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Remote Sensing for Mapping the Distribution of Poverty and Inequality in Gunungkidul Regency, Yogyakarta Special Region

Anatansyah Ayomi Anandari[1]

[1]Master of Sensing Technology, Faculty of Defense Technology, Republic of Indonesia Defense University, Indonesia Peace and Security Center (IPSC) Sentul Area, Sukahati, Citeureup District, Bogor Regency, West Java Province 16810, Indonesia. Tel. (021) 87951555, Fax: 021-29618761 / 021-29618764.

Corresponding author

[1]anatanayomiii@gmail.com

Abstract: Remote sensing is a technology to make it easier to make maps and analyze an area without having direct contact with the object to be studied. This study uses a remote sensing method that can be applied to social mapping, namely in making maps of the distribution of poverty. Poverty is a very complex problem in society and is influenced by many factors, including environment, health, income level, and location of residence. Therefore, there is a need for proper poverty alleviation. The Poverty Distribution Map is one of the map prototypes, which can be used to display spatially based poverty data. Poverty data, which is usually displayed in the form of numbers or indexes, can be displayed on a map sheet or visualized, making it easier to understand the condition of poverty in the community. Mapping was carried out using satellite image data sources in Gunungkidul Regency, Yogyakarta Special Region Province, Indonesia. This study aims to interpret maps of the distribution of poverty, poverty conditions and community welfare through satellite imagery so that people's lives can be easily monitored by the government. In addition, poverty data can be updated, so that the availability of data is always up to date. Gunungkidul Regency has a Percentage of Poor Population value from 2014 to 2021 which almost always increases every year. Based on the analysis that has been carried out, a mapping is obtained, where the sub-districts included in the very poor category are the sub-districts of Semanu, Ponjong, Gedangsari, and Semin.

Keywords: Mapping, Poverty, Remote Sensing, Satellite Imagery, Spatial.

Introduction

Development basically aims to create prosperity and reduce poverty. Poverty is a person's inability to meet food and non-food needs as measured by spending. Poverty is a multidimensional problem, which includes not only economic conditions but also social, cultural and political conditions. Poverty is a major problem that occurs in every country, including Indonesia. Poverty is a problem that is often encountered in society (Chambers, 2006). The problem of poverty is caused by several factors, including environmental factors, health, income levels, and education. According to the Presidential Regulation of the Republic of Indonesia Number 13 of 2009, poverty is an urgent national problem and requires steps to handle and a systematic, integrated and comprehensive approach, in order to reduce the burden and fulfill the basic rights of citizens properly to pursue and develop a dignified life (Ernawati, 2012). At present poverty alleviation is the main program of the government, both the Central Government and Regional Governments.

Welfare improvement is carried out, it is necessary to get proper understanding by the community. That in improving welfare there is no element of self-enrichment and taking advantage. Thus it is hoped that there will be no social inequality. Gunungkidul Regency is one of the Regencies in the Special Region of Yogyakarta Province which has a fairly high poverty rate, reaching 15.86% (BPS, 2022). This number is decreasing, it is recorded that from 2014 to 2022 the percentage of poor people has decreased.

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Table 1. Percentage of Poor Population

Year	Percentage of Poor Population (%)	Line of Poverty (rupiah/capita/month)
2014	20.83	243847.00
2015	19.34	250630.00
2016	19.34	264637.00
2017	18.65	277261.00
2018	17.12	288748.00
2019	16.61	301125.00
2020	17.07	319851.00
2021	17.69	325907.00
2022	15.86	350739.00

Poor has been carried out by the local government in reducing the level of poverty. One important aspect to support poverty alleviation strategies is the availability of accurate and targeted poverty data (BPS, 2022). The Remote Sensing method is currently experiencing very rapid development. Remote sensing is a technology to make it easier to make maps and analyze an area without having direct contact with the object to be studied (Suwargana, 2008). The remote sensing method can be applied to social mapping, namely in making maps of the distribution of poverty. The Poverty Distribution Map, is one of the map prototypes, which can be used to display spatially based poverty data. Poverty data which is usually displayed in the form of numbers or indexes so that it is sometimes difficult to understand, can be displayed on a map sheet or visualized, making it easier to understand the conditions of poverty that occur in the community (Fauzy et al., 2016). In this study, social (poverty) mapping will be carried out based on remote sensing Landsat 8 OLI/TIRS satellite imagery in Gunungkidul Regency, Special Region of Yogyakarta Province.

Materials and Methods

Poverty Statistics Data

To measure poverty, BPS uses the concept of ability to meet basic needs (basic needs approach). With this approach, poverty is seen as an economic inability to meet basic food and non-food needs as measured from the expenditure side (Mihai et al., 2015). So the poor are residents who have an average per capita expenditure per month below the poverty line. The method used is to calculate the Poverty Line (GK), which consists of two components, namely the Food Poverty Line (GKM) and the Non-Food Poverty Line (GKNM). The calculation of the Poverty Line is carried out separately for urban and rural areas.

Table 2. Poverty Statistics Data

Poverty	Number of Poor People (thousands)	Poverty Depth Index	Poverty Severity Index
2014	148.40	3.74	1.03
2015	155.00	4.55	1.33
2016	139.15	4.16	1.30
2017	135.74	3.36	0.79
2018	125.76	3.84	1.16
2019	123.08	2.58	0.53
2020	127.61	2.68	0.63
2021	135.33	2.98	0.76
2022	122.82	2.63	0.67

Source: BPS, 2022

Mapping

Map is a picture of the earth's surface projected on a flat plane with a certain scale. The map is equipped with information explaining the appearance on the earth's surface, both natural and artificial features. In general, maps are divided into two, namely base maps and thematic maps. Likewise, there are two sources of map data, namely terrestrial surveys and remote sensing imagery. Terrestrial survey is taking direct measurements in the field. The advantage of the sestris survey is that the data produced is more accurate, but there are many obstacles faced, namely time, manpower and also cost constraints. Meanwhile, remote sensing imagery is an image of the earth's surface obtained from shooting using satellites or aircraft.

Utilization of satellite imagery for making maps provides many advantages, including mapping can be done more quickly, up to date (updated data) and lower costs. However, the drawback is that the data obtained has low accuracy. Therefore, at the mapping stage using satellite imagery, it is also necessary to carry out a ground check in the field. The use of satellite imagery for mapping purposes currently covers many fields. Among them are the agricultural and plantation sectors, the forestry sector, the mining sector, the regional planning and development sector, and also the disaster management sector. In the future, the use of satellite imagery will be even wider covering other fields. Mapping applications for the disaster sector also vary. Not only natural disasters but also non-

natural disasters such as technological failures and social disasters.

Mapping the distribution of poverty is one of the mapping applications in the field of disaster, namely social disasters. Mapping the distribution of poverty, using poverty data from survey results in the field. The results of poverty data collection are usually in the form of numbers and indexes. These numbers and indices are sometimes difficult for the public to understand because special expertise is required to interpret them. For this reason, another method is needed to make it easier to read the condition of people's poverty. One way is to visualize numerical data into image/map data. The mapping data source used is Landsat 8 OLI/TIRS satellite imagery. Landsat 8 was launched on February 11, 2013. This earth monitoring satellite has two sensors, namely the Operational Land Imager (OLI) sensor and the Thermal Infrared Sensor (TIRS). Both of these sensors provide a spatial resolution of 30 meters (visible, NIR, SWIR), 100 meters (thermal), and 15 meters (panchromatic). Mapping was done using ArcGIS 10.7.1 and QGIS 3.26 software. In simple terms, the mapping process carried out can be observed as follows:

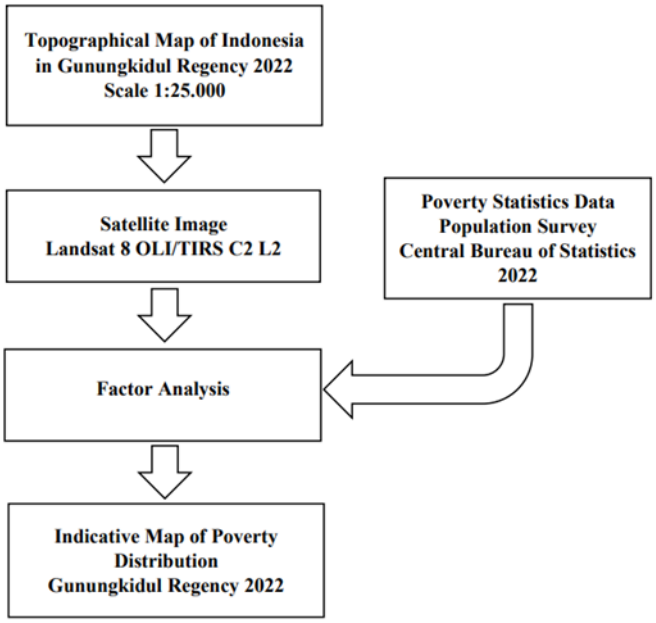

Figure 1. Research Flowchart

Results and Discussion

Gunungkidul Regency is located between 7⁰ 46'- 8⁰ 09' South Latitude and 110⁰ 21' - 110⁰ 50' East Longitude, which is bordered by Klaten Regency, Sukoharjo Regency, Central Java in the north. Wonogiri Regency, Central Java in the east. Indonesian Ocean in the south and Bantul Regency, Sleman Regency, DI. Yogyakarta to the west. The total area of Gunungkidul Regency is recorded at 1,485.36 km2 which includes 18 sub-districts and 144 villages/wards. Semanu District is the widest sub-district with an area of around 108.39 km2 or around 7.30 percent of the area of Gunungkidul Regency. Results of the 2020 Population Census, the Population of Gunungkidul Regency Reaches 747 Thousand People.

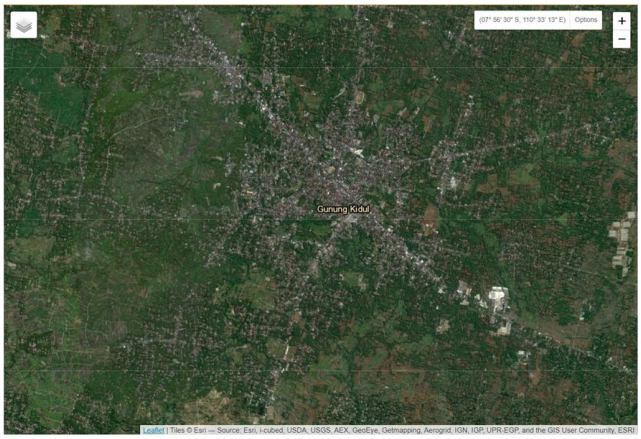

Figure 2. Image Map of Gunungkidul Regency (USGS, 2022)

The population of Gunungkidul is spread across 18 sub-districts and 144 villages. The population in sub-districts that are closer to and directly adjacent to the district capital of Gunungkidul is relatively more than those in sub-districts that are far from the district capital.

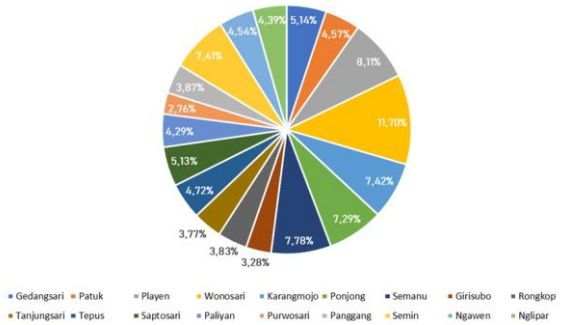

Figure 3. Distribution of Population by Subdistrict in Gunungkidul Regency

The largest population is in Wonosari District which reaches 87,454 people (11.70 percent), followed by Playen Subdistrict reaching 60,622 people (8.11 percent) and Semanu Subdistrict reaching 58,155 people (7.78 percent). It is not surprising that the three sub-districts have the largest population because they are located close to the district capital. Various educational, health and other infrastructure facilities as well as supporting facilities that are easier and faster to access and close to the center of economic activity are the main factors for the large population in sub-districts that are close to the capital. While the population is at least in Purwosari District reaching 20,655 people (2.76 percent), followed by Girisubo District reaching 24,490 people (3.28 percent) and Tanjungsari District reaching 28,178 people (3.77 percent).

The area of Gunungkidul Regency is 1,485.36 km^2 or 46.63 percent of the total area of the Special Region of Yogyakarta. With this area, Gunungkidul Regency has a population of 747,161 people in 2020 or a density of 503.02 people per km^2. This means that for every 1 km^2 of Gunungkidul's area, there are an average of 503 inhabitants. The level of population density varies greatly between sub-districts. The three districts with the highest population density based on the results of the 2020 Population Census are in Wonosari District (1,158 people/km^2), followed by Ngawen (727.80 people/km^2) and Semin (701.12 people/km^2). Meanwhile, the three districts with the lowest population density are in Girisubo District (258.96 people/km^2), Purwosari (287.83 people/km^2) and Panggang (290.09 people/km^2).

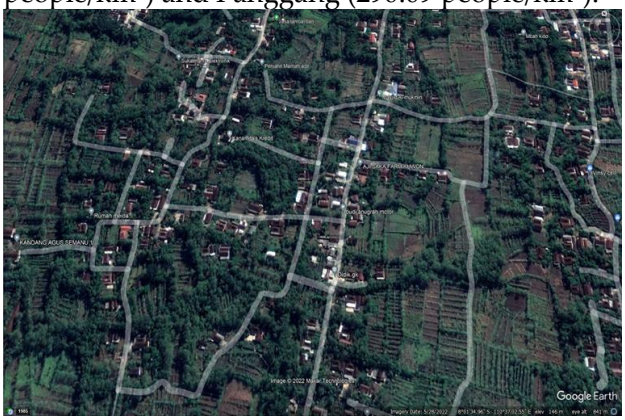

Figure 4. Gunungkidul Regency Settlements (Google Earth Pro, 2022)

Residents who are categorized as poor are residents who have an average monthly per capita expenditure below the poverty line. For 2021, residents of Gunungkidul who are included in the category of poor people are residents who have an average monthly per capita expenditure of below IDR 325,907 per capita per month. The number of poor people in 2021 is 135.33 thousand people, an increase compared to 2020 which was 127.61 thousand people. In 2021, the percentage of poor people in Gunungkidul has increased from 17.07 percent in 2020 to 17.69 percent in 2021. When compared to conditions in 2017, the percentage of poor people in Gunungkidul in 2021 has decreased from 18.65 percent in 2017. During the 2016-2021 period, the percentage of poor people in 2017 was the highest, while the lowest percentage of poor people was in 2019 at 16.61 percent. The percentage of poor people during 2017-2019 tends to decrease but increases again in 2020-2021.

When compared to the percentage of poor people in the Special Province of Yogyakarta in 2021, the percentage of poor people in Gunungkidul Regency is higher. The percentage of poor people in the Province of the Special Region of Yogyakarta in 2021 is 12.80 percent. The percentage of poor people in Gunungkidul is the second highest percentage after Kulonprogo which is 18.38 percent. The percentage of poor people is affected by the impact of the Covid-19 pandemic which began in mid-March 2020. The policy of limiting social mobility to deal with the Covid-19 pandemic has had an impact on economic conditions, one of which is the decline in people's purchasing power. This needs to be the concern of related parties in order to be able to increase the income of people who are classified as poor. Gunungkidul's economy has not grown stably until 2021 because during 2021 there will still be restrictions on activities to prevent the spread of the Covid-19 virus. Household income decreased significantly so that the poverty rate also increased.

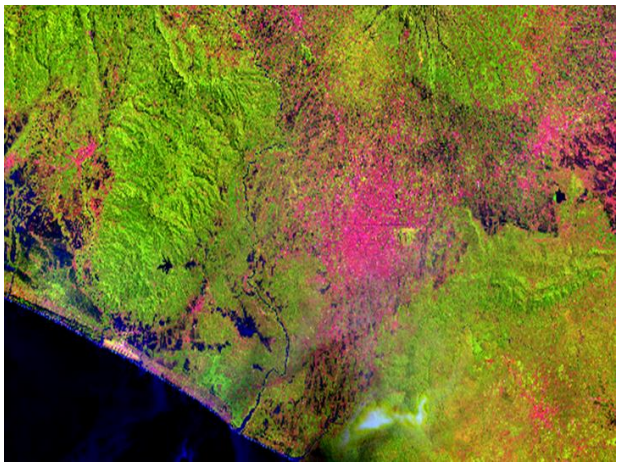

Figure 5. Landsat 8 Images Agriculture

Use this color combination to produce images with clear differences in vegetation, which are shown in green. The growth of the agricultural sector is related to the poverty rate because the number of poor households in Gunungkidul Regency is mostly derived from the characteristics of households with the main source of household income being the agricultural sector. The growth of the agricultural sector will also make a major contribution to poverty alleviation through increasing farm income, and can encourage non-agricultural sector activities in rural areas. Investment in the agricultural sector, and the land area of the agricultural sector have a positive and significant effect on the growth of the agricultural sector. Then imports of the agricultural sector have a positive and significant effect on poverty and exports of the agricultural sector have a negative and significant effect on poverty. Furthermore, poverty has a positive and insignificant effect on the growth of the agricultural sector. However, the growth of the agricultural sector has a negative and significant effect on poverty, so policies are needed to increase the growth of the agricultural sector. The contrast between vegetation dominance that will be visible via infrared, can provide effectiveness in the analysis of forestry or agricultural vegetation on a large scale. Gunungkidul is one of the regencies with an area dominated by karst landscapes covering 60% of the total area. Biologically, vegetation that lives in karst areas are plants that are able to adapt to dry conditions and thin soil layers such as ferns, orchids, and banyan. Geologically, the Gunungkidul karst is composed of a variety of rock formations consisting of the Semilir, Oyo, Wonosari and Kepek Formations. Physically, surface features are in the form of conical hills, lakes, closed valleys, and permanent springs as well as subsurface features in the form of speleothems and subsurface river flows with depths of up to 120 meters or more.

Figure 6. False Color (Urban)

The use of this color combination to produce images with clear differences in urban/urban areas. In theory, the environment is a spatial unit with all objects, power, conditions and living things, including humans and their behavior, which affect the continuity of life and the welfare of humans and other living things (UU. No. 23/1997). Suparmoko (1997), states that the Indonesian environment as a system consists of the social environment (sociosystem), the built environment (echnosystem) and the natural environment (ecosystem). The environment includes natural resources that have the ability to recover (recovery), but due to the increasingly extreme pressure of human activities compared to the slow rate of recovery of natural resources, there will be degradation and even faster damage to natural resources, due to the movement of destruction efforts carried out by humans faster than nature's ability to recover. If population pressure is not proportional to the availability of natural resources, it will certainly slow down the recovery of natural resources. Damage to the environment is very difficult to avoid if the intensity of pressure on the environment continues to occur so that development efforts that pay attention to environmental principles are one of the necessary

ways to maintain its existence. Incorrect environmental management will have a fatal impact on prolonged environmental damage that cannot be repaired in the long term. If this happens, it is difficult to avoid that this condition will cause environmental disasters, as has happened recently in several areas, such as landslides, flash floods and other disasters.

Poverty and environmental damage are negatively correlated and influence each other. Poverty occurs because of environmental damage or vice versa the environment is damaged because of poverty in the surrounding area. This causal relationship can continue to form an endless cycle. In such conditions, poverty will get worse and the environment will be more damaged. The longer the condition lasts, the more chronic the condition. So that the status of poverty changes non-linearly. From poor to poorer, and finally very poor or very poor, the same trend also applies to environmental damage. It is characterized by human activity and life that exceeds the capacity of nature. Humans who are poor to survive because they have no other choice make excessive use of natural resources beyond the carrying capacity of existing natural resources.

Mapping

Gunungkidul Regency is located in a bustling area with various tourist centers in the Special Region of Yogyakarta. Such conditions should lead to a high level of community welfare in Gunungkidul Regency. However, conditions on the ground were different. There are still people who are less prosperous and fall into the poor category. The local regional government pays special attention to efforts to increase welfare in Gunungkidul Regency. In addition, the community also needs to know welfare and poverty information. In this way, it will indirectly raise public awareness in the process of improving the welfare that has been carried out.

The poverty distribution map is one of the publication vehicles that can be used as a means of disseminating poverty information. Making a poverty distribution map using high-resolution satellite imagery data, another data source is the 2022 RBI map as information on administrative boundaries. Information on land use in Gunungkidul Regency was obtained by digitizing satellite imagery, which was then added to poverty data from a survey conducted by the Central Bureau of Statistics. The following is the Poverty Distribution Map of Gunungkidul Regency:

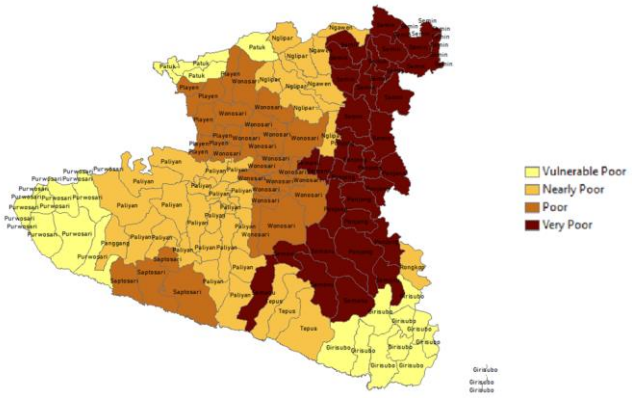

Figure 7. Poverty Distribution Map of Gunungkidul Regency

Conclusions

Poverty data based on community statistical survey data obtained more accurate data. The statistical data can be realized in a visual form, namely a map of the distribution of poverty. Utilization of remote sensing methods can be applied in mapping the distribution of poverty. With the existence of a poverty distribution map, poverty conditions and community welfare can be easily monitored. In addition, poverty data can be updated, so that the availability of data is always up to date. In order to obtain spatial data in the form of the latest land use, in the future satellite imagery with the latest coverage is also needed. In addition, it is necessary to carry out a ground check in the field as a map validation process. Based on the analysis that has been carried out, a mapping is obtained, where the sub-districts included in the very poor category are the sub-districts of Semanu, Ponjong, Gedangsari, and Semin. Then for sub-districts that are included in the poor group are Saptosari, Karangmojo, Wonosari, and Playen Districts. Furthermore, Panggang, Paliyan, Tepus, Tanjungsari, Rongkop, Nglipar, and Ngawen sub-districts are in the near-poor category. Then finally, for the sub-districts of Purwosari, Girisubo and

Patuk, they are included in the group of regions that are vulnerable to poverty.

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