BUKTI KORESPONDENSI

ARTIKEL JURNAL INTERNASIONAL BEREPUTASI

diajukan oleh :

Dr. Juhadi, M.Si.

FAKULTAS ILMU SOSIAL

UNIVERSITAS NEGERI SEMARANG

2021

SURAT KETERANGAN

KORESPONDENSI DAN PROSES REVIEW ARTIKEL PADA INDONESIAN JOURNAL OF GEOGRAHY (IJG) MELALUI INTERNATIONAL CONFERENCE ON ENVIRONMENTAL GEOGRAPHY AND GEOGRAPHY EDUCATION (ICEGE) FKIP UNIVERSITAS JEMBER

Yang bertandatangan di bawah ini :

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Dengan ini menyatakan bahwa :

a. Artikel dengan judul "**Rural–Urban Transformation and Landuse Dynamics in Gunungpati on the Northern Flank of Mt. Ungaran, Semarang, Indonesia**" (url artikel : https://jurnal.ugm.ac.id/ijg/article/view/52385) yang telah terbit pada Indonesian Journal of Geography Vol 53 No 2 (Penerbit Fakultas Geografi Universitas Gadjah Mada bekerjasama dengan Ikatan Geograf Indonesia) telah melalui proses korespondensi antara Editor IJG dengan penulis pertama sekaligus penulis korespondensi (Dr. Juhadi, M.Si).
b. Penulis pertama sekaligus penulis korespondensi (Dr. Juhadi, M.Si) telah melakukan revisi naskah sesuai permintaan editor dan reviewer pada seluruh tahapan proses review.

Demikian surat keterangan ini saya buat dengan sesungguhnya agar dapat digunakan sebagaimana mestinya.

Jember, 14 Oktober 2021

Dr. Sumardi, M.Hum
NIP. 196005181989021001

DAFTAR KEGIATAN KORESPONDENSI

ARTIKEL JURNAL INTERNASIONAL BEREPUTASI

Judul Artikel	:	Rural-Urban Transformation and Landuse Dynamics in Gunungpati on the Northern
Nama Penulis	:	Juhadi, Tjaturahono Budi Sanjoto, Elok Surya Pratiwi, Edy Trihatmoko, Istiqomah, dan Aprilia Findayani
Nama Jurnal	:	Indonesian Journal of Geography
Indeksasi Jurnal	:	Scopus Q3 dengan SJR 0,21

No.	**Kegiatan**	**Tanggal**
1.	Bukti konfirmasi *submit* artikel dan artikel yang di*submit*	10 Desember 2019
2.	Bukti konfirmasi *review* dan hasil *review* pertama	3 Desember 2020
3.	Bukti konfirmasi *submit* revisi pertama, respon kepada *reviewer*, dan artikel yang di*resubmit*	24 Desember 2020
4.	Bukti konfirmasi *review* dan hasil *review* kedua	26 Maret 2021
5.	Bukti konfirmasi *submit* revisi kedua, respon kepada *reviewer*, dan artikel yang di*resubmit*	24 April 2021
6.	Bukti konfirmasi artikel *accepted*	7 September 2021
7.	Bukti konfirmasi artikel *published* secara *online* dan artikel yang dipublikasikan secara online	28 Agustus 2021

Bukti konfirmasi *submit* artikel

dan artikel yang di*submit*

Bukti konfirmasi *submit* artikel

INDONESIAN JOURNAL OF GEOGRAPHY
ISSN 2354-9114(print) ISSN 0024-9521(online) http://jurnal.ugm.ac.id/ijg

#52385 Summary

SUMMARY REVIEW EDITING

Submission

Authors	Juhadi Juhadi, Tjaturahono Budi Sanjoto, Elok Surya Pratiwi, Edy Trihatmoko, Istiqomah Istiqomah, Aprillia Findayani
Title	Rural–Urban Transformation and Landuse Dynamics in Gunungpati on the Northern Flank of Mt. Ungaran, Semarang, Indonesia
Original file	52385-153173-1-SM.DOCX 2019-12-10
Supp. files	52385-163155-1-SP.DOCX 2020-03-06 52385-163156-1-SP.DOCX 2020-03-06
Submitter	Dr Sumardi Sumardi
Date submitted	December 10, 2019 - 07:38 AM
Section	Research Articles
Editor	Pramaditya Wicaksono
Abstract Views	1022

Artikel yang di*submit*

THE SPATIAL IMPACT AND LAND UTILIZATION DYNAMIC IN THE NORTHERN FLANK OF UNGARAN VOLCANO,SEMARANG, INDONESIA

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Abstract. Ungaran Volcano is classified as a quaternary dormant volcano that facing massive land occupation. It happens as a consequence of the diversity of its natural resources. This study aims to (1) identify the process, pattern, and structure of spatial utilization; (2) Assess the trend of spatial utilization in Gunungpati Subdistrict. Data had been acquired from the aerial photographs in 1997, IKONOS Imagery in 2000, Quick bird Imagery in 2006, SPOT-5 Imagery in 2010, and Sentinel-2A imagery in 2018. The study was conducted by a geographic information system (GIS). The result showed that (1) land cover transformation had been revealed, that were occurred in: forest area up to 1,777 ha, garden up to 551 ha, dry field up to 315 ha, built-up area up to 1,295 ha, and paddy field up to 441 ha, (2) built-up area patterns were dominated by the leapfrog pattern and developed into linear pattern, (3) the trend of land cover transformation decreases on paddy field and forest, but then increases on dry field, garden, and built-up area, (4) the rate of land transformation up to 72 % or 4,379 ha in 1997-2018, (5) land cover transformation affects the spatial structure from rural to urban character. High rate productive land conversion into an urban area that is occurring in the northern flank of Ungaran Volcano decreases the paddy field area. The study concludes that the prevention acts need to be initiated to protect the paddy field as the food source of the surrounded area.

Keywords: spatial impact, land utilization dynamic, land transformation rate, UNNES, Ungaran Volcano

1. Introduction

One of the disaster threats in Indonesia is a volcanic eruption. This is a consequence of the plate's complexity forming the volcanic range along Indonesia archipelago [1][2][3]. The existence of volcanic range in Indonesia is associated with high potential of volcanic eruption, not only for its primary impacts in form of falling pyroclastic materials but also for the secondary impacts in form of lahar flow.

The complexity of volcanic range in Indonesia is facing massive inhabitant. Indonesia is the 4th populated country following China, the United States, and India. Java Island is the most populated island in Indonesia with the density up to 1,304 per square km by the last census in 2010 [4]. As a consequence, Java Island facing the massive land occupation [5][6]. Java island is not only populated but also having the most complex volcanic range in Indonesia.

Ungaran volcano is located in Central Java, Indonesia and classified as a quaternary dormant volcano. By this condition, the surrounding area of Ungaran Volcano is dominated by the quaternary alluvium (Qa) material. This material is highly fertile [7] due to the new minerals that are produced recently by the volcanic activities are have not transformed yet by the exogenic processes. Those minerals consist of silica (Si), steel (Fe), aluminum (Al), calcium (Ca), magnesium (Mg), sodium (Na), and potassium (K). Those minerals are highly needed for the plant grow, mainly for corps. Following this fertile condition, Ungaran Volcanic area has developed mainly in the northern flank. This

condition was initiated by the North Coast Line as the densest road in Indonesia [8]. The theory stated that the development of infrastructures was considered as a vital object within a certain area stimulating the area development as well [9].

This research aims to assess the spatial impact and land utilization dynamic in the northern flank of Ungaran Volcano. The research area was focused on Gunungpati Subdistrict, as one of the most massive areas in land use change as the consequence of the existence of Universitas Negeri Semarang (UNNES) campus. The campus is considered as the vital object in the area, particularly for the national asset. The main method was conducted by utilizing the geographic information system (GIS) with multi-source imagery applying for multi-temporal analysis from 1997 to 2018.

2. Methods

Study Area

Gunungpati, a district in Semarang City, is located on the northern slope of Mount Ungaran (Figure 1). In the Spatial Plan Document of Semarang City in 2011-2031, Gunungpati belongs to the category of BWK VIII (Bagian Wilayah Kota is a part of the city, the outcome of functional landuse zoning). It is designated as an education centre covering an area of approximately 5,399 ha. The Semarang State University (UNNES) campus relocated from Gajahmungkur to Gunungpati in 1990, and it has triggered changes in land cover since. This landuse conversion is in line with the increase in population size, from 29,713 people in 1994 to 93,866 people in 2018 [10]. The relatively high and rapid population growth has raised the need for shelter and other necessary life support facilities and at the same time accelerated the process of land cover change in the area.

Gunungpati, part of the outskirts of Semarang City, was initially used for paddy fields, dry agricultural land and plantation. In the 1990s it started to change gradually and develop into an education centre. Higher Education created new activities in Gunungpati and turned this district into a trigger to the development of the surrounding areas. A formerly rural area had transformed into a suburb, followed by changing environmental conditions that influenced the lives of the surrounding communities.

Figure 1. The location of Gunungpati Subdistrict

Methodology Overview

The data used in this study were obtained from time-series imagery as a multi-source spatial data for multi-temporal analysis (Table 1). The research population is the area stretching across the northern slope of Mount Ungaran, specifically in the location of Semarang State University (UNNES) and its surroundings. In this quantitative descriptive study, the samples were based on landuse type (Table 2).

Table 1. Data Acquisition

No	Data	Data
1	Aerial Photograph	1997
2	Ikonos	2000
3	Quick Bird	2006
4	SPOT-5	2010
5	Sentinel-2A	2018

Table 2. Total of samples in each land use in Gunungpati

No	Land use type	Area (Ha)	Total of samples
1	Forest	2016	13
2	Built up area	1383	10
3	Paddy field	1065	8
4	Mix garden	548	3
5	Dry field	344	2

The research variables included the spatial patterns, spatial processes, spatial tendencies, and spatial structures of landuse. Document review (i.e., maps and high-resolution satellite images) and ground checking were employed to collect the main data. The satellite image data were validated with confusion matrices and then analysed using the geographic information system (GIS) approach in ArcGIS 10.5. The landuse in each year was interpreted by manual digitization. Because of the large scale of analysis and output, manual interpretation was preferred to reduce the possibility of generalization in automated processes. Besides, manual interpretation is deemed sufficient for a small study area.

3. Results and Discussion

Land use spatial pattern

The built-up landuse patterns of Gunungpati in 1997, 2000, 2006, 2010 and 2018 are presented in Figure 2. At first, leap-frog development was dominant, as evident from the scattered pattern of the settlements [11] [12]. As the population grew over time, the settlements developed into a linear pattern. However, a concentric pattern was formed in Sekaran, a subdistrict in Gunungpati. Therefore, the two major changes in the development were from leap-frog to linear and concentric patterns [13], as shown in Figure 2.

The leap-frog pattern was attributable to the construction of buildings in the middle of the farming area, including dry agricultural land and paddy field. Every distribution pattern of built-up land is connected to a transportation route, i.e., roads. The leap-frog pattern emerged because many people in Gunungpati lived off their farmlands that required intensive care, which made the idea of living close to them seems convenient. In 1997 the agricultural land still occupied a large area and, consequently, the distance between clusters of buildings was quite far.

Figure 2. (a) leap frog pattern and (b) concentric built-up area development

The Semarang State University (UNNES) campus and its surrounding built-up areas form a compact pattern on the northern slope of Ungaran Volcano. UNNES is a vital asset functioning as the centre of growth, education, services and trade and also a pulling factor for migrants to reside and build their business around it [9]. In an area with concentric development pattern, the road network is well-developed and has reached all built-up lands within the concentric zone. Table 3 shows the results of the landuse change in 1997-2018.

Table 3. Land use area in Gunungpati Subdistrict during 1997-2018

No	Land use	Luas (Ha)				
		1997	2000	2006	2010	2018
1	Forest	3.941	3.238	2.913	2.742	2.164
2	Mix garden	90	110	151	389	641
3	Dry field	340	735	1.019	759	655
4	Built up area	876	1.206	1.379	1.692	2.171
5	Paddy field	837	795	622	502	396
6	Jatibarangreservoir					57

Between 1997 and 2018 the size of the forest area and paddy field shrank each year. The former experienced the most substantial decrease, i.e., 1,777 ha, while the latter narrowed by 441 ha. On the contrary, the areas of dry agricultural land, plantation and built-up land expanded each year by 315 ha, 551 ha and 1,295 ha, respectively. Then, there is Jatibarang Reservoir, which was converted from 57 ha of paddy fields. The landuse conversion in Gunungpati is shown in Figure 3.

Gunungpati has five land covers, namely forest, plantation, dry agricultural land, paddy field and built-up land. From 1997 to 2018 each land cover showed a trend of change in size. This change is illustrated in Figure 4.

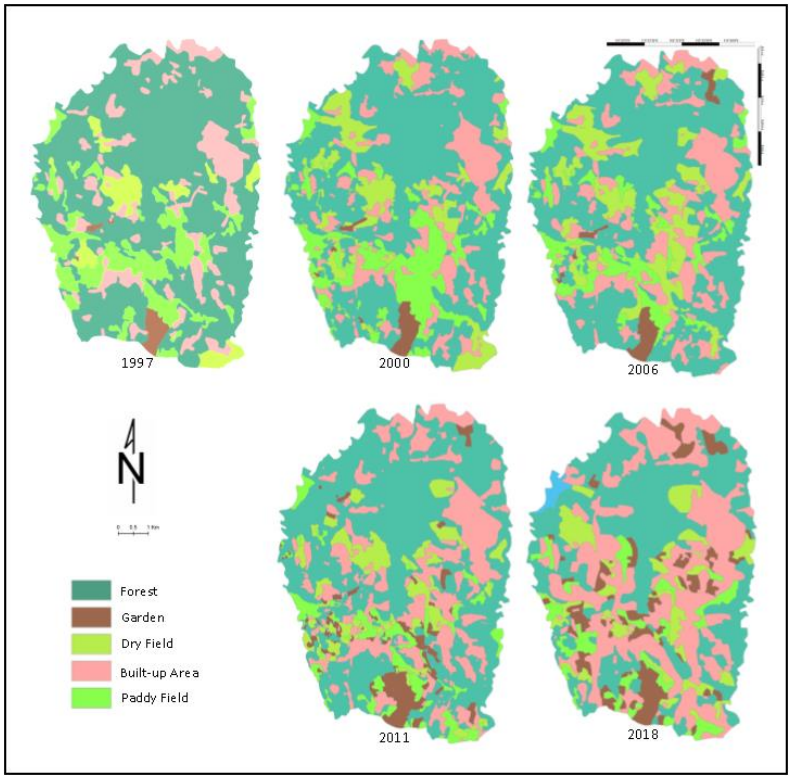

Figure 3. Land use change in Gunungpati Subdistrict during 1997-2018.

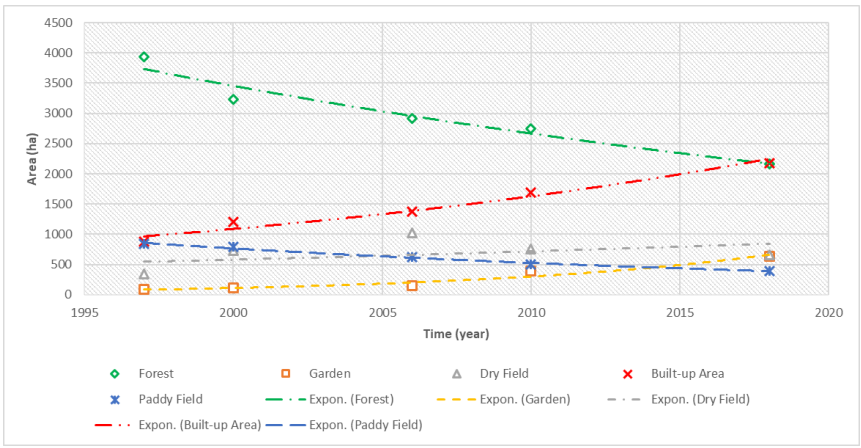

Figure 4. Land use change pattern in Gunungpati Subdistrict.

The Rate of Land Cover Change in Gunungpati District

The rate at which land cover transforms measures the extent of change occurring in each land cover in a specified time. It is expressed in percent (%) and unit of area. This rate can be calculated from the area of the land cover in question, as listed in Table 4 (further details are available in Appendix 1).

Tabel 4. Land use change condition in Gunungpati Subdistrict

No	Period	area (Ha)					Total area (Ha)
		forest	Mix garden	Dry field	Built-up area	Paddy field	
1	1997-2000	703	20	395	330	42	1.490
2	2000-2006	325	41	284	173	173	996
3	2006-2010	171	238	260	313	120	1.102
4	2010-2018	578	252	104	479	106	1.519
5	1997-2018	1.777	551	315	1.295	441	4.379

In this study, the rate of land cover change was calculated in five periods, namely 1997-2000, 2001-2006, 2007-2010, 2009-2018 and 1997-2018. For each period, the rate of change in each land cover was computed (Table 5).

Table 5. Rate of Landuse Change in Gunungpati Subdistrict

No	Period	Landuse Change		Landuse Change Annual Rate	
		%	ha	%	ha
1	1997-2000	24,49	1.490	8,16	123
2	2000-2006	16,37	996	2,73	27
3	2006-2010	18,11	1.102	4,52	50
4	2010-2018	25	1.519	3,12	47
5	1997-2018	72	4.379	3,42	150

Source: research data, 2018.

The Spatial Structure of Land Cover in Gunungpati District in 1997-2018

In 1997-2018 the spatial structure of land cover in Gunungpati District has changed. With rural features covering >75% up to <100% of the total area, rural frame zone dominated the district in 1997. However, the rural structure decreased to >25% up to<50% in 2018, making the rural-urban frame zone prevailed in this year. The data below showed the spatial structure zoning in Gunungpati District in 1997, 2000, 2006, 2010 and 2018 (Table 6).

Table 6. Spatial structure of land utilization in northern part of Ungaran Volcano during 1997-2018

No.	Village	1997	2000	2006	2010	2018
1	Jatirejo	1	1	1	1	1
2	Ngijo	1	1	1	1	1
3	Sukorejo	1	2	2	2	2
4	Sadeng	1	1	1	1	2
5	Kandri	1	1	1	1	2
6	Sekaran	2	2	2	2	2
7	Pungangan	1	1	1	1	2
8	Kalisegoro	1	1	1	1	1

9	Patemon	1	1	1	2	2
10	Nongkosawit	1	1	1	2	3
11	Cepoko	1	1	1	2	2
12	Mangunsari	1	2	2	2	2
13	Gunungpati	1	1	1	1	2
14	Pakintelan	1	1	2	2	2
15	Plalangan	1	1	1	1	1
16	Sumurejo	1	1	1	1	2

Note: "1" represents for rural frame zone, "2" represents for rural-urban frame zone, and "3" represents for urban-rural frame zone.

4. Conclusions

The period of 1997-2018 was also marked with a shift in the pattern of built-up land, from leap-frog to linear development. There were two trends of land cover change in Gunungpati, namely a downward trend in forest area and paddy field and an upward trend in dry agricultural land, plantation and built-up area. The highest rate of change in 1997-2018 was detected in plantation, which increased by 551 ha or 612.2%. Meanwhile, the lowest rate was found in the paddy field with a decrease of 441 ha or -53%. The land cover changes also affected the spatial structure on the north side of Mount Ungaran, from dominant Rural Frame Zone in 1997 to dominant Rural-Urban Frame Zone in 2018.

Acknowledgments

Authors would like to express their gratitude the Rector, Dean of Social Science Faculty, and research institutions and community service (LP2M) of Universitas Negeri Semarang to fund the research, partially and to all colleagues and lecturers that had contributed to develop this research.

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Appendix 1

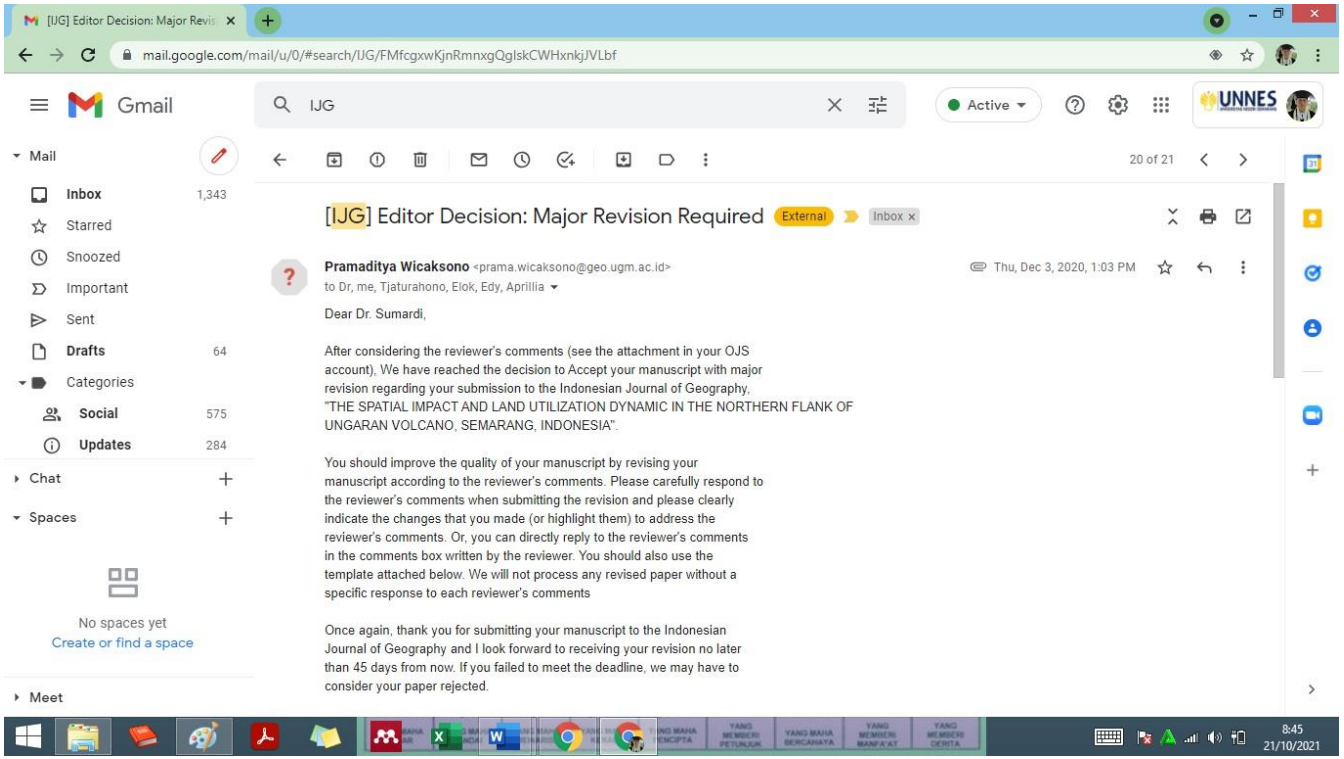
Tabel 4. The rate of land use change in Gunungpati SUbdistrict during 1997-2018

No	Land use	Area (Ha)					Rate of change									
		1997	2000	2006	2010	2018	1997-2000		2000-2006		2006-2010		2010-2018		1997-2018	
							Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
1	forest	3.941	3.238	2.913	2.742	2.164	703	-17,8	325	-10	171	-6	578	-21	1.777	-45
2	Mix garden	90	110	151	389	641	20	22,2	41	37,27	238	157,6	252	65	551	612,2
3	Dry field	340	735	1.019	759	655	395	116,17	284	39	260	-25,51	104	-14	315	93
4	Built-up area	876	1.206	1.379	1.692	2.171	330	38	173	14,34	313	23	479	28,3	1.295	148
5	Paddy field	837	795	622	502	396	42	-5,01	173	-22	120	-19,29	106	-21,11	441	-53

Bukti konfirmasi *review*

dan hasil *review* pertama

Bukti Konfirmasi *Review*



Hasil Review Pertama

Dear authors,

This study had the potential to be published but revisions are required. My main concern lies on the following points:

1. Study area did not reflect the title (Gunungpati vs northern flank of ungaran)
2. Methods were not explained properly (spatial structure explanation?)
3. Missing confusion matrix even though It was mentioned that validation was conducted in the method
4. Weak introduction and discussion. Need more depth on how the changes can affect the environmental or the living quality of the people living in Gunungpati for instance, and
5. Need to add the landuse trajectory map so that historical changes can be tracked

Abstract

1. The study was conducted by a geographic information system (GIS). → please add a specific process conducted to each data to acquire the results i.e visual interpretation
2. (4) the rate of land transformation up to 72 % or 4,379 ha in 1997-2018 → mentioned the highest change occurred in study area, otherwise it is difficult to imagine which main change took place in the study area

I**ntroduction**

Introduction is weak and need more references to back up the statement mentioned. No problem statement was mentioned so that the importance of this study remains unclear.

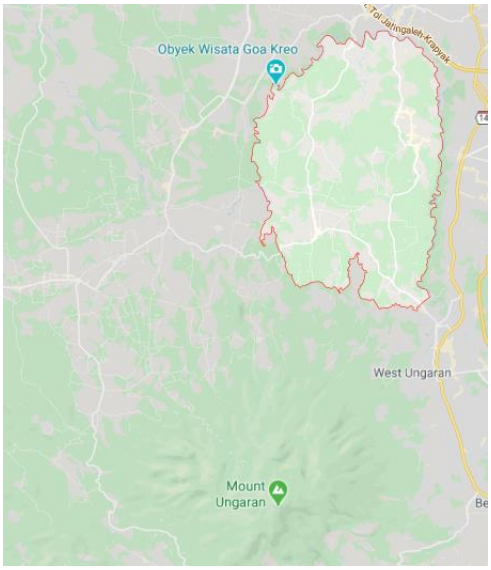
1. Java island is not only populated but also having the most complex volcanic range in Indonesia. → a bit repetitive from the first sentence, consider to remove this
2. Corps → crops
3. The campus is considered as the vital object in the area, particularly for the national asset → I don't think that this is relevant to your study unless study regarding the correlation between the land use change and the existence of the campus can be referred here.

Methods

1. Figure 1 →
    a. scale cant be read, map size is wasting spaces. Placement of the map element can be better arranged by positioning the gunungpati inset to the upper right corner
    b. it seems that there is a big gap between those two maps of Indonesia and gunung pati. Consider removing the Indonesia map and change it to central java province.

2. The Semarang State University (UNNES) campus relocated from Gajahmungkur to Gunungpati in 1990, and it has triggered changes in land cover since. → need reference here

3. The research population is the area stretching across the northern slope of Mount Ungaran, specifically in the location of Semarang State University (UNNES) and its surroundings. → it seems that you choose this study area due to the location of UNNES. If so, the title should be replaced as not all northern slope of mount ungaran were assessed but only the site that close to the UNNES i.e. Gunung Pati.



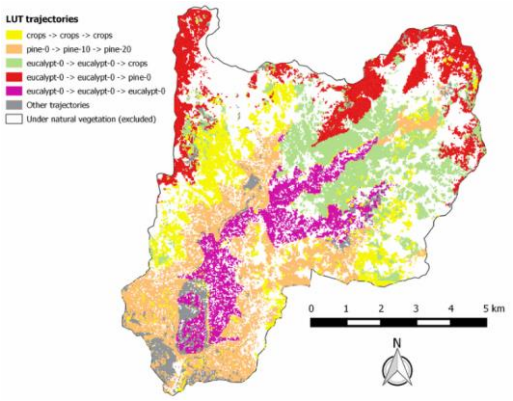
Left side of gunungpati is also a northern flank of ungaran mt. isn't it?

4. Sentinel 2a has different spatial resolution from 10 to 60 m, which bands that you use? And how do you make sense of the visual interpretation it with the other imageries with much higher spatial resolution? The point is, you did a interpretation on data with 1 – 5 m, and suddenly you used data with 10 – 60 m resolution, then the detail will be different. Did you perform a spatial resampling so that the visual interpretation was consistently conducted with no gap of information between different data?

Results and Discussion

1. Figure 2 →
    a. need to show the location of UNNES in the map. Since all of the analysis focus on the influence of UNNES, the reader should make a logical relationship between the location of unnes with the developed pattern.
    b. Where is the Scale?

2. With such data, it is imperative to have the map of land-use trajectory. This is beneficial to understand the specific land use pattern for each location.



Example of land use trajectory

3. Spatial structure → no explanation on defining the rural and urban area in the method section. Please add the section of spatial structure so that reader can understand how to define rural and urban definition here.

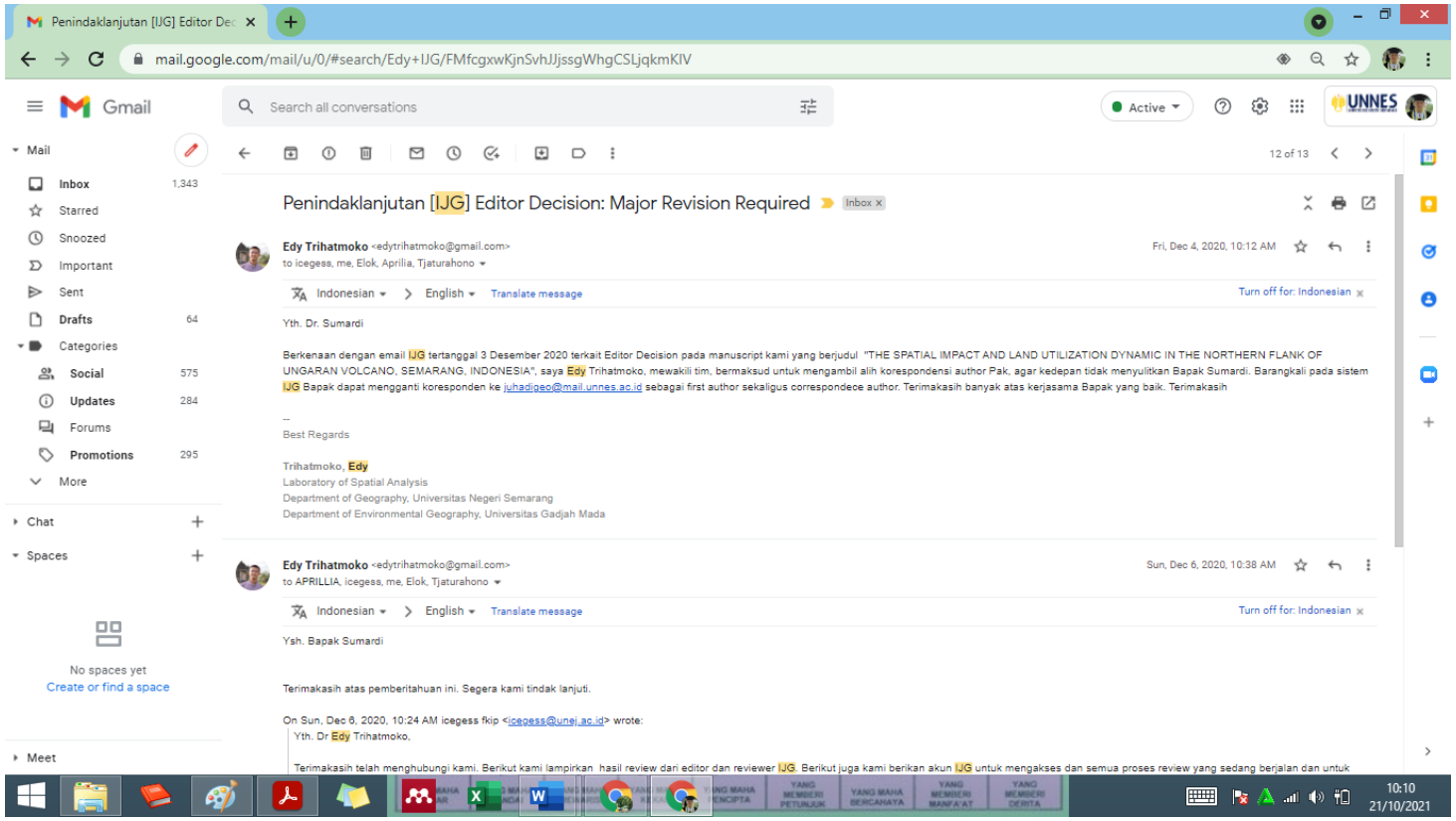
4. No accuracy assessment was conducted? Then why table 2 existed? Where is the confusion matrix?

Conclusion

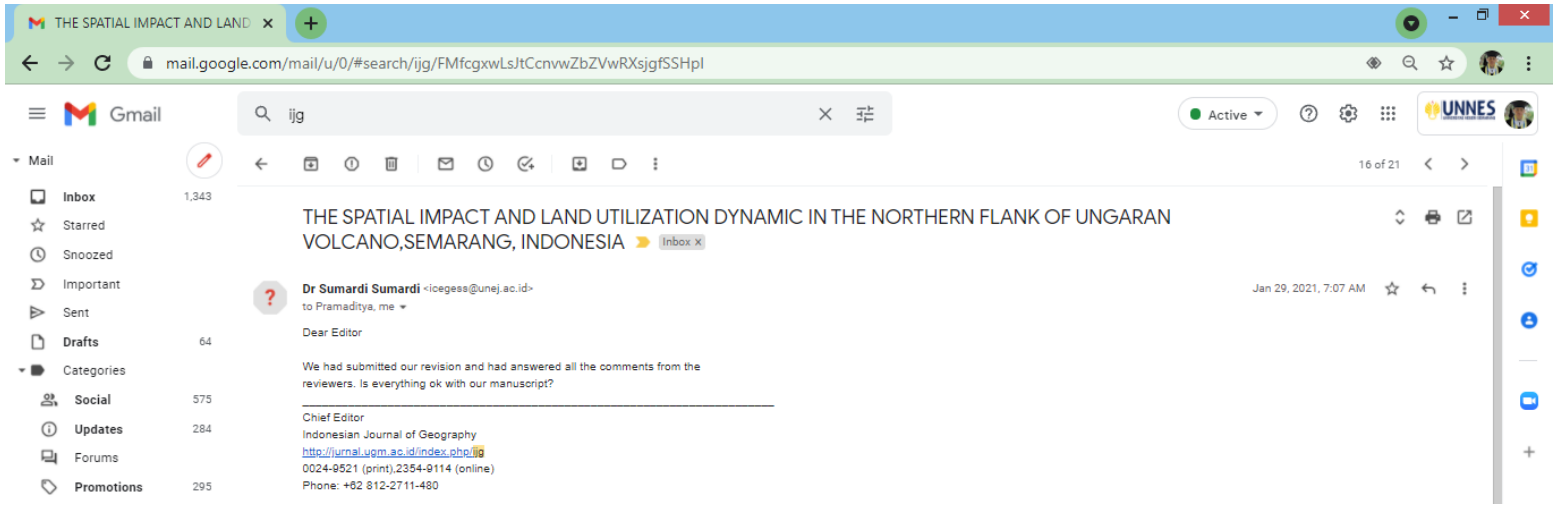
In the abstract you mentioned that there is a prevention act needed to mitigate the LULC, but no mention here in the conclusions nor discussion.

Bukti konfirmasi *submit* revisi pertama, respon kepada *reviewer*, dan artikel yang di*resubmit*

Pengalihan Korespondensi dari Dr. Sumardi (Ketua Panitia ICEGE Universitas Jember 2019) menuju Dr. Juhadi (Penulis Pertama sekaligus Penulis Korespondensi)



Bukti konfirmasi *submit* revisi pertama



Respon Kepada *Reviewer*

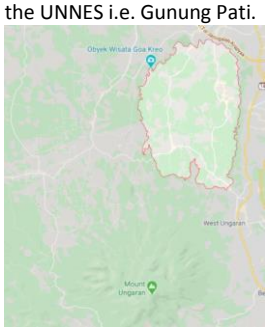
INDONESIAN JOURNAL OF GEOGRAPHY

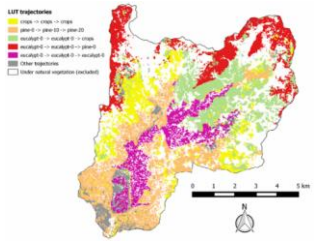
RESPOND TO REVIEWER'S COMMENTS

Paper ID : 52385

Paper Title : THE SPATIAL IMPACT AND LAND UTILIZATION DYNAMIC IN THE NORTHERN FLANK OF UNGARAN VOLCANO,SEMARANG, INDONESIA

No.	Page	Reviewer's comments	Author's responses
1	1	Study area did not reflect the title (Gunungpati vs northern flank of ungaran)	Thank you for the advice, we change the tittle as written in the revised manuscript and will be highlighted.
2	4	Methods were not explained properly (spatial structure explanation?)	Thank you for the comment, we have put the additional information about the relationship of the method we had used with the acquisition of the spatial structure in the research location. To make it easier to be reviewed, we also made a highlight in the sentence we have made.
3	4	Missing confusion matrix even though It was mentioned that validation was conducted in the method	Thank you for asking this problem. We decide to remove the confusion metric analysis.
4	1	Weak introduction and discussion. Need more depth on how the changes can affect the environmental or the living quality of the people living in Gunungpati for instance,	Thank you for this constructive advice, we have added some locational analysis to improve the introduction and discussion.
5	7	Need to add the landuse trajectory map so that historical changes can be tracked	It is such a great idea. We have put the trajectory map so the readers can easily understand the landuse change.
6	1	The study was conducted by a geographic information system (GIS). → please add a specific process conducted to each data to acquire the results i.e visual interpretation	Thank you for reminding us to specify our methodology. We have detailed the GIS methodology and highlight it with yellow color. We mentioned in the abstract and methodology.
7	1	the rate of land transformation up to 72 % or 4,379 ha in 1997-2018 □ mentioned the highest change occurred in study area, otherwise it is difficult to imagine which main change took place in the study area	Thank you for the kind advice. We have put the information of the main precise landuse that change massively (in line number 139 and 140).
8	2	Java island is not only populated but also having the most complex volcanic range in Indonesia. □ a bit repetitive from the first sentence, consider to remove this	Thank you for giving us this consideration. We have deleted this sentence.
9		Corps → crops	Thank you for reminding us. We have retyped all the word of "crop".
10	2	The campus is considered as the vital object in the area, particularly for the	Thank you for giving us your idea, we decided to follow your

		national asset → I don't think that this is relevant to your study unless study regarding the correlation between the land use change and the existence of the campus can be referred here.	recommendation and deleted that sentence and change to other proper explanation.
11	2	1. Figure 1 → a. scale can't be read; map size is wasting spaces. Placement of the map element can be better arranged by positioning the gunungpati inset to the upper right corner b. it seems that there is a big gap between those two maps of Indonesia and gunung pati. Consider removing the Indonesia map and change it to central java province.	Thank you for your detail review, we have changed the Figure 1 visualization.
12	4	The Semarang State University (UNNES) campus relocated from Gajahmungkur to Gunungpati in 1990, and it has triggered changes in land cover since. → need reference here	Thank you for the comment. So far, the history of the UNNES relocation has not published yet, so we decided to re-write our explanation.
13	1	The research population is the area stretching across the northern slope of Mount Ungaran, specifically in the location of Semarang State University (UNNES) and its surroundings. it seems that you choose this study area due to the location of UNNES. If so, the title should be replaced as not all northern slope of mount ungaran were assessed but only the site that close to the UNNES i.e. Gunung Pati.  Left side of gunungpati is also a northern flank of ungaran mt. isn't it?	We do appreciate the reviewer's constructive comment, we have changed our title following the reviewer's comment.
14	4	Sentinel 2a has different spatial resolution from 10 to 60 m, which bands that you use? And how do you make sense of the visual interpretation it with the other imageries with much higher spatial resolution? The point is, you did a interpretation on data with 1	Thank you for the detail review. We have added an explanation (line 82-83) for the different high resolution satellite imagery that we used for the research. We produce medium-scale map that it means we are doing downscaling generalization; it will be

		– 5 m, and suddenly you used data with 10 – 60 m resolution, then the detail will be different. Did you perform a spatial resampling so that the visual interpretation was consistently conducted with no gap of information between different data?	misinterpreted if we produce the detail scale for the output map from different low resolution satellite imagery or upscaling process.
15	3	Figure 2 → a. needs to show the location of UNNES in the map. Since all of the analysis focus on the influence of UNNES, the reader should make a logical relationship between the location of unnes with the developed pattern. b. Where is the Scale?	a. We have put the symbol contains of UNNES Campus in Figure 1. b. Thank you for asking, we have put the scale bar under the north arrow.
16	7	With such data, it is imperative to have the map of land-use trajectory. This is beneficial to understand the specific land use pattern for each location.  Example of land use trajectory	Thank you for the review, we have followed this instruction as well.
17	3	Spatial structure → no explanation on defining the rural and urban area in the method section. Please add the section of spatial structure so that reader can understand how to define rural and urban definition here.	Thank you for giving the comment, we have added some ideas relate to the spatial structure terminology in the line 63 and 64.
18		No accuracy assessment was conducted? Then why table 2 existed? Where is the confusion matrix?	Thank you for the question. To make our manuscript easier to be read, we decide to delete the confusion matrix.
19		In the abstract you mentioned that there is a prevention act needed to mitigate the LULC, but no mention here in the conclusions nor discussion.	Thank you for this comment. We have changed the conclusion explanation.

Important!

Please also indicate your changes in the revised manuscript using track changes or highlighted text.

Artikel yang di*Resubmit*

Rural-Urban Transformation due to Land Utilization Dynamics in Gunungpati - The Northern Flank of Mt. Ungaran, Semarang, Indonesia

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Abstract *Most of the area on the northern flank of Mt. Ungaran is facing a massive land occupation which makes landuse change inevitable. These research objectives were to examine the spatial patterns of land utilization dynamics from 1997 to 2018 and analyzing the impact on the rural-urban structure at Gunungpati Sub-District by conducting on-screen digitation. Rural-urban structure was analyzed based on the landuse area composition in each village. This research revealed that forest area and paddy fields were decreasing year by year. For over 21 years, Gunungpati experienced deforestation up to 1,777 ha and the increasing build up area was up to 1,295 ha forcing the rural structure shifting. Most villages were categorized as rural frame zones in 1997 changed significantly into urban-rural frame zones in 2018. This situation has to be controlled since most of Gunungpati territory takes a big role as a recharge zone for the Semarang lowland area.*

Key words: spatial impact, land utilization, land transformation rate, Mt. Ungaran

Abstrak *Sebagian besar wilayah di sisi utara Gunungapi Ungaran menghadapi pendudukan lahan besar-besaran yang membuat perubahan tata guna lahan tak terhindarkan. Tujuan penelitian ini adalah untuk mengkaji dinamika pola ruang pemanfaatan lahan dari tahun 1997 hingga 2018 dan menganalisis pengaruhnya terhadap struktur desa-kota di Kecamatan Gunungpati dengan menggunakan digitasi on-screen. Struktur desa-kota dianalisis berdasarkan komposisi luas penggunaan lahan di masing-masing desa. Hasil penelitian menunjukkan bahwa luas hutan dan persawahan semakin berkurang dari tahun ke tahun. Selama lebih dari 21 tahun, Gunungpati mengalami deforestasi hingga 1.777 ha dan peningkatan luas lahan terbangun hingga 1.295 ha yang memaksa struktur pedesaan bergeser. Sebagian besar desa yang dikategorikan sebagai zona bingkai desa pada tahun 1997 berubah secara signifikan menjadi zona bingkai kota-desa pada tahun 2018. Keadaan ini harus dikendalikan karena sebagian besar wilayah Gunungpati berperan besar sebagai zona resapan air untuk wilayah dataran rendah Semarang.*

Kata kunci *: dampak keruangan, pemanfanfaatan lahan, tingkat perubahan lahan, Gunungapi Ungaran*

1. Introduction

The northern flank of Mt. Ungaran now is facing a massive inhabitant due to the lack of land availability in the Semarang lowland area. Prior to the 1990s, the northern slope of Mt. Ungaran was dominated by rural structure due to the fact that it had a dense vegetation cover and limited built-up areas. However, it began to change after the construction of one of the state universities in Semarang located at the Gunungpati Sub-District in 1992. It was surely followed by other development activities, such as the construction of roads, building, and other public infrastructure. Thousands of students coming from other towns will have impacts on the change of local inhabitants' livelihood, from farmers to boarding house businessmen. As a consequence, a great deal of agricultural land has been converted into boarding houses and shopping areas. Moreover, the easier access to UNNES is likely to lead to land clearing for residential areas on hills. The changing rural structure due to land conversion should be taken into account, considering its function as the recharge area which is required to conserve. This massive development must be monitored since the development will harms the downtown area in Semarang City. There will several consequences appear when the area of Gunungpati Sub-District is not well managed. Since it is classified as the restricted preserved area based on the regional spatial plan law. The restricted preserved area implies to protect the natural habitat, groundwater availability, micro climate balance, and overland flow stability.

Geographically, Gunungpati Sub-District is located at Most of the areas lie about 200 meters above sea level and cover an area of 60.84 square kilometers. The landuse mapping conducted by the National Geospatial Agency in 1997 showed that 65% of these areas were forest and 14% were built-up areas. 28,361 inhabitants lived in this area in 2015 with the population growth rate of 1,665 per year (BPS, 2015). is part of Semarang upland and situated at the foot slope of Mt. Ungaran with hilly morphology.

Figure 1. Position of Gunungpati Sub-District with UNNES Campus within that lies in the northern flank of Mt. Ungaran

The development of built-up areas on the slope of the volcano can be detrimental to the hydrological balance in the upstream area which may result in flood and drought [1][2][3][4]. The analysis of the change pattern of landuse in the terminology of spatial structure is needed as the protection and mitigation of environmental damage causing disasters in the future [5][6]. The study of landuse changes can easily be identified using remote sensing image technology [7]. Study of landuse changes and their effects on the environment in the whole area of Semarang city were previously conducted by [8]. However, they worked on the medium scale because of the use of Landsat ETM medium-resolution satellite images as their data source. While, a detailed investigation of landuse changes in Semarang were still limited to the near shore area [9][10]. This research attempted to analyze the changes of landuse in the Semarang hilly area located in Gunungpati Sub-District as well as their implications on the regional structure shifting using the combination of high-resolution satellite images over 21 years.

2. Research Methods

The analysis of the change pattern of landuse was conducted from 1997 to 2018. We used the combination of aerial photographs and various medium to high resolution satellite images for landuse interpretation (table 1). The identification of the kinds of landuse was conducted using digital on-screen technique based on eight image interpretation elements, i.e., colour, shape, size, texture, pattern, shadow, site, and association to define the spatial structure of the research location in each year. The map output of landuse in this research is on a medium scale of 1:25.000 due to the availability of various data sources. The medium scale of the output map was chosen to accommodate detail information from the different high resolution of the satellite imagery. There are five kinds of landuse identified in the study area, i.e., forest, built-up land, paddy field, mixed garden, and dry land. The analysis of landuse change which was the focus of this research encompassed the changes of area, spatial pattern, and pattern every year.

Table 1. Data Acquisition

No	Source	Year	Resolution (m)
1	Aerial Photograph	1997	3
2	Ikonos	2000	4
3	Quick Bird	2006	2.4
4	SPOT-5	2010	5
5	Sentinel-2A	2018	10

Rural-urban structure shifting was analysed using landuse triangle continuum theory developed in Indonesia [11]. The theory classifies regional structure into four zones based on the percentage of urban and rural land in particular areas (table 2). Urban land is all built-up landused for non-agricultural functions, such as residential areas, shopping areas, government buildings, and public facilities, while rural land is used for agricultural purposes, i.e., paddy field, garden, dry land, and forest. The assessment of regional structure was conducted in every urban village in Gunungpati Sub-District.Eventually, the analysis was conducted in each village with Gunungpati Sub-District.

Table 2. Classification of rural and urban structure in the developing country [11]

No	Zone	Urban land	Rural land
1	Urban Structure	>75 % to < 100 %	<25 % to >0 %
2	Rural-Urban Structure	>50 % to <75 %	>25 % to < 50 %

3	Urban-Rural Structure	< 50 % to > 25 %>	>50 % to <75 %
4	Rural Structure	<25 % to >0 %	>75 % to < 100 %

3. Result and Discussion

3.1. Landuse change spatial pattern

The interpretation of landuse in Gunungpati Sub-District from 1997 to 2018 is depicted by the figure 2. A negative trend was experienced by forest and paddy fields, the areas of which tended to decrease annually, while built-up land, mixed garden, and dry land saw a positive trend, increasing every year (figure 3). In 1997, 65% of areas in Gunungpati were forest; only 14% of them were built-up areas. Nevertheless, the area of forest kept decreasing to only 36% in 2018, almost as large as the built-up areas. Built-up areas drastically rose from 876 Ha in 1997 to 2,171 Ha in 2018 or increased by 148%. The trend of agricultural activities in Gunungpati also changed from paddy fields to mixed gardens and dry land. The area of mixed garden even soared by 612% over 21 years.

The change in landuse area also had impacts on the change in the spatial pattern, especially in the built-up areas. Based on the interpretation of large-scale satellite images, the settlement pattern gradually changed from leap frog in 1997 into the concentric settlement (figure 4). The leap frog settlement showed a scattered one with a small group in the middle of a garden or forest. In the past, the leap frog settlement dominated owing to most of Gunungpati areas being forest and paddy. Subsequently, small group settlements grew larger and formed the concentric settlement. The concentric settlement in Gunungpati tended to grow in flat topography, on lowland and upland, and around Unnes in Sekaran Village.

The main cause of landuse change is the annual population growth. Human need for space resulted in deforestation to build residential areas. The improvement and opening of new roads and the relocation of the state university in 1990 also contributed to the development of built-up areas. Furthermore, the lowland of Semarang experienced urban problems, such as rob, flood, traffic congestion, noise, and air pollution. In other places, landuse changes due to the built-up growth has also been reported to increase surface water that is responsible for creating flood [12].

The availability of several plots of land with affordable prices caused people to choose to live on the upland, despite its far distance from the city center. Beside land conversion into residential areas, the risk factor of crop failure and its little profit might cause the decrease of paddy fields in Gunungpati. People cultivated their land as mixed garden and/or dry land as they did not rely on water as the main cause of crop failure and did not need to be intensively cultivated like a paddy field.

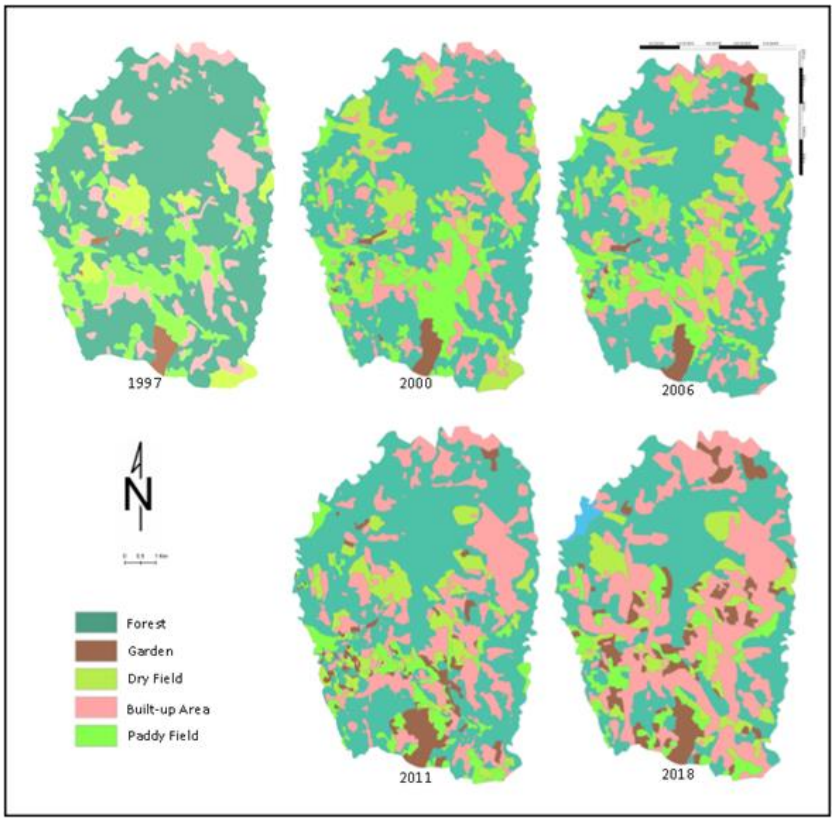

Figure 2. Landuse change in Gunungpati Sub-District during 1997-2018.

Figure 3. Landuse change trajectory in Gunungpati Sub-District during 1997, 2006 and 2018.

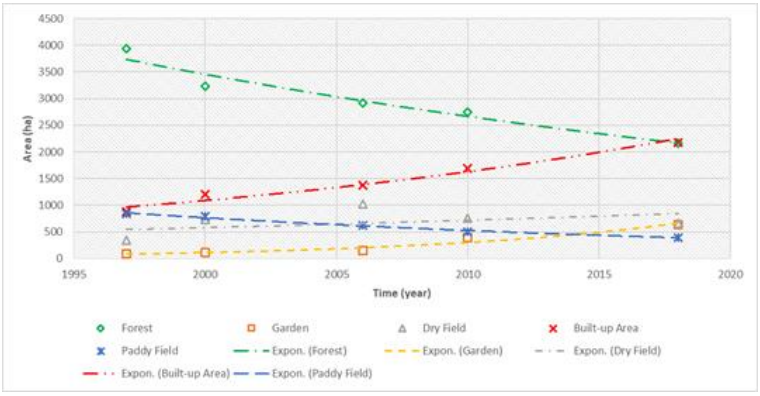

Figure 4. Landuse change pattern in Gunungpati Sub-District.

Figure 5. leap frog pattern dominated in the 1997 settlement area, then it developed into concentric in 2018.

3.2. The Rate of Landuse Change in Gunungpati Sub-District

The change rate of landuse in Gunungpati from 1997 to 2018 was 3.42% per year (table 3) resulting deforestation mainly for built-up area. In other words, the change of landuse was annually experienced by areas of 150 Ha. The decrease rate of forest reached 85 Ha/year, and conversely, the increase rate of built-up areas was 62 Ha/year. In terms of agriculture, the rise of garden areas reached 26 Ha/year, while the decrease of paddy field areas was 21 Ha/year. Dry land saw the lowest rate of landuse change of 15 Ha/year.

Table 3. The rate of Landuse Change in Gunungpati Sub-District

No	Period	Landuse Change		Landuse Change Annual Rate	
		%	ha	%	ha
1	1997-2000	24,49	1.490	8,16	123
2	2000-2006	16,37	996	2,73	27
3	2006-2010	18,11	1.102	4,52	50
4	2010-2018	25	1.519	3,12	47

5	1997-2018	72	4.379	3,42	150

Forest and built-up areas experienced the most dynamic landuse in Gunungpati Sub-District (table 4). Based on the trend and change rate, forest is likely to decrease in the future, and if forest conservation law is not enforced, Gunungpati is predicted to have no forest in 2048. Forests will be converted into built-up areas or mixed gardens. With the advancement of technology in the field of construction, the built-up area intervention is clearly seen from the large number of residential areas constructed at steep slopes. Beside built-up areas, land conversion also came from plantation which was deemed to have higher economic value.

Tabel 4. Total area of change in each type of landuse at Gunungpati Sub-District

Period	area (Ha)					Total area (Ha)
	forest	Mix garden	Dry field	Built-up area	Paddy field	
1997-2000	703	20	395	330	42	1.490
2000-2006	325	41	284	173	173	996
2006-2010	171	238	260	313	120	1.102
2010-2018	578	252	104	479	106	1.519
1997-2018	1.777	551	315	1.295	441	4.379

3.3. *The Rural-Urban Structure Shifting in Gunungpati Sub-District*

The change in landuse led to regional structure shifting in Gunungpati. The analysis result in 16 villages showed a regional structural change from rural frame zone into rural-urban frame zone (Table 5). Villages having rural-urban frame zone characteristics kept rising annually. A significant increase occurred in 2010 when 44% of the villages in Gunungpati had rural-urban frame zone characteristics due to the increase of built-up areas. It reached a peak at 67% eight years later. A village even shifted to an urban-rural frame zone. Villages with urban-rural zone structures generally had main roads and/or were located near the construction site of Unnes.

Table 5. Spatial structure of land utilization in the northern part of Mt. Ungaran during 1997-2018

Village	1997	2000	2006	2010	2018
Jatirejo	1	1	1	1	1
Ngijo	1	1	1	1	1
Sukorejo	1	2	2	2	2
Sadeng	1	1	1	1	2
Kandri	1	1	1	1	2
Sekaran	2	2	2	2	2
Pungangan	1	1	1	1	2
Kalisegoro	1	1	1	1	1
Patemon	1	1	1	2	2
Nongkosawit	1	1	1	2	3
Cepoko	1	1	1	2	2
Mangunsari	1	2	2	2	2
Gunungpati	1	1	1	1	2
Pakintelan	1	1	2	2	2
Plalangan	1	1	1	1	1
Sumurejo	1	1	1	1	2

Note: 1, 2, 3 and 4 represent rural frame zone, urban-rural frame zone, rural-urban frame zone, and urban frame zone respectively.

Regional structure shifting from rural frame zone to rural-urban zone will surely have negative impacts on the recharge areas. The increasing number of built-up areas will decrease the amount of water absorbed by the soil which will fill the aquifer system [13]. Consequently, water shortage is likely to take place in the dry season. More areas in Semarang have been reported to experience drought since 2012 and it has directly been proportional to the massive change of regional structure in Gunungpati Sub-District. In addition, the decrease of forest areas also contributed to the higher intensity of flood on the lowland. Garang River in Semarang naturally has enormous potential for flood owing to the proximity of the upstream and downstream areas. The rise of overland flow due to the deforestation in the study area will certainly increase the level of flood

danger in Semarang. Due to the more complicated hydrological problem, the governments started to construct a reservoir on the western part of Gunungpati in 2009 to control flood in the rainy season and store water in the dry season.

4. Conclusion

The change of landuse in Gunungpati had impacts on regional structure shifting and its geophysical environmental balance. The increase of non-agricultural land in 1997-2018 led to the change from rural structure into peri-urban structure. Even based on the finding of the change rate trend, landuse can be an urban framework in the future. The urban structure in areas which ecologically function as the recharge areas will be detrimental as the land surfaces covered by concrete and asphalt will reduce the quantity of groundwater. The hydrological balance in the upstream area will negatively be affected and the consequences will be various hydrometeorological disasters. Laws and regulations on spatial planning should be enforced to protect the forest and agricultural land from the development intervention. Disaster mitigation-based city governance is also required to reduce the loss risk and realize sustainable development in the future.

Acknowledgement

Authors would like to express their gratitude to the Rector, Dean of Social Science Faculty, and research institutions and community service (LP2M) of Universitas Negeri Semarang to fund the research, partially and to all colleagues and lecturers that had contributed to develop this research.

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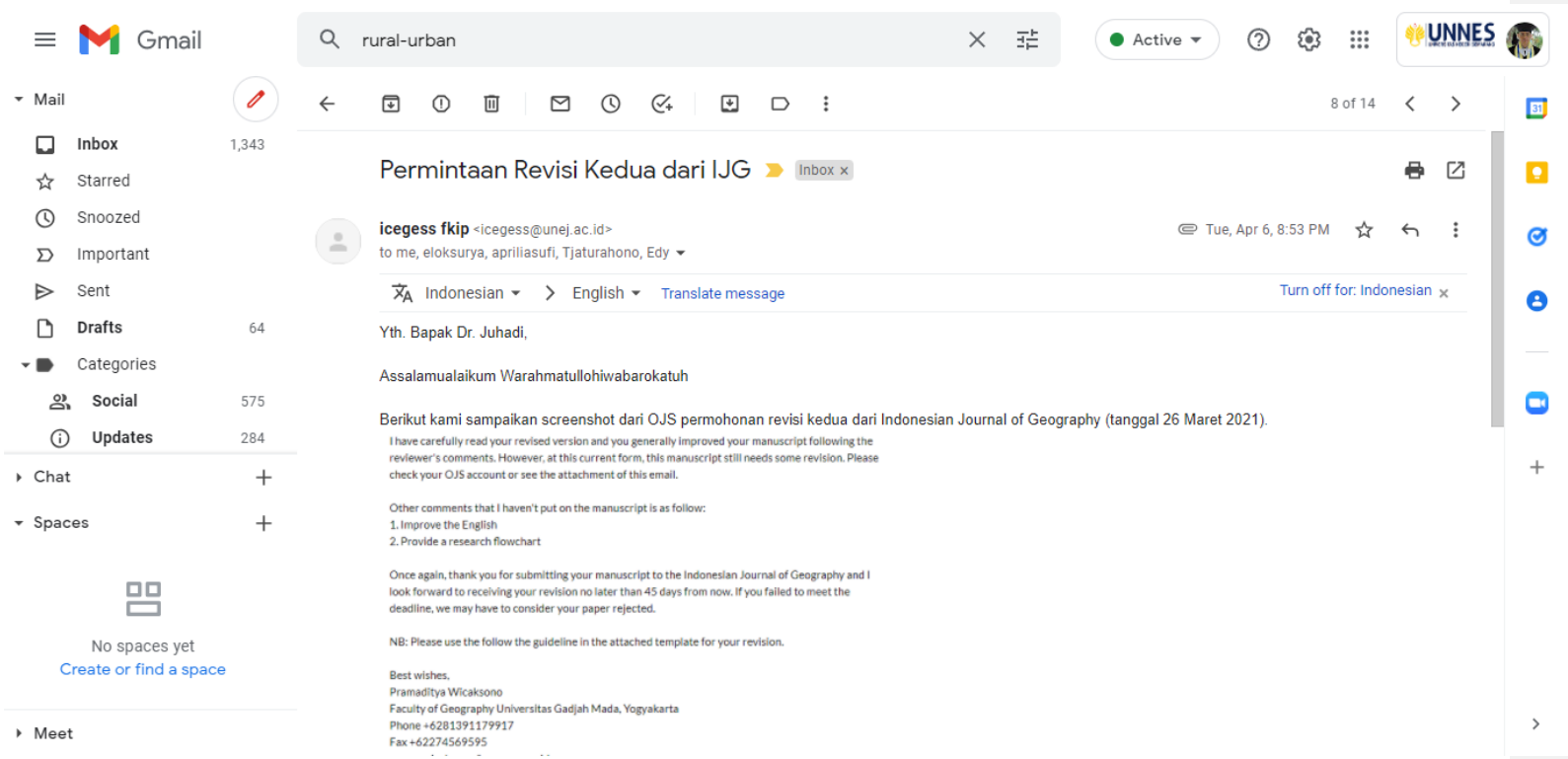

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Permintaan Revisi Kedua dari IJG Inbox ×

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Yth. Bapak Dr. Juhadi,

Assalamualaikum Warahmatullohiwabarokatuh

Berikut kami sampaikan screenshot dari OJS permohonan revisi kedua dari Indonesian Journal of Geography (tanggal 26 Maret 2021).

I have carefully read your revised version and you generally improved your manuscript following the reviewer's comments. However, at this current form, this manuscript still needs some revision. Please check your OJS account or see the attachment of this email.

Other comments that I haven't put on the manuscript is as follow:
1. Improve the English
2. Provide a research flowchart

Once again, thank you for submitting your manuscript to the Indonesian Journal of Geography and I look forward to receiving your revision no later than 45 days from now. If you failed to meet the deadline, we may have to consider your paper rejected.

NB: Please use the follow the guideline in the attached template for your revision.

Best wishes,
Pramaditya Wicaksono
Faculty of Geography Universitas Gadjah Mada, Yogyakarta
Phone +6281391179917
Fax +62274569595

Hasil Review Kedua

Rural-Urban Transformation due to Land Utilization Dynamics in Gunungpati - The Northern Flank of Mt. Ungaran, Semarang, Indonesia

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Abstract *Most of the area on the northern flank of Mt. Ungaran is facing a massive land occupation which makes landuse change inevitable. These research objectives were to examine the spatial patterns of land utilization dynamics from 1997 to 2018 and analyzing the impact on the rural-urban structure at Gunungpati Sub-District by conducting on-screen digitation. Rural-urban structure was analyzed based on the landuse area composition in each village. This research revealed that forest area and paddy fields were decreasing year by year. For over 21 years, Gunungpati experienced deforestation up to 1,777 ha and the increasing build up area was up to 1,295 ha forcing the rural structure shifting. Most villages were categorized as rural frame zones in 1997 changed significantly into urban-rural frame zones in 2018. This situation has to be controlled since most of Gunungpati territory takes a big role as a recharge zone for the Semarang lowland area.*

Key words: spatial impact, land utilization, land transformation rate, Mt. Ungaran

Abstrak *Sebagian besar wilayah di sisi utara Gunungapi Ungaran menghadapi pendudukan lahan besar-besaran yang membuat perubahan tata guna lahan tak terhindarkan. Tujuan penelitian ini adalah untuk mengkaji dinamika pola ruang pemanfaatan lahan dari tahun 1997 hingga 2018 dan menganalisis pengaruhnya terhadap struktur desa-kota di Kecamatan Gunungpati dengan menggunakan digitasi on-screen. Struktur desa-kota dianalisis berdasarkan komposisi luas penggunaan lahan di masing-masing desa. Hasil penelitian menunjukkan bahwa luas hutan dan persawahan semakin berkurang dari tahun ke tahun. Selama lebih dari 21 tahun, Gunungpati mengalami deforestasi hingga 1.777 ha dan peningkatan luas lahan terbangun hingga 1.295 ha yang memaksa struktur pedesaan bergeser. Sebagian besar desa yang dikategorikan sebagai zona bingkai desa pada tahun 1997 berubah secara signifikan menjadi zona bingkai kota-desa pada tahun 2018. Keadaan ini harus dikendalikan karena sebagian besar wilayah Gunungpati berperan besar sebagai zona resapan air untuk wilayah dataran rendah Semarang.*

Kata kunci *: dampak keruangan, pemanfanfaatan lahan, tingkat perubahan lahan, Gunungapi Ungaran*

1. Introduction

The northern flank of Mt. Ungaran now is facing a massive inhabitant due to the lack of land availability in the Semarang lowland area. Prior to the 1990s, the northern slope of Mt. Ungaran was dominated by rural structure due to the fact that it had a dense vegetation cover and limited built-up areas. However, it began to change after the construction of one of the state universities in Semarang located at the Gunungpati Sub-District in 1992. It was surely followed by other development activities, such as the construction of roads, building, and other public infrastructure. Thousands of students coming from other towns will have impacts on the change of local inhabitants' livelihood, from farmers to boarding house businessmen. As a consequence, a great deal of agricultural land has been converted into boarding houses and shopping areas. Moreover, the easier access to UNNES is likely to lead to land clearing for residential areas on hills. The changing rural structure due to land conversion should be taken into account, considering its function as the recharge area which is required to conserve. This massive development must be monitored since the development will harms the downtown area in Semarang City. There will several consequences appear when the area of Gunungpati Sub-District is not well managed. Since it is classified as the restricted preserved area based on the regional spatial plan law. The restricted preserved area implies to protect the natural habitat, groundwater availability, micro climate balance, and overland flow stability.

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Geographically, Gunungpati Sub-District is located at Most of the areas lie about 200 meters above sea level and cover an area of 60.84 square kilometers. The landuse mapping conducted by the National Geospatial Agency in 1997 showed that 65% of these areas were forest and 14% were built-up areas. 28,361 inhabitants lived in this area in 2015 with the population growth rate of 1,665 per year (BPS, 2015). is part of Semarang upland and situated at the foot slope of Mt. Ungaran with hilly morphology.

Figure 1. Position of Gunungpati Sub-District with UNNES Campus within that lies in the northern flank of Mt. Ungaran

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The development of built-up areas on the slope of the volcano can be detrimental to the hydrological balance in the upstream area which may result in flood and drought [1][2][3][4]. The analysis of the change pattern of landuse in the terminology of spatial structure is needed as the protection and mitigation of environmental damage causing disasters in the future [5][6]. The study of landuse changes can easily be identified using remote sensing image technology [7]. Study of landuse changes and their effects on the environment in the whole area of Semarang city were previously conducted by [8]. However, they worked on the medium scale because of the use of Landsat ETM medium-resolution satellite images as their data source. While, a detailed investigation of landuse changes in Semarang were still limited to the near shore area [9][10]. This research attempted to analyze the changes of landuse in the Semarang hilly area located in Gunungpati Sub-District as well as their implications on the regional structure shifting using the combination of high-resolution satellite images over 21 years.

2. Research Methods

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The analysis of the change pattern of landuse was conducted from 1997 to 2018. We used the combination of aerial photographs and various medium to high resolution satellite images for landuse interpretation (table 1). The identification of the kinds of landuse was conducted using digital on-screen technique based on eight image interpretation elements, i.e., colour, shape, size, texture, pattern, shadow, site, and association to define the spatial structure of the research location in each year. The map output of landuse in this research is on a medium scale of 1:25.000 due to the availability of various data sources. The medium scale of the output map was chosen to accommodate detail information from the different high resolution of the satellite imagery. There are five kinds of landuse identified in the study area, i.e., forest, built-up land, paddy field, mixed garden, and dry land. The analysis of landuse change which was the focus of this research encompassed the changes of area, spatial pattern, and pattern every year.

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Table 1. Data Acquisition

No	Source	Year	Resolution (m)
1	Aerial Photograph	1997	3
2	Ikonos	2000	4
3	QuickBird	2006	2.4
4	SPOT-5	2010	5
5	Sentinel-2A	2018	10

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What is the level of correction of each image?
Does all images georeferenced to each other?

Rural-urban structure shifting was analysed using landuse triangle continuum theory developed in Indonesia [11]. The theory classifies regional structure into four zones based on the percentage of urban and rural land in particular areas (table 2). Urban land is all built-up landused for non-agricultural functions, such as residential areas, shopping areas, government buildings, and public facilities, while rural land is used for agricultural purposes, i.e., paddy field, garden, dry land, and forest. The assessment of regional structure was conducted in every urban village in Gunungpati Sub-District. Eventually, the analysis was conducted in each village with Gunungpati Sub-District.

Table 2. Classification of rural and urban structure in the developing country [11]

No	Zone	Urban land	Rural land
1	Urban Structure	>75 % to < 100 %	<25 % to >0 %
2	Rural-Urban Structure	>50 % to <75 %	>25 % to < 50 %

3	Urban-Rural Structure	< 50 % to > 25 %>	>50 % to <75 %
4	Rural Structure	<25 % to >0 %	>75 % to < 100 %

3. Result and Discussion

3.1. Landuse change spatial pattern

The interpretation of landuse in Gunungpati Sub-District from 1997 to 2018 is depicted by the figure 2. A negative trend was experienced by forest and paddy fields, the areas of which tended to decrease annually, while built-up land, mixed garden, and dry land saw a positive trend, increasing every year (figure 3). In 1997, 65% of areas in Gunungpati were forest; only 14% of them were built-up areas. Nevertheless, the area of forest kept decreasing to only 36% in 2018, almost as large as the built-up areas. Built-up areas drastically rose from 876 Ha in 1997 to 2,171 Ha in 2018 or increased by 148%. The trend of agricultural activities in Gunungpati also changed from paddy fields to mixed gardens and dry land. The area of mixed garden even soared by 612% over 21 years.

The change in landuse area also had impacts on the change in the spatial pattern, especially in the built-up areas. Based on the interpretation of large-scale satellite images, the settlement pattern gradually changed from leap frog in 1997 into the concentric settlement (figure 4). The leap frog settlement showed a scattered one with a small group in the middle of a garden or forest. In the past, the leap frog settlement dominated owing to most of Gunungpati areas being forest and paddy. Subsequently, small group settlements grew larger and formed the concentric settlement. The concentric settlement in Gunungpati tended to grow in flat topography, on lowland and upland, and around Unnes in Sekaran Village.

The main cause of landuse change is the annual population growth. Human need for space resulted in deforestation to build residential areas. The improvement and opening of new roads and the relocation of the state university in 1990 also contributed to the development of built-up areas. Furthermore, the lowland of Semarang experienced urban problems, such as rob, flood, traffic congestion, noise, and air pollution. In other places, landuse changes due to the built-up growth has also been reported to increase surface water that is responsible for creating flood [12].

The availability of several plots of land with affordable prices caused people to choose to live on the upland, despite its far distance from the city center. Beside land conversion into residential areas, the risk factor of crop failure and its little profit might cause the decrease of paddy fields in Gunungpati. People cultivated their land as mixed garden and/or dry land as they did not rely on water as the main cause of crop failure and did not need to be intensively cultivated like a paddy field.

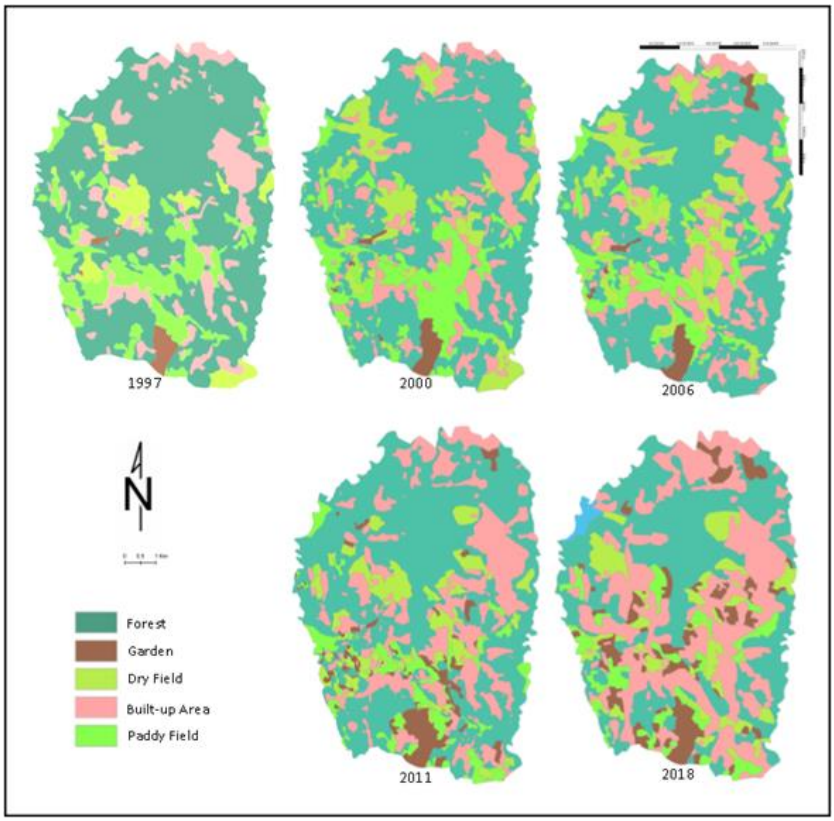

Figure 2. Landuse change in Gunungpati Sub-District during 1997-2018.

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If you want to create land use change map the legend would for example, forest to built-up area etc
How accurate is you land use map? Where's your accuracy assessment?
I want to know you field survey activities, it is not yet explained in the manuscript
How many samples used to validate and perform accuracy assessment on the resulting land use maps?
I want to see the confusion matrix table including the overall, user's and producer's accuracy of your map
If it not possible for all year, you can select several year as the representative

Figure 3. Landuse change trajectory in Gunungpati Sub-District during 1997, 2006 and 2018.

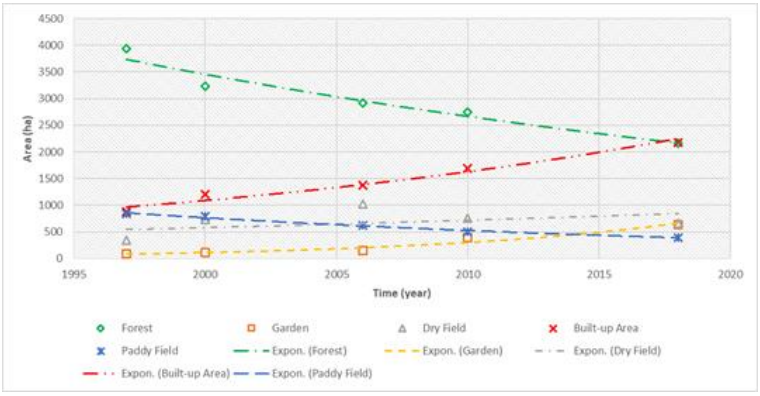

Figure 4. Landuse change pattern in Gunungpati Sub-District.

Figure 5. leap frog pattern dominated in the 1997 settlement area, then it developed into concentric in 2018.

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3.2. The Rate of Landuse Change in Gunungpati Sub-District

The change rate of landuse in Gunungpati from 1997 to 2018 was 3.42% per year (table 3) resulting deforestation mainly for built-up area. In other words, the change of landuse was annually experienced by areas of 150 Ha. The decrease rate of forest reached 85 Ha/year, and conversely, the increase rate of built-up areas was 62 Ha/year. In terms of agriculture, the rise of garden areas reached 26 Ha/year, while the decrease of paddy field areas was 21 Ha/year. Dry land saw the lowest rate of landuse change of 15 Ha/year.

Table 3. The rate of Landuse Change in Gunungpati Sub-District

No	Period	Landuse Change		Landuse Change Annual Rate	
		%	ha	%	ha
1	1997-2000	24,49	1.490	8,16	123
2	2000-2006	16,37	996	2,73	27
3	2006-2010	18,11	1.102	4,52	50
4	2010-2018	25	1.519	3,12	47

5	1997-2018	72	4.379	3,42	150

Forest and built-up areas experienced the most dynamic landuse in Gunungpati Sub-District (table 4). Based on the trend and change rate, forest is likely to decrease in the future, and if forest conservation law is not enforced, Gunungpati is predicted to have no forest in 2048. Forests will be converted into built-up areas or mixed gardens. With the advancement of technology in the field of construction, the built-up area intervention is clearly seen from the large number of residential areas constructed at steep slopes. Beside built-up areas, land conversion also came from plantation which was deemed to have higher economic value.

Tabel 4. Total area of change in each type of landuse at Gunungpati Sub-District

Period	area (Ha)					Total area (Ha)
	forest	Mix garden	Dry field	Built-up area	Paddy field	
1997-2000	703	20	395	330	42	1.490
2000-2006	325	41	284	173	173	996
2006-2010	171	238	260	313	120	1.102
2010-2018	578	252	104	479	106	1.519
1997-2018	1.777	551	315	1.295	441	4.379

3.3. *The Rural-Urban Structure Shifting in Gunungpati Sub-District*

The change in landuse led to regional structure shifting in Gunungpati. The analysis result in 16 villages showed a regional structural change from rural frame zone into rural-urban frame zone (Table 5). Villages having rural-urban frame zone characteristics kept rising annually. A significant increase occurred in 2010 when 44% of the villages in Gunungpati had rural-urban frame zone characteristics due to the increase of built-up areas. It reached a peak at 67% eight years later. A village even shifted to an urban-rural frame zone. Villages with urban-rural zone structures generally had main roads and/or were located near the construction site of Unnes.

Table 5. Spatial structure of land utilization in the northern part of Mt. Ungaran during 1997-2018

Village	1997	2000	2006	2010	2018
Jatirejo	1	1	1	1	1
Ngijo	1	1	1	1	1
Sukorejo	1	2	2	2	2
Sadeng	1	1	1	1	2
Kandri	1	1	1	1	2
Sekaran	2	2	2	2	2
Pungangan	1	1	1	1	2
Kalisegoro	1	1	1	1	1
Patemon	1	1	1	2	2
Nongkosawit	1	1	1	2	3
Cepoko	1	1	1	2	2
Mangunsari	1	2	2	2	2
Gunungpati	1	1	1	1	2
Pakintelan	1	1	2	2	2
Plalangan	1	1	1	1	1
Sumurejo	1	1	1	1	2

Note: 1, 2, 3 and 4 represent rural frame zone, urban-rural frame zone, rural-urban frame zone, and urban frame zone respectively.

Regional structure shifting from rural frame zone to rural-urban zone will surely have negative impacts on the recharge areas. The increasing number of built-up areas will decrease the amount of water absorbed by the soil which will fill the aquifer system [13]. Consequently, water shortage is likely to take place in the dry season. More areas in Semarang have been reported to experience drought since 2012 and it has directly been proportional to the massive change of regional structure in Gunungpati Sub-District. In addition, the decrease of forest areas also contributed to the higher intensity of flood on the lowland. Garang River in Semarang naturally has enormous potential for flood owing to the proximity of the upstream and downstream areas. The rise of overland flow due to the deforestation in the study area will certainly increase the level of flood

danger in Semarang. Due to the more complicated hydrological problem, the governments started to construct a reservoir on the western part of Gunungpati in 2009 to control flood in the rainy season and store water in the dry season.

4. Conclusion

The change of landuse in Gunungpati had impacts on regional structure shifting and its geophysical environmental balance. The increase of non-agricultural land in 1997-2018 led to the change from rural structure into peri-urban structure. Even based on the finding of the change rate trend, landuse can be an urban framework in the future. The urban structure in areas which ecologically function as the recharge areas will be detrimental as the land surfaces covered by concrete and asphalt will reduce the quantity of groundwater. The hydrological balance in the upstream area will negatively be affected and the consequences will be various hydrometeorological disasters. Laws and regulations on spatial planning should be enforced to protect the forest and agricultural land from the development intervention. Disaster mitigation-based city governance is also required to reduce the loss risk and realize sustainable development in the future.

Acknowledgement

Authors would like to express their gratitude to the Rector, Dean of Social Science Faculty, and research institutions and community service (LP2M) of Universitas Negeri Semarang to fund the research, partially and to all colleagues and lecturers that had contributed to develop this research.

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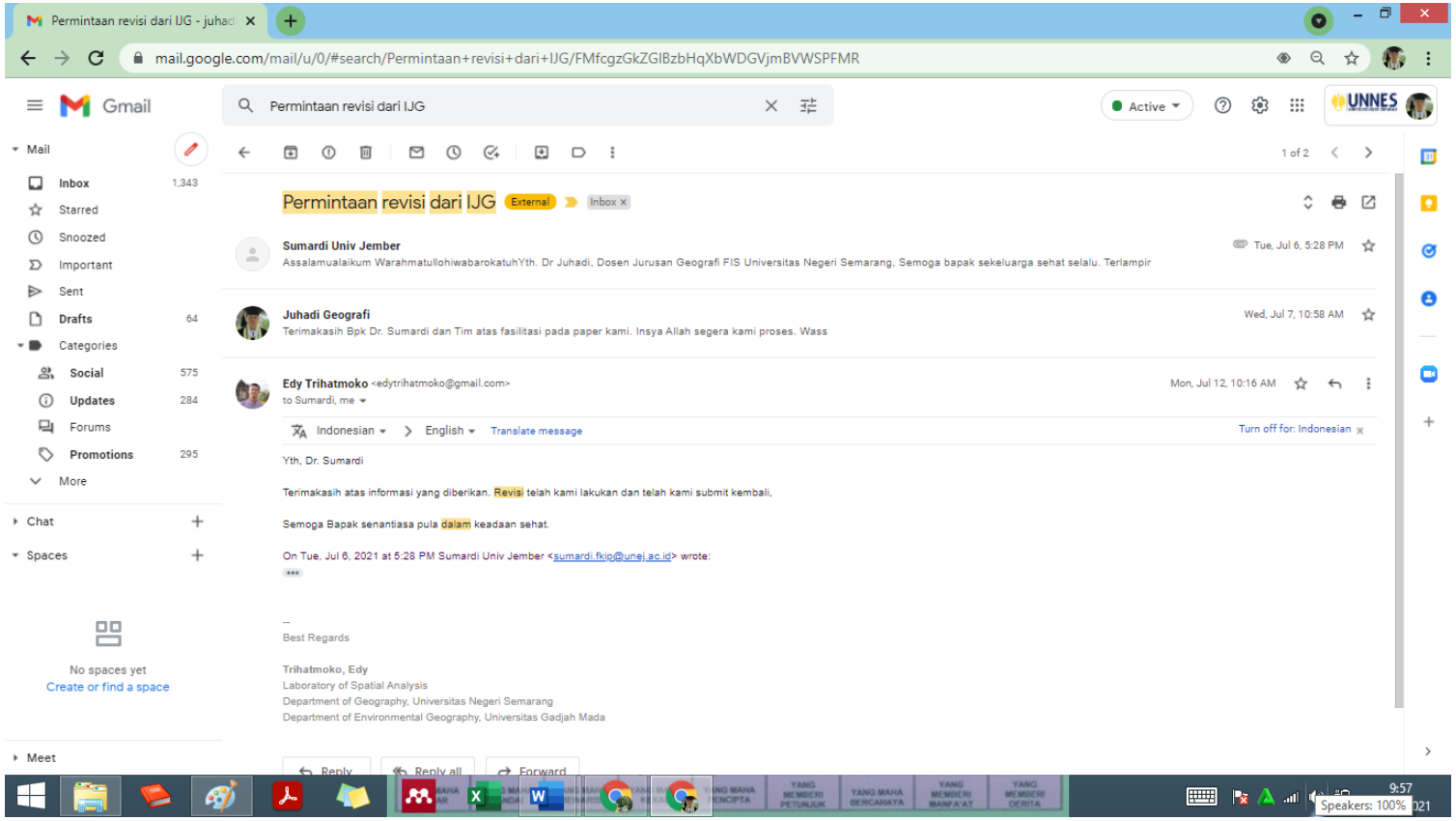
Bukti konfirmasi *submit* revisi kedua, respon kepada *reviewer*, dan artikel yang di*resubmit*

Bukti Konfirmasi *Submit* Revisi Kedua



Respon kepada *Reviewer*

INDONESIAN JOURNAL OF GEOGRAPHY

RESPOND TO REVIEWER'S COMMENTS

Paper ID : #52385

Paper Title : THE SPATIAL IMPACT AND LAND UTILIZATION DYNAMIC IN THE NORTHERN FLANK OF UNGARAN VOLCANO, SEMARANG, INDONESIA

No.	Page	Reviewer's comments	Author's responses
1		Improve the English	
2		Provide a research flowchart	Thank you for the advice, we have added the research flowchart on page 3 (Figure 2).
3	2	Almost all the sentences in this paragraph require a reference but you provided none	Thank you for the comment, we have put several references on this part on page 1.
4	3	The color shade representing you study are is too similar with the surrounding	Thank you, we have enhanced the color of our map.
5	4	You method section is very very short Needs to be expanded	This comment is really useful for us, we have added one more paragraph in the end of this part.
6	4	so you only use visual interpretation? If so, please provide the key interpretation for each land use class in a table	Thank you for the advice, eventually we used all keys to interpret the images added with local knowledge and random survey to validate the interpretation. We also rewrote the explanation on the text on page 4.
7	4	At what spatial resolution did you perform your analysis? How did you resample the different spatial resolution? What is the level of correction of each image? Does all images georeferenced to each other?	We conducted preprocessing image as well. But the key is we used medium scale as an output so it will accommodate all the resolution from the images. We reexplained it on page 4.
8	7	This is not land use change maps, but land use maps If you want to create land use change map the legend would for example, forest to built-up area etc How accurate is you land use map? Where's your accuracy assessment? I want to know you field survey activities, it is not yet explained in the manuscript	Thank you for your advice, as the local citizens we have our local knowledge of the location. That is also useful to identify the landuse. We also informed this as well in page 4. To enhance the information of landuse change we added the trajectory map as shown in Figure 4 (on the revised manuscript).

		How many samples used to validate and perform accuracy assessment on the resulting land use maps? I want to see the confusion matrix table including the overall, user's and producer's accuracy of your map If it not possible for all year, you can select several year as the representative	
9	8	What do you mean by leap frog?	Thank you for questioning this topic. We have rewritten our manuscript and added the theory of this terminology on page 5.

Important!

Please also indicate your changes in the revised manuscript using track changes or highlighted text.

Artikel yang di*resubmit*

Rural–Urban Transformation and Landuse Dynamics in Gunungpati on the Northern Flank of Mt. Ungaran, Semarang, Indonesia

Abstract *Most of the northern flank of Mt. Ungaran is subject to intensive land occupation that makes landuse change inevitable. The research objectives of this study were to examine the spatial patterns of land-use dynamics from 1997 to 2018 and to analyze their impact on the rural–urban structure of Gunungpati sub-district using on-screen digitation. Rural–urban structure was analyzed based on landuse composition by area in each village. This research revealed that forest areas and paddy fields were decreasing year by year. Over the study period of 21 years, Gunungpati experienced deforestation of 1,777 ha and increase in built-up area of 1,295 ha, forcing shifting in rural structure. Most villages that were categorized as rural frame zones in 1997 had changed into urban–rural frame zones by 2018. This situation must be controlled, since much of Gunungpati territory plays a significant role as a groundwater recharge zone for the Semarang lowland area.*

Key words: spatial impact, land use, land transformation rate, Mt. Ungaran

1. Introduction

The northern flank of Mt. Ungaran is facing significant increase in habitation due to the lack of available land in the Semarang lowland area [1][2]. Prior to the 1990s, the northern slope of Mt. Ungaran was predominantly rural in structure, featuring dense vegetation cover and limited built-up areas. However, in 1992 this situation began to change following the construction of a state university in Semarang, a city located in the Gunungpati sub-district. This was followed by other development, such as the construction of roads, buildings, and other public infrastructure. Thousands of students arriving from other areas has had impacts on local inhabitants' livelihoods, for example farmers becoming boarding house owners. As a consequence, a great deal of agricultural land has been converted into boarding houses and shopping areas. Moreover, easier access to UNNES (Universitas Negeri Semarang) is likely to lead to land clearing on hills for residential construction. The changing rural structure arising from this land conversion is of concern because of the area's function as a groundwater recharge area which must be conserved [3]. This rapid and extensive development must be continuously monitored, because it will have impacts on hydrological behavior in both uplands and lowlands [4]. Several consequences will follow if the area of Gunungpati sub-district is not well managed, since it is included in the buffer zone category for the Semarang urban area [5]. The buffer zone has crucial roles in biodiversity protection [6], groundwater preservation [7], microclimate control [8], and overland flow stabilization [9].

Geographically, Gunungpati sub-district (Figure 1) covers an area of 60.84 square kilometers and mostly lies at about 200 meters above sea level. The landuse mapping conducted by the National Geospatial

Agency in 1997 showed that 65% of this area was forested and 14% was built-up. There were 28,361 inhabitants living in the area in 2015 with population growth of 1,665 in that year (BPS, 2015). It forms part of the Semarang upland, is situated at the foot of the slope of Mt. Ungaran, and has a hilly morphology.

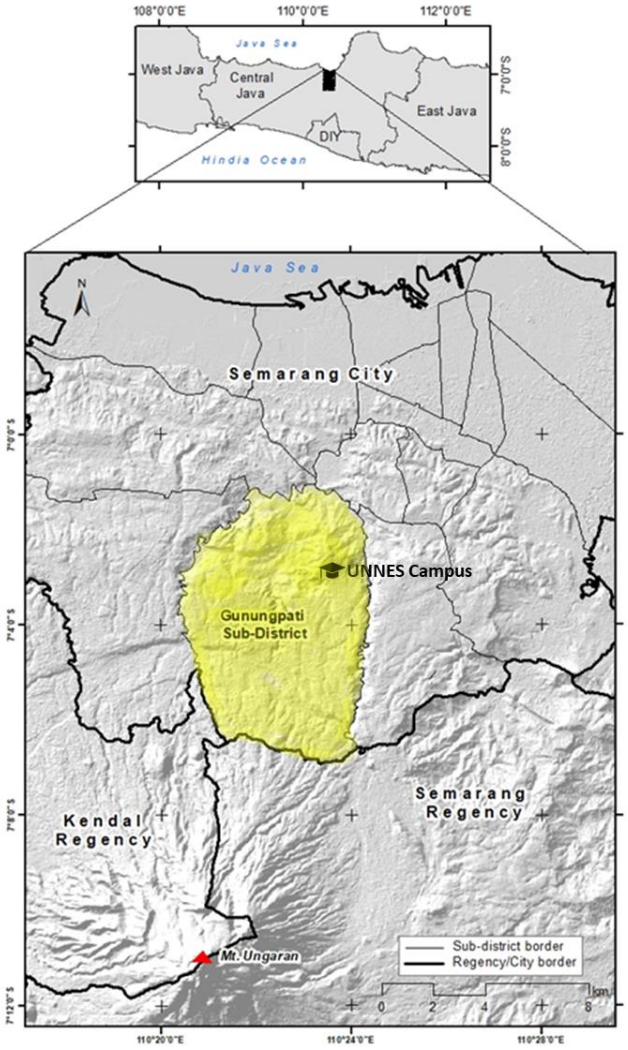


Figure 1. Position of Gunungpati sub-district and UNNES campus on the northern flank of Mt. Ungaran

The development of built-up areas on the slope of Mt. Ungaran can be detrimental to the hydrological balance of the upstream area and may result in flood and drought [10][11][12][13]. Analysis of the changing pattern of land use using the terminology of spatial structure is needed to support protection

against and mitigation of environmental damage that could cause future disasters [14][15]. Landuse changes can easily be identified using remote-sensing image technology [16]. Study of landuse changes and their effects on the environment in the whole area of Semarang city have been previously conducted [17]. However, the previous research worked at the medium scale using Landsat Enhanced Thematic Mapper (ETM) medium-resolution satellite images as its data source. Meanwhile, detailed investigation of landuse changes in Semarang is still limited [18][19]. Using a combination of high-resolution imageries over a period of 21 years from 1997 to 2018 as its research flowchart (Figure 2), this study attempts to analyze the changes of land use in the hilly area of Semarang located in Gunungpati sub-district and its implications for regional structure changes.

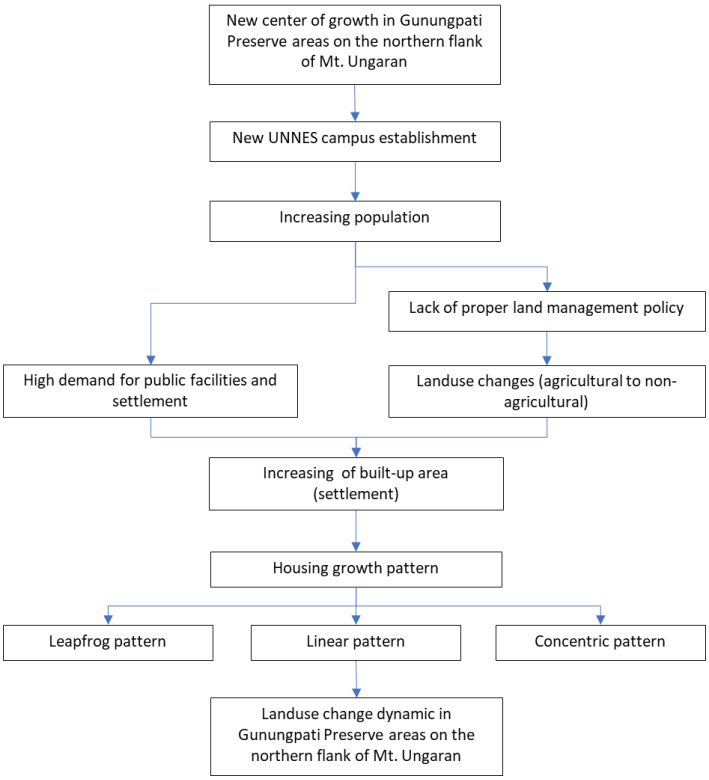


Figure 2. Research flowchart

2. Research Methods

The analysis of the landuse change pattern was conducted using data for the period 1997 to 2018. We used a combination of aerial photographs and various medium- to high-resolution satellite images for

landuse interpretation (Table 1). To define the spatial structure of the research location in each year, identification of types of land use was conducted using digital on-screen techniques based on eight image-interpretation elements—color, shape, size, texture, pattern, shadow, site, and association—combined with local knowledge and random survey to validate the interpretation. The landuse map output in this research is at a medium scale of 1:25,000, reflecting the availability of various data sources. The medium scale of the output mapping was chosen to accommodate detailed information from various high-resolution remote-sensing imageries, namely aerial photographs, Ikonos, Quickbird, SPOT-5, and Sentinel-2A. Five types of land use are identified in the study area—forest, built-up land, paddy field, mixed garden, and dry land. The analysis of landuse change which was the focus of this research encompassed yearly changes of area, spatial pattern, and structure.

Table 1. Data acquisition

No	Source	Year	Resolution (m)
1	Aerial photography	1997	3
2	Ikonos	2000	4
3	QuickBird	2006	2.4
4	SPOT-5	2010	5
5	Sentinel-2A	2018	10

Shift in rural–urban structure was analyzed using the landuse triangle continuum theory developed in Indonesia [20]. The theory classifies regional structure into four zones based on the percentage of urban and rural land in particular areas (Table 2). Urban land is all built-up land used for non-agricultural functions, such as residential areas, shopping areas, government buildings, and public facilities, while rural land is used for agricultural purposes, i.e. paddy field, garden, dry land, and forest. Assessment of spatial structure and analysis were conducted in every village in Gunungpati sub-district.

Table 2. Classification of rural and urban structure in developing countries[11]

No	Zone	Urban land	Rural land
1	Urban structure	> 75% to < 100%	< 25% to > 0%
2	Rural–urban structure	> 50 % to <75 %	>25 % to < 50 %

3	Urban–rural structure	< 50% to > 25%>	> 50% to < 75%
4	Rural structure	< 25% to > 0%	> 75% to < 100%

Determination of urban physical pattern in this study follows the model according to Northam [21], in which urban physical distribution or housing growth is classified as 1) concentric development pattern, in which the physical propagation of the city is equally distributed around the urban area, tends to be slow, and is characterized as a compact city; 2) linear development pattern (ribbon/linear/axial development), in which the physical spreading of the city follows the pattern of the road networks or rivers and is characterized by unequal distribution in each part of the urban development; and 3) leapfrog development, in which physical propagation of a city does not follow a particular pattern. Leapfrog development is also known as scattered development.

3. Result and Discussion

3.1. The spatial pattern of landuse change

Landuse change in Gunungpati sub-district from 1997 to 2018 is depicted in Figure 2. A negative trend was evident for forest and paddy fields, the areas of which tended to decrease annually. In contrast, built-up land, mixed garden, and dry land saw a positive trend, increasing every year (Figure 3). In 1997, 65% of areas in Gunungpati were forest and only 14% were built-up areas. The area of forest decreased to only 36% in 2018, similar in extent to the built-up areas. Built-up areas rose substantially, from 876 Ha in 1997 to 2,171 Ha in 2018, an increase of 148%. Agricultural activities in Gunungpati also changed from paddy fields to mixed gardens and dry land, with the area of mixed garden increasing 612% over the 21 years of the study.

These changes in land use had impacts on spatial pattern, especially in the built-up areas. Based on the interpretation of large-scale satellite images, settlement development gradually changed from a leapfrog pattern in 1997 to a concentric settlement pattern (Figure 4). Leapfrog settlement shows as scattered small groups of urban development in the middle of a garden or forest. In the past, leapfrog settlement dominated, owing to most Gunungpati areas being forest and paddy. Subsequently, small group settlements grew larger and formed concentric settlements. Concentric settlement in Gunungpati tended to grow in flat topography, on lowlands and uplands, and around UNNES, in Sekaran village.

The main cause of landuse change is the annual growth in population, with human need for space resulting in deforestation to enable the building of residential areas. The improvement and

opening of new roads and the relocation of the state university in 1990 also contributed to the development of built-up areas. Furthermore, the lowland of Semarang experienced urban problems such as crime, flooding, traffic congestion, noise, and air pollution. In other locations, landuse changes resulting from growth in built-up areas have been reported to increase the surface-water runoff that is responsible for flooding [22].

The availability of plots of land at affordable prices has led people to choose to live on the upland area, despite its distance from the city center. As well as the impacts of conversion of rural land into residential areas, the risk of crop failure and low profit returns might also have resulted in decrease in the area of paddy fields in Gunungpati. People may have chosen to cultivate their land as mixed garden and/or dry land as these did not rely so heavily on water availability and did not need to be as intensively cultivated as paddy fields.

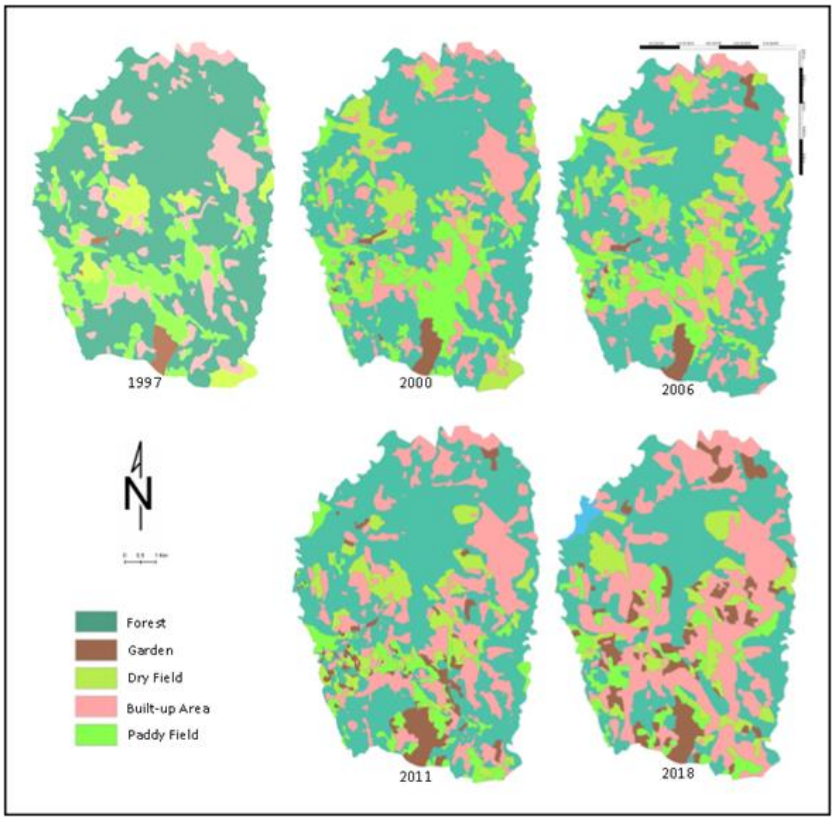


Figure 3. Landuse change in Gunungpati sub-district: 1997–2018.

Figure 4. Landuse change trajectory in Gunungpati sub-district: 1997, 2006, and 2018.

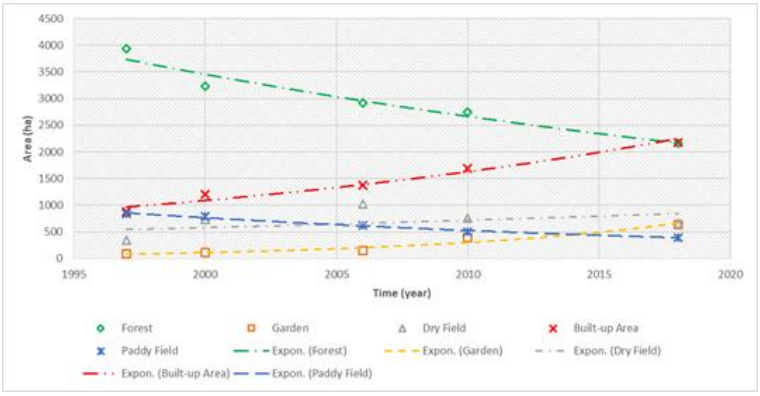


Figure 5. Landuse change pattern in Gunungpati sub-district.

Figure 6. Leapfrog pattern dominated in the 1997 settlement area, then developed into concentric pattern in 2018.

3.2. The rate of landuse change in Gunungpati sub-district

The change rate of land use in Gunungpati from 1997 to 2018 was 3.42% per year (Table 3) resulting in deforestation mainly for creation of built-up areas. In other words, the change of land use annually experienced was 150 ha. The decrease rate of forest was 85 ha/year, while the increase rate of built-up areas was 62 ha/year. In terms of agriculture, the rise of garden areas was 26 ha/year, while the decrease of paddy field areas was 21 ha/year. Dry land saw the lowest rate of landuse change of 15 ha/year.

Table 3. The rate of land-use change in Gunungpati sub-district

No	Period	Landuse change		Landuse change, annual rate	
		%	ha	%	ha
1	1997–2000	24.49	1,490	8.16	123
2	2000–2006	16.37	996	2.73	27
3	2006–2010	18.11	1,102	4.52	50
4	2010–2018	25	1,519	3.12	47
5	1997–2018	72	4,379	3.42	150

Forest and built-up areas experienced the most dynamic landuse change in Gunungpati sub-district (table 4). Based on trend and change rate, forest is likely to decrease in the future such that if forest conservation law is not enforced Gunungpati is predicted to have no forest by 2048, having been converted into built-up areas or mixed gardens. With the advancement of technology in the field of construction, the intervention of built-up areas is clearly seen from the large number of residential areas constructed on steep slopes. Beside built-up areas, landuse change also derives from conversion to plantations which are deemed to have higher economic value.

Table 4. Total area of change in each landuse type in Gunungpati sub-district

Period	Area (ha)					Total area (ha)
	Forest	Mixed garden	Dry field	Built-up area	Paddy field	
1997–2000	703	20	395	330	42	1,490
2000–2006	325	41	284	173	173	996
2006–2010	171	238	260	313	120	1,102
2010–2018	578	252	104	479	106	1,519
1997–2018	1,777	551	315	1,295	441	4,379

3.3. *Shifting in rural–urban structure in Gunungpati sub-district*

Change in land use has led to shift in regional structure in Gunungpati. The analysis results for 16 villages show a regional structural change from rural frame zone into rural–urban frame zone (Table 5). The number of villages having rural–urban frame zone characteristics rose annually. A significant increase occurred in 2010, when 44% of the villages in Gunungpati had rural–urban frame zone characteristics resulting from the increase of built-up areas. This proportion reached a peak of 67% eight years later. One village even shifted to an urban–rural frame zone. Villages with urban–rural zone structures generally had main roads and/or were located near the construction site of UNNES.

Table 5. Spatial structure of land utilization in the northern part of Mt. Ungaran 1997–2018

Village	1997	2000	2006	2010	2018
Jatirejo	1	1	1	1	1
Ngijo	1	1	1	1	1
Sukorejo	1	2	2	2	2
Sadeng	1	1	1	1	2
Kandri	1	1	1	1	2
Sekaran	2	2	2	2	2
Pungangan	1	1	1	1	2
Kalisegoro	1	1	1	1	1
Patemon	1	1	1	2	2
Nongkosawit	1	1	1	2	3
Cepoko	1	1	1	2	2
Mangunsari	1	2	2	2	2
Gunungpati	1	1	1	1	2
Pakintelan	1	1	2	2	2
Plalangan	1	1	1	1	1
Sumurejo	1	1	1	1	2

Note: 1, 2, 3 and 4 represent rural frame zone, urban–rural frame zone, rural–urban frame zone, and urban frame zone respectively.

Regional structure shift from rural frame zone to rural–urban zone will be likely to have negative impacts on groundwater recharge areas. Increase in built-up areas will decrease the amount of water absorbed by the soil which can then fill the aquifer system [23]. Consequently, water shortage is likely in the dry season. More areas in Semarang have been reported as experiencing drought since 2012 and this increase has been directly proportional to the extensive change in regional structure in Gunungpati sub-district. In addition, the decrease in forest areas has also contributed to higher intensity of flooding on lowland areas. The Garang river in Semarang has an enormous natural potential for flooding owing to the proximity of its upstream and downstream areas. Rise in overland flow due to deforestation in the study area will certainly increase the level of flood danger in Semarang. Due to the complicated hydrological problems

developing, local governments started to construct a reservoir in the western part of Gunungpati in 2009 to control flooding in the rainy season and to store water for the dry season.

4. Conclusion

Change of land use in Gunungpati has impacted on shifting regional structure and on geophysical environmental balance. The increase of non-agricultural land from 1997 to 2018 led to the change from rural structure to peri-urban structure. Based on our findings in terms of change-rate trends, land use will acquire an urban framework in the future. The urbanization of areas which function ecologically as recharge areas will be detrimental, because land surfaces covered by concrete and asphalt will reduce the quantity of groundwater. Hydrological balance in the upstream area will be negatively affected and the consequences will be various hydrometeorological disasters. Laws and regulations on spatial planning should be enforced to protect forest and agricultural land in the area from development. Disaster-mitigation-based city governance is also required to reduce the risk of loss and to realize sustainable development in the future.

Acknowledgment

The authors would like to express their gratitude to the Rector, Dean of Social Science Faculty, and research institutions and community service (LP2M) of Universitas Negeri Semarang for their contributions to the funding of this research and to all colleagues and lecturers who contributed to its development.

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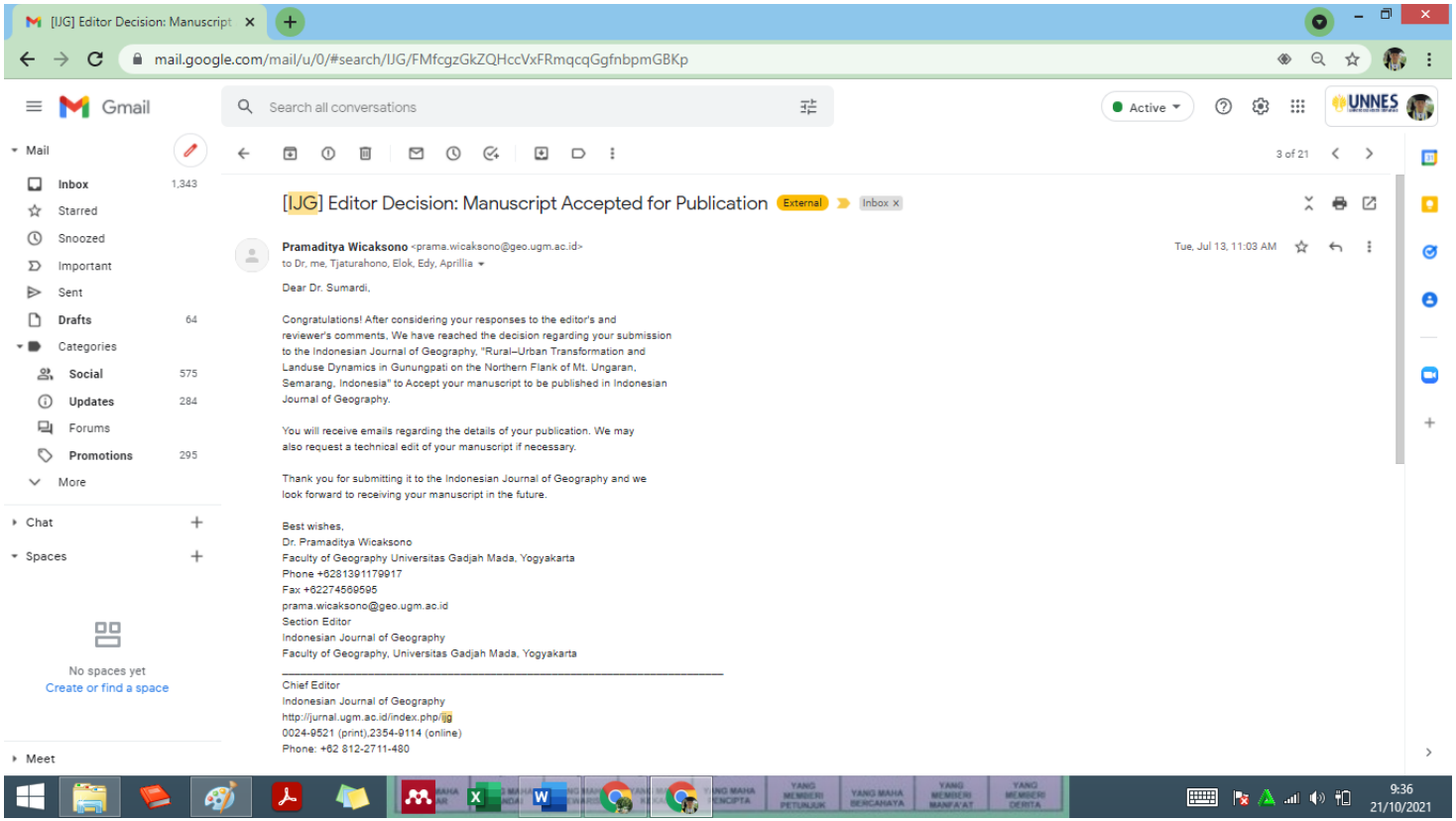

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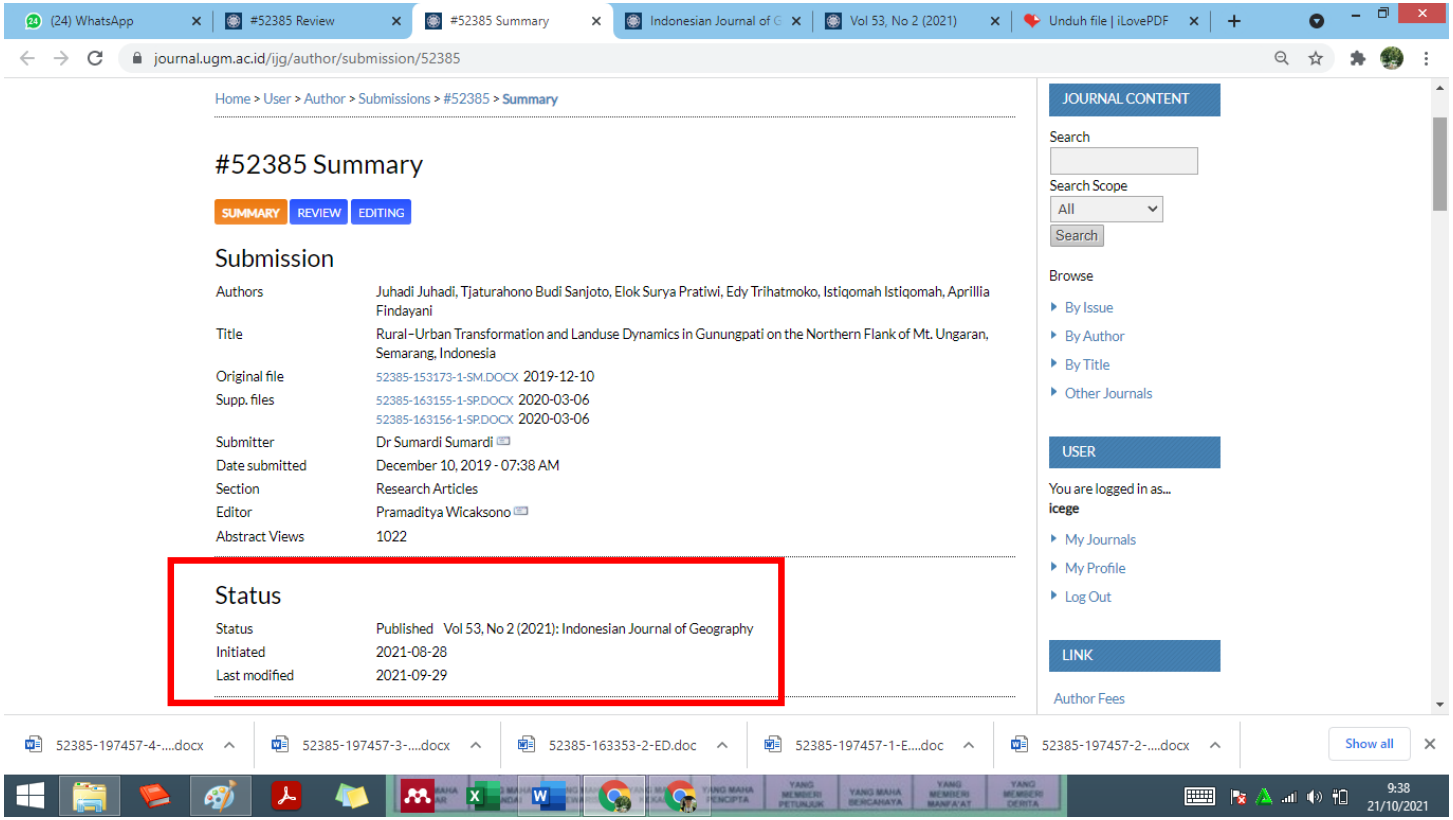

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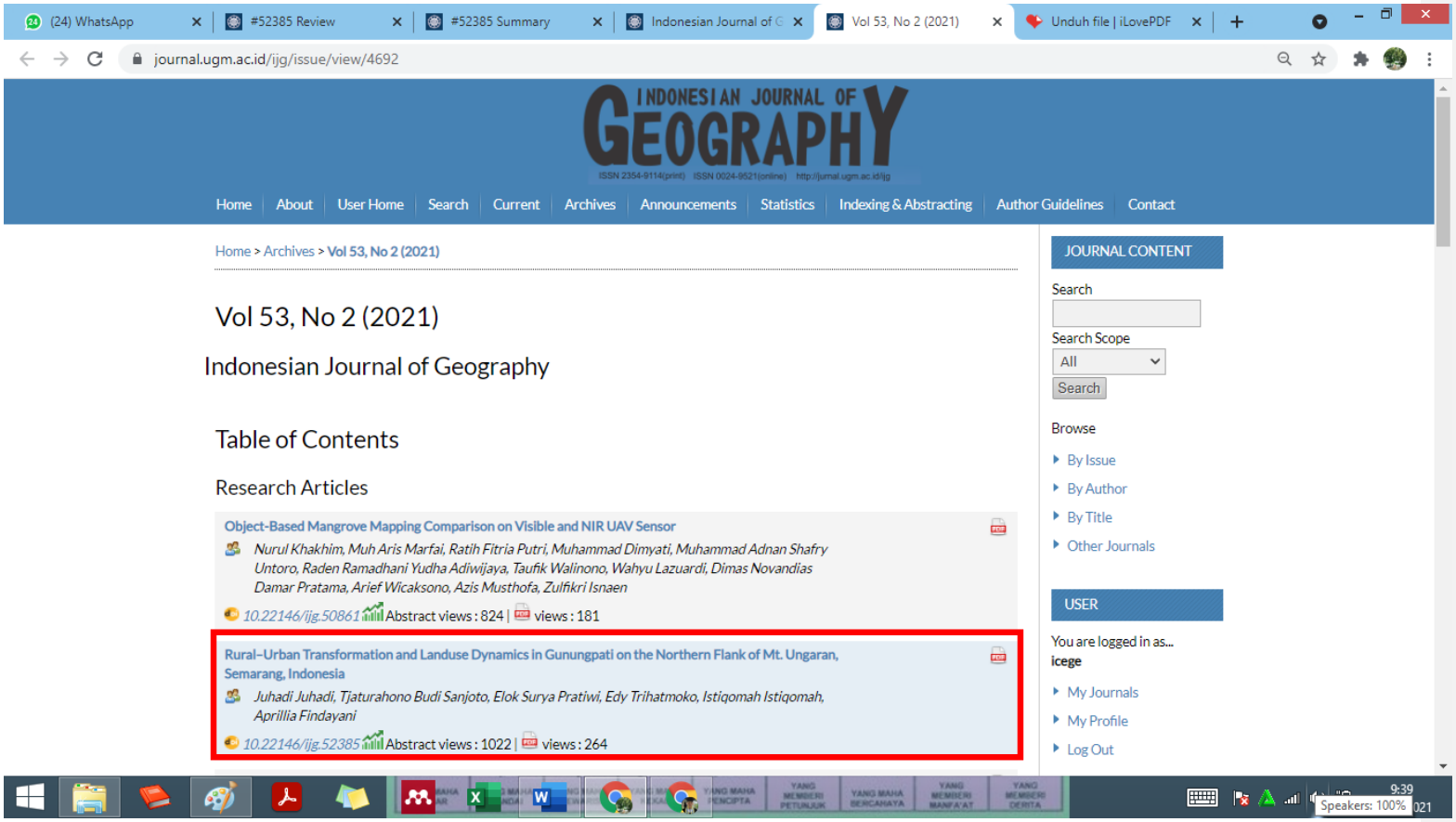

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