BANGKOK: SUBURBANIZING AND UNSUSTAINABLE
กรุงเทพ : การเปลี่ยนแปลงของเขตเมืองและความไม่ยั่งยืน

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Numerous studies have indicated that population density is one of the major indicators for socioeconomic and environmental impacts from urban development. Based on Bangkok Metropolitan Administration (BMA) population data, Bangkok is suspected to have an unsustainable urban development trend known as the 'donut effect', which occurs when the central part of the city loses population while the population in the surrounding suburbs increases. This paper will show that Bangkok's population density is increasing in the suburbs while decreasing in the core area, using the data collected by BMA from 1999-2005. Our analysis incorporates land use measures of population density which affect the proximity of trip origins to destination. Population density represents the connectivity of the city which affects the level of vehicle kilometers traveled (VKT), the rate of non-motorized transport, and thus the level of household vehicle emissions. Knowing and understanding the population density trend should provide additional information on whether or not Bangkok is experiencing this characteristic of unsustainable urban development.

Key words: Population density / suburbanization / sustainable urban development

จากรายงานการศึกษาด้านสิ่งแวดล้อม ความหนาแน่นของประชากร (population density) มีส่วนสำคัญที่ทำให้เกิดผลกระทบต่อ สังคม สิ่งแวดล้อม และเศรษฐกิจโดยรวม จากข้อมูลที่ถูกรวบรวมโดยกรุงเทพมหานคร พบว่าประชากรในส่วนกลางของกรุงเทพมหานครลดลงอย่างมีนายะสำคัญ ในขณะที่ประชากรในกรุงเทพมหานครรอบนอกเพิ่มขึ้น ทำให้เกิดผลกระทบที่เรียกว่าปฏิกิริยาโดนัท การศึกษาในครั้งนี้ได้นำทฤษฎีทางด้านพื้นที่และการเปลี่ยนแปลงของประชากรมาใช้เพื่อศึกษาความสัมพันธ์ระหว่างการวางผังเมืองและระยะการเดินทางของประชากร (VKT) ในเขตกรุงเทพมหานคร และ ปริมณฑล ทั้งนี้ความหนาแน่นของประชากรนั้นมีผลต่อระยะการเดินทาง ความถี่ในการใช้รถสาธารณะ และระดับมลพิษในอากาศ การศึกษานี้เป็นการศึกษาเพื่อที่จะวิเคราะห์แนวโน้มการกระจายตัวของประชากร เพื่อที่จะเป็นข้อมูลในการตัดสินว่ากรุงเทพมหานครกำลังพัฒนาอย่างยั่งยืนหรือไม่

คำสำคัญ: ความหนาแน่นของประชากร / การขยายตัวของเมือง / การพัฒนาอย่างยั่งยืน

1. INTRODUCTION

Population density has been long identified as a factor that has a significant impact on vehicle ownership and uses(Jacob 1992; Newman, Kenworthy et al. 1995; Newman and Kenworthy 1996; Badoe and Miller 2000; Marshall, McKone et al. 2005). It was documented that there is a negative relationship between density and vehicle kilometers traveled (VKT), and a positive relationship between density and transit usage (Badoe and Miller 2000). The close links between land use and transport have been also identified (Goldberg 1999; Gurin 1999; Pope 1999; Chiotti 2004; Clay and Johnston 2006), and studies have clearly shown that commuters in low density cities burn more fuel, and thus create more pollution, than do commuters in tighter, more compact cities (Van Metre, Mahler et al. 2000; Ewing, Pendall et al. 2002; Burchfield, Overman et al. 2005; Marshall, McKone et al. 2005).

Bangkok is a city renowned for its high level of car use, its extensive traffic jams and its poor air quality (Poboon 1997; BBC 2001; The Government Public Relation Department 2004). Many Bangkokians are very dependent on private motor vehicles especially those who live in the suburbs. The growth in numbers of motor vehicles together with the associated increase in air pollution and congestion impacts on the livability of Bangkok residents (Marshall, McKone et al. 2005). Reasons why Bangkokians live in the suburbs include: 1) most residential estates are being developed in the suburban areas since the land is cheaper; 2) it is believed that suburbs provide a better environment in which to reside because there is a lower rate of emission per hectare. The consequence of suburbanization is that journey distances or VKT will increase, since people who live in the suburbs generally have to travel further to their work place. It was documented that Bangkok's residential areas are based primarily on car access and these are expanding rapidly, and the city is thus becoming even more automobile dependent (Newman and Kenworthy 1996). This paper will investigate how population densities are changing in Bangkok, examining whether in fact densities are increasing in the suburbs while decreasing in central areas. Knowing and understanding the changes in population density should provide information on whether Bangkok is becoming more or less sustainable.

The following section provides a brief review of the the relationship between population density and travel behaviors. From these studies, population density has been identified as a suitable indicator for urban sustainability. The data showing changes in population density in Bangkok is presented in section3, and results are discussed in section 4. The study will use the population density of 50 districts in Bangkok to illustrate the trend in Bangkok's population distribution.

2. THE RELATIONSHIP BETWEEN POPULATION DENSITY AND TRAVEL BEHAVIORS

The suburbanization process is directly related to the level of car usage and the emission of pollutants such as carbon dioxide, a major greenhouse gas (Goldberg 1999; Frumkin 2002). The other pollutant gases that are related to suburbanization are NOx, SOx, and CO, while particulate matter has also been identified as a major pollutant with health impacts on residents. The increase in greenhouse gases emitted into the atmosphere is now exerting pressure on the global climate and threatening both human and natural environments in a number of ways such as, increased average global temperatures, increased prevalence of some infectious disease, decreased precipitation in some area, and rising sea level (UNEP 2002; G. Tyler Miller 2004; Cunningham, Cunningham et al. 2005; Kaye, Groffman et al. 2006).

An indicator of suburbanization and sustainability is population density (Jacob 1992; Newman, Kenworthy et al. 1995; Gurin 1999), and this is also a measure of the intensity of land use of a given area. It can be used to determine the level of automobile usage and the gasoline consumption level (Soltani 2005). A lower population density reflects inefficient land use, which results in an the increase in automobile use and dependency (Jacob 1992; Zhang and Guindon 2005). In a high-density living environment, people tend to walk, cycle, and use public transportation. To illustrate

this point, considered two city forms as shown in Figure 1, under the condition where both cities have equal area and equal population, residents that live in a city with higher density (1a) will travel less distance. This is because all of the population and employments are principally concentrated around the central part of the city. On the other hand, residents that live in the suburbanized city (1b) will have to travel a greater distance in order to get to the city central, hence requiring higher transportation energy. The importance of strengthening the city near the center with concentration of employment, can promote non-motorized modes of transportation, and reduce energy consumption (Mindali, Raveh et al. 2004; Giuliano and Dargay 2006). A comparative study of the two land developments in the cities of Freiburg, Germany and Chula Vista, United Sates indicates that higher density can lower the use of private motor vehicles (Ryan and Throgmorton 2003). Newman and Kenworthy also point out that high density living can lower the rate of motor vehicle usage, since people tend to walk and cycle in the dense mixed use setting (Newman and Kenworthy 1996). A study by Marshall, McKone et al. showed that an increase in population density will lower the VKT and the per capita intake of pollution emission. Hence, the study suggested that urban design features that reinforce high density living are necessary in order to reduce the health impacts from transportation emissions (Marshall, McKone et al. 2005).
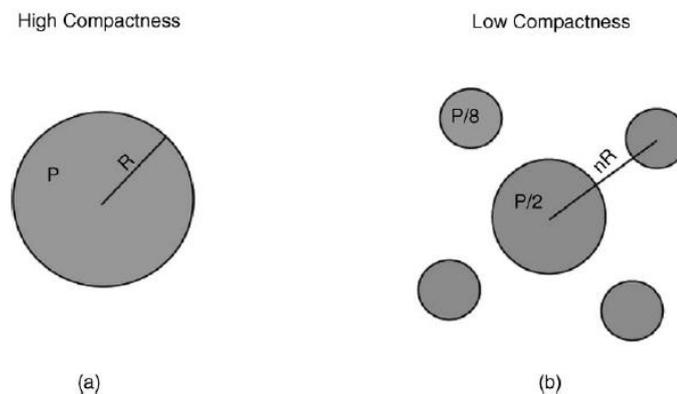

Figure 1: Conceptual diagram of compactness
Source: (Zhang and Guindon 2005)

Similarly, other researches found that households in a higher density neighborhoods are likely to use more public transportation, and generate less VKT (Badoe and Miller 2000). Cervero(1996) in a study on subcentering and commuting found that subcentering or the spread out of city has significant impact on transportation. Subcentering causes an increase in VKT since it induces travel per capita (Cervero 1996). A transportation study by Holtzclaw also found that when residential density is doubled, it is likely that VKT per capita will decrease by 20% to 30% (Holtzclaw 1994). It was also documented that a denser neighborhood in Nashville (68% more dense) had 25% less VKT, and produced 7% less toxic-emissions per capita per day from vehicles when compared to other less dense areas of Nashville (Marshall, McKone et al. 2005).

Population density is also related to the rate of energy consumption (Mindali, Raveh et al. 2004; Zhang and Guindon 2005). Studies have shown that under the condition where urban density is raised, the energy consumption and the rate of pollutant emissions will decrease (Frank, Stone et al. 2000; Mindali, Raveh et al. 2004; Marshall, McKone et al. 2005). A study by Frank, Stone et al. (2000) indicates that level of pollution emission is affected by density. They found that NOx are highly sensitive to land-use change as are CO and VOC emissions (Figure 2).
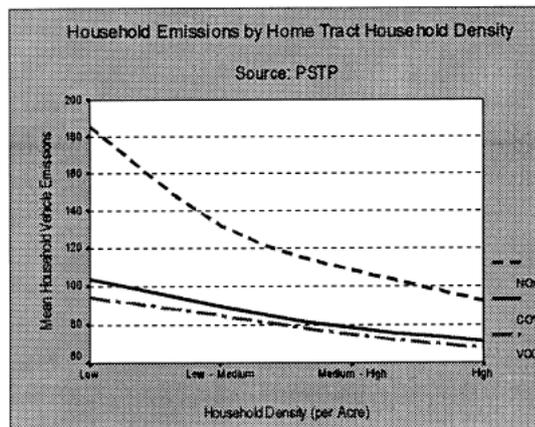

Figure 2: Household emissions by home tract household density
Source: (Frank, Stone et al. 2000)

Marshall, McKone et al.(2005) conducted a study concerning the effects of urban population and land area on the inhalation of motor vehicle emissions, and found that population density has significant impacts on the exposed urban population (Marshall, McKone et al. 2005). Their study suggested that high density living can reduce vehicle emissions and their associated health impact.

3. DATA/INFORMATION REQUIREMENTS AND SOURCES

Data from the Bangkok Metropolitan Administration (BMA) is the key information source that is being used in this paper. The interesting features of these data are the following:

- The change in density, land area, and number of houses in all Bangkok's districts from 1999-2005.
- The map of Bangkok and the parameter of each district.
- The land-use map of Bangkok which indicates zoning of Bangkok.

In this paper, we have selected to study the patterns of urban development through the use of population density. We have selected Bangkok, the capital city of Thailand to be the subject of this study. Bangkok is divided into 50 districts with the total registered population of around 6 million people. The majority of jobs in Bangkok are mainly located in central areas such as Sathorn, Dusit, Bangkok Noi, Bangkok Yai, and Ratchathewie. Moreover, districts that are located in the central area of Bangkok are connected by the sky train (BTS) and the underground train (MRTA), which provide an easy and convenient access via public transportation.

We have accumulated the data from the BMA regarding Bangkok's population density, housing numbers, and land area from 1999-2005. Our study, therefore, will be based on the comparison of population density of major districts in Bangkok's Central areas and Bangkok's suburbs. The assessment in the change of population density should allow us to understand the urbanization and the suburbanization trends occurring in Bangkok. In addition, emphasis will be placed on the graphical representations of results in order to make the results less complex to view.
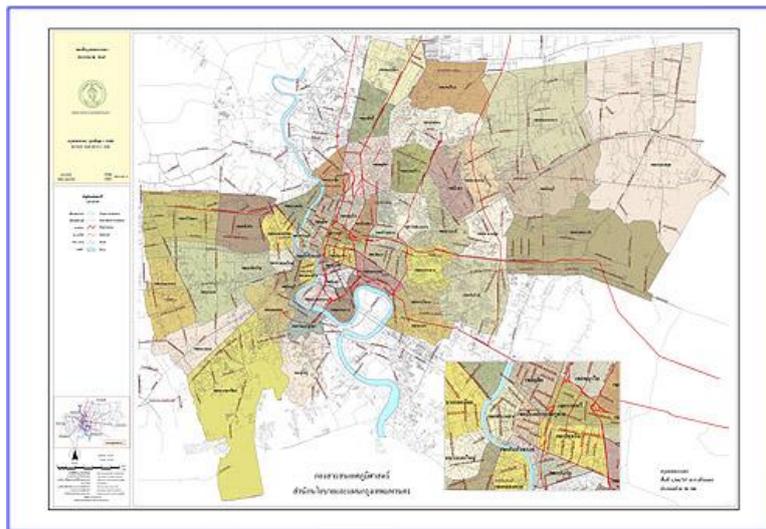

Figure 3: Map of 50 districts in BKK
Source: http://www.bma.go.th

4. DATA FORMULATIONS AND ANALYSIS

The basic features of suburbanization are the inefficient use of land that can be seen in the population density or the land use per capita (Kenworthy and Laube 1999; Zhang and Guindon 2005). In a low amount of population density area, public transportation is normally less efficient. Residents who live in these area are required to travel a greater distances to their destination such as their workplace. As a result, low-density living is normally related to higher use of private motor vehicle. Higher use of private motor vehicles can be considered as a primary indicator of transport related energy consumption and pollution emission. Hence, a measure of urban density is a good indicator that can be used to describe the environmental impacts caused by suburbanization.

In our analysis, we make a comparison of population density between 10 major districts in the central area of Bagnkok and 10 districts that are located in the suburbs of Bangkok. The 10 central area districts that are being included in our analysis are Pom Prap Sattru Phai, Samphanthawong, Din Daeng, Khlong San, Phra Nakhon , Ratchathewi, Dusit , Bangkok Yai, Bangkok Noi ,and Sathon. These 10 districts are being selected principally because they obtained the highest population density among the central area districts. While the 10 Bangkok's suburb districts that are being included in our analysis are Bang Kapi, Bang Khen, Don Mueang, Bang Khae, Sai Mai, Bang Bon,

Min Buri, Lat Krabang, Khlong Sam Wa, and Nong Chok. These districts are being selected since they are all located in the outer parameters of Bangkok and are known as areas with high residential development activities.

Figure 4.1 shows the population density of 10 Bangkok's central districts of Bangkok during 1999-2005. The graph shows the decrease in population density over the seven years period. A significant decline in population density is seen in two major central districts Dusit (from 14,752 persons/sq.km. to 11,377 persons/sq.km.) and Satorn(from 11,848 persons/sq.km. to 10,196 persons/sq.km.). These two districts are compactly occupied by schools, office building, financial institutions, residential estates, government
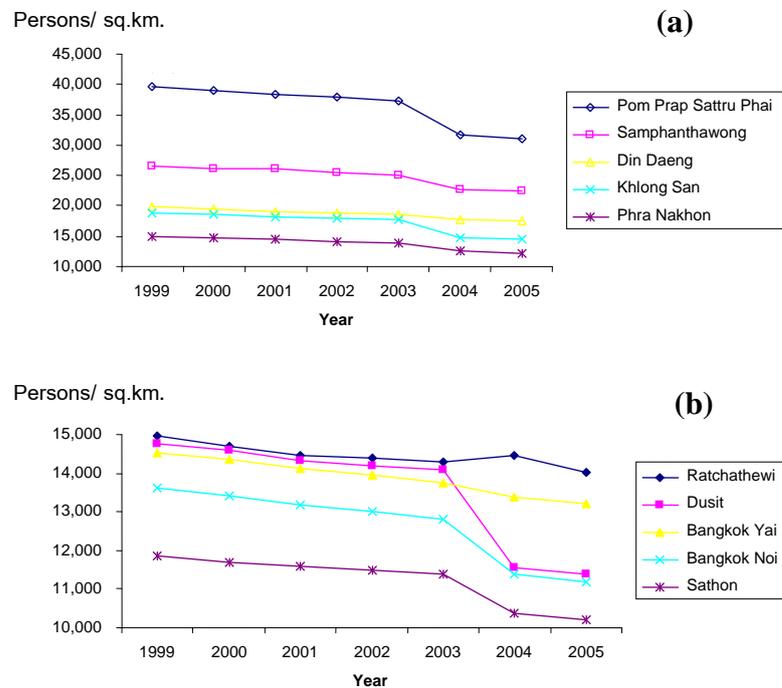
Persons/ sq.km. **(a)**

Persons/ sq.km. **(b)**

Figure 4.1: Population density in 5 CBD districts during 1999-2005: (a) Pom Prap Sattru Phai, Samphanthawong, Din Daeng, Khlong San, and Phra Nakhon; (b) Ratchathewi, Dusit, Bangkok Yai, Bangkok Noi, and Sathon.
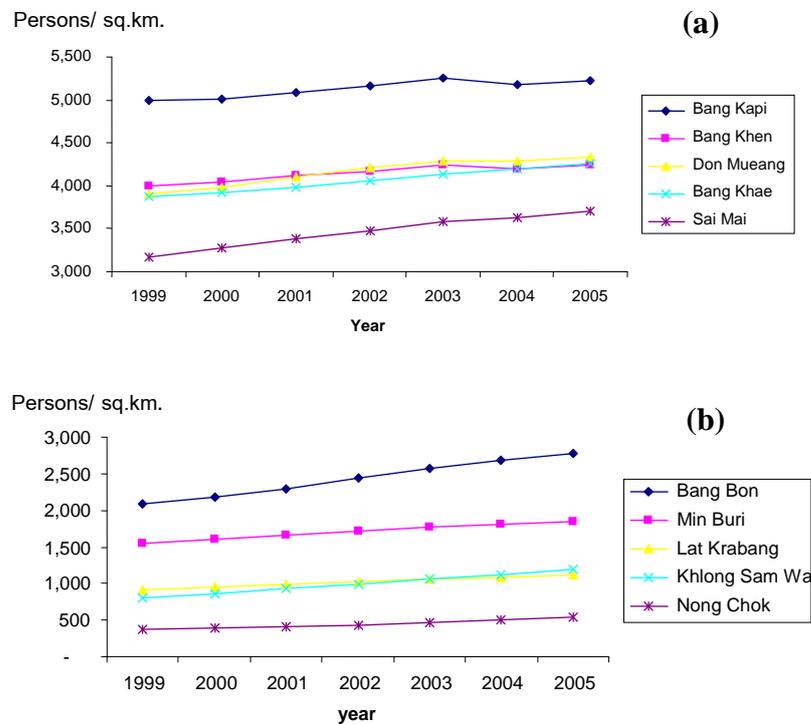
Figure 4.2: Population density in 5 Bangkok's suburb districts during 1999-2005: (a) Bang Kapi, Bang Khen, Don Mueang, Bang Khae, and Sai Mai; (b) Bang Bon, Min Buri, Lat Krabang, Khlong Sam Wa, and Nong Chok

institutions and offices, hospitals, department stores and etc. The decline in population density in these two areas implies that residents in these two areas are moving out of the central area of Bangkok.

Figure 4.2 shows the population density in 10 selected suburban districts. There is significant growth in population density especially in the two districts of Bangbon (from 2,093 persons/sq.km. to 2,784 persons/sq.km.) and Sai mai (from 3,176 persons/sq.km. to 3,709 persons/sq.km.). Bangbon and Sai mai are considered as two of the outer most districts of Bangkok. Both of these districts used to be known for their fertile land which is suitable for farming. However, at present, according to BMA, Bangbon and Sai mai have changed to areas with high level of residential development activities. In terms of public transportation, these two districts and all of the other suburban districts are not easily accessible by public transportation. The only public transportation means that is available in these areas is public bus. As a result, people who live in these two areas or the other suburban areas of Bangkok must rely on private automobiles as their mean of transport.

According to figure 4.1-4.2., it is evidenced that Bangkok's population density is declining in the central part of Bangkok while growing significantly in the outer areas. Figure 4.3 provide a more apparent population density trend of Bangkok using graphical representations of the results.
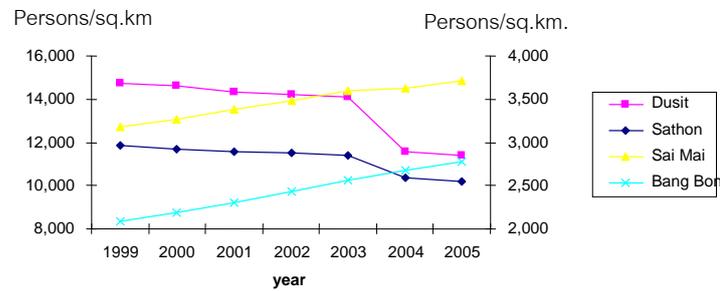
Figure 4.3 : Population density of two selected CBD and suburb districts

The figures clearly indicate that Bangkok's population density is spreading out in a 'donut effect' fashion. Donut effect occurs when the central part of the city loses population while the population in the surrounding suburbs increases leading to what looks like a hole in the middle (Beaujot 2002). The donut effect always leads to an increase in automobile numbers. According to the Thailand Ministry of Transport, between 1998 and 2004, more than 9.6 million vehicles were registered (Ministry of Transport 2004). In addition, more than 87 percent of the new vehicles being registered in this period were private cars and motorcycles (Ministry of Transport 2004).

In order to confirm that Bangkok is suburbanizing, a more complete data on vehicle kilometer traveled (VKT) is needed. Since VKT is the indicator that is directly related to the degree of suburbanization and pollution emission from motor vehicles (Henderson and Mokhtarian 1996; Mokhtarian and Varma 1998; Frank, Stone et al. 2000; Van Metre, Mahler et al. 2000; Zhang and Guindon 2005). The data on VKT would have to be supplemented by further random household travel surveys on the sample population across Bangkok 50 districts.

5. CONCLUSION

The changes in population density in Bangkok exhibit an unsustainable trend which planners need to take into account. The data from BMA indicates that population density in the central area is decreasing while the population density in the suburbs is increasing. This is a sign of suburbanization and is having a significant impact on the urban environment. Suburbanization converts natural areas to houses, roads and other infrastructures, and causes air pollution to increase due to a substantial growth in automobile numbers. Suburbanization also bears congestion cost, and other social costs such as the destruction of community values and is an unsustainable form of city planning. As a result, it is important to find a way to reverse this development trend. One of the possibilities for tackling suburbanization is transit-oriented planning. However, in order to strengthen the conclusion that Bangkok is suburbanizing and to identify the most appropriate solution to the problem, a further study on vehicle kilometer traveled (VKT) of Bangkokians is needed.

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