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The Role of Logar River in Sustaining Agricultural Production: A Case Study

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ABSTRACT

This study explores the impact of diminished water flow from the Logar River on water system practices and agricultural productivity within the Logar Province, Afghanistan. As climate change worsens water scarcity, nearby agriculturalists face critical challenges in maintaining trim yields and supporting their livelihoods. The research aims to quantify the percentage of agricultural products in the Logar Province that are directly attributed to the irrigation provided by the river and investigate the critical challenges faced in water management within the province, particularly in the context of climate change. Using quantitative data analysis and Geographic Information Systems (GIS), the research identifies trends and correlations between water availability and agricultural productivity. Around 61% of the total agricultural products within the Logar Province are ascribed to the Logar River, implying its central role in driving agricultural yield and maintaining agricultural production in the region. Approximately 90,740 people, constituting around 21% of the province's population, benefit specifically from the agricultural products irrigated by the Logar River.

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INTRODUCTION

Water is a fundamental resource for agricultural production, particularly in regions where agriculture serves as the primary livelihood for local populations (Qureshi, 2007). In Afghanistan, the Logar River is a vital water source that supports agricultural activities, directly impacting the livelihoods of a significant portion of the local community. The river's role in irrigation is critical, as it provides essential water to a substantial percentage of arable land, contributing to food security and economic stability in the region. However, the Logar Province faces increasing challenges due to climate change, which has led to a noticeable decline in water flow from the river. This decline poses significant risks to agricultural

productivity and the socio-economic well-being of the communities that depend on these water resources (Wasiq et al., 2001).

This area encompasses approximately 48,872 hectares of land suitable for agriculture, with the central district, Pol-e-Alam, being the most agriculturally productive area. The river is crucial for irrigation, supplying water to about 41% of the irrigated lands in the province and contributing to approximately 61% of the total agricultural output. This interdependence underscores the river's critical importance in maintaining food security and economic stability for local farmers (Formoli, 1995).

The agricultural landscape of Afghanistan is characterized by its diverse geography and climate, which influence the types of crops that can be cultivated. The reliance on the Logar River for irrigation is particularly significant in a region where water scarcity is a pressing concern. Recent observations indicate a significant decrease in water volume from the Logar River, primarily attributed to climate change. This reduction in water availability has forced farmers to increasingly rely on underground water sources, which imposes additional financial burdens on them and threatens the sustainability of agricultural practices in the region the performance and sustainability of water supply infrastructure in urban areas, ensuring that communities have access to safe and reliable water resources now and in the future (Mujeeb et al, 2024). The shift to changing water sources often leads to increased costs, further straining the financial resources of farming households. As water scarcity intensifies, farmers face challenges maintaining crop yields, directly affecting their income and food security (Mullick, 2013).

The socio-economic implications of reduced agricultural productivity are profound, as decreased crop yields can result in job losses and reduced employment opportunities, exacerbating poverty and food insecurity in the region. By identifying the critical relationship between water availability and agricultural productivity, the study underscores the urgent need for effective water management strategies to mitigate the impacts of climate change and ensure the long-term viability of agriculture in the region. The research aims to contribute to the understanding of the water-energy-food nexus in Afghanistan, offering recommendations for policymakers and practitioners to foster sustainable agricultural practices in the face of environmental challenges (Osama, 2017). The study emphasizes the importance of integrating socio-economic factors into water resource management to achieve sustainable agricultural production and improve the quality of life for local populations. Effective water management practices are essential for optimizing the use of the River resources and ensuring the continued productivity and resilience of agriculture in the Logar Province. The research highlights the need for adaptive strategies to mitigate the effects of climate change, ensuring that local farmers can maintain their livelihoods and contribute to the overall economic stability of the region. In conclusion, the Logar River is not just a water source; it is a lifeline for the agricultural communities in the Logar Province (Osama, 2017).

As climate change poses significant threats to water availability, understanding the intricate relationship between water resources and agricultural productivity becomes increasingly critical. This research serves as a foundational step toward addressing the challenges faced by the agricultural sector in the region and promoting sustainable practices that can enhance resilience and support the livelihoods of those dependent on the river. By focusing on the socio-economic implications of water scarcity and the importance of effective water management, the study aims to contribute to the broader discourse on sustainable development in Afghanistan and similar regions facing environmental challenges (Ma et al., 2013). Due to reducing accessibility of water from the Logar River and its consequent impact on agricultural productivity inside the province, and despite the river's principal role in providing water systems for a significant portion of the province's agricultural land, later trends indicate a substantial decline in water flow, attributed to climate change, mismanagement of water resources, and natural changeability. To be more specific, the aims of the study are:

1. To evaluate the percentage of agricultural products within the province that are specifically attributed to the water system provided by the Logar River, highlighting its importance in sustaining local agriculture.
2. To explore the key challenges confronted in water management inside the Logar Province, especially within the context of climate change, and to propose feasible techniques for water resource management to ensure the versatility and productivity of agriculture within the region.

METHODS AND MATERIALS

Quantitative data were analyzed using statistical techniques to identify trends and correlations between water availability and agricultural productivity. In this study, Geographic Information Systems (GIS) and Origin-PRO were utilized to form a point-by-point outline of the study area and to analyze spatial data concerning the conveyance of irrigated lands and the flow of the Logar River. This approach facilitated a visual representation and analysis of the geographical components that impact agricultural practices within the Province. To viably analyze the collected information concerning the effect of the Logar River on agricultural generation, a combination of (quantitative) statistical methods was utilized. Insights inferred from GIS mapping and quantitative statistics from governmental sources, the research gives a comprehensive understanding of how the River flow dynamics influence agricultural productivity within the region. This integration enhances the in-general analysis by thoroughly examining the relationships between geographical factors and agricultural yield.

Study Area and Data Availability

The research focuses on a particular study zone, a small but agronomically significant region in Afghanistan, including approximately 439,103 hectares. Within this region, around 48,872 hectares are designated as irrigated lands, which are pivotal for rural production. The

agricultural landscape of the province highlights a combination of irrigated and rain-fed ranges, with the last mentioned utilized for wheat development. In any case, a considerable portion of the land—approximately 82,608 hectares—is classified as degraded due to unfavorable geography, insufficient water resources, and the lack of successful irrigation systems.

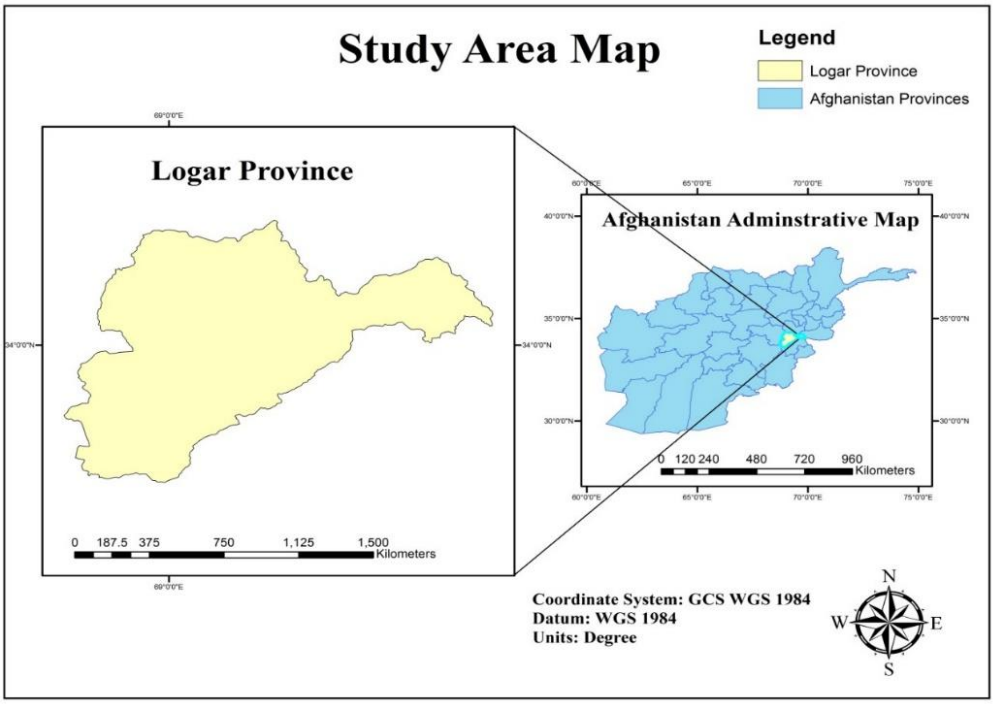

Figure2. Study Area Map (Arc-GIS)

FINDINGS

Out of the total area of Logar Province, approximately 48,872 hectares are suitable for agriculture, with the highest amount of agricultural land located in the central district (Pol-e-Alam). There are 106 irrigation canals, 38 of which originate from this river, irrigating about 20,250 hectares of land. In 2020, this Province cultivated around 34,000 hectares of land, producing approximately 289,229.197 tons of crops, with 61% of these agricultural products attributed to the Logar River. The river flow in this region contributed significantly to the agricultural sector, generating approximately 61% of the total rural revenues in the province. An estimated 90,740 people, constituting about 21% of the province's population, directly benefit from the agricultural products irrigated by river flow, which also plays a vital role in supporting agricultural activities in the province, with a substantial portion of irrigated lands and crop yields attributed to its water supply. This River's significance in sustaining agricultural production is evident through its contribution to agricultural revenues and the livelihoods of a significant portion of the population. The study highlights the importance of sustainable water management practices to ensure the continued availability of water resources for agriculture, especially in the face of challenges like climate change (Ahmadzai, 2023).

Land Cover

A significant portion of the province, approximately 82,608 hectares, is unsuitable for agriculture due to topography, inadequate water resources, and the absence of regular irrigation systems. Furthermore, the Province encompasses approximately 16,661 hectares of shrublands and 270,099 grasslands. The presence of 5,580 hectares of residential areas, predominantly concentrated around the provincial capital of Pul-e-Alam, is also notable. Additionally, there are 3,094 hectares of swamps, primarily located in the capital. These diverse land cover types collectively influence agricultural potential and productivity, reflecting the intricate interplay between natural resources and human settlements shown in Figure 3.

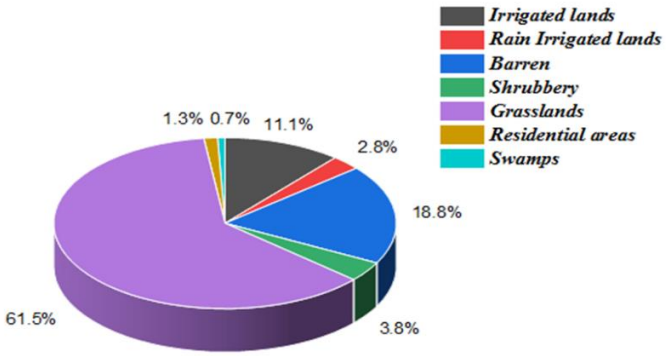

Figure 3: Land Cover of the study area (MEW)

The land use and land cover in Logar Province play a pivotal role in shaping the agricultural landscape. With a total area of 439,103 hectares, this area comprises 48,872 hectares of irrigated lands distributed across various districts. Additionally, 12,189 hectares of rain-irrigated lands are primarily dedicated to wheat cultivation. However, these rain-irrigated lands generally yield less compared to irrigated lands.

Changes in the River Discharge

Like other rivers in Afghanistan, the Logar River water regime is influenced by climatic features and topographic structures. Unfortunately, with the advent of climate change, the amount of water in the river has decreased significantly in recent years. The average amount of water discharge in the Sang-e-Naweshta station between 2006 and 2015 was 227.9 MM^3, while the average between 2016 and 2022 was 192.6 MM^3. This decrease in water volume represents a 35.3 cubic meters reduction in the river water volume over the past decade, as shown in Figure 4.

The impact of this decrease in water volume has been significant, with the river drying up during summer months, causing considerable problems for farmers in the province. The decline in water volume has also led to increased costs and a continued reduction in groundwater levels. Therefore, it is essential to take measures to conserve the water of the Logar River during winter months to prevent water wastage and ensure sustainable agricultural practices. The changes in the flow and discharge of the Logar River highlight the

need for sustainable management of water resources in the province. It is crucial to develop strategies to mitigate the impact of climate change on the river water volume and ensure the continued prosperity of the agricultural industry in Logar Province.

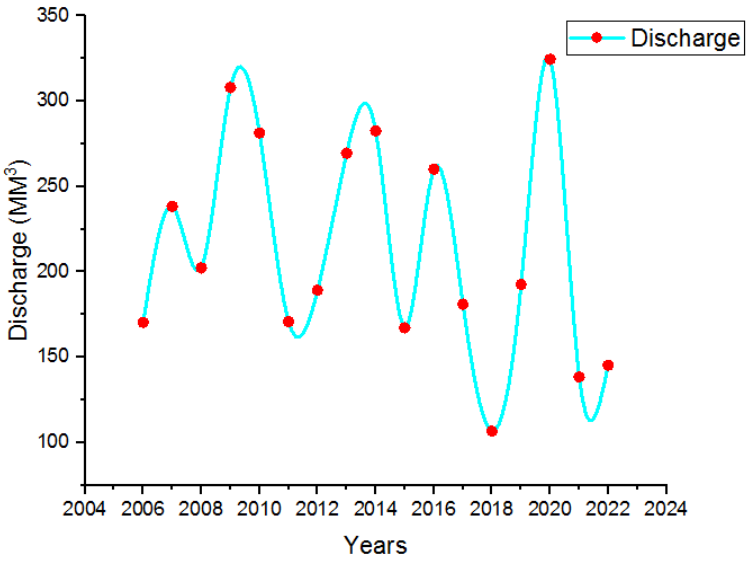

Figure 4: Annual Water Discharge between2006-2022 (MEW)

However, the study also highlighted the challenges climate change poses, particularly the substantial decrease in water volume in the flow regime. This phenomenon has led to increased reliance on underground water sources, resulting in additional financial burdens for farmers and posing a threat to the sustainability of agricultural practices in the province.

The quantitative analysis provided contextual insights into the significance of the socio-sustaining agricultural production of the Logar River, emphasizing its broader impact on the livelihoods of the local population. The river sustaining agricultural production and social importance was evident, with approximately 21% of the province's population directly benefiting from its role in sustaining agricultural activities. The study's findings align with similar research efforts, such as the work by (Singh et al., 2001), which investigated the impact of irrigation canals on sustaining agricultural production and social indicators in a province of India. These parallels underscore the broader relevance of the study's findings and their potential applicability to other Provinces facing similar challenges related to water resource management and agricultural sustainability.

In a nutshell, the study's analysis of the Logar River sustaining agricultural production impact on the agricultural sector provides valuable insights for informed decision-making and policy formulation. The study's implications extend to the need for sustainable water resource management practices and adaptive strategies to mitigate the effects of climate change, ensuring the continued productivity and resilience of agriculture in Logar Province and beyond (Ahmad, 2004).

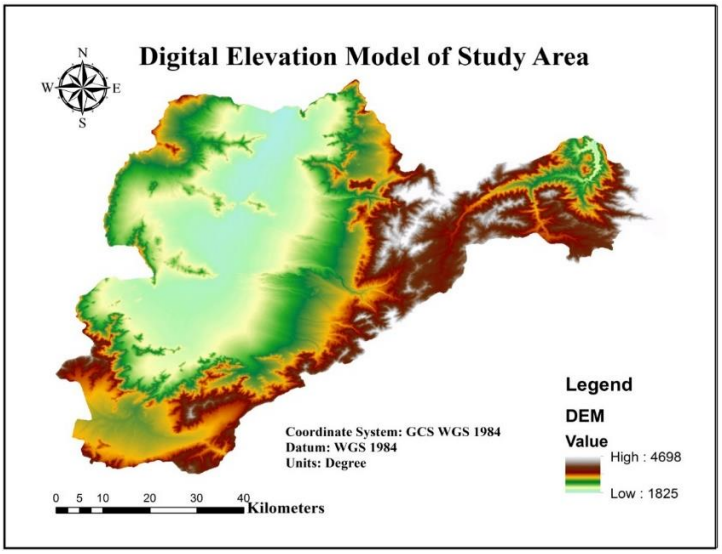

Figure 5: Digital Elevation Model (Arc-GIS)

The Climate of the Study Area

According to ESCAP (2012), climate change results from natural and human factors, including higher concentrations of greenhouse gases and aerosols, crustal movements, volcanic activity, and Earth's rotation. There is scientific proof that the effects of climate change on life on Earth are growing. It is anticipated that precipitation patterns will alter, average temperatures will rise, and extreme weather events, including heat waves, hurricanes, floods, and droughts, will occur more frequently and with greater intensity (Jawhar et al, 2024). In central Afghanistan, Logar Province experiences a continental climate characterized by distinct seasonal variations. The province is marked by hot summers and cold winters, with significant yearly temperature fluctuations. Average summer temperatures can reach as high as 35°C (95°F), while winter temperatures can drop to around -10°C (14°F), particularly in the higher elevations. Precipitation in Logar Province is relatively low, with annual rainfall averaging between 300 to 500 millimeters. Most rainfall occurs during the spring and autumn, which is crucial for agricultural activities. The winter months may bring snowfall, particularly in the mountainous areas, contributing to the Province's water resources as the snow melts in the spring, replenishing rivers and irrigation systems. The surrounding mountainous terrain heavily influences the climate, which affects local weather patterns and water availability. The Logar River, a vital irrigation water source, relies on rainfall and snowmelt from the surrounding mountains. However, the province has faced challenges due to climate change, which has led to changes in precipitation patterns and reduced water flow in the river. This has significant implications for agriculture, as farmers depend on a consistent water supply for crop production (Qureshi, 2007).

DISCUSSION

The findings of this study highlight the fundamental role played by the Logar River in supporting agricultural production inside the province. This river serves as a significant asset

for roughly 21% of the province's population, explicitly linking water availability to country efficiency and socio-economic stability. The quantitative analysis demonstrates a considerable dependence on the river's water resources, with 61% of agricultural yields credited to its waters. This dependence underscores the pressing requirement for effective water management procedures, particularly in light of climate change, which has eminently reduced Water Rivers and heightened water shortages. Existing writing demonstrates that climate change, compounded by mismanagement of water assets, has driven a critical lessening in water accessibility, presenting serious challenges for local farmers. These findings resonate with the work of comparative thinkers, such as those by Singh et al. (2001), which examined the effect of irrigation frameworks on rural sustainability in different settings. The parallels drawn from these ponders suggest that the challenges faced within the Logar Province are not isolated but rather part of a broader global drift affecting agricultural practices in water-scarce locales.

Moreover, the socio-economic implications of decreased rural efficiency from water shortages cannot be exaggerated. To begin with, the selection of climate-resilient trim assortments and feasible cultivating practices is crucial. Strategies such as edit revolution, agroforestry, and preservation can upgrade soil well-being and improve water retention, expanding agricultural flexibility to climate change. Additionally, advanced water system strategies, such as drip or sprinkler systems, should be promoted to minimize water wastage and improve effectiveness. Instructive programs for ranchers on these advances can significantly improve crop yields while moderating vital water assets.

Additionally, investing in water capacity offices, such as stores and water collecting systems, can provide a buffer during droughts, stabilizing agricultural production and ensuring food security. These techniques address prompt water shortage challenges and contribute to long-term supportability in rural practices. In conclusion, this study serves as an essential step toward understanding the complex relationship between water resources and agricultural productivity inside the Logar Province. The discoveries underscore the pressing need for effective water management techniques to relieve the impacts of climate change and guarantee the sustainability of rural employment. By executing the prescribed methodologies, partners can collaborate to improve agricultural resilience and overall community well-being.

CONCLUSION

This research analyzes the essential part of the Logar River in supporting agricultural production within the province. It finds that almost 41% of watered lands depend on the waterway, contributing to roughly 61% of the region's rural yield, highlighting its centrality for neighborhood horticulture and community jobs. The study identifies challenges from climate change, such as changing precipitation and decreased water flow, which debilitate agricultural efficiency and food security, possibly leading to expanded poverty and social instability. To address these issues, inquire about advocates for economical water

management hones and versatile methodologies to upgrade agrarian flexibility. This incorporates collaboration among partners, venture into present-day irrigation, and advancement of climate-resilient farming practices. Overall, this study underscores the need for compelling approaches to back maintainable water management, guaranteeing the vocations of neighborhood communities and cultivating long-term rural strength amid natural changes in Logar Province.

Recommendations

- Establish a localized water management arrangement that incorporates the unique climatic and topographical characteristics of the Logar Province. This arrangement should prioritize maintainable water utilization, considering regular varieties in water accessibility and local crops' particular water system needs.
- Encourage collaboration between nearby universities; inquire about teachers and rural organizations to conduct inquiries about water management and agricultural practices particular to the Logar Province. This collaboration can lead to the advancement of inventive solutions custom-made to the region's needs.

Ethical Approval

Ethical approval was not sought for the present study because the research involved information freely available in the public domain and the analysis of datasets obtained from other researchers, where the data were adequately anonymized and informed.

Conflict of Interest

The author declares that they have no conflicts of interest to disclose.

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