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FORMATION OF SURFACE WATER RESOURCES IN THE KASHKADARYA PHYSICAL-GEOGRAPHICAL REGION

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Abstract. This study is devoted to a comprehensive analysis of the formation, distribution, and management characteristics of water resources in the Kashkadarya physical-geographical region. The research examines the closed-basin nature of the territory, the main river and its tributaries, as well as their sources of recharge. It is substantiated that climatic differences between mountainous and plain areas significantly influence the formation of water resources. In addition, the role of reservoirs, main canals, and irrigation systems in the regional economy is thoroughly revealed. The impact of anthropogenic factors on both the quality and quantity of water resources is analyzed separately. The findings of the study contribute to identifying effective approaches for the sustainable use of water resources in the region.

Keywords: Kashkadarya, hydrology, water resources, closed basin, river flow, irrigation, reservoirs, climate, glaciers, precipitation, anthropogenic impact, main canal, water balance, groundwater, ecology, management.

The Decree of the President of the Republic of Uzbekistan No. PF-5418 dated April 17, 2018, “On Measures for the Radical Improvement of the State Management System in Agriculture and Water Resources,” as well as subsequent presidential resolutions, demonstrate that the Ministry of Water Resources and its subordinate water management organizations operate on the basis of the basin management principle. The structure of the Ministry includes the Ministry of Water

Resources of the Republic of Karakalpakstan and 12 Basin Irrigation System Administrations. Under these basin administrations operate 13 meliorative expeditions, pumping station and energy management departments, 49 irrigation system administrations, and 152 district irrigation departments. In addition, 7 main canal operation administrations, 3 machine canal operation administrations, main system administrations, administrations for protective dams and riverbed regulation structures, the Right Bank Collector Operation System Administration, reservoir operation administrations, 1,503 Water Consumers' Associations (WCAs), and a centralized communication and cadastre dispatch service were established.

Since the Kashkadarya physical-geographical region is one of the largest agricultural centers of Uzbekistan, the study and management of its water resources are of strategic importance. Due to the significant water scarcity in the region, this issue has long remained at the center of attention of hydrologists and ecologists.

V.L. Shuls is regarded as the "founding father" of the hydrology of Central Asian rivers, including those of Kashkadarya. In his work *"Rivers of Central Asia,"* the discharge and sources of the Kashkadarya River were comprehensively analyzed for the first time. O.P. Shcheglova studied the feeding sources of rivers (glacial, snow, and rainwater) and their distribution according to altitudinal zones.

Among modern Uzbek hydrologists, F.H. Hikmatov is considered a leading figure of the Uzbek hydrological school. He developed methods for calculating the runoff of mountain rivers within the Kashkadarya basin. A.D. Nazarov investigated the long-term variability of the Kashkadarya River discharge and the influence of climatic factors on it. G.X. Yunusov studied water resource management, hydrological forecasting, and the water balance within the basin. S.V. Myagkov mathematically modeled the impact of climate change on Kashkadarya glaciers and river runoff. M.H. Hamidov is a prominent scholar in water management and irrigation, who conducted research on improving irrigation technologies in the region. A.M. Arifjanov carried out studies on hydraulic engineering structures and water movement in canals. S.Sh. Mirzayev is recognized as the founder of the scientific school for the assessment and integrated use of groundwater resources in Uzbekistan and participated in compiling groundwater maps of the Kashkadarya oasis. N.X. Khojiboyev investigated the role of groundwater in the development of the Karshi Desert and the processes of salinization. Alongside studying Uzbekistan's water resources, these scholars also explored measures for addressing the problems of water scarcity.

The Kashkadarya physical-geographical region (or Kashkadarya depression) is located in the southern part of Uzbekistan and differs from other regions due to its closed-basin relief and distinctive climatic conditions. Geographically, the region has an "amphitheater-like" form, surrounded by mountains on three sides and adjoining extensive plains in the west. The Kashkadarya region is bordered by the

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Zarafshan Mountains in the north, the Hissar Mountains in the east and south, and the Sandikli and Kyzylkum deserts in the west, forming a unique closed basin.

The Kashkadarya region is considered a closed basin. This means that the main river of the region—the Kashkadarya River—does not flow into any sea or major river system (such as the Amu Darya), but instead dissipates within sandy areas and is largely consumed for irrigation purposes. The main river is the Kashkadarya River, with a length of 372 km. Its tributaries include Jinnidarya, Qorasuv, Oqsuv, Tamshush, Tankhozdarya, Sarito‘qay, Chilhazor, Qoranqo‘l, Qizildarya, Tirna, Langar, Yakkabog‘darya, Egrisuv, Katta O‘radarya, Kichik O‘radarya, and G‘uzordarya flowing from the east. The Orqapchig‘ay rivers are also included in this system. From the northwestern part, the Oyoqchi River and Govxonasoy River flow through the region. These rivers are primarily fed by snow and glaciers originating in the Hissar Mountains.

Kashkadarya is considered one of the regions of Uzbekistan with the highest number of sunny days, receiving an average of 2,800–3,000 hours of sunshine annually. Summer temperatures are extremely hot, dry, and prolonged. The average temperature in July ranges from +28°C to +32°C in the plains, while maximum temperatures in the Karshi Desert and around Muborak may rise to +45°C or even +50°C. Winters are relatively mild but unstable. The average January temperature ranges between 0°C and +4°C. However, during the intrusion of cold northern air masses, temperatures may drop to as low as –20°C to –25°C.

The Kashkadarya region differs from other regions of the Republic in that temperatures rise rapidly and summer begins early. The average temperature in January is around +2°C, and winters are generally not extremely cold. Summers in the region are very hot and extremely dry. In the latitudes of Chiroqchi District, the Karshi Desert, and the Nishon deserts, vast dry barren plains can be observed. In districts such as Muborak, Koson, and Yangi Nishon, winters are dry and cold. In contrast, districts such as Dehqonobod, Kitob, Shahrisabz, and Yakkabog receive more precipitation, and winters there are relatively mild.

The hydrological structure of the Kashkadarya physical-geographical region is closely connected with its relief. The region is mainly considered a closed basin, where rivers do not flow into the Amu Darya or other major basins but instead disappear within sandy areas.

The Kashkadarya River and Its Characteristics

The main water artery of the region is the Kashkadarya River.

- Source: The river originates at an elevation of approximately 2,960 meters from the western branches of the Hissar Range (Obikhanda Mountains), located on the border between Sughd Region of Tajikistan and Uzbekistan.
- Length: Approximately 372 km.

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- Flow direction: The river mainly flows from east to west and, upon reaching the Karshi Desert, divides into branches and dissipates in the sands. For this reason, it is considered a "blind river."
- Feeding sources: The river is mainly fed by snow and glaciers, and partly by rainwater. Consequently, the river level rises during May–June, which is the flood period.

Main Tributaries

Almost all major tributaries of the Kashkadarya River join it from the left side. These tributaries originate from the permanently snow-covered peaks of the Hissar Range.

Jinnidarya is a river located in Kitob District of Kashkadarya Region and is considered the first left tributary of the Kashkadarya River. It originates from the western slope of Shertog Mountain, which connects the Zarafshan and Hissar ranges, at an elevation of 2,500 meters. In its upper course, the river is called Zo'g'atasoy. The basin area covers 367 km², while the river length is 57 km. The Kitob State Geological Reserve is located on the left bank of the river. The river's name derives from its rapid and unpredictable flow, especially during spring floods.

Oqsuv is one of the most water-rich tributaries in the region. It originates from glaciers located at elevations of 3,400–4,000 meters on the western slopes of the Hissar Range. The river is approximately 154 km long, with a basin area of around 1,280 km². In its upper reaches, the river flows rapidly through narrow gorges, resulting in a very swift current. Tamshush, Hisorak, and many other streams flow into the river. Oqsuv is mainly fed by melting snow and glaciers, and its flood period is observed during June–July. The Hisorak Reservoir and Hydroelectric Power Station were constructed on this river.

Tanxozdaryo is an important mountain river flowing through the Kitob and Shahrisabz districts of Kashkadarya Region and is considered a left tributary of the Kashkadarya River. It originates from the Osmontorash Mountains, which are part of the western branch of the Hissar Range, at elevations above 3,000 meters. The river is 93 km long, and its basin area is approximately 460–470 km². The river is mainly fed by seasonal snow and rainwater. The flood period generally occurs between April and June. The word "Tanxoz" means "narrow valley."

Yakkabog'daryo is formed by the confluence of the Qizilsuv and Tirnadaryo rivers descending from the western slopes of the Hissar Range. The river is approximately 100–110 km long, with a basin area of about 1,180 km². It is mainly fed by snow and glaciers, and partly by rainwater. The highest water discharge occurs in June and July. Near the town of Yakkabog, the river divides into the Oqdaryo and Qoradaryo branches. The river plays a significant role in supplying water for agriculture.

Guzordaryo is an important river located in the southern part of Kashkadarya

Region and is significant for the region's economy and agriculture. The river mainly flows through the G'uzor and Dehqonobod districts. It is formed by the confluence of the Katta O'radaryo and Kichik O'radaryo rivers, which originate from the southwestern slopes of the Boysuntog and Hissar ranges. From the confluence point, the river length is approximately 86 km, while together with Katta O'radaryo it exceeds 160 km. The basin area exceeds approximately 3,170 km². One of the most important features of the river is that the Pachkamar Reservoir was constructed on it. The river is mainly fed by seasonal snow and rainwater, with the flood period occurring from April to June.

Numerous reservoirs have been constructed within the Kashkadarya physical-geographical region:

- Hisorak Reservoir — built on the Oqsuv River; one of the reservoirs with the highest dams, used for both energy production and irrigation.
- Chimqo'rg'on Reservoir — located on the Kashkadarya River; supplies water to the central part of the Karshi oasis.
- Pachkamar Reservoir — situated on the G'uzordaryo River; irrigates lands in the G'uzor and Nishon districts.
- Tallimarjon Reservoir — receives water from the Amu Darya River and is the largest hydraulic structure supplying the southwestern part of the region.
- Yangiqo'rg'on Reservoir — located on the Yakkabog'daryo River.
- Qalqama Reservoir — constructed on the Qumdaryo Canal.
- Langar Reservoir — situated on the Langar River.
- Other reservoirs include the Qorabog', Qamashi, and Dehqonobod reservoirs.

The natural water resources of the Kashkadarya River are insufficient to meet all the needs of the region. Therefore, the massive Karshi Main Canal was constructed to divert water from the Amu Darya River. Through this canal, water from the Amu Darya is lifted by pumps to a height of 132 meters and transferred into the Kashkadarya basin. With the help of the Karshi Main Canal, hundreds of thousands of hectares of virgin land in the Karshi Desert have been reclaimed and developed.

In the plain areas of the region, particularly in the Karshi Desert, groundwater occurs at considerable depths and is often saline.

Natural factors determine the potential quantity and seasonal distribution of water resources. The region is surrounded by the Zarafshan Range in the north and the Hissar Range in the east and southeast. Mountainous areas serve as natural "barriers" that retain moisture. The Kashkadarya River and its tributaries (Oqsuv, Tanxozdaryo, and Yakkabog'daryo) mainly originate from these mountains.

In the upper parts of the basin (mountain areas), annual precipitation reaches 1,000–1,200 mm, whereas in the lowland areas it does not exceed 200–300 mm. As a result, the rivers are primarily fed by snow and rainfall in mountainous regions.

The permanent glaciers of the Hissar Range function as natural "accumulators," supplying rivers with water even during the hottest summer months. However, in recent years, due to global warming, the area covered by these glaciers has been gradually decreasing.

Human activity plays a decisive role in altering the natural flow of water, redistributing water resources, and affecting water quality. Large reservoirs such as Chimqo'rg'on, Pachkamar, and Hisorak have been constructed to regulate river

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