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Internal Subbasins of The Sangzor River Basin: A Case Study of The Kokjar Basin

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ABSTRACT

Objective: *This study investigates the hierarchical division of the Sangzor River Basin, with a specific focus on the Kokjar Basin as one of its major internal sub-basins. It aims to describe the basin's geographical extent, boundaries, surface morphology, soils, climate, and land-cover characteristics in relation to its natural potential for recreation and tourism development.* ***Method:*** *The research employed cartographic and Geographic Information System (GIS) methods to delineate basin boundaries and analyze geomorphological, hydrological, and climatic parameters.* ***Results:*** *The findings reveal that the Kokjar Basin, oriented north–south toward the Chumqor Mountain watershed, benefits from moist air inflow from the west, resulting in higher precipitation and increased surface runoff. Its fertile brown soils support extensive agricultural and horticultural activities, while forest and water resources promote eco-tourism opportunities.* ***Novelty:*** *This study contributes a systematic spatial assessment of the Kokjar Basin's natural features within the hierarchical framework of the Sangzor River Basin, emphasizing its dual potential for sustainable agriculture and eco-tourism development based on integrated basin management principles.*

INTRODUCTION

A basin is a region of land where water flows toward a river, and this region is associated with the continuous or nearly continuous distribution of sedimentary mineral deposit layers; they are related to certain rock formations [1].

A river basin is the part of the Earth's surface that contains the river system and is bounded by other waterways (waterways) [2]. Each river basin also includes the basins of the tributaries that flow into it. The Sangzor River is, in relation to the basins of its tributaries, a complex geosystem. In turn, each tributary is simple in itself, but to the basins of the tributaries that feed into it, it is regarded as a complex geosystem. Because first-order basins, in general, reflect the characteristics of the Sangzor River basin.

The division of rivers into basins of different orders is called hierarchical division [3]. The hierarchical division of river basins is the tiered classification of drainage areas. Each level consists of smaller inner basins that are partially included in the next level and fully cover the river's flow [4]. The boundaries are defined by the drainage divide.

F.N. Lisenskiy, A.V. Zemlyakova and others identified 62 separate small basins in Belgorod Oblast [5], and classified them for agricultural purposes into hydrographic-geographic types; M.G. Erunova and O.E. Yakubaylikli, on the basis of zoning the basins of Krasnoyarsk Krai's major rivers Kan and Mana, divide them into 513 large and small basins of 1st-4th orders as geosystems [6]. In addition, researchers from the Chinese

Academy of Environmental Studies, Lihui Sun, Chang Shu and others, studied the Daqing River basin area and, based on basin zoning, classified it into 1-5-order basins. B.I. Gartsman analyzes the Kamarovka basin areas by remote sensing to classify and analyze them according to morphological, hydrological, and climatic indicators [7].

RESEARCH METHOD

This study delineates and analyzes the Sangzor River Basin and the tributary basins that drain into it. In delineating the tributary basins, methods based on cartography and GIS technologies were employed. On this basis, the Ko‘kjar tributary basin was subdivided into a number of sub-basins. The Sangzor River Basin is formed by the Ko‘kjar tributary that drains from the northern slope of Mount Chumqor [8]. The characteristics of the delineated basins – namely the geomorphological structure of the land surface, the mean elevation above sea level, flora and fauna, population settlement indicators, and other attributes – were studied and analyzed. In delineating the internal basins, the catchment area of the basins was taken as the basis, reflecting the relief of the land surface. In this context, basins that directly feed the Sangzor River (perennial and seasonal) were regarded as primary basins. Among the primary basins, the Ko‘kjar Basin holds a special place; it drains from the northern slope of Mount Chumqor.

RESULTS AND DISCUSSION

Result

One of the largest valleys that drains into the Sangzor River from its left bank is the Ko‘kjar valley. The Ko‘kjar valley begins at an altitude of about 2700–2800 m on the northern slope of the Chumqor Mountain, from which it takes its name. To its right flows Aldashman, and to its left flow Terakli and Paloxmon valleys. This basin covers a total area of 235.6 km², widening from the northwest toward the southeast and rising in height [9]. The total boundary length is 67.4 km. The widest part of the basin in its middle is about 17-18 km across.

The northernmost point of the Ko‘kjar valley basin lies at 39°43′48" N along the portion that drains into the Sangzor River, while its southern boundary passes through the Chumqor ridge watershed. The westernmost point lies at 67°57′58" W, coinciding with the border with the Oqqo‘rg‘on valley basin, and the eastern boundary point lies at 68°11′24" E, coinciding with the border with the Boyqo‘ng‘irsoy basin.

The Ko‘kjar valley basin itself is divided into 23 smaller basins, see figure 1 and 2. These basins, while forming a simple geosystem for the main basin, become a more complex geosystem for the downstream tributaries.

Figure 1. Space photo of the Kokjar stream basin

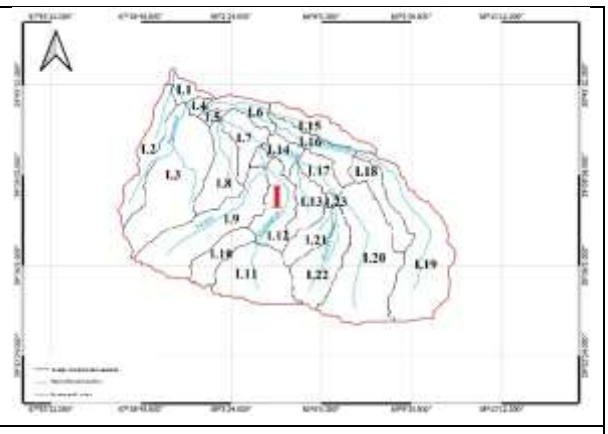

Figure 2. Division of the Kokjar stream basin into sub-basins

The formation of the basin's climate is directly based on the climate of the Sangzor Basin. This can be attributed to factors such as the size of the basin's catchment area and its position relative to moist air masses arriving from the west and northwest [10]. One of the climatic indicators is the precipitation depth, with the area recording an average annual precipitation of 408 mm. In the region, annual precipitation and evaporation indicators vary by month, see Figure 3.

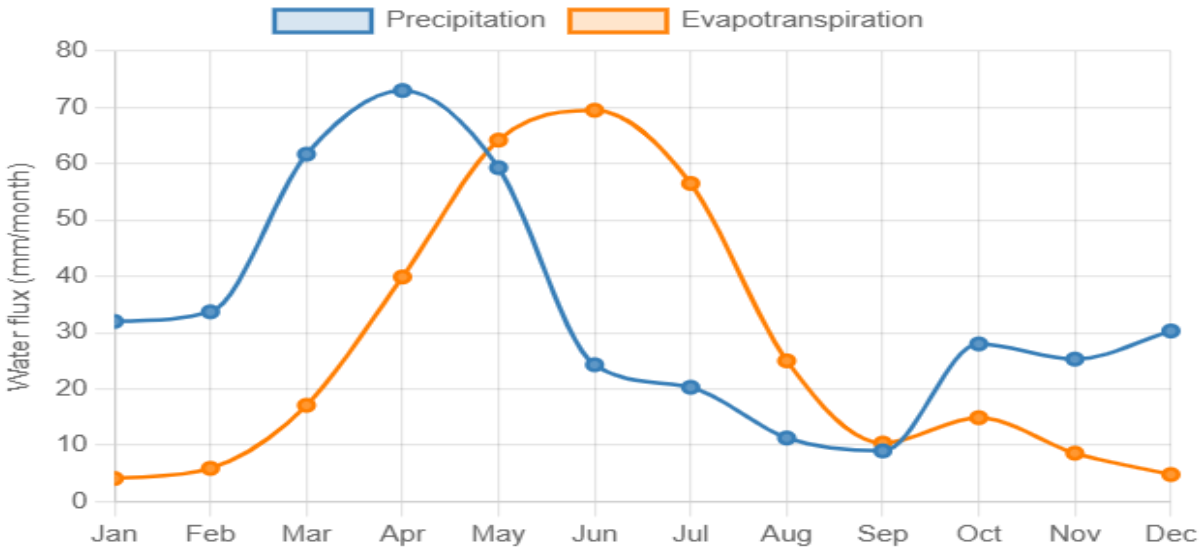

Figure 3. Basin climate: average monthly precipitation and evaporation in the basin

In the basin, soils formed in the Quaternary period as deluvial–proluvial–alluvial complexes are represented by light-colored, brown, and dark-colored bog soils [11], [12], [13].

The vegetation cover and species composition increase toward the upper part of the basin, with both the number of species and their diversity growing [14].

The land fund of the Kokjar Basin is widely used for economic activities. In particular, agriculture, animal husbandry, horticulture, and recreation are actively pursued [15]. Currently, arable lands in the basin exceed 1,890 ha, and these areas are

primarily planted with autumn- and spring-sown cereals such as wheat, barley, peas, and millet.

In recent years, attention to horticulture has led to the establishment of extensive orchards, with large areas planted with fruit trees. To supply these plantations with water, several artesian wells have been drilled and are in use. The area of such orchards, together with forestry lands, surpasses 1,000 ha.

Furthermore, the upper parts of the basin lie within the lands of the Baxmal Forestry Enterprise, where several species of archal trees, as well as walnuts, apricots, and other trees, are cared for and propagated.

The most widespread land-cover type in the water basin in 2020 was dense herbaceous vegetation, occupying an area of 111 km², see Figure 4.

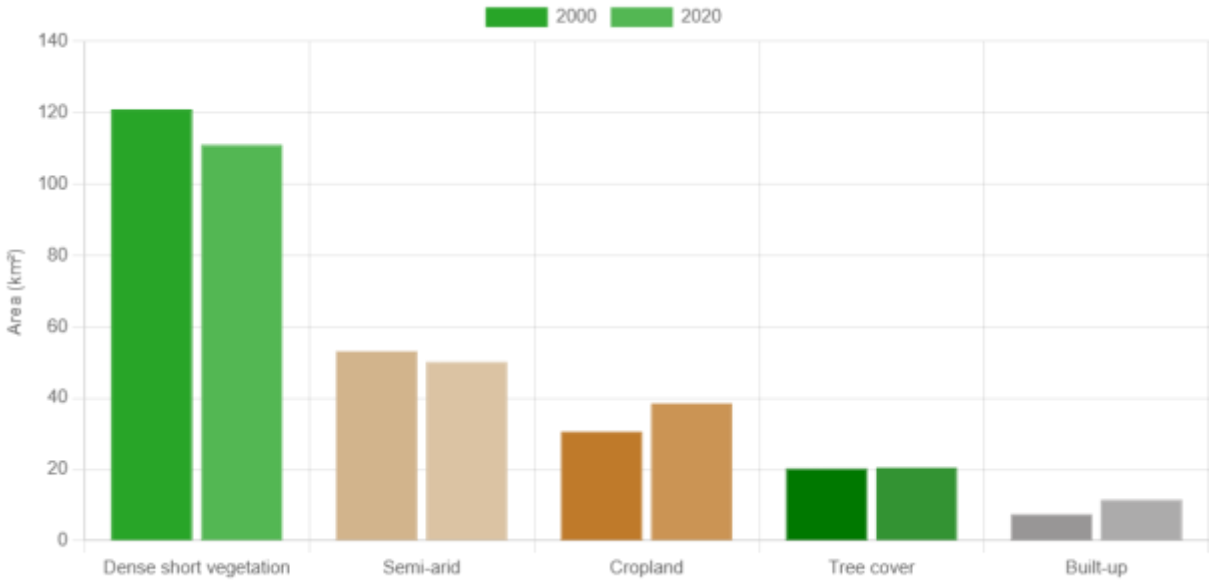

Figure 4. Land cover in the watershed

In the basin area, settlements are located on cone-shaped projections of shade and on shaded terraces. In addition, livestock farming is widely practiced along the shaded banks of the basin, at elevations above 1,600 meters in the upper parts of the mountains. As one ascends from the basin, the natural forest cover also increases. For this reason, in the summer months both local and foreign recreational tourists are attracted to the area. A number of rest houses have been established along the shaded banks of the basin. These include, among others, the "Big Ecotourism Baxmal," the "Bek-Sher-Shox" recreation facility, "Abdumalik Ota," the "Baxmal" recreation area, the "Ormonchi Ecotourism" village, "Oq Qayin," "Asilbek," "Bunyodbek," "Ayritosh," "Ecotourism Baxmal," "Sharshara," and "Kokjarsoy."

Discussion

The geomorphological structure of the Kokjar Basin reflects a complex interaction between topography, hydrology, and climate that defines its ecological and agricultural potential. Its north–south orientation toward the Chumqor Mountain watershed enables the inflow of moist air masses from the west, creating a microclimate characterized by

relatively high annual precipitation and stable surface runoff. This combination of favorable climatic and geomorphological conditions results in fertile soils, which sustain diversified agriculture and horticulture. The cartographic and GIS analyses confirm that these environmental features collectively establish the Kokjar Basin as one of the most productive internal subbasins of the Sangzor River system.

At the same time, the integration of natural and economic activities in the Kokjar Basin presents both opportunities and challenges for sustainable development. The expansion of irrigated agriculture, the establishment of orchards, and the growing number of recreational facilities have increased the economic importance of the basin. However, these developments must be managed within an integrated basin framework to avoid overexploitation of water and soil resources. The study suggests that effective coordination between land-use planning, hydrological conservation, and tourism management is necessary to maintain ecological balance while enhancing livelihoods in the region.

Furthermore, the Kokjar Basin exemplifies how regional planning grounded in geomorphological and climatic assessments can guide sustainable rural development. The application of GIS-based zoning provides an essential foundation for monitoring land-cover change, evaluating water availability, and forecasting environmental risks. Future studies incorporating hydrological modeling and socio-economic data could further strengthen the understanding of how climate variability and human activity influence the basin's resilience. Therefore, the Kokjar Basin offers an important case for developing adaptive management strategies that harmonize environmental sustainability with agricultural productivity and eco-tourism growth in Uzbekistan's river systems.

CONCLUSION

Fundamental Finding : The Kokjar Basin, as one of the key inner sub-basins of the Sangzor River system, demonstrates a unique north–south geomorphological orientation toward the Chumqor Mountain watershed that positively influences the local microclimate. Its open western exposure allows moist air masses to enter freely, generating higher annual precipitation and sustaining continuous surface and groundwater discharge compared with neighboring regions. The predominance of fertile brown soils enhances its agricultural and horticultural potential, while abundant water and forest resources strengthen its ecological and recreational significance. **Implication :** These findings underscore the basin's dual role as both an agricultural heartland and an emerging eco-tourism hub, suggesting that integrated basin management and sustainable land-use policies could optimize natural resource utilization while maintaining ecosystem stability. **Limitation :** However, the study remains primarily descriptive, relying on cartographic and climatic analyses without incorporating long-term hydrological or socio-economic datasets that could reveal dynamic interactions between human activities and environmental processes. **Future Research :** Subsequent investigations should employ hydrological modeling, climate projection, and geospatial

simulation to assess the impacts of climate change, water resource variability, and land-use transformation on the Kokjar Basin's sustainability and regional development potential.

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