



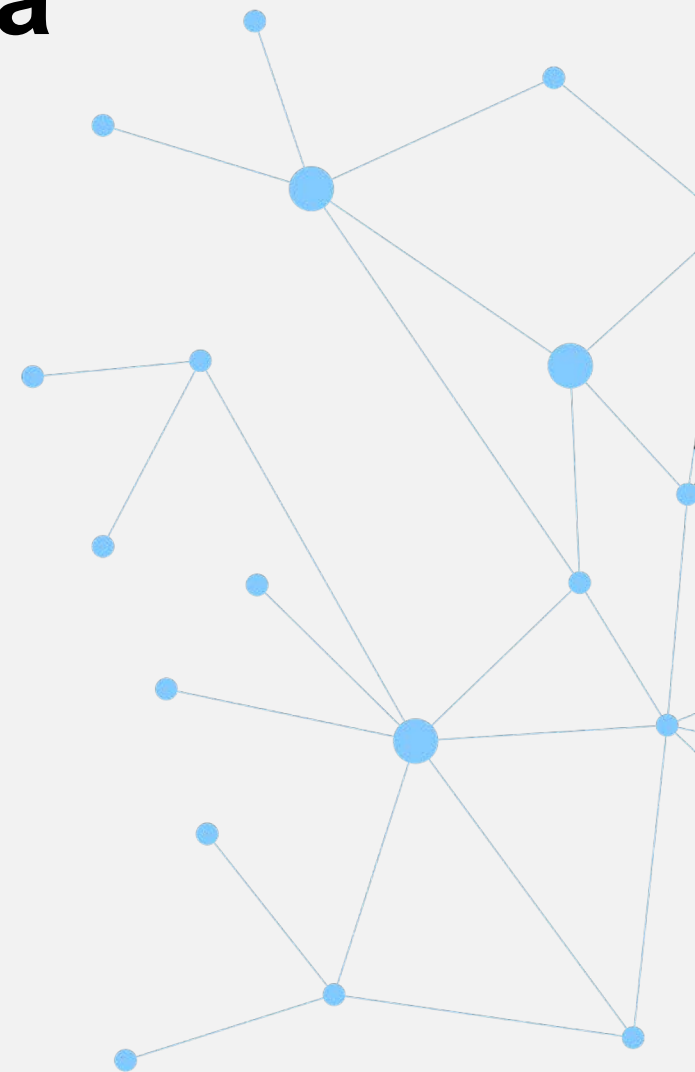
# The Effects of Excessive Water Use and Agricultural Intensification on Aral Sea Shrinkage: SES Dynamics within the Syr Darya River Basin

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AgriTech Hub KazNARU



# Ecological situation of the Aral Sea



**PARTNERSHIPS FOR ENHANCED ENGAGEMENT IN RESEARCH (PEER)**  
Cycle 9 (2020 Deadline)

**The effects of excessive water use and agricultural intensification on Aral Sea shrinkage: socioeconomic-environmental systems (SES) dynamics within the Syr Darya River Basin**

PI: Maira Kussainova (mairakussainova@gmail.com), Kazakh National Agrarian University  
U.S. Partners: Ranjeet John, University of South Dakota, and Jiquan Chen, Michigan State University  
Project Dates: April 2021 - March 2023

**Project Overview:**

[Project Website](#)

One of the most dramatic changes in the Earth's surface over the past six decades has been the shrinking of the Aral Sea in Central Asia. This project focuses on the causes of reduced stream flows through analysis of land cover trends, agricultural development, water withdrawals, irrigation intensity trends, population density, economic development, and policy shifts. Concepts, principles and methods from socioeconomic-environmental systems (SES) will be applied for three districts along the Syr River, the largest tributary for water supply to the shrinking Aral Sea. The long-term goal is to build a comprehensive database and knowledge to understand physical and socioeconomic changes, as well as their forcing and consequences on the ecosystems and societies within the Syr Darya River basin (SDRB). Specific project objectives are as follows: (1) to construct a comprehensive database of climate, stream flows, agricultural lands, time series of land cover at 5-year intervals since 1973, economic measures, social indicators, and major policies for three districts along the Syr Darya River; (2) to explore the interdependent changes of food, energy, and water fluxes for the three districts with high-resolution data for mechanistic understanding of coupled changes between climate and land use; (3) to identify critical drivers (including policy shifts) on stream flows and evapotranspiration loss for the sustainable future of food, water, and energy; and (4) to construct an open-access webpage to share all the data and research findings with the public. The research team will integrate socioeconomic and biophysical changes by infusing databases from multiple sources, including satellite images, government statistics, past ground measurements of vegetation, soil, stream and climate, the literature, and their own field measurements. They will focus on three districts (Aralskiy, Syrdariya, and Zhanakorganskiy) that are located in the upper, middle, and lower sections of the river. Installations of three automatic weather stations and extensive surveys of the landscapes in Kyzylorda will fill some major data gaps.

Built on rich literature and multiple sources of data, this project will be the first attempt in the region to integrate socioeconomic and ecological changes toward a holistic understanding of the causes and consequences of climate change and land uses. This project will be the first to produce land covers for the three districts at five-year intervals for the past five decades. When integrated with other long-term climate, hydrology, and physical changes, the researchers will be able to quantify the changes of SES functions, providing scientific evidence for revising local management plans and policies, as well as for transboundary policy developments for partner countries within the Aral Sea basin. The project is built upon the team's past research in the Aral region, including an ongoing project on the food-water-energy nexus of Kazakhstan (working with NASA and USDA/ARS) and curriculum development for more than five universities in Kazakhstan (in conjunction with the American Council). The researchers will collaborate directly with the management teams of the Akimat in each district/city, making the recommendations directly to the managers and policy makers. They will share data openly with the international community, setting a model template for other teams who do not have such a sharing protocol. In addition to providing direct support for a graduate student, the project will enhance data and lessons to be used in several undergraduate and graduate courses, summer schools at local universities, and workshops with local policy makers.

**Summary of Recent Activities**

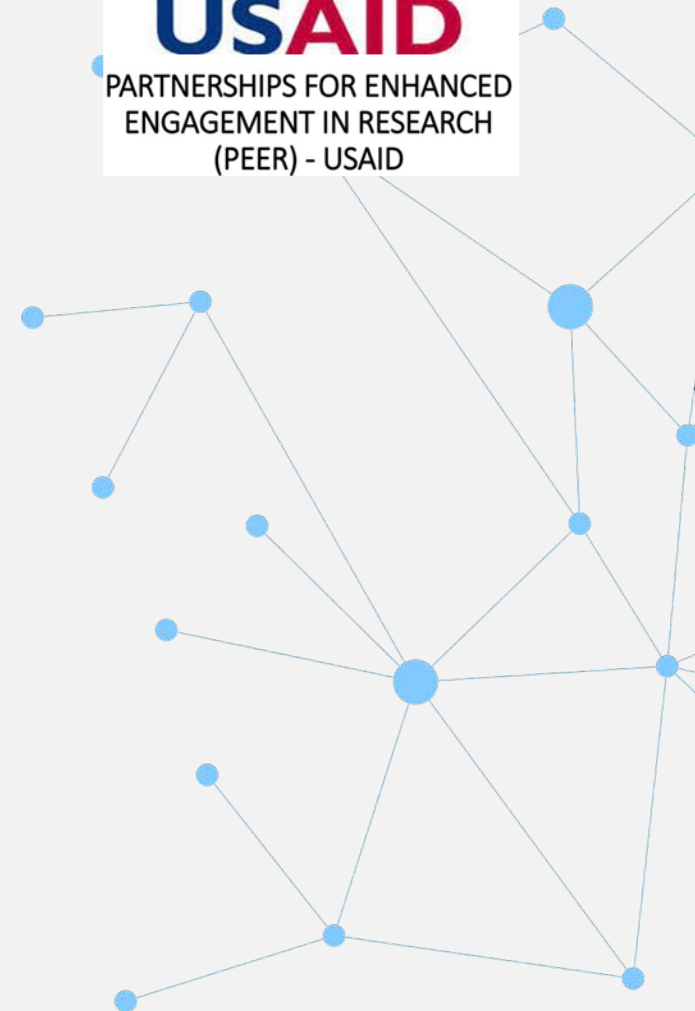
During the last quarter of 2022, the project team continued to develop the program and share results with regional stakeholders. The team organized a series of training seminars and webinars, allowing researchers to master all the necessary skills to conduct research and implement projects in the field of environmental conservation and agriculture. They also met with farmers and heads of peasant farms who focus on crop production and animal husbandry, as well as local agricultural departments and representatives of the higher educational universities in the Kyzylorda Region. Finally, team members participated in a series of international conferences and various training covering most aspects of climate change and environmental research work.

PI Maira also visited her USG-supported partner during this period. As part of this trip to the University of South Dakota, the partners used archival data from libraries, various literature, and data from the statistical bureau of Kazakhstan, to analyze causal and non-causal relationships between the elements of the biophysical matrix and socio-economic variables.



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# Research Tasks:



## **Task 1**

Construct a comprehensive database of climate, stream flows, agricultural lands, time series of land cover at 5-year intervals since 1973, economic measures, social indicators, and major policies for three districts along the Syr Darya River



## **Task 2**

Explore the interdependent changes of food, energy and water fluxes for the three districts with high-resolution data for mechanistic understanding of coupled changes between climate and land use



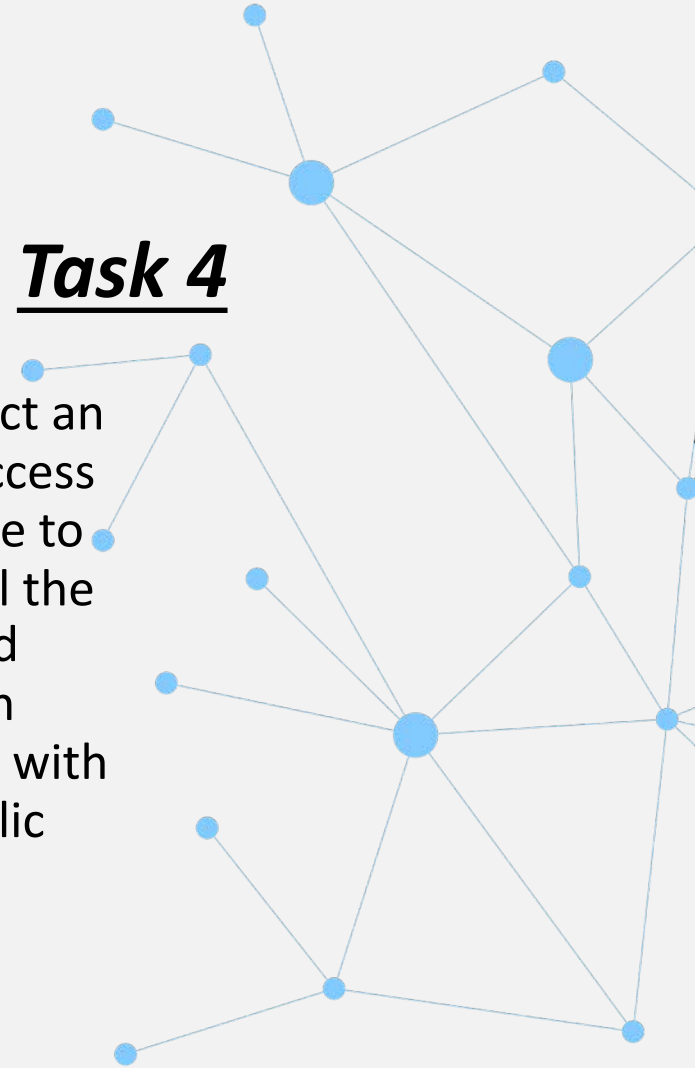
## **Task 3**

Identify critical drivers (including policy shifts) on stream flows and ET loss for the sustainable future of food, water and energy

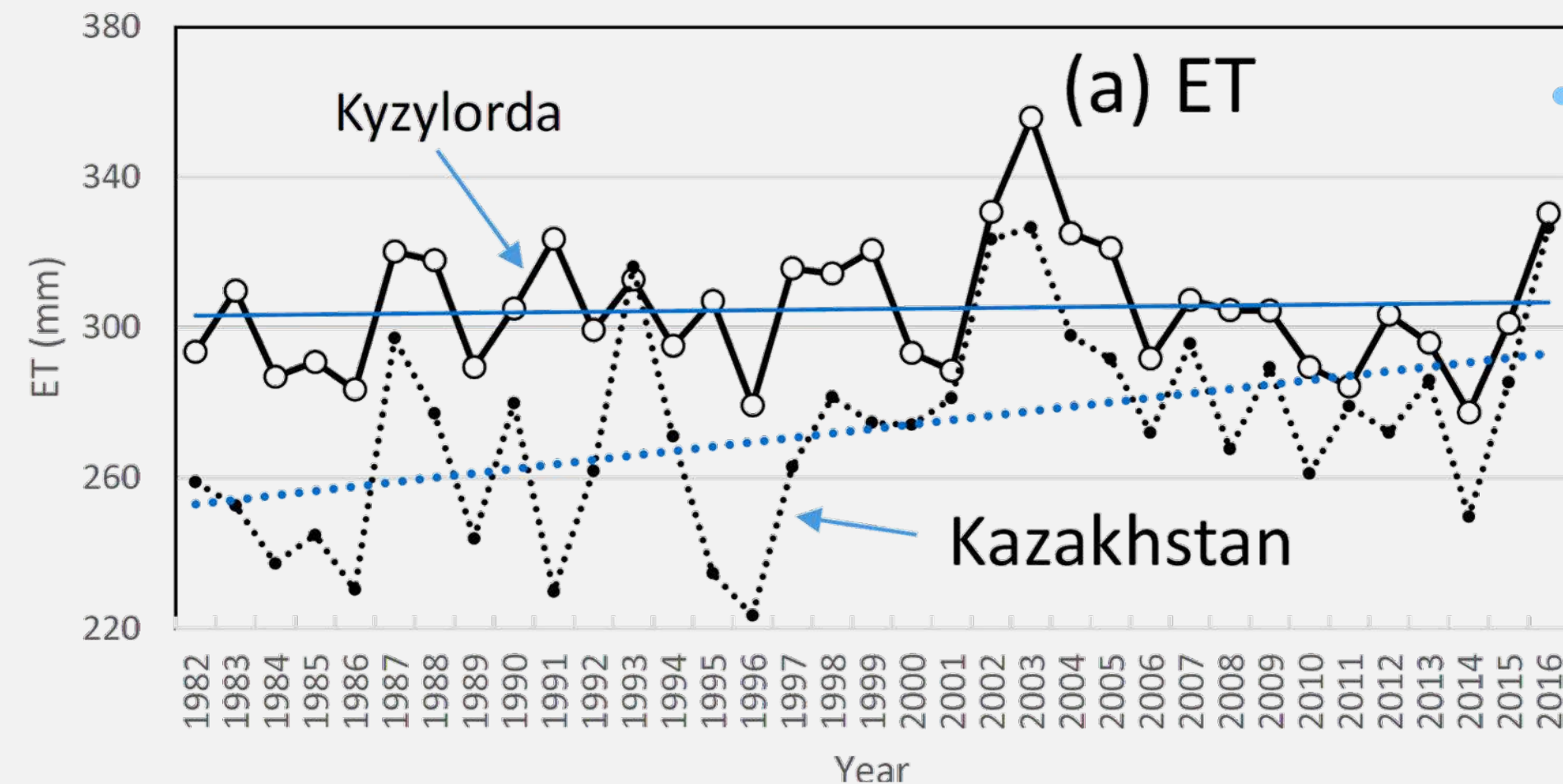


## **Task 4**

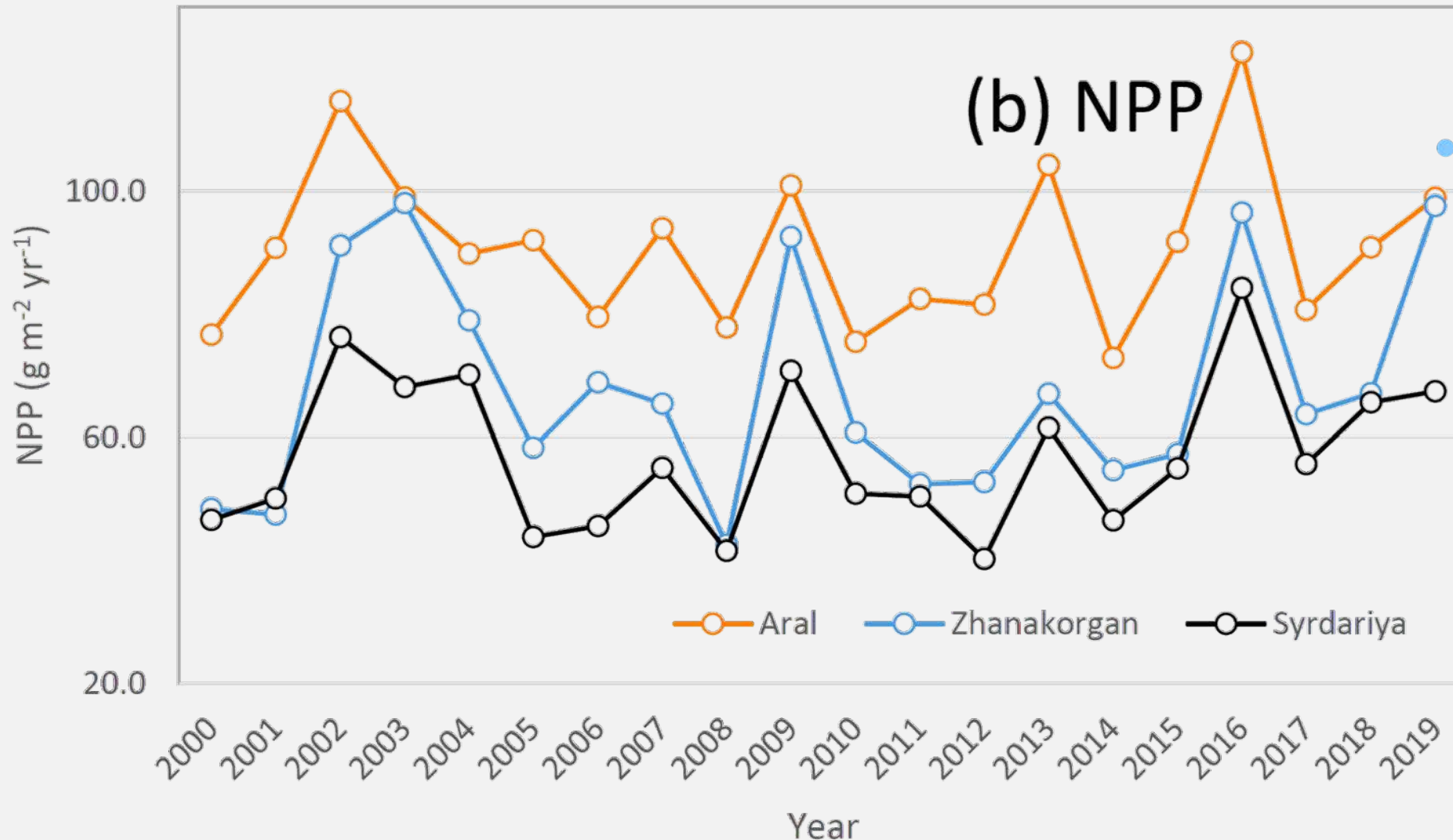
Construct an open-access webpage to share all the data and research findings with the public



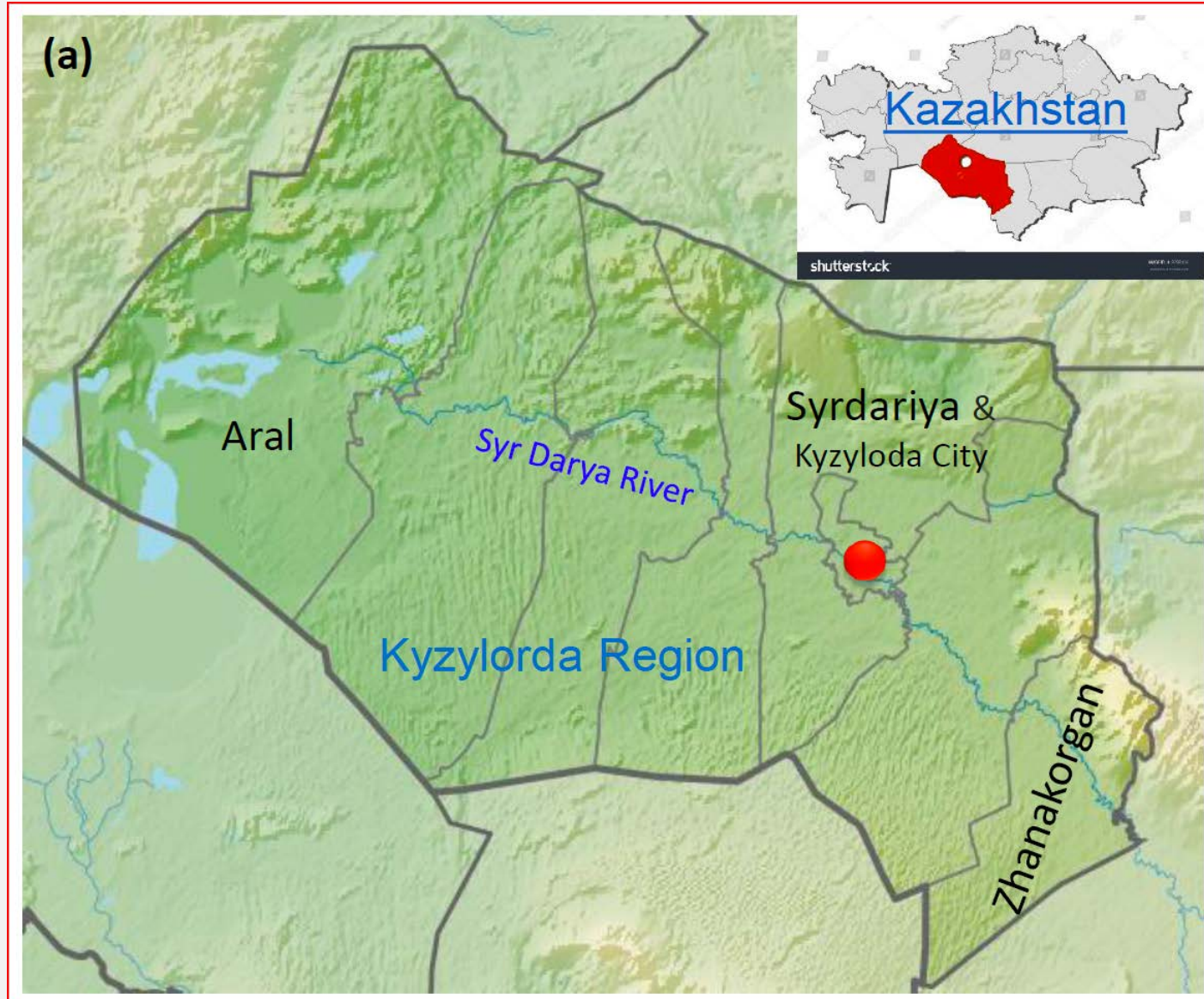
# Changes in evapotranspiration (ET, 1982-2016) in Kyzylorda and Kazakhstan with linear trend lines



# Net primary production (NPP, 2000-2019) in the 3 study districts

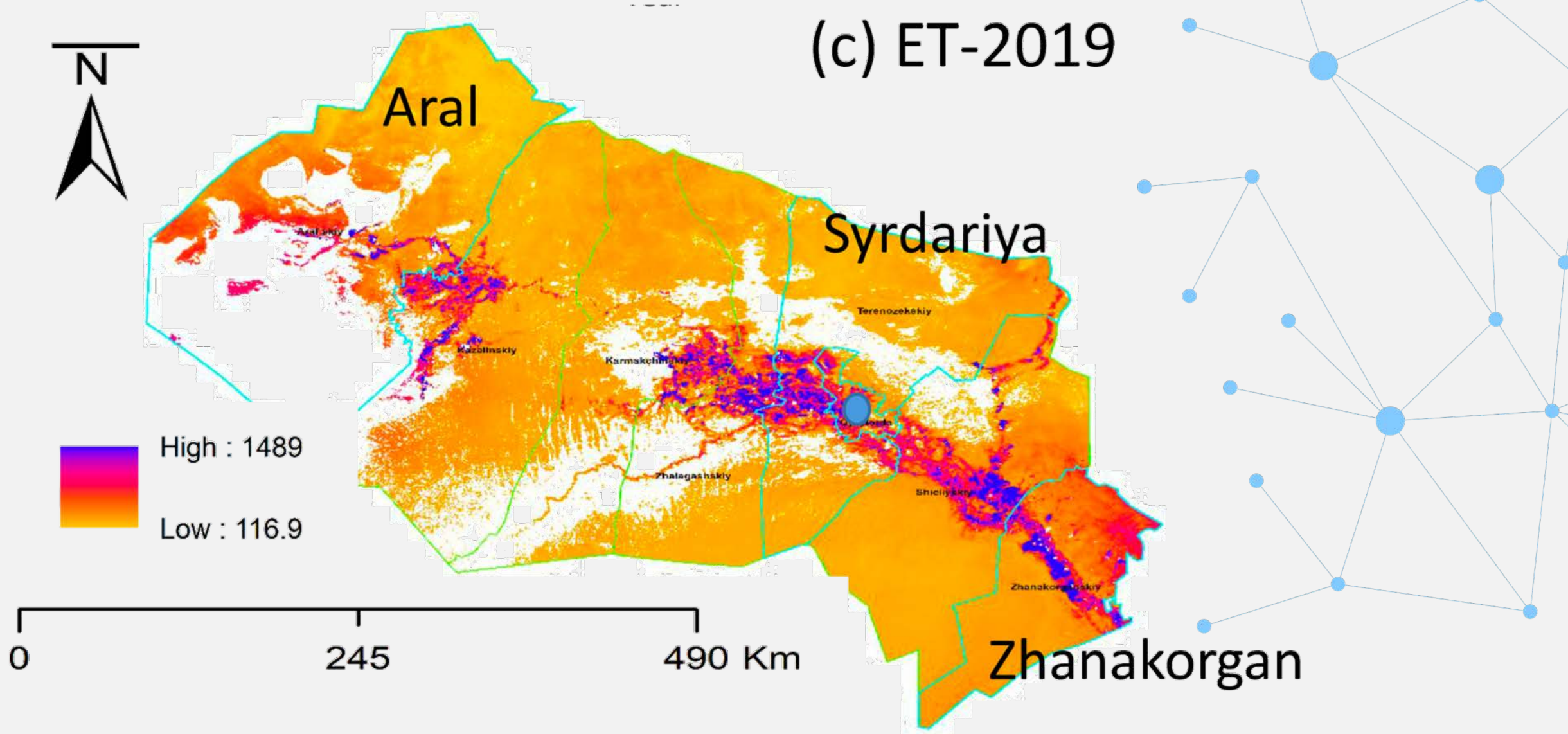


# Geographic locations of study site in Kazakhstan



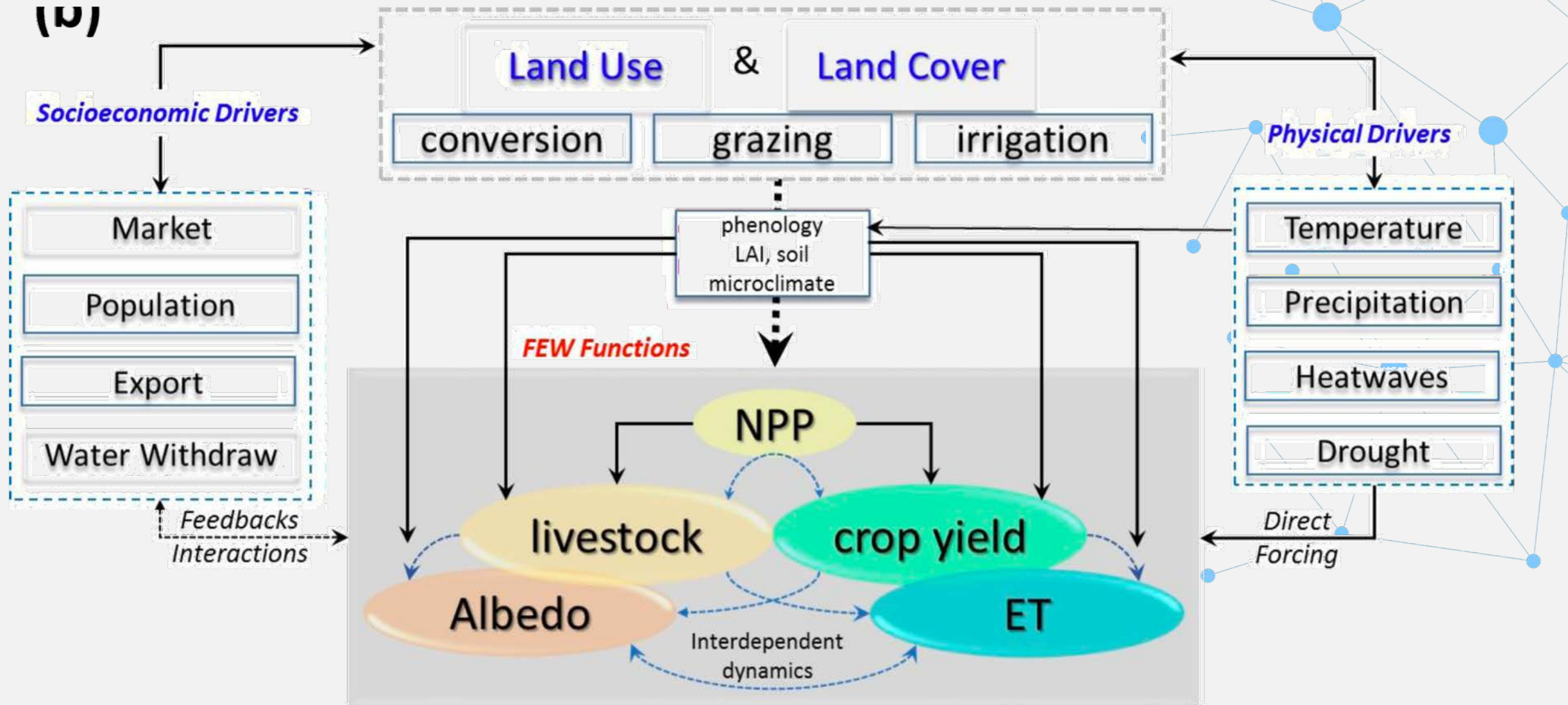


# Spatial distributions of ET in 2019 for Kyzylorda





# Conceptual working framework (b) on the interdependent changes among food (livestock and crops), energy (albedo -> global warming potentials: GWP) and water (ET, stream flow, irrigation)



# RESEARCH SCIENTIFIC PROJECTS



2021-2023



## STUDIES OF GREENHOUSE GAS EMISSIONS FROM AGRICULTURE



### The essence of the project:

Assessing the effectiveness of different land-use systems to mitigate climate change by reducing greenhouse gas emissions and increasing albedo



### Results of the study:

- To assess the emission of greenhouse gases ( $\text{CO}_2$ ,  $\text{CH}_4$  and  $\text{N}_2\text{O}$ ) and albedo in arable soils when using fertilizers and when applying different types of basic tillage for different crops.
- Understand and assess how our traditional and efficient methods affect emissions and mitigate the negative impact of agriculture on global climate change.



# Main curricula in ecology and environmental sciences in educational institutions of Kazakhstan and Central Asia



**Key Curriculums for Ecology and Environmental Sciences in Kazakhstan and Central Asia Academic Institutions**

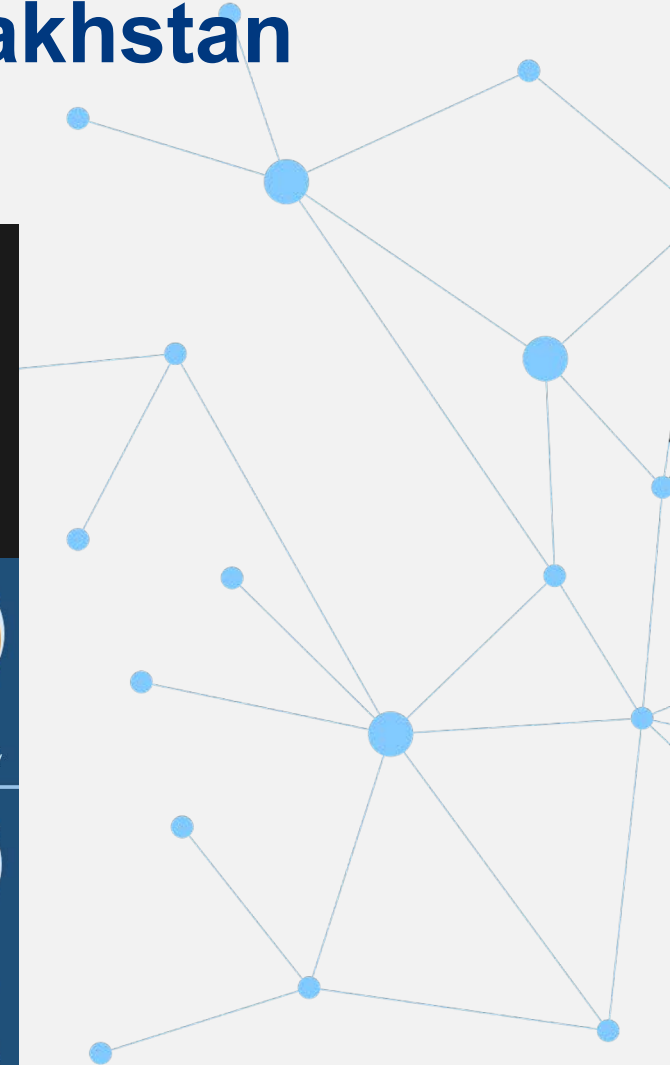
**AMERICAN COUNCILS FOR INTERNATIONAL EDUCATION**  
30 YEARS TOGETHER

**MICHIGAN STATE UNIVERSITY**

**UNIVERSITY OF SOUTH DAKOTA**  
1865 THE UNIVERSITY OF MAINE  
**PACE UNIVERSITY**  
THE GEORGE WASHINGTON UNIVERSITY  
WASHINGTON, DC

**The free workshop schedule will run for 3 WEEKS (May 24-June 11) at 7-10 am, EST, USA (18:00-20:00 Almaty time)**

Dr. Ginger Allington George Washington University	Dr. Jiquan Chen Michigan State University	Dr. Peilei Fan Michigan State University
Dr. Wei Fang Pace University NYC	Dr. Norman A. Graham Michigan State University	Dr. Ranjeet John University of South Dakota
Dr. Colt Knight University of Maine	Dr. Catherine Lindell Michigan State University	Dr. Ashton Shortridge Michigan State University





## U.S. Partner University



## U.S. Investigators

**Dr. Wei Fang (PI)**  
Pace University  
Ecology and GIS

**Dr. Jiquan Chen**  
Michigan State University  
Land Cover and Land Use Science

**Dr. Peter M. Groffman**  
CUNY Brooklyn College  
Climate Change Science

**Dr. Peilei Fan**  
Michigan State University  
Sustainable Development

**Dr. Jessica Gurevitch**  
Stony Brook University  
Research Design

**Dr. George Hendrey**  
CUNY Queens College  
Applied Ecology and Adaptation

## C.A. Partner University



The goal of this workshop is to enhance teaching and learning capacities by modernizing curriculum and developing jointly taught courses and to increase research capacities at Central Asian universities by creating regional knowledge hubs in UN SDGs of "Climate Action" and "Sustainable Cities and Communities".

## Detailed Schedule for the workshops:

June 12: Arrival to AUCA dormitory  
18:00 Meeting of the participants, instructors, and AUCA hosts

June 13: Climate Change Science  
9:00 Introduction of the lectures and format (Fang)  
9:30 Keynote speech & panel discussion (Groffman)  
13:00 Lunch  
14:00 Climate intervention (Parker and Hendrey)  
16:00 Curriculum reflection and adaptation  
18:00 Daily summary and introduction of next day

June 14: Sustainable Development  
9:00 Keynote speech & panel discussion (Fan)  
12:00 Lunch  
14:00 Building collaboration with joint programs (Pulatov and Alimbekova)  
16:00 Curriculum reflection and adaptation  
18:00 Daily summary and introduction of next day

June 15: Research Design and Proposal Writing  
9:00 Keynote speech & panel discussion (Gurevitch)  
12:00 Lunch  
14:00 Curriculum reflection and adaptation (Karimov and Kulmatov)  
16:00 Group discussion and proposal writing  
18:00 Daily summary and introduction of next day

June 16: Land Cover and Land Use Sciences/GIS  
9:00 Keynote speech & panel discussion (Chen)  
12:00 Lunch  
14:00 Field trip to National Park Ala Archa (Kulenbekov and Mambetova)

June 17: Applied Ecology and Adaptation  
9:00 Keynote speech & panel discussion (Hendrey)  
12:00 Lunch  
14:00 Excursion to Forest Park in Karagachevaya Rosh (Kulenbekov, Boizeau and Kelgenbaeva)

June 18: Final Reflection and Adaptation  
9:00 Panel discussion and Q&A (Kussainova, Sarsembin and Kenbayeva)  
12:00 Lunch  
14:00 Group discussion and breakout room discussion  
16:00 Wrap up workshop and exit survey (Fang)  
18:30 Farewell social at AUCA

June 19: Departure

## Primary Contacts

**Dr. Wei Fang**  
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**Dr. Zheenbek Kulenbekov**  
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The workshop is made possible by the Central Asia University Partnerships Program (UniCEN), which is funded by the U.S. Embassy in Uzbekistan, and administered by the American Councils for International Education



Modernizing Curriculum towards the Goals of UN SDGs for Central Asian Universities-Climate

*Bishkek, Kyrgyz Republic  
12-19 June*

[https://www.auca.kg/en/workshop\\_committee/](https://www.auca.kg/en/workshop_committee/)

Registration deadline: 15/05/2022

# Conducting open lessons

- Open lectures focus on soil research, precision farming and smart farms.
- From the procurement process to sales and logistics, how digital technologies allow farmers to remotely monitor their fields and animal welfare. And also make decisions to get a high yield.

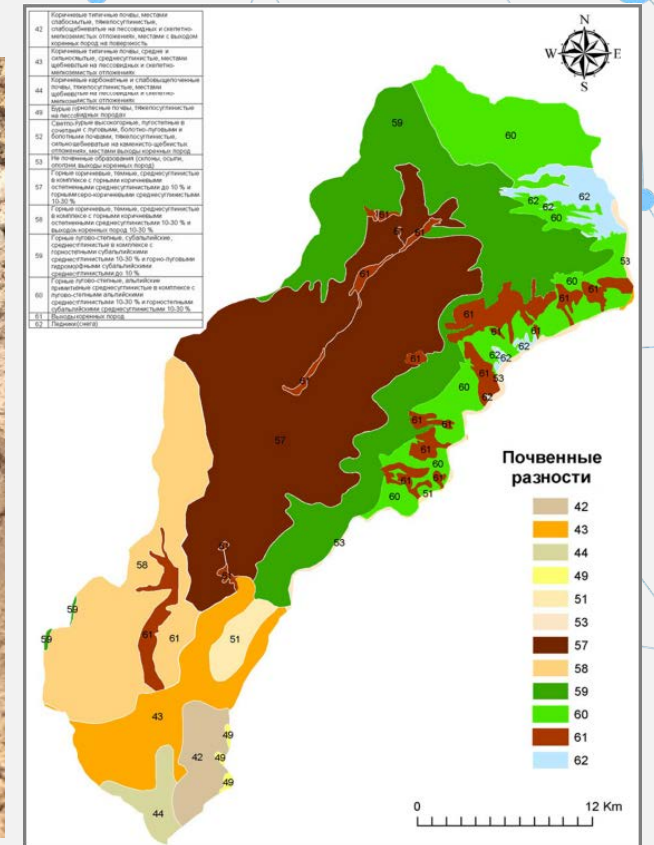
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- Soil mapping







# OUR PARTNERS



United States Department of Agriculture



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# Thank you for your attention!

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 <https://www.kaznaru.edu.kz/>



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