SUBJECT: THE MELIORATIVE-ECOLOGICAL STATE OF IRRIGATED LANDS IN THE FERGANA VALLEY AND PROBLEMS OF WATER RESOURCE UTILIZATION

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Abstract: This work is dedicated to studying the current water-meliorative state of the Fergana Valley and the impact of anthropogenic factors on the region's geoecology. The article analyzes the principles of hydromodule zoning in multi-layered soil-ground conditions and the problems associated with determining irrigation norms. The main focus is directed toward the impact of developing *adyr* (foothill) zones on lower landscapes, specifically regarding changes in the groundwater regime and issues of groundwater pollution. Research results indicate that traditional irrigation methods and the uncontrolled use of drainage waters are leading to soil degradation and irrigation erosion. The paper also assesses the ecological risks of hydro-technical facilities planned in Central Fergana (reservoirs on plains) and provides conclusions on sustainable water resource management.

Keywords: Fergana Valley, hydromodule zoning, meliorative state, groundwater, *adyr* landscapes, irrigation erosion, Sokh underground water reservoir, soil degradation, water-saving technologies.

Introduction: Under current conditions where water resources are limited, the increasing demand for water necessitates a review of several issues related to water use, particularly irrigation. It is known that the majority of water is consumed by irrigation. Irrigation norms are determined based on the water requirements of plants, soil properties, and climatic indicators within a hydromodule zone, considering its specific conditions.

Hydromodule Zoning and Soil Characteristics: Hydromodule zoning is carried out based on the thickness of the fine-earth soil layer, the mechanical composition (texture) of the soil, and the depth of the groundwater table.

- **Zones I, II, and III:** These consist of soils with a thickness of up to 50 cm developed on pebble deposits and bedrock in automorphic meliorative conditions, as well as soils with a thick sand layer.
- **Zones IV and V:** Formed in semihydromorphic (mesohydromorphic) and mesoautomorphic conditions, Zone IV consists of soils with light mechanical

composition and a thick fine-earth layer, while Zone V consists of those with heavy mechanical composition.

- **Zones VI and VII:** These are assigned to hydromorphic soils under the moderate influence of groundwater.
- **Zones VIII and IX:** These consist of soils in conditions of excessive moisture with a groundwater table higher than 1 meter. Their meliorative state is considered very poor. Such areas are transferred to other zones only after serious meliorative improvement measures are implemented.

The soil properties within each hydromodule zone vary across a wide range. The absorption, retention, and return of water applied for irrigation depend on the soil's water-physical properties, soil compaction, and lithological structure. In this sense, the indicators underlying hydromodule zoning are characteristic of soil-grounds that are homogeneous in mechanical composition.

However, the main part of the irrigated areas is located on alluvial and proluvial plains. A characteristic of the lithological profile of these areas is their multi-layered nature regarding mechanical composition. In multi-layered soil-grounds, water properties and water regimes differ sharply from those in homogeneous soils. Soil water permeability deteriorates; the water permeability of multi-layered grounds is very low, field moisture capacity varies across layers, and water release when moving from one layer to another is unsatisfactory.

These noted properties also depend on the arrangement of layers in the profile of multi-layered soil-grounds. Moisture in fine pores (capillaries) cannot pass into large pores, or conversely, fine pores absorb moisture present in the voids of large pores. That is, the fine capillaries of loamy and clayey layers absorb water from sand and loamy sand layers; in the reverse situation, water movement slows down significantly.

In many parts of Central Fergana, layers containing *arziq* (hardpan), gypsum, and *shokh* are found, which possess high density, very low porosity, and extremely poor water permeability. These are often located in the main nutrition zone of plant roots. Under these conditions, it is recommended to reduce the irrigation norm and increase the irrigation frequency. In practice, however, crops are either under-watered or, conversely, suffer from excessive vegetative growth. *Berch* and marl layers also affect irrigation quality.

In short, there is a necessity to determine irrigation norms and timing for agricultural crops by taking into account the lithological structure and soil properties of the soils constituting the hydromodule zone.

Irrigation Methods and Ecological Consequences: Furrow irrigation of crops is a very ancient, tested, and reliable method. However, this method consumes a large amount of water. According to data, more than 40 percent of the water supplied for irrigation in the provinces of the Fergana Valley flows into the Syr Darya as discharge and drainage water. Irrigation erosion is widespread in irrigated tracts. This method cannot be used at all on *adyrs* and sands. We have outlined its negative consequences below.

Transitioning to a water-saving, discharge-free irrigation system is a requirement of the times; it is also necessary to regulate irrigation, i.e., to carry it out based on a strict schedule and for a specific duration. The time has come to implement progressive methods such as subsoil, drip, and sprinkler irrigation, as seen in developed countries. True, implementing these methods is difficult and requires significant funds, but their use is very convenient, economical, and effective.

Regional Problems: Adyrs and Groundwater: Let us now examine the problems that have arisen in connection with irrigation. The development of the *adyrs* surrounding the Fergana Valley on all sides for irrigation has caused a rise in groundwater levels, as well as an intensification of waterlogging and salinization processes in areas located lower hypsometrically. This phenomenon can be observed in the *adyr*-foothill lands of the Besharyk, Uzbekistan, Rishtan, Kuva, and Marhamat districts.

For a single example: in the Rishtan district, the groundwater level rose from 12–15 meters in the 1970s–80s to 0.5–1 meter by the eve of the 90s and thereafter. The cause of this was the development of lands in the Burgandi massif of the neighboring Osh province. In the Yormozor depression, the groundwater table rises to the surface during the vegetation period.

The development of *adyr* lands has intensified over the last 20 years. The majority of lands were developed unofficially, without projects, and without taking into account the relief and soil conditions of the territory. As a result, technogenic disturbance of lands, erosion, and gully formation processes have intensified significantly. Places where the soil cover has been washed away, exposing bedrock, can be frequently encountered.

Pollution of Underground Water Reservoirs: Developing *adyr* lands and the upper parts of alluvial fans is very dangerous, especially in areas possessing underground water reservoirs. As a result of the short-term operation of the Yangi Kokand Chemical Plant built on the upper part of the Sokh alluvial fan, the waters of the Sokh underground water reservoir existing in this area were heavily polluted. It has been nearly 30 years since the plant stopped operating, but the zone of polluted water, though reduced, still remains.

Currently, more than 20,000 hectares of land have been developed in this area. Various chemical substances used in growing agricultural crops are playing a serious role in contaminating groundwater. The high filtration indicators of the pebble deposits constituting the alluvial fan and the absence of a filtering layer created conditions for the rapid pollution of groundwater. Consequently, the quality of the waters of the Sokh underground water reservoir, considered unique, deteriorated, and pollution rose to a certain level.

Sandy Lands and Drainage Water Issues: There are nearly 80,000 hectares of sandy land in the Fergana Valley, the main part of which has been developed. Very large funds were spent on this work in its time, but the work done in this area did not justify itself.

Years ago, at the Fergana State Water Design Institute, strictly by order of the Ministry of Water Resources, research had to be conducted on the meliorative and economic situation that arose in developed sandy tracts. The research results were regrettable. Positive agronomic changes in the state of sands farmed for 30–40 years or more were very few. In most places, the sands remained as sand and did not turn into soil. However, in some areas where rice was planted chronically for many years and which were under grass vegetation, "loamification" was observed, i.e., an increase in physical clay particles in the mechanical composition. Currently, the meliorative-ecological state of sandy tracts is poor. The deflation process is proceeding strongly. Windbreaks have been destroyed in many places in the Koshtepa, Yozyovon, and Besharyk districts. Irrigation and collector-drainage systems are covered with sand, and most of them are in disrepair. In the Besharyk district, sands that were once stabilized and semi-stabilized are now deprived of vegetation and have turned into shifting sands.

I want to draw attention to another problem. Last year, I had occasion to see a large part of the irrigated lands between Besharyk and Boz. We encountered many places where irrigation water does not reach. There are quite a few areas where crops have not been planted for 10–15 years due to a lack of water. Water delivery branches are broken or disconnected. Some farmers who can afford it are extracting water from drains via pumps and growing cotton and wheat in limited areas.

It must be mentioned in its place that irrigating crops with drainage water is done out of necessity, but it is not expedient. The mineral composition of drainage water is magnesium-enriched. During irrigation, magnesium accumulates in the soil and enters the soil's absorption capacity in large quantities. As a result, magnesium salinization (solonetzicity) occurs, and fertility deteriorates.

Conclusions and Recommendations

The points stated above lead to the following conclusions:

1. Organization of development and irrigation works on *adyr* lands must be done by taking into account the consequences that may occur in hypsometrically lower landscapes.

2. Systematic monitoring of land and water resource utilization must be conducted on lands in agricultural circulation, or at least on specific parts thereof.

Many objections have been raised regarding reservoirs built and being built in the upper parts of mountain rivers. This is understandable. But what happens if a reservoir is built on the plain? What will be its consequence?. Specifically, what meliorative and ecological consequences might the reservoir being built in Central Fergana bring?. This reservoir is being built on the site of Sassiqkul or a filtration zone. The surface of the former lake was lower than the ground surface, causing waterlogging and salinization of the surrounding soils. The surface of the future reservoir will be higher than the ground surface. Even if there is an anti-filtration coating under the reservoir, there is no guarantee that water will not seep through. Waters seeping under hydrostatic pressure may cause a rise in groundwater in the lands surrounding and below the reservoir, intensifying waterlogging and salinization processes. The problem is very serious; the consequence of not fully studying and considering it may be very negative in the not-so-distant future.

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