TEMPERATURE OF GROUNDWATER SOURCES AND THE EFFECTIVENESS OF ENVIRONMENTAL EFFECTS ON PRODUCTIVITY OF GRAIN CROPS.

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Abstract. *Low groundwater temperatures lead to longer plant growth periods. For example, the growth and development of cotton and grain are delayed by 7-15 days. All this ultimately affects the yield and quality of the agricultural crop, the ripening period of its fruits. In turn, the low-temperature water-air soil environment of the aeration zone, of course, does not ensure the timely dissolution of natural and artificial nutrients and fertilizers and does not allow their timely full assimilation by plant root systems. Under such conditions, some of these nutrients sink under the influence of falling currents of cold water and mix with groundwater. On the other hand, a cold aquatic-airy soil environment of 14–18 C° is detrimental to cotton, significantly reduces the rate of growth and development, and exposes it to various diseases. All this ultimately affects the yield and quality of the agricultural crop, the ripening period of its fruits.*

Introduction

The intensification of agricultural production and an increase in the productivity of the agroecosystem in various zones of our country require a deep comprehensive study of a complex dynamic system of natural conditions and the establishment of quantitative values for the parameters of the functional dependence of soil fertility in each zone on a complex of natural processes, as well as factors caused by active human activity. This is especially important for mountainous countries, such as, for example, the territory of Tajikistan, where climatic conditions are very variable both in time and space. These conditions, together with the well-known distinctive features of a complex of interrelated physical, geographical and hydrological factors, in particular, in the South Tajik region, led to the formation of special agro-climatic and hydro-reclamation regions of the arid zone, which differ significantly from other cotton-growing regions of Central Asia. In this, a significant role is played and will be played by the regulation of the flow of the river. Vakhsh Nurek and Rogun reservoirs, which has led and will lead to a certain change in hydrological, hydrophysical, hydrophysical, hydrothermal characteristics in the flat part of the river basin.

The Amu Darya River, called the Oxus in the ancient Greek period, begins in Tajikistan as the confluence of the Pianj River (which begins in Afghanistan and forms its border with Tajikistan for several hundred kilometers) and Vakhsh River (which begins in the Kyrgyz Republic). The Amu Darya basin – 534.700 square kilometers in all unfolds westward from the mountains of the Kyrgyz Republic and Tajikistan, descending and contracting into the Karakum Desert of Turkmenistan and Uzbekistan as the river arcs gradually clockwise to the southern end of the Aral Sea, a total distance of 2.400 kilometers. The river splits into a delta with numerous arms as it approaches the Aral Sea. But in dry years since the 1960s, its waters, exhausted from diversion for irrigation, do not reach the sea (Figure 1).

Near the river's entrance into Turkmenistan, the Soviets built the Karakum Canal, the longest such structure in the world that takes a third of the Amu Darya's water and sends it to the parched southwestern parts of Turkmenistan to irrigate expanding cotton-growing areas.

Various other transboundary rivers, including the Pamir, Kafirnigan, Surkhan Darya, and (formerly) Zarafshan rivers, flow into the Amu Darya basin. All the rivers in the basin influence the system to some extent. Some of the Pianj River's water, for example, is diverted for irrigation. Its catchment includes the dangerous Sarez Lake, described below. On the Vakhsh River in Tajikistan, the planned extension of a mining and aluminum processing plant in Tursunzade could have repercussions on users downstream, not least because a large reservoir is needed for hydropower to run the plant. As the Amu Darya travels through Turkmenistan and then Uzbekistan, it receives returned water from irrigation and groundwater, which add pollutants from agriculture (pesticides and fertilizer), industry (toxic chemicals), and domestic sources. Health problems from drinking the water are common. Soil erosion from upstream countries causes sediments to build up downstream along the river and Karakum Canal, and almost complete silting up of the Kalif lakes.

The average capacity of the canal and the reservoirs on the river has fallen by more than half as a result. The sediments also damage irrigation infrastructure. The new Zeid reservoir is expected to take up much of the sedimentation in the Karakum Canal. But there are other issues: parts of the canal have not been maintained and huge losses from seepage and leakage occur; also the flood approach to irrigation results in salinization of the soil and returned water to the canal.

In February 1911, an earthquake shook the Murgab River valley in the East Pamir mountains in what is now Tajikistan. Giant rock masses hurtled down mountain slopes, blocking the Murgab River with a 5-kilometer wide, 200-meter-high natural dam (Usol Dam)–Lake Sarez was born. Central Asia is home to several rock-dammed lakes of which Sarez is the largest. Ominously, the waters of Sarez are constantly rising. Recent reports suggest its volume is approaching 16 billion cubic meters and growing steadily. This poses incredible danger. The lake's growing size–which builds pressure behind the dam–and the area's highly seismic nature create devastating potential. The canyon surrounding the lake is eroding at an annual rate of 30–40 meters, and seepage through the dam has significantly increased. Should a debacle occur, a catastrophic flash flood would roar down from the lake's 3.200-meter height, engulfing 70.000 square kilometers and 6 million people in Tajikistan, Turkmenistan, and Uzbekistan. To minimize this risk, the Government of Tajikistan, with the aid of international donors, has launched a safety program. It includes a monitoring and early-warning system that came on line in 2005 (Figure 2).

Materials and Methods

It should be noted that the whole complex of agro and hydrophysical, chemical-biological and other soil-hydrological factors, which was the main physiological essence and productivity of plants, is inextricably linked with the nutrient regime of the root-inhabited soil layers. As a rule, the process of formation of the optimal nutritional regime and its further effective assimilation by the plant fundamentally depends on the optimal thermal, water-air regime of the soil. However, in arid zones, under conditions of irrigated agriculture, especially in cotton growing, the optimality of the thermal, water-air regime is determined by anthropogenic impact based on the results of long-term targeted laboratory experiments and large-scale scientific and industrial research [4–6].

In turn, the low-temperature water-air soil environment of the aeration zone, of course, does not ensure the timely dissolution of natural and artificial and artificial nutrients and fertilizers, and prevents their complete timely development by the root systems of plants. Under these circumstances, part of these nutrients, under the influence of downward currents of cold water, sinks down and mixes with groundwater. On the other hand, a relatively cold water-air soil environment of 16–20°C for cotton has a detrimental effect, significantly reducing the rate of growth and development, exposing it to various diseases. All this ultimately affects the yield and quality of raw cotton, the duration of the ripening of its fruits [7–9].

These problems turned out to be very poorly studied in cotton growing in the mountainous conditions of Tajikistan, and this includes the regions of the Kyrgyz Republic. Thus, before agricultural sciences, especially before agrophysics and soil hydrology in general, ameliorative hydrogeology and agroamelioration of irrigated agriculture, a new task arises to develop effective methods for managing the water-salt, nutrient and thermal regimes of fertile soils of intermountain depressions and foothills in the early vegetation period, which essentially determine the further growth and development of the plant, the timing of the ripening of cotton fruits and the quality of raw cotton [1, 10].

In this regard, the development of science-based measures for the development and improvement of hydro-reclamation, agro-physical and agro-technical foundations for the integrated regulation of plant life factors, a comprehensive analysis and justification of design developments, the reconstruction of the system of integrated reclamation of irrigation and land cultivation methods are especially important in cotton-growing areas of a mountainous region with heavy and structurally unstable soils.

In determining the agro-climatic and hydro-reclamation features of irrigated lands in a mountainous region, the decisive place should be occupied by the heat balance of the aeration zone, the assessment of thermal resources and the water-salt regime of fertile soil layers, taking into account the temperature regime of irrigation soil and ground waters and the relationship of these factors with solar radiation factors, the temperature of the day surface of the soil and the surface layer of air. It is also important here to assess the hydrothermal resources of mountain rivers and reservoirs of the main canals and the on-farm irrigation network; dynamics of the thermal regime of irrigation canals along the length, irrigation water at the entrance to the field, its temperature regime when moving along the furrow in various relief conditions of the irrigated massif and soil classification [3. 11].

Results and Discussion

This paper discusses the issues of assessing the water resources of high-mountain reservoirs, in comparison with lowland reservoirs; hydro-physical, hydrological and reclamation characteristics of rivers when they are regulated by a high-mountain reservoir.

Field experiments are presented with the aim of studying the influence of the physicochemical and thermal properties of the irrigation water surface and groundwater on the dynamics of development and cotton yield in two farms in the Bukhara region, very close to the northern cotton-growing regions of Central Asia.

The main purpose of the experiment is to establish the influence of the thermal regime, salinity and sediment saturation of irrigation water on the vital factors of cotton and on the productivity of the irrigated field. The choice of these objects is not random. Firstly, these areas are quite remote from the influence of cool mountain reservoirs and cold glaciers, snowy mountains. Irrigation canal waters, as well as underground ones, are quite mineralized, but the temperature regime of surface irrigation sources differs significantly from the temperature regime of groundwater, since the thermal regimes of irrigation canals with distance from the mountainous terrain approach the thermal regimes of soils and soils of warm flat places. At the same time, we note that in a significant part of the South Tajik region, the temperature of groundwater is close to the temperature of the main canals and irrigation of various types, being relatively cool no more than 15–18°C and, thereby, sharply differs from warm (more than 24°C) surface waters of Uzbekistan and Turkmenistan.

Based on the foregoing, the topic of the dissertation work is modern and relevant, the main goal of which is the following. Based on the assessment and analysis of water resources, we conduct scientifically based development and pilot activities in order to improve and develop hydro-agrophysical methods of irrigated agriculture. It can significantly increase productivity cotton field by preserving and increasing the natural thermal resources of the fertile layers of the aeration zone of lands in the intermountain and foothill valleys of Tajikistan, as well as in other areas adjacent to low-temperature surface and underground sources of irrigation [12].

In this regard, in accordance with the well-known classification, the subject matter of this work, in terms of significance and degree of influence on agricultural production, can be attributed to class I research work. It attempts to generalize known studies and, on their basis and on the basis of our own research, develop proposals for improving the productivity of the cotton field in intermountain and foothill areas with an area of more than 300 thousand hectares adjacent to low-temperature (15–18°C) surface and underground sources of irrigation , as well as in areas where groundwater is used for irrigation with an initial temperature of 15–18°C.

The substantiation of the expediency and necessity of conducting theoretical, scientific, and industrial research on the proposed topic is connected with the phenomena and natural processes of anthropogenic origin, which we managed to analyze, generalize and systematize in the following order.

1. An analysis of the thermal regime of groundwater and the fertile regime of groundwater and the fertile soil layer of the Tower Valley shows [6] that over 50 years of development of the fertile lands of the valley for irrigation, the average temperature of the aeration zone compared to the temperature of the soil and soil in the early 1930s years, decreased during the growing season by

1.2–2.5°C. It in total resulted in the loss of natural thermal resources in the aeration zone of the Tower Valley lands from 300 to 400 °C.

2. According to preliminary computational experiments [6], the following phenomena take place in the South Tajik cotton-growing region:

if the temperature and depth of the groundwater level are, respectively, T = 15°C and l = 1.0 m, then the loss of natural thermal resources of the aeration zone in the 0.4–1 m layer for May–September is about 650°C;

if T = 15°C and l = 2.0 m, then the similar loss in the indicated layer is equal to 400 °C;

if T = 15°C and l = 3.0 m, then such a loss in the specified layer is 100–120 °C.

3. According to methodological recommendations [8], it is accepted to carry out pre-sowing irrigation on a large area of land in the Tajik Republic. Often this event is carried out in March and even in early April, where the irrigation water temperature is much lower than the soil temperature in the aeration zone. The negative side of these measures is that during these measures the loss of natural thermal resources in the 0.2–1.0 layer reaches 300–400 °C.

4. After the construction of the Nurek reservoir and its regulation of the flow, one cubic meter of water from the river. Vakhsh at the downstream of the Nurek dam, the amount of suspended sediments decreased by 25–30 times. As a result, 10–40 t/ha of mineral-rich solid runoff of the river ceased to flow into the irrigation network and irrigated field. Vakhsh irrigation water lost its clogging ability - it became transparent, 2.0–2.5 times the difference between the filtration rates of clean and turbid water through light loam columns was 6 times or more, for example [5, 7], the vertical penetrating ability of fresh water increased transparent water in the soil soils during irrigation. The latter phenomenon led to an increase in the volume of waterfalls by 1 ha. In addition, in March-May, the temperature of clear irrigation water decreased by 1–1.5 °C (by 15–20%) compared with the period before the river flow regulation. In addition, at the height of the irrigation season (June-August), Vakhsh water is taken from the reservoir from a depth of 50 m, where the water temperature is not higher than 10°C. As a result, both in the northeastern part of the Tower valley and in large areas of the Yavan-Obikiik and Dangara valleys, a significant rise in the level of groundwater and saturation of the aeration zone with relatively cold water occurred. It also led to the loss of a significant amount of thermal resources in the fertile layers of the aeration zone. Irrigated lands in the region reduce the dissolving ability of irrigation water in relation to mineral fertilizers and other nutrient biochemical components of the soil and slow down their digestibility by the plant. In particular, all these factors can be the cause of

the disease and a decrease in the growth and development of cotton, a delay in the ripening of bolls, and a decrease in the quality of raw cotton [7, 12, 19, 20].

With the existing technology of furrow irrigation, for example, in the Tower valley with the number of 6–8 irrigations the total irrigation rate is 12–14 thousand m³ ha during the growing season and the duration of one irrigation is up to 2–3 days (currently this period has increased to 3–4.5 days) for 15–20 days the cotton field is under continuous influence of low-temperature irrigation water. In particular, in the northeastern part of the Kurgan-Tepa region, its temperature is 15–19°C and during the irrigation period (June-August) the total loss of natural thermal resources in a layer of 0.2–1.0 m is 200–300°C. It should be noted that at a very high temperature of the soil surface in the daytime (45–60°C and more) and a low temperature of groundwater (16–18°C), enormous forces arise in the thickness of the aeration zone associated with a temperature drop (gradient), the value of which per 1 m in summer reaches 35–45°C. This force, which we call gradient effect, has a significant negative impact on the dynamics of growth, development and other physiological parameters of cotton.

Conclusion

According to the data of physiologists and agro-physicists, the optimum soil temperature at which cotton seeds begin their growth is 13–16 °C. However, during the period of fruiting and ripening of the bolls, the optimum soil temperature (in a layer of 0.1–0.4 m) should be at least 24–30°C. Further, as established by physiologists, for every 100°C loss of thermal resources during the growing season (especially at the beginning of the growing season), there is a loss of 100 kg of cotton per 1 ha, while the ripening period of the bolls is extended to two days.

Thus, within the framework of the existing technology of irrigated agriculture and cotton cultivation, both in intermountain and foothill areas, and in other areas adjacent to both low-temperature underground and surface irrigation sources, the loss of cotton yield (primarily fine-fiber varieties) reaches 4.5–6, 5 p/ha. And the time interval for the ripening of fruits (bolls) is extended by 1–2 weeks, which also leads to a decrease in the quality of raw cotton and a significant loss of yield in rainy late autumn.

These conclusions, obtained by us on the basis of generalization of theoretical premises and calculations in various areas of agricultural sciences, are confirmed by our scientific and production research in specific cotton-growing areas, the results of which we tried to substantiate with appropriate methods of mathematical modeling [1–24].

REFERENCES

1. Sattarov M A 1985 Prevention of heat loss in the soil during irrigation from low-temperature irrigation *Inf. sheet Tajik NIINTI* 33-85
2. Sattarov M A 1985 Assessment of the hydrophysical characteristics of the Nurek reservoir and the reclamation state of the lands of the mountain river basin *Inf. sheet Tajik NIINTI* 103-105
3. Olimov Kh Kh, Juraev A N, Imomov Sh J, Orziev S S, Amrulloev T O 2021 Application of energy and resource engineering software in cotton fields *IOP Conf. Ser.: Earth Environ. Sci.* 868 012067
4. Central Asia Regional Economic Cooperation (CAREC). Water Resources. International Union for Conservation of Nature (IUCN), the International Water Management Institute (IWMI), the Ramsar Convention Bureau, and the World Resources Institute (WRI). 2003. Watersheds of the World, available at: http://multimedia.wri.org/watersheds_2003/index.html
5. Sattarov M.A. Features of the water-thermal regime of soil soils in foothill and intermountain valleys adjacent to low-temperature sources of irrigation. Izvestia A.N.Taj. SSR. Department of Physical and Mathematical Sciences, Chemical and Geological Sciences. 1985. No. 4, 33-35 pages.
6. Akhmedov Sh.R. Modular study of the influence of thermal effects of irrigation sources on the productivity of a cotton field. Dissertation for the academic senior Ph.D. Tashkent 1991 pages.
7. Akhmedov Sh.R. Study of the dynamics of growth and productivity of cotton by the method of mathematical modeling. Proceedings of the International Scientific and Practical Conference Mathematical Problems of Technical Hydromechanics, Theory of Filtration and Irrigated Agriculture. Dushanbe 2008, p.4-7.
8. Urazkeldiev A.B. Chemical reclamation. Bukhara. 2011. 24-35 pages.
9. S. Abdullaev, X. Nomozov. Soil reclamation. Tashkent. 194-247 pages.
10. Nerozin A.E. Selskoxozyaystvennye melioratsii // Toshkent. 1980 -262-pages.
11. Juraev, F., Karimov, G. Water saving technique and technology of subsurface irrigation. IOP Conference Series: Materials Science and Engineering this link is disabled, 2020, 883(1), 012095
12. Hakimov Sh.H, Tursunov I.N, Yakkubov T. Buxoro viloyati sharoitida zamonaviy suvtejamkor sug'orish texnologiyalarini qo'llash (Buxoro viloyati Peshku tumani misolida). – 2 (2021) / ISSN 2181-1415.
13. Juraev, F., Karimov, G. Mathematical model of water absorption area in intensive garden irrigation from the ground. E3S Web of Conferences this link is disabled, 2021, 264, 01044.

14. Amanova Z. U. et al. WATER-SAVING TECHNOLOGY DEVELOPED BY "GIDROGEL" FOR IRRIGATION OF WINTER CEREALS // Agroprocessing. - 2020. - №. SPECIAL.
15. SR Akhmedov, XT Tuxtaeva, ZU Amanova, IN Tursunov, SH Hakimov, ...
16. IOP Conference Series: Earth and Environmental Science 1138 (1), 012034 1
17. KHUDAEV, I., & FAZLIEV, J. (2022). MODERN INNOVATIONS, SYSTEMS AND TECHNOLOGIES. Учредители: ООО" Сибирский Научный Центр ДНИТ", 2(2), 301-309.
18. Sarimsakov, M., Shaymanov, N. O., & Narbutaev, J. E. (2018). DETERMINATION OF SOIL MOISTURE DEPTH. *Irrigation and Melioration*, *2018*(2), 29-33.
19. Фазлиев, Ж., Тожиев, Ш., & Холиқов, Ш. (2023). СПОСОБЫ ЭКОНОМИИ ВОДНЫХ РЕСУРСОВ В САДАХ. In Uz-Conferences (Vol. 1, No. 1, pp. 520-525).
20. Khamidov, F. R., Imomov, S. J., Abdisamatov, O. S., Sarimsaqov, M. M., Ibragimova, G. K., & Kurbonova, K. I. (2020). Optimization of agricultural lands in land equipment projects. Journal of Critical Reviews, 7(11), 1021-1023.a