
Case Study Paper

How to Define the Boundaries of Metropolitan Areas: Case Study of Wuhan, China

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Abstract

To plan ahead for an efficient and smart growth, this paper explores the methodology of defining the boundaries for metropolitan areas. Using Wuhan as a megacity in Central China with a population of more than 10 billion as an example, this paper attempts to set up an analytical framework to define the boundary of metropolitan areas by quantitative analysis on urbanization, geography, transport, economics and qualitative analysis on ecological, spatial and cultural aspects.

Keywords

Urban boundary, Metropolitan areas, Megacities, Wuhan, China

1. Introduction

To plan ahead for a smart growth of urban clusters and megacities, there has been a trend of developing metropolitan areas for megacities in China, which considers defining the boundaries of metropolitan areas as the basis and premise. Defining a city boundary has already been a challenge for urban planners and geographers let alone metropolitan areas considering their cross-bordering characters. Where do metropolitan areas start and end? Is there a continuum of rural and urban land uses to define them? If is, what kinds of factors are the boundaries of metropolitan areas relevant to? Based on literature reviews and case studies, this paper explores the methodology of defining the boundaries of metropolitan areas by the case study of Wuhan, China.

With a population of more than 10 million, Wuhan has already become a megacity in terms of its population, economic development and regional roles in Central China. Along with the paced-up city expansion, Wuhan has moved into the stage of regional collaboration with the goals towards a more competitive and liveable metropolitan area in smart growths. However, the role of metropolitan areas is missing in the case of Wuhan. Compared to megacities home and abroad, the scale of Wuhan municipality and Wuhan clusters, which also include 6 cities surrounding it, is too small and too big to be defined as a metropolitan area. To plan ahead for a more efficient and sustainable megacity, it is necessary to define the boundary of Wuhan metropolitan area.

The reminder of the paper is structured as follows. The next section provides an understanding of metropolitan areas and the methodologies of defining their boundaries based on literature review and case studies. The third section focuses on Wuhan contexts and discusses the current development stage of Wuhan as well as its relations with the surrounding areas. Based on the trends of regional cooperation, it is necessary to define the metropolitan area between the municipality and urban cluster. Following this, the next section attempts to define the boundary of Wuhan metropolitan area in dimensions of its urbanization, geography, transit, economics, ecology, psychology and culture. First, layers of analysis on urbanization rates, economic relations and traffic commutes have been overlapped so as to define a rough boundary of Wuhan metropolitan. Then, ecological and cultural factors have been made to check and adjust the boundary. Last but not least, further investigation has been made to correct and adjust the boundary by considering the local cultural and psychological factors. The conclusion has been made that the methodology of defining the boundaries by the case study of Wuhan could be also applied to other metropolitan areas.

2. Literature Review

The research on metropolitan areas initiated at an early age. It was in 1910 the concept of metropolitan area first brought up in the USA. After the World War II, metropolitan areas have become a new model of urban structures with the rapid development of economics. In the middle ages of 20th century, the concept of metropolitan area has been elaborated in Tokyo and large amounts of new town practices have been carried out in Britain. It was in the 1980s that the new town theories and the concept of metropolitan area have been brought in China influenced greatly by the former Soviet urban planning ideas. In 1993, the concept of metropolitan area has been brought up in Shanghai, which initiated a series of research on metropolitan areas and new towns in China. However, the existing literature focuses mostly on the understanding of metropolitan areas but not on the methodology of defining their boundaries, which can be referenced in practices.

2.1. Metropolitan Areas

In the Tokyo Plan 1960, the concept of metropolitan area was brought up, indicating an area including the central city with the population of more than one million surrounding by towns with over half a million residents. The central city, well connected with towns by highways in a radius of 50 kilometres, would attract more than 10 percent of its population from its surrounding towns, with the commuting time of 1 hour to 2 hours. In 1990, Kenneth Fox has formally established the concept of metropolitan area based on the research of Jean Gottmann. It implies that the central city with more than 50 thousand residents are surrounding with central towns and peripheral towns, with the population density more than 50 people per square miles and the increase percent more than 15 percent every 10 years. At least 15 percent of the non-agriculture labours of the peripheral towns, which should take account for more than 70% of the whole towns, would commute to central towns or 20% of the non-agriculture labours would commute back and forth. On this basis, the metropolitan area can be defined as central cities and their surrounding towns, with frequent commutes and convenient transits, which usually take 1 or 2 hours.

Based on the practices, metropolitan areas consist of central cities and their surrounding towns, the scale of which is between cities and urban agglomeration. Within the metropolitan area, central cities and their surrounding towns have been working closely with each other with between 10 and 20 percent residents commuting in between at a distance ranging from 60 to 80 kilometres. London, as an example, can be used to better understand the spatial scale of metropolitan areas and their function structure. The metropolitan area of London covers an area of 12109 square kilometres at a radius of about 60 kilometres centring at the city London covering an area of 1580 square kilometres, which has been defined by the commuting distance. With the cities and towns in the east, London metropolitan area have developed as an urban agglomeration area or megalopolis, covering an area 39 thousand square kilometres. The metropolitan area of London includes 8 new towns surrounding the city of London, working closely with each other with different functions. Some are mainly residential like Wokingham, while some are dominated by commercial and administrative functions like Crawley Town and some are famous as university towns like Reading. The frequent commutes between London and its surrounding towns like Crawley and Kent have relieved the overpopulation of London city and also increase the population of periphery areas. Tokyo metropolitan area, as another example, consists of the city Tokyo as the political, administrative, financial, informative, economic and cultural centre and towns with specific functions like educations and port industries. In 2008, a commuting circle has been formed between the city Tokyo and its surrounding towns, from which residents come to the central city for work or school above the age of 15 and accounting for more than 10 percent of the whole population. Based on this, metropolitan areas, exemplified by these cases, can be considered as units made up of central cities and their surrounding towns between urban municipality and urban clusters. Within the radius of between 60 and 80 kilometres, the central cities and their surrounding towns with between 10% and 20% of their residents commuting to central cities have been working closely with each other.

2.2. The Boundaries of Metropolitan Areas

The practices of defining the boundaries of metropolitan areas can be reviewed based on the examples of New York, London, Paris, Tokyo, Shanghai and Beijing. In the cases of New York, the boundaries of the metropolitan area have been defined at a radius of 60 kilometres centred at New York city. Made up of the central city and 26 counties from 3 states, the metropolitan area of New York covers an area of 32 thousand kilometres with the population of 178 million. Also at a radius of between 60 and 80 kilometres from the centre, the metropolitan area of Paris covers an area of 120 thousand kilometres with the population of 11 million. Similar to the radiuses of the previous two cases, the metropolitan area of Tokyo, consisting of Tokyo city, Kanagawa-Ken, Saitama-arena and Chiba-ken, has an area of 134 hundred square kilometres and a population of 36 million. At a larger scale, the metropolitan area of Beijing has a radius of 90 kilometres and an area of 27 thousand square kilometres including Beijing city and 9 towns in its surrounding area. With a much bigger radius of 120 kilometres, the metropolitan area of Shanghai consists the central city and its surrounding 6 towns, taking up almost 30 thousand square kilometres. The methodologies of defining the boundaries of the metropolitan area of Shanghai is based both on quantitative and qualitative analysis. The towns not only within the 90-minute travelling distance but also with closer economic connections, more frequent transits and more similar culture identities can be included in the metropolitan area of Shanghai.

Based on the literature reviews, the methodologies of defining the boundaries of metropolitan area focuses more on quantitative analysis with the indexes of populations, coverages, economic development, commutes and etc. It has been proposed that towns adjacent to central cities with the non-agriculture population of more than 200 thousand, non-agriculture products taking up more than three fourths of GDP and non-agriculture economic activities taking up more than 60 percent can be included into the metropolitan area(Zhou,2000). On this basis, a system of 14 indexes including economic development, traffic conditions, telecommunications, Gini coefficient, urban densities, capital ratios, industry location quotient index, coverage of built-up areas, growths of enterprises, commodity circulation, industry trophy, economic export-oriented degree, urbanization and industrialization level has been established (Fang, 2005). Meanwhile, it has been estimated that there could be about 20 metropolitan areas in the plains of China, which can cover an area of between 40 and 50 thousand square kilometres with a population of 50 million and a radius of 120 kilometres.

3. The Wuhan Contexts

As a geographic central megacity in China, the municipality of Wuhan covers an area of 8569 square kilometres with a population of about 11 million. Wuhan and its surrounding cities including Xiaogan, Hanchuan, Xiantao, Huanggang, Ezhou, Daye, Xianning and etc all make up the Wuhan cluster covering an area of 58 thousand square kilometres (see figure 1). Aimed to be one of the national centres, Wuhan has been proved to be at the very stage of urban agglomeration according to the statistics of its urban development. With the development of service industries, the proportion of which will increase and surpass the manufacturing industries, it is estimated that Wuhan will enter the stage of dispersed development and the era of post industries around 2030. It is also has been exemplified by the cases of megacities worldwide that their growth will bring about functional complementation across borders and regional corporations at different scales. Therefore, it is necessary for Wuhan to define different scale of areas to plan ahead for an efficient and sustainable megacity. However, the scale of Wuhan municipality and Wuhan clusters is either too small or too large to achieve spatial integration at the first step, in comparison with the cases of other megacities home and abroad (table 1). The case study of Tokyo and London has demonstrated that the metropolitan area, as a spatial scale between municipalities and urban clusters, can help with the regional cooperation based on the division of labours and the allocation of regional resources.

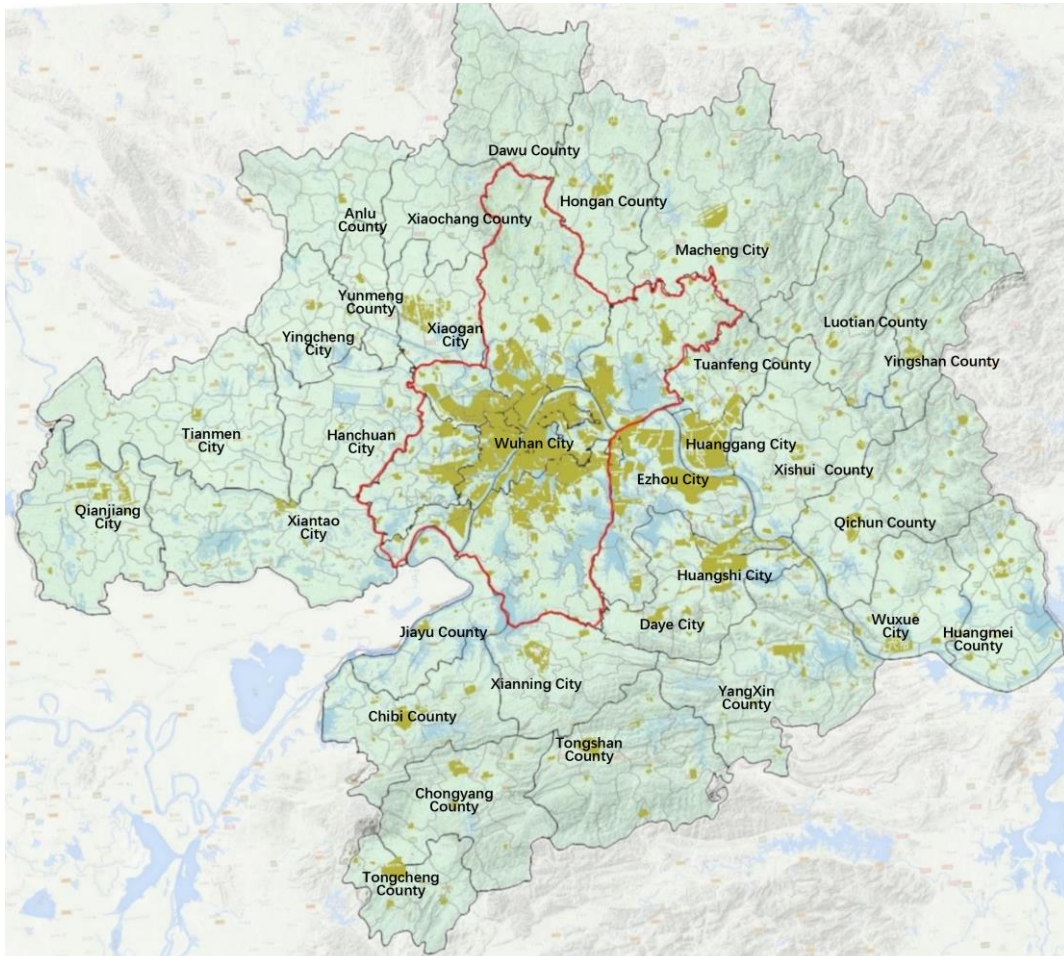


Figure 1 The Wuhan Cluster

Table 2 The Scale Comparison of Megacities Home and Abroad

| Cites | The Areas of municipalities | The Areas of metropolitan areas | The Areas of Urban Clusters |
|-----------|-----------------------------|---------------------------------|-------------------------------|
| Tokyo | 2200km ² | 13.4 thousand km ² | 36.9 thousand km ² |
| London | 1600km ² | 11.4 thousand km ² | 45 thousand km ² |
| Shanghai | 6340km ² | 17.1 thousand km ² | 212 thousand km ² |
| Guangzhou | 7434km ² | 11.3 thousand km ² | 56 thousand km ² |
| Wuhan | 8569km ² | — | 58 thousand km ² |

On one hand, the cities and towns surrounding Wuhan have demonstrated the potential to share the responsibilities of Wuhan as a future national centre. With the Shunfeng Airport aimed to be the largest freight hub in the world located in the municipality of Ezhou adjacent to Wuhan, lots of logistics and e-commercial enterprises have been attracted to locate around. Besides, there are already industrial parks around Wuhan, which can help with the commercialization of science and technology research due to their abundant land resources and cheaper costs. Meanwhile, industrial parks in Wuhan have also found their partnerships in the surrounding areas, which has improved the efficiency of regional cooperation and the levels of urbanization. On the other hand, the fast-paced urbanization has made the built-up area of Wuhan expand out of its urban growth boundary, which there

is also a tendency that the adjacent cities are gradually expand to. With the regional cooperation between Wuhan and its neighbours, it is obvious to find urban agglomerations around the municipal borders, in the Wuhan-Xiaogan, Wuhan-Hanchuan and Wuhan-Ezhou adjacent areas. With the strong intention for more regional cooperation between local governments, there will be more resources to be allocated and more functions to be shared in a larger scale. For example, the neighbouring city Xianning and Ezhou intend to share tourism and manufacturing functions with Wuhan based on their resources.

Therefore, developing metropolitan areas, as universal law for megacities, is an important strategy for Wuhan to realize its goal as the national centre, a necessary step for Wuhan to achieve regional integration and an essential tool to plan ahead for an efficient and sustainable megacity. Based on the current development stage of Wuhan, it is necessary to define the metropolitan area between the municipality and urban cluster which have an average commuting distance of 40 and 150 kilometres respectfully.

4. Research Contents

Based on the literature review and case studies, according to the local conditions in Wuhan, the metropolitan area of Wuhan could be interpreted as an area with adjacent spaces, frequent communications, close economic connections and complementary functions. Thus, the methodologies of defining the boundaries of the metropolitan area should be based both on quantitative and qualitative analysis. Indexes like commuting distances, economic connections and population mobilities can be used to define a rough boundary of the metropolitan area. On this basis, the boundary can be checked and adjusted according to the ecological and cultural factors. The quantitative analysis will be conducted by GIS tools, which can spatialize the data of population, economics, industries and commutes so as to define the boundary. Data has been collected not only from relevant government departments of Wuhan and its six surrounding cities but also on internet like the immigration of inhabitants, railway and bus transits as well as the economic connections between headquarters and branch companies. Based on the literature reviews and case studies, not only quantitative analysis has been made on social and economic connections, but also qualitative analysis has been made in the ecological, spatial and cultural aspects.

4.1. Quantitative Analysis

(1) Analysis based on commuting distances

Based on the case studies, the areas within one-hour's driving distance could be included into the metropolitan areas. Thus, analysis has been made on the GIS platform to define the boundary of the areas within one-hour's drive by planned networks starting from the residential and business districts in the central city of Wuhan, which can be shown in the Figure 2. In addition, commuting by public transport has also been included. With the same method, the boundary of the areas within 30-minute's travel by train starting from the train stations in the central city of Wuhan has also been defined (Figure 3). On this basis, the areas in the above two boundaries have been combined to be included within the boundary of the Wuhan metropolitan area based on commuting distances, which includes 11 administrative unites surrounding Wuhan (Figure 4).

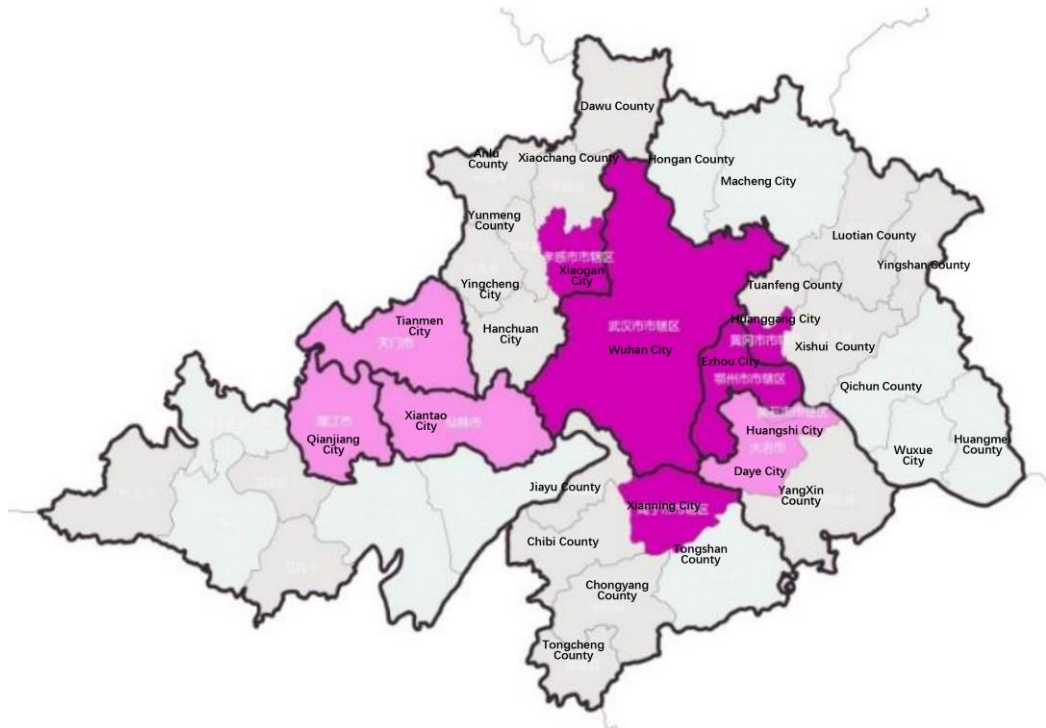


Figure 5 The Areas with More In-migrants and Out-migrants between Wuhan

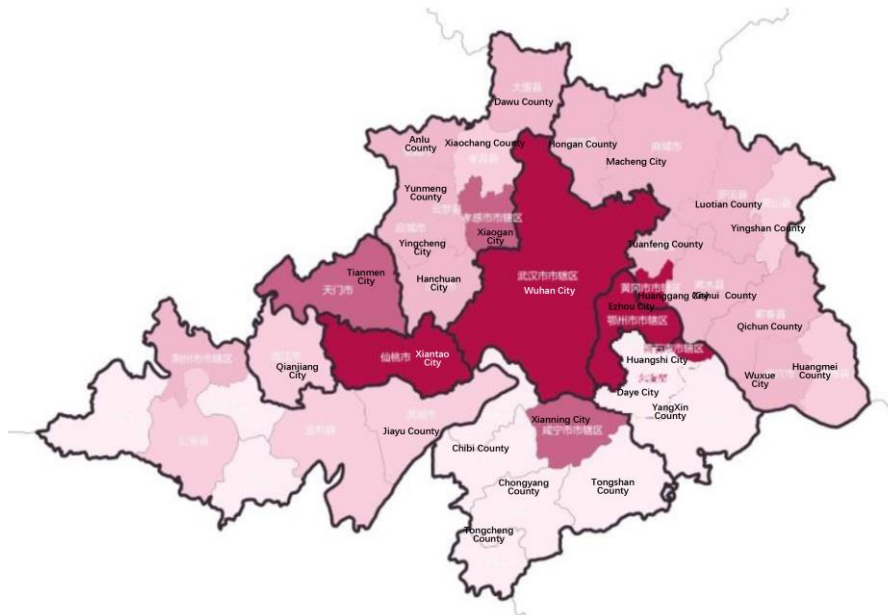


Figure 6 The Areas with Relatively More Intercity Bus Services between Wuhan

(1) Analysis based on ecological resources

Ecological resources, as key elements to maintain regional sustainability, should be included into the boundary of metropolitan areas. In the cases of Wuhan, major ecological elements like forest parks, wetland parks and lakes have been taken into accounts which concern five cities surrounding Wuhan. Among the ecological elements, there are two lakes locating in the cross-bordering areas of Wuhan, Xianning and Ezhou, one of which is not only the alternative reservoir of Wuhan but also the one of best-maintained wetlands in Asia. In addition, ecological resources with tourism functions could also been included into the metropolitan area to complement the regional roles of central cities, which can increase the competitiveness as a whole (Figure 13). By analysing the attractiveness of existing tourist sites, hot touring spots concerning two administrative units should be included into the Wuhan metropolitan areas.

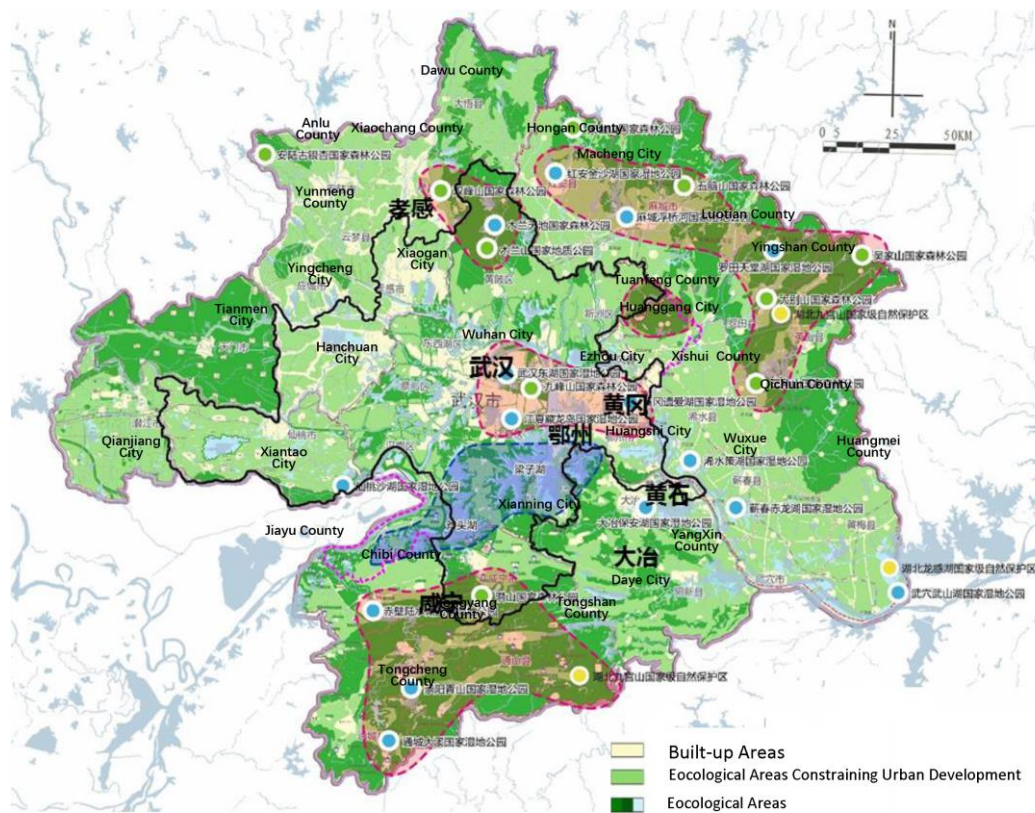


Figure 13 Analysis on Ecological Resources surrounding the Wuhan Municipal

(2) Analysis based on adjacent spaces

Although quantitative analysis based on commuting distances has taken the adjacent spaces into account but failed to pay attention to the functions. On one hand, there are some areas with similar functions like industrial parks adjacent to Wuhan, which have achieved mutual cooperation along with competitions and longed for regional integrations. On the other hand, it is obvious that Wuhan municipality has expanded to neighbouring areas as the early forms of urban agglomerations, like the bordering areas between Wuhan and Ezhou, Huangshi (Figure 14). Therefore, major infrastructures like airports and harbours which will

have great impact on regional integrations should also be included into the boundary of metropolitan areas. In the cases of Wuhan, one existing airport, two planned airports and five harbours have all been taken into account.

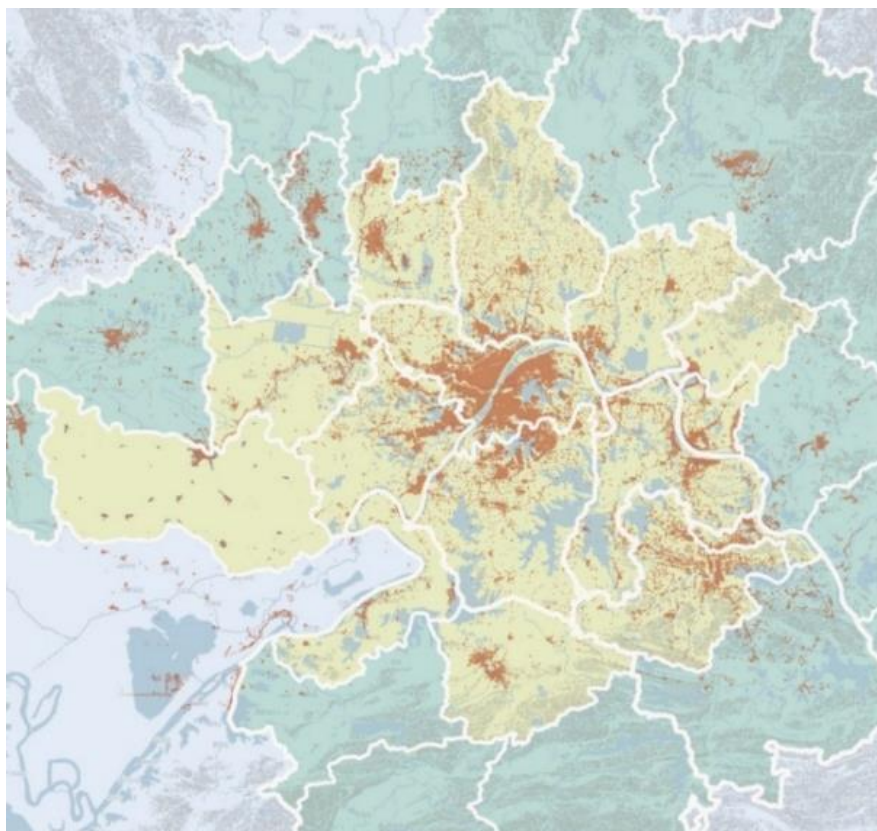


Figure 14 Analysis on the Adjacent Spaces the Wuhan Municipality

(3) Analysis based on cultural factors

As the root of urban developments, culture can exert unseen but profound effects on regional developments. Throughout history, the cities in the Wuhan Cluster have been underwent several administrative changes from the same affiliation to different ones. In addition, there is also a shift of the central city geographically from the west to the east, which used to be Wuhan and Ezhou. Base on the analysis on the histories, it is necessary to include Ezhou into the boundary of Wuhan metropolitan areas. If urban histories can demonstrate the regional city structures in the past, dialects as important means of communication can be used to reflect regional connections at present. In the cases of the Wuhan Cluster, there are mainly at least three kinds of dialects, based on which cultural zones can be defined to readjust the boundary of Wuhan metropolitan area by including 3 more administrative units.

4.3 Summary

First, quantitative analysis based on commuting distances, population mobilities and economic connections has been made to define the rough boundary of the areas in which Wuhan municipality has been well connected with its 8 surrounding administrative units. Then, qualitative analysis based on ecological resources, adjacent spaces and cultural factors has readjusted the boundary by including 3 more administrative units. Therefore, the

metropolitan areas concern different factors, the goal of this paper is not to be taken reference from but to establish a framework to shed lights on other megacities to define their boundary of municipal metropolitans.

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6. References

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