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Article

Wu Zhong and The Governance of The Tonghui Canal During The Ming Dynasty

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Abstract: Wu Zhong (吴仲) played a pivotal yet underexplored role in the restoration and governance of the Tonghui Canal during the Ming dynasty. This study critically examines his multifaceted contributions as a hydraulic engineer, policymaker, and historiographer. It explores how he led the technical and administrative efforts in restoring the Tonghui Canal and evaluates his intellectual legacy, especially through his authorship of the *Gazetteer of the Tonghui Canal* (通惠河志), which offers valuable insights into the canal's history and governance. Addressing the scholarly gap concerning Wu Zhong's historical significance, this research employs library research and qualitative textual analysis to reconstruct the historical, technical, and institutional dimensions of his work. The findings demonstrate that Wu Zhong's engineering initiatives significantly enhanced transportation efficiency, reinforced political stability, and stimulated economic growth in the Beijing region. His policy advocacy, conveyed through strategic memorials and institutional reforms, contributed to long-term improvements in water conservancy and urban logistics. Furthermore, his compilation of the *Gazetteer of the Tonghui Canal* provided an enduring epistemic foundation for subsequent hydraulic governance and historiography. By reassessing Wu Zhong's contributions, this study offers a more comprehensive understanding of the intersection between technology, statecraft, and knowledge production in the Ming dynasty. It concludes that Wu Zhong's leadership and intellectual legacy generated lasting societal and scholarly impacts, positioning him as a central figure in the development of Ming dynasty infrastructure and governance.

Keywords: Wu Zhong; Tonghui Canal; Ming dynasty; hydraulic engineering; institutional governance; *Gazetteer of the Tonghui Canal*

Introduction

The Tonghui Canal, located within the semi-arid region of the North China Plain, drew its water supply from the spring-fed sources of Beijing's Xi Mountain area. Serving as a crucial transportation waterway from the Jin (金) to the Qing dynasties, the canal operated for over six centuries. During this period, it facilitated the development of an extensive network of rivers and lakes, contributing significantly to the creation of a picturesque aquatic environment around Beijing. As a key artery for grain transportation, particularly in linking the port town of Tongzhou to the imperial capital, the Tonghui Canal held strategic importance not only for economic integration but also for political stability and military logistics (Cai Fan, 1985).

Within this historical context, the Ming official Wu Zhong (1482–1568) emerged as a transformative figure in the rehabilitation and governance of the Tonghui Canal, was born in Wujin during the Ming dynasty. After successfully passing the imperial examination in 1517 and obtaining the prestigious *jinshi* degree, as defined by Hucker (1985) signified success in the highest-level regular civil service examinations and

qualified the recipient for appointment to official government positions. He embarks on an official career. His scholarly legacy was also notable, with authored works such as the *Gazetteer of the Tonghui Canal* and *Jiangquan Zouyi Ji (剑泉奏议集)*, reflecting his intellectual engagement with both administration and historiography (Gao Shouxian, 2013, Wu Zhong, 2015, Wang Yun, 2019).

During his tenure as Zhili Xun'an Jiancha Yushi (A dedicated surveillance official). Wu Zhong played a central role in the revitalisation of the Tonghui Canal. In 1527, he submitted a memorial to Emperor Jiajing, advocating strongly for the Tonghui Canal's restoration. He emphasised its critical function in grain transportation and argued that its rehabilitation would reduce logistical costs and mitigate risks associated with military provisioning. The proposal received imperial endorsement, and in 1528, Wu Zhong personally directed and completed the dredging and reconstruction project in just over four months. That same year, the canal transported approximately two million *dan* (An ancient Chinese measurement unit, with 1 *dan* equalling 50 kilogrammes) of grain from Tongzhou to Beijing, generating savings of over 110,000 *taels* (A monetary unit in ancient China, 1 *tael* was approximately equal to 30 *grams*) of silver (Wu Zhong, 2015). This milestone not only improved the overall efficiency of imperial grain logistics but also yielded substantial economic benefits to the state.

Wu Zhong's influence, however, extended well beyond his engineering achievements. He was widely respected for his political acumen, administrative skill, and moral courage in public service. His work in water conservancy engineering was complemented by his forward-looking institutional reforms and his scholarly commitment to documenting and preserving technical knowledge and administrative practices. As both a practitioner and chronicler, Wu Zhong left an indelible mark on the governance of Ming infrastructure (Hu Mangquan, 2008).

This study aims to examine Wu Zhong's multifaceted contributions to the restoration and governance of the Tonghui Canal during the Ming dynasty. Specifically, it explores his roles as a hydraulic engineer responsible for technical innovation and project execution, as a policymaker who formulated institutional reforms to ensure sustainable canal management, and as a historiographer who systematically preserved his knowledge and practice through the *Gazetteer of the Tonghui Canal*. By analysing these interlinked dimensions, the study offers a comprehensive understanding of Wu Zhong's historical significance and the broader implications of his work for water conservancy, governance, and knowledge production in imperial China.

Literature Review

Research on the Tonghui Canal and its historical significance has been approached primarily through the lenses of regional history, hydraulic engineering, and logistics studies. Scholars such as Hu Mangquan (2008), in his extensive account of China's water transport systems, acknowledges the importance of the Tonghui Canal but devotes little analysis to its administrative evolution during the Ming dynasty. His focus remains on large-scale canal systems such as the Grand Canal and neglects the micro-political dynamics of segment canals like the Tonghui Canal. Similarly, Shi Weinan (2022) provides a focused yet descriptive chronology of dredging projects during the mid-Ming period. While valuable for technical data, the author does not critically evaluate the bureaucratic and political processes that underpinned these engineering efforts.

Wang Yun's (2019) work on water management reforms during the Jiajing era highlights the economic pressures caused by canal silting and flooding. His analysis of river transport challenges underlines the importance of administrative foresight in preserving food security. However, Wu Zhong is mentioned only briefly and framed as one among several officials involved in the reforms. This generalised portrayal overlooks the distinctive features of Wu Zhong's approach, particularly his capacity to institutionalise reform through formal documentation and policy articulation.

Hu Jixun (2015), writing from a local historical perspective, includes a short commentary on Wu Zhong's memorials, noting their rationalist tone and technical specificity. However, his account fails to situate these documents within the broader Ming political and epistemological context. He does not examine how these memorials functioned as tools for both persuading the throne and establishing lasting administrative

precedent. This paper builds on these studies by offering a more integrative interpretation that positions Wu Zhong not just as a reformer but as a historian of his own work.

From an interdisciplinary standpoint, few studies have addressed the historiographical functions of administrative texts like the *Gazetteer of the Tonghui Canal*. The field of historical water governance in Ming China has benefited from the contributions of international scholars such as Joseph Needham, whose *Science and Civilisation in China* (Vol. 4) analyses Chinese hydraulic engineering practices in broad terms, yet does not investigate how individuals like Wu Zhong documented and systematised these innovations. Moreover, the concept of epistemic governance that is, the ways in which knowledge was produced, archived, and transmitted through bureaucratic documentation remains underexplored in the context of local water infrastructure.

Some Chinese-language sources including edited volumes such as *Chinese Water History Classics: Canal Volume* (《中国水利史典·运河卷》), *Gazetteer of the Canals of China: Figures* (《中国运河志·人物》), *Governance and Transformation of the Northern Grand Canal in the Grain Transport Era* (《漕运时代北运河治理与变迁》), and *Management of Transportation Infrastructure in the Ming Dynasty* (《明代交通设施管理研究》) offer valuable insights into canal governance, historical transportation systems, and regional development during imperial China. These works contain a rich collection of memorials and imperial edicts that reference the restoration of the Tonghui Canal. However, such materials are often presented with limited analytical interpretation or contextual commentary. While they offer evidence of Wu Zhong's technical decisions, they fall short of examining how these texts functioned as political instruments or as part of a broader historiographical tradition. This study engages directly with these understudied sources to demonstrate that Wu Zhong's administrative interventions were not only implemented but also meticulously recorded. In doing so, it reconstructs the evolving ideologies surrounding water governance in the Ming dynasty through the lens of textual preservation and bureaucratic narrative.

In sum, the existing literature has tended to isolate technical, political, and textual dimensions of the Tonghui Canal's history. This study seeks to synthesise these aspects by focusing on Wu Zhong's integrated role as engineer, policymaker, and historiographer. In doing so, it addresses key gaps in both Chinese and international scholarship and proposes a framework for understanding infrastructure as a layered and multidimensional arena of statecraft in Ming China.

Methodology

This study adopts a historical-analytical approach grounded in both primary source analysis and historiographical synthesis. Its core methodology is structured around a triangulated framework that integrates close textual analysis, contextual interpretation, and comparative institutional study. The primary sources include Wu Zhong's official memorials submitted to the Ming court, excerpts from the *Gazetteer of the Tonghui Canal* (通惠河志), Ming dynasty imperial records such as the *Ming Shilu* (明实录) and *Ming Huidian* (明会典), as well as local gazetteers from Tongzhou and surrounding jurisdictions. These are further supported by Ming administrative cartography, personnel rosters, hydrological datasets from canal archives, and temple inscriptions from the period that commemorate Wu Zhong's contributions.

Each source was examined through a dialectical lens that highlights the interplay between technical imperatives and bureaucratic structures. This analytical approach enables an investigation into how engineering knowledge was converted into administrative policy, and how such policies were subsequently institutionalised or resisted within the Ming bureaucratic apparatus. In analysing Wu Zhong's memorials, specific emphasis was placed on their rhetorical construction, target audience, political context, and concrete outcomes particularly with regard to imperial approval or dissent. This enables an understanding of the memorials not merely as technical submissions but as strategic instruments embedded within the political culture of the Ming court.

In addition, the study employs historiographical tools to interrogate the dual function of the *Gazetteer of the Tonghui Canal* as both an administrative reference and a textual artefact of epistemic governance. This includes an analysis of the formal conventions of the gazetteer genre, cross-referencing its content with

analogous canal-related texts from the Ming and Yuan dynasties, and identifying underlying institutional logics and bureaucratic norms. Comparative frameworks are applied through references to the works of prominent hydraulic engineers and officials—such as Guo Shoujing of the Yuan dynasty and Yu Chenglong of the Qing dynasty—to position Wu Zhong's practices within a longue durée of water management in imperial China.

The research also incorporates interdisciplinary perspectives from environmental history and infrastructure studies to situate Wu Zhong's interventions within a broader sociotechnical landscape. This includes analysis of the spatial reconfiguration of canal routes, environmental challenges such as siltation and seasonal flooding, and the socioeconomic ramifications of restored water transport—particularly in terms of urban provisioning and grain price stabilisation.

The study acknowledges certain limitations, notably the fragmentary nature of some primary materials and the historiographical partiality inherent in official compilations. Wherever possible, such gaps were mitigated through cross-validation with alternative records, including fiscal documents, personnel registries, and contemporaneous commentaries from regional officials based in Tongzhou. By integrating textual, technical, and spatial data, this research constructs a multifaceted account of Wu Zhong's contributions grounded in verifiable historical evidence while remaining attuned to the ideological and administrative discourses of his era.

The Findings

Wu Zhong's contributions to the rehabilitation of the Tonghui Canal can be measured through three interrelated dimensions: technical practice, institutional construction, and knowledge production. He devised and implemented innovative engineering strategies that improved repair efficiency and enhanced the hydraulic performance of the canal. In parallel, he played a central role in reorganising water management structures and strengthening key institutions through targeted institutional and administrative reforms. Through policymaking, Wu Zhong helped establish a durable governance framework for the Tonghui Canal that influenced long-term management practices. His compilation of historical records and official documents laid the foundation for the preservation of canal history and enabled future scholarly research. As such, Wu Zhong emerged as a pivotal figure in the Ming dynasty's water conservation knowledge system, with his ideas and practices frequently recognised, recorded, and transmitted throughout the period.

1. Wu Zhong and the Practice of Hydraulic Engineering

Wu Zhong's expertise in hydraulic engineering and his capacity for practical implementation were most clearly exhibited during his oversight of the Tonghui Canal rehabilitation.Wu Zhong's leadership was evident in his meticulous selection of personnel and his skilful organisational coordination. For example, the Tonghui Canal restoration team included pivotal figures such as Yin Sizhong, serving as *Langzhong* of the Ministry of Revenue; He Dong, *Langzhong* of the Ministry of Works; and Chen Fan, a Vice Commander. Additionally, a supplementary team of twenty-seven military officers, including notable individuals such as Ye Mao and Yu Ding, operated under Wu Zhong's command. These individuals were affiliated with relevant military guard units and were tasked with construction supervision and administrative management (Wu Zhong, 2015). A close analysis of their official titles and affiliations reveals a systematic mobilisation of specialists across multiple agencies, including the Ministries of Works, Revenue, and military command structures. This deliberate and strategic assembly of human resources underscores Wu Zhong's capacity to build a highly qualified and coordinated team, forming a strong foundation for the successful rehabilitation of the Tonghui Canal.

In 1528, Wu Zhong and his team conducted an on-site inspection, thoroughly examining the Tonghui Canal route from Datong Bridge to Tongzhou. This field investigation exemplified Wu Zhong's hands-on leadership style. He supervised the dredging of channels, the reconstruction of bridges and sluices, and the restoration of critical infrastructure, including embankments, government offices, and workshops. After the project's completion, the Jiajing Emperor ordered He Zhao, the Vice Minister of Works, to inspect the canal and submit a report on its operational condition which ultimately affirmed the success of Wu Zhong's efforts

(Wu Zhong, 2015).

The engineering accomplishments achieved under Wu Zhong's leadership were substantial, and his team's collective expertise, combined with a commitment to systematic execution, played a decisive role in the project's success. Furthermore, the effective rehabilitation and streamlined operation of the Tonghui Canal ensured its navigability across successive Ming administrations. The canal's sustained functionality attests to the structural durability and institutional foresight embedded in Wu Zhong's engineering innovations.

Wu Zhong's strategic planning and technological framework in water conservation and infrastructure engineering warrant closer scholarly examination. Confronted with a declining water supply along the Tonghui Canal, Wu Zhong developed a scientific and adaptable strategy to address the dual challenges of silt accumulation and inadequate flow. In addition to dredging the riverbed, he re-evaluated the spatial arrangement of hydraulic structures to optimise water supply and flow regulation.

Furthermore, Wu Zhong implemented a thorough reorganisation of the Tonghui Canal's alignment and infrastructure. One of his primary interventions involved redirecting the canal's estuary and relocating the grain transport dock from Zhangjiawan to Tongzhou Beiguang. To shorten the canal's overall length, he removed four sluices and two water gates between Zhangjiawan and Tongzhou. In their place, two new dams were constructed, forming what became known as the "Five Sluices and Two Dams" system. In addition, Wu Zhong introduced a wide range of structural improvements, including the deepening and widening of the riverbed. These enhancements significantly improved the canal's capacity to regulate water levels, maintain steady flow during drought periods, and ensure year-round navigability. The reconfiguration also reduced transport time and enhanced logistical coordination (Lu Jishu, 1610).

To address both water scarcity and the elevation disparity between Beijing and Tongzhou, Wu Zhong reconstructed five sluices along the Tonghui Canal, primarily for water storage purposes. Unlike the design from the Yuan period—which allowed vessels to navigate directly through the sluices Wu Zhong's redesigned sluices were not navigable between canal segments. In response, he introduced an innovative segmented transport method, known as the "Reverse Loading System," to maintain continuity and improve the efficiency of grain shipments.

Importantly, Wu Zhong approached the logistics system holistically. He recommended specific types of boats for grain transport, appointed new administrative personnel, and established maintenance and operational facilities along the canal route. This segmented relay-based system not only alleviated transport bottlenecks but also enabled more effective control over cargo movement. The structure and implementation of this transport innovation were later depicted in the *Tonghui Canal Grain Transport Scroll* (通惠河漕运图卷), painted by Shen Yu (沈喻). Figure 1 illustrates the operational framework of the Reverse Loading System, with the red line indicating the specific route along which labourers transported grain from downstream to upstream sections.

The Reverse Loading System, a distinctive logistical innovation introduced during the restoration of the Tonghui Canal, is vividly illustrated in the historical painting. Moreover, the depiction reveals both the mechanical components and the manual labour involved in the process, offering valuable insight into the system's operational functionality and efficiency. The adoption of the Reverse Loading System not only improved transport efficiency and reduced logistical costs but also strengthened the strategic role of water conservancy in securing the grain supply for the imperial capital.

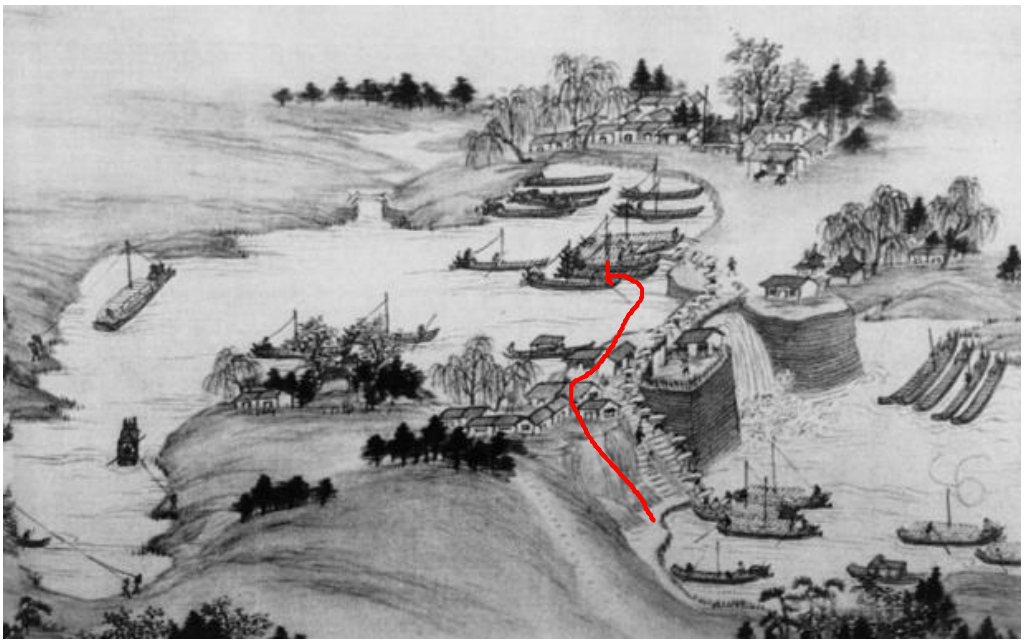

Figure 1. The specific implementation scenario of Reverse Loading System

2. Institutional Architect of Canal Governance and Reform

To prevent the re-siltation of the Tonghui Canal and to ensure uninterrupted transportation and efficient administrative control, Wu Zhong submitted a memorial in 1528 proposing five actionable governance measures, which were subsequently adopted by the Ming dynasty.Wu Zhong emphasised that the canal's complex geography and its impact on transportation capacity were critical to maintaining continuous transit. For example, the 40 *li* segment between Beijing and Tongzhou was characterised by steep gradients and sandy terrain. This feature was particularly problematic during summer and autumn, when heavy rainfall caused rises in water level, erosion, and sedimentation (Wu Zhong, 2015). Therefore, Wu Zhong petitioned the court to appoint a sluice manager to monitor the canal and conduct regular inspections. Upon identifying obstructions, this official would mobilise dredging workers to ensure navigational continuity. In addition, the appointed officer was tasked with preventing illicit excavations and ensuring the proper maintenance of the canal system. Wu Zhong also recommended that one thousand taels from sluice tolls collected under the Tongzhou administration be allocated specifically for canal maintenance. This comprehensive proposal which included the appointment of dedicated personnel, routine inspection, prompt dredging operations, and the establishment of a designated maintenance fund effectively addressed the canal's topographical challenges and ensured its long-term operability (Ming Sizong Shilu, 1962).

In matters of governance, Wu Zhong underscored the importance of professionalism and administrative specialisation in canal management. He proposed the appointment of a *Tonghui Canal Langzhong* (an official responsible for the canal's maintenance and operations) to be stationed in Tongzhou to manage the Datong Sluice section (Hucker, 1985). This measure ensured consistency in management practices and facilitated rapid resolution of operational issues. To further enhance administrative efficiency, he recommended assigning a *Guanhe Tongzhi* (a Deputy Magistrate for river affairs) to oversee the canal section from Datong Bridge to Xianyu Sluice (Lu Jishu, 1610). This dual appointment expanded oversight, clarified duties, and established a well-structured and hierarchically coordinated management system. The sluice administrator would supervise all relevant matters, including maintenance, dredging, and routine inspections. This centralised administrative model enabled swift implementation of policies and improved regulatory enforcement. Wu Zhong's recommendations demonstrated the Ming dynasty's commitment to effective waterway management through institutional refinement and clear delegation of responsibility. The resulting system was both scientifically grounded and administratively efficient, ensuring the Tonghui Canal's continued function post-1528 (Ming Sizong Shilu, 1962).

Concerning institutional capacity and workforce deployment, Wu Zhong highlighted the urgent need to strengthen the operational efficiency of the sluice management system. To support the uninterrupted functioning of the canal, he recommended expanding the personnel structure to include two supervising officers, two maintenance workers, and an additional 188 labourers. This adjustment aimed to match workforce size with the scale and complexity of maintenance tasks, ensuring that newly appointed labourers remained dedicated solely to canal operations. Additionally, 80 more labourers were to be assigned exclusively for the transportation of special materials, such as bamboo and timber, required by the imperial court. This targeted labour deployment reflected a deliberate alignment between logistical needs and resource availability, and it also underscored the canal's critical role in sustaining daily state functions. By enhancing labour capacity and clarifying worker responsibilities, Wu Zhong's proposal optimised the human resource framework and improved the institutional resilience of the canal management system (Ming Sizong Shilu, 1962).

Wu Zhong advocated for the renovation of hydraulic infrastructure outside the West Water Gate in Tongzhou to improve water regulation and transport safety. He proposed constructing a new stone sluice gate at this site and relocating an existing stone dam to the south to accommodate higher transport volumes. Controlling water flow through improved sluice mechanisms would stabilise water levels, mitigate erosion, and ensure navigability. He recommended extending the stone dam southward by over 20 *zhang* (approximately 66.6 metres) and adding a second stone sluice gate. This redesigned configuration—the "Five Sluices and Two Dams" system—was intended to optimise hydraulic flow, reduce sediment erosion, and strengthen flood control and transport reliability. Wu Zhong also advised that the new and renovated sluice gates remain closed under normal conditions to prevent excessive flow, and be opened only when water levels dropped, allowing the regulated release of stored water. This dynamic management strategy helped stabilise canal levels and improved overall transportation efficiency, contributing to the sustainable operation of the Tonghui Canal (Ming Sizong Shilu, 1962).

With respect to transport logistics, Wu Zhong stressed the centrality of boats in maintaining grain supply to the capital. The *Ming Veritable Records of Shizong* (1962) documents the allocation of 300 boats distributed across different sluice sections, with 60 vessels stationed at each sluice. Each boat could carry over 150 *dan* of grain, yielding a daily capacity of approximately 2,000 *dan*. The grain transport season extended from May to September, covering a total of 150 days, during which boats operated continuously to ensure timely delivery. The annual grain shipment to Beijing via the Tonghui Canal was projected to reach 2.56 million *dan*, meeting the city's essential needs. To support this large-scale operation, Wu Zhong advocated for strict regulatory oversight encompassing rational distribution of vessels, enforcement of weight limits, careful scheduling, and rigorous safety protocols. This comprehensive management model not only maximised transport efficiency but also underscored the strategic role of the Tonghui Canal in sustaining imperial supply chains

3. Historiographer of Hydraulic Memory

In 1529, while travelling along the Tonghui Canal en route to Tongzhou, Wu Zhong was confronted with memories of the arduous journey and the numerous challenges encountered during the canal's rehabilitation. Concerned that such experiences might be forgotten over time due to administrative turnover and fading institutional memory, he recognised the need to document and preserve this knowledge for future generations. As noted by Hu Mangquan (2008), Wu Zhong undertook the compilation of the *Gazetteer of the Tonghui Canal* as a means of safeguarding institutional experience. Hu Jixun (2015) further highlights that this work was based on a diverse range of materials, including historical records, antique maps, field investigations, and textual analysis. This two-volume work, comprising over 20,000 characters, presents meticulously organised content and incorporates a wealth of first-hand data. It remains the only extant chronicle dedicated exclusively to the Tonghui Canal. Upon its completion, the gazetteer served as both an administrative guide and a technical reference for officials engaged in subsequent canal repair and maintenance. Later supplements included the names of 33 officials who oversaw the canal from 1527 to 1571, thereby increasing its institutional value (Wu Zhong, 2015).

The gazetteer features Wu Zhong's critical reflections and evaluative commentaries. Thoroughly structured and enriched with both text and illustrations, the work possesses substantial historical and scholarly merit. It not only serves as a foundational source for understanding Ming water conservancy but also functions as a model for future research and practical reference. Focused on the mid-Ming rehabilitation period a pivotal phase in the canal's history the gazetteer captures the unique technical challenges and administrative shifts that characterised this transformative era (Wu Zhong, 2015).

In 1533, Qin Jin, then *Gongbu Shangshu* (Minister of Works) (Hucker, 1985), acknowledged Wu Zhong's enduring contributions in an official memorial. He emphasised that the uninterrupted grain transport and the resulting stability of the nation's economic lifeline in recent years were largely attributable to Wu Zhong's leadership and engineering accomplishments achievements regarded as both exceptional and irreplaceable, meriting historical commemoration. In 1566, the residents of Tongzhou erected the Tonghui Temple in honour of Wu Zhong. During this period, he was deified as the "Dam God" (Shen Gong) and formally venerated in the annual Canal Opening Festival. As Hu Mangquan (2008) observes, this ritual commemoration reflects the deep local appreciation for Wu Zhong's enduring contributions to infrastructure development and public administration.

Discussion

The study of Wu Zhong and his contributions to the rehabilitation of the Tonghui Canal during the Ming dynasty provides significant insights into the historical, technical, and institutional dynamics of hydraulic engineering in late imperial China. Wu Zhong emerged as a pivotal figure whose multidimensional expertise and strategic foresight substantially reshaped the operational efficiency and governance of one of the empire's most critical waterways. Wu Zhong recognised the strategic importance of the Tonghui Canal to Beijing's economy and logistics. He devised and implemented comprehensive engineering and administrative solutions to address water scarcity, silt accumulation, and elevation disparities. His preventative measures included rerouting water supplies, modifying canal architecture, and introducing innovative technologies such as the Reverse Loading System. These reforms enhanced transport efficiency and contributed to the long-term structural stability of the canal.

His leadership during the restoration project is particularly noteworthy for its technical rigour and efficiency. He assembled a multidisciplinary team, enforced strict construction protocols, and oversaw the successful completion of one of the Ming dynasty's most complex canal rehabilitation efforts in under four months. His meticulous organisational planning and active on-site supervision illustrated his ability to translate hydraulic engineering principles into effective management practice.

Wu Zhong also demonstrated a profound understanding of institutional governance. He established a sustainable framework for long-term canal maintenance and administration, extending the impact of the rehabilitation project well beyond its immediate success. His proposals encompassed routine dredging, the appointment of specialised personnel, and the creation of grain transportation offices. These institutional reforms ensured the continued operation of the Tonghui Canal from the late Jiajing reign through to the end of the Ming dynasty.

His compilation of the *Gazetteer of the Tonghui Canal* represents one of his most enduring legacies. This text not only detailed the canal's engineering and historical development but also served as a technical and administrative reference for future generations. As one of the earliest comprehensive treatises on Ming water conservancy, the gazetteer exemplifies the integration of hydraulic expertise with state policy and documentary governance.

In summary, Wu Zhong's legacy can be encapsulated in four core contributions: the successful execution of a major hydraulic engineering project under tight logistical and temporal constraints; the implementation of durable institutional reforms in canal governance; the creation of a hierarchical and accountable management system; and the production of technical literature that informed subsequent policy and engineering practice. These accomplishments not only addressed contemporary logistical challenges but also laid the theoretical and practical groundwork for future water management in imperial China.

Wu Zhong's model of integrative leadership merging engineering acumen, institutional reform, and epistemic documentation stands as a defining paradigm in the hydraulic history of the Ming dynasty. His work continues to provide valuable insights for scholars examining the intersection of infrastructure, statecraft, and environmental governance in premodern East Asia.

Conclusion

This study has examined Wu Zhong's multidimensional contributions to the rehabilitation and governance of the Tonghui Canal during the Ming dynasty, highlighting his role as an engineer, administrator, and historiographer. By analysing primary sources including Wu Zhong's memorials, the *Gazetteer of the Tonghui Canal*, and official Ming records, this research has offered an integrated understanding of the technical, institutional, and documentary aspects of hydraulic governance in late imperial China.

The findings demonstrate that Wu Zhong not only led one of the most efficient and technically advanced canal rehabilitation projects of the Ming era but also established enduring institutional mechanisms for maintenance, labour organisation, and logistical coordination. His innovative initiatives such as the Reverse Loading System, the redesign of sluice infrastructure, and the strategic redistribution of grain transport capacity reflect a sophisticated understanding of both hydraulic engineering and state governance. Moreover, his compilation of the *Gazetteer of the Tonghui Canal* ensured the transmission of technical knowledge and administrative precedent, illustrating his awareness of the importance of documentary governance and historical memory.

In terms of practical and scholarly contribution, this study advances the historiography of Chinese water conservancy by moving beyond macro-narratives focused on the Grand Canal and highlighting the agency of a single official in effecting sustainable local reform. It contributes to the fields of historical infrastructure studies, environmental governance, and Chinese administrative history by offering a nuanced case of integrative leadership that links engineering, bureaucracy, and knowledge production.

However, several limitations should be acknowledged. First, the analysis is constrained by the availability and reliability of Ming-era documents, some of which are fragmentary or written with retrospective bias. Second, while the study focused on Wu Zhong's achievements, it did not fully explore resistance or institutional constraints that may have shaped the implementation of his reforms. Third, the study is primarily textual; future research could benefit from spatial analysis or archaeological evidence related to the physical remnants of the canal infrastructure.

Despite these limitations, the study affirms Wu Zhong's pivotal role in transforming the Tonghui Canal into a model of effective statecraft and hydraulic management. His legacy continues to offer valuable lessons for scholars interested in the intersection of infrastructure, institutional design, and environmental sustainability in premodern Asia.

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