Land use and spatial planning in the border area of Bogor Regency and Bogor City, West Java Province, Indonesia

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Abstract. Spatial Planning (RTRW) is a policy direction and strategy for using regional space used as a reference by the Governments. Inconsistencies often occur between current land use (LU) and spatial planning. The research focus is a similar land use in villages/kelurahan on the border of the two regions. Similar land use is essential to compare inconsistencies in two adjacent districts/cities (e.g., inconsistency occurs in paddy fields in district A, not in district B). The research objectives are 1). Identify LU and its changes in the border area of Bogor Regency and City in 2010-2020, and 2). Analyze similar land use (2020) and alignment with RTRW. The analysis used is the logical matrix tabulation, geographic information system (GIS), and scalogram. The study locations identified 62 villages on the border of Bogor Regency and City. In the border area of Bogor Regency and City, the dominant land use is settlements, and between 2010 to 2020, there is an increase in the area of settlements by 2.196 hectares. This shows that regional development has expanded to the periphery. Furthermore, the alignment of land use with spatial patterns on similar lands in border areas can see the tendency of regional spatial planning policies, whether exploitation or conservation.

1. Introduction
Bogor City is directly adjacent to Bogor Regency. Previously, these two regions became one region (Bogor), and since 1975 the Minister of Home Affairs has separated them. Bogor Regency has the largest population in Indonesia, more than 5 million people [1]. The population growth in Bogor Regency is high-speed. The difference in population between 2010 and 2020 is 1 million people with a growth rate of about 22.40%. Meanwhile, the population growth rate per year in Bogor City is 1.93% [2]. With the increase in human numbers and activities, the demand for land also increases. Increasing population will increase the need (land) for settlements [3]. The increasing population has implications for land needs, encouraging the land conversion, primarily agricultural land, into built-up land [4]. Land conversion is unavoidable in the implementation of development [5]. Rapid population growth and the increasing demands of community needs for land often result in conflicts of interest over land use and misalignment between land use and planned use [6]. This situation occurs in almost all regencies/cities in Indonesia, including in the border areas of Bogor regency/city.

Bogor Regency is a strategic area for agricultural development (especially horticulture). Horticultural farming areas such as vegetables and fruit spread in all regions (districts). Over time, the use of space continues to experience dynamic changes [7]. Likewise, in Bogor city, space availability is more limited because it is dominated by built-up land. Thus, residents will occupy suburban areas and
even live in the Bogor Regency area. Bogor Regency and Bogor city boundaries are challenging to identify because they have been mixed and developed as residential areas. The rural characteristics in the Bogor regency boundaries are no longer visible. The natural increase in population and migration and the various demands for infrastructure facilities have led to land settlements and infrastructure for existing activities [8]. This condition triggers a shift in land-use patterns on the border of Bogor City and Regency.

The prevailing spatial pattern refers to the existing resource potential (UU 26/2007). The region's carrying capacity should be one of the most critical considerations in spatial planning, preparing the RTRW, and evaluating space utilization [9]. The incompatibility of land use with the RTRW can reduce the physical capabilities of the land and threaten the sustainability of resources [10]. One way to reduce land conversion is policy (land permit), where policy is a government strategy in protecting land use, primarily agricultural land/rice fields (e.g., LP2B). Assessment of spatial planning performance indicators compiled in the two regions is carried out by comparing land cover alignment (similar) with spatial planning (spatial pattern) in border areas. Identifying this alignment can show the performance of spatial policies in both regions, commitment to law enforcement, and ensuring that spatial policies consider sustainability aspects [11].

The aims of this research are 1). identify land use and changes in the boundaries of Bogor Regency and City in 2010-2020, 2). Identifying similar land use in the two adjacent villages/kelurahan and 3) Conducting a comparative analysis of similar land use with spatial patterns.

2. Methodology
Research location in villages/kelurahan on Bogor Regency and Bogor City border covering 62 villages/kelurahan (32 villages in Bogor Regency and 30 villages in Bogor City) (Figure 1). Determination of the study location based on the boundaries of the village/kelurahan at the regency/city border. The research takes place from December 2019 to November 2020.

![Figure 1. Study location](image)

**Note. Sub District (Bogor City):**
A=Kayu Manis; B=Mekarwangi; C=Kencana; D=Sukadama; E=Sukaresmi; F=Kedunghalang; G=Cparigi; H=Ciluar; I=Cimahpar; J=Katulampa; K=Sindangrasa; L=Sindangsari; M=Harjasari; N=Bojongkerto; O=Rancamaya; P=Kertamaya; Q=Genteng; R=Pamoyanan; S=Mulyaharja; T=Cikaret; U=Pasirkuda; V=Pasirmulya; W=Loji; X=Sindangbarang; Y=Margajaya; Z=Babulak; A1=Balumbangjaya; B1=Situgede; C1=Semplak; D1=Curug

**Sub District (Bogor Regency):**
1=Parakan Jaya; 2=Cimanggis; 3=Waringin Jaya; 4=Cilebut Barat; 5=Cilebut Timur; 6=Pasir Jambu; 7=Cimandala; 8=Pasirlaja; 9=Cadasngampar; 10=Sukaraja 11; 11=Cibonan; 12=Pandansari; 13=Ciawi; 14=Telukpinang; 15=Bitungsari; 16=Cipangpongok; 17=Cheluang; 18=Cipucung; 19=Palasari; 20=Sukaharja3; 21=Sukamantari; 22=Kotabatu; 23=Mejeraya1; 24=Ciomas; 25=Ciomas Rahayu; 26=Laladon; 27=Ciherang; 28=Dramaga; 29=Babakan2; 30=Cikarawang; 11=Semplak Barat; 32=Atang Sanjaya
2.1. Data analysis

2.1.1. Identification of land use in 2010 and 2020
Land use data for 2010 and 2020 come from different sources. Land use data in 2010 was sourced from Bappeda (Bogor Regency and Bogor City, scale 1:50,000), and land use data for 2020 was sourced from Google Earth image classification. Land use classification in 2020 using the 2010 map base (Bappeda) through visual updates or manual delineation. Overlay, process analysis, and delineation using ArcGIS 10.3 software.

2.1.2. Analysis of land use change in 2010 and 2020
Analysis of land use change can indicate the development of an area. Land development can be displayed from land conversion, from vegetated land to non-vegetated land, or agricultural land to built-up land. These changes show the effect of activities in the area driven by various factors, including land needs and land policies. The technical analysis overlays land use in 2010 and 2020, then looks at the crosstab between the two land uses and calculates the area [12]. Different land use between 2010 and 2020 indicates a change, and the same land use indicates no land change. For example, an indication of a difference with the code SW – PMK, which changes from rice fields to settlements, is calculated (in hectares).

2.1.3. Identification of similar land use in direct bordering areas
Comparison between spatial planning policies and spatial control performance is carried out by identifying the same land use in one stretch in both regions. The technical analysis is the following [12]. This type of land use was determined to obtain information on the same land policy (spatial pattern) to be compared. For example, the land is the same for agriculture, sometimes the space allocation will be different in the future (spatial pattern), so this information needs to be collected. Identification of similar land cover is carried out in villages on the border of the district and city (research location). The analysis was processed manually using ArcGIS10.3 software.

2.1.4. Spatial alignment with land use (similar) in directly bordering areas
The alignment of spatial planning and land cover is used to evaluate the status of the ongoing spatial planning. Besides that, it is helpful to see whether or not a spatial layout revision is necessary. The wider the area of land that is not aligned, it indicates the need for introspection in terms of control and vice versa. Technically, the 2020 similar land use map overlaid with a spatial pattern map, and the data used as a database. The logical alignment matrix used is presented in Table 2. This alignment matrix is divided into 2, namely aligned (S) and not aligned (TS). Aligned (S) means that land use and spatial patterns are not contradictory, for example, residential land in the spatial (pattern) plan (RTRW) of residential areas. Meanwhile, those that do not align (TS) conflict with each other, for example, residential land in the spatial pattern (RTRW) of conservation areas.

| Spatial planning (spatial pattern) | BA | PM | PP | SW | SB |
|-----------------------------------|----|----|----|----|----|
| BA                                | SE | SE | SE | SE | SE |
| KK                                | SE | SE | SE | SE | SE |
| KPM                               | SE | SE | SE | SE | SE |
| KPR                               | SE | SE | SE | SE | SE |
| KPP                               | SE | SE | SE | SE | SE |
| RDS                               | SE | SE | SE | SE | SE |

Note: SE= aligned between land use and spatial pattern (RTRW), TSE= not aligned between land use and spatial pattern (RTRW); BA= Water Bodies, PM= Settlements, PP= Agriculture and Plantations, SW= Rice Fields, SB= Shrubs/Scrub, KK= Special Areas, KPM= Settlement Areas, KPR= Agricultural Areas, KPP= Trade Designated Areas, RDS= RTH and Border.
Table 2. Alignment comparison matrix

|                  | Bogor Regency |                  |
|------------------|---------------|------------------|
|                  | Se            | TSe              |
| Se               | S             | SS               |
| TSe              | SS            | TS               |

Note: Se= aligned between land use and spatial pattern (RTRW), TSe= not aligned between land use and spatial pattern (RTRW); S= aligned, SS= partially aligned TS= not aligned;

A logical alignment matrix is used to see the possible deviation in space utilization against the RTRW. Alignment analysis uses a map of similar (existing) land use in 2020 with a spatial plan map for Bogor Regency in 2016-2036 and Bogor City in 2011-2031. The comparison matrix for the alignment of the two regions is presented in Table 2. In the results of the alignment analysis phase 2, it is known that there are three, namely aligned (S), partially aligned (SS), and not aligned (TS). Aligned (S) means that there are no problems (conflicts) in terms of both the Regency and the City of Bogor in terms of coverage and spatial planning policies (RTRW), for example, Regency | rice field | settlement (S) - City | settlement | settlement (S). Partially aligned (SS) means that there is one in the district or city of Bogor where the land-use conflicts with each other, for example, Regency | settlement | agriculture and plantations (TS) - City | settlement | settlement (S). Meanwhile, it means that in the two areas of Bogor Regency/City, the land use and spatial patterns of the RTRW are contradictory, for example, Regency | settlement | agriculture, and plantations (TS) - City | settlement | RDS (TS).

3. Results and Discussion

3.1. Land use at the borders of Bogor Regency and City in 2010 and 2020

The type of land use in the two years is not the same in number, and this is because one of the lands used that is not on the 2010 map but will exist in 2020, namely the transportation network (toll roads). Land use in 2020 that didn't exist in 2010 because it hasn't been built yet. The complete results of the presentation and interpretation of land use in 2010 and 2020 are presented in Table 3 and Figure 2.

Table 3. Area of land use at the border of Bogor Regency and Bogor City in 2010 and 2020

| Land use             | 2010  | 2020  | 2010-2020 |
|---------------------|-------|-------|-----------|
|                     | Area (ha) | %    | Area (ha) | %    | Difference (ha) |
| Water body          | 224.14  | 1.48  | 217.8     | 1.34  | -6.34           |
| Business            | 92.6    | 0.61  | 317.32    | 2.09  | 224.72          |
| Public facility and offices | 159.29  | 1.05  | 245.69    | 1.62  | 86.4            |
| Transportation network | 0      | 0     | 450.78    | 2.97  | 450.78          |
| Green area          | 1.399,71| 9.23  | 383.75    | 2.53  | -1.015,96       |
| Open land           | 1.350,26| 8.9   | 321.5     | 2.12  | -1.028,76       |
| Settlement          | 3.987,73| 26.3  | 6.184,30  | 40.72 | 2.196,57        |
| Agriculture and plantation | 4.203,57| 27.72 | 3.699,20  | 24.36 | -0.504,37       |
| Rice field          | 3.449,73| 22.75 | 2.412,04  | 15.88 | -1.037,69       |
| Shrubs              | 0.297,01| 1.96  | 931.66    | 6.38  | 634.65          |
| Total               | 15.164,03| 100   | 15.164,03 | 100   | 0               |

Description: sign (+) increases, (-) decreases

The most dominant land use in 2010 was agriculture and plantations, followed by settlements at 28% and 26%, respectively. Meanwhile, land use in 2020 will be the dominant settlement (40%). For example, the cover/use of rice fields has decreased from 2010 to 2020 from 22% to 15%, and several other land covers have also been reduced in sizes, such as open land and green areas. One of the causes of the decrease in rice fields is because it has turned into built-up land (houses and other infrastructure facilities). This is partly because the population continues to increase, thus requiring a place to live and a place to do activities (work) so that settlements show an increasing trend. In addition, it is considered...
that the Bogor area is a buffer for the capital city of Jakarta (Maurinus et al., 2017). In 2010 rice fields had an area of 3,449 ha to 2,412 ha in 2020. Changes in rice fields into other land uses occur in border areas and other sites that are not border areas.

According to [13], land-use types such as agricultural land, urban forests, lakes/riverbanks always show a decrease in area, except for land use for graves, parks, and sports facilities tend to increase space. Several regions in Bogor City developed for commercially cultivated graves, such as in South Bogor District. The most frequent changes in agricultural land use occurred due to the proliferation of new housing developments. An example is Villa Mutiara Bogor, built in 2013 by Sinarmas Group and Sandiaga Land Indonesia near Bojonggede station (Figure 3a), and other infrastructure such as the Jagorawi Kedunghalang-Kemang toll road flyover in 2019 (Figure 3b).

3.2. Land-use change in 2010-2020
The analysis of land-use change was carried out from 2010 to 2020. The analysis results showed various changes, and there were 42 combinations of land-use changes. The most significant land change from 2010 to 2020 was agriculture and plantations into settlements, covering 1,088 ha or 7.56% of the total area of the study site. The second-largest change is rice fields into agriculture and plantations with 930.30 ha or 6.47% of the study site area. Meanwhile, the third largest change is rice fields (2010) to settlements (2020), with an area of 771.86 ha or 5.36% of the study area. The three most significant land-use changes are all settlements. Changes in other lands into dominant settlements indicate that there is regional development. The need for housing is increasing along with the increase in population. The development challenge in the future is the increasing population [14]. The growing population makes the demand for land for housing continues to increase. Settlements are basic human needs that cannot
be separated from economic activity, industrialization, and development [15]. The complete spatial distribution of land-use change in 2010-2020 is presented in Figure 4.

Most agricultural land conversion in urban areas occurs in rice fields, thus threatening food availability and loss of multifunctionality of land. In the last five years, rice fields in Bogor City have decreased drastically to 320 ha [16]. According to [17], along with the city's growth, urban expansion is caused by the suburbanization process with a distribution pattern increasingly spreading spatially. Suburbanization itself is the process of forming settlements and industrial areas on the outskirts of urban areas, primarily due to the increasing population in urban areas so that the need for places to live and carry out industrial activities is high [18]. According to [19], besides being sold, rice fields in Bogor City were also converted into gardens and built-up land in 2005-2012. Similar research in the Subang area stated that rice fields that turned into fields/moorlands or mixed gardens occurred because rice productivity decreased from year to year due to pest disturbances and declining soil fertility [20]. This condition can occur in the research location and turn into built-up land (settlements).

3.3. Similar Land Use in Bogor Regency and City Borders in 2010 and 2020

The analysis results show similar land uses (in one stretch) in both regions (Bogor Regency and Bogor City) and are partially limited by roads or water bodies. The total area of similar land on the border of Bogor Regency and City is 2,981.30 hectares, and the locations are spread across all villages/kelurahan with various land uses. Land uses include water bodies, settlements, agriculture and plantations, rice fields, and shrubs (Table 9). The use of similar land on the 2020 border, the widest is between West Cilebut Village, Bogor Regency, and Sukaresmi Village, Bogor City, which is 251 ha (11%). Then followed by land on the border of Sukaharja Village (Bogor Regency) with Mulyaharja Village (Bogor City), which is 151.7 ha (5.31%). More detailed information is presented in Table 4 and Figure 5.

Rice fields dominate the use of similar land. Its area of 655.52 ha or 42.01% of the total area of the study site. Rice field or agriculture is one of the leading sectors, especially in Bogor Regency. In addition, there are also dominant residential lands on the border in both 2010 and 2020. This shows that in 2010 the Bogor Regency and City areas were already developing and supporting spaces for the capital
city of Jakarta. Most of the workers in Jakarta live in this Bogor Regency/City area. The conversion of rice fields into settlements on similar land in the two regions is mainly found on Kemang District (Bogor Regency) and Parakan Jaya, Atang Sanjaya, and West Semplak Villages (Bogor City).

Table 4. Similar land use along the border of Bogor Regency and Bogor City in 2010-2020

| Land use                  | 2010 Area (Ha) | 2010 (%) | 2020 Area (Ha) | 2020 (%) | 2010/2020 Difference (Ha) |
|---------------------------|----------------|----------|----------------|----------|--------------------------|
| Open land                 | 3.35           | 0.11     | 3.75           | 0.13     |                          |
| Settlement                | 621.98         | 20.86    | 2152.10        | 72.19    | 1530.21                  |
| Agriculture and plantation| 279.52         | 9.38     | 646.65         | 21.69    | 367.13                   |
| Rice field                | 655.52         | 21.99    | 178.64         | 5.99     | -476.88                  |
| Other                     | 1420.90        | 47.66    |                |          |                          |
| **Total**                 | **1560.40**    | **100.00**| **2981.30**    | **100**  | **1420.40**              |

Figure 5. Map of similar land use on the border of Bogor Regency and Bogor City in 2010 (a) and 2020 (b)

3.4. Alignment of similar land use with spatial patterns of RTRW and comparison of its alignment in the border area of Bogor Regency and Bogor City

This section compares existing land use alignments on the Bogor Regency side, and the Bogor City side will be explained with the spatial pattern according to the logical alignment matrix (Tables 2 and 3). The level of alignment between land use and spatial planning (RTRW) is divided into two, namely aligned (Se) and not aligned (TSe). Furthermore, a comparative analysis of the alignment carried out on both sides, the results of the research divided into three, namely aligned (S), partially aligned (SS), and not aligned (TS). Based on the analysis of the percentage of land area, S covers 72.47%, while SS is 295.11% and TS is 17.62%. According to these results, there is a need for spatial control and anticipation, especially on TS, because it can cause conflicts in the future. The TS condition means inconsistencies between land use and spatial patterns on both the Regency and City sides of Bogor [12]; [21]. Suppose this continues to happen without law/policy enforcement. In that case, there will be more widespread inconsistency, and it feared that it could lead to disasters or other problems (congestion,
scarcity, flooding [22], and others). The alignment analysis and the comparison of harmony between Bogor Regency and Bogor City are presented in Table 5 and Figure 6.

The spatial plan of the Bogor City RTRW developed following the trend of developments taking into account the optimization of space utilization, i.e., the pattern to be developed must accommodate the main activities, including urban settlement activities [23]. In addition, the use of urban space will pay attention to aspects of environmental sustainability by allocating space for conservation. The land-use plan that has a large portion is housing and trade and services, which is in line with the main functions of Bogor City, which are directed at services, tourism, business, and housing. The development of trade and service activities in Bogor City is relatively rapid. In addition to serving the residents of Bogor City, it is also the surrounding areas, including Bogor Regency. Bogor City is a local and foreign tourist city, affecting trade and service activities [23]. The most significant inconsistency factor along the border area is the large number of existing land uses (settlements) that can not be changed anymore. Land use that is still not aligned should be aligned according to the spatial plan of the RTRW for each region, both Bogor Regency and Bogor City. Land use that is in harmony with the spatial pattern is recommended to continue in the future.

Table 5. Distribution of land use alignment with spatial patterns in the two border areas

| Alignment combination (X | Y | H | I)* | Alignment code | Area (Ha) | % |
|---|---|---|---|
| Ba|Pp|Pp|Kpm | SS | 0,77 | 0,03 |
| Kpd|Pm|Pm|Kk | S | 16,43 | 0,55 |
| Kpd|Pm|Pm|Kpd | S | 15,41 | 0,52 |
| Kpd|Pm|Pm|Kpm | S | 135,92 | 4,56 |
| Kpd|Pp|Pp|Kpm | S | 18,34 | 0,62 |
| Kpd|Sw|Sw|Kpm | S | 6,61 | 0,22 |
| Kpm|Pm|Pm|Kk | S | 38,6 | 1,29 |
| Kpm|Pm|Pm|Kpd | S | 25,09 | 0,84 |
| Kpm|Pm|Pm|Kpm | S | 1.378,85 | 46,25 |
| Kpm|Pp|Pp|Kpm | S | 336,08 | 11,27 |
| Kpm|Sb|Sb|Kpm | S | 1,88 | 0,06 |
| Kpm|Sw|Sw|Kpm | S | 99,78 | 3,35 |
| Kp|Pm|Pm|Kpm | SS | 69,95 | 2,35 |
| Kp|Pm|Pm|Kp | TS | 360,16 | 12,08 |
| Kp|Pp|Pp|Kpm | S | 13,7 | 0,46 |
| Kp|Sw|Sw|Kpm | S | 43,82 | 1,47 |
| Rs|Pm|Pm|Kpd | SS | 36,5 | 1,22 |
| Rs|Pm|Pm|Kpm | S | 75,28 | 2,53 |
| Rs|Pp|Pp|Kpm | SS | 112,61 | 3,78 |
| Rs|Pp|Pp|Rs | TS | 165,15 | 5,54 |
| Rs|Sb|Sb|Kpm | S | 1,81 | 0,06 |
| Rs|Sw|Sw|Kpm | S | 28,43 | 0,95 |
| Total | | 2.981,30 | 100 |

Note: *X = Bogor Regency spatial pattern, Y = Bogor Regency land use, H = Bogor City land use, I = Bogor City spatial pattern,
- Alignment Code: ts=unaligned, s=aligned, ss=partially aligned
- Land use: Ba= water bodies, pp=agriculture and plantations, pm=settlement, sw=rice fields, sb=shrubs, rs= green open space and borders
- Spatial Pattern: kpd=trade area, kpm=area for settlement, kp=area for agriculture, kk= special area

Alignment of similar land use with spatial patterns along the border has S status with 58 villages, both on the Bogor Regency and Bogor City sides. Furthermore, the villages that have TS status are 36 villages and 46 villages that are partially aligned. Alignment of similar land use with RTRW of each area is the widest in the cover/use of residential land in residential areas in its spatial pattern. One location is on the border of West Cilebut Village (Bogor Regency) and Sukaresmi Village (Bogor City), 211.61 ha or about 7% of the total area study site. The most widespread discrepancy (in the form of agricultural land use) found on the border of Sukaraja Village (Bogor Regency) and Katulampa Village
(Bogor City) about 5% of the total area of similar land use. Meanwhile, most of the land with aligned status is located on Dramaga Village (Bogor Regency) and Margajaya Village (Bogor City), 69.63 ha. In the case of SS, the land use of a residential type in Bogor Regency is planned as a Settlement Area, while on the other hand, it is prepared in a spatial pattern on residential land on the side of Bogor City green open space. This shows that the land use is the same, but the land use planning is different. In this case, it won't be easy to control a ground not in alignment if it is already in progress. As in the case above, the land was allocated as green open space, but now residential land has been built, which can negatively impact and even lead to disaster. In addition, there is a need to align policies between the two regions further to ensure sustainable development in both areas [24]. For example, one place is planned as an agricultural area in rice fields on the border with a vast expanse, while the other site allocates for a residential area. This condition will significantly affect the policies of the two regions. Land of sustainable food agriculture protection (LP2B) must be synergized because food needs are limited to one area and other areas and require comprehensive planning [25]. Differences in planning between regions are natural because they have different resources [26].

4. Conclusion and Suggestion

4.1. Conclusion
On the border of Bogor Regency and Bogor City in 2020, settlements are spread evenly over two areas and are the most dominant. This shows that the two regions are pretty developed, and the boundaries are difficult to identify. The change of agricultural land into residential land has increased significantly (two and a half times) between 2010-2020. Similar residential land in the broadest border is between Mulyaharja Village (Bogor Regency) and Sukaharja Village (Bogor City) in settlements and agricultural land. The spatial performance of an area can be seen, one of which is the level of alignment in both regions. Alignment on the border of the two regions shows a high level of alignment (72%). However, there is still a discrepancy of around 25% that needs attention to avoid negative impacts (inconsistency).

4.2. Suggestion
It is crucial to conduct research on harmony at the border, one of which can measure the level of achievement of sustainable development. The indicator of the tumpeng stacking land use with a spatial pattern on similar land in the border area can see the tendency of the spatial policy of the site, whether exploitation or conservation is dominant. This will be the aim of further research.

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