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TOWARDS SUSTAINABLE DEVELOPMENT: EVALUATION OF SPATIAL PLANNING REGENCY/MUNICIPALITY IN WEST JAVA PROVINCE, INDONESIA

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Abstract: Spatial planning performance indicators are related to sustainability. This approach combines quantitative and qualitative data to see the sustainability of regional spatial planning based on land and policies. This study aims to: (1) Analysis of the sustainable development index (IPB) and (2) Analysis of causal conditions of spatial planning performance assessment per regencies/municipalities based on IPB. The approach used is IPB, geographic information system, multi-value qualitative comparative analysis and literature study. The highest score of IPB is Bandung Municipality. The income per capita, education and welfare of the Municipality of Bandung are higher than in other regions. Considering the distribution of IPB scores and their constituent variables, subsequent analysis shows the need to differentiate between regencies and municipalities. Regional sustainability in this regency offers high compatibility between spatial planning policies and forest area status policies have extensive vegetation cover and small land-use diversity. Whereas in urban areas, it shows the opposite. This article can answer the sustainability of spatial planning policies and differentiate between regencies and municipalities—the use of mvQCA is a new approach to spatial planning evaluation.

Keywords: Causal condition, land, mvQCA, performance, policy.

Introduction

Spatial planning is a form of positive intervention in social and environmental life to improve sustainable welfare. Thus, spatial planning is closely related to the principle of sustainable development (Birkmann, 2003; Piro & Ganser, 2016; Gorzym-wilkowski, 2017). However, the policies and spatial development strategies implemented to achieve individual sustainability objectives frequently interact and conflict presenting decision-makers (Caparros-Midwood *et al.*, 2015). The urgency of spatial planning arises because of the awareness of the importance of public intervention against market failures in creating spatial patterns and structures that follow common goals and make sustainable spaces (Rustiadi *et al.*, 2011).

Local governments are actors in sustainable development and sustainable municipality management (Roseland, 1991). The principle of sustainability considers social, economic and environmental aspects which is in line with the regulation principle of spatial planning (Kaiser *et al.,* 1995; Alexander, 2016; Sofeska, 2016; Nogués *et al*., 2019; Albert *et al.*, 2020). Spatial planning as an instrument for sustainable development is crucial and regulated in various international theoretical literature (Gorzym-wilkowski, 2017). Sustainable development in spatial planning is related to multiple aspects, namely the development of renewable energy (Baltas & Dervos, 2012), climate change (Klimas, 2020), community involvement (Silver, 2014), maintaining historic urban landscapes (Santander & Garai-Olaun, 2016) and instruments, conservation, biodiversity and ecosystem services (Albert *et al.,* 2020).

This study explores a quantitative-qualitative land and policy causal approach to explain sustainability based on the sustainable development index (IPB) (outcomes). It consolidates sustainability issues in local (regional) planning processes (Högström *et al.,* 2021). Land and policy are essential and fundamental elements in spatial planning (Wang, 2018) and future challenges to achieve sustainable development (Rustiadi *et al.,* 2015; Indrajit *et al.,* 2019). Land scenarios can represent how various policies will look on the ground and the implications for development (Geneletti, 2012; Stead, 2021; Tang *et al.*, 2021). The approach used is qualitative comparative analysis (QCA) (Ragin, Charles, 1989). Apart from not being widely used in the spatial planning field, the reasons for using QCA are its sensitivity to context (sustainable spatial planning), its ability to use small/medium cases and its causal complexity (Verweij & Trell, 2019) and supporting comparative research in planning research (Markusen & Gadwa, 2010). In addition, QCA can more systematically generalise and draw lessons across points (Pallagst, 2010). Currently, not many studies related to causal conditions compare between regions. In the literature, there are cases of comparing marine spatial approaches such as those carried out by (Allnutt *et al*., 2012; Lu *et al*., 2015) but not explicitly comparing regions.

Spatial planning systems have never been thoroughly tested in terms of performance (Mastop, 1997). Spatial plans should be evaluated, not primarily in terms of their material outcomes but in how they improve decision-makers understanding of the problems they face now and in the future (Faludi, 2000). Thus, a causality-based comprehensive approach is needed to answer these challenges by providing an overview of sustainable spatial planning comparisons between regions (horizontally). Generally, spatial policy reviews are carried out by each area (vertical), looking at misalignment between sectors, policies and actual conditions such as research by (Mulya *et al.*, 2017; Mulya *et al.,* 2019a; 2019b).

This research can be used as an evaluation development in the context of an early warning system (early information) whether or not spatial planning revisions are necessary and contribute to the literature on the evaluation of planning results. The critical point in comparing the performance of the RTRW (land context and policy) between regions is the material for evaluating the performance of the regency/municipality government, which is carried out by the central government (Grădinaru *et al.*, 2018). Thus, the control function can be carried out in a broader scope. The aims of this research are: (1) Analysis of the sustainable development index (IPB) and (2) Identify and analyse causal conditions related to land and policies that can assess and compare the sustainability of regional spatial planning.

Material and Methods

Study Area

The research area is a regency/municipality in West Java Province. The capital of the province of West Java is the Municipality of Bandung. Its area is 35,377.76 km^2, consisting of 18 regencies and nine cities (Figure 1). West Java Province is one of six provinces on the island of Java, with a population in 2020 of 49,935,858 people (BPS-Statistics of West Java, 2021).

Data Collection

This study uses secondary data. Data were obtained from various government agencies, both at the central and regional levels, including the Central Statistics Agency (BPS), the Ministry of Agrarian Spatial Planning/National Land Agency (ATR/BPN), the Ministry of Environment and Forestry (KLHK), the Geospatial Information Agency (BIG), Development Planning Agency at Sub-national Level (Bappeda) of regency and municipality. The complete data are presented in Table 1.

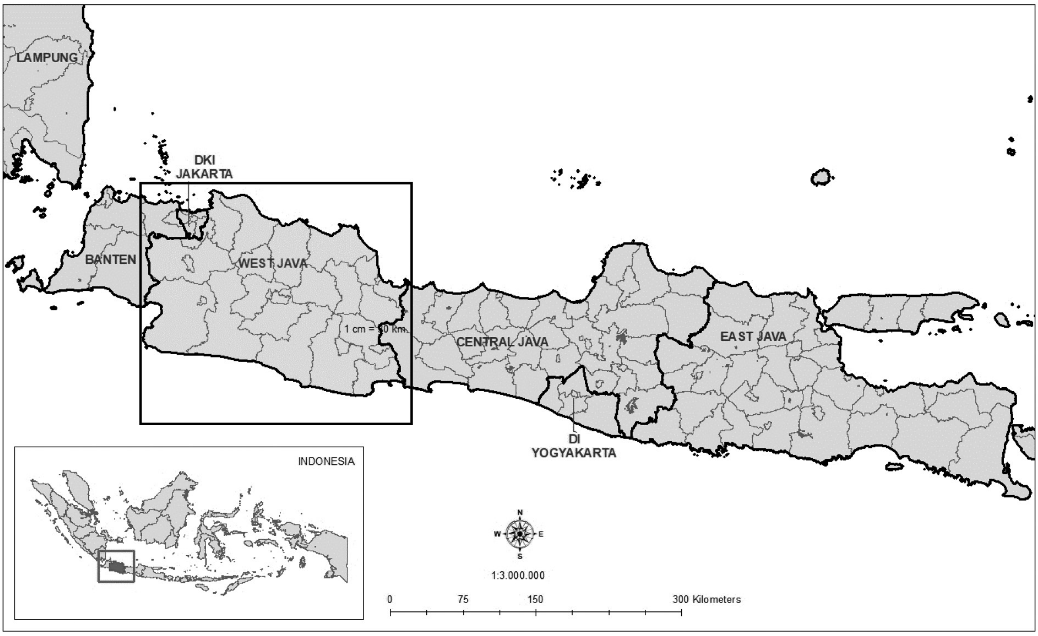


Figure 1: The study area (box)

Table 1: Types and sources of data

No.	Data	Year/Scale	Scope	Source
1	GDP data	2020	Calculating the GDP index (IPDRB) per capita	BPS
2	HDI data per regency/ municipality in West Java province	2020	Getting HDI data	BPS
3	Village potential data	2018	Getting data to calculate the environment index	BPS
4	Administration maps	1:50,000	Getting data on regency/ municipality boundaries in West Java Province	BIG
5	Regulation on detailed layout plan (RDTR) data	2020	Identify RDTR regional regulations in each regency/ municipality	ATR/ BPN
6	Regulation of sustainable food farm (LP2B) data	-	Identifying the existence of local regulations related to LP2B in each regency/municipality	Internet
7	Land use map 2019	1:100,000	Calculating percentage of vegetation area, percentage of alignment area and area entropy	KLHK
8	Forest and fishery area status map	1:250,000	Calculating the percentage area of alignment	KLHK

9	Spatial pattern map of 27 regencies and municipalities in West Java Province	2011-2031, 2014-2034, 2016-2036, 2018-2038 1:25,000/ 35,000 (municipality) and 1:50,000 (regency)	Calculating the percentage area of alignment	ATR/ BPN, Bappeda of Regency and Municipality

The methodology used Sustainable Development Index (IPB) analysis, geographic information system (GIS), multi-value QCA (mvQCA) and literature studies. The flow of research carried out in this study is presented in Figure 2. The details of each method are described as follows:

Sustainable Development Index Analysis (IPB)

The concept of sustainability is commonly used in the economic, social and environmental dimensions (Liu & Ma, 2020). In this study, IPB will be analysed based on these three dimensions as the outcome of the QCA analysis. Calculating IPB according to the following equation (Fauzi & Oxtavianus, 2014) modified.

$$IPB = \frac{IPDRB+IPM+IL}{3} \quad \textbf{(1)}$$

Note:

- IPB = Sustainable Development Index
- IPDRB = Domestic Product Gross Ratio Index
- IPM = Human Development Index
- IL = Environmental Index

The value of IPB is sourced from the agency and obtained from the calculations (analysis) results. The full measure is presented in Table 2.

Table 2: The type of index used and its calculation

No.	Index	Calculation
1	IPDRB	The minimum and maximum values are based on the 2,000 ADHK GDP value. The greater the IPDRB value, the better the per capita income level of the population. IPDRB formulation: $\mathbf{IPDRB = \frac{GDP\ per\ capita - min\ value\ of\ GDP\ in\ West\ Java}{max\ value\ of\ GDP\ in\ West\ Jaya - min\ value\ of\ GDP\ in\ West\ Java}}$ **(2)** Next, to standardise IPDRB value [IPDRB (std)] on a scale of 0-100, we used this formulation: $\mathbf{IPDRB\ (std) = IPDRBi - IPDRB(min) \times \frac{100}{IPDRBi(max) - IPDRBi(min)}}$ **(3)** Source: BPS, Analysis

2	IPM	Human Development Index (HDI) data per regency/municipality in West Java Province. This index is formed from the average achievement of three main dimensions of human development: A long and healthy life, knowledge and a decent standard of living. Data indicates that the greater the HDI value, the better the community's level of education and welfare. To standardize IPM value [IPM(std)] in scale 0-100, we used this formulation: $$\mathbf{IPM\ (std) = IPMi - IPM(min)\ x\ \frac{100}{IPMi(max) - IPMi(min)}} \quad \mathbf{(4)}$$ Source: BPS-Statistic of West Java
3	IL	The environmental index was calculated using an analytical scalogram. Selection of data related to the environment in regency's/cities in West Java Province. Data sources for village potential in 2018. The variables used are the existence of settlements on the banks of the river (villages), the number of settlements on the banks of the river (locations), the number of residential houses on the banks of the river, the number of families living on the banks of the river, the number of slum settlements, the number of slum buildings. The number of families living in slums, the incidence of air pollution, the number of drought events, the number of floods, the number of landslides, the number of people suffering from diarrhoea per 1,000 population and the percentage of villages with water pollution (%). Disaster and pollution variables refer to (Choi & Lee, 2016). Rationalise the data. To all data, the higher the value, it indicates the environment in the area is getting worse (-). So, equalising other variables (IPDRB and HDI) is necessary. The formula inverts all data: y = 1/xij, where y is the new variable and xij is the environmental variable j in region i. If y is not defined (xij = 0), then the value of y is searched by the equation: y = xij (max) + standard deviation of distance j. It was weighing the data through the capacity data j divided by the weight of the facility j, where the weight of the facilities j = the total number of capacities j divided by the number of areas that have facilities j. perform data standardisation. Formula: yij = [xij-min(xj)]/sd. Yij = standard value, xij = number of units related to the environment, min(xj) = minimum index value on the jth feature and sd = standard deviation value. Summing up the data per region to get the i-th region IL value. Furthermore, to standardise ILK value [ILK (std)] on a scale of 0-100, we used this formulation: $$\boldsymbol{ILki\ (std) = ILki - ILki(\mathrm{min})\ x\ \frac{100}{ILki(max) - ILki(min)}}$$ Source: BPS (Podes), Analysis

Analysis of Geographic Information Systems (GIS)

GIS analysis overlays various maps such as between land use maps and spatial patterns that produce maps of land use alignment and spatial patterns (percentage of PLPR alignment area). In addition, overlaying spatial pattern maps and forest area status maps have a map of spatial pattern alignment and forest area status (percentage of PRKH alignment area). GIS analysis using ArcGIS version 10.3 software using union, intersect, clip and calculate geometry tools. Furthermore, the pivot table process (Microsoft Excel) is carried out to get the area/percentage alignment data.

Multi-value Qualitative Comprehensive Analysis (mvQCA)

In mvQCA analysis, variables or conditions can be displayed in raw data that is nominal or ordinal. For these variables to be analysed through mvQCA, the data must first be transformed through calibration, namely a threshold (Legewie, 2017; Fauzi, 2019; Rahma *et al.,* 2021) mvQCA analysis using TOSMANA software.

Causal Condition and Outcome

A total of nine causal conditions that are thought to explain the sustainability phenomenon in each regency/municipality are used in the mvQCA model. The operational definition of causal conditions can be seen in Table 3.

Literature Study

The literature study collected data related to regional regulations governing sustainable food agricultural land (LP2B) and detailed spatial plans (RDTR). Literature is collected online on each regency/municipality's website and the Ministry of Agrarian and Spatial Planning/BPN.

Results and Discussion

Evaluation of the sustainability of spatial policies can be carried out with various approaches, including based on the dynamics of potential, existing and incompatible with planning and carrying capacity - indicators include carbon footprint (CF) and biocapacity (BC) within the framework of environmental carrying capacity (ECC) - (Świąder *et al*., 2020), city-level footprint (Baabou *et al.*, 2017), integration with disaster policy (Barredo *et al.*, 2005), spatial conflict (Cieslak, 2019) and others. Spatial planning which refers to the distribution of land use and community, focuses on the physical aspects of land and national economic, environmental and social policies (Chigudu & Chirisa, 2020). This paper evaluates spatial

Table 3: Operational definition of causal condition

Dimension	Condition	Code	Measurement Concept	Source
Policy and land	Alignment of land use and spatial patterns	S_PLPR	Percentage of land area that is aligned between land use vs. spatial pattern (ha)	Analysis. Appendix 1 and Appendix 4
	Green Open Space (GOS) area	Veg	Percentage of vegetation in each area compared to non-vegetation (built-up land, open land, etc.)	Analysis. Appendix 2 and Appendix 5
Policy	Alignment between policy	S_PRKH	Percentage of land area that is aligned between spatial pattern vs. forest area status (ha)	Analysis. Appendix 3 and Appendix 6
	LP2B policy	LP2B	The existence of a regional regulation on LP2B determination in each region	Internet
	RDTR policy	RDTR	The existence of regional regulations related to RDTR in each region	Internet*)
Land	Land diversity	Entropy	The closer to 1, the more homogeneous	Analysis

Note: *) https://gistaru.atrbpn.go.id and https://tataruang.atrbpn.go.id/protaru/Rdtr.

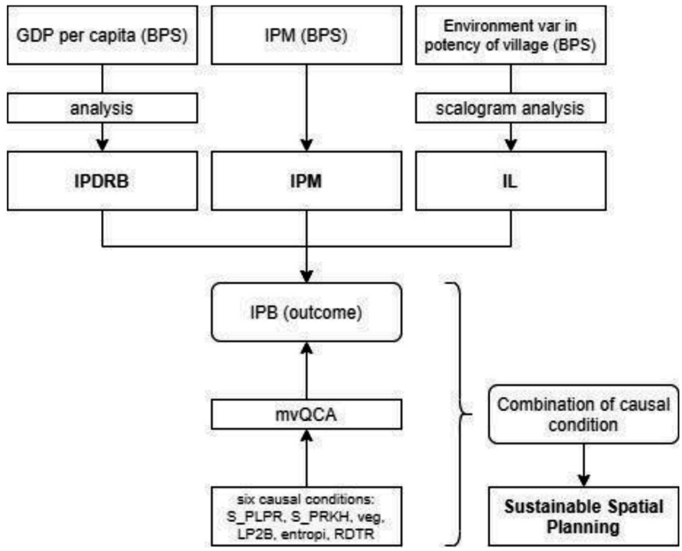


Figure 2: Research flow

planning using a causal approach between the sustainable development index (IPB), land conditions and current policies.

Sustainable Development Index (IPB)

In the IPB analysis, the index variables of GRDP, HDI and IL are considered. The highest IPDRB and HDI are in Bandung Municipality while the highest IL is in Banjar Municipality. It means that the Municipality of Bandung has a higher income per capita status and a higher HDI than other regions, which characterises education, health and welfare. Moreover, it is also inseparable from the Municipality of Bandung, the capital of West Java Province. Provincial capitals generally have superior facilities and services that can directly improve the welfare of their people (Tarigan *et al.,* 2016).

Meanwhile, Banjar Municipality and Sukabumi Municipality have the highest environmental index values compared to other regency's/cities. It shows that from an ecological point of view, Banjar Municipality and Sukabumi Municipality are best measured from various parameters, including not many locations, settlements and families living in slums and not many disasters. These results are in line with the research of (Świąder *et al.*, 2020) we are facing a global change associated with the rapid population growth and natural resources demand, whose impacts are accumulated in space and during the time. Therefore, humanity could be identified as Planet's Ecological Bigfoot. The anthropopressure disturbed the Earth's natural regulatory capacity, which could be noticed by the unavailability of freshwater, irregular temperatures, or interrupted biogeochemical flows. Moreover, the growth of population is expected, as well as the sprawl of urbanized areas, increasing demand for living space, food and humans' ecological footprint. Therefore, the aim of the study was the implementation of the environmental carrying capacity (ECC) and (Carsjens & Ligtenberg, 2007) where settlements' rapid development (land use) can affect environmental sustainability. Environmental conditions are closely related to population growth, expansion of urban areas, increasing demand for living space, food and human ecological footprint. IPB with its various variations is a strong sustainability indicator that measures the environmental efficiency of an area in realising human development (Hickel, 2020). The complete data for the calculation of IPB is presented in Table 4.

Table 4: IPB

Regency/ Municipality	IPDRB	IPM	IL	IPDRBstd	IPMstd	ILstd	IPB
	Original Data			Standardised			
Bogor Reg	0.181	70.400	1.311	18.142	31.207	1.731	17.027
Sukabumi Reg	0.077	66.880	1.530	7.666	9.412	2.326	6.468
Cianjur Reg	0.003	65.360	2.505	0.273	0.000	4.970	1.748
Bandung Reg	0.115	72.390	0.672	11.460	43.529	0.000	18.330
Garut Reg	0.012	66.120	1.246	1.224	4.706	1.557	2.496
Tasikmalaya Reg	0.000	65.670	4.586	0.000	1.920	10.611	4.177
Ciamis Reg	0.070	70.490	11.561	7.000	31.765	29.520	22.762
Kuningan Reg	0.026	69.380	4.360	2.631	24.892	9.999	12.507
Cirebon Reg	0.019	68.750	1.593	1.911	20.991	2.496	8.466
Majalengka Reg	0.065	67.590	3.240	6.479	13.808	6.963	9.083
Sumedang Reg	0.105	71.640	8.363	10.514	38.885	20.851	23.417
Indramayu Reg	0.320	67.290	11.678	32.027	11.950	29.837	24.605
Subang Reg	0.058	68.950	4.771	5.791	22.229	11.113	13.044
Purwakarta Reg	0.520	70.820	8.283	51.961	33.808	20.634	35.468
Karawang Reg	0.836	70.660	3.705	83.581	32.817	8.221	41.540
Bekasi Reg	0.769	74.070	2.055	76.897	53.932	3.749	44.859
Bandung Barat Reg	0.063	68.080	13.550	6.340	16.842	34.912	19.365
Pangandaran Reg	0.086	68.060	13.968	8.574	16.718	36.046	20.446
Bogor Municipality	0.232	76.110	7.967	23.151	66.563	19.776	36.497
Sukabumi Municipality	0.189	74.210	34.433	18.923	54.799	91.529	55.084
Bandung Municipality	1.000	81.510	3.112	100.000	100.000	6.615	68.872
Cirebon Municipality	0.599	74.890	13.086	59.883	59.009	33.656	50.849
Bekasi Municipality	0.129	81.500	14.638	12.879	99.938	37.862	50.227
Depok Municipality	0.087	80.970	8.451	8.733	96.656	21.090	42.160
Cimahi Municipality	0.351	77.830	17.834	35.105	77.214	46.527	52.949
Tasikmalaya Municipality	0.149	73.040	9.002	14.857	47.554	22.583	28.331
Banjar Municipality	0.062	71.700	37.557	6.169	39.257	100.000	48.475
Min	**0.000**	**65.360**	**0.672**	**0.000**	**0.000**	**0.000**	**1.748**
Max	**1.000**	**81.510**	**37.557**	**100.000**	**100.000**	**100.000**	**68.872**
Stdev	**0.276**	**4.722**	**9.187**	**27.623**	**29.240**	**24.908**	**18.849**

Spatially, the description of the variables IPDRB, HDI and IL that make up IPB looks different in each regency/municipality. For example, IPDRB with dark blue is spread in Karawang Regency, Bandung Municipality and Bekasi Regency. The highest HDI is in Bogor Municipality, Bekasi Municipality and Bandung Municipality. Meanwhile, the high IL was in Banjar Municipality and Sukabumi Municipality. When viewed as a whole, cities in West Java Province dominate IPDRB, HDI and IL. Generally, a good level of economy and HDI is in urban areas. Still, the opposite is true for IL, given the strong correlation between economics (income) and ecological impact - which violates sustainability principles (David *et al*., 1996; Hickel, 2020). The complete picture is presented in Figure 3. The dominance of IPB scores is greater in the municipality administration area, showing a significant difference between the regency and municipality areas.

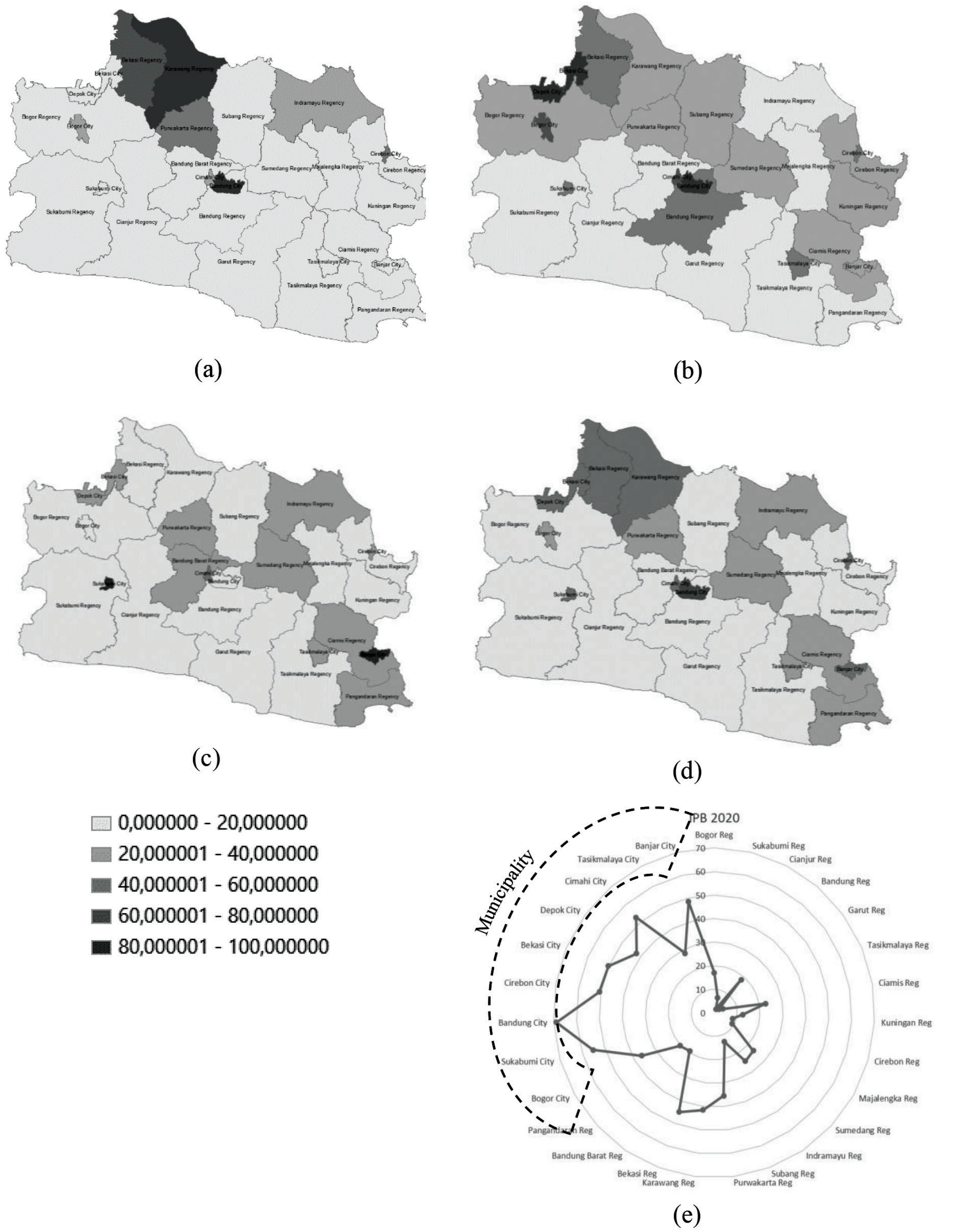


Figure 3: (a) IPDRB, (b) HDI, (c) IL, (d) IPB and (e) IPB for each regency/municipality in West Java Province

If it is distinguished between regencies and cities, the role of indicators informing IPB can be seen more clearly. The parameters in the municipality are higher than in the regency. It shows that income, education, welfare and others are better in the municipality than in the regency. Meanwhile, the environmental level does not differentiate between regencies and municipalities. There are good ecological levels in the regencies and municipalities. The complete data is presented in Figure 4.

The sustainable development index for each regency and municipality can be correlated with different variables to evaluate its behaviour. Figure 5 shows a simple linear correlation between the logarithm of population density and GDP per capita. R^2 indicates the moderate relationship between IPB and population density and per capita income in both cases. However, in R^2, the relationship between IPB and population density is more significant than per capita income. It shows that informing IPB, population density is more influential than GDP per capita although the difference is only minor.

Several suggestions are from various studies in sustainable spatial planning including: (1) Using a sustainable framework (Chigudu & Chirisa, 2020), (2) Formulate scientific and reasonable plans, strengthen the ecological improvement of land resources (Wu & Bai, 2022) and (3) Promote resource-based cities' sustainable development (Huang *et al.*, 2018; Wu & Bai, 2022). Various sustainability measures that have been developed can be used as long as they comply with scientific and reasonable planning rules (Wu & Bai, 2022).

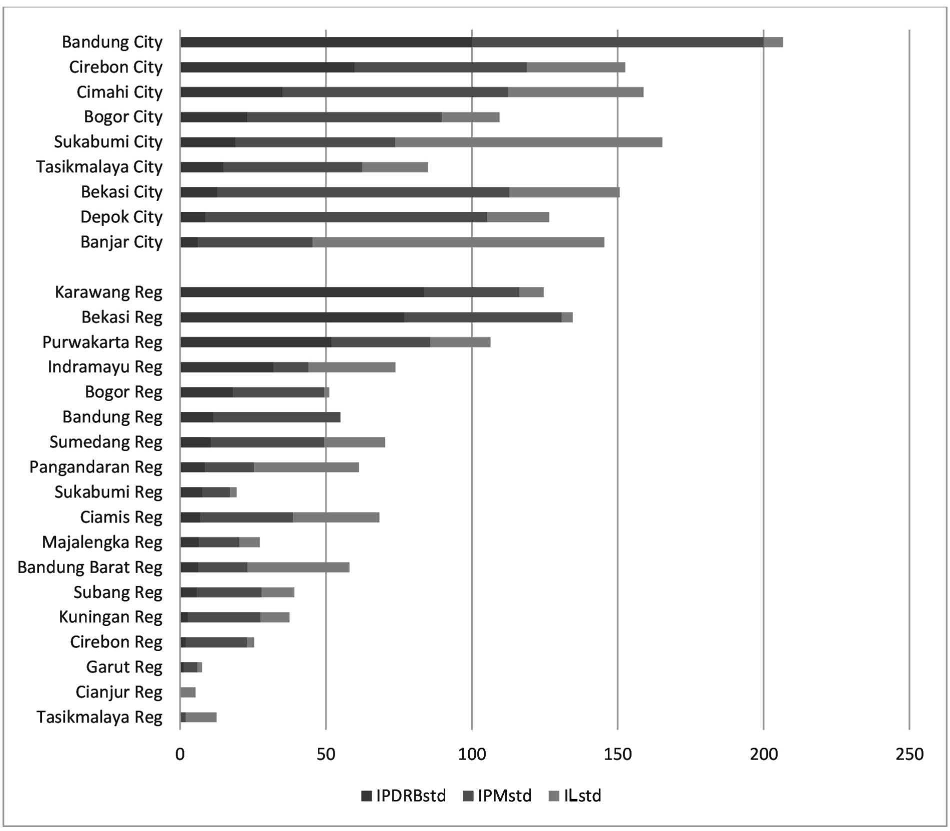
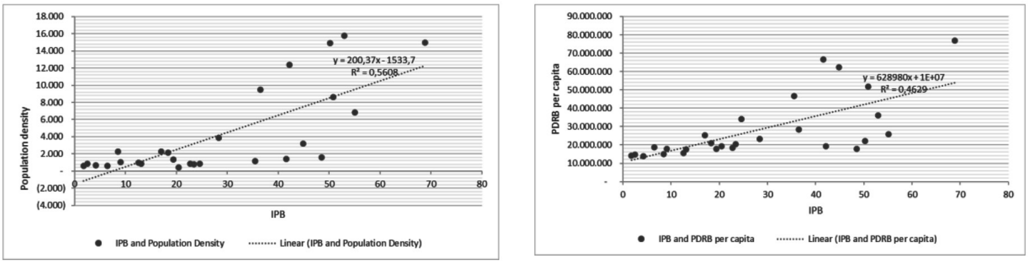


Figure 4: Role of indicators in establishing IPB in each municipality in West Java (remarks: City = municipality, Reg = regency)



(a) (b)

Figure 5: Correlation between IPB with (a) population density and (b) PDRB per capita

***Multi-value Qualitative Comprehensive Analysis* (mvQCA)**

From the previous section, it has been known that the sustainability level between West Java Province's urban regency is quite diverse. This diversity, of course, does not just happen. Some conditions explain why one area has high sustainability while another does not. This section identifies a number of these conditions by analysing the pattern of relationships between several condition variables and the level of sustainability experienced by each regency/municipality. The conditions used for the analysis are the percent of land area in harmony between land use and spatial patterns (S_PLPR) percentage of land area. Six causal conditions form a combination and can explain the phenomenon of spatial sustainability in 27 regencies/municipalities categorised differently between regencies and municipalities.

In the mvQCA analysis, a separation is made between regions in the form of regency and municipality because cities dominate the significant value of IPB. The characteristics of regency and municipality are generally different. Regencies are more concerned with the dominant rural traits in agriculture, while cities focus more on urban factors in industry and service centres (Suparmini, 2017). However, there is something unique in this West Java Province; good environmental conditions are found in the municipality (Sukabumi and Banjar). Even though both regions are cities, their characteristics are similar to rural areas. It is indicated by the still extensive rice fields reaching 28.9% (BPS-Statistics of Sukabumi, 2021). Besides rice, Sukabumi Municipality also produces horticultural and biopharmaceutical crops. The matrix data used accordingly is presented in Table 5.

The truth table (Table 6) shows that various combinations can achieve sustainability. In explaining the results of this mvQCA, it is distinguished by region, regency and municipality. In regency, areas included in sustainable spatial planning are large vegetation cover (veg), small land cover diversity (entropy) and local regulations on RDTR. In addition, sustainability can also be achieved with moderate to significant harmony between PLPR and PRKH, large vegetation cover, having a regional policy on LP2B and small land cover diversity (entropy). The municipality has a large to moderate harmony between PLPR and PRKH, regional regulations related to LP2B and regional policy about RDTR. The complete data from the analysis results are presented in the truth table as illustrated in Table 6.

When viewed from the configuration and distribution, sustainability in the regency area is generally indicated by the significant harmony between PLPR and PRKH, having large vegetation cover and small land cover diversity (entropy). Meanwhile, in urban areas, it is generally indicated by the amount of harmony between PLPR and PRKH while other conditions (veg, LP2B, entropy and RDTR) are not determinants of sustainability. Therefore, this difference can answer the sustainability differences in regencies and municipalities.

Table 5: Data matrix

Regency/ Municipality	Kwlind(1)	S_ PLPR(2)	S_ PRKH(3)	Veg(4)	LP2B(5)	Entropi(6)	RDTR(7)
Bogor Reg	27.20	90.90	97.97	82.60	1	0.28	0
Sukabumi Reg	16.22	92.86	87.94	96.10	1	0.34	1
Cianjur Reg	19.35	91.02	87.34	95.00	1	0.32	0
Bandung Reg	29.36	90.82	95.99	86.14	1	0.19	0
Garut Reg	72.08	89.35	70.09	96.09	1	0.27	0
Tasikmalaya Reg	61.43	47.24	44.77	97.39	1	0.23	1
Ciamis Reg	9.51	93.07	93.82	94.33	1	0.16	0
Kuningan Reg	40.89	66.37	68.09	90.12	1	0.14	0
Cirebon Reg	11.31	89.40	88.70	72.34	0	0.13	0
Majalengka Reg	28.63	79.86	78.16	85.81	0	0.15	1
Sumedang Reg	66.23	56.89	48.45	90.22	0	0.18	1
Indramayu Reg	5.57	94.56	98.14	66.31	1	0.21	0
Subang Reg	6.96	93.62	95.75	83.96	0	0.21	0
Purwakarta Reg	11.25	89.06	91.69	80.74	0	0.12	1
Karawang Reg	8.18	88.36	95.98	71.47	1	0.19	0
Bekasi Reg	9.44	99.35	91.72	60.03	0	0.14	0
Bandung Barat Reg	20.82	89.79	91.78	86.71	1	0.16	0
Pangandaran Reg	21.85	98.18	99.55	97.75	1	0.02	0
Bogor Municipality	10.43	99.12	100.00	29.01	1	0.12	1
Sukabumi Municipality	10.32	90.91	89.68	53.15	1	0.01	0
Bandung Municipality	12.55	87.45	87.47	12.13	0	0.03	1
Cirebon Municipality	8.64	91.18	91.36	30.92	0	0.01	1
Bekasi Municipality	0.00	100.00	100.00	10.18	0	0.03	1
Depok Municipality	12.94	99.60	99.97	22.31	0	0.03	1
Cimahi Municipality	24.33	75.75	75.67	14.90	0	0.01	0
Tasikmalaya Municipality	28.23	72.70	71.77	77.73	0	0.03	1
Banjar Municipality	7.01	93.42	92.99	77.41	0	0.02	0

Notes: (1) Percentage of protected area, (2) Percentage of land use alignment and polarity of RTRW money, (3) Percentage of polar alignment of RTRW money and forest area status map, (4) Percentage of vegetation area per regency/municipality, (5) Existence of regional regulations related to LP2B (1 = yes, 0 = none), (6) Land use entropy value per regency/municipality, (7) Existence of regional regulations related to RDTR (1 = yes, 0 = none)

Table 6: Truth table

Region	IPB	Configuration	Case	N
Regency	{1}	S_PLPR{0}*S_PRKH{0}*veg{1}*LP2B{0}*Entropi{1}*RDTR{1} +	Sumedang Reg	1
		S_PLPR{1}*S_PRKH{1}*veg{1)*LP2B{0}*Entropi{0}*RDTR{1} +	Purwakarta Reg	1
		S_PLPR{1}*S_PRKH{1}*veg{1}*LP2B{1}*Entropi{1}*RDTR{0} +	Ciamis Reg Bandung Barat Reg	2
		S_PLPR{1}*S_PRKH{2}*veg{0}*LP2B{1}*Entropi{1}*RDTR{0} +	Indramayu Reg	1
		S_PLPR{1}*S_PRKH{2}*veg{1}*LP2B{1}*Entropi{1}*RDTR{0} +	Bandung Reg Karawang Reg	2
		S-PLPR{2}*S_PRKH{1}*veg{0}*LP2B{0}*Entropi{1}*RDTR{0} +	Bekasi Reg	1
		S_PLPR{2}*S_PRKH{2}*veg{2}*LP2B{1}*Entropi{0}*RDTR{0} +	Pangandaran Reg	1
	{0}	S_PLPR{0}*S_PRKH{0}*veg{1}*LP2B{1}*Entropi{1}*RDTR{0} +	Kuningan Reg	1
		S_PLPR{0}*S_PRKH{0}*veg{2}*LP2B{0}*Entropi{0}*RDTR{1} +	Tasikmalaya Reg	1
		S_PLPR{1}*S_PRKH{1}*veg{1}*LP2B{0}*Entropi{0}*RDTR{0} +	Cirebon Reg	1
		S_PLPR{1}*S_PRKH{1}*veg{1}*LP2B{0}*Entropi{1}*RDTR{1} +	Majalengka Reg	1
		S_PLPR{1}*S_PRKH{1}*veg{1}*LP2B{1}*Entropi{2}*RDTR{0} +	Cianjur Reg	1
		S_PLPR{1}*S_PRKH{1}*veg{2}*LP2B{1}*Entropi{2}*RDTR{0} +	Garut Reg	1
		S_PLPR{1}*S_PRKH{1}*veg{2}*LP2B{1}*Entropi{2}*RDTR{1} +	Sukabumi Reg	1
		S_PLPR{1}*S_PRKH{2}*veg{1}*LP2B{0}*Entropi{1}*RDTR{0} +	Subang Reg	1
		S_PLPR{1}*S_PRKH{2}*veg{1}*LP2B{1}*Entropi{2}*RDTR{0} +	Bogor Reg	1
Municipality	{1}	S_PLPR{1}*S_PRKH{1}*veg{0}*LP2B{0}*Entropi{0}*RDTR{0} +	Cimahi Municipality	1
		S_PLPR{1}*S_PRKH{1}*veg{0}*LP2B{0}*Entropi{0}*RDTR{1} +	Bandung Municipality Cirebon Municipality	2
		S_PLPR{1}*S_PRKH{1}*veg{0}*LP2B{1}*Entropi{0}*RDTR{0} +	Sukabumi Municipality	1
		S_PLPR{1}*S_PRKH{1}*veg{1}*LP2B{0}*Entropi{0}*RDTR{0} +	Banjar Municipality	1
		S_PLPR{2}*S_PRKH{2}*veg{0}*LP2B{0}*Entropi{0}*RDTR{1} +	Bekasi Municipality Depok Municipality	2
	{0}	S_PLPR{1}*S_PRKH{1}*veg{1}*LP2B{0}*Entropi{0}*RDTR{1} +	Tasikmalaya Municipality	1
		S_PLPR{2}*S_PRKH{2}*veg{0}*LP2B{1}*Entropi{2}*RDTR{1} +	Bogor Municipality	1

Note: N = number of cases, Reg = regency

Conclusion

The framework produced in this research is developing a causality-based evaluation method. The study results focus on verifying the suitability between spatial planning objectives and actual land development patterns and supporting policies. The review is based on the IPB variable, which is composed of IPDRB (economic), HDI (social) and IL (environment) variables. The highest IPB score is Bandung Municipality. Based on the constituent variables, the highest IPDRB and HDI are also in the Municipality of Bandung while the highest IL is in the Municipality of Banjar. It shows that the Municipality of Bandung has a higher income per capita and social conditions by HDI than other regions. It is also due to the Municipality of Bandung, the capital of West Java Province, having various advantages as a service centre, infrastructur and infrastructure that can directly improve the welfare of its people. The dominance of the three variables in the municipality was followed by dividing the area by regency and municipality. This perspective produces different configurations in the meaning of regional sustainability both in regency and municipality. The sustainability of the regency area is generally indicated by the great harmony between PLPR, PRKH, having large vegetation cover and small land cover diversity (entropy). Meanwhile, in urban areas, it is generally indicated by the amount of harmony between PLPR and PRKH while other conditions (veg, LP2B, entropy and RDTR) are not determinants of sustainability. This difference can answer the differences in sustainability in regencies and cities.

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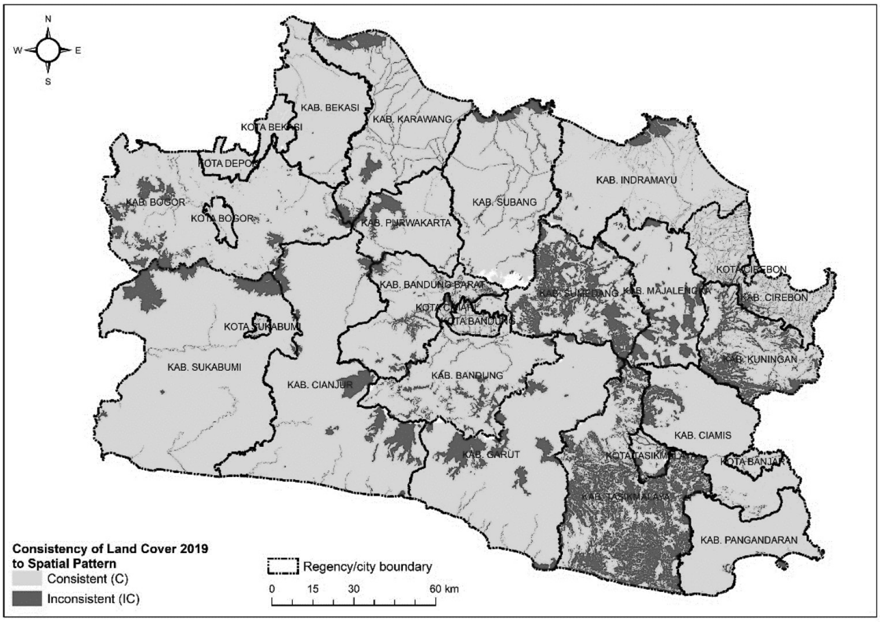
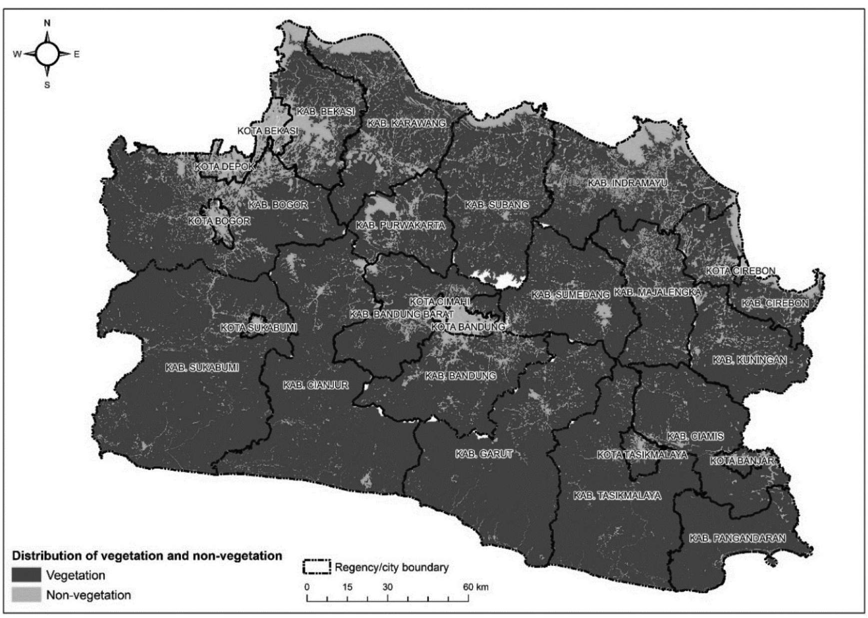
Appendix

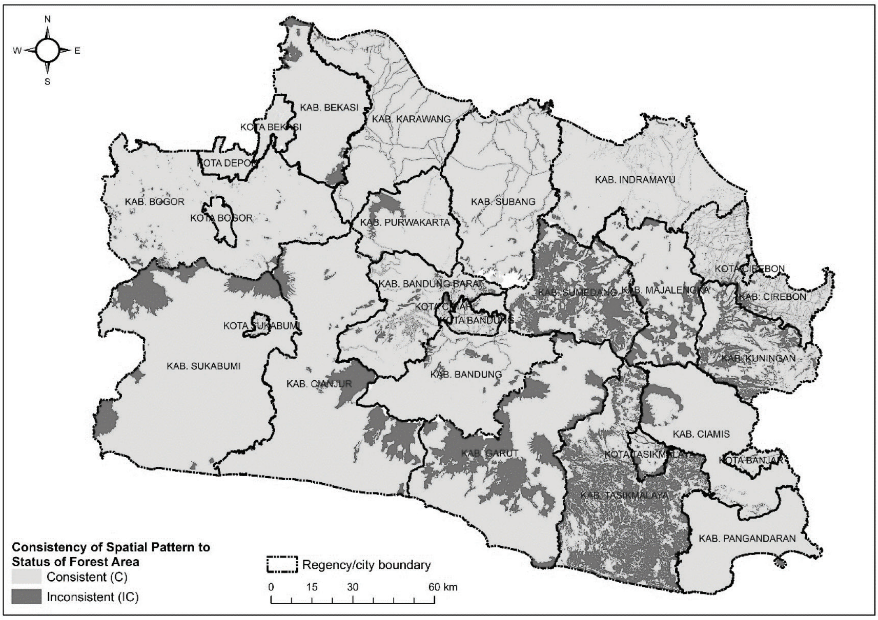
Appendix 1: Conformity of land use and spatial patterns of RTRW (existing conditions and policies)



Appendix 2: Distribution of vegetation and non-vegetation (GOS) in West Java Province (in 2019)



Appendix 3: Conformity of spatial pattern of RTRW and status of forest area in West Java Province, Indonesia



Appendix 4: Area and percentage land use conformity with spatial pattern (RTRW) for each regency/ municipality in West Java Province, Indonesia

No.	Regency/ Municipality	Area (ha)			Area (%)	
		Consistent (C)	Inconsistent (IC)	Total Area	Consistent (C)	Inconsistent (IC)
1	Bandung Regency	155,583.88	15,735.70	171,319.58	90.82	9.18
2	Bandung Barat Regency	115,788.58	13,165.85	128,954.43	89.79	10.21
3	Bekasi Regency	124,882.61	823.15	125,705.76	99.35	0.65
4	Bogor Regency	268,291.53	26,857.08	295,148.61	90.90	9.10
5	Ciamis Regency	148,540.12	11,067.74	159,607.86	93.07	6.93
6	Cianjur Regency	325,872.18	32,159.96	358,032.15	91.02	8.98
7	Cirebon Regency	94,851.72	11,250.21	106,101.93	89.40	10.60
8	Garut Regency	274,292.22	32,688.52	306,980.74	89.35	10.65
9	Indramayu Regency	196,742.86	11,326.91	208,069.77	94.56	5.44
10	Karawang Regency	168,711.13	22,226.44	190,937.57	88.36	11.64
11	Kuningan Regency	78,912.19	39,993.97	118,906.16	66.37	33.63
12	Majalengka Regency	104,397.10	26,321.94	130,719.04	79.86	20.14
13	Pangandaran Regency	110,783.01	2,053.15	112,836.16	98.18	1.82
14	Purwakarta Regency	87,369.30	10,728.88	98,098.18	89.06	10.94

15	Subang Regency	195,804.22	13,352.65	209,156.88	93.62	6.38
16	Sukabumi Regency	386,066.48	29,693.77	415,760.25	92.86	7.14
17	Sumedang Regency	88,329.22	66,920.96	155,250.18	56.89	43.11
18	Tasikmalaya Regency	127,170.13	142,003.24	269,173.37	47.24	52.76
19	Bandung Municipality	14,560.79	2,089.05	16,649.83	87.45	12.55
20	Banjar Municipality	12,126.26	854.31	12,980.57	93.42	6.58
21	Bekasi Municipality	19,751.74	0.04	19,751.79	100.00	0.00
22	Bogor Municipality	10,984.11	97.88	11,081.99	99.12	0.88
23	Cimahi Municipality	3,032.44	970.65	4,003.09	75.75	24.25
24	Cirebon Municipality	3,376.96	326.85	3,703.82	91.18	8.82
25	Depok Municipality	19,835.30	79.19	19,914.49	99.60	0.40
26	Sukabumi Municipality	4,330.51	433.11	4,763.61	90.91	9.09
27	Tasikmalaya Municipality	13,164.45	4,943.37	18,107.83	72.70	27.30
	Total	**3,153,551.05**	**518,164.58**	**3,671,715.62**		

Appendix 5: Distribution of vegetation and non-vegetation by regency/municipality in West Java Province, Indonesia

No.	Regency/ Municipality	Area (ha)			Area (%)	
		Consistent (C)	Inconsistent (IC)	Total Area	Consistent (C)	Inconsistent (IC)
1	Bandung Regency	164,452.49	6,867.09	171,319.58	95.99	4.01
2	Bandung Barat Regency	118,352.42	10,602.01	128,954.43	91.78	8.22
3	Bekasi Regency	115,303.15	10,402.61	125,705.76	91.72	8.28
4	Bogor Regency	289,161.19	5,987.42	295,148.61	97.97	2.03
5	Ciamis Regency	149,742.75	9,865.11	159,607.86	93.82	6.18
6	Cianjur Regency	312,706.49	45,325.66	358,032.15	87.34	12.66
7	Cirebon Regency	94,115.02	11,986.90	106,101.93	88.70	11.30
8	Garut Regency	215,168.08	91,812.66	306,980.74	70.09	29.91
9	Indramayu Regency	204,202.59	3,867.18	208,069.77	98.14	1.86
10	Karawang Regency	183,263.74	7,673.83	190,937.57	95.98	4.02
11	Kuningan Regency	80,968.33	37,937.82	118,906.16	68.09	31.91
12	Majalengka Regency	102,165.62	28,553.43	130,719.04	78.16	21.84
13	Pangandaran Regency	112,329.60	506.56	112,836.16	99.55	0.45
14	Purwakarta Regency	89,946.03	8,152.15	98,098.18	91.69	8.31
15	Subang Regency	200,274.24	8,882.63	209,156.88	95.75	4.25
16	Sukabumi Regency	365,600.17	50,160.08	415,760.25	87.94	12.06

17	Sumedang Regency	75,225.79	80,024.39	155,250.18	48.45	51.55
18	Tasikmalaya Regency	120,495.97	148,677.40	269,173.37	44.77	55.23
19	Bandung Municipality	14,563.76	2,086.07	16,649.83	87.47	12.53
20	Banjar Municipality	12,069.99	910.58	12,980.57	92.99	7.01
21	Bekasi Municipality	19,751.79		19,751.79	100.00	-
22	Bogor Municipality	11,081.99		11,081.99	100.00	-
23	Cimahi Municipality	3,029.19	973.90	4,003.09	75.67	24.33
24	Cirebon Municipality	3,383.97	319.85	3,703.82	91.36	8.64
25	Depok Municipality	19,907.57	6.92	19,914.49	99.97	0.03
26	Sukabumi Municipality	4,271.90	491.72	4,763.61	89.68	10.32
27	Tasikmalaya Municipality	12,995.35	5,112.48	18,107.83	71.77	28.23
	Total	**3,094,529.17**	**577,186.46**	**3,671,715.62**		

Appendix 6: Area and percentage spatial pattern (RTRW) conformity with forest area status for each regency/ municipality in West Java Province, Indonesia

No.	Regency/ Municipality	Area (ha)			Area (%)	
		Consistent (C)	Inconsistent (IC)	Total Area	Consistent (C)	Inconsistent (IC)
1	Bandung Regency	164,452.49	6,867.09	171,319.58	95.99	4.01
2	Bandung Barat Regency	118,352.42	10,602.01	128,954.43	91.78	8.22
3	Bekasi Regency	115,303.15	10,402.61	125,705.76	91.72	8.28
4	Bogor Regency	289,161.19	5,987.42	295,148.61	97.97	2.03
5	Ciamis Regency	149,742.75	9,865.11	159,607.86	93.82	6.18
6	Cianjur Regency	312,706.49	45,325.66	358,032.15	87.34	12.66
7	Cirebon Regency	94,115.02	11,986.90	106,101.93	88.70	11.30
8	Garut Regency	215,168.08	91,812.66	306,980.74	70.09	29.91
9	Indramayu Regency	204,202.59	3,867.18	208,069.77	98.14	1.86
10	Karawang Regency	183,263.74	7,673.83	190,937.57	95.98	4.02
11	Kuningan Regency	80,968.33	37,937.82	118,906.16	68.09	31.91
12	Majalengka Regency	102,165.62	28,553.43	130,719.04	78.16	21.84
13	Pangandaran Regency	112,329.60	506.56	112,836.16	99.55	0.45
14	Purwakarta Regency	89,946.03	8,152.15	98,098.18	91.69	8.31
15	Subang Regency	200,274.24	8,882.63	209,156.88	95.75	4.25
16	Sukabumi Regency	365,600.17	50,160.08	415,760.25	87.94	12.06
17	Sumedang Regency	75,225.79	80,024.39	155,250.18	48.45	51.55

18	Tasikmalaya Regency	120,495.97	148,677.40	269,173.37	44.77	55.23
19	Bandung Municipality	14,563.76	2,086.07	16,649.83	87.47	12.53
20	Banjar Municipality	12,069.99	910.58	12,980.57	92.99	7.01
21	Bekasi Municipality	19,751.79		19,751.79	100.00	-
22	Bogor Municipality	11,081.99		11,081.99	100.00	-
23	Cimahi Municipality	3,029.19	973.90	4,003.09	75.67	24.33
24	Cirebon Municipality	3,383.97	319.85	3,703.82	91.36	8.64
25	Depok Municipality	19,907.57	6.92	19,914.49	99.97	0.03
26	Sukabumi Municipality	4,271.90	491.72	4,763.61	89.68	10.32
27	Tasikmalaya Municipality	12,995.35	5,112.48	18,107.83	71.77	28.23
	Total	**3,094,529.17**	**577,186.46**	**3,671,715.62**		