

NON-TECHNICAL SUMMARY

1. Context

Central Asia, characterized by an arid climate and limited water resources, is facing growing challenges driven by climate change, population growth, and increasing pressure on natural ecosystems. These changing conditions, combined with inefficient water use, have reduced irrigation efficiency and accelerated land degradation. As irrigated agriculture is the largest consumer of water in the region, there is an urgent need to revise outdated irrigation norms and better account for the spatial variability of soil and climatic conditions.

Improving water-use efficiency in the agricultural sector has therefore become not only a regional priority but also a prerequisite for sustainable socio-economic development. Achieving more effective water management requires a comprehensive approach that combines institutional measures with the application of modern, science-based technologies.

Particular importance is attached to considering local soil and climatic conditions, as well as irrigation methods and scheduling, when planning water use. Such an approach aims to optimize water consumption, increase agricultural productivity, and reduce water losses. Under increasing climate pressures, it also strengthens the resilience of agricultural production while promoting the sustainable use of scarce water resources.

The project "Correction of Hydromodule Zoning in the Syr Darya River Basin Using Remote Sensing and Satellite Mapping Technologies to Improve Agricultural Water Demand Estimates and Irrigation Scheduling for Crops Cultivated in the Region" is being implemented on irrigated lands in the Turkestan and Kyzylorda regions of Kazakhstan, as well as on irrigated lands in the Fergana Valley within the Andijan, Namangan and Fergana regions of Uzbekistan.

2. Objective of the project

The goal of the project is to adjust the boundaries of hydromodular zoning (HMZ) and develop recommendations on irrigation standards and regimes for major agricultural crops using remote sensing (RS) and geographic information systems (GIS) technologies.

planning (HMP) is a division of a territory into zones with uniform water consumption characteristics, taking into account the complex influence of climatic, soil-hydrological, and agronomic factors, including the mechanical composition and hydrophysical properties of soils, groundwater depth, crop types, and crop rotation structure. This approach allows for the determination of the optimal volume of water resources required by each zone and the scientifically sound development of irrigation regimes.

Traditional methods for determining water consumption rely heavily on weather station data and averaged water consumption coefficients. These approaches fail to account for spatial variability in water use within a single hydromodule and do not allow for the rapid assessment of the efficiency of water resource allocation. Remote sensing methods provide spatially disaggregated data on evapotranspiration—the total water consumed by evaporation from the soil and transpiration by plants—which accurately reflects the actual water consumption of vegetation.

The last large-scale work to establish hydrometeorological parameters was conducted in the 1980s and no longer reflects the significant changes that have occurred in recent decades. During this period, climatic conditions, farming systems, the state of drainage infrastructure, the characteristics of cultivated crops, cropping patterns, and hydrological parameters, including groundwater levels, have undergone significant transformations.

In today's environment, hydrometeorological management should be viewed as a flexible and adaptive tool for water and land resource management, capable of taking into account both current and projected changes in natural and economic factors. Adjusting and refining irrigation standards and regimes based on current data and modern technologies is essential for improving the efficiency and sustainability of irrigated agriculture.

3. Methodology

The project applies an integrated approach that combines remote sensing, field observations, and GIS technologies. This combination provides objective and spatially detailed information on irrigated land conditions and actual water use.

Satellite imagery is used to assess vegetation conditions and soil moisture. The SEBAL model is used to determine the actual water requirements of agricultural crops. (*Surface Energy Balance Algorithm for Land - the algorithm is based on energy balance: the energy driving the hydrological cycle is equal to the incoming energy minus the energy used to heat the soil and air, and the energy reflected back into space*), which is used to calculate evapotranspiration.

Hydromodule zone boundaries are updated using current cartographic data, including administrative boundaries, within a GIS environment. Ground-based information is integrated by overlaying two key spatial datasets: soil texture and groundwater depth, allowing accurate delineation of hydromodule zones and revision of irrigation norms and schedules.

Satellite-based assessments are complemented by field surveys and measurements at representative sites to validate the results and improve their reliability.

The project also incorporates climate change scenarios, taking into account projected increases in air temperature and changes in the regional water balance. This enables irrigation recommendations to be adapted to future climate conditions, thereby enhancing the long-term resilience of agriculture in the region.

4. Expected results and practical benefits:

- Updated Hydromodule Zoning Maps and an Interactive Digital Map that identify irrigation zones based on climatic, soil, and hydrological conditions. The interactive platform will allow regular updates and facilitate adaptive irrigation planning.
- Practical Irrigation Recommendations tailored to local soil and climate conditions. These recommendations will promote water-saving irrigation practices, help prevent land degradation, and improve the efficiency and sustainability of irrigated agriculture.
- Integrated Database containing harmonized information on soils, water resources, climate, and irrigated lands. The database will support future monitoring, planning, and evidence-based water management.