

The LCLUC NEESPI-NEFI: Accomplishments and Synthesis

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1. HISTORY

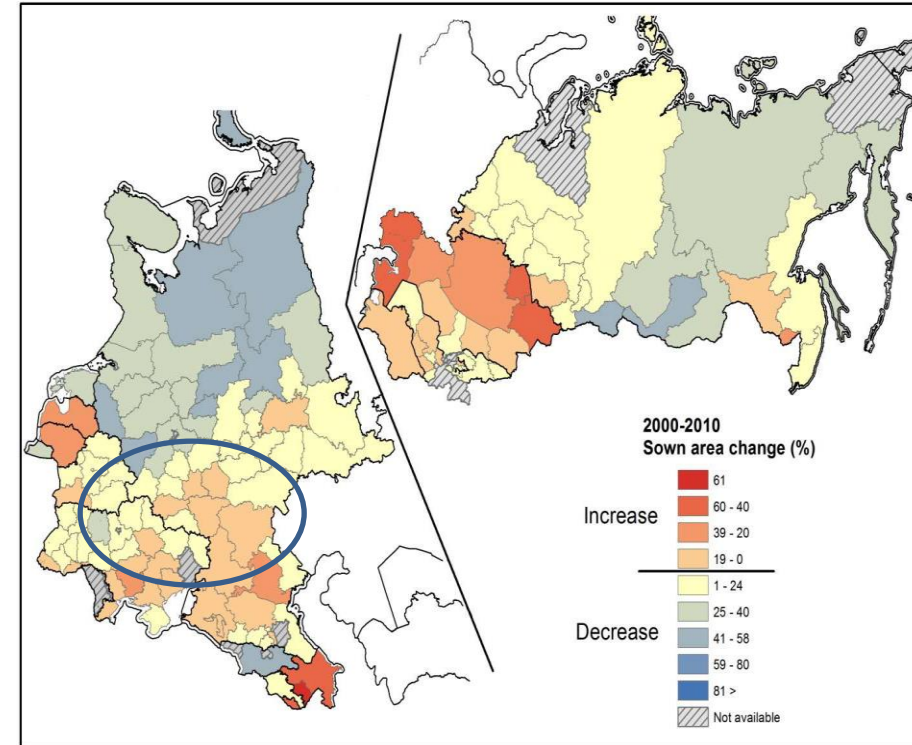
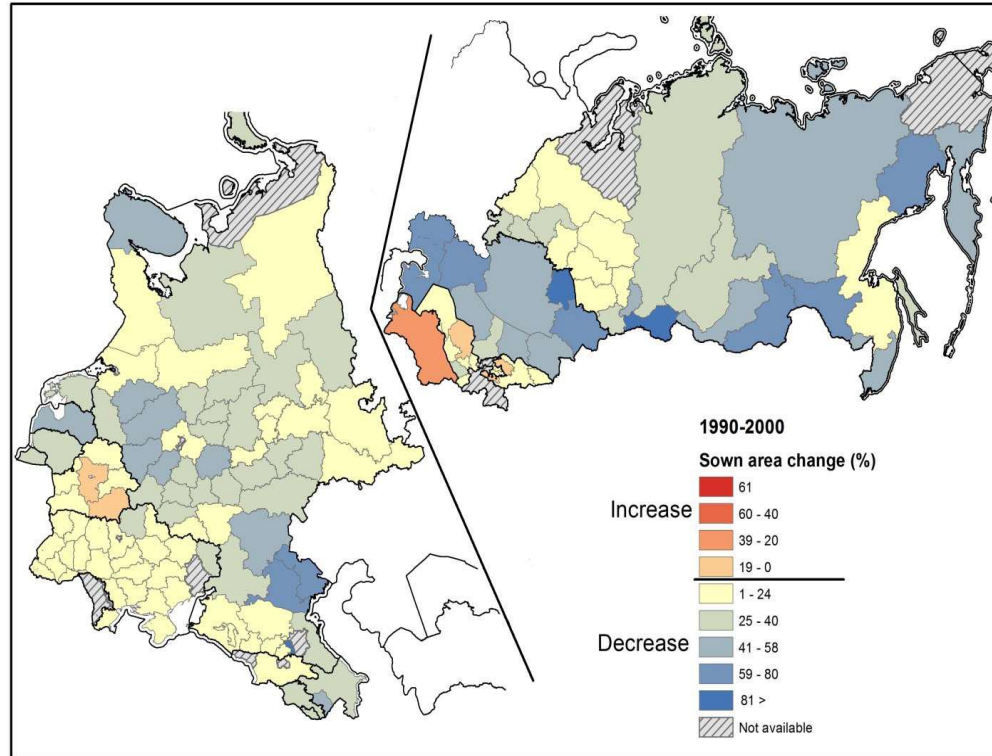
Some consequences of demolition of the USSR in the 1990s

- Partition of the nation into 15 (now 18 or 20?) states
- Industry demise and corresponding demise of branch scientific institutions related to it (70% of scientific research in the USSR was conducted in branch institutions instead of Academia or Universities)
- Mean life expectation of men in mid 1990s – **was 58 years**
- International scientific collaboration was spotty. It was unequal: scientific skills were compatible, but in Russia there were no resources for salaries, field studies, and new equipment, including computers
- Internal immigration of professionals (e.g., Ph.D. physicist => taxi driver)
- External immigration of scientists from the former USSR created a **new scientific diaspora**
- Abandonment of the farmland (**cf., see below**)

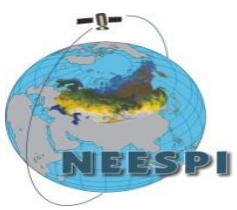
Sown area changes (%)

from 1990 to 2000

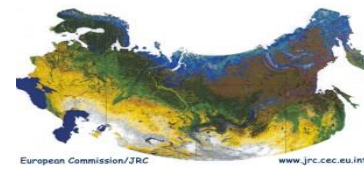
from 2000 to 2010



Areas of abandoned agriculture land from 1990 to 2010: Russia – 40×10^6 ha; The Ukraine – 5.4×10^6 ha; Kazakhstan – 13×10^6 ha (Prishchepov et al. 2017).



For tango you need at least two persons



Situation at the end of 2002:

- In Russia science funding was low, many Russian Academy of Science (RAS) institutes were surviving and loosing their young specialists
- In the Western countries, a new prominent Russian-language scientific diaspora emerged
- Since early 1990s, NASA “Earth Science Enterprise”, “Mission to Planet Earth”, now “NASA Earth Science” has been focused on studying the Earth System
- The World Scientific community is concerned with global change (global warming) and it is clear that changes in Northern Eurasia are among the strongest and quite unusual
- **The need for cooperation between NASA and RAS became mutual.**

2000s; RAS & NASA: Northern Eurasia Earth Science Partnership initiative, (NEESPI)

Preparation of NEESPI Science Plan, its reviews and presentations

Suzdal, 21-25 April 2003.

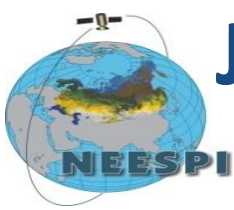


Livadia, 7-9 September 2003.



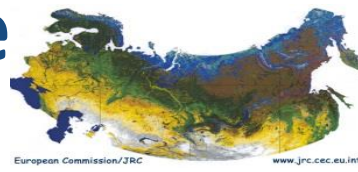
Unique features of Northern Eurasia

- **The most continental climate that is cut off from the humid tropics →**
 - The world's largest cold region (e.g., 2/3 of the terrestrial permafrost, 2/3 of the land seasonal snow cover, etc.) →
 - **The highest levels of climate and weather variability**
 - **Highly vulnerable natural and agricultural ecosystems**
 - **Extensive and variable dry land areas, and**
 - **Thus, the largest source of the extratropical dust**
- **Significant source of terrestrial carbon**
- **The world largest area of forest**
- **All the above => Potential for large climate change feedbacks**



Justification of the NEESPI Science Plan structure

<http://neespi.org/science/index.html>



- Rapid and strong climatic changes
- Significant probable changes in the carbon cycle of land and shelf regions
- Changes in the land energy budget
- Changes in the land water budget
- Interactions with human activities
- Interaction of climatic and biospheric changes
- Areas of special research foci:
 - Changes in the cryosphere (snow, ice, and permafrost)
 - Changes in the coastal zone (including those in the shelf seas)
 - Atmospheric aerosols



After endorsements by the International Expert Panels, a broad support of NEESPI in the U.S. and Russia began. Individual NEESPI projects had two requirements: the project **must be international and include the participants from the Northern Eurasia countries**. Later NEESPI received epigones (for example, the European Program “Pan-Eurasian Experiment”, PEEEX).

Achievements of the NEESPI Program to early 2015

- Incomplete list of publications produced within the NEESPI projects includes **36** books and more than **1400** papers (cf., http://neespi.org/science/NEESPI_publications.pdf).
- More than **750 scientists from more than 200 institutions of 30 countries** worked on **172** projects under the NEESPI umbrella.
- NEESPI promoted organization of the **early career scientist workshops** —10 during the 5 yr. period from 2010 to 2014 (currently, such seminars are organized once per year by the Siberian Center for Environmental Research and Training, **SCERT**, TOMSK, RUSSIA).
- **More than 80** Ph.D. theses on the broad topics of the regional studies in the area of the Earth Science were defended during the research studies within the NEESPI Program.
- Preparation of the new Science Initiative (**Northern Eurasia Future Initiative, NEFI**) has been launched.

2. SWITCH TO NEFI

NEESPI was launched in 2004 with its scientific horizon of 10-12 years.

During the past decade, NEESPI has included 172 individual projects and more than 1500 peer-reviewed publications. Now it is gradually discontinuing by attrition (no new projects were accepted).

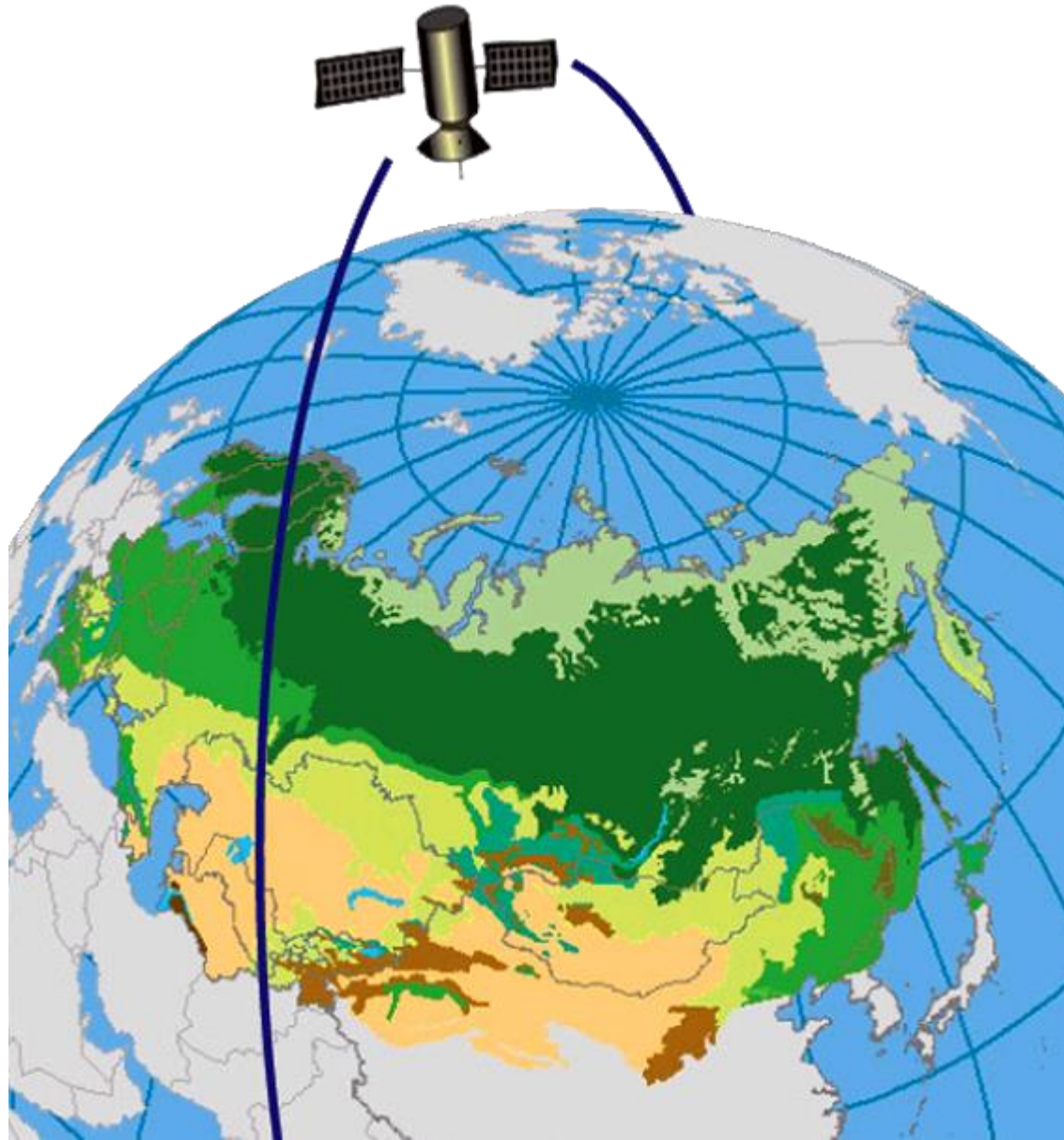
NEFI was launched in 2016.

The NEESPI Science Plan is available at <http://neespi.org/science/index.html>.

The NEFI Core Science Plan (White Paper) is available at <http://nefi-neespi.org/NEFI-WhitePaper.pdf>.

Currently 38 international projects are associated with NEFI.

The NEESPI Study Area



NEESPI Study Area includes: Former Soviet Union, Northern China, Mongolia, Fennoscandia, & Eastern Europe.

The NEFI Study area is the same.

Background. Northern Eurasia Future Initiative (NEFI) has emerged as an essential continuation of the Northern Eurasia Earth Science Partnership Initiative (NEESPI) –an interdisciplinary program of internationally-supported Earth systems and science research –that has addressed large-scale and long-term manifestations of climate and environmental changes over Northern Eurasia and their impact on the Global Earth system.

However, its science questions and research methods became different.

The overarching science questions:

- **NEESPI:** How do Northern Eurasia's terrestrial ecosystems dynamics **interact** with and alter the biosphere, atmosphere, cryosphere, and hydrosphere of the Earth?
- For NEFI, this question has been appended with the following science question: **How to provide in Northern Eurasia a sustainable societal development (economy well-being, activities, health, and strategic planning) in changing climate, ecosystems, and... societies?**



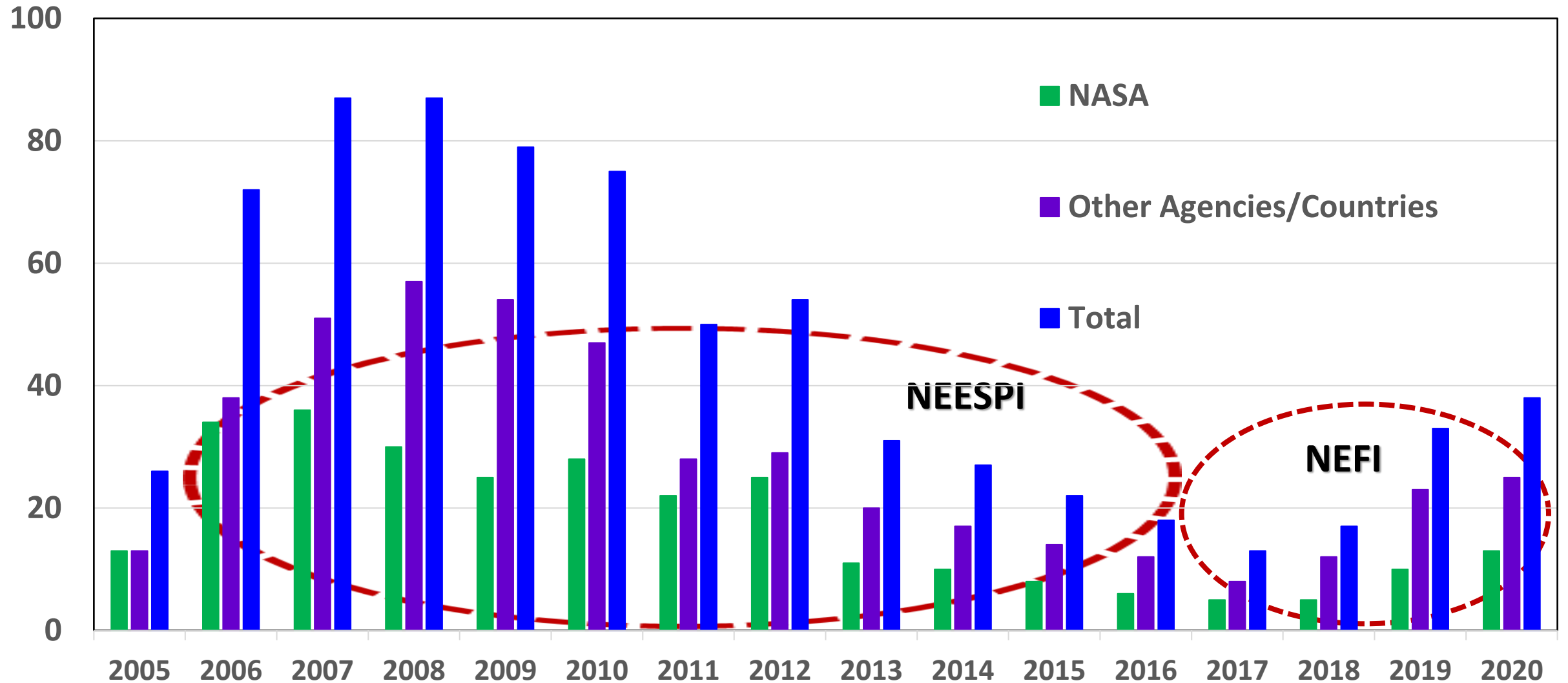
Speaking about models, NEFI will develop and rely upon regional models of dynamic processes, Earth System Models (ESM), and Integrated Assessment Models (IAM) that will be used for projections of the future under different scenarios of environmental changes as well as changes of socio-economic conditions with foci on Northern Eurasia.

Present NEFI programmatic papers

- Groisman et al. 2017: Northern Eurasia Future Initiative (NEFI): Facing the Challenges and Pathways of Global Change in the 21st Century. *Problems of Earth and Planetary Sciences, PEPS*. <https://doi.org/10.1186/s40645-017-0154-5>
- Monier et al. 2017: A Review of and Perspectives on Global Change Modeling for Northern Eurasia. *Environ. Res. Lett.*, 12, 083001
<http://iopscience.iop.org/article/10.1088/1748-9326/aa7aae/meta>.
- Chen, Y.Z et al. 2017: Quantitative assessment of carbon sequestration reduction induced by disturbances in Temperate Eurasian Steppe. *Environ. Res. Lett.*, 12, 115005 <http://iopscience.iop.org/article/10.1088/1748-9326/aa849b>
- Chen, J., et al. 2022: Sustainability Challenges for the Social-Environmental Systems across the Asian Drylands Belt. *Environ. Res. Lett.* 17, 023001, <https://iopscience.iop.org/article/10.1088/1748-9326/ac472f>

3. CURRENT NEFI STATUS

Active NEESPI-NEFI Projects by year



Since The Prague Workshop in **May 2015**, we discontinued accepting new projects to the NEESP Initiative redirecting them to NEFI.

Devoted NEFI outlet and outreach activities

NEFI Special Focus Issue of *Environ. Res. Lett.* was launched in March 2017

“Focus on Northern Eurasia in the Global Earth and Human Systems: Changes, Interactions, and Sustainable Societal Development”

<http://iopscience.iop.org/1748-9326/focus/NEFI>. The journal has high impact factor; in this year it is equal to 6.793. As of today, the Focus Issue includes 73 papers and several other manuscripts remain in the review process.

If we count previous four NEESPI Special Focus Issues of *Environ. Res. Lett.*, the number of the NEESPI/NEFI-related papers in this journal reach more than 135.

Every year, we organize scientific sessions at the international Conferences in the U.S., Japan, and Russia, devoted to environmental and socio-economic studies in Northern Eurasia (AGU, JpGU, ENVIROMIS). Since February 2020, these sessions have been mostly held online or in the hybrid formats due to the COVID Pandemy.

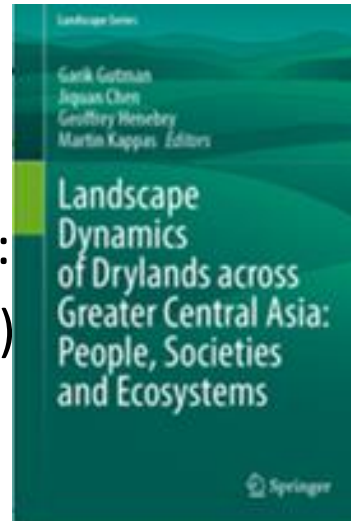
Conferences/workshops/symposia convened/planned in 2020; In blue are the meetings that were canceled or converted into virtual events

- **Feb. 19-21, 2020. Hirosaki, Japan.** International workshop on snow cover changes and its modeling over Northern Eurasia (Lead: Prof. A. Yatagai). **Since that Workshop, we had only hybrid or online meetings.**
- March 2-6, 2020. **Tokyo, Japan.** Sixth International Symposium on Arctic Research (ISAR-6). Presentation by P. Groisman, O. Bulygina, S. Gulev, A. Dufour, D. Streletskiy, G. Peng, N. Speranskaya, and N. Tchebakova, 2020: “Environment changes in the Eurasian Arctic” [**symposium was held in virtual mode**].
- March 9-10, 2020. **Nagoya, Japan.** The 1st International Joint Workshop on “Pan-Arctic Water-Carbon Cycles and Arctic Hydrological Cycle Changes” [**cancelled**].
- May 24-28, 2020. **Chiba, Japan.** JpGU-AGU Annual Conference. Three Sessions “Environmental, socio-economic and climatic changes in Northern Eurasia” [**shifted to July 2020 and was held in virtual mode**].
- 7-11 Sept, 2020. **Tomsk, Russia.** International Conference and Early Career Scientists School on Environmental Observations, Modeling and Information Systems *ENVIROMIS-2020* 28 June – 4 July, 2020.
- **Hongcheon, Korea.** Session AS67, *Environmental Changes in Asian Mountains and Northern Eurasia* at the 17th Asia-Oceania Geoscience Society Meeting, AOGS2020 [**cancelled**].
- 24-26 September 2020. **Barcelona, Spain.** Up to 3 Sessions at *the 3rd World Congress on Climate Change* (devoted to the Eurasian Arctic, Boreal Zone, and Drylands) [**cancelled**].
- **December 1-17, 2020.** San Francisco, California, USA: AGU Annual Conference. Two Sessions “Environmental, socio-economic and climatic changes in Northern Eurasia” [**in virtual mode**].

In 2021-2022, only five NEFI Events (or Session Groups) were convened: in Yokohama and Chiba (Japan), in Moscow and Tomsk (Russia), and in New Orleans (USA) [all were held in hybrid mode].

Past and planned major NEFI events:

- **May 2016:** The NEFI White Paper (Science plan) has been completed and exposed for public comments at the NEESPI web site.
- **December 2016 - January 2017:** Two programmatic papers were published in *ERL* and *PEPS*
- **The first NEFI Special Issue of *Environ. Res. Lett.* was launched in March 2017**
<http://iopscience.iop.org/1748-9326/focus/NEFI>
- **The NEFI Sessions were convened at the AGU (Dec. 2016 – 2021) and JpGU (May 2017 - 2019, June 2020 – 2022) Annual Meetings.**
- **In Russia, we have annual NEFI Workshops within ENVIROMIS and CITES Conferences organized by Siberian Center for Environment Research and Training (SCERT) in Zvenigorod, Tomsk, and Moscow (2017 – 2022).**
- **Thematic Workshop on Drylands of Eurasia (Ulaan Baatar, June 2017)** resulted in book: published by *Springer* in June 2020 (<https://www.springer.com/gp/book/9783030307417>)
- **In 2023, we plan to have at least two NEFI Events/Sessions, in Russia and in Japan.**
- **The AGU venue for the NEFI Sessions has been abandoned since December 2022.**

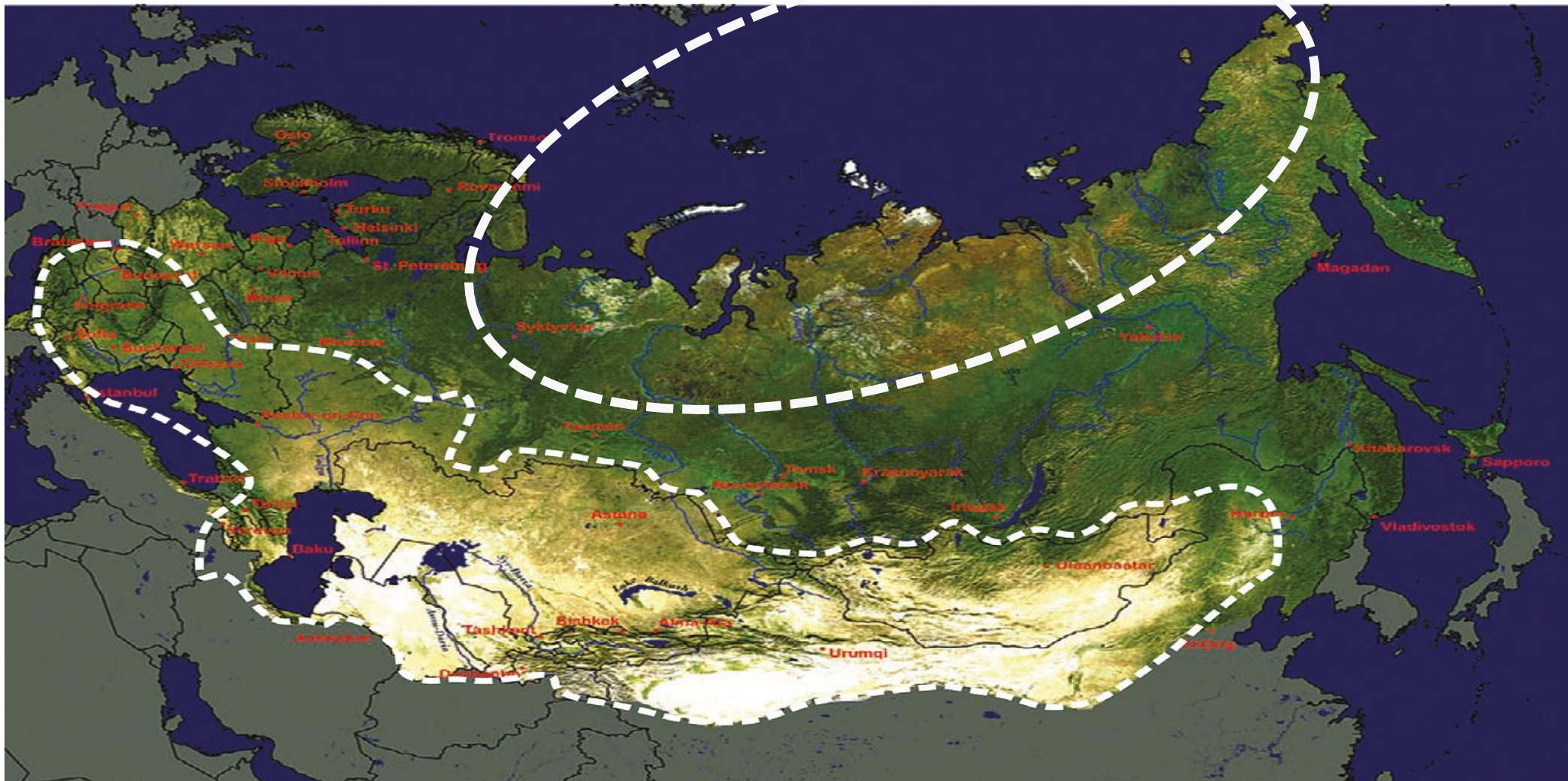


4. Three regional groups of NEFI studies

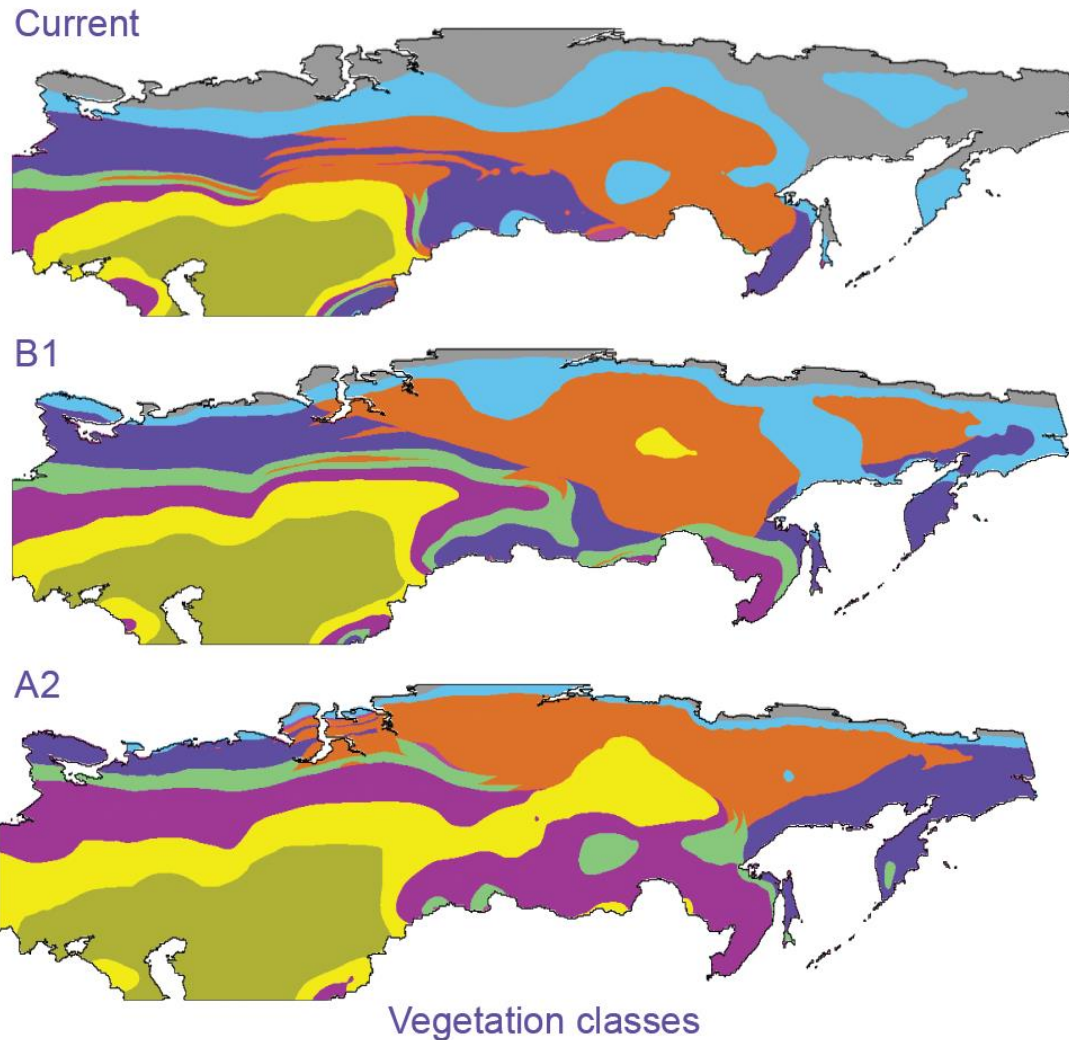
Keeping in mind new sets of science questions, the new generation of NEFI studies became and will continue to be “more regional”.

Three main regions of the NEFI studies are located in:

- **The Eurasian Arctic** – the region of the most prominent natural changes.
- **Dry Latitudinal Belt of Northern Eurasia** – the largest region with acute water deficit in the extratropics.
- **Boreal Forest zone** – the largest storage of terrestrial carbon. Ecosystems' boundaries here are unstable.



Scenarios of the expected ecosystems' shifts to 2090



Vegetation distribution in contemporary climate conditions and its stable distribution in scenarios of future climate in 2090 over the former USSR territory (archive of the work by Tchebakova et al. 2016).

Studies in the Arctic

- ARCTIC climate change and its impact on Environment, infrastructures and Resource Availability, ARCTIC ERA. **BELMONT Forum. Russia, France, and the USA.**
- Atmospheric **M**oisture **T**ransport and European climate **EX**tremes (AMTEX). **France + Russia.**
- **ARCTIC** Hydrological Cycle **CH**anges: Impacts on environment sustainability and natural resources (ARCTIC-CHI). **Japan + Russia.**
- The impact of unofficial transportation routes on remote Arctic communities. **Russia + USA.**
- Hydrochemistry of inner water bodies in the Eurasian Arctic. **RSF, RFBR.**
- NNA Research: Collaborative Research: Frozen Commons: Change, Resilience and Sustainability in the Arctic. **USA, Canada, Russia**
- Three more new Belmont Forum Projects were initiated in 2020:

- a. **Rapid Arctic Changes Implications for Evolution of Arctic Communities (RACIEAC),**
- b. **Coastal Ocean Sustainability in Changing Climate (COAST), and**
- c. **Building Socio-Ecological Resilience through Urban Green, Blue and White Space (SERUS).**

Established in 2009, the Belmont Forum is a partnership of funding organizations, international science councils, and regional consortia committed to the advancement of transdisciplinary science. It encourages *International transdisciplinary research providing knowledge for understanding, mitigating and adapting to global environmental change* <http://belmontforum.org>.

The rules of the project support within the Forum are:

The science team from three or more countries prepared their research proposals within a broad framework of **Collaborative Research Actions (CRA) i. e., the Proposal Calls**. All proposals are assessed by independent experts from these countries.

Two CRA, in 2004 and 2009, were devoted to the Arctic. After approval of all appropriate national sponsors, ten **Belmont Forum** Arctic projects were launched in **2014** and eight in **2019**. In fact, all of them started one year later. In 2015, **four of ten Arctic projects** included Russian Institutions and, thus, were **devoted to the Russian Arctic**. In 2020, **five of eight Arctic projects** included Russian Institutions.

Grebenets et al. 2021: The problem of storage of solid waste in permafrost. *Environ. Res. Lett.*, 16, 105007.

Solid waste in the Arctic are especially dangerous due to fragile natural environment, its interaction with permafrost, and difficulties with its liquidation. In the Russian Arctic these problems are more visible due to the higher population density and industrial development.

Waste dumps of industrial, municipal, and forest processing origins



← Abandoned settlements

Destruction of the vitally-important infrastructure →



NEFI-related Studies in the Boreal Zone

- Three joint **Japanese – Russia Projects**:
 - Greenhouse gas monitoring by aircraft over Siberia
 - JR-STATION tower monitoring network of greenhouse gas observations in West Siberia
 - Terrestrial water cycle; swamps.
- Baltic Earth Working Group on Regional variability of water and energy exchanges in the Baltic Sea region includes one **Belarus + Russia NEFI Subproject**.
- Wildfire disturbance-recovery dynamics in southern Siberia: feedbacks between climate change and ecosystem resilience. **UK + Russia**.
- Research into information, policy and on-ground action for primary forest protection: Boreal and temperate primary forests. **Australia, Russia, USA**.
- Study of vegetation dynamics and climatic changes in Altai-Sayan region since Late Glacial to present by method of complex palaeoecological and isotopic research. **Russia + Taiwan**.
- **Three (of six) Belmont Forum Projects in 2020 have Russian Institutions participation**:
 - **Permafrost** degradation impacts on soils, human societies, water resources and carbon cycle (**PRISMARCTYC**). France, USA, Russia
 - Global change impact on vulnerable **carbon reservoirs**: carbon sequestration and emissions in soils and waters From the Arctic To the Equator (**VULCAR-FATE**). France, USA, Russia
 - Stakeholder-supported decision making for sustainable conjunctive management of soil and groundwater (**INCLUSIVE**) France, USA, Russia, Taiwan.

Tchebakova et al. 2022: Do droughts cause dark-needle forests decline/die-back in the southern Siberian mountains? *Forests*, **13**, 1378

- In the South Siberian Mountains, climatic moisture/dryness indices rarely went down to high risk levels for the last 60 years (1960-2019). These levels are characterized by SPEI < -1.5 values and are representative of drought stress conditions of dark-needle conifers dieback/survival.
- Trees are capable of recovering two dry sequential years.
- The authors **did not find steady aridization trends** indicating drying climate that could cause die-back of dark-needle forest at middle-to-high elevations over the South Siberian Mountains.
- But, the phenomena of decline and dieback of dark conifer forest on the slopes of the South Siberian Mountains **is observed** and its causes should be studied further.

Currently a lot of Earth science studies in Eurasian Drylands are supported by sponsors from the United States, China, Russia, Turkey, Japan, and Germany. Investments are made also into the scientific infrastructure. Since 2008, the Aga Khan Foundation supports the International University of Central Asia (IUCA) with two campuses in Khorog, Tajikistan and Naryn, Kirgizstan.

• **Seven projects in the Eurasian Drylands are supported by the NASA Land Cover and Land Use Change Program:**

1. Atmospheric Teleconnections and Anthropogenic Telecouplings Drive Land Change in Central Asian Highlands: How Environmental Changes, Migration, and Remittances Threaten Montane Agropastoralist Livelihoods and Community Viability
2. Interdependent Dynamics of Food, Energy and Water in Kazakhstan and Mongolia: Connecting LULCC to the Transitional Socioecological Systems
3. Rapid Urbanization, Changing Croplands and Increasing Population Health Vulnerabilities in the China-Central Asia-West Asia Economic Corridor
4. How Environmental Change in Central Asian Highlands Impacts High Elevation Communities
5. Land Use Change in the Caucasus Mountains Due to Ethnic Differences, National Policies, & Armed Conflicts
6. Land Use Patterns and Political Instability as Predictors for the Re-Emergence of Malaria in the Caucasus
7. Comprehensive Analysis of Thirty Years of Land Change in Georgia: Patterns, Carbon Dynamics and Drivers.

~~EU Study: Solutions for climate-smart land use in the dry steppes of Russia (CLIMASTEPE).--~~

RFBR study: Postagrogenic (secondary) steppe landscapes of Buryat Republic: potentials and trade-offs between agricultural development and ecosystem functioning, socioeconomic and environmental impacts (AGROBUR). (RF)

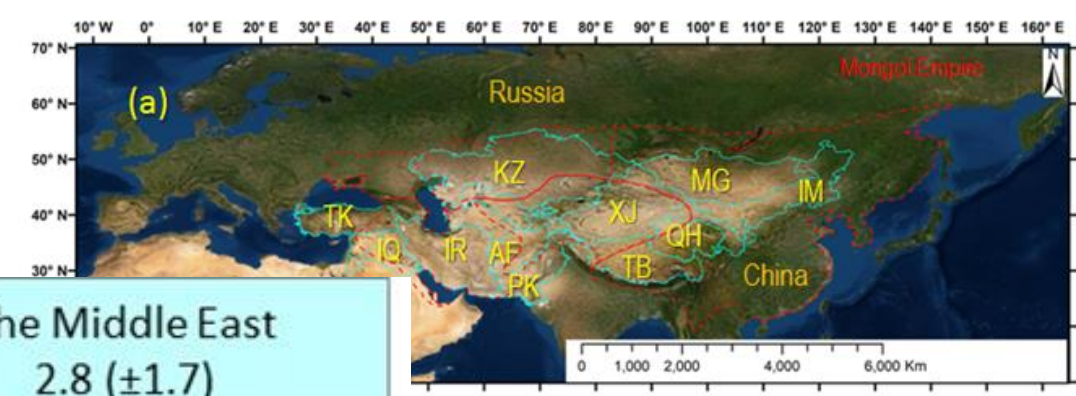
RFBR study. Evaporation over the Azov Sea. (RF)

NSFC study. Regulatory Mechanisms of Early Occurring Heat Waves on Carbon and Water Cycles in a Meadow steppe. (PRC)

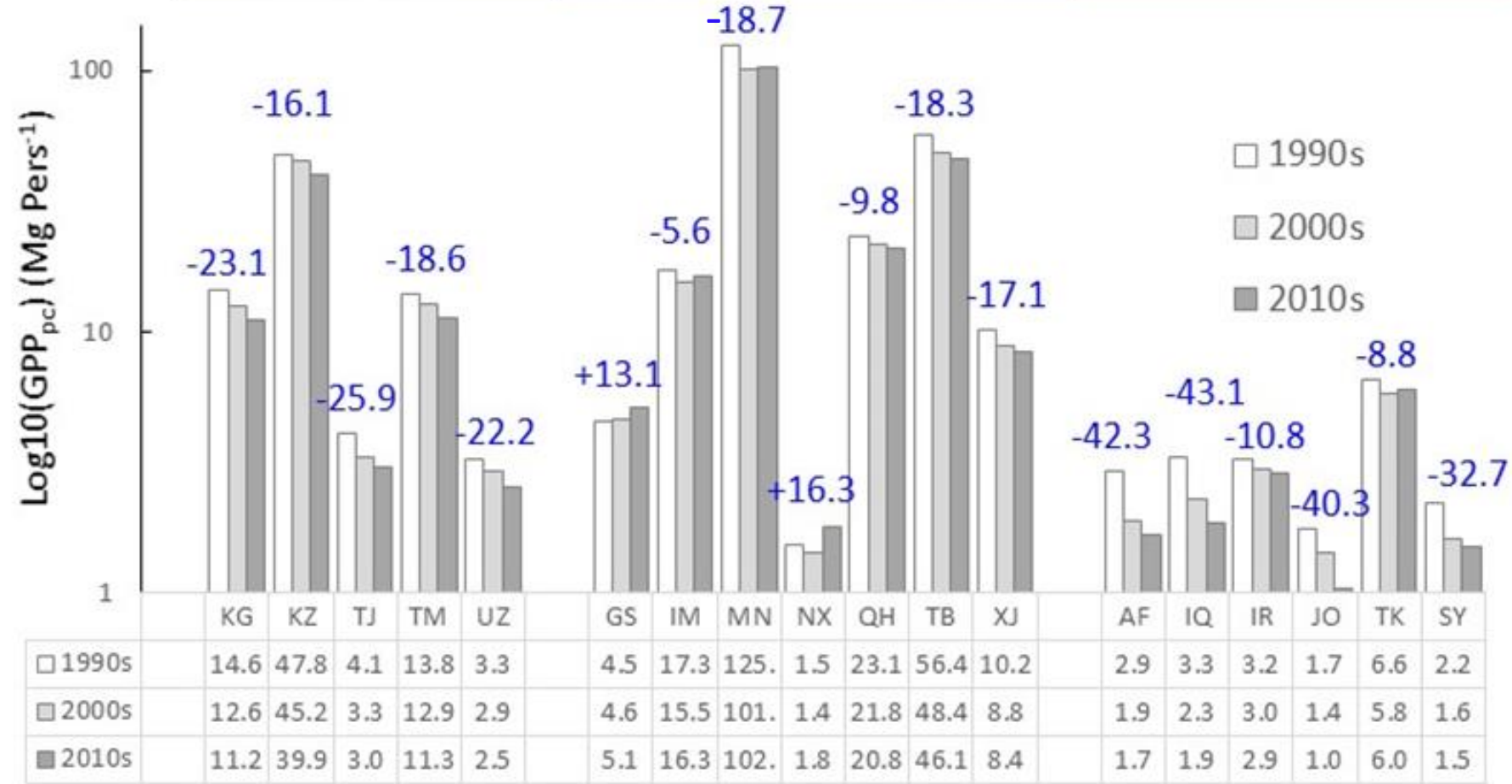
GCRF study. Solutions to Clean Water in the Glacier-fed Catchments of Central Asia: What Happens after the Ice? (UK)

Dynamics of changes of gross primary production, GPP, per capita in the nations/provinces of the Asian Dry Belt. Chen, J. *et al.* 2022

Sustainability Challenges for the Social-Environmental Systems across the Asian Drylands Belt. *Environ. Res. Lett.* 17, 023001



Subregion	Central Asia 15.2 (±15.8)	East Asia 30.6 (±36.9)	The Middle East 2.8 (±1.7)
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The number in blue above the bars are the percentage of changes from 1990s to 2010s

Only in Ningxia & Gansu Provinces of China GPP/capita ↑

Thank you for your attention!
Спасибо за внимание!

