Analysis of the Relationship between Official Rain-Praying Rituals and Droughts in China over the Past 2000 Years

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Abstract: Official rain-praying rituals, as an institutionalized cultural response to drought in ancient China, offer a crucial window into the evolution of state governance logic and disaster relief responses during climate crises. In this study, 1,825 official rain-praying records from the Western Han to the Qing

15 dynasties were collated on the basis of the Twenty-Four Histories and the Qing Shigao, resulting in the construction of a long-term sequence with a ten-year resolution and a high-resolution annual sequence for the Ming and Qing periods. Sliding window correlation analysis was employed in combination with historical drought sequences to investigate long-term patterns of change. Functioning as a cultural disaster response indicator, this sequence, when integrated with other socioeconomic proxy indicators,

20 enables a more comprehensive characterization of the climate change–impact–response process. The findings reveal that official rain-praying rituals exhibit a four-phase fluctuation pattern of low-high-low-high, with a significant nonlinear relationship between drought occurrence and such rituals. During the Han and Tang dynasties, rain-praying primarily constituted a direct response to environmental stress. In the Song and late Qing periods, confronted with crises of legitimacy amid internal turmoil and external

25 threats, rulers favored high-frequency rain-praying to proclaim the mandate of heaven and pacify public sentiment, resulting in a strong correlation between rain-praying and drought. Conversely, during the Yuan and late Ming dynasties, influenced by ethnic cultural differences or the collapse of state administrative efficacy, a decoupling emerged whereby disasters occurred without corresponding rain-praying. Moreover, the Qing dynasty established systems of regular rain prayers and confidential

30 memorials, transforming rain rituals from reactive disaster relief into proactive administrative routines. These rituals even exhibited a temporal lead over drought outbreaks, becoming institutionalized. During periods of relative fiscal abundance, state disaster responses prioritized substantive relief measures—such as opening granaries for distribution and tax reductions—over reliance on ceremonial rain prayers. As rulers' focus shifted from celestial principles to pragmatic grain storage for famine relief, the

35 frequency of rain-praying rituals also declined markedly. Research findings indicate that ancient Chinese official rain-praying rituals were not determined solely by climate but constituted a complex political process regulated by state capacity, demands for political legitimacy, and institutional sophistication.

Keywords: official rain-praying rituals; drought; past 2000 years; social response

1 Introduction

40 While cultural disaster responses cannot alter external climatic conditions, they play a vital role in maintaining social order, enhancing psychological resilience, and fostering collective survival in the face of environmental unpredictability (Adger et al., 2013; Espín-Sánchez and Gil-Guirado, 2022). Throughout history, drought has exerted profound effects on human societies and economies, representing a pervasive and long-standing environmental stressor throughout the annals of human

45 civilization (Mishra and Singh, 2010; Dai, 2011; Cook et al., 2018). Droughts have multifaceted effects on society and the economy, such as agricultural crop failure, famine, and the large-scale migration of displaced people, all of which threaten livelihoods (Endfield and Tejedo, 2006; Chen et al., 2022; Chen et al., 2024a). They have been demonstrated to be a critical risk factor for social instability, peasant revolts, civil wars, regime change, and even civilizational collapse(Zheng et al., 2014; Chen, 2015;

50 Kaniewski et al., 2015; Liu et al., 2018; Han and Yang, 2021). Through centuries of drought management, ancient states have evolved dual response systems that combine substantive relief and ceremonial rituals. On the one hand, governments have enhanced drought resilience through pragmatic measures such as agricultural improvements, hydraulic engineering, consumption adjustments, grain storage facilities, and relief exemptions (Tao et al., 2024; Tian et al., 2024; Tao et al., 2025; Tian et al., 2025a). On the other

55 hand, since ancient times, cultural responses to the limited technological capabilities of traditional societies have led to universal strategies for coping with uncontrollable natural environmental pressures (Salite and Poskitt, 2019). Globally, numerous cultural records demonstrate that people have engaged in rain praying rituals, sacrificial ceremonies, and communal dances to appease supernatural entities—such as deities, ancestors, or gods—performed with the aim of controlling the weather and thereby producing

60 rainfall (Murphy et al., 2016; Jobbová et al., 2018; Murray and Xing, 2020; Hong et al., 2024). Culture and faith assist individuals in navigating disaster environments, enabling them to comprehend and alleviate traumatic experiences (Cannon, 2008; International Federation of Red Cross et al., 2014; Webb, 2018).

65 The official rain-praying rituals of ancient China bore distinct political and institutional characteristics. On the basis of the Confucian political philosophy of 'Nature and humans respond to each other' and 'Heaven's warnings and condemnations of rulers through natural disasters or anomalous phenomena,' official rain-praying rituals evolved beyond mere folk beliefs or religious ceremonies into a highly institutionalized tool of state governance (Snyder-Reinke, 2009). Through solemn rituals, rulers

70 demonstrated attitudes of 'sincerity' and 'self-reflection,' thereby proclaiming the legitimacy of their regime. Such rituals served to allay public panic during the initial stages of disasters, bolster social cohesion, and even function as mobilization mechanisms to organize public participation in drought relief efforts (Lin and Xie, 2025). The research literature includes in-depth explorations of societal response mechanisms to climate change, encompassing quantitative analyses across multiple dimensions from

75 agricultural production and population migration to political-fiscal systems and warfare (Ye et al., 2012; Huang et al., 2014; Xiao et al., 2014; Xiao et al., 2018; Tao et al., 2025; Tian et al., 2025b). Although the proxy sequences obtained in various studies provide rich climate response data, few studies have specifically examined the long-term evolution of cultural responses to disasters; moreover, cultural proxy

indicators are more challenging to characterize (Wei et al., 2020). Existing research predominantly treats

80 rain-praying records as proxy data for reconstructing climate change (Domínguez-Castro et al., 2011; Bravo-Paredes et al., 2020; Domínguez-Castro et al., 2021) and overlooks their independent status as proactive social adaptation behaviors within state governance systems. This oversight limits our comprehensive understanding of ancient psychological adaptation and social mobilization mechanisms in response to climate crises.

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In light of this, the present study focuses on official rain-praying rituals in China from the Western Han dynasty to the Qing dynasty, with the aim of exploring the evolutionary logic of this quintessential cultural response behavior over the long term. Specifically, this research addresses the following core questions: (1) What long-term trends have characterized official rain-praying rituals in China over the

90 past two millennia? (2) How closely have rain-praying rituals been correlated with actual drought events? During which periods has such correlation been stronger? (3) What differences in state governance and institutional frameworks were reflected by the shifts in this relationship? This research not only contributes to refining models of societal response mechanisms to historical climate change from a cultural perspective but also offers historical insights for contemporary society. This research also reveals

95 both the wisdom and limitations of ancient responses to extreme climate events. In doing so, it provides valuable lessons for fostering social resilience and collective communication during the current climate crisis, thereby promoting the application of historical knowledge to contemporary challenges.

2 Data and Methods

2.1 Data source

100 #### 2.1.1 Official Rain Praying Rituals Data

This study covers the period from the Western Han to the Qing dynasties (202 BC–1911 AD), spanning 2,113 years of Imperial China. Data on official rain-praying rituals were collected from the Chinese Digital Archives (https://www.zhonghuadiancang.com), specifically the Twenty-Four Histories, the Draft History of the Qing, and the Veritable Records of the Ming and Qing dynasties (Table 1). The

105 Twenty-Four Histories are the orthodox official histories of ancient China, primarily written in a biographical-thematic style. They are highly credible and recognized as the foundational resources for studying Chinese history. To maintain comparability across the long-term sequence, the Draft History of the Qing was selected for the Qing dynasty segment as it follows the same traditional historiographical structure and paradigms as the preceding Twenty-Four Histories. Using the Twenty-Four Histories and

110 the Draft History of the Qing to construct the long-term sequence minimizes temporal bias arising from inconsistencies in historical documentation. For the Ming and Qing periods, the Veritable Records provide more granular data. Unlike the summarized nature of the dynastic histories, the Veritable Records are chronological accounts compiled by contemporary officials, recording the emperors' daily activities and state affairs in great detail. The Veritable Records of the Ming (Ming Shilu)—supplemented by the

115 Veritable Records of Chongzhen (Chongzhen Shilu) for the late Ming—consist of 2,911 volumes, while the Veritable Records of the Qing (Qing Shilu) comprise 4,433 volumes. These records offer microscopic

details; for example, where the Draft History of the Qing might briefly mention "praying for rain," the Veritable Records specify the exact date, the specific ritual location (e.g., Dagaodian or Shiying Palace), and the specific princes or officials dispatched by the Emperor. Utilizing these as primary sources allows

120 for the construction of high-resolution sequences, offering deeper insights into the specific rituals of these two dynasties.

2.1.2 Historical Drought Data in China

The aridity data for the relevant historical periods in China required for this paper are sourced from the *Collection of Meteorological Records in China for the Past 3,000 Years*. Edited by Zhang De'er and her

125 team, this work was compiled in chronological order, consulting 8,228 historical documents and citing 7,835 of them. It is a compilation of meteorological and disaster records spanning three millennia from the oracle bone script period to the late Qing dynasty (1911 AD). It details the severity and geographical extent of meteorological disasters alongside post disaster response measures while also covering phenological events, crop yields, pest outbreaks, and famines linked to climatic conditions. This work

130 constitutes a foundational meteorological resource of considerable authority and scholarly merit. Utilizing the county as the spatial unit and the year as the temporal unit, this collection offers broad geographical coverage and a long time span, effectively illustrating the extent and severity of droughts and providing a comparable drought record for this study.

Table 1: Historical Records Extracted and Sources

Dataset Title	Extracted Information	Number of Records Extracted
Twenty-Four Histories	Official rain praying rituals from the Western Han to Ming dynasties	446
Veritable Records of the Ming Dynasty (Ming Shilu)	Official rain-praying rituals during the Ming dynasty	197
Veritable Records of the Qing Dynasty (Qing Shilu)	Official rain praying rituals during the Qing dynasty	1056
Draft History of the Qing Dynasty (Qing Shigao)	Official rain praying rituals during the Qing dynasty	136
Collection of Meteorological Records in China for the Past 3,000 years	Number of drought records from Western Han to Yuan dynasties	1775
	Number of counties affected by drought during the Ming and Qing dynasties	24697

135 **2.2 Research Methods**

2.2.1 Definition of Official Rain-Praying Rituals

Rain-praying rituals refer to sacrificial ceremonies and ceremonial activities conducted to petition deities for rainfall. Official rain-praying rituals were dynasty-political rituals led by feudal rulers, expressing appeals to deities to alleviate droughts and thereby stabilize governance and social order. The core

140 elements for judging official rain-praying rituals include the following three points.

Ideological Foundation

The widespread acceptance of the concept that "nature and humans respond to each other" led to the

145 prevalence of religious rituals and superstitious rituals. This not only instilled reverence for rulers among

the populace but also linked natural disasters to the moral character of those in power. Rulers inevitably organized rain-making ceremonies to convey their legitimate authority to the people.

Official Leadership

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Conducted under the auspices of the imperial court or local authorities, these ceremonies were presided over by the emperor, officials, or dedicated priests and thus were often recorded in historical texts such as official histories and local gazetteers.

155 Comprehensive Ritual Structure

Although rain-praying systems varied across dynasties, official rain-praying rituals typically featured designated sites (e.g., the Temple of Heaven, the Guang run Shrine, and the Dragon God Shrine); specific deities (e.g., dragon spirits, wind-cloud-thunder-rain entities, and city gods); and standardized protocols
160 (fasting, prayers, sacrifices, dances, and concluding thanksgiving rites). Special methods for rain-praying also emerged in different dynastic contexts. In statistical analysis, each verified rain-praying record that can be precisely dated to a specific point in time is counted as one "official rain-praying ritual."

Types of Official Rain Praying Rituals
165 Under different criteria, official rain-praying rituals can be categorized into distinct types. For instance, classifications based on the objects of worship or the locations of rituals vary across dynasties. The study period spans from the Western Han Dynasty to the Qing Dynasty, and when organized by group, it is highly consistent. Therefore, this paper categorizes official rain-praying rituals on the basis of organizational groups (Table 2), supplemented by an assessment of behavioral motivations. These
170 include five types: rain-praying rituals conducted by local officials, rain-praying rituals conducted by officials dispatched by the emperor, rain-praying rituals conducted by imperial clan members dispatched by the emperor, rain-praying rituals conducted personally by imperial clan members, and rain-praying rituals conducted personally by the emperor. Analysis of the types of rain-praying rituals revealed that, in addition to instances where a single official rain-praying activity occurred, there were also records
175 where two to three types of official rain-praying rituals appeared within the same document. To further analyze the characteristics of official rain-praying rituals, a tiered classification was established on the basis of the organizing entities: rituals personally attended by the emperor were designated Level 3; those involving imperial clan members or noble officials were Level 2; and those organized or attended by functional department officials, provincial governors, or local officials were Level 1. When multiple
180 official rain-praying rituals were identified within a single record, the highest tier was recorded. This grading system indirectly reflects the central government's level of emphasis on each ritual.

Table 2: Description and Classification of Official Rain-Praying Rituals

Types of official rain-praying rituals	Chief officiant of the ritual	Description	Level
The emperor personally performed rain	The emperor	The emperor went to designated sacrificial sites to pray for rain or performed rain-praying rituals within the palace.	3

prayers			
Imperial clan members were dispatched to perform rain prayers	Imperial clan members	Imperial princes, dukes, and other members of the imperial clan, along with marquises, were commanded by the emperor to attend rain-praying rituals at the central sacrificial site in his stead. This constituted a passive obligation for members of the imperial clan.	2
Imperial clan members personally performed rain prayers	Imperial clan members	Imperial clan members such as the empress and empress dowager conducted rain-praying rituals in their personal capacities, constituting voluntary actions undertaken by members of the imperial family.	2
Officials were dispatched to perform rain prayers	Central sacrificial department	The Shuntian Prefecture, the Ministry of Rites, and other central ritual departments conducted rain-praying ceremonies either by imperial decree or in the direct exercise of their departmental duties, traveling to ritual sites within and around the capital. This constituted a passive action.	1
	Senior local officials	The emperor dispatched high-ranking local officials such as provincial commissioners and governors to disaster-stricken areas to perform rain-praying rituals. In addition to governors, the emperor would also send envoys for rain prayers. These envoys were typically senior officials tasked with conveying the emperor's edicts and executing the rain-praying ceremonies, constituting a passive action.	1
	Local officials	The emperor ordered local officials in drought-stricken areas to perform rain prayers, with the prayer sites typically located in disaster zones—a passive action.	1
	Specialized technicians	Professional ritual practitioners such as Taoist priests, Buddhist monks, and lamas performed rain-prayer ceremonies at the emperor's command, constituting a passive act. These ceremonies were often linked to the religious beliefs of the dynasty or the emperor's personal beliefs.	1

2.2.2 Official Rain-Praying Rituals Database and Sequence Construction

Step 1: Using the keywords "雩" (rain ritual), "祈" (prayer), "祷" (prayer), and "祠" (shrine), chapter-by-chapter searches were conducted within selected historical texts spanning the period from the Western Han Dynasty to the Qing Dynasty (202 BC–1911 AD) (Fig. 1). The initial search yielded 10,577 entries. These keywords correspond to the official term for rain-praying rituals (雩), the act of supplication (祈/祷), and the sites for rain-praying (祠), respectively.

Step 2: A secondary search was conducted using the prayer object "rain," supplemented by textual analysis to extract all rain-related information from the primary search data. Records pertaining to non-rain-related rituals or those not specifically associated with rain prayers were excluded. The screening criteria for this step were as follows: (1) Rituals honoring heaven, earth, mountains, rivers, ancestral temples, etc., were included only when drought conditions or rain-praying intent are explicitly mentioned in the text. (2) Sacrifices to wind, clouds, thunder, and rain were counted only when drought or agricultural impacts were mentioned. (3) Dispatches for sacrifices without explicitly stated rain-praying purposes were excluded. (4) "Thanksgiving for rain" was treated as corroborating evidence of successful rain-praying. If a criterion corresponded to a preceding rain-praying record, it was deduplicated; if not, it was counted separately. (5) When officials petitioned the emperor for rain-praying, records indicating imperial consent ("granted", "approved", etc.) were verified; "denials" were excluded.

Step 3: Non-rain-praying actions and duplicate entries were excluded. (1) Institutional texts, rain-praying poems, and other non- "actual rain-praying actions" were removed. (2) Item-by-item comparisons were conducted for duplicate records caused by multiple keywords to ensure the uniqueness of official rain-praying rituals.

Step 4: Standardization and time normalization were recorded. On the basis of the original text in the database, the reign year, lunar month, and stem-branch date for each official rain-praying ritual were extracted. These data were converted to Gregorian calendar dates and the event types were determined. For the seasonal events, the month containing the season was used as the statistical timeframe. When the month or season was unclear, the year was used as the time unit. Among the official rain-praying rituals in the Twenty-Four Histories and the Draft History of the Qing Dynasty, 10 entries could not be accurately dated, accounting for 1.93% of all such records from the Western Han Dynasty to the Qing Dynasty. These mostly appeared in the biographies of the official histories concerning rain-praying missions by dispatched officials or imperial clan members. For such data, the middle value of the time interval was used as the occurrence year.

Finally, the records of official rain-praying rituals were organized and categorized according to the following criteria: source, original date, original content, type of rain-praying ritual, and Gregorian calendar date (Table 3). In this way, a database of official rain-praying rituals from the Western Han Dynasty to the Qing Dynasty (202 BC–1911 AD) was constructed.
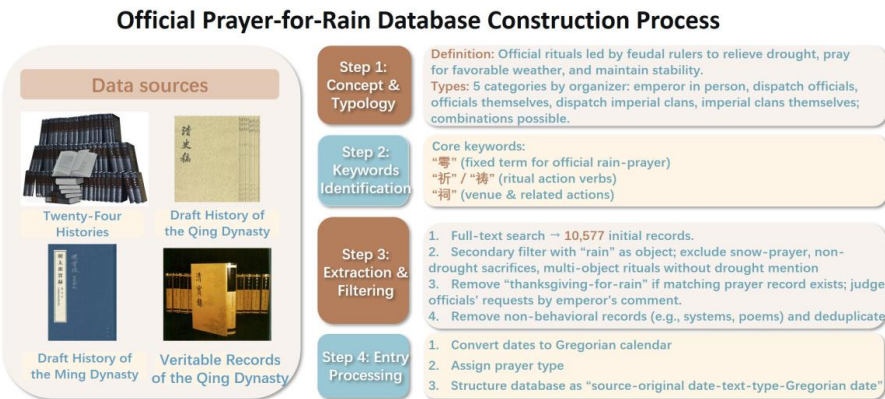
Figure 1: Database and Sequence Construction Flowchart for Official Rain-Praying Rituals.

Table 3 Examples of Data on Ancient Chinese Official Rain-Praying Rituals

Source	Original date	Original content	Type of rain-praying ritual	Gregorian calendar date
The History of the Former Han Dynasty, Annals of Emperor Zhao, Volume 7	Summer of the sixth year of Shiyuan	During droughts and major rain rituals, it is forbidden to light fires (旱，大雩，不得举火)	The emperor personally performed rain prayers	81BC.6—9
The History of the Former Jin	The fourth month of the	In the second year of the Xianning era, a prolonged drought persisted	Officials were dispatched to	276.5.11

Dynasty, Volume 9	second year of Xianning, on the day of Ding-si	throughout the spring. On the day of Ding-si in the fourth month, an imperial edict proclaimed: "In all regions afflicted by drought, intensify prayers for rain." (咸宁二年，春久旱。四月丁巳，诏曰：诸旱处广加祈请)	perform rain prayers	
Old History of the Five Dynasties, Annals of Emperor Mingzong, Volume 8	The fourth month of the second year of Changxing, on the day of Yi-si	On the day of Yisi in the fourth month, the emperor visited the Longmen Buddhist Temple to pray for rain. (四月乙巳，帝幸龙门佛寺祈雨）	The emperor personally performed rain prayers	931.5.7
…	…	…	…	…

Official rain-praying rituals extracted according to the above principles were reconstructed into a sequence using the sequence construction method. On the basis of data from the Twenty-Four Histories and the Draft History of the Qing Dynasty covering official rain-praying rituals from the Western Han

230 Dynasty to the Qing Dynasty, the data were divided by era. The frequency of official rain-praying rituals per decade was calculated to construct a 10-year-resolution sequence of official rain-praying rituals spanning from 202 BC to 1911 AD (Western Han to Qing dynasties). Simultaneously, leveraging more detailed veritable records from the Ming and Qing dynasties, annual counts of official rain-praying rituals were calculated. This established a high-resolution, year-by-year sequence of official rain-praying

235 activities from 1368 to 1911 AD, organized by dynasty. This approach comprehensively and systematically revealed the temporal distribution characteristics of ancient official rain-praying rituals.

2.2.3 Processing of drought sequence data

The construction of the drought sequence from the Western Han Dynasty to the Qing Dynasty relied primarily on the *Collection of Meteorological Records in China for the Past 3,000 Years* as its data source.

240 Owing to the extended research period, the recorded details vary in depth. The vast majority of records from the Western Han Dynasty to the Five Dynasties and Ten Kingdoms cannot be precisely localized to specific locations; they indicate only the overall drought conditions across China for that year. For the period spanning the Western Han Dynasty to the Yuan Dynasty, the number of drought records was used as the foundational data for constructing the drought sequence. During the Ming and Qing dynasties,

245 most records specified clear locations, with many detailing specific counties. Therefore, the drought sequence for this period was constructed on the basis of the number of counties affected by drought each year.

Drought entries from the Western Han Dynasty to the Yuan Dynasty were extracted on the basis of

250 descriptions from four categories of historical records in the *Collection of Meteorological Records in China for the Past 3,000 Years*. Category One: Direct statements of drought intensity, with some records specifying the drought season or month, such as "Autumn: drought across the land" or "Drought in the capital." Category Two: Descriptions of abnormal precipitation, such as "From summer until July, no rain fell, and the heat was especially intense" or "Spring rains were late." Category Three: Reports on

255 crop growth, harvest conditions, soil moisture levels, or river states, such as "wheat crops withered," "no

wheat seedlings," "soil parched and springs dried up," or "the Sand River exposed its bed." Category Four: Descriptions of the people's water situation, such as "water dried up, people starved." Whether the drought falls under the second category of meteorological drought, the third category of agricultural hydrological drought, the fourth category of socioeconomic drought, or the first category of comprehensive meteorological, soil, and agricultural drought as a holistic perception, it is considered a drought.

Rules for Determining Drought Occurrence and Year Attribution. To ensure temporal consistency, standardized treatment is applied to special expressions: (1) Any occurrence of the character "旱" (drought) was counted as a drought in that year, even when it appears in postdisaster response descriptions. (2) Drought conditions mentioned in imperial edicts were counted only when explicitly referring to the current year's situation. Descriptions such as "recent years," "in recent times," or "since ascending the throne"—which are retrospective—were excluded from the tally. (3) Distinctions were made for temporal pronouns: "last year" was counted as the recorded year minus one; "since last year." indicated continuity and was counted as two years; terms such as "consecutive years (连年)", "compared to previous years (比岁)", "several years (数年)" and "year after year (累年)" were excluded because of uncertain start/end dates. (4) "Kang yang (亢阳)" was included as a meteorological indicator of persistent drought.

The final dataset comprised 1,775 drought records spanning the Western Han to Yuan dynasties and 24,697 drought occurrences across counties during the Ming and Qing periods.

2.2.4 Correlation Analysis

This study aims to investigate the dynamic evolution characteristics of the relationship between prayer for rain and drought events. First, Spearman's correlation coefficient is employed to assess the overall correlation between drought and prayer-for-rain time series across different periods. Sliding window methods are subsequently used to conduct an in-depth analysis of their dynamic association within distinct time intervals. Spearman's correlation analysis is a nonparametric method that effectively measures monotonic relationships between variables without assuming specific probability distributions (e.g., normal distribution) or linear relationships. It is particularly suitable for nonlinear data such as climatic and historical events (Schober et al., 2018). The calculation is as follows:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \tag{1}$$

Here, ρ denotes the Spearman correlation coefficient, d_i represents the difference in rank between the two sequences at the i-th time point, and n is the total effective sample size. By calculating this metric across the entire study period, a global correlation indicator is obtained to characterize the average strength and direction of the relationship between the two variables.

To analyze the dynamic relationship between rain-praying and drought, a sliding window correlation

analysis method was employed. The window width was set to 10 years with a step size of 1 year. A minimum effective sample size threshold of 5 years was established, meaning that calculations proceeded only if the window contained at least 5 valid pairs of drought-rain-praying data. This approach avoids unreliable estimates at the sequence ends because of insufficient sample size. For each sliding window meeting the minimum sample threshold, the local correlation within that time period is calculated. Ultimately, a dynamic time series reflecting the temporal variation in the correlation coefficient is generated. By analyzing the fluctuations and trends in this series, the phased characteristics of the relationship between rain-praying rituals and drought are revealed.

3 Results

3.1 Temporal and Typological Characteristics of Official Rain-Praying Rituals from the Western Han to the Qing Dynasties

3.1.1 Statistical Characteristics of Official Rain-Praying Rituals

The Twenty-Four Histories and the Draft History of the Qing Dynasty collectively document 517 official rain-praying rituals from the Western Han Dynasty to the Qing Dynasty, averaging 2.45 ceremonies per decade. However, significant temporal variations are evident, with the most pronounced divergence occurring at approximately 960 AD. Therefore, by using 960 AD as a temporal marker and dividing the historical period by dynasty, we can identify distinct phases of high and low frequency in official rain-praying rituals.

202 BC–959 AD, which spanned the Western Han Dynasty to the Five Dynasties and Ten Kingdoms period, averaged 1.38 rituals per decade. When official rain-praying rituals were ranked by frequency, the top 20 most frequent eras accounted for 68% of all such rituals, with each era conducting ≥4 rituals per decade. Notably, 940 AD recorded 13 official rain-praying rituals—the highest among all 117 eras—corresponding to the Five Dynasties and Ten Kingdoms period. Among the remaining 97 eras, 63 showed no recorded rain-praying rituals (although unrecorded causes cannot be ruled out), concentrated in the Han Dynasty, the Jin Dynasty and Sixteen Kingdoms period, and the Tang Dynasty—particularly during the early phases of feudal dynasties—indicating a correlation with dynastic longevity.

960 AD–1911 AD, spanning the Song to Qing dynasties, was characterized by official rain-praying rituals occurring across various eras. When ranked in descending order by frequency, the 20 most frequent periods featured ≥12 rain-praying rituals per decade. During these periods, 241 official rain-praying rituals occurred, accounting for 59% of the total events in this phase. The three dynasties with the highest frequency of official rain-praying rituals across all the periods were the Southern Song Dynasty (1200 AD: 29 times/10a; 1190 AD: 23 times/10a), the Northern Song Dynasty (960 AD: 15 times/10a), and the Qing Dynasty (1830 AD: 15 times/10a). Among the remaining 76 years, only 18 generated no official rain-praying records (although reasons for missing records cannot be ruled out), with 11 of these records concentrated in the Ming Dynasty.

Second, an examination of the frequency of official rain-praying rituals across dynasties revealed that the Song Dynasty (163 instances combined for Northern and Southern Song) conducted the most such rituals, followed by the Qing Dynasty (127 instances). To account for variations in dynastic duration, a

335 deeper analysis was conducted by calculating the frequency per decade for each dynasty (Figure 2). The Song Dynasty (5.1 times/10a) ranked first, followed by the Five Dynasties and Ten Kingdoms period (5.28 times/10a) and the Qing Dynasty (4.76 times/10a) as the top three dynasties in terms of average official rain-praying frequency. Their frequency of official rain-praying rituals far exceeded the overall ancient average (2.45 times/10a), making them dynasties with a high incidence of such rituals. The Han

340 Dynasty, the Three Kingdoms and Jin Dynasties, the Northern and Southern Dynasties, the Sui and Tang Dynasties, the Liao Dynasty, and the Ming Dynasty all exhibited official rain-praying rituals with frequencies below the ancient Chinese average (2.45 times per decade), indicating periods with a low incidence of such rituals.

3.1.2 Analysis of Types of Official Rain-Praying Rituals

345 The types of official rain-praying rituals from the Western Han Dynasty to the Qing Dynasty were determined on the basis of the official rain-praying ritual classification criteria outlined in Table 2. Overall, ancient official rain-praying rituals recorded 337 instances of emperors personally praying for rain (including both standalone imperial rain prayers and collective rain prayers where imperial participation cooccurred with other types), accounting for 57.90% of all rain-praying events across all

350 dynasties (Fig. 2). Officials were dispatched to perform rain rituals 176 times (including instances where officials were solely dispatched and instances where official dispatch occurred alongside other ritual types in collective rain rituals), with only the Three Kingdoms, Sui, and Liao dynasties lacking such records. In contrast, dispatching imperial relatives to pray for rain (including standalone instances and collective prayers involving imperial relatives alongside other types) and imperial relatives praying for

355 rain occurred less frequently, with 8 and 5 instances, respectively. The former appeared only during the Southern and Northern Dynasties (1 instance) and the Qing Dynasty (7 instances), whereas the latter was evenly distributed across the five statistical periods: the Southern and Northern Dynasties, Northern and Southern Song Dynasties, and Ming and Qing Dynasties.
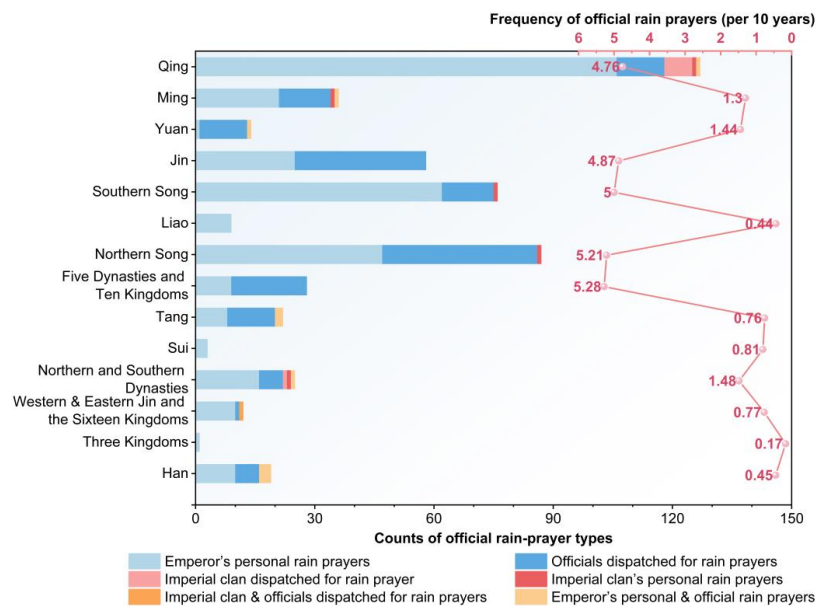
Figure 2: Types of Rain-Praying Rituals, Frequency per 10-Year Period, and Total Occurrences across Dynasties.

3.1.3 Long-Term Time Series Changes and Phases of Official Rain-Praying Rituals

To characterize the long-term changes in official rain-praying activities, this study first employed the number of rain-praying years within a decade—that is, the number of years during which official rain-praying rituals occurred within a ten-year period, ranging from 0 to 10 years—to measure the persistence and frequency of such activities. On the basis of the dual indicators of 10-year occurrence frequency and behavioral frequency, official rain-praying rituals exhibited a four-phase fluctuation pattern of "low-high-low-high" over the past 2,000 years (Fig. 3). This long-term fluctuation is closely linked to political structures, climate change, and social governance models, providing a foundation for further exploration of the political-environmental context of rain-praying rituals.

Phase I, spanning the Western Han Dynasty to the Five Dynasties and Ten Kingdoms period (202 BC–959 AD), marked a low-frequency era for official rain-praying rituals. The overall frequency of rain-praying rituals per decade remained low, averaging only 0.82 years/10a. Although minor peaks of 3–4 years occurred during the late Three Kingdoms period, the mid-to-late Northern and Southern Dynasties, the early Sui Dynasty, and the mid-Tang Dynasty, the overall frequency remained low. Official rain-praying rituals during this period totaled only 133 instances (25.7%), an average of 1.1/10a. These rituals were concentrated in the Han, Northern and Southern Dynasties, Tang, and Five Dynasties, with 94 rituals accounting for 70.6% of the total rituals in this stage. The Five Dynasties and Ten Kingdoms period stands as the only era with notably frequent rain-praying rituals. Ritual types evolved from early-period (Han Dynasty, Three Kingdoms) rituals dominated by imperial personal prayers, gradually diversifying in the middle period (Eastern/Western Jin, Sixteen Kingdoms, and Southern and Northern Dynasties) and

shifting toward late-period (Tang Dynasty, Five Dynasties and Ten Kingdoms) rituals of dispatching officials to conduct rain-praying ceremonies.

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In Phase II, spanning the Song, Liao, and Jin Dynasties (961–1279 AD), rain-praying rituals increased significantly in frequency, averaging 3.72 years/decade. Three peaks emerged in 990 AD, 1040 AD, and 1200 AD, with 1040 AD and 1200 AD recording rain-praying in nine out of ten years—the highest frequency in the entire sequence. The frequency of rain-praying rituals also increased substantially during

390   this period, totaling 233 rituals (45% of the total), with an average of 7.06 rituals/10a—the highest value across the entire study period. The Northern Song, Southern Song, and Jin dynasties were high-incidence periods, collectively accounting for 9 high-incidence years. In terms of ritual types, emperor-led rain prayers predominated, followed by rain prayers conducted by dispatched officials.

395   Phase III, spanning the Yuan and Ming periods (1280–1643 AD), marked a low-frequency era for official rain-praying rituals. The number of rain-praying years per decade decreased significantly, averaging 1.05 years per decade. Minor peaks occurred internally in 1480 AD, 1580 AD, and 1640 AD. The total number of rain-praying activities reached 47 (9.1%), averaging 1.3 times per decade. Imperial rain-praying by Yuan emperors was exceptionally rare, occurring only once—the lowest frequency among all dynasties.

400   The rain-praying rituals in the Ming Dynasty exhibited diversifying patterns. Overall, this phase demonstrated a gradual fluctuation characterized by a "decline followed by an increase."

Phase IV, spanning Qing Dynasty (1644–1911 AD), dynasty witnessed 127 official rain-praying rituals, marking the highest frequency across all dynasties. The number of rain-praying years per decade

405   rebounded to 3.11 years/10a. From 1740 to 1860 AD, all 13 consecutive decades exceeded the phase average, indicating sustained high-frequency rain-praying activities. The Qing Dynasty recorded 127 official rain-praying rituals (23.3% of the total), averaging 4.7/10a—the highest frequency for any single dynasty. These activities were concentrated in the middle and late periods and exhibited a pattern of "initial increase followed by decline." Imperial participation reached its historical peak during this era,

410   while official involvement slightly decreased.
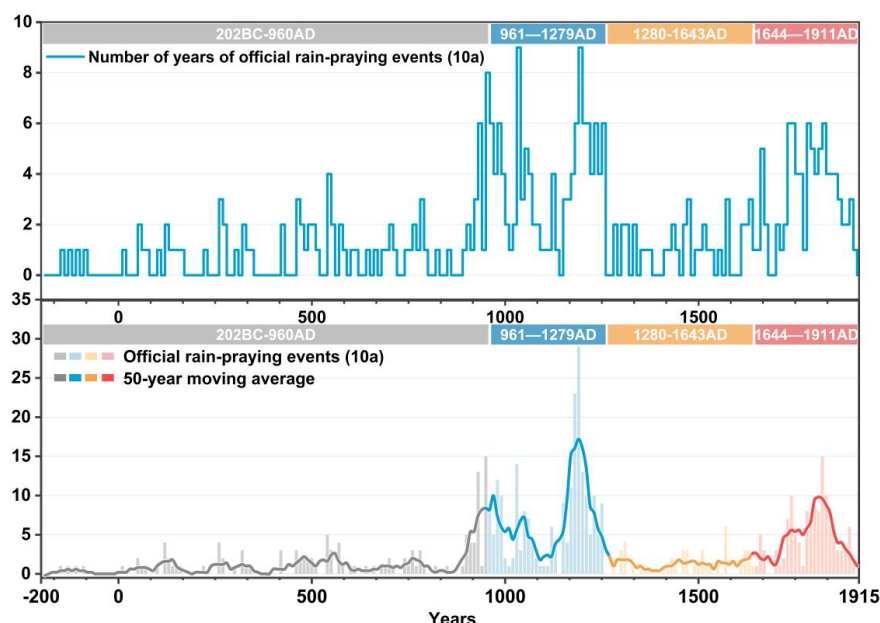
Figure 3: Number of Years and Frequency of Official Rain-Praying Rituals from the Western Han Dynasty to the Qing Dynasty (10a).

3.2 Relationships between Official Rain-Praying Rituals and Drought

415   **3.2.1 Comparative Analysis of Official Rain-Praying Rituals and Drought from the Western Han Dynasty to the Yuan Dynasty**

Using the *Collection of Meteorological Records in China for the Past 3,000 Years* as the data source, drought data from the Western Han Dynasty to the Yuan Dynasty were collected on the basis of the number of records. This yielded 1,775 drought records spanning 804 years, averaging 22.08 drought

420   records per decade. A greater number of drought records indicates more frequent droughts. To compare official rain-praying rituals with drought occurrence, drought records were aggregated at a 10-year resolution, yielding a drought record sequence for the Western Han to Yuan dynasties (Fig. 4a). The year 1320 AD recorded the greatest number of droughts at 76, followed by 1180 AD and 1200 AD, each with 55 droughts. These three periods were concentrated in the Southern Song, Jin, and Yuan dynasties. Only

425   three eras recorded zero drought events, all of which occurred before the Common Era: the -180s, -160s, and -50s, accounting for 1.9% of the Western Han to Yuan period. Overall, the drought record counts exhibited pronounced fluctuations with distinct phase-specific variations. From 202 BC to 960 AD (Western Han to Five Dynasties and the Ten Kingdoms period), the fluctuation range was relatively small. However, from 970 AD to 1360 AD (the Song, Liao, Jin and Yuan Dynasties), the fluctuation range was

430   large, with the greatest number of drought records occurring in 1320 AD (76 records). The influence of historical documentation being more detailed for recent times and less so for ancient times cannot be ruled out.

A comparative analysis of official rain-praying rituals and drought sequences from the Western Han to

the Yuan dynasties revealed that the correlation between official rain-praying rituals and drought varied across different periods (Fig. 4c). Therefore, on the basis of an overall analysis of their correlation during this era, a sliding window correlation analysis with a 50-year window was conducted for the Western Han to Yuan period. Calculating the Spearman correlation coefficient revealed a positive correlation between annual official rain-praying rituals and droughts during this period (r=0.685, p<0.01), indicating that the severity of droughts strongly explains the frequency of such rituals. From the Western Han Dynasty to the Five Dynasties and Ten Kingdoms period (202 BC–960 AD), droughts generally exhibited high correlation coefficients with official rain-praying rituals (Fig. 4c). This correlation can be explained by the socioeconomic conditions and the nature of rain-praying rituals during this era. During the Han, Sui, and Tang dynasties, relative economic prosperity and advanced agricultural development allowed governments to respond to droughts through relief efforts and tax exemptions. The Three Kingdoms, Wei-Jin-Southern and Northern Dynasties, and Five Dynasties and Ten Kingdoms periods were marked by frequent warfare and large-scale southward migrations of northern ethnic minorities, leading to social instability. Central governments prioritized warfare and regime stability, which limited drought mitigation measures. Furthermore, official rain-praying rituals required adherence to specific protocols and consumed significant manpower and resources. During periods of severe drought, governments often shifted their focus to more practical disaster relief measures. These factors diverted the central government's attention away from rain-praying as a drought response, thereby influencing the correlation results between official rain-praying rituals and drought severity.

During the Song, Liao, and Jin dynasties (961–1279 AD), the number of drought records increased significantly, and the overall number of official rain-praying rituals also increased. Spearman's correlation analysis revealed a correlation coefficient of 0.478 (p < 0.01) between the two phenomena. This era coincided with the late phase of the Medieval Warm Period and the onset of global cooling, characterized by heightened climate variability and markedly increased drought frequency, posing severe threats to agricultural production. The Song Dynasty actively adjusted its policies, implementing practical measures such as constructing water conservancy projects while also emphasizing official rain-praying rituals to reassure the populace and demonstrate the Mandate of Heaven, particularly during confrontations with ethnic regimes such as the Liao and Jin. Influenced by Central Plains culture, ethnic regimes such as the Liao and Jin also adopted Song-style disaster response measures to consolidate their rule, developing hybrid official rain-praying rituals combining indigenous shamanic rituals with Sinicized ceremonies. These factors collectively led to an increase in official rain-praying rituals during this period. However, by the late Northern Song Dynasty, political corruption, social unrest, and frequent warfare prevailed. Entering the early Southern Song Dynasty, the state had yet to recover from war, and peasant uprisings persisted. Even when severe droughts occurred, the central government lacked the capacity to organize extensive official rain-praying rituals. Consequently, a brief period from the 1120s to the 1170s resulted in severe droughts accompanied by a scarcity of official rain-praying rituals.

Overall, the Yuan Dynasty experienced severe droughts, with the number of drought records reaching a peak during this period from the Western Han Dynasty to the mid-Yuan Dynasty, while official rain-

475   praying rituals were relatively infrequent. Analysis was conducted from the perspectives of political structure and sociocultural context. As a regime established by the Mongols, the Yuan Dynasty saw the elevated status of Shamanism and Buddhism gradually marginalize the Confucian concept of "heaven-human resonance." Moreover, officially organized sacrificial rituals primarily served the spiritual needs of the Mongol nobility rather than addressing agricultural disasters in the Central Plains. The traditional

480   nomadic mindset reinforced a disregard for agriculture, thereby reducing official rain-praying rituals. Moreover, the Yuan Dynasty favored practical relief and preventive disaster response measures. For instance, during the 1329 AD Shaanxi drought, Emperor Wenzong ordered the opening of granaries to distribute grain but did not conduct official rain-praying rituals. Notably, during the mid-to-late Yuan Dynasty, local officials' negligence and corruption led to delayed or falsified drought reports, hindering

485   timely rain-praying rituals and gradually reducing them to mere formalities. Consequently, the correlation between official rain-praying rituals and droughts during the Yuan Dynasty was not significant.
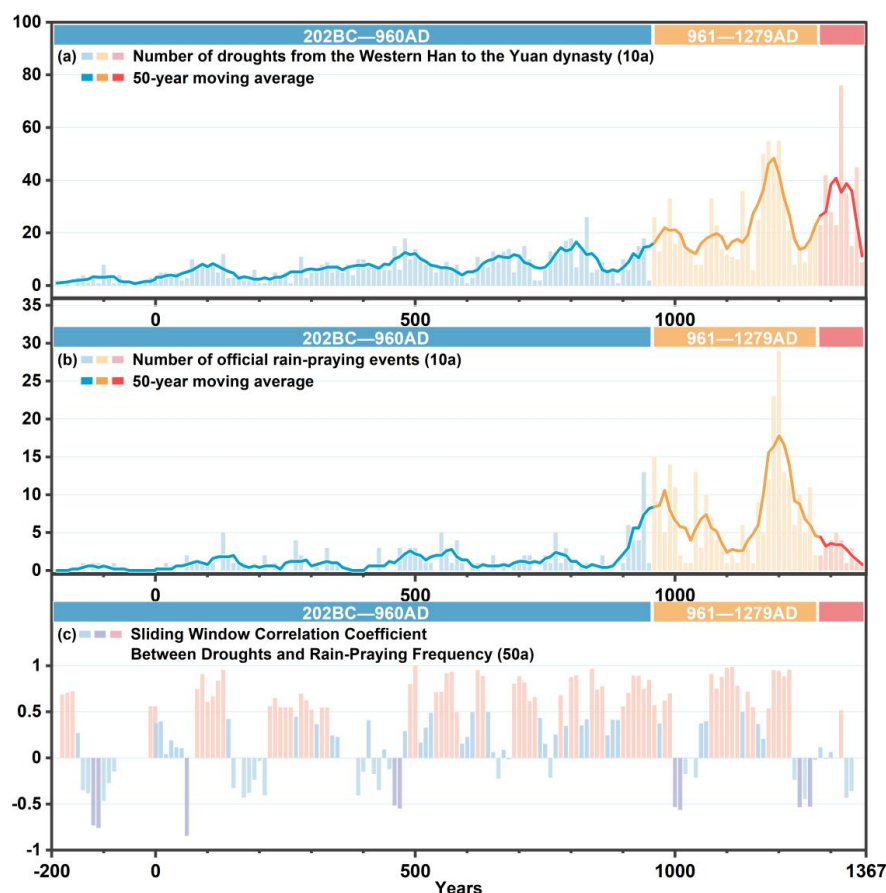
Figure 4: Sequence Diagram of Droughts and Rain-Praying Rituals from the Western Han Dynasty to the

490   **Yuan Dynasty and Correlation Coefficients in a Sliding Window**

3.2.2 Comparative Analysis of Official Rain-Praying Rituals and Droughts during the Ming

Dynasty

The Ming Dynasty spanned 276 years. A Spearman correlation analysis was conducted between the annual frequency of official rain-praying rituals and the number of counties affected by drought each

495   year. The results indicate a moderately positive correlation between official rain-praying activities and drought conditions during the Ming Dynasty (r = 0.41, p < 0.01). This suggests that the severity of drought has explanatory power for the frequency of official rain-praying rituals during the Ming Dynasty.

Official rain-praying rituals during the early Ming Dynasty period from 1368 to 1375 were strongly

500   correlated with drought (Fig. 5c), indicating that the frequency of such rituals during this period was linked to the severity of drought conditions. In the early Ming Dynasty, Emperor Taizu Zhu Yuanzhang standardized rain-praying rituals and codified them into law, establishing a clear and implementable official rain-praying system for future generations. Additionally, he instituted a reporting system for officials to submit rain reports, linking it to their performance evaluations. This facilitated the central

505   government's timely grasp of local disaster situations, ensuring the effectiveness of official rain-praying efforts. As the final Han Chinese dynasty, the rulers of the Ming dynasty linked droughts to their moral governance through the concepts of "heaven-human correspondence" and "disaster as divine punishment." As recorded in the Treatise on the Five Elements of the History of the Ming Dynasty, in the eighth year of the Hongwu era (1375 AD), severe drought struck northern Huai. Emperor Taizu Zhu

510   Yuanzhang issued an edict blaming himself: "*My virtue is shallow and inadequate, thus offending Heaven's harmony*," and dispatched envoys to offer sacrifices at the imperial tombs. The Veritable Records of the Ming Taizong, Volume 94, records that in the seventh year of the Yongle era (1409 AD), a severe drought struck Beiping. Emperor Chengzu Zhu Di personally composed a prayer for rain, declaring, "*If there are deficiencies in governance, may punishment be inflicted upon my person*," thereby

515   upholding his sovereign authority and conveying the "Mandate of Heaven" to the populace. This practice intensified when water conservancy projects and grain storage systems proved inadequate against disasters, serving to maintain social stability.

During the period from 1425 to 1620 AD, the correlation coefficient between official rain-praying rituals

520   and droughts fluctuated. The correlation during the Chenghua era (1460–1487 AD) was significantly stronger than that observed from the Xuande to Zhengde periods (1425–1521 AD). During the Chenghua era, social unrest stemming from the Jingxiang migrant uprising and the Yao rebellion in Guangdong and Guangxi compelled Emperor Chenghua to seek opportunities to reinforce his divine mandate. Rain prayers during droughts provided an opportunity to demonstrate the "divine right of kings." As recorded

525   in Volume 80 of the Veritable Records of Emperor Xianzong of Ming, a severe drought struck North China in the sixth year of the Chenghua reign (1470 AD). Emperor Xianzong personally composed the "Prayer for Rain," declaring, "When governance strays from the right path, calamities arise as warnings." He reduced his meals and suspended music to demonstrate self-reflection. Moreover, the expansion of eunuchs' power and the decline in civil officials' effectiveness during the mid-Ming period led to disaster

530   responses becoming largely ceremonial, often substituting rain prayers for actual relief efforts. The Records of Official Achievements section of the Jiangxi General Gazetteer mentions that during the

fourteenth year of the Chenghua reign (1478 AD), when drought struck Jiangxi, the provincial governor repeatedly petitioned for rain rituals but failed to organize repairs to reservoirs and ponds, resulting in the complete loss of the late rice crop. During the Hongzhi and Zhengde reigns, which were characterized

535   by clear governance and steady economic growth—termed the "Middle Revival"—the central government functioned normally and prioritized practical drought relief efforts. Consequently, the correlation coefficient between official rain-praying rituals and drought severity decreased. The second phase, spanning the Jiajing to Wanli reigns (1522–1620 AD), encompassed the rule of three emperors: Jiajing, Longqing, and Wanli. Official rain-praying rituals continued to exhibit a moderate positive

540   correlation with drought conditions.

During the Wanli era (1572–1620 AD), the correlations between these factors were stronger than they were during other periods. The Wanli period coincided with the Little Ice Age, compounded by the weakest intensity of the Asian summer monsoon. Reduced precipitation led to frequent droughts in

545   northern regions, where abnormal weather threatened agricultural production, resulting in dire conditions such as "parched fields," "rivers running dry," and "wheat seedlings withering." Consequently, even the politically disengaged Wanli Emperor personally conducted rain-praying rituals or authorized central official rain-praying rituals to respond to societal expectations for central disaster relief, demonstrating concern for the people's welfare and alleviating public discontent. From 1620 to 1644 AD, which spanned

550   the reigns of Emperors Taichang, Tianqi, and Chongzhen, the correlation between official rain-praying rituals and droughts sharply decreased and became negative. Frequent warfare during this period depleted the central government's finances and paralyzed its administration, rendering it incapable of organizing regular sacrificial rites. This led to an apocalyptic period where disasters struck without prayers. Particularly between 1638 and 1644 AD—a period marked by one of the Ming Dynasty's most severe

555   droughts—320 counties experienced drought in 1640, yet only one official rain-praying ritual was conducted, illustrating the stark reality.
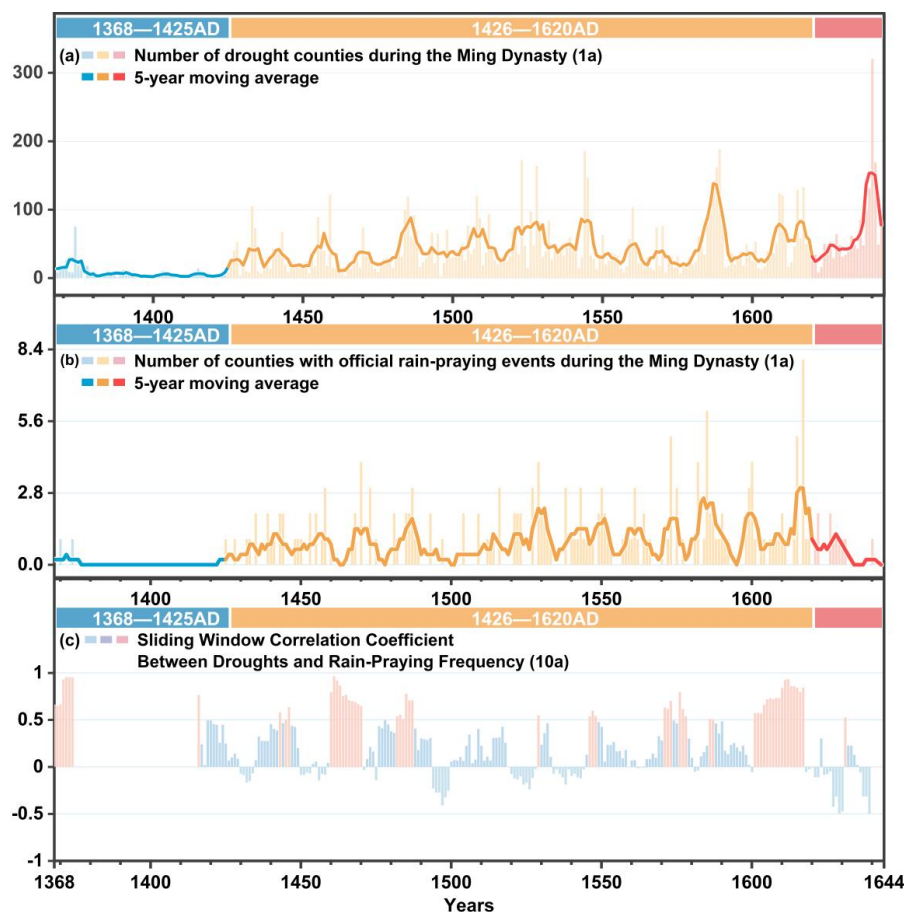
Figure 5: Sequence Diagram of the Correlations between Official Rain Praying in the Ming Dynasty and Annual Drought Occurrence by County, along with a 10a Sliding Window.

3.2.3 Comparative Analysis of Official Rain-Praying Rituals and Drought Events during the Qing Dynasty

The Qing Dynasty spanned 268 years. A Spearman correlation analysis was conducted between the annual frequency of official rain-praying rituals and the number of counties affected by drought each year. The results indicate that the correlation between official rain-praying rituals during the Qing Dynasty and drought is not significant, suggesting that the relationship between the two cannot be explained in simple terms. In addition to drought, other factors influenced official rain-praying rituals. Analysis of the sliding 10a window correlation coefficients between Qing dynasty rain-praying rituals and drought also revealed high values (r > 0.5) in the early and late periods, with significant fluctuations and alternating positive and negative values during the middle period. Therefore, the correlation between official rain-praying rituals and drought is discussed in distinct segments.

By combining the sequence of official rain-praying rituals with drought sequences during the Qing Dynasty (Fig.6a and 6b), it was found that from 1644 to 1735 AD, spanning the reigns of Shunzhi to

Yongzheng, multiple peak years of drought occurred across counties. This period witnessed the most

575   severe drought conditions throughout the Qing Dynasty; however, official rain-praying rituals were relatively infrequent. Sliding window correlation tests further revealed no significant association between official rain-praying rituals and droughts during this period. Historical context supports this finding: as documented in Studies on Military Expenditures in the Qing Dynasty, following the Qing conquest of the Central Plains during the Shunzhi reign, the Southern Ming forces remained active, compelling the

580   state to prioritize military expenditures—which consistently exceeded 70% of annual budgets. The sacrificial system was still underdeveloped during this era, with official ceremonies limited to essential rites such as imperial enthronement and heaven worship. It was not until the 14th year of Shunzhi (1657 AD) that the emperor personally visited the Circular Mound Altar and the Altar of Land and Grain, followed by the establishment of a series of institutional regulations for official rain-praying rituals. As

585   a minority ethnic regime, the Qing Dynasty initially had a limited understanding of traditional rain-praying customs in the Central Plains. Both the Kangxi and Yongzheng emperors prioritized practical disaster relief responses over empty rituals. According to the Manchu Archives of the Inner Court History Bureau in the Early Qing Dynasty, during the severe drought in Zhili Province in the tenth year of Shunzhi's reign, Regent Prince Dorgon instructed, '*Rather than empty prayers and sacrifices, swiftly*

590   *distribute grain from the storehouses*.' Emperors Kangxi and Yongzheng likewise prioritized practical disaster relief measures. Yongzheng repeatedly emphasized in his imperial edicts that "*dredging canals and rivers*" outweighed "*superficial rituals and sacrifices*." Moreover, this period coincided with the transition between dynasties, during which the grassroots bureaucratic system disintegrated and the disaster reporting mechanism collapsed. This prevented disaster information from reaching the central

595   government. With fiscal resources heavily allocated to military expenditures, officials adopted a passive approach, responding only when disasters were formally reported by local authorities.

1735–1850 AD, during the reigns of the Qianlong, Jiaqing, and Daoguang emperors, the correlation coefficient between official rain-praying rituals and droughts fluctuated significantly, indicating an

600   overall weak correlation. First, the promulgation of the Great Qing Code of Rites in the 24th year of Qianlong's reign (1759 AD) incorporated rain-praying rituals into the national legal code, further standardizing the Qing dynasty's rain-praying system. Beginning in the 9th year of Qianlong's reign (1744 AD), annual regular rain-praying rituals were conducted, heightening the central government's attention to droughts and rain-praying events themselves, resulting in a noticeable increase in official

605   rain-praying activities. Notably, records such as the Imperial Diagrams of Ceremonial Vessels and compilations of memorials detailing rainfall measurements indicate that the establishment of the "Qing yulu" system during this period enabled precise documentation of precipitation levels. This facilitated drought forecasting and provided targeted references for initiating official rain-praying rituals. For instance, during the drought in Shandong in the 40th year of the Qianlong reign (1775 AD), the imperial

610   astronomical bureau analyzed precipitation cycle variations from 1735 to 1775 AD to anticipate the progression of drought. This enabled the central government to initiate official rain-praying rituals early, enhancing their targeted effectiveness. Furthermore, incorporating rain-praying into the evaluation criteria for local officials motivated them to conduct such rituals proactively on the basis of actual

conditions and to report promptly. This practice was further refined during the Jiaqing reign. During this
615   period, droughts afflicted many regions of China because of global climate change. Even while
continuing practical measures inherited from previous dynasties—such as constructing water
conservancy projects and opening granaries for disaster relief—the government found these efforts
increasingly strained under fiscal constraints. However, compelled to respond to disasters, the
government grew more reliant on rain-praying rituals. This dependency intensified in the Jiaqing era,
620   particularly during the White Lotus Rebellion (1796–1804 AD), and in the Daoguang era (1840–1842
AD), particularly during the Opium War, both of which posed severe threats to Qing rule. The central
government urgently needed to demonstrate its legitimized authority through rain-praying rituals during
droughts to consolidate its power. This significantly heightened the correlation between official rain-
praying activities and drought conditions compared with the preceding period.

625

1850–1911 AD marked the reigns of four emperors: Xianfeng, Tongzhi, Guangxu, and Xuantong.
Spearman's correlation during this period was not significant. From the perspective of the 10-year sliding
window correlation coefficient, official rain-praying rituals during 1858–1867 AD were negatively
correlated with drought. This period was marked by internal turmoil and external threats: the Taiping
630   Rebellion (1851–1864 AD) and the Second Opium War (1856–1860 AD) plunged the Qing government
into severe governance crises, compelling the central authorities to intensify rain-praying rituals to
leverage their political functions. Additionally, the disaster reporting system collapsed, preventing timely
transmission of local disaster information to the central government. This disconnect caused centrally
organized rain-praying rituals to become detached from actual local disaster conditions. Even when some
635   local disaster reports reached the central government, they often contained exaggerated claims, frequent
rain-praying ceremonies, and requests for tax exemptions—all designed to create an illusion of diligent
governance. For instance, Volume 23 of the Supplementary Records to the Strategy for Suppressing the
Guangdong Rebels documents how, in the sixth year of the Tongzhi reign (1867 AD), Anhui Governor
Ying Han falsely reported disasters in 11 drought-free prefectures and counties and even conducted nine
640   simultaneous rain-praying ceremonies.

Moreover, although the intensity of disaster relief efforts by private organizations increased during this
period, such activities were not recorded in official histories. These factors significantly weakened the
correlation between official rain-praying rituals and drought conditions during this era. Official rain-
645   praying rituals during the periods 1868–1878 AD and 1900–1909 AD exhibited high correlation
coefficients (r > 0.5) with drought conditions, far exceeding those of other periods. The devastating
impact of the Dingwu Famine (1876–1879 AD) in the early years of the Guangxu reign drew extensive
attention from the central government, prompting frequent and effectively targeted rain-praying rituals
to address local drought conditions. More significantly, the political function of rain-praying rituals
650   expanded further during this period. The defeat in the First Sino-Japanese War and the impact of the
Boxer Rebellion compelled the Qing government to seize every opportunity to demonstrate its "mandate
from heaven," with drought-relief rain prayers being one such occasion. For instance, in the 26th year of
the Guangxu reign (1900 AD), when a severe drought struck North China, the Qing government still

ordered Yulu, the Viceroy of Zhili, to preside over rain-praying rituals at the Temple of Heaven during
655 the Boxer Rebellion crisis, attempting to alleviate public discontent through the concept of "heaven-
human resonance." In the first year of the Xuantong reign (1909 AD), a severe drought struck Shaanxi
and Gansu. Regent Prince Zai Feng specifically instructed Gansu Governor Sheng Yun to "pray with
utmost devotion to appease the people's hopes." However, citing "financial constraints," he also reduced
disaster relief funds—a reluctant measure born of fiscal pressure. During this period, to emphasize
660 official orthodoxy among the populace, privately constructed temples associated with rain-praying rituals
were demolished. For instance, in 1883 AD, Li Hongzhang, Governor of Zhili, ordered the demolition of
37 privately built Dragon King temples, replacing them with officially standardized spaces for sacrificial
rites. It can be argued that droughts during this phase provided a significant explanatory force for official
rain-praying rituals, with drought serving as the dominant factor driving such rituals.

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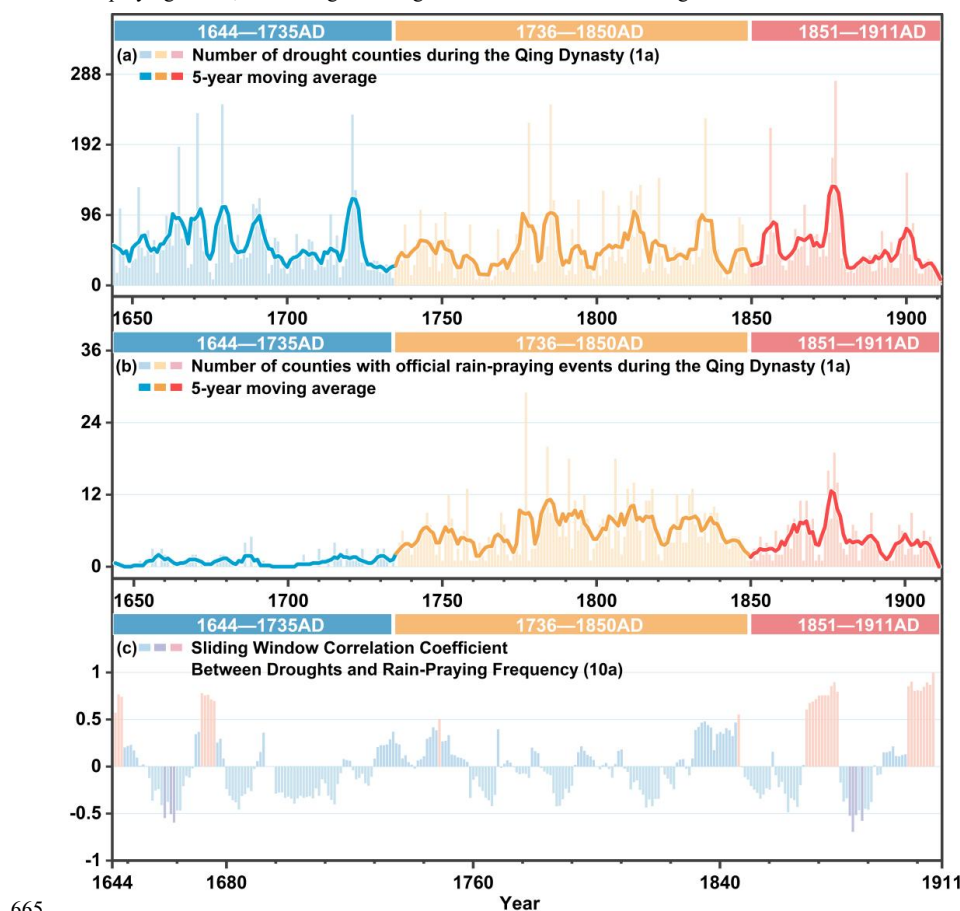
**Figure 6: Sequence diagram of correlation coefficients between Qing Dynasty official rain-praying periods
and annual drought frequency at the county level, along with a 10a sliding window analysis**

4 Discussion

4.1 Phased Fluctuations in Rain-Praying Rituals

670   This study reveals that over the past two millennia, official rain-praying rituals in ancient China have exhibited a four-phase fluctuation pattern of "low-high-low-high." This phenomenon has sparked profound discussions regarding the driving mechanisms behind rain-praying rituals: Why did the frequency of rain-praying rituals vary significantly across different dynasties during cold or arid periods with similar climatic conditions? This suggests that pure climate determinism may not fully explain

675   intergenerational variations in rain-praying rituals. Instead, the underlying levels of institutionalization and the evolution of state governance capacity likely played a more crucial role.

    During the Han and Tang dynasties, rain-praying rituals occurred relatively infrequently. This was not due to a lack of droughts but rather because such rituals had not yet fully evolved beyond their role as

680   emergency responses to disasters and were constrained by the prevailing governance model. The Tang Dynasty, as a golden age, enjoyed relatively abundant state funds. This enabled the government to rely more on substantive relief measures—such as opening grain stores for relief and reducing taxes—when responding to disasters rather than solely on ritualistic rain prayers(Mao, 2012; Gao and Hui, 2019). Moreover, early dynasties exercised relatively loose control over local societies, lacking the rigorous

685   ritual-legal management systems of later periods. The sharp increase in rain-praying rituals during the Song Dynasty (5.1 times per decade) represented a reactive response to the end of the Medieval Warm Period and subsequent climate cooling that triggered frequent disasters. Faced with insufficient human resources, Song rulers sought control and solutions through divine intervention, esoteric rituals, and witchcraft. The central government repeatedly promulgated rain-invocation decrees, mandating local

690   officials' compliance (Guo, 2012). When "heaven-human resonance" became a core metric for bureaucratic evaluation and political legitimacy, prayer for rain transformed from an ad hoc disaster relief measure into an administrative duty that must be fulfilled by local officials.

    By the Qing Dynasty, rain-praying rituals had reached their historical peak, which was likely attributable

695   to innovations in administrative techniques. The Qing established a refined reporting system based on precise measurements of rainfall and snowfall (Yu xue fen cun), enabling the central government to swiftly determine drought conditions across the realm. After the Kangxi period, although imperial sacrifices diminished, rain-praying rituals at the local level were incorporated into a strict regular rain-praying (常雩) system (Zhu, 2011). This high frequency of rain-praying rituals fundamentally reflected

700   the state's accelerated response to environmental crises, signifying the evolution of rain-praying from a purely religious practice into a standardized administrative procedure for addressing environmental pressures. This path of institutional evolution explains why, under comparable drought pressures, later dynasties recorded far more rain-praying rituals than earlier dynasties did.

4.2 Nonlinear Relationship between Rain-Praying and Drought

705   The data indicate a significant nonlinear relationship between droughts and official rain-praying rituals: droughts served as a necessary condition for such rituals, but the demand for political legitimacy and the level of administrative efficiency constituted key factors that moderated this relationship. We hypothesize that when regimes faced crises, rain-praying—as a low-cost tool for political declaration—markedly

increased in frequency, potentially leading to excessive ritualization detached from actual drought
710   conditions.

During the Song Dynasty and late Qing periods, the strong correlation between rain-praying and droughts
likely stemmed from political anxieties over internal turmoil and external threats. Confronted with
military pressures abroad or rebellions at home, rulers urgently sought to establish their mandate of
715   heaven through frequent rain-praying rituals. As demonstrated by cases in the southeastern Tang Dynasty,
officials gathered the populace through rain-praying rituals not only to solicit rainfall but also to reshape
social order amid crises (Lin and Xie, 2025). Here, rain-praying functioned as a political symbol,
signaling to society that the government was actively engaged to alleviate governance pressures
stemming from environmental deterioration.

720

Conversely, the low/moderate correlation observed during the Yuan Dynasty and the mid-to-late Ming
period reveals how declining administrative efficiency suppressed rain-praying rituals. During the mid-
to-late Ming Dynasty, as extreme droughts became increasingly frequent, existing socioeconomic models
(such as the li-jia system and military farming settlements) gradually collapsed. When grassroots
725   administrative organizations became paralyzed and information flow to higher levels was obstructed, the
state lost its capacity to organize large-scale rituals and disaster relief efforts even during severe droughts.
This led to a situation where disasters occurred without corresponding rain-praying ceremonies.
Moreover, the Kangxi reign provides a unique perspective: when the emperor questioned the ways of
heaven and shifted the government's focus to pragmatic measures such as stockpiling grain for famine
730   relief, the frequency of rain-praying rituals also declined. These findings demonstrate that rulers'
perceptions of calamities directly influence their choice of response strategies. If rulers prioritized human
welfare over divine mandates or if, as during the Yongzheng reign, disasters were concealed to maintain
a facade of stability, records of rain-praying rituals would diverge from actual drought conditions. Thus,
fluctuations in rain-praying rituals reflect the interplay between environmental pressure and the political
735   system's capacity to respond.

4.3 Rain Praying as a Social Function Tool

Although this study reveals the evolutionary patterns of rain-praying rituals on the basis of long-term
data, certain limitations remain. First, historical records suffer from survivor bias. As noted above,
historical accounts tend to document successful rain-praying instances while overlooking failed attempts,
740   potentially leading us overestimations of the actual efficacy or frequency of rain-praying rituals at the
time. Second, the varying levels of detail in historical materials across different dynasties (e.g., Qing
dynasty records far exceed those of the Han and Tang dynasties) may impact the precision of quantitative
analysis to some extent.

745   Nevertheless, from a sociological perspective, rain-praying is fundamentally a mechanism for enhancing
social cohesion through shared rituals, with rain-praying ceremonies serving as part of the development
of social resilience (Gómez-Baggethun et al., 2012; Hiwasaki et al., 2015; Hunowu et al., 2025). In

traditional agricultural societies, when technological solutions (such as water conservancy projects) fail
to resolve drought crises, rain-praying rituals provide an outlet for societal anxiety (Zhao and Liu, 2011).
750 During the periods considered in the current research, officials in China mobilized dispersed individuals
through rain-praying rituals, and this mobilization could sometimes be directly translated into human
resources for practical disaster-relief actions such as dam construction and river dredging, effectively
reducing the harm caused by drought and its impact on the populace (Lin and Xie, 2025). It can be argued
that in the face of disasters, ritualistic prayer itself constitutes a form of social self-help activity. It
755 functions as a sedative and is capable of calming the populace during the initial stages of a catastrophe
(Sun, 2009; Chen et al., 2024b).

At a deeper level, this cultural response to official rain-praying rituals served as a means for rulers to
express repentance through "self-blame" or "self-reflection," thereby assuming moral responsibility for
760 disasters and ensuring people's understanding and obedience. When confronting environmental shocks,
this mechanism mitigates public perceptions of relative deprivation while reinforcing the emperor's
authority and legitimacy as the "Son of Heaven." It transforms disaster relief into a demonstration of the
fusion of imperial and divine power, thereby consolidating regime stability (Zhu, 2011; Li and Huang,
2018). In addressing environmental crises, in addition to material disaster responses, cultural and
765 institutional response strategies played equally crucial roles in maintaining social system stability. Future
research could further explore whether this belief- and ritual-based disaster response model persists in
some variant form when modern societies encounter force majeure crises and its potential governance
implications.

5 Conclusions

770 In this study, on the basis of official histories and veritable records, a database of 1,825 explicitly
documented official rain-praying rituals spanning two millennia from the Western Han Dynasty to the
Qing Dynasty (202 BC–1911 AD) was constructed through rigorous text mining and information
standardization processes. This enabled the reconstruction of a long-term sequence with ten-year
resolution and a high-resolution annual sequence for the Ming and Qing periods. Sequence analysis
775 revealed significant phased variations in official rain-praying rituals: prior to 960 AD, the frequency was
relatively low (an average of 0.82 times/10a), whereas it increased markedly thereafter. The following
dynasties had the most frequent rain-praying rituals: the Song Dynasty (5.1 times/10a), the Five
Dynasties and Ten Kingdoms period (5.28 times/10a), and the Qing Dynasty (4.76 times/10a).

780 Sliding window correlation analysis revealed that the correlation between official rain-praying rituals
and drought sequences from the Western Han Dynasty to the Qing Dynasty was not constant but
fluctuated dramatically across historical periods. From the Western Han dynasty to the Five Dynasties
and Ten Kingdoms period, rain-praying was significantly positively correlated with drought (r=0.685,
p<0.01), indicating that early official rain-praying was driven primarily by environmental pressures and
785 was highly sensitive to disaster responses. However, this correlation differed between the Yuan Dynasty
and the Ming-Qing period. Rain-praying rituals during the Yuan Dynasty were largely decoupled from

droughts (with a nonsignificant correlation), reflecting the nomadic regime's marginalization of the Confucian political philosophy of heavenly human resonance. During the mid-to-late Ming Dynasty and the Xianfeng-Tongzhi era of the Qing Dynasty, despite frequent droughts, the correlation between rain-praying rituals and drought conditions significantly weakened or even became negative. This phenomenon was influenced by declining administrative efficiency, fiscal crises, and delays in disaster information dissemination, reflecting an apocalyptic pattern whereby disasters occurred without corresponding prayers. Conversely, during the Qianlong to Daoguang reigns and the final years of the Guangxu era in the Qing Dynasty, the establishment of a regular rain-praying system and the intensification of political legitimacy crises led to a resurgence of high correlation between rain-praying and drought (e.g., r=0.43 during the Guangxu and Xuantong periods). This correlation even manifested as rain-praying sequences temporally preceding drought sequences, indicating that rain-praying had been transformed into an active tool for political defense and social mobilization.

The fluctuation in the frequency of official rain-praying rituals was profoundly shaped by the dual regulation of state governance capacity and the demand for political legitimacy. Long-term data reveal that such rituals were not determined solely by climate but resulted from the combined influence of political institutions, state capabilities, and societal crises. The sharp increase in rain-praying frequency during the Song Dynasty (5.1 times per decade) and the high frequency observed in the Qing Dynasty not only responded to the natural backdrop of cooling climates but also reflected the permeation of elaborate ritual systems into the state governance framework. During dynastic golden ages (such as the Tang and early Qing), abundant state finances led governments to favor material relief measures (such as grain storage and tax exemptions) over ceremonial rain-praying, resulting in relatively lower rain-praying frequencies. During dynastic crises, however, rulers urgently needed high-frequency rain-praying rituals to proclaim the legitimacy of the "Mandate of Heaven," calm social panic, and deflect conflicts. At such times, the political function of rain-praying rituals surpassed their practical disaster-relief role.

Author contributions

Shuo Wang: Writing – review & editing, Writing – original draft, Visualization, Investigation, Conceptualization. Yun Su: Writing–review & editing, Resources, Methodology, Funding acquisition, Conceptualization. Jingxue Pan: Writing – review & editing, Supervision, Project administration, Conceptualization. Nianjie Zhang: Writing–review & editing, Visualization, Methodology. All authors reviewed the manuscript.

Data availability

All the materials and data are from historical documents. Data will be made available on supplementary file (Table S1 and S2).

Competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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