The Determination of Village Area in Semarang Regency Using The Circle Method

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Abstrak

Pada penelitian ini, akan dilakukan perhitungan luas seluruh desa (253 desa) yang terletak di kabupaten Semarang. Data yang diperoleh berdasarkan data dari GADM dan Google Earth dengan memanfaatkan titik koordinat (*latitude* dan *longtitude*). Langkah-langkah penelitian yang digunakan adalah (1) mencari titik koordinat batas desa yang ada di kabupaten Semarang berdasarkan data dari GADM dan *Google Earth*, (2) perhitungan luas desa menggunakan 2 metode (metode polygon Karney dan metode lingkaran) dan (3) analisis perbandingan luas desa berdasarkan setiap kecamatan berdasarkan luas acuan dari BPS (Badan Pusat Statistik). Tujuan dari penelitian ini adalah peneliti ingin membuktikan apakah metode polygon yang diusulkan oleh Karney dapat digunakan untuk menghitung luas desa, dengan jumlah total 253 desa yang terletak di kabupaten Semarang. Didapatkan prosentase perbedaan dengan prosentase terendah dan tertinggi berdasarkan data dari GADM dan *Google Earth*. Prosentase terendah menggunakan metode polygon Karney (GADM) sebesar 7.63% dan prosentase tertingi sebesar 66.5%. Prosentase terendah menggunakan metode lingkaran (GADM) sebesar 14.39% dan prosentase tertinggi sebesar 74.79%. Prosentase terendah menggunakan metode polygon Karney (*Google Earth*) sebesar 7.59% dan prosentase tertingi sebesar 66%. Prosentase terendah menggunakan metode lingkaran (*Google Earth*) sebesar 15.87% dan prosentase tertinggi sebesar 234%. Hasil MdAPE untuk data berdasakan dari GADM menggunakan metode polygon Karney sebesar 18.73% dan menggunakan metode lingkaran sebesar 35.19%. Berdasarkan *Google Earth* menggunakan metode polygon Karney didapatkan hasil 18.48% dan menggunakan metode lingkaran sebesar 33.93%. Dapat ditarik kesimpulan bahwa metode polygon Karney dapat digunakan untuk menghitung luas 253 desa pada 19 kecamatan yang teletak di kabupaten Semarang, berdasarkan data dari GADM dan *Google Earth*.

Keyword: GADM, *Google Earth*, Metode Pendekatam Lingkran, Metode polygon Karney

Abstract

This research conducted a calculation of all villages area (253 villages) which located in Semarang regency. The data obtained is based on the data from GADM and Google earth by using the coordinate points (latitude and longitude). The research stage used were (1) finding the coordinate of villages boundaries in Semarang regency based on the data from GADM and Google Earth, (2) calculating the village area using two methods (Karney polygon method and circle method) and (3) analyzing the comparison of villages area based on each district and the reference area from Central Statistics Agency (BPS). The purpose of this research is the researchers would like to find out whether or not the Karney polygon method can be used to calculate the area of 253 villages in Semarang regency. From this research, it obtains the percentage difference with the lowest and highest percentage based on the data from GADM and Google Earth. The lowest percentage uses the Karney polygon method (GADM) of 7.63% and the highest percentage is 66.5%. The lowest percentage uses the circle method (GADM) is 14.39% and the highest

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percentage is 74.79%. The lowest percentage uses the Karney polygon method (Google Earth) is 7.63% and the highest percentage is 66%. The lowest percentage uses the circle method (Google Earth) is 15.87% and the highest percentage is 234%. MdAPE results for the data based on GADM using the Karney polygon method has the percentage of 18.73% and 35.19% by using the circle method. Based on Google Earth using the Karney polygon method, it has the percentage of 18.48% and 33.93% by using the circle method. It can be concluded that the Karney polygon method can be used to calculate the area of 253 villages in 19 districts in Semarang regency based on the data from GADM and Google Earth.

Keyword: GADM, Google Earth, Circle Approach Method, Karney Polygon Method

INTRODUCTION (10%)

Semarang Regency is a regency that has an area of ± 950.21 km2 and has 235 villages/wards which are divided into 19 sub-districts (Central Statistics Agency of Semarang Regency,2020). The largest sub-district is located in the Pringapus sub-district, which has an area of 78.35 km2 (8.25%) and the smallest area is Ambarawa sub-district in which the area is 28.22 km2 (2.97%). There is a lake called Lake Rawa Pening which is located in the middle of Semarang Regency. Besides, there are 8 regencies/cities directly adjacent to Semarang Regency. The temperature in Semarang district is relatively cool as some areas are highlands, with an altitude of 544.21 meters above sea level. Sumowono, Getasan, and Bandungan sub-districts are the subdistricts that have the highest elevation compared to other sub-districts, while the Bancak sub-district is the lowest altitude.

The coordinate system is a direction that will determine the coordinates contained in a map and can be represented in a coordinate point (Wartika & Ghoni, 2018). Coordinate systems can be used to address any location on the earth's surface. Addressing with a coordinate system is based on the distance from East to West, north to south from a certain starting point, and the distance can be measured in units of degrees. The position of a place is addressed by longitude and latitude coordinates. Longitude is usually called the meridian line, which is the straight line that connects from the north to the south pole of the earth (Miftahuddin et al., 2020). The longitude coordinate value starts from 0º longitude in which is Greenwich, then enlarges to the East and West until they meet again at the international boundary line, which is located in the Bering Strait with a value of 180º (Awangga, 2013). The coordinates (latitude and longitude) can be used to calculate the distance between two locations if a straight line is drawn between them (Yulianto et al., 2018).

Google Earth is a GIS (Geographical Information System) service in which to provide information related to locations (maps) that cover the entire world and it's all behind (Zaki, 2010). The source of the images provided by Google Earth is a combination of aerial photography, images (satellite), and GIS processing. Google Earth not only provides the map image, but also it includes the data information from Google Image in the form of latitude and longitude coordinates. Google Earth provides distance measurement of two points using a coordinate system conversion (Islami, 2017).

GADM (Global Administration Area) is a big data that provides maps and spatial data for all countries and sub-divisions. The data information that will be presented to the user is in the form of latitude and longitude coordinates, the name of the region, and the boundaries of the region that have each level. Level 1 contains provincial areas, level 2 contains district areas, level 3 contains sub-district areas and level 4 contains village areas (Hijmans, 2018).

Based on the background which has been explained, the researcher would like to strengthen the previous research conducted by Windarni, et al., with the title Determination of Land Area with the Circle Approach Method Based on Google Earth and GADM for the Region. District (Windarni et al., 2021). The research which conducted by Windarni et al. calculated all the subdistricts (19 sub-districts) in Semarang Regency by utilizing data from GADM and Google Earth using the

Karney polygon method and the circle method. The study concluded that the comparison between area calculations using data from Google Earth and GADM using the circle and Karney polygon approach shows that GADM data using the Karney polygon method is better than others. The Karney polygon method is considered better since it has a smaller percentage of 9.71% and is close to the results of BPS.

Through this study, the researcher would like to calculate a wider land area, it is to count all villages in Semarang Regency with a total of 235 village/wards. 2 methods used to calculate the village area in the district Semarang, is the circle method and the polygon method proposed by Karney which will then be analyzed and the results will be compared with the actual area based on information data from BPS. The researcher makes use of the data owned by Goggle Earth and GADM (level 4) and uses the R software as a tool to solve the problem. The R software is used on this method since there are a lot of tools that can be used in statistical data analysis, including linear and non-linear modeling, time series analysis, statistical tests, classification and clustering, and others (Syaifudin, 2020).

There are some different findings which can be concluded through this research, such as this research calculated a wider area, it is the area of all villages in Semarang district, a total of 253 villages scattered in each area subdistricts, while the research conducted by Windarni, et al., is calculated the total area of the subdistricts (19 subdistricts) in Semarang regency. The purpose of this study is to prove whether the data obtained from GADM using the polygon method proposed by Karney can also be used to calculate the area results on a larger scale, it is for counting all villages in Semarang district (253 villages).

METHODOLOGY

Research Flow

This research was held according to the research flow which can be seen in Figure 1. The circle approach and the polygon method proposed by Karney used in this research and utilize data from Google Earth and GADM to calculate the area of all villages in Semarang district. The research flow used is as follows:

1. Data search

Data search in this research is a land boundary coordinates in the form of latitude and longitude in which taken from GADM and Google Earth. The data taken in GADM is level 4 since level 4 contains land boundaries for the village scope. In this research, the 235 villages are taken through the boundaries of the scope of land in the Semarang Regency.

2. Data Processing

As the data of land boundary coordinates in a form of latitude and longitude through GADM dan Google Earth from the scope of villages in Semarang district, each village calculated by using the polygon method proposed by Karney and the circle approach. There are several steps done in using the Karney polygon method. These stages are as below:

a. In conducting the program by using R software, firstly is creating the code. Karney proposed the polygon method which can be used to calculate the area if given the coordinates of the land/region boundary (Karney, 2013). To calculate the village area based on GADM, it will use level 4 (village/ward).
b. Discover the distance between point P and point A using the equation (17), where point P is the center of the circle and point A is on the land boundary.
c. Calculate r (radius of the circle) to calculate land boundary to the center of mass.
d. Calculate the area of the village in the district of Semarang, by using equation (1).

3. Result Analysis

At this stage, an analysis of the results of the comparison of the area of 235 villages in Semarang district is conducted. The analysis used the data based on GADM and Google Earth through the circle method and the polygon method proposed by Karney. Then the results were analyzed and compared with the actual area based on information data from BPS.

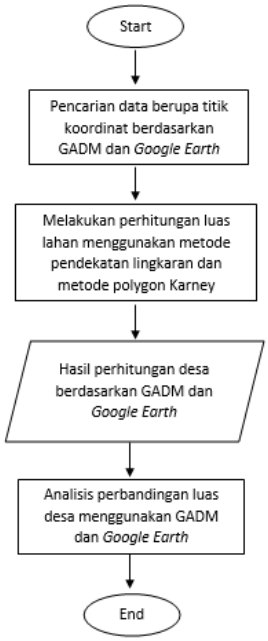


Figure 1. Research Flowchart

Literature review

The research to determine the land area has been conducted by several researchers by utilizing data from both GADM and Google Earth using the polygon method proposed by Karney and the circle method. The previous research such as The application of the truncated cone and square method in the calculation of the area of contoured land using the help of Google Earth / Google Maps information media (Alivah et al., 2016b), Determination of Flat Land Area Using the Circle Approach Method Based on Google Earth / Google Maps (Devi et al., 2016), The Use Of Google Maps And Circle Approach Method in Land Area Measurement (Alifah et al., 2016c), Determination of Land Area through Google Earth (Alivah et al., 2016a), Determining the area of regencies and cities in the province of Central Sulawesi using the polygon method through Google Earth (Basaria et al., 2018), Determination of Indonesia's Mainland Area Based on Big Data from the GADM Database Using the Circle Approach Method (Prayogi et al., 2019), and Determination of Land Area through Circle Approach Method based Google Earth and GADM for Semarang Regency Area (Windarni et al., 2021).

Area Approach Method

Prayogi et al. state that the circular approach method is a faster method used to calculate the area of an area rather than using the regular polygon method. The center of mass and the average distance (center of mass to the boundaries of the area) counted by using the circular approach method is r (Vincenty, 1975). The formula for the area of a circle can be found in equation (1), where = 3.14 and r is the radius.

$$L=\pi r^2 \quad (1)$$

The distance of Vincenty

Vincenty distance is a distance used to calculate the distance between two points on the earth's surface which is assumed to be in the form of an ellipsoid (Vincenty, 1975). For example, there are 2 points (A and B), thus the A (Φ1, L1) and B (Φ2, L2). Given the coordinates of two points (Φ1, L1) and (Φ2, L2), the inverse problem finds the azimuth α1, α2, and the ellipsoidal

distance s. Calculate the U1, U2, and L, by setting the initial value of λ = L and evaluate the iterative as follows up to λ.

$$\sin\sigma = \sqrt{(\cos U_2 \ \sin\lambda)^2 + \ (\cos U_1 \ \sin U_2 - \sin U_2 \cos U_2 cos\lambda)^2} \quad (2)$$

$$\cos\sigma = \sin U_1 \sin U_2 + \cos U_1 \cos U_2 \cos\lambda \quad (3)$$

$$\sigma = arctan\frac{\sin\sigma}{\cos\sigma} \quad (4)$$

$$\sin\alpha = \frac{\cos U_1 \cos U_2 \sin\lambda}{\sin\sigma} \quad (5)$$

$$\cos(2\sigma m) = \cos\sigma - \frac{2\sin U_1 \sin U_2}{cos^2\alpha} = \cos\sigma - \frac{2\sin U_1 \sin U_2}{1-sin^2\alpha} \quad (6)$$

$$C = \frac{f}{16}cos^2\alpha[4 + f(4 - 3\,cos^2\alpha] \quad (7)$$

$$\lambda = L + (1 - C)f \sin\alpha\{\sigma + C\ sin\sigma[\cos(2\sigma m) + C\ cos\sigma(-1 + 2cos^2(2\sigma m))]\} \quad (8)$$

When λ converged to the preferred level of accuracy (10-12 around 0.06 mm), evaluate the following:

$$U^2 = cos^2\alpha(\frac{a^2-b^2}{b^2}) \quad (9)$$

$$A = 1 + \left(\frac{u^2}{1024}\right)\{4096 + u^2[-768 + u^2(320 - 175u^2)]\} \quad (10)$$

$$B = \left(\frac{u^2}{1024}\right)\{256 + u^2[-128 + u^2(74 - 47u^2)]\} \quad (11)$$

$$\Delta\sigma = B\ sin\sigma\{\cos(2\sigma m) + \frac{1}{4}B[cos\sigma(-1 + 2\,cos^2(2\sigma m)) - \frac{b}{6}\cos(2\sigma m)(-3 + 4cos^2(2\sigma m))]\} \quad (12)$$

$$s = bA\ (\sigma - \Delta\sigma) \quad (13)$$

$$\alpha_1 = arctan2\ (cosU_2 \sin\lambda, cosU_1 \sin U_2 - \sin\ U_1 cosU_2 cos\lambda) \quad (14)$$

$$\alpha_2 = arctan2\ (cosU_2 \sin\lambda, -\sin U_1 \cos U_2 + \cos\ U_1 sinU_2 cos\lambda) \quad (15)$$

In which,

a : radius at the equator (6378137.0 meter),
f : Flattening the ellipsoid (1/298.25722356),
b : (1−*f*) a: radius at the poles (6356752.314245 meters),
Φ1, Φ2 : latitude point,
U1 = arctan ((1 − *f*) tan Φ1), U2=arctan ((1 − *f*) tan Φ2)
: reduce the latitude (latitude on additional balls),
L : L2 − L1: The difference in longitude of two points,
λ1, λ2 : Longitude of the points on the additional sphere,
α1, α2 : Advance *azimuth* at points,
α : *azimuth* at the equator
S : Ellipsoidal distance between two points
σ : Length of arc between points on the additional sphere.

Earth Assumed is Ellipsooid Shape

Meeus states that the earth can be assumed as an ellipsoid, assuming that the two points used are on the surface of the earth in the form of an ellipsoid (Meeus, 2003). 1998). In this case, a is the radius of the earth at the equator and f (flattening), then it can be calculated as in equation (16), with ω in a radian as follow. Thus, the distance between the two points can be determined by equation (17).

$$F = \frac{\varphi_1+\varphi_2}{2}, G = \frac{\varphi_1-\varphi_2}{2}, \lambda = \frac{L_1-L_2}{2} \quad (16)$$

With ω in radians,

$$a = 6378.14, f = \frac{1}{298.257}$$

$D = 2\omega a, H_1 = \frac{3R-1}{2C}, H_2 = \frac{3R+1}{2S},$

$$s = \mathrm{D}(1 + fH_1 \sin^2 F\cos^2 G - fH_2 \cos^2 F\sin^2 G) \quad (17)$$

RESULT AND DISCUSSION

The geographical location of Semarang Regency is 110°14'54,75" - 110°39'3" East Longitude and 7°3'57" - 7°30'0" South Latitude which limits the area of ± 950.21 km2. There are 19 sub-districts spread across Semarang Regency with regional boundaries which can be seen in Table 1. Each sub-district has a different number of villages, if seen in Figure 2, the highest total number of villages is 17 villages is in Suruh and Pabelan sub-districts. While the lowest village is 9 villages located in the sub-districts of Bawen, Bancak, and Pringapus.

Table 1. Boundary Points (Latitude and Longtitude) in Each District

No	Sub-districts	*Latitude*	*Longitude*
1	Getasa	-7.376397	110.440711
2	Tengaran	-7.420203	110.522245
3	Susukan	-7.410219	110.592061
4	Kaliwungu	-7.461543	110.616430
5	Suruh	-7.367290	110.572687
6	Pabelan	-7.296055	110.511849
7	Tuntang	-7/296055	110.453618
8	Banyubiru	-7.293527	110.404019
9	Jambu	-7.275389	110.371920
10	Sumowono	-7.224514	110.320582
11	Ambarawa	-7.255641	110.404555
12	Bandungan	-7.222625	110.366525
13	Bawen	-7.223682	110.430463
14	Bringin	-7.253077	110.520259
15	Bancak	-7.238344	110.591839
16	Pringapus	-7.189225	110.464667
17	Bergas	-7.186676	110.426771
18	West Ungaran	-7.129417	110.386462
19	East Ungaran	-7.133881	110.437172

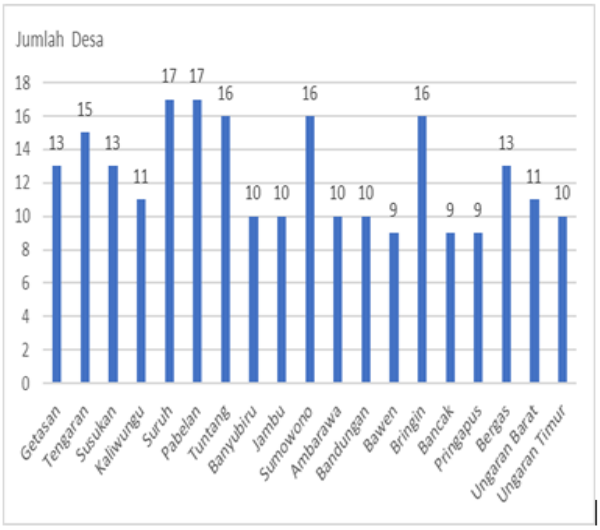


Figure 2. Total Villages in Each District

The example can be seen in the Tengaran sub-district which was chosen randomly and has a total of 15 villages. The 15 villages are Tegalrejo village, Barukan village, Bener village, Need village, Cukil village, Duren village, Karangduren village, Klero village, Nyamat village, Patemon village, Regunung village, Sruwen village, Sugihan village, Tegalwaton village and Tengaran village. The results of the calculation of the village area (Ha) in the Tengaran sub-district which was calculated by using the Karney polygon method and the circle method based on data from GADM and Google Earth can be seen in Table 3.

Table 3. Results of Village Areas in Tengaran District based on Data from GADM and Google Earth

No	Village	GADM		Google Earth		Central Statistics Agency (BPS)
		Polygon Method by Karney	Circle Method	Polygon Method by Karney	Circle Method	
1	Tegalrejo	225 ha	215 ha	220 ha	219 ha	215 ha
2	Barukan	323 ha	493 ha	325 ha	442 ha	254 ha
3	Bener	283 ha	324 ha	283 ha	292 ha	272 ha
4	Butuh	262 ha	284 ha	262 ha	275 ha	261 ha
5	Cukil	282 ha	322 ha	281 ha	299 ha	362 ha
6	Duren	433 ha	427 ha	424 ha	414 ha	453 ha
7	Karangduren	561 ha	602 ha	561 ha	588 ha	509 ha
8	Klero	287 ha	308 ha	286 ha	320 ha	288 ha
9	Nyamat	150 ha	184 ha	149 ha	159 ha	147 ha
10	Patemon	384 ha	364 ha	352 ha	296 ha	372 ha
11	Regunung	468 ha	473 ha	468 ha	438 ha	347 ha
12	Sruwen	319 ha	309 ha	317 ha	296 ha	296 ha
13	Sugihan	242 ha	304 ha	242 ha	308 ha	339 ha
14	Tegalwaton	398 ha	434 ha	399 ha	448 ha	346 ha
15	Tengaran	191 ha	205 ha	190 ha	212 ha	261 ha

After obtaining the results of the village area in the Tengaran sub-district, the next step was to find the percentage difference, by comparing the area results that have been obtained based on data from GADM and Google Earth, both using the polygon method proposed by Karney and the circle method with a reference area from Central Statistics Agency (BPS). The different areas and reference areas produced the percentage difference which can be found by using the following formula:

$$\text{Percentage} \left| \frac{\text{The result of the calculated area} - \text{The reference area}}{\text{The reference area}} \right| \text{x } 100\%$$

Table 4. Percentage of Differences in Village Areas in Tengaran District

No	Village(s)	GADM		*Google Earth*	
		Polygon Method by Karney	Circle Method	Polygon Method by Karney	Circle Method
1	Tegalrejo	4.65 %	0.00 %	2.33 %	1.86 %
2	Barukan	27.17 %	94.09 %	27.95 %	74.02 %
3	Bener	4.04 %	19.12 %	4.04 %	7.35 %
4	Butuh	0.38 %	8.81 %	0.38 %	5.36 %
5	Cukil	22.10 %	11.05 %	22.38 %	17.40 %
6	Duren	4.42 %	5.74 %	6.40 %	8.61 %
7	Karangduren	10.22 %	18.27 %	10.22 %	15.52 %
8	Klero	0.35 %	6.94 %	0.69 %	11.11 %
9	Nyamat	2.04 %	25.17 %	1.36 %	8.16 %
10	Patemon	3.23 %	2.15 %	5.38 %	20.43 %
11	Regunung	34.87 %	36.31 %	34.87 %	26.22 %
12	Sruwen	7.77 %	4.39 %	7.09 %	0.00 %
13	Sugihan	28.61 %	10.32 %	28.61 %	9.14 %
14	Tegalwaton	15.03 %	25.43 %	15.32 %	29.48 %
15	Tengaran	26.82 %	21.46 %	12.95 %	16.90 %
Average		12.78 %	19.28 %	12.95 %	16.90 %

The results of the village area (15 villages) located in the Tengaran sub-district can be seen in Table 4. Based on the data obtained through the average data from GADM, the lowest percentage results used the Karney polygon method which was 12.78% more than the reference area, while using the circle method obtained a percentage of 19.28% more than the reference area. Based on data taken from Google Earth, the lowest percentage results are using the Karney polygon method which is 12.95% wider than the reference area, while using the circle method the percentage is 16.90% wider than the reference. It can be concluded that the use of the Karney polygon method based on data from GADM and Google Earth is considered better as the value is close to BPS (Central Statistics Agency).

Table 5 shows the percentage of village area yields based on each sub-district in Semarang district. Based on data from GADM and Google Earth, it can be seen that the percentage is the difference, from the lowest to the highest. Based on data from GADM using the Karney polygon method, the lowest percentage yield is 7.63%, while the highest percentage is 66.5%, and using the circle method the lowest percentage is 14.39% and the highest is 79.65%. If viewed from Google Earth using the Karney polygon method, the lowest percentage is 7.58% while the highest is 66%, and using the circle method the lowest percentage is 15.87% and the highest is 234%.

Table 5. Results of the Percentage of Differences in Village Areas in Each District

No	Village(s)	GADM		*Google Earth*	
		Polygon Method by Karney	Circle Method	Polygon Method by Karney	Circle Method
1	Getasan	22.33%	57.74%	23.14%	46.58%
2	Tengaran	12.78%	19.28%	12.95%	16.9%
3	Susukan	13.27%	28.81%	17.45%	29.61%
4	Kaliwungu	13.56%	42.57%	15.5%	39.66%
5	Suruh	7.63%	18.86%	7.58%	15.87%
6	Pabelan	18.73%	21.15%	18.48%	29.7%

7	Tuntang	22.34%	35.27%	24.77%	30.8%
8	Banyubiru	10.67%	14.39%	16.75%	39.25%
9	Jambu	14.41%	41.17%	9.59%	33.45%
10	Sumowono	19.14%	22.13%	19.14%	24.24%
11	Ambarawa	29.22%	35.19%	29.91%	34.35%
12	Bandungan	66.04%	79.65%	66%	81.24%
13	Bawen	23.16%	36.52%	51.4%	40.47%
14	Bringin	15.93%	19.4%	16.12%	17.53%
15	Bancak	12.43%	24.01%	12.47%	22.17%
16	Pringapus	23.91%	35.41%	25.24%	33.93%
17	Bergas	19.78%	43.95%	18.46%	45.87%
18	West Ungaran	10.97%	22.59%	19.31%	234%
19	East Ungaran	66.5%	74.79%	65.94%	74.49%
MAPE		22.25%	35.41%	24.74%	46.84%
MdAPE		18.73%	35.19%	18.48%	33.93%

After obtaining the lowest and highest percentage values, then the next step analyzed the MAPE (Mean Absolute Percentage Error) which was used to find the difference of overall average percentage from the village area in each sub-district, through the referenced data and sought data. Then the median MdAPE (Median Absolute Percentage Error) was searched, the formula for MdAPE (19) is as follows Armstrong & Collopy, 1992):

$$MdAPE = median\left\{\left|\frac{y_i - \hat{y}_i}{y_i} x100\right|, i = 1,2, \dots, n\right\} \quad (19)$$

The result of MdAPE for data based on GADM through the Karney polygon method is 18.73% and through the circle, the method is 35.19%. Based on Google Earth using the Karney polygon method, the result is 18.48%, and using the circle method is 33.93%. Karney polygon method based on data from GADM and Google Earth can be used to calculate the area of 253 villages in Semarang district. There is a sub-district that has different results from other sub-districts, it is the Bawen sub-district. The percentage result through data from GADM dan Google Earth by using the Karney polygon method and circle method is different. The percentage of total village area in Bawen sub-district based on data from GADM using the Karney polygon method is 23.16% and using the circle method has a percentage of 36.52%. Based on data from Google Earth, which used the circle method of 40.47% and uses the Karney polygon method, the percentage is 51.4%, as shown in Table 5.

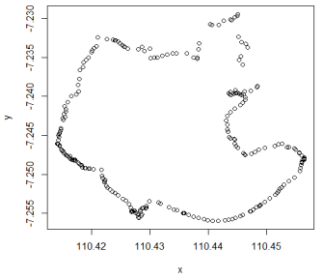
Table 6. Results of Village Areas in Bawen District Based on Data from GADM and Google Earth

No	Village(s)	GADM		Google Earth		Central Statistics Agency (BPS)
		Polygon Method by Karney	Circle Method	Polygon Method by Karney	Circle Method	
1	Asinan	467 ha	604 ha	775 ha	560 ha	775 ha
2	Bawen	788 ha	887 ha	2489 ha	1240 ha	581 ha
3	Doplang	284 ha	297 ha	285 ha	306 ha	372 ha
4	Harjosari	592 ha	538 ha	595 ha	521 ha	457 ha
5	Kandangan	917 ha	1189 ha	916 ha	1058 ha	945 ha
6	Lemahireng	742 ha	740 ha	743 ha	815 ha	601 ha
7	Polosiri	801 ha	1130 ha	801 ha	1072 ha	585 ha
8	Doplang	284 ha	297 ha	285 ha	306 ha	372 ha
9	Poncoruso	133 ha	170 ha	133 ha	161 ha	127 ha

10	Samban	209 ha	262 ha	210 ha	250 ha	187 ha

As seen in Table 6, the result areas in Bawen village are different from the reference results (BPS). Based on data from Google Earth through the Karney polygon method and the circle method, the area of Bawen by village using the Karney polygon method is 2489 ha and using the circle method is 1240 ha, while the area based on the BPS reference is 581 ha. The difference is due to differences in regional boundaries based on GADM and Google Earth which can be seen in Table 7.

Table 7. Results of Differences in Bawen Village Area Boundaries Based on Data from GADM and Google Earth

Desa Bawen	
GADM	
Google Earth	

CONCLUSION

The results of this research can be concluded that based on calculations and discussions using both GADM and Google Earth data, the Karney polygon method can be used to calculate the area of 253 villages in the Semarang district. The lowest and highest percentage differences were obtained based on data from GADM and Google Earth. Based on data from GADM using the Karney polygon method, it shows that the lowest percentage large is 7.63% while the highest percentage is 66.5%, and using the circle method shows the lowest percentage large is 14.39% and the highest is 79.65%. If seen through Google Earth by using the Karney polygon method, the lowest percentage is 7.58% while the highest is 66%, and using the circle method the lowest percentage is 15.87% and the highest is 234%. The MdAPE result for data based on GADM using the Karney polygon method is 18.73% and using the circle method is 35.19%. Based on Google Earth using the Karney polygon method, the results obtained 18.48% and using the circle method of 33.93%. The Karney polygon method based on data from GADM and Google Earth can be used to calculate the area of 253 villages in the Semarang district. The polygon method proposed by Karney can be used to calculate the area of districts, cities, land areas in Indonesia, sub-districts, and villages/wards.

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