ASTANA IT UNIVERSITY

BR24992899

Development of a system for forecasting catastrophic floods in the East Kazakhstan region using remote sensing data, GIS technologies, and machine learning

Program-targeted funding 2024-2026

About the program

Scientific direction

- **Priority**: Advanced manufacturing, digital and space technologies.
- **Sub-priority**: Remote sensing of the Earth and GIS.

Research area

- Engineering and technologies; Computer science; Interdisciplinary applications of computer science.

Executing organizations

- **Principal executor:** Astana IT University.
- **Co-executor:** Sarsen Amanzholov East Kazakhstan University.

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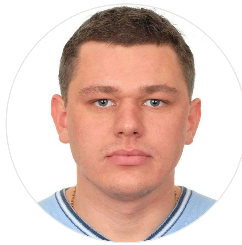
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Zhansaya Makhambet


Aiganym Mansurova

Relevance of the program

- Interannual streamflow variability in the river basins of Northern Eurasia is largely determined by snow reserves.
- Snowmelt floods are among the most damaging natural hazards.
- The situation is especially acute in catchments whose headwaters are in mountainous areas, where snow cover has the strongest influence on runoff.
- In East Kazakhstan (~40% of Kazakhstan's water), spring peak flows have risen in recent decades.
- The main task in forecasting the volume and timing of floods is to assess snow reserves in the river basin and to study the hydrometeorological processes that determine the rate of meltwater inflow to the river network during snowmelt.
- Models of these complex processes are often limited, which justifies deeper research into the conditions of flood formation.

Research problems addressed

Accurate estimation of snowpack

- Accurate assessment of snow reserves in river basins, based on ground observations of snow depth and density, complemented by aerial photography and remote sensing.

Identification of flood-prone areas

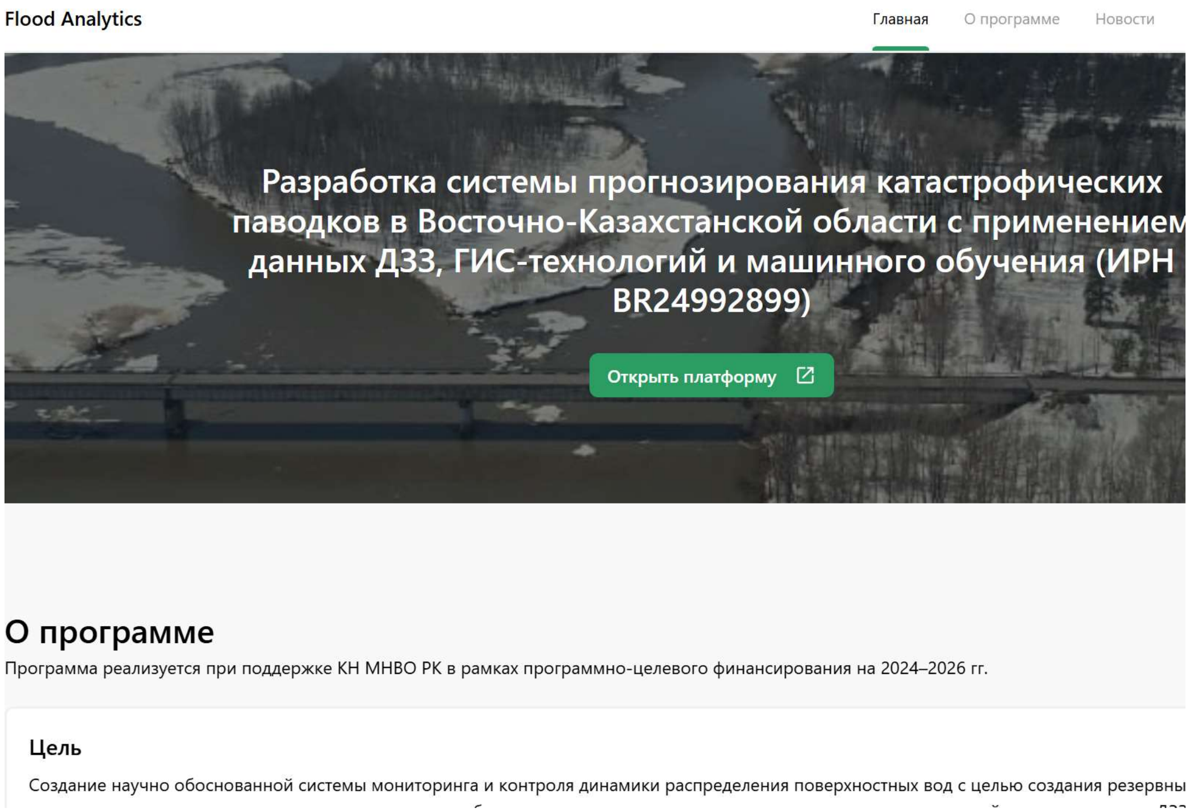
- Investigation and delineation of areas vulnerable to flooding during spring snowmelt, with analysis of the hydrometeorological, topographic, and anthropogenic processes shaping their water regime.

Flood modeling and forecasting

- Modelling and forecasting of water regime changes in the identified areas under different climate change scenarios and environmental conditions.

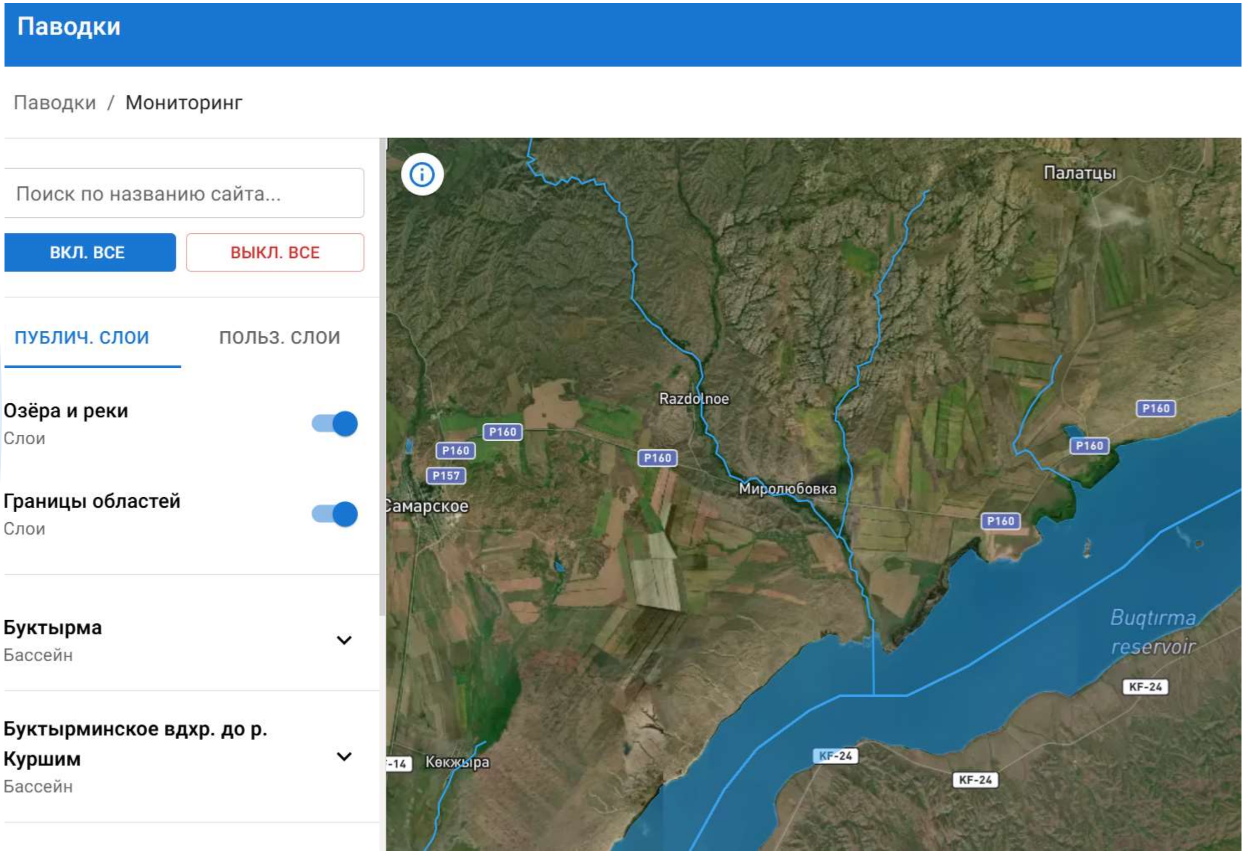
Project website

https://flood.astanait.edu.kz/



GIS framework

https://panel.flood.astanait.edu.kz/



Program Objectives and Tasks

Objective: To develop a scientifically grounded monitoring and control system for surface water dynamics aimed at creating reserve reservoirs for runoff and drainage management.

1. Study, analysis, and assessment of flood situations in East Kazakhstan based on long-term data

2. Remote sensing of meltwater catchments and flood-prone areas in East Kazakhstan

3. Development of digital models of meltwater catchments and flood-prone areas in East Kazakhstan

4. Development of a digital model of the hydrographic network of East Kazakhstan

5. Estimation of meltwater accumulation and assessment of collection methods and technologies

6. Identification of areas most vulnerable to snowmelt flooding

7. Development of a methodology for flood mapping and forecasting

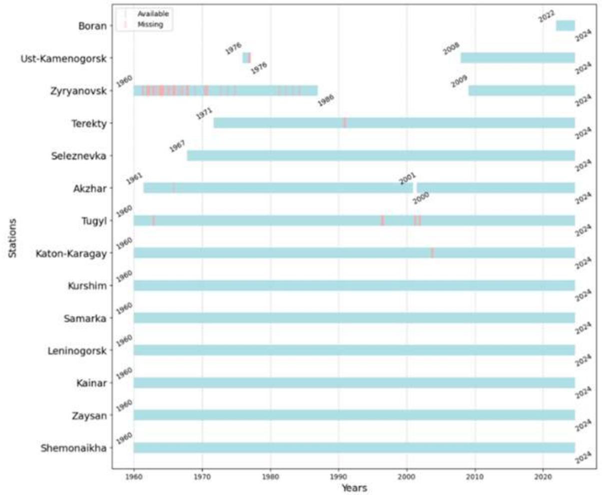
8. Development of a harmonized database and GIS framework

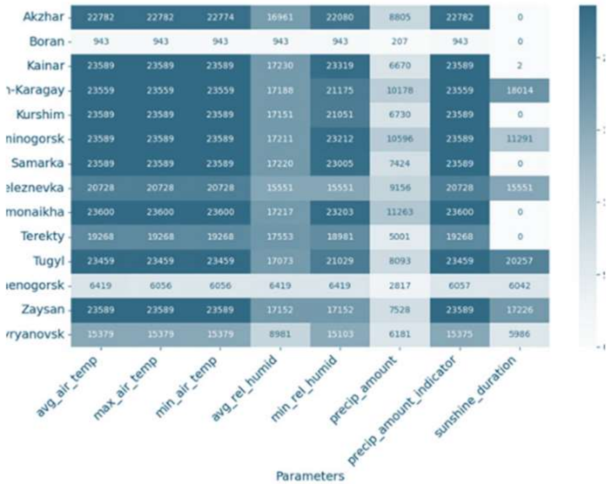
Recommendations on the use of meltwater for agriculture, irrigation, and energy

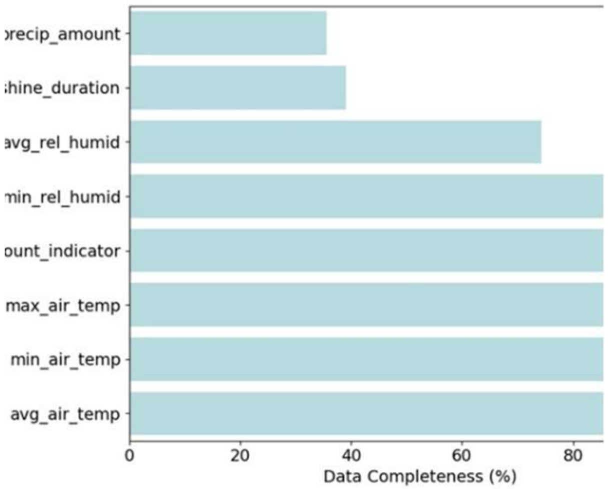
1

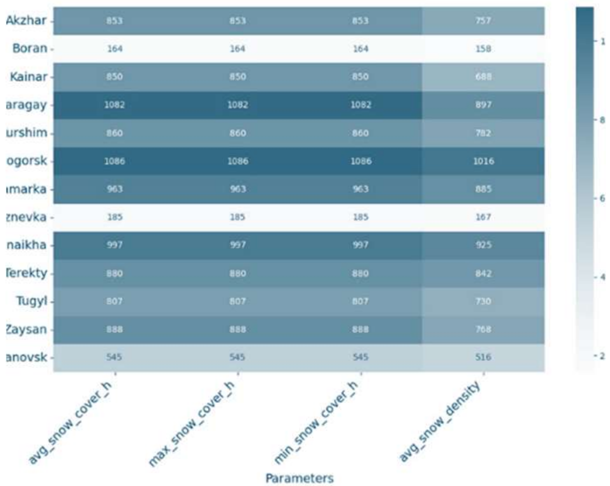
Study, analysis, and assessment of flood situations in East Kazakhstan based on long-term data on precipitation, snow reserves, and snowmelt processes

№	Title of works under the Contract and main stages of its implementation	2024	2025	2026
1.1	Collection and analysis of multi-year data on precipitation, snowpack, temperature regimes, and solar radiation	100%	-	-
1.2	Ground-based snow surveys at snow stations and along snow courses to validate data obtained by remote methods	-	100%	-
1.3	Estimation of maximum water storage in the snowpack using measured snow density and volume data	-	90%	-
1.4	Mapping of snow reserves	-	80%	-
1.5	Ground-based snow surveys at snow stations and along snow courses to validate data obtained by remote methods	-	-	🕘









1.1 Collection and analysis of long-term data on precipitation, snow reserves, temperature regimes, and solar radiation in East Kazakhstan

Datasets on precipitation, snowpack, temperature, and solar radiation in East Kazakhstan covering the period 1960–2024 were integrated.

30 meteorological stations, 16 in the East Kazakhstan Region and 14 in the Abai Region.

1.2 Ground-based surveys at snow survey points and routes

A dataset on snow reserves was compiled based on field snow survey measurements conducted in 2025 at 111 snow survey points in key areas of the East Kazakhstan region.

Snow depth was measured with a snow stake, and density with a BC-43 snow sampler. In total, 2,331 depth measurements and 555 density measurements were taken.

The average snow depth was 54 cm, ranging from 5 to 144 cm. The average density was 0.23 g/cm³, ranging from 0.15 to 0.35 g/cm³.

1.3 Calculation of maximum water reserves in the snow cover based on the obtained data on snow density and volume

A dataset on snow water equivalent for 2025 was compiled for key areas of the East Kazakhstan region.

The maximum snow water equivalent (SWE) in the snow cover was calculated and approximated.

SWE values were obtained for the Saur, Zaisan, Southern Altai, Kalba Ridge, and the Kalba foothills.

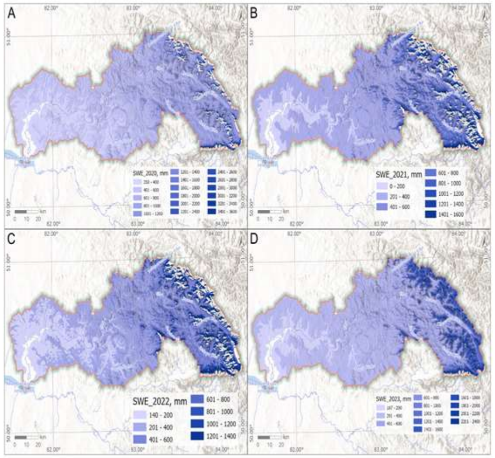
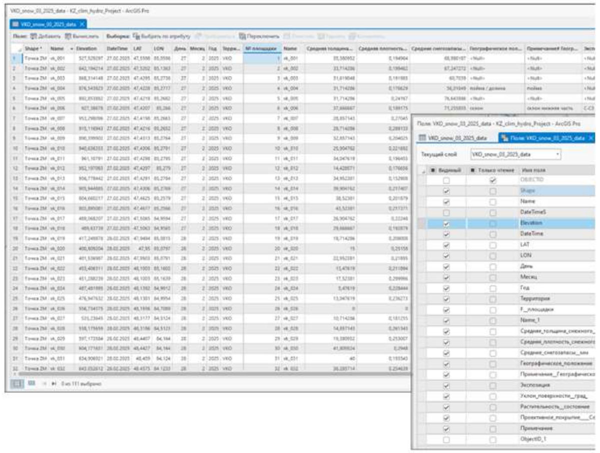
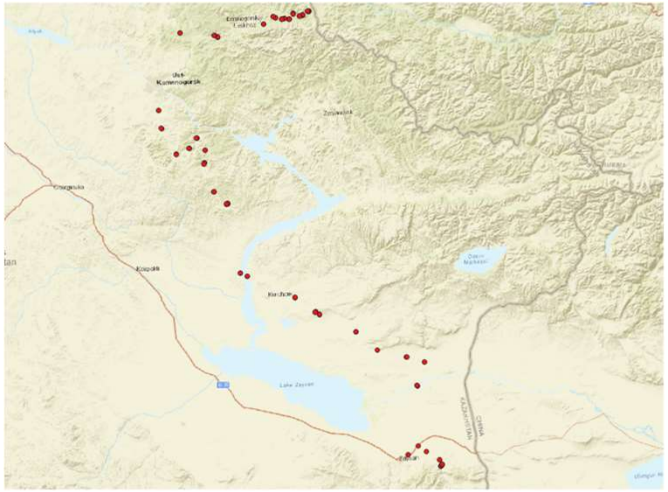
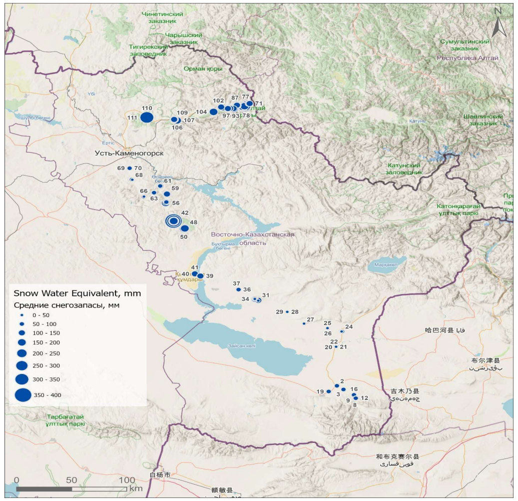


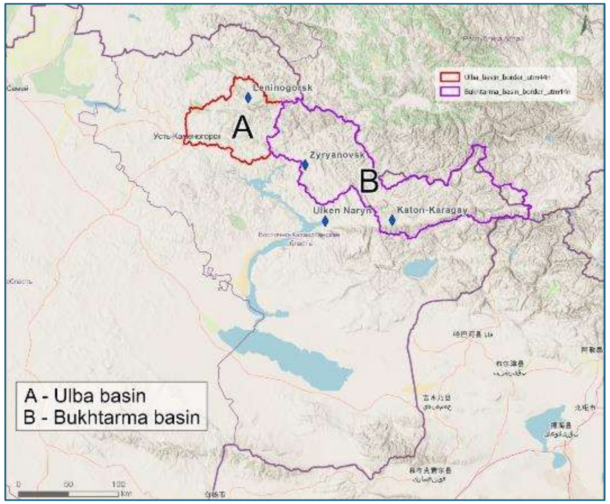
Figure 5. Maximum water reserve of snow cover in the Uba River basin in 2020–2023 (A—2020, B—2021, C—2022, and D—2023).

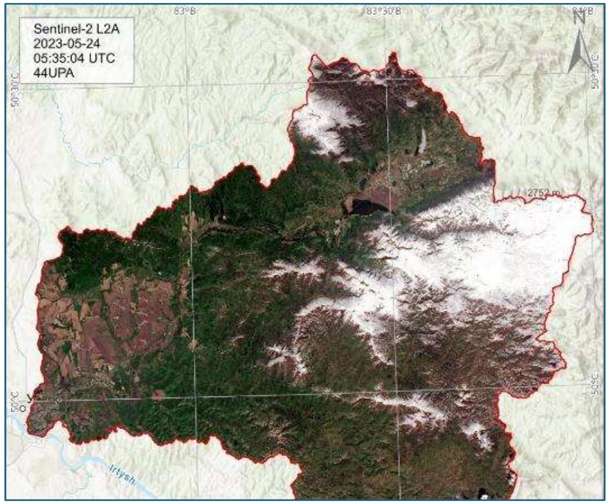


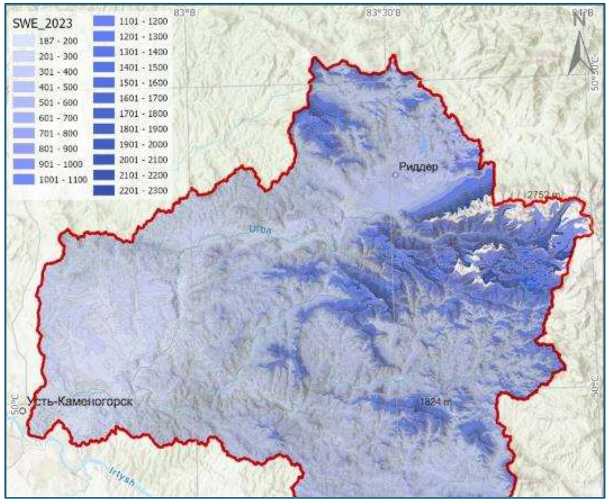


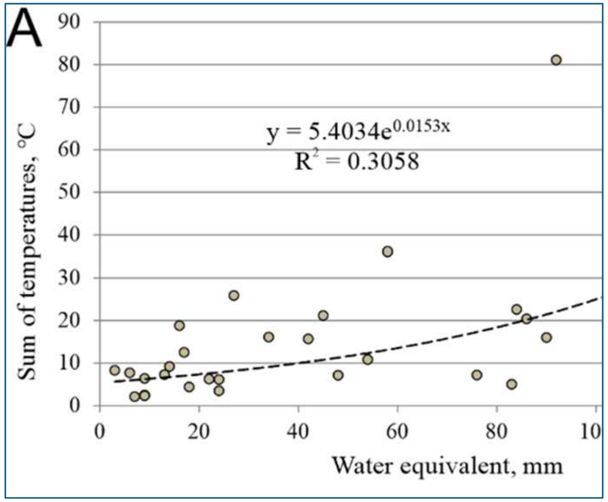


Snow survey site locations in East Kazakhstan region.









1.4 Mapping of snow reserves

Based on Kazhydromet data (2013–2023) and Sentinel-2 satellite imagery, an analysis of maximum snow storage was conducted in the Ulba and Bukhtarma River basins.

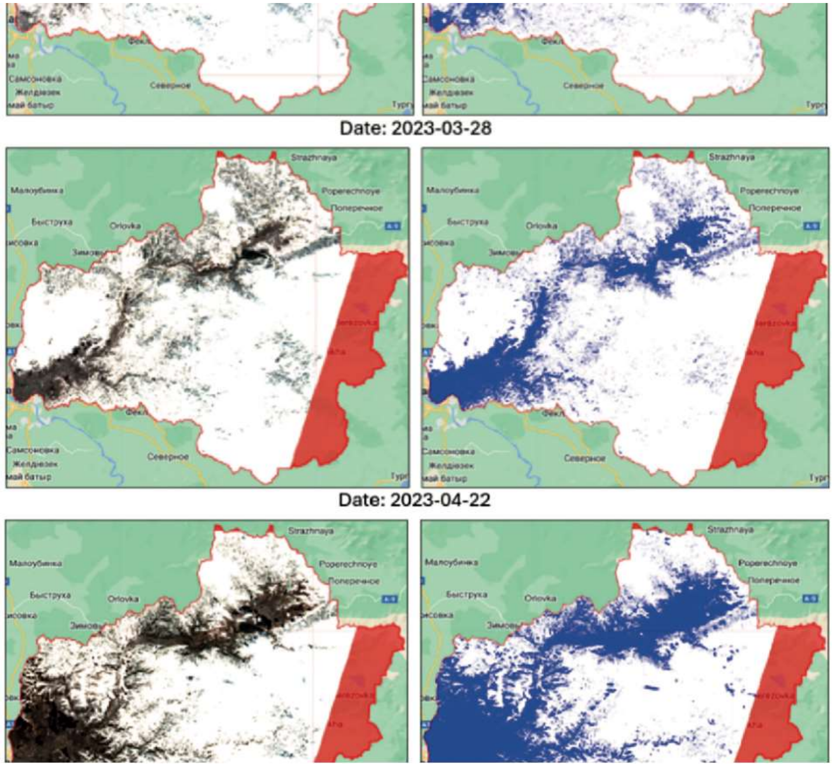
Snowmelt coefficients were calculated, and maps of snow cover extent and maximum storage across East Kazakhstan were generated.

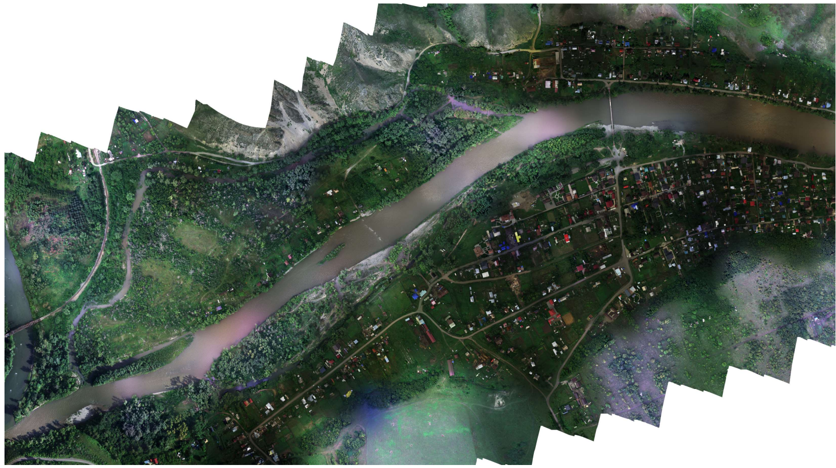
For verification, meteorological data from Kazakhstan (2020–2023) were used, showing high correlation with the calculations and confirming the reliability of the methodology.

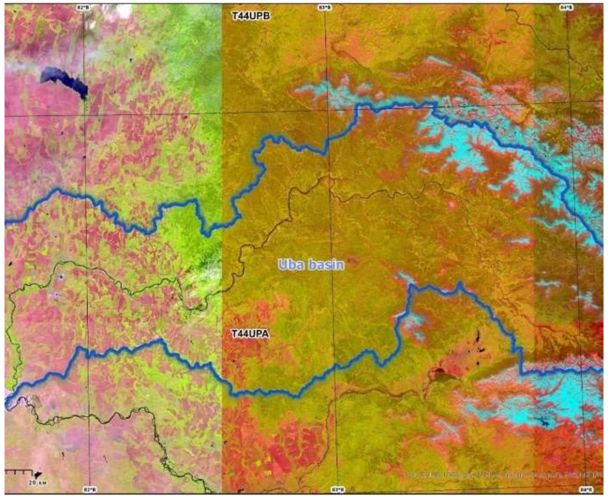
2

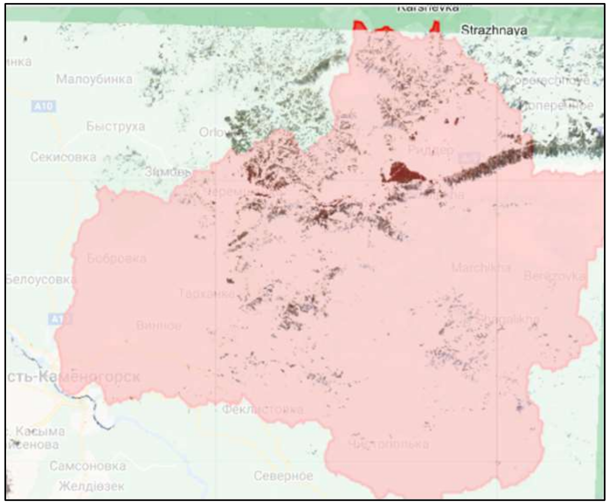
Remote sensing of meltwater catchments and flood-prone areas in East Kazakhstan based on satellite and UAV data

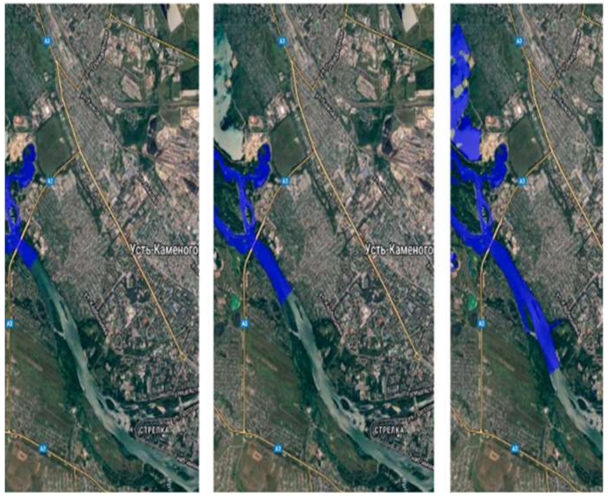
№	Title of works under the Contract and main stages of its implementation	2024	2025	2026
2.1	Scene selection from global satellite datasets for East Kazakhstan, with subsequent correction and co-registration of imagery.	100%	-	-
2.2	Land cover classification of catchments and flood zones in East Kazakhstan using hybrid methods combining automated and manual delineation.	-	100%	-
2.3	Field surveys for verification of land cover classification in East Kazakhstan, with point descriptions on 10×10 m plots.	-	100%	-
2.4	Land cover mapping of catchments and flood zones in East Kazakhstan with consideration of long-term dynamics.	-	60%	-

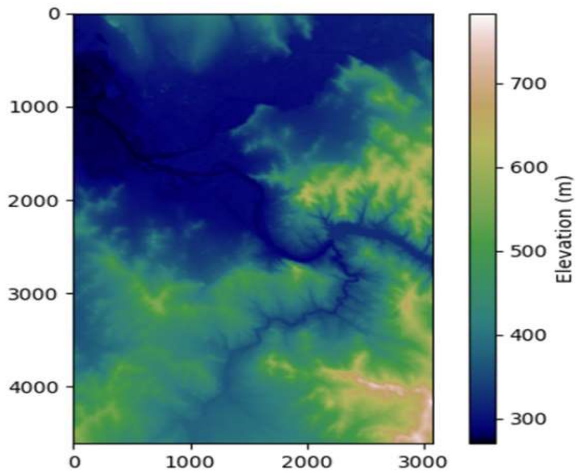










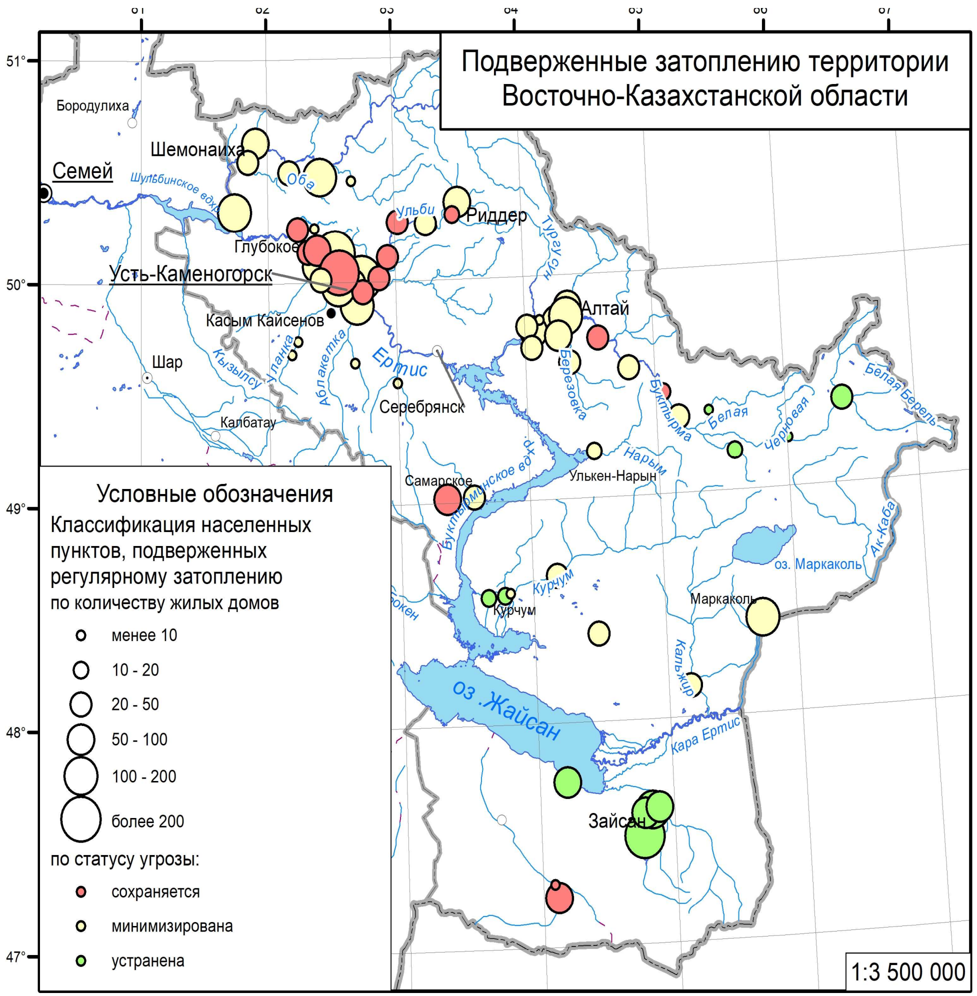


2.1 Selection of scenes from available global satellite data archives for the entire territory of East Kazakhstan

A dataset of satellite images of watershed areas and flood zones in East Kazakhstan was compiled in GeoTIFF format.

Spatial, temporal, and cloud filtering (cloud cover ≤10%) was applied, and the data were exported in GeoTIFF format.

Radiometric correction and co-registration of the images were performed.

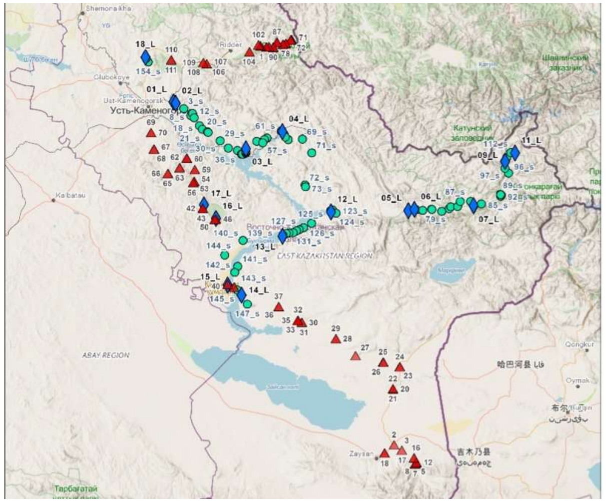


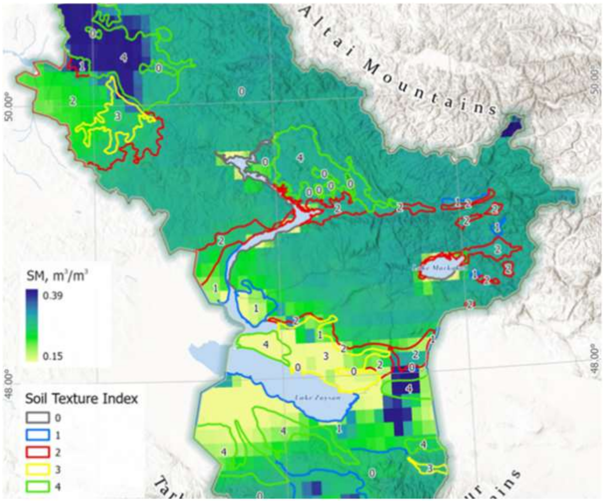
2.2 Land cover classification of watershed areas and flood zones in East Kazakhstan was performed using 'hybrid' methods that combine automated processing with manual visual delineation of watershed and flood zone boundaries

Data from available sources on hydrography and historical floods were reviewed.

Based on topographic maps and the Copernicus DEM, 43 watershed basins in East Kazakhstan were delineated using ArcGIS tools.

Flood-prone zones were identified, resulting in the delineation of 68 inundated areas where flooding has affected between 2 and 330 residential buildings annually





2.3. Field surveys for the verification of land cover classification results in East Kazakhstan. Point-based land cover descriptions were conducted on plots of 10×10 m

Field surveys were conducted to verify land cover classification in East Kazakhstan along the route Ust-Kamenogorsk – Zaysan – Samar – Ridder.

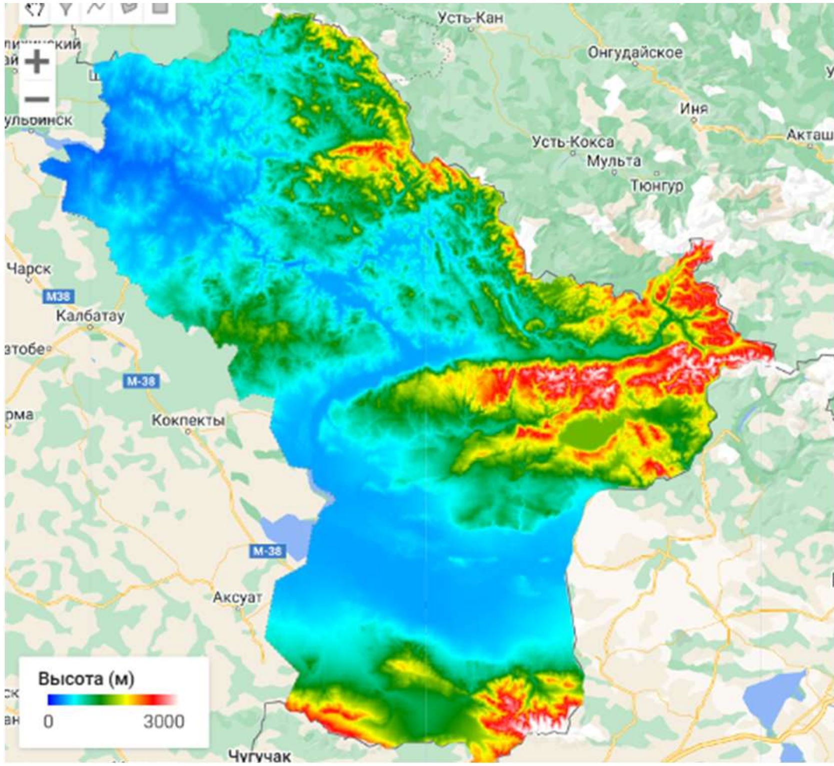
A registry of more than 150 control points was compiled using GPS surveying to verify remote sensing data and to develop reference spectral signatures of the landscapes in watershed areas and flood zones of East Kazakhstan.

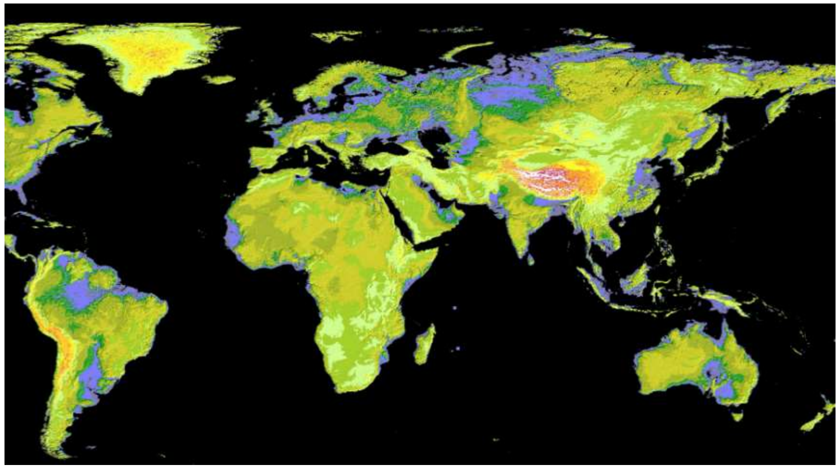
On key plots (10×10 m), 18 comprehensive landscape descriptions were carried out, including botanical characteristics and soil profiles.

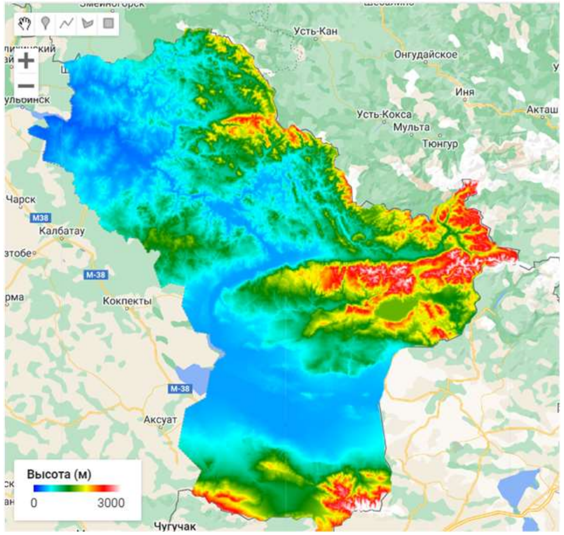
3

Development of digital models of meltwater catchment areas and flood zones in East Kazakhstan

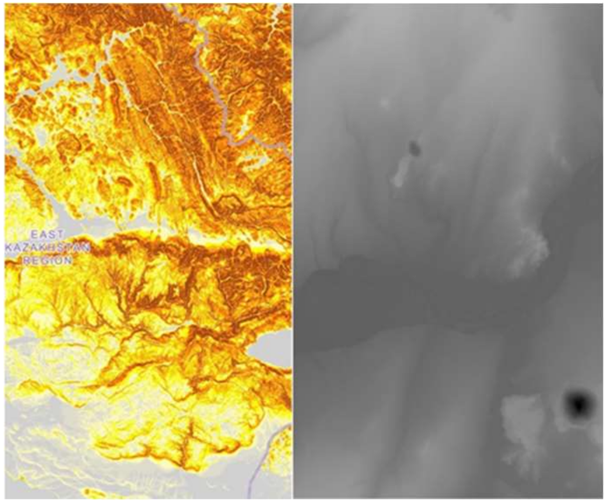
№	Title of Works under the Contract and Main Stages of its Implementation	2024	2025	2026
3.1	Development of digital elevation models (DEMs) of watershed areas and flood zones in East Kazakhstan based on satellite imagery	100%	-	-
3.2	Adaptation of scenario-based climate models to the watershed areas and flood zones of East Kazakhstan	-	80%	-
3.3	Construction of orographic models of watersheds in key areas of East Kazakhstan	-	100%	-
3.4	Development of hydrological models of watershed areas and flood zones in East Kazakhstan	-	-	🕘



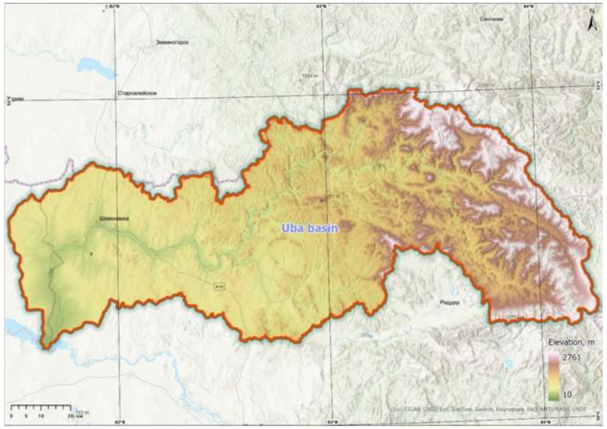




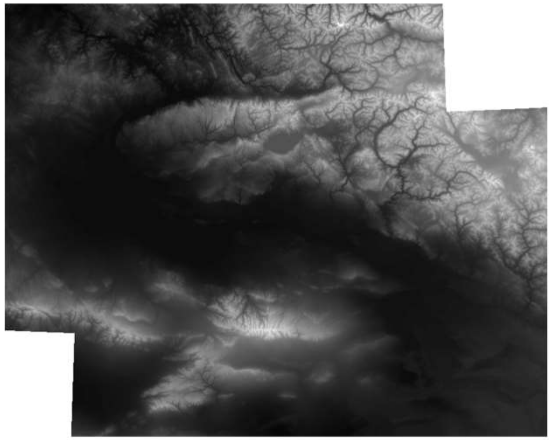
Digital elevation model (DEM) of East Kazakhstan derived from SRTM data



Fragment of the image showing slope distribution (Slope Map) and the digital elevation model (DEM).



Hypsometric map of the Uba River basin based on the FABDEM model

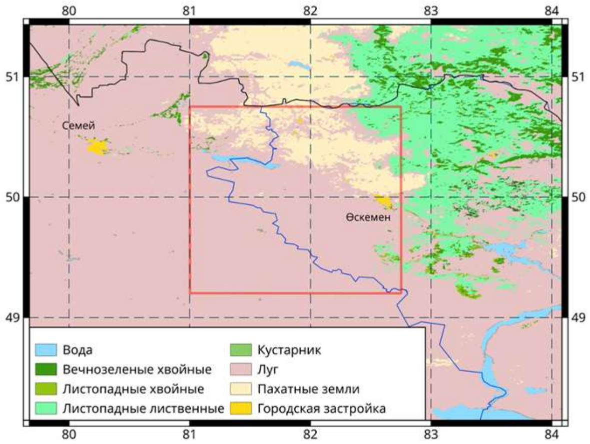


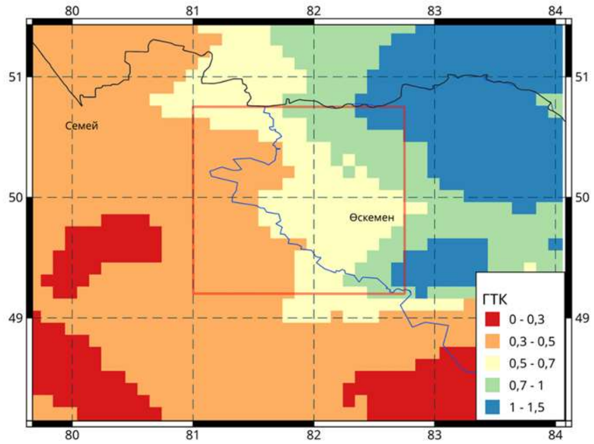
FABDEM digital elevation model for the territory of East Kazakhstan

3.1 Development of digital elevation models of watershed areas and flood ones in East Kazakhstan based on satellite imagery

For the territory of East Kazakhstan, digital elevation models (DEMs) of watershed areas and flood zones were generated. In particular, a DEM of the Irtysh River basin was developed using SRTM data within the Google Earth Engine environment, and a hypsometric map of the Uba River basin was constructed based on the FABDEM model

A comparative analysis of satellite-derived DEMs was carried out to evaluate their suitability for hydrological modeling. For the territory of East Kazakhstan, the Copernicus DEM project provides the highest level of detail.





Statistical metrics PCC, MAE, MSE, and R^2 obtained from the comparison of modeled and measured HTC values.

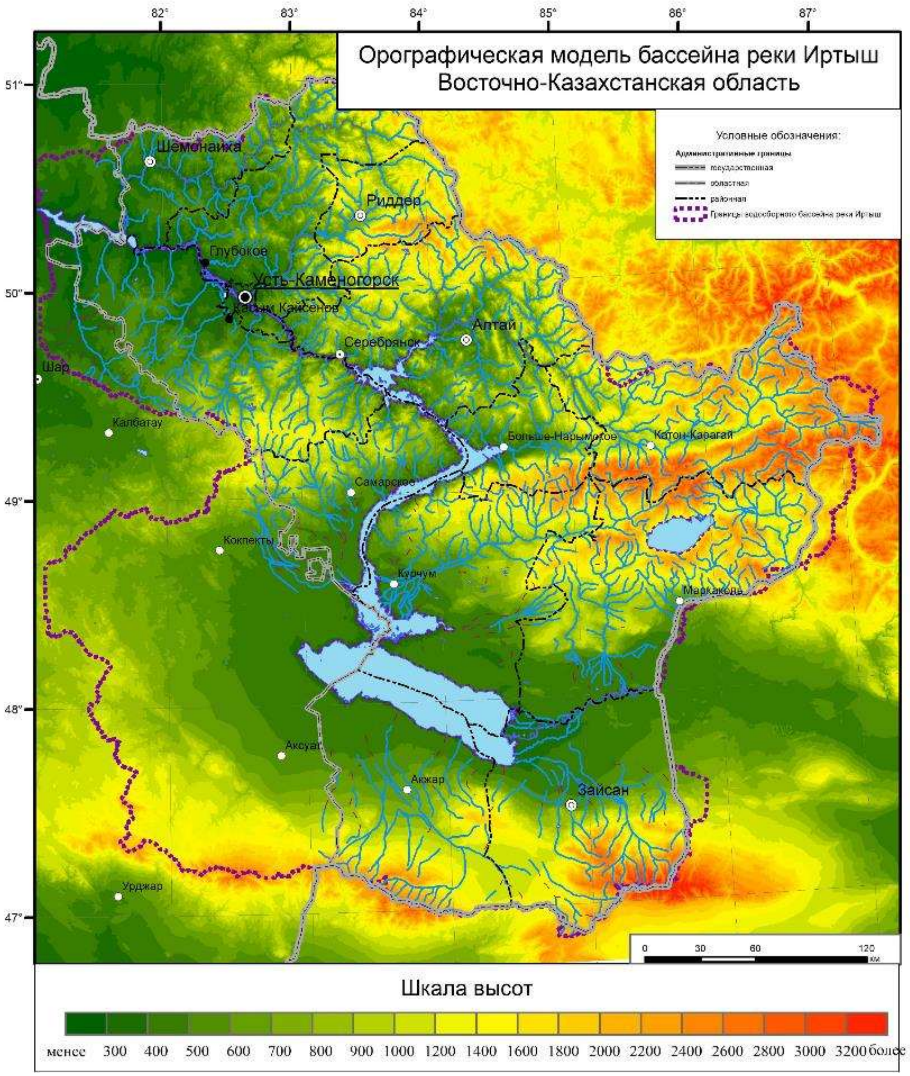
Модель	Коэффициент корреляции (PCC)	Средняя абсолютная ошибка (MAE)	Среднеквадратичная ошибка (MSE)	Коэффициент детерминации (R^2)
INM-CM5-0	-0,005	0,42	0,31	-2,73
CESM2	0,115	0,35	0,23	-1,84
EC-Earth3-CC	0,154	0,50	0,38	-3,91
GFDL-ESM4	-0,085	0,52	0,41	-4,27
CNRM-CM6-1	-0,104	0,52	0,41	-4,02
NorESM2-MM	-0,046	0,45	0,34	-2,81

3.2 Adaptation of scenario-based climate models to the catchments and flood-prone areas of East Kazakhstan Region

Global climate models CMIP6 have been adapted according to the SSP2-4.5 and SSP5-8.5 scenarios.

"The underlying surfaces (MODIS MCD12Q1) were classified for the plain and foothill regions of East Kazakhstan (49.20–50.75° N, 81.0–82.75° E)."

The Selianinov Hydrothermal Coefficient (HTC) and the Aridity Index (AI) were calculated using data from Kazhydromet and ERA5.



3.3 Construction of orographic catchment models for key areas of East Kazakhstan region

Individual sheets of 1:100,000 scale topographic maps have been registered and integrated into a unified map within the GIS environment.

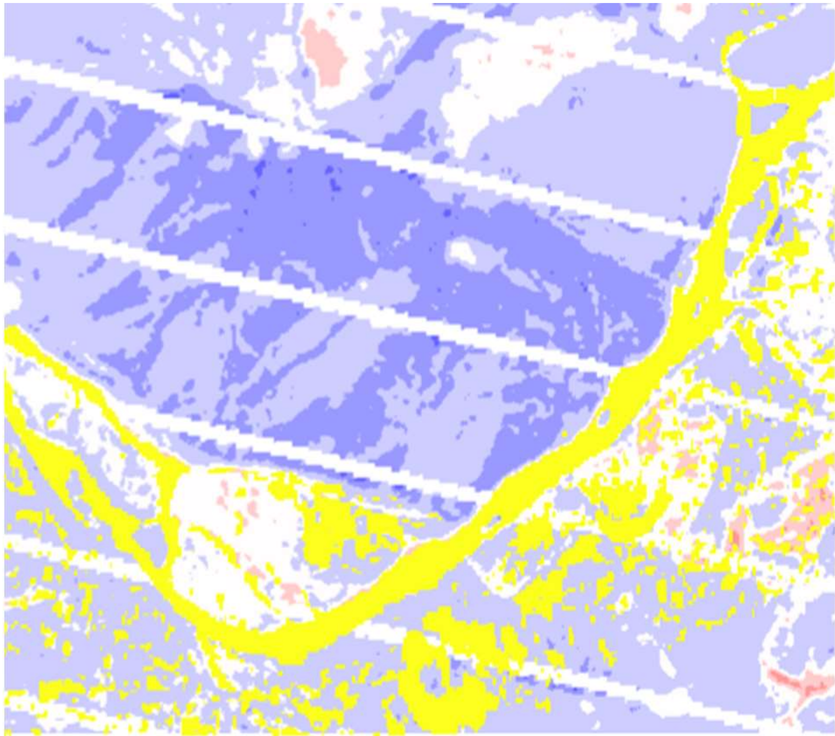
Based on data from the Ministry of Emergency Situations of Kazakhstan and Kazhydromet, key flood-prone areas have been identified for detailed studies.

Using Copernicus DEM, an orographic model of East Kazakhstan region and individual catchments has been created; subdivision into sub-basins is in progress.

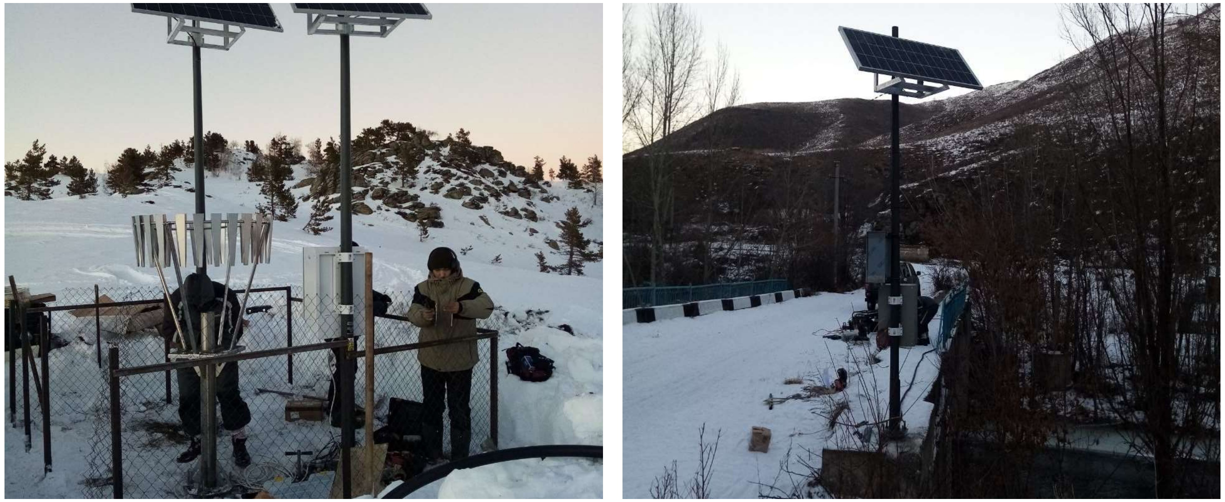
4

Development of a digital model of the hydrographic network of East Kazakhstan

№	Title of Works under the Agreement and Main Stages of Implementation	2024	2025	2026
4.1	Collection and systematization of attribute data on water bodies across the entire territory of East Kazakhstan Region	100%	-	-
4.2	Development of a mathematical model of the hydrographic network of East Kazakhstan Region	-	80%	-
4.3	Development of a geoinformation model of the hydrographic network of East Kazakhstan Region	-	80%	-



	№	Тип водоток	Название	Длина, км	Бассейн	Режим
2	1	река	Маховка	0	Ульба	Постоянная
3	2	ручей	Самарушка	4	Ульба	Постоянная
4	3	ручей	Таловка	4	Уба	Постоянная
5	4	река	Таловка	9	Уба	Постоянная
6	5	ручей	Крутой Ключ	6	Уба	Постоянная
7	6	ручей	Кокориха	1	Уба	Постоянная
8	7	ручей	Кокориха	7	Уба	Постоянная
9	8	река	Жартас	6	Иртыш	Постоянная
10	9	река	Грязнуха	0	Уба	Постоянная
11	10	река	Бухтарма	2	Бухтарма	Постоянная
12	11	река	Манат	35	Бухтарминское вдхр.	Постоянная
13	12	ручей	Самарушка	1	Ульба	Постоянная
14	13	река	Серебрянка	10	Усть-Каменогорское вдхр.	Постоянная
15	14	река	Серебрянка	0	Усть-Каменогорское вдхр.	Постоянная
16	15	река	Шумилиха	8	Красноярка	Постоянная
17	16	река	Аблакетка	33	Иртыш	Постоянная
18	17	река	Аблакетка	33	Аблакетка	Постоянная
19	18	река	Аблакетка	33	Иртыш	Постоянная
20	19	река	протока Тихая	11	Иртыш	Постоянная
21	20	река	протока Тихая	11	Иртыш	Постоянная
22	21	река	Уланка	30	Уланка	Постоянная
23	22	река	Уланка	30	Иртыш	Постоянная
24	23	река	Уланка	7	Уланка	Постоянная
25	24	река	Уланка	20	Уланка	Постоянная
26	25	река	Уланка	0	Уланка	Постоянная
27	26	река	Уланка	9	Уланка	Постоянная
28	27	река	Карасу	24	Шульбинское вдхр.	Постоянная
29	28	река	Ковалевка	12	Шульбинское вдхр.	Постоянная
30	29	река	Жартас	15	Иртыш	Пересыхающая
31	30	река	Маралиха	3	Уба	Пересыхающая
32	31	река	Козлушка	9	Уба	Постоянная
33	32	река	Лосиха	24	Уба	Постоянная
34	33	ручей	Сарымсакты	39	Куршим	Постоянная
35	34	ручей	Сарымсакты	39	Бухтарма	Постоянная
36	35	ручей	Свинячий ключ	1	Улькен Бокен	Постоянная
37	36	ручей	Камысты	0	Улькен Бокен	Постоянная



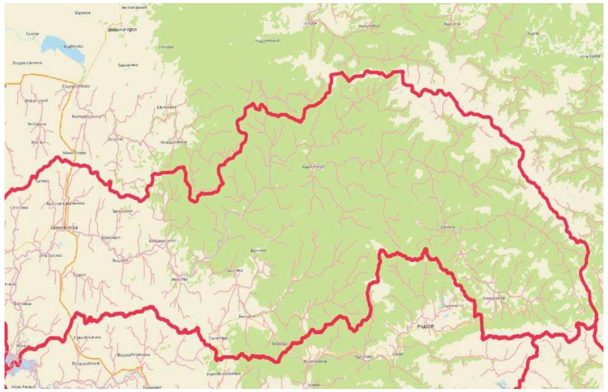
Installation of hydrological and meteorological stations in the upper reaches of the Chyornaya Uba River and the Tainy–Irtysh basin (November 25–27, 2024)

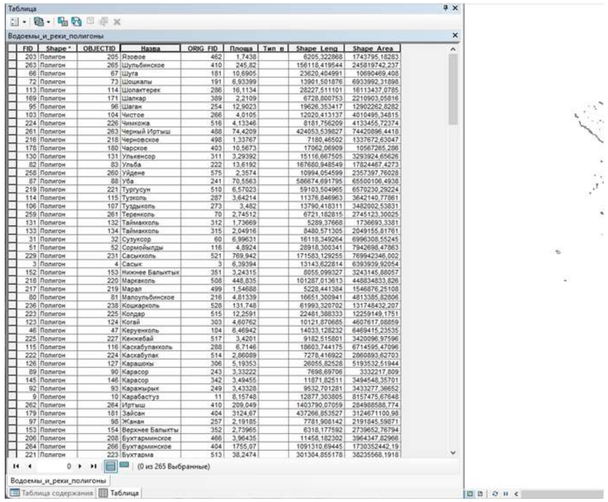
4.1 Collection and systematization of attribute data on water bodies across the entire territory of East Kazakhstan

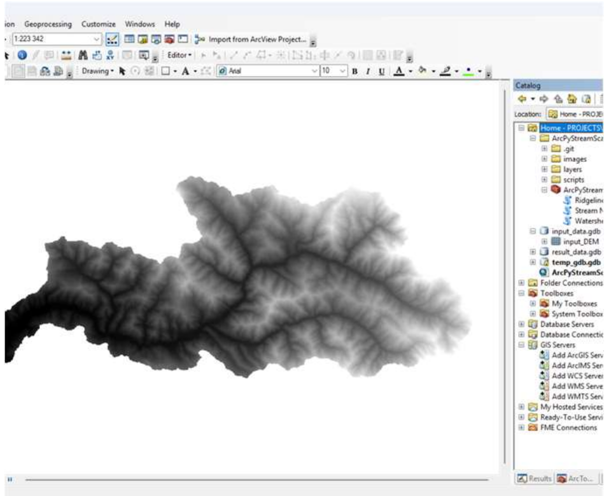
A dataset on water bodies in East Kazakhstan has been collected and systematized, including the names of water bodies, type, length/area, and hydrological regime.

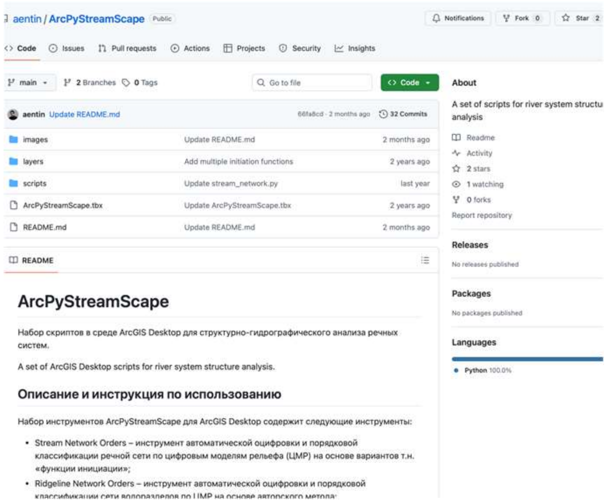
Data on hydrological stations have been structured, including routine observations (discharge, water level), location (coordinates), and observation periods (1995–2021).

Two hydrological stations from OTT Hydrostation and two meteorological stations from Vaisala Oyj have been procured and installed.









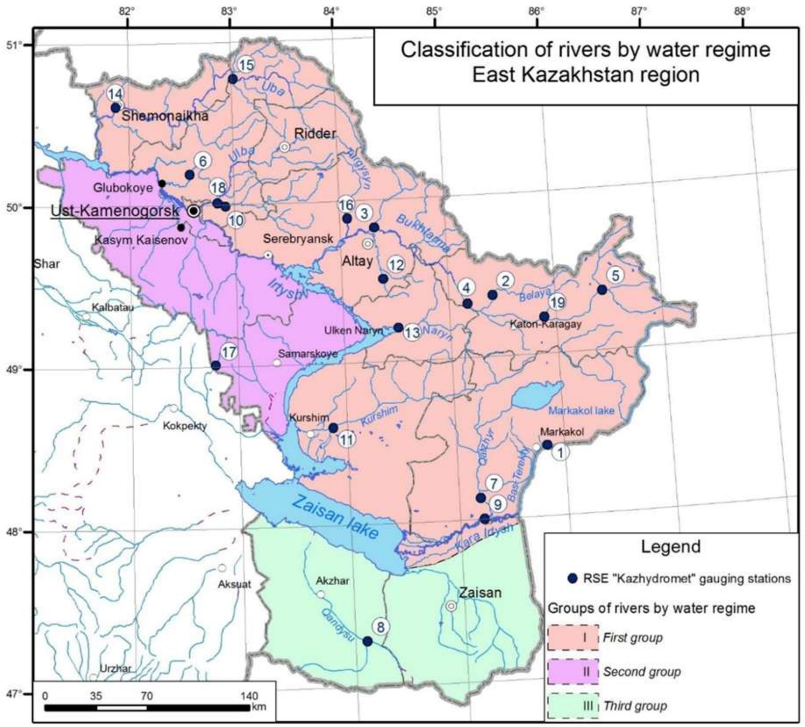
4.2 Development of a mathematical model of the hydrographic network of East Kazakhstan

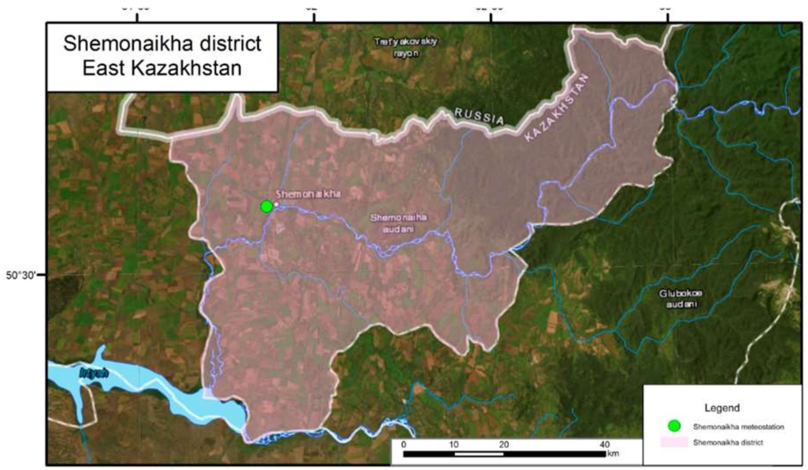
- Lists of water bodies and watercourses in East Kazakhstan region (based on topographic maps and the Water-Energy Cadastre) have been compiled, with updated toponymy.
- Using the ArcPyStreamScape tool, watershed boundaries were refined and supplemented with a modeled river network.
- A preliminary version of a mathematical model of the hydrographic network of the Irtysh river basin within East Kazakhstan region has been developed, comprising 769 river segments, 43 sub-basins, and 50 hydrological monitoring stations.

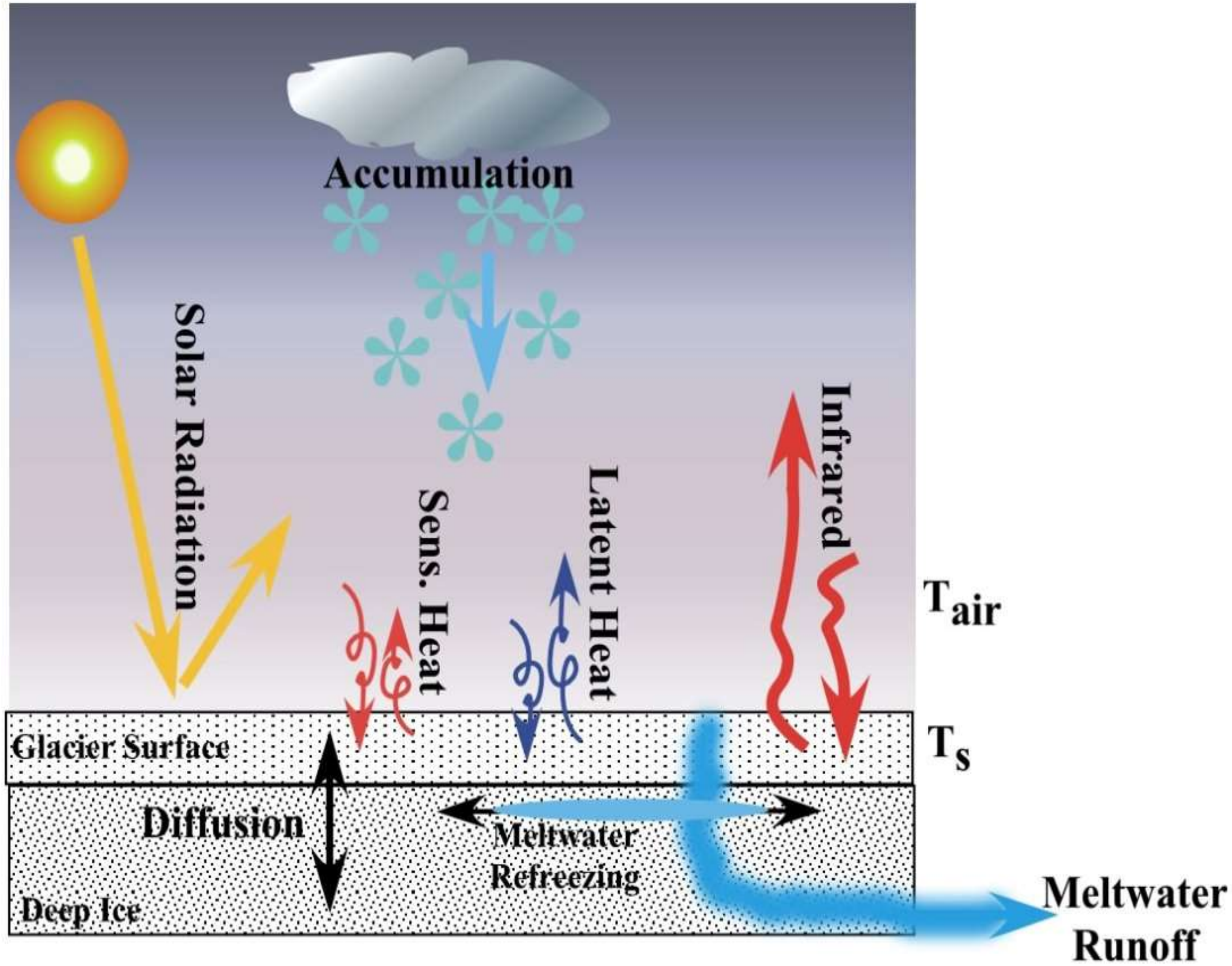
5

Estimation of meltwater accumulation and assessment of collection methods and technologies

№	Title of Works under the Agreement and Main Stages of Implementation	2024	2025	2026
5.1	Critical analysis of existing models and methodologies for calculating meltwater accumulation	100%	-	-
5.2	Development of a mathematical model of meltwater accumulation in key areas of East Kazakhstan Region	-	80%	-
5.3	Identification of runoff pathways and meltwater accumulation zones based on terrain analysis and soil aquifer characteristics in key areas of East Kazakhstan Region	-	80%	-







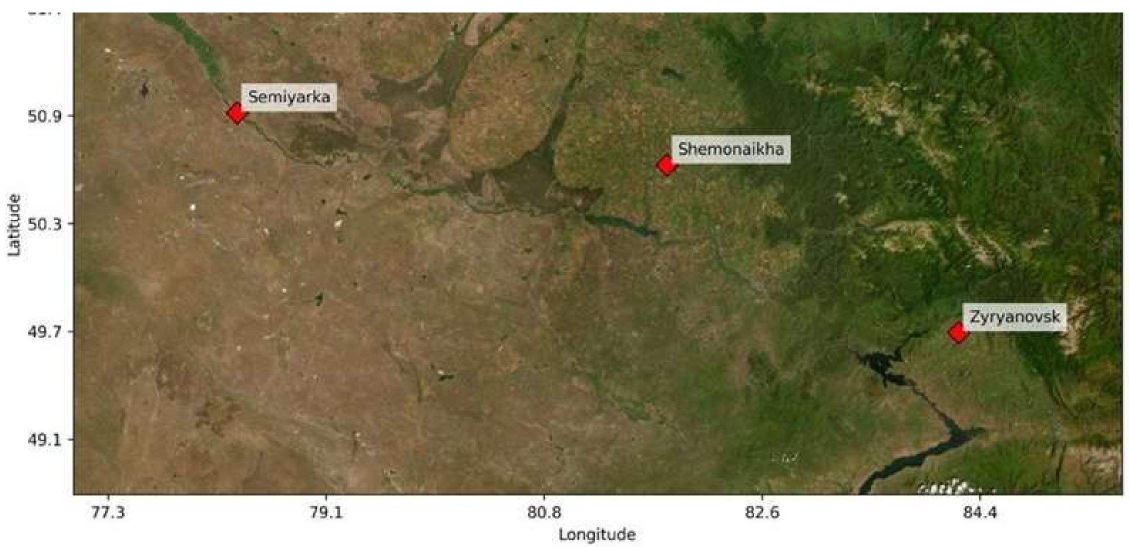
Source: https://geosci.uchicago.edu/~rtp1/glaciers/EnergyBudget.html

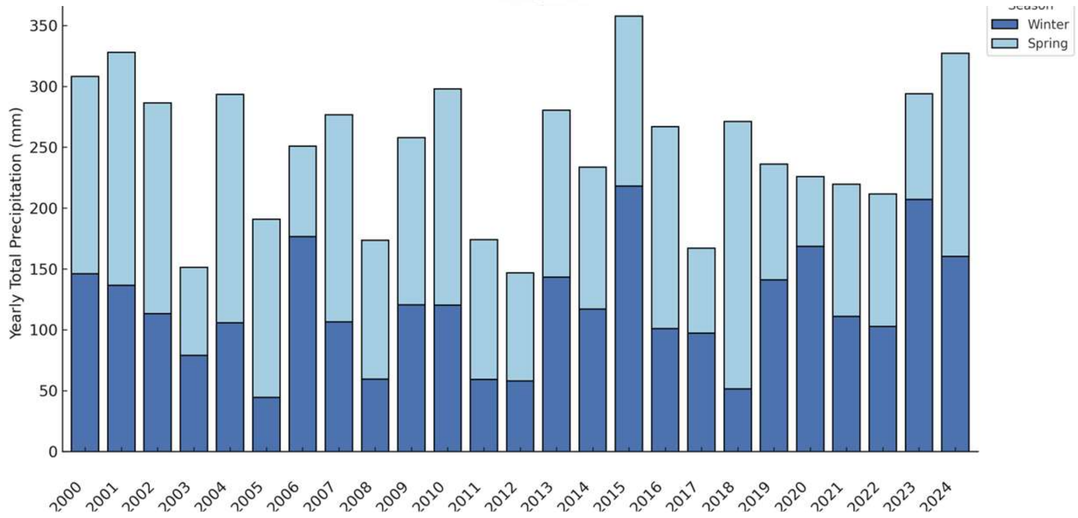
5.1 Critical analysis of existing models and methodologies for calculating meltwater accumulation

An analytical report on existing models and methodologies for calculating meltwater accumulation has been prepared. The models were classified into four main groups:

- Empirical models;
- Physically based models;
- Hydrological models;
- Machine learning models.

The key components of each group were reviewed, along with their advantages and limitations. Case studies of the application of these models in related research were analyzed, allowing us to assess their practical value and areas of applicability.





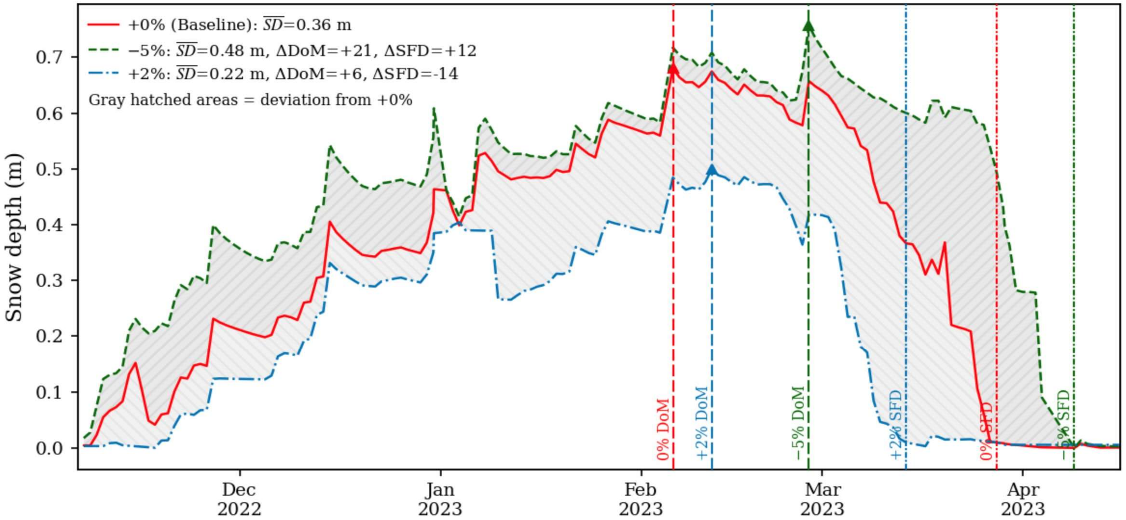
5.2. Development of a mathematical model of meltwater accumulation in key areas of East Kazakhstan

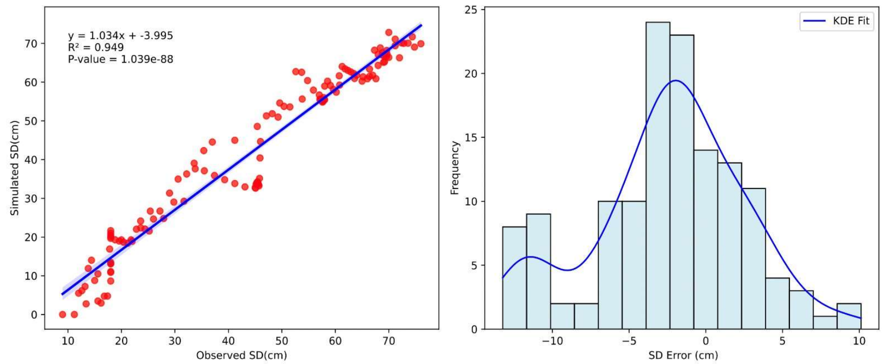
A physico-mathematical model of meltwater accumulation was developed for representative sites in East Kazakhstan Region: Shemonaiha (~297 m), Semiyarka (~146 m), and Zyryanovsk (~456 m).

Calculations were performed with a 1-hour time step, ensuring high temporal resolution of snowmelt dynamics and soil moisture saturation.

The model reproduces the key characteristics of snow and thermal regimes, including snow depth, density, and temperature, snow water equivalent (SWE), timing of snowmelt and snow cover disappearance, meltwater formation, and its infiltration into the soil.

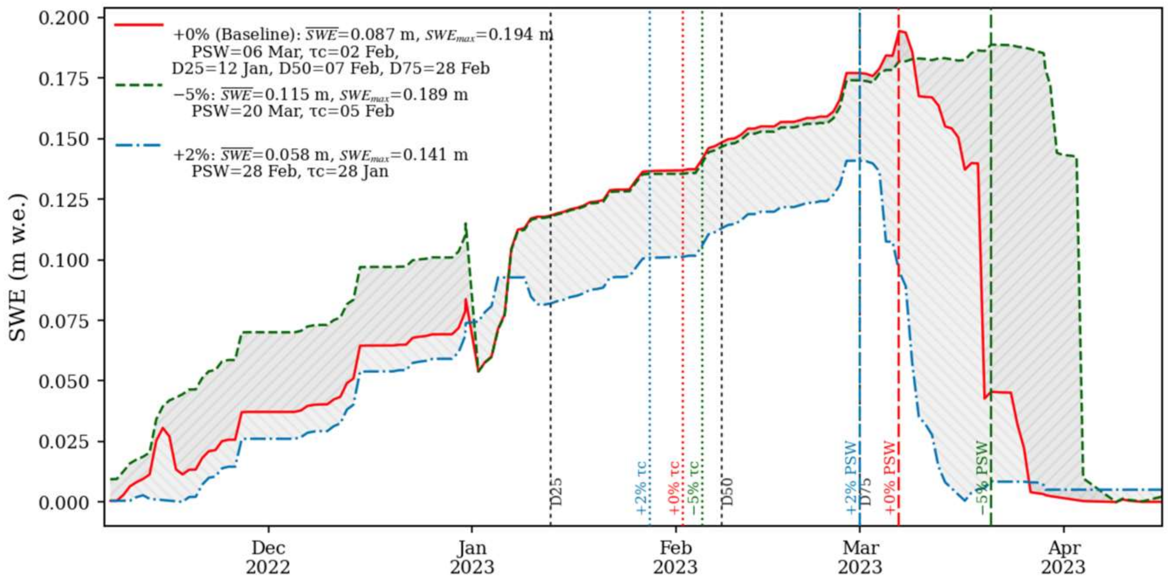
Comparison of Snow Depth: SNTHERM vs. Kazhydromet Observations

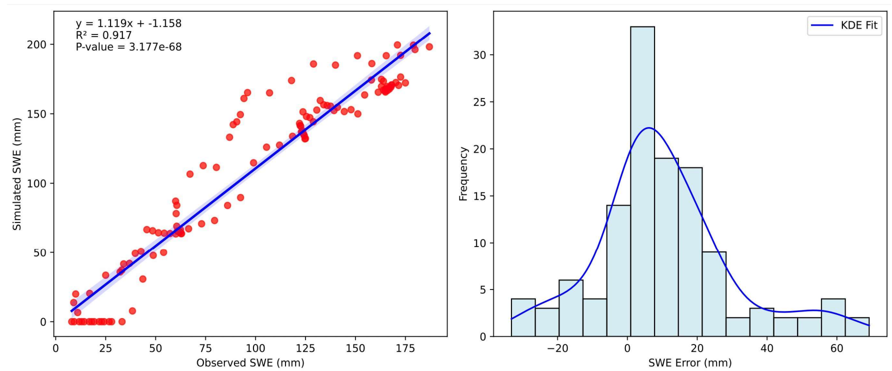




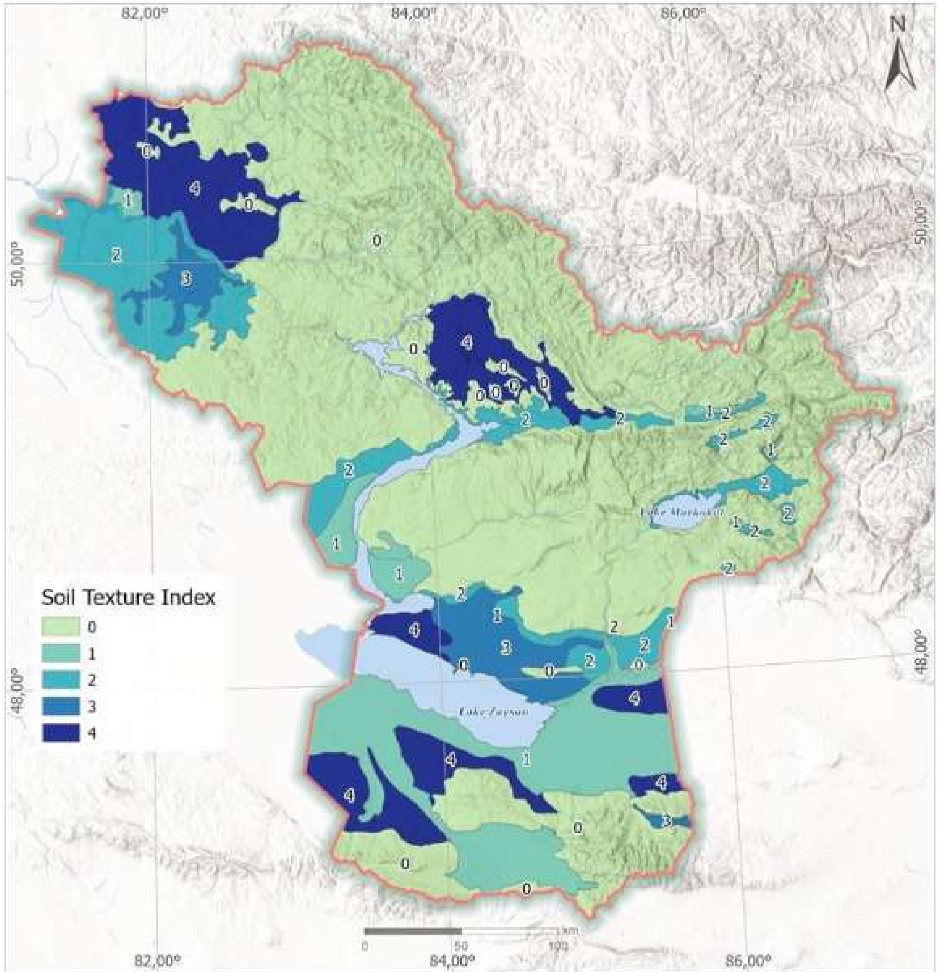
R² = 0.949
RMSE = 5.48 cm
MAE = 4.22 cm
Bias = −2.46 cm

Comparison of SWE: SNTHERM Model vs. Kazhydromet Observations





R² = 0.917
RMSE = 2.2 cm
MAE = 1.56 cm
Bias = +1.04 cm



Soil Texture Classes in East Kazakhstan Region

5.3 Identification of runoff pathways and meltwater accumulation zones based on terrain analysis and soil water-bearing characteristics in key areas of East Kazakhstan

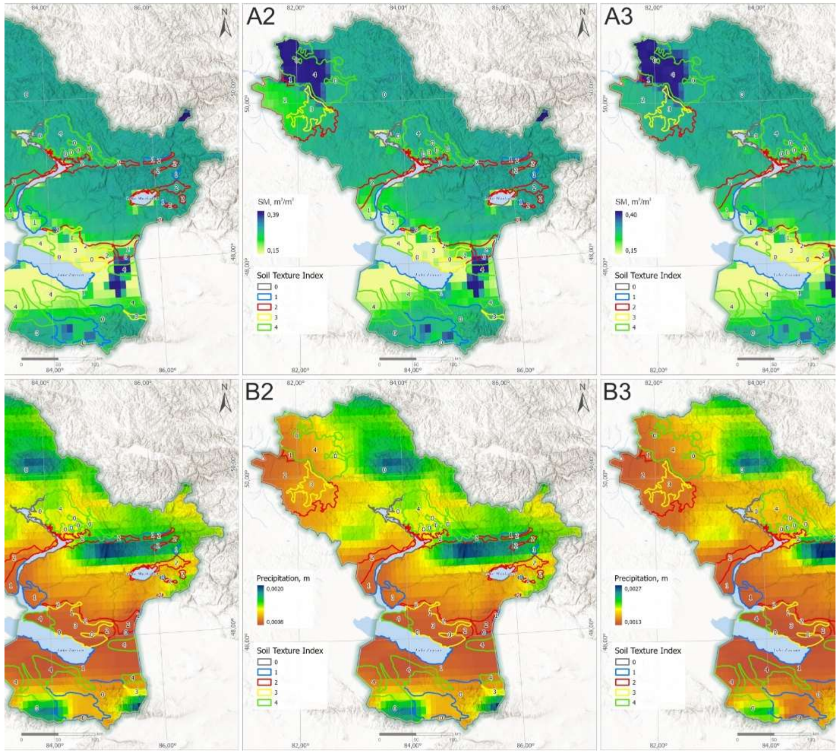
Field expeditions were conducted, covering the northern, central, eastern, and western parts of East Kazakhstan region, including settlements such as Barnaul, Ust-Kamenogorsk, Katon-Karagai, Shyngystai, Berel, Rakhmanovskie Klyuchi, Kaiyndy, Samarskoe, and others.

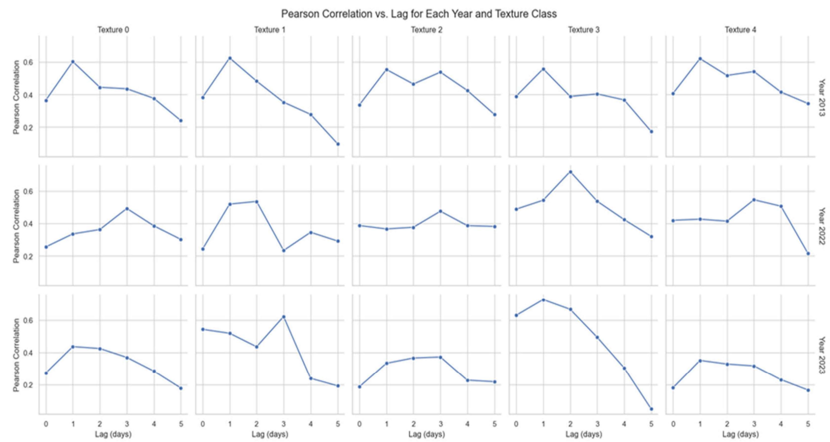
Five general soil texture classes were identified: 0) Bedrock soils; 1) Very light soils: sand; 2) Light soils: loamy sand; 3) Medium soils: sandy loam; 4) Heavy soils: loam, loam with silt, and sandy clay loam.

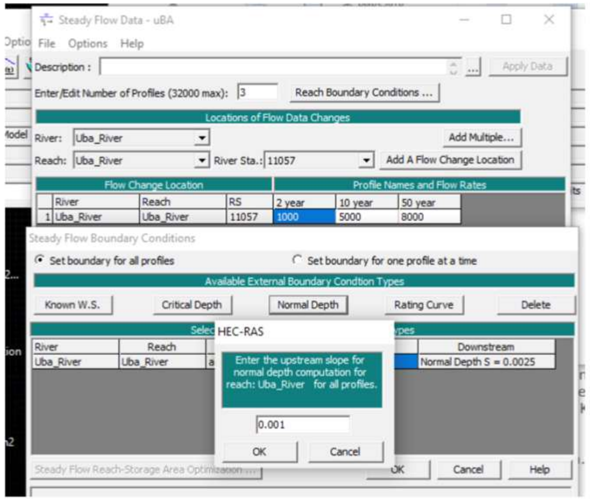
6

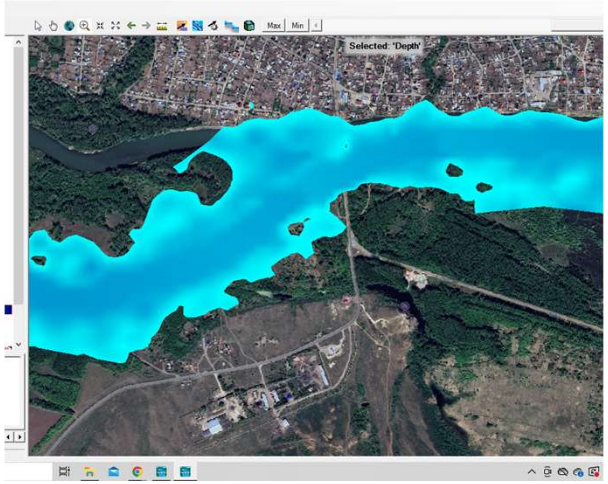
Identification of areas most vulnerable to snowmelt flooding

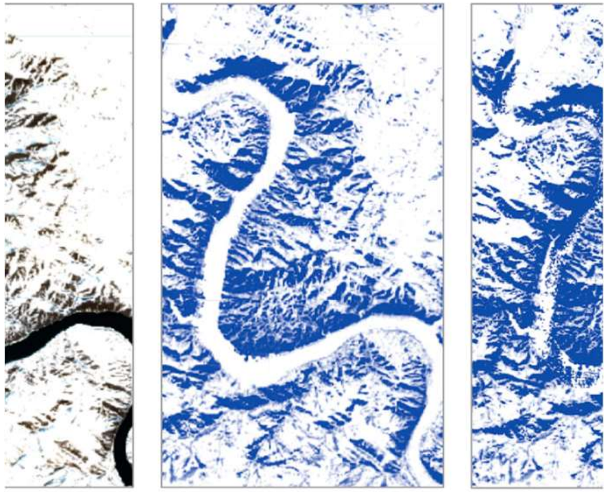
№	Title of Works under the Agreement and Main Stages of Implementation	2024	2025	2026
6.1	Critical analysis of existing models and methodologies for identifying areas most prone to snowmelt-induced flooding	100%	-	-
6.2	Collection and analysis of data on soil freezing and autumn soil moisture reserves at different elevation levels in key areas of East Kazakhstan region	-	100%	-
6.3	Modeling of flooding scenarios in key areas of East Kazakhstan region based on the collected data	-	80%	-

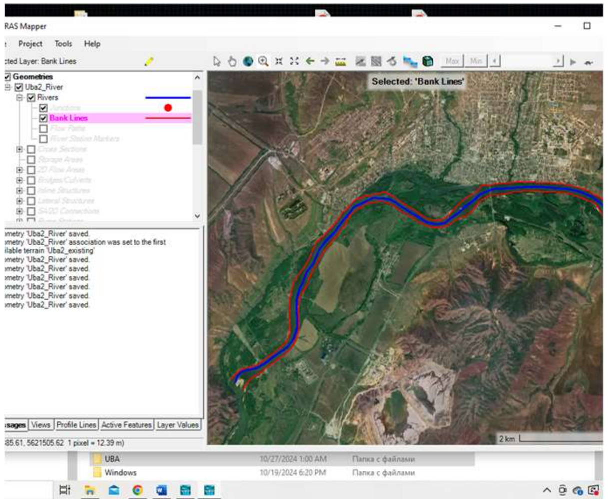












6.1 Critical analysis of existing models and methodologies for identifying areas most prone to snowmelt-induced flooding

An analytical report was prepared, providing a critical review of models and methodologies for identifying areas subject to snowmelt flooding. The report includes an analysis of relevant literature sources and a description of flood zone delineation using the HEC-RAS model.

Experiments were conducted on simulating the overflow of the Uba River in the Shemonaiha area, which confirmed the effectiveness of the HEC-RAS model for predicting flood zones and assessing flood risks.

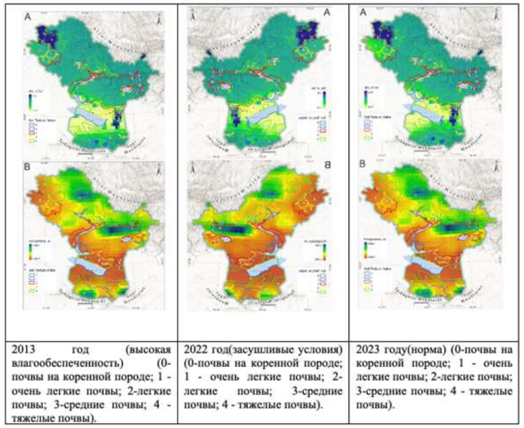


Рисунок 7. Пространственное распределение максимальных значений SM (**А**) и ежедневные осадки (**Б**) по территории ВКО в 2013, 2022 и 2023 году.

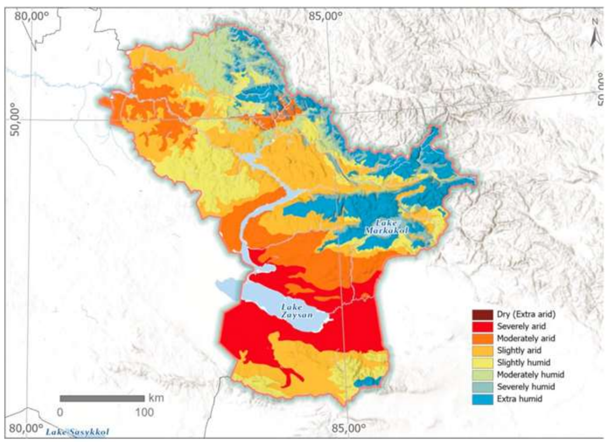


Figure 11. The climate types of the EKR modern landscapes.

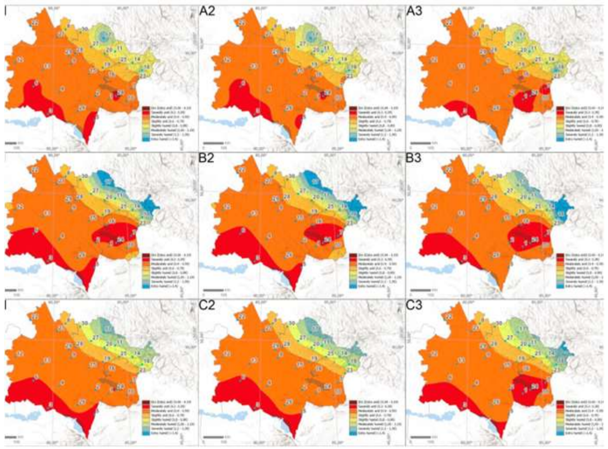


Figure 8. HTC produced by interpolating values of the weather stations (1 – 1981–1990; 2 – 198
2010; 3 – 2011–2023; A – IDW, B – Spline, C – EBK).

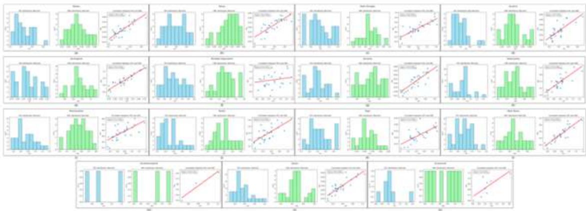


Figure 4. Evaluating normality of data distribution for 1981–2110 period across EKR weather stations.

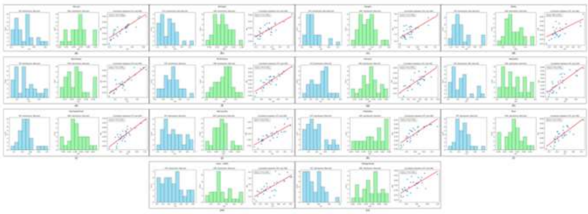


Figure 5. Evaluating normality of data distribution for 1981–2110 period across Abay region weather

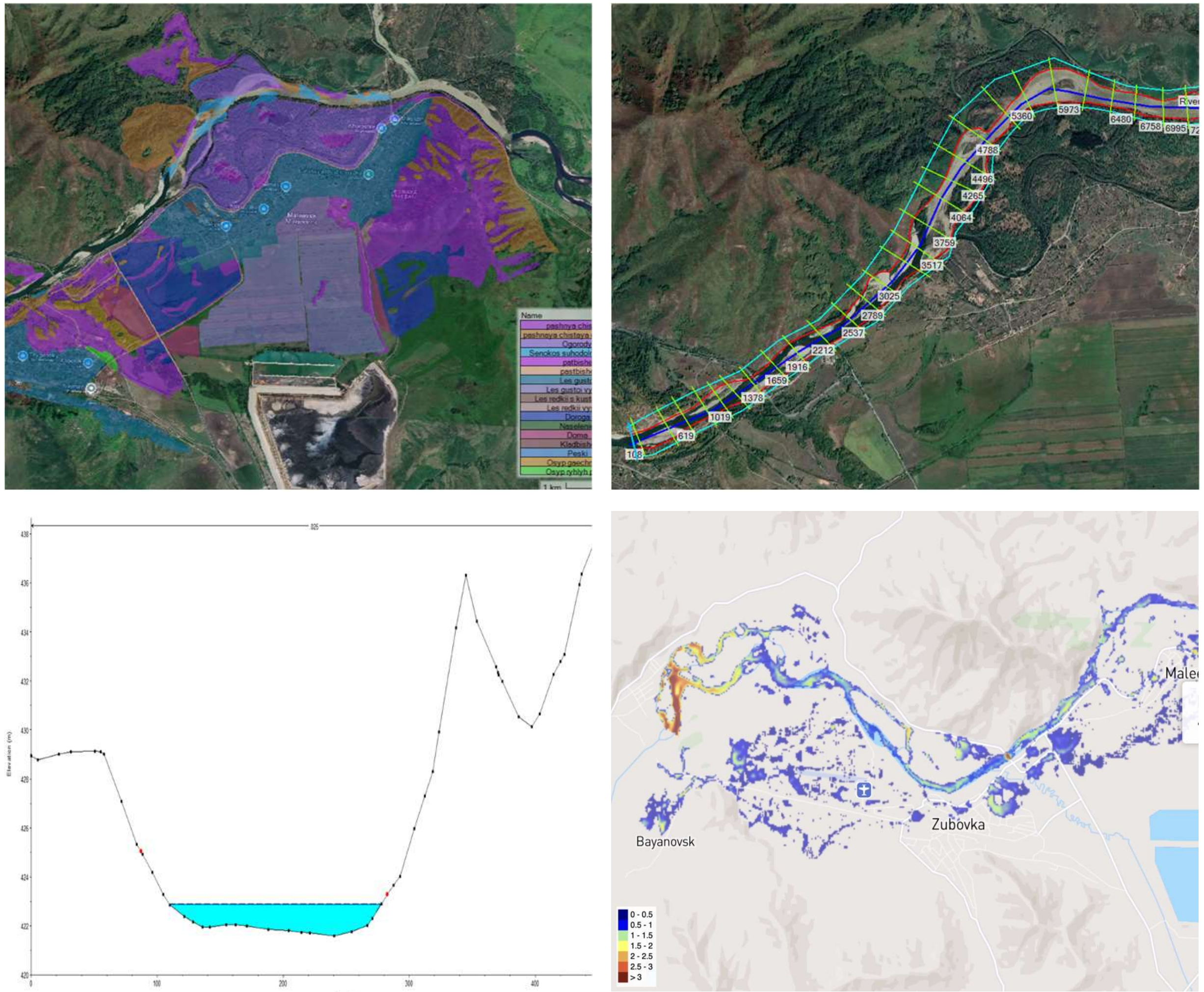
Source: The Calculation and Mapping of the Moisture Indices of the East Kazakhstan Region for the Preventive Assessment of the Climate-Hydrological Background (Land 2025)

6.2. Collection and analysis of data on soil freezing and autumn soil moisture reserves at different elevation levels in key areas of East Kazakhstan region

An analysis of open-source information on soil temperature and moisture across Kazakhstan was conducted using the International Soil Moisture Network platform.

A monitoring network was deployed to collect meteorological, hydrological, and soil-hydrological data.

An assessment of soil water-holding capacity dynamics in East Kazakhstan region was performed using ERA5-Land datasets combined with geological and hydrological information.



Article under review in the journal *Vestnik KazNPU*:
"Visualization of Flood Zones Using the HEC-RAS Method (Case Study of a Section of the Bukhtarma River)"

6.3. Modeling of flooding scenarios in key areas of East Kazakhstan region based on the collected data

Flooding scenarios were simulated in HEC-RAS 6.6 using the Copernicus DEM (30 m resolution) for a section of the Bukhtarma River valley.

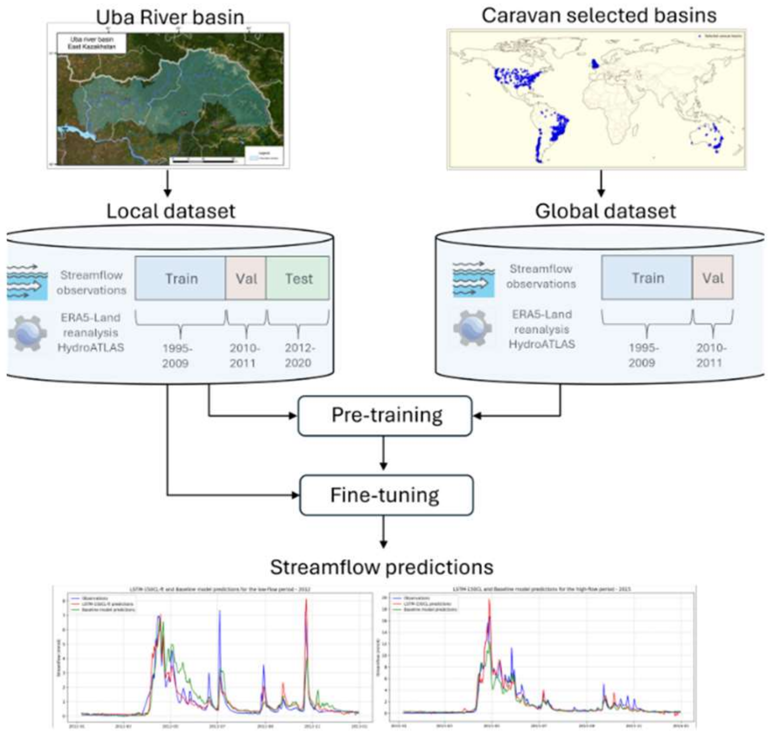
Model verification was carried out using Landsat 7 satellite observations, applying the Normalized Difference Water Index (NDWI) to delineate actually flooded areas.

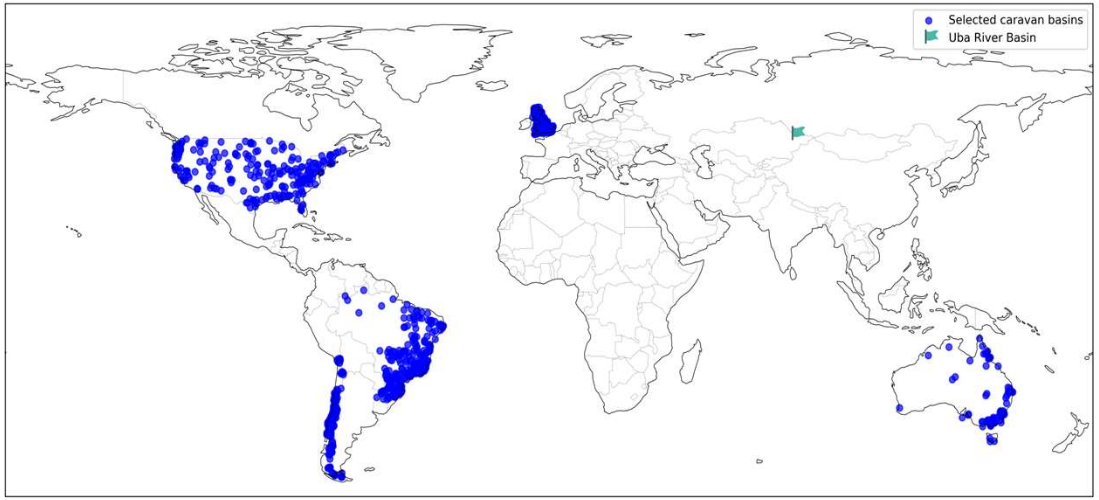
The overlap of simulated and observed flood boundaries reached 87%, with an area discrepancy of less than 2%, confirming the model's accuracy.

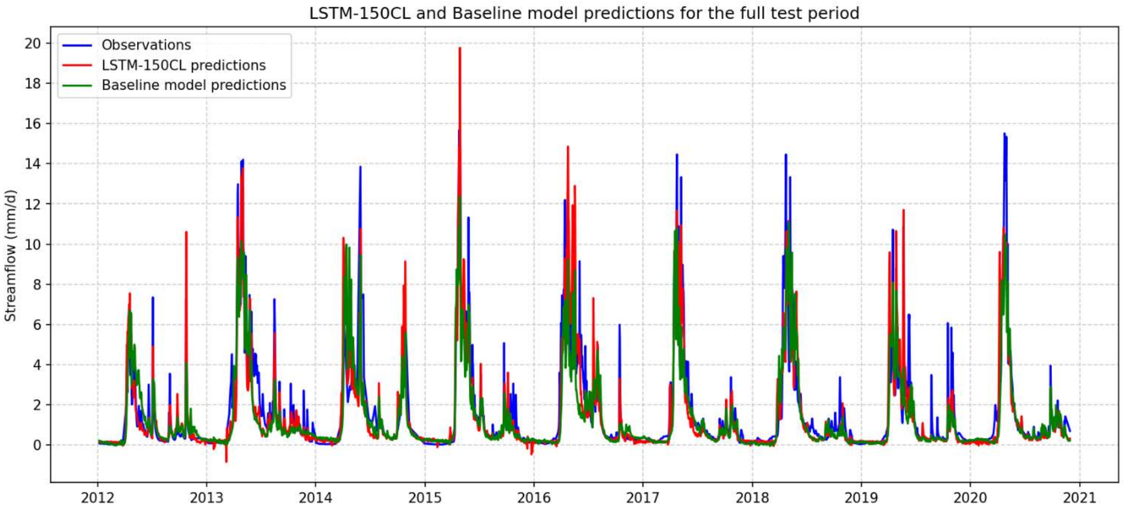
7

Development of a methodology for flood mapping and forecasting using modern techniques of radar remote sensing, optical (multi- and hyperspectral) imaging, satellite altimetry, and UAV surveys

№	Title of Works under the Agreement and Main Stages of Implementation	2024	2025	2026
7.1	Critical analysis of existing models and methodologies for calculating and forecasting flood-prone areas	100%	-	-
7.2	Development of methodologies for river runoff formation in the studied catchments of East Kazakhstan Region	-	90%	-
7.3	Development of machine learning models based on LSTM neural network architecture for forecasting hydrological runoff in key areas of East Kazakhstan Region	-	50%	
7.4	Creation of a digital model for calculating and forecasting flood-prone areas in East Kazakhstan Region using remote sensing data, GIS technologies, and machine learning	-	-	
7.5	Development of a predictive methodology for long-term hydrometeorological flood forecasting, incorporating current information from various sources and meteorological forecasts for key areas of East Kazakhstan Region	-	-	





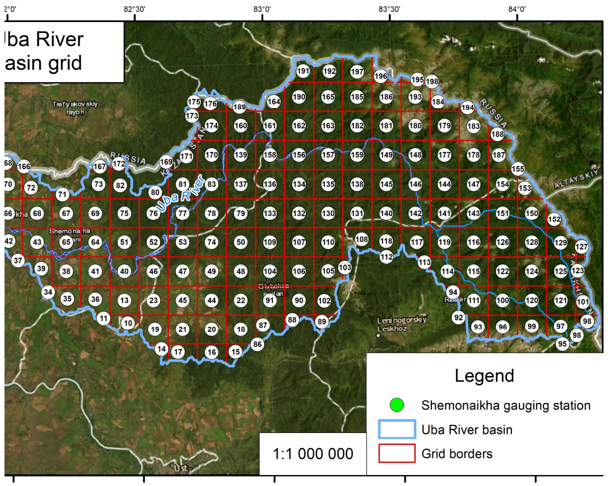


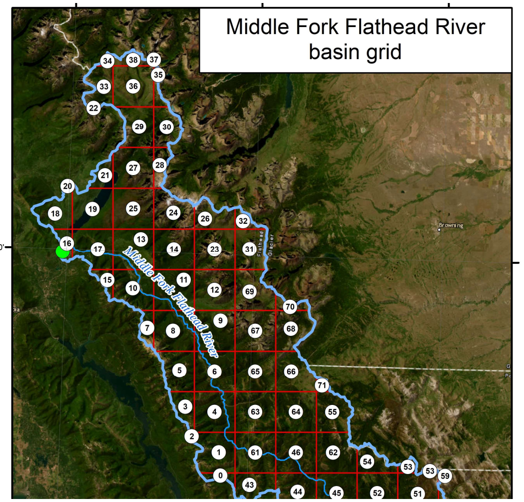
An article under review in Environmental Modelling & Software:
"Transfer Learning Using the Global Caravan Dataset for Developing a Local River Streamflow Prediction Model"

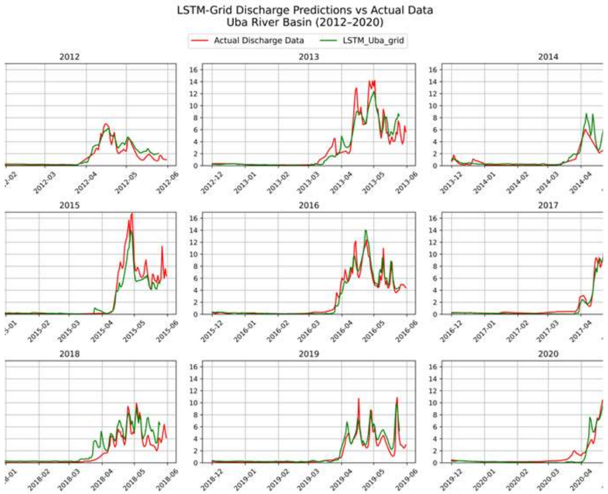
7.2 Development of methodologies for river runoff formation in the studied catchments of East Kazakhstan Region

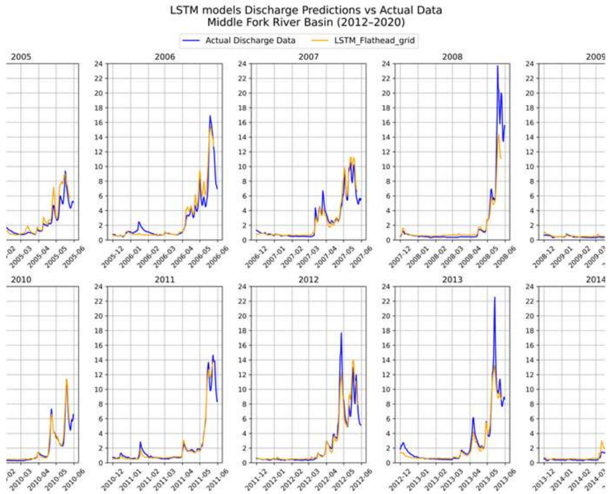
LSTM models for water discharge forecasting in the Uba River basin have been developed using transfer learning methods based on the global hydrological dataset Caravan.

The results of the trained models demonstrated high consistency with the observed water discharges in the Uba River basin, achieving NSE = 0.81. The transfer learning approach improved the forecasting of high flows and peaks compared to the baseline model.







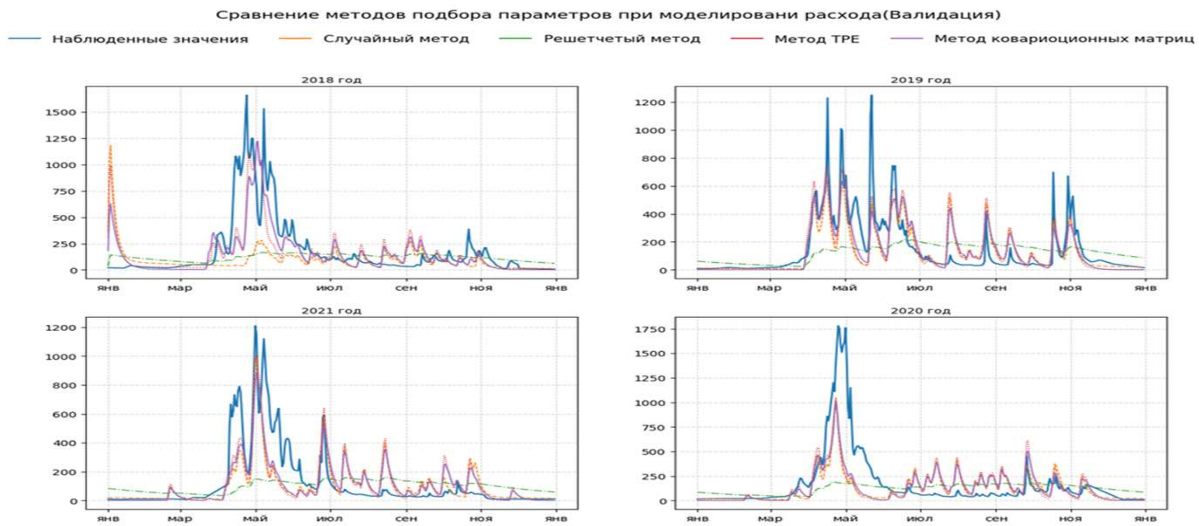


Article in *Data* (2025):
"LSTM-Based River Discharge Forecasting Using Spatially Gridded Input Data"

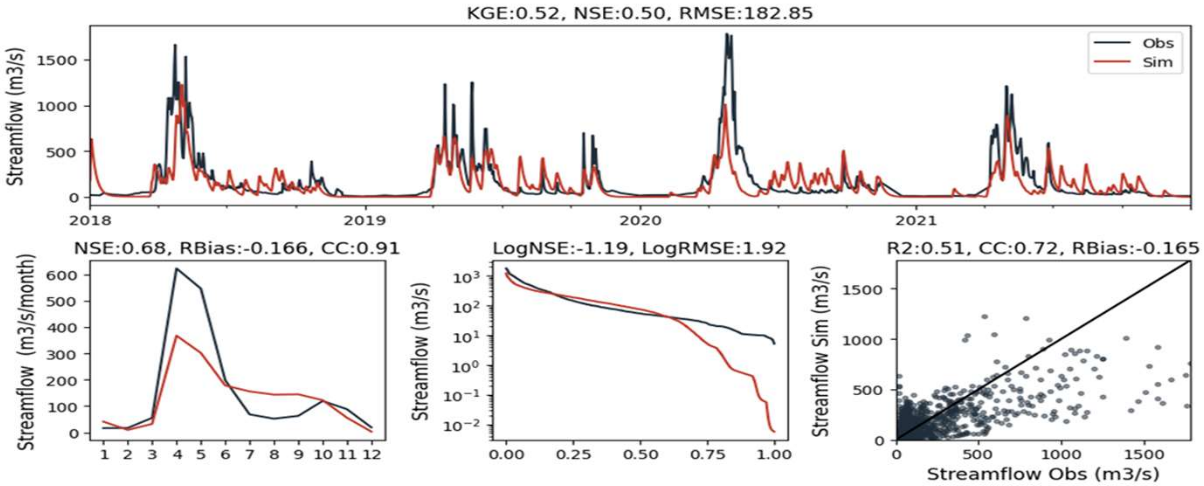
7.2 Development of methods for river runoff formation in the studied catchments of the East Kazakhstan Region

Developed water discharge prediction models for the river basin using LSTM based on a spatially distributed grid of input data.

The results of this approach show high consistency with the observed streamflow in the Uba River basin, demonstrating the effectiveness of using spatially distributed data in a basin dominated by snowmelt.



Automatic calibration of the HBV model parameters for the Uba River.



Automatic calibration of the GR4J model parameters for the Uba River.

7.2 Development of methodologies for river runoff formation in the studied catchments of East Kazakhstan Region

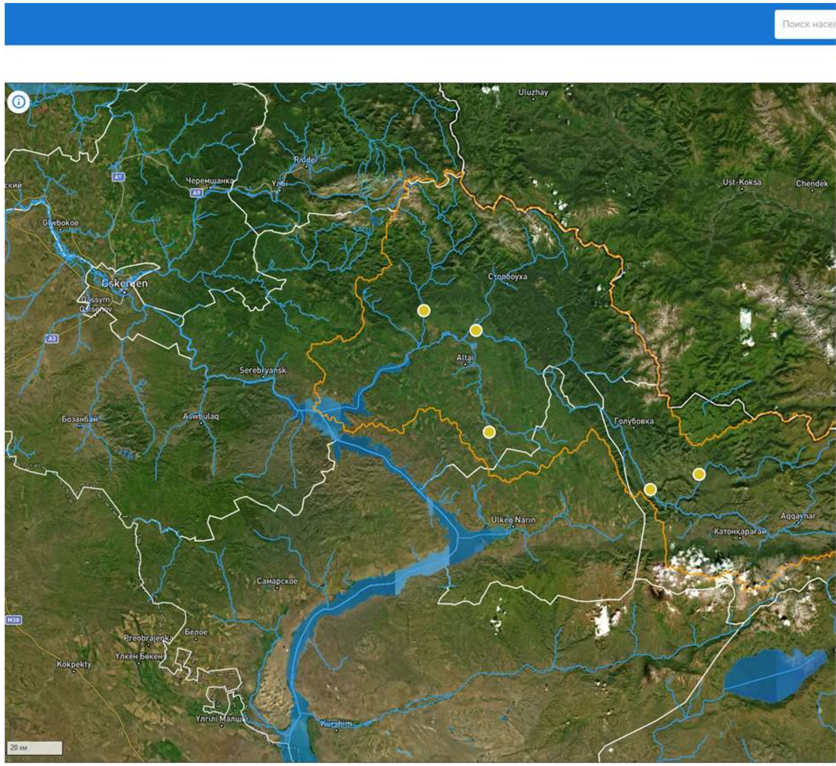
River runoff formation models were developed based on GR4J (Génie Rural à 4 paramètres journalier) and HBV (Hydrologiska Byrå Vattenbalansavdelning).

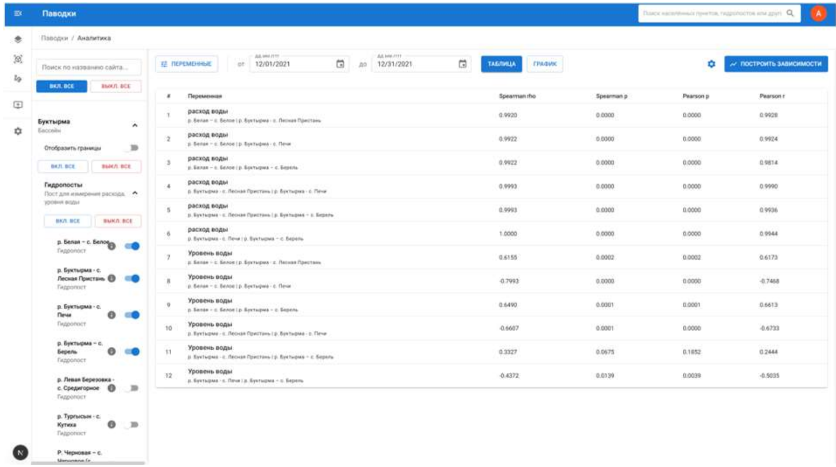
As a result of the calibration comparison between the HBV and GR4J models, it was found that both models demonstrate a comparable level of performance under conditions of limited data for the Uba River catchment upstream of Shemonaikha.

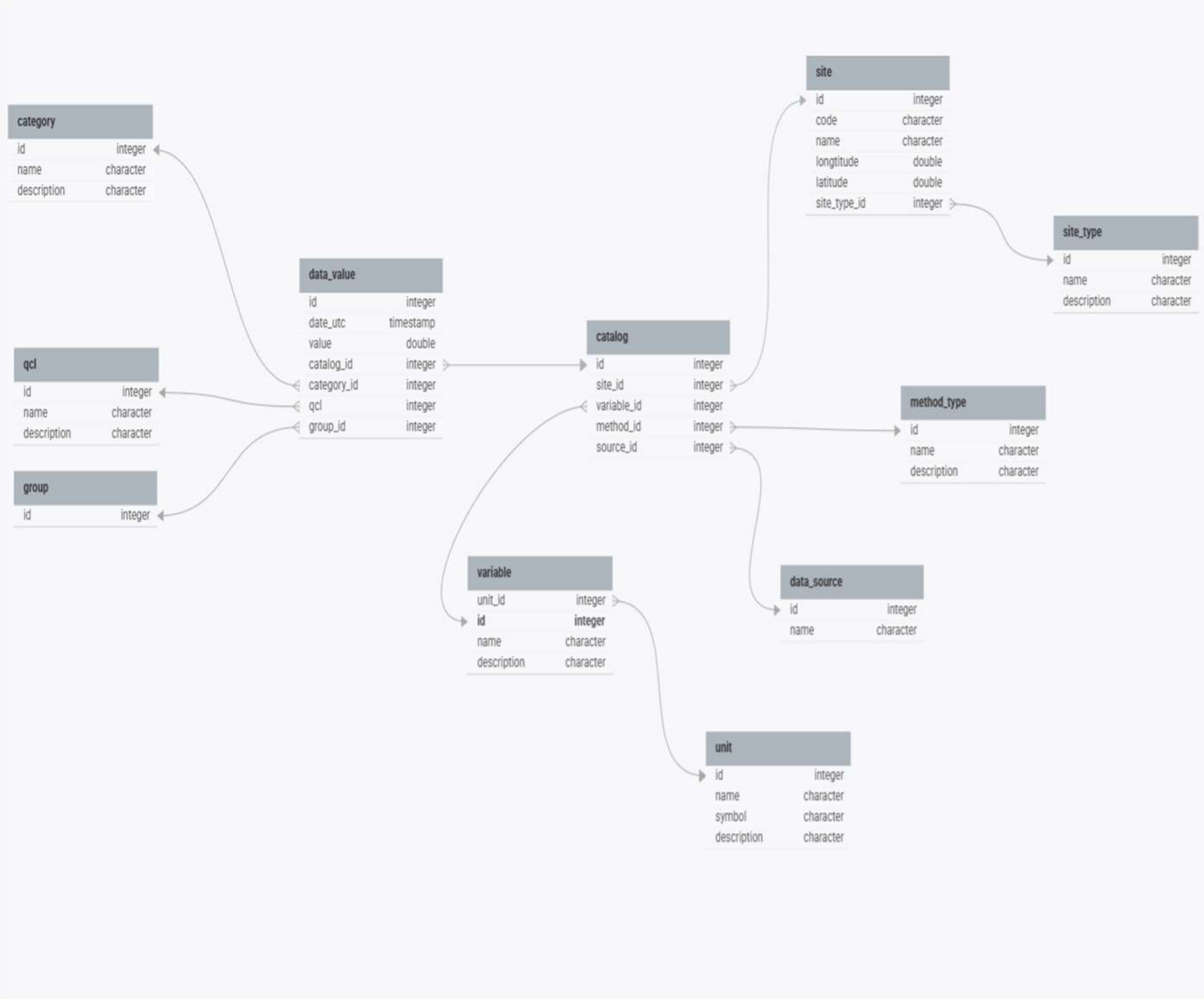
8

Development of a harmonized database and GIS framework

№	Title of Works under the Agreement and Main Stages of Implementation	2024	2025	2026
8.1	Conceptual Design of the Georelational Database	100%	-	-
8.2	Database Population	-	80%	-
8.3	Design of the GIS Service Architecture	-	90%	-
8.4	Development of a GIS service providing access to flood scenario modeling	-	-	



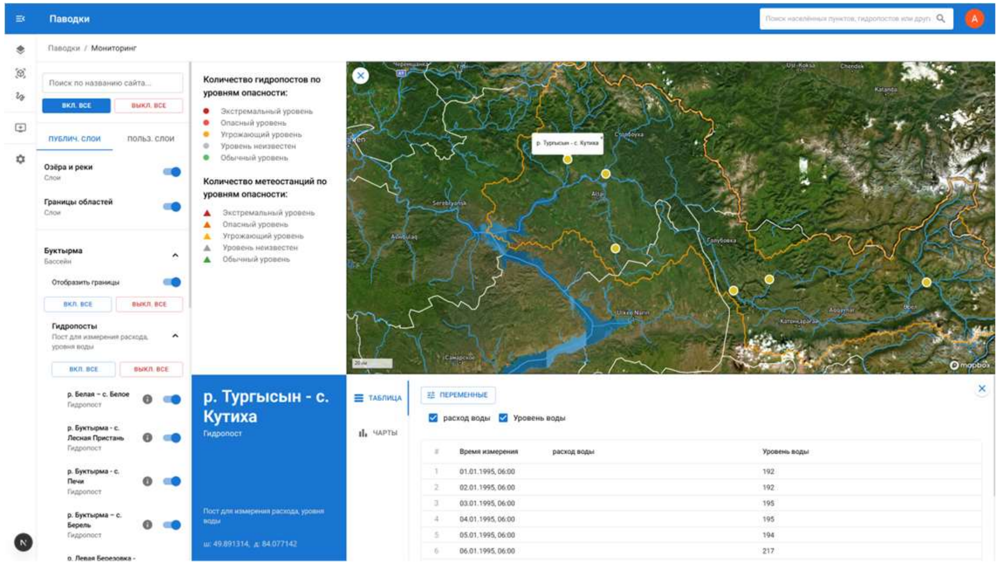


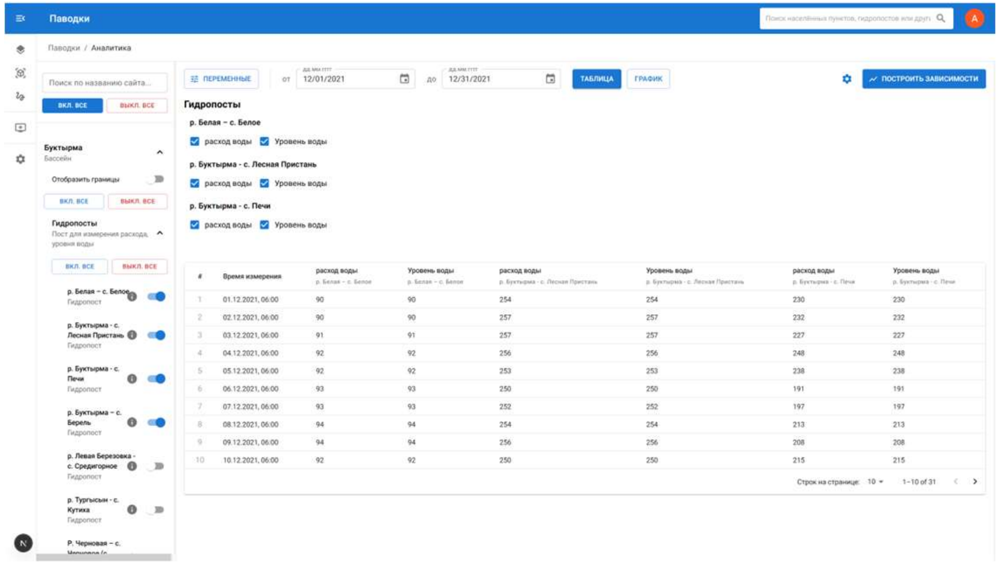


8.1 Conceptual design of the georelational database

A conceptual georelational database model of water resources in East Kazakhstan Region has been developed based on the Observation Data Model (ODM).

PostgreSQL with the PostGIS extension, providing geodata support and geospatial analysis capabilities, was used for implementation.



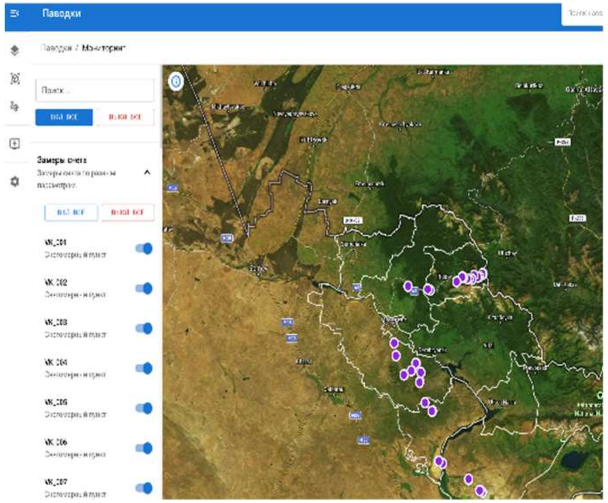


8.2 Database population

Structured loading of snow survey data and hydrological station data for East Kazakhstan Region into the georelational database has been performed.

The database contains 800,000 observation records, including the following parameters:

- Water discharge and water level at hydrological stations
- Snow depth along the river, snow depth at snow gauges, and snow weight at snow gauges



Thank you for your attention

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https://flood.astanait.edu.kz