IWRM and the Indus River Basin: Principles, Frameworks, and Strategies for Effective Implementation

Dr Bushra Bibi[*]*, Dr Ke Jian*[**] *& Abid Hussain* [***]

Abstract

The Indus River Basin is a critical water resource management region, particularly in view of growing demand and climate change impacts on one of the most vulnerable parts of the world. The Integrated Water Resources Management (IWRM) offers a promising approach to effectively managing the basin's water resources. This paper explores the journey of IWRM; defines its principles and underpinnings, and assesses their applicability to the Indus River Basin. Additionally, in this paper an Integrated River Resources Framework is proposed as a way forward to implement IWRM effectively. This research also examines the policy and legal framework required for successful implementation while outlining the necessary institutional and management strategies. In conclusion, this study suggests that the successful implementation of IWRM can offer a sustainable strategy to manage water resources within the Indus River Basin Treaty, enabling stakeholders to achieve durable sustainability.

Keywords: Indus River Basin, IWRM, Frameworks, Strategies, Policy, Legal Framework, Institutional Framework

[*] Dr Bushra Bibi is associated with Research Institute of Environmental Law (RIEL), School of Law, Wuhan University, China. She can be reached at bushrafarooq53@gmail.com.

[**] Dr Ke Jian is Professor at Research Institute of Environmental Law (RIEL), School of Law, Wuhan University, China. He can be reached at fxykj@whu.edu.cn.

[***]Abid Hussain is associated with Research Institute of Environmental Law (RIEL), School of Law, Wuhan University, China. He can be reached at abid@whu.edu.cn.

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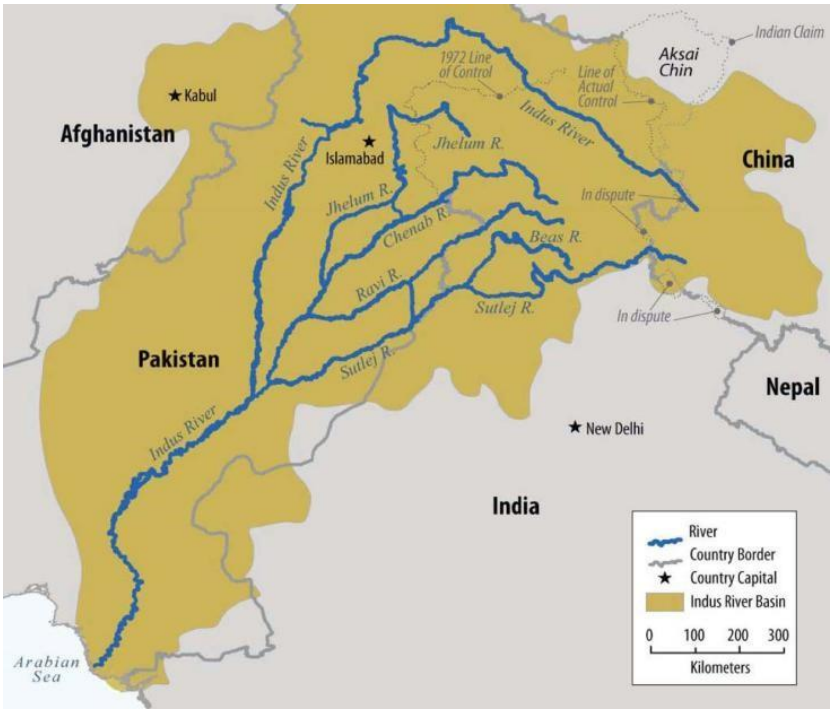
Introduction

The Indus Basin, originating from the Tibetan Mountains and spanning Pakistan, India, China, and Afghanistan, is the lifeline for over 300 million people. However, the basin faces a range of environmental and legal challenges as the region's water resources are strained due to population growth, industrialisation, and climate change. The Indus Waters Treaty signed between India and Pakistan in 1960, through the office of the World Bank aimed at facilitating equitable water resource sharing, but political differences, especially between India and Pakistan, have partially impeded its effective implementation.



Source: Map by Author

Map of Indus Basin

Water scarcity, climate change, and pollution have reduced the region's water quality and quantity, straining water management systems. The IWT also ignored climate change and other environmental issues, requiring urgent changes. Climate change is a serious threat in the Himalayas region.[2] Glacial retreat, diminishing ice mass, early snowmelt, and increasing winter stream flow indicate that climate change has already influenced the Himalayan cryosphere. The Indus basin is sensitive to climate change because snowmelt and glacier melt from the Western Himalayas contribute a large percentage of its water.[3] The world's most strained basin is the Indus since the water quality is deteriorating in the Indus Basin due to pollution. The Indus is also among the top 10 rivers for plastic contamination.[4]

Another contentious issue is the construction of dams. Water scarcity and increasing demand causes interstate conflict in the Indus region. Pakistan and India sorely need water to grow their economies due to their agro-based economies. Moreover, due to massive population growth, water demand for irrigation and energy has also increased manifold. Their hydroelectricity production ambitions to power their large businesses and meet the demands of ever increasing population growth has complicated the water issue. This has caused a record drop in per capita water accessibility.

The best way to manage transboundary water resources is through an integrated approach where cooperation among riparian states is vital for sustainable progress, and managing collective water resources.

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[2] Shrestha, Uttam Babu, Shiva Gautam, and Kamaljit S. Bawa, "Widespread climate chang e in the Himalayas and associated changes in local ecosystems," *PloS One* 7, no. 5 (2012): 36741.

[3] Lone, Suhail A., Ghulam Jeelani, Virendra Padhya, and R. D. Deshpande, "Identifying an d estimating the sources of river flow in the cold arid desert environment of Upper Indus River Basin (UIRB), western Himalayas," *Science of The Total Environment* 832 (2022): 154964.

[4] Hojjati-Najafabadi, Akbar, Mojtaba Mansoorianfar, Tongxiang Liang, Khashayar Shahin, and Hassan Karimi-Maleh, "A review on magnetic sensors for monitoring of hazardous p ollutants in water resources," *Science of The Total Environment* 824 (2022): 153844.

IWRM is a sophisticated and ecologically sound approach for managing water resources sustainability.[5] It harmonises economic, social, and environmental considerations and engages stakeholders in decision-making through regional cooperation. IWRM is iterative, continuously improving, and tailored to the unique characteristics of each river basin. It coordinates water resource management across all sectors and scales, from local to global, emphasising stakeholder participation and good governance. Tools such as environmental and social assessments, policy interventions, and monitoring systems support the process.

The traditional sectoral management approach has generally failed to address global water concerns and resolve conflicts between diverse water use sectors and societies. The IWRM offers an alternative by promoting coordinated management across borders. It addresses conflicts between upstream and downstream regions, urban and rural water consumers, hydropower demand, and irrigated agriculture. Achieving sustainable water management through IWRM requires consensus and political commitment, making it a politically sensitive but no less vital challenge.

This research will examine IWRM's development as a promising water resource management strategy. We aim to understand the principles, frameworks, and strategies for an effective IWRM implementation in the Indus River Basin. The institutional and policy frameworks needed to implement IWRM in the Indus River Basin will also be examined. Finally, we will discuss engagement by the stakeholders, capacity building, and monitoring and evaluation for basin-wide IWRM implementation. This research seeks to improve understanding of IWRM and its potential to solve water scarcity and distribution issues in South Asia. We recommend equitable and sustainable outcomes for policymakers and practitioners to improve the region's future.

[5] Overton, I. C., D. M. Smith, and J. M. Kirby, "Implementing environmental flows in integ rated water resources management and the ecosystem approach," *Hydrological Sciences J ournal* 59, no. 3-4 (2014): 860-877.

The Journey of IWRM

Historically, we may trace the origins of the current IWRM paradigm back to centuries, if not millennia. Over millennia, water management has been organised comprehensively and is integrative in the governance of many nations. The history of IWRM's modern formulation dates back to the early 20th century. In Spanish Valencia, for instance, multi-party, participatory water tribunals have existed since at least the tenth century. Spain was likely the first nation to organise a water management plan delineated from political constraints and based on river basins. It approved the system in 1926.[6] Significant efforts have been made to deploy IWRM in several global regions over the past decades. In the 1940s, the Tennessee Valley Authority initiated the development of the region's water resources. Since then, major efforts have been made to adopt IWRM in numerous other global locations.[7] For instance, in 1960, Integrated Water Resources Management Planning was developed in Hessen, Germany, using the same multidisciplinary methodology.[8]

Over the past twenty to thirty years, IWRM has dramatically been transformative, becoming recognised worldwide as a crucial strategy for accomplishing water-related sustainable development goals. The Mar del Plata Action Plan, itself the result of an international water conference held in 1977, can be seen as the genesis of the current demand for integration throughout the water sector.[9] IWRM was incorporated into the Dublin Principles in 1992, a foundation for IWRM's inclusion in Agenda

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[6] O. Varis, M. M. Rahaman, and V. Stucki, "The Rocky Road from Integrated Plans to Implementation: Lessons Learned from the Mekong and Senegal River Basins," *International Journal of Water Resources Development* 24, no. 1 (2008): 103-121.

[7] A.K Biswas, "Integrated water resources management: A reassessment - A Water Forum Contribution," *Water International* 29 no. 2, (2004): 248–256.

[8] M. M. Rahaman, "Integrated Water Resources Management: Constraints and Opportunities with a Focus on the Ganges and the Brahmaputra River Basins," (PhD diss., Helsinki University of Technology, 2009), https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=e03f5ea25147fa17141e538327710772cf7a0526.

[9] Martinez-Santos, Pedro, Maite M. Aldaya, and M. Ramón Llamas, ed., *Integrated water resources management in the 21st century: revisiting the paradigm* (London: CRC Press, 2014).

21 of the "United Nations Conference on Environment and Development (UNCED)."[10] The goal is to better manage water resources by integrating the various existing water-related services through effective management and appropriate infrastructure.[11] To foster stability through the sustainable development, management, and utilisation of water resources, the Global Water Partnership (GWP) was founded in 1996. It aimed to encourage IWRM and provide an international platform for dialogue among businesses, government agencies, water users, and environmental organisations. In 2002, "the World Summit on Sustainable Development" in Johannesburg reiterated the call for the development of IWRM, with all participating countries agreeing to create IWRM and water efficiency plans.[12]

A series of events, including "The International Conference on Water and Environment (1992), the Second World Water Forum (2000), the International Conference on Fresh Water (2001), World Summit on Sustainable Development (2002), and Third World Water Forum (2003)," contributed to significant advancements that propelled IWRM to the forefront of political agendas.

Definition of IWRM

The international water sector gathered in the Hague in 2000, for the second World Water Forum. In preparation for this event, the Global Water Vision was established. The 2000 Global Water Vision exercise consisted of "not just to speed up the implementation of the Dublin principles, but also to propose a comprehensive set of practical principles for implementation."[13] Notwithstanding the effort to be practical, the Vision document's glossary defines IWRM as

[10] Cherlet, Jan. "Tracing the emergence and deployment of the Integrated Water Resources Management' paradigm," Paper presented at the 12th EASA Biennial Conference, Ghent University, Department of Third World Studies, France, July 2012, https://biblio.ugent.be/publication/2964994.
[11] Agenda 21, chapter 18.3.
[12] Agenda 21...
[13] W. J. Cosgrove and F. R. Rijsberman, *World Water Vision: Making Water Everybody's Business (*England: Earthscan, 2000).

> *"A philosophy that holds that water must be viewed from a holistic perspective, both in its natural state and in balancing competing demands on its agricultural, industrial and environmental. Water resources and services management must reflect the interaction between these different demands and so must be coordinated within and across sectors. If the many crosscutting requirements are met, and if there can be horizontal and vertical integration within the management framework for water resources and services, a more equitable, efficient, and sustainable regime will emerge."*[14]

After having observed that "an unambiguous definition of IWRM does not currently exist," the GWP presented in 2000 a definition of IWRM in two parts: 1. "What is IWRM? And 2. How to implement IWRM"?

Furthermore, the GWP (2000) has established a definition according to which IWRM is "a process that promotes the coordinated development and management of water, land, and related resources, in order to maximise the resultant economic and social welfare equitably without compromising the sustainability of vital ecosystems."[15]

A few key elements are derived from these definitions:

- IWRM emphasises coordination among all stakeholders.
- It prioritises economic, social, and environmental well-being.
- It bases judgments on scientific data/tools.
- For its precise implementation, democratic governance is emphasised.

Thus, it is important to note that IWRM is a process used for evaluation and program evaluation, not a sheer product. Ideally, IWRM's principles,

[14] Olli Varis, Konrad Enckell, and Marko Keskinen, "Integrated water resources manageme nt: horizontal and vertical explorations and the 'water in all policies' approach," *Internati onal Journal of Water Resources Development* 30, no. 3 (2014): 433-444.

[15] Peter Rogers and Alan W. Hall, *Effective water governance* (Sweden: Global Water Partn ership, 2003).

strategies, and regulations must be tailored to each country, territory, or river basin.

Principles of IWRM and their applicability to the Indus River Basin

In future, problems and issues about water and the environment are anticipated to deepen and expand, and water resources will need to be managed more comprehensively to avoid regional and international conflicts. IWRM promotes a comprehensive approach to water management that incorporates the administration of all sectors that use or are affected by water. The Dublin principles are the first significant international endeavor to clarify concisely the central issues and objectives of water management.[16] The principles are based on four major themes: the environment, economics, social requirements, and the role of women, with sustainability as the overarching objective.[17] These principles are discussed below in the context of the transboundary Indus basin.

1) **Ecological:** Fresh water is a limited and perilous resource indispensable for sustaining life, development, and the environment.[18]

IWRM, which aims to manage water resources sustainably, is based on the "Dublin Principle 1." Recognising environmental and social values while balancing sustainable growth is necessary. New organisations and regulations are needed to coordinate water use across sectors, with basin-level organisations empowered to manage water resources within a

[16] Solanes, Miguel, and Fernando Gonzalez-Villarreal, "The Dublin Principles: Institutional and legal arrangements for integrated water resource management," *Water and Developm ent* no.1 (2009): 34-52.
[17] Georg Meran , Markus Siehlow , Christian von Hirschhausen, *The Economics of Water: Rules and Institutions* (Switzerland: Springer, 2021).
[18] Smith, Mark, and T. Jønch Clausen, "Integrated water resource management: A new way forward," *World Water Council* 152, no. 1–3 (2015): 333-338.

hydrological boundary.[19] Integration at multiple levels is required to ensure that efforts to improve water quality are coordinated locally, nationally, and internationally. Data collection and distribution must be rigorous to coordinate water resource management across physical and socio-economic measures.

IWRM would apply a holistic and integrated approach to managing the Indus River basin's water resources. This would require balancing the water needs of agriculture, industry, and households with those of the environment and ecosystem. It would also involve promoting efficient and sustainable use of water resources, reducing water waste and losses, and improving water storage and distribution systems to increase water availability and resilience. The Indus River basin stakeholders would also need to collaborate to create and implement water policies, laws, and regulations that promote equitable and sustainable water use for future generations.

2) **Decentralisation:** Participation from people who plan for, make use of, and make decisions regarding water resources is required at every stage of the process of developing and managing water resources.[20]

This participatory approach aims to educate policymakers and the public about water issues. IWRM requires decentralisation because effective organisations and institutions must be near resource management. Stakeholder and public participation are essential to decentralising water management reforms.[21] The second IWRM strategy involves assigning the

[19] Jusi Sari, "Integrated water resources management-a paradigm to sustainable development in Lao PDR," *Progress in Industrial Ecology, an International Journal* 7, no. 4 (2012): 307-321.
[20] Smith, Mark, and T. Jønch Clausen, "Integrated water resource management: A new way forward," *World Water Council* 152, no. 1–3 (2015): 333-338.
[21] Pahl-Wostl, Claudia, "The role of governance modes and meta-governance in the transfor mation towards sustainable water governance," *Environmental Science & Policy* 91 (2019): 6-16.

management of water resources to the lowest effective administrative level, fulfilling the second Dublin principle's subsidiarity goal.[22]

This principle is specifically crucial for the Indus River Basin. Taking the examples from the world, one realises that several nations share the basin, each with their own priorities. Governments, civil society organisations, and local communities must work together for basin management to succeed. Participatory water management in the Indus River Basin can take several forms. For instance, local communities can be involved in water management decisions. Similarly, examples may include consultation, information sharing, and active involvement in water project planning and implementation. Another option involves agriculture, industry, and domestic users in water resource management. Water allocation plans that considers the needs of all sectors and water user associations to enable stakeholder participation in water resource management can be created to accomplish this. Participatory management can also foster cooperation among Indus River Basin nations. This may include the examples of joint projects, data, and information sharing, and institutional frameworks for cooperation and coordination.

In conclusion, participatory management is a key component of IWRM and essential for sustainable water resource management and development in the Indus River Basin. Water management must include all stakeholders at all levels due to the basin's complexity and competing demands.

3) **Participation:** Women play an essential part in the provisioning, management, and protection of water resources.[23]

[22] Global Water Partnership (GWP), *Integrated Water Resources Management* (Sweden: Global Water Partnership Secretariat Technical Advisory Committee, 2000).
[23] Meinzen-Dick, Ruth, and Margreet Zwarteveen, "Gendered Participation in Water Management: Issues and Illustrations from Water Users' Associations in South Asia," *Agriculture and Human Values* 15, no. 4 (1998): 337-345.

IWRM also emphasises the significance of incorporating community-based groups, water user associations, and other stakeholders in the management process. Sustainable water resource management is IWRM's long-term goal. This requires building the capacity of these organisations and stakeholders and promoting gender consciousness and inclusiveness to ensure the participation of women and vulnerable groups. Regardless of the degree of centralisation in water resources management, the participation of water users and interest groups is essential for fostering an enabling environment and securing the commitment and success of IWRM. [24] This principle acknowledges women's role in water management as primary caregivers and providers of domestic water, sanitation, and hygiene. Women can improve water resource management and sustainability by using their water management knowledge and skills.

Women's central role in water supply, management, and protection is relevant in the Indus River Basin also. The Indus River provides water, means of transportation, food for millions of people in the region, and all the stakeholders, including women, must participate in its management and governance. Women collect water from distant sources, manage household water use, and ensure agriculture and livestock have water in more or less all Indus River Basin rural areas.

However, women's participation in water management decision-making is often limited and undervalued. To address this, efforts are underway to increase women's participation in water management and decision-making in the Indus River Basin. For instance, the International Water Management Institute (IWMI), Sri Lanka, has partnered with local organisations to train women in water management, improve their access to water resources, and increase their participation in community-level water management committees.

[24] Jan Hassing, Niels Ipsen, Torkil Jønch Clausen, et al, *Integrated Water Resources Management in Action* (Paris: *UNESCO*, 2009).

The World Bank-supported Indus Basin Initiative also works to increase women's participation in water governance and management, recognising their importance to sustainable water management in the region.[25]

4) **Sustainability:** Water should be acknowledged as both an economic and a social benefit because it possesses monetary worth across all of its potential applications.[26]Rising water supply costs and inefficiencies in water service delivery have shown the economic value of water in many countries. Water must be priced at full cost to ensure long-term sustainability, including withdrawal, delivery, opportunity cost, and economic and environmental externalities.[27] Water should be used by sectors that value it most, so laws and policies should establish clear water use rights and create markets for trading them (while protecting social and environmental concerns). Long-term water management in the Indus Basin requires recognising water's economic and social worth. Recognising water's economic value in agriculture, industry, and domestic use is necessary to sustainably and equitably manage water supplies. In the Indus Basin, water is scarce and used for numerous reasons. Given water's importance in various industries, recognisng it as an economic and social good and encouraging sustainable water management practices is critical.

Recognising water's economic value can help solve some of these problems by encouraging more efficient and sustainable water use. Farmers may be encouraged to use more efficient irrigation methods that reduce water waste and boost crop yields by pricing water according to its economic value. Water-efficient technologies that reduce water use and save money may also be encouraged for industries.

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[25] Menezes,Debbie; Hensha,Taylor; Fruman,Cecile, *South Asia Water Initiative (SAWI) : Annual Report for July 2019 - June 2020 (English)* (Washington, D.C.: World Bank Group, 2020).

[26] Semdoe Mary, "Effects of Human Settlement and Activities on Water Resources in Morogoro Region: A Case of Mlali Ward in Mvomero District," (PhD diss., Mzumbe University, 2015).

[27] James Winpenny, *Managing Water as an Economic Resource* (London: Routledge, 2005).

This principle must be balanced with social and environmental considerations. For example, high water prices may disproportionately affect low-income households and not be socially equitable. Environmental factors like river ecosystem health and biodiversity must also be considered when allocating water resources.

Integrated River Resources Framework in the Indus River Basin: A Way Forward

Entrenched mindsets, complex issues, political barriers, mistrust, and negative perceptions can hinder progress in the division of the Indus River Basin water. Its management must be integrated and sustainable to address these issues. Indus water management can learn from the Integrated River Basin Management (IRBM) framework, which has been successful worldwide.[28] Successful practices applied by Australia, the US, and South Africa drawn from the IWRM framework, can be replicated to the Indus River basin also.[29] Land, water, plants, knowledge, and people must be managed sustainably in a similar manner. Mutual confidence and trust amongst all the Stakeholders must be built by sharing a vision of water challenges faced by all the affected countries.

The Indus Basin Treaty fairly recognises the risks and uncertainties of ensuring a sustained water supply from upstream sources to meet the needs of the downstream. This includes environmental factors affecting annual and seasonal water supply. Thus, the future management strategy must balance land, water, vegetation, and socio-economic factors to ensure sustainable development. The IWRM framework can help achieve this balance by addressing climate change adaptation and disaster reduction, which are increasingly important in the Indus Basin due to climate and socio-economic changes.

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[28] Gupta, Ashim Das. "Challenges and opportunities for integrated water resources management in Mekong river basin," *Role of Water Sciences in Transboundary River Basin Management* (2005): 221-230.

[29] Bruce Hooper, *Integrated River Basin Governance, Learning from International Experien ce* (London: IWA Publishing, 2005).

To manage water in the Indus Basin, a comprehensive, coordinated, sustainable, and ecologically friendly plan is required. This strategy should take into account upstream, downstream, and future generations. IWRM can assist sub-basin and basin managers in achieving these objectives.[30] The Indus River Basin has many sub-basins and transboundary catchments, so a basin-wide framework for IWRM is necessary. This framework can be used across national boundaries to manage water resources efficiently and fairly. Basin-wide data collection is needed to adopt an IWRM framework. This data can create basin-wide and sub-basin water resources management and sustainable development plans. These measures will help the Indus Basin manage water efficiently, fairly, and with sustenance.

The Global Water Partnership's IWRM toolbox helps implement the management of the integrated water resources. IWRM requires adjustments across many sectors and levels while realising a one-size-fits-all blueprint is impossible. Thus, the GWP's toolbox offers a variety of means and methods for IWRM practitioners to choose and use based on their needs. The tools fall into three main categories:[31] "(a) Legislative framework, (b) Institutional Roles, and (c) Management Instruments."

The Policy and Legal Framework for Implementing IWRM in The Indus Basin

The Legislative framework is the legal infrastructure for managing and regulating water resources, including the constitution, legislation, laws, treaties, policies, and regulations for sustainable resources management

[30] Karki, Manoj B., Arun B. Shrestha, and Matthias Winiger. "Enhancing Knowledge Management and Adaptation Capacity for Integrated Management of Water Resources in the Indus River Basin," *Mountain Research and Development* 31, no. 3 (2011): 242-251.

[31] Meran, Georg, Michael Siehlow, and Claudia vonHirschhausen, "Integrated Water Resource Management: Principles and Applications," *The Economics of Water* (2021): 23-121.

and development.[32] Incorporating the IWRM principles of "integration, decentralisation, participation, and sustainability," policies should adopt a comprehensive approach towards water management, recognising its intrinsic value and accounting for the needs of all potential users, land uses, and water quality. This involves safeguarding the rights and interests of all stakeholders while protecting public assets.

A policy and legal framework for implementing IWRM in the Indus River Basin is required. A comprehensive water law that establishes a legal framework for water allocation, management, and conservation could be developed. The law should include dispute resolution and law enforcement mechanisms. The following are some of the framework's key elements:

National Water Policy

Revising a national water policy is the first step in implementing IWRM in the Indus River Basin. Policies at the national level are critical because they lay the groundwork for things like lawmaking, long-term strategy, and day-to-day management. The states that share the Indus basin must ensure the making and revision of national water policies based on IWRM principles as a top priority. The development of this policy should involve input from a wide range of sectors, including agriculture, industry, and civil society. Given the dynamic nature of a country's political, economic, social, environmental, and technological landscapes, the policy must be flexible and adaptable over the medium term. It requires constant attention and revision. The policy's top priorities should be ensuring that water is used effectively, protecting water quality, and equitably distributing water among various users.

[32] Qadir, Shireen Ali. "Integrated Water Resources Management: Case Study of Iraq," (PhD diss., Faculty of Political Science, Public Administration and Diplomacy, Notre Dame University, Louaize, 2010).

Regional Water Laws

The existing water laws in the Indus River Basin Treaty need to be updated to align with the principles of IWRM. The laws should address water allocation, quality, and conservation issues. In order to encourage the participation of stakeholders in the administration of water resources, the laws should also allow the formation of water user associations. Changes in environmental and demographic conditions on both sides of the border necessitate revising the Indus Water Treaty's dispute resolution mechanism to align it with modern international law governing watercourses. Surface and subsurface water resources are included in the scope of international watercourse law, which regulates their use and protection wherever they flow across international borders. Water issues should be decoupled from other unresolved matters between the two countries, and prioritising the resolution of water disputes should be a key component of future confidence-building measures.

Water Allocation and Management

Water allocation and management are critical components of IWRM, and a policy and legal framework should define the principles and rules for water allocation and management based on equity, efficiency, and sustainability. This could involve the development of a water allocation plan that considers the needs of different users, such as agriculture, industry, and households, and ensures that water is used in an environmentally sustainable way. The plan should also establish mechanisms for monitoring and enforcing water allocation rules.

Environmental Protection

Environmental protection is a key component of IWRM, and a policy and legal framework should include provisions for protecting and conserving the environment and biodiversity in the Indus River Basin. This could involve establishing protected areas, such as wetlands, forests, and riverine ecosystems, and developing strategies to manage water-related environmental risks, such as floods and droughts. The policy should also

establish mechanisms for monitoring and enforcing environmental protection rules.

Water Infrastructure

Water infrastructure, such as dams, canals, and irrigation systems, is critical for the efficient use and management of water resources, and a policy and legal framework should support the development of water infrastructure that is efficient, safe, and sustainable. This could involve establishing standards and guidelines for the design, construction, operation, and maintenance of water infrastructure, as well as measures to ensure that the benefits of water infrastructure are equitably distributed among stakeholders.

Monitoring and Evaluation

A policy and legal framework should monitor and evaluate IWRM implementation in the Indus River Basin. A monitoring and evaluation system could track IWRM goals and targets and evaluate policies, laws, and programs. The upper basin needs long-term monitoring and database development and sharing. This program would give water managers and policymakers the possible trends and scenarios of the basin and sub-basin. This initiative would strengthen national and regional research capacities, creating an integrated river basin-wide database and information system (IRBIS). This database addresses key Indus Basin issues. Data also helps water resource planners and managers plan and design water infrastructure and implement development programs and projects to meet future supply demands. Laws should regulate water quality and pollution. Pollutant limits and water quality should be regulated. The law should also monitor water quality and enforce regulations.

Institutional Framework

Institutional roles encompass a variety of elements, such as official policies and procedures, traditional customs and habits, knowledge and information, and networks of stakeholders and communities. These factors together form the institutional framework or context within which

decision-makers make their choices. An institutional framework is essential to coordinate stakeholders' efforts and facilitate collaboration and cooperation. This could involve establishing a River Basin Organisation (RBO) that brings together representatives of different stakeholders to coordinate the planning and management of water resources in the basin. The RBO should have the authority to make water allocation and management decisions and should be supported by technical and administrative staff.

River Basin Organisation

A RBO can be established to manage the Indus River Basin's water resources. It can be a platform for cooperation among the riparian countries and can facilitate dialogue, negotiation, and coordination to manage the basin's water resources. Various insights can be gleaned from the experiences of the Mekong and Orange-Senqu River Basins that apply to the Indus River Basin. Cooperation among "Cambodia, Laos, Thailand, Vietnam, China, and Myanmar," the six countries sharing the Mekong River, is crucial in successfully implementing IWRM in the region.[33] The Mekong River Commission (MRC), established by these nations, is responsible for coordinating the management and development of water resources in the Mekong River Basin. Similarly, the 2000-founded ORASECOM manages the Orange-Senqu River Basin's water resources in "Botswana, Lesotho, Namibia, and South Africa."[34] ORASECOM promotes sustainable basin water management and equitable water resource usage. Stakeholder participation, a basin-wide water management vision, and integrated water resources management have been achieved by ORASECOM.

Global experience in river basin management has demonstrated the importance of establishing a long-term vision for the entire river basin,

[33] Ha Mai-Lan, "The role of regional institutions in sustainable development: a review of the Mekong River Commission's first 15 years," *Consilience* 5 (2011): 125-140.
[34] Mirumachi Naho and E. Van Wyk, "Cooperation at different scales: challenges for local a nd international water resource governance in South Africa," *Geographical Journal* 176, no. 1 (2010): 25-38.

supported by major stakeholders and accompanied by an appropriate water management strategy at the river basin level.[35]

The Indus consultation should also strive to unite all stakeholders in developing a shared vision and strategy. Both India and Pakistan should use the platform of the South Asian Association of Regional Cooperation (SAARC) to address water management and agricultural growth issues. By focusing on increased interaction and collaboration among member countries, they can explore solutions for water management through joint hydropower projects and energy exchanges between the two nations.[36]

Stakeholder Participation

The involvement of diverse stakeholders, including scientists, researchers, managers, and policymakers, is crucial for conducting action research on long-term impacts and vulnerability analysis in the Indus Basin region. These stakeholders are needed to design and implement effective adaptation strategies by producing and sharing data and information on various aspects of climate and environmental changes, particularly in river runoff, hydrology, and the water cycle.[37] The strategy ought to be nested, with research conducted at various scales and with a focus on various themes.

Data and Information Management

Researchers, scientists, and water managers in the Indus River Basin need updated spatial and non-spatial data. Regional studies and scenario projections must be more detailed for effective Indus water resource

[35] Tim Jones, "Elements of good practice in integrated river basin management. A Practical Resource for implementing the EU Water Framework Directive," Paper presented at Water Seminar Series, World Wide Fund for Nature, Brussels, Belgium, 2001.

[36] Bruce Hooper, "Covenant action to facilitate integrated river basin management," *Water SA* 34, no. 1 (2008): 456-460.

[37] Madhav Bahadur Karki, Arun Bhakta Shrestha, Matthias Winiger, "Enhancing knowledge management and adaptation capacity for integrated management of water resources in the Indus River Basin." *Mountain Research and Development* 31, no. 3 (2011): 242-251.

management. Water resource research must be interdisciplinary. Resource managers must manage "too much" and "not enough" water scenarios using integrated and transboundary approaches.[38] There also needs to be a continuous focus on fostering long-term communication between management and academics.[39] Understanding how natural, social, and economic factors affect the Indus Basin's ecosystems and water supplies requires a solid scientific foundation. The local community and water managers must cooperate in implementing the program.

A formalised system for sharing the hydrology of ongoing and future river projects is needed to ensure fair water distribution. A satellite-based data collection system is recommended to eliminate data transfer scepticism and for implementing a satellite-based data collection system. The cost of such a system should be borne by both countries.

Financing Mechanisms

Water is an essential resource and an economic asset in every country. Financial principles can improve water resource distribution and water facility growth. Regardless of income, everyone should access a minimum amount of safe water. Economic instruments should be designed to promote water distribution efficiency and equity using value and price principles. This approach can improve water resource management's allocative and technical efficiency, supporting the Indus Basin's social and economic development.[40] An agriculture tax that addresses constitutional and legal flaws preventing large farmers from being taxed could be a solution. This tax can improve government irrigation infrastructure and services, benefiting the region.

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[38] Daniel P Loucks and Eelco Van Beek, *Water resource systems planning and management: An introduction to methods, models, and applications* (New York: Springer, 2017).

[39] Daniel Viviroli, David R. Archer, Wouter Buytaert, et al, "Climate change and mountain water resources: overview and recommendations for research, management and policy," *Hydrology and Earth System Sciences* 15, no. 2 (2011): 471-504.

[40] Government of Pakistan, " Chapter 20, Water, *" Pakistan Economic Survey 2010-2011*, 228-49, Retrieved from https://www.pc.gov.pk/uploads/plans/Ch20-Water1.pdf.

Political Will

Both/all sides must show the political will to jointly manage the Indus Basin without politicising the issue. A joint group must harmonise tools, models, and scenarios, exchange information, involve stakeholders, and work with international organisations to conduct a basin-wide vulnerability assessment.[41] Historic grievances and other issues such as Kashmir should not be discussed during the Indus Waters Treaty talks/parleys. Instead of fighting over water, both sides should use it to develop cooperation. Pakistan and Afghanistan should cooperate in developing Kabul River water resources and protecting Pakistan's historic water rights, emphasising the need for dialogue.

The upper riparian holds regional hegemony and all the cards. The Institute of Defense Studies in India calls India the "epicenter of riparian politics," emphasising the need for change in India. Thus, brave and open-minded Indians must explain to the public why this is a crucial issue for Pakistan.

Management Strategies

Water management policies are implemented through various tools and techniques, such as water structures, technologies, and other instruments. These instruments are designed to tackle specific management issues and provide decision-makers with options. Essentially, management instruments make informed and logical decisions by offering alternative courses of action.[42]

Water Allocation

The management framework should establish a transparent and participatory process for water allocation based on principles of equity,

[41] Sarfraz Hamid, "Revisiting the 1960 Indus waters treaty," *Water International* 38, no. 2 (2013): 204-216.

[42] Masud Alam and Philippe Quevauviller. "An evaluation of Integrated Water Resources Management (IWRM) activities in Bangladesh," *Asia Pacific Journal of Energy and Environment* 1, no. 1 (2014): 22-38.

efficiency, and sustainability. This includes defining water rights and entitlements and developing water allocation plans that consider the needs of different sectors and the impacts of climate change and other environmental factors.

Water Use Efficiency

Enhancing the efficiency of water usage constitutes an essential aspect of IWRM within the Indus River Basin. This includes promoting efficient irrigation practices, such as drip and sprinkler systems, and reducing water losses due to leakage and evaporation. It also involves encouraging water-saving technologies and practices in other sectors, such as industry and domestic water use.

Water Quality Management

The management framework should address water quality issues in the Indus River Basin, including controlling water pollution from point and non-point sources. This includes developing water quality standards and monitoring programs and implementing appropriate treatment and disposal measures for wastewater and industrial effluents.

Environmental Sustainability

The management framework should protect and improve the Indus River Basin ecology and help to promote biodiversity and ecosystem conservation while ensuring environmentally sustainable water resource development projects.

First, IWRM optimises basin water resource allocation. The Indus River Basin's ecological balance depends on agriculture, and efficient water management can help maintain the river's environmental flow. IWRM principles can sustainably allocate water to different sectors while considering environmental and human needs.

Second, IWRM can promote basin renewable energy use. IWRM can help small hydropower projects in the Indus River Basin. These projects can reduce fossil fuel use and promote regional sustainability.

Thirdly, IWRM helps manage basin wastewater. Untreated wastewater is a major environmental issue in the Indus River Basin. IWRM principles can treat and reuse wastewater for agriculture or other purposes, reducing river and groundwater stress.

Finally, IWRM can conserve and restore basin ecosystems. IWRM can protect biodiversity in the Indus River Basin by ensuring water flow and quality. It can also help restore degraded ecosystems, which is essential for basin ecology.

Climate-informed Water Management

IWRM can help the Indus River Basin deal with climate change by encouraging a more holistic and integrated water resource management approach. This approach considers the interactions of agriculture, industry, and households with the environment. IWRM can balance water demands by bringing stakeholders together and encouraging cooperation and collaboration.

IWRM can help water resources adapt to climate change. Improved irrigation practices, better water storage and management, and early flood and drought warning systems can achieve this. IWRM can help mitigate climate change's effects on ecosystems and biodiversity by protecting and restoring wetlands and other vital habitats.

Finally, IWRM can reduce greenhouse gas emissions and mitigate climate change by adopting sustainable and low-carbon water management practices. Promoting renewable energy in water pumping and treatment and reducing water losses through leak detection and repair can reduce the Indus River Basin's water management carbon footprint.

Conclusion

Adopting Integrated Water Resources Management presents a feasible approach to achieving sustainable water management in the Indus River Basin. IWRM is pivotal to attaining Sustainable Development Goals and ensuring the ecological, decentralised, participatory, and sustainable management of water resources in the Indus River Basin. Implementing IWRM in the Indus River Basin will bring numerous benefits, such as improved water availability, enhanced water quality, and increased social and economic development. However, several challenges, including limited financial resources, conflicting interests of stakeholders, and inadequate legal frameworks, may deter the successful application of IWRM in the region.

To overcome these challenges, an integrated river resources framework in the Indus River Basin, coupled with a robust policy and legal framework and institutional capacity building, will be essential. Furthermore, cooperation and collaboration among all stakeholders, including China and Afghanistan, will be crucial for implementing IWRM in the Indus River Basin. Despite all these issues and challenges, one may surmise the IWRM as a decisive tool for sustainable water management in the Indus River Basin, and its successful implementation will require collaborative efforts and a comprehensive approach from all the stakeholders.■