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CHALLENGES POSED BY URBAN SPRAWL PATTERN IN WUHAN/CHINA (1990-2010)¹

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Abstract

This empirical study analyzes the spread over Wuhan city urban expansion from the current decades (1990-2010) and specifically sheds light on its sprawl issue.

To give our study a concrete form, we need specific materials for monitoring the sprawling phenomenon in this Chinese middle size city, and its consequences on the future for a well sustainable development. Finally, the result we want to reach is to obtain the impact of several and main features of spreading over the core city of Wuhan, and by the same token, indicate its future urban boundaries. The reason is that urban growth control is a great duty for local authorities for offering a good lifestyle to every urban dweller. In practice, control and management of sprawl have relied on programs to regulate land uses and the timing of growth through mechanisms such as comprehensive plans, zoning ordinances, and smart growth strategies (J. K. Lein, 2003). But urban expansion is different from urban sprawl, because sprawling is just a form of urban expansion. Nowadays, a broader consensus likely appears on that urban sprawl is recognized as a rapid and uncoordinated growth at the urban fringe. Several types of sprawl were identified in Wuhan Urban Agglomeration (WUA), such as continuous suburban growth, linear\ribbon development, and scattered development\leapfrog development.

To measure the sprawl pattern of this city we use qualitative and quantitative methods for our inquiry. This study challenges decision makers of Wuhan to take in consideration the current increase of urban sprawl, in order to control it. This is because urban sprawl varies in degrees between the developed and the developing world and consequently they have different consequences (M. O. Alabi, 2009)

The main outcome of this study is to track the outward expansion and its sprawling urban pattern for better understanding its social, economic, and environmental consequences. And to analysis several challenges related to sprawl phenomenon in this mega-city. This paper aims to establish a correlation between land-use and population density in Wuhan Urban Agglomeration (WUA). The availability of satellite remote sensing data has increased significantly in the last two decades, and these data constitute a useful data source for mapping the composition of urban settings and analyzing changes over time (Jorge E.P, Juan C.D, 2012).

KEY WORDS: Urban sprawl; urban boundaries; Sprawl patterns; Monitoring; Measurement; Sustainable development.

1 *NB: This paper comes from my doctoral dissertation defended in May 2014 in College of Urban And Environmental Science at CCNU (Central China Normal University)*

Résumé

Cette étude empirique porte sur l'étude des défis de l'extension de la ville de Wuhan (République Populaire de Chine) durant les récentes décades (1990 - 2010), et met en lumière l'analyse de son modèle d'expansion. Pour donner une forme concrète à notre étude, nous utiliserons des moyens et des outils spécifiques pour délimiter le phénomène de son extension dans cette ville moyenne de « l'Empire du Milieu » et par ricochet étudier son impact sur le développement durable de ladite agglomération.

Finalement, le résultat auquel nous aspirons est de quantifier l'impact des différentes formes de son extension allant de l'étalement du centre-ville vers les nouvelles zones d'extension ; et par ricochet d'indiquer sinon de prévoir ses futures frontières urbaines. La raison fondamentale est que le contrôle de l'expansion urbaine est, et demeure un éminent devoir pour les autorités locales (Municipales), celui d'offrir ou de procurer aux citoyens un style ou un cadre de vie adéquat.

Dans la pratique, il est admis que le contrôle et la gestion de l'extension urbaine sont liés ou du moins reliés aux programmes de régulation des usages de la terre (gestion du sol urbain), - mais aussi au minutage (réglage) de la croissance à travers des mécanismes tels que les plans de gestion de l'espace urbain ; les ordonnances de zonage des différents secteurs ; et le développement de stratégies dites de croissance intelligente « smart growth, » (James K. L, 2003). Mais il convient de retenir une fois pour toute que l'expansion urbaine est différente de l'extension urbaine, pour la simple raison que l'extension urbaine n'est juste qu'une forme de l'expansion du tissu urbain du centre-ville vers la périphérie. De nos jours un plausible (vraisemblable) large consensus apparaît qui reconnaît l'extension ou l'étalement urbain comme une forme continue de la croissance urbaine qu'elle soit une croissance en bande linéaire, ou un développement éparpillé (épars ou dispersé) autrement appelé un développement par bond ou en « saut de grenouille ».

Ainsi pour évaluer ou jauger les dimensions de l'extension de cette ville, nous avons utilisé des méthodes d'investigation quantitatives et qualitatives. Cette étude interpelle (invite) les décideurs de Wuhan à prendre en considération la récente hausse (agrandissement) du phénomène de l'extension urbaine, dans le dessein de le contrôler, ou du moins de le piloter de façon réfléchie. Ceci en raison du fait que l'extension d'une ville varie en degré (échelon, rang) selon qu'on soit en pays développé ou en pays sous-développé ; et par conséquent, elle a des implications différentes. (Michael O A, 2009).

Le but ultime de cette recherche est de pister les éléments fondateurs de la morphologie de l'extension urbaine afin de mieux appréhender ses implications sociales, économiques et environnementales. Mais aussi cette étude nous permettra d'analyser les multiples challenges relatifs au phénomène du « sprawl », dans cette agglomération, tout en ébauchant l'étude de la vocation du sol urbain à Wuhan. Nous osons espérer que les développeurs notamment les services techniques de l'urbanisme puissent s'inspirer de ce cas pour mieux agencer les contours de nos villes actuelles et à venir. La disponibilité de bases de données d'imageries satellitaires a augmenté ces deux dernières décennies. Bien-sûr que ces bases de données permettront de dresser des cartes d'utilisation du sol, de tenir les cadastres, mais aussi d'analyser les défis de l'extension spatiale à travers le temps. (Jorge E P Juan C.D, 2012).

Mots clefs: Extension urbaine, frontières urbaines, Mesurer l'extension urbaine, contrôler l'étalement spatial, développement durable.

I. INTRODUCTION

Urbanization is taking an overwhelming trend in China, causing population concentration and construction expansion in the urban areas. Urbanization and industrialization are inseparably interconnected (Q. GAO ,Y.T. Liu , and al, 2006).Urbanization can be also considered as the increase in the population of cities in proportion to the region's rural population (T.V.Ramachandra, Uttar Kumar, 2009).This urban phenomenon exhibits a concentration of human activities and settlements around the regions of large economic activities. Urbanization is simply the rapid concentration of population in a limited area (a geometrized space).The combination of economic and population growth has led China to a transitional period from a largely rural society to a predominantly urban life. In present days, the urbanization rate attains 76percent. Infact, this rapid urbanization observed specifically in the accelerate speed urbanization regions like Beijing, Shanghai, Guangzhou and currently Wuhan, has posed serious challenges to the decision makers in the city planning and management process bringing plethora of issues such as infrastructure development, traffic congestion and accessibility of basic amenities like electricity, water sewages, water, and sanitation. This is the main reason why, monitoring urban dynamic becomes of critically important for urban planning and sustainable development in China. The urban morphology still rests a concern for decision makers (politics, urban planners, geographers, sociologists etc.).

The present debate turns around how to control land to indicate the urban boundaries of most of Chinese cities. In this case, it is of great importance to remark that, until now, a lot of researches just focus on urban expansion in China, while few studies deal on measuring urban sprawl (Yeh and Li, 2001; Fang, J and al, 2006; Huang, 2006; J. Xi and al, 2007). This means therefore that, understanding urban sprawl in China still rests on qualitative discussion instead of quantitative analysis (F. Li, S. Siedentrop, 2008). Still now, there is no clear response to recognize and measure the extent of sprawl in Chinese cities. In summary this study has shown that, the research on the urban sprawl in China is just a new field of research. In this case, the basic characteristics of urban sprawl in China have no explicit expression and the reveal of its internal mechanisms has been maintained in the level of empiricism (F. Li, S. Siedentrop, 2008).

Urban sprawl is a major problem in the course of urban development of the western countries in the 20th century. In this part of the world, most of urban sprawl is considered to be the expansion of low-density accompanied by a series of environmental and socio-economic issues. It is important to remind that the cities of China have been developing rapidly after Reform and Opening up since 1980, and urban sprawl has emerged in some regions (Beijing, Shanghai, Guangzhou, and Wuhan recently). For example the Greater Shanghai Area experienced, high speed impervious surface sprawl over the past thirty years at the average speed of 38, 84 square kilometers per annum. Land development or its use has become out of control and the construction land (built-up area) has kept expanding blindly especially in the marginal of metropolises, as noted Feng Li (2008).

In the light of this analysis, it becomes obvious that the outward expansion of cities in China has become a source of concern and policy debate for decisions makers for managing the well-being of the city dwellers. This sprawling urban landscape has been cited as a contributing factor behind the loss of open space, environmental damage and increased congestion (J. K-Lein, 2003). In practice, a control and management of sprawl has relied on programs to regulate land uses and limit growth through mechanism such as the comprehensive plan, zoning ordinances, smart growth strategies and so on. These, therefore mean that the need for monitoring urban development has become imperative to curb the problem of this type of growth down. In addition, we need to find good ways for analyzing the spatial features and its mechanisms which will be surely very noticeable.

(Sekhar, 2001) states that, it has been observed that monitoring urban development is mainly to find the type, amount and the location of land conversion for future planning. Fewer studies have sought, that, although, urban growth is perceived as useful for sustainable development, but unchecked or sprawling urban growth causes various problems. Jeffery Allen and Kang Lu, (2003) argue that, not only does urban sprawl rapidly consumes rural land resources at the urban fringe, but also results on landscape infrastructure pressure, raising taxes, and neighborhood conflicts.

This study focuses on the following main questions;

Where will be Wuhan's new urban areas located?

What should be done to mitigate negative impacts of sprawl in the future?

And lastly how large will be Wuhan city in the next decades?

The study is grounded on the analysis of monitoring data, literature, field survey and experts interview in Wuhan urban agglomeration.

II. AIM AND OBJECTIVES

The aim of this research is to study the patterns and measure sprawl by GIS method indicating two locations factors, distance from the town Centre and distance from roads to show and analyses spatial pattern of sprawl in Wuhan city.

This research also looks to establish a correlation between population densities and sprawl distribution in Wuhan municipality.

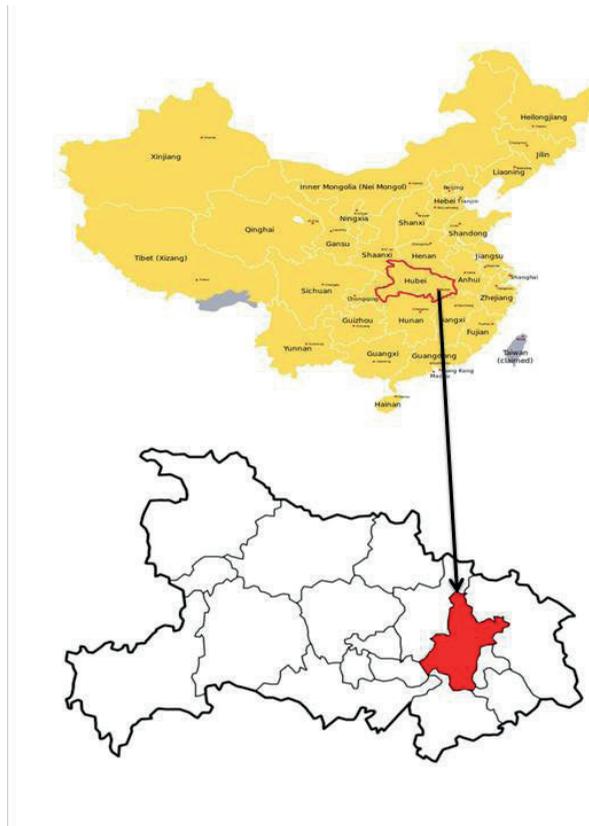
This study equally seeks to monitor the urban sprawl in the research area,

To identify the basic patterns of sprawling in study area

And lastly to analyze the internal and external forces of urban sprawl in the growth poles of the city (we will paid great attention to the relation between population density and sprawl phenomenon).

III. STUDY AREA

Map 1:



LOCATION: HUBEI IN CHINA, WUHAN IN HUBEI PROVINCE.

Wuhan was a small commercial town. In present, Wuhan Urban Agglomeration, the capital city of Hubei Province is located in Centre South of China, and is one of the major industrial centers in central China. Wuhan is regarded nowadays as a middle size city in Chinese urban structure and is the fourth city after Beijing, Shanghai, and Guangzhou. Wuhan is also the most populous city in central China, with an estimate population of 9,700,000 inhabitants in 2007 (Y. Xiao, 2002), and a total municipal population of 8 million people.

Wuhan is described as the principal political, economic, financial, cultural, transportation center in this part of China Mainland. Wuhan city lies in Jiangnan Plain where the Han River joins the Yangtze River (blue river). The city covers an area of 8,467 square kilometers, which includes an urban built-up area of 211 km². Wuhan's urban area is divided into three parts (Hankou, Hanyang, and Wuchang), by the Yangtze River and the Han River.

Politically in China, Wuhan is the capital city of Hubei Province (we should keep in our mind that in China every Province has his one Government), limited in the North by Henan Province; in the South by Hunan Province; in East by Anhui Province; and in West by Chongqing Province. Geographically Wuhan is made up of three cities composed of Wuchang, Hanyang, and Hankou. The city is located at 115°41' West longitude and 29°58' North Latitude and 31°22' South Latitude. The name Wuhan comes from the combination Wu for Wuchang and Han for Hanyang and Hankou. Wuhan is also the junction Beijing-Guangzhou railway line, and a fiscal point for water because of Yangtze River and Han River (so called water city). The topography is relatively flat land, only 22, 27 meters above sea level. Some little hills are observable in the landscape. There is also a presence of many lakes around the city such as Liangzi Hu, Dong Hu, and Tangxu Hu. Wuhan city appears like a low zone with many swampy areas.

There are many natural water points in most parts of the city (L.Ballo, G. Hu, X. Wen, Ping and al, 2008).

Wuhan's climate is subtropical monsoon one with abundant rainfall and four distinct seasons: summer, autumn, winter and spring. Wuhan is one of the three furnaces of China after Nanjing and Chongqing. The city is also known for its hot summers with mean temperature which reaches 37.2°C (99°F), often 40°C (104°F). Spring and autumn are generally mild while the winters are cool with occasional snow. In the last thirty years, the city had an average annual rainfall of 1269 millimeters mainly from June to August. The period of annual freeze is 211 to 272 days per annum. The duration of sunshine is 1810 to 2100 hours with a mean altitude of 19 meters (62 feet).

IV. DATA SETS AND METHODOLOGY:

The present study uses population census data and remote sensed data as a base for image registration. GIS is used to show the recent increase of Wuhan built-up area and the expansion of the city. Three zones of the town are selected, which serves as economic growth poles. It is worth noting that, in the study area it was a bit difficult to separate various land use because of the practice of mixed land use. The area selected includes Hanyang, Hankou and Wuchang. Rapid growth of built-up area from 1990 to 2010 was chosen because it characterized obviously the spread over outskirts of city land –use and urban management.

V. PATTERN OF SPRAWL IN WUHAN

To study the sprawl pattern in Wuhan is not an easy task as it might appear at first glance. Wuhan city has experienced (has been subject to) a great influx of population from its surroundings regions, which has led to a rapid growth and expansion that bring thus profound changes on its landscape in terms of land use and land cover. Wuhan also benefits from large rural migrants that are looking for jobs, education, health and well-being accessible in the city. In the hundred kilometer distance around it there are eight cities including Huangshi, Ezhou, Xiaogan, Huanggang, Xianning, Xiantao, Qianjiang, and Tiananmen.

In this study we have noticed two main types of urban development: The expansion on the urban-rural fringe and redevelopment in existing urban areas (renovation, restoration, and re-structuration). These two types of development have brought drastic changes in the urban morphology especially in over the last three decades. In Wuhan, the urban expansion process is in a continuous expansion at urban-rural fringe, and also on the redevelopment of satellite towns around the core of the urban area.

Wuhan is in a rapid urbanization process, especially due to rural-urban migration. Wages of rural migrants reach Wuhan city because of the wish for better living conditions and mainly because of the rapid economic growth of the city. According to Kam Wing Chan, (2008) based on 2000 census data indicating the share of migrant workers (Non-Hukou), 46 percent of them are employed in the sector of industry. The unprecedented combination of economic and population growth has led China into transition from a large rural society to a predominantly urban one (Q. Zhang, Y. Ban, 2010). It is obvious that Wuhan's urban growth is the result of economic development and social revival. The study shows that China in general and Wuhan in particular, has attended a great moment of development of industry and trade (The factory of the world). It shows also that Wuhan urban area is changing. In the light of this analysis, the control of urban sprawl becomes crucial.

The rapid urban growth is summarized by a spread out on large fringe from the core Centre. This discontinuous urban growth results in accelerated industrialization and nonstop concen-

tration of urban citizen, and non-well application of master plan. Furthermore, this study found that in Wuhan, the direction of the expansion is following the highways (roads) in a ribbon spread pattern. The easy access to the manufactures (industries) despite the often heavy traffic congestion, and means of communication presence attested the fact that Wuhan city is experiencing leapfrogging development due to the lack of proper application of master plan. The scattered form of sprawl is observed in the mixed land use area like the zone where workers come to live near the factories.

In conclusion this study has noticed that, the rapid urban expansion stuffily damaged the accessibility of valuable land resources, and lead to environmental degradation and reduction of green land coverage, and, in long-term, will jeopardizes economic and environmental sustainability of Wuhan city. Great attention must be given to this for the wellbeing future of the city.

VI. MEASURING URBAN SPRAWL

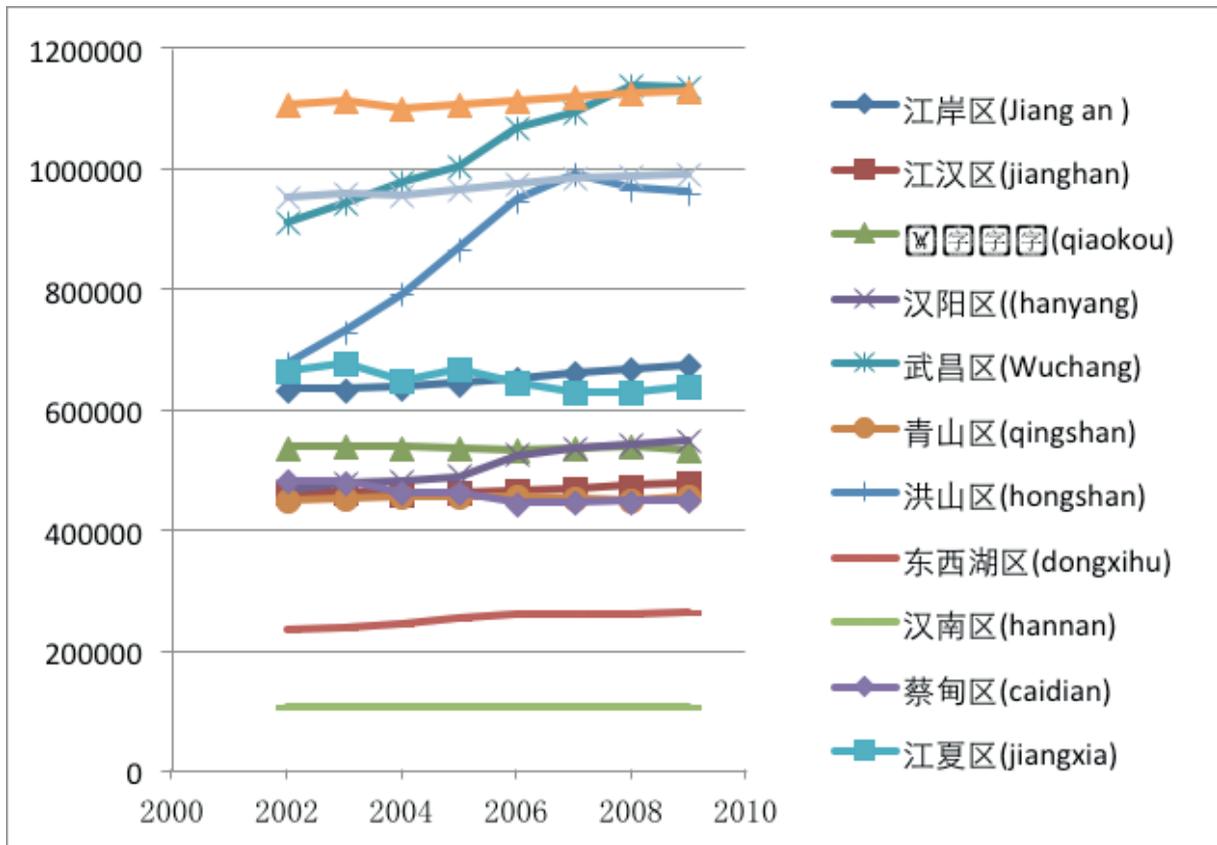
To measure urban sprawl pattern of the city, the researchertook into consideration the spatial concentration and the dispersion according to geographical location. The dispersion'srate increases with expansion from the city-Centre to the suburb. The analysis lays emphasis on also about the urban boundaries of the selective zones among this decade and the nearest future ones as data hasshown. The density of Wuhan built-up area was established from dividing the built-up area of each selective zone by the total area of the city. Location and distance from urban core, roads, and highways also has kept our attention because of their main role in measuring sprawling. Furthermore we used indicators of measuring urban sprawl such as surface delimitation (total area of the city, total built-up area, the area change of built-up area);the pattern(the shape change of built-up area, open space efficiency);the density(urban density, the change of urban density).The urban edge of Wuhan city has been extended from 12 kilometers in 1949 to 24 kilometers in 2000,according to Y. XIAO (,2002).the built-up area is 1600 square kilometers, and 6400 square kilometers of non-built-up area. We use this data as reference to calculate the percentage of built-up area of each district.

Name of area	Population 2010	Projected population 2015	Total area Km2	Population Density 2010	Population Density prediction 2015
Jiang'an	895635	902777.9768	64.42	13942	14013.94
jianghan	683492	688943.0683	33.43	20445	20608.53
Qiaokou	828644	835252.7021	46.39	17863	18005.02
Hanyang	792183	798500.9139	108.34	7312	7370.324
Wuchang	1119127	1128052.397	87.42	13717	12903.83
Qingshan	485375	489246.0215	68.40	7096	7152.72
Hongshan	1549917	1562278.086	480.20	3228	3253.39
Dongxihu	451880	455483.8882	439.19	1029	1037.1
Hannan	114970	115886.9227	287.70	400	402.8047
Caidian	410888	414164.9638	1108.10	371	373.7614
Jiangxia	644835	649977.7663	2010.00	321	323.372
Huangpi	874938	881915.9116	2261.00	387	390.0557
Xin Zhou	848760	855529.1336	1500.00	566	570.3528
TOTAL	9,785,392		8,494,41	1,152	

Source: survey, 2011.

NB: In this table above, the projected population is obtained by the formula: $P_n = P_0 (1+\Theta)^n$, Where P_n is the researched population; P_0 , the population of reference; Θ , the population growth rate, and n , the difference between the year of reference and the arrival year. The projected density is obtained by dividing the population of the reference year by the total surface area.

Figure 1: curve of urban residents.



Source: survey 2011.

This figure above shows a continuous and low growth of population district by district. Taking into consideration the three important parts of the city, three growth poles are observable: -Hankou and its suburban and rural districts such as Dongxihu, Hannan, Caidan appears as the most populated part of the city of Wuhan. The main reason of this visible concentration of people in this geographical area stems from the fact that, Hankou was the commercial town of Wuhan city. Hankou was also the first core of the city in the near past, and nowadays it is still the commercial center and the site of industrial implementation. The high density of the center comes from the mixed land use practiced here: commercial, residential and industrial. The suburban part of Hankou is also a large available farmlands and primeland; which can be used or planned for the future expansion of the city. It is also a good site for scattered or leapfrog of sprawl pattern. Continuous growth pattern of sprawling is also observable with the presence of many rural districts close to Hankou. The compact development can also be localized because of the high density of the city core. As E. Wang, J. Song and al (, 2010), argued, over the last decades, China's urban area has undergone staggering transformation. One of the most visible changes has been rapid expansion and suburbanization of Chinese cities. With the expansion of urban transport network, utility provisions and infrastructures, new development projects are being placed on the fringe of the city... Correspondingly, more and more urban residents move to the suburban areas for new housing.

-Hanyang is known as the industrial centre of Wuhan because most of the factories and companies are located here. The urban morphology points out two types of sprawl pattern namely scattered/leapfrogging development and continuous suburban growth. In Hanyang due to the continuous arrival of rural migrants who generally live close to the job centres, and the danwei residents who live in situ, also large income owners also built a little far of the companies;

land use appears mixed. Factories and companies location bring also the increase of highways and roads development, which consequently bring linear\ribbon development of sprawl.

-Wuchang, situated on the rightbank ofYangtzeRiver, is the second core of the city.Wuchang is the second crowded part of these polycentriccity. Here the land use is mixed too because of commercial, residential, and industrial in the outskirts of the Centre.Wuchang appears as the educational centre of Wuhan city because of the location of numerous universities and research institutes. Compact city occurs in WuChang with linearor ribbon development because of highways converging the others parts of the city (Hankou and Hanyang).

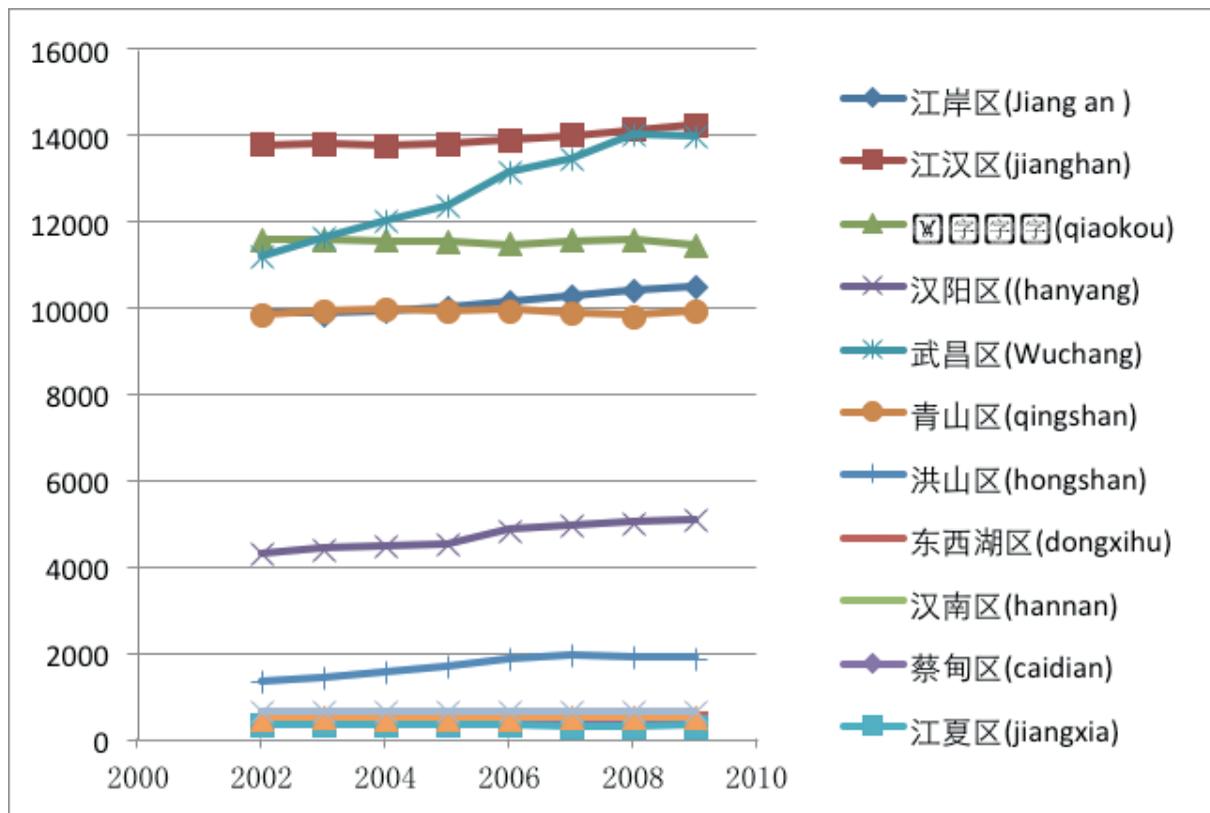
Figure 2 below indicates population density of districts per year. Analysis of density curve shed lights on the sprawl pattern distribution in Wuhan city. Taking the three parts of the city as reference, observation can be made that in Wuchang specifically in Qingshan District, located near the core city, there is a low density because of the commercial and service use. Its residential use is not remarkable.

In Hongshan District, the density becomes very low due to its location in the core city, in the CDB where commercial, real estate and educational services are noticeable. In this part of city, the sprawl pattern is the compact development, and linear called also ribbon development resulting on the presence of several highways.

In Hankou specifically in Jiang'an District, Jiangnan and Qiaokou Districts, density appears very low due certainly to commercial land use, and industrial and transportation network. The residential use is not developed because; Hankou appears as a zone of job, commerce and real estate. Here, the sprawl type is continuous suburban development, mainly observable in its suburban districts like Huangping, Dongxihu, Xing Zhou, etc. In this area, we have noted the existence of many farmlands, and vacant land available for future urban expansion. In some rural districts the population rate is acceptable but the density is particularly low. It is the appropriate place for scattered or leapfrog development of sprawl pattern.

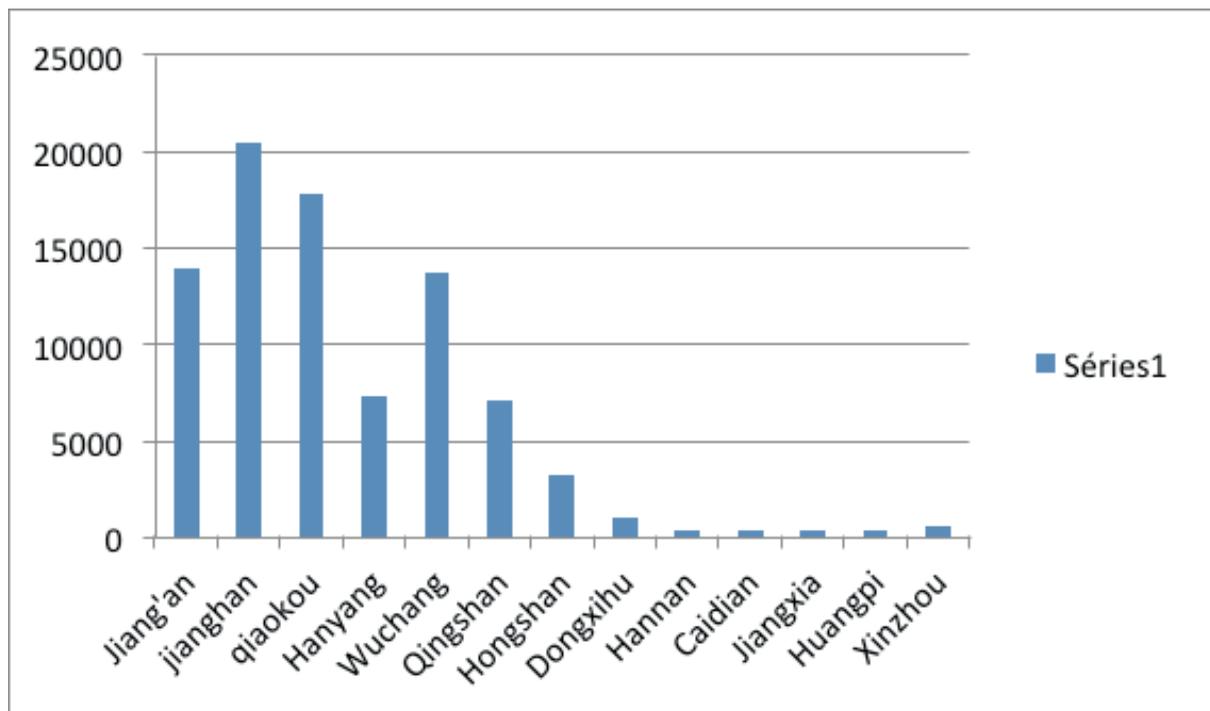
In Hanyang, land use is dominantly occupied by the industrial use due to its physical morphology and the advantages of its location (far from the residential area). The other patterns are not noticeable because of the nuisance caused by the factories, and also the noise possibly causing disturbing in an eventual residential area.

Figure2: Evolution curve of population density of districts per year.



Source: survey 2011.

Figure 3: curve of population density of districts in Wuhan



Source: Wuhan statistical year book, 2010, No: 22

This figure above indicates the density of each district of Wuhan city. The density appears high in order in Jianghan District, Qiaokou, Jiang'an Districts, Wuchang, Qingshan and Hongshan.

The very lowest density rate is found in the suburban and rural districts such as Dongxihu, Hannan, Caidian, Jiangxia, Huangpi, and Xinzhou which are the site of many types of the sprawling phenomenon.

In the core cities like Hankou and Wuchang, the increase of the density is due to inter-connection between population growth and economic expansion. Another reason resides in the renovation, restructuration, restoration of several old buildings for multiple usages (commercial, residence, industrial, real estate, etc).

7. DISCUSSION

The main objective of this paper was to analysis and monitor the patterns of sprawl in this city. In the analysis of the table and figures above, it clearly appears that there is a real pressure on Wuhan's urban land, paying attention to the fast increase in population over the study period.

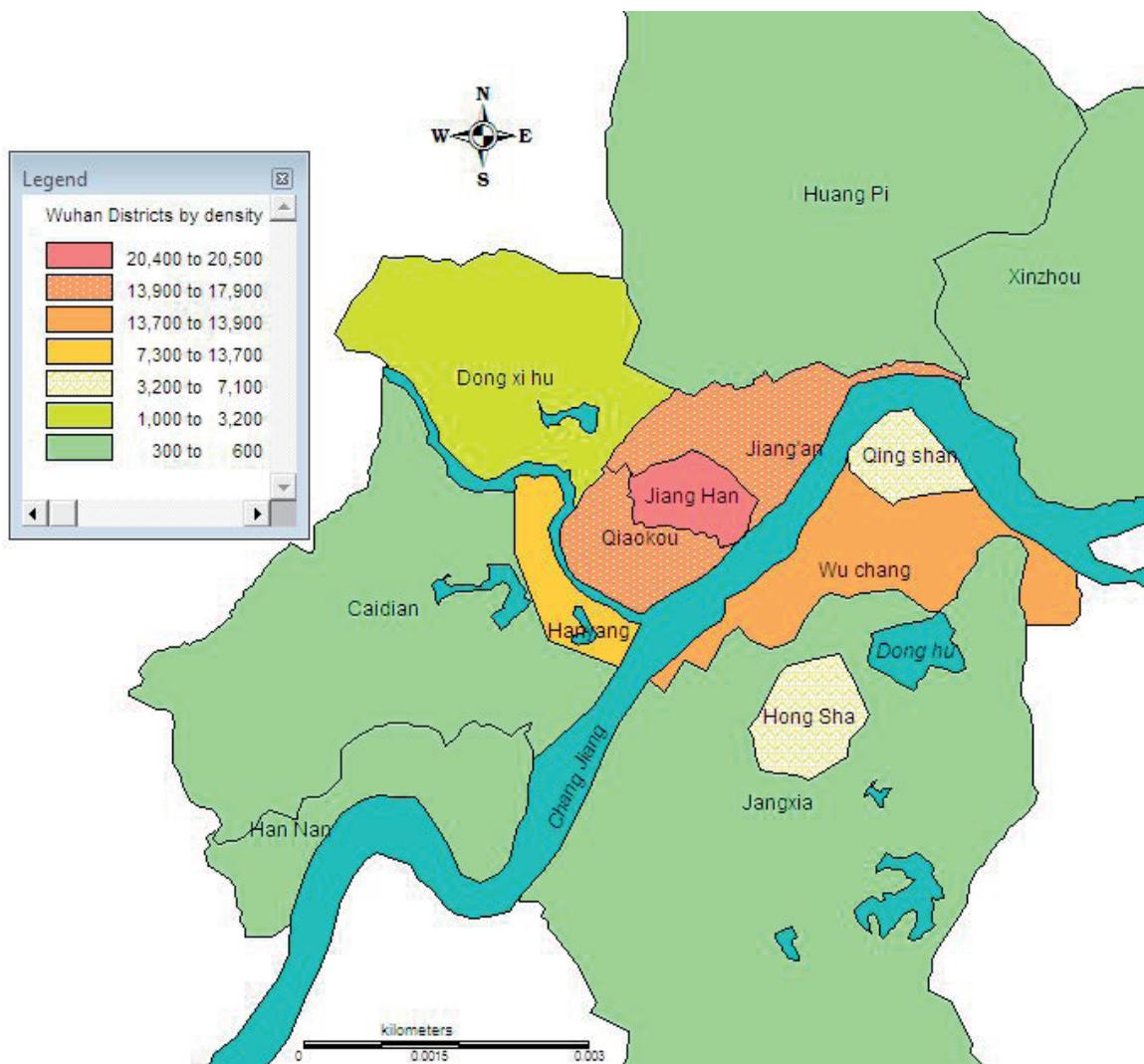
The highest value of the increase of the population is observed with dispersed settlement in Hanyang (scattered development), because population moves from the core city to the suburb to follow the job decentralization brought by factories relocation farther from the city Centre.

Hankou still remains a compact development area, and a part of Wuchang in its commercial zone.

The population density shows a correlation between the settlement rate and dynamic of economy growth, the reduction of density for some zones shows clearly the indicative spread over space which design surely an evidence of sprawl.

Furthermore an increase in density and compaction was observed. This is indicative of a dispersed distribution across space. This area also indicates a high concentration of settlements away from the city core. So this area has leaped gorged from the core to maintain a concentrated settlement far from the main core zones. The spatial pattern of sprawl can also be systematically mapped/monitored and accurately assessed with data, the rapid growth of population continues to exert a hard pressure on available land in Wuhan city, and its limits have been pushed towards fringes, that created the city new boundaries. The roads buffer zones show that the city also has a high degree of sprawl along the highways (linear strip development) despite the presence of natural obstacles which normally posed problems for the physical development of Wuhan city. Description of observable phenomenon indicates on this map below that: Hankou combined with Jianhan district, Jian'an district and Qiakou district appears like the populated part of the city with a high density due to the fact that it is one of the noodle of the municipality. Also its historical and commercial roles play for that. Anyang district has a weak density because of its role of industrial area.

Wuchang district presents a medium density due to residential use and the presence of universities and institutes. But, Qingshan district brings an acceptable density because of trade and residential mixed use. The very lowest density rate is observable in Caidan district due to its dominance of industry location. Dongxihu and Huangpi districts have insufficient density because of their location at the urban fringe.



SOURCE: According to our survey data.

In this study, an enormous amount of attention has been paid to the relationship between population density and sprawl location. A full analysis shows us that population density has a close impact on sprawl distribution. In that way to control urban growth must be perceived as a necessity for sustainable development of Wuhan urban agglomeration. In order to guide intervention strategies to monitoring sprawl, great attention must be paid to its negative impacts: rapid consumption of rural land resources at the urban fringe; landscape alteration; environmental pollution; traffic congestion; infrastructure pressure, etc.

Conclusion

This study provides quantitative data for a well planning and helping decision making in the case of projecting Wuhan city growth, and in the planning of the direction of its future growth.

It demonstrates that Wuhan is experiencing growth along highways, and lead several forms of sprawl which are identified: randomly expansion at the urban fringe, scattered development of industrial land (Hanyang), leapfrog development of urban residence area (Hankou, Wuchang), -linear strip along the roads and the river Borland and compact development in high density city Centre. The new development areas are located in Hanyang and a part of Wu Chang. Hankou and a part of Wuchang know redevelopment by renewing ancient buildings and compounds and creating new public amenities such as gardens, green spaces, game places and cemeteries. The remarkable low density of Hankou suburban and rural districts, indicates the emerging of many

sprawl types' experimentations.

The method used in this study indicated that GIS appears as a good way of measuring and monitoring spatial distribution of urban phenomena: especially the correlation between population-density and sprawl distribution. The result of which will help planners to monitor, identify areas of the city which need immediate attention, especially where sprawl takes place and to understand the intensity of sprawl and to direct growth in managing the city. It is obvious, according to this study, that it should be important for the decisions makers of Wuhan city to take in consideration the increasing of urban sprawl, in order to control it. Indicators assessing the impacts of sprawling must be analyzed into several categories such environmental, economic and social. For a well-being of its city dwellers, and a well future sustainable development, decisionmakers should take up this great challenge. Because of the fact that sprawl phenomenon is recent in Chinese cities, researchers must think more to propose consequent solutions to reduce the negative impacts of sprawling on Wuhan's urban morphology. The reason is, that, in the case_ study of China urban sprawl pattern, assertion can be made that, until now, and there is no clear answer to identify properly the extent of sprawl. Many indicators developed for urban expansion such as density of built-up area, intensity of annual growth rate, elasticity of urban growth to population, etc were experimented by scholars, but how to use those indicators to measure urban sprawl in the Chinese context is still a challenge. This study has pointed out that, built-up area and density are a potential and fair parameters of measuring urban sprawl in the context of Wuhan city.

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