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Sustainability Analysis of Settlement Area on Cikapundung Riverside, Bandung City, Indonesia

Edi Rusdiyanto*, Santun Sitorus, Bambang Pramudya**, Ramalis Sobandi****

* Study Program of Natural Resources and Environmental Management, Bogor Agricultural University, Indonesia
** Department of Soil Science and Land Resource, Bogor Agricultural University, Indonesia
** Department of Mechanical and Biosystem Enginering, Bogor Agricultural University, Indonesia
** Urban Expert Researcher, Tunas Nusa Foundation, Bandung, Indonesia

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Abstract- Existing condition of settlement area on Cikapundung riverside is dense population, mostly illegal status, low quality of infrastructure, and ecological function decrease. The aim of this study was to analyze sustainability status and sensitive attributes affecting settlement area sustainability. This study used qualitative-quantitative method and its data type was ordinal data. Data analysis method used was statistical method with Multi Dimensional Scalling (MDS) with Rapid appraisal (Rap) – riverside settlement analysis. The result of settlement area sustainability status on Cikapundung riverside was included in less sustainable category by index of 48.65**.** The result showed analysis of 42 attributes from 5 sustainable dimensions in settlement area was undergone 16 sensitive attributes were obtained consisting of ecological (4 attributes), economical (3 attributes), social (3 attributes), institutional (3 attributes), and technological dimension (3 attributes). Those 16 leverage attributes sensitively affect settlement area sustainability on Cikapundung riverside.

Index Terms- leverage attribute, dimension, settlement, sustainability

I. Introduction

The Sustainable Development Goals (SDGs) program's 11th goal related to urban and settlement problems is to build inclusive, safe, resilient, and sustainable cities and settlements. One of the targets (point 11.1) is to guarantee societies' access to settlement and feasible, safe, affordable basic service, including slum settlement area arrangement in 2030 (UNESCO 2017). This goal positions cities in sustainable development core amid rapid urbanization conducing to increasing total population. McGee (1955) predicted that more than 56 % population in Southeast Asia (ASEAN) dwells in urban area.

Urbanization has influenced total population increase of Bandung City. Total population increase average of Bandung city (2014–2019 period) annually was 7,417 people (0.3 %), while recorded low income total population in 2019 was 84,670 people (3.38 %) (Bandung City Central Bureau of Statistics 2020). This phenomenon will inflict on existing of irregular settlement clusters if it is not anticipated by avoiding low price houses for low income population (Ooi and Phua 2007). Turner and Fitcher (1972) postulated that house was a complete part of settlement, not merely physical result, but it was a progressive process. In this context, house had sustainability meaning**.**

Most of low-income population do not afford to feasible legal buy house or land. They look for low price house and land (infeasible) or even they dwell in illegal land whose it does not have insecurity of tenure, such as riverside informal settlement. Doxiadis (1968) postulated that settlements meant settlements for humans. Settlement has larger meaning than housing. Recently, Cikapundung riverside settlement area has irregular spatial use, high population density, illegal status, low qualified infrastructure and ecological function decrease (Rusdiyanto et al. 2020). This condition might inflict on settlement area sustainability decrease. Principally, sustainability could be defined as effort of need fulfillment for recent generation without decreasing capability of upcoming generation to fulfill their needs (WCED 1987).

Base on regulation, we could do condemnation by relocating illegal population to overcome Cikapundung riverside settlement area problem, while legal population might be offered to choose land consolidation program alternative (Law and Human Rights Ministry 2011). Since this condition has been existing and it relates on human right and nation responsibility to care low income ppulation, this solution should be undergone carefully by humanistic persuasive approach to avoid conflict. By considering this condition, the urgent short term solution is to increase the settlement area sustainability, by examining the actual condition of sustainabilty status and sensitive attribute which could increase the settlement area sustainability.

Based on previous researches (Wihadanto et al. 2017; Wijaya et al. 2017; Rahayu et al. 2018), it was known that the research done in Cikapundung riverside was undergone partially, from both functional aspect (either upstream or downstream) and administrative area. In conclusion, research examining settlement area sustainability by taking locations in 3 areas (upper, middle, lower area) simultaneously hadn't been undergone. This research was undergone to analyze sustainability status and important factors (sensitive attributes) affecting on Cikapundung riverside settlement area , Bandung City.

II. TIME AND LOCATION OF THE STUDY

This research had been undergone for 9 months started from March until December 2019. Generally, it had been undergone in Bandung City (Indonesia) in 3 settlement area passed by

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Cikapundung river consisting of Kampung Pelangi 200 (Dago Subdistrict), Kampung Cimaung (Tamansari Sudistrict), and Kampung Mengger Tengah (Mengger Subdistrict). Specifically, the study location could be seen in Picture 1.

Picture 1. Research Location

III. DATA COLLECTION

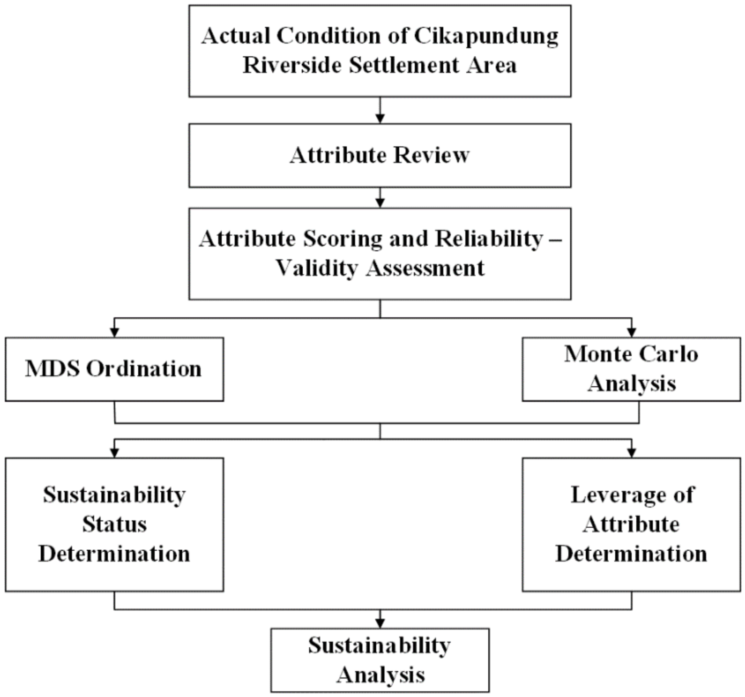
Data collection method consists of reference study, indepth interview, and expert judgment. The data is categorized as primary and secondary data. Primary data was collected from respondents including common populations, experts and other stakeholders and direct observation. Sampling determination was undergone by purposive sampling. Secondary data was obtained from previous studies result and other publications.

IV. STATISTICAL ANALYSIS

Data analysis method was processed by Multidimensional Scalling (MDS) by using software Rap-riverside settement as adjustment of RAPFISH (Rapid Appraisal for Fisheries). MDS is a statistical analysis technique that attempts to carry out multidimensional transformations into simpler dimensions (Kavanagh and Pitcher 2004). Sustainability status assessment used 5 (five) dimension approaches consisting of ecology, economy, social, institutional and technology. Dimensional attribute arrangement and assessment to attributes in each dimension were undergone based on literature study or previous study result, actual condition, valid legality, and consultation to experts.

Overall, there were 42 sustainability attributes consisting of ecology dimension (9 attributes), economy dimension (8 attributes), social dimension (10 attributes), institutional dimension (8 attributes), and technology dimension (7 attributes). Index arrangement and sustainability status of each dimension and their attributes followed concept developed by Pitcher and Preikshot (2001). Assesment score of each dimension was asserted from bad scale 0% until good scale 100%. Assessment score was underlied in existing condition analysis result and obtained secondary data. Index score >50 % could be asserted that examined dimensions had been sustainable. In another hand, <50 % of those dimensions had not been sustainable. Sustainability index category is shown in Table 1. The stages of sustainability analysis using Rap-riverside settlement are presented in Picture 2.

Picture 2. The stages of sustainability analysis using Rap-riverside settlement



Picture 2. The stages of sustainability analysis using Rap-riverside settlement
Source: Modification of Kusmana et al. (2020)

Table 1. Sustainability Index Category
Source: Pitcher dan Preikshot (2001)

Index Score	Sustainability Category
0 – 25	Worse (Unsustainable)
> 25 – 50	Bad (Less Sustainable)
> 50 – 75	Moderate (Moderate Sustainable)
> 75 – 100	Good (Sustainable)

V. RESULT AND DISCUSSION

SETTLEMENT AREA SUSTAINABILITY STATUS

The sustainability index assessment result on Cikapundung riverside settlement area is shown in Table 2.

Table 2. Settlement Area Sustainability Status

Cikapundung River	Ecology	Economy	Social	Institution	Technology	Multi dimension
Upper Part	50.59	61.19	51.78	41.94	39.78	49.06
Middle Part	56.01	63.02	53.91	39.12	48.00	52.01
Lower Part	46.94	45.54	47.06	38.15	46.77	44.89
Average	51.18	56.59	50.92	39.74	44.85	48.65

Sustainability index assessment result was 48.65 for settlement area sustainability score categorized as less sustainable. Lower part of Cikapundung riverside settlement area was placed in the lowest sustainability level by score of 44.89 (less sustainable) continued by upper part by score of 49.06 (less sustainable), while middle part had the highest sustainability level by score 52.01 (moderate sustainable). Based on sustainability dimension assessment it could be obtained that institution dimension was the lowest dimension by score of 39.74 (less sustainable) and economy dimension was the highest dimension by score of 56.59 (moderate sustainable).

Assessment result by using Rap -riverside settlement method, we got stress score (S) and determination coeficient score (R^2) as shown in Table 3.

Table 3. Rap-riverside settlement assessment result

Dimension	Index Score	Stress (S)	Coeficient (R^2)
Ecology	51.18	0.16	0.93
Economy	56.59	0.14	0.92
Social	50.92	0.16	0.93
Institution	39.74	0.13	0.94
Technology	44.85	0.15	0.93

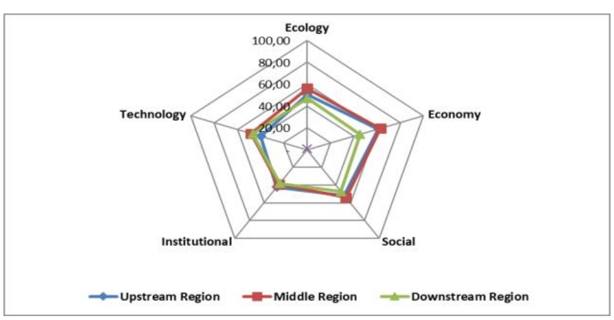
Based on the S and R^2 score, according to analysis guideline of statistical model feasibility, a good model will occur if S score < 0.25 and R^2 approaches 1 (Kavanagh and Pitcher 2004). It is concluded that the examined model in this study is good of fit observed by ecology, economy, social, institution, and technology dimension. It shows that all attributes for each dimension describe the actual Cikapundung riverside settlement area condition which means it does not need to get addition or dimension of attribute total. Monte Carlo analysis result is shown in Table 4.

Table 4. Comparison between MDS index score and Monte Carlo analysis

Dimension	Index Score (a)	Monte Carlo (b)	Deviation (a – b)
Ecology	51.18	49.16	2.02
Economy	56.59	55.88	0.71
Social	50.92	49.57	1.35
Institution	39.74	38.66	1.08
Technology	44.85	43.32	1.53

Analysis result in Table 4 shows that deviation of index score and Monte Carlo analysis score for every dimension is no more than 5 %, therefore it could be interpreted that sustainability index score of Cikapundung riverside settlement area has relatively small random error (Hardjomidjojo et al. 2016).

For getting clearer description, sustainability index score of each dimension could be visualized in kite diagram shown in Picture 3.

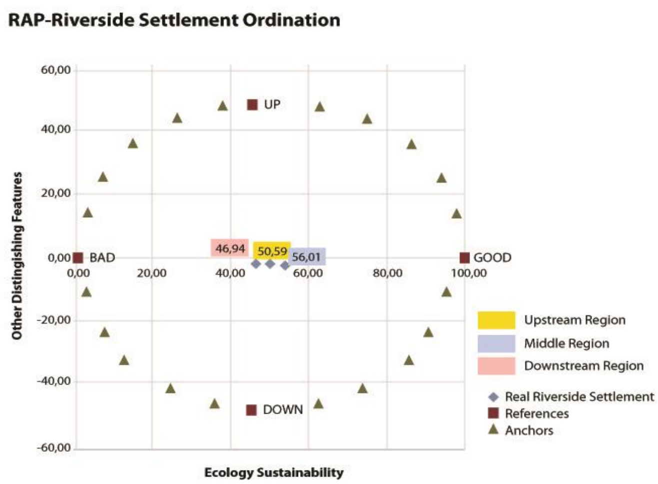


Picture 3. Settlement area sustainability kite diagram

Hereby researcher show sustainability status index and leverage of attributes consisting of 5 (five) dimensions of Cikapundung riverside settlement area sustainability.

1. Ecology Dimension Sustainability Index

Ecology dimension sustainability describes ecological functions existing condition on Cikapundung riverside settlement area described in 9 (nine) attributes. Picture 4 shows Rap-Riverside Settlement ordination nalysis result in ecology dimension resulting in sustainability index score average of 51.18 (moderate sustainable) in details of upper part, middle part, and lower part by score of 50.59, 56.01, and 46.94 respectively.



Picture 4. Ecology Dimension Ordination Chart

Based on leverage analysis result shown in Figure 1, there are 4 of 9 analyzed attributes sensitive to affect on value of ecology dimension sustainability index score consisting of (1) land convertion into built land by score of 2.11, (2) settlement arrangement by score of 2.07, (3) green open space availability by score of 1.54 and (4) waste management by score of 1.07.

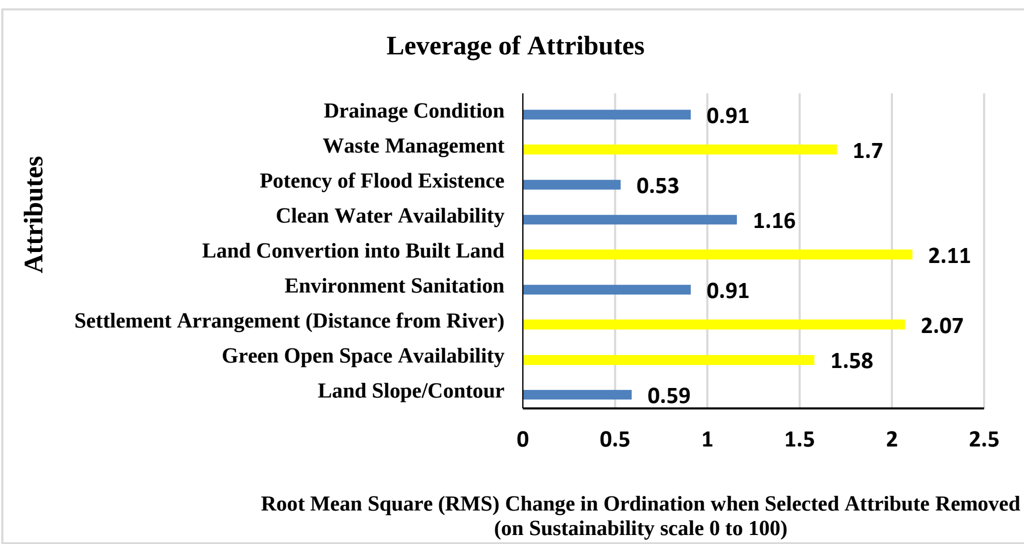
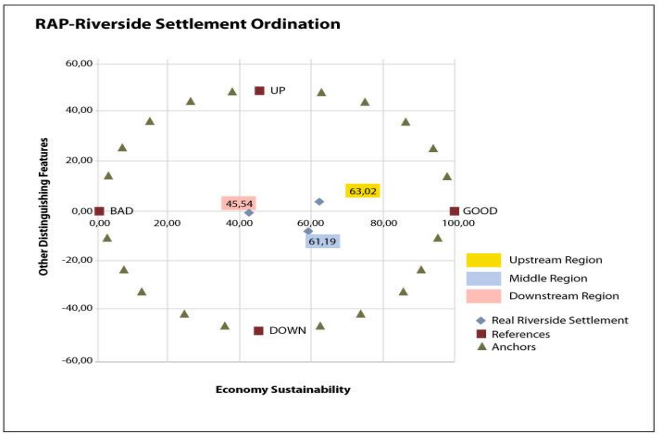


Figure 1 Ecology Dimension Leverage Attribute

2. Economy Dimension Sustainability Index

Economy dimension sustain-ability depicts area and society economical condition in Cikapundung riverside settlement area and its impact to long term sustainability described in 8 attributes. Picture 5 shows Rap-Riverside Settlement ordination analysis result in economy dimension resulting in sustainability index score average of 56.59 (moderate sustainability) in details of upper part, middle part, and lower part by score of 61.19, 63.02, and 45.54 respectively.



Picture 5. Economy Dimension Ordination Chart

Based on leverage analysis result shown in Figure 2, there are 3 of 8 analyzed attributes sensitive to affect on value of economy dimension sustainability index score consisting of (1) settlement restoration fund availability by score of 7.74, (2) population properity improvement by score of 6.73 and (3) population income by score of 6.02.

3. Social Dimension Sustainability Index

Social dimension sustainability describes social aspect in settlement area arrangement directly affecting on long term environment and resource sustainability depicted in 10 (ten) attributes. Picture 6 shows Rap-Riverside Settlement ordination analysis result in social dimension resulting in sustainability index score average of 50.92 (moderate sustainable) in details of upper part, middle part, and lower part by score of 51.78, 53.91, and 47.06 respectively.

Based on leverage analysis result shown in Figure 3, there are 3 of 10 attributes sensitive to affect on social dimension sustainability index consisting of (1) population density by score 1.78, (2) low income total population by score of 1.42 and (3) population participation in environmenment management by score of 0.80.

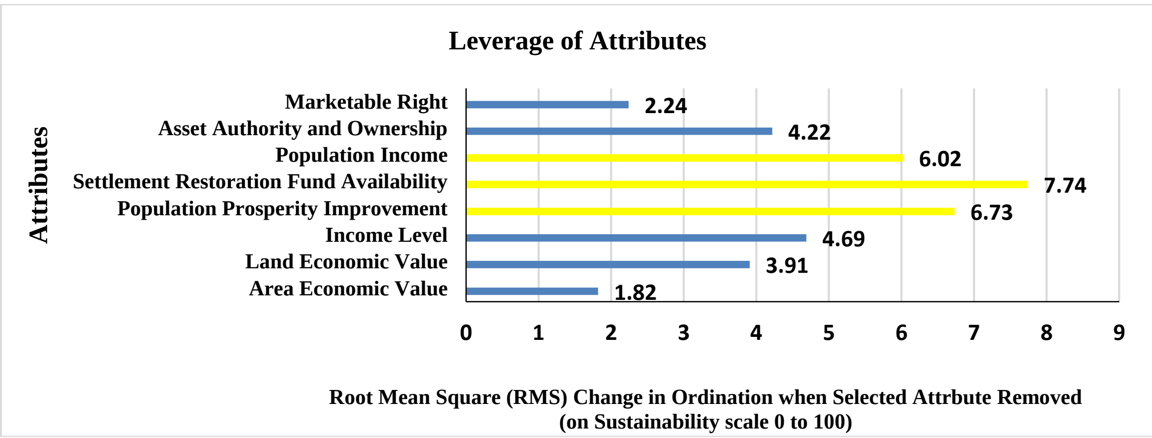
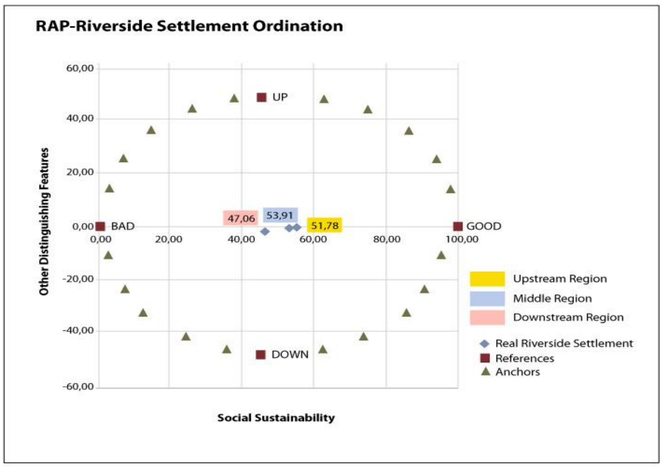


Figure 2. Economy Dimension Leverage Attribute



Picture 6. Social Dimension Ordination Chart

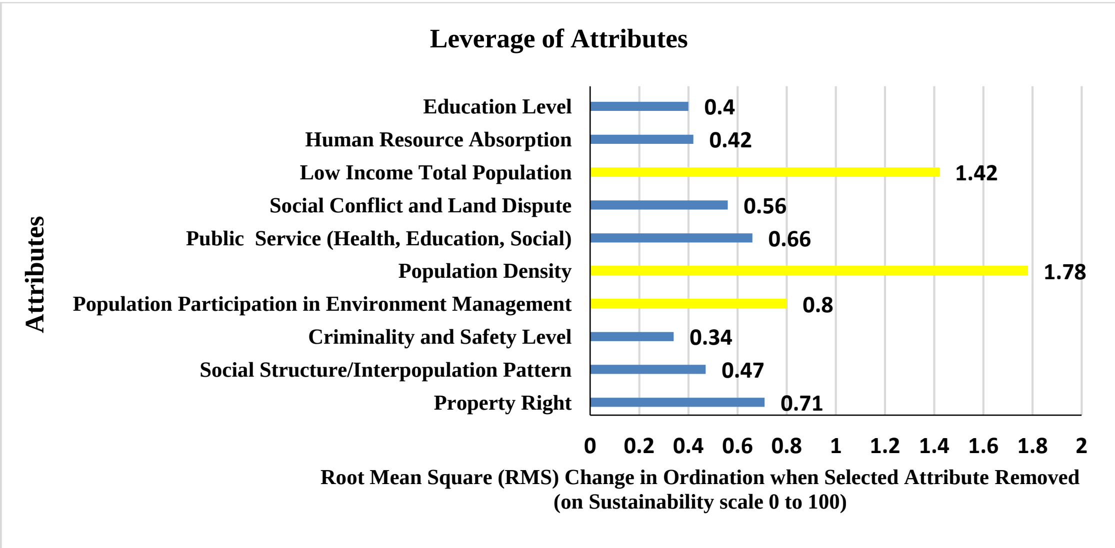
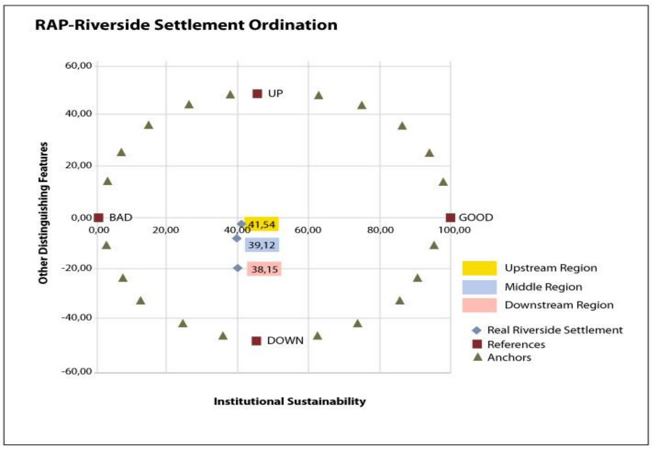


Figure 3. Social Dimension Leverage Attribute

4. Insitution Dimension Sustainability Index

Insitution dimension sustainability describes institution role in Cikapundug riverside settlement area sustainability depicted in 8 (eight) attributes. Picture 7 shoes Rap-Riverside Settlement ordination analysis result in institution dimension resulting in sustainability index score average of 39.74 (less sustainabile) in details of upper part, middle part, and lower part by score of 41.94, 39.12, and 38.15 respectively.

Based on leverage analysis result shown in Figure 4, there are 3 of 10 attributes sensitive to affect on value of instituion dimension sustainability index score consisting of (1) mechanism simplicity of development permission by score of 4.27, (2) interarea cooperation by score of 4.21 and (3) coordination in infrastructure restoration by score of 4.14.



Picture 7. Institution Dimension Ordination Chart

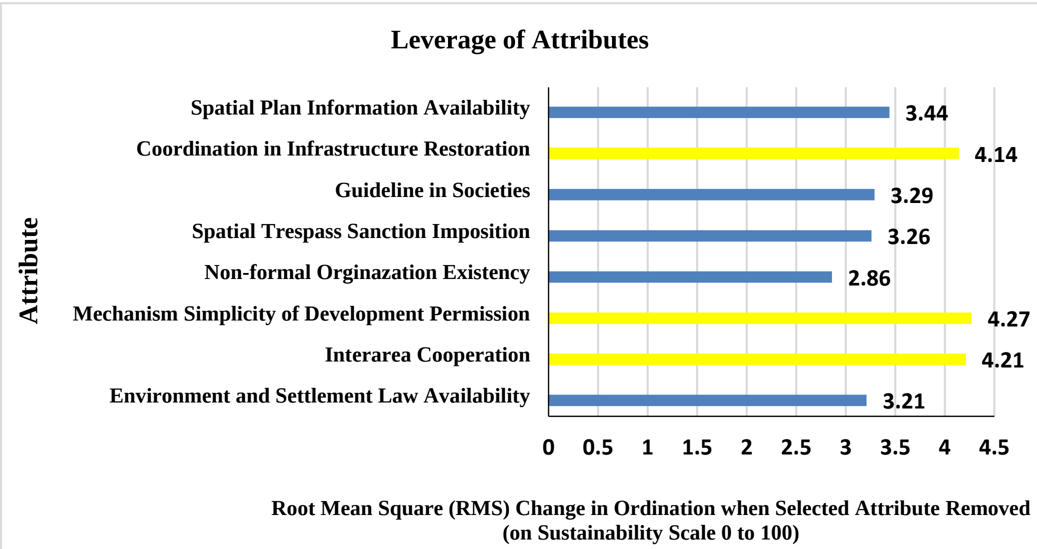
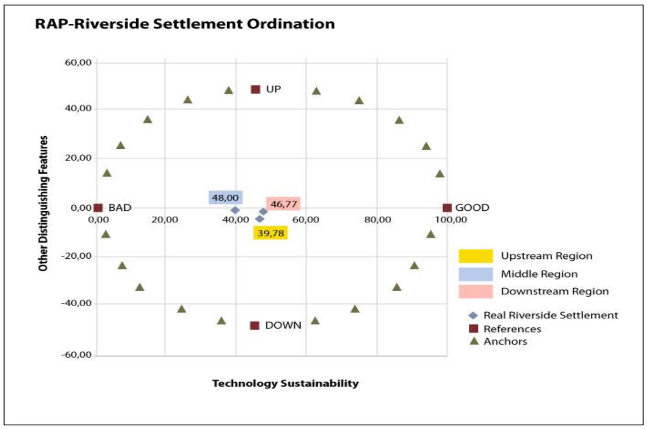


Figure 4. Institution Leverage Attribute

5. Technology Dimension Sustainability Index

Technology dimension sustainabiliy describes technological role in Cikapundung riverside settlement area sustainability depicted in 7 (seven) attributes. Figure 8 shows Rap-Riverside Settlement ordination analysis result in technology dimension resulting in sustainability index score average of 44.85 (less sustainable) in details of upper part, middle part, and lower part by score of 39.78, 48.00, and 46.77 respectively.



Picture 8. Technology Dimension Ordination Chart

Based on leverage analysis result shown in Figure 5, there are 3 of 7 attributes sensitive to affect on technology dimension sustainability index score consisting of (1) dense waste management technology availability by score of 6.59, (2) land conservation technology availability by score of 6.46 and (3) wastewater management installation availability by score of 6.11.

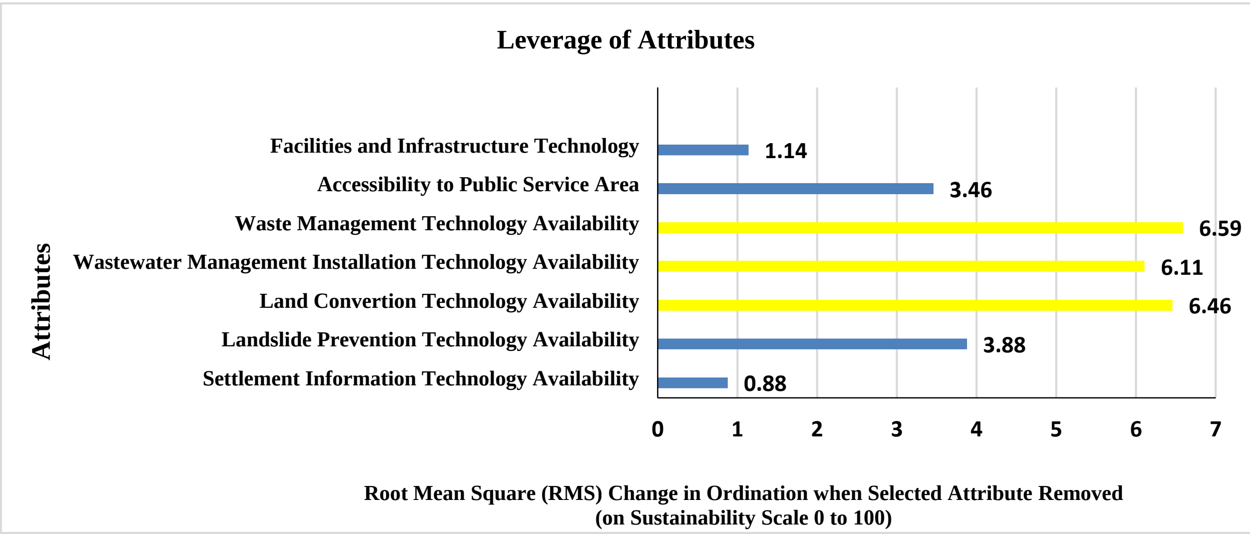


Figure 5. Technology Dimension Leverage Attribute

Furthermore, there are 16 leverage of attributes derived from analysis of 42 attributes for those 5 dimensions (ecology, economy, social, institution, and technology) shown in Table 5.

Table 5. Sustainability Settlement Leverage of Attribute

No	Dimension	Leverage of Attribute	RMS
I	Ecology	1. Land convertion into built land 2. Settlement Arrangement (distance from river) 3. Waste Management 4. Green open space availability	2.11 2.07 1.70 1.58
II	Economy	5. Settlement restoration fund availability 6. Population prosperity improvement 7. Population income	7.74 6.73 6.02
III	Social	8. Population density 9. Low income total population 10. Population participation in enviroment management	1.78 1.42 0.80
IV	Instituion	11. Mechanism simplicity of development permission 12. Interarea cooperation 13. Coordination in infrasctructure restoration of settlement area	4.27 4.21 4.14
V	Technology	14. Dense waste management technology availability 15. Land convertion techonology availability 16. Wastewater management installation technology availability	6.59 6.46 6.11

VI. Conclusion

Sustainability status of Cikapundung riverside settlement area is in less sustainable category by score of 48.65. Sustainability status ranking of each dimension is economy by the highest score of 56.59 (moderate sustainable), social by score of 50.92 (moderate sustainable), technology by score of 44.85 (less sustainable), and institution dimension by the lowest score of 39.74 (less sustainable). There are 16 of 42 attributes sensitive to affect on increasing sustainabililty index of Cikapundung riverside settlement area. Those attributes are 4 attributes in ecology dimension, 3 attributes in economy dimension, 3 attributes in social dimension, 3 attributes in institution dimension, and 3 attributes in technology dimension.

VII. Suggestions for Settlement Area Arrangement and Future Research

For increasing sustainability status of Cikapundung riverside settlement area, we suggest to prioritize attributes improvement focusing on sensitive attributes improvement. These sustainability index scores only represent condition in 2019, therefore the dynamic could not be described. Hence, attributes choosing and their dimension will be underlied on attribute progressivity in study period if there is upcoming research about sustainability status score.

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AUTHORS

First Author – Edi Rusdiyanto, Candidate Doctor, Study Program of Natural Resources and Environmental Management, Bogor Agricultural University, Indonesia, and email address: edirus.ut@gmail.com
Second Author – Santun Sitorus, Department of Soil Science and Land Resource, Bogor Agricultural University, Indonesia.
Third Author – Bambang Pramudya, Professor, Department of Mechanical and Biosystem Enginering, Bogor Agricultural University, Indonesia.
Fourth Author – Ramalis Sobandi, Doctor, Urban Expert Researcher, Tunas Nusa Foundation, Bandung, Indonesia

Correspondence Author – Edi Rusdiyanto, edirus.ut@gmail.com, contact number: +6281290410422.