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The Spatial Study of Catholic Market in China

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Abstract

This article is designed to use geo-spatial, digital and statistical methods to visualize and measure tl demand and supply of Catholic market in China. Selecting nine representative cities covering three regio of China, the article measures the density of Catholics through discussing the number of Cathol population and number of Catholic churches in an effort to calculate the average number of Catholics usi each church. In addition, this article utilizes two spatial methods to visualize and gauge the distance a driving time between the Catholic residential area and the nearest church in an effort to measure the chur availability and accessibility in the selected nine cities. After proposing three measurable criteria evaluating the shortage of church, this article identifies five specific cities as the areas in which there is Catholic church shortage in China.

Keywords: Spatial study, Catholic market, Church density, Church accessibility, Church availability.

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1. Introduction

The Catholic market, to a larger extent, is determined by the demand of the Catholic population and the supply of Catholic churches (Iannaccone, 1991; Yang, 2006). According to the qualitative and conventional research findings, most scholars have concluded that the Catholic market in today's China should be characterized by the demand over supply and thus Catholic churches are overcrowded or overpopulated (Yang, 2006; Yang, 2010). However, few, if any, scholars provided virtualized, digital and measurable descriptions concerning the shortage of Catholic churches in China.

Benefited from the Geographic Information System (GIS), scholars are able to utilize geo-spatial and digital methods to map the demand and supply of Catholic market in China. Authors have published several articles addressing the shortage of Protestant churches in China spatially, digitally, statically and comparatively (Hong and Zeng, 2012; Hong *et al.*, 2014; Hong and Yan, 2015). This article is designed to continue the similar effort to focus on the shortage of Catholic churches and the Catholic market in China by means of selecting nine representative cities covering three regions of China.

This article measures the density of Catholics through discussing the number of Catholic population and number of Catholic churches in an effort to calculate the average number of Catholics using each church. In addition, to measure the church availability and accessibility in the selected nine cities, this article has used two spatial methods to visualize and gauge the distance and driving time between the Catholic residential area and the nearest church. After proposing the reasonable and statistical criteria of evaluating the shortage of church, this article identifies specific cities as the areas in which there is a Catholic church shortage in China. The innovative spatial research methods and exceptional perspective on this study may shed new lights of understanding religious market and religious economy.

2. Methodology

This article has used both statistical and spatial methods to check the density, availability and accessibility of Catholic churches in the nine major cities covering the east, central and west regions of China in 2004. Relying on conventional statistical techniques, this study calculates the average number of the Catholic population using one church to demonstrate the density of churches in each selected cities.

Supplemented by the spatial method, which visualizes the location of Catholic churches, the quantitative table is capable of showing the statistic data that denotes the balance of church supply and Catholic demand. Obviously, the more Catholic members each Catholic church has, the worse the church shortage is. Following the proper and unified measurement, the areas with a Catholic church shortage can be identified.

In addition to the church density, it is vital to study the church availability and accessibility through estimating the distance and driving time between the Catholic residential area and the nearest church. Needless to say, the longer the distance or the longer the minutes for local Catholics to travel from home to their nearest church, the worse experience they have in terms of the shortage of church. As an effective program for spatial study, ArcGIS 10.1 is able to address the availability and accessibility of Catholic churches in the designated areas. Benefitting from the GIS technique, this study first applied the Two Step Floating Catchment Area (2SFCA), which is aimed at estimating the driving time from Catholic residential areas to the closest church within the nine cities. Consequently, the average Catholic members who can't reach their nearest church within the allotted time frame can be statistically demonstrated. To supplement and verify the results discovered by the 2SFCA, this study has used a second spatial method, the Network Analysis Method (NAM), which can measure both driving time and driving distance (Hong and Yan, 2015).

The differences between the 2SFCA and the NAM are worth addressing. While relying on the street map, the 2SFCA in this study uses a straight line of distance travel time, due to the limited street map data in the nine cities. This is based on the assumption that the Catholic population is distributed equally throughout the area. Obviously, this method is not accurate, but it may be the second best option in light of current incomplete data provided by the Chinese government.

By contrast, the NAM takes the district map, instead of the street map, as the key reference. It is possible to integrate network data, maps and spatial information through GIS and other spatial statistical methods in an effort to estimate driving time and distance. Meanwhile, Google Maps provides an effective tool for the NAM to measure the average driving speed and calculate the starting and ending locations for the randomly selected cities around the center of the representative city. As a result, the NAM can visualize different driving times (in minutes) and distances in a designated location (Hong and Yan, 2015).

3. Data

Indentifying the accurate and complete data about the total Catholic population in China is challenging, due to the disparity of various data sources and the lack of religious information on China's census. Therefore, scholars have to rely on reputable institutes and Chinese government information for key references. For instance, the Pew foundation in 2011 estimated there were 9,180,000 Catholic people in China in 2010, accounting for 0.7% of the total population (Pew Research Center, 2011). By contrast, an official Blue Book on Chinese religions published by the Chinese Academy of Social Sciences (CASS) (Wang, 2010) accepted the estimation by the Xinde Institute for Cultural Studies, that is, approximate 5.7 million of Catholic population in 2009 (Xinde Institute for Cultural Studies, 2009). Here, the Pew Research Center has added additional 3.3 million Catholics who are affiliated solely with unregistered Catholic congregations (Pew Research Center, 2011). The authors of this paper have accepted the conservative estimation of 5.7 million as the reference number of Catholics in China.

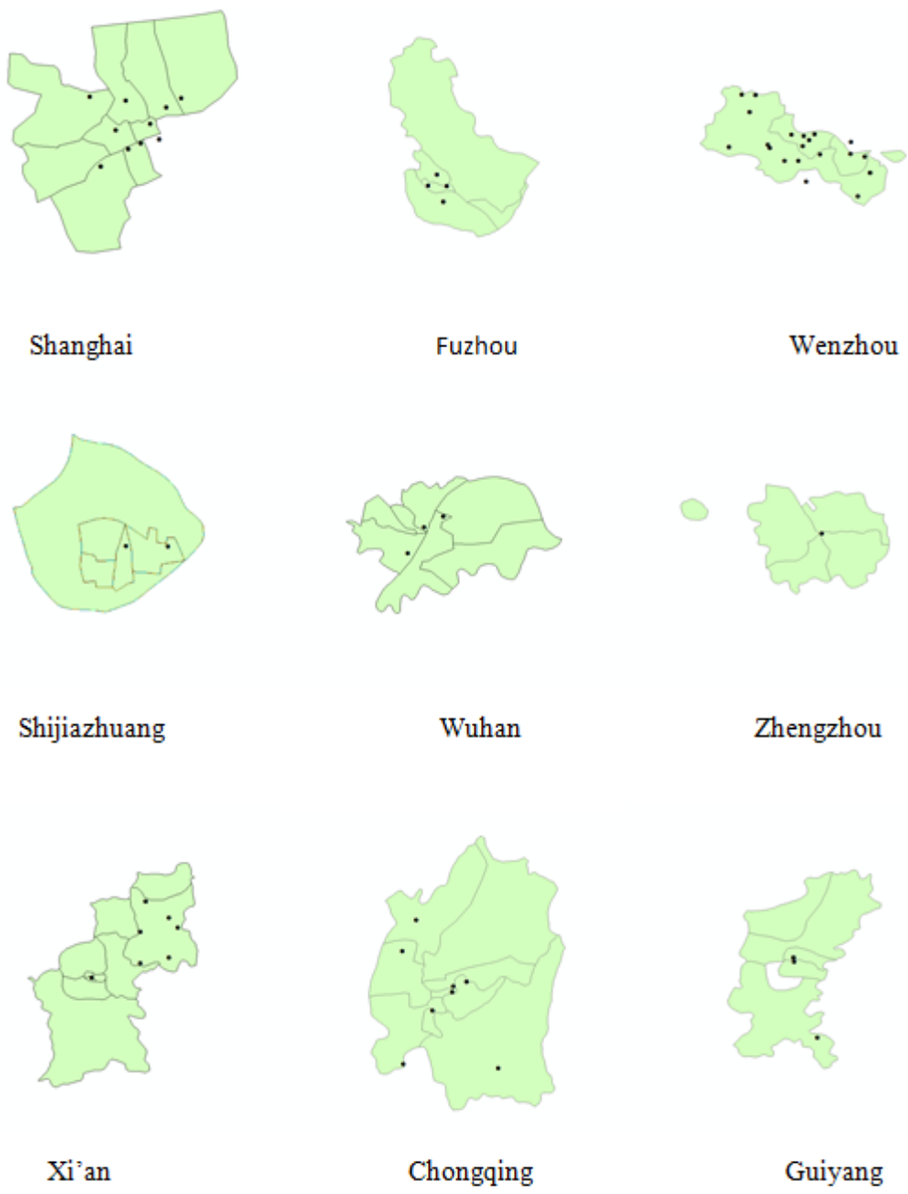
A further complication is caused by the calculation and estimation of Catholics at the level of cities. Few, if any, institutes conducted scientific surveys on the Catholic population in the local areas. The only exceptions were the city's yearbook, individual scholars' research and online information. In an effort to maintain regional balance in

selecting Catholic churches in China, this study has identified three major cities in each of China's three regions. For the east region, Shanghai, the largest city in China; Fuzhou, the provincial capital city of Fujian; and Wenzhou, the so-called Chinese Jerusalem in Zhejiang province were all selected. In addition, three provincial capital cities in the central region were selected, including Shijiazhuang city of Hebei province, Wuhan city of Hubei province and Zhengzhou city of Henan province.

The three additional provincial capital cities in the west region were also chosen as case studies: Xi'an city of Shaanxi province, Chongqing city, and Guiyang city of Guizhou province. Map 1 shows the locations of the nine cities in Chinese map.

Map-1. Location of the Nine Cities in the Three Regions of China

In order to understand the spatial locations of all Catholic churches in the nine cities, Map 2 below visualizes the spots of Catholic churches in each city indicated by each specific dot on the map.



Map-2. Spatial Catholic Church Maps for the Nine Cities

Given the limited information, it is impossible to have all data pertaining to Catholics from the different cities in the same year. Thus, this paper selects the years close to the first ten years of 21st Century. Table 1 below demonstrates the number of Catholics in the nation and the nine cities supported by various references on column 4.

Table-1. Catholic Population in China and its Nine Cities, 2000-2010

Location	Catholic Population	Percentage of Catholic	Reference
China	5,700,000	0.44%	(Wang, 2010)
Fuzhou	63,989	3.01%	(Yao, 2000)
Wenzhou	18,450	1.35%	(Wen, 2002)
Shanghai	68,704	1.11%	(Office of Shanghai Government, 2004)
Shijiazhuang	19,845	1.07%	(Office of Shijiazhuang Government, 2002)
Chongqing	53,775	0.86%	(Xie, 2012)
Xi'an	42,728	0.83%	(Office of Xi'an Government, 2005)
Guiyang	5,000	0.26%	(Guizhou Database, 2000)
Wuhan	6,406	0.15%	(Wuhan, 2000;2005)
Zhengzhou	1,684	0.05%	(Religion in Zhengzhou, 2010; Zhengzhou Government, 2010).

In addition to the number for the Catholic population, an accurate number of Catholic churches in China is not easily calculated. According to the China Census Bureau, there were 2,419 registered Catholic churches in 2004 (China Census Bureau, 2005). However, in 2010, the Blue Book on Chinese Religion indicated there were 5,967 Catholic churches and houses of prayer (Wang, 2010).

Obviously, the houses of prayer included a substantial number of independent and unregistered Catholic churches which did not have legal status and had not affiliated with the official Patriotic Catholic Association (Pew Research Center, 2011). Also, the number of 5,967 churches was based on the year of 2009, while the number of 2,419 was the record in 2004. Therefore, this paper accepts the number of 2,419 Catholic churches published by the China Census Bureau. Meanwhile, the China Census Bureau (2005) also lists the number of Catholic congregations at the level of each individual city. Table 2 below shows the data about the Catholic churches in the nation and the selected nine cities in 2004. As a comparative reference, Table 2 also lists the U.S. Catholic church information.

Table-2. The Number of Catholic Churches in the U.S., China and the Nine Cities (2004)

Location	Number of Catholic Churches
US	22,095
China	2,419
Wenzhou	33
Shanghai	17
Xi'an	15
Guiyang	8
Fuzhou	7
Chongqing	7
Wuhan	6
Shijiazhuang	2
Zhengzhou	1

4. Results and Findings

4.1. The Density of Catholics: Statistical Method

To estimate the density of Catholics in the selected nine cities, it is important to figure out the number of the Catholic population and number of Catholic churches. Obviously, the size of Catholic churches matters when measuring the average number of Catholics using each church, but it is difficult to estimate the size of each individual church unless the intensive empirical investigation would be conducted in each church. Furthermore, although it may be possible to collect the information concerning the number of available seats in each church, it is still not possible to accurately measure the actual participation rate of Catholics during the weekend religious service. Therefore, this project decides to calculate the average number of density based on the number of Catholics and Catholic churches, without considering the size, seats and participation rates of each individual church.

Table 3 below finds five important data about the density of Catholics in the nine cities, the whole nation, and the U.S. As discussed in Table 1 given the limitation of available data on the number of Catholics in the same year, the data has been selected covering the first decade of the 21st Century instead of the exact same year. Among the nine cities, Shanghai has the largest Catholic population (68,700), as it is the largest city in China. However, with respect to the percentage of Catholics among the total population, Fuzhou, the capital city of Fujian province, reached the highest percentage of Catholics (3.01%)--seven times more than the national average (0.44%). While looking at the number of Catholic churches, Wenzhou city, as the only non-provincial capital city among the selected nine city, had 33 Catholic churches, almost doubled from Shanghai's 17. This is attributed to its historical legacy, east coast location, and more importantly, less governmental regulations during Deng Xiaoping's China (1978-1997) (Cao, 2010; Chan, 2011).

After presenting the number of Catholic population and Catholic churches, it is easier to figure out the average number of Catholics per church in the designated location. Indicated by Table 3 while Shijiazhuang city suffered from an overcrowded condition (9,900 Catholics sharing one church by average), it is again surprising that Wenzhou city had its best rate of church density (561 Catholics using one church by average). This is more than five times better than the density rate in the U.S. (2,933) and four times better than the average rate of nationwide China (2,356). Finally, Table 3 finds the rankings of Catholic church density, demonstrating that both China (#5) and the

U.S. (#7) stay in the middle rankings among other nine Chinese cities. In particular, Chinese ranking of Catholic density is better than the U.S. This may be caused by the different sizes of churches available (larger churches in the U.S.) and the underestimation of the Chinese Catholics, due to political sensitivity (Hadaway *et al.*, 1993; Potter, 2003; Morris, 2011; Hanson, 2014).

Table-3. The Density of Catholics in China and its Nine Cities, 2004

City/Nation	Number of Catholics	Percentage of Catholics	Number of Catholic Churches	Average Number of Catholics per Church	Rankings of Density
Shijiazhuang	19,800	1.07%	2	9,900	11
Fuzhou	64,000	3.01%	7	9,143	10
Chongqing	53,800	0.86%	7	7,686	9
Shanghai	68,700	1.11%	17	4,041	8
U.S.	64,800,000 (2005)	23.90%	22,095	2,933	7
Xi'an	42,700	0.83%	15	2,847	6
China	5,700,000	0.44%	2,419	2,356	5
Zhengzhou	1,700	0.05%	1	1,700	4
Wuhan	6,400	0.15%	6	1,067	3
Guiyang	5,000	0.26%	8	625	2
Wenzhou	18,500	1.35%	33	561	1

To provide a much clearer comparative picture pertaining to the different densities of Catholics, Figure 1 below shows the rankings of Catholics using each church by average in the nine cities, China and the U.S. Apparently, no matter how incomplete or inaccurate the data of church size might be, the fact that approximately 5,000 Catholics shared one church is not only unbelievable, but not acceptable.

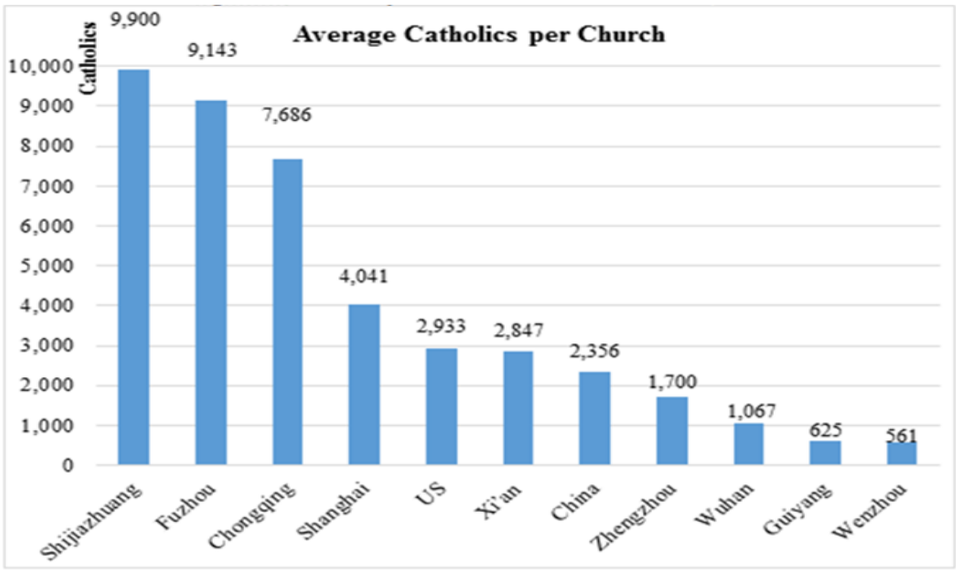


Figure-1. The Density of Catholics in China and the U.S., 2004

4.2. The Time Measurement by the Two Step Floating Catchments Area (2SFCA)

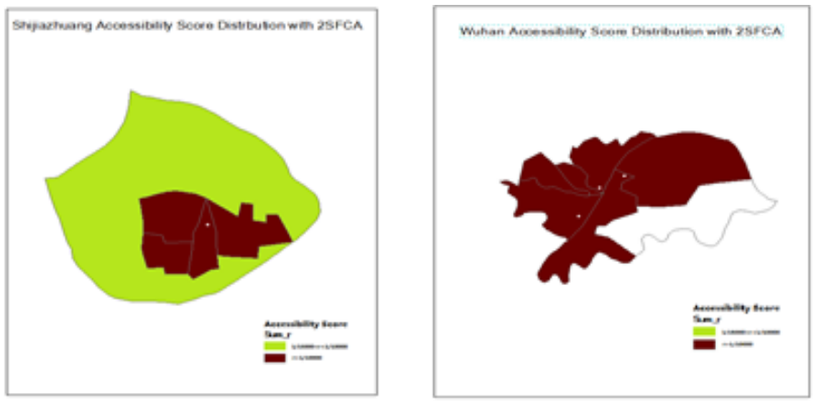
Having briefly explained in the section of methodology, in an effort to address the accessibility of Catholic churches in the specific area, the Two Step Floating Catchments Area (2SFCA) is an effective spatial method used to measure driving time between the Catholic residential areas and the closest church. The faster time represents better accessibility in which Catholic individuals are able to participate in their church services as quickly as possible.

Benefitted from GIS, spatial maps of Catholic accessibility in the selected nine cities can be visualized by the 2SFCA (see Maps 3, 4, 5 and 6 below). The area covered by the brown color in Map 3 shows that Catholic individuals can reach their nearest church within 30 minutes of one-way driving. In addition, the 2SFCA is setting r>1/10000 or 0.0001 as the basic measurement of church accessibility--demonstrated by the brown color--while the green color means 1/10000>r>1/15000 and the white color indicates 1/15000>r>=0. In other words, the larger the area covered by brown color, the better accessibility the Catholic population has.

Therefore, both Shanghai and Wenzhou cities should have their best accessibility score, as they have been covered by all brown color (see Map 3)

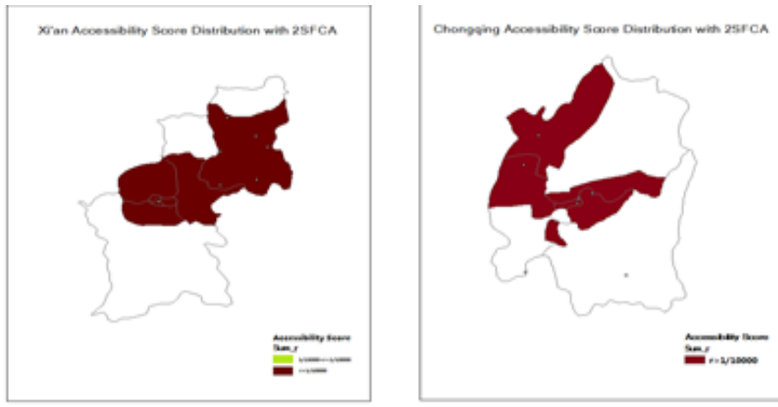
Map-3. The Best Areas of the Catholic Church Accessibility Scores by the 2SFCA

Meanwhile, Shijiazhuang and Wuhan may be relatively catalogued by the second best accessibility performance, as the majority of their areas are covered by both brown and green colors, as indicated by Map 4 below.



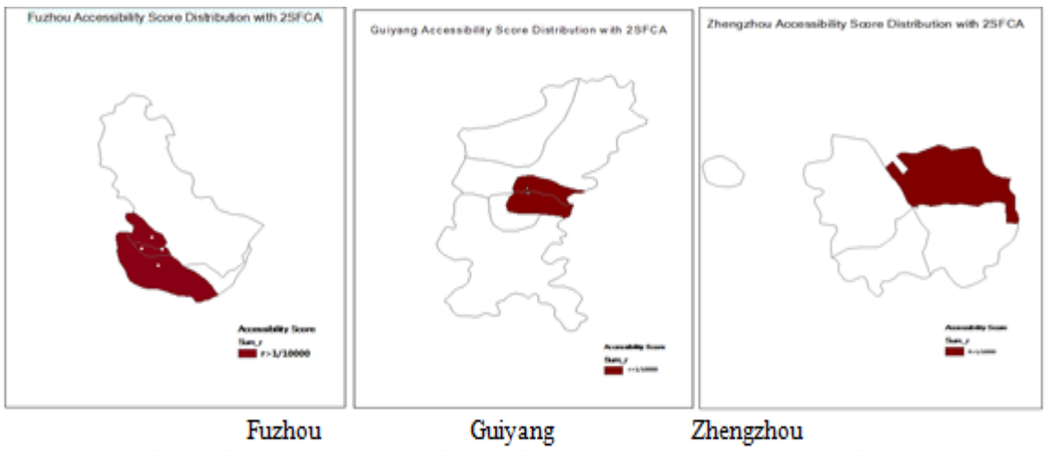
Map-4. The Second Best Areas of the Catholic Church Accessibility Scores by the 2SFCA

In addition, given that Xi'an and Chongqing cities in west region of China are covered by more white color than that of brown color (denoted by Map 5 below), they may be set as the third level of Catholic church accessibility score.



Map-5. The Third Best Areas of the Catholic Church Accessibility Scores by the 2SFCA

Finally, the worst church accessibility areas include Fuzhou, Guiyang and Zhengzhou because most areas are wrapped by the white color shown in Map 6 below.



Map-6. The Worst Areas of the Catholic Church Accessibility Scores by the 2SFCA

To convert the spatial information above to the statistical data, Table 4 below shows the different percentages of Catholics in the nine cities who take more than 30 minutes of one-way driving to arrive at their nearest churches. As a result, there are six cities where more than 45% of Catholics can't reach their nearest church within 30 minutes. Meanwhile, Catholics in both Shanghai and Wenzhou had more accessibility to local churches. The reason for Wenzhou with the highest accessibility should relate to the fact that only 561 Catholics shared one church by average, representing the highest density of Catholic churches, as compared to the other eight cities in China (see Table 3 above). With respect to the case in Shanghai, although its density of Catholics was not good enough (4,041 Catholics sharing one church by average), the modern public transportation system and facilities might help overpopulated Catholics reach their churches as quickly as possible.

Table-4. Catholic Church Accessibility in China by the 2SFCA

Cities	Percentage of Catholic Population taking more than 30 minutes to the nearest church	Ranking
Guiyang	92%	9
Zhengzhou	77%	8
Fuzhou	76%	7
Xi'an	55%	6
Chongqing	49%	5
Shijiazhuang	46%	4
Wuhan	25%	3
Shanghai	0.00%	1
Wenzhou	0.00%	1

Apparently, the statistical rankings of Catholic church accessibility match the spatial discovery virtualized by Maps 3-6. While both Wenzhou and Shanghai have the best rankings and best accessibility score, Guiyang, Zhengzhou and Fuzhou are ranked with the worst performance, as supported by spatial maps. It may provide added value to study Catholic market through combining both innovative spatial method and conventional statistical technique.

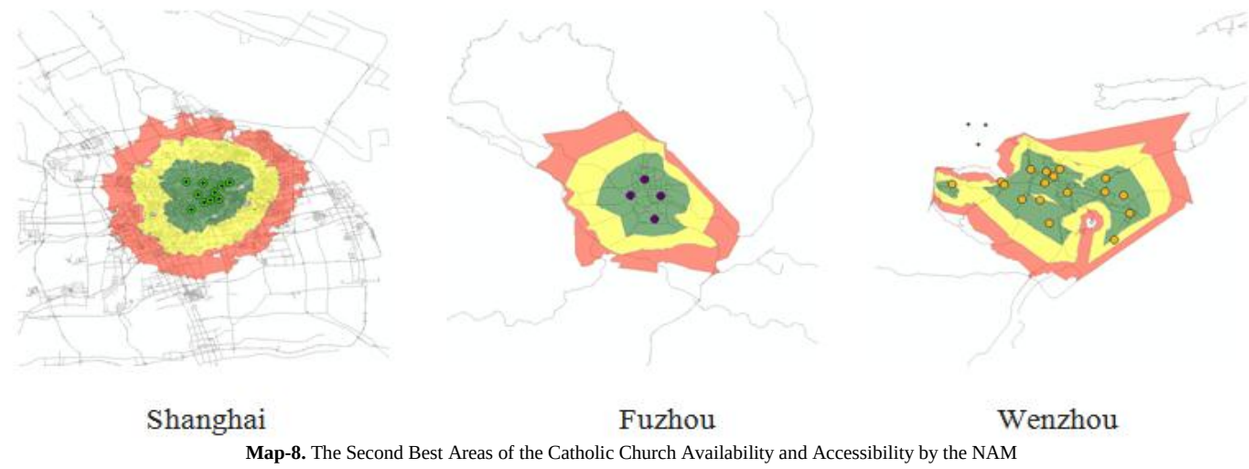
4.3. The Time Measurement by the Network Analysis Method (NAM)

In an attempt to verify the results by the 2SFCA, it is imperative to use another spatial method, the Network Analysis Method (NAM), to address the driving distance and time between the Catholic residential areas and the nearest church. To be consistent, this project sets up the fixed category of 12km and 30 minutes of one-way driving to measure the average distance and driving time between the two designated locations.

Maps 7 8 & 9 below demonstrate spatial driving maps for the Catholic churches in the nine cities. Here, the circle with green color symbolizes 15 minutes of driving time, the middle circle with yellow color symbolizes 30 minutes of driving and the largest circle in red represents 45 minutes of driving. The area without color indicates that Catholic individuals can't reach their nearest church within 45 minutes. The location of Catholic churches is indicated by a specific spot (Hong and Yan, 2015). Obviously, the more green and yellow areas a city has, the better church accessibility and church availability. Thus, Map 7 below denotes that Shanghai, Fuzhou, and Wenzhou cities in all the east region of China may be the best areas for Catholic individuals who can reach their churches quickly and shortly.

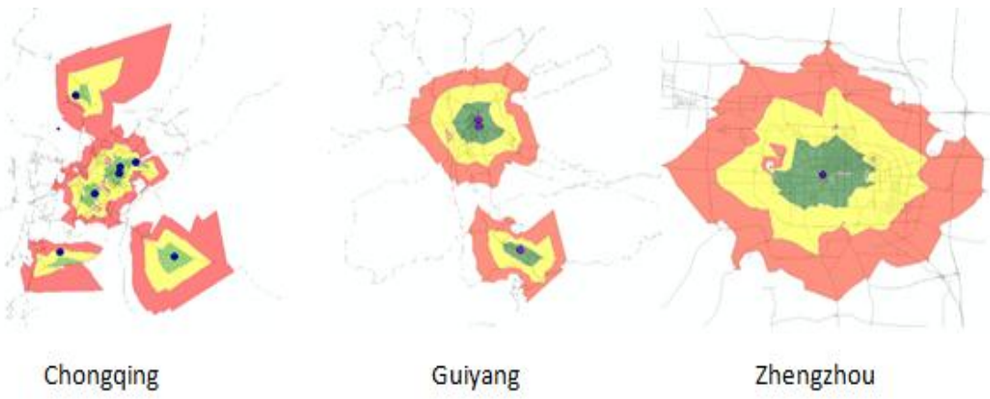
Map-7. The Best Areas of the Catholic Church Availability and Accessibility by the NAM

As the areas with the second best church availability and accessibility, Wuhan, Xi'an and Shijiazhuang cities have more green and yellow color covered (see Map 8).



Map-8. The Second Best Areas of the Catholic Church Availability and Accessibility by the NAM

Finally, Map 9 shows there are few green and yellow colors over the cities of Chongqing, Guiyang and Zhengzhou.



Map-9. The Worst Areas of the Catholic Church Availability and Accessibility by the NAM

Table 5 below displays the NAM statistical data about the accessibility and availability of Catholic churches in the nine cities. First, Wenzhou city is consistently the highest ranking of church accessibility by both 2SFCA and NAM and church density by the statistic method. Meanwhile, given that 66% of Catholics in Chongqing (ranking 9 of 9) and 54% in Shijiazhuang (ranking 6 of 9) can't arrive at the nearest church, both cities are still ranked as the worst areas of church accessibility, which is consistent to their situation of church density supported by Table 3 and Table 4.

Table-5. Catholic Church Accessibility in the Nine Cities by the NAM (30 minutes)

12km (30minute)	Accumulated Area (km2)	Catholic and Area Coverage	Percentage of Catholics Can't Reach the Nearest Church	Number of Catholics Who Can't Reach	Ranking
Chongqing	1,280.66	34%	66%	35,376	9
Zhengzhou	390.67	41%	59%	990	8
Guiyang	490.42	44%	56%	2,781	7
Shijiazhuang	504.02	46%	54%	10,663	6
Xi'an	1,408.60	47%	53%	22,605	5
Wuhan	566.56	50%	50%	3,210	4
Shanghai	787.58	54%	46%	31,805	3
Fuzhou	413.32	60%	40%	25,615	2
Wenzhou	1,298.44	64%	36%	6,576	1

More importantly, visualized maps demonstrated by Maps 7-9 are consistent to the spatial statistics denoted by Table 5 above. For instance, while Wenzhou, Fuzhou and Shanghai cities are ranked by the top 3 of their church availability and accessibility based on the statistic result, they are also characterized by the best areas of accessibility demonstrated by Map 7. Similarly, both statistical data and spatial maps all verify that Chongqing, Zhengzhou and Guiyang should be identified as the worst cities with respect to their availability and accessibility of Catholic churches. The similar results by spatial and statistical methods may prove that it is vital for scholars to combine and supplement different research methodology in search for the truth on the religious market in China.

5. Discussions

The study of Catholic density, Catholic church availability and church accessibility in the selected nine cities may propose three sensible criteria of identifying the areas which have the shortage of Catholic churches. First, in reference to the average density rate of Catholics in China (2,356 Catholics per church) and in the U.S. (2,933 Catholics per church), it is reasonable to assume that an area that has more than 5,000 Catholics sharing one church by average should be determined as the place of the Catholic church shortage in China. If this is the case, Shijiazhuang (central China), Fuzhou (east China) and Chongqing (west China) should fall in the category of church shortages. This criterion is consistent to the standard of identifying shortage of Protestant churches in China defined by authors' other article (Hong and Yan, 2015).

In addition, given the information provided by Table 4 it may present the second criterion of judging the shortage of Catholic churches, with emphasis on the church accessibility by the 2SFCA. It can be proposed that areas with more than 45% of Catholic individuals in a specific city who must take more than 30 minutes of one-way driving or 60 minutes of round trip to reach their nearest church should be defined as the location of church shortage. In light of this second standard, in addition to Guiyang (92%), Zhengzhou (77%) and Xi'an (55%), other three cities, Fuzhou (76%), Chongqing (49%) and Shijiazhuang (46%), should also be determined as areas with Catholic church shortages, which is similar to the first criterion based on the Catholic density. Therefore, six cities can be identified as the areas with Catholic church shortages, based on the second standard.

Finally, relying on the results revealed the NAM in Table 5 a third criterion can be added. That is, if more than 45% of Catholics in a city need to travel more than 12km and 30 minutes to reach their nearest church, it should be categorized by the area of church shortage. As a result, the NAM indicates that there are seven cities which fall into the category of church shortage. Obviously, the NAM may provide much accurate calculation and stricter standard than the 2SFCA, because the NAM is using street map data while the 2SFCA is relying on the district map (Hong and Yan, 2015).

To summarize the three methods testing the Catholic church density, church availability and church accessibility, three different rankings by three methods for each city can be averaged out to discover information about the church shortage situation. Table 6 below shows the combined rankings of Catholic church shortage in the nine cities of China's three regions. In reference to the three criteria used to judge the shortage of Catholic churches and the combined rankings of the selected nine cities, it is appropriate to identify the top five worst cities as the areas of Catholic church shortages in China--focusing on their church density, church availability and church accessibility by the two spatial methods.

As a result, Chongqing (west), Zhengzhou (central), Shijiazhuang (central), Guiyang (west) and Fuzhou (east) should be determined as the areas with a Catholic church shortage. Consequently, these five cities need to build more Catholic churches in an effort to improve its church density and church accessibility, thus maintaining the balance of supply and demand for the Catholic market and economy.

Table-6. Combined Rankings of Catholic Church Shortage in the Nine Cities

Cities	Density Rankings	Rankings by NAM	Rankings by 2SFCA	Combined Rankings	Final Rankings
Chongqing	7	9	5	7.0	9
Zhengzhou	4	8	8	6.7	8
Shijiazhuang	9	6	4	6.3	7
Guiyang	2	7	9	6.0	6
Fuzhou	8	2	7	5.7	5
Xi'an	5	5	6	5.3	4
Shanghai	6	3	2	3.7	3
Wuhan	3	4	3	3.3	2
Wenzhou	1	1	1	1.0	1

6. Conclusion

This article has utilized three statistical and spatial methods to address the Catholic church density, church accessibility and church availability, focusing on the nine major cities and covering the three main regions of China equally. Proposing the three measurable criteria of discovering the shortage of Catholic churches, this article identifies five cities as the areas that indicate a high demand of Catholics but low supply of churches, thus leading to a church shortage. These criteria may be applicable in understanding the Catholic market in other Chinese cities.

Needless to say, this spatial study on the religious market and church shortages is a dynamic approach capable of supplementing and improving the conventional research methods, such as the qualitative and empirical studies. Although the data provided by the Chinese government is incomplete and insufficient, applying the spatial method supported by GIS may contribute added value to innovative methodology and exceptional findings on the religious study in general, and Catholic church accessibility in particular.

Hopefully this spatial study of Chinese religion and society will inspire and influence the national census to include more detailed information concerning the number of Catholics and number of Catholic churches in the levels of nation, region and city, and perhaps more importantly, encourage the creation of more accurate spatial street maps and district maps. This creation would be crucial for a reliable and reputable study of mapping and visualizing Catholic market and economy.

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