OPEN ACCESS

Vol 4, No. 1, 2017, 83-96

Geoplanning
Journal of Geomatics and Planning
E-ISSN: 2355-6544
http://ejournal.undip.ac.id/index.php/geoplanning
doi: 10.14710/geoplanning.4.1.83-96

SPATIAL TRANSFORMATION OF SURAKARTA'S PERIPHERAL RURAL VILLAGES UNDER IN-SITU URBANIZATION PHENOMENON: THE CASE OF GENTAN VILLAGE

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Article Info:
Received: 18 October 2017
in revised form: 2 February 2017
Accepted: 20 February 2017
Available Online: 30 March 2017

Keywords:
Spatial Transformation, In Situ Urbanization, Peripheral Rural villages, Surakarta

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Abstract: *Surakarta is one of the rapidly growing Indonesian cities. The pressure towards its peripheral area results in 'in-situ urbanization' phenomenon of its rural village surroundings. Gentan is one of Surakarta adjacent rural villages that has been undergoing rapid spatial transformation from rural to urban settlement in the last 20 years (1995-2016). This research aims to clarify the spatial transformation in Gentan village through examinations of its spatial elements on higher resolution level; (1) transformation of its street network connectivity, (2) land use pattern, (3) building density, and (4) public facilities and accessibility. Secondary data from satellite imagery and government institution and primary data from field survey were used in this research as sources. From Gentan's spatial elements observations, this research concluded that this village was transforming into urban settlements by its spatial elements characteristics. Furthermore, this research provides interesting findings by its analysis on the neighborhood level that while Gentan was transforming into urban settlement, its internal connectivity was decreasing, residential uses dominated its land use, the village was dominated by the formal settlement, and the reach distance of its public facilities fluctuated across the time.*

How to cite (APA 6th Style):
Purnamasari, L. S., Yudana, G., & Rini, E. F. (2017). Spatial transformation of Surakarta's peripheral rural villages under in-situ urbanization phenomenon: the case of Gentan Village. *Geoplanning: Journal of Geomatics and Planning, 4*(1), 83-96. doi:10.14710/geoplanning.4.1.83-96

1. INTRODUCTION

Cities with more than 100.000 in total population are predicted to grow by 170% in size at 2030 and will transform their surrounding rural areas frequently resulting in surrounding village reclassification into urban annexes (UN Habitat, 2015). This transformation phenomenon of rural villages and their populations into urban without any significant relocation/migration of their residents is often called as in situ urbanization (Brookfield, Hadi, & Mahmud, 1991; Zhu, 2002, 2004). This kind of urbanization could occur in many forms as village in-city, desakota, quasi-urban area, and encompassed villages (Hareedy & Deguchi, 2011). The transformation of the outskirt area further forms the in-place peri urban zone which is characterized by an area located near the city with rapid rural-to-urban transformation. In Indonesia, the population influx from urban core into its rural surroundings is actually an indispensable element of population growth in big cities (Mamas, Jones, & Sastrasuanda, 2001). Firman, Kombaitan, and Pradono, (2007) stated that the raise of urban population occurred much greater in peripheral rural villages and became the largest contributor to the overall accumulation of urbanization phenomenon.

This kind of urbanization is strongly caused by the trend of urban sprawl that "swallowed" their surrounding rural villages and transformed them into urban in characters (Brookfield et al., 1991; Kalabamu & Bolaane, 2013). Beside the urban sprawl, village transformation phenomenon could be an accumulated result of certain policies imposed in urban-rural development system and the natural growth of the rural villages themselves (Mcgee, 2009; Zhu, 2000). In situ urbanization, like the term of urbanization in general, occurs in multi-dimensional way including physical-spatial, economic, social dimensions. In spatial aspect, the transformation process of village to be considered urban in spatial characteristic could be best possibly

defined through observing the character of its morphological elements (urban form) that consist of land use pattern, street network, and buildings (Daldjoeni, 1998; Setyono, Yunus, & Giyarsih, 2016; Sinulingga, 1999; Soetomo, 2009; Yunus, 2006). While BPS (2010) and Yunus (2008) also stated that public facility is also an indicator to be considered in terms of village transformation in peripheral area besides the morphological elements.

In spatial aspect, rural villages are characterized as low building-density settlement, dominated with agricultural land use, with few public facilities that are difficult to access, and low transportation network connectivity (Bintarto, 1986; Giyarsih, 2003; Jayadinata, 1986; Yunus, 2008). Otherwise, urban settlements are often characterized with high building density; its land use is dominated with urban uses (non-agricultural) with more complete and easy to access public facilities—as urban area which are commonly defined as the center of services, and more complex, high transportation network connectivity. The characteristic shifts of the elements between urban and rural area forwardly become the indices of the transformation itself.

Surakarta is one of Indonesian cities continuously growing, transforming, and swallowing its surrounding rural villages into urban annexes. The continuous influences of the city towards its rural surroundings contributed to the shifts of the rural spatial characteristics into urban. Previous researches conducted in Surakarta's rural villages surroundings by Anna, Kaeksi, and Astuti (2010), Astuti (2010), Jayanti (2012), Oktavia (2010) clarified that spatial transformations constantly occur and transform the previously agricultural land into urban in character. One of the Surakarta's peripheral rural villages undergoing rapid urbanization is Gentan which is located adjacent to Surakarta city in the south border. Based on the preliminary observation of satellite images, Gentan village undergoes the most significant transformation—to 58% in the development of built-up area compared to other Surakarta's adjacent rural villages in the last 20 years (1995-2016). This rapid transformation of Gentan was triggered by the development of modern/formal settlement of Pondok Baru Permai in 1995 that marked the trend of formal (planned) housing and gated-community development there (Fitriastuti, 2010).

Some prominent previous researches observing the phenomenon of in-situ urbanization in spatial aspect by Bentinck (2000), Brookfield et al. (1991), Zhu (2000) were mainly focused in land-use change on the macro range (regional level) of a city's peripheral area. While the examination of land-use change on the macro level is effective to trace the trend of urbanization in regional level, those researches did not provide deeper insights about how urbanization could triggered spatial transformation affecting the lives of the village inhabitants, thus needs examination on higher resolution level. However, there are already some previous researches observing the in situ urbanization phenomenon in neighborhood level (higher resolution observation) of a rural village located adjacent to rapidly growing cities.

Hareedy and Deguchi (2011) conducted a study that focuses on the transformation of urban fabric, block configuration, and building characteristic occurred in the peripheral rural village of El-Minya City using specific typological approach and village residents' information to clarify the transformation. This approach will be difficult to replicate and apply to another region with different characteristic. By contrast, Kalabamu and Bolaane (2013) conducted a study that focus on housing densification in spatial aspect in Tlokweng village, Bostwana as the accumulation result of changing economic structure in in situ urbanization phenomenon, and not providing broader insights about how the built environment and other spatial elements of the village have changed.

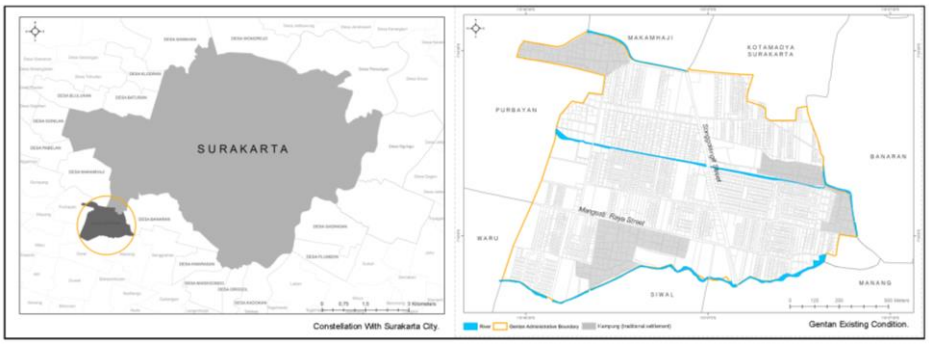
This research aims to fill the gap of understanding spatial transformation under in situ urbanization phenomenon in higher resolution scope by taking more applicable, comprehensive and detailed observation of changing rural spatial elements from the urban form quantitative analysis perspectives. This research examined the transformation of Gentan village spatial elements characteristic including (1) street network connectivity, (2) land use pattern, (3) building density, and (4) public facilities and the accessibility from 1995 to 2016. The further applications of this research would be easily replicated in different regions and would benefit the urban and regional policy formulators to comprehensively understand the in situ urbanization phenomenon in spatial aspect. This will foster more effective and detailed plan in order to accommodate rapid spatial transformation that occurs in city's rural village surroundings.

2. DATA AND METHODS

2.1. Research Scope (Area and Period)

Gentan village administratively belongs to Sukoharjo regency. This village located adjacently to Surakarta city in the south border (adjacent to Laweyan District) has 149.09 Hectare in total area. Long before the trend of urbanization happened, Gentan village consisted of 4 *kampungs* (traditional settlements) that inhabited by local agricultural communities (Figure 1) for centuries.

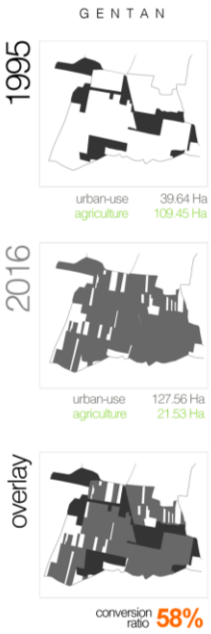
Figure 1. Map of Gentan's Constellation With Surakarta and Its Existing Condition (Author, 2016)



Gentan village was selected as the representative case study area to study in-situ urbanization in Surakarta's peripheral village for the following reasons: (1) Gentan is located adjacent to Surakarta city, and (2) it showed the most significant growth of built-up area (58%) from 27% into 85% compared to others Surakarta's adjacent rural villages (Figure 2). The year 1995 was chosen as a starting point as it remarked the trend of formal housing and gated-community developments that highly contributed to the transformation of Gentan village into urban settlement (Duhri, 2015; Fitriastuti, 2010). While in overall trend of population growth in all Surakarta's rural adjacent villages, 1995 marked the highest spike to 3% of population growth compared to 1% in common condition.

Figure 2. Research Scope Justification (Author, 2016)

No.	W. A. Desa (*Adjacent To Surakarta*)	*Area of Urban Use* 1995	*Area of Rural Use* 1995	*Area of Urban Use* 2016	*Area of Rural Use* 2016	*Urban/Total Area Ratio 1995*	*Urban/Total Area Ratio 2016*	*Conversion Rate (Percent)*	Total Area
1	Blulukan	94,8	94,7	124,8	64,7	50%	65%	15%	189,5
2	Gonilan	76,2	67,1	107,02	36,28	53%	74%	21%	143,3
3	Pabelan	120,23	63,07	147,92	35,38	66%	80%	14%	183,3
4	Cemani	139,89	23,55	159,36	4,08	86%	97%	11%	163,44
5	Banaran	90,4	34,99	91,41	33,98	72%	72,4%	0,4%	125,39
6	Gentan	40,9	109	127,56	22,34	27%	85%	58%	149.09
7	Makamhaji	189,2	49,1	224,11	14,19	79%	94%	15%	238,3
8	Kwarasan	76,25	39,45	99,9	15,8	66%	86%	20%	115,7
9	Madegondo	109,59	52,55	156,3	5,84	68%	96%	28%	162,14
10	Grogol	80,7	23,2	103,9	0	78%	100%	22%	103,9
11	Kadokan	73,9	136,52	80,87	129,55	35%	38%	3%	210,42
12	Plumbon	52,1	123,32	60,12	115,3	30%	34%	4%	175,42
13	Gadingan	70,1	214,8	76,08	208,82	25%	26%	1%	284,9
14	Palur	174,7	316,1	187,9	302,9	36%	38%	2%	490,8
15	Ngringo	283,8	172,4	376,1	80,1	62%	82%	20%	456,2
16	Baturan	98,4	69,68	123,7	44,38	59%	73%	14%	168,08
17	Klodran	76,22	70,08	100,73	45,57	52%	68%	16%	146,3
18	Sawahan	274,3	267,04	285,6	255,74	51%	52%	1%	541,34
19	Plesungan	198,8	469,8	205,5	463,1	30%	30,6%	0,6%	668,6
20	Wonorejo	135,4	250,77	180,9	205,27	35%	46%	11%	386,17



2.2. Data

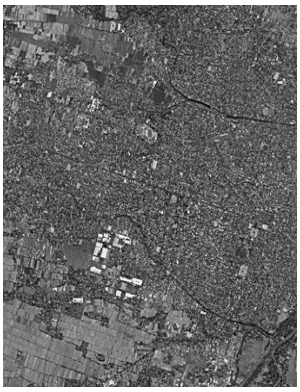
In order to identify the spatial transformation of Gentan villages, time-series data (1995, 2000, 2005, 2010, 2016) of land use, building, transportation network, and public facilities were used in this research. Two types of data resources were used in this research. Firstly, the secondary data were obtained from

government institutions and satellite images. Secondly, primary data were obtained from field verification survey (Table 1). Two methods namely (1) map interpretation using satellite imageries and digitation into editable map format (Figure 3) and (2) statistical data tabulation using Microsoft Excel were carried out to process the obtained.

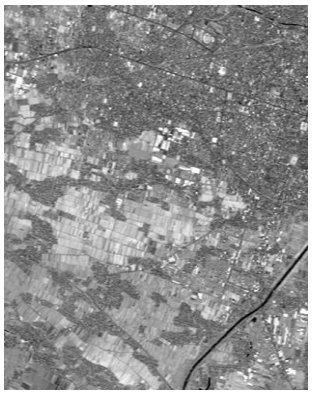
Table 1. Research Data

Data	Sources
SPOT3 10 m Panchromatic Imagery Aug. 1995 & 2000 (Digitized Into ArcGIS Polygon Shapefiles (.shp), result shown in analysis map)	SPOT 3 Satellite Imagery
DigitalGlobe satellite imagery archives over Gentan 2000, 2005, 2010, 2016 (Digitized Into ArcGIS Polygon Shapefiles (.shp), result shown into analysis map)	DigitalGlobe archive—GoogleEarth Pro
Gentan profiling map (hardfile archives) year 1995, 2000, 2005, 2010	Gentan Administrative Office
1995, 2000, 2010 Sukoharjo street data	BAPPEDA Sukoharjo (Sukoharjo Dept. of Development Planning) and DPU Sukoharjo (Sukoharjo Dept. of Public Works)
1995, 2000, 2010 Sukoharjo land use data	BAPPEDA Sukoharjo (Sukoharjo Dept. of Development Planning) and BPN Sukoharjo (Sukoharjo Dept. of Survey and Land)
Statistical data of Gentan Village from *Baki Dalam Angka* 2000-2016	BPS Sukoharjo (Sukoharjo Dept. of Statistic)
Land-use + public facilities field verification data	Gentan Local Leaders

Figure 3. Satellite imageries data



SPOT 3 Panchromatic 12/8/1995



SPOT 3 Panchromatic 21/11/2000

DigitalGlobe Archive 8/12/2000

DigitalGlobe Archive 08/2005

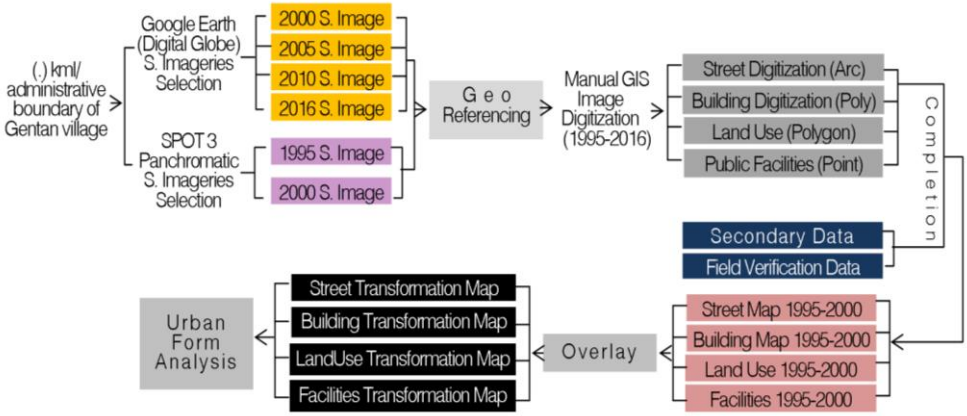
DigitalGlobe Archive 05/2010

DigitalGlobe Archive 02/2016

As the first step for further analysis, this research used Geographical Information System by ArcGIS 10.2.2.to digitalize satellite imagery into digital map. This approach was selected since in one side satellite images supply up-to date information but is restricted by pixel resolution, multispectral classification, and visibility and digitization of aerial photography/imagery (Illert, 1991). The intention of map digitization is to

create *spatio-temporal* data in the form of vector based digital maps to show and measure changes in the research area. In this research, the workflow towards creating the spatio-temporal data is similar with the works of Lu et al. (2014), Malarvizhi, Kumar, and Porchelvan (2016), Mehmood et al. (2016), Ohri and Yadav (2012), Raza et al. (2016), Yang and Lo (2002) as they utilized satellite image digitization to analyze changes in urban growth. While those researches were intended to analyze uniquely land use land cover (LULC) change to detect urban sprawl/growth, in this research satellite image was digitized in broader scope including building mapping and land use in the form of polygon, street mapping in the form of arc lines, public facilities in the form of dots combined with information from secondary and field survey data. Overlay method was intended to show how the gradual transformation is spatially manifested (Figure 4).

Figure 4. Data processing framework

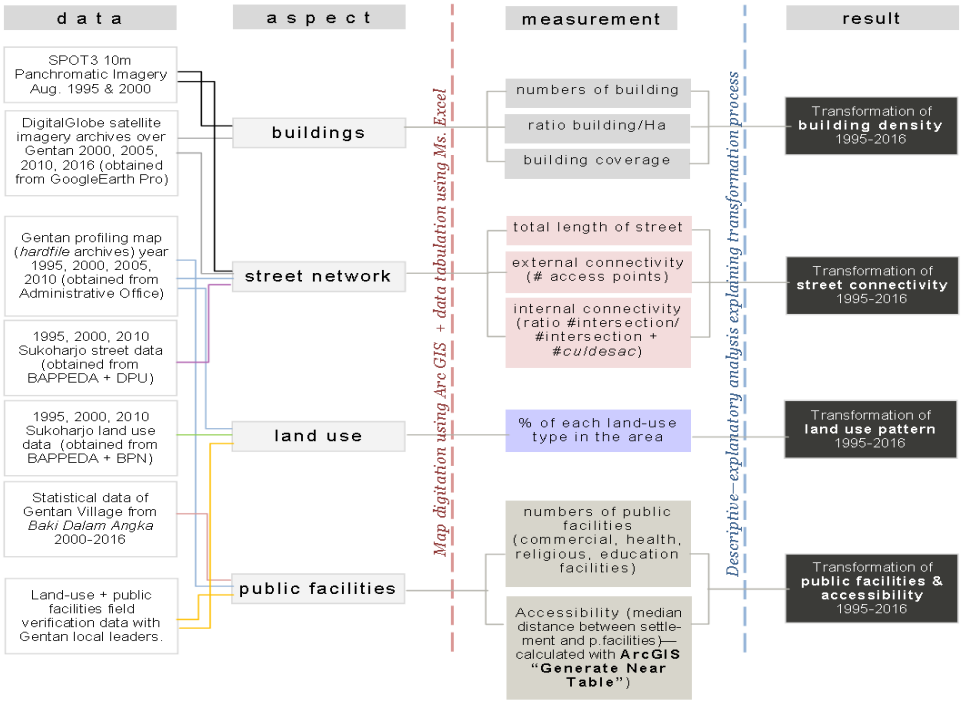


Data processing was started with delineating the research area by creating a (*.kml*) form administrative boundary of Gentan Village. The *.kml* file was intended to strategically select the area of satellite imageries of Digital Globe Archives and SPOT 3 for the further analysis and used to delineate the research area for each period year (1995-2016). SPOT 3 imageries were used to complete the data needed for 1995 time-period which is unavailable in Google-Earth Historic View (Digital Globe Archives). After satellite imageries were delineated for each year of research time-period, satellite imageries were being georeferenced in GIS to add geographic information. The next step is manual georeferenced-satellite image digitization in ArcGIS 10.2.2 in order to digitize information of street, building, land use, and public facilities (urban form elements). Manual digitization was preferred due to the requirement of broader elements to be mapped (urban form elements). This step was also equipped with data completion from secondary data and field verification data to add more information that is unavailable by only observing satellite imageries. After all the necessary information is completed, a map was produced for each urban form element for each time-period. The next step was the 'overlay' meaning that each map of urban form elements from each time-period was being layered based on the urban form element type. In order to spatially observe the changes, a transformation map was further produced for each urban form element for the further urban form analysis.

2.3. Research Analysis Methods

This research carried out a descriptive analysis method to explain the results of each calculation of spatial element transformations and discuss the findings towards its position in literature and previous studies. Measurement instruments used for calculation analysis were conducted using statistical data obtained from analysis of (1) building density, (2) land use pattern, (3) spatial accessibility of public facilities, and (4) connectivity. These were compiled from literature review of *urban form measurement* in higher resolution analysis level based of the work of Song and Knaap (2004), Southworth (1997), Berghauser-Pont & Haupt (2010), Brail & Klosterman (2001) (Figure 5). This higher resolution level urban form analysis fits into the context of this research's objectives as it used community design perspective and commonly addressed how the area adapt to growth and to study the pattern of development itself. The main focused of this research analysis was to measure the shifts of building density, land use pattern, spatial accessibility, and connectivity into more urban in characters.

Figure 5. Research framework



3. RESULTS AND DISCUSSION

3.1. Transformation of Street Network Connectivity

The observation of the transportation network connectivity was based in the growth of the street network inside the area, internal and external connectivities. Urban settlement is often characterized as the area with complex and dense street network contributing to higher street connectivity (Giyarsih, 2003; Sinulingga, 1999; Yunus, 2008). As opposed, rural is characterized with less street networks and connectivity (Giyarsih, 2003). The transformation trend showed that as the street network grows, the external connectivity increases whilst the internal street connectivity declines (Figure 6). This result showed that in the last twenty years Gentan experienced rising number of access points in external connectivity which means that this village can be easily accessed from its surrounding area. Meanwhile, the reduction of internal connectivity was caused by the dominating development of cul-de-sac streets that negatively affects internal circulation (Table 2).

Figure 6. Street network transformation map (Analysis, 2016)

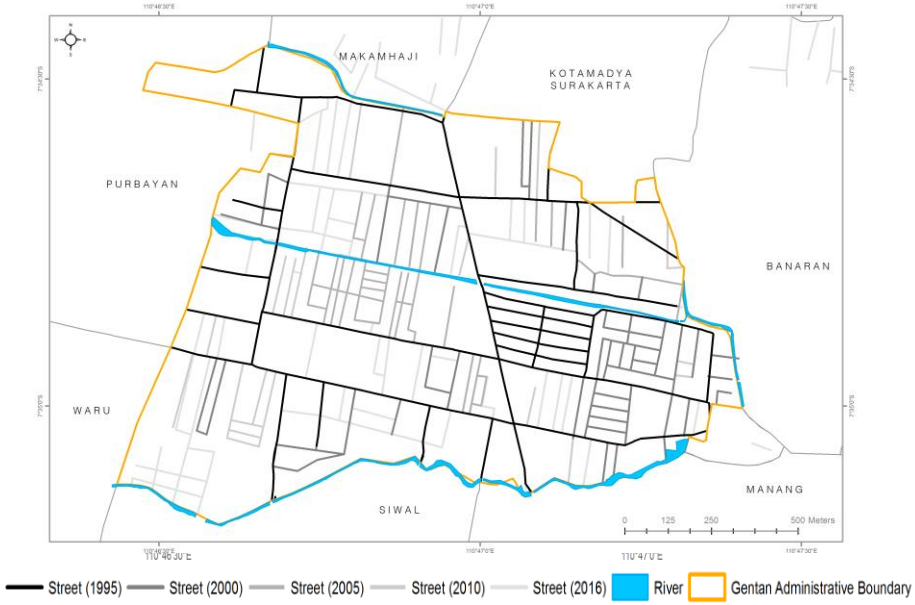


Table 2. Street network connectivity transformation (Analysis, 2016)

Connectivity	1995	2000	2005	2010	2016
external connectivity (access points)	18	19	21	23	25
# intersections	43	90	139	166	197
# *culdesac*	4	9	25	34	42
internal connectivity	0.91	0.91	0.85	0.83	0.82

The development of the street network and the external connectivity transformation across the time could clarify two facts. Firstly, urbanization occured in the area as the characteristics shift to resemble urban settlement. Secondly, in the last twenty years internal connectivity transformation showed an anomaly. The rise of cul-de-sac street numbers across the time that negatively contributed to the decrease of internal connectivity indicates that the village resembles more to a sub-urban area rather than urban in characteristics. This result has been highlighted by Song and Knaap (2004) that characterized sub-urban as the area formed by urban sprawl with dwindling streets, many dead-end (cul-de-sac) streets. In Gentan village, this type of street was found in gated-community settlement and formal housing imposing high security system, which is also common in spatial manifestation of urban sprawl (Song & Knaap, 2004; Southworth, 1997). This evidence of decreasing internal connectivity implies an indication that this village has transformed more into urban settlement under the great influence of urban sprawl rather than natural growth of traditional settlement that often manifested in the form of housing densification and land subdivision. This result showed different issue occurs in Gentan village compared to a previous in situ urbanization research conducted by Hareedy & Deguchi (2011). They studied the village in El-Minya which transformed into urban carrying the characteristic of traditional settlement rather than showing the common characteristic of urban sprawl.

3.2. Transformation of Building Density

Building density is often described as the ratio of the number of buildings and total area whilst some literature such as Song and Knaap (2004) and Dempsey et al. (2008) stated that the plot density is also an indicator to represent building density using the median value of overall plot density (Figure 7). This research combined the two indicators by identifying the numbers of building in the study area, the ratio of the number of buildings per area (Ha), median number of plot density, and building coverage. Building density itself is an observable indicator in order to clarify in situ urbanization phenomenon as the urban settlement.

Figure 7. Map of building transformation (Analysis, 2016)

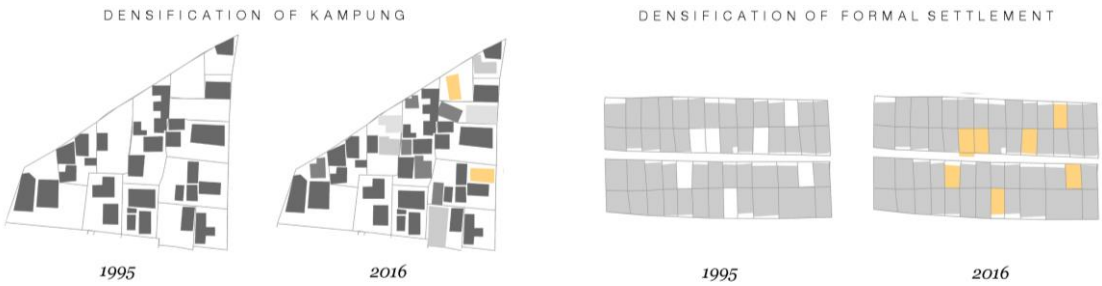
Urban settlement is characterized by an area with higher density compared to rural villages (Daldjoeni, 1998; Sinulingga, 1999; Soetomo, 2009; Yunus, 2008). As opposed, the rural village settlement is characterized by an area with very low building density (Bintarto, 1986). As in situ urbanization phenomenon itself means transformation of rural villages into urban in characters, the shifts of rural characters into urban indicates the urbanization itself. The results showed that Gentan experienced escalation in all building density measurements. The rise in total numbers of building, the ratio of numbers of building per hectare, and the building coverage were correlated. The rise of median plot density consequently clarified that in situ urbanization has been occurred in Gentan village in the last twenty years (Table 3).

Table 3. Building density transformation (Analysis, 2016)

Density	1995	2000	2005	2010	2016
#Buildings	1,332	2,455	3,522	3,874	4,442
Building Coverage (Ha)	17.3	30.61	43.07	47.34	57.93
Median Plot Density (%)	65	90	92	92	93

In addition, this research also discovered that the median value major shift of plot density from 1995 to 2000 shows that the village was started to be dominated by the formal settlements and gated community previously consisted and dominated by *kampung* (organic/informal settlement). The formal settlements in Gentan commonly have high ratio of plot density while the organic settlements/*kampungs* that has been there long before the explosion of formal housing development have lower value of plot density. This finding formed special characters of *in situ* urbanization occurring in the village from the perspective of building density. The numbers of buildings and the building coverage transformation clarified the urbanization phenomenon. The escalation in plot density indices indicated that there are two types (dualism) of evolving settlements inside the village; traditional (organic/*kampung*) and modern (formal) (Figure 8). Finally, the shifts of the density identified shifting domination of the modern ones. Compared to previous research, this finding provided different kind of spatial manifestation of *in situ* urbanization. Kalabamu and Bolaane (2013) identified the settlement densification under *in situ* urbanization in Tlokweng village in Bostwana which was dominated by the infilling development inside the traditional settlement area. According to the research, this was the result of the establishment of housing rentals trend by the village inhabitants in order to improve economic condition.

Figure 8. Dualism of Settlement Type



3.3. Transformation of Land Use Pattern

Land use is an element of urban form and a vital variable to observe the shifts between rural land use and urban land use that indicate urbanization phenomenon (Soetomo, 2009; Yunus, 2008). Rural land use is often characterized by an area with agricultural use dominance (Jayadinata, 1986). In the context of in situ urbanization, land use is the main spatial elements in which its transformation towards more urban land use characteristics indicates the phenomenon of in situ urbanization itself (Brookfield et al., 1991). In this research, land use pattern was examined in each sample year to show how the land-use gradually changes over time. The result showed that land use in Gentan village changed in pattern from 1995 to 2016 (Table 4). It showed that Gentan village was previously dominated by the agricultural use and then gradually

doi: 10.14710/geoplanning.4.1.83-96

dissipated into urban uses. This rapid agricultural land-use conversion clarified that the village transformation into urban settlement (Figure 9).

Table 4. Land use pattern transformation (Analysis, 2016)

Land Use	1995		2000		2005		2010		2016	
	Area (Ha)	%	Area (Ha)	%	Area (Ha)	%	Area (Ha)	%	Area (Ha)	%
Agricultural	109.45	**73.41**	86.59	**58.08**	64.15	**43.03**	53.75	36.052	21.53	14.44
Residential	32.75	**21.97**	52.53	**35.23**	72.46	**48.60**	79.96	53.632	103.83	69.64
Commercial	3.63	**2.43**	4.39	**2.94**	5.89	**3.95**	7.41	4.970	12.87	8.63
Public Service/Facilities	3.26	**2.19**	4.54	**3.05**	5.55	**3.72**	6.73	4.514	9.07	6.08
Industrial	0	**0.00**	1.04	**0.70**	1.04	**0.70**	1.24	0.832	1.79	1.20

Figure 9. Map of land use pattern transformation (Analysis, 2016)

The research analysis highlighted the biggest land conversion imposed by the residential use, followed by commercial, public services, and the industrial use. By 2016, agricultural use occupied only 14.4% of total Gentan village area. The research finding on dominance of residential use converting previously agricultural land use under *in situ* urbanization indicates that the population explosion driving the new housing expansion is the main force transforming land use. This also indicates that this land use transformation was driven by the continuously expanding major population influx of the neighboring city.

3.4. Transformation of Public Facilities Characteristic

In 2010, Indonesian Census Board (*Badan Pusat Statistik*) considered public facilities as the criteria to be assessed in order to decide rural village reclassification through their (1) availability and (2) distance towards them. Giyarsih (2003) stated that public facilities are harder to access in rural area than urban. Tamin (2000) stated that accessibility towards objects is calculated through the distance, although non-spatial aspects such as individual preferences are also considered affecting the access (Table 5). This research identified the transformation of public facilities characteristic through examination of the change in numbers and the median reach-distance of the overall Gentan's existing settlement towards each public facility sub-types. The result showed that most of Gentan's public facilities increased in numbers except for some sub-types; elementary school, church, and *Puskesmas* (district-level health clinic) while the median reach distance picturing spatial accessibility fluctuated across time (Figure 10).

Table 5. Public facilities and their accessibility transformation (Analysis, 2016)

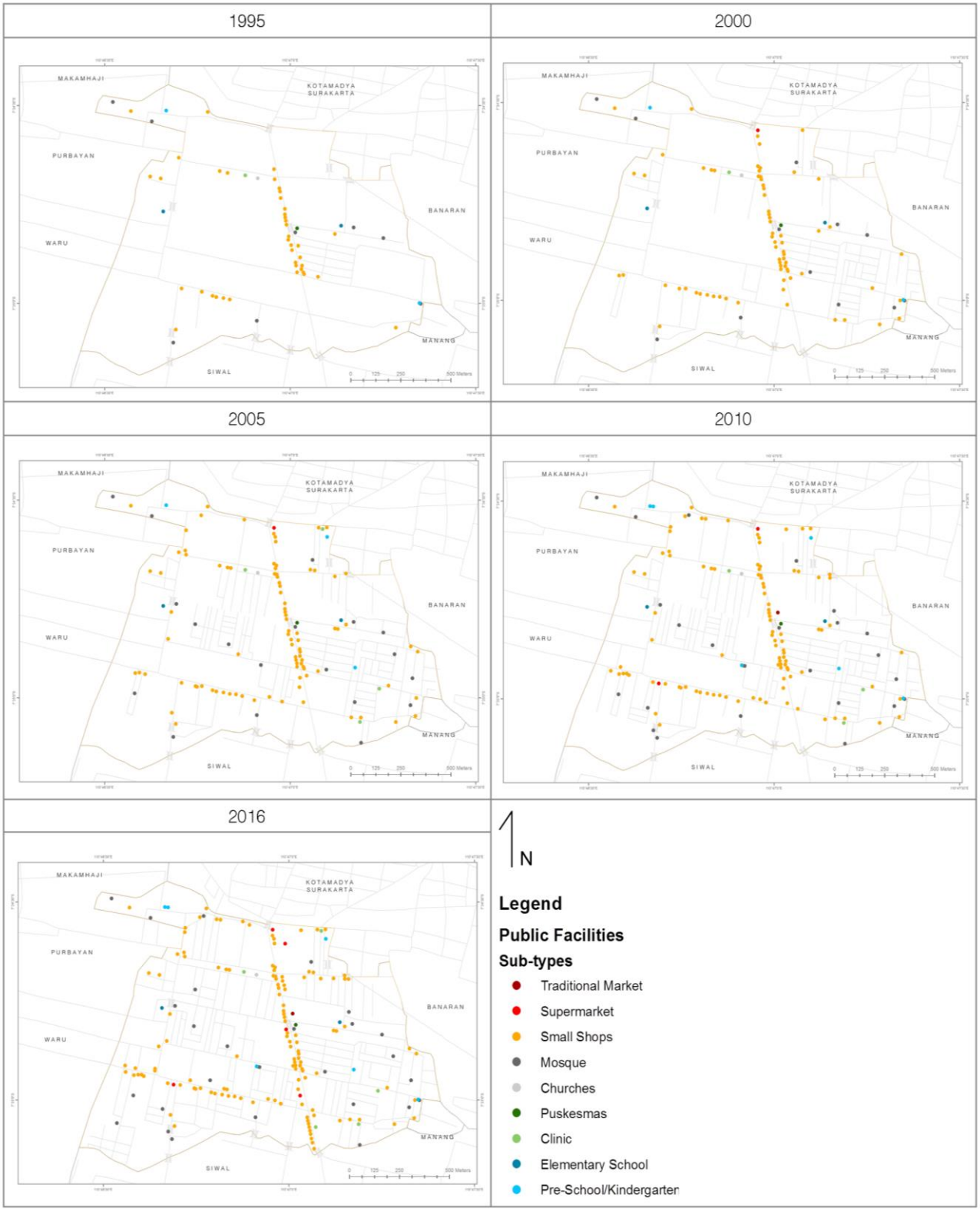
Public Facilities	1995		2000		2005		2010		2016	
	#	Median Distance/Access (m)	#	Median Distance/Access (m)	#	Median Distance/Access (m)	#	Median Distance/Access (m)	#	Median Distance/Access (m)
Commercial Facilities										
Traditional Market	0	**0**	0	**0**	0	**0**	1	**461**	1	**483**
Supermarkets	0	**0**	1	**719**	1	**645**	2	**507**	5	**285**
Small Shops	40	**81**	70	**78**	90	**85**	103	**86**	129	**88**
Religious Facilities										
Mosque	8	**153**	12	**120**	19	**98**	24	**94**	27	**91**
Church	1	**513**	1	**514**	1	**518**	1	**534**	1	**549**
Health Facilities										
***Puskesmas* (District-Level Clinic)**	1	**384**	1	**420**	1	**446**	1	**452**	1	**474**
Clinic	1	**538**	1	**650**	3	**374**	3	**324**	5	**319**
Edcation Facilities										
Pre-School (Kindergarten)	2	**486**	2	**458**	3	**344**	6	**248**	6	**269**
Elementary School	2	**279**	2	**328**	2	**321**	2	**330**	2	**340**

Commercial facilities tended to increase in distance except for *Swalayan* (supermarket) sub-type which showed that the distance towards the facilities were getting further. This could be explained by the centralized growth of commercial facilities along the main street of Gentan (Songgolangit & Mangesti Raya street) while the growth of residential use occurred throughout the village area. For religious facilities, the spatial access to the mosque decreased over time as the growth occurred evenly across the village area while the distance towards church increased because the numbers did not grow. Health facilities sub-type *Puskesmas* increased in median distance value since for the last twenty years the numbers of the facility did not grow while the health clinic tended to lower in distance as the number grew and equally spread across

doi: 10.14710/geoplanning.4.1.83-96

the village area. The distance-reduction in education facility occurred in pre-school subtype as the number grows while the elementary sub-type experienced escalation in distance as the number halted.

Figure 10. Map of public facilities transformation (Analysis, 2016)



4. CONCLUSION

This study aimed to identify the spatial transformation of Gentan village under *in situ* urbanization phenomenon. Taken the results together, this research clarified that Gentan village has transformed into an urban settlement from previously rural village and justified that *in situ* urbanization took place in the village. Moreover, this research also highlighted several issues from the analysis of Gentan's spatial elements. Firstly, external connectivity showed that Gentan became more accessible from outside area, but the internal connectivity decreased by the trend of *cul-de-sac* development that negatively affects the internal circulation. The trend of *cul-de-sac* development that belongs to the gated community in the village for the last twenty years resembles the trend of sub-urban development. This indicated that the transformation occurred in the area was majorly influenced by the urban sprawl rather than the characteristic of the existing traditional settlement.

Secondly, while all building density measurements showed escalation for the last twenty years and clarified the urbanization phenomenon, the plot density changes showed that formal settlements dominate Gentan village. This finding also indicates that there are dualisms of settlement types in Gentan village that form the village transformation towards urban settlements. Thirdly, the higher resolution examination of the change in land use pattern showed that the land-use conversion is dominated by the residential uses. This findings indicated that the rapid land use conversion was caused by the population explosion that influenced the needs for new settlement development. The result further suggests that this phenomenon was possibly caused by the influx of new population imposed by the urban sprawl of the neighboring city.

Fourthly, the enhancement in public facility numbers did not always go in line with their spatial accessibility that shows fluctuation, even as the urbanized village. In addition, the numbers of public facilities grew to support the growth of urban settlement. In the last twenty years, the fluctuation of spatial accessibility stated that the distribution of public facilities was mostly centered along the main street, not evenly across the village. This results and findings provided deeper perspectives to understand the urbanization phenomenon on the neighborhood level that could foster more effective development policies to deal with such transformation. The findings of spatial element transformation also highlighted several issues of *in situ* urbanization to be recommended for further researches that include; dualism of settlement types in the transformation of peripheral rural villages, factors influencing spatial transformation, and the relationship between peripheral rural villages transformation with the rapidly growing adjacent city.

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