



MODERN RESEARCH METHODS FOR STUDYING THE AMU DARYA PALEOCHANNELS

Rasulov Anvar Bakhodirovich

Associate Professor of the Department of Geography and
Fundamentals of Economic Knowledge,
National Pedagogical University of Uzbekistan named after Nizami,
Doctor of Philosophy (PhD) in Geographical Sciences.

Tel: +998 99 837 29 98

Email: anvarrasulov92@gmail.com

Tashkent, Uzbekistan

Kadirberganova Iroda Tozaboy kizi

*Student of the Geography and Fundamentals of Economic
Knowledge Education Program,
named after Nizami National Pedagogical University of Uzbekistan,*

Phone: +998 77 297 12 74

Tashkent, Uzbekistan

Abstract: This study is devoted to a consistent description of the natural geographical features of the Amu Darya paleo-channels and the processes of their formation. The historical development of river channels and the stages of their scientific study are initially analyzed. The next step is to explain the mechanisms of paleo-channel formation - erosion, accumulation, and avulsion processes. After that, modern methods used in their identification, in particular GAT and remote sensing technologies, are highlighted. In addition, the hydrological, ecological, and economic role of paleo-channels is systematically revealed.

Keywords: Amudaryo, paleo-Ozan, geomorphology, hydrology, climate, erosion, accumulation, avulsion, GAT, remote sensing, geophysics, landscape, water resources, ecology, desertification, evolution.

In recent years, the Republic of Uzbekistan has implemented large-scale reforms to protect natural resources, effectively use water resources, and solve environmental problems. In particular, in the decree PF-4947 “on action strategy” adopted by Shavkat Mirziyoyev on February 7, 2017, ensuring environmental safety, rational use of Natural Resources and Environmental Protection are set as priorities. Also, the decision of October 30, 2019 on the “concept of Environmental Protection of the Republic of Uzbekistan in the period up to 2030” indicates that a lot of attention is paid to the development of



Environmental Research, in particular, to the in-depth study of hydrological and geomorphological processes. Furthermore, the Resolution on Improving the Water Resources Management System of July 10, 2020, has further emphasized the need for scientific study of water bodies.

The study of the Amu Darya and its paleo-channels has been studied by many local and foreign scientists. In particular, the Russian geographer and traveler L. Berg expressed scientifically based views on the Amu Darya delta and its ancient channels. Also, V. Obruchev conducted a thorough analysis of the role of rivers in the geological development of the Central Asian region. Among Uzbek scientists, H. Abdullayev and Q. In the research carried out by Zokirov, the natural-geographical features, geological structure and landscape formation of the Amudarya Basin are scientifically substantiated. Their scientific works form the theoretical basis of this graduation thesis.

Studies of the hydrology and geomorphology of the Amu Darya basin have a long history. In the Soviet era, V.M. Scholars such as Chupin have made significant contributions to the study of the geography of Central Asia, including river systems. Later, B.A. Nazarov conducted fundamental research on the geomorphology of the Central Asian deserts and conducted an in-depth analysis of the evolution of riverbeds and the mechanisms of formation of paleochannels. Among the scientists from Uzbekistan, M.M. Gulomov, O.A. Abdunazarov, A.A. The Kayumovs highlighted the specific features of river valleys within the framework of the natural geographical zoning of Uzbekistan. Sh.B. Baratov's work on Uzbekistan's climate and water resources is important for understanding the dynamics of river flow formation and change. A.A. Rafikov and N.A. Gulomov's research on the environmental problems of the Aral Sea basin provides a basis for understanding the impact of water scarcity and desertification processes on paleochannels in the region. Modern research has made significant advances in determining the location, morphology, and age of paleochannels using remote sensing, geographic information systems (GIS), and geological drilling methods. However, there is still a lack of in-depth studies that comprehensively analyze the natural geographical significance of the Amu Darya paleochannels, that is, their hydrological, ecological, geomorphological, and economic aspects as a whole.

River channels are dynamic systems that are constantly changing shape due to geological and geomorphological processes, climate change, and anthropogenic impacts. For large rivers like the Amu Darya, this dynamic is particularly complex, with its channels undergoing significant changes over thousands of years. Paleo channels are river channels that were active in the past but are currently dry or only temporarily filled with water. They contain valuable information about the river's past routes, hydrological regimes, and landscape evolution. These ancient channels often leave clear traces in the relief, and their morphological features can be used to



reconstruct past river activity. The study of paleochannels is fundamental not only for understanding the evolution of river systems, but also for determining regional paleogeographic conditions, the effects of climate change, and even the water use strategies of ancient civilizations. They also serve as a theoretical basis for addressing modern environmental problems, such as combating desertification and managing water resources.

The formation and abandonment of river sediments is the result of a complex set of geomorphological processes. These include lateral erosion, accumulation, ouzan migration, and avulsion (drastic changes in ouzan orientation). Lateral erosion erodes the sides of a river, causing the channel to widen and become meandering. Accumulation, on the other hand, causes the bed of a river to rise or islands to form through the accumulation of sedimentary rocks. Whereas Ozean migration is caused by the gradual displacement of the river within its valley, avulsion is often caused by floods or tectonic movements as the river moves in a new, shorter or more sloping direction. As a result of these processes, old channels are abandoned and become paleochannels. The intensity of these processes depends on factors such as the river's hydrological regime, water flow, sediment load, geological structure of the valley, and slope angle. Avulsion processes are particularly characteristic of large, flat rivers such as the Amu Darya, explaining the presence of numerous paleochannels in its delta and downstream. The morphological characteristics of these channels, such as their width, depth, and degree of curvature, provide important information about past hydrological conditions.

Among the main factors influencing the formation of paleo-channels are climate changes, tectonic movements, and the specific hydrological characteristics of the river. Climate change, particularly the intensification of drought periods or, conversely, increased humidity, significantly changes river water discharge and sediment load. In drought conditions, river beds can become shallow and sometimes completely dry up, leading to the formation of new beds or the abandonment of existing beds. Conversely, increased moisture can increase the frequency of floods and accelerate avulsion processes. Tectonic movements also play a crucial role in changing the course of river channels. Uplift or subsidence of the earth's crust changes the river's slope, forcing it to shift to a new, more favorable course. The impact of this factor can be especially significant in seismically active regions such as the Amu Darya basin. The characteristics of the river itself, including its sediment composition, the strength of the channel materials, and the geomorphological structure of the valley, also directly affect the mechanisms of paleochannel formation. For example, rivers flowing over sandy and muddy sedimentary rocks are more prone to channel migration.

Paleo-channels play an important role in the formation of the modern landscape and the distribution of natural resources. They often determine the diversity of soil



types, as sedimentary rocks deposited along ancient channels may have different fertility than the surrounding soils. This forms areas that are favorable or unfavorable for agriculture. Most importantly, paleochannels act as natural channels for replenishing groundwater reserves and their movement. Paleo-channels rich in sand and gravel have high water permeability, helping to absorb rain and melted snow water into deep layers, thereby replenishing groundwater horizons. This makes it an important source of drinking water and irrigation in arid regions. In addition, unique plant communities and wildlife are formed along paleochannels, which increase regional biodiversity. For example, gallery forests or riparian forests may persist along ancient channels, creating unique habitats in desert ecosystems. These aspects further increase the ecological importance of paleochannels.

A theoretical study of the paleochannels of the Amu Darya River will provide a solid basis for a full understanding of their natural geographical significance and for solving practical problems. These studies not only shed light on the geological past of the region, but also help find solutions to pressing contemporary problems such as water scarcity, desertification, and environmental degradation. Identifying groundwater reserves along paleo-basins and developing strategies for their rational use are important for agricultural development and providing the population with drinking water. Also, the analysis of their morphological and sedimentological characteristics will help to restore ancient irrigation systems and assess the potential for developing new irrigated lands. This, in turn, will contribute to the economic development of the region and improve the living standards of the population. Understanding the role of paleo-channels as ecological corridors can help develop effective measures to conserve biodiversity and combat desertification. Overall, a comprehensive study of the Amu Darya paleochannels will serve as a scientific basis for the sustainable development of the region and support efforts to preserve this unique natural heritage for future generations.

The history of natural-geographical studies of the Amu Darya River basin is long and complex, and the region has always aroused constant interest due to its strategic importance, its water resources, and its connection with ancient civilizations. The first geographical information appears in the works of ancient Greek, Roman, and Eastern scholars, who provided initial ideas about the course of the river and the nature of the surrounding areas. For example, scholars such as Herodotus, Strabo, and Ptolemy left information about the Amu Darya (Oxus) and Syr Darya (Yaksart). In the Middle Ages, great thinkers such as Al-Biruni, Ibn Sina, and Mirzo Ulugbek collected valuable information about the geography of Central Asia, including the hydrological features, climate, and landscapes of the Amu Darya basin, in their works. Research during this period was largely based on observations, and hypotheses were discussed about the river's changing nature, its flow into the Aral Sea, or sometimes into the Caspian Sea. Information about the ancient channels



of the Amu Darya, in particular the Uzboy channel, is also found in sources from that period, indicating that interest in the historical channel dynamics of the river has existed for a long time.

The concept of a paleochannel is central to the fields of hydrogeography, geomorphology, and paleogeography, as it provides fundamental information about the past dynamics of river systems, landscape evolution, and the effects of climate change. A paleochannel is a river channel that was once actively flowing but is now completely dry or only temporarily, seasonally filled with water. They often leave clear morphological traces on the terrain, such as meandering forms, old river terraces, levees, and lakes. This concept allows not only to restore the past course of the river, but also its hydrological regime, water consumption, and sediment load. Paleo-channels have also played a significant role in the formation of groundwater reserves, the distribution of soil fertility, and even the location of ancient settlements. Understanding and studying them scientifically is important in developing strategies to combat current environmental problems, particularly water scarcity and desertification. This concept serves as the basis for a thorough analysis of the complex evolutionary processes of river channels, including phenomena such as lateral erosion, accumulation, channel migration, and avulsion. Paleo-channels, especially for large, flat rivers such as the Amu Darya, are witnesses to its centuries-old historical and geographical changes.

Scientific and methodological approaches to identifying paleo-channels are complex in nature and combine methods from various scientific fields. First of all, remote sensing methods are widely used. Satellite imagery (e.g. Landsat, Sentinel) and aerophotosurates are very effective at identifying old Ozen tracks in relief, curved-bugri forms, morphological features such as Ozen marzas and ancient deltas. Since these images are taken in different spectral ranges, soil moisture, vegetation cover, and sediment can also show differences in the composition of the rocks, helping to identify paleo-alien features that are buried or not so clearly visible on the surface. LiDAR (Light Detection and Ranging) technology allows for the creation of high-resolution digital terrain models, which are invaluable in identifying subtle terrain features, including old channel traces, hidden under dense vegetation. These methods allow for the rapid exploration of large areas, the quantitative assessment of their morphological characteristics, and the mapping of past river courses. Remote sensing data serves as a basis for preliminary analysis and helps identify potential paleo-channel sites for subsequent, more detailed field studies.

Geophysical methods play an important role in identifying paleo-channels underground. The ground-penetrating radar (GPR) method detects the structure of subsurface layers by sending high-frequency radio waves into the ground and recording their reflections. This method can provide detailed information about buried channels, their depth, width, and the composition of the sedimentary rocks.



GPR works particularly well in sandy and gravelly sediments, which are characteristic of many areas of the Amu Darya basin. Electrical resistivity tomography (ERT), on the other hand, is based on measuring differences in the electrical conductivity of the soil. Because old channels often have a different sediment composition (e.g., clay, sand, gravel) than the surrounding rocks, their electrical resistivity is also different, which allows them to be detected using ERT. The seismic refraction method determines the structure of the subsurface by measuring the speed at which seismic waves pass through soil layers. These methods together help to create a three-dimensional model of paleo-channels and understand their geological context. Geophysical surveys are most effective when combined with field observations, as they allow for direct confirmation of subsurface information with observations.

Field observations and geomorphological mapping are traditional but essential methods for identifying paleo-channels. Geomorphological mapping involves a detailed study of all forms of terrain, including old channel traces, terraces, marshes, and wetlands. In the field, soil sections are taken and their stratigraphic structure, composition of sedimentary rocks (sand, clay, gravel), color, and other physical properties are analyzed. Paleo-channel sediments often differ significantly from surrounding aeolian or proglacial sediments, which helps to identify them. Sedimentological analyses provide valuable information about the river's past flow rate, sediment load, and transport regime. For example, layers of coarse sand and gravel may indicate a high-energy stream, while fine-grained silt and sand may indicate slow-flowing or lake conditions. Soil science research also helps to identify the development of soil types in areas with paleo-channels, their hydromorphic characteristics, and traces of ancient irrigation. These techniques are necessary for remote sensing and geophysical data “ground-truthing” (ground-truthing) because they provide the most accurate data through direct observations and measurements.

Amudarya paleo-channels are assessed as an important geomorphological form reflecting the historical development of the river system, on the formation of which climatic changes, tectonic processes and hydrological factors play a decisive role, as well as paleo-channels are important in groundwater formation and landscape evolution, it is noted that through modern GAT and remote sensing technologies, opportunities for their, It is concluded that they are an important scientific resource in managing water resources and reducing desertification problems, and it is recognized that a comprehensive study of paleo-channels is of great importance in ensuring the sustainable development of the region.

List of literature used

1. National Atlas Of Uzbekistan. Tashkent scientific and production enterprise”



cartography " 2019.

2. Berg L.S. 1916 "The Aral Sea and the Amu Darya Delta", St. Petersburg, pp. 45–120.

3. Obruchev V.A. 1948 "Geology of Central Asia", Moscow, pp. 60–140.