

Geospatial Archaeology of Ulung Buayeh (crocodile mound): The Integration of Location, Landscape and Mound Effigies in Lundayeh Culture in Long Pasia and Long Mio

Geospatial Ulung Buayeh (*crocodile mound*): Pengintegrasian lokasi, landskap dan arkeologikal guar effigi warisan budaya etnik Lundayeh di Long Pasia dan Long Mio

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Abstract

This study focuses on the significance of Ulung Buayeh (Crocodile Mounds), ancient effigy mound sites which are the cultural heritage of the Lundayeh ethnic group. The researchers also examined the extent Ulung Buayeh as a catalyst for reinforcing land ownership and territorial expansion of the Lundayeh around 1700s (300 years ago). This article emphasizes the application of geospatial approach in identifying and analyzing Ulung Buayeh in the contexts of location, landscape, and heritage integration of the ancient earthen-effigy mound sites at Long Pasia and Long Mio in the district of Sipitang, Sabah, Malaysia. The surface mapping analysis through geographic information systems (GIS) produces a geospatial thematic map of Ulung Buayeh. Hence, the geospatial mapping of Ulung Buayeh can also be used as a spatial reference to promote Long Pasia as one of the archaeotourism destinations in the context of the conservation of the foremost ancient mound effigy site in Sabah and Malaysia.

Kajian ini memberi perhatian penuh terhadap signifikansi tapak purba guar effigi Ulung Buayeh (crocodile mound) yang menjadi warisan dan budaya kepada etnik Lundayeh. Penyelidik turut meneliti sejauhmana peranan tapak Ulung Buayeh ini menjadi pemangkin kepada pengukuhan pemilikan tanah dan perluasan wilayah etnik Lundayeh. Artikel ini memberi fokus kepada pengaplikasian pendekatan geospatial dalam mengenal pasti dan menganalisis Ulung Buayeh dalam konteks pengintegrasian lokasi, landskap dan warisan bagi tapak guar tanah purba ini di kampung Long Pasia dan kampung Long Mio di daerah Sipitang, Sabah, Malaysia. Analisis pemetaan permukaan (*surface analysis*) menerusi aplikasi (GIS) digunakan untuk menghasilkan peta tematik geospatial Ulung Buayeh. Pemetaan geospatial Ulung Buayeh yang terhasil juga boleh dijadikan sebagai sumber rujukan untuk mempromosi Long Pasia sebagai salah satu destinasi arkeopelancongan dalam konteks pemuliharaan tapak tradisi guar effigi purba yang terulung di Sabah dan Malaysia.

Keywords: Effigy mound, archaeology, geospatial, heritage, Ulung Buayeh, Long Pasia | Guar effigi, arkeologi, geospatial, warisan budaya, Ulung Buayeh, Long Pasia

Introduction

Geographic information systems (GIS) provides a means of integrating information in a way that helps us understand and address geo-referenced data. GIS is concerned with data relating to geographic scales of measurement as well as to ask questions of the geographic database and obtaining the physical environment, both natural and built (Martin 1995). Hence, the capability of the application to manage archaeological data is suitable since archaeological data comprises of two features which are space and time. Based on the flexibility of the GIS technology and its potential to manage archaeological data, it is therefore able to analyze historical data to unravel the cultural heritage relics which are treasures of the native community at a regional level. The studies using geospatial approach have now gained full and scientific attention in investigative studies related to the field of archaeology. Those that were published were orientated towards geographic information system integration as one of the approach paradigms to evaluate archaeological field as what had been carried out by scholars such as Zubrow (1990), Lock and Stancic (1995), Katsianis (2012), Wheatley and Gillings (2002), Conolly (2008), Davies et al. (2019) and Jebur (2021). The analyses prepared in GIS applications are attractive as they could prove the accuracy of data and information which serve as the reference sources in the form of layers based on environmental variables that influence the activities of native residents. GIS mapping in the form of layers can identify the accuracy of location whereby the combination of environment features matches the observed patterns in the studied prehistoric site (Kuiper and Wescott 1999). Additionally, according to Dell'Unto and Landeschi (2022), the development of GIS implies its capability to present more dynamic findings as evident from more accurate and clearer findings in a three-dimensional (3D) display.

Henceforth, in unraveling the cultural heritage through ancient earthen mound sites with GIS, it is indeed pertinent to evaluate the extent to which GIS applications can potentially analyze effigy mounds such as Ulung Buayeh sites so that the accuracy of data and information based on the perspective of location and landscape setting can give a closer and more detailed description of the Lundayeh cultural heritage. Based on several GIS analysis workflows through the ModelBuilder's geoprocessing on the Ulung Buayeh site for shape, pattern, and configuration, this has raised some expectations of the research findings regarding the Lundayeh cultural heritage. The archaeological distinction and uniqueness of the ancient effigy mound sites especially for Ulung Buayeh implied the greatest potentials for it to be presented as an esteemed cultural heritage in the archaeotourism industry in Sabah in the future.

Lundayeh Demographics

The Lundayeh is one of the various ethnic minority groups found in the state of Sabah and around Borneo Island. Based on historical records, this ethnic minority is believed to originate from the northern central region of Kalimantan, Indonesia. Uniquely, this ethnic group is known by various names such as Lun Dayeh, Lun Lod and Lun Bawang based on their location. The word Lun means "people", Dayeh "upper-river", Lod "downstream" while Bawang means "region or locality" (Moody 1984). In the state of Sabah, the term Lundayeh is used.

The ancestors of the Lundayeh originated from the southern region of the mainland of China and immigrated to the island of Borneo about 15,000 to 20,000 years ago (Harrison 1959). The migration

inspired by the unique burial mounds constructed by the Native Americans. Some effigies are in the form of birds, bear, deer, spirit animals or people (Birmingham and Eisenberg 2000). Since pioneer studies in late 1870s in United States (Sayre 1998; Shetrone 2004), this term is widely used for referring to an archaeological feature resembling or having shared characteristics with animal forms. Mound building is found in different parts of the world dating from 5,000 BCE up to 100 years ago in the case of Long Pasia effigy mounds tradition (Ismail Ali and Baszley Bee Basrah Bee 2010). This archaeological feature has become a cultural heritage inherited by the Lundayeh (Lun Bawang) ethnic group about 3,000 years ago (Datan 2011).

In Long Pasia and Long Mio there are other archaeological features associated with Lundayeh found within the area where effigy mounds are located such as the Batu Narit petroglyphs, Long Midang open burial mound site, slab graves and dolmens (Bilcher Bala et al. 2021; Jelinus 2018; Bilcher, cited in Topp (2006) and Simpson (2007) have also briefly related the legends surrounding the Ulung Buayeh and the Lundayeh maintain their culture through activities such as the annual fiesta every May and tourism performances.

The tradition of constructing animal effigy mounds is associated with head hunting culture that was practiced by numbers of indigenous ethnic groups in Borneo from the introduction of metal sword through maritime trade in 10th century to the end of World War II in 1945 (Baszley Bee Basrah Bee and Md Saffie Abdul Rahim 2010). This practice head hunting was banned by the British North Borneo Chartered Company (BNBCC) and Dutch administration in the early 20th Century. However, only the Lundayeh built the effigy mounds as part of the ritual elements in their head-hunting culture and they still maintain a tradition that symbolises the power of its heroes during ancient times, by performing dance ceremonies around a crocodile-shaped monument made of clay (Jelinus 2017). The tradition was once held after a hero successfully beheaded his enemies. In this context the hero would set up and dance around a crocodile decorated wood known as "ulung buayeh" while striking it. The Lundayeh insist that the crocodile mounds as a symbol of strength (Ricky et al. 2018).

In Kampung Long Pasia and Kampung Long Mio, the effigy mound is a tourism attraction even though the tradition has long been abandoned (Baszley Bee Basrah Bee and Bilcher Bala 2009). Furthermore, the existence of the ancient effigy mound site is important in the traditional mound builder culture in Malaysia and Southeast Asia because of its features are not found in elsewhere in Southeast Asia except in the heart of the Borneo plateau (Baszley Bee Basrah Bee and Bilcher Bala 2009).

Early archaeological research in the form of primary surveys were carried out by a team of researchers headed by Baszley Bee, under the fundamental research grant (FGR0102-NSH-1/2007) for inventorying eight effigy mound sites in the form of crocodiles known as "Ulung Buayeh" by locals during the first expedition in 2008 (Baszley Bee Basrah Bee and Bilcher Bala 2009). A second expedition in 2016 which included the National Heritage Department inventoried two more effigy mound sites found around the river basin of Matang river, Pa Sia River and Padas River in Kampung Long Pasia and Kampung Long Mio. The existence of these sites is related to other sites in the area of Lawas Damit, Long Semadoh, Ba'Kelalan in Sarawak and Kerayan in Kalimantan Timur. Hence, the distribution of Ulung Buayeh sites is in the triangular area of the Borneo plateau, Maligan Highland-Bario-Kerayan Highland also known as Apo-Kayan plateau (Figure 2).

One interesting fact about the effigy mound sites in Long Pasia relates to the number that are still being preserved, and their size - more than 10 meters in length (Baszley Bee and Bilcher Bala 2009). Up to now, Long Pasia and Long Mio are the only areas where Ulung Buayeh can be found in Sabah. The sites were identified through inventory during the archaeological research expedition which listed ten of the 14 Ulung Buayeh sites around Long Pasia and Long Mio (Table 1). The physical characteristics of the mounds are discussed below.

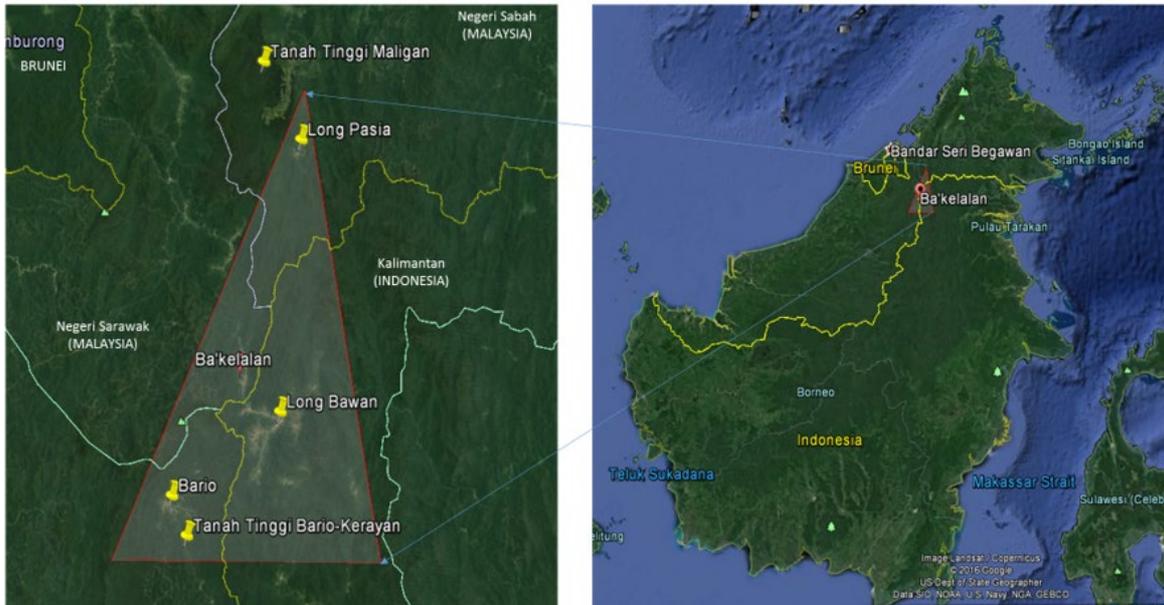


Fig. 2 Site location of Lundayeh Ethnic Group Region Between Maligan Highland → Bario-Kerayan Highland. Source: Adapted from Google Earth Image (2021)

No	INVENTORY CODE	ULUNG BUAYEH & CHARACTERISTIC	COORDINATE	
1	UMS-FRGS/LP/2009/UB01	Name: Rebaruh Ruan Dimension: Length (11.8 m); Width (4.1 m); Height (1.48 m). Site: Located at the top of the hill on the left side of Matang river.	4°20'45.76"N	115°43'58.29"E
2	UMS-JWN/LP/2016/UB02	Name: Pekung Butoi Dimension: Length (9.3 m); Width (5.1 m); Height (1.41 m). Site: Located at the slope of the hill on the left side of Matang river.	4°23'21.50"N	115°43'20.70"E
3	UMS-JWN/LP/2016/UB03	Name: Lu'puluh 1 Dimension: Length (9.52 m); Width (5.3 m); Height (1.9 m). Site: Located at the slope area on the left side of Matang river.	4°22'37.70"N	115°43'53.80"E
4	UMS-JWN/LP/2016/UB04	Name: Lu'puluh 2 Dimension: Length (5.1 m); Width (3.3 m); Height (0.3 m). Site: Located at the river bank and on the left side of Matang river.	4°22'54.80"N	115°44'04.60"E
5	UMS-JWN/LP/2016/UB05	Name: Kinangan Dimension: Length (6.2 m); Width (4.05 m); Height (0.59 m) Site: Located at the top of the hill on the left side of Matang river.	4°24'19.30"N	115°44'14.70"E
6	UMS-JWN/LP/2016/UB06	Name: Confrontation Battle Site Dimension: <i>Not Available</i> Site: Located at the area of Confrontation Battle Site on the south of Long Pasia village.	4°24'06.30"N	115°43'30.70"E
7	UMS-JWN/LP/2016/UB07	Name: Onol Dimension: Length (9.1 m); Width (5.0 m); Height (1.24 m) Site: Located at the top of the hill on the left side of Matang river.	4°17'33.50"N	115°42'12.20"E
8	UMS-JWN/LP/2016/UB08	Name: Long Magut Dimension: <i>Not Available</i> Site: Located at the slope of the hill on the left side and upper river of Matang river.	4°19'56.85"N	115°44'9.90"E
9	UMS-JWN/LP/2016/UB09	Name: Puek Marit Dimension: <i>Not Available</i> Site: Located at the slope of the hill on the left side and upper of Matang river.	4°20'47.61"N	115°43'27.60"E
10	UMS-JWN/LM/2016/UB10	Name: Natad Tawak Dimension: Length (6.7 m); Width (1.3 m); Height (0.85 m) Site: Located at the middle of the hill on the left side of Long Miao Village.	4°26'20.20"N	115°44'10.10"E

Table 1 Ulung Buayeh Effigy Mound Sites Inventory at Long Pasia and Long Mio. Source: Archaeological Research Expedition of Long Pasia and Long Mio Earthen Mound Sites (2016-2017).

Geometry of Ulung Buayeh Mound Effigies

The geometry of the Ulung Buayeh typology inventoried around the river basins of Matang river, Pa Sia River and Padas River indicated differences in size and dimension. However, to describe the dimension and size of the Ulung Buayeh sites, this article explains in detail only two sites which are UB01 Rebaruh Ruan and UB10 Natad Tawak. For other sites (UB02 - UB09) the criteria and dimension measurements are only listed in general as in Table 1 above. The selection of the two sites is because they have gone through a comprehensive recording (with the exception of excavation) as compared to the other eight sites.

UB01 Rebaruh Ruan Ulung Buayeh

The location of UB01 Rebaruh Ruan is located south of Long Pasia village. The distance from the village is 8 km. The Rebaruh Ruan site is located close to river of Sg. Matang with a distance of approximately 150 meters. The Rebaruh Ruan site is on a hillside at an altitude of 1,060 meters above sea level (Figure 3). The site of UB01 Rebaruh Ruan Ulung Buayeh measures at 12.2 m in length from the snout to the tail end. The width is 4.1 m and 1.48 m in height. The division of measurement according to segment for UB01 is as follows: head segment is 2.2 m; body section is 4.8 m and tail segment is 6.2 m. Meanwhile, the length measurement for front leg section is 3.15 m and the length of the back leg is 4.2 m (Figure 4). UB01 site is the largest Ulung Buayeh that was inventoried around Long Pasia.

UB10 Natad Tawak Ulung Buayeh

The location of UB10 Natad Tawak is located northwest of Long Miau village. The distance from the village is only 1.3 km. The nearest river to the Natad Tawak site is Sg. Padas with a distance of approximately 1.5 km. The Natad Tawak site is also on a hillside at an altitude of 1,120 meters above sea level (Figure 3). UB10 Natad Tawak Ulung Buayeh site measures length 6.7 m from the snout to the tail. Its width is 1.3 m and height at 0.85 m. The division of measurement according to segment for UB10 Natad Tawak is as follows: head section is 1.79 m (destroyed); body section is 3.43 m and tail segment is 2.3 m. Meanwhile, the length measurement of the front leg section is 1.92 m and the length of the back leg is 1.8 m. UB10 site is the Ulung Buayeh located around Long Mio (Figure 5).

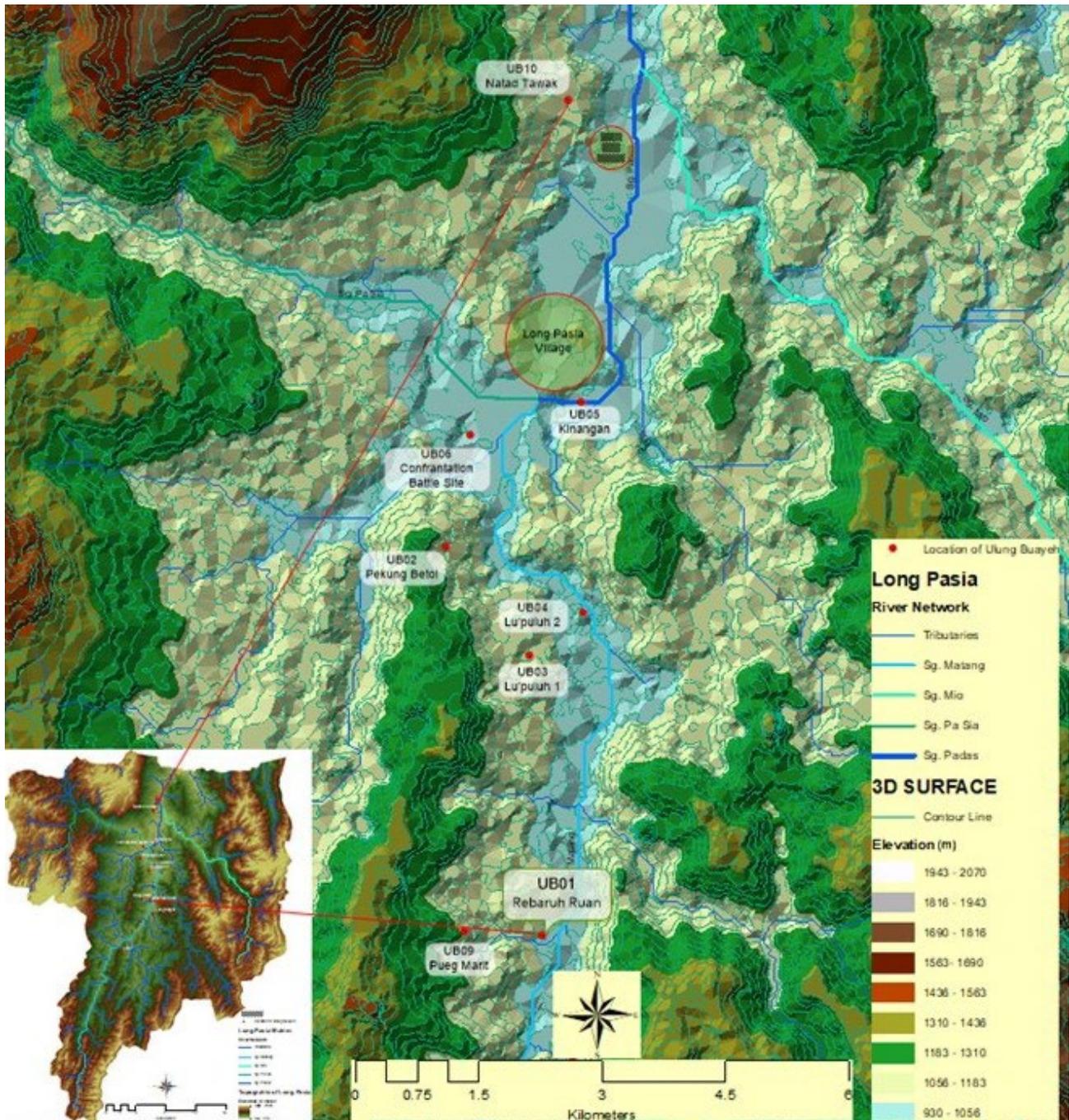


Fig. 3 Location of UB01 Rebaruh Ruan and UB10 Natas Tawak.

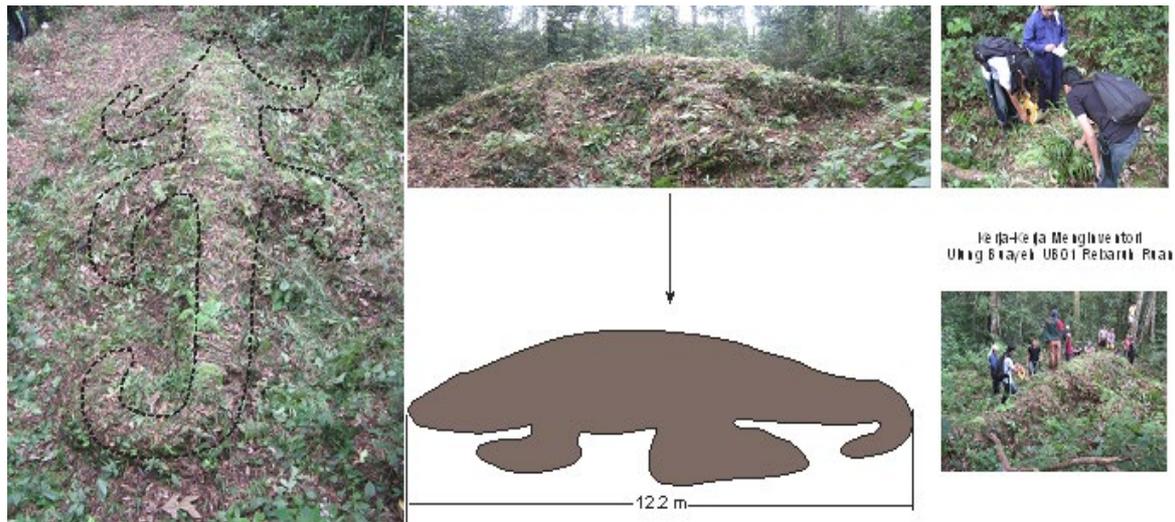


Fig. 4 Image and shape of Ulung Buayeh – UB01 Rebaruh Ruan. Source: Archaeological Research Expedition of Long Pasia and Long Mio Earthen Mound Sites (2016-2017). Source: Photographs by authors.



Fig. 5 Image and shape of Ulung Buayeh – UB10 Natad Tawak. Source: Archaeological Research Expedition of Long Pasia and Long Mio Earthen Mound Sites (2016-2017). Source: Photographs by authors.

Methodology

A quantitative approach with the ModelBuilder™ modeling technique in ArcGIS was used to produce an integrated map of locations and landscapes of the Ulung Buayeh sites for Long Pasia and Long Mio region of Sipitang, Sabah (Figure 6). The workflow model used the Modelbuilder geoprocessing to produce new derivative maps which serve as the research findings shown in Figure 7.

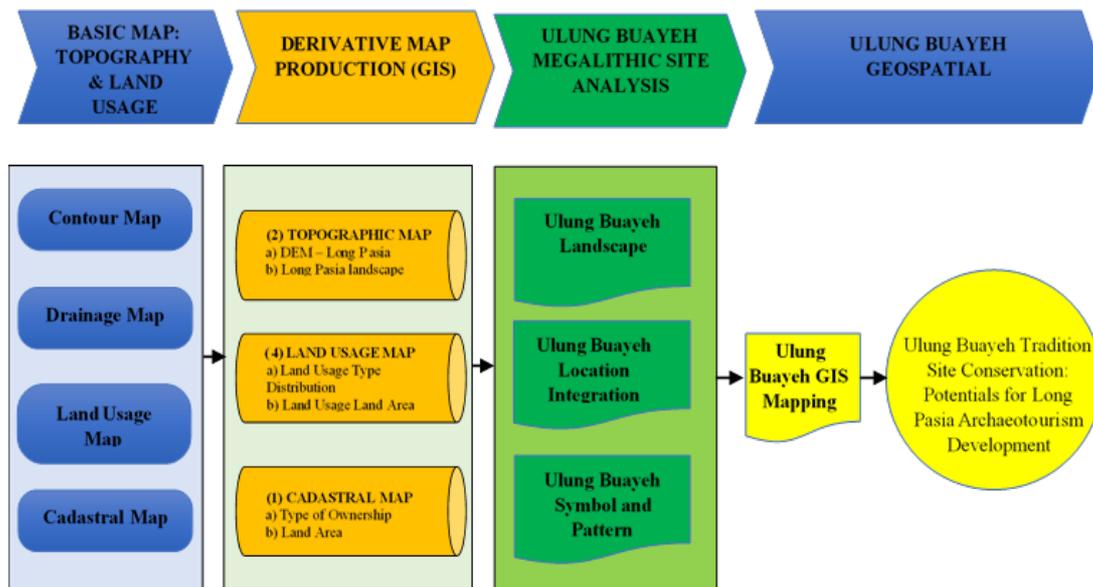
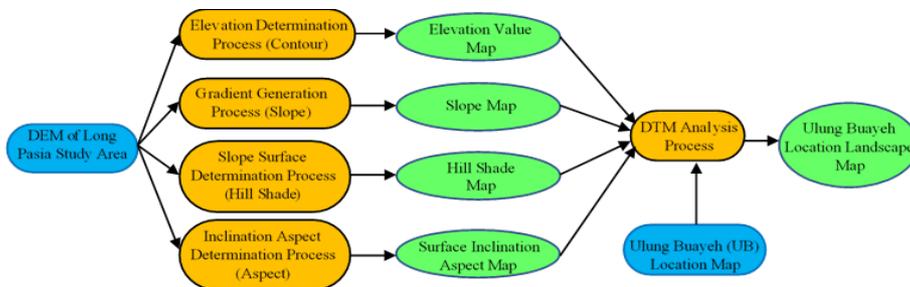


Fig. 6 GIS Application Framework in analyzing location and landscape of Ulung Buayeh in Long Pasia and Long Mio, Sipitang, Sabah.

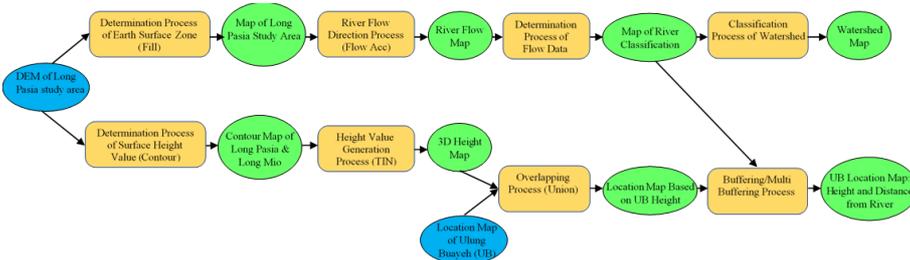
Ulung Buayeh Geospatial Mapping Analysis

Workflow Model GIS Analysis: ArcGIS Geoprocessing – ModelBuilder

Workflow Model 1:
Geospatial data mapping process for landscape based on Long Pasia and Long Mio’s Ulung Buayeh location

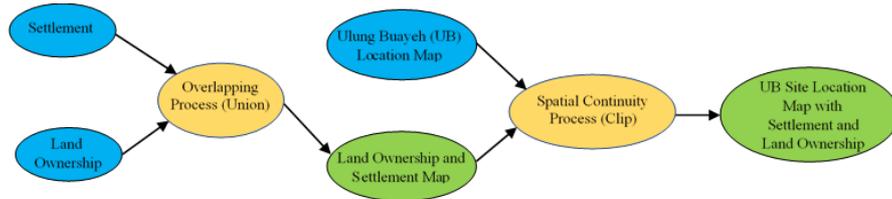


Workflow Model 2:
Landscape geospatial data mapping process for river basin and DEM of Long Pasia



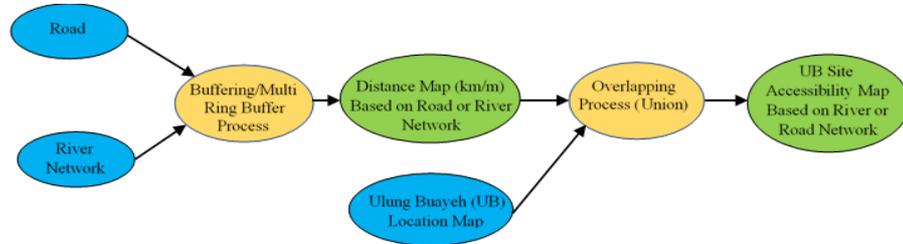
Workflow Model 3:

Geospatial data mapping process for land usage in Long Pasia



Workflow Model 4:

Geospatial data mapping process on accessibility to Ulung Buayeh site location



Workflow Model 5:

Geospatial data mapping process for location pattern with territorial dominance or demarcation of Lundayeh ethnic group land boundary in Long Pasia and Long Mio

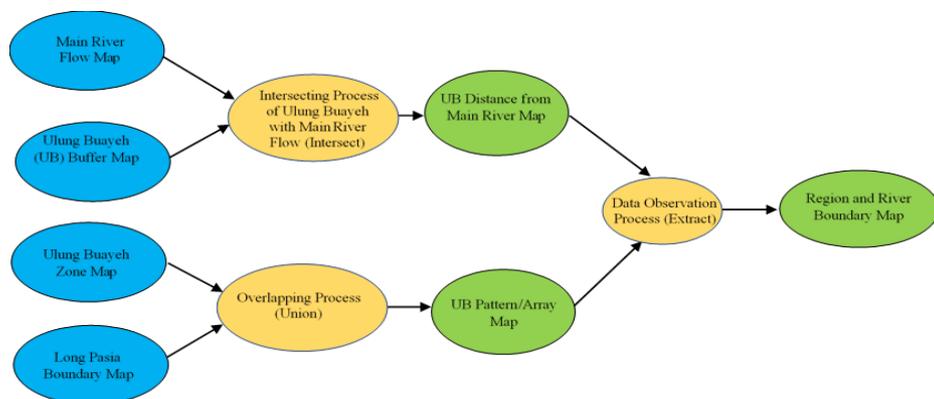


Fig. 7 Workflow model of ArcGIS - ModelBuilder for this study.

The geospatial mapping of the archaeological Ulung Buayeh sites around Long Pasia and Long Mio give a clear picture of an ancient effigy mound in the shape of a crocodile that was constructed. This study was divided into five workflows to produce a map of the location and landscape for Ulung Buayeh sites. First, to investigate the real locations of the sites based on positioning on the earth surface by looking at the elevation angle from the sea level and a cross-sectional gradient profile of Ulung Buayeh sites around Long Pasia and Long Mio. Secondly, to investigate the location setting of Ulung Buayeh sites based on Digital Elevation Model (DEM) by looking at the topography which indicates the influence of elevation and river flow. Thirdly, mapping based on human activities, specifically the relationship of land usage and land ownership factors with the traditional earthen mound site location of Ulung Buayeh. Fourthly, geospatial mapping by investigating the accessibility based on distance to the Ulung Buayeh site. Lastly, positioning pattern mapping of the Ulung Buayeh sites and their relationship with the markers of land boundary or territories of the Lundayeh.

Mapping of Ulung Buayeh Site Locations

The findings indicate the positioning of the Ulung Buayeh locations based on the X and Y stagnation coordination position using the Timbalai_1948_Bornei_RSO_meter coordinate system (Figure 8). Meanwhile, the cross-sectional profile analysis of slope angle was used for each of the Ulung Buayeh sites located on a hill or on top of a hill (Figure 9).

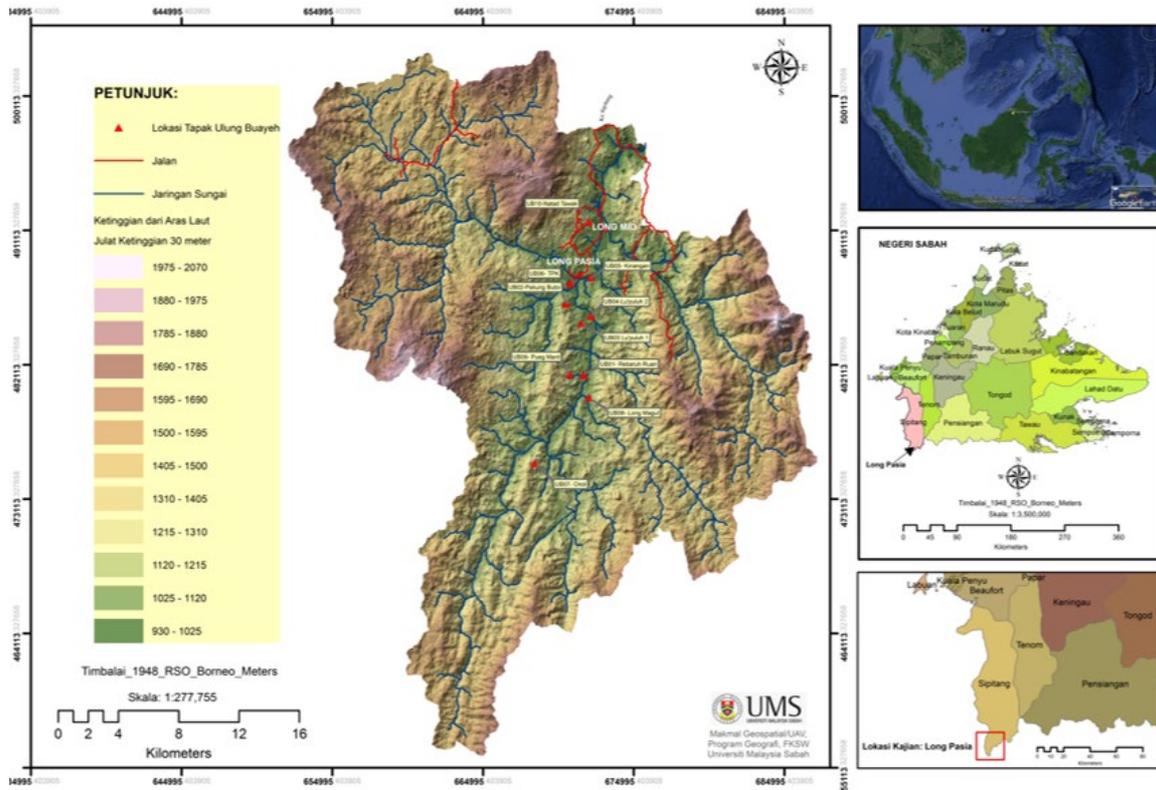


Fig. 8 Ulung Buayeh site locations based on elevation from sea level.

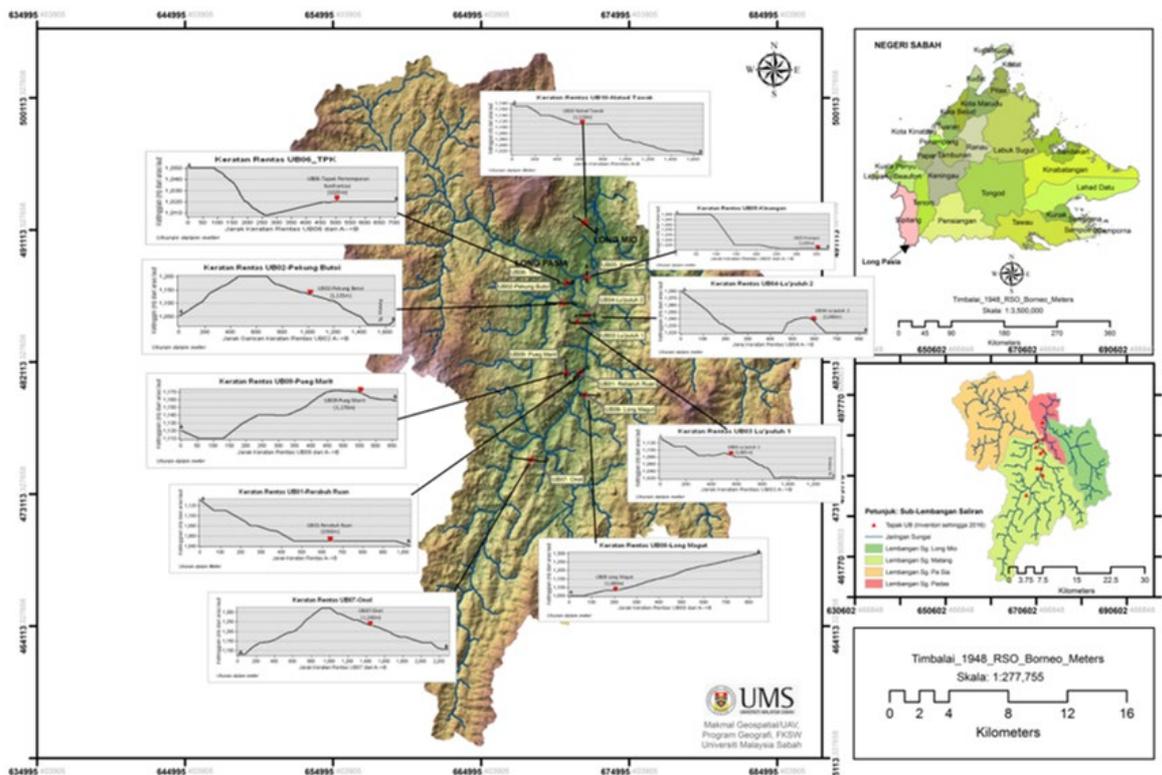


Fig. 9 Cross-Sectional Profile for Ulung Buayeh around Long Pasia and Long Mio.

The analysis based on river basins or watershed area had also found that the location and landscape of Ulung Buayeh were in line with the main river flow in Matang river, Pa Sia river, Mio river and Padas river watershed areas (Figure 10).

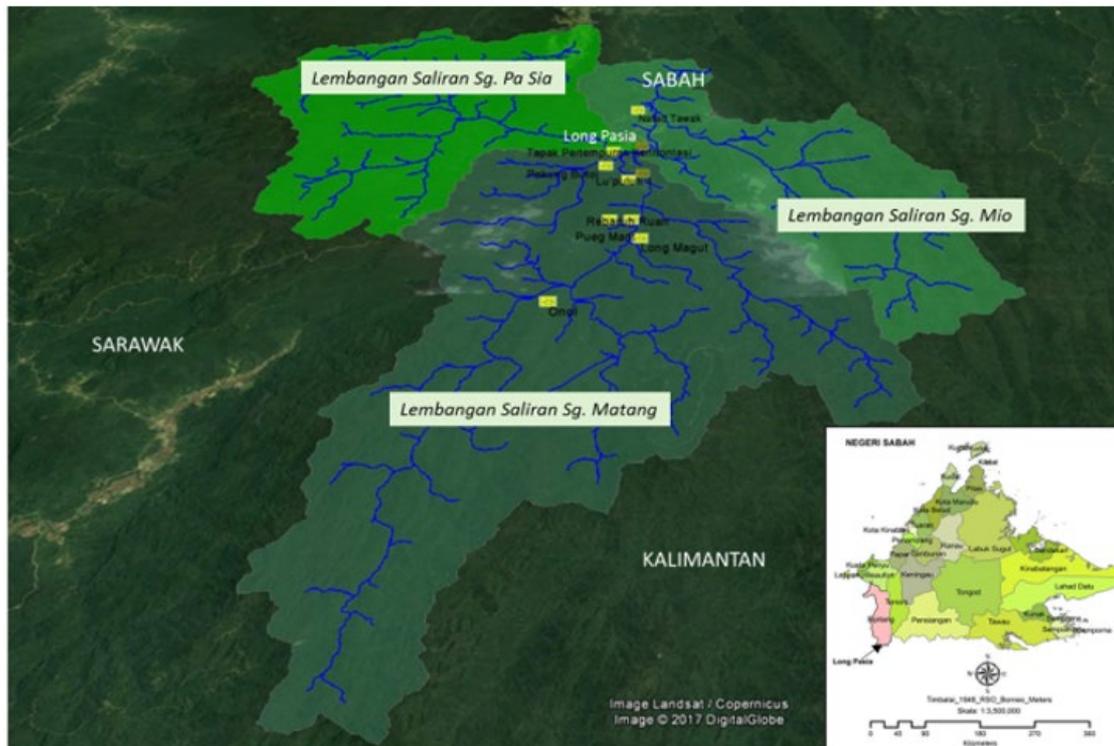
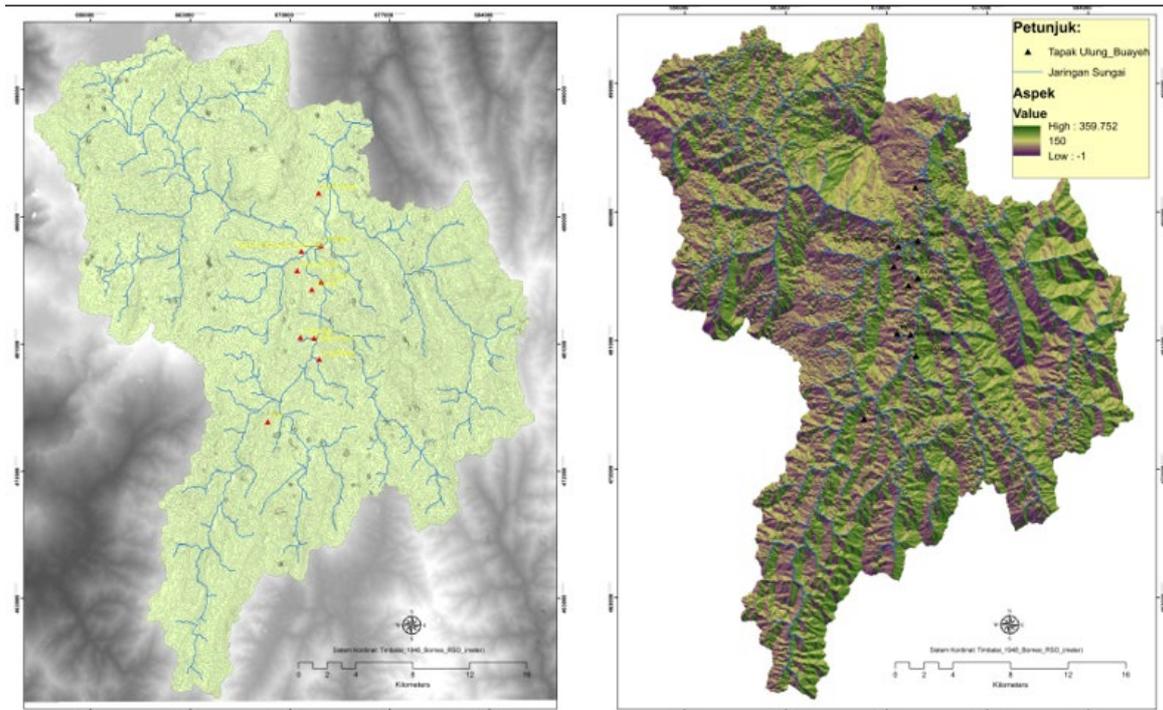


Fig. 10 Ulung Buayeh site locations based on river basins and networks.

Ulung Buayeh Site Location on Three Dimensional Analysis

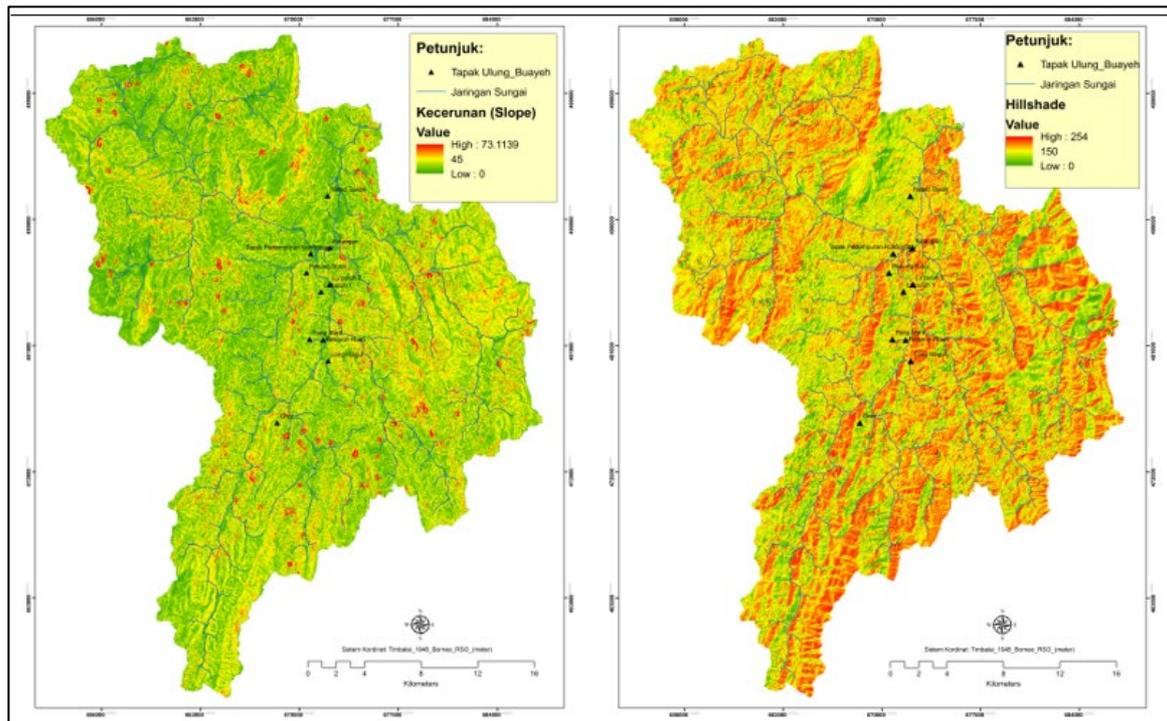
A three-dimensional (3D) analytical technique for surface elevation and slope in a digital manner which presents statistical data of the earth's surface based on the continuity of X, Y and Z coordinates whereby these data enable more advanced analysis (Aronoff 1991; Garbrecht and Martz 2000). With the value added of elevation data, the digital analysis findings using GIS application can display the earth surface and slope with a 3D perspective. Using contour lines, aspects, slopes and hillshade tools in ArcGIS spatial analysis exhibits the location and landscape of the inventoried Ulung Buayeh sites with more clarity. Hence, contour lines, aspects, slope and hillshade as a group of spatial analysis tools to generates raster image to identify shaded relief raster to show the direction of the slopes and view of the hillshaded surface (Van den Eeckhaunt et al. 2005).

Figure 11 (a)-(d) presents the earth surface landscape around Long Pasia and Long Mio showing the distribution of Ulung Buayeh sites. Based on the contour line map for a 30-meter range, the site locations are at an average elevation between 1,100 – 1,250 meters from the sea level.



(a) Contour for the Study Area

(b) Aspect for the Study Area



(c) Slope for the Study Area

(d) Hillshade for the Study Area

Fig. 11 Surface Analysis Describing the Landscape of Ulung Buayeh Site Locations around Long Pasia and Long Mio.

The function of surface analysis that determines the location and landscape of Ulung Buayeh sites from a geospatial perspective is to add new data and information that can produce the configuration of the sites. In general, these research findings were made possible through surface analysis of

function and features such as contour lines, aspects, slope and hillshade. Contour lines for example, show the elevation level of Ulung Buayeh sites from the sea level and the cross-sectional profile as shown in Figure 11 provides information on the accurate location of each of the effigy mound sites. The combination of elevation of the contour data with inclination angle that represent the earth surface aspect has contributed to the accuracy of data and information as the direction of a decreasing surface angle identifies the location and landscape of Ulung Buayeh. Landscape from the slope angle portrays the location of the site based on the percentage of elevation or inclination angle of the earth surface slope. With that description, each Ulung Buayeh’s location site can be identified more easily for further studies in the future.

Land Usage and Accessibility to Ulung Buayeh Site

Land usage is related to the location and landscape based on settlement, land ownership and available infrastructure around the sites. Land ownership has been gazetted as village land for Long Pasia and Long Mio with permanent ownership from the Sabah state government (Ismail Ali and Baszley Bee Basrah Bee 2010; McMorrow and Talip 2001). The distribution of land ownership showed with the boundary of the land parcels showed in Figure 12, illustrating that the distribution of land ownership has a close relationship with the location of the Ulung Buayeh sites. This means that part of the Ulung Buayeh site is 1-3 km from the Lundayeh people's land with accessibility for the community to monitor, protect and conserve the Ulung Buayeh sites.

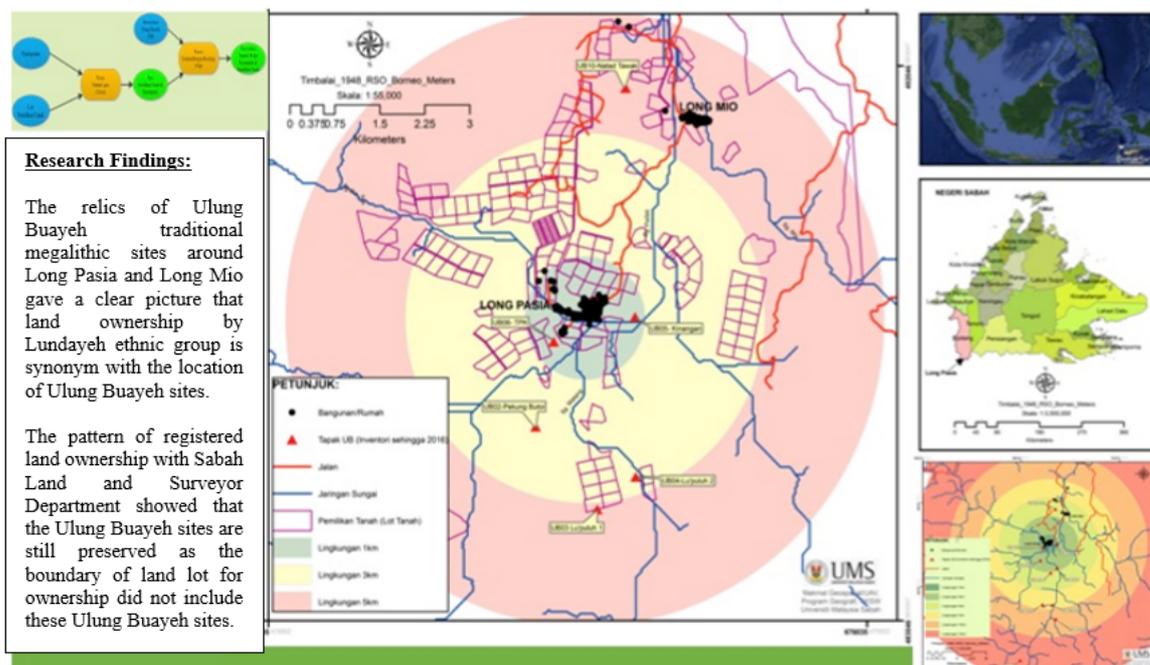


Fig. 12 Ulung Buayeh location with land parcel distribution around Long Pasia and Long Mio village.

Accessibility to the Ulung Buayeh sites from the settlement areas such as Long Pasia and Long Mio was also analyzed. The sites can be visited via a pedestrian walkway. However, for sites that are close to the major river such as Sg. Matang, a boat route is used and then continued with a journey on foot (Figure 13a and b). The distance between the location of the Ulung Buayeh and the main river is about one kilometer only (Figure 14).



Fig. 13 (a) Route Through the River (b) Walking Path. Source: Photographs by authors.

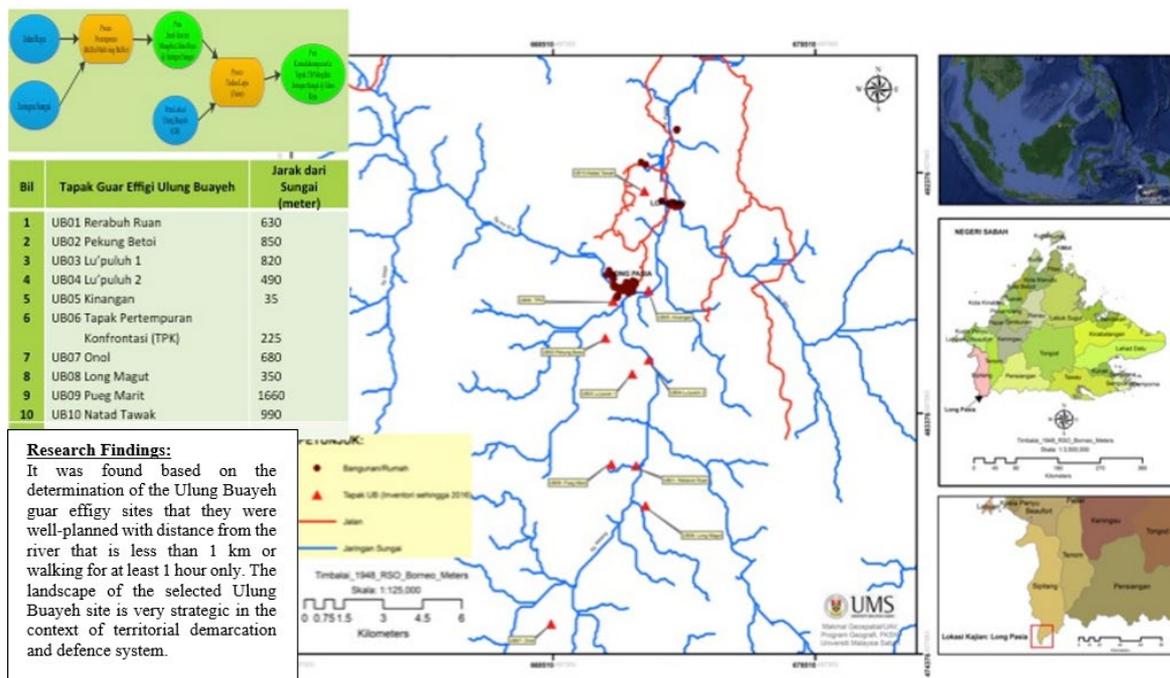


Fig. 14 Ulung Buayeh location based on river network around Long Pasia and Long Mio.

Lastly, the geospatial analysis on the location and landscape indicated that the location pattern of Ulung Buayeh was in line with the river system around Long Pasia and Long Mio and this reflected a territorial manifestation (Figure 15). The geospatial mapping that is shown in that figure below indicated such patterns that can be related to territorial boundary expansion. This situation is evidenced with the territorial domination of tribes (Bilcher et al. 2021) whereby the dominant group from the Lundayeh presided over Long Bawang, Long Semado and Long Pasia regions while on the river basins of Maligan river, the Murut dominated these areas.

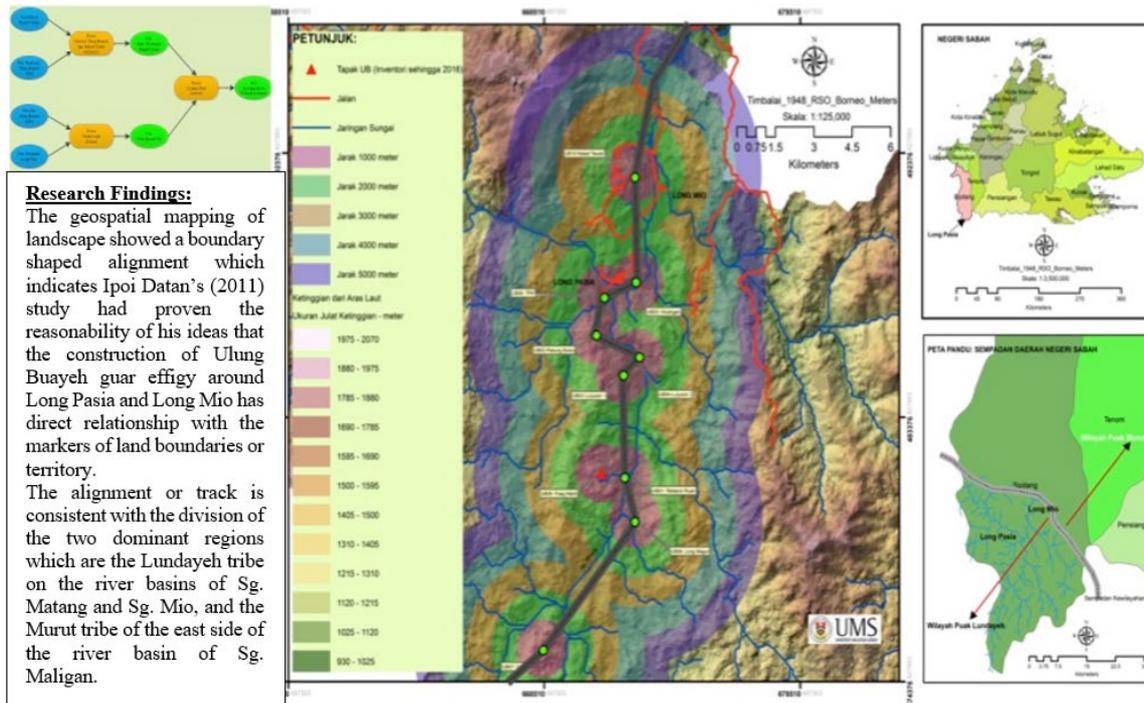


Fig. 15 Ulung Buayeh Site location based on the river alignment around Long Pasia and Long Mio.

Overall, the results of geospatial mapping have produced new data and information that can be used for future heritage management Ulung Buayeh landscape and sites, and area development planning at Long Pasia and Long Mio.

Conclusion

The ancient effigy mound sites of Ulung Buayeh in Long Pasia and Long Mio is considered as a highly valued for Sabah and Borneo cultural heritage. The existence of newly-discovered mounds has attracted the interest of the National Heritage Department, the Sabah State Museum Department, and Universiti Malaysia Sabah through this research to conduct collaboration studies. In the context of Ulung Buayeh as cultural heritage sites, the geospatial perspective has shown the location of these sites by highlighting the landscape and patterns.

The setting of the location based on natural landscape for the Long Pasia and Long Mio effigy mound has produced new geospatial map that can show the extent of these archaeological sites in giving implications to aspects such as ancient territorial and ethnicity expansion of the Lundayeh. Geospatial mapping which involves the analysis of elevation degree, slope, design and accessibility of Ulung Buayeh has proven these features also a symbol of culture identity for the Lundayeh. This study will assist in the development of future heritage planning and systematic management for the site, and in understanding the study of Ulung Buayeh in the context of the ancient cultural development of the Lundayeh people.

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