



A GIS-based Study on the Distribution of Religious Buildings in Lhasa and its Historical Urban Spatial Pattern

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This study examines the pivotal role of religious architecture in shaping Lhasa's urban landscape, emphasizing Buddhism's profound impact on the rise, development, and spatial organization of Tibetan cities. Religious architectures serve as essential nodes for public engagement with Buddhism and are central to the city's socio-cultural fabric. Using Geographic Information Systems (GIS), the research quantitatively and qualitatively analyzes the distribution, density, and architectural characteristics of Lhasa's religious edifices. This approach offers a comprehensive understanding of the spatial interplay between these religious sites and the broader urban matrix. By integrating Lhasa's natural topography and socio-historical context, the study provides insights into how geographical and cultural factors influence urban planning and architecture. The objective is to delineate the spatial symbiosis between religious architecture and Lhasa's urban form, revealing how these structures have shaped the city's physical and cultural landscape. Through this multidisciplinary lens, the paper aims to contribute to the broader discourse on the intersection of religion, architecture, and urban development, particularly in historically and religiously significant cities.

Keywords: Religious Architecture, Urban Development, Geographic Information Systems (GIS), Lhasa, Tibetan Buddhism

Introduction

In exploring the formation and development of cities, the influence of religion can be substantial. Urban historian Lewis Mumford profoundly revealed the dual driving forces of social and religious aspects in ancient societies. He believed that it was the synergistic effect of these two forces that ultimately led to the formation of human cities. Mumford further pointed out that the earliest human gathering places, which are the embryonic forms of cities, were often centered around ritualistic sites that attracted pilgrims from various regions. As he noted, 'The earliest ceremonial gathering places of humanity, which became the targets of pilgrimage, were the embryonic forms of cities .' (Mumford, 1990)

Tibetan Buddhism has had a profound impact on various aspects of Tibet's politics, economy, culture, and customs. The most tangible manifestations of this influence are religious buildings. Religious sites, represented by these structures, gradually became the carriers of urban public life, significantly influencing the formation and development of cities. The city of Lhasa, in particular, can be described as a city born out of its monasteries. When conducting research on the historical urban layout of Lhasa, it is essential to focus on religious buildings and the temple architectural landscapes they form.

Currently, research on urban religious buildings mainly focuses on building types, layouts, religious art, and the compilation of urban religious history. Although the spatial distribution of religious buildings has received some attention, most studies interpret distribution and evolution primarily from the perspectives of historical literature and the spread of religion. Some studies have used technologies such as GIS for data analysis, but these mainly focus on spatial-temporal distribution characteristics and provide limited explanations for the mechanisms of evolution and influencing factors. Despite some research integrating the relationship between religious buildings and urban layouts, further studies are needed. These should combine macro and micro perspectives, traditional and modern viewpoints, and simultaneously study feature extraction and the exploration of intrinsic factors to more deeply reveal their internal connections and influences.



Research Geographic Scope, Data Sources, and Methods

● Scope of the Study

Lhasa City is located in the southwestern region of China and serves as the capital of the Tibet Autonomous Region. It is also the political, economic, cultural center of Tibet, and a sacred site of Tibetan Buddhism. In this paper, the spatial information data of religious buildings is limited to the administrative boundaries of Lhasa City. This scope encompasses the entire urban area and its surrounding regions, including three districts and five counties: Chengguan District, Doilungdêqên District, Dagzê District, Linzhou County, Damxung County, Nyêmo County, Qüxü County, and Maizhokunggar County.

Unlike historical cities in other regions of China, the development of Lhasa City exhibits a distinct uniqueness: it developed around monasteries as its core. Over 1300 years ago, the Jokhang Temple was initially built, serving as the central point from which the ancient city expanded outward in concentric circles, gradually flourishing. This paper focuses on the historical Lhasa City and its surrounding areas.

● Sources of Data

Tibetan Buddhist religious sites can be classified into different levels according to their functions and importance. The data in this paper includes monasteries, branch monasteries, Lakhangs, and retreat centers, all collectively referred to as religious buildings.

The location data was sourced from Google Earth. After determining the spatial locations, the data was stored as KML files and projected in ArcGIS 10.8 to generate geographic coordinates, thereby establishing a geographic information database of Lhasa's religious buildings. Research materials were sourced from various archaeological survey data and local chronicles of Lhasa, including temple gazetteers, travel notes by foreigners, 'Chinese Tibetan Buddhist Monasteries,' (Ran Guangrong, 1994) 'Tibetan Buddhist Monasteries in Lhasa,' (Qunpei, 2010) and contemporary research outcomes, along with various publicly published and internally printed materials. Historical map data primarily came from the 'Lhasa Historical City Map Atlas,' (Larsen, 2005) local chronicles of Lhasa, online historical map libraries, and relevant historical documents. Administrative boundaries and hydrography data were obtained from the National Geographical Information Resource Directory Service System's 1:1,000,000 fundamental geographic information data (2021), using the 2000 National Geodetic Coordinate System, the 1985 National Elevation Datum, and latitude-longitude coordinates. The topographic data were sourced from the 30 m digital elevation data provided by the Geospatial Data Cloud.

● Research Methods

This study uses GIS as a data processing tool, combining field surveys and literature review. Initially, 234 religious buildings within Lhasa were selected to establish a database for relevant data processing and analysis. By translating historical maps, the historical city limits within the modern city were defined. The spatial distribution characteristics of religious buildings in three layers—Lhasa Old City (original urban form), Lhasa City (historical urban area), and Lhasa Suburbs (evolved city)—were analyzed. Finally, the relationship between the spatial distribution of religious buildings and the urban layout of Lhasa was systematically summarized and analyzed based on the city's geographical features and historical evolution.

GIS Data Collection: Geospatial data for Lhasa was obtained using satellite remote sensing images, aerial photographs, and ground surveys, creating a digital map database.

Data Processing and Analysis: Using GIS software, data processing included data cleaning, geographic coordinate transformation, data overlay, and spatial analysis to reveal the distribution characteristics of religious buildings and historical urban patterns.

Spatial Statistical Analysis: Spatial statistical methods were used to evaluate the clustering and distribution patterns of religious buildings, including: Cluster Analysis, using kernel density estimation to determine the spatial characteristics of temple distribution, such as clustering locations and degrees; Spatial Correlation Analysis, analyzing the impact of roads, water systems, and other spatial factors on the distribution pattern of religious buildings and the mechanisms of spatial interaction.

Historical Map Translation: Since most historical maps have low geographical accuracy due to empirical generalizations of spatial relationships, this study translated historical maps from the perspective of urban mapping. Modern Lhasa's roads and buildings were exported from ArcGIS as CAD drawings with geographic coordinates and imported into Photoshop as base maps. Using important temple buildings as references, historical maps were overlaid, adjusted, and validated to define the boundaries of Lhasa Old City, Lhasa City, and Lhasa Suburbs within the modern city.

Historical Document Research: Historical documents, such as chronicles, local gazetteers, and religious texts, were investigated to obtain historical information and distribution details of religious buildings in Lhasa.



The Spatial Construction of Lhasa: Correlation Analysis of the Evolution of Urban Layout with Religious Buildings and Roads

- Dispersed Religious Buildings and Urban Boundaries: Spatial Autocorrelation Characteristics of the Distribution of Religious Buildings in Lhasa

According to the selection, within the total area of 29,640 square kilometers in the Lhasa region, there are 236 Tibetan Buddhist religious buildings. These buildings belong to the four main sects—Gelug (Yellow Hat), Kagyu (White Hat), Nyingma (Red Hat), and Sakya (Flower Hat)—as well as numerous sub-sects. Chengguan District has the highest density of religious buildings, with 61 structures concentrated in the smallest administrative area (554 km²), accounting for 25.84% of the total. The remaining buildings are more evenly distributed across the two districts and five counties: Doilungdêqên District with 22 buildings, Dagzê District with 15, Linzhou County with 38, Damxung County with 22, Nyêmo County with 22, Qüxü County with 16, and Maizhokungar County with 39.

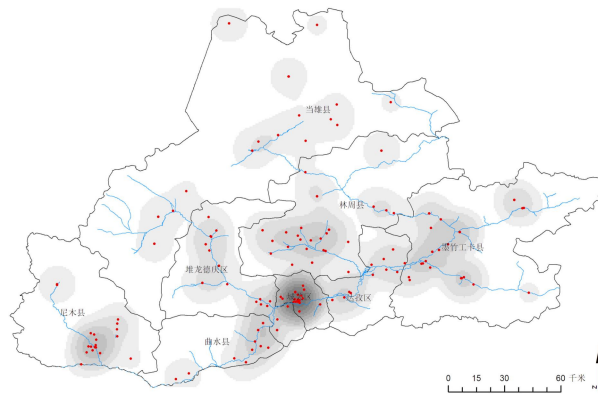


Figure 1: Kernel Density of Religious Buildings

The high-density and low-density areas of religious building distribution are clearly separated. The densely populated areas exhibit the following characteristics:

Firstly, the most evident phenomenon is that religious buildings are primarily concentrated in Lhasa's urban area and nearby counties. These regions have an extremely high density of religious buildings, forming distinct high-density clusters. The core area of Chengguan District is the most densely populated, with a distribution density surpassing the average level. Due to the radiating effect of Chengguan District, surrounding counties also have one or two secondary dense clusters.

Secondly, on the whole, the distribution density of religious buildings in the western part of Lhasa is higher than in the eastern part, and the density is higher in the southern part than in the northern part. This creates a clear religious building belt centered around Chengguan District.

Additionally, considering the geographical environment, religious buildings, whether clustered or dispersed, are distributed along the Lhasa River and its tributaries.

In summary, the distribution characteristics of religious buildings in Lhasa primarily manifest as a clear separation between high-density and low-density areas and a tendency to cluster in specific geographical regions. This distribution reflects the combined influence of Lhasa's religious history, cultural context, and geographical environment.

- The Extension of Religious Buildings and Urban Space: Bivariate Analysis of Religious Buildings and Roads

Lhasa is home to three famous circumambulatory paths. The first is the Nangkhor, the square inner path around the main hall of the Jokhang Temple. The second is the Barkhor, the roughly square middle path around the Jokhang Temple. The third is the Lingkhor, the outer path that encircles major religious buildings including the Jokhang Temple, Ramoche Temple, and the Potala Palace. These circumambulatory routes have evolved over history and represent the ancient origins of Lhasa city.

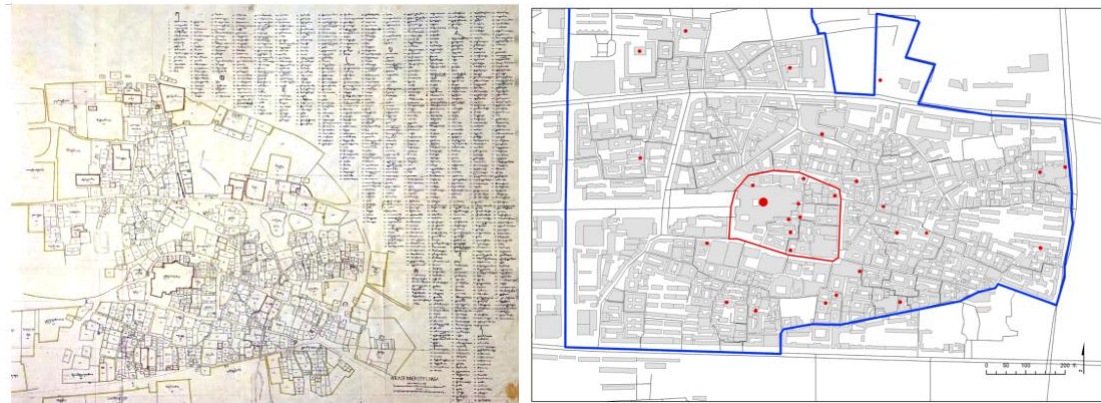


Figure 2: Historical Map of Lhasa Old City (Central Area of Lhasa, Peter Aufschneider, 1946) and Distribution of Religious Buildings

The old city of Lhasa, or the core area, refers to the nearby urban district centered around the middle circumambulation path, Barkhor (Figure 2, The red path in the right image), of the Jokhang Temple (Figure 2, The blue area in the right image). This area is roughly bounded by Beijing Middle Road to the north, Beijing East Road to the east, Jiangsu Road to the south, and Zang Yiyuan Road to the west. This region represents the highest density cluster of religious buildings in Lhasa, with a total of 31 structures, accounting for 50.8% of the religious buildings in Chengguan District. The distribution of these buildings is densest around the Jokhang Temple area, primarily arranged in a circular pattern centered on the Jokhang Temple, with the densest cluster along the Jokhang Temple axis. A secondary dense area is located north of the Jokhang Temple in the Ramoche Temple area. This distribution pattern reflects the central role of religion and faith in the historical development of Lhasa's old city and the continuity of Lhasa's history and culture.

In 633 AD, Songtsen Gampo established the first unified regime and moved the capital to Lhasa, marking the beginning of a series of urban construction projects. The construction activities of this period focused on building palaces, temples, houses, and roads. Around 647 AD, the main hall of Jokhang Temple was established, quickly becoming the center of Tibetan Buddhism and regarded as the 'heart' of Tibet. Simultaneously, the Ramoche Temple was established north of the Jokhang Temple, forming a cluster. Religious buildings became a crucial component of urban space.

The Jokhang Temple, as a religious center, is regarded as the center of the Tibetan Buddhist world, attracting numerous devotees daily for circumambulation, thereby promoting population concentration. To better accommodate the needs of pilgrimage and worship, many other religious buildings and Buddhist facilities were established near the Jokhang Temple. Over time, residential, commercial, and other infrastructure related to the populace extended around these religious buildings, with roads connecting them, gradually forming the Barkhor Street area. This area became a significant urban residential cluster, marking the beginning of Lhasa's urban structure development. People even referred to the entire Lhasa (in a narrow sense) by the Barkhor Street area.

Thus, from the early stages of Lhasa's formation, religious buildings played a crucial role. The construction of the Jokhang Temple and the Ramoche Temple was innovative and pioneering in the architectural history of Tibet's capital. These constructions left a profound impact on the evolution and progress of the capital. The compact settlement form formed by the enclosure reflects the origin and development of Lhasa city and reveals the spiritual core influencing this city (He Yimin, 2013).

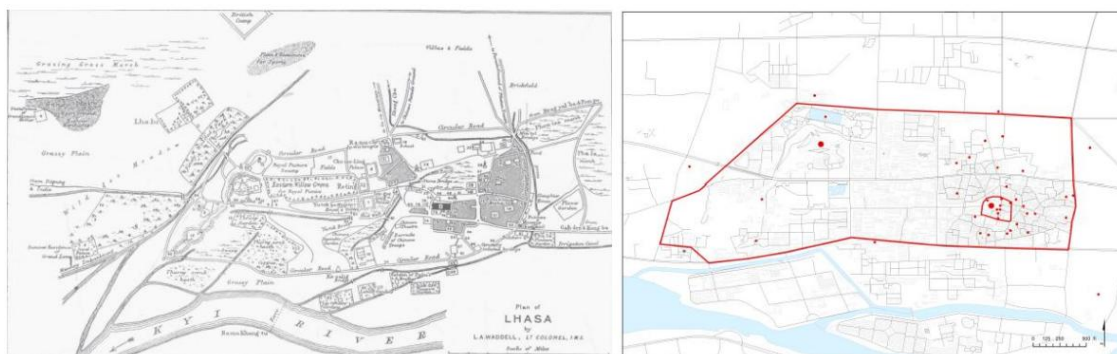


Figure 3: Historical Map of the Lingkhor Area (Plan of Lhasa, L. Austine Waddell, 1905) and Distribution of Religious Buildings

The Potala Palace, located on Marpori Hill to the northwest of the Barkhor area, represented the political center of the Tubo Dynasty and became another important element defining Lhasa's urban space. An independent



Tsuklakang area was formed around the Potala Palace, Chakpori Hill, Dragon King Pond, Mopan Hill, and the associated Shol Village. The approximately 1 km open area between the Tsuklakang complex and the Barkhor complex gave rise to the main roads and secondary road network connecting the two centers. The Lingkhor outer circumambulatory path, encompassing both the Tsuklakang and Barkhor complexes, defines the space of the old city of Lhasa, functioning primarily as a major urban thoroughfare. The Lingkhor encircles these two core areas and connects them closely, forming a double-core, double-ring structure with an east-west elliptical axis, which provides more construction space in the western part of the city (Figure 3, Left).

This 7.5 km long pilgrimage route roughly follows the western side of Lingkhor East Road, the northern side of Jiangsu Road, the eastern side of Zang Yiyuan Road, and the southern side of Lingkhor North Road, with a circumference of 7.5 km, enclosing an area of approximately 1.33 km², perfectly integrated with the modern road system. The modern Lingkhor closely resembles the ancient one, though with slight route differences (Figure 3, Right).

Within this old city area of Lhasa, there are a total of 37 religious buildings. Beyond the 31 buildings within the dense area of the Barkhor, only 6 more are added, primarily distributed in the Potala Palace area and along the northern and southern lines of Lingkhor. This characteristic can be traced back to multiple historical reasons. With the gravitational pull of the Jokhang Temple area, nobles began to build residences nearby, and many believers and merchants also started to flock in. To meet the residential and living needs of these people, residential areas and other public facilities were built on the vacant land within the Lingkhor range, limiting the space available for religious buildings. Moreover, religious buildings in this area were not as well protected as those in the Barkhor and Tsuklakang areas. During Lhasa's development and construction, they may have been altered or destroyed due to various reasons such as socio-political factors, urban planning, or traffic layout.

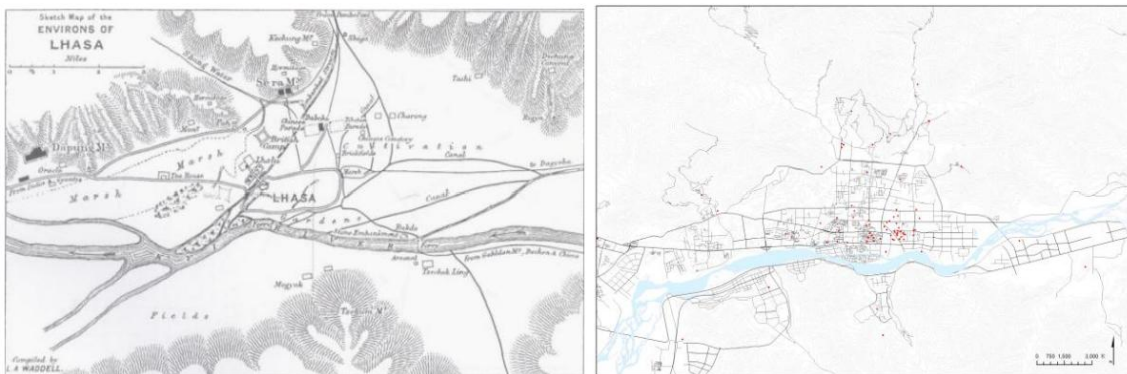


Figure 4: Historical Map of Lhasa Suburbs (Lhasa Suburb Map, L. Austine Waddell, 1905) and Distribution of Religious Buildings

With the continuous expansion of the city and the deepening development of Buddhism, the old city began to show signs of saturation. Additionally, due to differing sectarian ideologies, some large monasteries and their subordinate temples started considering construction in the suburbs and surrounding areas of the city. Lhasa City and its suburbs have a total of 61 religious buildings, with 24 outside the 37 within the old city. Notable large religious buildings, such as Lhasa's three major monasteries—Ganden Monastery, Drepung Monastery, and Sera Monastery—are representative of this expansion. Small towns formed around these significant monasteries. Traditional circumambulation paths underwent a series of evolutions, and the suburban religious buildings promoted the construction of external roads. Besides the original Potalakhor, Doekhor, and Maikhor paths (additional circumambulatory paths, unrelated to the city's structure), new radial roads connecting significant monasteries with the old city emerged. These roads were no longer circular in shape; instead, they connected the inner ring of the city with suburban monasteries located on the northern side of the river and higher elevations in the mountains. Extending westward, northward, and eastward, they formed a radial road network, providing devotees with more pilgrimage route options. The city's boundaries were ultimately constrained by the northern mountains and the southern Lhasa River, preventing further growth. The urban structure shifted from a centripetal circular layout. In L. Austine Waddell's 1905 book 'Lhasa and its Mysteries,' the city formed a triangular pattern enclosed by two mountains and a river (Figure 4, Left).

In summary, religious buildings, roads, and urban layout form a dynamic and interactive system. Religious buildings serve as the cultural and religious centers of the city, roads as the connecting network, and the urban layout reflects the combined effects of history, culture, economy, and social interactions. Together, these elements have shaped the appearance and characteristics of Lhasa, making them essential parts of the city's historical and cultural heritage.



Urban development is a self-organizing process based on natural conditions and local political culture, resulting from the interaction of various elements that together shape the city's layout. Natural geographic conditions, historical development, and Buddhist philosophy all play key roles in this process. The natural geographic environment, especially Lhasa's unique mountains and rivers, provides natural spatial coordinates and symbolic meanings for religious buildings. These features ensure that the buildings are not only functional but also convey specific religious significance.

Historical evolution, including political, economic, and cultural changes across different periods, has left unique imprints on the city's physical form, reflecting the dynamic interactions between religion and governance, faith centers, and urban development during particular historical periods. However, the pervasive influence of Buddhist philosophy, particularly the centripetal cosmology of the mandala, has provided a theoretical foundation for Lhasa's urban structure. This philosophy has closely linked the spatial organization of the city with religious principles, achieving a harmonious unity between religion and urbanism.

The interaction among these three factors—natural geography, historical evolution, and Buddhist philosophy—has laid a solid foundation for Lhasa's urban space, constructing a unique and deeply meaningful religious cityscape.

- Religious Space Distribution Influenced by Natural Geography

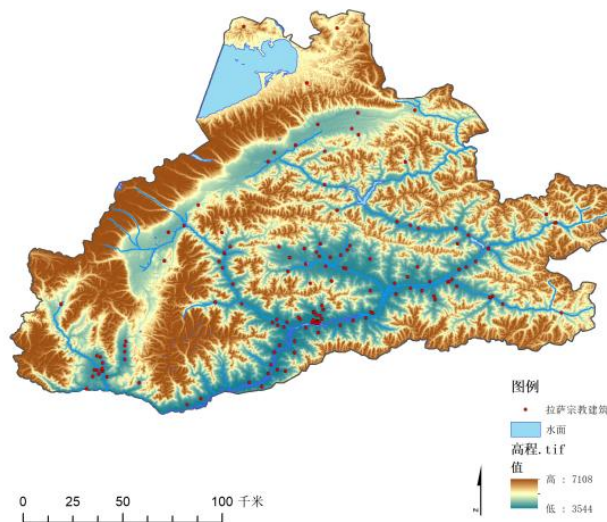


Figure 5: Topographic Map of Lhasa City

As the political, economic, and cultural center of Tibet, Lhasa's geographic form and historical development are deeply intertwined, reflecting a unique interaction between mountains and rivers. Lhasa's distinctive geographic location on the alluvial plain at the lower reaches of the Yarlung Tsangpo River in the highlands features a mild and humid climate, flat terrain, and fertile soil, providing excellent conditions for human habitation and activities. On a macro scale, the topographical features within Lhasa's three districts and five counties are particularly prominent. The Nyainqentanglha Mountains to the north form a natural defensive barrier, while the Yarlung Valley to the south provides easy transportation access and significant strategic value. This natural geographic setting echoes the historical name of Tibet's first regime, 'Tubo,' meaning 'Valley Plain in the Highlands.' This is not only a straightforward description of Lhasa's environment but also a geographic imprint of Tibet's early civilization. (He Yimin, 2013) In this plain, surrounded by mountains, numerous religious buildings are scattered along the rivers, coexisting harmoniously with the natural landscape and forming a unique religious and cultural landscape in Tibet.

Focusing on Lhasa city and its suburban areas, the phrase 'a city flanked by two mountains and traversed by a river' aptly describes Lhasa's geographical structure. The mountains on the north and south sides exceed 5,000 meters in altitude, enhancing its military defensibility and giving Lhasa a unique spatial depth. Before urban development, this area was an open wetland marsh. During the Ganden Phodrang period, Lhasa city and its outskirts still featured numerous wetlands, with several small water systems converging into the Lhasa River in the southern suburbs. These tributaries collectively formed the Lhasa River system. The core building area of Lhasa is located within a circular region formed by these small rivers, whose paths roughly correspond to the circumambulation route of the Lingkhör, delineating the city's main boundaries.

Historical maps from different periods, such as the 1884 Survey of India by Dehradun and the 1828 map by Nikita Yakovlevich Bichurin (Figure 6), show multiple water systems flowing from the northern mountains. One stream passes through the western suburbs near the Potala Palace and Marpori Hill, circles around Chakpori Hill, and finally flows into the Lhasa River. The eastern part of the city has two streams that converge and flow southwest into the Lhasa River, while another stream flows from south to north and merges with the eastern



streams. Notably, a stream from the northeast cuts diagonally through the Lhasa city area, joining the Lhasa River in the southwest, which essentially defines Lhasa's three major religious districts: the Barkhor area, the Ramoche Temple area, and the Potala Palace with Shol area (Ou Lei, 2013). L. Austine Waddell's 'Plan of Lhasa' (Figure 3, Left) illustrates that the Lingkhor circumambulation path runs roughly parallel to the river's course. Although the distances between them vary in different sections, they maintain a consistent relationship, marking clear boundaries for the main urban area.

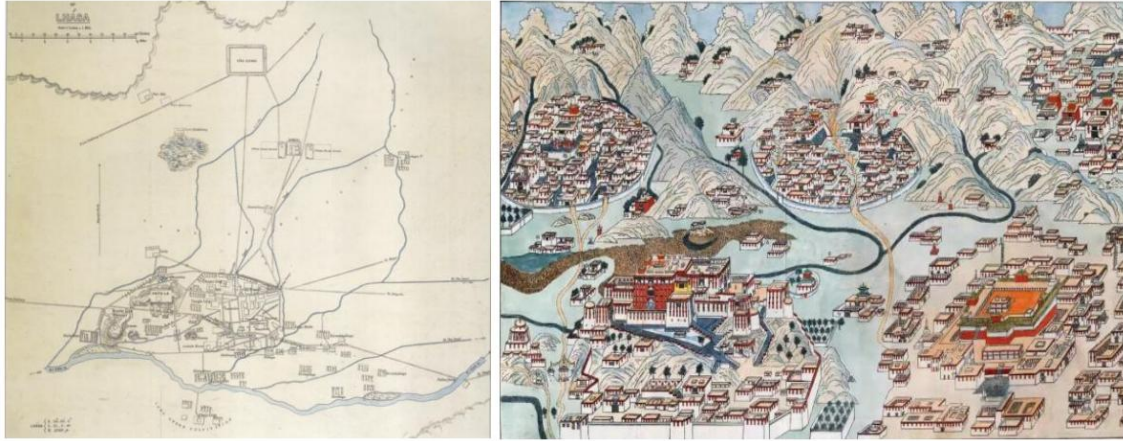


Figure 6: Historical Maps of Lhasa [Left: Plan of Lhasa, Dehra Dun, 1884, Right: Map of Lhasa, Nikita Yakovlevich Bichurin, 1828]

The forms of these rivers suggest that they may not have entirely formed naturally. It remains unclear whether the locations of monasteries were chosen based on the river courses or if the river courses were artificially altered to fit the urban planning and residential needs associated with significant monasteries. Nevertheless, we can observe that this geographic configuration vividly illustrates the influence of mountain and water conditions on the distribution of religious spaces in Lhasa, indicating a profound connection between the mountains, water systems, monasteries, and circumambulation paths. Together, these elements shape the city's unique character and charm. The presence of mountains reinforces Lhasa's geographical features, while the rivers intertwine with the city's religious and historical depth, enriching Lhasa's cultural and developmental narrative.

● Development of Religious Space Under Political and Historical Influence

The pattern of urban development in Tibet has always been closely linked to the construction and presence of religious buildings. Historically, Tibetan cities and towns have often developed around monasteries, stupas, and other religious structures, forming a unique urban structure and spatial pattern. However, the development of religious spaces has not always been smooth and steady, as it has been closely tied to the political landscape. Changes in governance, policy adjustments, or external influences at specific times have often led to the decline or transformation of religious spaces, impacting urban development.

In the early 7th century, with the establishment of the Tubo regime, Tibet entered an important phase of urban development. Lhasa became Tibet's first capital city. The construction of the Potala Palace, Jokhang Temple, and Ramoche Temple laid the foundational structure of the city, and more religious buildings were established around Jokhang Temple, filling much of the urban space with religious sites. In the late 9th century, the decline of the Tubo dynasty, coupled with internal strife, led to significant destruction in Lhasa and its monasteries. Construction on temples initiated during the reign of Trisong Detsen was halted, and the Jokhang and Ramoche temples were closed. The city's growth stagnated and even contracted during this period.

With the establishment of the Yuan dynasty, Tibet was incorporated into a unified administrative system under the central government, marking a significant turning point in Tibetan history. The Yuan and Ming dynasties' emphasis and support for Tibetan Buddhism led to a resurgence of the religion. Under the Yuan dynasty's central government, the Sakya sect established a theocratic local government, profoundly influencing Tibet's subsequent development and significantly enhancing the role of religion in shaping and developing Tibetan cities (Dai Fawang, 2006). The political power held by the Sakya sect facilitated the rapid spread of its influence, leading to the establishment of monasteries across Tibet, around which towns quickly developed.

In the 14th century, Tsongkhapa founded the Gelug sect in Lhasa. During this period, the three major monasteries of Lhasa—Ganden Monastery, Drepung Monastery, and Sera Monastery—were built. Due to saturation within the city, these monasteries were established outside Lhasa and were vast in scale. The construction of these large monasteries attracted many monks, leading to the formation of monastic towns. The development of Lhasa was guided and constrained by these monastic towns. Despite the rapid development outside the city during this period, construction within the city continued, with the building of the Lower and



Upper Tantric Colleges and numerous subsidiary temples. These temples and associated estates formed a network, once again becoming a driving force in Lhasa's development.

As Buddhism gradually revived, its influence on urban development in Tibet became increasingly apparent. The flourishing of Tibetan Buddhism led to the formation of various sects, each constructing religious sites. 'Over approximately two and a half centuries, numerous temples were built in Lhasa, with as many as twelve notable ones. These temples formed different sects, which, despite their differences, were closely linked in religious culture, all centered around Lhasa.' (Fu Chonglan, 1994) These temples either became integral parts of the city or led to the development of towns around them.

In 1642, the Ganden Phodrang regime established a unified theocratic system, reaffirming Lhasa's status as the political and religious center of Tibet. Favorable relations with the central government ensured substantial funding for the construction of religious buildings. During this period, Lhasa's historical urban layout matured. Following the peaceful liberation, Lhasa became the capital of the Tibet Autonomous Region, with continuous urban development, forming a comprehensive historical urban layout that seamlessly blends ancient and modern features.

● Urban Spatial Structure Under the Influence of Buddhist Philosophy

Buddhist philosophy is characterized by its unique centripetal cosmology, which posits that the universe contains a fundamental force that governs the creation, movement, and transformation of all things. This concept not only highlights the distinctiveness of Buddhist philosophy compared to other schools of thought but also expresses itself spatially through a concentric layout, known as the 'Mandala,' which emphasizes the centrality of a core. The mandala, originating from the cosmological concepts of ancient India's Vedic texts, uses its unique imagery, figures, colors, and layouts to reveal the essence of the universe's 'circular completeness' and 'wholeness.'

In Tibetan Buddhism, the practice of circumambulation, known as 'kora,' involves devotees walking clockwise around religious buildings or sacred images. This core religious practice embodies the Buddhist cosmology, consistent with Tibetan Buddhism's philosophical considerations of 'samsara' (the cycle of birth, death, and rebirth) and the 'sacred center.' The clockwise movement symbolizes the harmonious unity of the cosmos and philosophy.

Religious buildings, as places for contemplation and enlightenment, serve as three-dimensional projections of the Buddhist cosmology. Tibetan monasteries' architectural layouts often materialize the mandala's significance and spiritual essence, showcasing its essential elements in their design. Early Tibetan Buddhist architecture incorporated specific proportional shapes, images, colors, and layouts, reflecting the mandala space, typically represented in square or rectangular forms. The main hall of Jokhang Temple, as Lhasa's first Buddhist temple, was established according to this cosmological concept and the esoteric mandala structure. Early traditional Tibetan Buddhist monastery layouts also embodied this cosmic spirit, displaying order through their development and enclosures.

Religious buildings possess an inherent attraction, and the practice of circumambulation integrates daily life and religious activities around these religious centers. The urban layout and road system were significantly influenced by this religious practice. The circumambulation routes not only form the foundational skeleton of Lhasa's urban space but also fulfill the spiritual needs of the devotees, creating a harmonious unity between urban space and spiritual requirements (Deng Chuanli, 2010). In Lhasa, a city built around its monasteries, the urban form not only becomes a religious space in itself but also functions and activities are closely centered around religion, resulting in a naturally compact characteristic.

From a broader perspective, the kernel density map of religious buildings in the entire Lhasa city area seems to exhibit this concentric layout, with a central focus surrounded by auxiliary peripheries. This geographical manifestation not only demonstrates Tibetan Buddhism's profound influence on spatial organization and urban layout but also reflects its role in shaping social and cultural structures. This layout encourages social cohesion and order at a deep level, promoting the exchange and development of religion, culture, art, and economy.

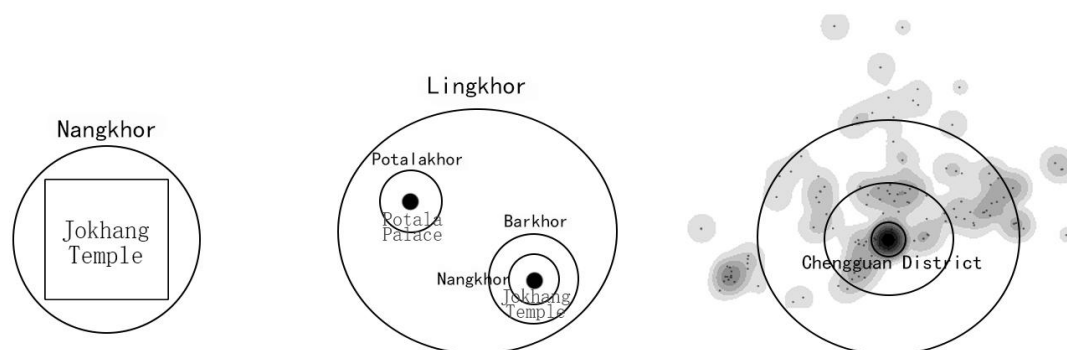




Figure 7: Architectural Plan, Spatial Organization, and Urban Layout Under the Influence of Buddhist Philosophy

The evolution and development of a city occur on the foundation of its natural environment, driven by local political and cultural factors through a series of self-organizing and adaptive processes. This evolution involves not just the transformation of physical space but also a comprehensive social, cultural, political, and economic metamorphosis. It is shaped by the interaction and mutual influence of various elements, forming the city's shape and layout. This transformation constitutes a complex system network encompassing population migration, resource allocation, regime changes, cultural inheritance, and integration. Each aspect uniquely impacts the city's growth and changes. The influence of religious spaces becomes a primary characteristic of urban spatial formation and a major factor in urban spatial organization. In this context, religious buildings are not merely static spatial structures but active social entities closely connected to their social, political, and cultural environments, creating a dynamic and multifaceted urban development history.

Lhasa, the most representative city in Tibet, holds a central position with a far-reaching influence. Despite its turbulent history, no city has replaced it as the capital until today. Like other religious cities, religious buildings in Lhasa serve as the city's core or initial landmarks. As religious activities and pilgrims increased, the surrounding areas flourished, forming markets, residential areas, and other social facilities. Roads initially developed to connect religious buildings with other parts of the city, providing convenient transportation routes that gradually improved over time. The initial urban layout was significantly influenced by religious buildings, often radiating from these central points. As commercial activities grew, the road system expanded further, driving the evolution of the urban layout to meet increasingly complex transportation needs. As the city grew, new religious buildings might be established on the outskirts or peripheral areas, becoming centers for new communities or districts. The construction of new religious buildings would necessitate new roads, impacting the entire city's transportation network and layout. The introduction of new roads could also alter the original urban core and layout, possibly leading to the emergence of new commercial, residential, or cultural centers. The relationship between religious buildings, roads, and urban layout is complex and tightly interconnected, collectively shaping the city's history, culture, and development trajectory.

Lhasa, as a historic city on the plateau, exhibits distinct religious, regional, and ethnic characteristics in its urban layout. In recent decades, like other cities in China, Lhasa has been undergoing rapid urbanization and the influence of external cultures, which may lead to the gradual disappearance of its original urban form to accommodate urban development. Therefore, studying the historical layout of the city is significant for sustainable urban planning.

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Image sources

Figure 1,5,7: Author's own drawing.

Figure 2,3,4: Left, Larsen, Knud, and Amund Sinding Larsen. *The Lhasa Atlas: Traditional Tibetan Architecture and Townscape*. Translated by Muya Qujijian Cai and Li Ge. Beijing: China Architecture & Building Press, 2005.[p.29,25,24]. Right, Author's own drawing.

Figure 6: Left, Larsen, Knud, and Amund Sinding Larsen. *The Lhasa Atlas: Traditional Tibetan Architecture and Townscape*. Translated by Muya Qujijian Cai and Li Ge. Beijing: China Architecture & Building Press, 2005.[p.8]. Right, File:Bichurin Lhasa.jpg - Wikimedia Commons.