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RESEARCH ARTICLE

Three-Dimensional Participatory Mapping for Toponymical Name in Nglanggeran Ancient Volcano of Yogyakarta

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Abstract Place naming of a local area is closely related to geographic elements. Local names can also be used as a cultural identity and natural condition of a region. Nglanggeran Ancient Volcano (AV) area has local name elements highly influenced by those conditions. It is an interesting study material where a three-dimensional (3D) model can contribute as a medium to collect the place naming traces (toponym) in this area through participatory mapping. Participatory mapping, usually using 2D models in the form of sketches or maps, will be a separate story in interactive 3D media usage resulting from the photogrammetry process. It is expected that the media be able to show the geographical appearance of the Nglanggeran A.V area more clearly, such as geomorphology, geology, vegetation, hydrology, and even local culture, and contribute unexplored information. The results of participatory mapping in toponym collection are expected to be a medium that organizes the place naming of a local area into a complete database, along with the origin of the place names. It is also proposed that the results of participatory mapping through the 3D model be a means of preserving local culture in the Nglanggeran A.V area, making it more familiar to local residents and tourists.

1. Introduction

Nglanggeran A.V is a popular tourist destination in the Special Region of Yogyakarta. It is located in the coordinates of S7°50'50.0" E110°32'48.0" in Gunungkidul Regency, the Special Region of Yogyakarta, Indonesia. It was included in the UNESCO Global Geopark in 2015 and was selected as the best Tourism Village according to the UN World Tourism Organization (UNWTO, 2021). The Nglanggeran Ancient Volcano (GAP) area has a variety of very unique local names. For example, some villages, such as Pitu, Planggeran, Song Gudel, Sumpitan Aisle, Virgin Water Source, Kedung Kandang, and even Nglanggeran itself, have a history of place naming quite interesting to examine. The place naming in the Nglanggeran A.V area is heavily influenced by geographical elements (natural and cultural elements). One example is the Sumpitan Aisle, which is a footpath flanked by large rocks. The natural elements here highly dominate the place naming in the Nglanggeran area. Another example is Pitu Village, which is only inhabited by 7 families, according to our observation. The name Pitu itself is closely related to the number of families (houses) in this location, meaning that man-made cultural elements strongly dominate the place naming here (Sekarsih & Priyambodo, 2022).

The local names have their unique history or characteristics (Zhong et al., 2020), which are very interesting to study in more depth. Place naming cannot be separated from the history of an area, its physical characteristics, cultural elements inherent in it, people's habits, and so on (Muhammad et al., 2020). In cartography, the study of geographical names is called toponym or toponymy. The toponym dataset of historical geographical names can serve as a database for preserving cultural heritage and as a basis for sustainable development in Yogyakarta City (Cahyono et al., 2024).

This quite interesting toponymic information certainly requires tools for better collection and organization. The purpose of organizing this toponym is to preserve local culture through the application of the place naming elements (Segara & Hermansyah, 2021) in the Nglanggeran A.V area. This toponym database has not been well organized and is still limited to folk tales still partially collected. It is feared that as time goes by, the meaningful values contained in local toponyms in the Nglanggeran A.V area will become extinct. Indigenous place names are key to preserving living heritage, particularly wildlife, as a form of living heritage (Moyo, 2021). Active participation of local figures, such as village elders, *pokdarwis* leaders (Tourism Awareness Group) of Nglanggeran A.V, Hamlet Heads, Village Heads, etc. is required to collect information about local toponyms in the Nglanggeran A.V in the form of participatory mapping. Participatory mapping is emphasized on the object of the program objectives (Suarma et al., 2019). One approach that can be used to map the unique points in the Nglanggeran A.V tourist area is three-dimensional (3d) participatory mapping. Three dimensional models are a part of graphic arts that is now urgently needed by various disciplines (Minnegalieva et al., 2020). In this approach, local people and visitors can participate in spatial data collection. A participatory approach can provide valuable local knowledge (Klonner et al., 2021), such as dangerous

location (Priyambodo et al., 2023). It is hoped that this participatory mapping will be more interactive through a 3D model that has been made before.

Participatory mapping refers to the use of GIS and modern communication technologies to involve the general public and stakeholders in participatory planning and decision-making (Fagerholm et al., 2022). In other words, participatory mapping is used to (1) identify values, perceptions, or a place-based attitude, such as landscape values, ecosystem services, environmental quality factors, perceived problems, or unpleasant experiences; (2) analyze people's spatial behavior, especially daily practices and activities, such as mobility patterns, routes taken, or places visited; (3) communicate preferences or visions about the use of land in the future; and (4) collect place-based observations through what is called geographic citizen science, such as track networks or wildlife observations (Fagerholm et al., 2021).

Three-dimensional models are increasingly being used in various sectors (Ghani et al., 2019), one of which is for tracking toponyms in the Nglanggeran A.V area. As mentioned before, place names (toponyms) are not only the identity of a culture but also the geographical forms on the surface of the earth that become the background for naming an area. A three-dimensional model will resemble a more realistic object since it gives dimensional depth to objects. A three-dimensional object can be observed from various points of view so that the characteristics of an area can be optimally explored.

Participatory mapping is required to preserve the local culture through the place naming in the Nglanggeran A.V area. A place name has a story or unique physical characteristics that become the identity of an area. In this participatory mapping activity, a medium is necessary to provide more interesting and interactive information. The novelty of this research is the use of 3d visualization for participatory mapping. The resulting three-dimensional model is obtained from aerial photographs processed by photogrammetric techniques. This data collection uses UAV (Unmanned Aerial Vehicle) by taking points at important locations around the Nglanggeran A.V area, such as at the Top of the West Nglanggeran Ancient Volcano, East Nglanggeran Ancient Volcano, Kedungkandang, and Nglanggeran Reservoir. It is hoped that aerial photographic information from the four locations can be used as material for participatory mapping discussions regarding the toponym traces of the Nglanggeran Ancient Volcano area. Spatial ability has a strong relationship with the equality of participatory mapping results (Nugraha & Santosa, 2022). Based on literature review surveys, many participatory methods use 2D maps, which may have drawbacks. The presence of the Nglanggeran A.V 3d visualization is expected to provide in-depth information about toponyms and their local stories.

2. Methods

This research was conducted in 2 stages, namely creating 3D models of the Nglanggeran A.V tourism area and community participatory mapping for this area.

a. Building 3D Models

3D geoinformation has recently emerged as one of the most popular research themes (Saran et al., 2018). In recent decades, 3D models have been widely used for visualization (Biljecki et al., 2015). 3D modeling is very useful for several urban applications, such as planning, management, representation of urban views, etc. (Yalcin & Selcuk, 2015). A wide variety of applications connected to environmental simulation, such as urban planning, building energy characteristics mapping, environmental noise mapping, flood modeling, etc. have used urban virtual 3D models to simulate the real world (Saran et al., 2018)(Sekarsih et al., 2022).

Many ways can be used to get a 3D model. The methods include vector map data, digital elevation models, texture mapping, high-resolution satellite photos, aerial photographs, and terrestrial imagery using photogrammetry (Wolf, 1993). It is categorized as close-range photogrammetry because the shooting distance is no more than 300 m. 3D city models are becoming increasingly significant in today's GIS. In addition, one of the rapidly growing fields of study is the oblique (sideways) photogrammetric approach (Yalcin & Selcuk, 2015). Taking pictures at a certain angle (sideways) allows taking images from different angles. Oblique photos also allow objects to be well modeled from top to bottom.

Photogrammetry is a science that continues to develop along with technological development, especially in the last ten years. The basic principle used in photogrammetry is triangulation (Sajinkumar & Oommen, 2018). Photogrammetry is the science and technology of gathering accurate information about real-world objects and their surroundings. It uses photographic images, imaging patterns of electromagnetic radiation, and other phenomena (Wolf, 1993). This technique allows measuring an object without touching it (Gomarasca, 2009). Generally, each component of the object being shot must be photographed from at least three different perspectives (Sun et al., 2017). To get three different points of view, oblique photos are required to obtain a parallax difference with an overlay of at least 60%. Oblique photogrammetry for 3D modeling can achieve cm-level accuracy (Zhang et al., 2020). A three-dimensional (3D) model based on oblique photogrammetry describes the landscape spatially (Liang et al., 2017). Next, intersecting the line of sight mathematically produces the 3-dimensional coordinates from the destination (Sajinkumar & Oommen, 2018). Through this angular difference (parallax), it is possible to find out the X, Y, and Z coordinates of a point in a 3D model. A 3D model in the Nglanggeran A.V area was made in two versions, namely medium and detailed scales. For the medium-scale 3d model, satellite imagery from Google and SRTM (Shuttle Radar Topographic Mission) data were used for the altitude of the location. Meanwhile, the detailed scale was used by the DJI Mavic Pro 2 drone and the 3D Pilot Survey application to create the flight path.

b. Identifying Toponym by the Community

In the world of cartography, the place naming is called toponymy cartography. The toponymy of a country, region, city, or geographical territorial boundaries is a unified design for each component of that space (Alasli, 2019). Toponymy is also a form of human culture (Taqyuddin, 2008). Toponymy cannot be separated from its supporting cultural experiences reflecting the knowledge of the local population. The legislation in Indonesia has regulated place naming through the Law of the Republic of Indonesia Number 24 of 2009 concerning the national flag, language, emblem, and anthem. It is clearly written in Article 36 that geographical names must use Indonesian (Indonesian Government, 2009). The Law of the Republic of Indonesia Number 23 of 2014 concerning regional government states in Article 48 states 'that changes in regional boundaries, changes in regional names, **naming and changes in the name of topographical parts of the earth** (Indonesian

Government, 2014), transfers of capitals and changes in the name of capitals are stipulated by PP (government regulations). The most competent party has also made regulations regarding the standardization of topographical names in *Perka BIG No 6 of 2017*.

The naming process of a toponym cannot be separated from ancestral cultural heritage. According to the Law of the Republic of Indonesia Number 11 of 2010, efforts to protect cultural heritage can be made by preserving the toponym of an area based on the origins, history, and customs of the area. Article 36 emphasizes that the Indonesian language must be used in naming buildings, roads, apartments or settlements, offices, trade complexes, trademarks, business institutions, educational institutions, and organizations established or owned by Indonesian citizens or Indonesian legal entities (Indonesian Government, 2010). Language and culture have a very close relationship (Rabiah, 2018). Meanwhile, the intended name can use a regional language or foreign language if it has history, culture, customs, and/or religion (Balraj et al., 2020).

Topographical naming has also been regulated by the Geospatial Information Agency (BIG). According to *Perka BIG* No. 6 of 2017, the naming principle must a) use good and correct Indonesian or regional languages; b) use the Roman alphabet; c) use one official name for one topographical element; d) use a local name; e) respect the existence of ethnicity, religion, race, and class; f) avoid using personal names or names of people who are still alive; and g) avoid using mathematical symbols (BIG, 2017).

The participatory mapping method has many advantages. It can control mapping, collect more detailed information, and have the possibility to obtain more accurate spatial data (Blachowski et al., 2018). Information from local residents can be definitely used to explore a lot of local potential not widely known to the general public. Knowledge is divided into four different types based on various references: scientific (or expert) knowledge, local knowledge, bureaucratic (administrative) knowledge, and native knowledge (Yumagulova & Vertinsky, 2019). Local knowledge obtained from village elders, tour guides in the Nglanggeran A.V area, village officials, and local cultural figures will certainly provide broad insight into this toponymic information.

As many as 20 people were invited to participate in identifying important points (specific places) in the Nglanggeran GAP area. The identification is based on elements of visual interpretation, especially shape and size. In general, the research method is presented in a flowchart in Figure 1.

3. Result and Discussion

a. Building 3D Detailed Models

The next mapping is detailed scale mapping. Three-dimensional mapping using UAV (*Unmanned Aerial Vehicle*) is one of the newest technologies in mapping and surveying. This technology utilizes UAVs or unmanned aircraft to collect geospatial data from an area or a certain object with high accuracy and resolution. The data collected by the UAV were then processed and analyzed to produce a detailed and precise 3D map. Three-dimensional mapping using UAVs has more advantages over conventional mapping methods, such as faster mapping times, higher cost efficiency, and more accurate results. In addition, UAVs can also explore the hardest areas to reach by humans, such as dangerous or remote areas. According to (Pytharouli et al., 2018) UAV (Unmanned Aerial Vehicle) is a tool and, therefore, must be used for proper applications in mapping/monitoring small areas, which are less than 10,000 m2 (1 Hectare). Ortho-photos generated from multiple photographs show the potential for obtaining detailed information from a landscape with a ground resolution of around 0.05 m, which is much higher than current satellite image resolution (Budiharto et al., 2021).

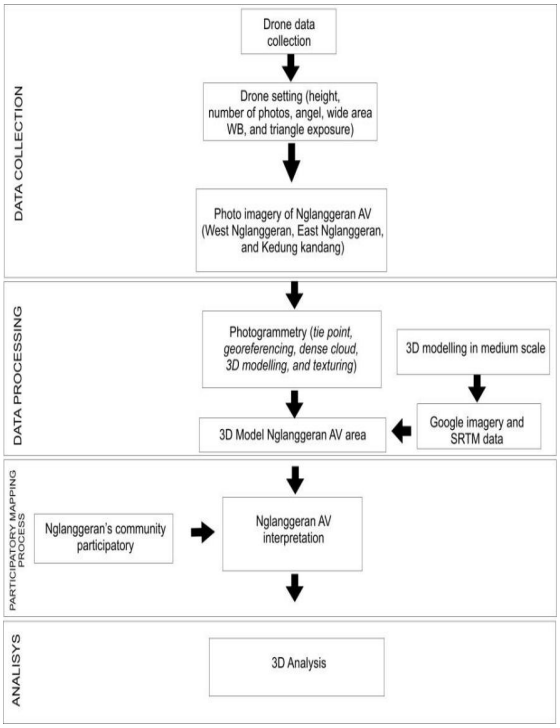

Figure 1. Research protocols. 1) data collection, 2) data processing, 3) participatory mapping, and 4) analysis. In this first stage, flight planning is carried out by setting up the equipment and creating a flight path. The second stage is building a 3D model from aerial imagery from stage 1. The third stage is 3D participatory mapping, and the fourth stage is analysis.

The main data in 3D mapping is aerial photography. In 3D mapping using UAV, this UAV is equipped with cameras and sensors capable of collecting data in various formats, such as imagery, video, and laser data. It is necessary to consider some technical parameters before flying the UAV: required orthophoto resolution, flight altitude, overlap between photographs, lens, and camera characteristics (Tziavou et al., 2018). The collected data were then processed using special mapping software to produce 3D maps used for various applications, such as land mapping, construction surveys, crop mapping, and more. Figure 2 shows the result of 3D data processing from UAV.

Photos to be modeled in 3D are those overlapping at least 60%. In general, an overlap value is more than 60% and a side lap of approximately 20% is considered sufficient in photogrammetry for an orthomosaic (Campbell & Wynne, 2011). In practice, for UAV, a higher overlap value will minimize the possibility of gaps in the orthomosaic and is recommended (Tziavou et al., 2018).

Overlapping aerial photographs are the main data in 3D modeling. This technique is called photogrammetry. This method collects aerial photo data to be processed using a certain software. Basically, the overlapping aerial photography method utilizes the principle of triangulation, which estimates the position of three points to obtain complete information about an object.

After collecting the aerial images, the images were processed using a special mapping software, that is AgisoftMetashape. This software will recognize the same points (XYZ and RGB) in these images to determine the distance between the object and the camera by using trigonometry principles. The advantage of the overlapping aerial photography method is its ability to take accurate and detailed aerial images quickly.

b. Participatory Mapping for Toponym

3D participatory mapping is a part of Participatory GIS (PPGIS, 2023). Capacity building is needed to increase public awareness and enable citizens to be toponymists (Putra Perdana & Ostermann, 2019). In this participatory mapping, the tool used is a 3D model of the Nglanggeran A.V area. PGIS itself can also use other tools, such as sketches, aerial photographs, satellite imagery, Global Position System (GPS) and GIS, and other 2D maps. 3D mapping is an approach in mapping involving the active participation of the community or users in the mapping area. 3D mapping has now become a widespread form, allowing local people to create their own maps and models and use them for research, analysis, assertion of rights and resolution of their conflicts over land. In participatory mapping, the community or users are expected to participate in the mapping process, starting from data collection to making decisions regarding the utilization of the mapping results. Participatory mapping is expected to reflect the voice of the community (Laituri et al., 2023). The following Figure 3 shows the process of identifying areas in the Nglanggeran A.V area using a 3D model that has been made.

This 3D participatory mapping is considered very effective. Analysis from local managers for the identification of the Nglanggeran A.V area can be explained in detail. Other

Figure 2. Results of 3D Data Processing from Patched Aerial Photographs
Source: Data Processing (2023)

Figure 3. 2D and 3D Participatory Mapping in Small Groups for Area Identification by Using a Map and 3D Model in the Nglanggeran A.V Area
Source: Field Survey (2023)

results obtained from this mapping showed the existence of local names given by residents at certain points with unique characteristics in the Nglanggeran A.V area. The local names included Nglanggeran, Pitu Village, Mount Kelir, Sewer Water Source, Sumpitan Aisle, Mount Bagong, Song Gudel, Mount Bongos, Mount Gedhe, Mount Blencong, Mount Limajari, Mount Buchu, Mount Elbow, Kedung Kandang, Ngekong Peak, Guyangan Lake, and Kali Song. Toponyms can be classified according to the following principles: 1) parametric characteristics, 2) ontological characteristics, 3) type of toponymic basis, 4) etymological characteristics, 5) motivational characteristics, 6) chronological characteristics, 7) structural characteristics, 8) toponymic polysemy, 9) degree of toponymic nomination, 10) variety of toponymic nomination, and 11) localization of an object (Abdikhalikovna, 2020). This principle will be used to classify local names in Nglanggeran AV.

c. Analysis

One area with unique toponym is Nglanggeran. Nglanggeran is derived from the word "nglanggar" or in Indonesian "melanggar"(breaking). It is said that in the past, it came from residents who damaged the puppets of a puppeteer who was invited to a harvest party. The residents who destroyed the puppets were then thrown into a place called "Nglanggeran." Figure 4 is the orthomosaic of the Nglanggeran area, along with the toponym information attached to it.

This area has a collection of ancient mountains with unique names. Some of the unique names are closely related to the form and story of *wayang*, which is about Nglanggeran. One of the mountains is Mount Buchu (Figure 5.a). Buchu is taken from the word "buchu," which means a prism-shaped lamp for lighting during a puppet show, according to wayang terms.

Another mountain in the Nglanggeran AV area is Mount Lima Jari (Figure 5.b). As the name implies, Lima Jari means five fingers. The shape of this mountain resembles 5 human fingers looking up. Another mountain is Mount Kelir (5.c). The word k*elir* in Javanese means a fold of clothes. This mountain, seen from above, has a flat elongated shape resembling a folded cloth. The results of the 3D participatory mapping analysis for the identification of toponymic traces in the Nglanggeran A.V area are presented in Table 1.

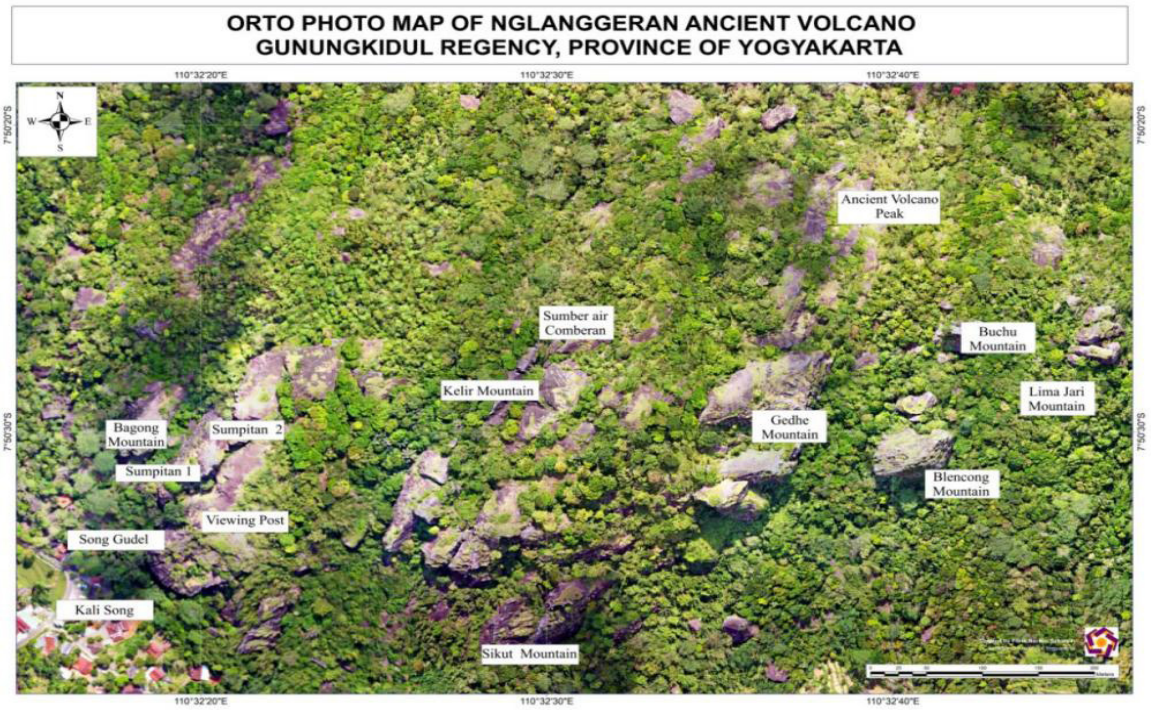

Figure 4. Nglanggeran Toponym's Map

Figure 5. Mount Buchu (a); Mount Lima Jari (b); and Mount Kelir (c)
Source: Field Survey and Data Processing (2023).

Table 1. Analysis of Toponymic Traces in the Nglanggeran A.V Area Using a 3D Model.

No	Location name	The meaning of the name	Classification of toponymic nominations
1.	Nglanggeran	It is derived from the word "nglanggar" or in Indonesian "melanggar"(breaking). It is said that in the past, it came from residents who damaged the puppets of a puppeteer who was invited to a harvest party. The residents who destroyed the puppets were then thrown into a place called "Nglanggeran".	Principle Toponym number 3. Type of toponymic basis which relates to Ergotoponyms. Nglanggeran is a geographical name reflecting the activity of some people breaking puppets.
2.	Pitu Village	*Pitu* in Javanese means seven. The word *Kampung Pitu* means a village which is only inhabited by seven families (heads of families).	Principle Toponym number 8. Place names are subdivided into *multiple objects*.
3.	Mount Kelir	The word "kelir" means the screen used to play the dolls/puppets. *Kelir* can also be interpreted as a folded cloth.	Principle Toponym number 2. Classification based on ontological characteristics. The name is divided into a manmade object (*kelir*/folded cloth)
4.	Sumber Air Comberan (Sewer Water Source)	*Comberan* means a pool of dirty water. It is called Sewer Water Source because the water source at the top of the Nglanggeran A.V will still be there (stagnate) even in the dry season.	Principle Toponym number 2. The classification is based on ontological characteristics. Hydronyms Branch
5.	Lorong Sumpitan (Sumpitan Aisle)	It is derived from the word "sumpit" which means small/narrow. The Sumpitan Aisle is a narrow and long path in the Nglanggeran A.V area.	Principle Toponym number 7. Structural characteristics
6.	Song Gudel	*Song Gudel* comes from 2 words that are "song" and "gudel". In Javanese, *song* means a cave that is not too deep (still visible from the outside). While *gudel* means baby buffalo. Thus, "*Song Gudel*" means the cave used to rest baby buffaloes.	Principle Toponym number 7. Structural characteristics
7.	Mount Bagong	*Bagong* in *wayang* is also called *Semar*. *Semar* is a highly respected figure because of his wisdom. The character of Semar is depicted as an old figure with a bow. This character is the background for the name "Bagong" which seems to resemble a person who is in a bent position.	Principle Toponym number 3. Type of toponymic basis which relates to *Anthropotoponyms Semar/Bagong*
8.	Mount Bongos	It is derived from the word "bongos" which means black. Seen from aerial photography, indeed this mountain looks darker than the others.	Principle Toponym number 1. The classification is based on parametric characteristics.
9.	Mount Gedhe	It is derived from the word "gedhe". *Gedhe* in Javanese means big. This means that it is the largest and highest mountain in the Nglanggeran A.V area.	Principle Toponym number 1. The classification is based on parametric characteristics.
10.	Mount Blencong	It is derived from the word "blencong". *Blencong* in Javanese means slightly tilted in position.	Principle Toponym number 1. The classification is based on parametric characteristics.
11.	Mount Lima Jari	It is derived from the word "lima jari" which also in Indonesian means five fingers. It is given the name five fingers because it physically looks like 5 human fingers looking up.	Principle Toponym number 1. The classification based on parametric characteristics.
12.	Mount Buchu	It is called "buchu" because it has a sharp shape like the buchu "pamp" in puppet show.	Principle Toponym number 2. The classification is based on ontological characteristics. The name is divided into a manmade object (Buchu/Lamp).
13.	Mount Sikut	It is derived from the word "sikut" which in Indonesian means elbow.	Principle Toponym number 7. Structural characteristics
14.	Kedung Kandang	It is derived from the words "kedung" and "kandang". *Kedung* means a place with a fairly deep pool of water while *kandang* is a pet house. So, the meaning of *Kedung Kandang* is a location in a lower area used as a pet house.	Principle Toponym number 2. The classification is based on ontological characteristics. Hydronyms Branch

15.	Ngekong Peak	*Ngekong* in Javanese means "concave".	Principle Toponym number 7. Structural characteristics
16.	Guyangan Pond	*Tlogo* means pond, while *guyangan* means bathing pets such as cows, buffaloes, and horses. *Tlogo Guyangan* means a pond that, according to local people, is used to bathe the angel's vehicle, the Sembrani Horse.	Principle Toponym number 3. This is a type of toponymic basis which relates to Ergotoponyms. Its geographical names reflect professional activity.
17.	Kali Song	*Kali Song* comes from 2 words, "kali" and "song". In Javanese, *song* means a cave that is not too deep (still visible from the outside), while *kali* means a small river.	Principle Toponym number 2. The classification is based on ontological characteristics. The name is classified into the Hydronyms Branch.
18.	Gunung Butak	*Butak* in Javanese means not clear.	Principle Toponym number 1. The classification is based on parametric characteristics.

Source: Field Survey and Data Processing (2023)

Apart from the visible locations, local residents also mentioned several locations around the Nglanggeran A.V area that they believe to exist but are invisible. These locations are Talang Kencono, Wungu Lake, and Pamean Gadhung. Talang Kencono is an invisible lake that connects Guyangan Lake to Kotagede. Wungu Lake is an invisible lake in the Nglanggeran A.V area which, according to the story of the local people, is used by angels to bathe. The last one is Pamean Gadhung, which is an invisible tree that spreads from the Nglanggeran A.V to the peak of Mount Merapi.

The 3D participatory mapping can indeed describe shapes more realistically. This mapping involves people of the Nglanggeran A.V area, especially Pokdarwis (Tourism Awareness Group), in identifying important points (specific areas) in Nglanggeran. In 3D participatory mapping, the community was allowed to look at the detailed 3D model of the Nglanggeran A.V area and write down the information on the maps and sketches that have been provided.

Three-dimensional participatory mapping can produce more accurate data because of active community participation in the mapping process. The data collected were also very detailed and complete because the people living in the area have deeper knowledge about the condition of the Nglanggeran A.V area. In participatory mapping, the community can assist in the data collection process so that the mapping process can be carried out more quickly and efficiently. In participatory mapping, the community interests are the main focus of the mapping process. This can help ensure that the results of the mapping will benefit the community. This is also in line with the research (Rye & Kurniawan, 2017) where mapping involving the participation of local residents is a powerful tool as a reference for defending the territory/territory of indigenous people.

4. Conclusion

The toponym of an area cannot be separated from the local culture of an area. Local wisdom and historical stories of a place are immortalized, one of which is by naming a location. As one of the world heritages, the Nglanggeran A.V has an interesting toponym story not widely known by the general public. Three-dimensional participatory mapping can provide detailed information about points, physical characteristics, and interesting stories around the Nglanggeran A.V area. The results of this mapping collected 18 toponyms in the Nglanggeran A.V area. These locations are Nglanggeran itself, Kali Song, Pitu Village, Mount Kelir, Sumber Air Comberan (Sewer Water Source), Lorong Sumpitan (Sumpitan Aisle), Song Gudel, Mount Bagong, Mount Bongos, Mount Gedhe, Mount Blencong, Mount Lima Jari, Mount Buchu, Mount Sikut, Kedung Kandang, Ngekong Peak, Gunung Butak, and Guyangan Pond.

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References

Abdikhalikovna, K. F. (2020). Principles of Toponyms (Place Names) Classifications. *International Journal of Multicultural and Multireligious Understanding*, *7*(6), 73. https://doi.org/10.18415/ijmmu.v7i6.1738

Alasli, M. (2019). Toponyms' contribution to identity: The case study of Rabat (Morocco). *Proceedings of the ICA*, *2*(July), 1–7. https://doi.org/10.5194/ica-proc-2-3-2019

Balraj, B. M., Singh, S., & Abd Manan, M. H. (2020). The Relationship Between Language and Religion. *International Journal of Academic Research in Business and Social Sciences*, *10*(11), 1217–1224. https://doi.org/10.6007/ijarbss/v10-i11/8198

BIG. (2017). *Peraturan Badan Informasi Geospasial Nomor 6 Tahun 2017 tentang Penyelenggaraan Pembakuan Nama Rupabumi*.

Biljecki, F., Stoter, J., Ledoux, H., Zlatanova, S., & Çöltekin, A. (2015). Applications of 3D city models: State of the art review. *ISPRS International Journal of Geo-Information*, *4*(4), 2842–2889. https://doi.org/10.3390/ijgi4042842

Blachowski, J., Łuczak, J., & Zagrodnik, P. (2018). Participatory GIS in design of the Wroclaw University of Science and Technology campus web map and spatial analysis of campus area quality. *E3S Web of Conferences*, *29*. https://doi.org/10.1051/e3sconf/20182900025

Budiharto, W., Irwansyah, E., Suroso, J. S., Chowanda, A., Ngarianto, H., & Gunawan, A. A. S. (2021). Mapping and 3D modelling using quadrotor drone and GIS software. *Journal of Big Data*, *8*(1), 48. https://doi.org/10.1186/s40537-021-00436-8

Cahyono, A., Susilo, B., Wirasanti, N., & Rahardjo, N. (2024). Learning the past landscape of Yogyakarta city from historical maps. *Proc. SPIE*, *12977*, 129770C. https://doi.org/10.1117/12.3009197

Campbell, J. B., & Wynne, R. H. (2011). *Introduction to remote sensing*. Guilford Press.

Fagerholm, N., García-Martín, M., Torralba, M., Bieling, C., & Plieninger, T. (2022). Public participation geographical

information systems (PPGIS) Participatory research methods for sustainability – toolkit #1. *GAIA - Ecological Perspectives for Science and Society*, *31*(1), 46–48. https://doi.org/10.14512/GAIA.31.1.10

Fagerholm, N., Raymond, C. M., Olafsson, A. S., Brown, G., Rinne, T., Hasanzadeh, K., Broberg, A., & Kyttä, M. (2021). A methodological framework for analysis of participatory mapping data in research, planning, and management. *International Journal of Geographical Information Science*, *35*(9), 1848–1875. https://doi.org/10.1080/13658816.2020.1869747

Ghani, D. A., Supian, M. N. Bin, & Abdul 'Alim, L. Z. Bin. (2019). The research of 3D modeling between visual & creativity. *International Journal of Innovative Technology and Exploring Engineering*, *8*(11 Special issue 2), 180–186. https://doi.org/10.35940/ijitee.K1029.09811S219

Gomarasca, M. A. (2009). *Elements of Photogrammetry BT - Basics of Geomatics* (M. A. Gomarasca (ed.); pp. 79–121). Springer Netherlands. https://doi.org/10.1007/978-1-4020-9014-1_3

Indonesian Government. (2009). UNDANG-UNDANG REPUBLIK INDONESIA NOMOR 24 TAHUN 2009 2009 TENTANG BENDERA, BAHASA, DAN LAMBANG NEGARA, SERTA LAGU KEBANGSAAN. In *Indonesian Government*.

Indonesian Government. (2010). UNDANG-UNDANG REPUBLIK INDONESIA NOMOR 11 TAHUN 2010 TENTANG CAGAR BUDAYA. In *Indonesian Government*.

Indonesian Government. (2014). UNDANG-UNDANG REPUBLIK INDONESIA NOMOR 23 TAHUN 2014 TENTANG PEMERINTAHAN DAERAH. In *Indonesian Government*.

Klonner, C., Usón, T. J., Aeschbach, N., & Höfle, B. (2021). Participatory Mapping and Visualization of Local Knowledge: An Example from Eberbach, Germany. *International Journal of Disaster Risk Science*, *12*(1), 56–71. https://doi.org/10.1007/s13753-020-00312-8

Laituri, M., Luizza, M. W., Hoover, J. D., & Allegretti, A. M. (2023). Questioning the practice of participation: Critical reflections on participatory mapping as a research tool. *Applied Geography*, *152*. https://doi.org/10.1016/j.apgeog.2023.102900

Liang, J., Shen, S., Gong, J., Liu, J., & Zhang, J. (2017). Embedding user-generated content into oblique airborne photogrammetry-based 3D city model. *International Journal of Geographical Information Science*, *31*(1), 1–16. https://doi.org/10.1080/13658816.2016.1180389

Minnegalieva, C. B., Gabdrakhmanov, R. I., Khambelov, A. I., Khairullina, L. E., Bronskaya, V. V., & Kharitonova, O. S. (2020). 3D modeling in the study of the basics of computer graphics. *Journal of Physics: Conference Series*, *1515*(2). https://doi.org/10.1088/1742-6596/1515/2/022045

Moyo, M. (2021). The Role of Place-Names in Preserving Living Heritage in Matabeleland. *International Journal of Research and Scientific Innovation (IJRSI) |*, *VIII*(II), 257–261. www.rsisinternational.org

Muhammad, I. B., Isah, A. D., Banki, M. B., & Salawu, A. (2020). Toponym and evocation of cultural landscape heritage: A case of an african community. *Pertanika Journal of Social Sciences and Humanities*, *28*(3), 2427–2440.

Nugraha, Y. K., & Santosa, P. B. (2022). Influence of Spatial Abilities on Spatial Data Quality in Participatory Mapping. *Indonesian Journal of Geography*, *54*(2), 185–194. https://doi.org/10.22146/ijg.64931

PPGIS. (2023). *About PGIS*. http://www.ppgis.net/about-pgis/

Priyambodo, D. Y., Suriyanto, R. A., Artanti, M. S. T., Basworo, W., Prasamya, E., & Sekarsih, F. N. (2023). *Pelatihan Bantuan Hidup Dasar (BHD) Kelompok Sadar Wisata (Pokdarwis) di Desa Wisata Nglanggeran*. *3*(2), 1684–1692. https://merahputih.com/post/read/desa-ngelanggeran-raih-predikat-desa-wisata-terbaik-dunia-2021

Putra Perdana, A., & Ostermann, F. O. (2019). Eliciting Knowledge on Technical and Legal Aspects of Participatory Toponym Handling. *ISPRS International Journal of Geo-Information*, *8*(11). https://doi.org/10.3390/ijgi8110500

Pytharouli, S., Souter, J., & Tziavou, O. (2018). Unmanned Aerial Vehicle (UAV) based mapping in engineering geological surveys: Considerations for optimum results. *Engineering Geology*, *232*(May), 12–21. https://doi.org/10.1016/j.enggeo.2017.11.004

Rabiah, S. (2018). *Language as a Tool for Communication and Cultural Reality Discloser*. https://doi.org/10.31227/osf.io/nw94m

Rye, S. A., & Kurniawan, N. I. (2017). Claiming indigenous rights through participatory mapping and the making of citizenship. *Political Geography*, *61*, 148–159. https://doi.org/https://doi.org/10.1016/j.polgeo.2017.08.008

Sajinkumar, K. S., & Oommen, T. (2018). *Photogrammetry*. https://doi.org/10.1007/978-3-319-73568-9_221

Saran, S., Oberai, K., Wate, P., Konde, A., Dutta, A., Kumar, K., & Senthil Kumar, A. (2018). Utilities of Virtual 3D City Models Based on CityGML: Various Use Cases. *Journal of the Indian Society of Remote Sensing*, *46*(6), 957–972. https://doi.org/10.1007/s12524-018-0755-5

Segara, N. B., & Hermansyah. (2021). Toponym investigation as introduction to the local value in Cirebon City. *IOP Conference Series: Earth and Environmental Science*, *683*(1). https://doi.org/10.1088/1755-1315/683/1/012014

Sekarsih, F. N., Mustopa, A., & Kusnawi. (2022). Nglanggeran 3D Modelling for Virtual Reality Asset with Oblique Close Range Photogrammetry. *2022 5th International Conference on Information and Communications Technology (ICOIACT)*, 232–237. https://doi.org/10.1109/ICOIACT55506.2022.9972014

Sekarsih, F. N., & Priyambodo, D. (2022). Kematian yang Ditolak di Kampung Pitu, Nglanggeran, Patuk, Gunungkidul. *DEMOS: Journal of Demography, Ethnography and Social Transformation*, *2*(1), 51–57. https://doi.org/10.30631/demos.v2i1.1288

Suarma, U., Hizbaron, D. R., Sudibyakto, & Nurjani, E. (2019). Participatory Implementation within Climate Change Related Poli cies in Urbanized Area of Indonesia. *Indonesian Journal of Geography*, *50*(2), 121–132. https://doi.org/10.22146/ijg.36263

Sun, T., Xu, Z., Yuan, J., Liu, C., & Ren, A. (2017). Virtual Experiencing and Pricing of Room Views Based on BIM and Oblique Photogrammetry. *Procedia Engineering*, *196*, 1122–1129. https://doi.org/https://doi.org/10.1016/j.proeng.2017.08.071

Tziavou, O., Pytharouli, S., & Souter, J. (2018). Unmanned Aerial Vehicle (UAV) based mapping in engineering geological surveys: Considerations for optimum results. *Engineering Geology*, *232*, 12–21. https://doi.org/https://doi.org/10.1016/j.enggeo.2017.11.004

UNWTO. (2021). *Nglanggeran Indonesia*. https://tourism-villages.unwto.org/en/villages/nglanggeran/

Wolf, P. (1993). *Elemen Fotogrametri dengan Interpretasi FotoUdara dan Penginderaan Jauh*. UGM Press.

Yalcin, G., & Selcuk, O. (2015). 3D City Modelling with Oblique Photogrammetry Method. *Procedia Technology*, *19*, 424–431. https://doi.org/https://doi.org/10.1016/j.protcy.2015.02.060

Yumagulova, L., & Vertinsky, I. (2019). Moving beyond engineering supremacy: Knowledge systems for urban resilience in Canada's Metro Vancouver region. *Environmental Science & Policy*, *100*, 66–73. https://doi.org/https://doi.org/10.1016/j.envsci.2019.05.022

Zhang, X., Zhao, P., Hu, Q., Ai, M., Hu, D., & Li, J. (2020). A UAV-based panoramic oblique photogrammetry (POP) approach using spherical projection. *ISPRS Journal of Photogrammetry and Remote Sensing*, *159*, 198–219. https://doi.org/https://doi.org/10.1016/j.isprsjprs.2019.11.016

Zhong, A., Wu, Y., Nie, K., & Kang, M. (2020). Using local toponyms to reconstruct the historical river networks in Hubei Province, China. *ISPRS International Journal of Geo-Information*, *9*(5). https://doi.org/10.3390/ijgi9050318