SHIFTING URBANISASION PRESSURE OF URBAN LAND USE CHANGE IN BANJARMASIN, INDONESIA

THESIS

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PREFACE

Urban land use change is imperative subject for research and assessments toward city expansion. The reality of urban land use change clearly non-linear. Fallibility and complexity are inherent, where cause and effect are often vague. Jay W Forrester said (1987) state, "We live in highly non linear world" in Keil and Elliot (1997).

Furthermore, in developing countries cities, impact of urban expansion complexity have been growing in, generating strong imbalance between urban land use expanse and open space. Urban land use also highly expanse in urban fringe through leapfrog development. The need to address this complexity in assessing urban land use change of both theory and practice is strongly felt now a day.

There is also problem in developing countries for data readability and reliability. Therefore, determining the rate of urban land use expanse, from remote sensing data is a prevalent approach in recent urban land use planning. Thematic maps of urban land use derivate from remote sensing data can assist planners visualizing the path of city expansion, underlying its rate, trend, and pattern.

In the recent development of computer and technology, there are abundant of application of analytical methods and modeling available in urban land use change by using the remote sensing data tandem with geographic information system (GIS) approach. However, despite the promising of new and fast developing remote sensing and GIS collaboration, a gap between the theory-focused and the practical application of these analyzes and models, planner find that those approach is a handy tools in planning.

Finally, it is a never-ending interesting question about city expansions. Necessities for theory focused research and practical application intentional covered in this research.

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ABSTRACT

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Exploring population growth as driving force that shape urban land use structure and pattern is the main objective of this research. Result of population growth analysis with satellite image and GIS analysis about land use changes will counter pattern, rates and trends of urban expansion.

Method used in this research, due to land use change data deficient as many cities in developing country, need to take a long road by examines the remote sensing data and GIS to produce more reliable data. The next phases of this research carry on spatial statistical analysis of correlation between population growth and city expansion.

Detail phases of this research are divided into four steps. The first step is data preparation. Data preparations consist of preparation remote sensing data, preparation administration map and preparation for population data of sub district. The second step is data processing. This step is process data into information. Detail of image processing. Other process is land use analyses that extract image processed data into land use information. The other process is population analysis, which explores sub district population data. The third step is modeling. Develop robust model of shifting urbanization pressure to prepare analysis process. This model inflate urban land use change into city center spillover, inner ring spillover, outer ring spillover, spillover of urban fringe, and leapfrog development, so that shifting of population growth as urbanisation pressure will arise. The last fourth step is correlation analyses that verify hypothesis, whether population growth affects to city expansion or there is no correlation. This step also will explain correlation population growth and shifting urbanization pressure Furthermore, this step will examine how urbanisation pressure shapes city expansion.

Results of this research about correlation population growth and urban land use change in Banjarmasin city that even though theoretically population growth is driving force of land use change but statistically there is no strong linear correlation between population growth and urban land use change. Nonetheless, population growth has minor correlation to urban density changes.

Other result is pattern of urbanisation pressure. Urbanisation pressure of urban land use change has negative correlations, which mean the closer areas to city center, the lower urban land use expanse. On the contrary, urban density has positive correlation that the closer to city center the higher urban density change, except for leapfrog development. In leapfrog development, urban density is highly increased.

In conclusion, this research provides relation between population growth and urban land use change for both theory and practice. Theoretically, population growth is driving force of city expansion. However, affect of population growth practically are different to each part of city area. Population growth is driving force of urban land use expansion in outer ring, urban fringe, and leapfrog development. Meanwhile, Population growth in inner ring tends to form urban density growth. Both of urban land use change and urban density change in city center, not affected by population growth but by other factor.

This research also point up problem in land use planning in many developing countries for lack of consistent data can be solved by image analysis and GIS modeling in tandem. Furthermore, GIS modeling, shifting urbanization pressure model is a handy tool to explore population growth affect to urban land use expansion and urban density growth.

Keyword; *urban land use change, urban density growth, population growth, shifting urbanisation pressure model*

1. INTRODUCTION

1.1. Background

The developments of city need land to adequate urban activity that increased rapidly. City need sufficient open land to provide space expansion base on population growth and increased city activity (van Dijk, 2009 and McCann, 2001). The conversion into urban land-use as elements of regional services often became compulsory in response to urban need as a direct result of city activities (Healey & Ilbery, 1990 and Gordon, 1990)

Beside of the land use changes data, precedent events and other historical information needed to support identification of the issues of land use change. Land use change analysis identifies development impact of the city expansion. Land use changes analysis requires understanding a city history. Historical background such as population data, time-lines of historical events, and related information that all used to explain the land use changes. From those elements of land use change, population growth is the first and foremost urban pressure factor of rapid land use expansion of urban area.

Population growth data correlate with the urban land use change so that the dynamic of urban activity can translate into an interpretation. Such as Conway interpretation that population increases suggest economic growth and the availability of jobs in an area, and population declines suggest a decline in livability or economic issues that cause people to leave a region (Conway et al., 2003). In line with Conway, Bhata (2010) interpret population growth itself affected by two factors, pull factor and push factor. Push factor explained as condition in the area of origin, which is perceive as detrimental to migrant well being. Push factor include high unemployment and political nuisance. Full factor in the other hands, the conditions of an area attract people to come. Pull factor include job opportunities or better living facilities.

In developing countries, there are problem with data availability and reliability (Akbar, 2000). Therefore, land use change analysis could base on a time line of image analysis. This analysis process result is land cover thematic map. Despite the different between land-cover and land use (Meyer, 1994 and Lambin et al., 2001), land cover data is useful information for constructing land use map. Employ land cover for land use classification in this research, such as urban land use contain land cover; building, road, parking area, warehouse, etc.

This image analysis supported with GIS procedures can provide for more unambiguous planning process. Through analyzing population growth and land use change temporal database, it will show spatial patterns, rates of change and trends. Those results can provide insight into cities development under any social, economic, and environmental conditions (Tarigan, 2005; Schock, 2000; Irwin, 2002; Kaufmann, 2005).

Nonetheless, those procedures include significant population growth from side to side with rapid land-use changes explaining urban developments. The plain urban developments will give multiple planning authorities for better coordination including local, province and central governments (Cook, 1975 and van Fossen, 2001)

The case study for the Banjarmasin land use changes shows that there are emerging challenges. The city named "Thousand Rivers" developed itself by doing its inland navigation activities (Subiyakto, 2004). Structure and pattern of land-use changes in Banjarmasin is reflects a more systemic structure and pattern, which may be manifesting itself in a number of rivers around Banjarmasin. Water transportation network is the main part, which becomes the supporter of the growth and development of Banjarmasin city. Population growth in this condition develops not only ribbon development along the street but also development alongside the river.

Finally, through analyzing Banjarmasin population growth time series data correlated with urban land use rates of change and trends can explain Banjarmasin city expansion. Furthermore, it can also provide insight into population growth as main driving force of urban land use changes.

1.2. Objectives

Main objective of this research is to explore population growth as driving force that shape urban land use structure and pattern. Result of temporal database analysis about population growth and land use changes will counter pattern, rates and trends of urban expansion

This research also examines how far the remote sensing data and GIS can help explain city expansion in which reliable data is deficient.

1.3. Research Question

The main purpose of this research is to address population growth affect to urban land use change. Result of this research is to understand population growth as shifting urbanisation pressure that generates city expansion. City expansion can be horizontal through urban land use expansion and vertical through urban density change.

Furthermore, this research will analyze how population growth as urbanisation pressure shifting from city centre to urban fringe that shape city structure and pattern. Therefore, this research will develop according to some research questions as follows:

1. *Is there any correlation between population growth and urban land use change?*

This research tends to explain relationship between population growth and city expansion, firstly this research will confirm horizontal expansion, in which if there is correlation between population growth and urban land use change.

2. *Is there correlation between population growth and urban density change?*

Secondly, the question address if population growth is directly cause vertical city expansion. By testing correlation between population growth and urban density change, we can describe how population growth influences urban density growth.

3. *How Urbanisation Pressure affect Urban Land Use Change?*

The next question is there any correlation of urbanization pressure and urban land use change. This statistical correlation address if there systematic changes in population growth can cause systematic changes in urban land use change.

Furthermore, how population growth as urbanization pressure that shape city structure and pattern can be definite using shifting urbanization pressure model.

4. *How Urbanisation Pressure affects Urban Density Change?*

Finally, the last question is how urbanisation pressure affects vertical city expansion. Using regressions analysis, correlation between urbanization pressure and urban density change will be explain how population growths will mold urban density change.

2. LITERATURE REVIEW

2.1. Land Use Changes

In shifting urbanisation pressure, when the city expands and the population density is high, the land use problems emerge. The analysis of a temporal database about land use changes results in pattern, rates and trends of the land use changes. The results of analysis depict the extent to which the city expands. The data of population density incorporated in the temporal database reveal the city socio-economic progress so that city development is observable. According to Conway (2003), as the population increases, socio-economic and job availability grow higher. On the other hand, if the population declines or the economic problems occur, people tend to leave the city.

Mapping a temporal database of land use change through the conventional ground survey methods using *theodolite*, compass, and other tools is considerably labor intensive, time consuming, and often inaccurate because by and large city develops . Thus, maps soon become obsolete, particularly in a city where the urban land use grows rapidly. Moreover, it is quite difficult to monitor land use change and apply time-series analysis through traditional method of ground survey.

In recent years, satellite remote source techniques are developed. This technique is highly accurate in mapping and monitoring land changes at regular time intervals. This technique is the possible way of obtaining the necessary data in difficult-to-reach area.

In early 2009, USGS launched a program called “Free Landsat Scenes Go Public by the Million.” (www.educationgis.com, 2008). The program has web-based Landsat archive and is free access. Therefore, this program can be a great advancement in analyzing and modeling of land use and land-cover changes worldwide.

It is very useful to use satellite image for creating a temporal perspective over large area when the conventional ground methods are considerably ineffective to apply. Satellite image gives overview at land use changes over time, from decades and even into minutes (Schott, 2007).

Database gathers from sub-district population statistic and satellite image from Landsat. Landsat is a multi-spectral mapper and a thematic mapper that has limited spectral resolution, but it has high spatial resolution (Elachi, 2006). Therefore, it is appropriate for analyzing land use changes.

The process of making quantitative decisions in analyzing land use changes needs Image classification. Image data, which group pixels or regions of the image into classes, represent different land use types. The result of the satellite image classification process is a thematic map rather than as an image (REES, 2001).

Land cover classification type has many standards. For instance, Anderson Classification (1976) proposes nine class of a hierarchical classification framework (Anderson, et al., 1976 and Aronoff, 2005). The other classification is Malingreau Classification (Malingreau and Christiani, 1981). This classification divides land use into 24 land use classes.

Lambin asserts that land-cover and land use is different (Lambin et al., 2001). Land-cover involves any figure that as show from satellite image such as building, house, farming, etc. Meanwhile, land use is any actual activity in which the land used, such as building for market, house for living, farming for food stock. Meyer also made differentiation between land use and land cover (Meyer, 1994). The land use defined as the terrain that utilize by the human; meanwhile land cover is the physical condition of the ground. Nevertheless, all changes in the location of land use can be associated with observation of land cover changes (Vanwambeke, 2007). Therefore, land cover database change can analyze land use change.

A number of studies in land use change have conducted in Indonesia. A study conducted by Sitorus et al. (2000) concerns on the sub-urbanisation process in land use changes in Jabotabek areas (Jakarta-Bogor-Tangerang-Bekasi). The study reveals that population has enormously increased sub-urbanisation in Jabotabek. Another study carried out by Dimyati et al. (1995) in Yogyakarta applies MSS Land sat and land use map. The study superimposes Land use images of 1972 and 1984 from MSS Landsat with land use map of 1990 to calculate the index of change. Therefore Landsat Image can be used to analyze or making model of land use change in Indonesia.

2.2. Shifting Urbanisation Pressure

A process model is a simulation of real world processes. Beck et al. (1995) defined as pragmatic point of view decisions made and actions taken about spatial phenomena. From philosophical point of view, a process model may be the only way of evaluating our understanding of the complex behaviors of spatial systems (Heywood et al., 2006).

Before considering shifting urbanisation pressure into GIS model, it needs to classify the model. Model can categorize in multiple ways; two of them are Agarwal model category and Koomen model characterization.

Agarwal categorizes as show table 2.1, land use change based on two distinctions that are model scale and model complexity (Agarwal, 2001). Model scale, the first category divide into three subcategories time that the first is step and duration, the second is spatial resolution and extend, and the third is agent and domain. Model complexity, the second category divide model into two subcategories that are temporal complexity and spatial complexity

Table 2.1 Land Use Change Model Categories (Agarwal, 2001)

No	**Category**	**Model**	**Scope**
1.	Model scale	step and duration	Temporal unit and length of time
		spatial resolution and extend	Smallest geographical unit and geographic area
		agent and domain	Actor and society incorporated
2.	Model complexity	temporal complexity	Index of temporal complexity
		spatial complexity	Whether spatially representative or spatially interactive

The first subcategory is time step and duration. Time step is the smallest temporal unit of analysis for change to occur for a specific process in a model. Duration is the length of time that the model will apply.

The second subcategory is spatial resolution and extend. Resolution is the smallest geographic unit of analysis for the model, such as the size of a cell in a raster grid system. Extend describes the total geographic area to which the model applied.

The third subcategory is agent and domain. Agent refers to the human actor/actors in the model who make decision. Domain, in the other hand, refers to the broadest social organization incorporated in the model.

Model complexity, the second category is the approach of this category is to address the complexity of time, space, and human decision-making found in the real-world situation. Model complexity divided into two subcategories that are temporal complexity and spatial complexity. (Agarwal, 2001).

The first subcategory is temporal complexity. Index of temporal complexity divided into three; low temporal complexity, mid-range temporal complexity and high value of temporal complexity. Low temporal complexity is a model that has not many time leaps with short duration. Mid-range temporal complexity is models that use many time leaps with longer duration. High value of temporal complexity is models that integrate large number of time leaps and have different time steps for each sub models

The second subcategory is spatial complexity. Spatially complexity divided into spatially representative and spatially interactive. Spatially representative is a model that change is not dependent on neighboring cell. Spatially interactive means that models describe each cell might change or remain the same interdependent with surrounding areas.

Another model category based on Koomen that divides model characterization of land use change into four classification models. Those model characterizations are static or dynamic model, transformation or allocation model, deterministic or probabilistic model, and sector specific or integrated model (Koomen, 2007).

The first characteristic is static or dynamic model. Static model is a cross sectional model that directly calculate the situation at a given in time, where as dynamic model work with intermediate time-steps. The opposed is dynamic model that intermediate data develop into initial point for next situation analysis.

The second characteristic is transformation or allocation model. Transformation model starts from the current land use change into another land use type where the change effected by transformation likelihood or neighboring area. In contrast, allocation models mean change from the current land use change into another type base on its characteristic that current land use is one of the factor influencing.

The third characteristic is deterministic or probabilistic model. The model is appropriate with severe cause effect relationships. On the other hand, probabilistic model is applies uncertainty and possibility of land use change.

The fourth characteristic is the model sector. Specific model is the model that focuses on one part of the land use system. Integrated model integrated relations with a whole part of land use system.

Land use model characterization base on Koomen interpretation as show in table 2.2.

Table 2.2 Land Use Model Characterization, (Koomen, 2007)

No	Characterization	Model	Scope
1	Static or dynamic model	Static model	Land use change at a given time
		Dynamic model	Land use change at intermediate time-steps
2	Transformation or allocation model	Transformation model	Land use change affected by neighboring area
		Allocation model	Land use change affected by current land use
3	Deterministic or probabilistic model	Deterministic model	Strict cause effect relationship
		Probabilistic model	Uncertainty and possibility
4	Sector specific or integrated model	Sector specific	Focus on one part of land use change
		Integrated model	Relation with whole part of land use system

Those characteristics will give basic principle to develop shifting urbanisation model into GIS model. The urban land use change analyze base on satellite image.

2.3. Shifting Urbanisation Pressure Model

Land use change modeling in planning an existing city is highly important. According to Koomen (2007), Land use change modeling will help us to understand the processes of enduring urbanisation. The model can also be very useful in informing decision maker about possible future of Land use change under different scenarios. Many Land use change models have developed based on researchers' needs.

This research will use a model based on the shifting urbanisation pressure theory of van Dijk; "The urbanisation pressure will often be diverted to other next areas next to demarcated zones where the restriction are less severe. Therefore restricting effectively means redistributing…" (van Dijk et al., 2008). The theory discussed in a paper entitled 'Open Space preservation in the Netherlands: Planning, Practice and Prospect'. It will show whether urbanization pressure of land use change also shifting on different context and complexity such as in Banjarmasin, Indonesia.

Problems related to urbanisation, the expansion of a frontier, land degradation and recreational uses of vacant land has long been research interest. Urbanisation defined as the natural environments shifting that form and preserve urban places (Rindfuss, 2004 and Hara, 2005). Urban place defined as the settlements where most people live and work (Elvidge, 2004). Although studies about urbanisation in developing countries grow fast, urbanisation shifting and pattern, especially urbanisation from open space to urban place, are of little interest. Moreover, ideas of bio-diversity and natural preservation have been ignore in planning practice.

The faster the population grows, the more rapidly the population density increases. When the growth is restricted due to restrictive policy, the city will redirect urbanisation pressure. City expansions will produce ‘spill-over effect’ and unpredictably lead to ‘leap frog development’ according to van Dijk et al., (2008). Of course, this study conducted in the Netherlands context that has strong restrictive policies.

On the contrary, many Asian countries, particularly Indonesia, has less restrictive policies for land use. It is interesting to figure out the extent to which the shifting urbanisation pressure concept implemented in the city where the restrictive policies are very less, land use management is poorly coordinated and land regulatory is inflexible (Firman, 2004). Banjarmasin city as capital of south Kalimantan province has many restrictive policies, but the implementation of those policies is other story. For example one of restriction is land use planning. Evaluation of Banjarmasin city plan 2000 shows that high deviation of land use from its plan. (Bappeko, 2006) Nevertheless, there is less restrictive of policies, urbanisation pressure still exists and spreads to other next areas because of limitation to urban carrying capacity.

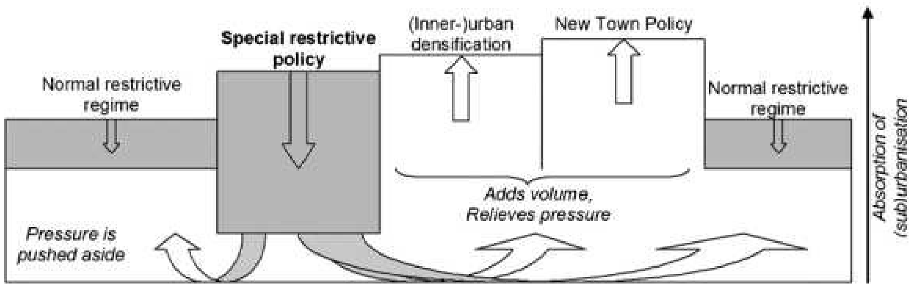


Figure 2.1 Shifting Urbanisation Models (van Dijk et al., 2008)

It is not easy to find previous research on shifting urbanisation pressure model. Even though I cannot find exactly the same topics to this study, there are several previous studies related to the shifting urbanisation.

2.3.1. Urban Spillover

Urban spillover effect is resulted from redirecting urbanisation pressure. Determining the degree of urban spillover in urban fringe is often difficult because an urban component appears in the urban fringe component (Berry & Plaut, 2004)

In urban spillover of shifting urbanisation pressure, when the city growth clashes with distribution, then urban spillover of neighboring regions occurs. Developments of urban spillover cause a large numbers of workers move to the city looking for jobs. Since urban housing is unaffordable, some citizens rent out rooms and some others may even build illegally dormitory in green open space.

City growth might spill over city border into the adjacent part of rural and emergent of city might appear in the midst of rural areas. The delineation of urban and rural areas usually based on population and building density rather than socio-economic links (Amcoff, 2006). Spillover cannot separate from the random shaping of the part of an urban fringe into urban land use. The areas that considered urban expand and consequently hold more to the urban spillover.

Delineation of rural and urban area due to urban spillover must periodically attune to keep the demarcation of rural and urban areas up to date, so that rural and urban population definition is consistent overtime.

Urban spill-over carrying along four main effect that are spreads effect, subsidiary effect, land price decreasing, and green open space reducing effect (Brueckner, 1995; Kubis, 2007; andYapping, 2009)

The first effect of the urban spillover is spreads effect. The spillover not only affects the expanding city but also other neighboring cities. Brueckner (1995) asserts that the change in the characteristic of a single city creates a spillover effect, which then alters the growth-control choices of all cities in the region. Nevertheless, in this research will emphasize on single city that expansion of urban land use.

The second effect of urban spillover is that subsidiary effect of city as a stronger economic growth has a larger contribute to the slower economic growth area. Additional growth impulse the gain in growth in stronger economic growth city might even over-compensate the lost in the slower economic growth area. The slower growing economic receives an additional inclination by the spillover effect (Kubis, 2007). The urban spillover affects the slower economic growth area to participate on the strengthened city growth.

The third effect is land price decreasing that gives negative effect for citizen, especially in urban fringe of urban spillover. Urban fringe citizen will suffer from their land price most likely be expropriated at a below-market price (Yapping, 2009).

The fourth urban spill-effect effect is that decreasing of green open space effect. Green open space and farmland converted into urban function due to urban expansion. Therefore, integrated land use planning will be needed that designated to protect farmland and green open space from urbanisation.

Those effects will be unique in many cities when the urban spillover is not only ribbon development along the road, but also sprawl along rivers. The urban spillover expanded mainly along the river in a linear growth that is subject to historical trends of the river city expansion (Subiyakto, 2004)

2.3.2. Leapfrog development

In the shifting urbanisation pressure, the term "leapfrog development" means discontinuous development in which more remote land developed previously is located close to city central. In the other word, leapfrog development is urban land expansion showing a dispersion of new city expansion on isolated tracts separated from other region by open space (Kostov, 2006 and Liu, 2005).

Three main factors cause leapfrog development. Those factors are including land price, green belt policy, and land–use management inefficiency.

The first factor is land price. Alonso classic theory about land rent argues that the farther to the city center the cheaper likely the land price.

The second factor is green belt policy. There is potential for leapfrog development produced by the green open space. According to Platinga et al. (2003), green open space can lead to leapfrog development. The study find outs that green open space may cause leapfrog development when green open space located at the city periphery. Greenbelt policy that its objective is to prevent urban sprawl keeps new city development away from greenbelt. Therefore, Greenbelt policy when the green open space is located adequate remote from the city center, slightly forced leapfrog development.

The third factor is land–use management inefficiency which the absence of integrated planning will produce sprawl development (Firman, 2004)

Those factors have generated leapfrog development in urban expansions in many developing countries, which are oriented to green belt development policy. Banjarmasin structure plan also use greenbelt development policy where conceptually city surrounded by green open space as a green belt. Contrast to greenbelt concept, the Ecopolis concept and the Dutch Green Heart that integrated open space in the city center. The concept will avoid leapfrog development (Tjalingi, 2004; Tjalingi, 2005; and van Dijk, 2009).

A number of studies about leapfrog development caused by shifting urbanisation pressure were conduct worldwide. The studies are from USA, China and Korea.

In the USA, Herold (2003) states that the California urban lands use increase as fractal dimension, edge density and the peak in some pathway. As indicated in the study done in 1967, the city has the sprawl and leapfrog-style urban development. Furthermore, the study finds out intensive growth and urban sprawl in the 1960s and 1970s, where most of sub area show fragmented urban land use characterized by leapfrog development and sprawl. Dissimilar city expansion patterns show that more compact growth around existing city center in 1980s. The pattern of land use change described as the dense-union. The dense-onion model is cities expansion that directly allocated new development around city center. Thus, there is no leapfrogs development.

In China, Liu (2005) studies rapid urbanisation through linear, concentric, and leapfrog expansion caused by Chinese economic growth, driven by foreign investment and export. The study identifies that many Chinese cities such as Tibetan plateau, Shanghai, Tianjin, and Xi'an have urban expansion largely at the periphery of city center in the leapfrog expansion mode. Another study in China concludes that comparing to existing city center development; leapfrog urban sprawl not allowed in land-scarcity due to environmental challenges and the low-density leapfrog development (Chen et al., 2008).

In Korea, there was a study conducted to measure commuting costs of leapfrog new town development caused by greenbelt in Seoul. This study uses a contiguous new town development as an alternative development scenario to compare with leapfrog development. Commuting distance savings are use as a measure of the commuting costs of the leapfrog new town development. The study concludes that workers who live in the leapfrog new town development have to pay more amount of the commuting costs compared to workers who live in a contiguous new town development scenario (Jin Jun & Hur, 2001),

Base on those studies, there are three main problems carrying along by leapfrog development; economic inefficiency, social segregation, and expensive infrastructure provision.

First, leapfrog development frequently linked with economic inefficiency. Leapfrog development can be undesirable that reducing the land rent combine with increasing average commuting cost per household to the city center. Resident in the leapfrog development who lived or work in the city towns have to pay more amounts for the commuting costs daily. Residents of leapfrog development will suffer from the substantial lost of commuting costs.

The second problem is social segregation. In the case that green open space causes leapfrog development, it is possible to engender social segregation. Social segregation widens socio-economic disparities as in Hudalah (2007) that a single high-income develop neighborhood around the best side of green open space, where spatially separated from low-income neighborhoods other side of green open space that far from City center. The green belt and leapfrog new town development result in a significant discontinuity of urban population and employment density gradient.

The third problem related to an expensive infrastructure provision. Leapfrog developers mostly become free rider on the existing infrastructure built by the government. The externalities of the new development causes the government need to increase infrastructure capacity. Another infrastructure problem is that public services such as water supply, road, and electrical network are more expensive to provide under discontinuous development. There will be long infrastructure connection between leapfrog development and city center.

Underestimated those problems of the leapfrog development and disorganized land use management controlling city development, small private developers has made city expansion become fragmented by small scale housing spontaneous development.

3. RESEARCH METHODS

3.1. Research Framework

Research framework will divided into four steps, data preparation, data processing, modeling, and analysis of correlation. Figure 3.5 show research framework.

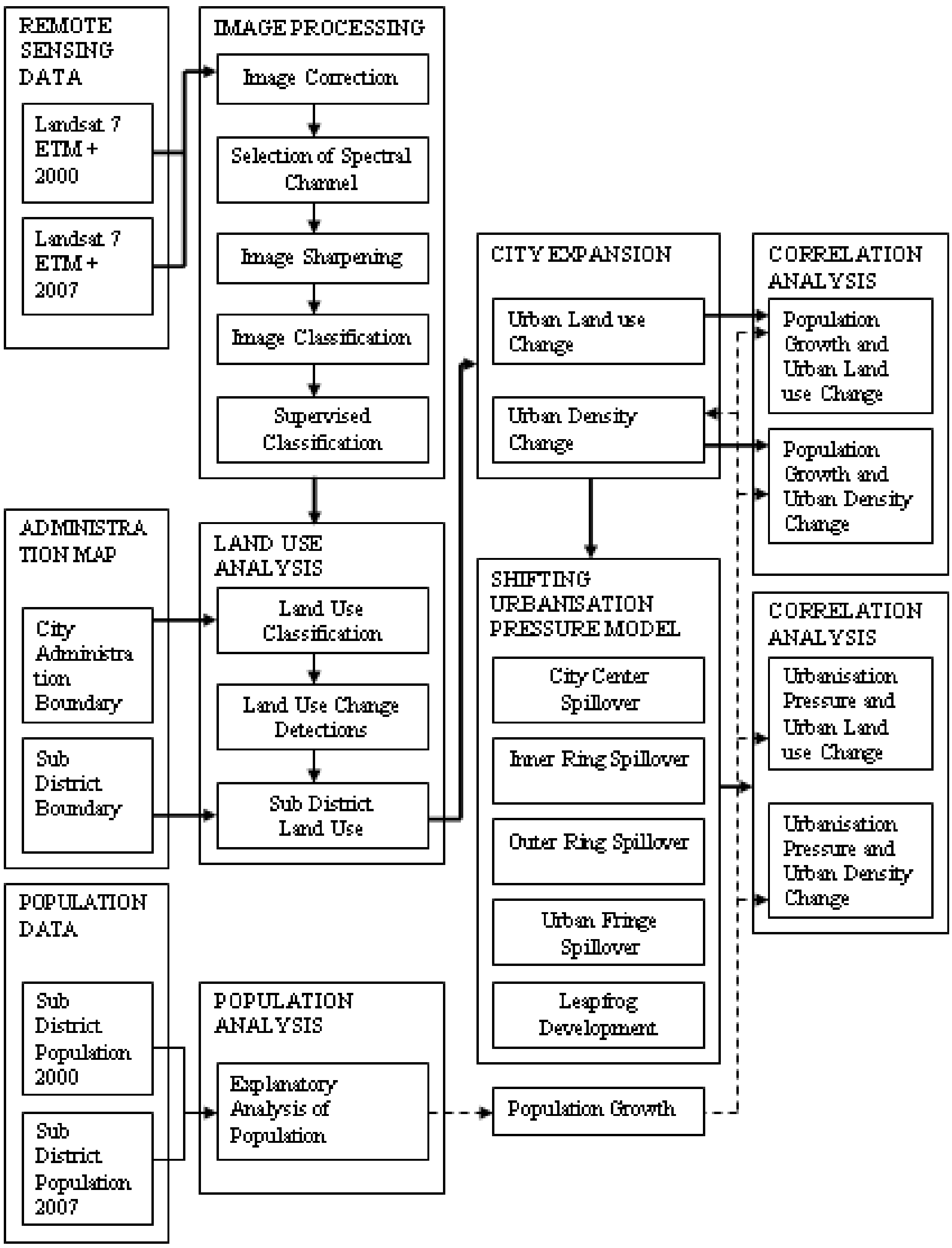


Figure 3.1 Research Framework

The first step is data preparation. Data preparations consist of preparation remote sensing data, preparation administration map and preparation for population data of sub district.

The second step is data processing. This step is process data into information. Detail of image processing explained in sub chapter 3.1. Other process is land use analyses as in chapter 3.2 that extract image processed data into land use information. The other process is population analysis, which explores sub district population data in sub chapter 3.3.

The third step is modeling. Develop robust model of shifting urbanization pressure to prepare analysis process. This model inflate urban land use change into city center spillover, inner ring spillover, outer ring spillover, spillover of urban fringe, and leapfrog development, so that shifting of population growth as urbanisation pressure will arise. Details of this step explain in sub chapter 3.4.

The last step is correlation analyses that verify hypothesis, whether population growth affects to city expansion or there is no correlation. This step also will explain correlation population growth and shifting urbanization pressure that explained in sub chapter 3.5. Furthermore, this step will examine how urbanisation pressure shapes city expansion.

3.2. Image Processing Methods

Land use data were obtain from image processing of Landsat satellite images with the following steps; selection of spectral channel, geometric correction, image sharpening, and image classification.

3.2.1. Image Correction Process

The first image correction is geometric correction. During satellite image acquisition, a geometric distortion can occur, such as influence of curvature earth, earth rotation, effect of panoramic position. The distortion can cause objects in satellite image have different position on earth surface (Sitorus et al., 2000). Geometric correction process, objects as base point in satellite image and basic map have the same object that same and stated as Ground Control Point. GCP need for correction adjusted with accuracy of the models.

Technically, correction methods can be done by many ways, two of them are image to image correction and image to map corrections.(Sardana, 2005) Image to image correction is image alignment using satelite image as base of correction. In the other hands image to map alignment is corection of image using map as a base of correction.

Geometric correction in this research used ArcGIS with the command control Align Tools. Explanation of geometrict image correction process as show on figure 3.2.

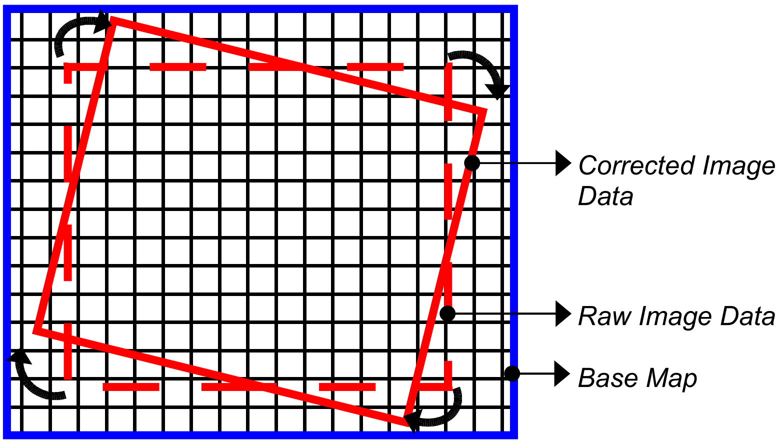


Figure 3.2 Geometric image corection process. (Sardana, 2005)

The second image correction is radiometric correction that conducted to repair radiometric error, that grey value shifting of object from the exact value. Radiometric error caused by sensor error, atmospheric electromagnetic interference, or transmission error from satellite to grounds stations

Those errors repaired by using absolute value correction to the relative value method. In this research radiometric correction only to the relative value, that histogram and normalization index used water reflection as zero (0).

3.2.2. Selection of Spectral Channel Process

Landsat satellite image has limited spectral resolution, but it has high spatial resolution (Elachi, 2006). Therefore, in order to make model we need to combine Landsat 7 ETM+. The bands available are band-1, visible blue with wave spectrum 0.45-0.52µm. Band-2 is visible green with wave spectrum 0.52.0.60 µm. Band-3 is visible red with wave spectrum 0.63-0.69 µm. Band-4 is near infrared, with wave spectrum 0.75-0.90µm. Band-5 is short wave infrared, with wave spectrum 1.55-1.75 µm. Band-6 is thermal infrared, with wave spectrum 104-12.5 µm. The last band is band-7 that shortwave infrared band with wave spectrum 2.08-2.35 µm (Aronoft , 2005). Figure 3.3 show Landsat image combinations of Banjarmasin, Indonesia.

Image loading is visualization process of satellite image data digital format that consist of bands become three-color channel showed together in Red-Green Blue (RGB) format. Visualization process of Landsat image into three RGB channel, can possibly make user to change combination of bands that appropriate with desired visible object. Three combinations of the seven Landsat thematic map data, that are normal color, color infrared, and simulated color (Aronoft, 2005). The three combination of Landsat image combination is in figure 3.3.

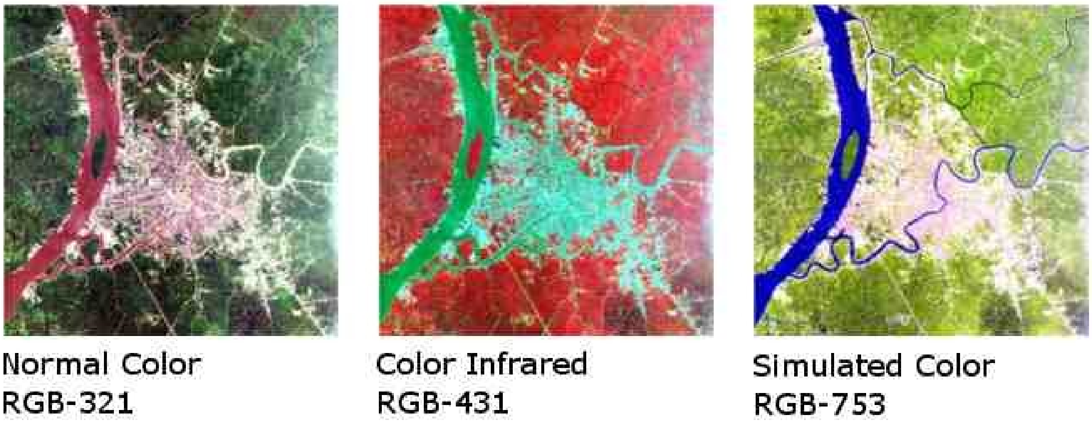


Figure 3.3 Landsat Image Combinations (Rakhman&Arif, 2010)

Normal color produced by combination of red channel use band 3 (visible red 0.63-0.69µm), blue channel use band 1 (visible blue 0.45-0.52µm) and green channel use band 2 (visible green, 0.52.0.60 µm).

Color infrared can be combined from red channel use band 4 (near infrared, 0.75-0.90µm), green channel use band 3 (visible red 0.63-0.69µm), and blue channel use band 1 (visible blue 0.45-0.52µm).

In addition, to the last combination is simulated color. Simulated color is combined of red channel use Band 7 (shortwave infrared 2.08-2.35 µm), green channel use Band 5 (short wave infrared, 1.55-1.75 µm) or band-4 (near infrared, 0.75-0.90µm), and blue channel use band 3 (visible red 0.63-0.69µm).

The normal color, the band 1 (visible blue) and band 2 (visible green) are atmospheric effect sensitive, that produce fairly dull image. The image affected by atmospheric dispersion of short blue wavelength.

In order to reduce atmospheric effect, simulated color, using band 3 (visible red) to replace band 1 (visible blue) and using two short-wave infrared bands that produce more contrast and appears as a normal color interpretation.

Color infrared image, in the other hands can distinguished easily vegetation type and give clear differentiation of urban land use and green open space. Therefore, this type of image will be the most appropriate for analyzing shifting urbanization pressure, that analyzing conversion from green open space into urban land use.

Therefore, base on those considerations, this research band selection will use band 3 (visible red), band 4 (near infrared) and band 7 (shortwave infrared 2.08 -2.35 µm).

Satellite image combination in ENVI 4.3 has two methods that are permanent and temporary. A first method, permanent is combined satellite image into a composite RGB file. The second method is temporary, that satellite image combination not saved into file only saves in memory. This second method of image composite RGB is faster than first methods, but in shifting urbanization pressure first method is more appropriate due to the file will be used in the next analysis step.

Permanent composite band combination used Menu Available Band List, so that band adjustment on RGB composite color can produce permanent file.

3.2.3. Image Sharpening Tools

Image sharpening tools in this research used to merge a low-resolution color, image with a high-resolution gray scale image that re-sampling to the high-resolution pixel size. Landsat has only one SWIR (Short Wave Infra Red) band that makes predicting spectral feature difficult (Winter, 2006). Nevertheless, image sharpening technique can use HSV (Hue Saturation Value) transforms that for transform byte-scaled RGB (Red Green Blue). Other sharpening method, a Gram-Schmidt transforms use for sharpening spectral imagery.

HSV sharpening is transforming a RGB image to HSV color space, replace the value band with the high-resolution image, and automatically resample the hue and saturation bands to the high-resolution pixel size. The output RGB images will have the pixel size of the input high-resolution data (Vrabel, 2000)

Gram-Schmidt transform is sharpening multi-spectral data using high-resolution data. The low spatial resolution spectral bands that use to simulate the panchromatic band must drop in the array of the high spatial resolution as in Laben and Brower (2000). Image sharpening result is show in figure 3.4.

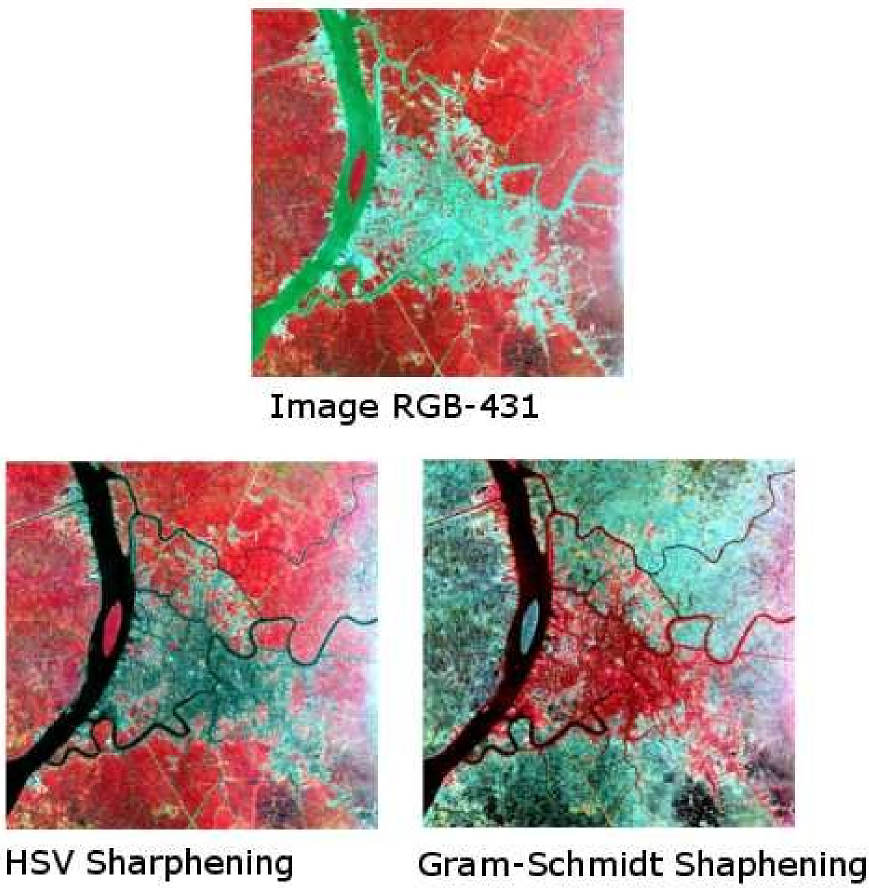


Figure 3.4 Image Sharphening (Rakhman&Arif, 2010)

3.2.4. Image Classification Process

According to Gonzalez (1977), classification is a process, which all the pixels in an image that have similar spectral signatures identified to become a certain class (Sitorus et.al, 2000).

As mention in chapter 2.1 land use change on page 4, classification type has many standards in land use classification two of them Anderson classification and Malingreau classification. This research will use classification of modified Anderson Classification (1976) that proposed a hierarchical classification framework; first is urban or built up land, second is agricultural land, third is rangeland, fourth is forestland, fifth is water, sixth is wetland, seventh is barren lands, eighth is tundra and ninth is perennial snow or ice (Aronoff, 2005). Nevertheless, classification system that used in shifting urbanization pressure model for naming classes will simplify.

3.2.5. Supervised Classification Methods

Classification Method, are divided into two classification method can be used in image processing, supervised and unsupervised classification.

Supervised classification is the analyst defines area in the image that is representatives of each information class. Field data use representation of Landsat satellite image to define areas that are urban land use, open space, and water body.

On the other hands, unsupervised classification, the analyst does not provide examples of the classes found. Instead, pixels are classified using algorithms that find statistical groupings in the spectral data with the assumption that some or all those groupings will correspond to useful information classes (Aronoff, 2005).

This analysis will use supervised method with ISO data (Iterative Self-Organizing data) algorithm. Shifting urbanisation model will use a supervised method that has advantage that users can give identity constructively from reference data. Training classes selected within the Landsat satellite images that are representative of land use classes of interest (Kubi, 2007)

Supervised methods with ISO data will tests pixels that have not yet identified and group pixel into a class based on clustering system. The result of this classification represents classes identities relied on grouping of standard maximum deviation, minimum distance, or classes mean parameters.

3.3. Land use Analysis Methods

3.3.1. Land Use Classification Methods

Land use detection results of supervised methods are three classifications that are urban land use, open space, and water body.

First result is urban land use. Urban class consists of settlement, industrial area, road, and seaport. Spectral profiles of urban land use are high red spectral, high blue spectral and low green spectral.

Second result is open space land use. Open space class represents land use of vegetation and farming. Open space spectral profiles are high green spectral, low red spectral and low blue spectral.

The third result is water body. Water body has a high blue spectral profile also zero green spectral and zero red spectral.

Furthermore, land use thematic map will utilize city boundary of Banjarmasin city 2000 as administration borderline. Administration borderline map has 1: 50.000 map scales. The Administration boundary map is in JPEG format. Therefore, need to convert JPEG into Geo-tiff format. Process of geo-referencing of administration boundary will employ Landsat 2000 satellite image as base map.

3.3.2. Land Use Change Detections

Land use change detection is the first step of analyzing shifting urbanization pressure, identifies the actual location and magnitude of change of the urban land use changes analyzed by digital change detections. Digital change detection methods according to Singh (1989) divided into ten methods that are *univariate* image differencing, image regression, image rationing, vegetation index differencing, principal component analysis (PCA), post-classification comparison, direct multi-date classification, change vector analysis, background subtraction, and *kalmogorov-smirnov* test. Other new method is SMA (Spectral mixture analysis). SMA method used to handle the mixed pixel problem, which increases accuracy of traditional classification (Kubi, 2007).

Urban land use changes in shifting urbanization model only need a simple detection method. From those methods, two of them are appropriate for analyses of urban land use change that are post-classification comparison and direct multi-date classification.

The first methods, post classification comparison, compare of different classified thematic map that produce map changes show a complete matrix of changes (Singh, 1989). The advantage of post classification comparison is minimizing the problem of normalizing for atmospheric and sensor difference between two dates. This method also avoid problem of getting accurate registration of multi-date images.

The second methods, direct multi date classification based on single analysis of combined data set of two or more dates to identify area of change. The change classes should have significantly different statistic from no change classes (Singh, 1989). Direct multi date classification method has advantage that only requires a single classification. Problems of direct multi date classification are very complex classification process and too many features. Other limitation is that the temporal and spectral features have equal status in the combined data set.

Nevertheless, post classification comparison has limitation of multiplying the accuracies. Multiplying the accuracies shows reduce of accuracies comparable to the product of each classified thematic map. If classified land use 2000 thematic map has 80% accuracy, and classified land use 2007 thematic map has 90%, then joint classification only 72% Accuracy (0.80x0.90x100%=72%). Landsat 7 enhanced image about 15 meter with accuracy 72%, so the image accuracy resolution about 20.8 meters. Minimum measurement is 0.1 ha or 1000 meter square. Requirement image accuracy is $\sqrt{1000}$ or about 23 meter. Therefore, this image process more than enough for urban land use changes analysis for shifting urbanization pressure model. Other study about accuracy of Landsat 7 ETM in Indonesia conducted by Danoedoro, they found for original classified image with 40 classes acuuracy about 86.84% and Kappa Index about 0.8628 (Danoedoro et al., 2004).

3.3.3. Overlay of Sub District and Land Use Change

Sub district land use map is result of overlay methods between land use map and sub district boundary map. Tables generated by overlay between land use map and sub district boundary map that give sub district extraction of each polygon as well as give the name of each sub district by relating name of each sub district administration map. Four variable columns consist of first sub district total area, second sub district urban land use, third sub district open space, and fourth sub district water body.

The next analysis is more specific to urban land use change of sub districts. This will exam structure and pattern of sub district urban land use. This analysis also exam pattern of sub district urban land use change compare to open space as land availability to expanse.

3.3.3. Explanatory Analysis of Population

Sub district population growth as driving force of city expansion. Data use sub district population 2000 and sub district population 2007 base on 2005 census. Sub district will be independent variable for the next analysis.

Explanatory analysis will describe population growth structure of sub districts. Description includes the highest population growth of sub district, the lowest population growth of sub district and population growth average of sub district.

3.3.4. Urban Density Change Analysis

Urban density defined in planning refers to the number of people inhabiting a given urbanized area. In the other word, urban density change is population growth divided by urban land use change. Urban density change formulated as follow;

$$DensityCHG_i = \frac{Pop_i - Pop_h}{UrbanLC_i}$$

Density CHG_i = Urban Density Change of sub district *i*
Pop_i =Population year 2007 of sub district *i*
Pop_j =Population year 2000 of sub district *i*
$UrbanLC_i$ =Urban Land use Change of sub district *i*

3.4. Population Growth and City Expansion Correlation

To check whether population growth and city expansion has correlation or no correlation, analysis will use regression analysis. Regression is relationship between two or more independent variables (X_1, X_2, X_3 …) with one dependent variable (Y).

Positive regression result mean independent variables (X_1, X_2, X_3 …) has positive (direct). Therefore, if independent variables increase, dependent variables (Y) also directly increase. Correlation analysis between population growth and city expansion will use Coefficient of determination (r^2) coefficient and t test result as parameter.

Coefficient of determination (r^2), explain independent variables (X1, X2, X3,…) will explain dependent variables (Y) as much as (r^2)%, where (100- r^2)% explain buy other variables. Coefficient of determination (r^2) formulated as follow;

$$r^2 = \frac{\sum \left(\hat{Y}_i - \overline{Y}\right)^2}{\sum \left(Yi - \overline{Y}\right)^2}$$

The other parameter is t test. Result of t test show how far independent variables (X1, X2, X3,…) individually explain dependent variable. (Y). So that if t-test positive, H_0 is rejected and H_1 is accepted. This means there are positive significant relationship between independent variables (X1, X2, X3 …) and dependent variable (Y). Formulation of t-test is as follow;

$$t = \frac{\overline{X}_1 + \overline{X}_2}{\sqrt{\frac{S_1^{\ 2}}{n_1} + \frac{S_2^{\ 2}}{n_2}}}$$

Where

t = result of t-test

$\overline{X}_1$ = means of sample 1

$\overline{X}_2$ = means of sample 2

n_1 = number of subject in sample 1

n_2 = number of subject in sample 2

S_1 = variance of sample 1 = $\frac{\sum (X_1 - \overline{X}_1)}{n_1}$

S_2 = variance of sample 2 = $\frac{\sum (X_2 - \overline{X}_2)}{n_2}$

Assumed there is correlation between X and Y, so that correlation formulated;

$$Y = \beta_0 + \beta_1 X_i + \varepsilon_i$$

Where

$$\beta_1 = \frac{(n\sum xy - \sum x \sum y)}{\left(n\sum x^2 - \left(\sum x\right)^2\right)}$$

$$\beta_0 = \frac{\left(\sum y \sum x^2 - \sum x \sum xy\right)}{\left(n \sum x^2 - \left(\sum x\right)^2\right)}$$

$$\varepsilon i = \sqrt{\frac{\sum \left(Y - \hat{Y}\right)^2}{n - 2}}$$

3.4.1 Population Growth and Urban Land use Change Correlation

Correlation test between population growth and urban land use change will confirm if population growth affect to city horizontal expansion. Hypothesis of this correlation is bellow:

H_0: There is no linear relationship between population growth and urban land use changes.

H_1: There is a linear relationship between population growth and urban land use changes.

Assumed that there is a linear relationship between population growth and urban land use change:

$$\text{Urban } LC_i = \beta_0 + \beta_1 * PopCHG_i + \varepsilon_i$$

Where:

Urban LC_i = Urban Land use Change Sub District *i*

$PopCHG_i$ = Population growth Sub District *i*

3.4.2 Population Growth and Urban Density Change Correlation

The second correlation analysis is relationship between population growth and urban density change. This analysis attends to examined population growth affect vertical urban expansion with hypothesis:

H_0 There is no linear relationship between population growths and density change

H_1 There is a linear relationship between population growths and density change

Assumed that there is a linear relationship between population growth and density change, where population growth is X variables and urban density change is Y variables.

$$\text{Density } C_i = \beta 0 + \beta 1 * PopCHG_i + \varepsilon_i$$

Where:

Density C_i = Urban Density Change Sub District *i*

$PopCHG_i$ = Population growth Sub District *i*

3.5. Shifting Urbanisation Pressure methods

Shifting urbanisation pressure model has two type expansions that are urban spillover and leapfrog development.

The first city expansion, urban spillover consist of four type that are city center spillover, inner ring spillover outer rings spillovers, and spillover of urban fringe. This urban spillover type is base on simple city structure.

City center is a focal point of a city. City center function includes the commercial, office, retail, and cultural center of the city as well as the center point for transportation networks.

Inner ring spillover is area surrounding to the city center. Urban spillover will directly expand to this neighboring region when the city center growth prohibited.

An outer rings spillover is area surrounding the inner rings. If inner rings urban spillover is limited, the urbanisation pressure will shift to these regions. Because of population in urban spillover not always increases. Therefore, outer rings urban spillover divided into positive population growth area and negative population growth area.

Spillover of urban fringe is spillover of sub district existing area that has leapfrog development. Because population data is administration base, there will be also sub district urban spillovers in leapfrog area.

The second type city expansion is leapfrog development. Leapfrog development is discontinuous development in which more remote land developed previously is located close to city central. In the other word, leapfrog development is urban land expansion showing a dispersion of new city expansion on isolated tract separated from other region by open space.

Finally, shifting urbanization pressure model is compilation of population growth and urban land use change, in which Y is population growth, and X is urban land use change. This model will use to research correlation between urbanization pressure and city expansion.

3.6. Urbanisation Pressure and City Expansion Correlation

3.6.1. Urbanisation Pressure of Urban Land use Change Correlation

There is two analysis will explore urbanization pressure affect to horizontal city expansion. The analyses are urbanisation pressure and urban land use change magnitude and correlation analysis between population growth and urban land use change.

The first exploration is to analysis urbanisation pressure and magnitude of urban land use change. Urbanisation pressure and urban land use change magnitude is the percentage of urban land use change compared to the last urban land use. Urbanisation pressure of urban land use change equation as follow;

$$P.Lc_i = \frac{(UrbanLu2007 - UrbanLu2000)_i}{UrbanLc2007_i} \times 100\%$$

P.Lc_i : Urbanisation pressure of urban land use change
$UrbanLu2007_i$: Urban Land use 2007 of i area
$UrbanLu2000_i$: Urban Land use 2000 of i area

The second exploration is correlation analysis between population growth and urban land use change of shifting urbanization pressure model, with hypothesis as follow:

H_0: There is no correlation between population growth and urban land use change
H_1: There is correlation between population growth and urban land use change

3.6.2. Urbanisation Pressure of Urban Density Change Correlation

Analyses of vertical city expansion will exam urbanization pressure of urban density change and correlation between two variables.

Urbanisation pressure of urban density change is the percentage of urban density change compared to the last urban density. In this case, the change equals the percentage of urban density change 2000-2007 divided by urban density 2007. Urbanisation pressure of urban land use change formulated as follow;

$$P.Dens_i = \frac{(Dens2007 - Dens2000)_i}{Dens2007_i} \times 100\%$$

P.$Dens_i$: Urbanisation pressure of urban Density change
$Dens2007_i$: Urban Density 2007 of *i* area
$Dens2000_i$: Urban Density 2000 of *i* area

Correlation analysis of two variables is population growth as independent variable and urban density change as dependent variable. The hypotheses of correlation between population growth and urban density change formulated as follow;

H_0: There is no correlation between population growth and urban density change
H_1: There is correlation between population growth and urban density change

3.7. Data, Software, and Limitations

3.7.1. Research Dataset

3.7.1.1. Remote Sensing Data

Remote sensing data will use Landsat 2000 and Landsat 2007. Detail of Landsat image show in table 3.1

Table 3.1 Satellite image description data

No	Satellite Image	Path Rows	Orbital Date
1	Landsat 2000	Path 117 Row 062	16 July 2000
2	Landsat 2007	Path 117 Row 062	05 August 2007

3.7.1.2. Map Data

Digital Banjarmasin city administration boundary map, SHP file format, year 2000, Source BAPPEKO Banjarmasin

Digital Banjarmasin city sub-district boundary map SHP file format, year 2000, Source BAPPEKO Banjarmasin

3.7.1.3. Population Data

Population Data 2000, source Banjarmasin statistical agency, Census 2000

Population Data 2007, source Banjarmasin statistical agency, population 2007 base on estimation base on midterm census 2005 (Perhitungan antar sensus/PASUS)

3.7.2. Software used

3.7.2.1. ENVI 4.3

ENVI is the software for processing and analyzing geospatial imagery used by GIS analysts. ENVI software developed by ITT as image analysis combines spectral image processing technology and user-friendly interface to produce information. This software will used to process Landsat spectral satellite image into land use thematic map.

3.7.2.2. ArcGIS 9.3.1

ArcGIS is integrated GIS software developed by ESRI that offers a standards-based platform for spatial analysis and GIS data management. ArcGIS is a handy utensil for spatial analysis and free for master spatial science program student of RUG (Student version of ArcGIS 9.3.1) including the complete ArcGIS analysis tools.

3.7.2.3. SPSS 16

SPPS is a statistical data analysis program developed by IBM Company. This program will used for analyzing correlation between urban LULCC and population. Due to limitation of copyright, shifting urbanization pressure statistical analyze will be conducted on Campus GIS Lab computer.

3.7.2.4. AutoCAD

AutoCAD is a computer aided design program developed by Autodesk Company. This program will used for drawing shifting urbanisation pressure model.

3.7.3. Research Limitation

Major limitation of the research data is an error in Landsat satellite image 2007 on band 3 visible red. Although the visible Red band can opened in ENVI, but I thinks it will be better to use other Band. Another technical problem is that are some cloud on Landsat satellite image 2000 at eastern part of Banjarmasin City. Fortunately, the clouds are not covered the study area, only end of eastern part of the city that is green open space area. Nevertheless, this problem can be solving via supervised classification methods. These both limitations will not affect analysis process of shifting urbanisation pressure.

Other limitation is modifiable areal unit problem (MAUP) effect (Bhatta, 2010). MAUP effect is a problem of spatial statistic in the analysis of spatial data arranged in zones such us land use. Results of statistical data depend on particular size of the land use. Two problems are the scale effect and the zoning effect (Bhatta, 2010). The scale effect is the variation in spatial statistic that reflect of number of bigger land use utilize in smaller unit. In this research, due to spatial resolution of Landsat 7 ETM is 15 meter so that units of land use larger than 15 m will transform to lower units. For example, house with size 15x17 m will transform to house 15x15 m. The zoning effect is the variation in spatial statistic arising from the transformation of small area unit into larger unit. This effect, mostly on open space of land use detection, where vegetation lowers than 15 m will transform to 15 m resolution. Therefore, the same spatial statistic area result will be different for the same analytical methods, depend on with one is more dominant, urban land use or open space.

Finally, shifting Urbanisation pressure study will emphasize only on correlation between population and urban land use change. Other factors such as politics, culture, etc not analyzed.

3.8 Description of Study Area

Banjarmasin City is capital of South Kalimantan. There four description of the city that is physical characteristic, history, population and land use changes.

3.8.1. Physical Characteristic

The first description is physical characteristics. Banjarmasin city is located on strategic location as the main access of Trans of Kalimantan. Land transportation connects the province of Central Kalimantan and East Kalimantan, and sea transportation connects the province of south Kalimantan and Central Kalimantan geographically, as show in picture 3.4.

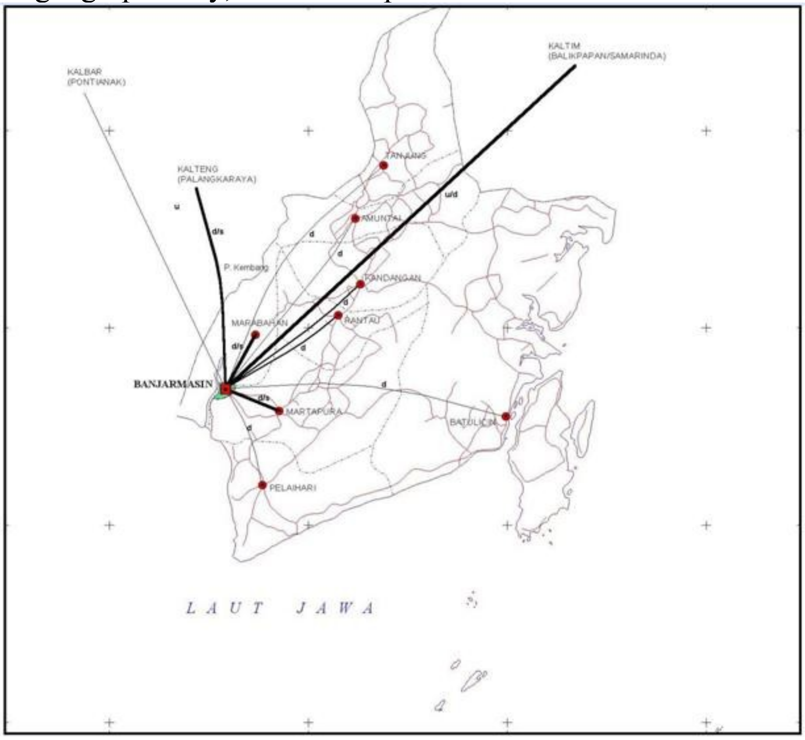


Figure 3.4 Accessibility of Banjarmasin City (Bappeko, 2000)

Banjarmasin city is located on the position of 3’15’-3’22 south latitude and 114’98’ East longitude. Its wide covers 72km2 or about 0.19% of the wide of the South Kalimantan province. Banjarmasin divided into five districts, namely:

(1) Sub district of North Banjarmasin is 15.25 km2 widely;
(2) Sub district of East Banjarmasin is 11.54 km2 widely;
(3) Sub district of West Banjarmasin is 11.54 km2 widely;
(4) Sub district of Central Banjarmasin is 13.37 km2 widely;
(5) Sub district of South Kalimantan is 20.18 km2 widely.

The administrative borders are Northern part is bordered on Barito Kuala Municipal, Eastern part is bordered on Banjar Municipal, Western part is bordered on Barito Kuala Municipal and Southern part is bordered on Banjar Municipal.

3.8.2. History of Banjarmasin

The second description is History. Banjarmasin City starts from the long history of Banjar Kingdom. At that time, it had known the term of Banjarmasin. This term taken from the name of Patih who has rendered many services in founding the Banjar kingdom. He has Patih Masih who came from the village of Oloh Masih that in the term of ngaju language means the people of Malay or village of Malay people. The village of Oloh Masih becomes village of Banjarmasin thereafter. Patih Masih and some of other Patih agreed to assign the Prince Samudera to become The King. Prince Samudera is one of the sons of Kingdom Daha who thrown away and isolated in the village of Oloh Masih. Since that time, the Banjar Kingdom founded. Then Prince Samudara subjugated Muara Bahan and other small kingdoms, and dominated the river lanes where at that time became central of trading. The development of Banjar Kingdom had disturbed the power of Prince Tumenggung. He has the King of Daha who was also the uncle of Prince Samudera.

Finally, there had been invasion by Daha. The long war had made Prince Samudera had been pushed and needed some helps from Demak Kingdom. Demak Kingdom was the first Islamic and the largest Kingdom in Indonesia. Demak agreed to help Banjar Kingdom with the term that the King and their people declared to become Moslem. Prince Samudera agreed. The military of Demak came with Khatib Dayan to Islamize the people, and the Prince Samudera changed his name to become Sultan Suriansyah. Banjar Kingdom attacked and defeated Daha with the supports and help of Demak. It occurred on September 24, 1526. The event declared as the day of the winning of Prince Samudera. It was the origin Banjar's Islamic empire. The surrender of Daha Kingdom to Banjar Kingdom is the birthday of city of Bandjarmasih as the capital city of the Kingdom; it had succeeded in dominating the rivers and mainland of South Kalimantan.

Name of Banjarmasih called by the Dutch Banjarmasih. Until 1664, the letters came from Nedherland to Indonesia for Banjarmasin Kingdom still mentioned the Kingdom of Banjarmasin. In the dutch, they called it "Bandzermash" after 1664 it changed to be bandjarmassingh, in the middke of 19 century, when the Japanese arrived, it mentioned again Bandjarmasin and the in Indonesia New Spelling, it is mentioned Banjarmasin.

In the Dutch era, Banjarmasin had become the harbor for all the area of Barito river stream. It was also a transit harbor for the ships, which came from Singapore and Java to the east coast of East Kalimantan. The goods sent from Kalimantan namely rattan, dammar, purun mat, duck egg, fruits, plaited rattan, material, jewelry, Diamonds. The goods sent from java and Singapore such as rice, salt fish, ceramics, kerosene, salt, etc.

3.8.3. Population History

The third description is population. The population of Banjarmasin city in 1995 is about 534,025 people, and decrease in 1996 become about 502,627 people. Population in 1997 highly increase become about 546,466 people. Population growth slowly increase in 1998-1999 from 550,606 people to 558,550 people, Population 2000 base on projection is about 532,556 people but it is over estimation, that later corrected by population census 2000.

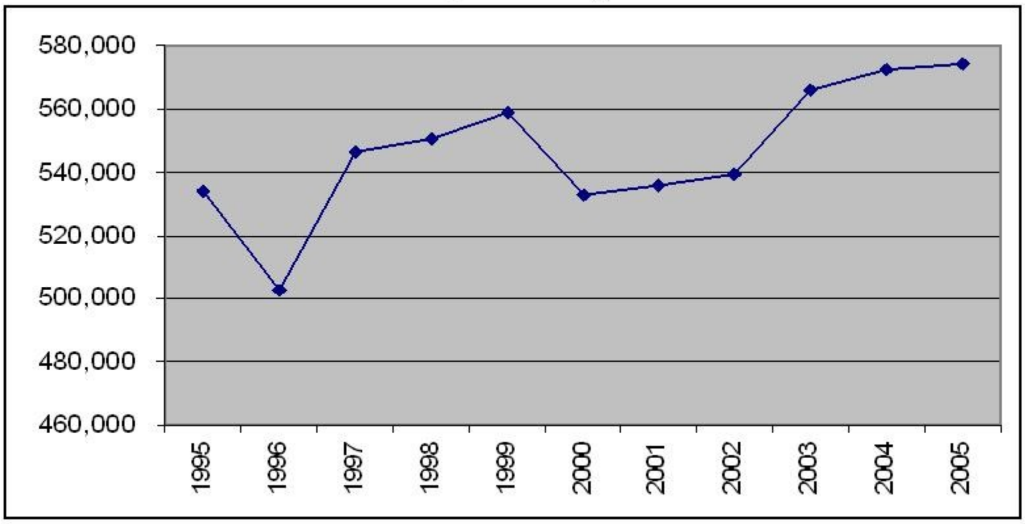


Figure 3.5 Population

Urban density change pattern, as show in figure 3.5, the densest is in the Banjarmasin Tengah district. This density due to in Banjarmasin Tengah district is a city center.

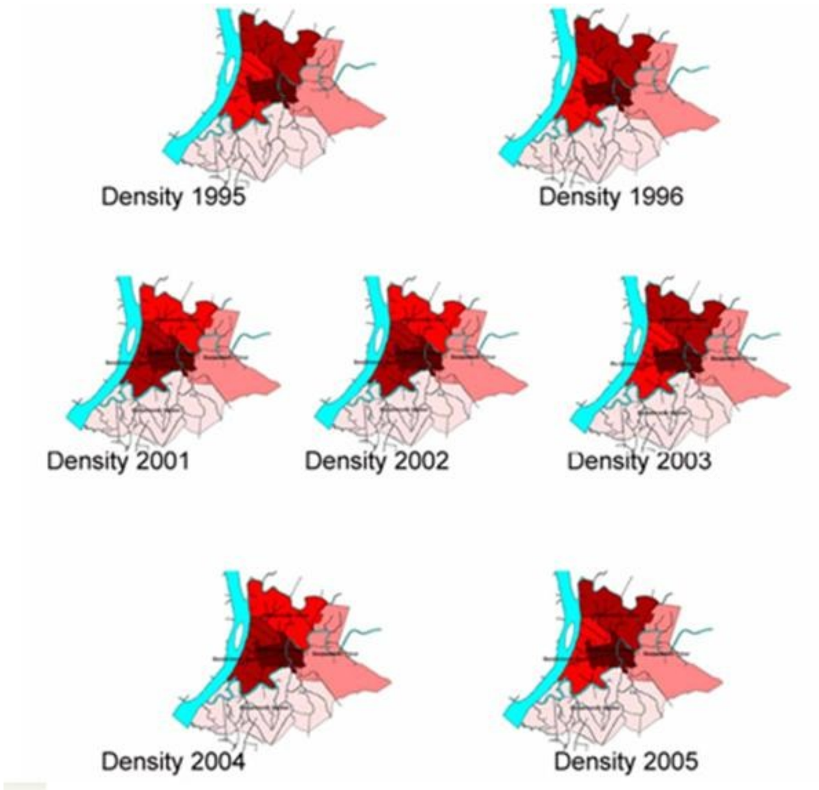


Figure 3.6 Urban density change pattern (Rakhman et al., 2008)

Meanwhile the second dense is north part in Banjarmasin Utara district, due to increase of new settlement. In year 2001-2002 Banjarmasin Utara development slowing down that affected from Indonesia Economic crisis and the second most urban dense is the west part of the city. In year 2003 to 2005, the second densest back to north part, where many local developer starts build new settlement. (Rakhman, et al., 2008)

3.8.4. Land use Change

3.8.4.1. Urban Land use

Urban land use consists of city center, settlement, industrial area, road, etc. Figure 3.7 show picture of Banjarmasin urban land use. City of Banjarmasin as part of South Kalimantan province has directed function as (1) Hinterland, center for surrounded region services, (2) Center for communications between region, (3) Center of manufacturing industry and (4) Center for housing and settlement (Surya, 2007). Those four directed function has generated rapid urban land use expansion.

Figure 3.7 Urban land use Pictures

The urban land use change driving force, especially in commercial land use has two main factors that are commercial aglomeration and population density

(Anggita, 2007). The research founded that the trends of commercial development did not distributed equally in each district in Banjarmasin city.

Urban land use change of Banjarmasin city is mostly expansion of settlement. Urban spillover is conversion of open space into urban land use. This type of land use conversion is mostly from paddy field. Leapfrog development also conduct in urban fringe.

There is three type of leapfrog development in urban fringe that are high class leapfrog development in east part of the city, middle income leapfrog development in the south part, and lower income leapfrog development is the west part of the city.

Urban spillover

Middle income class leapfrogs development

Urban Land use into water body

Low income class Leapfrog development

Figure 3.8 Urban Land use change Pictures

Nevertheless, there is also reduction of urban land use, conversion urban land use into water body. This conversion is provincial government removing squatter settlement from river Martapura.

3.8.4.2. Open Space

Second land use type is open space land use. Open space class represents land use of vegetation and farming. Banjarmasin has low land vegetation type, due to Banjarmasin located in tidal area of Barito River. Lower land vegetation can discover such as coconut tree and lower tree. Other type of open space is paddy field and scrub.

Figure 3.9 Open Space Pictures

Open space in Banjarmasin city mostly converted into urban land use, and a little bit conversion to water body. Conversion of open space to water body is through canalization for farming.

Figure 3.10 Open Space Land use Change Pictures

Current open space structure is base on Banjarmasin Master Plan 1984. The Banjarmasin structure plan is base on green belt that surrounded by low land farming. As stated on City plan point seven stated that open space on the urban fringe with good quality stated at low density level" (Bappeko, 1984).

3.8.4.3. Water Body

The last land use type we will discuss in this research. Main water body of Banjarmaisn city is Barito River and Martapura River Barito River is the big river that mainly use for transportation connecting Banjarmasin to Java Sea. Martapura River use as transportation, network connect Banjarmasin to Martapura hinterland. On the riverbed of Martapura River, there is traditional housing, along the river.

Barito River

Martapura River

Housing along Martapura River

Figure 3.11 Water Body Photo Pictures

River catchments area along the river has pronounced as green open space that are 10 meter of left and right of the river in hgh dense and city center. 15 meter in transition area and 15 meter in the urban fringe (Bappeko, 1984)

Scattered housing on the river

Street Vendor use water body

Figure 3.12 Water Body Land use change Photo Pictures

Although area along the river pronounce as green line but in the reality those area also become part of urban land use. Land use conversion of water body is into urban land use, mostly in Martapura River. Figure 3.12 show some of water body conversion to urban land use. Scattered housing is house develop on the river, where transportation use little boat. Other conversion of water body to urban land use is street vendor that use waterfront area for their temporary building.

Due to this deteriorating of river catchments area, in the later spatial plan, there is also concept to develop waterfront city. This concept is alternative to special development that oriented to water use, so that area along the river will be more effective and productive (Bappeko, 2000).

4. ANALYSIS AND DISCUSSION

4.1. Image Processing

4.1.1. Image Correction

4.1.1.1. Geometric Correction

The geo-referenced of Landsat 7 Geo-TIFF year 2000 will use as the base image. Image files from Landsat 7 Geo-TIFF year 2007 warped to match with Geo-Tiff 2000. Landsat 7 Geo-TIFF year 2007 point made using ENVI.

The image will be use is path 062 row 082. The analysis will use part of Landsat 7 image that is Banjarmasin city only. Therefore, image crop between 114º.31' E to 114 º.45' E and 3 º.15' S to 3 º.23' S.

4.1.1.2. Radiometric Correction

Landsat 7 Geo-TIFF files not contained radio calibration coefficients. Therefore, it needs tools for Landsat TM calibration to specify the calibration coefficients and other related parameters.

Radiometric correction use ENVI menu > Basic Tools > Preprocessing Data Specific Utilities Landsat TM >Landsat TM Calibration. There are two input that the spectral radiance (Ll) and the exoatmospheric reflectance (rp). The Parameters of Landsat 7 Geo-TIFF files obtained from the EROS Data Center as CPF files and Meta data files.

4.1.2. Selection of Spectral Channel

Although we have complete 8 band Landsat image, for the selection of spectral channel that use three band of visible color combination base on Aronoft methods as explained on chapter 3.1.2.

Bands selected are band-7, band-4, and band-3 of Landsat 7 that combined RGB band. Band 7, which represents Red, is a shortwave infrared 2.08-2.35 μm band. Band 4, which represents Green, is near infrared, 0.75-0.90μm; meanwhile Band 3, which represents Blue, is visible red 0.63-0.69 μm. The result can see on appendix B-1

4.1.3. Image Sharpening

Image sharpening technique uses HSV sharpening to transform Landsat 7 RGB-743. HSV set for hue, saturation, and value. Hue is the attribute of a visual sensation similar to perceived colors: red, yellow, green, and blue. Saturation is color brightness. HSV sharpening transforms Landsat 7 RGB-743 with resolution 30 Meter to HSV color space, replaces the value band with Landsat band-8, and resamples the hue and saturation bands to the high-resolution pixel size of band-8. The output RGB images will have the 15-meter pixel size of the input high-resolution data. The result of HSV Sharpening is on appendix B-2.

4.1.4. Landsat Image Classification

Landsat Image Classification system use in urban land use change for naming classes will simplified into only three classes; those are:

1. Urban class consists of settlement, industrial area, road, and seaport. Figure 4.1 describes spectral profile of urban land use. Spectral profiles of urban land use are high red spectral, high blue spectral and low green spectral.

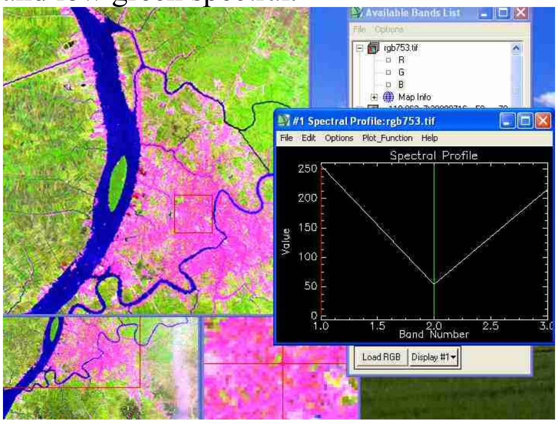


Figure 4.1 Spectral profile of Urban Land use

2. Open space class represents land use of vegetation and farming. Spectral profile of Open Space land use as show on figure 4.2. Open space spectral profiles are high green spectral, low red spectral and low blue spectral.

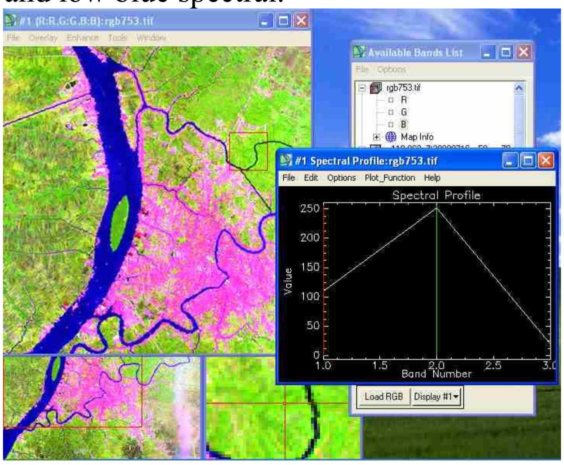


Figure 4.2 Spectral profile of Open Space Land use

3. Water body class; land use is primarily river as shown in figure 4.3. Water body spectral profiles are high blue spectral, zero green spectral and zero red spectral.

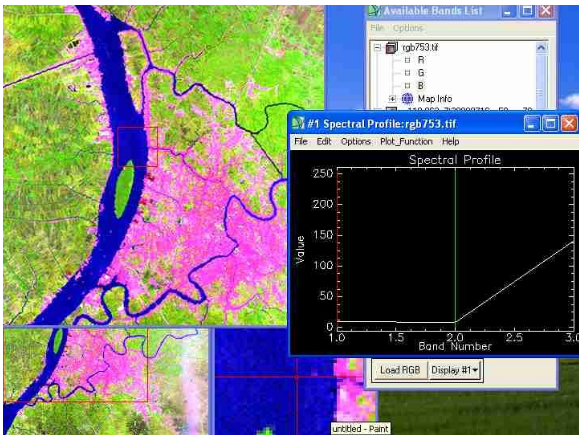


Figure 4.3 Spectral Profile of Water Land use

Supervised image classification as the analyst defines area in the image that represents and pictures each information class. The supervised classification result as show on appendix B-3.

4.2. City Expansion

4.2.1. City Land use Change

4.2.1.1. Land use 2000-2007

Total area of Banjarmasin city is 9,647.5 ha. Land use in 2000 describes that the total area consists of open space land use (6,375.8 ha), urban land use (2,447.3 ha) and water land use (824.4 ha). The land use 2000 as show in Map-1.

After seven year, the city has expanses. Urban land use increases up to 3,385.7 ha. Open space land use reduces into 5,457.6 ha. Water land use, both Barito river and Martapura river, reduce until 804.2 ha. Map 2 shows the 2007 land use.

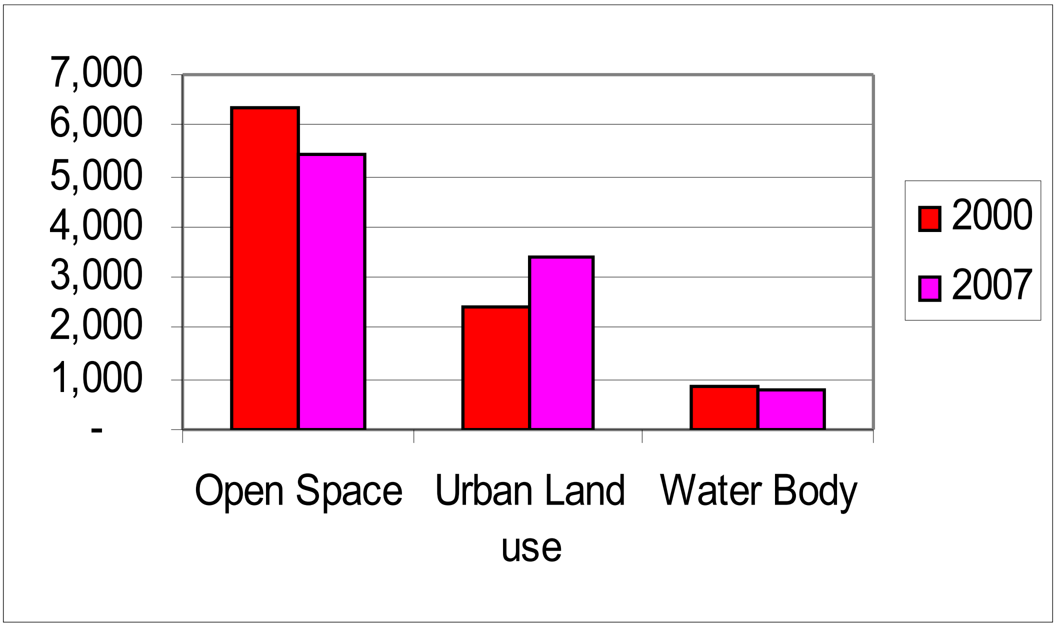


Figure 4.4 Land use 2000-2007

Figure 4.4 shows the land use pattern from 2000 to 2007. The pattern portrays that the water land use (blue) slightly reduces, open space land use (green) reduces significantly; however, urban land use (red) goes up. It is justified by the fact that urban land use change mostly extends from open space.

Land use composition of Banjarmasin city in 2000 comprises open space 66.1%, urban land use 25.4%% and water land use 8.5%. However, Land use composition in 2007 shows that urban land use extends to 35.1%, open space reduces into 56.6%, and water land use reduces into 8.3%. The Land use composition of Banjarmasin city from 2000 to 2007 as show on figure 4.5.

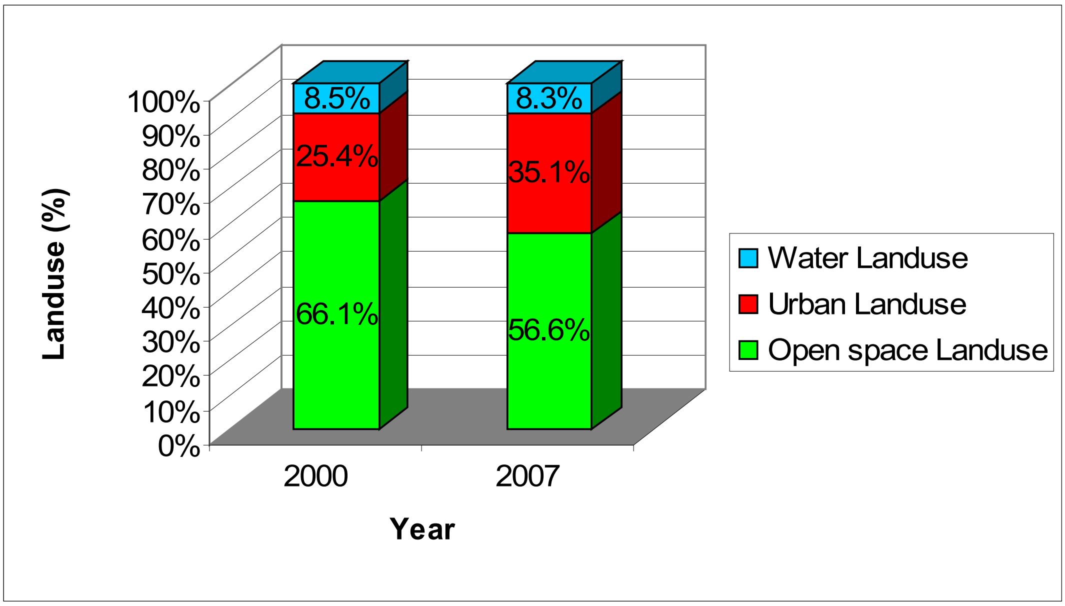
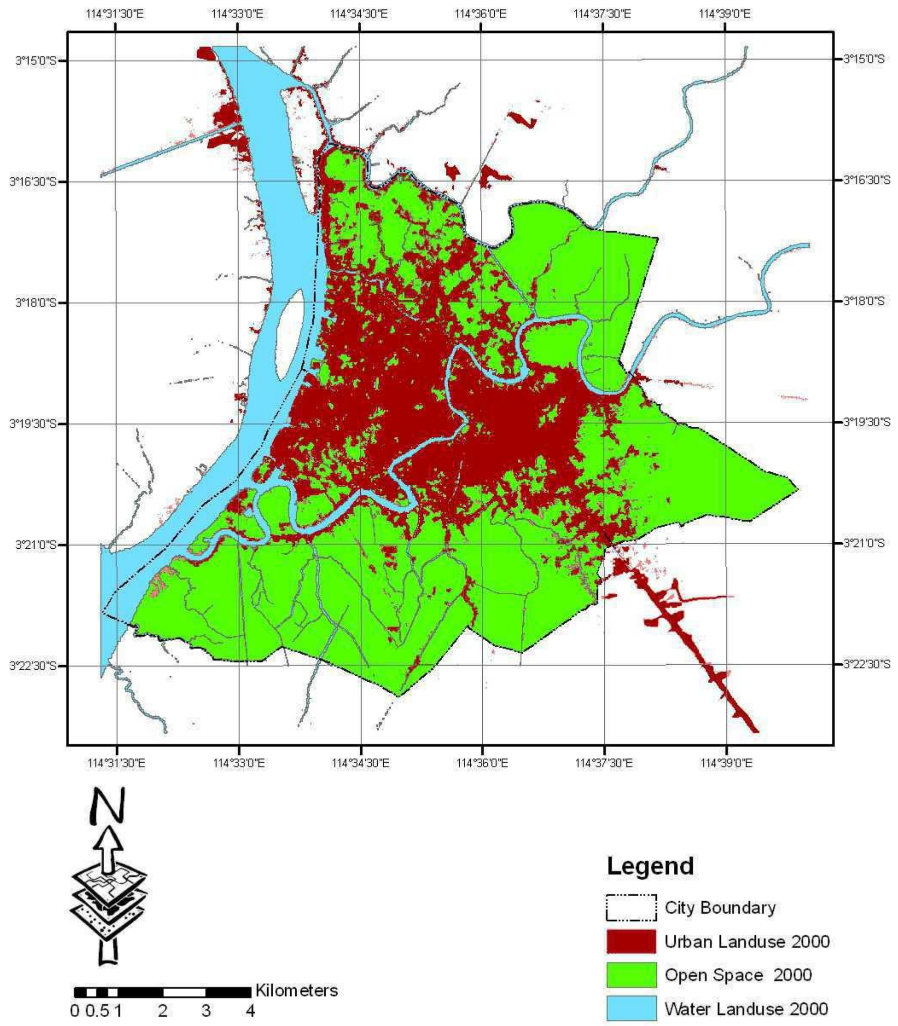


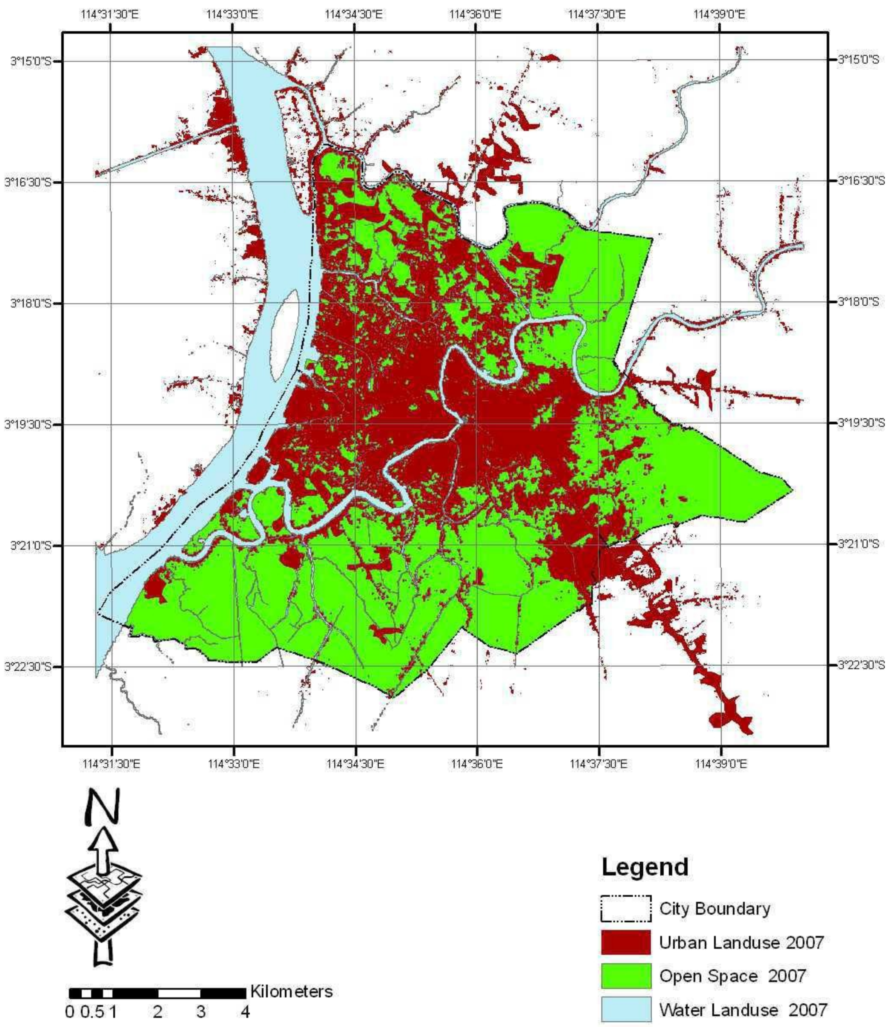
Figure 4.5 Land use Compositions 2000-2007

MAP-1
LANDUSE 2000



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

MAP-2
LANDUSE 2007



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

4.2.1.2. Land use Change

During seven years, land use composition has changed. Urban land use has expanded about 938.4 ha which converted about 918.2 ha from open space area and about 20.2 ha from water area. The detail of land use change as show in Table 4.1 and map 3.

Table 4.1 Land use Change (ha)

Land use	2000	2007	Change
Open Space Land use	6,375.8	5,457.6	-918.2
Urban Land use	2,447.3	3,385.7	938.4
Water	824.4	804.2	-20.2

In brief, Land use composition change from 2000 to 2007 depicts that urban land use extends until 9.5%, green open space reduces -9.7% and water land use decreases into 0.2%. Table 4.2 shows land use composition change 2000-2007.

Table 4.2 Land use Composition Change (%)

Land use	2000	2007	Change
Open Space Land use	66.1%	56.6%	-9.5%
Urban Land use	25.4%	35.1%	9.7%
Water	8.5%	8.3%	-0.2%

The Land use composition change in 2007 shows that open space land use is diminished about 918.21 ha which about 914.8 ha (99.6 %) becomes urban land use and water land use about 3.4 ha (0.4 %).

Land use inter-correlation change described in table 4.3 (land use change matrix).

Table 4.3 Land use Change Matrix

Land use Change		Land use 2007		
		Urban (ha)	Open (ha)	Water (ha)
Land use 2000	Urban (ha)	938.4	0	1.5
	Open (ha)	914.8	918.2	3.4
	Water (ha)	25.1	0	20.2

Expansion of urban land use is 939.9 ha. Urban land use expansion mostly form open space 914.8 ha and from water body 25.10 ha. Mean while urban land use reduces about 1.5 ha conversion urban land use to water body. There is also no urban land use change to open space. Therefore, total urban land use change is about 938.4 ha.

Open space mostly decrease with total change about 918.2 ha. Open space is change into urban land use about 914.8 ha and change into water about 3.4 ha. There is no urban land use and water body change to open space.

Water body also decreases with total about 20.2 ha. Water body has effected by urban expansion about 25.1 ha. In contrast, water body also increase about 4.9 ha that from urban land use about 1.5 ha and from open space about 3.4 ha.

In Figure 4.6, Land use change describes inter-correlation among land uses hypothetically and practically.

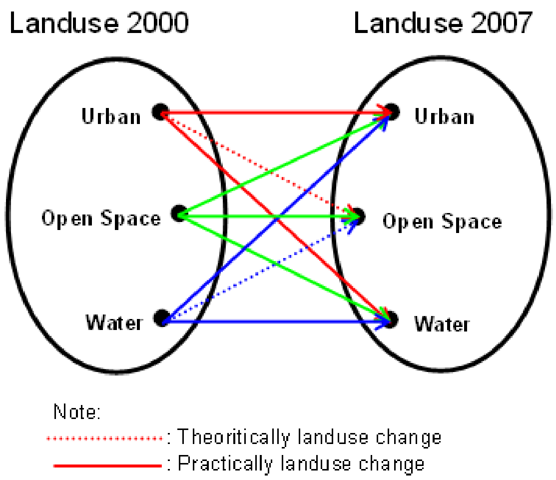
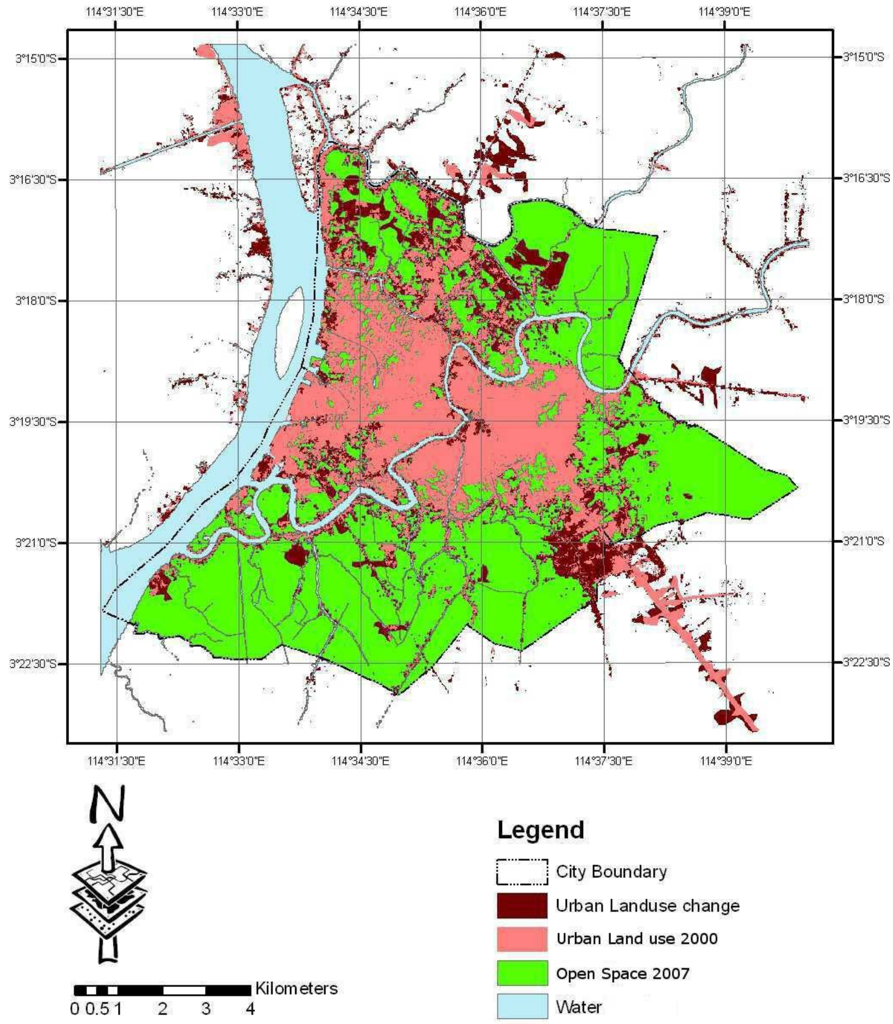


Figure 4.6 Land use Change Possibilities

Hypothetically, urban land use can change to be open space land use, water land use, or stand still as urban land use. Open space land use can change into urban land use, water land use, or stand still as open space land use. Water land use can change into urban land use, open space land use or stand still as water land use. However, in practice, no urban land use changes into open space; or water land use changes into open space land use.

MAP-3
LANDUSE CHANGE 2000-2007



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

4.2.2. Sub District Land use

4.2.2.1. Sub District Urban Land use

Total sub district urban land use of Banjarmasin city in 2000 is 2447.4 ha. The largest urban land use is Teluk Dalam sub district about 147.4 ha and the smallest urban land use is Tanjung Pagar about 10.5 ha. On the average, urban land use per sub district is about 48.9 ha. Urban land use per sub district in 2000 includes 23 sub districts which have urban land use from 0 to 39 ha; 19 sub districts which have urban land use 40 to 79 ha; 7 sub districts which have urban land use 80 to 119 ha; and 1 sub district which has urban land use more than 120 ha.

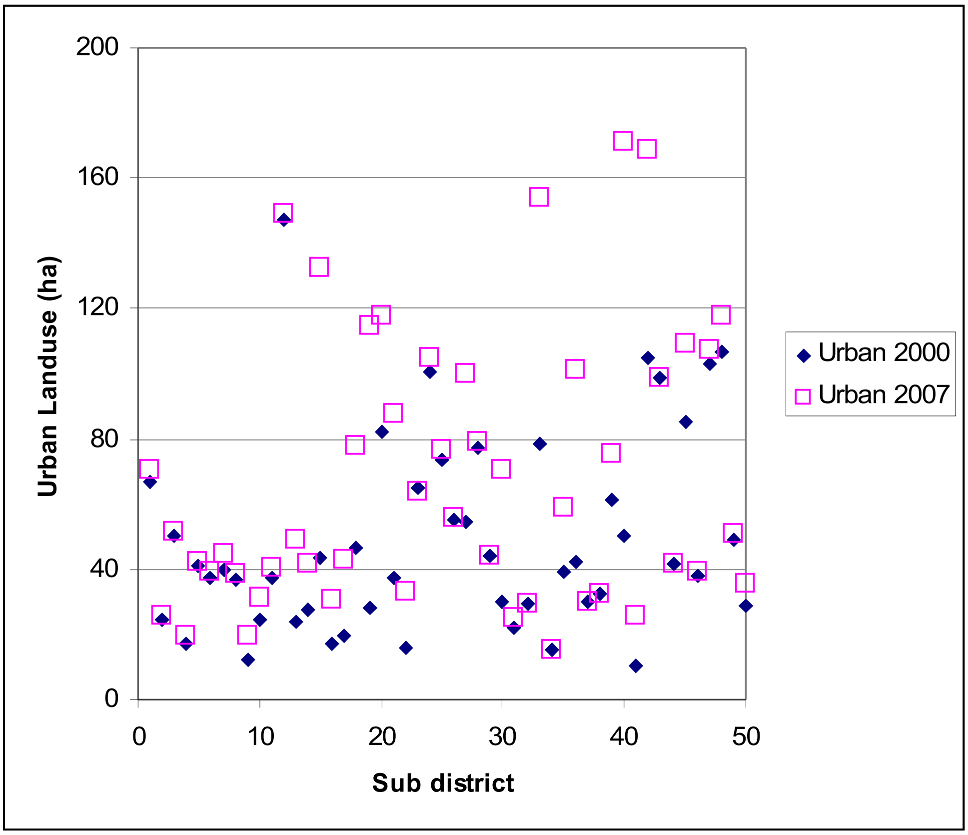


Figure 4.7 Sub District Urban Land use 2000-2007

In 2007, total sub district urban land use is 3.385.8 ha. The largest urban land use is Pemurus Dalam sub district about 171.3 ha and the smallest urban land use is Kelayan Tengah about 15.5 ha. Average urban land use is about 67.7 ha.

Urban Land use 2007 involves 14 sub districts. Urban land use between 0 to 39 ha; 21 sub districts with urban land use between 40 to 79 ha; 10 sub districts with urban land use between 80 to 119 ha; 3 sub districts with urban land use between and 120 to 159 ha; and 2 sub districts with urban land use between more than 160 ha.

Figure 4.7 depicts that most of sub district urban land use 2000 and sub district urban land use 2007 not overlaid each other. This indicates that the sub district urban land use changes 2000-2007 has dynamic and very high variation land use change.

4.2.2.2. Sub District Open Space Land use

Sub district open space 2000 and 2007 show that only little variation of open space change compared to total open space as described in Figure 4.8.

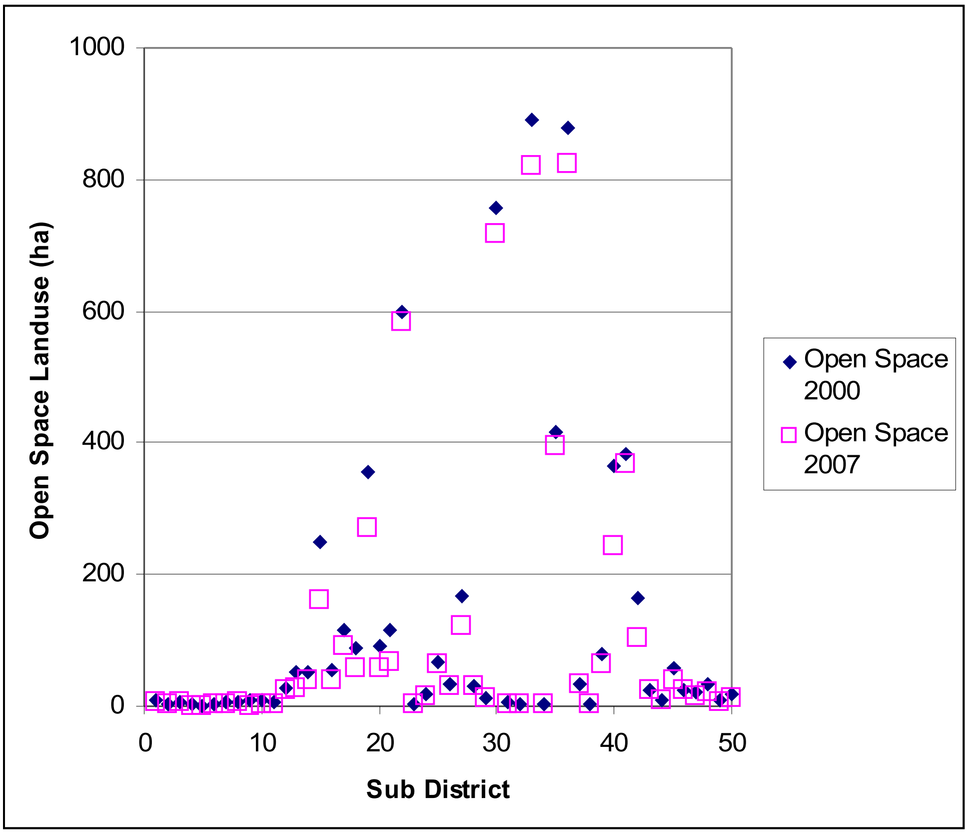


Figure 4.8 Sub District Open Space Land use 2000-2007

The total area of sub district open space of Banjarmasin city in 2000 is about 6,375.8 ha. The largest open land use is Kelayan Selatan sub district about 891.5 ha. The smallest open space land use is Kertak Baru Ilir about 1.2 ha. On the average, open space land, use per sub district is about 127.5 ha.

Open space 2000 includes 42 sub districts which have open space from 0 to 199 ha; 4 sub districts which have open space 200 to 399 ha; 1 sub district which has open space 400 to 599 ha; 1 sub district which has open space 600 to 799 ha; and 2 sub districts have open space more than 800 ha.

Total sub district open land use area in 2007 is 5,457.6 ha. The largest open space land use is Kelayan Selatan sub district about 891.5 ha and the smallest open space land use is Kertak Baru Ilir about 1.2 ha. Average open space land use is about 127.5 ha.

Open space land use 2007 comprises 41 sub districts. Open space between 0 and 199 ha; 4 sub districts which have open space between 200 and 399 ha; 2 sub district which have open space between 400 and 599 ha; 1 sub district which have open space 600 to 799 ha; and 2 sub districts which have open space more than 800 ha.

The next analysis is to see pattern of land use and open space correlation. These analysis bases on city structure consideration of urban land use that the closer to the city center the lower open space. The further open spaces to the city center the higher open space. Figure 4.9 show ratio between urban land use 2007 and open space 2007 that confirm that correlation.

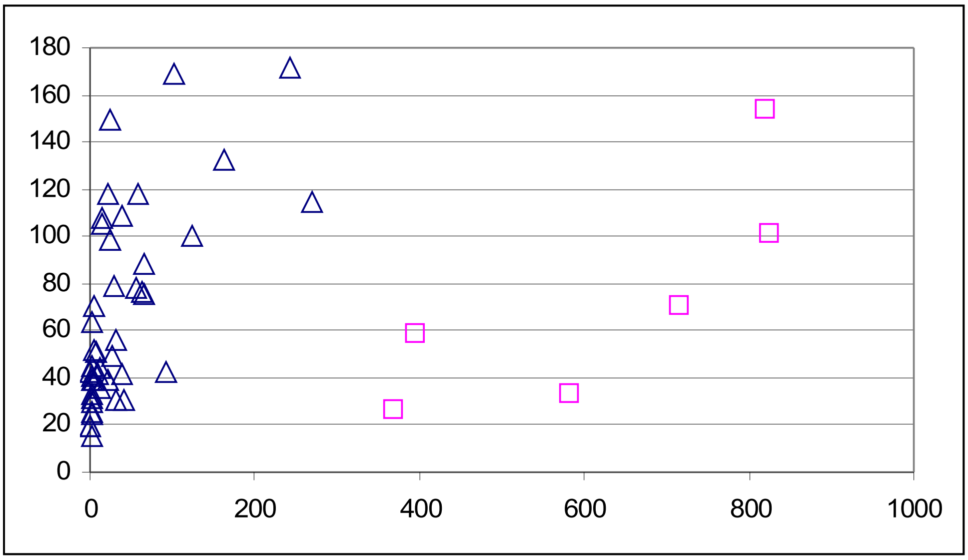


Figure 4.9 Ratio Urban Land use 2007 and Open Space 2007

That figures show that there is positive correlation between urban land use and open space. Other pattern show in that figures there is two type of correlation. The first type, box series, has lower urban land use and open space ratio. The second type, triangle series, has higher urban land use and open space.

Further, six sub districts have lower urban land use and open space ratio, which are Banua Hanyar sub district, Sungai Lulut sub district, Kelayan Selatan sub district, Kelayan Timur sub district, Mantuil sub district, and Tanjung Pagar sub district. Those sub districts are in urban fringe. Therefore, land availability and structure of the city affects the possibility of urban land use expansion.

Land availability also use for analyzing sub district urban land use change. The analysis of sub district urban land use pattern will explain in next subsection 4.2.3.4 (sub district urban land use change).

4.2.2.3. Sub District Water Land use

Total water land use of Banjarmasin city in 2000 is 824.5 ha with the average about 16.5 ha. The largest water land use is Mantuil sub district about 268.9 ha. This sub district is located in the streamline between Barito River and Martapura. Thus, it has a big amount of water land use. On the contrary, there are 3 sub districts that have no water land use. Those sub districts are Mawar sub district, Kebun Bunga sub district, and Pemurus Luar sub district.

A change of water land use is very low; the land use fairly decreases about 20.2 ha. In 2007, total water land use is about 804.2 ha. Average of water land use decreases about 16.1 ha compared to the previous year. This decrease is due to low-income housing development on the Martapura River. The largest water land use is Mantuil sub district, which is about 262.7 ha. The smallest water land use is marked in those three sub districts.

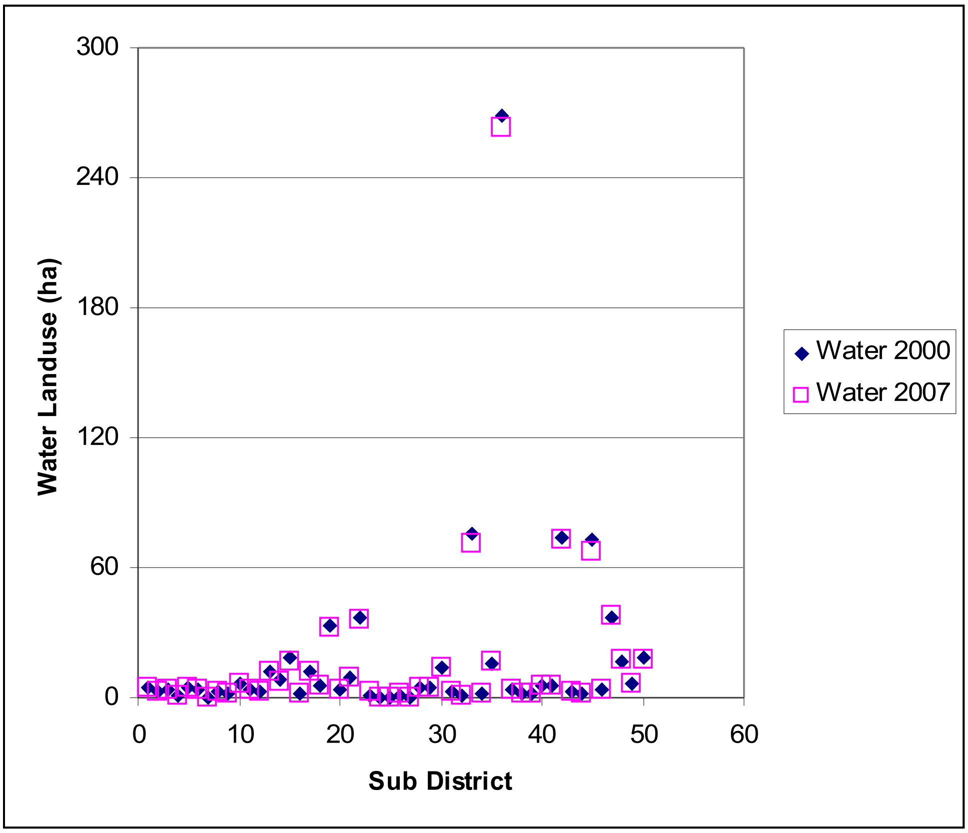


Figure 4.10 Sub District Water Land use 2000-2007

As shown in Figure 4.10, all water land use of sub district 2000 and 2007 are highly overlaid each other. It can state that the water land use of sub district 2000-2007 changes very slightly.

4.2.2.4. Sub District Urban Land use Change

The urban land use changes per sub districts vary. Most of sub districts (about 36 sub districts), which have urban land use changes between 0 ha to 25 ha. Other sub districts have changes as follow: five sub districts changes between 25 ha to 49 ha, three-sub district changes between 50 ha to 75 ha, and three-sub district changes between 75 ha to 100 ha. Only one sub district changes about more than 100 ha. The other two sub districts have a decrease of urban land use.

Total urban land use change in 2000-2007 is 938.4 ha. The average of sub district urban land use change is 18.8 ha. The largest urban land use change is 121.0 ha in Pemurus Dalam sub district. The smallest urban land use change is -1.3 ha in Karang Mekar sub district. Conversion of urban land use change to water body due to water normalization program by provincial government that removes slump settlement in Martapura River.

The urban land use changes also depend on land availability to expand. Land availability to expanse is the area of open space that can convert to urban land use. Ratio of urban land use and open space is show in figure 4.11. The figure show there is positive correlation between urban land use and open space. The pattern almost the same with ratio of urban land use and open space, but here the ratio of urban land use change and open space even stronger correlation.

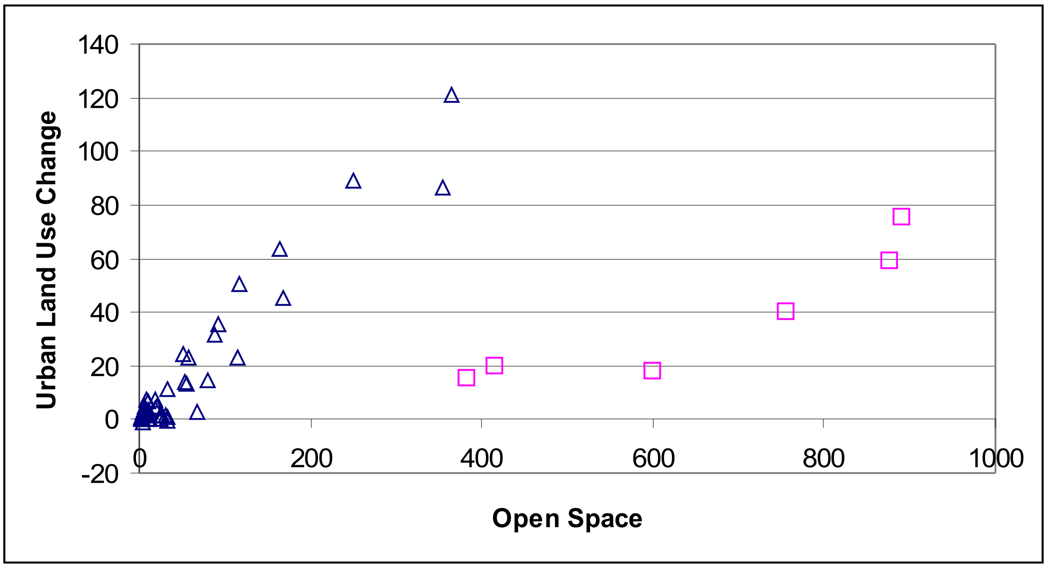
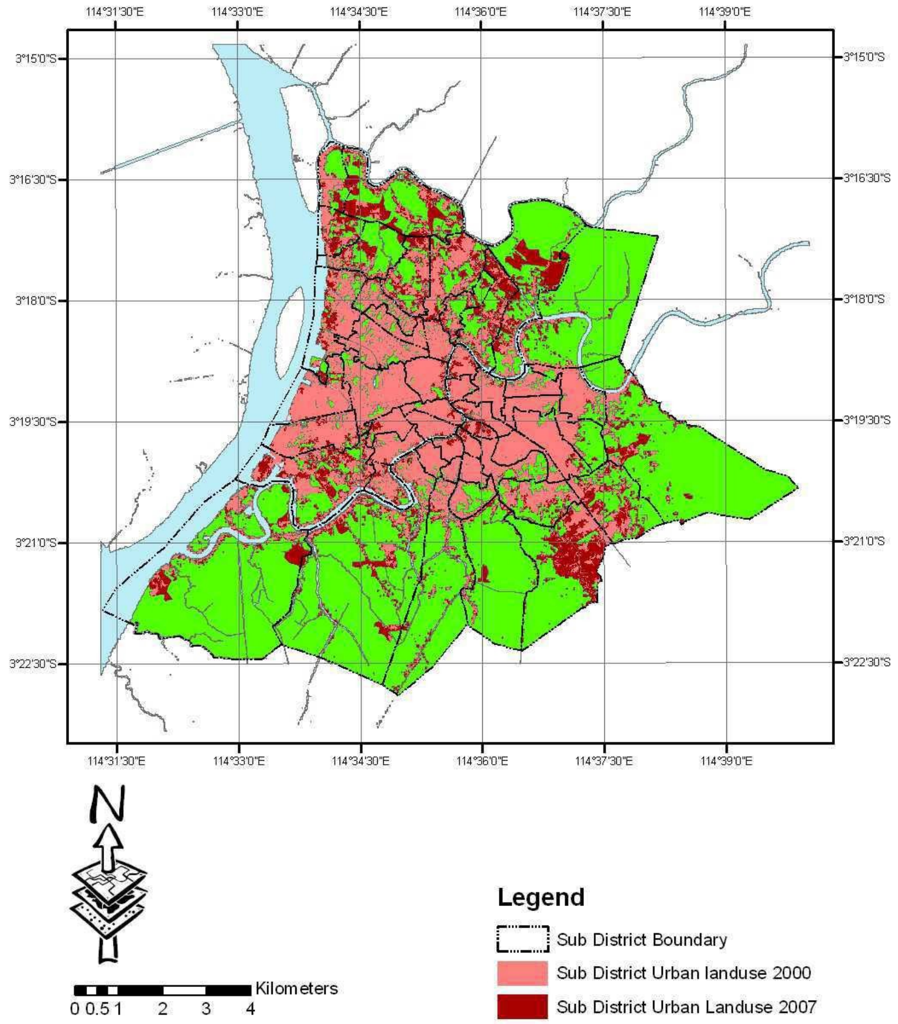


Figure 4.11 Ratio Urban Land use Change and Open Space 2000

Nevertheless, the correlation also has two distinct patterns. The first is high urban land use change on low open space. The second pattern is low urban land use change on high open space. Six sub districts have low urban land use change on high open space. Those sub districts also have lower urban land use and open space ratio as explain in sub chapter 4.2.2.2 that Banua Hanyar sub district, Sungai Lulut sub district, Kelayan Selatan sub district, Kelayan Timur sub district, Mantuil sub district, and Tanjung Pagar sub district. Those sub districts, all of them are in urban fringe. Therefore, not only urban land use change has positive correlation with open space but city structure also shapes urban expansion.

MAP-4
SUB DISTRICT URBAN LANDUSE CHANGE



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

4.2.3. Population Growth

Total population of Banjarmasin city in 2000 is about 534,525 people. The population goes up about 623,109 people in 2007. Population growth rate 2000-2007 is approximately 16.5% and Annual population growth rate is 2.3%.

Average of sub district population is 12.463 people in 2007. Teluk Dalam sub district gains the highest population in 2007, which are about 30,784 people. Pangeran sub district has the lowest population in 2007, which are only about 8,013 people.

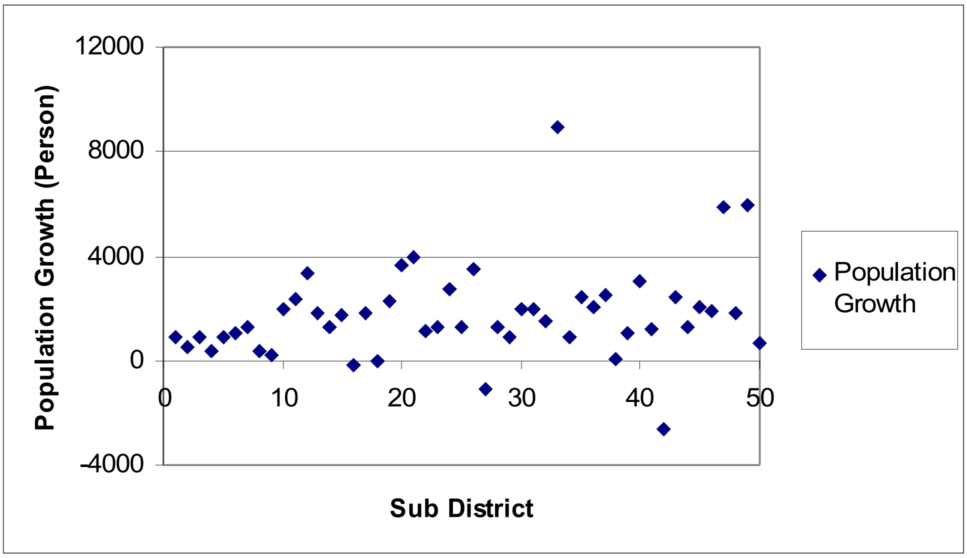


Figure 4.12 Population Growth

Total sub district population growth is 88.584 people. The average population growth of sub district is 1,772 people.

Kelayan Selatan sub district is the highest population growth of sub district about 8.967 people. This sub district is low-income class that the nearest to the city center so that become the highest population growth. The second highest population growth is Telawang sub district, which has about 5.938 people, and the third is Pelambuan sub district that is about 5.892 people. Other sub districts have population growth. The population growth between 0 to 4000 people is 3 sub districts and between 4000-8000 is about 43 sub districts.

In contrast, 4 sub districts have population decreases. Those sub districts are Basirih with -2627 people, Pemurus Luar with -1106 people, Antasan Kecil Timur with -149 people, and Pangeran with -30 people. Figure 4.12 shows population growth in detailed.

4.2.4. Density Change

4.2.4.1. Urban Density 2000-2007

Urban density means the number of people inhabited in any urban area divided by total area of urban land use. Urban density is an important factor to understand how city expanse vertically. The higher density means population expanse their living to up that from one level house to multi level house.

Total urban density in Banjarmasin city is about 12.816 people per ha in 2000, with urban density average about 256 people per ha. The highest urban density is Antasan Kecil Timur sub district about 539 people per ha. The lowest urban density is Kertak Baru Ulu sub district about 45 people per ha.

Meanwhile in 2007, total urban density is 11,004 people per ha with the average is about 220 people per ha. Compare with 256 people per ha in 2000, so it became less density over larger area. Kelayan Tengah sub district is the highest urban density about 561 people per ha and Kertak Baru Ulu sub district is the lowest urban density about 70 people per ha.

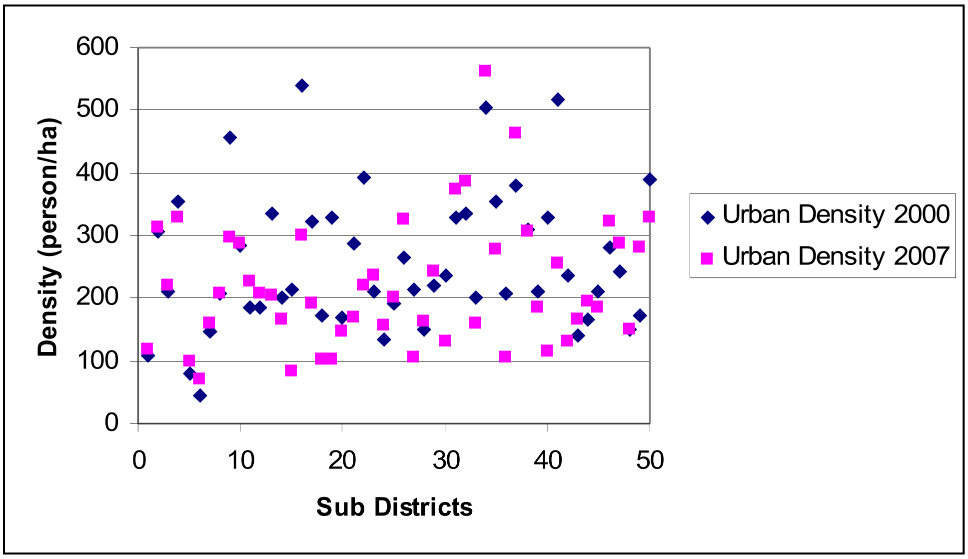


Figure 4.13 Urban Densities 2000-2007

Figure 4.13 urban density in 2000 shows that three sub districts have urban density between 0-100 people per ha and 13 sub districts has urban density 100-200 people per ha. Other Eighteen sub districts have urban density 200-300 people per ha, Thirteen sub districts have urban density 300-400 people per ha, One sub district has urban density 400-500 people per ha, and the other three sub districts have more than 500 people per ha.

In 2007, 3 sub districts have urban density between 0-100 people per hand twenty one sub districts have urban density 100-200 people per ha. Other Sixteen sub districts have urban density 200-300 people per ha, eight sub districts have urban density 300-400 person per ha, one sub district has urban density 400-500 people per ha, and one sub district has more than 500 person per ha.

Low-density sub district such as Kertak Baru Ulu sub district cause urban sprawl. Urban sprawl is an auto-dependent settlement that spread clustered. Urban sprawl has disadvantages higher infrastructure costs for person per ha.

On the contrary, high urban density such as Kelayan Tengah sub district results in more traffic congestion and more pollution especially in the work hour. Land price also tends to be more expensive those sub district.

4.2.4.2. Urban Density Change

Total urban density change is decreased about -1,813 people per ha and the average is -36 people per ha. The highest urban density change is 111 people per ha in Telawang sub district. The lowest urban density change decreases about -260 people per ha in Tanjung Pagar sub district. Figure 4.14 portrays urban density change.

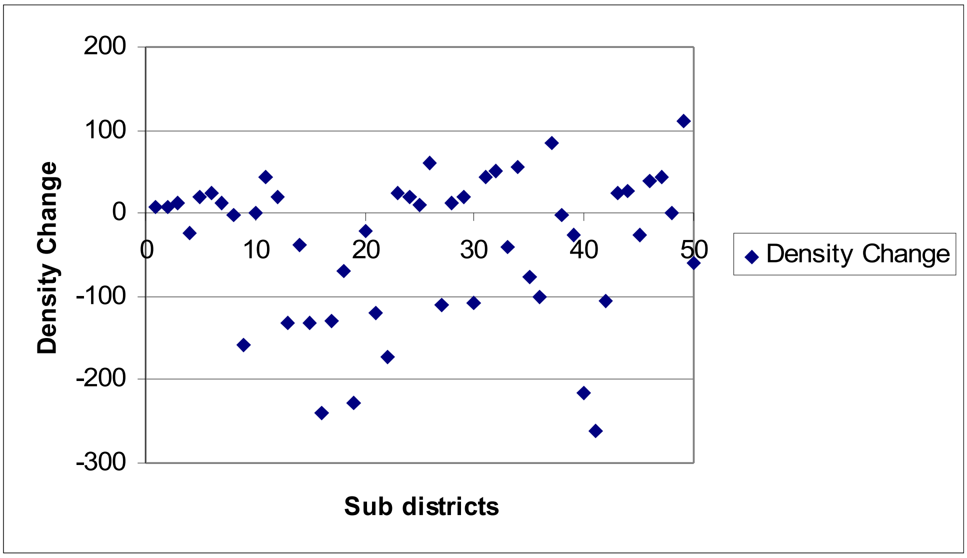


Figure 4.14 Urban Density Change

According to Figure 4.14, there is urban density increase in some sub districts. 24 sub districts have urban density change between 0 to 100 people per ha, meanwhile 1 sub district has more than 100 person per ha. Moreover, urban density in 11 sub districts decreases between 0 to -100 people per ha, 10 sub districts decrease between -100 to -200 person per ha, and 4 sub districts reduces less than -200 person per ha.

Urban density often correlated with the population concentration and sub district size. Sub district that has large population may tend to have larger urban density. However, density can decrease not only due to negative population growth but also due to urban land use change faster than its population growth. In contrast, when population grows faster than urban land use change, then its urban density will decrease. Therefore, although there is positive population growth, urban density can decrease.

4.3. Population Growth and City Expansion

4.3.1. Population Growth and Urban Land use Change

Population growth defined as the first and foremost force that develops urban land use change. The main inquiry is the population growth has linear correlation to urban land use change.

Figure 4.15 and table 4.7 explain one sub district, Kelayan Selatan, is outlier that has very high population growth and high urban land use change. The second outlier is two-sub district that has negative urban land use change and four-sub district did not have urban land use change.

Urban land use change has three patterns. The first is population negative growth has high urban land use change about four-sub district. The second pattern is population growth has low urban land use change about nineteen-sub district. The third is population growth with high urban land use change.

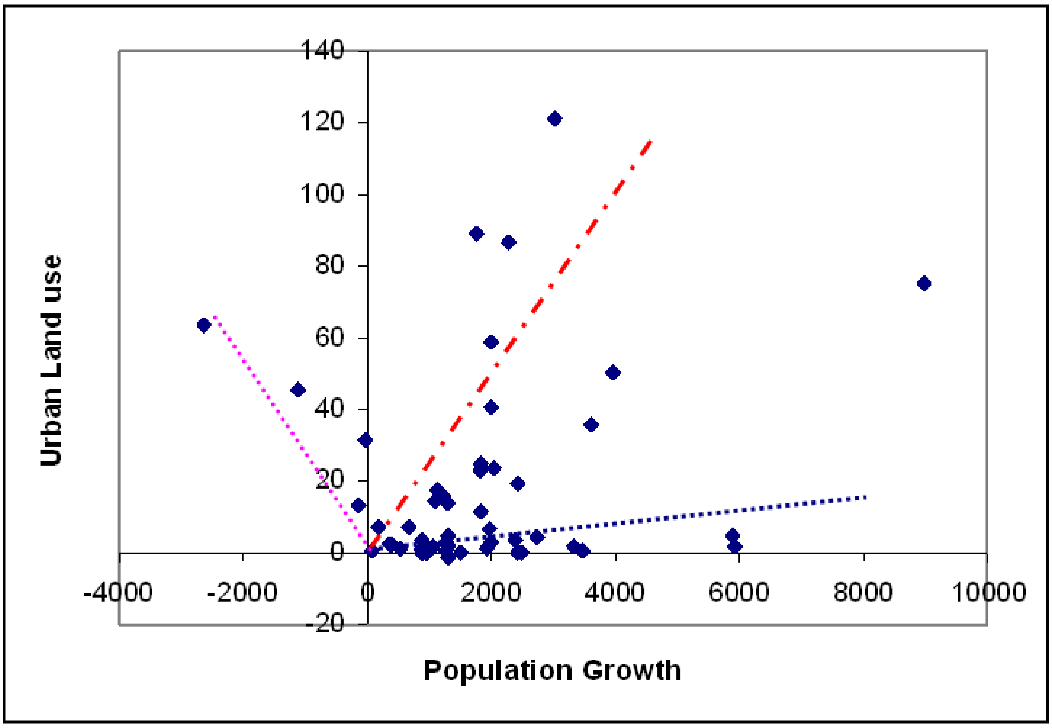


Figure 4.15 Population Growth and Urban Land use Change Correlations

Scatter plot of table 4.7 describes population growth and urban land use change. The population growth represented by X-axis and urban land use change is represented Y-axis.

Based on the distribution of data describe the population growth in 2000-2007 has no linear correlation with urban land use change in 2000-2007. Most of data seems clustering.

Table 4.8 Population growth and Urban Land use Change

ID	Sub District	Population growth (person)	Urban Land use Change (ha)
1.01	Antasan Besar	891	3.8
1.02	Gadang	527	1.1
1.03	Melayu	887	1.4
1.04	Kelayan Luar	368	2.4
1.05	Kertak Baru Ilir	875	0.7
1.06	Kertak Baru Ulu	1,068	1.9
1.07	Mawar	1,303	5.0
1.08	Pasar Lama	391	2.1
1.09	Pekapuran Laut	190	7.3
1.10	Seberang Mesjid	1,953	6.7
1.11	Sungai Baru	2,369	3.5
1.12	Teluk Dalam	3,333	1.8
2.01	Alalak Selatan	1,814	24.7
2.02	Alalak Tengah	1,284	14.0
2.03	Alalak Utara	1,769	88.8
2.04	Antasan Kecil Timur	-149	13.5
2.05	Kuin Utara	1,828	22.8
2.06	Pangeran	-30	31.5
2.07	Sungai Jingah	2,272	86.4
2.08	Sungai Miai	3,627	35.6
2.09	Surgi Mufti	3,978	50.3
3.01	Banua Hanyar	1,139	17.6
3.02	Karang Mekar	1,307	-1.4
3.03	Kebun Bunga	2,746	4.3
3.04	Kuripan	1,266	2.8
3.05	Pekapuran Raya	3,480	0.6
3.06	Pemurus Luar	-1,106	45.6
3.07	Pengambangan	1,307	1.7
3.08	Sungai Bilu	934	0.0
3.09	Sungai Lulut	2,003	40.3
4.01	Kelayan Barat	1,995	2.8
4.02	Kelayan Dalam	1,497	0.0
4.03	Kelayan Selatan	8,967	75.3
4.04	Kelayan Tengah	872	0.0
4.05	Kelayan Timur	2,413	19.6
4.06	Mantuil	2,011	58.9
4.07	Murung Raya	2,495	-0.1
4.08	Pekauman	71	0.5
4.09	Pemurus Baru	1,073	14.3
4.10	Pemurus Dalam	3,025	121.0
4.11	Tanjung Pagar	1,221	15.5
5.01	Basirih	-2,627	63.6
5.02	Belitung Selatan	2,428	0.0
5.03	Belitung Utara	1,252	0.4
5.04	Kuin Cerucuk	2,037	23.4
5.05	Kuin Selatan	1,916	1.3
5.06	Pelambuan	5,892	4.6
5.07	Telaga Biru	1,820	11.4
5.08	Telawang	5,938	1.8
5.09	Teluk Tiram	663	7.2

However, based on the assumption that population growths 2000-2007 has a strong relation with urban land use changes 2000-2007, the hypotheses are formulated as follow:

H_0: There is no linear relationship between population growth and urban land use changes.

H_1: There is a linear relationship between population growth and urban land use changes.

Assumed that there is a linear relationship between population growth and urban land use change:

$$\text{Urban } LC_i = \beta_0 + \beta_1 * PopCHG_i + \varepsilon_i$$

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.176[a]	.031	.011	27.58437

a. Predictors: (Constant), Population growths 2000-2007

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1160.676	1	1160.676	1.525	.223[a]
	Residual	36523.067	48	760.897		
	Total	37683.743	49			

a. Predictors: (Constant), Population growths 2000-2007

b. Dependent Variable: Urban Land use Changes 2000-2007

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		β	Std. Error	Beta		
1	(Constant)	13.971	5.506		2.538	.014
	Population growths 2000-2007	.003	.002	.176	1.235	.223

a. Dependent Variable: Urban Land use Changes 2000-2007

From coefficient and model summary using SPSS, the results of regression shows that, the relationship between population growth and urban land use change represented by model with standard error 0.002.

$$\text{Urban } LC_i = 13.971 + 0.003 * PopCHG_i + \varepsilon_i$$

Figure 4.16 explains that at 20% level of significance and degree of freedom 49 (n-1) then the rejections value is ± 1.299. The coefficient value of population growth is statistically not significant. The value of t-test for coefficient of population growth of 1.235 falls in the acceptance area of H_0. Therefore, accept H_0 and reject H_1.

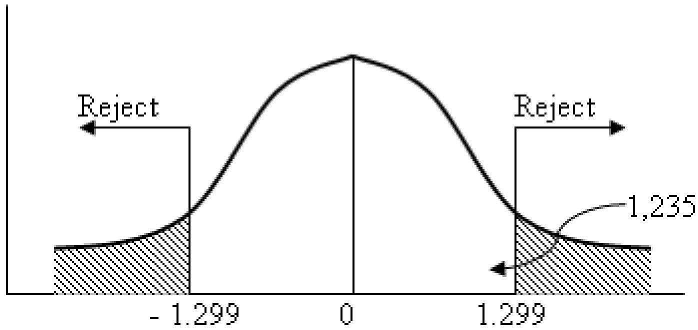


Figure 4.16 Acceptance Area of Population growth and Land Use Change

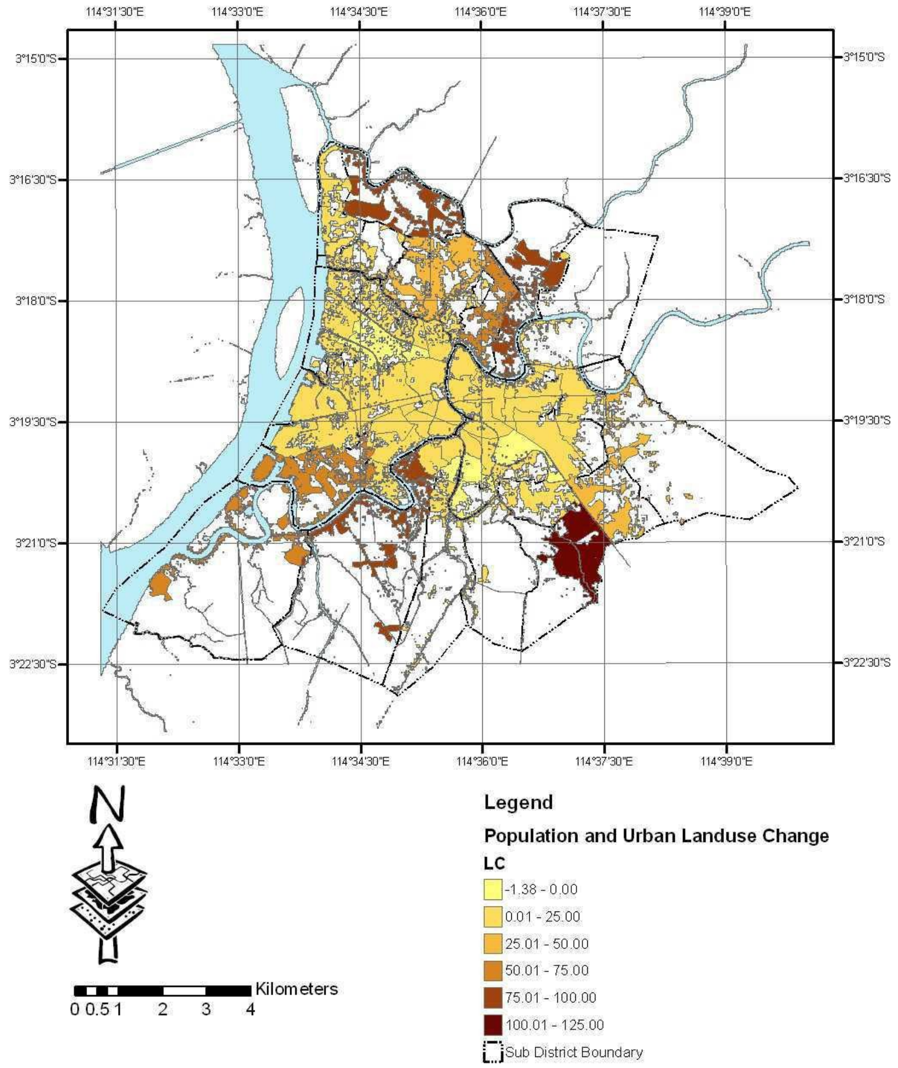
From coefficient of determination or R-squared value of 0.031, we can say that 3,1% of variance of urban land use change can explained by population growth and the rest explained by other variables.

R square value of 0.031 indicates that population growth as independent variable has less capability to explain land use change as dependent variable. Thus, the relationship between population growth and urban land use change in the model is weak or only 3%. Therefore, there is **no strong linear relationship between population growth and urban land use changes**

It can be stated that population growth not only produce urban land use change but also produces urban density change. In the other words, population growth produces urbanization pressure that spreads not only in horizontal expansion through urban land use change but also in vertical expansion through density change.

Other argument is that effect of population growth to urban land use change varies depending on city structure. This means population growth as Urbanisation pressure is shifting among sub districts. Therefore, effect of population growth to city expansion needs further examination using shifting urbanisation pressure model.

MAP-5 POPULATION GROWTH AND URBAN LANDUSE CHANGE



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

4.3.2. Population Growth and Urban Density Change

The previous analysis show there is no linear correlation between population growth and urban land use change. It could be the population growth converted into urban density growth.

Figure 4.17 and table 4.8 explained that urban densities of twenty-five sub district are decrease. Four of decreases sub district affected by population decline. Other urban density decrease, about twenty-one sub district, due to high urban land use change.

Quite the opposite, twenty-five sub districts have population density increase. The increase caused by population growth and low urban land use change. Therefore, nineteen-sub district that low urban land use change, urban density tends to increase. Urban density also increase in four sub district that have not urban land use change and two sub district that have decline urban land use change.

The outlier is Kelayan Selatan sub district that has urban density decrease about -39.7 people/ha with very high population growth about 8.967 people.

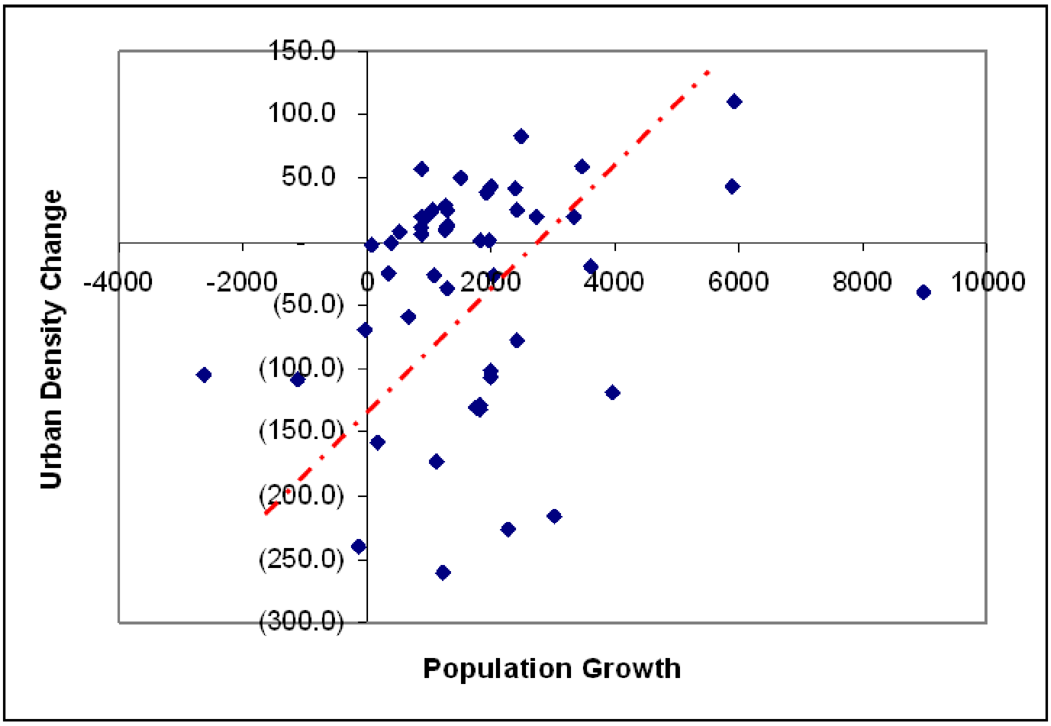


Figure 4.17 Population Growth and Density Change Correlations

Correlation between population growth and density change as seen in a scatter plot in figure 4.17 that population growth could be has positive linear correlation with density change.

Based on the distribution of data, it shows that most of them, although seem clustering, but it constructing an imaginary linear line. Detailed population growth and density change as show in table 4.8.

Table 4.7 Population growth and Density Change

ID	Sub District	Population Growth (person)	Density Change (person/ha)
1.01	Antasan Besar	891	6.7
1.02	Gadang	527	7.6
1.03	Melayu	887	11.5
1.04	Kelayan Luar	368	-24.6
1.05	Kertak Baru Ilir	875	19.5
1.06	Kertak Baru Ulu	1,068	25.1
1.07	Mawar	1,303	12.8
1.08	Pasar Lama	391	-1.4
1.09	Pekapuran Laut	190	-158.7
1.10	Seberang Mesjid	1,953	1.2
1.11	Sungai Baru	2,369	42.6
1.12	Teluk Dalam	3,333	20.1
2.01	Alalak Selatan	1,814	-132.1
2.02	Alalak Tengah	1,284	-37.2
2.03	Alalak Utara	1,769	-131.2
2.04	Antasan Kecil Timur	-149	-240.2
2.05	Kuin Utara	1,828	-129.1
2.06	Pangeran	-30	-69.6
2.07	Sungai Jingah	2,272	-226.9
2.08	Sungai Miai	3,627	-20.0
2.09	Surgi Mufti	3,978	-118.6
3.01	Banua Hanyar	1,139	-173.2
3.02	Karang Mekar	1,307	25.1
3.03	Kebun Bunga	2,746	20.6
3.04	Kuripan	1,266	9.4
3.05	Pekapuran Raya	3,480	59.7
3.06	Pemurus Luar	-1,106	-108.9
3.07	Pengambangan	1,307	13.4
3.08	Sungai Bilu	934	20.8
3.09	Sungai Lulut	2,003	-106.7
4.01	Kelayan Barat	1,995	43.1
4.02	Kelayan Dalam	1,497	50.9
4.03	Kelayan Selatan	8,967	-39.7
4.04	Kelayan Tengah	872	56.8
4.05	Kelayan Timur	2,413	-76.8
4.06	Mantuil	2,011	-101.3
4.07	Murung Raya	2,495	84.0
4.08	Pekauman	71	-2.5
4.09	Pemurus Baru	1,073	-25.8
4.10	Pemurus Dalam	3,025	-215.7
4.11	Tanjung Pagar	1,221	-260.5
5.01	Basirih	-2,627	-105.0
5.02	Belitung Selatan	2,428	24.6
5.03	Belitung Utara	1,252	28.1
5.04	Kuin Cerucuk	2,037	-26.6
5.05	Kuin Selatan	1,916	39.4
5.06	Pelambuan	5,892	44.4
5.07	Telaga Biru	1,820	1.1
5.08	Telawang	5,938	110.5
5.09	Teluk Tiram	663	-59.6

Therefore, from that explanation, we can make hypothesis that population growth has a linear relation with density change. Therefore the hypotheses are:

H_0 There is no linear relationship between population growths and density change

H_1 There is a linear relationship between population growths and density change

Assumed that there is a linear relationship between population growth and density change,

$$\text{Density } C_i = \beta_0 + \beta_1 * \text{PopCHG}_i + \varepsilon_i$$

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.212[a]	.045	.025	87.33765

a. Predictors: (Constant), Population growths 2000-2007

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17238.221	1	17238.221	2.260	.139[a]
	Residual	366137.484	48	7627.864		
	Total	383375.705	49			

a. Predictors: (Constant), Population growths 2000-2007

b. Dependent Variable: Density Changes 2000-2007

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		β	Std. Error	Beta		
1	(Constant)	-54.747	17.432		-3.141	.003
	Population growths 2000-2007	.010	.007	.212	1.503	.139

a. Dependent Variable: Density Changes 2000-2007

From coefficient and model summary using SPSS, the results of regression is the relationship between population growth and density change is represented by model with standard error 0.002.

$$\text{Density } C_i = -54.747 + 0.01 * \text{PopCHG}_i + \varepsilon_i$$

Figure 4.18 shows degree of freedom 49 (n-1) and level of significance 20% then t table is ± 1.277. The coefficient of population growth is statistically not significant. Since the value of t-test for coefficient of population growth of 1.503 falls in the rejection area of H_0, it can say that rejectH_0 and acceptH_1. Thus, there is a linear relationship between population growths and density change

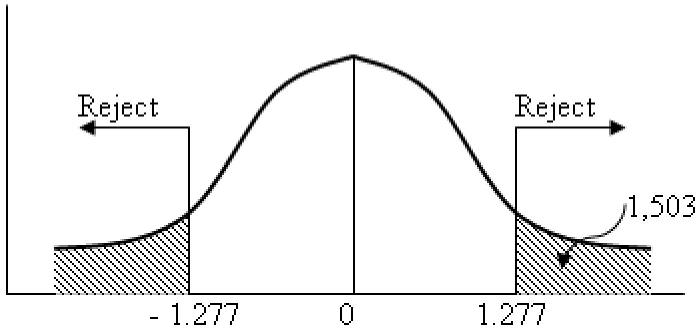


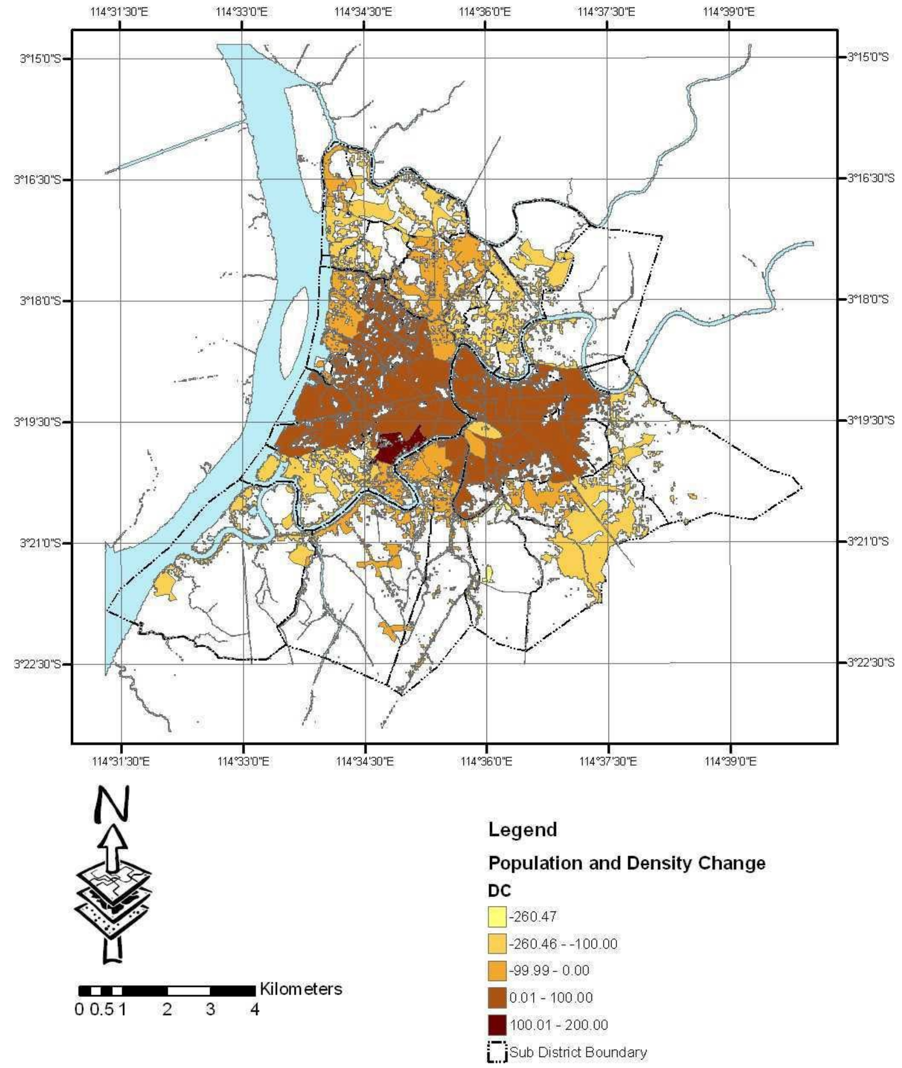
Figure 4.18 Acceptance Area of Population growth and Density Change

From coefficient of determination or R-squared value of 0.045, we can say that 4.5% of variance of urban density change can clarify by population growth and the rest explained by other variables.

The relationship between population growth and land use change in the model is not too strong or only 4.5%. Therefore, **there is a weak linear relationship between population growths and density change.**

Nevertheless, correlation of population growth to city expansion will examined further using shifting Urbanisation pressure model in the next sub chapter.

MAP-6 POPULATION GROWTH AND URBAN DENSITY CHANGE



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

4.4. Shifting Urbanisation Pressure

4.4.1. City Center Spillovers

City center is a focal point of a city. City center function includes the commercial, office, retail, and cultural center of the city as well as the center point for transportation networks.

According to RUTRK 2000 (Banjarmasin City Plan 2000), city center consists of three sub districts; Antasan Besar sub district, Kertak Baru Ulu sub district, and Kertak Baru Ilir sub district.

Antasan Besar sub district functions as provincial government offices area. Kertak Baru Ulu sub district functions as business area where CBD, banks, malls, services, motor dealer, and market are located. Kertak Baru Ilir sub district functions as for local government offices area.

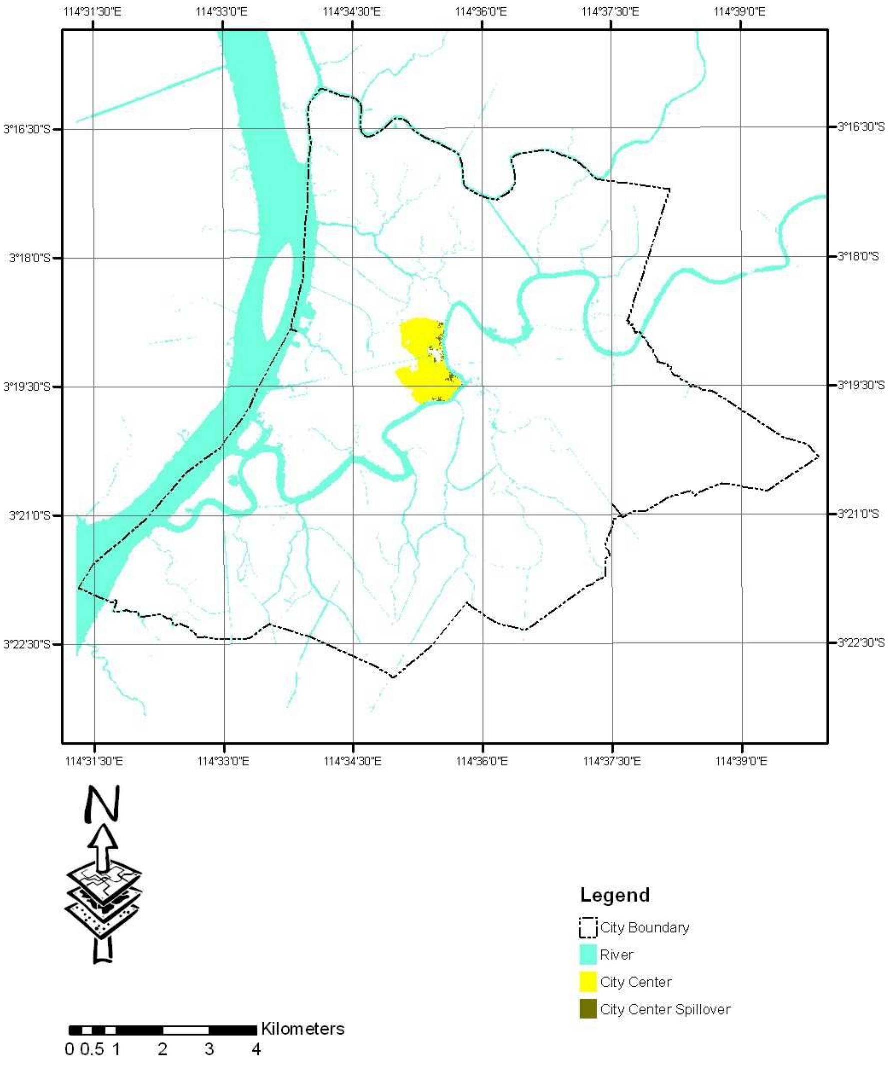
Table 4.9 City Center Spillover

Sub District	Total Area (Ha)	Urban Land use 2000 (ha)	Urban Land use 2007 (ha)	Spillover (ha)
Antasan Besar	80.6	66.7	70.5	3.8
Kertak Baru Ilir	47.0	41.3	42.0	0.7
Kertak Baru Ulu	45.0	37.2	39.1	1.9
Total	**172.6**	**145.3**	**151.7**	**6.4**

City center spillover is emerging due to urban land use expansion from 145.3 ha in 2000 into 151.7 ha in 2007 as shown in table 4.9. Therefore, city center spillover is about 6.39 ha. The highest expansion is 70.5 ha (59%) in Antasan Besar sub district and the lowest urban spillover is 0.70 ha (11%) in Kertak Baru Ulu. Other spillover is 1.9 ha (30%) in Kertak baru Ilir. Average spillover of city center is 2.13 ha.

Population change in city center increases about 2,834 people, which is from 12,235 people in 2000 into 15,069 people in 2007. The highest population increase is in Kertak baru ulu, which has 1,068 people (38%), and the other population increase includes 891 people (31%) in Antasan Besar sub district and 875 people in Kertak baru Ilir (31%). Average population increase is 945 people.

MAP-7
CITY CENTER SPILLOVERS



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

4.4.2. Inner Rings Urban Spillovers

The development of city center causes a large number of workers moving to the center to look for jobs. In shifting urbanisation pressure, when the city center growth is limited, then urban spillover of neighboring regions occurs. The nearest area surrounding the city center defined as inner rings area.

There are 12 sub districts become inner rings surrounded city center as shown in table 4.10.

Table 4.10 Inner Ring Urban Spillover

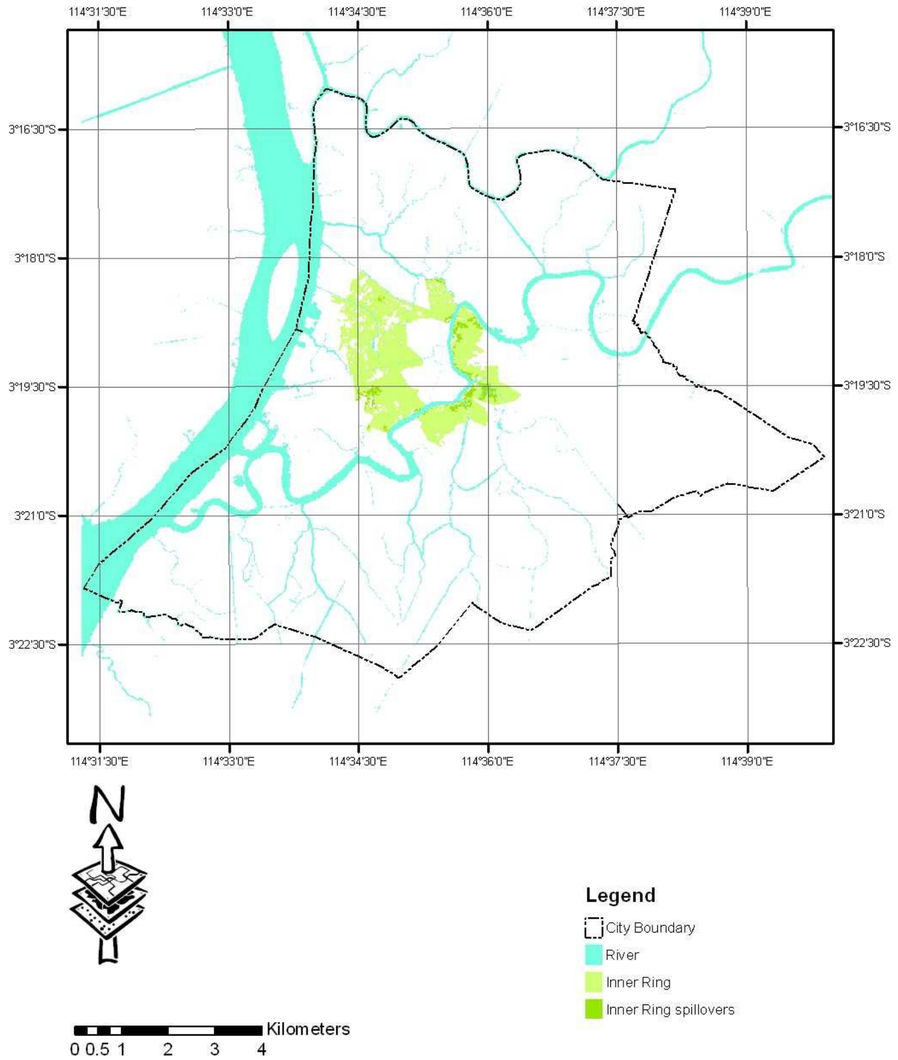
Sub District	Total Area (ha)	Urban Land use 2000 (ha)	Urban Land use 2007 (ha)	Spillover (ha)
Gadang	29.8	24.5	25.6	1.1
Kelayan Luar	21.8	17.3	19.7	2.4
Mawar	46.6	39.7	44.7	5.0
Pasar Lama	46.5	36.8	38.9	2.1
Pekapuran Laut	22.4	12.5	19.8	7.3
Seberang Mesjid	40.8	24.5	31.2	6.7
Sungai Baru	46.4	37.3	40.8	3.5
Teluk Dalam	177.5	147.4	149.2	1.8
Kelayan Barat	29.3	22.2	25.0	2.8
Pekauman	36.8	32.3	32.8	0.5
Belitung Selatan	126.2	98.6	98.6	0.0
Telawang	64.2	49.2	50.9	1.7
Total	**688.3**	**542.3**	**577.2**	**34.9**

The highest inner ring urban spillover is 7.3 ha in Pekapuran Laut sub district. The lowest inner ring spillover is zero in Belitung Selatan Sub district. The average inner ring urban spillover is 2.9 ha.

Total of inner ring urban spillover is 35 ha which increases from 24.5 ha in 2000 into 25.6 ha in 2007. Since the increase is very low, it is hard to see the urban land use change in the map. However, Map 8 shows the inner rings urban spillover.

Inner rings area population growth increases about 20,886 people from 113.715 people in 2000 into 134,581 people in 2007. The highest population growth is 5,938 people in Telawang sub district and the lowest population increase is 71 people in Pekauman sub district. The average population increase in inner rings area is 1,738 people

MAP-8
INNER RING SPILLOVERS



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

4.4.3. Outer Rings Urban Spillovers

4.4.3.1. Urban Spillover in Decrease Population Sub District

When inner rings area growth is limited, urban spillover occurs in neighboring regions. Therefore, area surrounding the inner rings except for leapfrog development area defined as outer rings area.

Population in urban spillover not always increases. Thus, it needs to separate outer rings urban spillover between decreased population area and increased population area.

Even though, on the average, the population of Banjarmasin increases, there are four sub districts, which have decreased population. Outer ring spillover in decrease population is in map 5.

The highest population decrease is -2,627 people in Basirih sub district and -1,106 people in Pemurus Luar sub district. The significant decrease in Basirih sub district and Pemurus Luar sub district occurs because too many plywood factories closed due to inadequate timber raw material available. The lowest population decrease is -30 people in Pangeran sub district. The average population decrease is -978 people. Total population decreases from 54,051 people in 2000 into 50,139 people in 2007.

Table 4.11 Outer Ring Decreased Population Spillovers

Sub District	Total Area (ha)	Urban Land use 2000 (ha)	Urban Land use 2007 (ha)	Spillover (ha)
Basirih	343.8	105.1	168.7	63.6
Pemurus Luar	223.0	54.5	100.1	45.6
Antasan Kecil Timur	73.2	17.4	30.9	13.5
Pangeran	140.4	46.8	78.2	31.4
Total	**780.4**	**223.7**	**377.9**	**154.1**

Even though total population of those four sub districts decrease, urban Land use still increase a little bit. The highest urban spillover increase is 63.6 ha in Basirih sub district. The lowest urban spillover decrease is 13.5 in Antasan Kecil timur sub district. The average urban spillover is 38.5 ha. Therefore, urban spillover in decreased population area is 223.7 ha in 2000 increases up to 377.9 ha in 2007 as shown in table 4.11.

4.2.4.2. Urban Spillover in Increase Population Sub District

Area surrounding the inner rings except leapfrog development area defined as outer rings area. There are 4 sub districts in decreased population area and 22 sub districts in increased population area are defined as urban spillover.

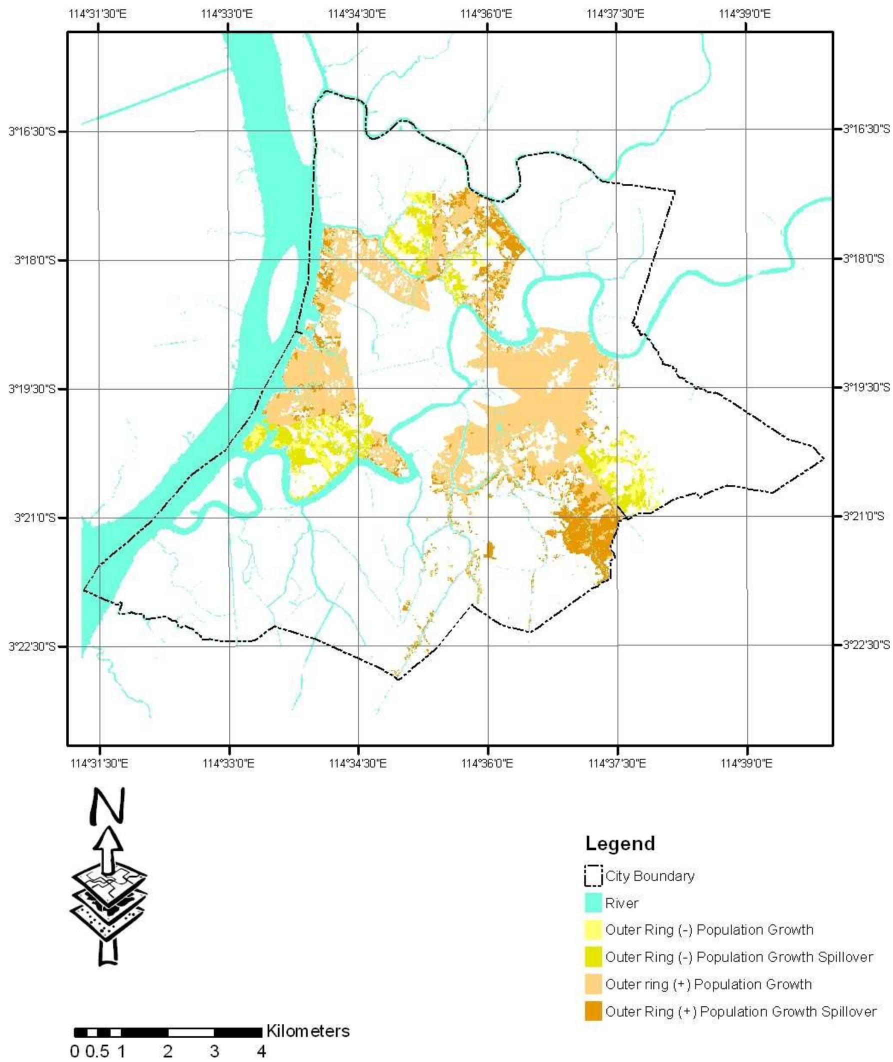
The highest population growth of urban spillover in increased population sub district is 5,892 people in Pelambuan sub district. The lowest population growth is 663 people in Teluk Tiram sub district. The average population growth is 2,077 people. The total population change is 45,708 people in which the population increases from 277,846 people in 2000 into 323,554 people in 2007.

Table 4.12 Outer Ring Increase Population Spillovers

Sub District	Total Area (ha)	Urban Land use 2000 (ha)	Urban Land use 2007 (ha)	Spillover (ha)
Melayu	60.8	50.3	51.7	1.4
Sungai Miai	178.8	82.4	117.9	35.5
Surgi Mufti	163.1	37.6	87.9	50.3
Karang Mekar	69.8	65.0	63.6	-1.4
Kebun Bunga	119.3	100.7	105.0	4.3
Kuripan	140.5	73.8	76.7	2.9
Pekapuran Raya	89.0	55.1	55.7	0.6
Pengambangan	112.9	77.2	78.9	1.7
Sungai Bilu	61.5	44.3	44.4	0.1
Kelayan Dalam	33.5	29.4	29.4	0.0
Kelayan Tengah	19.3	15.6	15.5	-0.1
Kelayan Timur	470.4	39.3	58.9	19.6
Murung Raya	66.9	30.3	30.2	-0.1
Pemurus Baru	142.2	61.2	75.5	14.3
Pemurus Dalam	420.3	50.2	171.3	121.1
Tanjung Pagar	399.5	10.5	25.9	15.4
Belitung Utara	53.8	41.6	42.0	0.4
Kuin Cerucuk	215.6	85.6	109.0	23.4
Kuin Selatan	66.0	37.7	39.1	1.4
Pelambuan	160.7	102.8	107.4	4.6
Telaga Biru	156.5	106.5	117.8	11.3
Teluk Tiram	66.4	28.7	35.9	7.2
Total	**3,266.8**	**1,225.8**	**1,539.7**	**313.9**

The highest urban spillover in increased population sub district is 121 ha in Pemurus Dalam sub district. Urban spillovers are decreased in two sub districts that are -1.4 ha in Karang Mekar sub district and 0.1 ha in Murung raya sub district. Two sub districts that have no spillover are Kelayan Tengah and Kelayan Dalam. The average urban spillover in increased population sub district is 14.3 ha. Total urban spillover in increased population sub district is 314.1 ha which increases from 1,225.5 ha in 2000 into 1,539.5 in 2007 as shown in table 4.12.

MAP-9
OUTER RING SPILLOVERS



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia sia

4.4.4. Urban Fringe Spillover

Urban fringe also identified as the outskirts or the urban hinterland, can depict as the transition zone where urban and rural uses mix. Instead, urban fringe viewed as a landscape that has own characteristic as result of interaction between urban and rural land uses. In this research, urban fringe is the region exacts the next to the city border.

In sub district database, it is the same sub district with leapfrog development. The different urban fringe area emphasize on continues expansion of previous urban land use, leapfrog development emphasizes on new independent urban land use. There are nine sub districts as urban fringe area that described in table 4.13 and map-6.

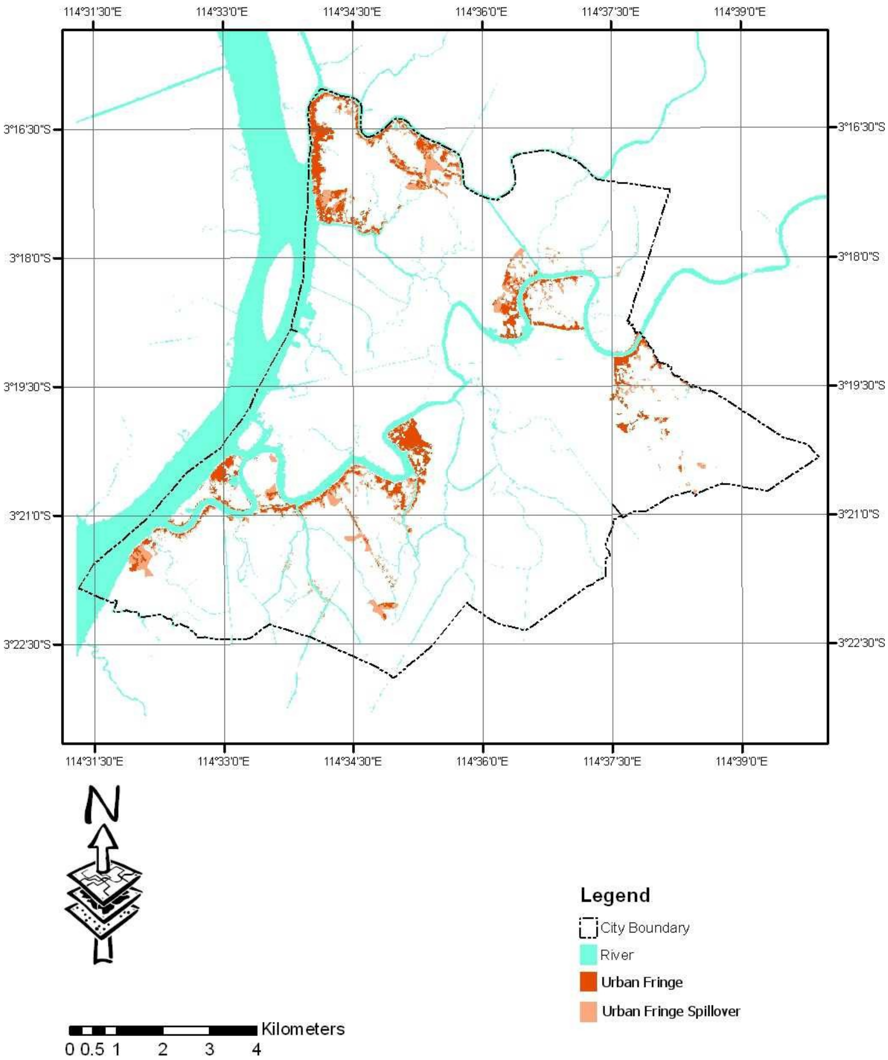
Table 4.13 Spillover in Urban Fringe

Sub District	Total Area (ha)	Urban 2000 (ha)	Urban 2007 (ha)	Spillover (ha)
Alalak Utara	311.2	35.9	84.6	48.7
Alalak Tengah	88.5	26.6	31.3	4.7
Alalak Selatan	87.3	21.2	37.7	16.5
Kuin Utara	147.6	18.5	38.4	19.9
Kelayan Selatan	1,046.1	78.7	152.0	73.3
Mantuil	1,188.9	42.2	83.8	41.6
Sei Jingah	416.2	24.3	45.2	20.9
Banua Anyar	652.3	15.7	28.2	12.5
Sungai Lulut	801.3	23.3	44.7	21.4
Total	**4,739.4**	**286.4**	**545.8**	**259.4**

The highest population growth is 8,731 people in Kelayan Selatan sub district, and the lowest population growth is 432 people in Alalak Tengah sub district. The average population growth is 1,853 people. Total population growth is 16,680 people that increase from 70,787 people in 2000 into 87,467 people in 2007.

The highest spillover in urban fringe is 73.3 ha in Kelayan Selatan sub district, and the lowest spillover in urban fringe is 4.7 ha in Alalak Tengah sub district. The average spillover in fringe area is 28.8 ha. Total spillover in urban fringe increases twofold about 259.4 ha from 286.4 ha in 2000 into 545.8 ha in 2007.

MAP-10
URBAN FRINGE SPILLOVER



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

4.4.5. Leapfrog development

Leapfrog development is discontinuous development in which more remote land developed previously is located close to city central. In the other word, leapfrog development is urban land expansion showing a dispersion of new city expansion on isolated tracts separated from other region by open space

In this case study, there are four areas of Leapfrog development ; Kasiba Banua Anyar, Alalak development area, and Sungai Lulut housing area, Mantuil new settlement spread on 9 sub district are portrayed in table 4.14 and map 17.

Table 4.14 Leapfrog Expansion

Sub District	Total area (ha)	Leapfrog 2000 (ha)	Leapfrog 2007 (ha)	Leapfrog expansion (ha)
Sei Jingah	311.2	4.2	65.5	61.3
Banua Anyar	88.5	0.0	5.2	5.2
Alalak Utara	87.3	7.5	40.0	32.5
Alalak Tengah	147.6	0.8	9.3	8.5
Alalak Selatan	1,046.1	3.0	8.3	5.3
Kuin Utara	1,188.9	0.0	4.3	4.3
Sungai Lulut	416.2	7.1	18.9	11.8
Mantuil	652.3	0.0	17.3	17.3
Kelayan Selatan	801.3	0.0	1.9	1.9
TOTAL	**4,739.4**	**22.8**	**170.7**	**148.1**

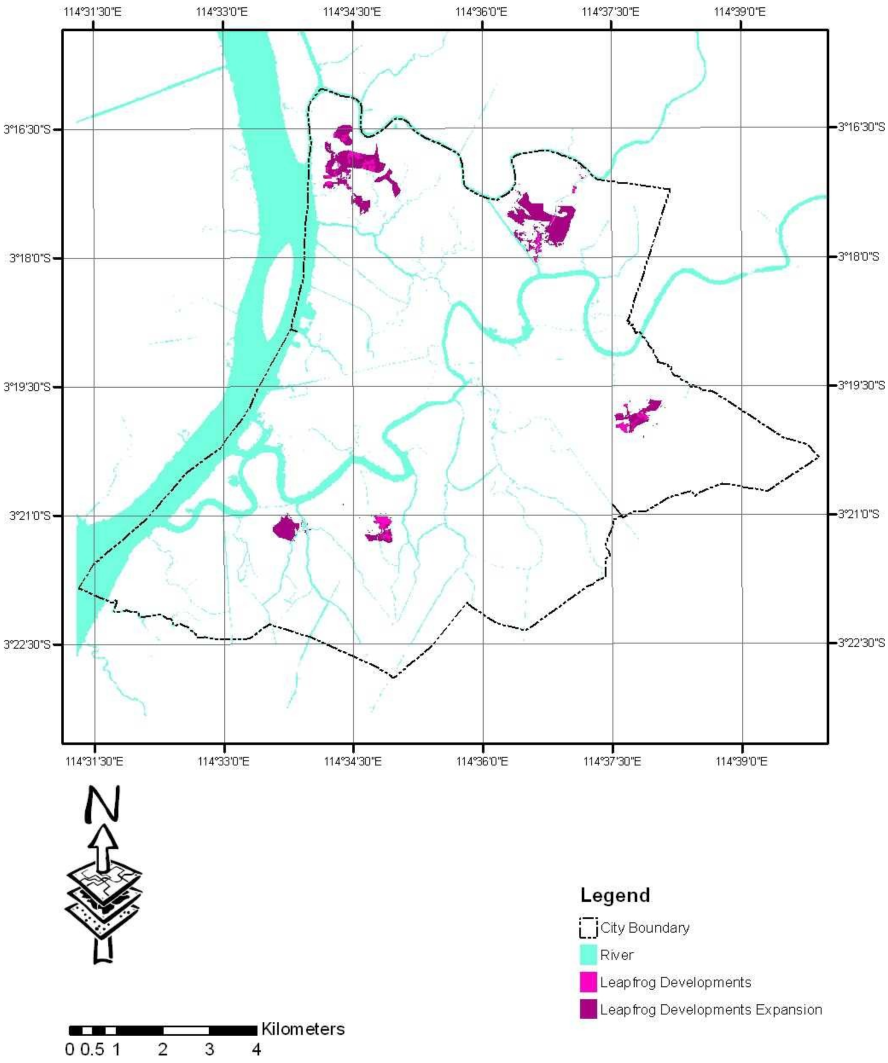
The first leapfrog area is in North East part of the city. This development is KASIBA (ready to develop area) program by local government of Banjarmasin. The leapfrog development includes Sei Jingah sub district and a little part of Banua Anyar Sub district.

The second leapfrog development is located on the Banjarmasin Utara district of the northern part of the city. Alalak Leapfrog development divided into four sub districts (Alalak Utara sub district, Alalak tengah sub district, Alalak Selatan sub district and Kuin Utara Sub district). The biggest leapfrog is in Alalak Selatan sub district, which is about 64.95% of 73.33ha. Other leapfrog development involves Alalak Utara sub district about 15.37%, Alalak tengah sub district about 13.83%, and Kuin Utara Sub district about 5.85%. All of leapfrog development 2007 are the expansion of leapfrog development in 2000, except for Kuin Utara sub district that settled as new leapfrog development. Leapfrog development expansion from 2000 to 2007 is about 6.41 times (11.43ha into 73.33 ha). Type of settlement is middle-high income settlement. Big Private developer exists since 2000.

The third development is Sungai Lulut housing area. This leapfrog development is in Sungai Lulut sub district that is located on south east of Banjarmasin city. The housing type is low-income housing conducted by small private developer. The urban expands 3.66 times from 7.10 ha into 26.02 ha.

The fourth leapfrog development is located on Banjarmasin Selatan district of the southern part of Banjarmasin. This leapfrog development is on two sub district, Mantuil sub district and Kelayan Selatan sub district. Most of development is in Mantuil district about 89.63% of 19.10ha, meanwhile Kelayan Selatan sub district only 10.37% of development area. Both leapfrog development are new development in 2007. The development is on purpose for low-income settlement type that handled by small Private developer.

MAP-11
LEAPFROG DEVELOPMENT EXPANSION



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

4.5. Urbanisation Pressure and City Expansion

Compiled from chapter 4.4.1 to chapter 4.4.5, it confirm that shifting urbanization pressure of population is mostly increase except for outer ring with negative population that decreases -9% or about -10,508 people. The highest population growth is 41% about 45,708 people in outer ring with positive population growth followed by leapfrog development 32% about 35,085 people. City center is the lowest population growth that is 3% or about 2,834%. Figure 4.19 show population increase (arrow up) and population decrease (arrow down).

This model uses urban land use change as spillover-leapfrog development (variable X) and population as Urbanisation pressure (variable Y) as indicated in Table 4.15. Shifting Urbanisation pressure model show in Figure 4.19 and map 12

Table 4.15 Shifting Urbanisation Pressure

Shifting Urbanisation Pressure	**Urbanisation Pressure**		**Spillover-Leapfrog**	
	Pop 2000 (person)	**Pop 2007 (person)**	**LU 2000 (ha)**	**LU 2007 (ha)**
City Center	12,235	15,069	145.3	151.7
Spillover in inner rings	113,715	134,581	542.3	577.3
Spillover in outer rings (-) decrease population	54,051	43,543	223.7	377.9
Spillover in outer rings (+)increase population	277,846	323,554	1,225.8	1539.7
Spillover in urban fringe	70,787	87,467	286.4	545.8
Leapfrog development	5.892	35,091	22.8	193.6
Total	**528,640**	**639,305**	**2,446.0**	**3,385.8**

Total urban spillover and leapfrog expansion is 939.7 ha. The highest urban spillover is 33% of total about 313.9 ha in outer ring with positive population growth, followed by spillover of leapfrog sub district about 28% about 259.4 ha. Leapfrog development expansion is 18% about 170.8 ha. Other area has minor expansion. Inner ring spillover is only 4% about 35.0 ha and the lowest spillover is city center about 1% that only 6.4%.

Nevertheless, all of shifting urbanization pressure area has expanse horizontally. The urbanization pressure diverted from high urbanization pressure area to other next areas next to demarcated zones where the urbanization pressure are less severe. The zones are from city center to inner rings, then to outer ring. In other words, when the spillover is limited due to restriction or scarce of space, the city will redirect its urbanization pressure. City will capriciously expand to 'leapfrog development'.

The pattern of redirection of urbanization pressure will be explained on the next chapter that consist of shifting urbanization pressure of urban land use change and shifting urbanization pressure of urban density change.

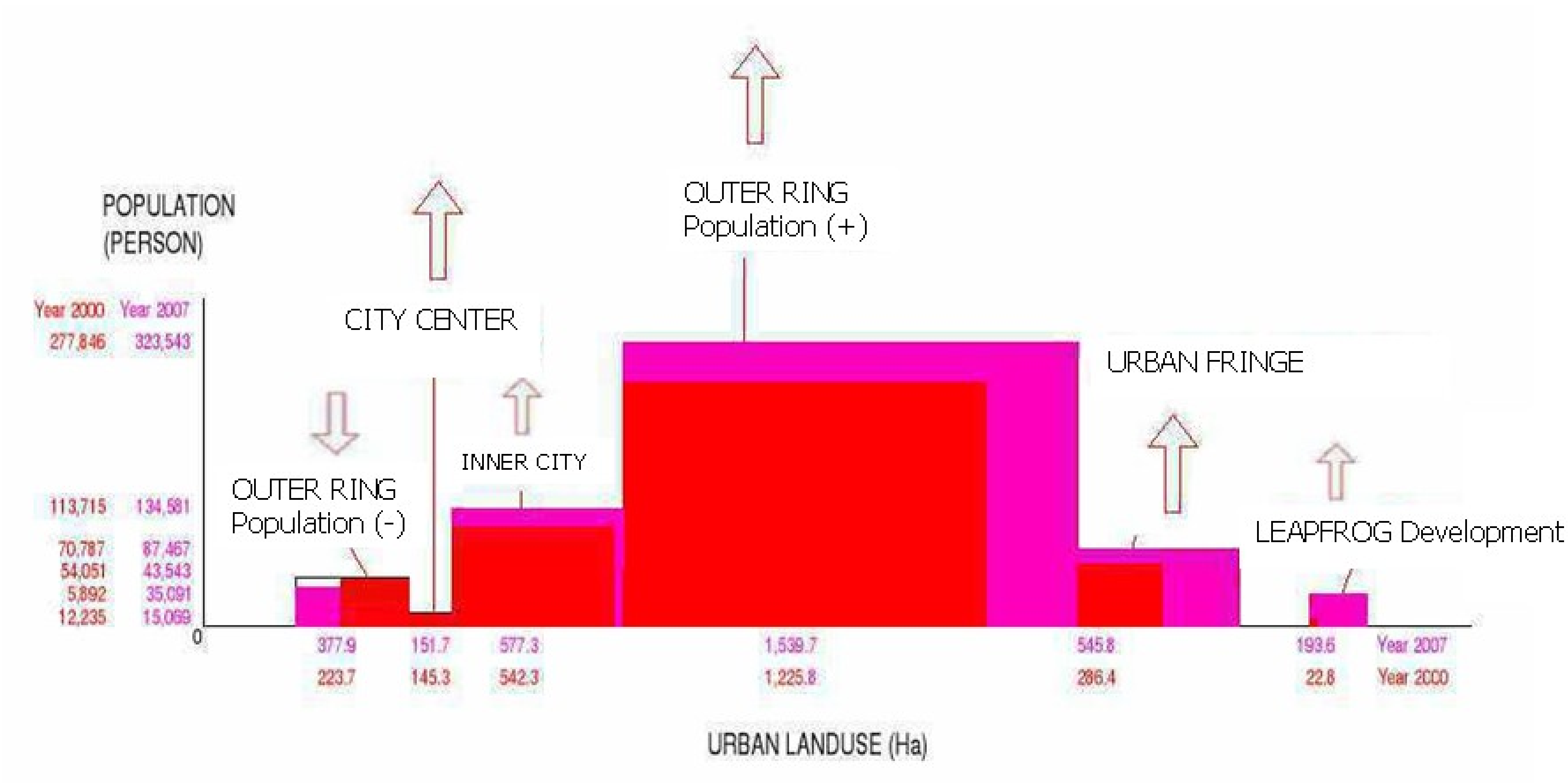
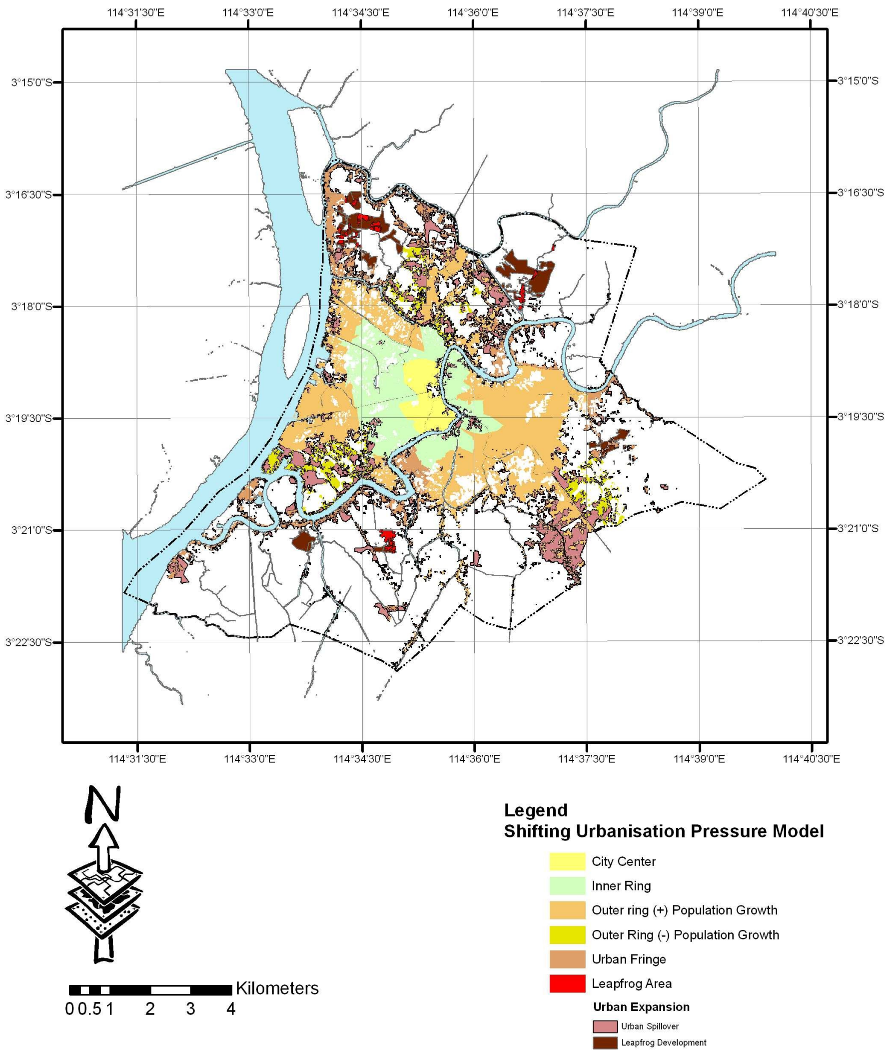


Figure 4.19 Shifting Urbanisation Pressure Model

MAP 12
SHIFTING URBANISATION PRESSURE MODEL



Source: Shifting Urbanisation Pressure of Urban Landuse Change in Banjarmasin, Indonesia 2010

4.5.1. Urbanisation Pressure of Urban Land Use Change

Urban land use change in shifting urbanization pressure model described in Figure 4.20. The highest urban land use is spillover in outer rings about 314 ha, the second highest urban land use is Spillover in leapfrog area about 259.4 ha, the third is leapfrog development about 170.8 ha, and the fourth is outer ring spillover in negative population growth area about 154.2 ha. The lowest urban land use is spillover in city center, which is only about 6.4 ha, and the second lowest urban land use is spillover in inner rings area that is about 35 ha. Urban land use change in shifting urbanization pressure model depicted in figure 4.20

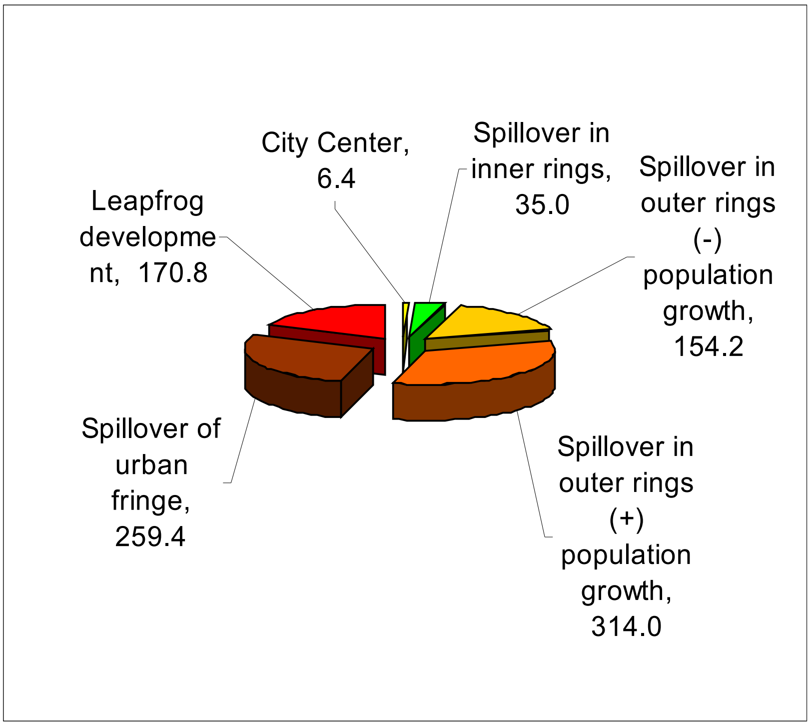


Figure 4.20 Urban Land use Change of Shifting Urbanisation Pressure Model

Urbanisation pressure of urban land use change is the persentage of urban land use change compared to the last urban land use. Urbanisation pressure of urban land use change formulated as follow;

$$P.Lc_i = \frac{(UrbanLu2007 - UrbanLu2000)_i}{UrbanLc2007_i} \times 100\%$$

$P.Lc_i$: Urbanisation pressure of urban land use change
$UrbanLu2007_i$: Urban Land use 2007 of i area
$UrbanLu2000_i$: Urban Land use 2000 of i area

The results of the formula are the highest urbanization pressure of urban land use change is 88.2% in leapfrog development area. The second urbanization pressure of urban land use change is 77.5% in Spillover of urban fringe about 47.5%. Spillover in outer rings is the third urbanization pressure of urban land use change that are 40.8% in decreased population areas and 20.4 in increased population areas. Spillover in inner rings is the fourth of urbanization pressure of urban land use change about 6.1%. The lowest urbanization pressure of urban land use change is in city center about 4.2%. Information that is more detailed presented in table 4.16

Table 4.16 Urbanisation Pressure of Urban Land use Change

Shifting Urbanisation Pressure	**LU 2000 (ha)**	**LU 2007 (ha)**	**Urbanisation Pressure of Land use Change**
City Center	145.3	151.7	4.2%
Spillover in inner rings	542.3	577.3	6.1%
Spillover in outer rings (-) population growth	223.7	377.9	40.8%
Spillover in outer rings (+) population growth	1,225.8	1539.7	20.4%
Spillover of urban fringe	286.4	545.8	47.5%
Leapfrog development	22.8	193.6	88.2%

Urban land use changes gradually from the highest to the lowest urban land use that occurs from Leapfrog development, Spillover of leapfrog development area, spillover in outer ring, spillover in inner ring and the city center.

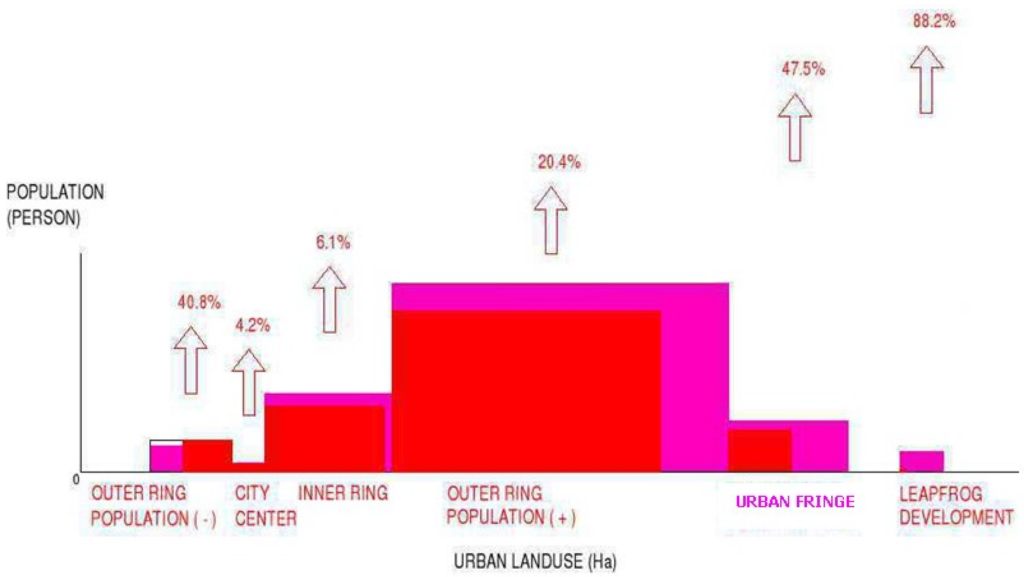


Figure 4.21 Urbanisation Pressure of Urban Land use Change

Urbanization pressure gradual change has many variations from 88.2% to 4.2%. Nevertheless, we can conclude that the distance to city center has effect to urbanization pressure of urban land use change. The nearer distance to city center the lower urbanization pressure of urban land use change and the farther the area to city center the higher the urbanization pressure of urban land use changes. Figure 4.21 shows shifting urbanization pressure model of urban land use change.

According to the main question of this research (is there any correlation of population growth as one of Urbanisation pressure to urban land use change?), we can analyze shifting urbanization pressure model using hypothesis as follow:

H_0: There is no correlation between population growth and urban land use change

H_1: There is correlation between population growth and urban land use change

Assumed that there is a linear relationship between population growth and urban land use change change,

$$LC_i = \beta 0 + \beta 1 * PopG_i + \varepsilon_i$$

Table 4.17 Urbanisasion Preesure and Urban Land Use Change Correlation

Shifting Urbanisation Pressure Model	**N**	**R Square**	β1 and β0	**Ttest**	**Ttab**	
City Center	3	0.003	2.823	0.205	±1.886	Ho
			0.000	-0.051		
Inner Ring Spillover	12	0.000	4.446	1.838	±1.363	Ho
			0.000	0.013		
Outer Ring Spillover pop (-)	4	**0.830**	22.752	**3.089**	±1.638	H_1
			-0.016	**-3.128**		
Outer Ring Spillover pop (+)	22	**0.112**	-0.359	**-0.033**	±1.323	H_1
			0.007	**1.585**		
Spillover of Urban Fringe	9	**0.645**	16.465	**2.860**	±1.397	H_1
			0.007	**3.563**		
Leapfrog Development	9	**0.774**	-10.156	**-1.605**	±1.397	H_1
			0.370	**4.903**		

Correlation of population growth and urban land use change show a statistical relation between two variables; systematic changes in population growth and systematic changes in urban land use change. Independent variable is population growth and dependent variable is urban land use change. The summary of correlation analysis between population growth and urban land use change and analysis as show in Table 4.17 and Appendix C-1.

Regression analysis result of shifting Urbanisation pressure model show that population growth has no correlation to urban land use change in city center and inner ring spillover. It can explain that city center also has urban land use change. However, urban land use changes caused by economic and business infestations, not caused by population growth. Inner ring spillover has low urban land use change. Due to high land price, urban land use change mostly occurs by city center for economic and business expansion. Other factor is land availability causing inner ring spillover has low urban land use change.

Another correlation of shifting Urbanisation pressure model is that population growth has weak correlation to urban land use change. Outer ring spillover in increased population area is only 11% of population growth. This weak correlation explains how urban land use change. The correlation between growth population and urban land use change in outer ring positive population growth is weak because the urban land use change due to existed population. Most of the land uses change because people enlarge their houses. Nevertheless, most of the new migrants choose to live in leapfrog development. Model of outer ring spillover in increase population;

$$LC_i = -0.359 + 0.007 * PopG_i$$

The other shifting Urbanisation pressure model proposes that population growth has strong correlation with urban land use change. The strongest correlation is outer ring spillover in negative population growth area has high correlation with population growth consisting 83% of population growth. This explains how urban land use change. The Model also explains negative correlation between population growth and urban land use change. It can summarize that although population growth is negative, urban land use positively changes. This is justified by the fact that land price goes down when negative population growth exists. This encourages many people buying the land and enlarging their houses. Model of outer ring spillover in negative population growth;

$$LC_i = 22.752 - 3.128 * PopG_i$$

The second strongest correlation is leapfrog development, which has high correlation with population growth (77% of population growth variable). This explains how urban land use changes in leapfrog development. This strong correlation gained because most of population growth especially new migrants prefer to live in leapfrog development Model of Leapfrog development;

$$LC_i = -10.156 + 0.37 * PopG_i$$

The third strongest correlation is spillover of urban fringe that has high correlation with population growth. The population growth variable explains 64% of urban land use change variable. This strong correlation occurred because in this spillover of urban fringe, the land price rather cheaper compared to the other areas. Model of Spill over of urban fringe;

$$LC_i = 16.465 + 0.007 * PopG_i$$

4.5.2. Urbanisation Pressure of Urban Density Change

Urban density 2000 of shifting urbanization pressure model explains that the highest urban density is about 47.1 people per ha in spillover of urban fringe. The second highest urban density is about 241.6 people per ha in outer rings in negative population growth area. The third is outer rings in positive population growth area about 226.7 people per ha, and the fourth is 209.7 people per ha in inner ring. The lowest urban density 2000 is leapfrog development only about 0.26 people per ha and the second lowest urban density is city center about 84.2 people per ha.

Urban density 2007 shifting urbanization pressure model shows that the highest density is 233.1 people per ha in inner ring, the second is 210.2 people in outer ring of positive population growth, the third is 181.3 people in leapfrog development, the fourth is 160.3 people per ha in spillover of urban fringe. The lowest urban density 2007 is city center about 84.2 people per ha which is followed by outer ring with negative population growth area about 115.2 people per ha. Urban density of shifting urbanization pressure portrayed in Figure 4.22.

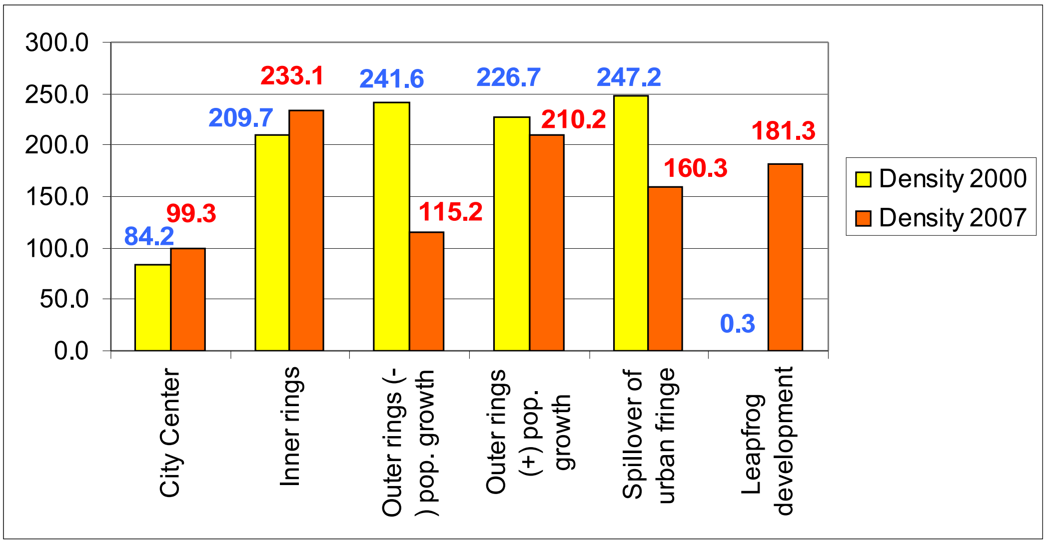


Figure 4.22 Urban Density of Shifting Urbanisation Pressure Model

Positive urban density change is in three locations; leapfrog development, spillover in inner rings, and city center. Leapfrog development urban density change increases about 181.0 people per ha. Spillover inner rings increases about 23.4 people per ha. City center urban density increases about 15.1 people per ha.

In other locations, urban density change decreased. Outer ring with negative population growth decreases up to -126.4 people per ha. The spillover of urban fringe, the decrease is -86.92 people per ha. Outer ring with positive population growth has a decrease about -16.57 people per ha.

Urbanization pressure of urban density change is the percentage of urban density change compared to the last urban density. In this case, the change equals the percentage of urban density change 2000-2007 divided by urban density 2007. Urbanisation pressure of urban land use change formulated as follow;

$$P.Dens_i = \frac{(Dens2007 - Dens2000)_i}{Dens2007_i} \times 100\%$$

P.$Dens_i$: Urbanisation pressure of urban Density change
$Dens2007_i$: Urban Density 2007 of *i* area
$Dens2000_i$: Urban Density 2000 of *i* area

Table 4.18 Urbanisation Pressure of Urban Density Change

Shifting Urbanisation Pressure	Density 2000 (person/ha)	Density 2007 (person/ha)	Urbanisation Pressure of Urban Density
City Center	84.21	99.34	15.2%
Inner rings	209.68	233.13	10.1%
Outer rings (-) population growth	241.61	115.24	-109.7%
Outer rings (+) population growth	226.73	210.16	-7.9%
Spillover of urban fringe	247.17	160.25	-54.2%
Leapfrog development	0.26	181.27	99.9%

Detailed urbanization pressure of density change as show in Table 4.18. The highest urbanization pressure of urban density change is 99.9% in leapfrog development area. The second urbanization pressure of urban density change is 15.2% in city center, which followed by inner rings about 10.1%.

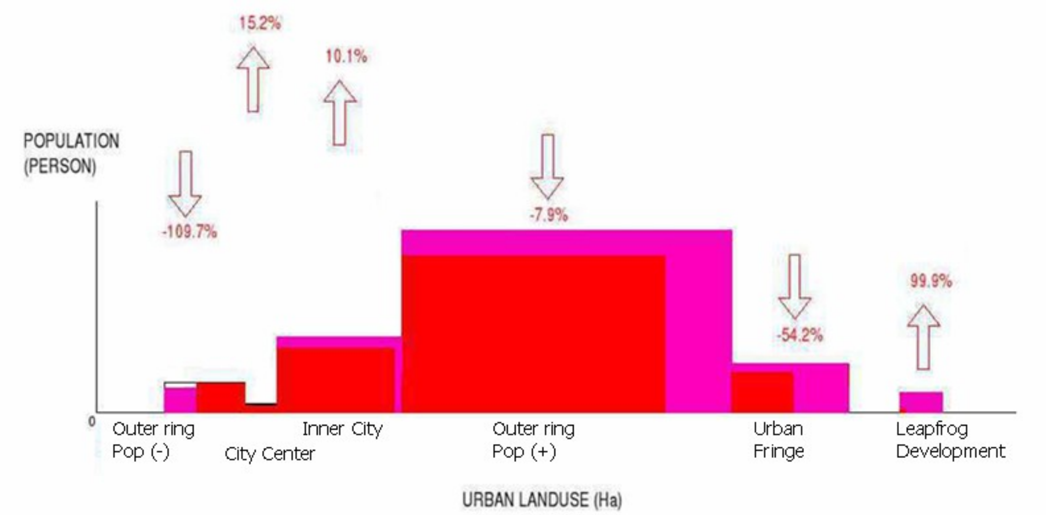


Figure 4.23 Urbanisation Pressure of Urban Density Change

Negative urbanization pressure is -109.7% in outer rings with negative population growth. The second negative urbanization pressure is -54.2 in spillover of urban fringe. The last negative urbanization pressure is -7.9 % in outer rings with negative population growth. Figure 4.23 shows shifting urbanization pressure model of urban density change.

The first pattern is that urbanization pressure of urban density increases in city center and inner rings. Leapfrog development also increases enormously due to high population growth.

The second pattern of Urbanisation pressure of urban density is a decrease. Outer rings with negative population growth urban density decreases because the population moves to other location. Outer ring with positive population growth and spillover of urban fringe also decrease due to high urban land use expansion.

The third pattern is that the nearer to city center, the higher Urbanisation pressure of urban density change. In other words, the farther locations to city center the higher urbanization pressure of urban density change. Except for leapfrog development, area where urbanization pressure of urban density change is very high due to this location has enormous population growth. Nevertheless, the main question is there any correlation between population growths as urbanization pressure to urban density changes.

Correlation between population growth and urban density change modeled with assumption there is correlation between population growth and density change, the correlation model as follow;

$$DC_i = \beta 0 + \beta 1 * PopG_i + \varepsilon_i$$

Population growth is independent variable, urban density change as dependent variable. Therefore, the hypotheses of urban density change of shifting Urbanisation pressure model formulated as follow;

H_0: There is no correlation between population growth and urban density change

H_1: There is correlation between population growth and urban density change

Table 4.19 Urbanisasion Pressure and Urban Density Change Correlation

Shifting Urbanisation Pressure Model	N	R Square	β1 and β0	Ttest	Ttab	
City Center	3	0.465	-39.607	-0.649	±1.886	Ho
			0.060	0.933		
Inner Ring Spillover	12	**0.451**	-36.520	**-2.191**	±1.363	H_1
			0.025	**3.391**		
Outer Ring Spillover pop (-)	4	0.083	-148.595	-2.461	±1.638	Ho
			-0.018	-0.427		
Outer Ring Spillover pop (+)	22	0.001	-12.256	-0.337	±1.323	Ho
			-0.002	-0.100		
Spillover in Urban Fringe	9	0.197	-112.302	-6.197	±1.397	Ho
			0.008	1.309		
Leapfrog Development	9	0.226	18.852	0.196	±1.397	Ho
			-0.166	-1.429		

Regressions analysis result of urban density change correlation of the shifting urbanization pressure model that show in table 4.19. Detailed regression analysis of correlation of population growth and urban density change as show on Appendix C-2.

Population growth has high correlation to urban density change in inner ring. This strong correlation in population growth in inner rings area explains 45% of urban density change. It can be summarized that land price in inner city rings is high, urban land use changes are low. Urban density change also caused by multiple land use such as "*Ruko*". *Ruko* stands for *rumah* (house) and *toko* (shop) in which ground floor functions as shop, the first and more floors function as house for living. Model of inner ring urban density change;

$$DC_i = -36.52 + 0.025 * PopG_i$$

The other urban density change correlation of shifting Urbanisation pressure model is that population growth has no correlation to urban density change. It means that population growth in outer rings, spillover of urban fringe and leapfrog development tends to expand horizontally, which causes urban land use change, rather than to expand vertically, which causes urban density change.

City center has no correlation to urban density change. Therefore, there is correlation between population growth and city expansion, no matter whether urban land use change or urban density change exist.

4.5.3. Model Projection

The reality of urban land use change clearly non-linear. Population growth is not directly affect linear to urban land use change. There is imperfection, where cause and effect are often fuzzy. Nevertheless, there is still pattern extracted from those dynamic systems. Through time series correlation, relationship between variable may result a severely structural. Keil and Elliot (1997).

As summary of shifting urbanization pressure model, it can employ to make projection of urban land use expansion using population growth data. The model shifting of urbanisation pressure model of urban land use change in Banjarmasin City:

$$UrbanLC = \sum (-0.016Pop_i + 22.75) + (0.007Pop_j - 0.36) + (0.007Pop_k + 16.46) + (0.37Pop_m - 10.16) + \varepsilon_r$$

$$UrbanLC = \sum (-0.016Pop_i + 0.007Pop_j + 0.007Pop_k + 0.37Pop_m) + 28.59 + \varepsilon_r$$

Where;

Pop_i : Population in outer ring (-) population growth

PoP_j : Population in outer ring (+) population growth

PoP_k : Population in spillover of Urban Fringe

PoP_m : Population in Leapfrog Development

ε_r : Error

Pattern

The closer to city center the lower urban land use Change

Trend

- Urban land use expansion of outer ring (-) population growth 83% caused by population growth
- Urban land use expansion of outer ring (+) population growth 11% caused by population growth
- Urban land use expansion of spillover of urban fringe 64% caused by population growth
- Urban land use expansion of Leapfrog Development 77% caused by population growth

The second use of shifting urbanization pressure model is for inference of urban density change in urban inner ring. Urban density change in Banjarmasin city urban inner ring base on population growth data formulated as follow:

$$UrbanDens = 0.025Pop_h - 36.520 + \varepsilon_r$$

Where;
PoP_m : Population in urban inner ring
ε_r : Error

Pattern

The closer to city center the higher urban density change.

Trend

- Urban density change of inner ring 45% caused by population growth

Shifting Urbanisation Pressure Model of urban density change in Banjarmasin City

4.5.4. Planning Discussion

There are two systems in urban land use change. The terms used are material system and human system (Portugali; 2008). The difference between material/physical system and human system are shown in figure 4.24. Physical systems as explained in subchapter **4.2.2**, the correlations between urban land use and open space are straightforward. In human system explained in subchapter **4.3.1**, the situation is diverse. Correlation of urban land use change to each of the part of population, is a person itself a complexity.

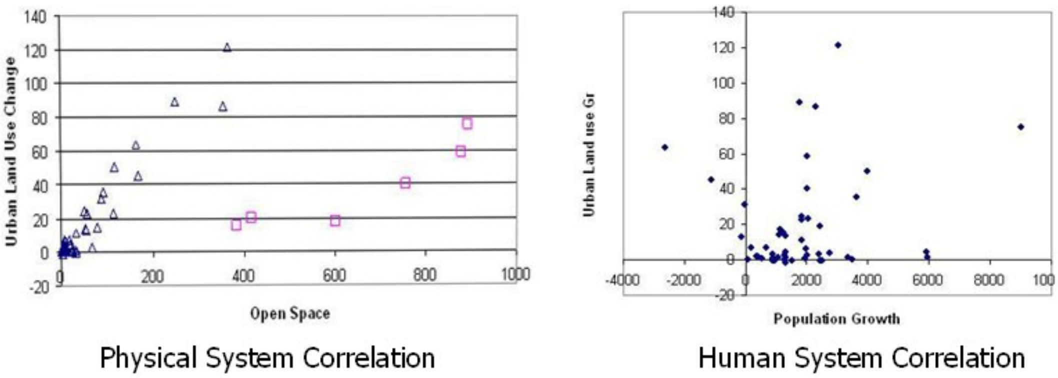


Figure 4.24 Physical System Correlations and Human System Correlations

This research results in confirming in the human system correlation between population growth and urban land use change is not linear. Population growth triggers urban land use change. However, population decline also enlarges urban land use change, it seem to be contradictory. In line with that, Portugali (2008) asserts in the complex system deductions-predictions guide to contradictory result.

Population growth is the main driving force of urban land use change, even though the correlation between population growth and urban land use change is not linear. The nonlinear urban land use reveals fact of chaos and fractal structure. The complex system is spontaneously self-organized (Portugali, 1997). The intention of population growth as driving force on the system does not determine urban land use change directly. Otherwise, population growth generates an internal and independent urban land use change that is explained by shifting urbanization pressure model.

To understand urban land use change, we need to establish complexity within the land use change as well. Complexity theory refers to open systems and complex network. Open, each element of the systems are so various, so that no way to found a simple correlation among them. Complex network means those elements have inter-correlation one another which unfeasible to follow systems developing effects. These lead to fuzziness in planning (Portugali, 2006 and deRoo, 2007).

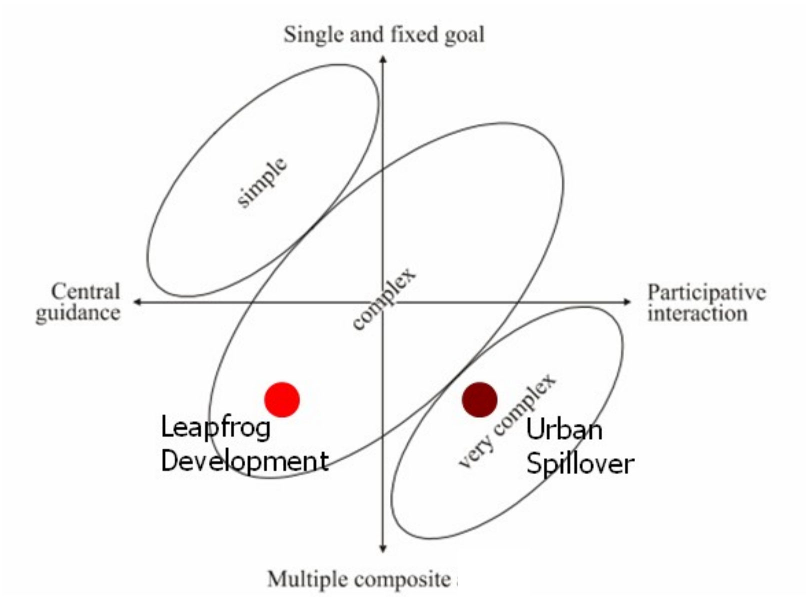


Figure 4.25 Frameworks for Planning Oriented Action in Urban Land Use

Dualism of two systems in urban land use change can be bridge by planning oriented action. Planning oriented action has two axis that the horizontal axis consist of (central guidance-participative interaction), and the vertical axis are (single and fixed goal-multiple composite and dependent goals) (deRoo; 2003). In urban land use change, central guidance means that there is a plan in urban land use development. Single and fixed goal mean there is a well-defined goal orientation in urban land use change. In contrast, participative interaction is self-organized activity of actors in urban land use development. Multiple composite and dependent goals are the numerous objectives of each actor to fulfill their needs in developing urban land use. Urban land use in planning oriented action framework is shown in figure 4.25 (modified from Framework for Planning Oriented Action, de Roo, 2003).

Leapfrog development is positioned in area of central guidance-multiple composite and dependent goals. Central guidance means although most of leapfrog development is not in city spatial plan, the leapfrog development actually planned by the developer. Multiple composite and dependent goals means leapfrog development of numerous developers independently are self-organized in developing urban land use resulted a scatter leapfrog development. Therefore, leapfrog development is in the complex situations.

Spillover urban land use is different from leapfrog development that mostly in area of participative interaction-multiple composite and dependent goals. Participative is this case, actors develop their own urban land use need as self-organized development. Multiple composite and dependent goals mean each actor has their own objective to develop urban land use, which the urban land use development so spontaneous mostly unplanned. Therefore, spillover has a very high complexity.

Current planning condition, local government treats both leapfrog development and urban spillover as central guidance-single and fixed goal. Land use plan based on restriction fails to control urban spillover complexity, which is very complex. This condition also creates a gap among planners (local government, city planner consultant, etc) and practitioners (developer, contractor, etc). In extreme, practitioners think there is no need planning at all.

The complexity reveals phenomena of non-linearity and instability (Portugali; 1997).This research accentuate that in complexity of urban land use change, it still needs a land use plan. Clearly, land use plan needs different approach considering two different ways of regulating the complexity spectrum.

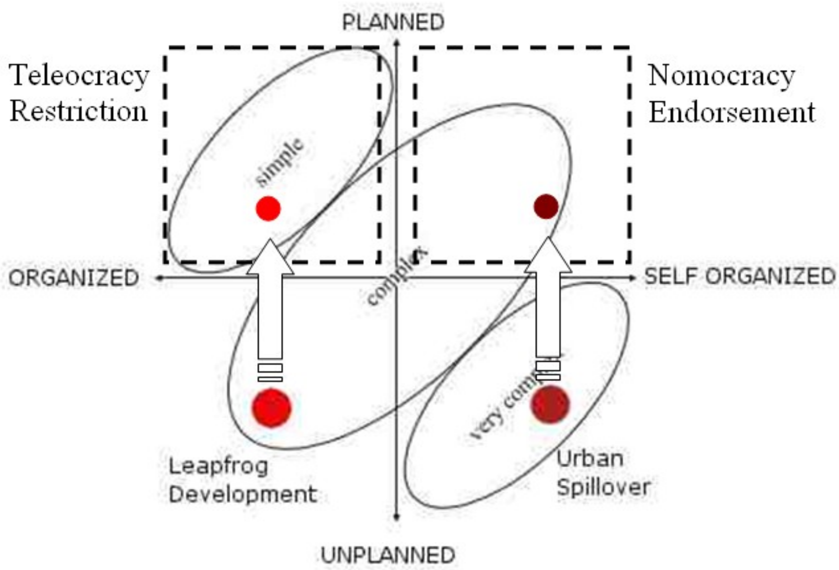


Figure 4.26 Urban Land Use Policies in Planning Oriented Action

Hence, land use planning is not always a restriction but also an endorsement. These two approaches are used in public regulation terms as *Teleocracy* and *nomocracy* (Moroni; 2010). Figure 4.26 shows planning oriented action, which shifts the complexity of urban land use policy

The first type of urban land use change is leapfrog development. Leapfrog development complexity is so complex that urban development mostly unplanned. Nevertheless, private developers organize urban development. For that reasons, to manage this kind development, local government drives leapfrogs development from unplanned-organized to planned-organized urban land use change. It necessitates not limiting the development; local government and private developer have to get a mutual understanding in making land use plan. In this type of urban expansion, urban plan is the primary assets of land use plan.

Leapfrog development is a low urban land use expansion, but the rate of growth in leapfrog development is very high as explained in sub chapter 4.5.1. This expansion will endanger the open space due to leapfrog development in urban fringe. In terms of protection of open space, local government can put a restriction as well.

The other problem in leapfrog development is the increase of urban density that is very high as show in chapter 4.5.2. The enormous leapfrog developments for solving urban density in city center emerges another problem. The development seems moving density problem in the city center to urban fringe. New problem arise such as congestion to leapfrog development on peak hour. Therefore, connecting leapfrog development area and city center is imperative.

The second type of development is urban spillover is spontaneous housing developments built by local inhabitant. An unplanned-self organized urban land use changed mostly in spillover area needs a different approach. An unplanned-self organized urban land use change has a large number of elements that create a complex system, which is difficult to predict or govern (Alfansi and Portugali, 2007). Complexity considered as a very complex situation and restriction, which has low impact and local government in this situation approach uses endorsement. The approach needs a paradigm shifting from infrastructure following urban development into urban development following the infrastructure. For example, local government firstly make road infrastructure so that local inhabitant will develop following the road, instead of local government follows amorphous urban development. This approach is better than eviction, due to the unsolved problem in eviction, which makes people move to other region of the city.

5. CONCLUSIONS AND RECOMENDATIONS

5.1. Conclusions

This research attends to analysis population growth affect to urban land use change. The previous analysis chapter, dispute the correlation between population growth and city expansion in Banjarmasin, Indonesia. This last chapter concludes those relations. For those points, this chapter firstly reply to the research questions.

The first reply is correlation between population growth and urban land use change. Although theoretically population growth is driving force of land use change, but on this research show that there is no strong direct correlation between population change and expansion of urban land use. In some sub districts population has positive growth and urban land use expanse. Meanwhile, in other sub districts population has negative growth but urban land use still expanse.

The second research result is correlation between population growth and urban density growth. This research shows that population growth has minor correlation to urban density changes.

The third reply is correlation of population growth and urban land use change in shifting urbanization pressure model. The population growth has no correlation with urban land use change in city center. However, population growth has strong correlation with urban land use change on spillover of inner ring, spillover of outer ring, spillover of leapfrog sub district, and expansion of leapfrog development. Pattern of urbanisation pressure of urban land use change is negative correlation. The closer areas to city center, the lower urban land use expanse. City center has lower urban spillover than inner rings. Inner rings have lower spillover than outer rings. Outer rings have lower spillover than leapfrog sub districts. Leapfrog sub districts have lower spillover than leapfrog development expansion

The fourth answer is population growth and urban density change in shifting urbanization pressure model. Contrast to the previous pattern, the population growth has no correlation to urban density change of city center, outer ring, Leapfrog sub district, and leapfrog development. Population growth only correlated with urban density of inner rings. In the other world population growth in inner ring have a tendency to urban density growth. The urbanisation pressure pattern of urban density change has opposite to urban land use change. Urban density has positive correlation that the closer to city center the higher urban density change, except for leapfrog development. In leapfrog development, urban density is highly increased. Therefore, city center has higher density change than inner rings. Inner rings have higher urban density change than outer rings. Outer rings have higher urban density change than leapfrog sub districts.

Finally, this research provides land use planning for both theory and practice. Theoretically, population growth is driving force of city expansion. Nevertheless, affect of population growth practically are different to each part of city area. Specially, city center, both of urban land use change and urban density change not affected by population growth but by other factor. Population growth is driving force of urban land use expansion in outer ring, urban fringe, and leapfrog development. Meanwhile, Population growth in inner ring tends to form urban density growth.

This research also point up problem in land use planning in many developing countries for lack of consistent data can be solved buy combination image analysis and GIS modeling. Landsat image can be useful not only it is reliable for land use analysis but also it is also free of charge. Furthermore, GIS modeling, shifting urbanization pressure model is a handy tool to explore population growth affect to urban land use expansion and urban density growth.

5.2. Recommendation

Recommendations from this research as last chapter, I afford ways forward considering the urban land use change. I offer theoretical recommendation in urban land use planning and continue with a more practical recommendation for recuperating the urban land use planning.

I recommended two theoretical aspect of urban land use change. The first recommendation is about *complexity in urban land use change*. Now a day urban land use changing is more complex, with all the imperfection. Population growth is still main driving force of urban land use change. However, correlation between population growth and urban land use change is not linear. Nevertheless, there is still pattern of land use change, which can be examined using shifting urbanisation pressure model. This model can help explain how urbanisation pattern and trend in city expansion, so that urban land use plan product will base on contextual not just by standard of form and function. The second recommendation is *satellite imageries and GIS as handy tools* in urban land use change analysis. This tool is very important, especially in developing country where reliable data not available.

The next recommendations are practical aspect with three main highlight. The first is about *urban land use change in Leapfrog development*. Planner aware that although some leapfrog development are low urban land use expansion, but the rate of growth in leapfrog development is very high. This expansion will endanger open space due to leapfrog development is in urban fringe. The second is *urban density growth in leapfrog development*. The increase of urban density is very high, it seem moving problem in the city center to urban fringe, not solve the problem. New problem such as congestion to leapfrog development area in time when working hour is finish, and congestion is early morning is leapfrog area when working hour is start. Therefore, integration planning between leapfrog development area and city center is important. For example, mass rapid transport to leapfrog development. The third recommendation is *managing urban land use change in complexity*. I emphasized that in complexity still need planning. Obviously, it needs different approach, that planning in land use not always by restriction but also by endorsement. For urban expansion leapfrog development where low complexity due to urban built by developer, local government can control through restriction. However, self organized housing development built by local inhabitant, mostly in spillover area need different approach. Spillover development in which complexity is very high where eviction and restriction has low impact, planner can approach with endorsement.

Finally, this research just slices of massive study of city expansion. Urban land use change is dynamic subject that can vary in other region depend on its people who form those expansion. Therefore, study of urban land use change can not separated with study to people behaviors. Population and urban land use is different face in the same coin, that has diverse face but correlated each other.

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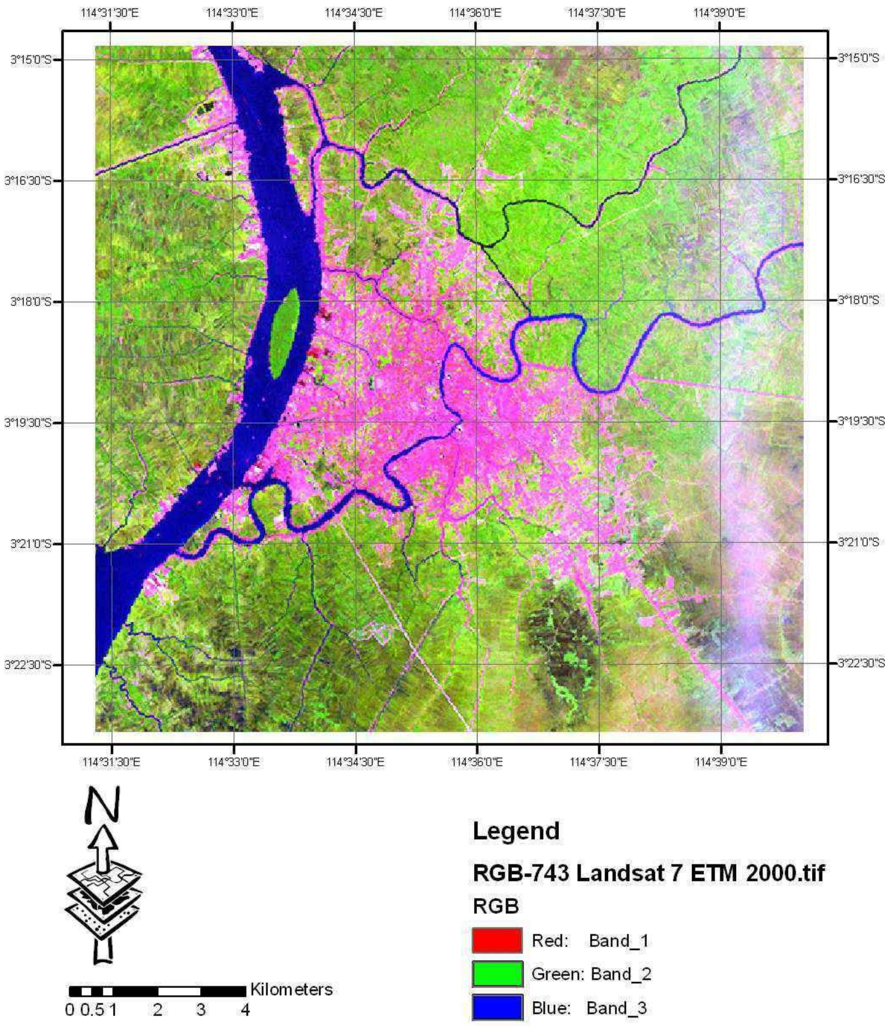
APPENDIX A – MASTER TABLE

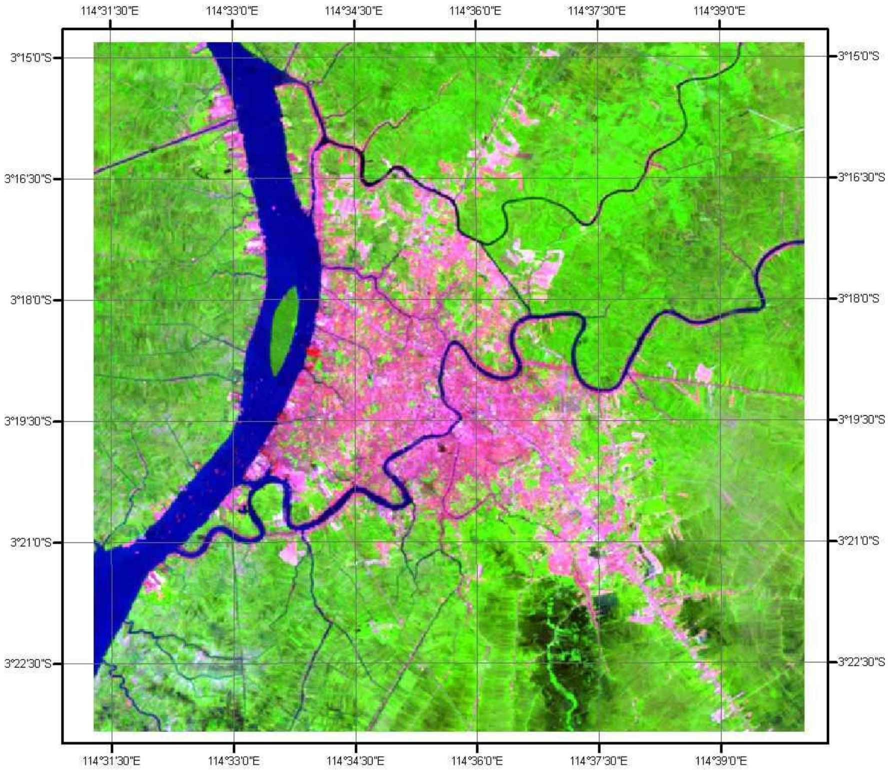
ID	Sub District	District	Total Area (Ha)	Open Space 2000 (Ha)	Open Space 2007 (Ha)	Water Body 2000 (Ha)	Water Body 2007 (Ha)	Urban Landuse 2000 (Ha)	Urban Landuse 2007 (Ha)	Population 2000 (person)	Population 2007 (person)	Urban Density 2000 (person/ha)	Urban Density 2007 (person/ha)	Population Growth (person)	Urban Landuse Changes (ha)	Urban Density Changes (person/ha)
1.01	Antasan Besar	Banjarmasin Tengah	80.7	9.6	5.9	4.3	4.2	66.7	70.5	7,330	8,221	109.8	116.6	891	3.8	6.7
1.02	Gadang	Banjarmasin Tengah	29.8	2.2	1.7	3.0	2.5	24.5	25.6	7,475	8,002	305.1	312.7	527	1.1	7.6
1.03	Melayu	Banjarmasin Tengah	60.8	7.0	5.6	3.4	3.4	50.3	51.7	10,541	11,428	209.5	221.0	887	1.4	11.5
1.04	Kelayan Luar	Banjarmasin Tengah	21.8	3.2	0.9	1.3	1.2	17.3	19.7	6,107	6,475	352.8	328.2	368	2.4	-24.6
1.05	Kertak Baru Ilir	Banjarmasin Tengah	47.0	1.2	0.4	4.5	4.6	41.3	42.0	3,248	4,123	78.6	98.1	875	0.7	19.5
1.06	Kertak Baru Ulu	Banjarmasin Tengah	45.0	4.3	2.5	3.5	3.4	37.2	39.1	1,657	2,725	44.5	69.6	1,068	1.9	25.1
1.07	Mawar	Banjarmasin Tengah	46.6	6.9	1.9	0.0	0.0	39.7	44.7	5,868	7,171	147.7	160.5	1,303	5.0	12.8
1.08	Pasar Lama	Banjarmasin Tengah	46.5	6.7	4.6	3.0	3.0	36.8	38.9	7,678	8,069	208.8	207.4	391	2.1	-1.4
1.09	Pekapuran Laut	Banjarmasin Tengah	22.4	8.1	0.9	1.8	1.7	12.5	19.8	5,682	5,872	454.9	296.3	190	7.3	-158.7
1.10	Seberang Mesjid	Banjarmasin Tengah	40.8	9.6	3.6	6.7	6.1	24.5	31.2	6,965	8,918	284.9	286.1	1,953	6.7	1.2
1.11	Sungai Baru	Banjarmasin Tengah	46.4	5.4	1.9	3.7	3.7	37.3	40.8	6,847	9,216	183.5	226.1	2,369	3.5	42.6
1.12	Teluk Dalam	Banjarmasin Tengah	177.5	27.2	25.4	2.9	2.9	147.4	149.2	27,451	30,784	186.2	206.3	3,333	1.8	20.1
2.01	Alalak Selatan	Banjarmasin Utara	87.3	50.6	26.4	12.5	12.1	24.2	48.9	8,123	9,937	335.2	203.1	1,814	24.7	-132.1
2.02	Alalak Tengah	Banjarmasin Utara	88.5	53.1	39.4	7.9	7.6	27.5	41.5	5,559	6,843	202.2	165.0	1,284	14.0	-37.2
2.03	Alalak Utara	Banjarmasin Utara	311.2	249.6	162.0	18.2	16.9	43.5	132.3	9,361	11,130	215.3	84.1	1,769	88.8	-131.2
2.04	Antasan Kecil Timur	Banjarmasin Utara	73.2	54.4	40.9	1.4	1.4	17.4	30.9	9,387	9,238	539.2	299.0	-149	13.5	-240.2
2.05	Kuin Utara	Banjarmasin Utara	147.6	115.4	92.6	12.4	12.3	19.9	42.7	6,389	8,217	321.5	192.4	1,828	22.8	-129.1
2.06	Pangeran	Banjarmasin Utara	140.4	87.9	56.3	5.7	5.9	46.8	78.2	8,043	8,013	172.0	102.5	-30	31.5	-69.6
2.07	Sungai Jingah	Banjarmasin Utara	416.2	354.4	269.4	33.4	32.0	28.5	114.9	9,345	11,617	328.0	101.1	2,272	86.4	-226.9
2.08	Sungai Miai	Banjarmasin Utara	178.8	92.6	57.1	3.8	3.7	82.4	118.0	13,844	17,471	168.1	148.1	3,627	35.6	-20.0
2.09	Surgi Mufti	Banjarmasin Utara	163.1	116.1	65.8	9.4	9.3	37.6	87.9	10,759	14,737	286.1	167.6	3,978	50.3	-118.6
3.01	Banua Hanyar	Banjarmasin Timur	652.3	599.9	582.9	36.6	36.0	15.8	33.4	6,202	7,341	393.0	219.8	1,139	17.6	-173.2
3.02	Karang Mekar	Banjarmasin Timur	69.8	3.4	3.4	1.4	2.7	65.0	63.6	13,677	14,984	210.6	235.7	1,307	-1.4	25.1
3.03	Kebun Bunga	Banjarmasin Timur	119.3	18.6	14.3	0.0	0.0	100.7	105.0	13,632	16,378	135.4	156.1	2,746	4.3	20.6
3.04	Kuripan	Banjarmasin Timur	140.5	66.6	63.8	0.1	0.1	73.8	76.7	14,166	15,432	191.9	201.3	1,266	2.8	9.4
3.05	Pekapuran Raya	Banjarmasin Timur	89.0	32.9	31.4	1.1	1.9	55.1	55.7	14,602	18,082	265.0	324.6	3,480	0.6	59.7
3.06	Pemurus Luar	Banjarmasin Timur	223.0	168.5	123.0	0.0	0.0	54.5	100.1	11,711	10,605	214.9	106.0	-1,106	45.6	-108.9
3.07	Pengambangan	Banjarmasin Timur	112.9	31.0	29.3	4.8	4.8	77.2	78.9	11,452	12,759	148.4	161.8	1,307	1.7	13.4
3.08	Sungai Bilu	Banjarmasin Timur	61.5	12.5	12.4	4.7	4.7	44.3	44.4	9,787	10,721	220.7	241.5	934	0.0	20.8
3.09	Sungai Lulut	Banjarmasin Timur	801.3	756.9	716.6	14.0	14.1	30.4	70.7	7,181	9,184	236.6	130.0	2,003	40.3	-106.7
4.01	Kelayan Barat	Banjarmasin Selatan	29.3	4.6	2.0	2.4	2.3	22.2	25.0	7,325	9,320	329.5	372.7	1,995	2.8	43.1
4.02	Kelayan Dalam	Banjarmasin Selatan	33.5	3.1	3.1	0.9	0.9	29.4	29.4	9,869	11,366	335.3	386.2	1,497	0.0	50.9
4.03	Kelayan Selatan	Banjarmasin Selatan	1,046.1	891.5	821.0	75.9	71.2	78.7	154.0	15,748	24,715	200.2	160.5	8,967	75.3	-39.7
4.04	Kelayan Tengah	Banjarmasin Selatan	19.3	2.3	2.3	1.4	1.5	15.6	15.5	7,843	8,715	504.0	560.8	872	0.0	56.8
4.05	Kelayan Timur	Banjarmasin Selatan	470.4	415.1	395.3	16.1	16.2	39.3	58.9	13,879	16,292	353.6	276.8	2,413	19.6	-76.8
4.06	Mantuil	Banjarmasin Selatan	1,188.9	877.8	825.1	268.9	262.7	42.2	101.1	8,770	10,781	207.9	106.6	2,011	58.9	-101.3
4.07	Murung Raya	Banjarmasin Selatan	66.9	33.0	32.7	3.7	4.0	30.3	30.2	11,490	13,985	379.7	463.7	2,495	-0.1	84.0
4.08	Pekauman	Banjarmasin Selatan	36.8	2.6	2.3	1.9	1.7	32.3	32.8	10,029	10,100	310.3	307.8	71	0.5	-2.5
4.09	Pemurus Baru	Banjarmasin Selatan	142.2	79.0	64.6	1.9	2.0	61.2	75.5	12,939	14,012	211.4	185.5	1,073	14.3	-25.8
4.10	Pemurus Dalam	Banjarmasin Selatan	420.3	364.8	243.8	5.3	5.3	50.2	171.3	16,589	19,614	330.2	114.5	3,025	121.0	-215.7
4.11	Tanjung Pagar	Banjarmasin Selatan	399.5	383.4	367.9	5.6	5.6	10.5	25.9	5,387	6,608	515.5	255.0	1,221	15.5	-260.5
5.01	Basirih	Banjarmasin Barat	343.8	164.7	101.9	74.1	73.2	105.1	168.7	24,910	22,283	237.1	132.1	-2,627	63.6	-105.0
5.02	Belitung Selatan	Banjarmasin Barat	126.2	24.6	24.6	2.9	2.9	98.6	98.6	13,846	16,274	140.4	165.0	2,428	0.0	24.6
5.03	Belitung Utara	Banjarmasin Barat	53.8	10.6	10.1	1.6	1.6	41.6	42.0	6,911	8,163	166.3	194.4	1,252	0.4	28.1
5.04	Kuin Cerucuk	Banjarmasin Barat	215.6	57.0	39.7	73.1	67.0	85.6	109.0	18,017	20,054	210.6	184.0	2,037	23.4	-26.6
5.05	Kuin Selatan	Banjarmasin Barat	66.0	24.5	23.0	3.8	3.9	37.7	39.1	10,644	12,560	282.0	321.4	1,916	1.3	39.4
5.06	Pelambuan	Banjarmasin Barat	160.7	20.9	15.6	37.0	37.6	102.8	107.4	24,830	30,722	241.6	286.0	5,892	4.6	44.4
5.07	Telaga Biru	Banjarmasin Barat	156.5	33.0	20.9	17.0	17.8	106.5	117.8	15,812	17,632	148.5	149.7	1,820	11.4	1.1
5.08	Telawang	Banjarmasin Barat	64.2	8.4	6.4	6.6	6.8	49.2	51.0	8,442	14,380	171.7	282.2	5,938	1.8	110.5
5.09	Teluk Tiram	Banjarmasin Barat	66.4	18.9	12.8	18.9	17.8	28.7	35.9	11,176	11,839	389.8	330.2	663	7.2	-59.6
T o t a l			**9,647.6**	**6,375.8**	**5,457.6**	**824.5**	**804.2**	**2,447.3**	**3,385.8**	**534,525**	**623,108**	**12,816.5**	**11,003.7**	**88,583**	**938.5**	**-1,812.7**

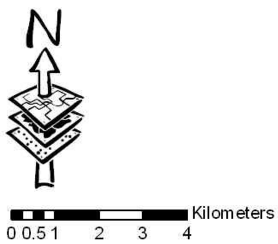
APPENDIX B-1
LANDSAT 7 ETM+ 2000 RGB BAND 743



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

APPENDIX B-2
LANDSAT 7 ETM+ 2007 RGB BAND 743





Legend

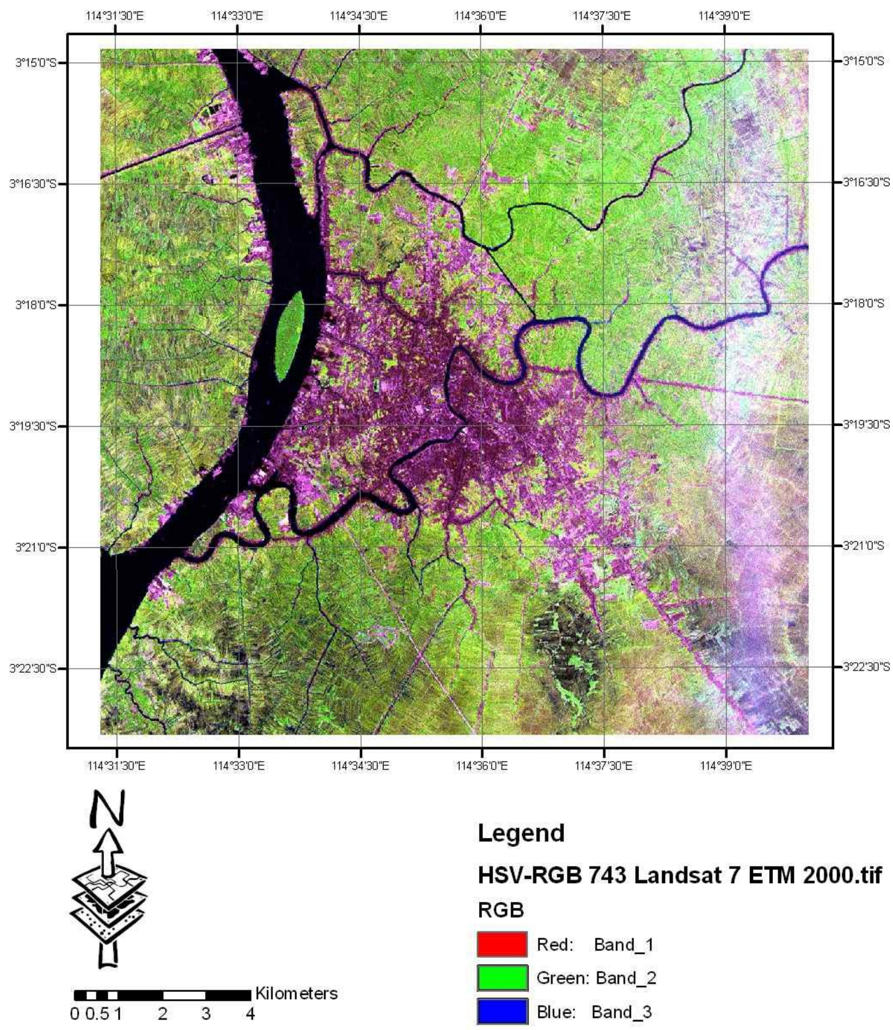
RGB-743 Landsat 7 ETM 2007.tif

RGB

- Red: Band_1
- Green: Band_2
- Blue: Band_3

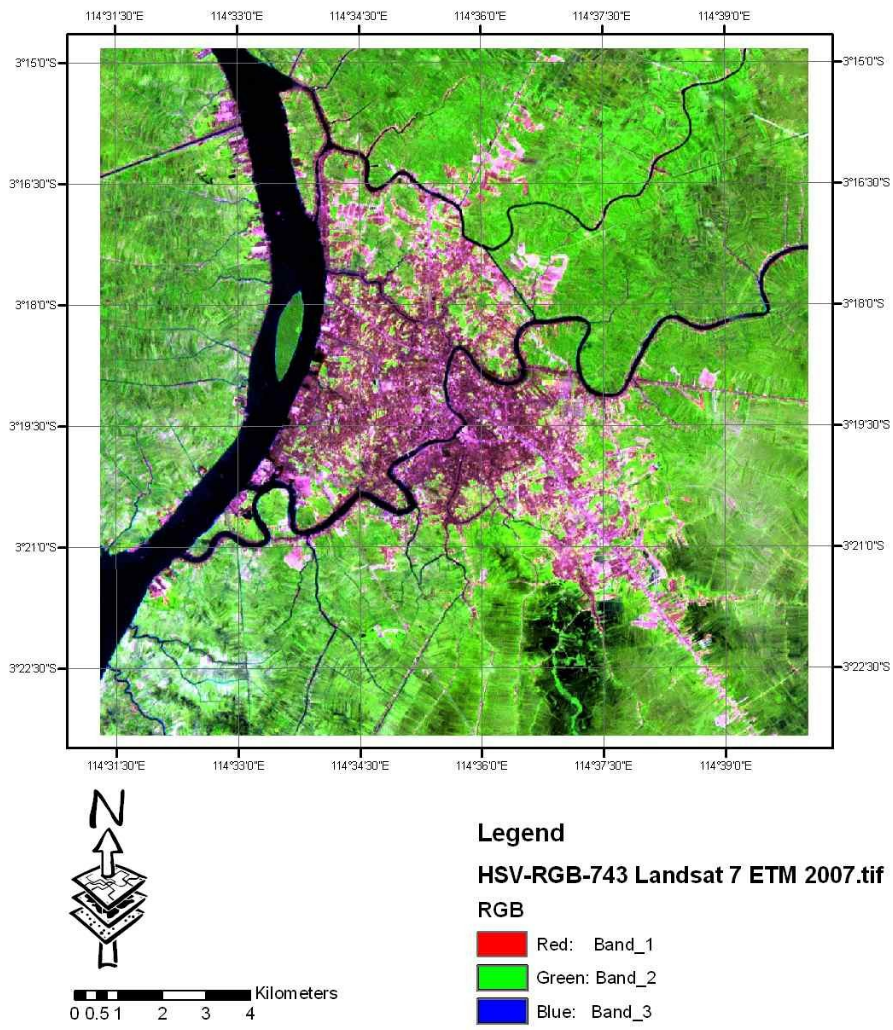
Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

APPENDIX B-3 LANDSAT 7 ETM+ 2000 IMAGE SHARPENING HSV RGB BAND 743



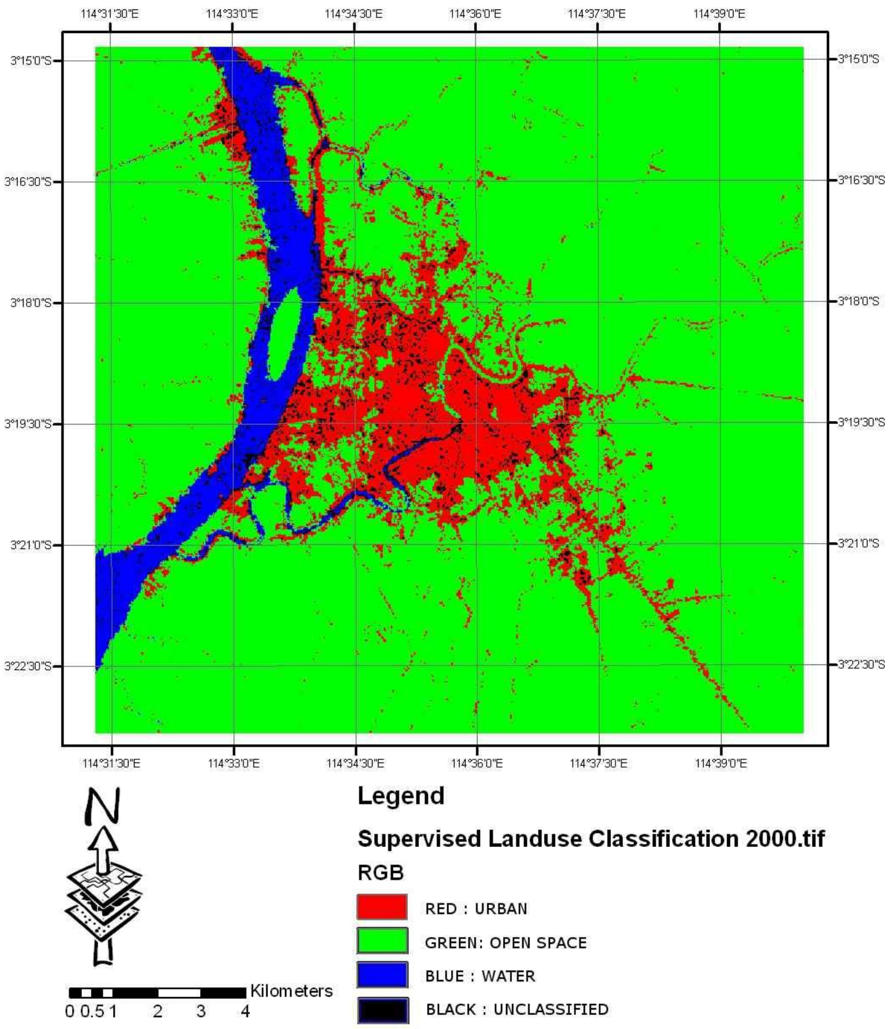
Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

APPENDIX B-4 LANDSAT 7 ETM+ 2007 IMAGE SHARPENING HSV RGB BAND 743



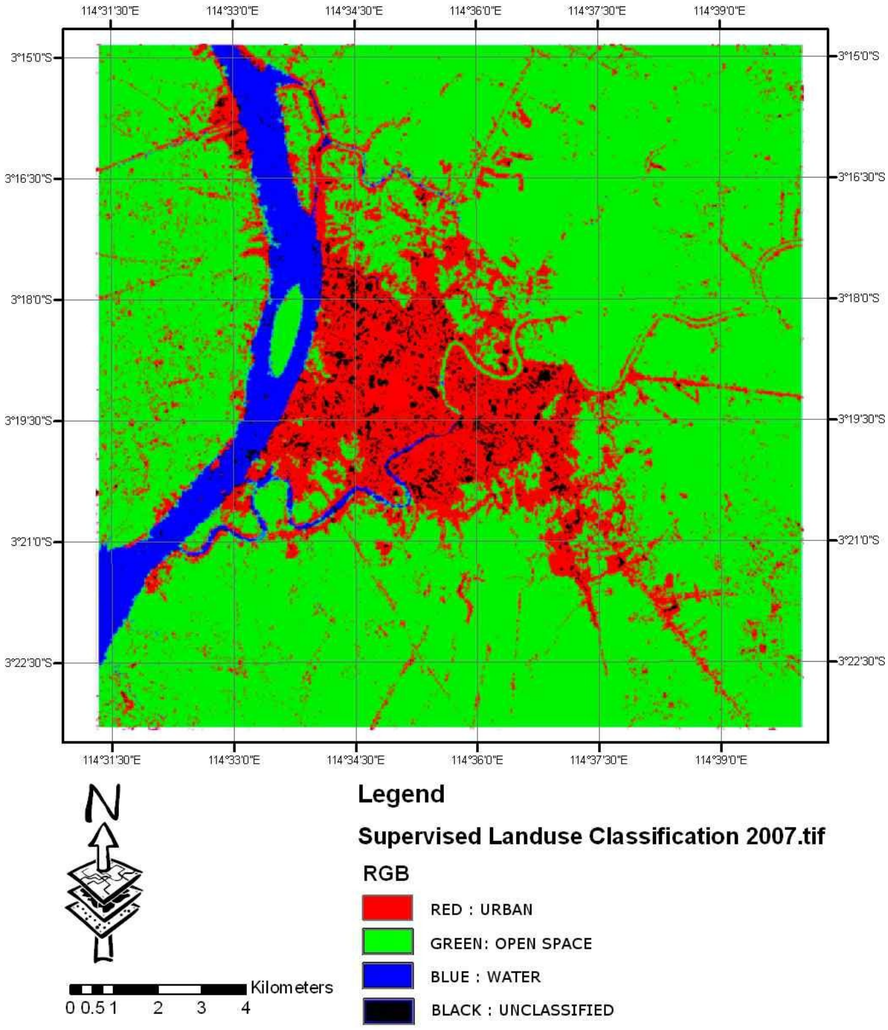
Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

APPENDIX B-5
SUPERVISED CLASSIFICATION 2000



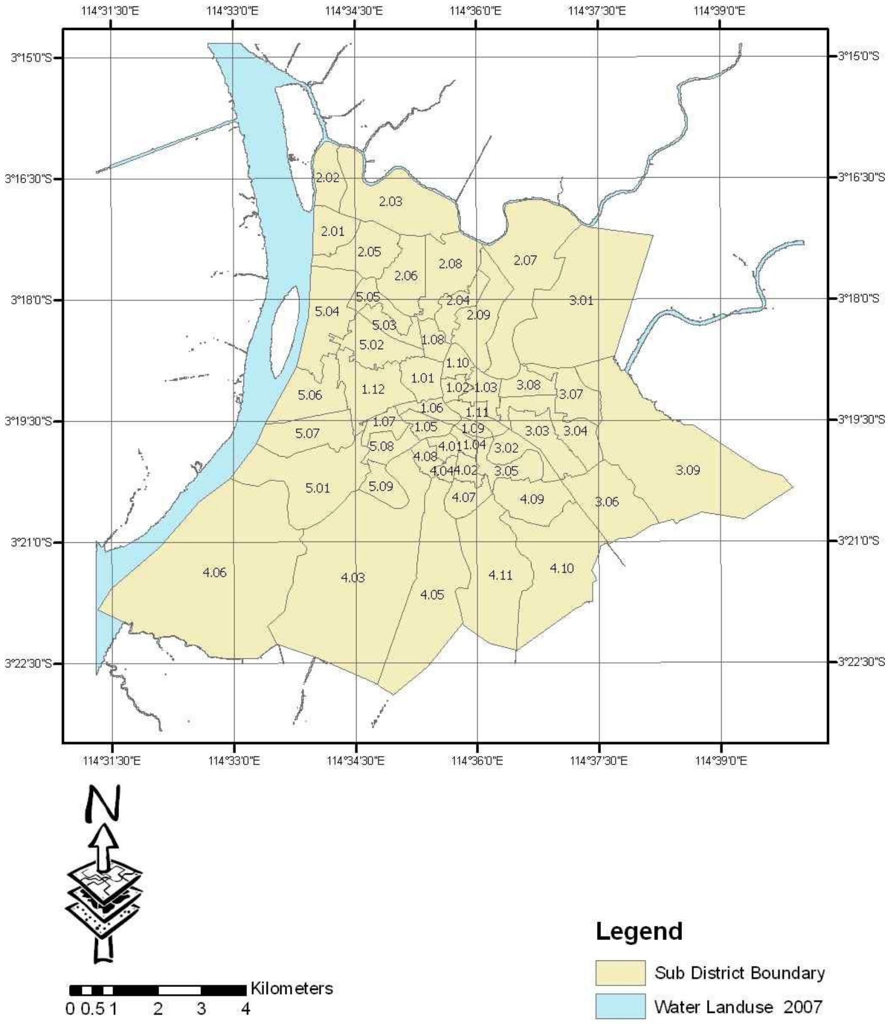
Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

APPENDIX B-6
SUPERVISED CLASSIFICATION 2007



Source: Shifting Urbanisation Pressure of Urban Land Use Change in Banjarmasin, Indonesia

APPENDIX B-7 SUB DISTRICT MAP



Source: Shifting Urbanisation Pressure of Urban Landuse Change in Banjarmasin, Indonesia 2010

APPENDIX C - CORRELATION ANALYSIS

1.1. City Center Spillovers

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Urban LU Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.051[a]	.003	-.995	2.20072

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.012	1	.012	.003	.968[a]
	Residual	4.843	1	4.843		
	Total	4.856	2			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Urban LU Chg

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.823	13.786		.205	.871
	Pop Chg	.000	.015	-.051	-.051	.968

a. Dependent Variable: Urban LU Chg

1.2. Inner Ring Spillovers

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Urban LU Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.004[a]	.000	-.071	6.10042

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.006	1	.006	.000	.990[a]
	Residual	521.012	14	37.215		
	Total	521.018	15			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Urban LU Chg

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.446	2.419		1.838	.087
	Pop Chg	1.413E-5	.001	.004	.013	.990

a. Dependent Variable: Urban LU Chg

1.3. Outer Ring Spillovers

1.3.1. Outer Ring Spillovers Negative Population Growth

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Urban LU Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.911[a]	.830	.745	10.72913

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1126.044	1	1126.044	9.782	.089[a]
	Residual	230.228	2	115.114		
	Total	1356.272	3			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Urban LU Chg

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	22.752	7.365		3.089	.091
	Pop Chg	-.016	.005	-.911	-3.128	.089

a. Dependent Variable: Urban LU Chg

1.3.2. Outer Ring Spillovers Positive Population Growth

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Urban LU Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.334[a]	.112	.067	26.30681

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1738.842	1	1738.842	2.513	.129[a]
	Residual	13840.965	20	692.048		
	Total	15579.807	21			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Urban LU Chg

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-.359	10.803		-.033	.974
	Pop Chg	.007	.004	.334	1.585	.129

a. Dependent Variable: Urban LU Chg

1.4. Urban Fringe Spillovers

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Urban LU Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.803[a]	.645	.594	13.78348

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2412.374	1	2412.374	12.698	.009[a]
	Residual	1329.890	7	189.984		
	Total	3742.264	8			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Urban LU Chg

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	16.465	5.756		2.860	.024
	Pop Chg	.007	.002	.803	3.563	.009

a. Dependent Variable: Urban LU Chg

1.5. Leapfrog Development Expansion

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Urban LU Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.880[a]	.774	.742	9.76737

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2293.355	1	2293.355	24.039	.002[a]
	Residual	667.811	7	95.402		
	Total	2961.166	8			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Urban LU Chg

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-10.156	6.327		-1.605	.152
	Pop Chg	.037	.008	.880	4.903	.002

a. Dependent Variable: Urban LU Chg

2.1. City Center Urban Density Changes

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Denst Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.682[a]	.465	-.069	9.74782

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	82.733	1	82.733	.871	.522[a]
	Residual	95.020	1	95.020		
	Total	177.753	2			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Denst Chg

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-39.607	61.065		-.649	.634
	Pop Chg	.060	.064	.682	.933	.522

a. Dependent Variable: Denst Chg

2.2. Inner Ring Urban Density Changes

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Denst Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.671[a]	.451	.412	42.02449

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20301.968	1	20301.968	11.496	.004[a]
	Residual	24724.813	14	1766.058		
	Total	45026.781	15			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Denst Chg

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-36.520	16.667		-2.191	.046
	Pop Chg	.025	.007	.671	3.391	.004

a. Dependent Variable: Denst Chg

2.3. Outer Ring Urban Density Changes

2.3.1. Outer Ring Negative Population Growth Urban Density Changes Urban Density Changes

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Denst Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.289[a]	.083	-.375	87.95822

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1408.986	1	1408.986	.182	.711[a]
	Residual	15473.296	2	7736.648		
	Total	16882.282	3			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Denst Chg

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	-148.595	60.377		-2.461	.133
	Pop Chg	-.018	.042	-.289	-.427	.711

a. Dependent Variable: Denst Chg

2.3.1. Outer Ring Positive Population Growth Urban Density Changes Urban Density Changes

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Denst Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.022[a]	.001	-.049	88.55611

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	78.914	1	78.914	.010	.921[a]
	Residual	156843.696	20	7842.185		
	Total	156922.610	21			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Denst Chg

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-12.256	36.365		-.337	.740
	Pop Chg	-.002	.015	-.022	-.100	.921

a. Dependent Variable: Denst Chg

2.4. Leapfrog Sub District Urban Density Changes

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Denst Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.444[a]	.197	.082	43.38875

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3227.497	1	3227.497	1.714	.232[a]
	Residual	13178.087	7	1882.584		
	Total	16405.584	8			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Denst Chg

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-112.302	18.121		-6.197	.000
	Pop Chg	.008	.006	.444	1.309	.232

a. Dependent Variable: Denst Chg

2.5. Leapfrog Development Urban Density Changes

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Pop Chg[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Denst Chg

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.475[a]	.226	.115	148.83091

a. Predictors: (Constant), Pop Chg

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	45208.694	1	45208.694	2.041	.196[a]
	Residual	155054.472	7	22150.639		
	Total	200263.166	8			

a. Predictors: (Constant), Pop Chg

b. Dependent Variable: Denst Chg

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	18.852	96.411		.196	.851
	Pop Chg	-.166	.116	-.475	-1.429	.196

a. Dependent Variable: Denst Chg