PAPER • OPEN ACCESS

Land mapping with least median of squares regression using landsat imagery: a case study Jakarta and sorrounding area

To cite this article: Bagus Mulyawan *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **852** 012024

View the article online for updates and enhancements.

Tarumanagara International Conference on the Applications of Technology and Engineering 2019
Jakarta, Indonesia | 21-22 November 2019

TICATE

Jakarta, 22 September 2019

No.   : 160-TIM/7440/UNTAR/IX/2019

FULL PAPER ACCEPTANCE NOTIFICATION

Reference Number   : TICATE- 200
Title Model   : Land mapping with least median of square regression using landsat imagery:a case study Jakarta and sorrounding area
Authors   : Bagus Mulyawan,Nicholas Jovianto, Janson Hendrily, Dyah Erny Herwindiati

Dear Mr./Madam

Thank you for your paper submission to the TICATE 2019. The reviewers have now finished reviewing your paper.

According to the results and recommendations from the reviewers, we would like to inform you since your paper has been accepted subject to **revision**. Hence, please improve your manuscript based on the reviewers' comments.

It will be appreciated if you put your Reference Number and your name as your paper revision file name (e.g. TICATE1-021 Bagus Mulyawan).

You need to send us your revised manuscript to the TICATE 2019 committee (ticate@untar.ac.id) by 30 October 2019 to avoid unnecessary delay.

Please complete your registration before 1 November 2019 for regular registration deadline. You are eligible to complete the payment before submitting the revision.

We invite you to present your paper at the conference. Further updated information will be published in our website (http://ticate.untar.ac.id)

If you have any questions, please do not hesitate to contact us.

Thank you very much for your cooperation.

Sincerely,

Dr. Hugeng, S.T.,M.T.(SMIEEE)
        Chairman

Land mapping with least median of squares regression using landsat imagery: a case study Jakarta and surrounding area

Bagus Mulyawan*, Nicholas Jovianto, Janson Hendryli, and Dyah Erny Herwindiati

Faculty of Information Technology, Universitas Tarumanagara, Jakarta 11440, Indonesia

*bagus@untar.ac.id; *Corresponding author's email

Abstract. Impervious surface is an area that has undergone natural or semi-natural substitution of artificial land cover which is usually waterproof and relatively permanent, including settlements, industrial buildings, road networks, railroad networks, high voltage electricity networks, airports air and sea ports. Changes cause the narrowing of rivers and open land which become water catchment areas. One of the problems that triggered an increase in impervious land is urbanization. This study aims to map land changes in the Jakarta and surrounding areas using the least median of squares regression method. Based on data from land classification results using 4 classes, Jakarta and Tangerang are areas that have more impervious land than non-impervious land. Meanwhile, Bogor, Bekasi, and Depok are areas that have more non-impervious land.

1. Introduction

Impervious surface (built up land) is an area that has undergone natural or semi-natural land cover substitution which is artificial cover which is usually waterproof and relatively permanent, including settlements, industrial buildings, road networks, railroad networks, high voltage electricity networks, airports air and sea ports [2]. According to Stankowski (1972) and Arnold & Gibbons (1996), population growth and urbanization are closely related to an increase in the percentage of developed land that cannot absorb water. Expansion of residential areas can result in a decrease in open land to build land that cannot absorb water. Flood disaster in urban areas is one of the real examples of the decline in open land as a water catchment area. In addition to flooding, various other environmental problems can arise as a result of the change in open land, including erosion disasters, landslides and water crises.

2. Method

The existence of outliers in linear regression which is a problem because outliers can cause the formation of a regression parameter model to be less accurate. In overcoming this problem, statisticians try to find alternative estimates of other parameters that are better at overcoming outliers. One of the methods suggested in muscular regression is Least Median of Squares (LMS). Least Median Squares (LMS) is a parameter estimation method with a high breakdown point that was introduced by Peter J. Rousseeuw in 1984. This method predicts the regression parameters by minimizing the median square of the remainder of the observations. The LMS estimator is defined as follows:

$$\hat{b}_{LMS} = \arg\min Q_{LMS}(b). \tag{1}$$

where $Q_{LMS}(b)$ is the median squared remaining of h observations, $\text{med}(e_h^2)$.

In general, the algorithm for applying the LSM Regression method can be summarized in the steps below. Suppose that a data group of size N is given, and you want to expect a vector θ of dimension p that contains the parameters of the data group. The steps that need to be done are:

1. Determine the size of the subset n, the number of subsets M according to the number of classes.
2. Randomly, take M subset size n from sample size N. Find the estimated parameter $\hat{\theta}_j$ for each subset. Find the median squared error e_{ij}^2 from each subset. Index i is the index for the example, and index j is the index for the subset.
3. Define:

$$m = \text{arg min } [med(e_{ij}^2)] \tag{2}$$

So the subset $\hat{\theta}_m$ is a subset with the median least square error and e_{im} is the error vector generated by that subset.

4. Count:

$$S_0 = 1.4826 \left(1 + \frac{5}{N-p}\right) \sqrt{med_i e_{im}^2} \tag{3}$$

5. Calculate the weight of w_i, for example with $w_i = 1$, $\left|\frac{e_i}{S_0}\right| \leq median(e)$ and $w_i = \frac{S_0}{|e_i|}$.
6. Give w_i the weight of each example.
7. Make a fit using the weighted least squares method using wi _as the weight to get the final $\hat{\theta}$.

The method used in building this application is the least median of square regression method. This method is a regression method that is very suitable to be applied to a calculation of the regression equation model when the data held have outliers. This method will form a regression parameter based on the median value of the data so that outliers will not be very influential on calculations. making this application program will require input data in the form of spatial data in the form of Landsat 8 satellite imagery for the Greater Jakarta area. Landsat 8 satellite imagery data that will be used on the system can be downloaded on the USGS Global Visualization Viewer website page (https://glovis.usgs.gov/). The Landsat 8 imagery downloaded will include two intersection files (map codes 122064 and 122065) for each time to cover the whole Jabodetabek area[3]. Jabodetabek map will be used as a subject in the making of an application program to detect changes in land use. The map that is used as data in making this land use change detection application program will cover band 1, band 2, band 3, band 4, and band 5. The choice of using these bands is based on the spectrum represented by each of these bands. Band 1 represents the coastal / aerosol spectrum, making it suitable for detecting territorial waters. Band 2, band 3, and band 4 represent RGB images that are easily captured by the human eye. Band 5 representing the Near-Infrared (NIR) spectrum is commonly used to detect vegetation density when combined with band 4, for example by implementing it in NDVI or SAVI calculations.

3. Result and Discussion

Testing with 4 (impervious land, green land, water, and vacant land) class will use testing data for the Greater Jakarta area in the 2014, 2015 and 2017 periods. Comparison between the actual area and the number of pixels per Jabodetabek scene in Landsat 8. can be seen in Table 1.

Table 1. Number of Pixels Represented for Jakarta and Surrounding Area

City	Area (km²)	Number of pixels per scene
Jakarta	659.26	732,514
Bogor	3,102.35	3,447,053
Depok	180.01	200,015
Tangerang	1,353.45	1,503,838
Bekasi	1,483.90	1,648,775

In image detection using Landsat 8 data, it is known that the resolution of each pixel in the Landsat 8 data represents the original area with a size of 30x30 meters. So that every 1 pixel of Landsat 8 data will represent an actual area of 0.0009 km2. The results of the calculation of land area based on each region in 2014, 2015, and 2017 with observations of 4 classes can be seen in Table 2.

Table 2. Calculation of Land Area for 4 Classes in 2017

City	Impervious (km²)	Green (km²)	Water (km²)	Clear (km²)	Area (km²)
Jakarta	570.2382	76.6107	11,7153	0.6984	659.26
Bogor	302,1255	2,460.9663	17,7795	321.4764	3,102.35
Depok	82.1691	95.0427	0,9243	1.8774	180.01
Tangerang	706.6944	581.7204	50,1795	14.8599	1,353.45
Bekasi	697.8627	596.8539	53,2593	135.9216	1,483.90
Jabodetabek	2,359.0899	3,811.1940	133,8579	474.8337	6,778.98

If categorized as impervious and non-impervious land (green land, water, and vacant land), the comparison of the percentage of impervious and non-impervious land detection results for each region based on 4 class observations can be seen in Table 3.

Table 3. Percentage of Class Impervious and Non-Impevious 4 Land Detection Results

Years	City	*Impervious*	*Non-impervious*
2014	Jakarta	84.78 %	15.22 %
2015	Jakarta	77.54 %	22.46 %
2017	Jakarta	86.49 %	13.51 %
2014	Bogor	8.06 %	91.94 %
2015	Bogor	10.26 %	89.74 %
2017	Bogor	9.75 %	90.25 %
2014	Depok	43.84 %	56.16 %
2015	Depok	39.87 %	60.13 %
2017	Depok	45.64 %	54.36 %
2014	Tangerang	52.41 %	47.59 %
2015	Tangerang	58.11 %	41.89 %
2017	Tangerang	52.21 %	47.79 %
2014	Bekasi	36.23 %	63.77 %
2015	Bekasi	49.45 %	50.55 %
2017	Bekasi	47.02 %	52.98 %

Based on data from land classification results using 4 classes, Jakarta and Tangerang are areas that have more impervious land than non-impervious land. Meanwhile, Bogor, Bekasi, and Depok are areas that have more non-impervious land. Percentage of the amount of impervious and non-impervious land every year experiences fluctuating changes. In the Bogor, Tangerang and Bekasi regions, the number of impervious land has increased in 2015 and decreased in 2017. While in the Jakarta and Depok area, impervious land has decreased in 2015 and experienced an increase in 2017.

4. Conclusion

In general, the most frequent changes in land use in most Jabodetabek areas are land use changes from the type of green land to impervious land. The following are some regional data samples that experienced changes in land use in the period 2014 to 2017 which can be seen from Figure 1 and Figure 2.
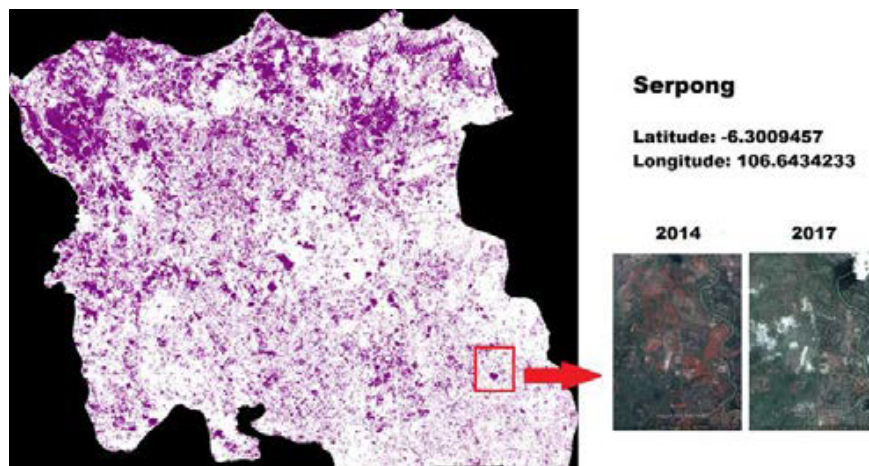
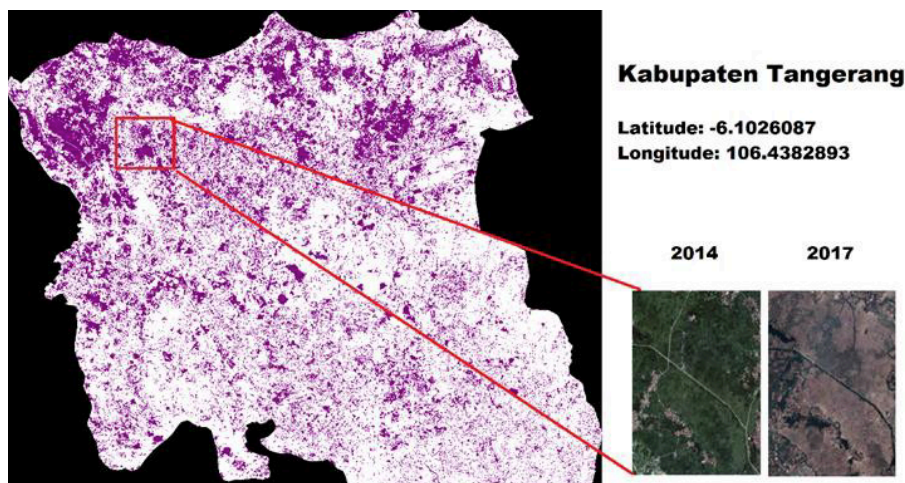**Figure 1.** Serpong Area (2014 and 2017)

Figure 2. Tangerang Area (2014 and 2017)

5. References

[1] Herwindiati, Dyah E., Hendryli, Janson, & Hiryanto, Lely. (2017). Impervious Surface Mapping Using Robust Depth Minimum Vector Variance Regression. *European Journal of Sustainable Developmen*t **6(3)** 29-39

[2] Rousseeuw, P. J. (1984). Least Median of Squares Regression. *American Statistical Association*, 79(388), 871-880

[3] U. S. Geological Survey. (2016). Landsat 8 Data User Handbook. Retrieved from https://landsat.usgs.gov/sites/default/files/documents/Landsat8DataUsersHandbook.pdf

[4] Draper, N. R. & Smith, Harry. (2014). *Applied Regression Analysis, Third Edition*. New York: John Wiley

[5] Rousseeuw, P. J. & Leroy, A.M. (1987). *Robust Regression and Outlier Detection*. New York: John Wiley
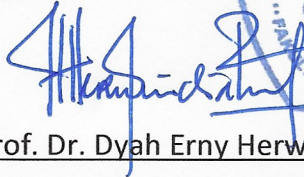
SURAT TUGAS

Nomor : 351-D/740/FTI-UNTAR/XI/2019

PERJALANAN DINAS

1	Pejabat yang berwenang memberi perintah	Dekan Fakultas Teknologi Informasi
2	Nama yang diperintahkan	Bagus Mulyawan, S.Kom., MM
3	Pangkat dan Golongan	Lektor
4	Jabatan	Dosen Tetap
5	Maksud dan Tujuan	Sebagai Pemakalah dalam Seminar Internasional TICATE 2019. Makalah berjudul *"Land Mapping With Least Median Of Squares Regression Using Landsat Imagery: A Case Study Jakarta And Surrounding Area"*
6	Alat angkutan yang digunakan	Kendaraan Umum
7	a. Tempat berangkat b. Tempat tujuan	Fakultas Teknologi Informasi Universitas Tarumanagara, Jakarta
8	c. Tanggal berangkat d. Tanggal kembali	21 November 2019 22 November 2019
9	Pembebanan anggaran	Fakultas Teknologi Informasi
10	Keterangan lain-lain	- Selesai melaksanakan tugas harap • Buat Laporan tertulis (paling lama satu minggu setelah pelaksanaan) • Melakukan Presentasi (bila diperlukan)

Jakarta, 18 November 2019
Dekan

Prof. Dr. Dyah Erny Herwindiati, M.Si

Tembusan :
1. Wadek
2. Ketua Program Studi TI
3. Kabag. Tata Usaha
4. Kasubag. Keuangan, Personalia

Gedung R Lantai 11
Kampus 1 Universitas Tarumanagara
Jl. Letjen S. Parman No.1, Jakarta 11440
P: 021 - 5676260 Ext. 30
F: 021 - 5677949
E: fti@untar.ac.id

http://fti.untar.ac.id   humas@untar.ac.id   FTI UNTAR   fti.untar