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A Survey on Land Irrigation Types and Survey of Malwa Region

Suprant Sharma, Asst. Prof. Hariram Rathore
Dept Of Civil Engineering
EKLAVYA UNIVERSITY
DAMOH, Madhya Pradesh- 470661

Abstract: The importance of irrigation in agricultural development and its impact on various aspects of farming is high. To study this kind of research needs an interdisciplinary approach, combining environmental science, hydrology, economics, and social sciences to comprehensively evaluate the proposed inter basin water transfer and lift scheme in the Malwa Plateau Region. This paper brief different types of irrigation apply in India, MP region. Further a deep survey of the Malwa region was done in the paper for the analysis of irrigation and steps to be taken to improve it more.

Keywords: Irrigation, Soil, Biodiversity.

I. INTRODUCTION

Irrigation involves using groundwater and surface water to supply the necessary amount of water to crops. This process ensures that agriculture remains a primary driver of production. However, if proper water supply is lacking, the use of fertilizers, seeds, pesticides, and other agricultural inputs will prove ineffective in generating a good yield.

When irrigation by gravity is feasible, much of the infrastructure installation can be accomplished through manual labor. However, employing technical aids in construction and earthmoving tasks can offer economic advantages, even in countries with low wage levels. In cases where gravity alone cannot deliver the required water to the land, pumping installations become necessary. Formerly, and to some extent still today, human and animal muscle power drove these pumping systems. However, modern mechanical sources of power have significantly improved water pumping efficiency, enabling the use of groundwater from considerable depths. Moreover, with the aid of sprinkler systems, irrigation can reach areas that would otherwise be economically unviable for cultivation.

Agricultural development is a complex process, influenced by various factors, both physical and non-physical in nature. One of the primary obstacles to modernizing agriculture is the lack of irrigation facilities. Regions with the least irrigation potential tend to lag behind in agricultural production.

Emphasizing irrigation has the advantage of ensuring a consistent water supply, which can synergize with other modern farming practices, leading to increased agricultural productivity and improved rural living standards. There is still a vast untapped potential for further development through the expansion of irrigation systems.

II. RELATED WORK

Charles W. Howe (1999) advocated for unified river basin-based planning and management to address increasing demands and climate change. Water markets were proposed as flexible solutions for water re-allocation at the basin level.

Alan H. Vicor discussed the key components of river basin-based planning and management, emphasizing the importance of integrated approaches, adequate funding, and stakeholder engagement.

Derrel L. Martin et al. (1984) developed a simulation model to estimate the effect of deficit irrigation on crop yield, crucial for economic water management decisions.
Andreas N. Angelakis et al. (1991) studied soil-water distributions in homogeneous soil profiles, focusing on trickle discharge rates and soil types, and their impact on wetting front locations and soil-water content distributions.

Anik Bhaduri et al. (2005) investigated water allocation scenarios when states prioritize the welfare of others. The spatial analysis by Amarasinghe et al. (2005) revealed significant disparities in water distribution, with the Ganga-Brahmaputra-Meghna River Basins draining over 60% of India's water resources despite housing 44% of its population. Cooperative river linking requires efficient institutions and coordination among states sharing water resources.

Nolton G. Johnson et al. (2007) examined the environmental implications of interbasin water transfers in Georgia. They compiled data from various sources to assess the potential adverse effects on river basins of origin. The study aimed to evaluate the impact of interbasin transfers and support water planning decisions.

M.A. Horn (1994) presented a method to estimate interbasin transfers and water use, crucial for accurate basin water budgets. L.C. Kjelstroim et al. (1988) evaluated methods to measure pumped irrigation water in closed-conduit systems, ensuring accurate pumpage data for different field sizes and shapes.

II. IRRIGATION TECHNOLOGY

Irrigation technology is typically categorized into seasonal or perennial, as well as supplementary or primary, based on the role it serves in agricultural practices. Seasonal irrigation involves the regular cultivation of one or, at most, two crops during a single season, making a second cropping cycle challenging.

This classification primarily revolves around the critical factor that no crop can thrive without sufficient water supply. The distinction between seasonal and perennial irrigation hinges on whether the water demand of the crops can be adequately met by natural rainfall. Additionally, the classification of irrigation as supplementary or primary depends on various factors, including the availability of water resources and local conditions. These categories, as outlined by Fukuda (1976), help define the nature and purpose of different irrigation practices.

In recent years, the region has faced significant challenges due to large-scale monsoon failures. During drought years, the success of agriculture is contingent upon efficient management and utilization of available resources, especially those suitable for the existing soil moisture conditions.

Water scarcity is a critical concern, as inadequate water supply deprives plants of essential nutrients and adversely affects crop yields. While natural water supply through rainfall is limited to approximately four months, the development of irrigation technology becomes paramount for sustaining the Indian economy.

In conclusion, understanding the distinct characteristics of irrigation technologies, such as their seasonal or perennial nature and supplementary or primary role, is crucial for making informed decisions on water management and agricultural practices. The efficient and strategic implementation of irrigation methods is vital in mitigating the impact of droughts and ensuring optimal crop production, thereby supporting the overall growth and stability of the Indian agricultural sector.

1.1 Lift Irrigation Technology:

Lift irrigation represents a modern and distinct approach to watering crops, setting it apart from conventional methods like well, canal, and tank irrigation. Over the last five decades, lift irrigation has made significant strides, leaving a profound and far-reaching impact on the agricultural economy of the region. While its implementation requires substantial initial investment, it has been successfully practiced on a cooperative basis along river banks. This research delves into the analysis of lift irrigation technology, examining its developmental spatial characteristics, influence on cropping patterns, and productivity based on primary data. Moreover, the study also scrutinizes the potential negative effects of lift irrigation, which have recently captured the attention of scientists.

Definition of lift Irrigation Technology:

Lift irrigation is commonly understood as the process of raising water from perennial river sources using powerful electric pumps and then distributing it through pipelines to the adjacent fields within its command area, typically located in the floodplains of the river.

This installation can be carried out either on a cooperative basis or individually. However, co-operative schemes typically involve high-capacity pumps, ensuring efficient water supply to a larger area.

Inter-Basin Water Transfer: The interlinking of rivers in India has two components: the Himalayan component and a peninsular one. All interlinking schemes are aimed at transferring of water from one river system to another or by lifting across natural basins. The project will build 30 links and some 3000 storages to connect 37 Himalayan and Peninsular rivers to form a gigantic South Asian water grid. The canals, planned to be 50 to 100 meters wide and more than 6 meters deep, would facilitate navigation. The estimates of key project variables - still in the nature of back-of-the-envelope calculations - suggest it will cost around US $ 246 billion (or Indian Rs 11,20000 crores, at 2014 price scale), handle 178 km of inter-basin water transfer/per year, build 12,500 km of canals, create 35 giga watt of hydropower capacity, add 35 million hectares to India’s irrigated areas, and create an unknown volume of navigation and fishery benefits. Similarly, 3700 megawatt would be required to lift water across major watershed ridges by up to 116 meters. The majority of observers agree that the Project may not be in operation even by 2050.

Inter-Basin Transfer through Lift Scheme: India's ambitious interlinking of rivers encompasses two main components: the Himalayan and peninsular regions. The primary goal of all interlinking schemes is to transfer

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water from one river system to another, including the lifting of water across natural basins. The proposed project envisions the creation of 30 links and approximately 3,000 storages, connecting 37 Himalayan and Peninsular rivers to establish a vast South Asian water grid.

The planned canals, designed to be 50 to 100 meters wide and more than 6 meters deep, have a dual purpose of facilitating navigation and efficient water transport. While the estimates for key project variables are still preliminary, they indicate a significant investment of around US $246 billion (or Indian Rs 11,20000 crores , at 2014 price scale). If successful, the project is projected to enable the annual transfer of 178 km of water between basins, construct an extensive network of 12,500 km of canals, create a hydropower capacity of 35 gigawatts, expand India's irrigated areas by 35 million hectares, and offer diverse benefits related to navigation and fisheries.

Notably, lifting water across major watershed ridges by up to 116 meters would necessitate a substantial power generation of 3,700 megawatts. While the project holds immense potential, many experts believe that its full operation may not materialize until at least 2050, given the complexities and scale of the endeavor.

Inter-Basin Water Transfer Links: Inter-basin transfer links propose the transfer of river water from regions with water surplus to those experiencing deficits. This approach offers effective solutions to enhance irrigation potential, mitigate floods and droughts, and reduce regional imbalances. The transfer of water across basins also enables additional irrigation, supports domestic and industrial water supply, fosters hydropower generation, and facilitates navigational facilities.

The National River Linking Plan (NRLP) was conceived as a response to emerging water scarcity challenges in India. By transferring 'surplus' water from primarily Himalayan rivers to more 'deficient' peninsular rivers, the NRLP aims to rectify water availability disparities across the country. The ambitious plan envisions the transfer of 33 km3 of water from the Himalayan component and 141 km3 from the peninsular component through an extensive network of 30 links, spanning a total length of 14,900 km (GOI 1999). If fully completed, the NRLP would stand as the largest infrastructure project in the world, entailing an estimated cost of 120 Billion US Dollars.

The proposed NRLP claims various additional benefits, including flood control, drought mitigation, increased irrigation, enhanced food-grain production, and electricity generation. However, the plan remains a subject of controversy in India. This is partly due to the non-transparent and largely uni-sectoral nature of water resources planning, which predominantly emphasizes irrigation development. Additionally, concerns have been raised about the characterization of specific river basins as either 'surplus' or 'deficient,' leading to uncertainty and lack of confidence in the plan.

In conclusion, inter-basin water transfer projects like the NRLP hold significant potential in addressing water imbalances and fostering comprehensive development. To ensure successful implementation and public acceptance, transparent and inclusive planning processes, incorporating diverse perspectives and expertise, are vital in maximizing the potential benefits of such transformative endeavors.

IV. PROJECT EXECUTION PLAN

The study area encompasses specific districts within Madhya Pradesh, as indicated in the Index-map. Geographically, it is located between 22.38º N to 22.63º N latitude and 75.59º E to 75.98º E longitude.

The selection of this catchment basin provides a relevant and significant context for the investigation, considering the importance of water resources and the potential implications of the Narmada K shipra link project on the region's hydrological dynamics and socio-economic aspects. The geographical coordinates mentioned ensure precise delineation and understanding of the study area's boundaries and spatial extent.

Climatic Conditions and Surface Water Status:

The Narmada basin, spanning an area of 98796 sq. km., is located on the northern extremity of the Deccan Plateau, encompassing significant portions of Madhya Pradesh, Gujarat, and a smaller area in Maharashtra. The basin is bordered by the Vindhyas to the north, the Maikala range to the east, the Satpuras to the south, and the Arabian Sea to the west. It exhibits an elongated shape, stretching approximately 953 km from east to west and 234 km from north to south. Within the basin, five distinct physiographic zones can be identified:

1. Upper Hilly Areas: This zone covers the districts of Shahdol, Mandla, Durg, Balaghat, and Seoni. These areas are characterized by hilly terrain and are richly forested.
2. Upper Plains: Encompassing the districts of Jabalpur, Narsimhapur, Sagar, Damoh, Chhindwara, Hoshangabad, Betul, Raisen, and Sehore, this zone consists of broad and fertile plains ideal for agricultural practices.
3. Middle Plains: Covering the districts of East Nimar, part of West Nimar, Dewas, Indore, and Dhar, this region also provides favorable conditions for cultivation.
4. Lower Hilly Areas: Including parts of West Nimar, Jhabua, Dhulia, and some areas of Baroda, this zone features hilly terrain and contributes to the overall diversity of the basin.
5. Lower Plains: Mainly comprising the districts of Broach and part of Baroda, this area is characterized by coastal plains with alluvial clays and a surface layer of black soils.

The Narmada basin predominantly consists of black soils, which are known for their fertility and suitability for agriculture. The coastal plains in Gujarat feature alluvial clays, adding to the agricultural potential of the region.

As for the climatic conditions, the basin experiences diverse weather patterns due to its vast geographical extent. It exhibits a monsoon-influenced tropical climate, with distinct wet and dry seasons. The monsoon, which generally arrives in June and lasts until September, brings the majority of the region's rainfall. This rainfall is crucial for replenishing surface water resources and sustaining agricultural activities in the area. However, the variability in monsoon patterns can lead to fluctuations in surface water availability and impact the overall water status in the basin.

Understanding the climatic conditions and surface water status in the Narmada basin is essential for effective water resource management, agricultural planning, and sustainable development in the region. The physiographic diversity and the monsoonal nature of the climate present both opportunities and challenges, necessitating a comprehensive approach to harnessing and conserving the available water resources for the well-being of the communities residing in the basin.

Climatic

The tropic of Cancer crosses the Narmada Basin in the Upper plains area and a major part of the basin lies just below this line. The climate of the basin is humid and tropical, although at places extremes of heat and cold are often encountered. In the year, four distinct seasons occur in the basin. They are (i) Cold weather (ii) Hot weather (iii) South west monsoon and (iv) Post monsoon.

In the cold weather, the mean annual temperature varies from 17o 5 C to 20o C and in the hot weather from 30oC to 32o 5C. In the South west monsoon the temperature ranges from 27o 5 C to 30oC. In the post monsoon season, the temperatures between 25 C to 27.5 C are experienced.

Rainfall:

According to the Indian Meteorological Deptt., there were ten rain gauges in 1867 in the entire Narmada basin. The number rose to 21 rain gauges in the year 1891, the year from which published rainfall data are available.

Thereafter, there has been a study growth of the rain gauge network in the basin. In 1965, the number of reporting rain gauges above Garudeshwar was 69.

Nearly 90% of this rainfall is received during the five monsoon months from June to October about 60% is received in the two months of July & August.

The rainfall is heavy in the upper hilly and upper plains areas of the basin. It gradually decreases towards the lower plains and the lower hilly areas and again increases towards the cost and south western portions of the basin.

In the upper hilly areas, the annual rainfall is, in general, more than 1400 mm (55") but it goes up to 1650 mm (65") in some parts. In the upper plains from near Jabalpur to near Punasa dam site, the annual rainfall decreases from 1400 mm (55") to less than 1000 mm. (40") with the high rainfall zone around Pachmarhi where the annual rainfall exceeds 1800 mm (70"). In the lower plains the annual rainfall decreases rapidly from 1000 mm. (40") at the eastern and to less than 650 mm. (25") around Barwani, and this area represents the most arid part of the Narmada Basin in the lower hill areas, the annual rainfall again increases to a little over 750 mm. (30”)

Kshipra Sub Basin Characteristics:

The Kshipra Sub Basin is located in Central India and is renowned as one of the sacred rivers, also known as Kshipra or Avanti nadi. Originating from the Vindhya Range, the river flows in a northerly direction, meandering across the picturesque Malwa plateau before eventually joining the Chambal River. With a catchment area of 5600 sq. km upstream of its confluence with the Chambal, the Kshipra finds its nominal source on the Kokri Bardi hill, approximately 20 km southeast of Indore, near the charming village of Ujeni (22° 31' N. and 76° E.).

Significant cultural and religious importance is attached to the Kshipra river, making it as sacred to the Hindus as the revered Ganga river. The holy city of Ujjain, a prominent pilgrimage destination, is situated on the right bank of the Kshipra river, further enhancing its significance. As the river meanders in a general north-westerly direction, it follows a highly sinuous course, creating a captivating landscape along its path.

The Kshipra covers a total distance of approximately 190 km, passing through Indore, Dewas, and Gwalior districts of the state, until it finally merges with the Chambal near Kalu-Kher village (23° 53' N. and 75° 31'). Two significant tributaries contribute to the flow of the Kshipra – the Khan river near Ujjain and the Ghambir river near Mahidpur.

While historically the Kshipra river maintained a perennial flow, over the years, it has experienced fluctuations in its water availability. Currently, the river runs dry for a period of 5 to 6 months each year. Despite this, the waters of the Kshipra remain vital for various purposes, including drinking, industrial use, and lift irrigation in the region.

Agriculture is the dominant land use along the banks of the Kshipra, reflecting the fertile and productive soil of the Malwa plains. The presence of high rocky banks in the Mahidpur region further adds to the distinct character of the river.

The Kshipra Sub Basin serves as a vital lifeline for the communities residing in its vicinity, sustaining their cultural, economic, and agricultural activities. As the river's flow patterns have undergone changes, careful and sustainable water management practices become crucial to ensure the continued prosperity of the region and the preservation of its sacred and ecological heritage.

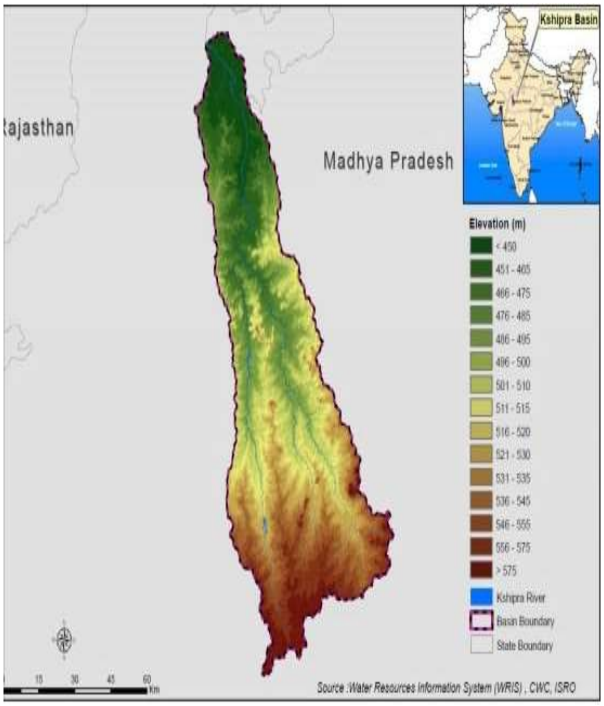

Figure 1 Different elevations of Kshipra Basin.

Objective of the Project:

The primary objective of the project is to enhance agricultural productivity and improve the livelihoods of farmers in Indore district by providing irrigation facilities to approximately 12,000 hectares of agricultural land. Additionally, the project aims to address the water requirements of towns and villages within its command area, catering to their domestic and industrial needs.

To achieve this objective, the project proposes to lift raw Narmada water from the Omkareshwar Right Bank canal at a specific location marked as RD. 9.775 km. This water lifting operation will serve as a crucial source of irrigation for the identified command area, significantly benefiting agricultural activities and promoting rural development.

The irrigation command area, which will receive water through this project, is clearly indicated on the index map, delineating the specific regions that stand to benefit from the water supply.

By providing reliable and sufficient water for irrigation, the project aims to enhance agricultural production, increase crop yields, and reduce dependency on rainfall, ultimately contributing to food security and economic growth in the region. Moreover, the availability of raw Narmada water for domestic and industrial purposes in towns and villages within the command area will significantly improve living standards, support local industries, and foster sustainable urban development.

Overall, the project's core objective is to harness the water resources effectively and ensure their optimal utilization to meet the diverse needs of agricultural, domestic, and industrial sectors, thereby enhancing the overall socio-economic well-being of the people residing in the project's influence area.

Water Availability in OSP Canal:

The Omkareshwar Sagar Project (OSP) canal holds a total water capacity of approximately 85 cubic meters per second (cumecs). Out of this total capacity, 50 cumecs of water will be released to cater to the flow irrigation needs in the designated areas under phase-II and phase-III of OSP canals. Additionally, 15 cumecs of water will be lifted from the junction structure located at 9.775 kilometers for providing irrigation facilities within the command area of phase-IV, known as the OSP lift canal.

Currently, there remains a surplus of 20 cumecs of water at the junction structure. To make efficient use of this surplus, it is planned to lift 5 cumecs of water from the under-construction Sasliya Tank to support the Narmada-Kshipra-Simhastha (NKS) link. As a result, a balance of 15 Cumecs will remain available in the canal, which is intended to be allocated for the Narmada-Malwa-Link Project.

Considering the nature of the scheme as a lift project, the irrigation duty taken into account for estimating water requirements is 0.27 liters per second per hectare (as per NVDA guidelines). This calculation is crucial in ensuring the water supply is sufficient to meet the agricultural needs and foster enhanced crop productivity in the command area.

Furthermore, as part of the water allocation plan, it is proposed to reserve 10% of the available water for domestic and industrial purposes in key districts such as Indore, Ujjain, Dhar (Pithampur), and Dewas. This strategic allocation aims to fulfill the drinking water and industrial requirements of these regions, supporting their population and industrial growth.

VI. CONCLUSION

In summary, the water availability in the OSP canal is well-planned and optimized to cater to the diverse needs of flow irrigation, lift irrigation, NKS link, and domestic and industrial purposes in the identified districts. The efficient allocation and utilization of water resources play a crucial role in enhancing agricultural productivity, promoting sustainable development, and improving the overall quality of life for the people in the region. The economic analysis in present context is basic on direct sell of crop produce. This can be extended to include other benefits due to increased prosperity of the farmers and its impact on the business in the area.

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