

Comprehensive Observations and Applications for Typical Terrestrial Ecosystems in China-Central Asia region

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中国科学院地理科学与资源研究所

Institute of Geographic Sciences and Natural Resources Research, CAS



Outlines

- **1. The issues to be addressed**
- **2. The team and research sites**
- **3. The implemented solutions**
- **4. The key achievements**
- **5. The implications and impacts**
- **6. Take home messages**

Challenges of Sustainable Development in Central Asia



15.1 ensure conservation, restoration and sustainable use of terrestrial and inland freshwater **ecosystems and their services**

15.3 combat **desertification**, and restore degraded land and soil

2030 Regional Strategy for Sustainable Development in Central Asia——

"Solving the ecological and environmental problems in Central Asia determines its social and economic development"

In Central Asia, ecosystems are fragile, ecological problems are becoming more and more serious, and ecosystem services are degrading.



Desertification



Decline in vegetation productivity

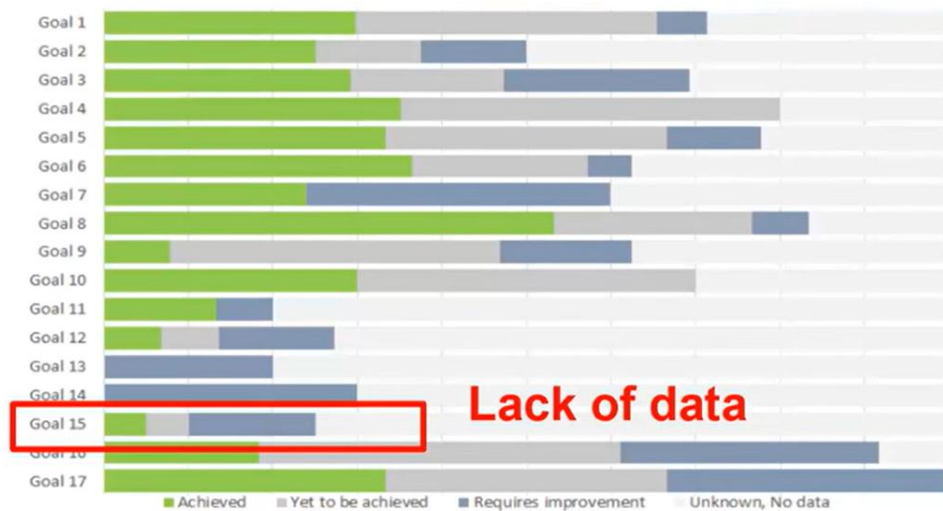
It is urgent to build an international coordination mechanism in the region, to unify ground monitoring protocols, and ground-near ground-satellite integrated monitoring and evaluation technologies to support the protection, restoration and sustainable use of **ecosystems and their services**

Issue 1: Lack of high-quality in-situ monitoring data in Central Asia



The World Bank led “Mainstreaming, Acceleration and Policy Support (MAPS) for Achieving SDGs in Central Asia countries” programme shows

- ❑ Poor standardization and comparability of existing data
- ❑ Lack of ecological data repository
- ❑ Lack of standardized data products



Data cannot effectively support the needs of ecosystem service assessment and SDG15

Issue 2 : Lack of an integrated ecological monitoring and evaluation system

In-situ observation

Advantage: Direct and more accurate
Disadvantage: Limited coverage at spacial and time scales, costly

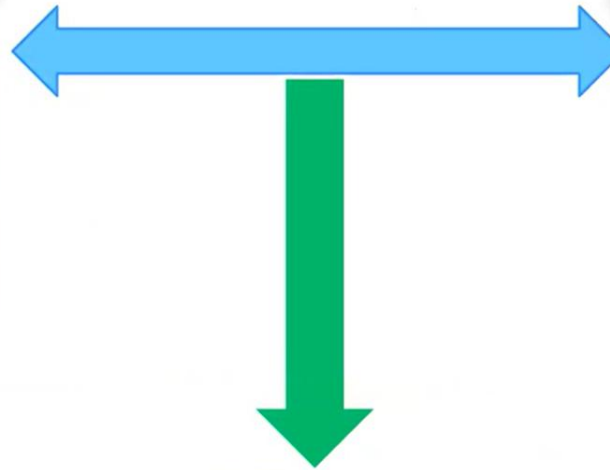


Remote Sensing

Advantage: Better coverage at spacial and time scales
Disadvantage: Poorer accuracy; Lack of systematic verification



??
data fusion



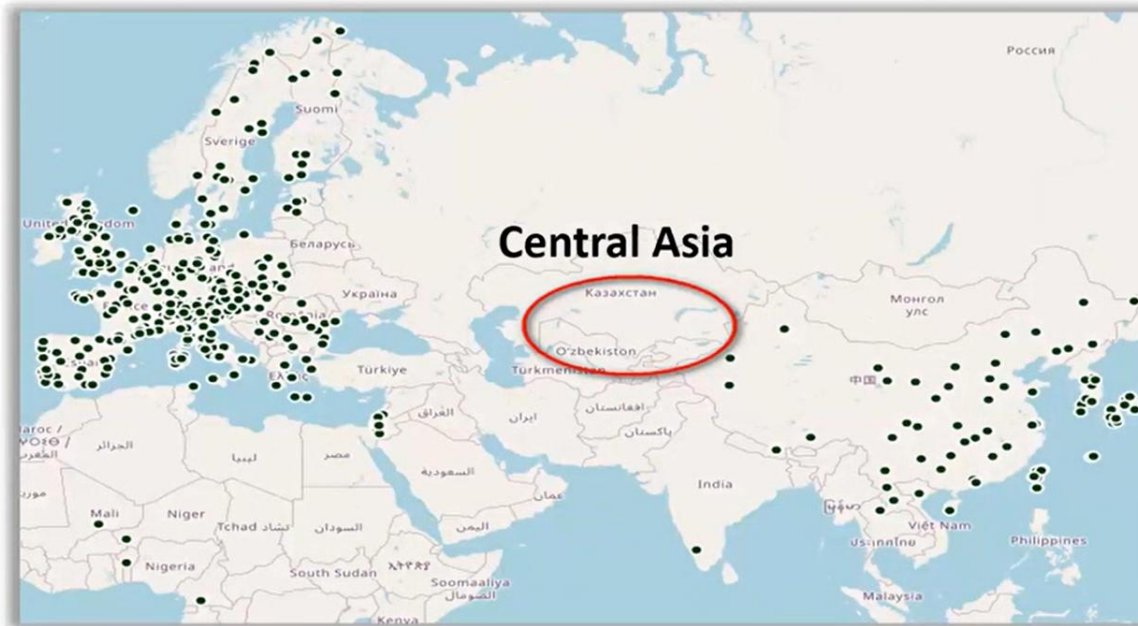
Necessity for integrated data system of RS-near ground-In situ observation

Issue 3: Lack of international data sharing mechanisms and GEO knowledge hub for Central Asia

- Lack of international data sharing mechanisms
- Lack of GEO knowledge Hub

Gap for SDG15 progress tracking

GEO lacks shared data for ground monitoring in Central Asia



In-Situ Observations and Applications for Ecosystem Status of China and Central Asia (IN-SITU-ESC) in GEO work program 2020-2022,2023-2025

WP23_25: In-Situ Observations and Applications for Ecosystem Status of China and Central Asia

1451,210

Basic Information

Full title of the Initiative

Comprehensive monitoring of typical terrestrial ecosystems and assessment of ecosystem services in the "Belt and Road" region of China and Central Asia

Short Title or Acronym

Ecosystem monitoring and assessment of ecosystem services in the "Belt and Road" region of China and Central Asia

Current category in the 2020-2022 GWP

Community Activity

Proposed category in the 2023-2025 GWP

Pilot Initiative

Points of Contact

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Xiaoli	Ren	renxl@igsnr.ac.cn

2020-2022 GEO Work Programme

2020-2022 GEO Work Programme: Community Activity

Advancing Communication Infrastructure and Services ACIS	Arctic GEOSS ARCTIC-GEOSS	Chinese High-Resolution Satellite Data Resources CHDR	Climate Observation, Simulation and Impacts CLIMATE-OBS	Copernicus Atmosphere Monitoring Service CAMS	Copernicus Climate Change Service CCS
Digital Earth Africa DE-AFRICA	Earth Observation and Copernicus in support of Sentinel Monitoring EOSENTINEL-MONITORING	Earth Observation Industrial Innovation Platform for Sustainable Development EOIIP	Earth Observations for Disaster Risk Management EO4DRM	Earth Observations for Managing Mineral and Non-Renewable Energy Resources EO4MNER	Earth Observations for the Atlantic Region ATLANTIC-EO
Earth Observations for the Water-Energy-Food Nexus EOWEF	Enhancing Food Security in African Agricultural Systems with the Support of Remote Sensing AFRICULTURES	GEO Citizen Science GEO-CITSCI	GEO Essential Variables GEO-EV	GEO Global Ecosystems GEO-GEO	Geobase for the Sentinel Framework GEOBASE4SENTINEL
Global Agricultural Drought Monitoring AGRI-DROUGHT	Global Crop Pest and Disease Habitat Monitoring and Risk Forecasting CROP-PEST-MONITORING	Global Ecosystems and Environment Observation Analysis Research Cooperation GEOABC	Global Flood Awareness System GLOFAS	Global Flood Risk Monitoring GFRM	Global Land Cover LAND-COVER
Global Observation of Delta and Estuaries DELTA-ESTUARY	In-Situ Observations and Applications for Ecosystem Status of China and Central Asia IN-SITU-ESC	Multi-source Synergistic Quantitative Remote Sensing Products and Services MSRVSQ	Next Generation Earth Observation Services NEXT-EOS	Night Time Light Remote Sensing for Sustainable Development Goals NIGHT-LIGHT	Open Earth Alliance OEA
Space and Security SPACE-SECURITY	Space Climate Observatory SCO	The International Grand Global Ensemble TIGGE	Understanding the Impacts and Value of Earth Observations GEO-VALUE		

2023-2025 GEO Pilot Initiatives

[WP23_25: In-Situ Observations and Applications for Ecosystem Status of China and Central Asia \(IN-SITU-ESC\)](#)

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The international team

10 Central Asia+23 Chinese Scientists participated



Honglin He



Xinyu Zhang



Xiaoli Ren



Weisheng Wang



Guoqin Wang



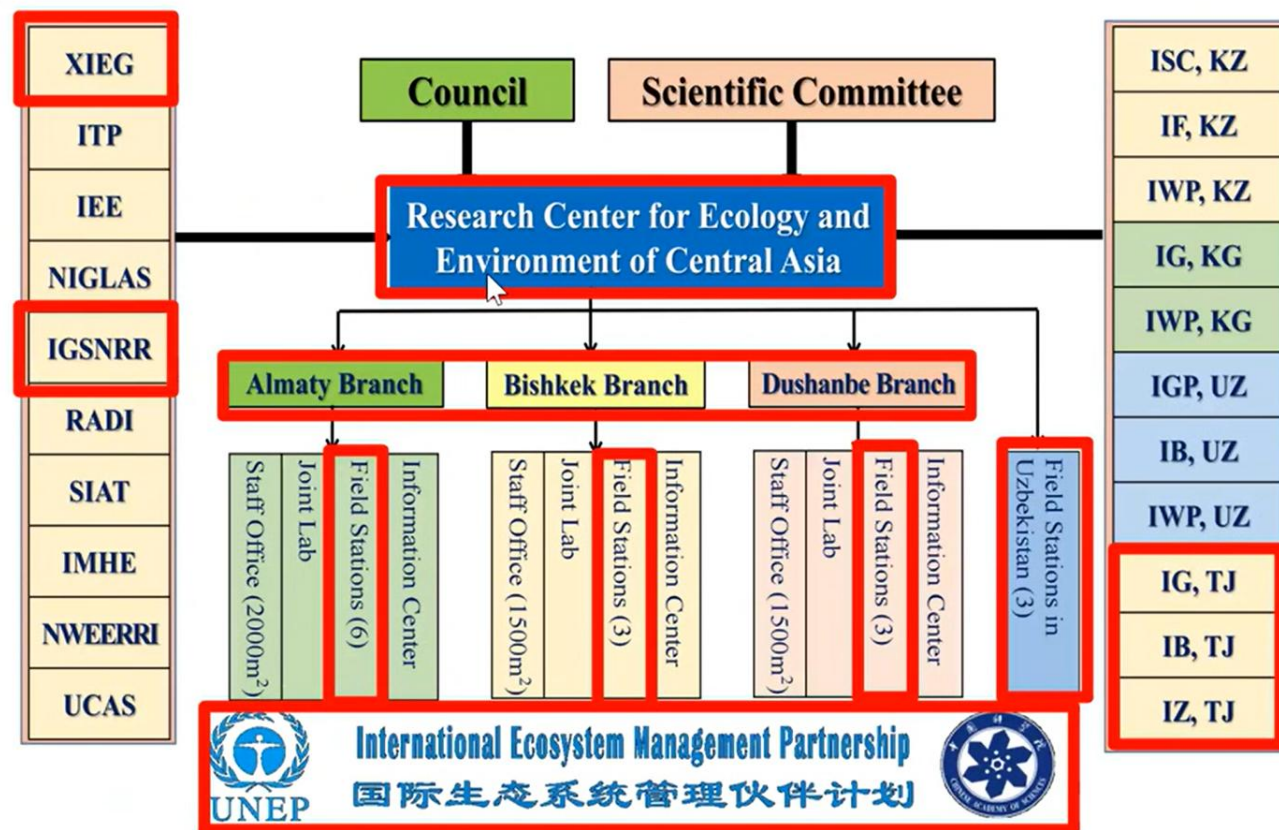
Anvar Kodiro



Kobuliev Zainalobudin



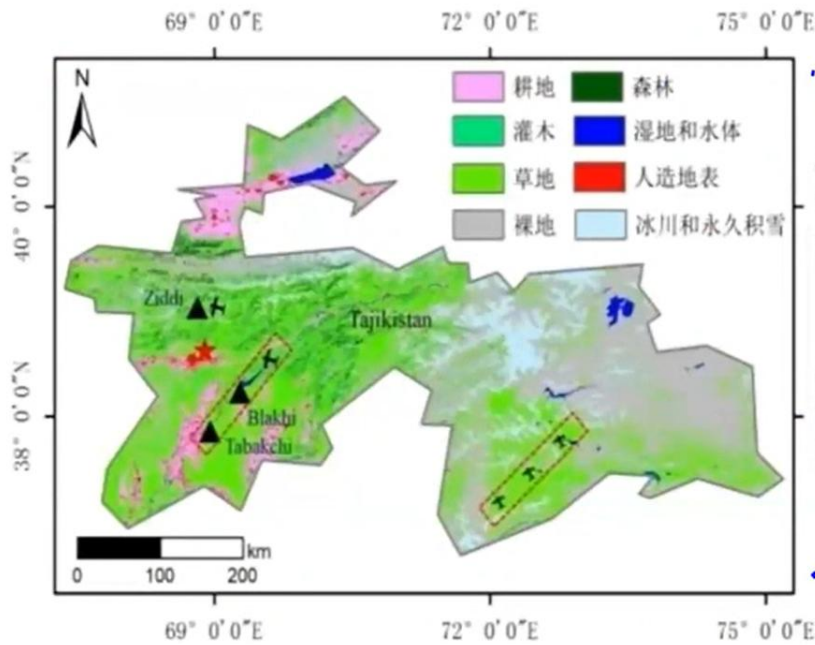
Gulayozov Majid



Research team from IGSNRR, XIEG and TJ

The research sites

- ◆ Covered 27 terrestrial ecological stations in the Belt and Road area of China-Central Asia region
- ◆ Selected degraded grassland stations in Tajikistan as demonstration site



Tajikistan Grassland



Distribution of ecological stations in the Belt and Road area of China-Central Asia region

Ecological sites: 15 in China, 12 from four central Asia

Four solutions in implementation

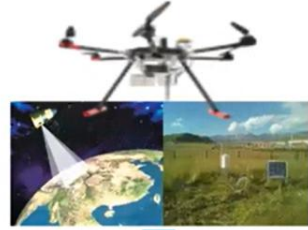
- ❑ To develop in situ monitoring and data sharing protocols of terrestrial ecosystems
- ❑ To produce key datasets of terrestrial ecosystem functions
- ❑ To pilot "In Situ-Near Ground- Remote Sensing" monitoring and evaluation technology in Tajikistan
- ❑ To establish an international coordination mechanism for integrated monitoring of terrestrial ecosystems

Solution delivering mechanism

China and Central Asia
Ecological Networks



Integrated monitoring of
ground-near ground-satellite



Establishment of
**Central Asia
ecosystem
monitoring alliance**

National pilot in Tajikistan

Pilot application of monitoring
protocols and management
system

Comprehensive monitoring and
evaluation of degraded
grassland in Tajikistan

Regional upscaling

Consultation and release of
regional unified ground
monitoring protocols

Technical training and
academic exchange

Regional/global policy impact

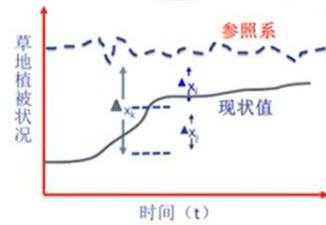
**In situ monitoring
protocols development**

**Integrated monitoring
& evaluation system
development**

International
coordination
mechanism

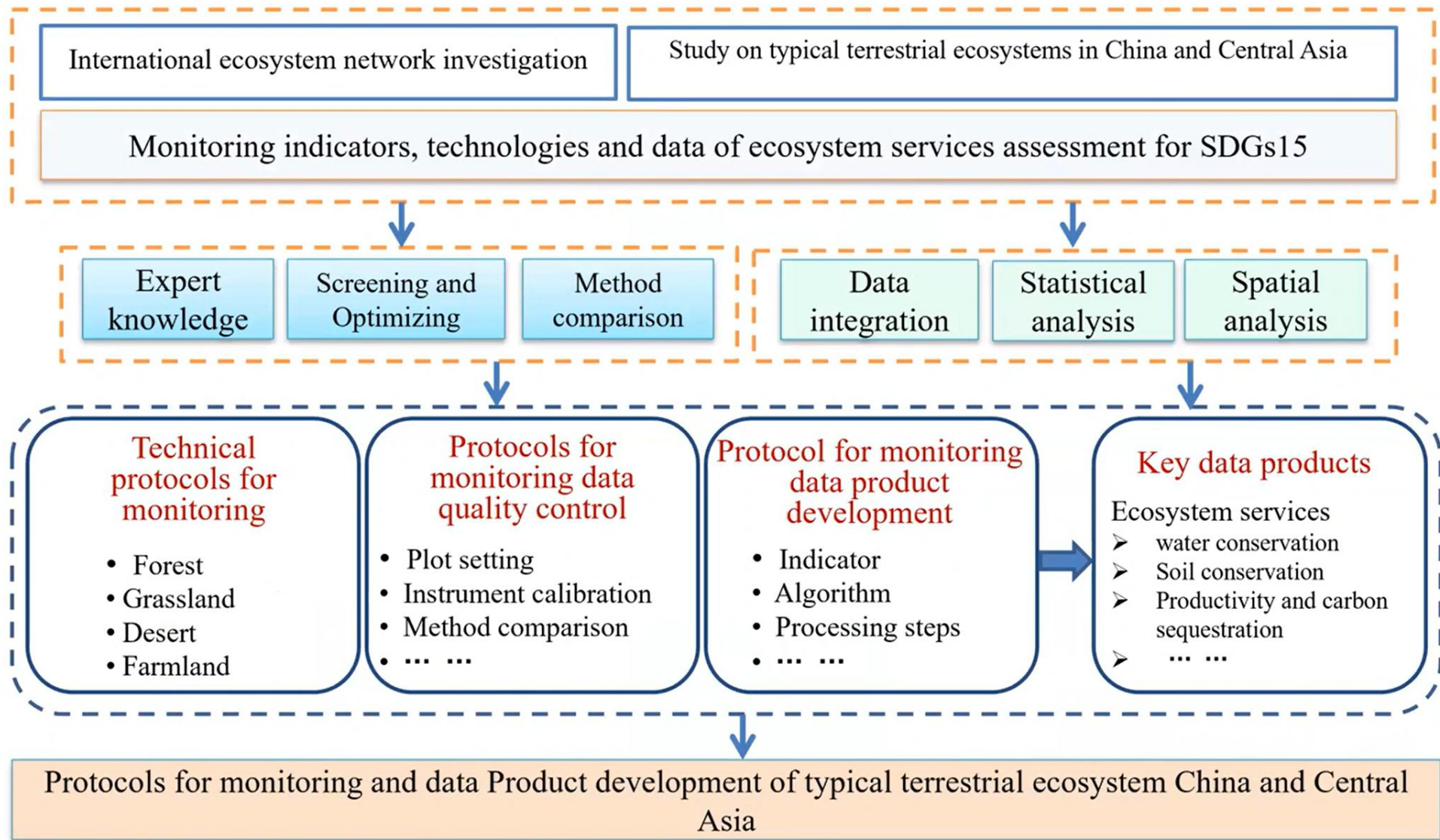


Development of
monitoring data
management
application system

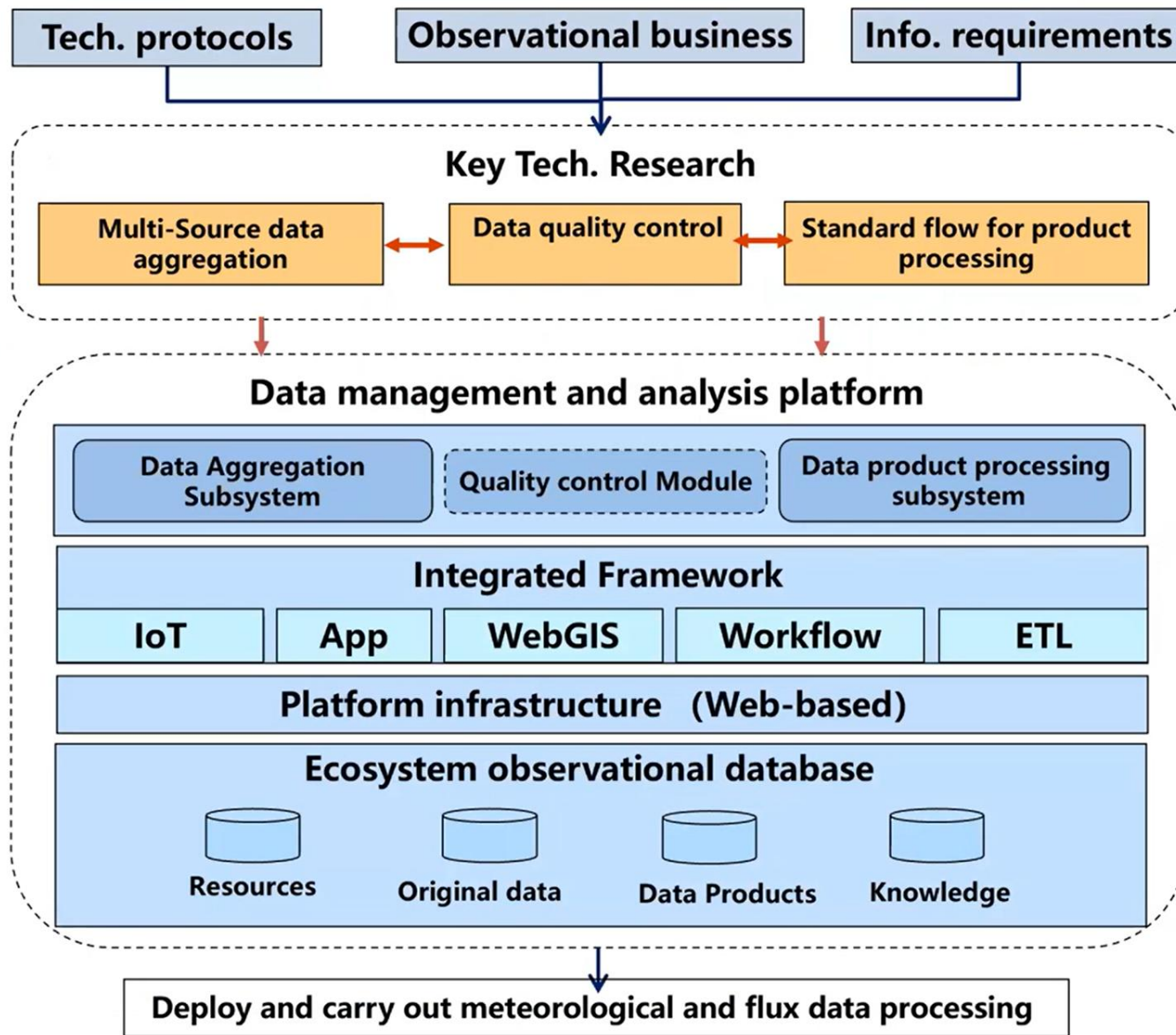


Grassland **assessment
technology development**

Regional **GEO
knowledge hub**



Task 1: Construction of Protocols for Monitoring and Data Product



Investigation



Key Tech. Research

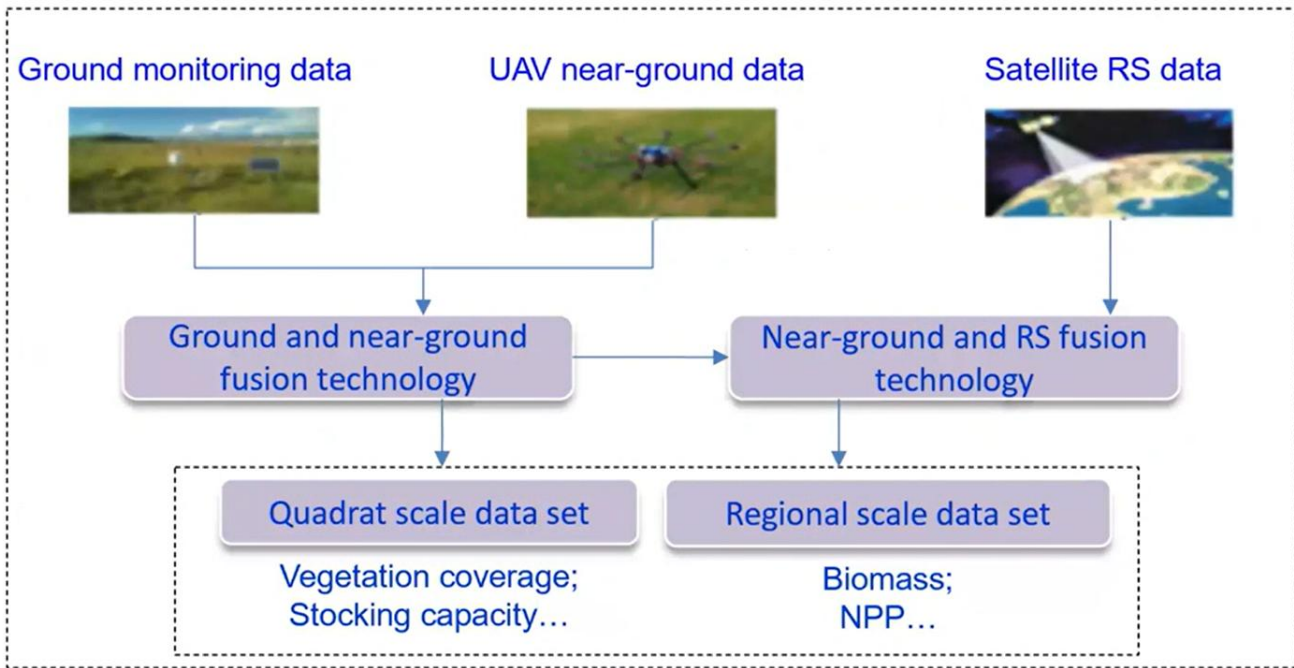


Platform development

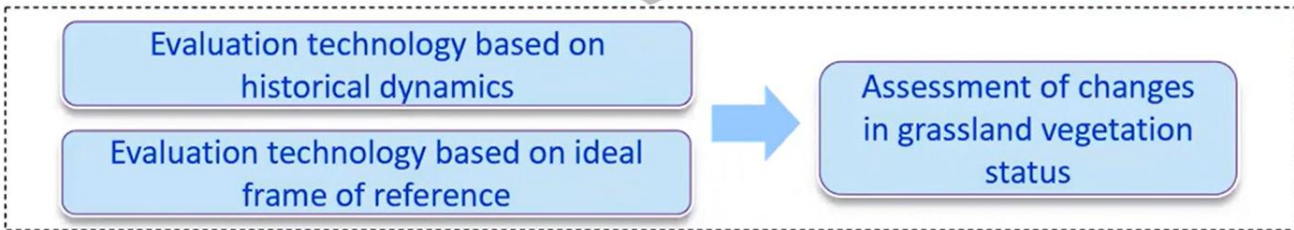


Application

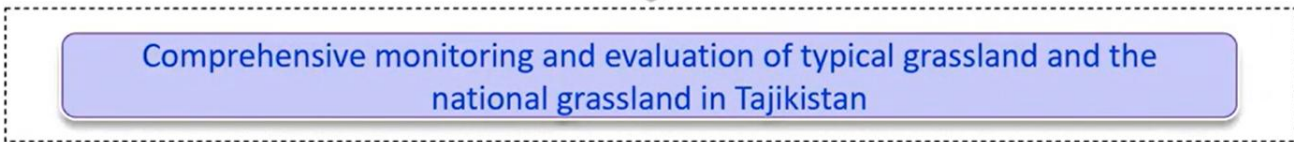
Task 2: Development of observational data management and analysis platform



Construction of ground—
near-ground—satellite RS
comprehensive monitoring
technological system



Construction of the evaluation
technology of grassland ecosystem
in Central Asia

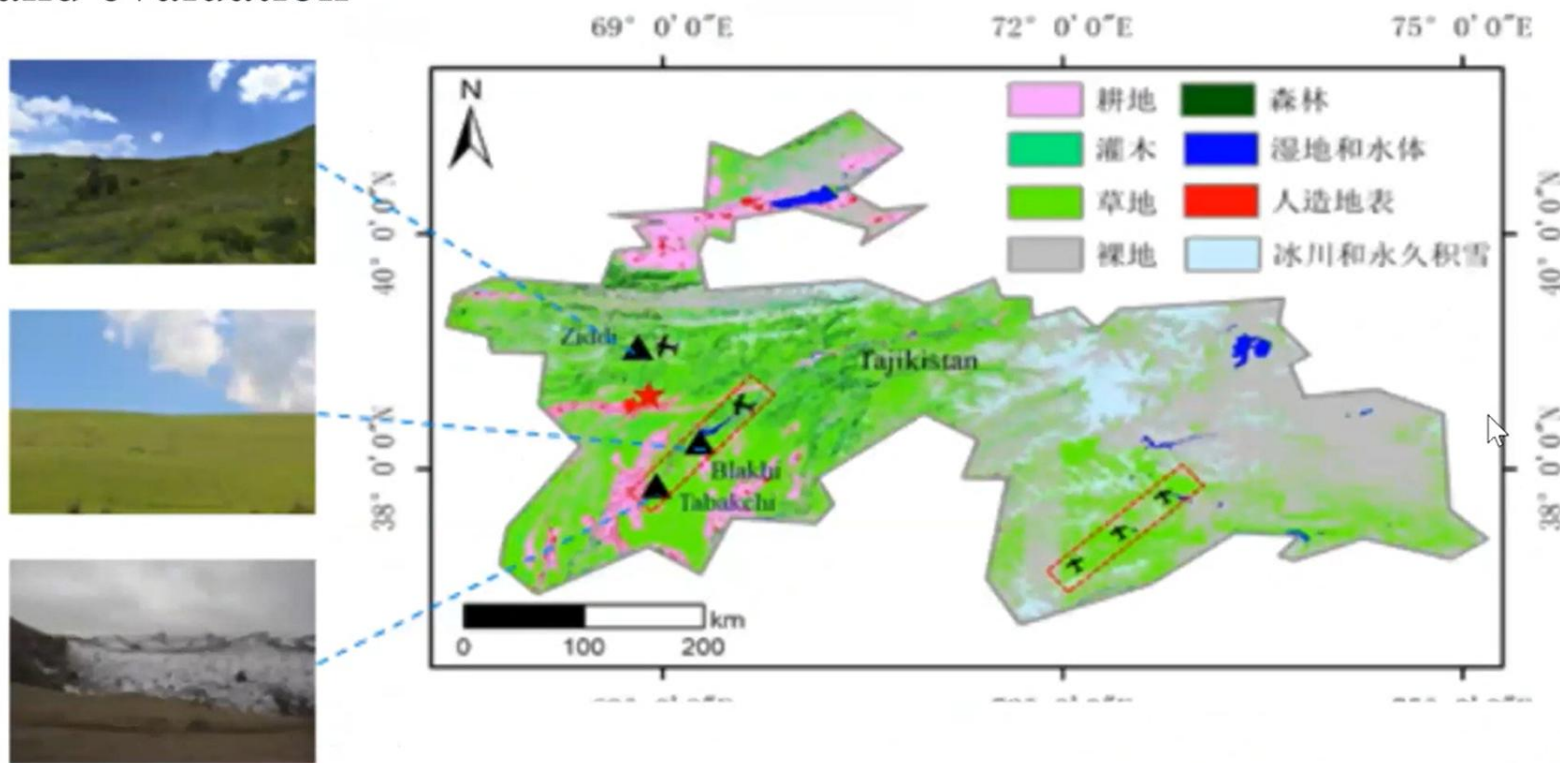


Application demonstration

Task 3: Construction and demonstration of comprehensive monitoring and evaluation technical system of grassland ecosystem in Central Asia

Demonstration area for comprehensive monitoring and evaluation of grassland ecosystem in Tajikistan

- **Site:** 3 typical degraded grasslands. Carry out ground monitoring and UAV observation
- **Belt transect:** 2 survey belts. Set 3-4 observation points for each belt for UAV observation
- **Nationwide:** Carry out application demonstration of national grassland ecosystem monitoring and evaluation



Task 4: Building an international coordination mechanism for integrated monitoring and application of typical regional terrestrial ecosystems

- **Establish the "China and Central Asia Regional Ecosystem Monitoring Alliance"**
- **Develop the portal of the "China and Central Asia Regional Ecosystem Monitoring Alliance"**
- **Building a GEO knowledge hub for typical terrestrial ecosystems in the Central Asian region**



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4.1 Technical Protocols for developing terrestrial ecosystem monitoring and data products

- **Developed three protocols, one integrated monitoring and evaluation systems, and two related standards**

Technical protocols for monitoring

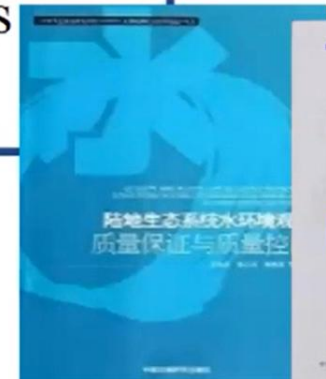
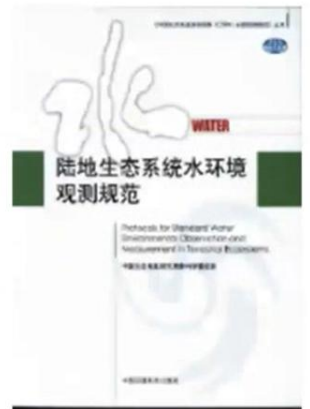
- Forest
- Grassland
- Desert
- Farmland

Protocols for monitoring data quality control

- Plot setting
- Instrument calibration
- Method comparison
-

Protocol for monitoring data product development

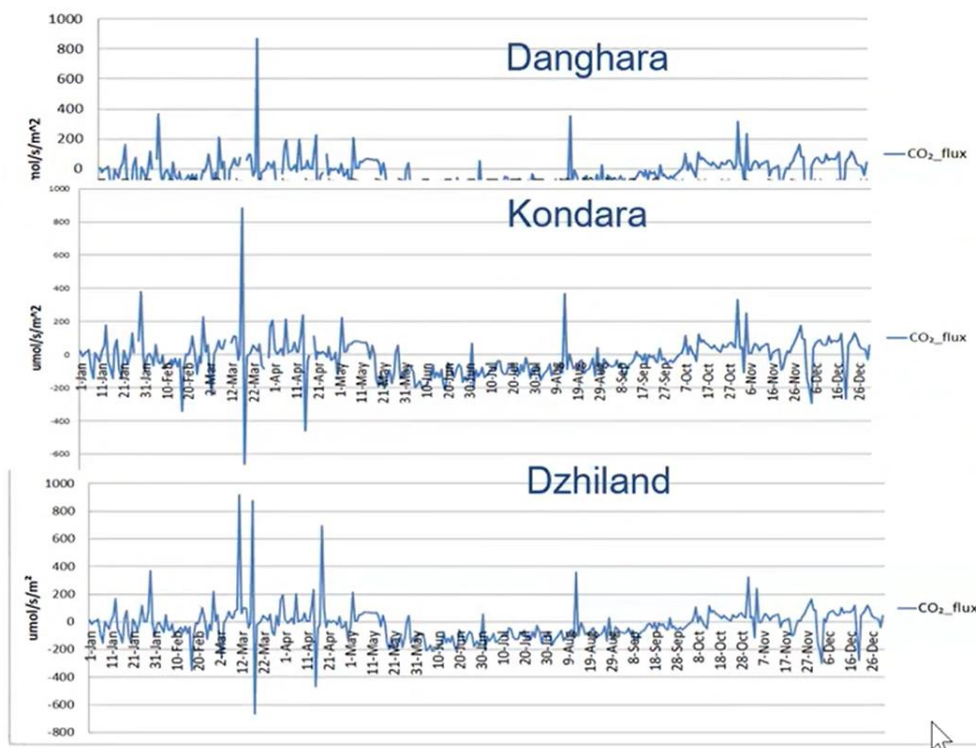
- Indicator
- Algorithm
- Processing steps
-



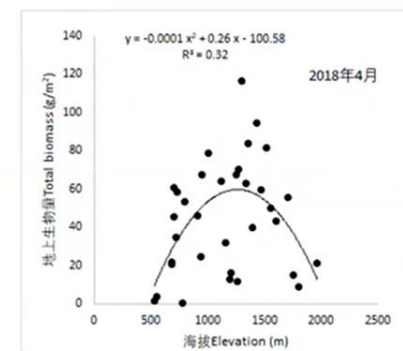
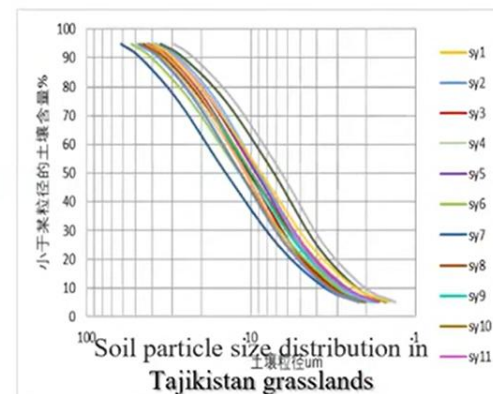
4.2 Key data products of in-situ observation in China and Central Asia

(1) Compiled dataset of ecological indicators in Central Asia

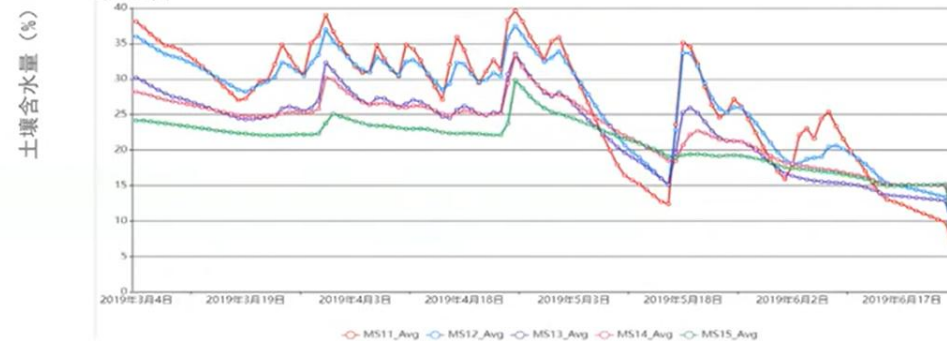
- 2012-2020 meteorological and carbon dioxide flux datasets of Central Asia
- 2005-2020 soil, water, atmosphere, and biological observation data of 23 stations in Central Asia and China
- 2018-2021 soil, plant community and biomass of Tajikistan grasslands



Daily carbon dioxide flux data from three ecological monitoring stations in Tajikistan



Above-ground biomass in Tajikistan grasslands

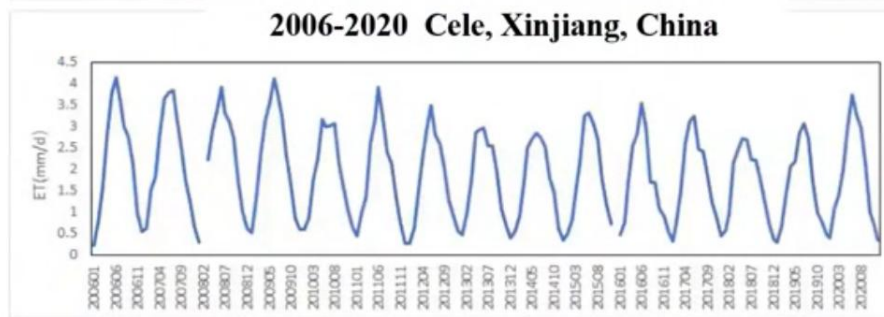
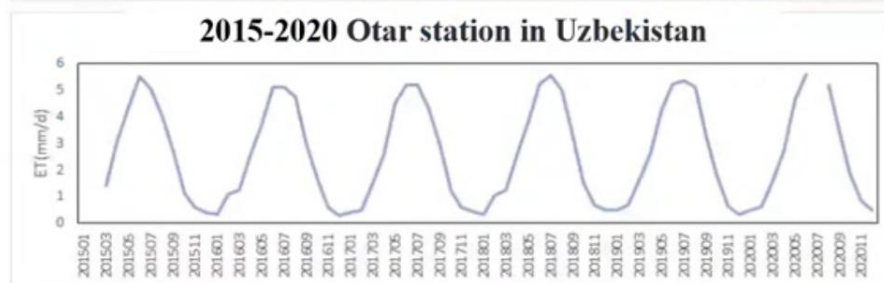
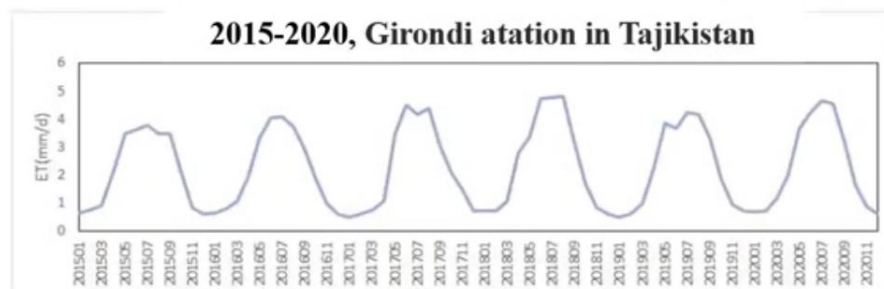


Soil moisture at Silte Luchob in Tajikistan grasslands

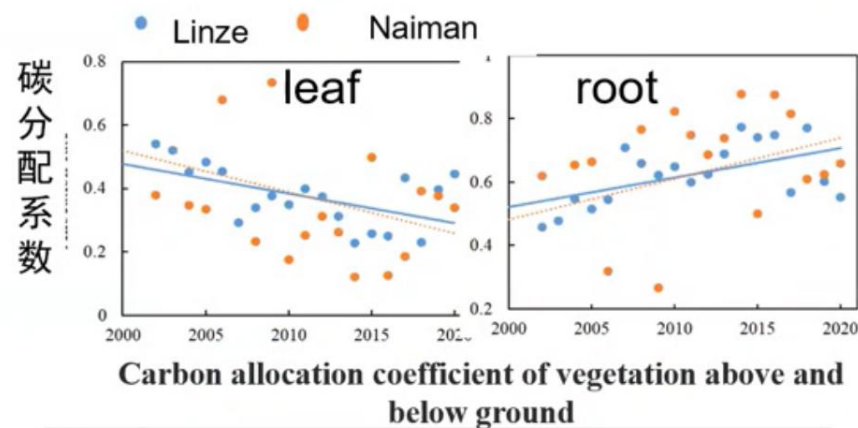
4.2 Key data products of in-situ observation in China and Central Asia

(2) Ecological function assessment dataset of typical dryland ecosystems

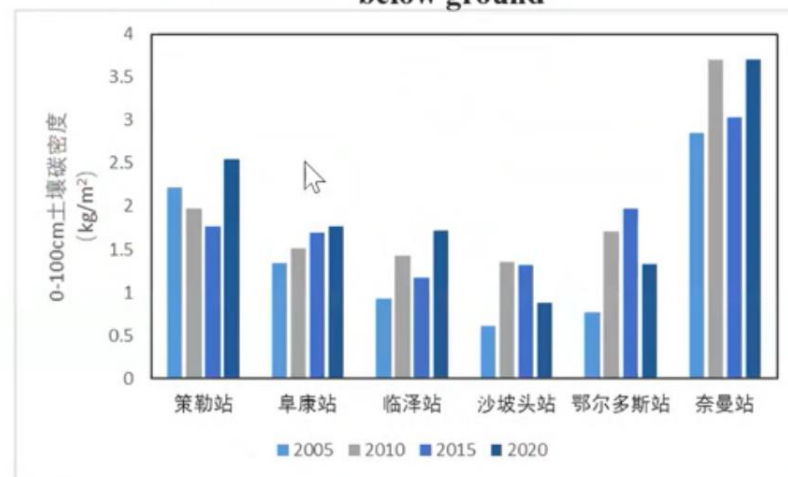
❖ Above-and below-ground biomass, soil carbon density, PET dataset



Potential Evapotranspiration



Carbon allocation coefficient of vegetation above and below ground



Soil Carbon Density

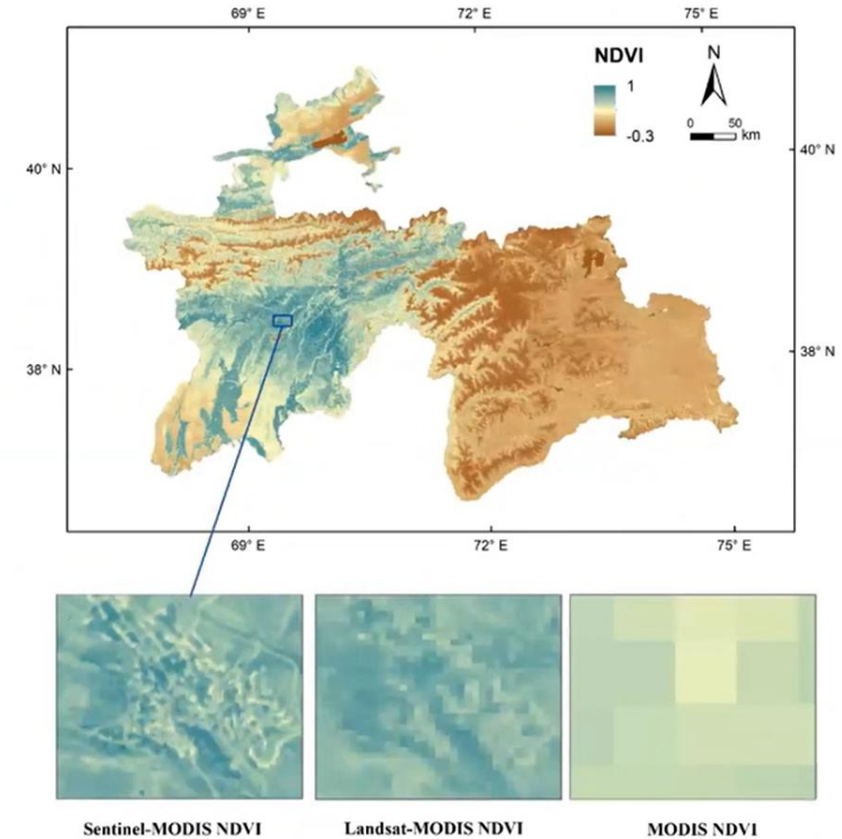
4.3 Standardized remote sensing dataset of crucial ecological parameters for grassland in Tajikistan and Central Asia

Remote sensing data collection

Region	Data Category	Period	Data Volume
Central Asia	MODIS13Q1	2001–2020	1.40 TB
	Landsat 8	2020	687 GB
Tajikistan	Landsat series data	2001–2020 (discrete)	562 GB
	Sentinel 2	2020	146 GB

NDVI dataset production

Region	Data Category	Period	Data Volume
Central Asia	MODIS NDVI	2001–2020	7.11 GB
	Landsat–MODIS Fusing NDVI	2020	81 GB
Tajikistan	Landsat–MODIS Fusing NDVI	2010–2020	16 GB
	Sentinel–MODIS Fusing NDVI	2020	13 GB



High spatial and temporal resolution data fusing product (NDVI, Tajikistan, 2020)

4.2 & 4.3 Key deliverables on Central Asia data products

Special issue of Chinese Science Data entitled “Key data for the functional assessment of typical terrestrial ecosystems in the arid zone of Central Asia”



Editor-in-chief:
Honglin He
Xinyu Zhang

to be published by the end of 2023



A dataset of plant aboveground biomass in typical ecosystems of arid and mid-arid area in China (2005–2020)



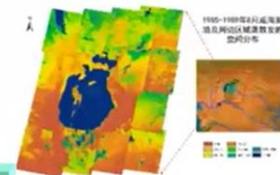
Dataset of soil organic carbon density of typical ecosystems in the arid region of northwest China from 2005 to 2020



Dataset of monthly potential evapotranspiration for ecological stations in arid central Asia from 2005 to 2020



Dataset of vegetation growing season NDVI with resolution of 250m from 2001 to 2020 and resolution of 30m in 2020 in Central Asia



A dataset of surface evapotranspiration estimates in the plain area of the Aral Sea basin (1985-2016)

4.2 & 4.3 Key deliverables on Central Asia data products: Open for guest editors and manuscript of central Asia

The tentative title of the Special Issue in “Science of the Total Environment” Multiple-scale assessment of terrestrial ecosystem functions in Central Asia



**to be proposed by
June 2023**

Tentative Guest Editors:

Xinyu Zhang (IGSNRR, China)

Xiaofeng Xu (San Diego State University, United States)

Majid Gulayozov (Research Center for Ecology and Environment of Central Asia (Dushanbe), Tajikistan)

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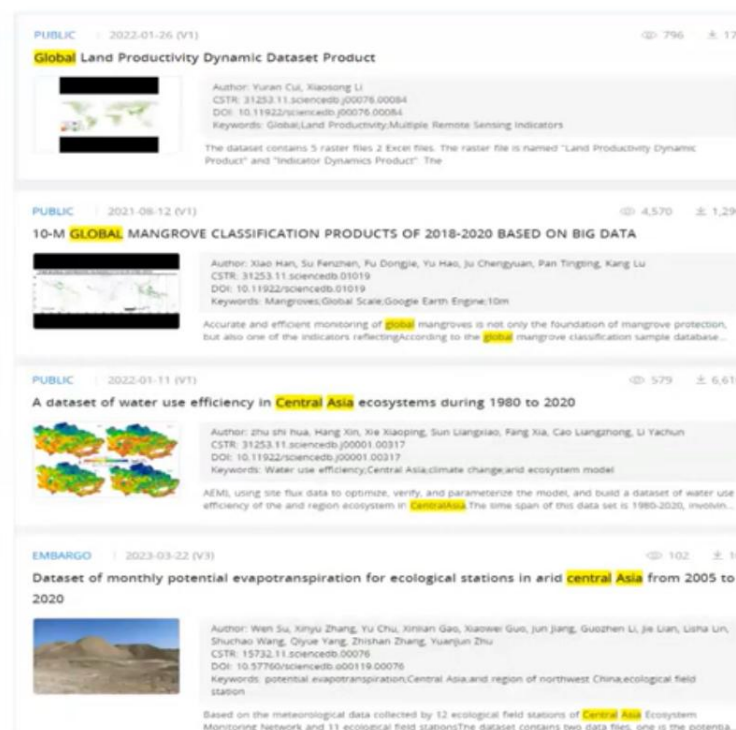
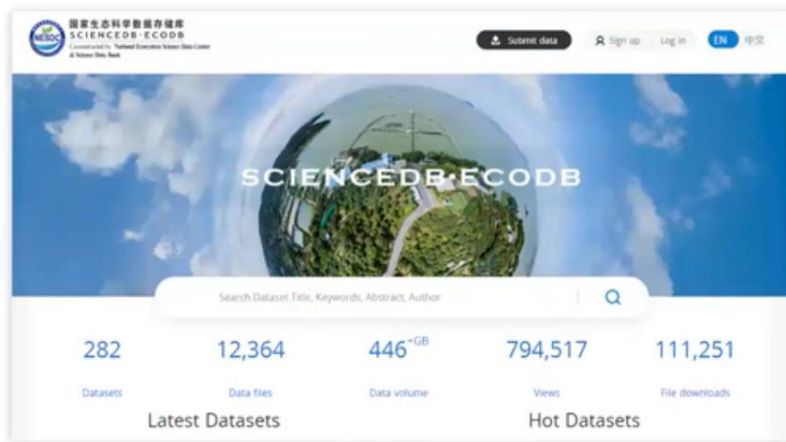
- Designing integrated observation and application indicators for grassland ecosystem monitoring to promote sustainable development in Central Asia
- Impacts of future climate extremes on the interannual variability of terrestrial ecosystem productivity in Central Asia from CMIP6 data
- Temporal and spatial variations in vegetation responses to natural and anthropogenic factors in Central Asia from 2001 to 2020
- Spatial variations in vegetation productivity along a climate gradient in the Central Asian grassland
- Using UAV multispectral and RGB images to estimate the aboveground biomass of grassland in Central Asia: A case study of a grassland in Tajikistan

.....

4.4 A data portal to share data products for users across the world

National Ecosystem Data Bank (EcoDB) is established as a FAIR (Findable, Accessibility, Interoperability and Reusability) data repository to provide data storage and sharing services for ecological researchers.

- Shared 446+GB data and downloaded by more than 110k times
- Data coverage is not limited to China



Built on [Science Data Bank \(ScienceDB\)](#)

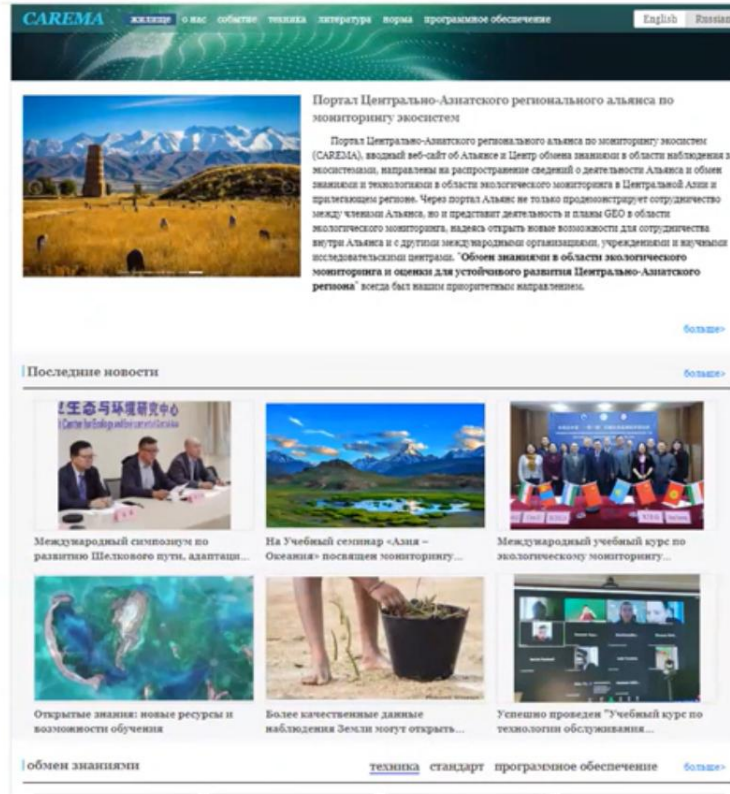
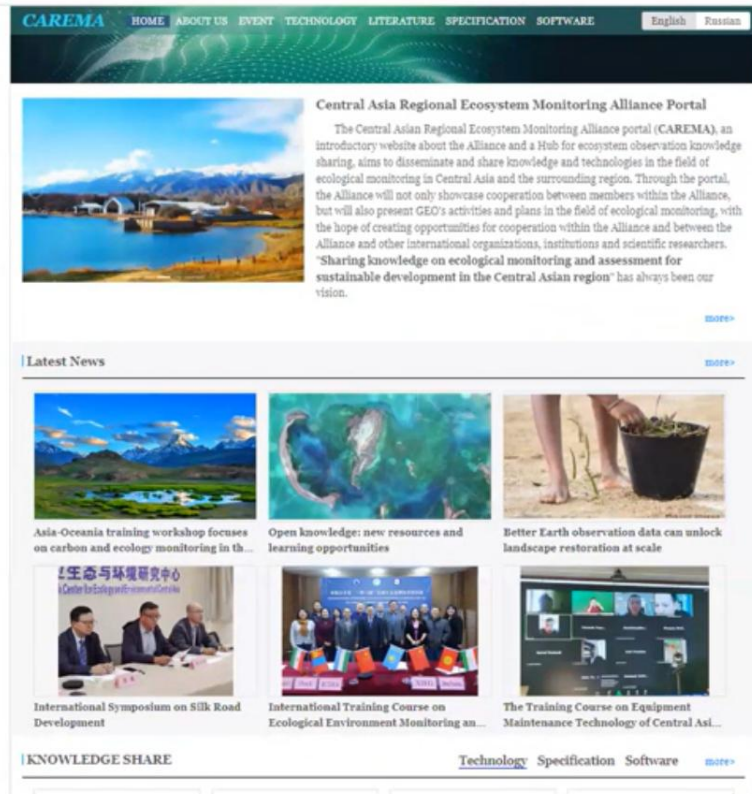


Accessible at
<https://ecodb.scidb.cn/>

Friendly to global researchers
Accessible anywhere

4.5 Knowledge Hub in Central Asia

- 1) Established knowledge hub for China-Central Asia ecosystem monitoring <http://www.ccarema.org/#/>
- 2) Established of China-Central Asia ecosystem monitoring alliance in 2022 within 16 organizations



Меморандум о сотрудничестве по исследованиям экологического мониторинга и управления в регионе Центральной Азии

Memorandum of Understanding for the Central Asian Regional Ecological Monitoring and Management Research Alliance

中亚区域生态监测与管理研究联盟备忘录

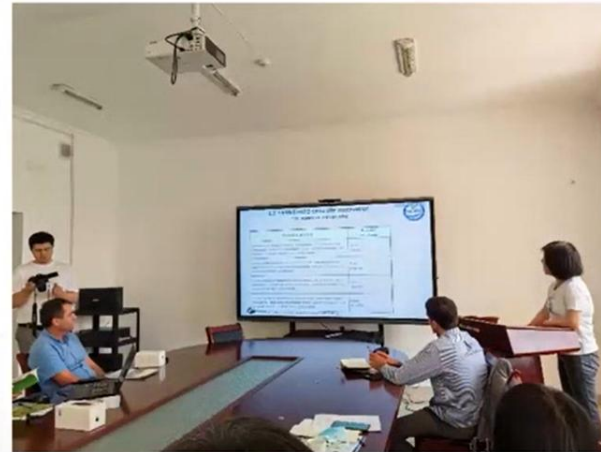
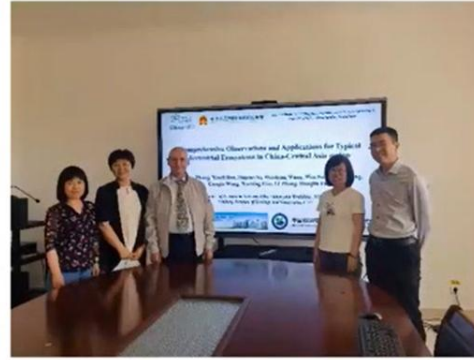
(11.2022)
(Nov, 2022)
(2022年11月)

Центральная Азия расположена в глубине Евразийского континента, занимая треть засушливых районов мира, охватывая Китай, Казахстан, Узбекистан, Киргизстан, Таджикистан, Туркменистан, Россию, Монголию, Афганистан, Иран и др. Климат данного района представляет собой типичный континентальный аридный климат, а хрупкая экосистема Центральной Азии очень чувствительна к деятельности человека и изменению климата. За последние 100 лет водные ресурсы, леса, пастбища и почва в засушливых районах Центральной Азии подверглись большому изменением, влияющими на стабильность и устойчивое развитие региональных экосистем и привлекли к себе пристальное внимание международного сообщества.

Central Asia, which lies deep in the hinterland of the Eurasian continent, occupies nearly one-third of the world's arid region, covering China, Kazakhstan, Uzbekistan, Kyrgyzstan, Tajikistan, Turkmenistan, Russia, Mongolia, Afghanistan, Iran, etc. It has a typical continental arid climate with a fragile ecosystem that is very sensitive to human activities and climate change. For nearly a hundred years, significant changes have taken place in water resources, forests, grasslands, and soils in the arid regions of Central Asia, which are affecting the stability and

4.5 Knowledge Hub in Central Asia

Organized the workshop of “Explore integrated monitoring programmes for degraded grassland” in Dushanbe, Tajikistan, May 12th-16th, 2023



4.5 Knowledge Hub in Central Asia

The "China and Central Asia Ecosystem Monitoring Technology Training" workshop participated by more than 100 foreign experts in 12 days

A screenshot of a video lecture slide from the United Nations Environment Programme (UNEP). The slide features a large image of the Earth and the title "Making Peace with Nature". Below the title, it states "A scientific blueprint to tackle the climate, biodiversity and pollution emergencies" and "UNEP's Synthesis Report". On the right side, there is a smaller graphic with text: "It is a synthesis of findings from some 25 major global assessments including IPCC, IPBES, GEC and IRP. It does not repeat assessments - it faithfully represents their carefully documented findings - but sometimes synthesis includes additional literature to update or complement the major assessments." The UN logo is visible in the top right corner.

UNEP Jian Liu lecture on Making peace with nature +

A screenshot of a video lecture slide from the United Nations Convention to Combat Desertification (UNCCD). The slide features the UNCCD logo and the title "The Role of Land in achieving Carbon Neutrality and SDGs". Below the title, it says "Workshop: Need for CST Integrated Support Programme (INSP) (Workshop) UNCCD Secretariat". At the bottom, it mentions "Ecological and Environmental Monitoring and Scientific Practice Webinar 18 Nov 2023". The slide is part of a presentation, with a "Next slide" button visible. The background of the slide is blue and orange.

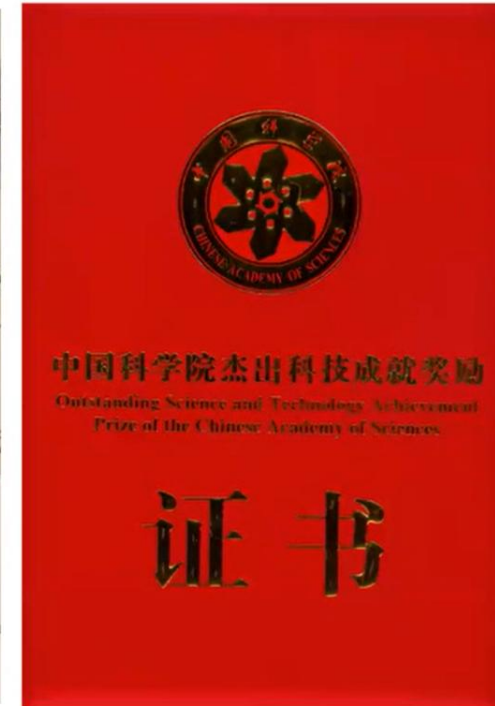
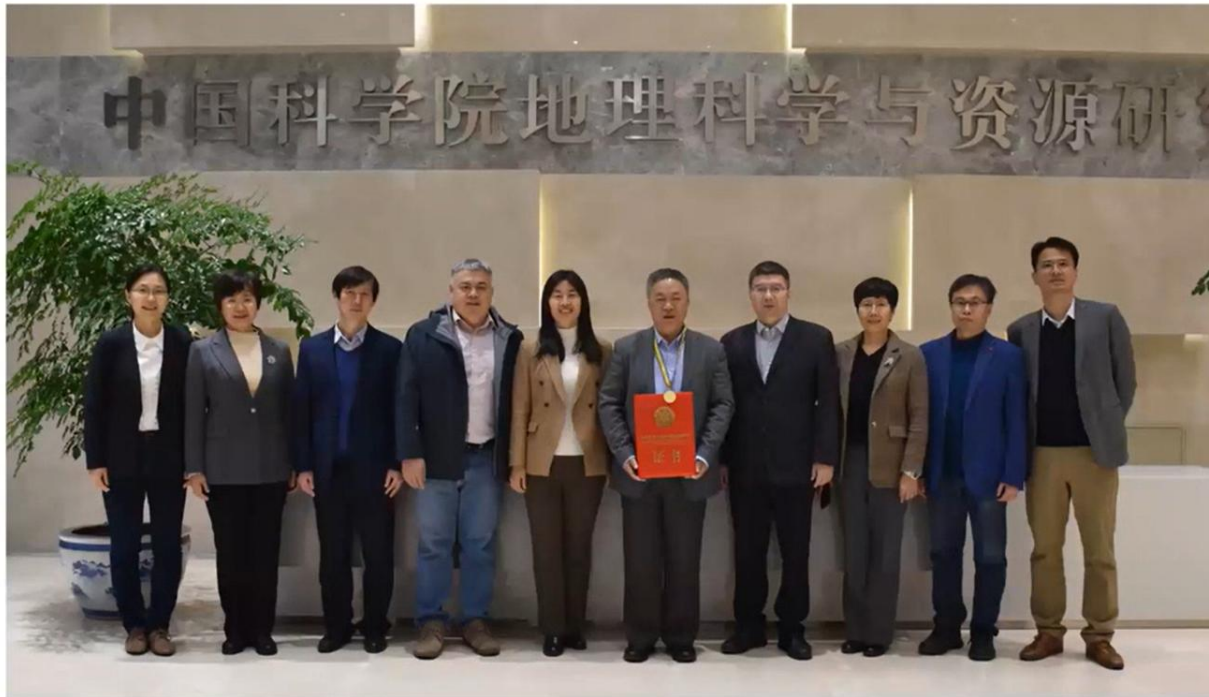
UNCCD lecture on Land Degradation Neutrality and Carbon Neutrality

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Impact 1: Selected as GEO 100 case study of earth observation

- “Case on carbon, nitrogen and water cycle research in terrestrial ecosystems of China based on model data fusion”
- Will be further promoted through GEO knowledge hub



Outstanding Science and Technology Achievement Prize of the CAS, 2022

Impact 2: Joint RS-in situ and near ground observation system in Tajikistan



- ❑ Joint RS-in situ-near ground observation system base well established in Tajikistan with training provided to local team
- ❑ The Tajikistan team is now undertaking more national tasks for disaster prevention and monitoring



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Take-home messages

- ❑ Essential data gap of ecosystems in Central Asia is addressed through the China-Central Asia Ecosystem Observation Network, and protocols for ecosystem monitoring and data products.
- ❑ Knowledge hub for Central Asia and its ecosystem research alliance further enhance its data sharing capacity and regional cooperation.
- ❑ Will contribute to the online open GEO Global Ecosystems Atlas for Central Asia.

Acknowledgement:

- *GEO Cooperation project under the National Key Research and Development Program (SQ2019YFE011288) : Comprehensive Observations and Applications for Typical Terrestrial Ecosystems in China-Central Asia region*
- *GEO work program 2020-2022 (Community activity) & 2023-2025 (Pilot Initiatives): In-Situ Observations and Applications for Ecosystem Status of China and Central Asia (IN-SITU-ESC)*

Thank you for your attention!

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Xiaoli Ren: renxl@igsnrr.ac.cn



中国科学院新疆生态与地理研究所
XINJIANG INSTITUTE OF ECOLOGY AND GEOGRAPHY CHINESE ACADEMY OF SCIENCES