

Contribution of Sindhu River and its Tributaries in India

Ar. Tirona Jayashree

School of Planning and Architecture, Vijayawada, Andhra Pradesh, India

Dr. RNS Murthy

School of Planning and Architecture, Vijayawada, Andhra Pradesh, India

Abstract- The Sindhu River, previously called the Indus River, has served as the cradle of Indian civilization and continues to be a lifeline that has defined the socio-economic, agro-based, and cultural paradigms of South Asia. This article will examine the source of the Sindhu River system and its tributaries, namely the Jhelum (Jhelum), Chenab, Ravi, Beas, and Sutlej, which have contributed to agriculture, hydropower generation and development. The article will offer an analysis of the water-sharing agreements under the 1960 Indus Water Treaty, which have asserted the treaty as a vehicle for cooperation amid other geopolitical tensions. We will also explore systems of traditional, ancient, and modern water management that have managed to support food security and economic development for generations. Issues concerning contemporary environmental degradation to delta, pollution, climate change and drought or water scarcity will be examined, with an emphasis on the of necessity of sustainable and cooperative river basin management. To accomplish this, the article will emphasize integrated conservation intervention to protect the Sindhu River systems for generations to come.

Keywords – Sindhu River, Indus Basin, Tributaries, Water Management, Indus Water Treaty

I. INTRODUCTION

The term "India" is derived from the Indus River, which was originally referred to as Sindhu and is a major river system draining into the Himalayan river system and one of the largest river basins in the world. The Indus Valley Civilization, one of the world's first urban cultures, settled on the fertile banks of the river and established a settled agriculture foundation for life on the Indian subcontinent, affording later civilizations a legacy of state-of-the-art urban planning and water development. The Sindhu River system continues to be a vital source of water for some of the most productive agricultural regions in South Asia, serving millions of people through irrigation and hydropower. When the river originates on the Tibetan Plateau, it is called Singi Khambai, or "Lion's Mouth." The river travels through Tibet, India, and Pakistan. The Indus River system covers six principal rivers: the Indus River, Jhelum River, Chenab River, Ravi River, Beas River, and Sutlej River. Because these rivers cross borders, the Indus Waters Treaty was established in 1960 and gives the jurisdiction of three eastern rivers (Indus, Jhelum, Chenab) to Pakistan and three western rivers (Ravi, Beas, Sutlej) to India. In addition, water from the Indus system is conveyed through extensive canal networks to the Indian states of Rajasthan and Haryana. This river system influences regional agriculture, energy production, and geopolitics. However, issues such as climate change, pollution, and water scarcity threaten its sustainability, necessitating cooperative management and conservation efforts (Ministry of External Affairs 2005) (Tariq 1996).

II. TRIBUTARIES OF SINDHU RIVER

2.1. *River Chenab*–

The Chenab River originates in the Bara Lacha Pass region of the Lahaul-Spiti section of the Zaskar Range in Himachal Pradesh. It is formed by the confluence of two rivers the Chandra and Bhaga at Tandi in the Lahaul and Spiti district. In its upper reaches, the river is referred to as the Chandrabhaga. Under the Indus Water Treaty (1960), the waters of the Chenab are allocated to Pakistan, although India is permitted limited non-consumptive uses like hydroelectricity generation. The Chenab Bridge in Jammu and Kashmir, the tallest railway bridge in the world, spans this river. After flowing through Jammu, it enters the Punjab plains of Pakistan, contributing significantly to agriculture (Abdul Rauf Kalair, 2019).

2.2. *River Sutlej*–

The Sutlej River, sometimes called the Red River, originates on the southern slopes of Mount Kailash, near Mansarovar and Rakas Lakes, outside the Indian territory. It enters India through Shipki La in Himachal Pradesh and flows south-westward through Kinnaur, Shimla, Kullu, Solan, Mandi, and Bilaspur districts. The river exits Himachal at Bhakra, where the Bhakra-Nangal Dam, one of the world’s tallest gravity dams, has been constructed. As per the Indus Water Treaty, India retains full rights over the waters of the Sutlej, which are extensively used for irrigation and hydroelectric power generation (Shalabh Agarwal, 2023).

2.3. *River Beas*–

The Beas River originates at Rohtang Pass in Himachal Pradesh. It flows through the Dhauladhar mountain range, turning southwest before merging with the Sutlej River at Harike in Punjab. The river is approximately 460 kilometers long and flows entirely within Indian Territory. Its banks, especially near Manali, are home to several tourist resorts, making it not only a vital water source but also a key part of the region’s tourism economy. The Beas River plays an important role in the irrigation system and is also one of the eastern rivers allocated to India under the Indus Water Treaty (Simons, 2019).

2.4. *River Ravi*–

The Ravi River originates in the Kullu Hills near Rohtang Pass in Himachal Pradesh. It flows between the Pir Panjal and Dhauladhar ranges, carving deep valleys, especially near Chamba. After entering the Punjab Plains near Madhopur, it crosses into Pakistan, flowing past Amritsar and merging into the Chenab River near Rangpur. The Shahdara Bagh area along its banks in Lahore is home to the tombs of Mughal emperors Jahangir and Noor Jahan. Like the Beas and Sutlej, the Ravi is also one of the eastern rivers granted for Indian use under the Indus Water Treaty (Sharma, 2024).

2.5. *River Jhelum*–

The Jhelum River originates from a spring at Verinag in the southeastern part of the Kashmir Valley. It flows into Wular Lake and then takes a southern path through the Baramulla hills, entering a deep gorge in the Pir Panjal Range. After reaching Muzaffarabad, it forms a zigzag bend and begins acting as the India–Pakistan border for about 170 kilometers. It eventually emerges near Mirpur, entering the Potwar Plateau and debouching into the plains near Jhelum city in Pakistan. The river contributes heavily to Pakistan’s agriculture and is one of the western rivers allocated to Pakistan under the treaty (Abdul Rauf Kalair, 2019).

River	Origin	Length (km)	Major Tributaries
Sutlej	Mansarovar–Rakas Lake, Tibet	1,450	Right Bank: Spiti, Beas, Chenab
			Left Bank: Baspa
Jhelum	Verinag, Pir Panjal Range	813	Right Bank: Arpath, Lidder, Neelam, Sindh, Kunhar
			Left Bank: Poonch, Sukhnag
Chenab	Bara Lacha Pass, Zaskar Range	1,180	Right Bank: Jhelum, Marusudar
			Left Bank: Ravi, Tawi
Ravi	Kullu Hills, Rohtang Pass	725	Right Bank: Budhil, Tundahan, Beljedi, Saho, Siul
			Left Bank: Chirchind Nala
Beas	Rohtang Pass, Beas Kund	460	Right Bank: Uhel
			Left Bank: Parvati, Sainj, Larji

Figure 1. River system showing length, tributaries, and origin. (Adda247)

III. HISTORICAL SIGNIFICANCE OF THE SINDHU RIVER

3.1. *History of Sindhu River*–

The Sindhu River, known as the Indus in Western texts, has played a foundational role in shaping Indian civilization. The river lent its name to the country India through the Sanskrit term "Sindhu," which was later adopted by the Persians as "Hindhu." This river supported the rise of the Indus Valley Civilization (3300–1300 BCE), one of the earliest urban cultures known for its planned cities like Harappa and Mohenjo-daro. These cities showcased remarkable water management systems, including wells, public baths, and underground drainage. The Sindhu is also revered in the Rigveda, where it is praised as the mightiest of rivers among the Sapta Sindhus. Spiritual references in the Vedic and post-Vedic periods indicate the river's divine and life-sustaining status, emphasizing its role beyond physical sustenance to cultural and religious identity (Sharma A. K., 2023).

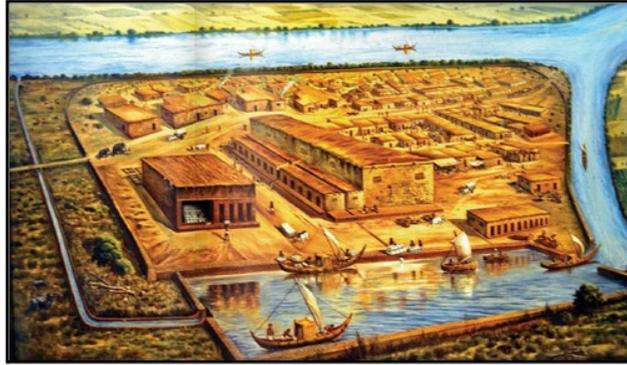


Figure 2. Indus River System

3.2. Traditional and Ancient Water Management Techniques–

The Indus Valley Civilization displayed sophisticated hydrological knowledge far ahead of its time. Cities along the Sindhu River had networks of wells Mohenjo-daro alone had around 700 alongside soak pits, cesspits, and terracotta drainpipes. These features demonstrate an understanding of urban sanitation and decentralized water access. In later periods, particularly during the Mauryan Empire (322–185 BCE), large-scale water infrastructure was developed, including dams with spillways, artificial reservoirs, and irrigation canals. Ancient texts like the Rigveda and Atharvaveda describe the complete hydrologic cycle evaporation, cloud formation, rainfall, and groundwater recharge indicating an early scientific approach to water systems. The use of water-lifting devices such as the Asmavāla cakra (similar to a noria) further reveals the technical ingenuity of early Indian hydraulic engineering (Singh, 2022).

IV. AGRICULTURAL CONTRIBUTIONS OF THE INDUS BASIN

The Sindhu (Indus) River basin has been crucial for agriculture from ancient times to the present day. Its fertile plains, particularly in Punjab and parts of Rajasthan, are highly productive due to glacier-fed rivers and irrigation systems originating in the basin. The basin's waters historically supported major crops like wheat, rice, cotton, and sugarcane. Today, Punjab, known as the "Granary of India," relies heavily on this water for irrigation, with over 80% of its arable land irrigated. The basin's influence also extends to traditional irrigation systems like Ahar–Pyne in Bihar and tank irrigation in southern India, which are rooted in basin-wide water management practices. The agricultural importance of the Sindhu River underscores its role in ensuring food security and livelihoods for millions (Moubarak, 2025).

V. MODERN HYDROPOWER AND WATER RESOURCE UTILIZATION

In modern times, the Sindhu and its tributaries (Jhelum, Chenab, Ravi, Beas, and Sutlej) have been harnessed for hydropower generation and irrigation. India has constructed several hydropower projects on the western tributaries allowed under the Indus Waters Treaty, such as the Baglihar and Kishanganga projects. These not only generate electricity but also regulate water flow for downstream irrigation. The river system supports multiple states Jammu & Kashmir, Punjab, and Himachal Pradesh by enabling agriculture, drinking water supply, and energy needs. Despite treaty restrictions, India has exercised its right to limited use of western rivers for non-consumptive purposes, balancing energy security with geopolitical sensitivity (Gardezi, 2020).

VI. ECONOMIC IMPORTANCE

Irrigation from the Indus River has played a crucial role in supporting agriculture for centuries. The development of modern irrigation systems began in the mid-19th century, during British administration, with the revival and

modernization of existing canals in the Sindh and Punjab regions. This led to the creation of the world's largest canal irrigation system.

However, at the partition of British India in 1947, the irrigation system was divided between India and West Pakistan (now Pakistan), causing disruptions in water supply for some parts of Pakistan. To resolve this, the Indus Waters Treaty was established in 1960, assigning the flow of the Indus, Jhelum, and Chenab rivers to Pakistan, and the flow of the Ravi, Beas, and Sutlej rivers exclusively to India (Bank, 2025).

Both India and Pakistan have constructed dams, barrages, and link canals to distribute water for irrigation. In India, the Harike Barrage diverts water from the Beas and Sutlej rivers to the Indira Gandhi Canal, providing irrigation to desert areas in Rajasthan. In Pakistan, several linking canals and barrages have been built, such as the Chashma-Jhelum link canal, to transfer water from western rivers to areas lacking water in the east (Team, 2020).

Major dams in Pakistan include the Mangla Dam on the Jhelum River, which generates hydroelectricity and provides water for irrigation and tourism, and the Tarbela Dam on the Indus River, with a greater generating capacity and potential. The Ghazi Barotha hydroelectric project and several barrages, such as the Guddu, Sukkur, and Kotri Barrages, further contribute to irrigation and electricity generation.

While canal irrigation has significantly supported agriculture, it has also posed challenges. Poorly controlled canals can lead to waterlogging and salinization of land. Efforts have been made to address these issues by providing drainage systems to prevent waterlogging and salt buildup.

Overall, irrigation from the Indus River has been vital for sustaining agricultural productivity, fostering economic development, and meeting the water needs of both India and Pakistan (Ministry of External Affairs, 2005).

VII. CHALLENGES AND CONSERVATION EFFORTS

The Indus River faces several modern issues that have significant social, environmental, and economic implications. Here are some key challenges:

Indus Delta Degradation: Construction of dams, barrages, and irrigation systems has significantly reduced the flow of water reaching the Indus delta. This reduced freshwater inflow, combined with deforestation, industrial pollution, and global warming, poses a threat to the delta's vegetation and wildlife. The population of the Indus river dolphin has been isolated due to damming, impacting its survival. The degradation of the delta affects local communities dependent on its resources (Aeman, 2023).

Climate Change Impacts: The melting of glaciers in the Tibetan Plateau, which serve as a crucial water source for the Indus River, is occurring at an alarming rate. While this initially increases water availability, it raises concerns about the long-term implications. The retreating glaciers and altered water supply patterns due to climate change could have severe consequences for water availability, agriculture, and ecosystems in the Indus basin (Siyal, 2023).

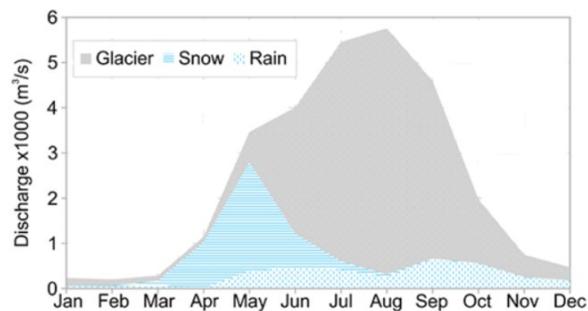


Figure 3. Quantifying the changes in the runoff and its components across the Upper Indus River Basin under climate change

Water Scarcity and Management: The Indus River Basin faces increasing water scarcity and management challenges. Population growth, industrial development, and agricultural demands strain the available water resources. Inefficient water management practices, including inadequate maintenance of canals and irrigation systems, contribute to water loss and reduced agricultural productivity. Balancing water allocation among different sectors and ensuring sustainable water use is a critical issue (Janjua, 2021).

Pollution: Industrial activities along the Indus River have led to high levels of water pollution, affecting both aquatic life and human health. The discharge of untreated industrial waste and agricultural runoff containing fertilizers and pesticides contaminates the river. Pollution has led to the decline of endangered species like the Indus river dolphin and poses risks to communities reliant on the river for drinking water and agriculture.

Plastic Waste: The Indus River is among the top contributors of plastic waste to the world's oceans. Improper waste management and the lack of effective recycling infrastructure result in large amounts of plastic debris entering the river. This not only harms aquatic life but also has broader environmental implications, including ecosystem disruption and micro plastic contamination (Tariq, 1996).

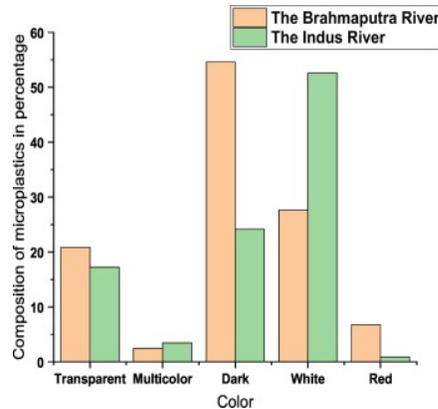


Figure 4. Percentage composition of microplastics by color in the Brahmaputra and Indus Rivers

Addressing these challenges requires comprehensive measures such as improving water management practices, implementing effective pollution control measures, promoting sustainable agriculture, and raising awareness about the importance of environmental conservation. Collaborative efforts involving governments, local communities, and international organizations are necessary to safeguard the Indus River's ecological integrity and ensure its sustainable use for present and future generations.

VIII. INDUS WATER TREATY

The Indus Water Treaty, signed in 1960, is an important agreement between India and Pakistan that governs the sharing of water resources from the Indus River and its tributaries. It was brokered by the World Bank and is considered one of the most successful water-sharing treaties in the world.

The treaty was necessary because the Indus River flows through both India and Pakistan, and tensions over water sharing had been rising between the two countries. The agreement aimed to provide a framework for managing water distribution fairly and peacefully.

Under the treaty, the Indus River and its three western tributaries, namely the Jhelum, Chenab, and Indus itself, were assigned to Pakistan. India was given control over the three eastern tributaries, namely the Ravi, Beas, and Sutlej. This division was based on the principle of equitable sharing, ensuring that both countries had access to water resources.

The treaty established a Permanent Indus Commission composed of representatives from both India and Pakistan to resolve any disputes or issues related to the implementation of the treaty. The commission meets regularly to exchange data, discuss water projects, and address concerns.

One of the key provisions of the treaty is the permission for each country to construct storage facilities, such as dams and barrages, on their allocated rivers. However, certain restrictions were placed to prevent significant harm to the other country. For instance, India agreed to limit the storage capacity of its projects on the western rivers to avoid reducing the water flow to Pakistan.

The treaty also promotes cooperation between the two countries in sharing data and information about river flows, hydrological data, and planned water projects. This transparency helps build trust and allows both sides to make informed decisions about water management.

The Indus Water Treaty has played a crucial role in preventing major conflicts over water resources between India and Pakistan. It has endured through periods of political tensions and conflicts between the two nations. The treaty has provided a mechanism for resolving disputes and has facilitated the development of water infrastructure and irrigation systems in both countries.

However, challenges and disputes still arise, particularly regarding the construction of new dams or water projects by either country. The treaty requires constant dialogue and cooperation to address emerging issues and ensure the equitable sharing of water resources. The Indus Waters Treaty has been marred by issues and accusations of

violations from both India and Pakistan. Pakistan raised concerns about India's hydroelectric projects, while India objected to Pakistan's projects in the Rann of Kutch. Bilateral relations have deteriorated, leading India to take steps to divert water from Pakistan. These include reviewing the Tulbul project suspension, objecting to the LBOD project, and initiating projects to utilize its share of water. There are also debates about the treaty's signing by Prime Minister Nehru instead of the head of state.

Overall, the Indus Water Treaty is a significant milestone in international water diplomacy. It has contributed to regional stability and cooperation by managing water resources in a fair and mutually beneficial manner. The treaty serves as a model for other countries facing similar challenges, highlighting the importance of dialogue, cooperation, and equitable sharing for sustainable water management.

Year / Date	Event	Details
1947	Partition of British India	Creation of India and Pakistan; boundary drawn across Indus basin causing water disputes
April 1, 1948	India begins withholding water from canals flowing into Pakistan	After expiration of the Standstill Agreement of 1947
May 4, 1948	Inter-Dominion Accord	India agrees to supply water to Pakistan canals in return for annual payments (temporary measure)
1951	Pakistan approaches United Nations	Accuses India of cutting water supply to Pakistani villages
1951–1960	Negotiations under World Bank mediation	Nine years of talks facilitated by World Bank led by President Eugene Black
September 7, 1960	Washington Working Party meeting	Final arrangements for publicity and signature of treaty discussed
September 19, 1960	Indus Waters Treaty signed in Karachi	Signed by Indian PM Jawaharlal Nehru, Pakistani President Ayub Khan, and World Bank VP William Illiff
April 1, 1960	Treaty effective date	The treaty's effective date precedes the signing date
1960–1970	Transition period	India supplies water from eastern rivers to Pakistan until Pakistan builds canal system for western rivers
1965	Indo-Pak war	Water supply to Pakistan under treaty not interrupted despite conflict
Post-1960	Permanent Indus Commission established	Commissioners from both countries meet annually for dispute resolution and cooperation
April 23, 2025	India suspends the Indus Waters Treaty	Following a terrorist attack in Jammu and Kashmir, India halts water flow to Pakistan and downgrades diplomatic ties

Figure 5. Timeline of significant events related to the Indus Waters Treaty from 1947 to 2025

IX. CONCLUSION

The Indus River system serves as a lifeline for South Asia, with a total river length of approximately 3,180 kilometers and a drainage basin measuring about 1.12 million square kilometers, supporting more than 300 million people in India, Pakistan, China, and Afghanistan. This river system once nourished one of the earliest civilizations in the world, and continues to define the culture, economy, and ecology of South Asia. The Indus River system annually transports approximately 243 cubic kilometers of water, which is nearly double the flow of the Nile River, and sustains significant agriculture, particularly in Punjab - often referred to as the 'Granary of India' - where more than 80% of the irrigated arable land is supported by water from the Indus River system. However, there are looming threats to the river system. Himalayan glaciers, that provide approximately 70% the flow of the Indus River, are melting at a rate of 10-15 meters per year due to climate change, and the meltwater flows disrupt the availability of water while increasing risks of flooding. Pollution in the river from plastics and untreated waste have degraded overall water quality and have created health risk from exposure for human and aquatic life, and the river is now a major contributor to the volume of ocean plastics. As agriculture accounts for 91% of freshwater use in South Asia, poor allocation and management of water contributes to water loss of as much as 30% perpetuating the scarcity. Adapting to these challenges require transboundary cooperation, pollution interventions, and sustainability practices.

The Indus River's preservation is vital not only for environmental balance but for the survival and prosperity of millions in the region today and in the future.

REFERENCES

- [1] E. C. Tahira Syed, "Scale interactions in transboundary water governance of the Indus River," 2018.
- [2] G. o. I. Ministry of External Affairs, "Indus Waters Treaty, 1960: Agreement between India and Pakistan on Water Sharing," 2005.
- [3] S. N. A. S. S. J. S. Abdul Rauf Kalair, "Water, energy and food nexus of Indus Water Treaty," *Science of The Total Environment*, 2019.
- [4] H. D. Shalabh Agarwal, "Hydroelectric potential and water management in Sutlej River basin," 2023.
- [5] M. Simons, "Hydropower development and water use efficiency in the Beas River basin," 2019.
- [6] A. B. Sharma, "Hydrological and Cultural Significance of the Ravi River under the Indus Basin Management," 2024.
- [7] A. K. Sharma, "The Sindhu River and Its Role in Shaping Ancient Indian Civilization," 2023.
- [8] R. K. Singh, "Ancient Water Management Systems of the Indus Valley Civilization," 2022.
- [9] E. B. contributors, "Indus River – Irrigation, Agriculture, Civilization," 2025.
- [10] B. K. a. M. Moubarak, "Restoring Ancient Ahar-Pyne Water Systems: A Rebirth of Traditional Farming Practices in India," 2025.
- [11] Z. Gardezi, "The Effectiveness of the Indus Waters Treaty 1960: A Case Study of the 1999 Baglihar Hydroelectric Project and 2007 Kishanganga Hydroelectric Plant," 2020.
- [12] I. B. f. R. a. D. (. Bank), "The Indus Waters Treaty 1960 and the Role of the World Bank," 2025.
- [13] D. I. E. Team, "60 Years of Indus Water Treaty: Evolution and Impact," 2020.
- [14] H. Aeman, "Quantifying the impacts of saltwater intrusion in the Indus Delta," 2023.
- [15] A. A. Siyal, "Impact of Climate Change in the Indus River Delta and Coastal Region of Pakistan," 2023.
- [16] S. Janjua, "Water management in Pakistan's Indus Basin: challenges and solutions," 2021.
- [17] J. Tariq, "Pollution status of the Indus River, Pakistan, through heavy metals," 1996.
- [18] W. Bank, "Announcement of Indus Water Treaty Signed," 2019.
- [19] V. & R. IAS, "Indus Water Treaty 1960, Map, Key Features, Timeline," 2025.
- [20] U. N. T. Series, "The Indus Waters Treaty 1960," 1962.
- [21] I. C. o. W. A. (ICWA), "The Suspension of the Indus Water Treaty: Its Implications," 2025.