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International Conference on Disaster Management and Climate Change IOP Conf. Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing
doi:10.1088/1755-1315/986/1/012061 1 GIS application for spatial analysis of public health centres in response to Covid-19 pandemic Pranichayudha Rohsulina 1, Agung Hidayat 2*, MS. Khabibur Rahman 1, Talitha Rahmawati 1, Bayu Kurniaaji 1 1Geography Education Study Program, Universitas Veteran Bangun Nusantara, Sukoharjo – Indonesia 2 Universitas Sebelas Maret, Surakarta *Email: agung.geographer@gmail.com Abstract.

The COVID-19 pandemic has made many people aware of the real condition of the national health system. The efforts to handle the pandemic occurred simultaneously throughout the territory of Indonesia that had never been thought of before. The Ministry of Health through the Health offices is working hard to tackle the Covid 19 outbreak. Public Health Centers are the technical implementing units in each region that have duties in carrying out promotive, preventive, curative, and rehabilitative efforts.

Problems arise when the service standards of the public health center are not the same in all regions of Indonesia. On the other hand, the reachability of health facilities is still a problem in some places. In this study, we are interested in mapping the pattern and reachability of level one health facilities in Nguter Sub-District, Sukoharjo Regency, Central Java, Indonesia using a geographic information system (GIS). This study would be spatially analysed by using nearest neighbour method in ArcGIS. The evaluation of reachability was done by using a minimum service standard by the Decree of the Minister of Settlement and Regional Infrastructure No. 534/KPTS/M/2001.

The results showed that the mapped health facilities in Nguter Sub-District were 2 Public Health Centers and 3 Sub-Public Health Centers. Based on the analysis of the nearest

neighbors, the public health center in the Nguter Sub-District show a dispersed pattern. From the results of buffering, it is known that almost the entire area of Nguter Sub-District has covered by the Public Health Centers and Sub-Public health centers. 1.

Introduction For more than a year, the world including Indonesia has been struck by the Corona Virus Disease 19 (Covid 19) pandemic. The deadly virus has infected more than 183 million people and caused the deaths of nearly 4 million people (Figure 1). In Indonesia, Covid 19 has infected more than 2.3 million people and caused the death of more than 61,000 people (Figure 2) [1]. The impact of Covid 19 is very broadly felt by the population, both in health sector and other sectors such as economy and social. International Conference on Disaster Management and Climate Change IOP Conf.

Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 2 Figure 1. The Global situation of confirmed numbers and deaths from Covid 19 [2] The spread of the virus is very fast due the transmission model between humans who have close interaction with the infected people of covid-19 virus (Figure 2). To date, epidemiologists have not succeeded in finding a vaccine that can prevent the spread of the corona virus.

The only way to prevent the spread is to take preventive measures such as frequent washing hand, wearing masks, maintaining distance and avoiding crowds. Figure 2. The cases of Covid 19 in Indonesia [3] Since it was first announced by the Indonesian President where two Indonesian citizens were positively infected by covid-19, the government immediately took action to handle it. One of them was by activating the referral hospitals for covid 19 as well as the community health centres as the spearhead in handling covid 19 cases in sub-district level.

The community health centre (which is later called Puskesmas) as an extension of the District Health Office plays an important role as the Level 1 of Health facility, who has authorization to handle covid 19 outbreak. Puskesmas has many tasks, especially during this Covid-19 pandemic. According to the Technical Guidelines for Public Health Centers during Covid 19 Pandemic issued by the Ministry of Health, Health Center or Puskesmas has duties to provide education about COVID-19, to conduct tracing on the close contacts of affected people, to monitor self-isolated patients, to refer COVID-19 patients to referral hospitals, to play an active role in socializing the prevention efforts, and to collect the data of the suspected people of covid 19.

If the suspects experience COVID-19 International Conference on Disaster Management and Climate Change IOP Conf. Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 3 symptoms, they will be

referred to referral hospital to get further treatment. Besides, the health center also becomes the first line in vaccinating people as the effort to tackle the outbreak. These additional functions can be interpreted as additional workload for them that makes the responsibility of health center is drastically increasing, and worsely some of their staffs are also affected by covid 19.

By considering the strategic function of the first-level health facilities in coping the covid 19 outbreak in both of preventive and curative measures, we are interested to conduct a study on the existence of health center and sub-health center in Nguter District, Sukoharjo Regency related to the distribution pattern and the reachability for the community. The mapping and the reachability analysis was carried out using Geographic Information System (GIS) technology [4] in which this technology has helped researcher in mapping and spatial analysis activity [5 12].

The evaluation of the reachability will refer to the Guidelines for Minimum Service Standards for Settlements through the Decree of the Minister of Settlements and Regional Infrastructure No. 534/KPTS/M/2001 for the coverage of the district/city area unit. Hopefully this evaluation can give information about the spatial distribution and the reachability of health center in Nguter Sub-district, Sukoharjo Regency. 2. Method This section will discuss about the object of study area, research tool and material, variable, data collection, data analysis, and research output. 2.1 Study Area and Object of study This study was conducted in Nguter sub-District, Sukoharjo District.

Nguter consists of 16 villages namely Lawu, Baran, Nguter, Gupit, Pengkol, Janggalengan, Tanjungrejo, Serut, Juron, Celep, Plesan, Kedungwinong, Daleman, Kepuh, Pondok, and Tanjung (Figure 3). The object of this study was the service of health facilities in Nguter sub-district. Figure 3. The administration Map of Nguter Sub-District in Sukoharjo International Conference on Disaster Management and Climate Change IOP Conf. Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 4 2.2

Research tool and material This study used the application of Geographic Information System (GIS) to analyse the distribution and the reachability of health facilities including: a. The administration map of Nguter that shows the boundaries areas b. Topographical Map of Nguter sub-district c. Road and river network data The tools used in this study includes: a. Global Positioning system (GPS) Garmin b. Digital Camera c. Field survey sheet d. Stationary e. Laptop installed with ArcGIS, Google Earth, Microsoft Office, and Corel Draw. 2.3

Data Collection The information about the location of health facilities in study area was

collected from Sukoharjo Statistical Bureau followed by field survey using GPS (Figure 4). Figure 4. The field survey in collecting coordinate points of health facilities 2.4 Data Analysis The data obtained from the field survey and imagery interpretation was then analysed in order to produce the map of health and education facilities. The steps were followed: a. Extracting the data of road and rivet network as well as administrative boundaries from Indonesian topographical map b. Input the location data based on field survey using GPS to ArcGIS c. Nguter sub district d.

Analyzing the spatial pattern of health facilities distribution using nearest neighbor analysis. This analysis is used to determine the pattern of a group of objects in certain region whether following random, clustered, or dispersed pattern that is showed from the value of Rn. Nearest neighbor analysis considers 3 aspects which are distance, the number of location points, and area. International Conference on Disaster Management and Climate Change IOP Conf.

Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 5 The Rn value or the nearest neighbor distribution index is obtained from below formula: (1) Rn : Nearest Neighbor value D (obs) : The average distance of neighbor observation a : Area n : The number of points (location) Then, the result of Rn value will be interpreted using Continuum Nearest Neighbor Analysis as pictured below: e. Analyzing the reachability of health facilities using buffering method and comparing with the number of populations within the scope of health facilities. 3.

Result And Discussion 3.1 Description of study area Nguter is one of sub districts in Sukoharjo Regency, Central Java [13]. It is located in the south east of the capital regency with approximately 8,2 km in distance. The area is around 5.488 Ha or about 11,76% of total area in Sukoharjo. To the north is bordered by Bendosari and Sukoharjo sub-districts and to the south by Bulu sub-district and Sukoharjo district. To the east is bordered by Karanganyar Regency and to the west is bordered by Sukoharjo, Tawang Sari and Bulu Districts. Most of the region is plain with the average altitude 104 mdpl.

Administratively, Nguter is divided into 16 villages with the activity center is in Nguter Village as described in Table 1. International Conference on Disaster Management and Climate Change IOP Conf. Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 6 Table 1. The villages and the area in Nguter sub district

No	Village	Area (ha)	%
1	Lawu	436,794	2
2	Baran	252,459	3
3	Nguter	325,592	4
4	Gupit	392,714	5
5	Pengkol	365,665	6
6	Jangglengan	380,692	7
7	Tanjungrejo	356,649	8
8	Serut	390,711	9
9	Juron	320,583	10
10	Celep	292,532	11
11	Plesan	431	

7,85 12 Kedungwinong 392 7,14 13 Daleman 268 4,88 14 Kepuh 395 7,20 15 Pondok 253 4,61 16 Tanjung 241 4,39 Total 5.488 100 Source: Sukoharjo Statistical Bureau, 2020

3.2 Landuse Nguter is entirely rural area where the land is generally used and classified as agriculture and non- agriculture area. The agriculture area includes 2.418 Ha while the non-agriculture area includes 3.070 Ha [13]. The non-agriculture area consists of yard, moor, and others. The land use of each village is presented in Table 2. Table 2. The area of land use in each village in Nguter No Village Paddy Fields (Ha) Moor (Ha) Yard (Ha) Others (Ha) 1 Lawu 245 47 134 10 2 Baran 139 6 104 3 3 Nguter 148 41 123 13 4 Gupit 132 54 180 26 5 Pengkol 85 57 161 62 6 Jangglengan 104 141 68 67 7 Tanjungrejo 152 49 85 70 8 Serut 169 58 138 25 9 Juron 210 19 78 13 10 Celep 92 26 163 11 11 Plesan 115 52 239 25 12 Kedungwinong 158 102 103 29 13 Daleman 167 10 78 13 14 Kepuh 243 8 124 20 15 Pondok 154 13 76 10 16 Tanjung 105 66 66 4 Total 2418 749 1920 401 Source: Agriculture Bureau of Nguter, 2020 [International Conference on Disaster Management and Climate Change IOP Conf. Series: Earth and Environmental Science 986 \(2022\) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061](#) 7 The largest agriculture area is Lawu village with 245 Ha followed by Kepuh village with 243 Ha. While th smallest paddy field area is Pengkol village with only 85 Ha.

On the other hand, the largest moor area is in Jangglengan village with 141 Ha while the smallest one is in Baran village with 6 Ha of moor area. Besides, the biggest yard is in Plesan village (239 Ha) while the least one is in Tanjung village (66 Ha). 3.3 Population 3.3.1 The population number and distribution The total number of people in Nguter in 2019 is 41.811 individuals with 20.708 males and 21.103 females [13]. The highest population is in Nguter village with 3.791 inhabitants and the least number is in Baran village with 1.669 individuals. Table 3 presents the population distribution in Nguter. Table 3.

The number of people per village in Nguter No Village Area (Km2) Male Female Total 1 Lawu 4,36 1359 1393 2752 2 Baran 2,52 834 835 1669 3 Nguter 3,25 1844 1947 3791 4 Gupit 3,92 1574 1517 3091 5 Pengkol 3,65 1279 1313 2592 6 Jangglengan 3,8 956 968 1924 7 Tanjungrejo 3,56 1030 1088 2118 8 Serut 3,9 1221 1200 2421 9 Juron 3,2 1243 1226 2469 10 Celep 2,92 1169 1195 2364 11 Plesan 4,31 1224 1307 2531 12 Kedungwinong 3,92 1411 1389 2800 13 Daleman 2,68 1290 1380 2670 14 Kepuh 3,95 1589 1654 3243 15 Pondok 2,53 1615 1570 3185 16 Tanjung 2,41 1070 1121 2191 Total 54,88 20708 21103 41811 Source: Sukoharjo Statistical Bureau, 2020 3.3.2 Population Density Population density is the number of populations per kilometer square [14].

In Nguter, the population density is 766/km2 with the highest density in Pondok village

(1.265/km²) and the lowest density in Jagglengan village (509/km²). The data of population density is presented in Table 4 International Conference on Disaster Management and Climate Change IOP Conf. Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 8 Table 4. Population Density in Nguter in 2019 No Village Area (Km²) Population Number Population Density (individual/km²) 1 Lawu 4,36 2752 631 2 Baran 2,52 1669 662 3 Nguter 3,25 3791 1166 4 Gupit 3,92 3091 789 5 Pengkol 3,65 2592 710 6 Jangglengan 3,8 1924 506 7 Tanjungrejo 3,56 2118 595 8 Serut 3,9 2421 621 9 Juron 3,2 2469 772 10 Celep 2,92 2364 810 11 Plesan 4,31 2531 587 12 Kedungwinong 3,92 2800 714 13 Daleman 2,68 2670 996 14 Kepuh 3,95 3243 821 15 Pondok 2,53 3185 1259 16 Tanjung 2,41 2191 909 Source : Sukoharjo Statistical Bureau, 2020 3.4

Health Facilities in Nguter There are two levels of health facilities in Nguter which are Puskesmas (Community Health center) and Puskesmas pembantu (Sub Community Health center) and this study will focus on those facilities. The main reason Nguter has been chosen is because its highest population density among other sub districts, so it needs more accessible basic health facilities. In addition, those facilities represent the basic health facilities in a region, particularly in Nguter. Practically those facilities has been supported by their own buildings with professional technical support personnel.

Meanwhile the PKD (Village Health Post) is united with the village office and do not serve public health checks every day. However, However, PKD remains little discussed in the description of the results of this study. There are 2 health centers currently operating, namely Nguter 1 Health Center in Nguter Village and Nguter 2 Health Center located in Celep Village (Figure 5). In carrying out health services to community, the two existing health centers are assisted by 3 sub-health centers located in Lawu, Tanjungrejo, and Pondok villages. International Conference on Disaster Management and Climate Change IOP Conf.

Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 9 (A) (B) Figure 5. (A) Nguter Health Center I in Nguter Village and (B) Nguter II Health Center in Celep Village. At the village level there is a Village Health Post (PKD) located in almost every village. PKD is usually a basic health service for the community coordinated by the local village midwife. It does not serve every day, but only on certain days. Based on field surveys, the PKD in some villages were in fairly good condition, because there is a regular schedule of health services and the health care facilities located in the local village hall.

However, in some villages PKD was inactive either because it is close to the Puskesmas or indeed the village conditions do not allow it. The complete facilities of Puskesmas,

Pustu, and PKD in Nguter District are presented in Table 5. Table 5. The facilities of Puskesmas, Puskesmas Pembantu (Pustu), and PKD in Nguter No Village Puskesmas Pustu PKD 1 Lawu 0 1 1 2 Baran 0 0 1 3 Nguter 1 0 0 4 Gupit 0 0 1 5 Pengkol 0 0 1 6 Jangglengan 0 0 1 7 Tanjungrejo 0 1 1 8 Serut 0 0 1 9 Juron 0 0 1 10 Celep 1 0 1 11 Plesan 0 0 1 12 Kedungwinong 0 0 1 13 Daleman 0 0 1 14 Kepuh 0 0 1 15 Pondok 0 1 1 16 Tanjung 0 0 1 Total 2 3 15 Source: BPS, 2020 [15] International Conference on Disaster Management and Climate Change IOP Conf.

Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 10 Figure 6. shows the spatially distribution of basic health facilities (Puskesmas and Puskesmas Pembantu) in Nguter. Figure 6. The distribution of basic health facilities in Nguter 3.5 Spatial Pattern of health facilities The spatial analysis to see the pattern of a group of objects distribution in an area can be done by using nearest neighbor analysis [5,9]. This analysis is used to determine the pattern of a group of objects in an area whether it follows a random, clustered, or uniform pattern as indicated by the magnitude of the Rn value.

This analysis considers 3 aspects namely distance, number of location points, and area. The value of Rn (the nearest neighbor spread index) is obtained through the formula: (2) $R_n = \frac{D(\text{obs})}{D(\text{exp})}$ where D (obs) : The average distance of observed neighbor a : Area n : The number of points (location) Then, the Rn value will be interpreted by using Continuum Nearest Neighbor Analysis which is pictured below: International Conference on Disaster Management and Climate Change IOP Conf. Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 11 The result shows that the spatial distribution of health services in Nguter is following dispersed pattern. These are the results using ArcGIS 10.2

software: Average Nearest Neighbor Summary Observed Mean Distance: 3300,006943 Meters Expected Mean Distance: 1852,025918 Meters Nearest Neighbor Ratio: 1,781836 z-score: 2,991415 p-value: 0,002777 Dataset information Input Feature Class : puskesmas Distance Method : EUCLIDEAN Study Area : 54880000,00 Meters The graphic that shows the result of nearest neighbor analysis is presented in Figure 7. Figure 7. The result of nearest neighbor analysis of basic health facilities in Nguter International Conference on Disaster Management and Climate Change IOP Conf. Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 12 3.6 The Reachability of health facilities The reachability analysis of health facilities in Nguter was done by doing the comparison between the real condition with the minimum standard of health facilities based on SNI 03-1733-2004.

The radius range of one public health services is 3000 m and for one sub-public health services is 1500 m. To get this, buffering analysis was undertaken by pulling out the distance about 3000 m from the point of health facilities and 1500 m from the auxiliary health facilities (Figure 8). The public health services were symbolized by red plus and the sub-public health services were symbolized by blue plus. From buffering, it can be understood that almost the entire area of Nguter was covered by health facilities service.

Only a small part of the area was not covered by health facilities service. Figure 8. The radius of health facilities service in Nguter Even though in terms of distance that small area is beyond the range of health facilities, but the good condition of road facilities which is categorized as arterial type makes the time travel become reachable for the community. The location reachability is not only seen from the proximity of the distance but also the road network. This road network will determine the closest alternative access to reach the location.

As closer the location of health facilities and as better the road network, as more useful these facilities for the community. Table 6 proves this statement based on the field survey of Village Potency in 2019 that shows the ease of local community to reach health facilities such as hospital, health center, and pharmacy. International Conference on Disaster Management and Climate Change IOP Conf. Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061 13
Table 6.

The Reachability easiness of health facilities in Nguter in 2019 No Village Hospital Health Facilities (Puskesmas) Pharmacy 1 Lawu Easy Easy Easy 2 Baran Easy Easy Easy 3 Nguter Easy Very Easy Very Easy 4 Gupit Easy Easy Very Easy 5 Pengkol Easy Easy Easy 6 Jangglengan Easy Easy Easy 7 Tanjungrejo Easy Easy Easy 8 Serut Easy Easy Easy 9 Juron Easy Easy Easy 10 Celep Easy Very Easy Very Easy 11 Plesan Easy Easy Very Easy 12 Kedungwinong Easy Easy Easy 13 Daleman Easy Easy Easy 14 Kepuh Easy Easy Easy 15 Pondok Easy Easy Easy 16 Tanjung Easy Easy Very Easy Total 2 3 15 Source: PODES Survey [16] 3.7

The Sufficiency Evaluation of Health Facilities To evaluate the sufficiency of health facilities service, the comparison with SNI 03-1733-2004 as the minimum standard of health facilities was done. The minimum service standard (threshold) for 1 health service is 120.000 people while the threshold for sub-health service is 30.000 people. The calculation of the sufficiency level of health facilities is presented in Table 7. Table 7. The calculation of the sufficiency level of health facilities in Nguter Health Facilities Population Threshold Requirement Availability FCC Sub health service 41811 30000 2 3 1,5 Health service 41811 120000 1 2 2 Based on above table, the carrying capacity of

sub health service is 1,5 while for the health service is 2. It means that the existing facilities are able to support the needs of population. Facility Carrying Capacity (FCC) value > 1 can be interpreted as sufficient service level (surplus).

4 Conclusion **The Covid-19 pandemic has** taught us about the importance of public health facilities as one of the spearheads in handling the pandemic. Based on the results of the mapping conducted in Nguter District, there are two **public health centers and** three sub-public health centers. The nearest neighbor analysis shows that health service facilities in Nguter indicate a dispersed pattern. This means that the existing of public health facilities are well spread in the Nguter District area. The buffering analysis also gives result **that almost the entire area of Nguter** is covered by public health centers.

Only a small part of the area is not covered by their facilities. Finally, the calculation of the carrying capacity of **International Conference on Disaster Management and Climate Change IOP Conf. Series: Earth and Environmental Science 986 (2022) 012061 IOP Publishing doi:10.1088/1755-1315/986/1/012061** 14 public health services shows that the existing facilities have been able to support the needs of population.

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