International Summit on Science Technology and Humanity
ISETH 2024
ISSN: 2615-1588 (online)

# Analysis of Shelters for Floods Disaster Management in Central Klaten and South Klaten Klaten District

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**Abstract**

*Purpose*: The goals of this research are (1) to analyze the distribution of shelter or houses that suitable temporary shelters during disaster and (2) examine the capacity and supportability the area for the temporarry shelter during disaster.
*Methodology*: The research methodology includedm followed by a descriptive quantitive approach and analysis of the carrying capacity of settlements.
*Results*: The findings indicate a clustered distribution pattern of shelter in South Klaten sub-district (NNR value of 0.366222 and a z-score of - 18.900393) in Central Klaten sub-district ( NNR of 0.468301 with a z-score of -15. The settlement carrying capacity value in both sub-districts are greater than 1, suggesting they can accommodate additional populations of 27,500 and 4,205 people, respectively.
*Applications/Originality/Value*: Distribution Pattern, Hydrometeorological Disaster, Nearest Neighbourhood Analyze, Shelter, Supportability

## Introduction

Indonesia is a country with disaster-prone areas and high disaster risk (Latofiana, 2021). The National Disaster Management Agency states that hydrometeorological disasters are disasters that still occur frequently in Indonesia. Hydrometeorological disasters such as floods, landslides and tornadoes are the most dominant disasters in Indonesia (Rosyida et al., 2019). Meteorological and hydrological conditions such as tornadoes, storms, floods, extreme or high-intensity rain, cause hydrometeorological disasters (Adi, 2013). According to Sularso, hydrometeorological floods are Indonesia's most costly material and non-material disasters (Sularso et al., 2021). Global climate change, such as rainfall and changes in land use and riverbanks for settlements influences flooding, which is experiencing an increasing frequency of occurance from year to year (Nugroho, 2018). Many people use land on the riverbanks, which is prohibited for building buildings (Setyadi, 2013). According to Mononimbar, along with the high population increase, many areas of the city that are unsuitable for development are used or used as settlements, including riverbank areas that are prone to flooding (Mononimbar, 2014). Settlement has become one of the most basic needs for humans. The increase in population that is not proportional to the existing area causes the need for housing to be even higher. To deal with this, a solution is needed that is expected to overcome the high demand for housing (S, 2020).
The rapid increase in population has led to people needing a decent place to live. Live population movements are characterized by an influx of people living in areas that are less prosperous or less secure (Andini et al., 2023). The increasing population and built-up land with limited land have contributed to uneven population density (Medayese et al., 2023). However, the limited amount of land makes people choose to build houses or create settlements in areas that are not supposed to be. As a result, people who live in these areas are affected by natural disasters that occur in the places where they live.
The importance of education for the Indonesian community, especially in densely populated settlements, is crucial in efforts to preserve the environment and minimize natural disasters such as floods. Through education, the community can understand sustainable practices that can be applied in their settlements, including water management, efficient drainage systems, and the preservation of green spaces (Setiawan et al., 2020; Susilawati et al., 2022). Understanding the significance of waste management and environmentally friendly behavior can also be integrated into this education. Consequently, the community can be more proactive in engaging in disaster prevention efforts, mitigating environmental impacts, and creating safer and sustainable settlements (Zakaria et al., 2022). This education not only provides practical knowledge but also builds collective awareness of shared responsibility for environmental conservation, thereby fostering a sustainable mindset in facing future natural disaster challenges (Samsudin et al., 2021).

Klaten Regency is one of the regencies in Central Java. Geographically, Klaten Regency borders Boyolali Regency to the north. Sukoharjo Regency to the east. Gunung Kidul Regency, The Special Region of Yogyakarta. As well as Sleman Regency, The Special Region of Yogyakarta to the West (BPS Kabupaten Klaten, 2020). Astronomically, Klaten Regency is located at 7°32'19" and 7°48'33" South latitude and between 110°26'14" and 110°47'51" East longitude (BPS Kabupaten Klaten, 2020). Klaten Regency is territorially divided into 3 areas, namely, the slopes of Mount Merapi in the north. Stretching to the lowlands in the east and the south is the limestone mountain plain (BPS Kabupaten Klaten, 2021). Klaten Regency is one of the districts that is experiencing rapid population growth. From 2018 to 2022, Klaten Regency, sourced from the Klaten Regency Statistics Agency, had a population of around 1,171,411 people in 2018 and 1,321,199 people in 2022 (BPS Kabupaten Klaten, 2021).

**Table 1.** Flood Disaster in Klaten Regency by Subdistrict in 2018 - 2022

| Sub-district | Floods | | | | |
|---|---|---|---|---|---|
| | 2018 | 2019 | 2020 | 2021 | 2022 |
| Prambanan | 6 | 1 | | | |
| Gantiwarno | 4 | 6 | 1 | 6 | |
| Wedi | 7 | 5 | 4 | 5 | |
| Bayat | 6 | 5 | 4 | 5 | |
| Cawas | 14 | 9 | 7 | 1 | |
| Trucuk | 5 | 5 | 3 | 5 | |
| Kalikotes | | | | 2 | |
| Kebonarum | | | | | |
| Jogonalan | | | | | |
| Manisrenggo | | | | | |
| Ngawen | | | | | |
| Ceper | | | | | |
| Pedan | | 1 | 3 | 2 | |
| Karangdowo | 15 | 4 | 6 | 9 | |
| Juwiring | 2 | 3 | 1 | 4 | |
| Wonosari | 3 | | | | |
| Delanggu | | | 1 | | |
| Polanharjo | | | | | |
| Karanganom | | | | | |
| Tulung | | | | | |
| Jatinom | | | | | |
| Kemalang | | | | | |
| Klaten Selatan | | 1 | 1 | 1 | |
| Klaten Tengah | | | | | |
| Klaten Utara | | | | | |

Based on data from the Table of Klaten Regency Central Bureau of Statistics, several hydrometeorological natural disasters have occurred in the Klaten Regency. Based on data from BPS from 2018 to 2022, floods are the most frequent disaster within 5 years (BPS Kabupaten Klaten, 2019, 2021, 2022, 2023). In 2018, Klaten Regency experienced flooding 62 times (BPS Kabupaten Klaten, 2019). In 2019 and 2021, the flood disaster hit Klaten Regency 40 times (BPS Kabupaten Klaten, 2019, 2020). Also, in 2020, floods occurred 31 times (BPS Kabupaten Klaten, 2021). There are village in several sub-districts, namely, Wedi, Bayat, Ceper, Gantiwarno, Karangdowo, Pedan, Prambanan, Trucuk, Wonosari, Cawas and Juwiring sub-districts (BPS Kabupaten Klaten, 2023). Wedi sub-district experiences flooding every year in 13 villages—followed by Cawas Sub-district in 12 villages, Bayat Sub-district in 9 villages and Trucuk Sub-district in 5 villages (BPS Kabupaten Klaten, 2023). The table above shows the number of flood events over 5 years. 2018 Prambanan, Gantiwarno, Wedi, Bayat, Cawas, Trucuk, Karangdowo, Juwiring, and Wonosari sub-districts experienced flooding. Karangdowo and Cawas's sub-districts were the most affected, with 15 and 14 floods, respectively (BPS Kabupaten Klaten, 2019).

For disaster management and prevention so that there are not many victims, of course, it is necessary to collect data for people who live in disaster-prone areas so that they can be temporarily relocated to areas that are safe enough. Later, the community gets a safer residence from the threat of disasters that might occur in the future. Therefore, analysing the

distribution of refugee houses that can be used as temporary relocations of people affected by disasters and who live in disaster-prone areas is necessary. The research 1) to analyze the distribution of shelter or houses that suitable temporary shelters during disaster, and (2) examine the capacity and supportability the area for the temporarry shelter during disaster. The research location was carried out in several sub-districts such as Klaten Selatan sub-district Klaten Tengah sub-district; based on the above background, the author conducted a research entitled "Analysis of Sheltters for Floods Disaster Management in Central Klaten and South Klaten Klaten District".

## Method

The research was conducted to survey the location of houses that can be used as refugee locations in the South Klaten District and Central Klaten District. Then, the distribution and carrying capacity analyses were carried out to get the final results, namely, the distribution map of rental houses and unique houses and the analysis of the carrying capacity of settlement capacity. An analysis of carrying capacity and capacity is helpful in knowing which carrying capacity is greater between one sub-district and the other. The research method carried out in this study is divided into several stages, namely, the sampling stage, data collection, data processing and data analysis. Figure 1 shows the research locations, namely Klaten Selatan and Klaten Tengah sub-districts.

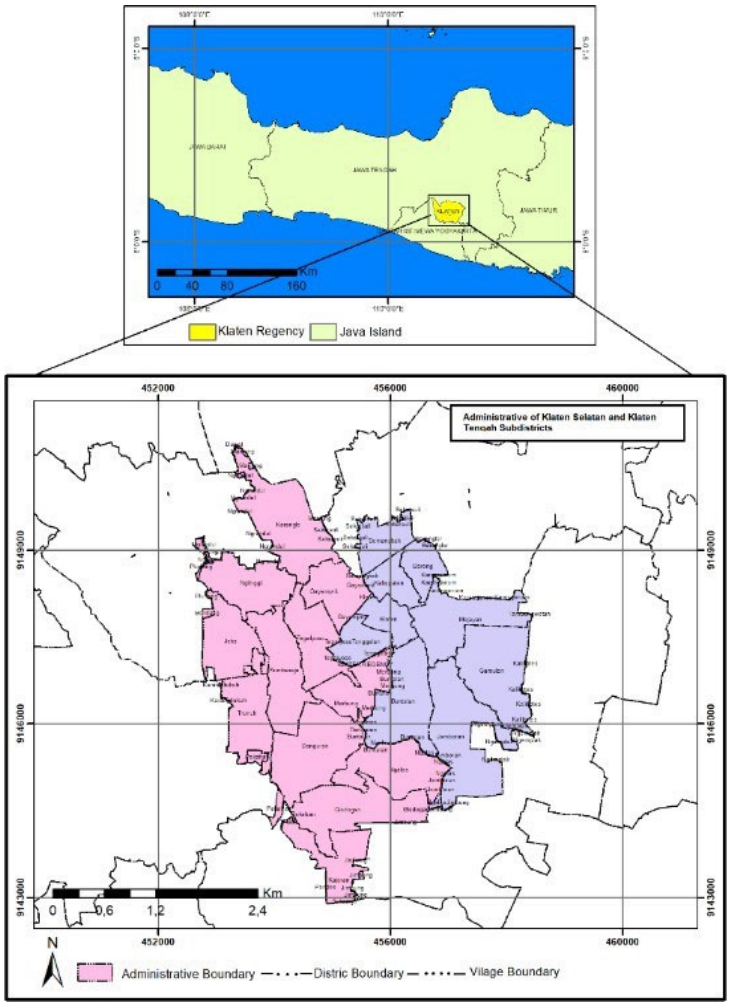



**Figure 1.** Study Area of Central Klaten & South Klaten District

### *Sample Collection Methods*

The sampling method used is a non-probability sampling method (purposive sampling), which does not represent the entire sample. Purposive sampling is a non-random sampling method in which research is determined from a unique identity that matches the research objectives (Lenaini, 2021). The unit of analysis used is the land unit in South Klaten Sub-district,

Central Klaten Sub-district; the unit used is the administrative boundary of RT / RW of South Klaten Sub-district, Central Klaten Sub-distric

### *Data Collection Methods*

The primary method of direct surveys at the research location in Central Klaten sub-district, South Klaten sub-district, Klaten Regency, was used to collect the data. The data that has been collected is then joined to get the coordinate points of the survey results. Research instruments and materials used are. Primary data used is data from observations. Observations are carried out using data on houses for rent, the physical condition of the building and the facilities of the building. The physical condition of the building is seen from the type of wall used, the type of roof used, and the type of floor used. Building facilities used are the availability of rooms, the number of rooms that are still empty, the availability of sanitation, the source of water used, electrical power, trash bins and the kitchen availability. The necessary information was obtained from the village head, rt and rw heads, building owner and the surrounding community. Also, the materials used to retrieve data sources are Android cameras, map reader applications such as Avenza Map, GPS and stationery. Secondary data was obtained from several government agencies in the Klaten Regency. Data on houses for rent was obtained from the Klaten Regency Housing Office. For the map material, a file used is administrative of regency, sub-district and land suitability. The shapefile is taken from https://geoportal.klaten.go.id/ (Dinas Pekerjaan Umum dan Penataan Ruang, n.d.). Researchs obtained secondary data from books, the internet, articles, and previous research that aligns with the required data and is relevance to the focus of research (S, 2020).

### *Data Analysis Methods*

Based on research, the analysis used is the research objectives. Data analysis was conducted using qualitative analysis methods. This analysis is expected to answer the research objectives regarding the distribution of potential houses for temporary shelter when a disaster occurs. The analysis method used is overlay, which is used to create a map of the distribution of houses that can potentially be used as temporary evacuation centres. The process involves overlapping house points with the sub-district administrative boundaries to carry out the overlay. Nearest Neighborhood Analysis is used to create an analysis of the distribution of houses that have the potential to be used as temporary shelters. Analysis of the Support and Capacity of settlements in Klaten Tengah and Klaten Selatan Sub-districts is used to analyze the ability of land to accommodate settlements.

## Results and Discussion

The shelters in South Klaten sub-district and Central Klaten sub-district are spread throughout the sub- district. The distribution of shelters is in the city area, so accessibility and mobility can be easily reached. Based on the observations made during the field survey, it can be found that the distribution points of shelters are thoroughly distributed in both sub-districts. Obtained data results in map decipting of the distribution of refugee houses and an analysis of the carrying capacity and capacity of residential areas in South Klaten sub-district and Central Klaten sub-district.

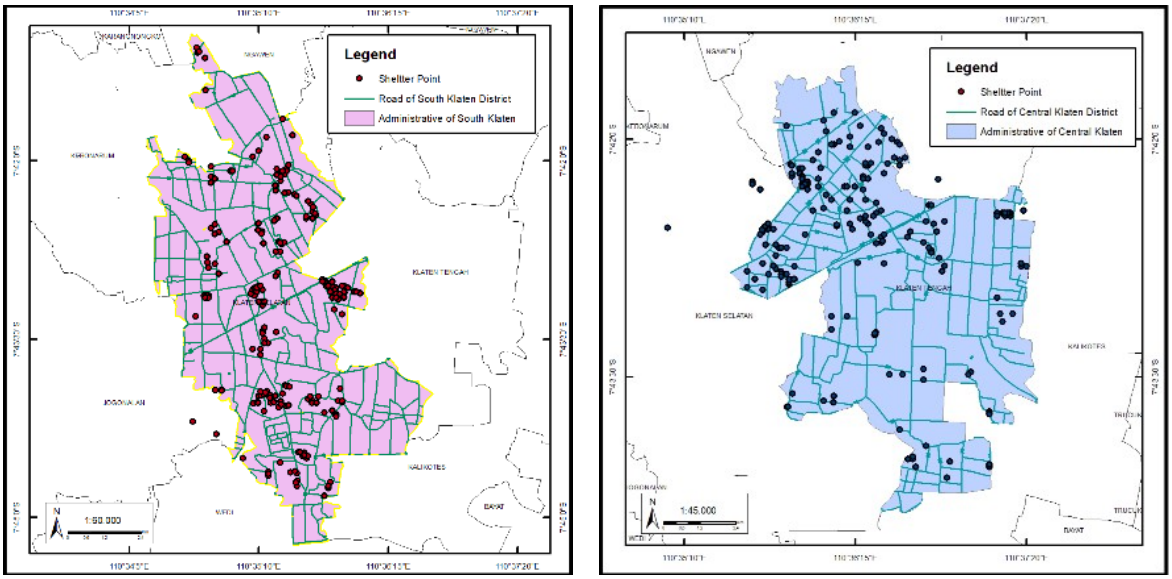
Based on the research results, the distribution of shelters for rent in South Klaten sub-district and Central Klaten sub-district differs due to different housing needs. The number of rental houses in South Klaten and Central Klaten sub-district are 313 and 340 houses, respectively. The observation results of the distribution of points of shelters that can be used for evacuation when flood disaster occurs. The types of rental houses in both sub-districts are divided into two types: boarding houses and rented houses. The number of boarding houses in South Klaten and Central Klaten sub-districts are 83 and 42, respectively. Then, rentals in the two sub-districts are 230 and 259 respectively. Both types of rental houses exist due to the needs of the house community, which are deliberately built as boarding houses and rented houses.

Rental house buildings, both boarding houses and rented houses have almost similar physical conditions. In the South Klaten sub-district, buildings with tiled floors are the most common. Tile roofs are still widely preferred because of the use of tile as a roof in both sub-districts, namely 305 and 309 houses. The most widely used walls in the sub-districts of South Klaten and Central Klaten are walled in as many as 312 and 335 houses. Some houses with wooden or bamboo and tin walls are still in both sub-districts. The ownership of rental house facilities in Central Klaten and South Klaten sub-districts is complete with various rooms. Almost all houses for rent in both sub-districts have sanitation, water sources such as wells and PDAM and electricity, which has power from 400 to 3300 watts. However, one house still needs electricity in the Central Klaten sub-district. This may be due to the house being built so that it still needs these facilities.

### ***Analysis of the Distribution Pattern of Shelters in South Klaten and Central Klaten Subdistricts***

Based on observations and field surveys, 653 were obtained in both sub-districts. The number of rental house points in South Klaten sub-district is 313 units, and Central Klaten sub-district is 340 units. Then, the point is analyzed using Nearest Neighbor Analysis (Pradana et al., 2023; Pungky et al., 2023). The results of the nearest neighbour analysis of the

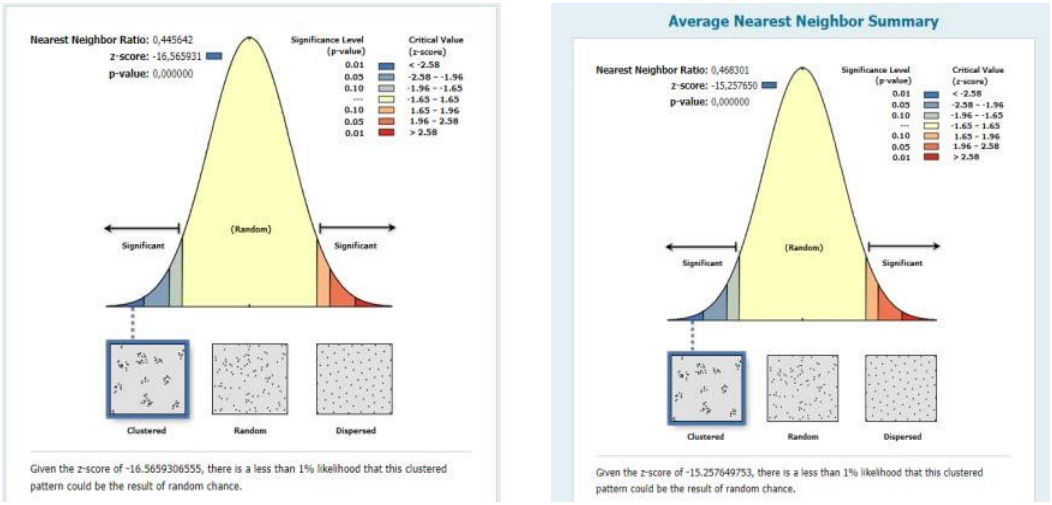
distribution pattern of rental houses in South Klaten sub-district and Central Klaten sub- district fall into the clustering category. This category is caused by the Nearest Neighbor Ratio owned by the South Klaten sub-district is 0.37, which means less than 1, or the distribution is clustered with a z-score value of -18.90, less than 0. These results indicate that the chance of clustered distribution of less than 1% is significant. The p-value or probability value of the data shows the result of the number of rental house points divided by the area of Klaten Selatan sub-district. The critical value (z-score) shows that the standard deviation in the calculation is -18.90. In South Klaten sub-district, the z-score is included in a clustered distribution pattern that is less than 1. The picture below shows the distribution of shelter houses in the South Klaten sub-district. The map shows that the points of refugee houses are scattered throughout the sub-district, but some are still clustered. For example, to the south of the main road of Klaten Regency and opposite it. Figure 2 shows the location of the distribution of shelters in South Klaten and Central Klaten sub-districts.




(a) (b)

**Figure 2.** (a) Distributtion Pattern of Shelters in South Klaten sub-district, (b) Distribution Pattern of Shelters in Central Klaten sub-district

The Nearest Neighbor Ratio owned by the Central Klaten sub-district is 0.47, which means less than 1 or the distribution is clustered with a z-score value of -15.26, less than 0. These results indicate that the chance of clustering the distribution of less than 1% is significant. The p-value or probability value of the data shows the result of the number of rental house points divided by the area of Central Klaten sub- district. The critical value (z-score) shows that the standard deviation in the calculation is -15.26. This z-score is included in the clustering distribution pattern, which is less than 1. The image above shows the point of clustered houses in Central Klaten sub-district. The houses clustered in the north are more dominant than those in the south. However, the distribution pattern also shows a clustering pattern in the north. This is different from Dewi Novita Sari's research on the spatial pattern of e-warong distribution, which has a random pattern with a Z-score of 1.439, which means that the value is close to 1 (Sari et al., 2023). The clustered distribution pattern means that development is less organized and unevenly distributed uneven (Dewi N. S, A. N. Anna, Taryono, M. Farid M, 2016). Figure 3 shows the distribution pattern of shelters in South Klaten and Central Klaten sub-districts.




(a) (b)

**Figure 3.** (a) Pattern oh Shelter in South Klaten sub-district, (b) Pattern of Shelter in Central Klaten sub-district

### *Analysis of Support and Capacity of Settlement Areas in South Klaten and Central Klaten Sub- districts*

To analyze the variable settlements, divide the settlement land area by variable the number of residents then divide the result by the per capita needs (Putri & Wibawa, 2023). Muta. Ali (2015) states that settlement carrying capacity analysis is an analysis to measure the capability of an area to provide settlement functions (Pantow Marsela et al., 2018). The analysis was carried out using the following formula (Pantow Marsela et al., 2018; Putri & Wibawa, 2023).

$$DDPm = \frac{(\frac{LPm}{Jp})}{\propto} \quad (1)$$

Description:
DDPm : settlement carrying capacity
Lpm : land area suitable for settlement (m²) JP : a total population (people)
α : coefficient of space requirement/capita (26 m²/capita)
the results of these calculations are then classified into three criteria (Pantow Marsela et al., 2018) that's it:
DDPm > 1 is land that can accommodate residents for settlement needs
DDPm = 1 is land that shows a balance between the resident population and the existing area. DDPm < 1 is land that shows its inability to accommodate the settled population
The following is a table regarding the results of the calculation of the carrying capacity analysis of settlements in Klaten Selatan and Klaten Tengah Subdistricts.

**Table 2.** Settleent Support Capacity in South Klaten and Central Klaten Sub-districts

| District | Population | Potential Area | LPm x 60% | DDPm | Nilai DDPm |
|---|---|---|---|---|---|
| South Klaten | 39,285 | 284.27 | 170.562 | 1.67 | DDPm > 1 |
| Central Klaten | 42,046 | 200.75 | 120.45 | 1.10 | DDPm > 1 |

Based on the table 2, both sub-districts have a DDPm value exceeding 1. This indicating their capacity can still accommodate additional settlements for the population residing whitin these areas. Specially, the South Klaten sub-district has a DDPm value of 1.67, highlighting a greater potesnsial for accomoding further settlements. Similary, the Central Klaten sub-district has a DDPm value of 1.10, signifying a compareable, albeit slightly lower, capacity for residential expasion. These results indicate that both su-districts have adequate spatial capacity to accommodate ongoing population growth and fututre settlement expansion. The analysis of settlement land capacity is carried out by calculating the potential land area or land area that is feasible to build settlements using the following formulation
Description :
DDPm : Settlement Support Capacity JP : a total Population
The following is a table of land capacity for settlements in South Klaten and Central Klaten sub-districts.

**Table 3.** Settelment Capacity in South Klaten and Central Klaten Sub-districts

| District | DDPm | Population | Population Capacity | Capacity Allowance |
|---|---|---|---|---|
| South Klaten | 1.67 | 39.285 | 66,785 | 27,500 |
| Central Klaten | 1.1 | 42.046 | 46,251 | 4,205 |

Based on the table 3, South Klaten sub-district has a capacity of 66,785 people. This means that South Klaten sub-district can accommodate a community of 66,785 people. Thus, the remaining population that can be accommodated is 27,500 people. Meanwhile, in Central Klaten sub-district the capacity obtained is 46,251 people. With the existing population until 2023, namely 42,046 people, the remaining population that can be accommodated in Central Klaten sub-district is 4,205 people. This relatively limited remaining capacity suggests that the area may face challenges in accommodating further growth without siginificant infrastructure or expansion efforts. In summary, while South Klaten has considerable capacity for additional population, Central Klaten's remaining capacity is much more constrained, potentially requiring careful urban planning to ensure sustainable growth in the future.

### *Discussion*

The field survey produced a map of the distribution of refugee houses that can be used during flood emergencies in South Klaten and Central Klaten Sub-districts, totalling 313 and 340. These houses have a variety of physical building conditions, such as tile roofs, walls and ceramic floors. In addition, the facilities available are adequate, such as electricity, sanitation, good water sources and kitchens. Analysis of house point data resulted in a clustering pattern of distribution of houses in Klaten Selatan and Klaten Tengah Sub-districts.

The distribution pattern of houses in South Klaten sub-district gets the Nearest Neighbor Ratio value owned by the South Klaten sub-district is 0.37, which means less than 1, or clustered distribution with a z-score value of -18.90 less than 0. Meanwhile, the pattern of distribution of houses in the Central Klaten sub-district gets the Nearest Neighbor Ratio value owned by the Central Klaten sub-district is 0.47, which means less than 1 or clustered distribution with a z-score value of -15.26 less than 0. Klaten Selatan sub-district has a settlement carrying capacity level above 1 of 1.67.

The Klaten Tengah sub-district has a settlement carrying capacity level above 1 of 1.10. This means that the carrying capacity of settlements in both sub-districts can still accommodate the population and settlements. Based on the results of the calculation of population capacity, Klaten Selatan Sub-district obtained a value of 66,785 people. This means that Klaten Selatan District can still accommodate 27,500 people. Then, the calculation of capacity in the Klaten Tengah Subdistrict obtained a value of 46,251 people. That means the Klaten Tengah sub-district can still accommodate 4,205 people

The spatial pattern of shelter distribution provides an overview for disaster management that is likely to occur in the future. Shelters that are concentrated in the city center will facilitate the allocation of aid logistics during a flood disaster. However, looking at the condition of the distribution pattern of existing shelters will require strategies to ensure that affected communities receive the necessary assistance. In addition, with differences in settlement capacity, a sustainable strategy is needed. South Klaten Sub-district will have a greater potential to receive more additional flood-affected residents than Central Klaten Sub-district in order to avoid overcapacity and reduce existing infrastructure.

### *Acknowledgement*

The author would like to thank Departement of Geography, Faculty of Geography Universitas Muhammadiyah Surakarta who have provided full support for the research I conducted. Appreciation also extended to Universitas Muhammadiyah Surakarta for thei financial assistance during the research and all parties involved and who provided support to me so that I completed this article on time and was carried out well.

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