

## **The Hydraulic Empire: River Systems and Agrarian Expansion in the Upper Ganga-Yamuna Doab, during the 16th and 17th centuries**

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### **ABSTRACT**

*This study examines the Upper Ganga Yamuna Doab, an interfluvial plain defined by the Persian term do-āb (two rivers), stretching from the Himalayan foothills to the confluence of the Ganga and Yamuna, as the geopolitical and economic pivot of the Mughal Empire during the sixteenth and seventeenth centuries. It explores the region administered through the twin cores of the Subah of Delhi and the Subah of Agra, the empire's important administrative and revenue generating region. While traditional historiography focuses on Akbar's administrative brilliance, notably the zabt land revenue system of Raja Todar Mal, this research argues that imperial consolidation rested fundamentally on the systematic control and management of the region's hydraulic environment. The expansion of agriculture in the Mughal state in the Upper Doab is termed as the creation of a hydraulic empire, deriving its power and wealth from the harnessing of river systems and groundwater to drive agrarian growth. In medieval Indian History agriculture being the main source of the economy, we can expect extensive cultivation in the Doab region, a fact substantiated by W.H. Moreland's analysis of the Ain-i Akbari, which confirms widespread cultivation by the Mughal period, making the Doab a key source of imperial income. The study investigates whether this transformation resulted from concerted imperial efforts through canal irrigation, forest clearances, and technologies like the Persian wheel (arghatta) or if local and indigenous initiatives also contributed to the expansion of settled agriculture. The alluvial plains, supporting crops like wheat, rice, barley, jowar, sugarcane, and indigo, underscore the region's agricultural richness, with commodities like Khurja's indigo and Shahgarh's shora gaining prominence. This paper critically assesses the interplay of state policy, local agency, and environmental factors in shaping the Doab's hydraulic landscape and economic significance.*

## **Introduction**

The region Upper Ganga-Yamuna Doab, the sawād (cultivated and populated, Habib, 1963) forming the interfluvial plain between the Himalayan sibāl (foothills) and the confluence of the two rivers, Its very name, from the Persian do-āb (two river), defines it not by its land, but by its rivers. The region was the geopolitical and economic pivot of the Mughal . In the sixteenth and seventeenth centuries, the area served as the Mughal Empire's agrarian heartland in north India due to its alluvial soils, perennial water sources, and climate. It was also the geopolitical and economic center of the Mughal Empire. The hydraulic geography of this tract, which roughly stretches from Delhi and Meerut in the northwest to Kannauj and Etawah in the southeast, and Allahabad in the east was greatly influenced by the Ganga in the east and the Yamuna in the west. Even though the term "hydraulic empire" needs to be used carefully, it offers a useful framework for comprehending the any state's endeavor, which derived its authority and wealth from the methodical management of water and the agrarian growth it enabled ( as it firstly used by Karl Augustus Wittfogel). This study focuses on the Upper Ganga Yamuna Doab the western and central portions of the plain, stretching from the Siwalik foothills in the north to a line roughly south of Delhi and Agra during the formative period of 1556 to 1605, coinciding with the reign of Akbar. Has this era witnessed a concerted imperial effort to harness the region's river systems, transform its landscape through canal irrigation ? It's the only state's effort which catalyzes a massive expansion of settled agriculture ? Or can we map some local or indigenous efforts to this region , which leads to agricultural expansion in this area? What technologies are used by state administration or by locals to irrigate the land ? Is it the state who sponsored the cut and cleared the forest for cultivation? or there are some indigenous efforts in this regard. These are some historical questions which I tried to look at in this paper.

This study focuses specifically on the region as administered through the twin cores of the Subah of Delhi and the Subah of Agra, the empire's primary administrative and revenue generating region. While traditional historiography has rightly emphasized the role of Akbar's administrative genius, particularly the *zabt* (land revenue) system of Raja Todar Mal, this study argues that imperial consolidation was fundamentally predicated on the control and management of the region's hydraulic environment. The expansion of the Mughal state in the Upper Doab was, in essence, the creation of a hydraulic empire, a political and economic entity whose power was derived from the systematic harnessing of river systems and groundwater to drive agrarian expansion.

During our period of study, since agriculture was the main source of the economy, we can expect extensive cultivation in the Doab region. Although we do not have clear evidence to support the extent of cultivation during the Sultanate period, we can confidently say that by the Mughal period, most parts of the Doab were under widespread cultivation. This fact was established by

W.H. Moreland through a detailed examination of the statistical data in the Ain-i-Akbari. So Doab area surrounding the Subah of Delhi and Agra was extensively cultivated and became the important source of Mughals income ( W.H. Moreland).

The alluvial plains of the Doab are suitable for almost all food crops. However, except for the lower Doab east of Etawah, wheat was the main food crop in most parts, while towards the east rice gradually replaced wheat. During the 16th and 17th centuries, other important food grains included barley and jowar, while cash crops such as sugarcane and indigo were also widely cultivated. Although indigo was produced in several other regions, the indigo of Khurja was in great demand for export outside India. Similarly, shora (saltpetre) produced at Shahgarh near Kol (Aligarh) was a highly sought after commodity.

### **Historical geography of Upper GangaYamuna doab: The Subahs of Delhi and Agra**

Geographically, the Upper Doab is a flat alluvial plain. It is a gift of the Ganga and Yamuna rivers and their Himalayan tributaries. My research demarcates the region as comprising the Mughal Subah of Delhi and Agra. This stretches from the imperial capital northwards to the sibāl ( Himalayan foothills). It also includes the Subah of Agra, the southern and middle expanse of the Doab. The imperial capital of Agra is situated on its defining river, the Yamuna. As illustrated in Irfan Habib's An Atlas of the Mughal Empire, this area was a complex hydrological landscape. It was characterized by the active channels of the Yamuna, the Ganga, and seasonal torrents like the Kali Nadi and Krishni. There was a network of jhils (swamps), taals (lakes), and old river courses alongside them which we can see in Irfan Habib map of medieval India. The soil composition is a mix of the newer, lighter khadar (floodplain) soils near the rivers and the older, more compact bangar (alluvial uplands). This created varied agricultural potential. The high water table is noted by contemporary chroniclers like Abul fazal. It made well irrigation exceptionally viable. This formed the bedrock of village level cultivation. This ecosystem was both a source of immense fertility and a challenge. It required management to mitigate floods and harness water for year round cultivation.

Political geography of the region , as well known that during the Sultanate times almost the whole of Doab was controlled from the capital city of Delhi, while south eastern parts of Doab were governed by the Sultan's governor of Kara . In 1580, Akbar reorganized the administrative structure of his empire. He divided the Doab region among three subas (provinces): Delhi, Agra, and Allahabad. This division continued unchanged throughout the 17th century. The northern part of the Doab fell under the suba of Delhi. It included areas of present day Bulandshahr ,Meerut, Saharanpur and its neighboring northern districts. The central or middle Doab was placed under the suba of Agra. It covered parts of Bulandshahr ( Baran) along with Aligarh ( kol), Etah, Mainpuri, Etawah, Farrukhabad, and Kanpur. The lower Doab was included in the

suba of Allahabad. It consisted of the districts of Fatehpur and Allahabad . In my research articles, I will focus on the subas of Delhi and Agra, as they geographically encompass most of the upper Doab and a portion of the middle Doab.

There appear to be no strategic considerations in the division of the Doab region among three subas. The only plausible reason seems to lie in linguistic considerations ( K. K Divedi ,1981) . In the Doab, four distinct dialects are found. It illustrates that Khari Boli is spoken in the upper Doab region, extending to the northern limits of the district of Bulandshahr. This region formed part of the suba of Delhi, including some areas of Bulandshahr shown under the Braj Bhasha dialect. The south-eastern boundary of the suba of Agra, marching with that of the suba of Allahabad, coincides with the Kanauji and Awadhi dialects. Thus, in the suba of Agra, two dialects are found, namely Braj and Kanauji. The area under the Kanauji dialect is notably small compared to the other three dialects spoken in the Doab. It appears, therefore, that during the demarcation of the suba boundaries, linguistic considerations were partly taken into account, as linguistic boundaries align with suba boundaries in the Doab ( K.K. Trivedi). The only exception is that the Kanauji dialect area was largely overlooked.

Subah of Delhi: This northern portion of the upper Doab is depicted as a temperate zone with riverine boundaries. On the east lies the capital Agra, on the north east it marches with Khairabad in the Subah of Oudh; to the north are mountains. On the south the Subahs of Agra and Ajmer; on the west is Ludhianah. Its length is 165 kos (from Palwal to Ludhianah on the Satluj River), and breadth varies from 140 kos (Rewari to Kumaon hills) to 130 kos (Hisar to Khizrabad). Chief rivers include the Ganges (rising here), Yamuna, and Ghaggar. Notable features are Northern mountains (Kumaon ) ,Saraswati River near Thanesar (Kurukshetra lake) hot springs and sulphur mines at Sahnah; rhinoceros habitats in Sambhal. The region includes inundated lowlands and scattered hills.

Subah of Agra: The central Doab core, with length 175 kos (from Ghatampur to Palwal) and breadth from Kanauj to Chanderi. On the east lies Ghatampur, to the north, the Ganges; to the south Chanderi, and to the west, Palwal. It possesses many rivers, of which the principal are the Jumna and the Chambal. The former flows down from the northern mountains, the latter rises at Hasilpur in Malwah and unites with the Jumna at Kalpi. Ranges of hills lie scattered to the south." Key sites: Agra on the Yamuna (river flows 5 kos through the city with villas and meadows); Mathura on the Yamuna; Chandwar on the Yamuna; Gwalior fortress with iron mines ,Alwar with glass and woollen carpet production; Fatehpur Sikri tank (12 kos circumference).

### **River systems and irrigation**

During our period of study, the physical setting of the Upper Ganga Yamuna Doab was substantially sculpted by its rivers the Ganga, and Yamuna and their numerous seasonal tributaries. These river systems not only defined the geomorphology of the region but also determined the limits and possibilities of agrarian expansion. During the early centuries of Delhi Sultanate, the area of Upper Doab mainly between Hastinapur and Kannauj consisted largely of forest and scrubland, with scattered pockets of cultivation along the natural levees ( IrfanHabib). The rivers were monsoon fed, and their annual inundation (*sailābī*) deposited fresh layers of alluvium that enriched the soil. These seasonal floods established the natural irrigation pattern of the Doab, shaping the rhythm of agricultural life.

In examining the hydraulic landscape of the Upper Ganga Yamuna Doab, it is important to recognize that irrigation represented a deliberate human intervention in water , a process distinct from the natural *sailāb* (inundation) that seasonally watered riverine tracts. Tripta Wahi reminds us that the stability of agrarian production in pre-modern India was directly proportional to human control over water, while its variability determined the rhythm of cultivation and revenue (Wahi 2013, 1–3). In this context, the Mughal state, like its predecessors, regarded irrigation as central to agrarian organization and statecraft. The Doab, with its complex system of rivers and shallow aquifers, lent itself naturally to both modes identified by Wahi the *nahr* (canal) and the *chah* (well). While the canals represented the organized might of the state and its capacity to mobilize resources and labour, the wells embodied field-specific, localized irrigation where rights to water and access reflected the social hierarchies of rural society.

By the early Mughal period, evidence suggests that irrigation in the Upper Doab was a combination of natural inundation, wells, and small-scale mechanical devices such as *rahat* (Persian wheel) and *charas* (animal-drawn water-lift). As David L. L. Wescoat Jr. observes Mughal water systems were “highly localized, decentralized, and closely adapted to geomorphic conditions,” emphasizing the dominance of village-level wells and tanks rather than large imperial canals . The shallow groundwater of the Doab made well irrigation feasible, and almost every settlement relied on its own well for irrigation of wheat, barley, and garden crops .

The Ain-i Akbari, when studied alongside W.H. Moreland’s analysis, strengthens this view. Moreland, through his detailed examination of the Ain’s revenue records, showed that the Doab was among the most intensively cultivated regions of Mughal India. The fertility of its alluvial plains, combined with irrigation from canal, wells and periodic flooding, supported widespread wheat cultivation in the western parts, while rice gradually took over from wheat towards the east. Cash crops such as sugarcane and indigo also cul0, particularly in areas with reliable irrigation. Wescoat’s research further reveals that imperial efforts such as the restoration of

earlier Sultanate canals, like those credited to Firoz Shah near the Yamuna were primarily aimed at serving royal estates, gardens, and urban centres like Agra and Fatehpur Sikri. Abdul fazal in *Ain-i-Akbari* recorded the empire's irrigation infrastructure. In Volume 2, he describes the Subah of Agra, noting canals diverting water from the Yamuna for cultivation. For instance, Firoz Shah Tughlaq's earlier canals were renovated under Akbar, such as the Western Yamuna Canal, which irrigated lands in Haryana and the Doab. Shah Jahan built the Nahr-i-Faiz (also called Shah Nahr), extending from the Yamuna near Delhi to irrigate parganas (districts) in the Upper Doab. Akbar's reconstruction of Firoz Shah's canals and Shah Jahan's subsequent expansion of them show that state-sponsored hydraulic projects were as much political statements as they were agricultural advancements. Such projects required coordination, surveying, and expertise among faujdars, subahdars, and maimār (architects) (Wahi 2013 P 7,8). These gravity-fed channels used embankments and sluices to control flow, supporting double cropping. (Translated in Jarrett, H. S. (1891). *The Ain-i-Akbari*, Vol. 2. Calcutta: Asiatic Society of Bengal.)

Consequently, the river systems of the Upper Ganga Yamuna Doab established the natural basis for the Mughal agrarian expansion. The hydraulic environment was not solely a product of a centralized water governance system nor completely abandoned to natural processes; instead, it was a negotiated area where rivers, wells, and local communities consistently engaged with one another. In contrast to the Sultanate era, this period experienced increased agrarian communities and heightened farming practices, a shift that converted the formerly wooded borderland into one of North India's most fruitful agricultural regions.

As a result, the Upper Ganga Yamuna Doab river systems created the ideal environment for the Mughal extension of agriculture. Rivers, wells, and local communities constantly interacted with one another in the hydraulic environment, which was neither entirely left to natural processes nor the result of a centralized water governance system. This period saw a rise in agrarian communities and improved farming methods compared to the Sultanate era. As a result, the once-forested borderland became one of North India's most productive agricultural areas.

### **Agrarian Expansion during the Mughal era**

When we came to the agrarian expansion, My study highlights the part that river systems played in this expansion, defining the subah of Delhi as extending from the imperial capital north to the Siwalik hills in the northern upper Doab, and the subah of Agra as extending to the southern and central region, including portions of the middle Doab. Irfan Habib's *An Atlas of the Mughal Empire* (1982) provide political and economic maps of these subahs, emphasizing the intricate system of rivers such as the Ganga, Yamuna, Kali Nadi, and Krishna, as well as jhils and ancient river courses that allowed for natural flooding in the Khadar lowlands. In Abu'l Fazl's *Ain-i Akbari*, the high water table is mentioned (c. In the Bangar uplands, the Persian wheel (arghatta)

became a crucial water-lifting tool in 1595, making well irrigation feasible and enabling the double cropping of wheat, rice, sugarcane, and indigo. Those at the Sultanate era had more primitive canals than this hydraulic infrastructure.

The expansion was not merely technological but also administrative and social. Akbar's reorganization in 1580 divided the Doab among the subahs of Delhi, Agra, and Allahabad, with Delhi including northern Bulandshahr and adjacent districts, and Agra covering the central zone from Aligarh to Kanpur. Revenue statistics from the Ain-i Akbari, indicate that the Doab was one of the most intensively cultivated regions, with measured arable land (arazi) in these subahs showing high yields due to imperial incentives for peasant settlement. Peasants, forming the bulk of the population, were encouraged through tax remissions and land grants to clear remaining forests and establish villages overcoming challenges like floods and droughts that had plagued earlier periods. In comparison to the Sultanate, where agrarian growth was sporadic and often coercive such as Balban's reported suppression of pastoralists the Mughal approach was more systematic, fostering a "hydraulic empire" where river systems underpinned economic prosperity. Irfan Habib, in *The Agrarian System of Mughal India, 1556-1707* (Habib 1963, pp. 1-35, 211-235), argues that this led to a doubling of cultivated area in the Doab by the late 16th century, with irrigation covering up to 20-30% of arable land through wells and canals, though he cautions that expansion was uneven, favoring cash crops near rivers.

In my view, this agrarian surge was linked to the Doab's hydrology, where the Ganga and Yamuna not only restore soils through annual floods but also made it possible of water lifting technologies like the charasa (leather bucket lift) and shadoof, as described in Sukhwinder Kaur's "Agricultural Implements and Water Lifting Devices in Medieval India" (2018). In contrast to the monsoon dependent east or the arid west, the upper Doab's consistent water supply reduced the risk of famine and encouraged urbanization, which boosted the empire's income. But this growth also increased the burdens on peasants, and Habib criticizes this as a barrier to sustainable development because high land taxes may result in debt. I contend that the Mughal hydraulic model established a standard for subsequent imperial policies by concentrating on the Delhi and Agra subahs, which geographically include the majority of the upper Doab and parts of the middle. This sets them apart from the Sultanate's disjointed efforts and emphasizes the rivers' crucial role in converting a once-rebellious frontier into a productive core.

## **Conclusion**

The analysis of the Upper Ganga Yamuna Doab region during the Mughal period reveals an interplay of geography and Mughal governance that possibly shaped its agrarian landscape, though not without limitations. The Ganga and Yamuna rivers, with their fertile alluvial deposits, offered a natural foundation for agricultural expansion, yet this potential was realized through

administrative intervention although some local efforts were there. The Mughal administration's integration of river systems into a revenue driven hydraulic framework marked a shift from the sporadic efforts of the Delhi Sultanate, where Sultan Balban's thirteenth-century forest clearances recorded in Barani's *Tarikh-i Firuz Shahi* aimed at curbing rebellion rather than fostering sustained cultivation. While the Sultanate left a sparsely settled Doab dominated by pastoralists, Akbar's policies built upon this foundation, promoting peasant settlement and irrigation with a degree of organization that distinguished Mughal rule.

Peasant settlement and the slow clearing of forests, which had started during the Sultanate, reached their zenith during Akbar's rule. Wells, arghatta, charasa, and small canals were among the irrigation innovations used by the Mughal government to increase cultivation, diversify crops, and stabilize agricultural output. In order to integrate water management into revenue and settlement policy, the imperial government was interested in promoting well irrigation throughout the Bāngar uplands and preserving older canal systems, such as those credited to Firoz Shah Tughlaq. Once a sparsely populated forested tract, the Doab became the empire's agrarian and fiscal center, providing the grain, money, and labor that kept the Mughal military and administrative system afloat.

In conclusion, the agrarian expansion of the Upper Ganga Yamuna Doab was both a product and an instrument of Mughal statecraft. It demonstrates how water, as both a natural resource and a political tool, structured the empire's economic geography. The Mughal rulers did not merely exploit the Doab's rivers they redefined them within an administrative and agrarian framework that bound ecology to the empire. This synthesis of environmental adaptation and bureaucratic rationalization not only reshaped the landscape but also laid the hydraulic foundations for North India's enduring patterns of settlement and cultivation.

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