Spatial Temporal Land Use Change Detection Using Google Earth Data

Spatial Temporal Land Use Change Detection Using Google Earth Data

Adi Wibowo[1,2], **Khairulmaini Osman Salleh**[2], **F.Th.R Sitanala Frans**[1] , **Jarot Mulyo Semedi**[1]

[1]Department of Geography, Faculty of Mathematics and Natural Sciences, University of Indonesia, 16424 Depok, Indonesia
[2]Department of Geography, Faculty of Arts and Social Sciences, University of Malaya, 50603 Kuala Lumpur, Malaysia

adi.w@sci.ui.ac.id, jarot.mulyo@ui.ac.id

Abstract. Land use as representation of human activities had different type. Human activity needs land for home, food, school, work, and leisure. Land use changed depends on human activity in the world within spatial and temporal term. This study aims to identify land use change using Google Earth data spatially and temporally. To answer the aim of this research, Google Earth data within five-year used for the analysis. This technique use for detection and mapping the land use change. The result saw the spatial-temporal land use change each year. This result addressed very importance of Google Earth Data as spatial temporal land use detection for land use mapping.

Keywords: Land Use, Google Earth Data, Change Detection, Spatial-Temporal

1. Introduction

Urbanization including residential, commercial, and industrial developments initiated one of the most dramatic human-induced changed of a natural ecosystem: a natural landscape, often containing transpiring vegetation and a pervious surface, is converted to a built, largely impervious landscape made up of rigid, sharp-edged roughness elements [1]. With rapid urbanization, there has been a tremendous growth in population and buildings in cities. In Singapore, rapid population influx has led to demands for converting natural areas to public housing [2]. The Urban conurbation within urbanized in Selangor has a remarkable related area in 1988 compared to the latest urban land cover in 1999 that urban land cover can be associated with buildings, road pavement, highways, green parks and also bare soil due to earthwork activities [3]. Land use type used climate information [4] as land use cover had ability absorb and reradiate sun radiation to generated urban heat ([2], [5], [6]).

Those phenomenon land use change as natural as consequences of human dimension within urban land uses cover types ([7], [8], [9], [10], [11]). Even though its natural phenomena in urban area, it could be threat in tropical cities ([9], [12], [13], [14]). Sun heat stored and reradiated related with land surface and urbanized area related with high temperature ([15], [16]), the other hand vegetated surfaces with moist soil related with low temperature [16] and without vegetated [15] of the city-core was higher temp than its surrounds covered by vegetation. Analysis spatial temporal ([1], [5], [17],

[18]) used to analysis spatial temporal of the highest vegetation cover on land use cover type ([5], [17], [18]).

The Google Earth (GE) shows the area at fine spatial resolution, revealing clearly that it were dominated by a few institutional structures, which a little investigation identifies as a medical school and close-up of the anomalous tract, showing its current mix of park and institutional land use [19]. The GE imagery were selected for a case study in Wuhan City to perform an object-based land use/cover classification with classification accuracy was assessed by using 570 validation points, the results showed that GE has an overall classification accuracy of 78.07% and strongly proved the potentials of GE in land use/cover mapping [20]. This research aim to identifying land use change using Google Earth Data. For detection and collecting data land cover can used Google Earth data. Google Earth has entered the realm of everyday life with powerful engaging (with) the world and an integral part of the processes of how we come to know spaces, places and sites [21].

Land use change is a phenomenon caused by human activities as a spatial temporal impact in line with human dynamic growth.

2. Material and method

This research study area is at Tangerang City on Banten Province, Depok City on West Java Province (the fast growing city near Jakarta) and University of Indonesia and University of Malaya (University of Inodonesia near Jakarta, Indonesia and University of Malaya near Kuala Lumpur, Malaysia). The focus of this research is on what are the Spatial and Temporal Land Use Change Detecting Using Google Earth Data (figure 1).

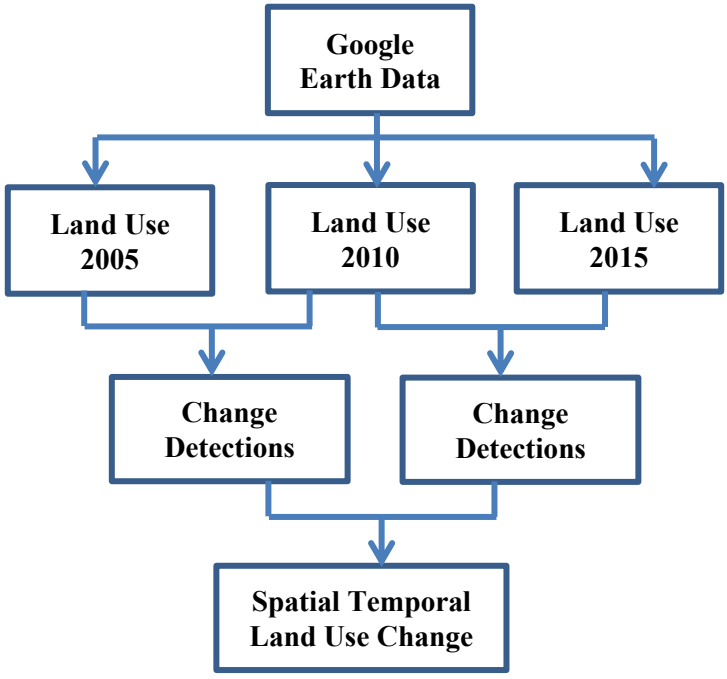


Figure 1. Diagram of Research Methodology

Data collection and extraction start from downloaded satellite imagery data of Google Earth as resource data. "*Google Earth software's success at tangibly impacting what is happening on the ground that's way Geographers, political theorists, and media scholars have begun to consider used Google Earth Data"* [22]. The satellite image data from Google Earth is mosaicked using ArcGIS software. The result of the mosaicked images does not have geographic references. A georeferenced tool is used to the mosaicked images to get a georeferenced image based on Universal

Transform Mercator (UTM) projection. Land use type from the Google Image was digitized based on 10 m x 10 m square grid ([6], [14], [16]) and the attribute on every land use types also being collected (figure 2). After finish created land use cover data from Google Earth then used survey validated the land use cover. Thus data land use cover types save in geodatabase storage and easy next processed summary of total area each land use cover type, setting within standard symbol and color, and the las processed is layout used Arc GIS with cartographic standard processes until ready presentation as land cover map ([6], [14], [16]).

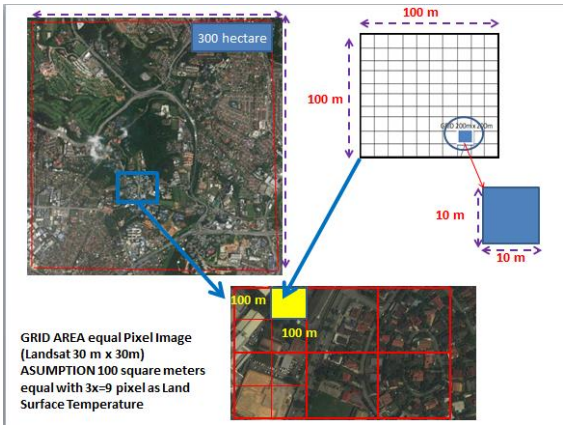


Figure 2. Digitize Land Use using grid 10 x 10

3. Result and discussion

3.1. Google Earth Data

Geographic Information Systems (GIS) Data is spatial data that is georeferenced to real-world locations on the Earth and there are two types of GIS data, **vector data** (vector datasets consist of points, lines, or polygons representing objects on the map) data and **raster** data (raster datasets are regular grids of data, which can represent images such as satellite or aerial photography, continuous surfaces such as elevation models, or thematic classes such as land cover or habitat maps) (https://www.google.com/earth/outreach/ tutorials/importgis.html). The accelerated rate of urban growth in tropical cities highlights the critical necessity of creating more outdoor spaces for leisure and recreation activities of citizens [23]. The Google Earth had data temporal depend on data archive already used with previous study in Pinang Sub-Districts, Tangerang City [24], Kukusan Depok City [25] and also studied at University of Indonesia ([14], [16]).

This research used data sample at area near Situ Cipondoh in Tangerang City used temporal archived Google Earth data between 2004, 2010 and 2015. Those data used five years to get different land use type, but the archive Google data did not have on 2005 then it changed into Google Earth data on 2004. Based on figure 3, area near Situ Cipondoh had land use on North Area within home, government official, road, river, and another land use type in urban area. This land use information representation on 2015 Google Earth Data on archive (7/8/2015).

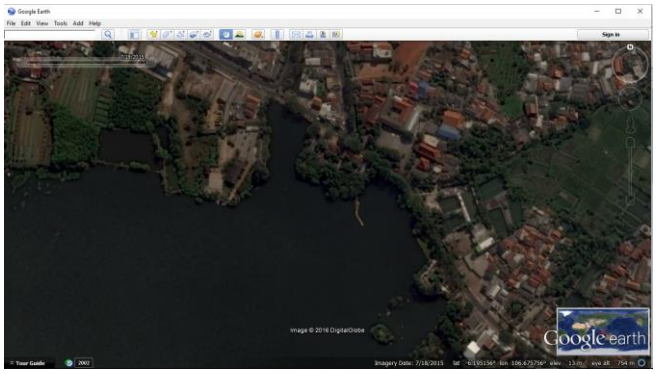


Figure 3. Google Earth Data 2015

Based on figure 4, area near Situ Cipondoh had land use on North Area within home, government official, road, river, and another land use type in urban area. This land use information representation as 2010 Google Earth Data archive (2/15/2010). In general, both Google Earth Data is very similar, but in detail within 10 x 10 square meters, Google Earth Data on data 2015 and Google Earth Data on 2005 had different land use type.

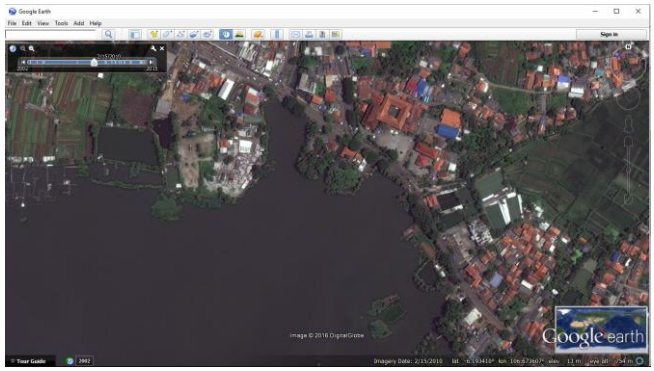


Figure 4. Google Earth Data 2010

Based on figure 5, area near Situ Cipondoh had Land Use on North Area within home, government official, road, river, and another land use type in urban area. This land use information representation on 2004 Google Earth Data archive (3/24/2004) with different information based on compare data with Google Earth Data on 2010 and Google Earth Data on 2015.

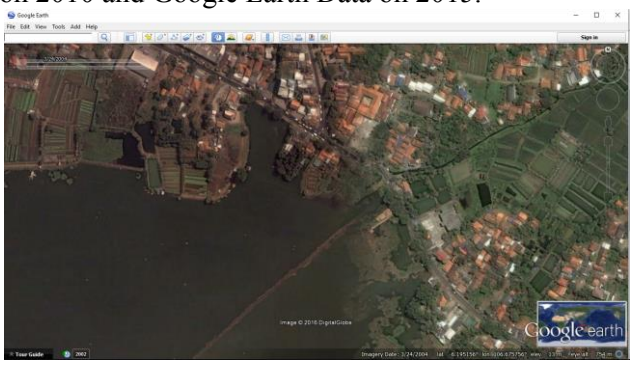
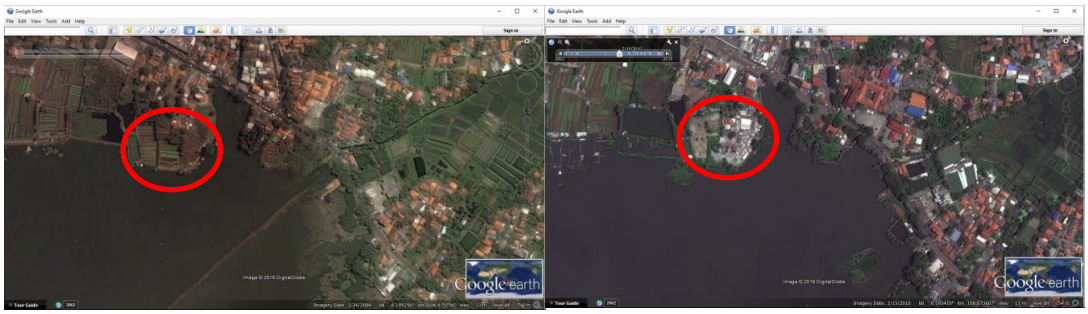


Figure 5. Google Earth Data 2004

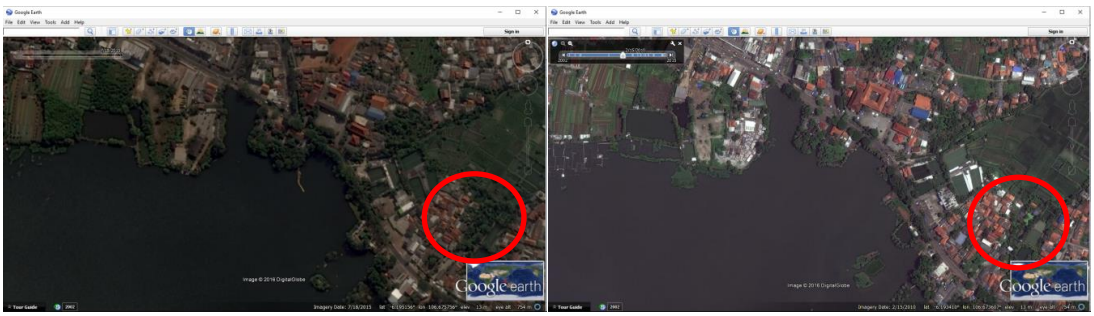
3.2. Change Detection Using Google Earth Data

Google Earth Data archived could be used to identify land use change on specific area. For example, land use changed on area near Situ Cipondoh in the past time (temporal analysis) could identify used Google Earth Data and easy to get the information of land use type existing in the past time. Based on figure 6 saw on circle red color were land use changed from land use type farming used Google Earth Data on 2004 compare to land use type home and office used Google Earth Data on 2010.



Data 2004 Data 2010

Figure 6. Change Detection Using Google Earth Data 2004 and 2010



Data 2015 Data 2010

Figure 7. Change Detection Using Google Earth Data 2010 and 2015

The previous study [11] in Tangerang City saw on figure 8 and table 1. Based on figure 8 saw on rectangle with red color were land use changed used Google Earth Data on 2001 compare to land use used Google Earth Data on 2012. These change detection using Google Earth Data archived very useful to get information of spatial-temporal land use change on the research study.

Figure 8. Change Detection Using Google Earth Data 2001 and 2012 at Situ Cipondoh, Tangerang City, Banten Province

Based on data land use change on table 1, the total area land cover change can detection, for example open space change negative 2,607.3 hectares and water bodies plus 143.2 hectares

Table 1. Land Use Changed 2001 and 2012 in Tangerang City, Banten Province

No.	General Land Cover Type	2001 (hectare)	2012 (hectare)	Changed (hectare)
3.	Street	1.945.58	1,945.58	0.0
4.	Open Space	2.572.10	35.17	-2,607.3
5.	Build up area	7,065.41	11,252.58	+4.187.2
6.	Water body	28.31	171.55	+143.2
7.	Vegetation cover	6,428.63	5,159.49	-1.269.1

The other research used Google Earth Data ([14], [16]) saw on figure 9. This research used Google Earth Data detection land use changed in university campus. The red and yellow rectangle gave the information new building at University of Indonesia and the purple rectangle as land use changed from park become sport area. The green rectangle land use changed from part become building and the black rectangle as land use change from parking area become building, both land use changed at University of Malaya.

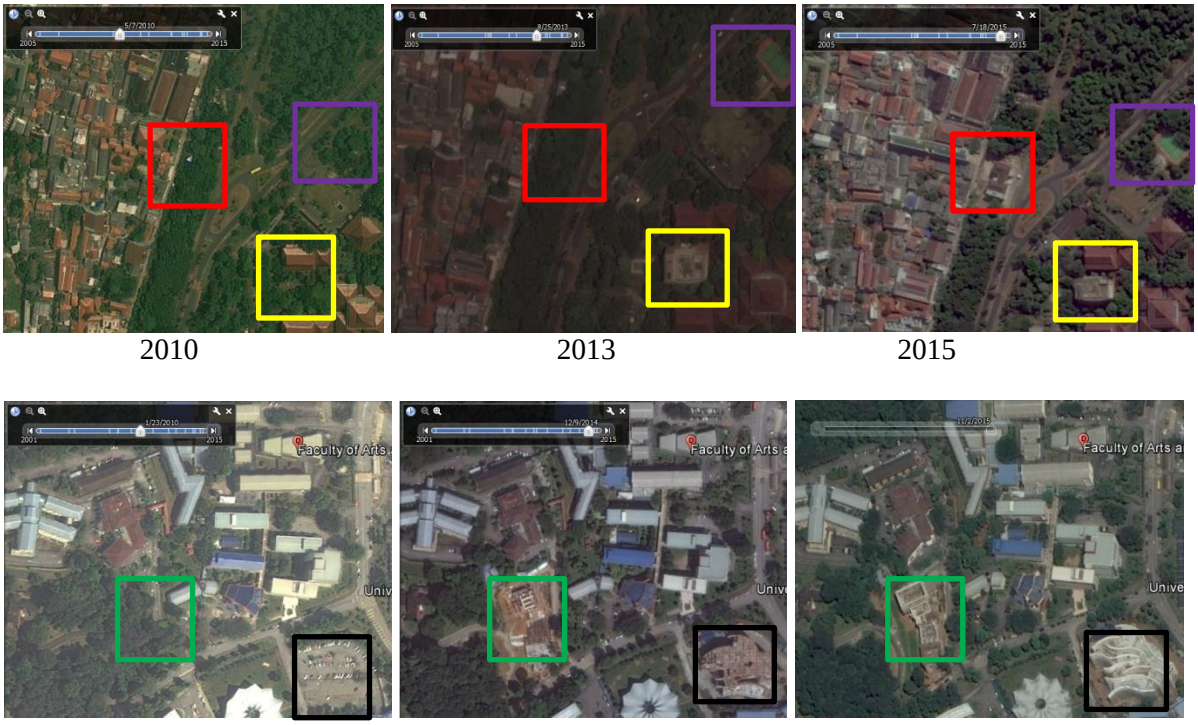


Figure 9. Change Detection Using Google Earth Data 2010, 2013 and 2015 at Univ. of Indonesia and Univ. of Malaya

The other research used Google Earth Data [23] saw on figure 10 and table 2. This research used Google Earth Data detection land use changed near university campus. The black rectangle (figure 10) gave the information building near toll road in 2015 (Google Earth Data 9/29/2015) more than building in 2012 (Google Earth Data 3/27/2012). Those are another Google Earth Data 5/17/2004 on figure 9 saw the information of land use before the new exit toll development in black rectangle area.

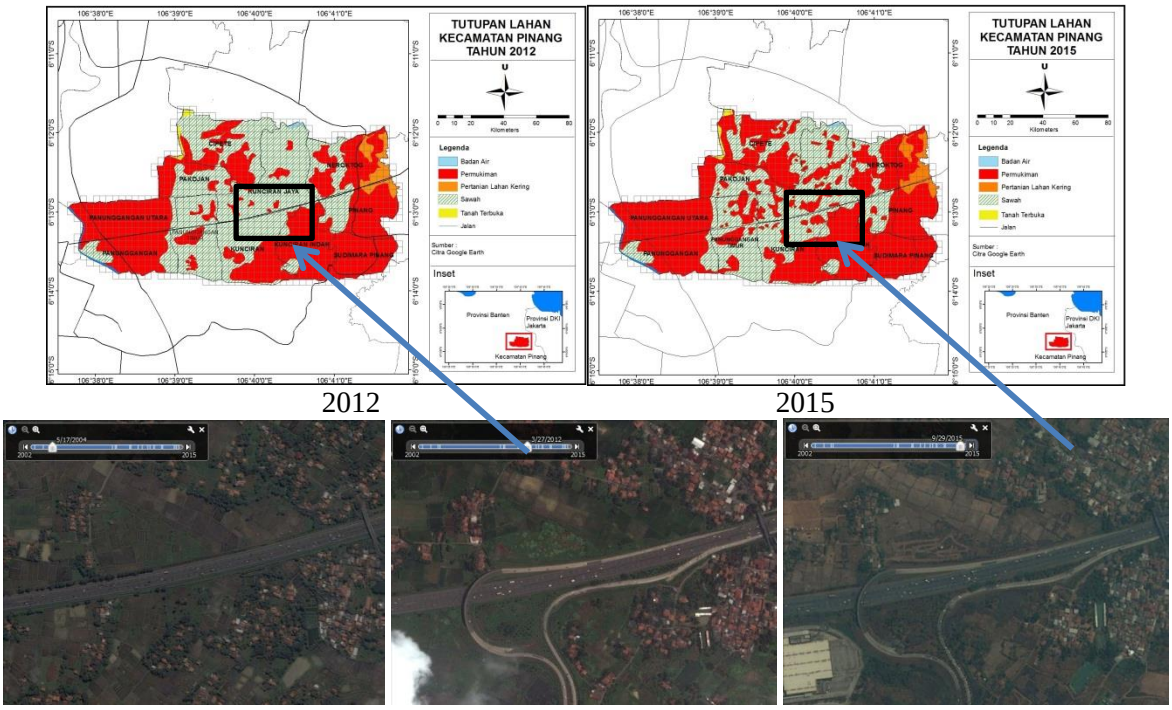


Figure 10. Change Detection Using Google Earth Data 2004, 2012 and 2015 at Pinang District, Tangerang City

The research saw on table 2 total building density changed between 2012 and 2015 at Penang District. This research used Google Earth Data detection land use changed within building changed saw with black rectangle (figure 10) gave the information of land use change within road and building added at Penang District.

Table 2. Building Density Changed 2012 and 2015 in Penang District, Tangerang City

No.	Building Density	2012 (hectare)	2015 (hectare)	Changed (hectare)
1.	Low	948.96	482.31	-466.65
2.	Moderate	1,104.10	1,214.10	+110.00
3.	High	88.02	456.93	+368.01

The other research used Google Earth Data [24] saw on figure 10 and table 3. This research used Google Earth Data detection land use changed near university campus. The red circle gave the information building near university campus (500 meters) in 2015(Google Earth Data 7/18/2015) more than building in 2005 (Google Earth Data 4/6/2005).

Figure 11. Change Detection Using Google Earth Data 2005 and 2015 at Kukusan Village, Depok City

The research saw on table 3 with total building changed between 2005 and 2015 within radius 100 meters from University of Indonesia gate at Kukusan Village. This research used Google Earth Data detection land use changed near university campus. The red circle (figure 11) gave the information building near university campus (500 meters) in 2015 more than building in 2005. The land use change as building added at Kukusan Village used Google Earth Data had detection that highest building change or added with radius 100-300 meters near UI campus.

Table 3. Building Changed between 2005 and 2015 in Kukusan Village, Depok City

No.	Radius (meters)	Total 2005	building 2015	Changed (hectare)
1.	<100	57	116	+ 59
2.	100-200	211	293	+ 82
3.	200-300	350	435	+ 85
4.	300-400	461	530	+ 69
5.	400-500	518	558	+ 40

Those all research at Tangerang, Depok and UM and UI saw that Google Earth Data very importance used to detection of land use changes.

4. Conclusion

The conclusion this research on the spatial-temporal land use change detection, using the Google Earth Data, is very importance and very useful as spatial temporal of land use detection for land use mapping.

Acknowledgements

The authors are deeply grateful to Department of Geography, Faculty of Mathematics and Natural Sciences, University of Indonesia for support of the research.

References

[1] Tran Hung, Daisuke Uchihama, Shiro Ochi and Yoshifumi Yasuoka 2006 Assessment with satellite data of the urban heat island effects in Asian mega cities *International Journal of Applied Earth Observation and Geo-information* **8** Issue 1 p34–48

[2] Wong N H and Yu C 2005 Study of Green Areas and Urban Heat Island in a Tropical City *Journal of Habitat International* **29** 547-558.

[3] Ahmad S and Noorazuan Md Hashim 2007 Effects of Soil Moisture on Urban Heat Island Occurrences: Case of Selangor Malaysia *Humanity & Social Sciences Journal* **2** p132-

[4] Chao, Rena, Tejo, Spit, Sanda, Lenzholzerc, Hung, Lam, Steve, Yimd, Bert, Heusinkvelde and Lutz Katzschnerf 2012 Urban climate map system for Dutch spatial planning *International Journal of Applied Earth Observation and Geoinformation* **18** p207–221

[5] Manat Srivanit and Kazunori Hokao 2013 Evaluating the cooling effects of greening for improving the outdoor thermal environment at an institutional campus in the summer *Building and Environment* **66** p158-172

[6] Adi Wibowo, Agung Raditya, Djoko Harmantyo, and Jarot Mulyo Semedi 2015 *Land Surface Temperature as Urban Hazard in Education Area (A Case Study: University of Indonesia) Proceeding the First International Conference of Indonesian Society for Remote Sensing Surabaya Indonesia*

[7] Parham A Mirzae and Haghighat F 2010 Approach to study urban heat island: abilities and limitation. *Journal of Building and Environment* **45** p2192-2201

[8] Rizwan A Memon Dennis Y C Leung and Chun-Ho Liu 2009 An Investigation of Urban Heat Island Intensity (UHII) as an indicator of urban heating *Journal of Atmospheric Research,* **94** Issue 3 p491-500.

[9] Ichinose Toshiaki Matsumoto Futoshi Kataoka and Kumi 2008 Urban thermal environment and its mitigation through urban planning process *Geographical Reports of Tokyo Metropolitan University* **43** p33-40.

[10] Kim Y H and J J Baik 2005 Spatial and Temporal Structure of the Urban Heat Island in Seoul *Journal American Meteorological Society* **44** p591-605

[11] Adi Wibowo, Andry Rustanto and Iqbal Putut Ash Shidiq 2013 Spatial-Temporal Analysis of Urban Heat Signature in Tagerang City *Journal Indonesian Geography* **45** 2 p101-112

[12] Laras Tursilowati, Josaphat Tetuko, Sri Sumantyo, Hiroaki Kuze and Erna Sri Adiningsih 2012 Relationship between urban heat island phenomenon and land use/land cover changes in Jakarta, Indonesia *Journal of Emerging Trends in Engineering and Applied Sciences* **3** 4 p645-653

[13] Laras Tursilowati 2008 Urban Heat Island and their contribution on climate change and relationship with land use change *Proceeding National Seminar on Global Warming and Global Change: Fact, Mitigation and Adaptation*. ISBN 978-979-17490-0-8

[14] Adi Wibowo and Khairulmaini Osman Salleh 2016 *Land Use Cover and Its Effect on Urban Heat Signature: A Spatial Temporal Analysis Proceeding 13th International Asian Urbanization Conference Yogyakarta Indonesia*

[15] Taha Haider 1997 Urban Climates and Heat Islands: Albedo, Evapotranspiration, and Anthropogenic Heat *Energy and Buildings* **25** 2 p99-103

[16] Adi Wibowo and Jarot Mulyo Semedi 2016 *Spatial Temporal Analysis of Air Surface Temperature Behavior on Small City (University) Proceeding the 13th International Asian Urbanization Conference Yogyakarta Indonesia*

[17] Wong N H Jusuf S K Aung L W Htun Kyaw Thu To Syatia and Wu Xuchou 2007 Environmental Study of the Impact of Greenery in an Institutional Campus in the Tropics *Journal of Building and Environment* **42** p2449-2970

[18] Wong N H and Jusuf S K 2008 GIS-based greenery evaluation on campus master plan *Landscape and Urban Planning* **84** p166-182

[19] M F Goodchild 2008 The use cases of digital earth *International Journal of Digital Earth* **1**

Issue **1** p31-42
[20] Shim, David 2014 Remote sensing place: Satellite images as visual spatial imaginaries. *Geoforum* **51** p152–160.
[21] Hu Q, Wu W, Xia T, Yu Q, Yang P, Li Z, and Song Q 2013 Exploring the use of Google Earth imagery and object-based methods in land use/cover mapping. *Remote Sensing* **5** 11 p6026-6042.
[22] Park, L 2009 Digging into Google Earth: An analysis of ‘‘Crisis in Darfur” *Geoforum* **40** p535–545
[23] Nastaran Makaremi, Elias Salleh, Mohammad Zaky, Jaafar Amirhosein, Ghaffarian Hoseini 2012 Thermal comfort conditions of shaded outdoor spaces in hot and humid climate of Malaysia *Building and Environment* **48** p7-14
[24] Anom Cahyo Galih Pranoto Adi Wibowo Djoko Harmantyo 2016 *Analysis Spatial Temporal Urban Heat Island in 2012 and 2015 at Pinang Sub-Districts, Tangerang City Department of Geography Faculty Mathematics and Natural Sciences University of Indonesia Depok West Java Indonesia*
[25] Dwi Fanny Wulandari Adi Wibowo Dewi Susiloningtyas 2016 *Spasial Pattern Studentification in Kukusan Depok West Java* Department of Geography Faculty Mathematics and Natural Sciences University of Indonesia Depok West Java Indonesia