²

- Russia: 735 gauges
- Country area : 17098246 км²

Examples of uncertainties of monitoring programs: fine sediments



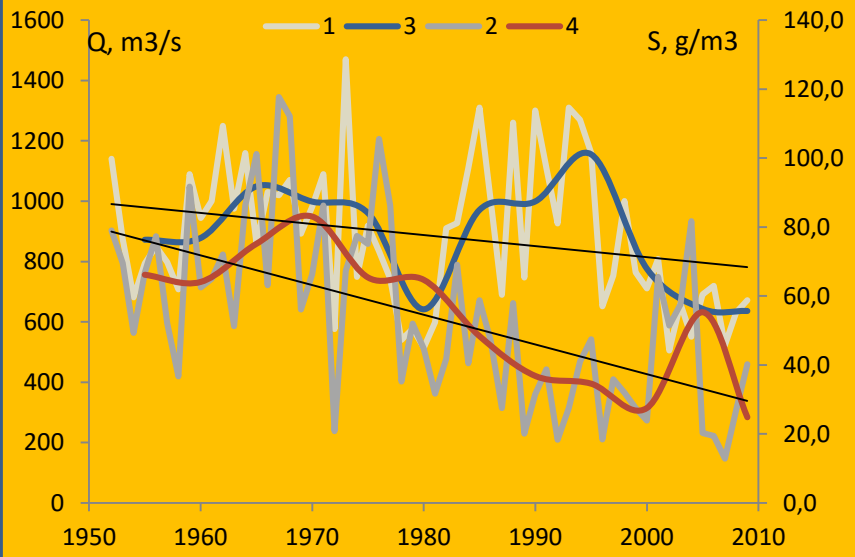
Tipping (1988)

- Up to 50 % of the suspended sediments are not counted by existed montoring systems
- This emphasize need in experiment al studies

Filter size used in Russian Hydromet Monitoring stations

Irregular observations

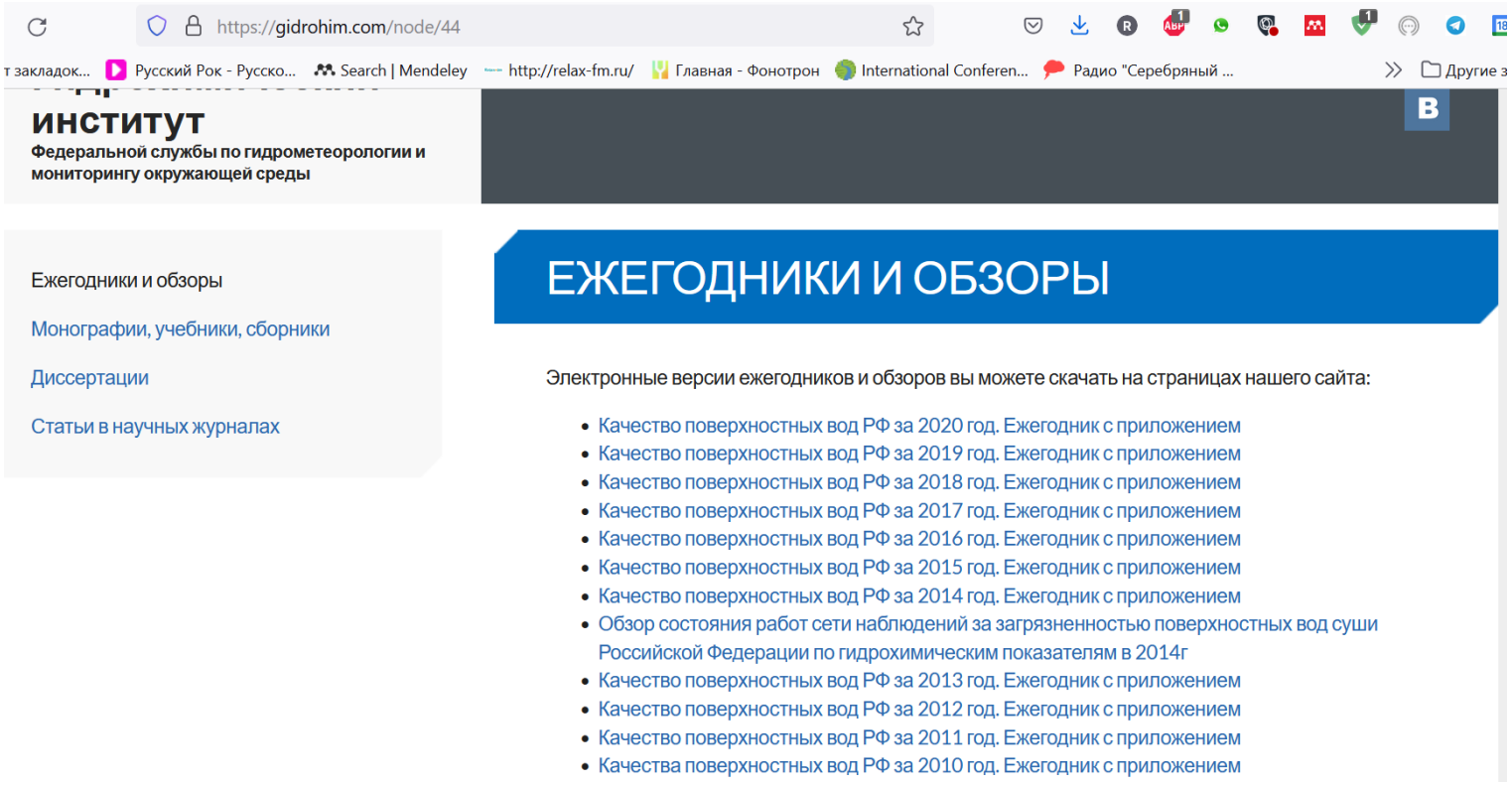
Regular measurements, rare stations, low quality



Irregular measurements, dense stations

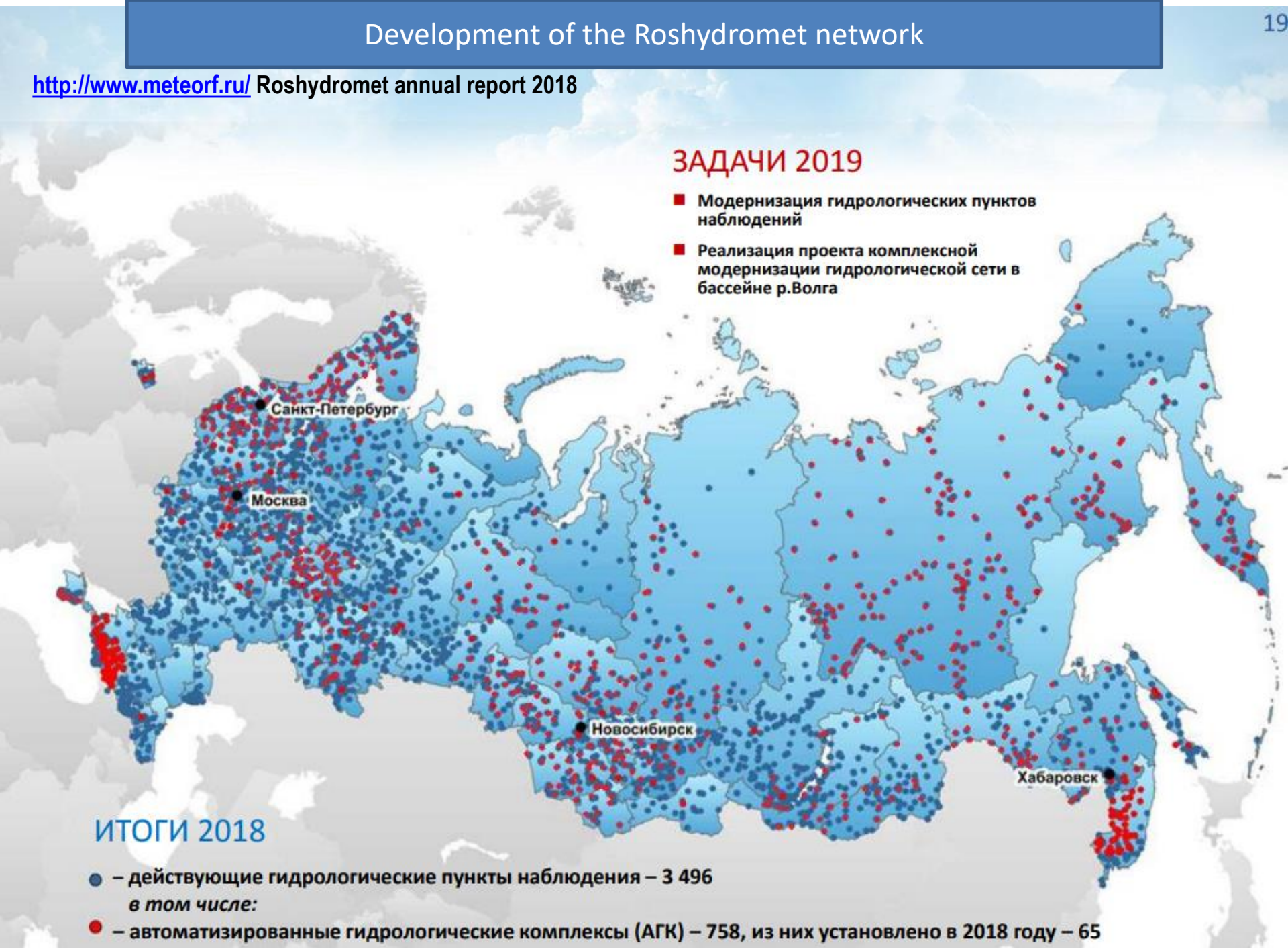
?

Data availability - constraints

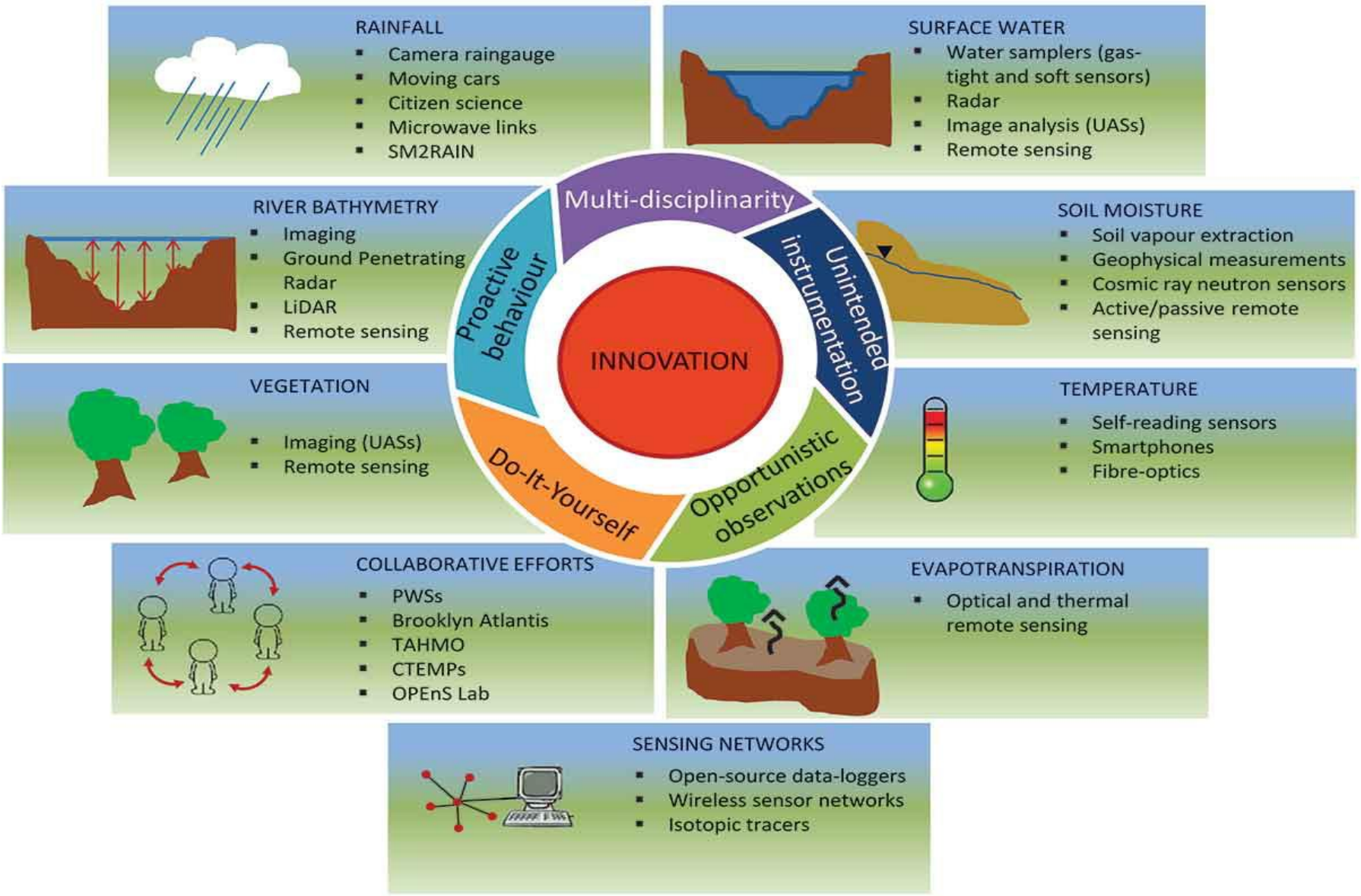


Development of the Roshydromet network

http://www.meteorf.ru/ **Roshydromet annual report 2018**

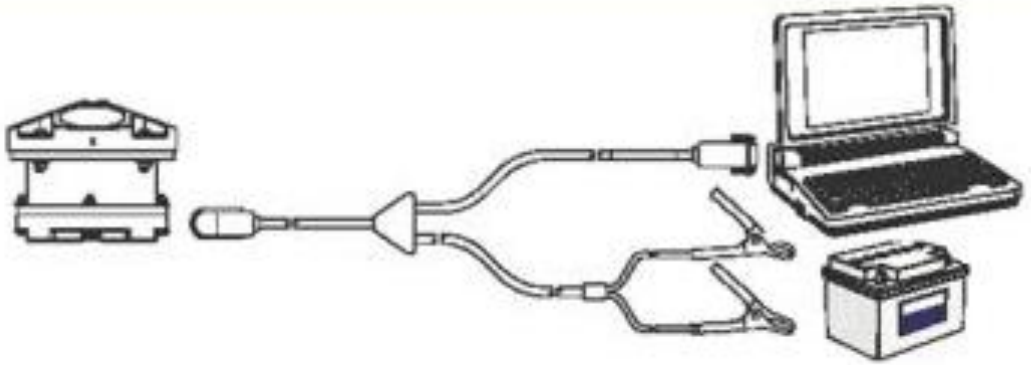


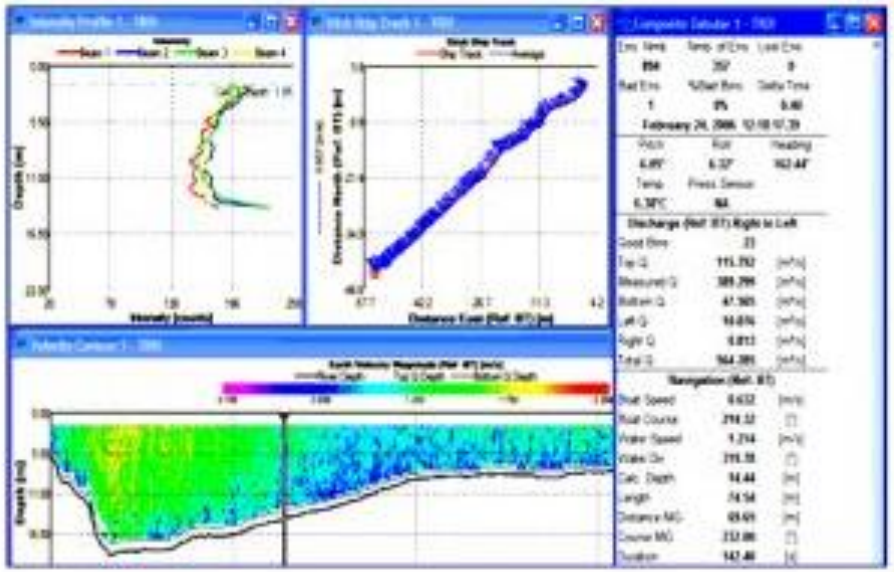
Innovations in hydrometeorological research



Novel technologies in Roshydromet practice

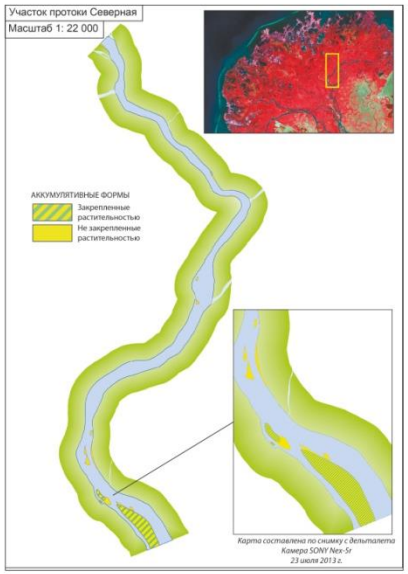
ADCP

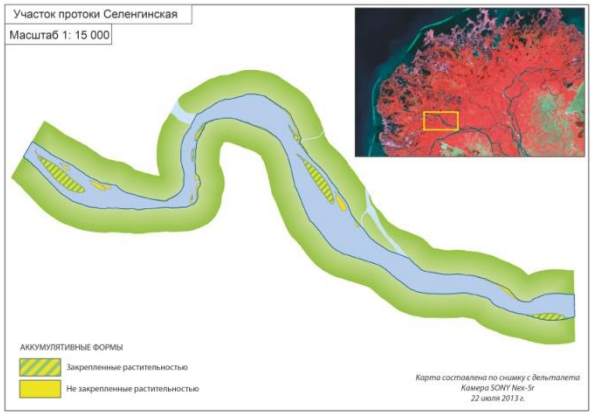




Remote sensing applications as an alternative tool for monitoring

ДЕШИФРИРОВАНИЕ РУСЛОВЫХ ФОРМ ПРОТОК ДЕЛЬТЫ Р. СЕЛЕНГИ





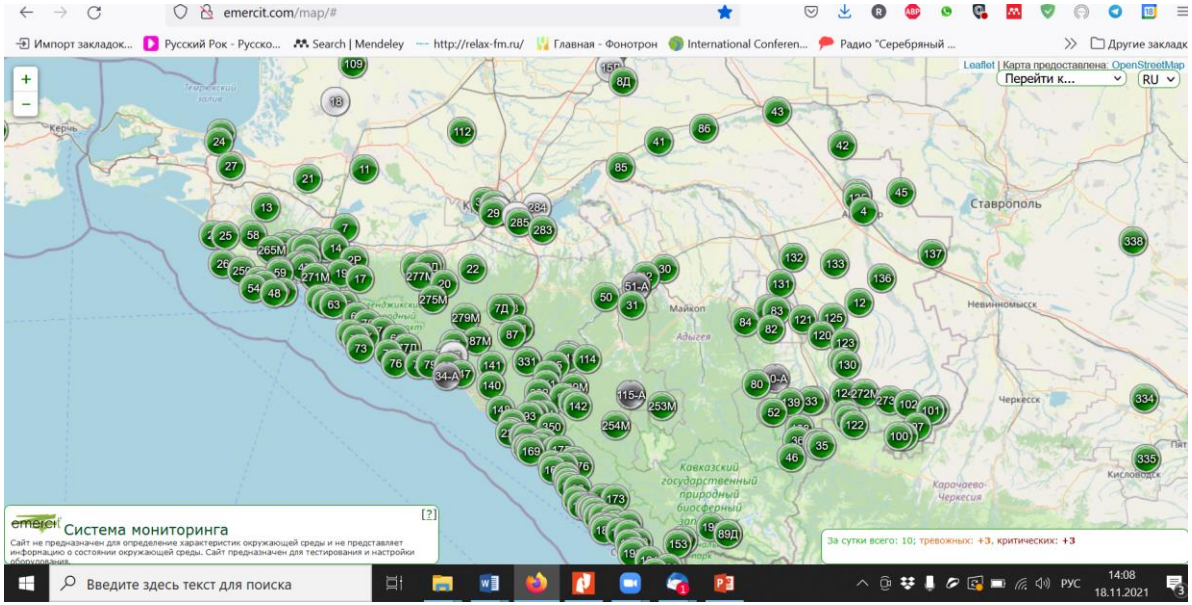
РАЗВИТИЕ ОВРАЖНОЙ ЭРОЗИИ

АБРАЗИЯ БЕРЕГОВ ДЕСНОГОРСКОГО ВОДОХРАНИЛИЩА

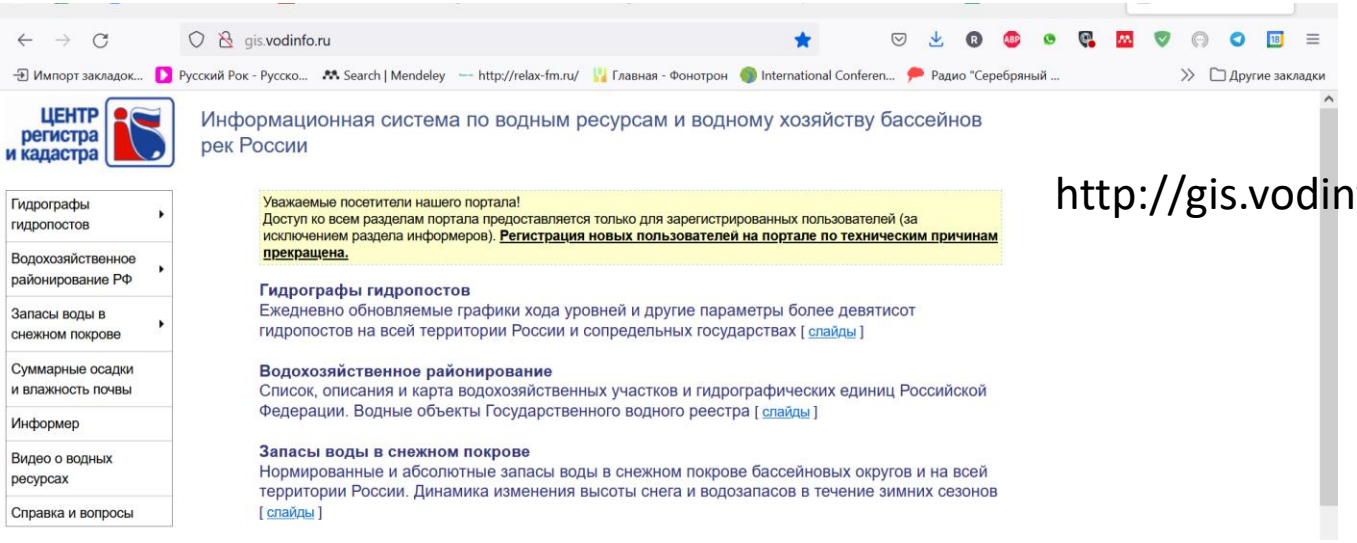
съемка А.Медведева

съемка А.Медведева

Open data – step forward in Russia



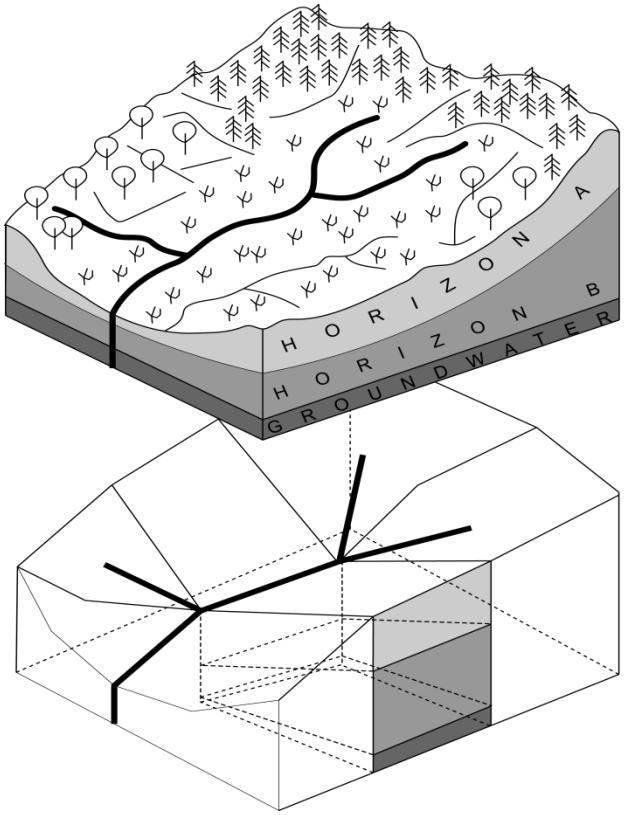
http://emercit.com/map

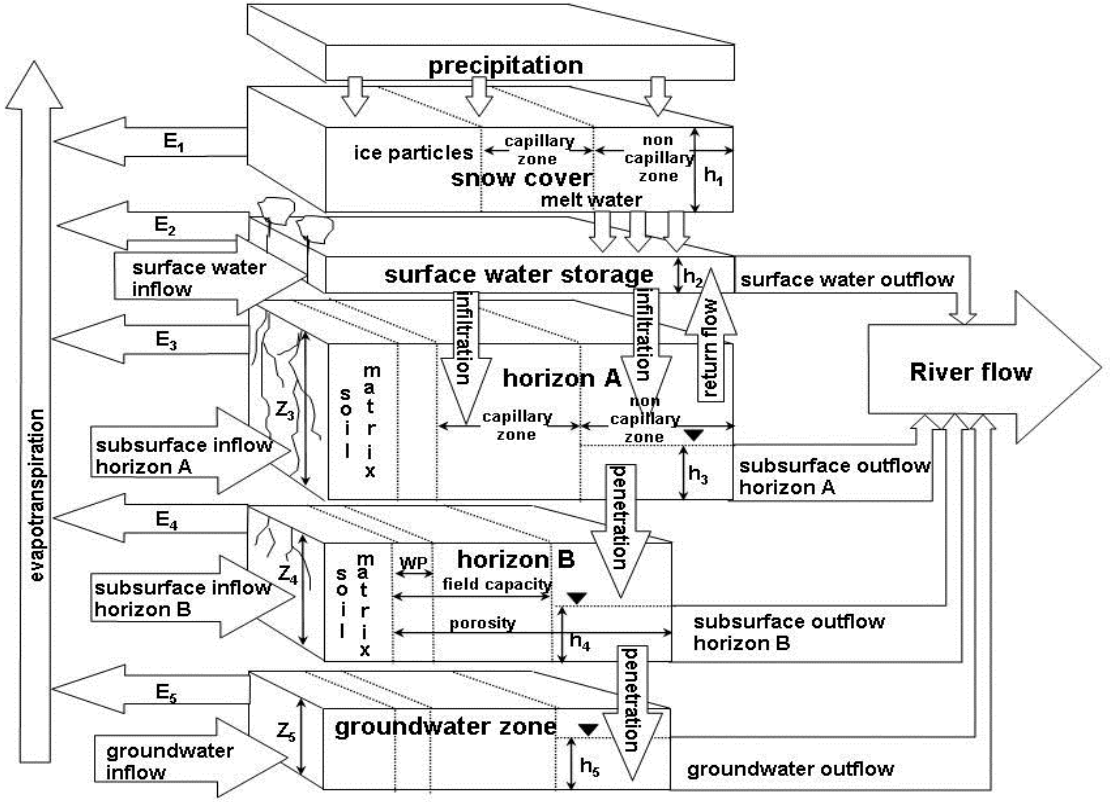


http://gis.vodinfo.ru/

Modelling tools – alternative for on-situ and remote monitoring

Physically-based semi-distributed model ECOMAG (ECOlogical Model for Applied Geophysics)



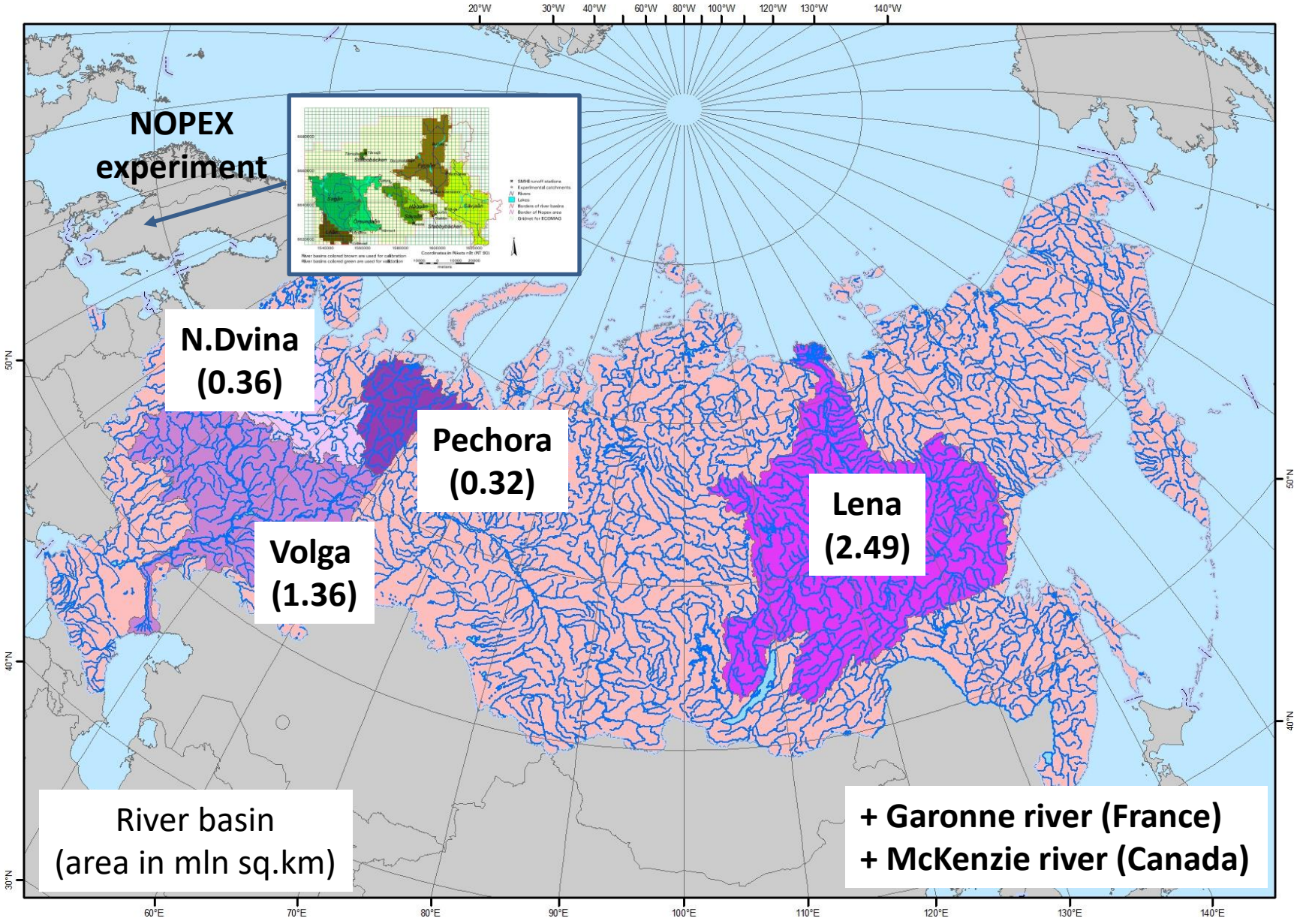


Motovilov, Yu., Gottschalk, L., Engeland K. & Rodhe A. (1999) Validation of a distributed hydrological model against spatial observation. Agric. For. Meteorol. 98–99, 257–277.

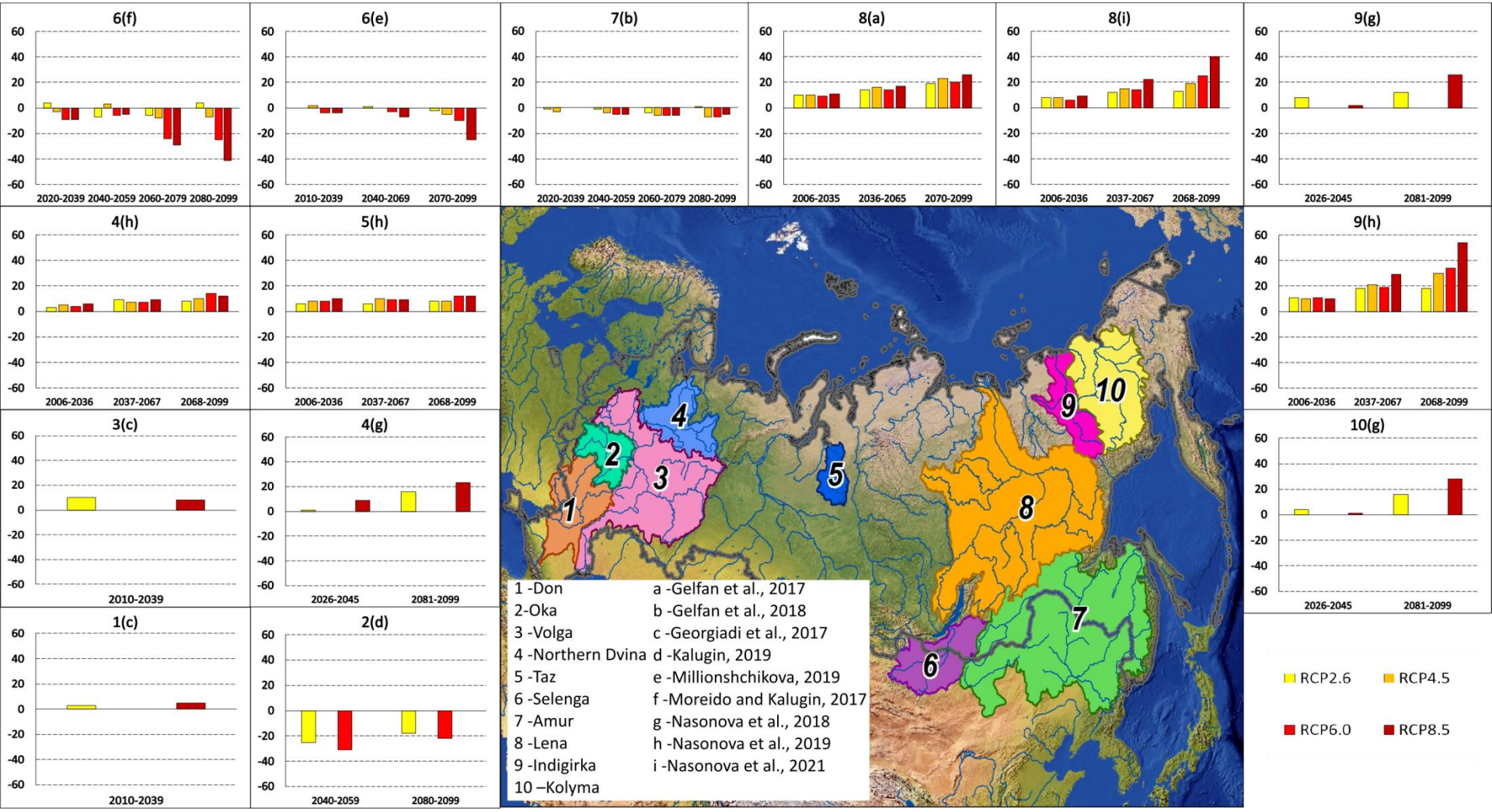
Motovilov, Yu., Gottschalk, L., Engeland, K., & Belokurov, A. (1999) ECOMAG – regional model of hydrological cycle. Application to the NOPEX region. Department of Geophysics, University of Oslo, Institute Report Series no. 105.

Gottschalk, L., Beldring, S., Engeland, K., Tallaksen, L., Salthun, N. R., Kolberg, S. & Motovilov, Yu. (2001) Regional/macroscale hydrological modelling: a Scandinavian experience. Hydrol. Sci. J. 46(6), 963–982.

ECOMAG applications for predictions of future changes in water and sediment transport rates

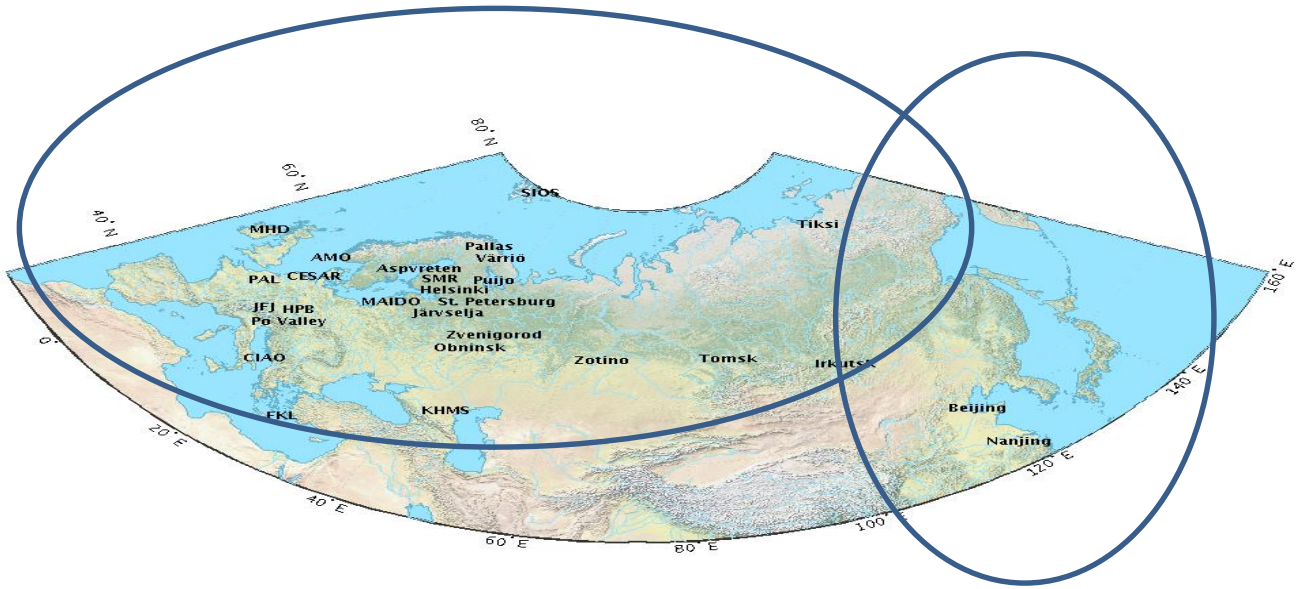


Mean annual runoff projections for the large Russian rivers in the 21th century under the different RCP-scenarios (HMs+GCMs ensemble experiments)



from Gelfan et al., 2022 (in press)

PEEX (Pan Eurasian Experiment)
2013 - 2033 (-2100)
www.atm.helsinki/peex
PEEX region



Station network, Marine, Airborne, remote sensing, multiscale modelling, Supradisciplinary

Baikal Selenga Network (BaSeNet) is a separate subprogram in PEEX

futurearth UArctic

in Russian in Chinese

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Baikal Selenga Network (BaSeNet)

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BaSeNet is interested in investigating and quantifying the waterborne transport of matter under changing hydro-climatic conditions on large drainage basin scales. BaSeNet aims to utilize and further develop an already established unique monitoring and modeling platform within Lake Baikal and its main tributary Selenga River Drainage Basin which are considered as a large-scale field laboratory. The area represents a region of the Arctic Ocean catchment, which will also be used for cross-regional comparison with other parts of the world.

BaSeNet is open to all interested parties and scientists to work together for the integrated hydrologic-hydrogeologic-geochemical region in the extensive Baikal Selenga

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Prof. Nikolay Kasimov
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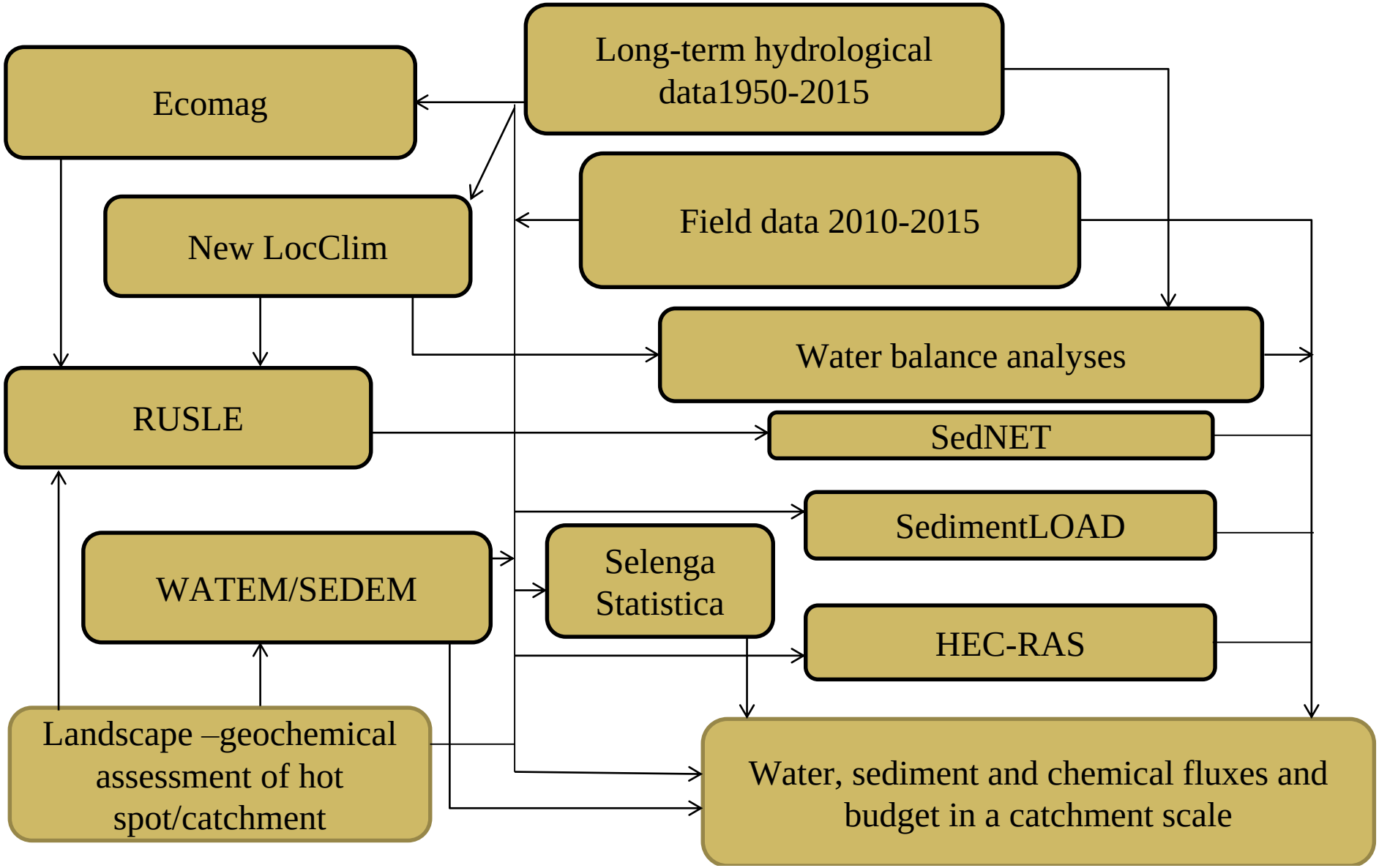
Russian Geographical Society

Principal Investigator:
Dr. Sergey Chalov
Lomonosov Moscow State University
For contact srchalov@geogr.msu.ru

Flowchart for modeling system of Selenga River basin



origin | transport | storage

Arctic Environment Laboratory

ЛКЭ-ГИА Objectives

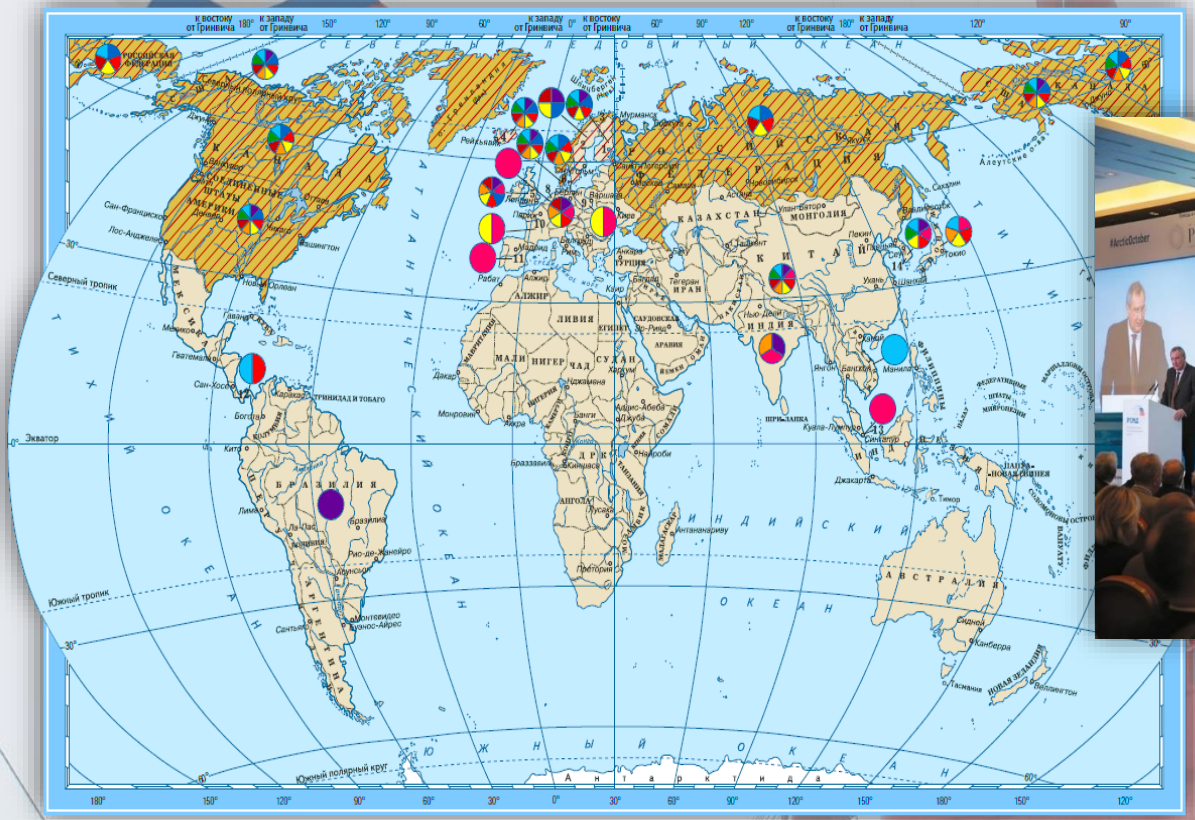
- Utilize all available observations and modelling products to quantitatively assess changes in meteorological, oceanographic and environmental variables that directly affect ongoing and future societal well-being and economic development in the coastal areas of the Circumpolar Arctic.

- Quantitatively evaluate the impacts of climatic and environmental changes on the societal well-being and economic development of the Arctic coastal areas. These include fossil fuels and mineral extraction, maritime and land transportation, industrial fishing, and infrastructure development.

- Quantitatively assess the magnitude and the spatial pattern of positive and negative climate-induced changes which have the potential to influence the economic development in the Circumpolar Arctic.

- Prepare a suite of recommendations to mitigate negative climate-induced impacts to achieve a sustainable development that contributes to the highest possible quality of life in the Arctic and benefits both the region and the Arctic nations.

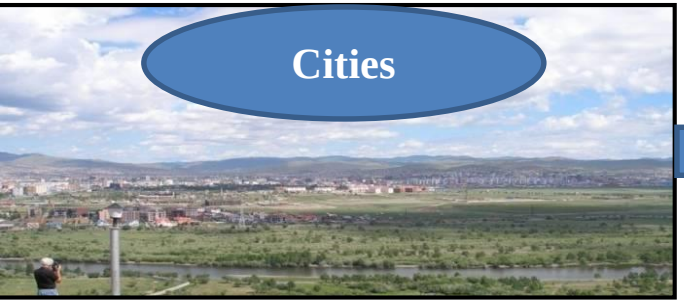
The Arctic is a zone of international cooperation



Risks in the Arctic

- Harsh and fragile environment
  - Special protection for people, infrastructure
- Economic development, environmental impact
  - Protection from anthropogenic impact, balance
- Adequate protection
  - Estimate the potential to damage, the impact
- Design appropriate infrastructure
  - Ports, towns, roads, exploration and exploitation sites
- Consider changes due to climate change
  - Sea ice cover, storms, wave climate, river discharge, freeze-up, spring break-up, permafrost, snow cover, albedo/radiation balance, gas exchange (methane)

Baikal Selenga Network (BaSeNet)



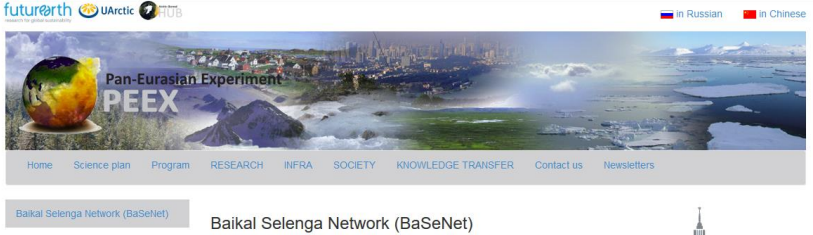
Metals, nutrients, organic compounds spreading:

Water pathways

Dissolved load

Particulate load

Bed load



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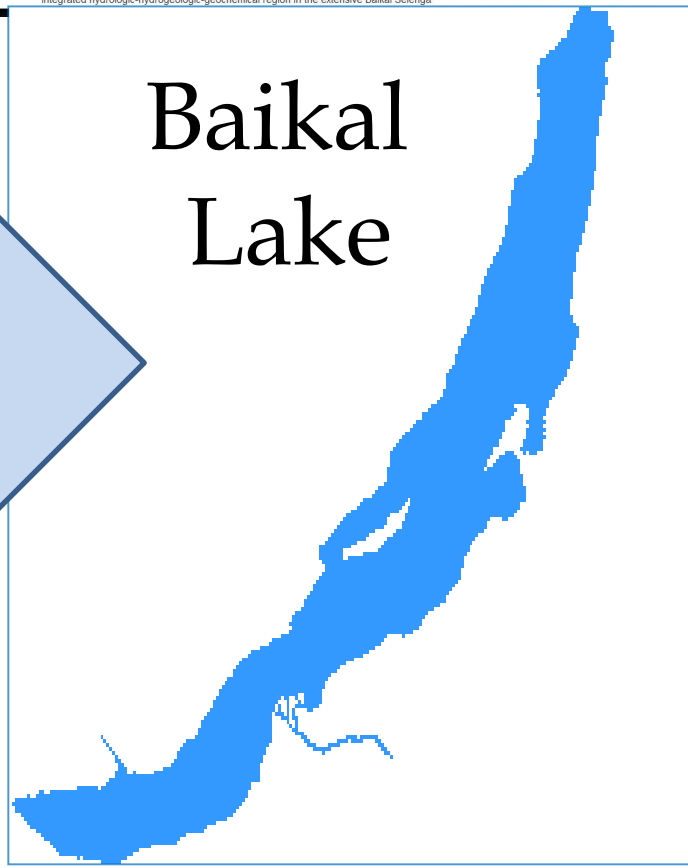
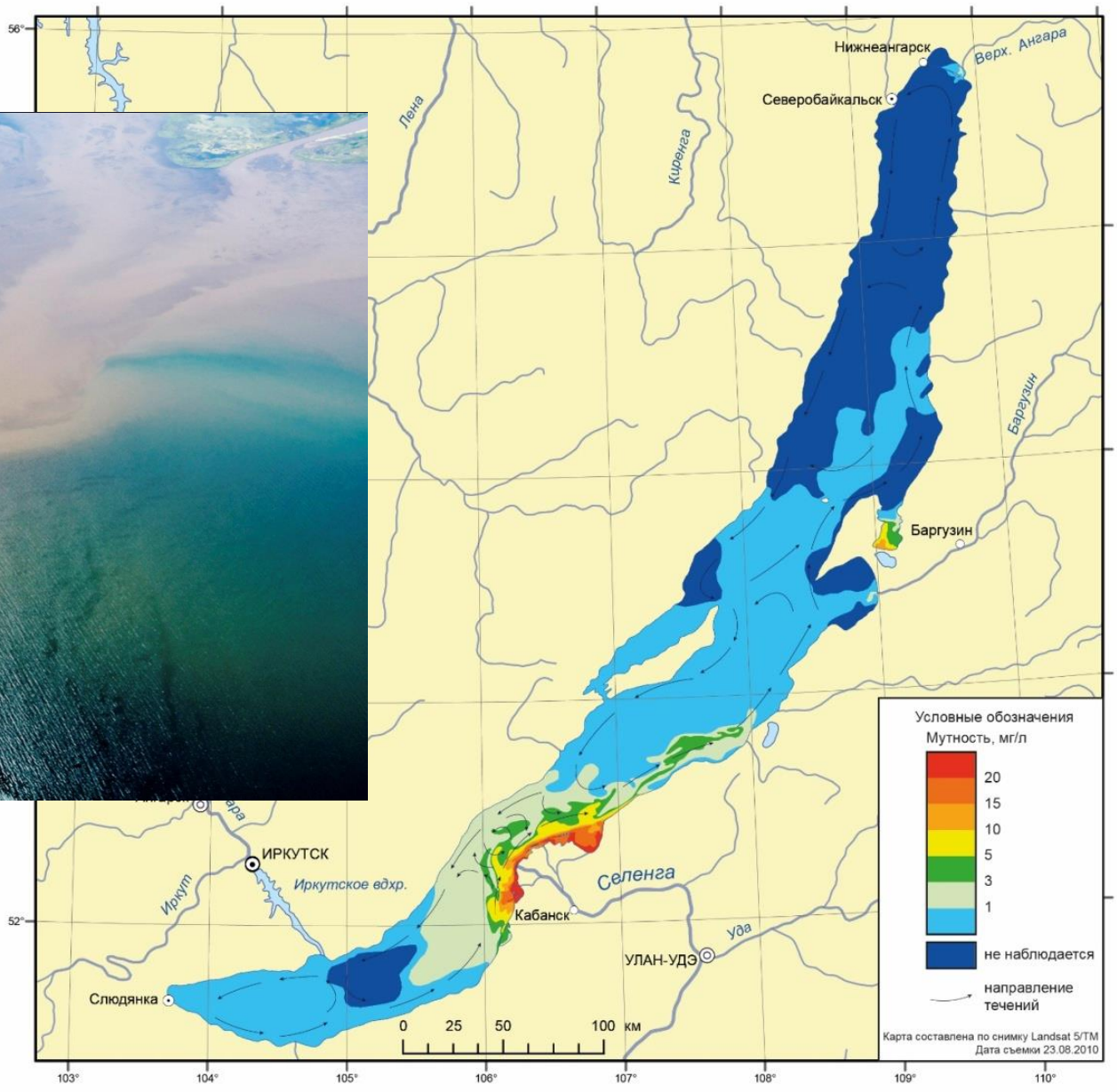


- 2013-2016: Basin-scale hydrological spreading of pollutants and wetland opportunities for reducing them under different hydroclimatic and other regional conditions, funded by the Swedish Research Council Formas (coordinator from Russia)
- 2015-2016 International Bureau of the German Federal Ministry of Education and Research (BMBF-IB) project “WQQ Baikal - Modelling of Water Quantity and Quality in the Selenga-Baikal-Angara Region: Current Potentials and Future Necessities"
- 2013-2015 т International Bureau of the German Federal Ministry of Education and Research (BMBF-IB) “Sustainable Water Management in the Baikal-Selenga Basin: Development of an Integrated Monitoring Concept for a Transboundary Catchment with Multiple Stressors”
- 2012-2016:проект UNDP-GEF «Комплексное управление природными ресурсами трансграничной экосистемы бассейна Байкала» “Integrated Natural Resource Management in the Baikal Basin Transboundary Ecosystem”

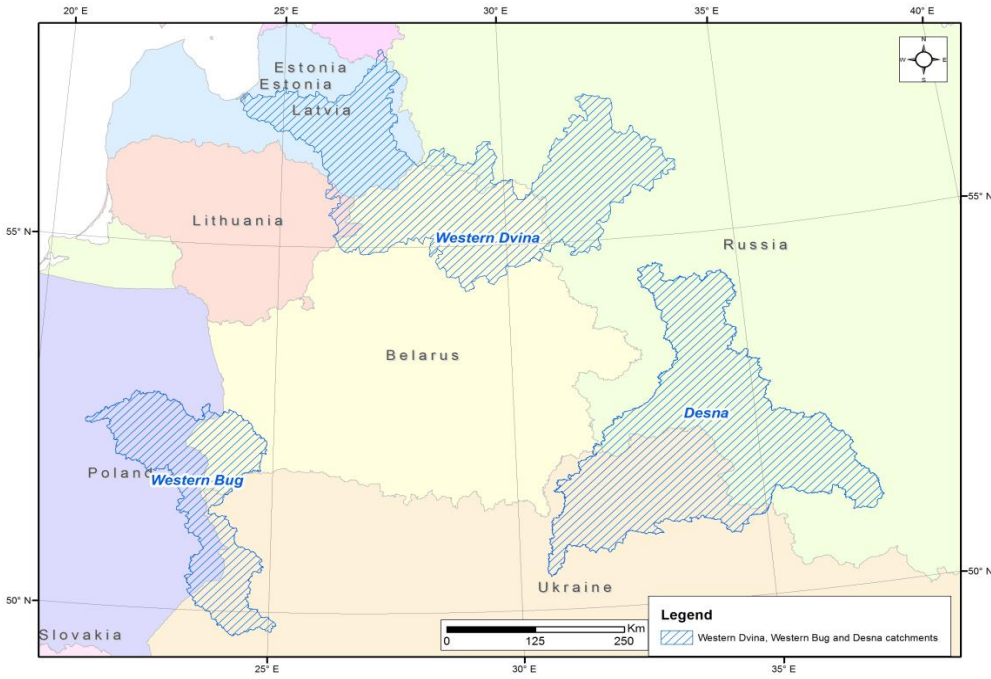
- On-going submission for Era-Net Rus Plus

Effects on the Lake Baikal conditions



Management of transboudary rivers project (Mantra-rivers project)

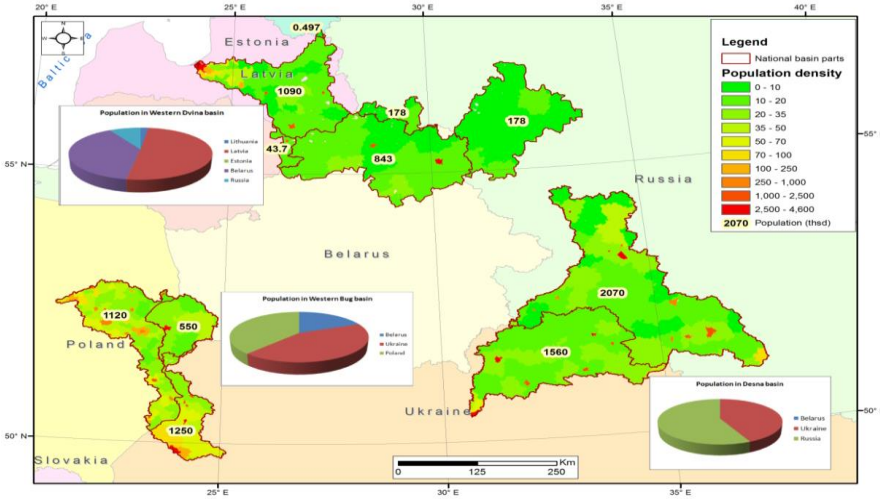
Germany (Technical University Dresden, Helmholtz Center for Environmental Research UFZ)
Ukraine (Ukrainian Hydrometeorological Institute (UHMI)
Russia
(Lomonosov Moscow State University (LMU)



Funded by **German Volkswagen Stiftung VWS**

Goals of the trilateral VWS projects:

- **Strengthen crossborder cooperation's**
- **Build up confidence and understanding**
- **Maintain the dialogue between colleagues**



Three Basins:

- Western Bug
- Desna
- Western Dvina

Large rivers research

UNESCO Chair on
Integrated River Research and Management
Vienna, Austria

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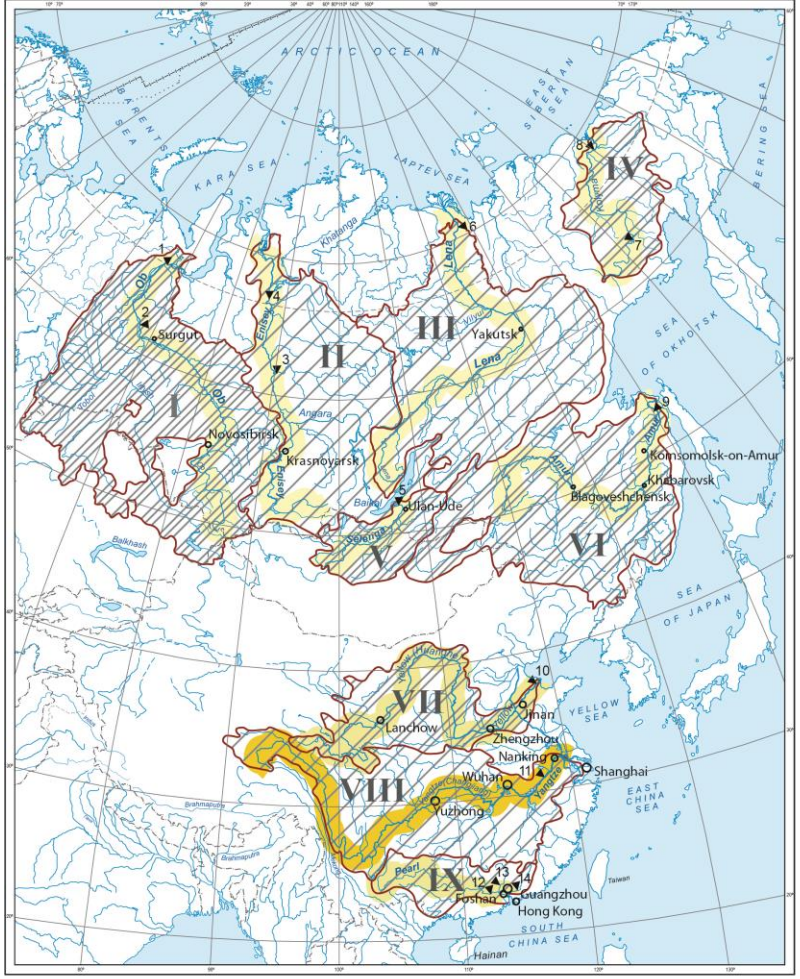
-Participating institution since 2013



Catchment area
I - Ob
II - Enisey
III - Lena
IV - Kolyma
V - Selenga
VI - Amur
VII - Huanghe (Yellow)
VIII - Yangtze (Changjiang)
IX - Pearl

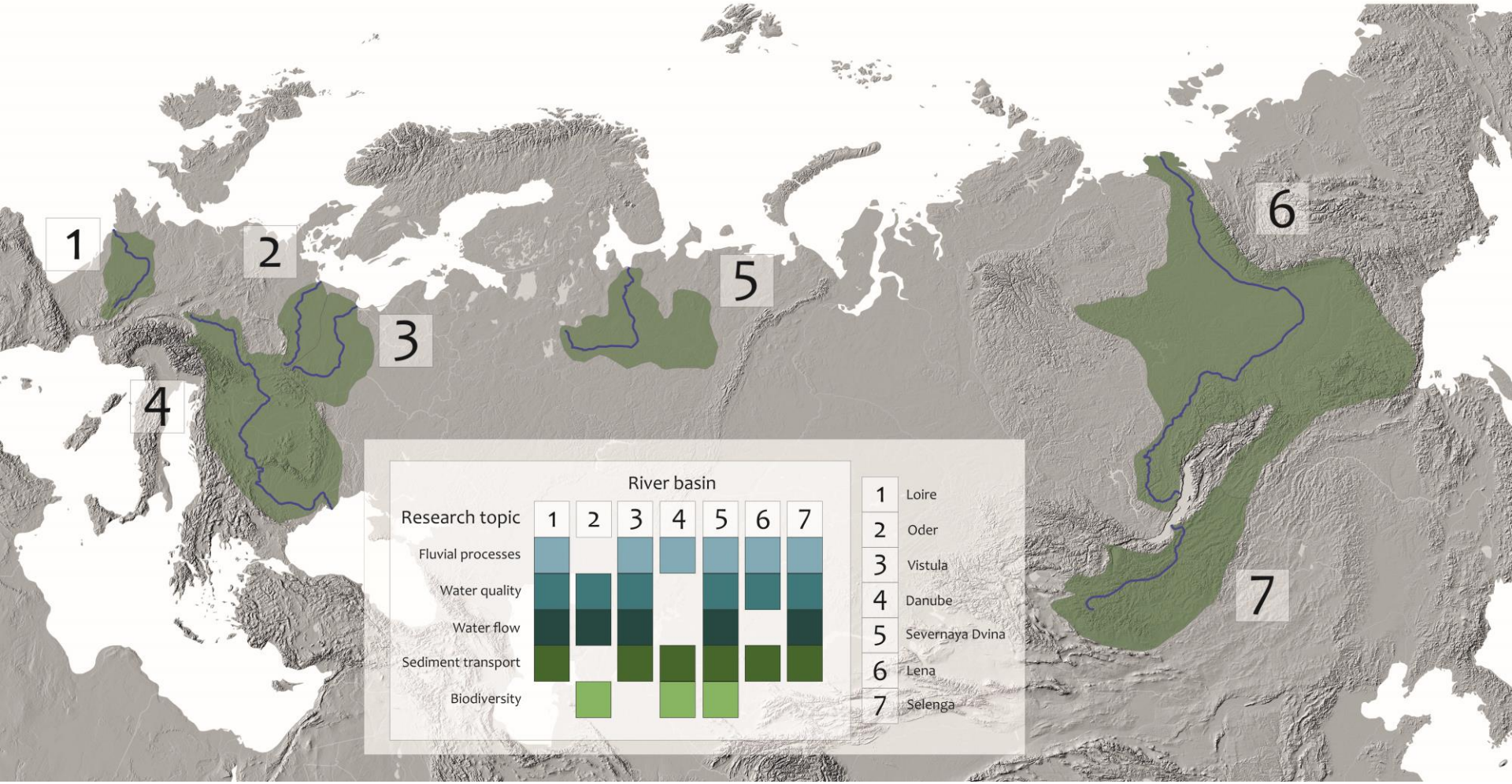
Unconfined channels
(percent from total main stem length, %)
less than 42
55-78
85-100

Dams frequency
(number per square kilometer of the catchment)
0 - 0,000003
0,00002 - 0,00003
more then 0,0001

Largest cities
(amount of citizens)
less then 1 million
from 1 to 2 million
from 3 to 10 million
more then 10 million

Gauging stations
1 – Salekhard (Ob)
2 – Karym Kary (Ob)
3 – Podkamennaya Tunguska (Enisey)
4 – Igarka (Enisey)
5 – raz'ezd Mostovoy (Selenga)
6 – Kyusyur (Lena)
7 – Ust-Srednekan (Kolyma)
8 – gidrostvor Kolymskoe 1 (Kolyma)
9 – Bogorodskoye (Amur)
10 – Lijin (Huanghe)
11 – Datong (Yangtze)
12 – Gaoyao (Pearl)
13 – Shijiao (Pearl)
14 – Boluo (Pearl)

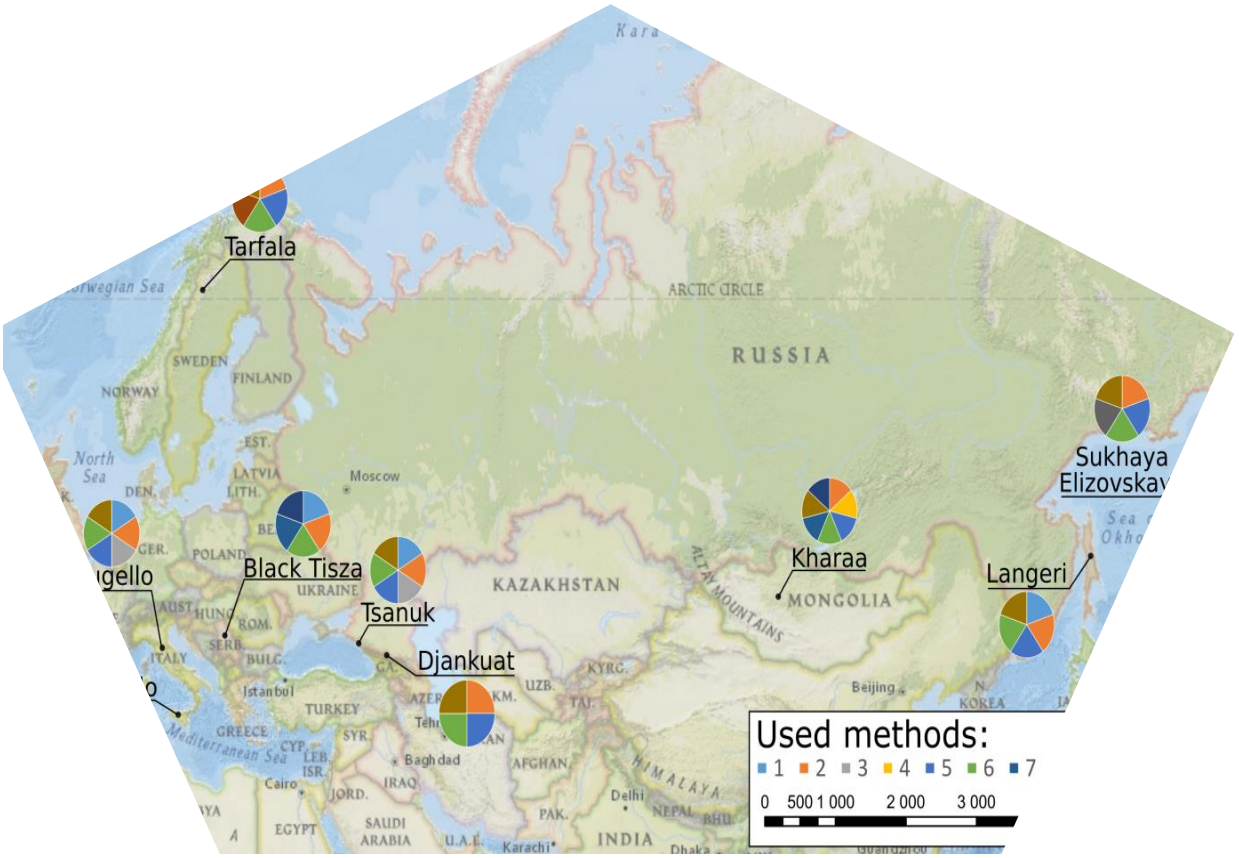
Natural Features and **Anthropogenic Impact on selected Northern Eurasian Rivers: Mutual Understanding for Science and Practice**



Horizon 2020 RISE project application

Strategies and Protocols for Climate Change Impact Assessment in Polar and Mountain Regions

Sediment and contaminants spreading in small catchments



«Marie Curie International Research Staff Exchange Scheme»

«Fluvial processes and erosion in European river systems, its ecological and social sequence under climate change and human activities impact»)

FLUMEN

1 - Laser scanning/geodetic techniques for the quantification of mass wasting slope processes; 2 - In-situ monitoring of sediment transport; 3- Soil morphological method and dating techniques; 4 - Sediment source fingerprinting; 5 - Sediment-water discharge relationships; 6 - Morphometric analysis; 7 - Riverbed monitoring based on remote sensing/historical maps; 8 - Satellite data for sediment transports estimates; 9 - Remote sensing for channel sediment connectivity); 10 - Soil erosion modeling and gully erosion; 11 – channel hydrodynamic modeling

«International Network for Terrestrial Research and Monitoring in the Arctic»

INTER ⇄ ACT

(1)The Royal Swedish Academy of Sciences (Координатор)
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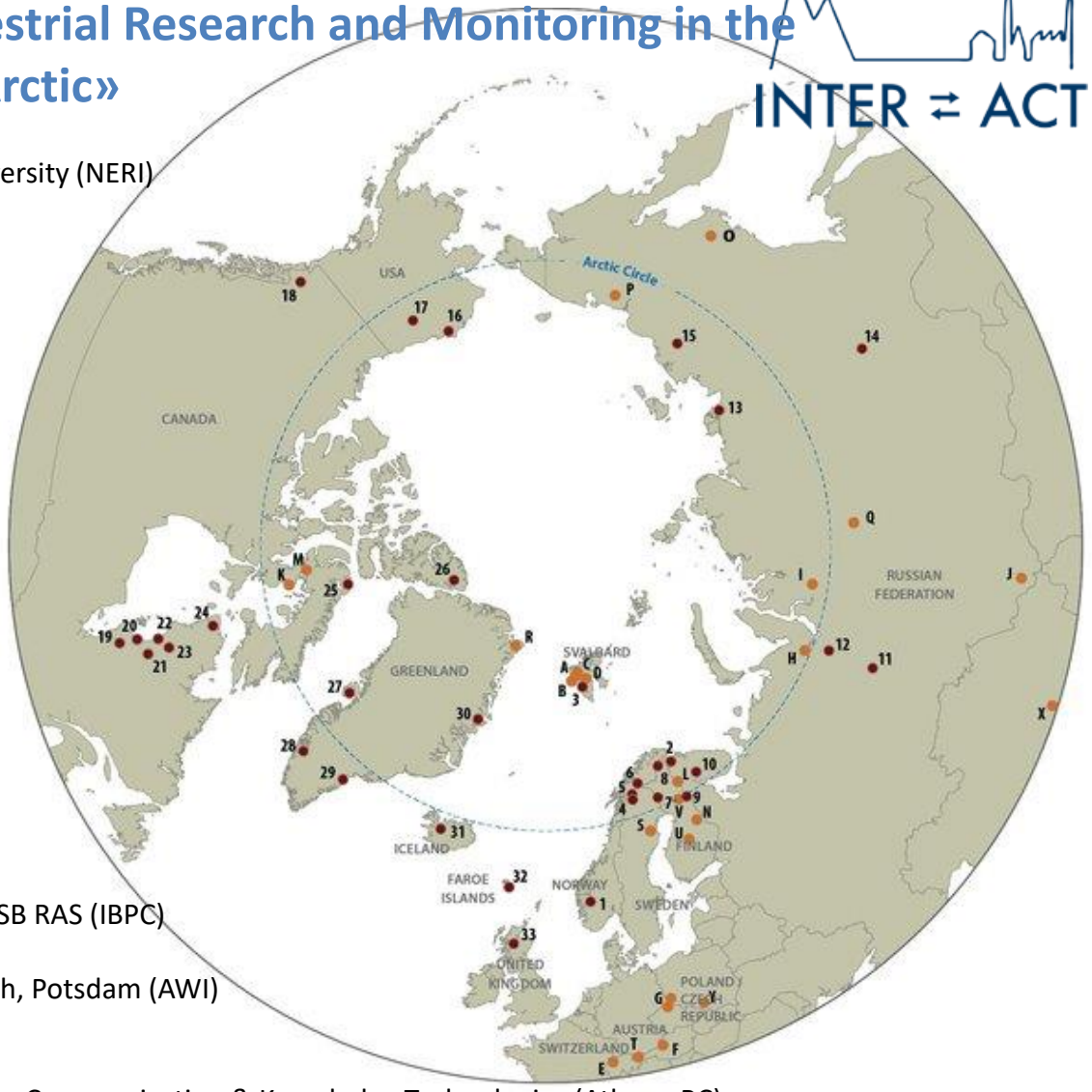
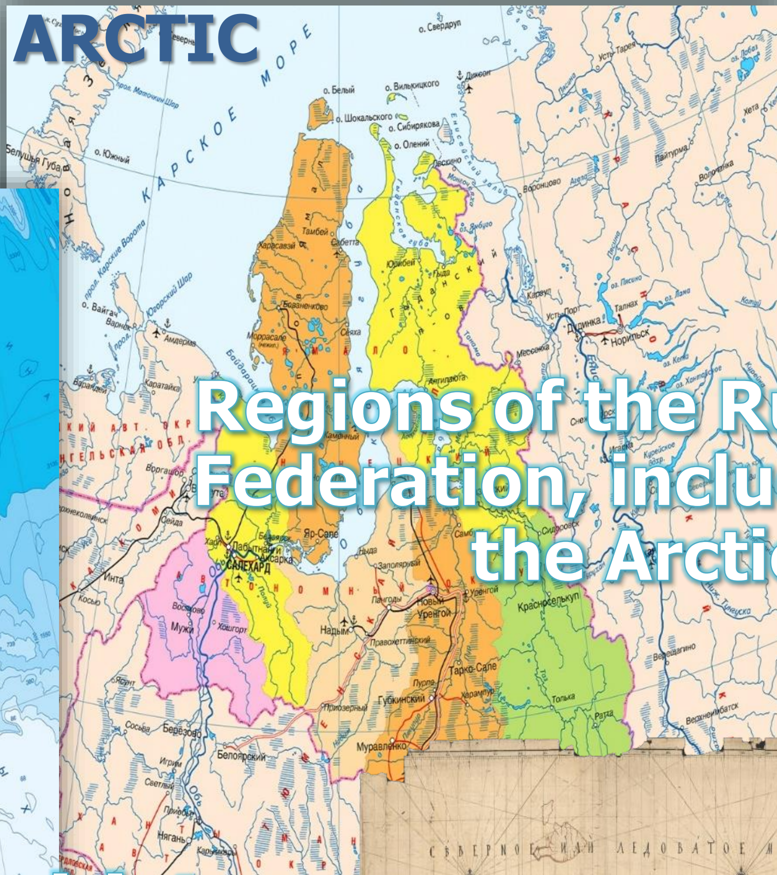
(28) Arctic Institute of North America (AINA)
(29) Swedish Polar Research Institute (POLAR)
(30) Barrow Arctic Science Consortium (BASC)
(31) World Wide Fund for Nature, Arctic Programme (WWF)
(32) Arctic Monitoring and Assessment Programme (AMAP) Secretariat



http://www.eu-interact.org/

NATIONAL ATLAS OF THE ARCTIC

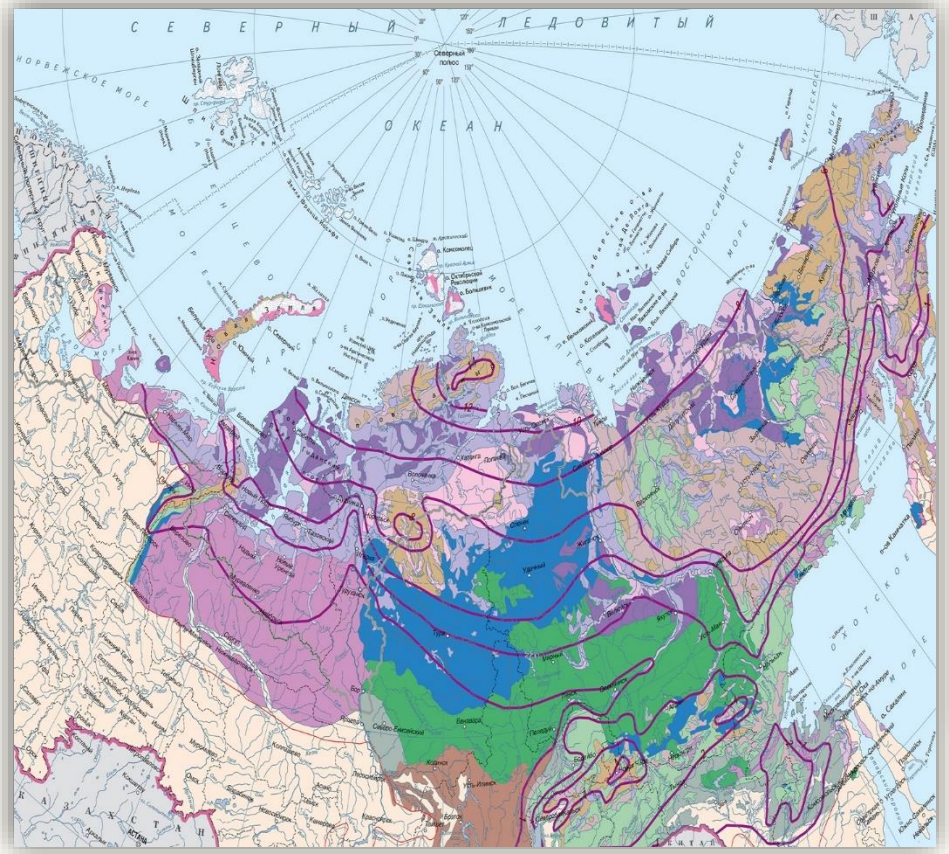
World Arctic

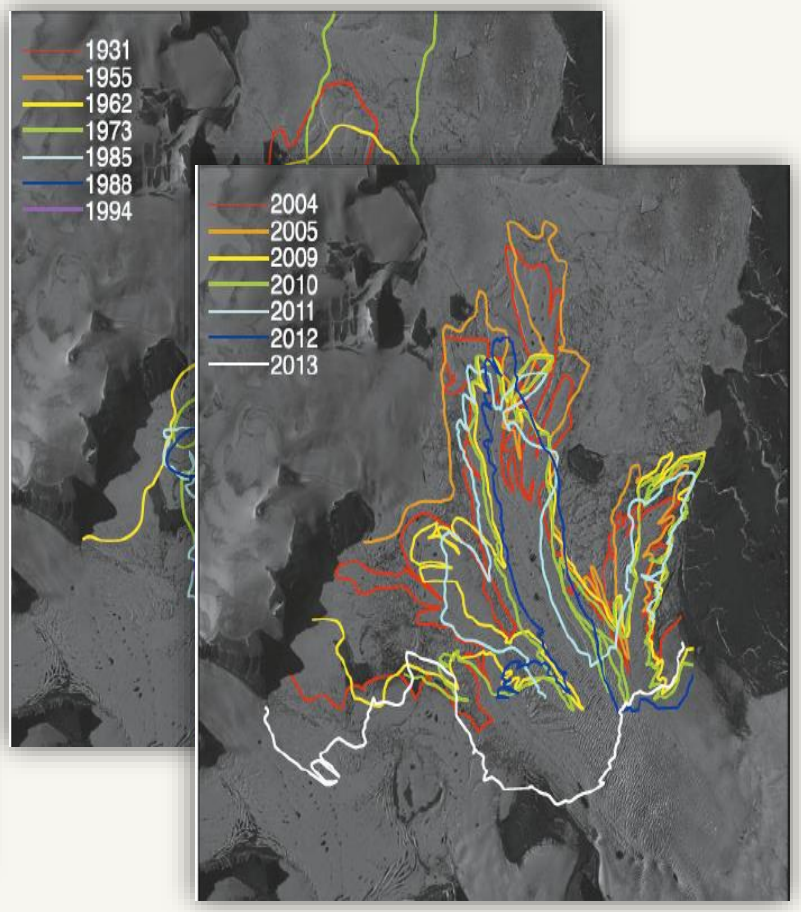


Regions of the Russian Federation, included in the Arctic zone

Research history and development of the Arctic

Snow cover. Glaciers. Permafrost





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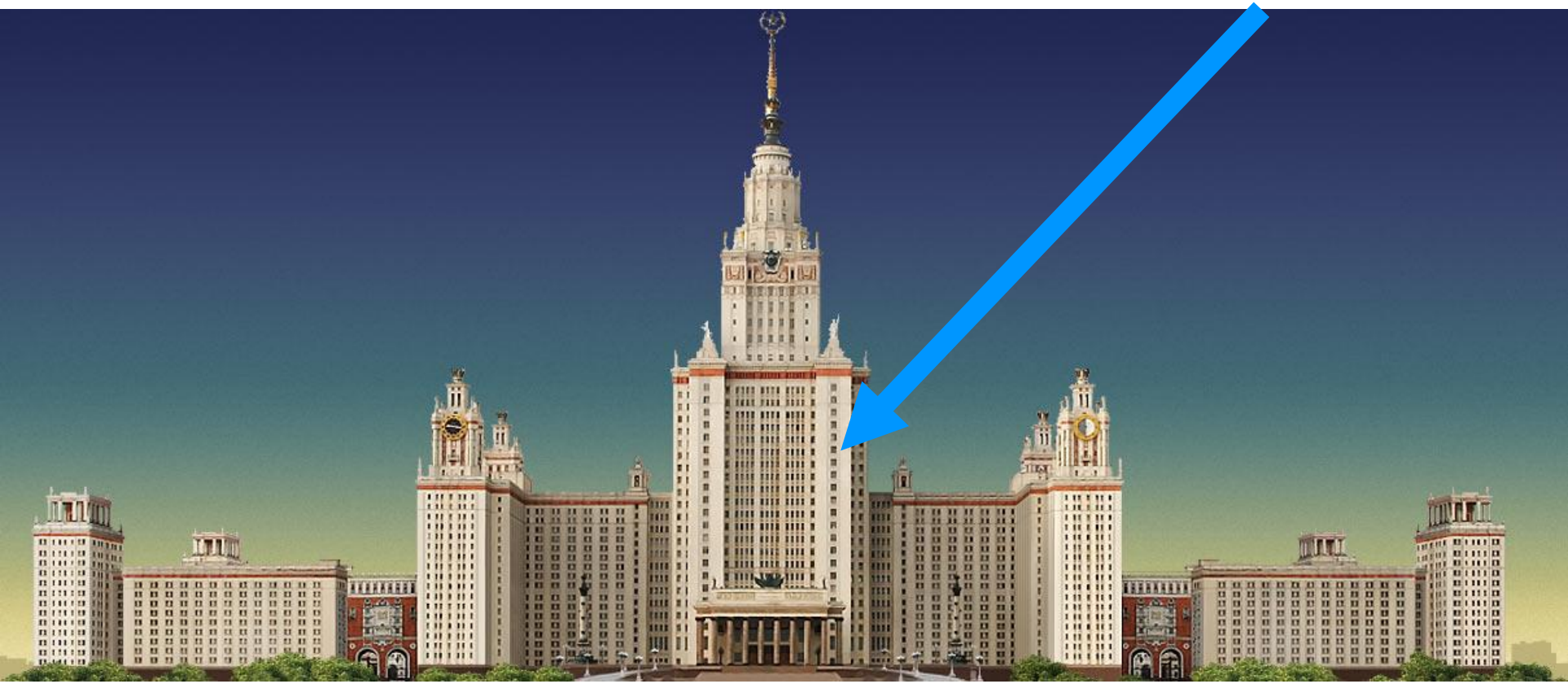

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