## Contents

**Original Article**

- **Alley Revitalization to Increase Green Areas in the Cities**
  Monica PEREZ BAEZ and Katsuhiko SUZUKI
  1

- **Basic Study on the Heat Release Characteristics from Shikkui - A Japanese Traditional Architectural Material**
  KazuhikoISHIMATSU, KeitaroITO, YasunoriMITANI, TetsuroOIKE, NobuyoshiYUKIHIRA, SyuichiTAKATA, YusukeIKEDA, KyoheiFUJITSUKA and YusukeNISHIO
  13

- **A Morphological Analysis on Changing Patterns of the Banjarmasin River City**, Indonesia
  BudiPRAYITNO
  23

- **Fundamental Study of Housing and Lifestyle in Lhasa City for Low-Environmental Load Housing Design**
  ErikoTAMURA, YasunoriAKASHI, JiapingLIU, YanfengLIU, BaimuSUOLANG and DaisukeSUMIYOSHI
  33

- **A Study on Residents’ Changing Activities and Impression - Focusing on Urban Waterfront Environment in Yogyakarta**
  ArfbanuWishnuAji, MasanoriSAWAKI and YuSHIBATA
  43

- **Identity of Selling Space in Flea Market - A Comparative Study between Chiangmai, Thailand and Kyoto, Japan**
  PandinOUNCHANUM and HiroakiKIMURA
  53

- **Mobile Phone Features and Physical Behavior based on Generation in Public Space - Case study: Losari Beach Platform in Makassar City, Indonesia**
  MukiALI and MasasigeMOTOE
  65

- **A Study on Changes of Regional Agglomeration of Textile Industry in Nishijin Area**
  TaithunLEE and TomohikoYOSHIDA
  75

- **Study on Physiological Responses and Thermal Sensation in Outdoor Space under Strong Solar Radiation**
  SaoriYUMINO, KiyoshiSASAKI and AkashiMOCHIDA
  85

- **Analysis Strategies for Masonry Structures - Application of Finite Element Analysis to a Historical Building**
  GhofamremAHARI and KentaroYAMAGUCHI
  95

- **Road Traffic Noise under Heterogeneous Traffic Condition in Makassar City, Indonesia**
  MuraliaHUSTIM and KazutoshiFUJIMOTO
  109
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A Morphological Analysis on Changing Patterns of the Banjarmasin Rivercity, Indonesia

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Configurations of morphology and structure of urban spaces develop based on the pattern and capacity of generators and its attractions. A phenomenon occurring in Banjarmasin, a city crisscrossed by many rivers, started as a riverine cultural habitation-based city. It developed towards a city with land-based settlement in the Dutch colonial period. The Dutch carried out the development by moving the center of the city growth to a city control system in the form of a fortress as the magnetic pull or attraction. Now this area has developed into the center of Banjarmasin. This long process has been a process of evolution which has "denied" the nature of Banjarmasin's ecological development as a city of rivers. The result of this is that the internal infrastructures of the city are poorly connected with their surroundings areas, and therefore its socio-economic, physical, health, and environmental conditions have deteriorated. In addition, the orientation of development of the structure of urban space has been lost. Through space syntax analysis, the study found that connectivity, integrity, and intelligibility, which are the concepts underlying the morphological and structural configurations of urban space, are not sufficient when they are only based on the concepts of networks and morphological patterns.

Keywords: Rivercity, Morphology, Connectivity, Integrity, Intelligibility

1. Introduction
Banjarmasin city is geographically 0.16 meters below average sea level. Its territory consists of large and small rivers intersecting one another. Therefore, Banjarmasin is known as the "city of a thousand rivers" and the rivers are used by Banjarmasin people to travel from one village to another. Barito and Martapura are two of the major rivers in Banjar Kingdom.

The Barito River, located on the west of Banjarmasin, is the largest river. The Martapura River flows from the northeast to southwest. Such conditions characterize Banjarmasin as a city of water, in addition to its strategic location. Historically Banjarmasin was a valley zone (Barito basin) that made this city under the sea level. Banjarmasin underwent two developments, a water-based development in Banjar Kingdom era and a development based on the trend of land-front cities initiated by the Dutch colonial government.

Land development, carried out by the Dutch colonial government, at the macro level has affected the water-based development occurred earlier.

The existing water networks have become inferior to the road network system. As a city with many rivers Banjarmasin should have made use of its rivers as the orientation of its development both in terms of socio-economic sector and transportation.

2. Banjarmasin and Its Rivers
Banjarmasin is a city with many rivers. Many of the rivers go across the region. The urban growth started in the 15th century when Banjar Kingdom reigned. This kingdom was located between the Kuin River and Barito River. Rivers were very important pathways or access in the development of early Banjarmasin. Rivers were the centers of socio-economic activities and major waterways that connect regions in Banjar Kingdom.

In the 19th century's the Dutch came to Indonesia and made changes to cities in Indonesia including Banjarmasin. Initially the Dutch built Fort Tatas on the Tatas River as the center of the Dutch government in Banjarmasin. The existence of Fort Tatas was the early development of Banjarmasin as a land-oriented city.

Five major changes affected three rivers in the Banjarmasin, namely the Barito River, Martapura River, and Kuin River. The first stage marked by a city located on the Kuin River (Fig. 1). The city saw oriented toward the Barito River which makes the region a center of the royal train. The second stage occurred when the Dutch colonial government developed canal systems in locations outside Banjar Kingdom. It made the Martapura River a...
new orientation for socio-economic activities. The third stage started when the Dutch reigned and they moved the administration center from an area by the Kuin River to a new area selected in the second stage. The fourth stage occurred when the Martapura River was made the new starting point of distribution in urban areas, replacing the Kuin River. The route of the distribution headed straight to the downtown area, which functioned as a regional trade center. At this stage, settlements of ethnic merchants emerged, which were Chinese, Arabic, Malay, and Bugis settlements. The fifth stage was the development stage of the region and it became the embryo of the modern Banjarmasin. The physical development of cities conducted by the Dutch government had significant effects on the structure of Banjarmasin City, mainly on land and water transport network system.

Urban development with a land-based approach for human habitation culture has had a big impact on the development of Banjarmasin, especially on the river banks and the rivers themselves since people are beginning to use them as residential areas (Fig. 2).

The development of road networks has begun to change the people’s way of thinking, especially in residential orientation that regards rivers as the rear zone of houses and this zone tends to be a waste zone. The condition of rivers in Banjarmasin is slowly degrading because of people’s activities and the sporadic settlements development on them. Another result of this is that several small rivers that were connected to each other have begun to break up and some even have already become dead. Based on the data obtained in 2000, there were nine streams that become dead due to residential activities and domestic waste. In 2011 there are only a few of major rivers and streams.

In addition to the threat to the rivers in Banjarmasin, the growth of settlements is also threatened. Moreover, the sectors in this city are not adjusted to the fact that Banjarmasin is actually a river-based city. Consequently, economic growth in this area is not balanced with ecological development and social development is not in harmony with the ecological development because environmental factors are not as strong as other factors. As a river-based city with a dense population, Banjarmasin is experiencing an environmental crisis, especially in urban centers where degradation is projected to deteriorate each year. This will affect both the green space (greenery) and the blue space (water space) areas.

![Fig. 1 Five Phases of Changes in Banjarmasin City](image)

![Fig. 2 Degradation of River Space in Banjarmasin City](image)
3. Research Purpose and Method

The purpose of this study was to understand the changing patterns of the river city of Banjarmasin based on the correlation between its connectivity and the integration of its urban space structure. The approach was based on space syntax simulation and descriptive research. This study included surveys on some certain areas and was also based on secondary data which identified and explained the city's morphology by space syntax analysis.

The method used in assessing diachronically the evolution pattern of development of Banjarmasin was through a data comparison. The written and oral data were used as supporting data for images (primary data) and they were examined with space syntax analysis as a tool to understand the evolution pattern of Banjarmasin City. The primary data were obtained from image data containing old maps and photographs. These were used to justify activities in certain regions. Space syntax describes the relationship between regional integration and connectivity. In this case, the method was concerned with linkage systems to see urban areas as the main focus of the observation. Final comparison was done by combining theoretical approaches associated with the findings of scatter diagram analysis.

4. Morphological Theory and Concept of the Network in the City Shaped

According to Kostof in The City Shaped (1991) development of a city has a variety of characteristics that he divides into a number of types such as energized crowding, urban clusters, and physical circumscription differentiation of uses, urban resources, written records, city and countryside, monumental framework, building, and people. Movements and development of a city are influenced by interconnected factors between small and big cities. This interconnection also promotes development, which finally will manifest in the meeting of a number of cities, which is in turn called a metropolitan city. An urban network can also affect an urban system or the city's shape and it is pointed out by Jim Mc Cluskey (1979) in his book Road Form and Townscape (Fig.3). He states that every inter-city relationship can affect the morphology of the city at the macro scale.

According to Rahman (2006) (Fig.4) the common morphological patterns in waterfront areas are linear, radial, concentric, and branch as shown in Fig.7 below. (A) Linear pattern is usually diffuse and elongated along the edge of water such as beaches and rivers. (B) Radial pattern is a pattern of spatial arrangement, whose mass surrounds areas of water such as lakes and bays. (C) Concentric pattern is a development from the radial form spreading in a linear fashion toward the rear of the radial center. (D) Branch pattern is formed when there are creeks and canals.

The shape of a city generally can be seen as a form of amoeba which, at the macro level, can showcase its identity and the city's direction of movement. According to Yunus, there are twelve types of urban forms based on their shapes (Fig.5). These types range from simple to...
complex shapes based on their physical form.

According to Spreiregen in his book *The Architecture of Town And Cities*, he states that the development of water-based cities basically occurs in coastal areas which is in turn connected by networks of land or water (Fig.6).

5. Morphological Logics by Space Syntax Analysis

A city comprises of networks that are mutually connected to each other on a wide scale. The networks influence one another. Banjarmasin City is a city with a lot of river networks that connect one another. Rivers become links connecting different regions so that they have configurations that affect further development of the city.

Space syntax is a theory of how to understand architecture and urban area from their configuration perspective. As generally known, space is a key aspect of social and cultural life. Configuration relates to the spaces that are interrelated to each other, not only does it stand alone but also takes into account the overall pattern that has been formed (Peponis, Zimring, and Choi, 1990).

Political and economic changes caused by the coming of the Dutch affected the configuration of space in Banjarmasin. Up until today the affected configuration still exists. It can be seen in the orientation of the development in Banjarmasin. Land has been widely used as the heart of the city’s growth, while rivers have become neglected backyards and they are losing their function to support people’s livelihood.

According to Hillier (1992) configuration is the main generator. Without understanding the configuration we will not be able to understand pedestrians’ movement, the distribution of attractors, or even the morphology of the urban grid itself. Because the movement driven by the configuration of the grid is the most fundamental aspect, Hillier refers to it as the natural movement. Space syntax is a technique to predict the natural movement but it is not intended to create a movement models. It is intended to understand the morphological logic of urban grid, especially its development. In an urban system grid configuration is the main factor that affects movement, and in general attractor can also have the same importance but working as a multiplier on a basic pattern that has been built by the configuration. The effect the multiplier causes is the creation of development pattern of a city. As a result, the direction of the city’s movement is formed.

By looking at Banjarmasin’s movement from its early years until today we can predict movement patterns of urban growth in the future based on the city’s structure, which affects this growth. In this way, we can revive dead spaces and restore rivers as some of the generators of the city growth and we can synergize these with the development of land networks.
A Morphological Analysis on Changing Patterns of the Banjarmasin Rivercity, Indonesia

It is not easy to picture an urban structure of Banjarmasin city, which is very complex when viewed from the existence of certain generators and attractors, or even from the place the structure began to move and the place where it stopped. This is because a city is a structure, in which the place it started to move and the place it stopped tend to be anywhere, such as in a dense location or at a major crossroad. In conclusion, the movement tends to move widely from one place to another. Basic assessment of the configuration value of Banjarmasin is an integration of global (Rn) or local (R3) with other spaces. This is because the movement of a line is influenced on the grid scale of the city. Assessment is represented in a graphic, axial in the form of axial map. Another most important value in the space syntax is the intelligibility. This value does not refer to individual environment units, but overall configuration system. "The intelligibility of a system" is measured in relation to local and global variables, generally between global integration and local connectivity. By looking at the intelligibility of a city we can see the city's accessibility and way finding.

6. Syntactic Analysis of Banjarmasin City
Syntactic analysis was done using maps of the city, which showed changes from the 16th century until 2011. These maps were transformed into axial maps. The variable observed was the pattern of the existing development of road networks during the period (Fig.7).

In the 16th century the center of the region was located by the Kuin River, which coalesces into the Barito River. This center was Banjar Kingdom whose movement network structure was based on residential areas by the river. In the central region there were several functions, namely: Banjar palace, mosque, and market.

In the 17th century the Dutch arrived in Banjarmasin. In 1843 the city was divided into two centers of governments, the Kingdom of Banjar located on the Kuin River and the Dutch Government on the River Tatas close to the Martapura River. The Dutch built Tatas Fort in the area.

In 1883 road networks began to form and they connected every facility in the region (Fig.8). The most integrated road network was the southern network which connected Fort Tatas with storage facilities. The road networks also directly connect with the fort. The movement pattern of the road network headed south toward the Martapura River.

Between 1883 and 1899 new developed networks emerged (Fig.9). These networks connected Fort Tatas with the Martapura River on the north. However, the
most integrated road remained the network connecting the fort with the storage facilities. These new networks encouraged residential areas to emerge.

Between 1899 and 1916 many new networks emerged around Fort Tatas (Fig.10). Residential areas began to develop and markets moved toward these areas. The number of well integrated networks increased around the fort, which further strengthened the fort as the grid core of the center of Banjarmasin's development. Networks with weak integration were outside the network grid and these networks were separated and became new networks. In this period spaces or areas around Fort Tatas were quickly connected by land networks as it was the center of Dutch government at the time. In addition, the development of the region moved inland with canal system along each road that was being developed.

1916 was a momentum for the development of Chinatown area at the east side of the fort. In this area there was a straight canal followed by a network that extended to the east as a trade route for the Dutch and residents of the Chinatown toward the headwaters of the Martapura River. The integrated development of the Chinatown is as strong as the development in areas around Fort Tatas.

In 1945 the most integrated network was in the southern area of Fort Tatas, which was a mixed-use settlement, a market and residential area (Fig.11). The old market area became less integrated or had medium integration. There were also emerging networks outside the area of Fort Tatas, which strengthened the separated networks (with weak integration) so that these networks had medium integration.

Between 1945 and 1954 new networks began to emerge and grow southbound so that the weak networks got reinforcement and their integration became medium or even strong (Fig.12). In this year network of grids began to form. These grids were driving grids which stimulated the growth of Banjarmasin. However, the strongest integration remained at Fort Tatas area while new networks started to grow as embryonic connection to the main grid, which formed the city. The development of the southern zone of the Fort Tatas was triggered by the center of trade that began to move to a new market area in 1920. Therefore, the integration around the area became stronger because trade activities between the rivers area and land occurred in this new market area. The network
A Morphological Analysis on Changing Patterns of the Banjarmasin Rivercity, Indonesia

Fig. 11 Integration Value in 1945

Fig. 12 Integration Value in 1954

Fig. 13 Integration Value in 1978

Fig. 14 Integration Value in 2011

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on the south side of the Marapura River (across the river) also developed along with the development in the new market area. As a result, new residential areas began to emerge in Kelayan, Peckauman, and the surrounding areas.

Between 1954 and 1978 a new network with strong integration emerged and it strengthened Banjarmasin’s super grid, which was centered at Fort Tatas (Fig. 13). Following this, new networks began to develop and connected the embryos of the city’s framework grids. The emergence of these new networks caused the integration of riverside area network on the Kuin River to lose its strength.

Between 1978 and 2011 embryonic networks in Banjarmasin began to connect with one another (Fig. 14). These embryonic networks formed a core network of the city (super grid) and it became the most integrated network in the city system. The development of radial networks centered at the Sabitlal Muhtadien mosque (former location of Fort Tatas and a hall of residence for soldiers) created many riverfront sides, especially along the banks of the Kin River. This was how the old city began to change into the rear zone.

6.1 Weak and Strong Integration of Banjarmasin City

Areas on the banks of some rivers became separated spaces from the framework of the city grid, making them into the rear zone of Banjarmasin, which resulted in the decrease of socio-economic quality. Riverside areas, which have strong integration, were only those at the core grid of the city (Fig. 15). In the analysis of integration value rivers become a region whose function is separated from the city development. Therefore, this region became weak in terms of its integration with Banjarmasin city.

In the axial analysis on a 2011 map it was found that Banjarmasin had been a land-based city where there was a framework of city grid centered at the former Fort Tatas (now Sabitlal mosque). This framework stimulated economic and social growth. Areas along the line of the framework became an area of trade.

From the axial line analysis it was found that Banjarmasin city had evolved from a river-based city as the region’s center of socio-economic activities into a land-based city. As a land-based city, all economic and social activities in Banjarmasin were based on the changes in the pattern of the city’s framework, which was developed from the early embryos (Fort Tatas). As for the riverside areas, they became under-developed.

6.2 Intelligibility of Banjarmasin City

The analysis on intelligibility value between 1883 and 2011 showed that there was a decrease in each phase.

<table>
<thead>
<tr>
<th>Syntax</th>
<th>Value</th>
<th>Syntax</th>
<th>Value</th>
</tr>
</thead>
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<td>Connectivity</td>
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<td>Real Relative Asymetry (RRA)</td>
<td>0.25</td>
<td>Intelligibility</td>
<td>0.018</td>
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Diagram 1 Intelligibility of Banjarmasin city

Fig. 15 Weak and Strong Integration Value in 2011
of the city development, from 1883 $R^2=0.043$ and in 2004 $R^2=0.0018$. When a region is not intelligible, confusion about a direction for development will occur. This confusion will negatively affect the accessibility to the region; many spaces will be separated from the grid system of the city’s framework. Consequently, the quality of wellbeing in the region will decrease. In Banjarmasin case, riverside areas became separated due to the pattern of the city’s development and movement, which neglected rivers as the main element for development (Fig. 16).

The analysis on the connectivity and integration values of Banjarmasin in 2011 illustrates that the value of intelligibility was low, with $R^2=0.018$. This meant that the spatial structure of Banjarmasin did not have intelligible spatial orientation and accessibility. This city also lost its orientation growth, which was supposed to be in line with its ecological characteristics and function as a wetland-based city or an amphibious city (Table 1, Diagram 1).

7. Conclusion
The result of the analysis on the relationship between integration and connectivity, that is the intelligibility value, showed that from 1883 until 1899 urban development had a medium value. This happened during the Dutch colonial and this was the initial formation of the framework structure of the city grid. While from 1916 to 2011 the intelligibility of spaces inside the city continued to decrease.

Banjarmasin city’s structure has a form which is centered at Sabilal mosque area, the former location of Fort Tatias. In this area there are riverside areas with low intelligibility. The analysis on the scattered chart diagram showed that the blue dots, representing low intelligibility value, were distributed on the riverside areas. On the other hand, the red dots, which represented high intelligibility value, are directly connected to the central grid of the city’s framework.

If viewed from the intelligibility value in each map of morphological development of Banjarmasin (1883-2004), the riverside areas always had low intelligibility and therefore, they were much less accessible from the centers of the city’s structure. As a result, these areas became separated and entirely disintegrated from the city’s development system or they became the rear zone in the development of Banjarmasin city.

Because of this disintegration, riverside areas were no longer the orientation and the centers of residential and transportation activities as they were in the early era of Banjarmasin city. This was confirmed by the observations and surveys, conducted by the author in 2011. These were conducted on space use, attachment to water, and the use of transportation modes which had shifted from the river-
Based transportation prior to 1980 to the domination of land-based transportation modes in 2011 (see the diagrams presented earlier).

If intelligibility of an area is low, its accessibility from the urban web is also low. This area will be underdeveloped. This will be shown by the use of this area as the rear zone of a residential area and as a waste zone. In addition, connecting access to rivers from main grids of framework of the city’s morphology will decrease. As a result, urban development will only occur on the framework grids of the city and areas directly connected to and accessible from both outside and inside of the city. On the contrary, riverside areas will be neglected.

By looking at the correlation between its intelligibility and the integration of its urban space structure and its infrastructures, the city of Banjarmasin, which was originally a river-based city, once called “the Venice of the East” and “a City of Thousand Rivers”, was disorientated in terms of growth and development. Because the original location of the generator, which was located at the center of Banjar Kingdom’s region in the 15th century, was shifted to the new location around Fort Tatas in the 19th century, environment quality had experienced degradation in the development of Banjarmasin city. In addition, since Banjarmasin had become a land-oriented city, it can be said that the city had also ‘denied’ its nature as a river-based city. As a result, riverside areas were no longer the orientation and the front zone of the city’s growth and development. Consequently, these areas were neglected and became the rear zone of the city. Finally, riverside areas are no longer structurally bound to the urban space and its infrastructures network. In other words, these areas had lost their integrity and connectivity functions.

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