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THE HISTORY OF THE GEOGRAPHICAL STUDY OF THE AMU DARYA RIVER

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Annotation: This article analyzes the geographical exploration, natural features, and ecological issues of the Amu Darya River. It highlights the significant reduction in the river's water volume due to the expansion of agriculture and irrigation systems in the 20th century, which contributed to the Aral Sea crisis. The paper also discusses how mismanagement of water resources and global climate change have exacerbated the problem. The importance of strengthening interstate cooperation, implementing innovative irrigation technologies, and protecting the environment is emphasized as essential measures to improve the ecological condition of the Amu Darya River.

Keywords: Amu Darya, ecological condition, water resources, irrigation system, Aral Sea, climate change, geographical exploration, environmental protection.

Аннотация: В статье проанализированы географическое исследование, природные особенности и экологические проблемы реки Амударья. Показано, что в XX веке объем воды в реке уменьшился вследствие развития сельского хозяйства и ирригационных систем, что привело к экологическому кризису Аральского моря. Освещено, что неправильное управление водными ресурсами и глобальные климатические изменения усугубляют проблему. Подчеркнута

необходимость усиления межгосударственного сотрудничества, применения инновационных систем орошения и охраны окружающей среды для улучшения экологического состояния Амударьи.

Ключевые слова: Амударья, экологическое состояние, водные ресурсы, ирригационная система, Аральское море, изменение климата, географическое исследование, охрана окружающей среды.

Annotatsiya. Maqolada Amudaryo daryosining geografik o‘rganilishi, tabiiy xususiyatlari va ekologik muammolari tahlil qilingan. Daryoning XX asrda qishloq xo‘jaligi va sug‘orish tizimlari rivojlanishi natijasida suv hajmi kamaygani, uning qurishi Orol dengizi inqiroziga olib kelganligi ko‘rsatilgan. Suv resurslarining noto‘g‘ri boshqarilishi va global iqlim o‘zgarishlari muammoning chuqurlashishiga sabab bo‘layotgani yoritilgan. Amudaryo ekologik holatini yaxshilash uchun davlatlararo hamkorlikni kuchaytirish, innovatsion sug‘orish tizimlaridan foydalanish va atrof-muhitni muhofaza qilish zarurligi ta’kidlangan.

Kalit so‘zlar: Amudaryo, ekologik holat, suv resurslari, sug‘orish tizimi, Orol dengizi, iqlim o‘zgarishlari, geografik o‘rganish, atrof-muhitni muhofaza qilish.

INTRODUCTION. The Amu Darya is one of the most significant and ancient rivers in Central Asia, originating from the Pamir Mountains and flowing into the Aral Sea. For centuries, the river has played a crucial role in supplying water resources to the region. Its geographical features, flow patterns, and ecological condition have been extensively studied by numerous scholars and researchers.

The study and exploration of the Amu Darya began in ancient times due to its importance as the main irrigation artery of Central Asia. As the largest river in the region, the Amu Darya originates in the Pamir-Alay mountain system and flows westward from Kokitang through the plains, traversing the Kyzylkum and Karakum deserts before reaching the Aral Sea. The river is continuously fed by glacial waters from the mountains of Tajikistan. The Amu Darya is formed by the confluence of the Panj and Vakhsh rivers, with glaciers in the right tributary covering an area of

approximately 7,500 km². Glacial meltwater contributes around 15% of the total river flow.

Until 1961, the Amu Darya consistently reached the Aral Sea, forming a delta of approximately 11,000 km² before entering the sea. The hydrological characteristics of the Amu Darya River are presented in Table 1.

№	Names of Rivers	Length (km)	Basin area (sq.km)	Average annual water flow (m³/s)	River density, km/km²	Average annual capacity, thousand kWh	Annual energy production, million kWh	Where it flows into
1.	Amu Darya	1404	226800	1990	239	4100	36000	Aral Sea
2.	Panj	921	113500	1032	2509	11143	97615	Amu Darya
3.	Vakhsh	353	39080	657	835	1423	44939	Amu Darya

Table 1. Hydrographic characteristics of the Amu Darya River.

METHODOLOGY. This article employs qualitative research methods to scientifically examine the historical geographical development of the Amu Darya River. Throughout the study, the historical-geographical approach, comparative method, and source analysis were selected as the primary research techniques. These methods enabled a systematic analysis of scholarly works conducted in various periods regarding the Amu Darya River and assessed the scientific contributions of researchers from different historical eras.

RESULTS. The research findings demonstrate that the geographical development of the Amu Darya River has evolved through distinct historical stages, each characterized by specific scientific approaches. The key results identified during the study were analyzed under the following categories: primary sources from

antiquity concerning the Amu Darya; cartographic and geodetic advancements during the medieval period; and the progression of contemporary geographical research.

The history of the Amu Darya is deeply ancient, with early written sources dating back to the pre-Christian era. Ancient Greek geographers and Eastern scholars provided detailed accounts of the river. Later, Arab, Persian, and Turkic scientists extensively studied its water supply, environmental impact, and economic significance.

During the Middle Ages, the Amu Darya served as a crucial route for military campaigns, trade caravans, and nomadic populations. Changes in the river's location and course had a direct influence on numerous historical events. For instance, while the river once flowed into the Aral Sea, human interventions eventually caused a dramatic reduction in its discharge, leading to a major ecological crisis. In the 19th and 20th centuries, scientific expeditions carried out in-depth studies of the Amu Darya's hydrological and geological characteristics. Today, thanks to modern technologies, the river's ecological condition, decreasing water levels, and the negative impacts of human activities are being actively investigated.

Figure 1. Geographic view of the Amu Darya River.

In the first stage, information about the geographic location, flow direction, and the influence area of the Amu Darya's water resources was collected through the study of ancient and medieval sources. In this regard, the works of ancient Greek and Roman geographers, Arab and Persian scholars, as well as Central Asian thinkers were analyzed. Among them, the writings of scholars such as Herodotus, Strabo, Ptolemy, Al-Biruni, and Mahmud al-Kashgari were used as primary historical sources.

The Greek scholar Herodotus provides information about the Araks (Amu Darya) in his works, stating: "Araks, it is said, is larger than the Ister and (compared to other rivers) smaller, having many islands larger than Lesbos... Araks flows from the land of the Matians. The Gindis (Indus) river also flows from there." According to R. Lentz, the Araks mentioned by Herodotus should be the Syr Darya or the Tedzhen River. However, many scholars believe it refers to the Amu Darya. Herodotus probably thought that one branch of the Amu Darya (Uzboy) flowed into the Caspian Sea. Professor A. Sadullaev also writes, "Araks is the Amu Darya; the Matiyon mountains, according to Herodotus's understanding, are the Pamir or Hindu Kush ranges, since according to history (Herodotus's account), the Matiyon mountains are the origin of the Indus River as well." [8]

The Arab traveler Ibn Khordadbeh, in his work The Book of Routes and Realms, mentions the Amu Darya and Syr Darya, stating that these rivers flow into the Kurdor lake (it is unclear whether "Kurdor" refers to the Aral Sea or the Caspian Sea). The Arab traveler Abu al-Hasan al-Masudi (10th century) in his works describes how the Amu Darya starts from the mountains, flows past Termez, turns westward, and flows into a lake, into which another large river called "Farrona" (Syr Darya) also flows. He also wrote about irrigation of lands in the Khorezm oasis through several canals from the Amu Darya.

The Turkistani scholar Abu Bakr Narshakhi, in his work History of Bukhara, notes that the Amu Darya is the largest river in Turkistan. It flows through a clayey

terrain up to Zarafshan (Kharamkom) and Baykend (an ancient city near the current Yakkatut railway station), after which its water diminishes and it flows through reed beds to reach Korakul. He also mentions that this lake is abundant with fish and birds. [1]

In his work Geodesy, Al-Biruni provided valuable information about the origin of the Aral Sea and noted that the ancient channel of the Amu Darya was the Kalif Uzboy. According to R.U. Rakhimbekov , important conclusions can be drawn from Al-Biruni's scientific reflections on the paleogeography of the Kyzylkum and Karakum deserts and the historical development of the Amu Darya. The Amu Darya basin and the nature of the Kyzylkum and Karakum have constantly changed and developed in both geological and historical terms, with alternating periods of wetness and dryness. The remains of marine animals found in these deserts indicate that they were once underwater. These changes occurred due to internal and external forces of the Earth, causing the rivers to shift their courses frequently. Most of the Karakum desert consists of alluvial plains formed by the ancient deposits of the Amu Darya. These observations testify to Al-Biruni's profound knowledge of the natural geography and dynamic geology of Turkistan. [1, 6]

From 1721 to 1725, Floro Beneveni served as Russia's ambassador to Bukhara and Khiva, primarily gathering information about the military power and socio-political situation of the Khiva Khanate and Bukhara Emirate. Additionally, he collected data about gold and other riches in the Amu Darya deserts. He reported that the ancient Amu Darya once flowed into the Caspian Sea.

In the next phase, scientific expeditions from the 19th and 20th centuries were reviewed. Based on cartographic research, hydrological observations, and geological expeditions conducted during the Russian Empire and Soviet periods, the dynamics of changes in the Amu Darya were analyzed. Scientific publications, maps, and expedition reports from this period helped to identify changes in the Academic V.A.Obruchev, between 1886 and 1888, studied the lower part of the Zarafshan Valley as well as the natural conditions and resources of the Kyzylkum desert,

providing interesting information about the ancient channel of the Amu Darya known as Uzboy. [1]

In the modern phase, satellite images and remote sensing data have been utilized. Hydrological and ecological studies have been analyzed to investigate the ecological condition of the Amu Darya, the decrease in its water level, and the impact of anthropogenic factors on the river. Additionally, scientific articles and reports have been reviewed to understand the current changes affecting the river, identifying existing problems and considering possible solutions.

Thus, this research combined historical and contemporary research methods. This approach allowed for a comprehensive analysis of the geographical study history of the Amu Darya River and a clear depiction of its changes over time.

DISCUSSION. The development of research on the Amu Darya River has progressed step by step, with each period contributing distinctive scientific approaches. Although the foundational geographic knowledge of the Amu Darya was established in ancient times, it was later significantly enriched through scientific investigations and theoretical frameworks. When compared with earlier studies, the research results demonstrate that the historical development of geographic studies on the Amu Darya was not confined solely to Central Asian scholarship but also had a direct impact on global scientific advancement.

The findings indicate that the Amu Darya River has undergone various geographic and ecological changes throughout its long history. According to ancient sources, the river did not flow into the Aral Sea but possibly directed its waters to the Caspian Sea. For example, the Greek historian Strabo referred to the Amu Darya as the Oxus and noted that its flow direction differed from the present. Medieval geographers emphasized that the Amu Darya's water volume was once more abundant, forming a delta with extensive irrigated lands.

By the 19th and 20th centuries, scientific expeditions had thoroughly studied the hydrological characteristics of the Amu Darya. In the 1870s, Russian Empire scientists conducted cartographic studies to monitor the river's movements. These

studies revealed seasonal variations in water volume in the lower reaches of the river. During the Soviet Union era in the 20th century, extensive irrigation use significantly reduced the river's flow. Especially from the 1960s onward, much of the Amu Darya's water was diverted for irrigation in Karakalpakstan and other regions of Uzbekistan. This diversion is recognized as one of the main factors leading to the drying up of the Aral Sea.

Today, the ecological condition of the Amu Darya faces serious problems. Satellite images show that the volume of the river's water has sharply decreased over the past 50 years. For example, while in the 1980s the river water used to reach the Aral Sea, nowadays this process often stops. The water supply of the Amu Darya is mainly influenced by climate change and human activities. As a result of global warming, glaciers in the Pamir and Hindu Kush mountains are melting, reducing the natural amount of water flowing into the river. At the same time, due to the insufficient implementation of water-saving technologies in agriculture, the water of the Amu Darya is being used wastefully.

In addition, industrial waste and untreated sewage discharged into the river further deteriorate its ecological condition. In particular, industrial enterprises in the territories of Tajikistan and Uzbekistan discharge harmful chemical substances into the river water, which reduces water quality and negatively impacts the environment. Specifically, in the Karakalpakstan region, the population is increasingly facing problems with drinking water shortages and related health issues.

To address the ecological problems of the Amu Darya in the future, a number of measures must be taken. It is crucial to widely implement water-saving technologies, transition to modern irrigation systems, and strengthen international cooperation on water resource management. Agreements on transboundary water resource management among Central Asian countries are necessary. Otherwise, the reduction of Amu Darya's water flow could pose a serious threat to the entire Central Asian ecosystem.

These results not only demonstrate the changes the Amu Darya has undergone throughout the history of its geographic study but also highlight its current urgent problems. This helps to create a scientific basis for the effective management of the river's water resources in the future.

The results obtained regarding the geographical study and current ecological state of the Amu Darya River indicate that this river has played and continues to play a decisive role in the water resource system of Central Asia. The research analyzed data ranging from historical sources to modern scientific observations, identifying the natural flow of the river, the impact of human activity, and its ecological problems. This section provides an in-depth analysis and discussion of these findings.

First of all, it is necessary to discuss the ancient geographical changes of the river based on historical data. Although some historical sources suggest the hypothesis that the Amu Darya once flowed into the Caspian Sea, it has since been proven that its waters are directed toward the Aral Sea. This indicates that natural processes, earthquakes, and climate changes have altered the river's original course. However, in the 19th and 20th centuries, human activities accelerated artificial changes in the river's direction.

In the 20th century, extensive use of Amu Darya's waters for agricultural irrigation disrupted its natural hydrological system. Especially during the Soviet Union era, large-scale irrigation projects significantly reduced the river's flow. As a result, the Amu Darya became one of the main causes of the Aral Sea's desiccation. This process not only caused an ecological disaster but also led to political tensions among Central Asian countries regarding the allocation of water resources.

Currently, the water volume of the Amu Darya has significantly decreased. Research indicates that several key factors contribute to this process. One of the primary causes is global climate change, which has led to the reduction of natural water flow into the river due to the melting of glaciers in the Pamir and Hindu Kush mountains. Another critical factor is the improper use of the river's water resources; effective irrigation systems have not yet been sufficiently implemented, which

remains a significant problem. Many farmers still rely on traditional irrigation methods, resulting in substantial water wastage.

Various proposals have been put forward to address the ecological problems of the Amu Darya. For instance, international organizations and Central Asian countries advocate the development of coordinated strategies for the sustainable use of the river's waters. At the same time, the widespread adoption of water-saving technologies is essential. Techniques such as drip irrigation and laser leveling can substantially reduce water consumption.

Moreover, improving wastewater treatment systems in industrial enterprises located along the river is an urgent issue. Currently, the quality of the Amu Darya's water has deteriorated sharply, posing a serious threat to public health. In particular, in the regions of Karakalpakstan and Khorezm, the decline in drinking water quality has been accompanied by an increase in various diseases. This underscores the necessity to preserve the river not only as a water resource but also as a vital component of the ecosystem.

The discussed findings indicate that a comprehensive approach is essential to improve the ecological condition of the Amu Darya River. Strengthening interstate cooperation, advancing scientific research, and increasing public ecological awareness are crucial for the river's sustainable future. Otherwise, the drying up of the river and degradation of its ecological environment may cause severe damage to the entire water supply system of Central Asia. Therefore, the efficient use and protection of the Amu Darya waters remain among the most urgent contemporary issues.

CONCLUSION. In conclusion, the Amu Darya is one of the most important water sources in Central Asia, and its geographic exploration and ecological status have undergone significant changes over the years. Historically, the river's course was shaped by natural processes; however, in the 20th century, human activity—particularly agriculture and irrigation systems—had a profound impact on its

hydrology. As a result, the drying up of the Aral Sea, reduction of water resources, and ecological problems have emerged.

Today, the volume and quality of the Amu Darya's water have drastically declined, becoming a pressing issue for the entire region. To address this situation, it is necessary to use water efficiently, implement ecological technologies, and strengthen interstate cooperation. Otherwise, the drying of the river and degradation of the ecological environment may lead to serious consequences for the population and economy of Central Asia.

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