

# 43923-157293-1-PB- compressed.pdf

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**Submission date:** 27-Feb-2022 08:38AM (UTC+0700)

**Submission ID:** 1771601728

**File name:** 43923-157293-1-PB-compressed.pdf (366.1K)

**Word count:** 5468

**Character count:** 30299



ethnic groups migrated in a short period of time but on a wider geographical scale. The transformation of the architecture was more dynamic because the exchange of cultural absorption was faster. The civilization adapted to tidal estuaries and the inundated marshes along the riverbank. The people livelihood traditionally carried on a mixed economy of wetland farming, fishing, and trading. Although highland is an ideal area for a settlement, the following civilization needs an area near the transportation route for trading; therefore, they established a settlement surrounding riverways.

There are three main cultures in the highland: Besemah, Rejang and Komereng. Those groups migrated to and expanded the settlement area in a wide geographical distribution with a variety of circumstances and external influences. Adaptation and problem-solving have triggered a diversity and transformation of the highland architecture (Barendregt, 2003). Every architecture shows specific characters on the spatial, physical, and stylistic system of the house (Nugroho & Hidayat, 2016).

Besemah is the most dominant culture among the other highland ethnic groups. The Besemah house is simple with only one room without partition and the room size is around 48-63m<sup>2</sup> with various functions, especially for resting after working on a plantation or rice field and sleeping at night. People mostly occupy the house at night and rarely during the day. The house is built from local resources materials, namely stone, wood, and bamboo and like other Southeast Asian vernacular houses, the proportion of the Besemah house is big on the roof, small on the body, and tall on stilt foundation. The house shape is almost square with thick post foundations. The foundations are six to nine round logs that stand on big river stones. All the stilt foundations are bound by joining beams (Ibnu, 2016). The Rejang group inhabits a small region on a hilly section of the Musi River. Their houses resemble the Besemah house - a saddle-roofed house on stilt foundations. It has three main differences from the Besemah house: foundation, entrance, and room function. The foundation stands on stone bases without bounding beams, the entrance is at the backside of the house, and many rooms for different functions. The Komereng house has a more proportional shape than the Besemah house - bigger house size, lower roof slopes, and taller walls. The room is divided into two main parts: main and bedroom. They use the main room for multipurpose activities such as dining, living, family, and other activities, while the bedrooms are private areas only for homeowners.

The Malay inhabits most of the lowlands along the Musi River, the busiest and oldest trading route. People developed lowlands because of its strategic area for trading (Asnan, 2016). The location is strategic because it is at the junction of internal transport routes and long-distance maritime trade as well as the entrance for the external cultures to assimilate with local cultures

(Manguin, Mani, & Wade, 2011). The diversity of mixed-culture has created new combinations of architecture as shown in the merchant houses in Palembang city. It is Iliran architecture that is also called Limas house, a combination of Malay, Dutch, Chinese and Javanese architectures (Siswanto, et al. 2011). The houses are adapting to flood, pulse, tidal, and river overflow. The settler on the Musi river bank lives in the aquatic culture (Bambang et al., 2016). Their living culture establishes the identity of riverbank settlements (Mentayani, 2016) (Zaki & Octavia, 2013).

This study focuses on identifying and analyzing the role of riverways on the expansion and evolution of the vernacular architecture in the settlements along four riverbanks in South Sumatra. It relates the spreading and blending of both types of the vernacular architectures to the riverways history as connecting lines between the settlements. It also studies the effect of blending cultures on the transformation of vernacular architecture. Every architectural transformation has to do with the local geography, so the analyzes of the house transformation focus on how architecture adjusted to the climate, topography, soil structure, and material resources.

## 2. The Methods

The study concentrated in South Sumatra, but the survey area encompassed the current administrative regions. The study region was more determined based on cultural characteristics than administrative delineation. The delineation was arranged based on ethnic identity, which was distinguished mainly by the daily language of the native people. The survey was focused on the vernacular settlements along the four main rivers in South Sumatra and the tributaries. The study limited the survey of the vernacular architectural houses on the settlements that have cultural significance on the history of riverbank settlements in the past two centuries. It was determined from various literature and verified through field surveys. The survey collected the vernacular architecture data through ancient houses known as *Rumah Bari*. Unfortunately, *Rumah Bari* abruptly ceased after the 1920s. In the past, building vernacular house required a certain ceremony and regulations on materials and location based on local custom; therefore, people tend to build more modern new stilt house not bound by a certain ceremony and strict development rules. Although most of the people had replaced the houses with the new style of housed, they still conserved the Bari houses as a family inheritance.

Analysis of vernacular architectures distribution using Geographic Information System (GIS). GIS is commonly used to gather, manage, and analyze various layers of information in the spreading of architecture. In previous studies, GIS was used to delineate vernacular regions and to evaluate the results of field surveys of the conservation of the built heritage (Ambinakudige,

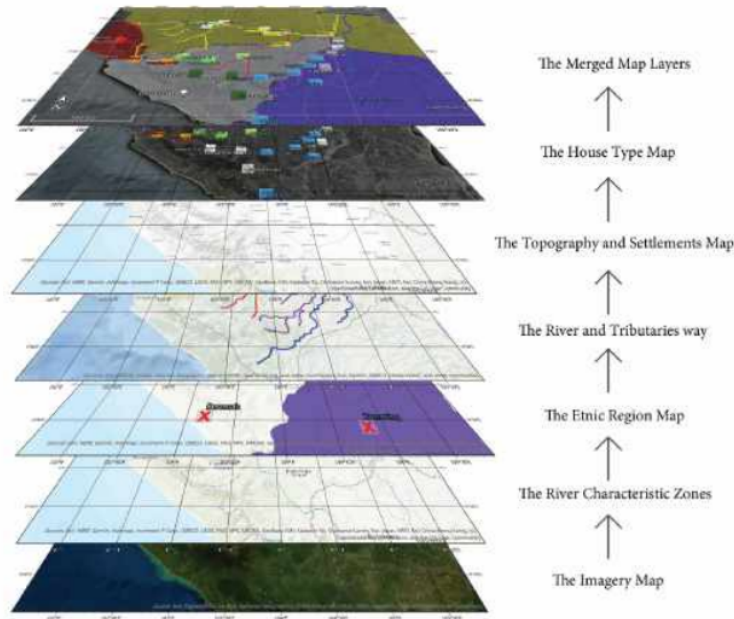


Figure 1. Illustration of merging map layers

2009). The GIS methodology has been used to identify certain landscape characteristics (Lazzari, Danese, & Masini, 2009). This study collected and analyzed data in the following stages (see Figure 1):

1. House observation to collect data photos, sketches, and measurements of the plan, elevation, sections, and details of the houses. It selected ancient houses that distinguished from the materials, shape, and ornaments. People built houses using the best quality of wood with great durability, solid glassless wood windows, carving on body houses, and division of rooms based on the old tradition.
2. Interviews to obtain data on the occupants, the owner, and the closest neighbors. This open interview focused on topics on history, tenure, years built, years occupied, room function, house form, and modifications.
3. Identification of the house types of vernacular architecture. The stage recognized and classified the house's architecture through the elements. The typology study examined the shape, space, and function of the house through the elevations, sections, and plans. Other than that, it also examined the use of materials, shapes, and building construction techniques.
4. Determination of the position of each type of house on the map. It was the basis for the sequence analysis of architectural transition along the river ways.
5. Build a map of ethnic group areas. The delineation of ethnic boundaries was done through literature studies and surveys. The survey activity interviewed residents and village leaders about the history of the village. It also paid attention to the use of language, especially the dialects of the native peoples. The data was the input of the ethnic region map for the next analysis.
6. Make maps of major riverways and subsequent tributaries. The focus was mainly on mapping the intersection, proximity, and physical characteristics of the river. The division of river zones related to the topography of the land from upstream to downstream. The river divided into three zones based on its characteristics, namely upstream, middle, and downstream. The river characteristics zone used to complete the analysis of the spatial cultural, observations collected data on the width of the river, the slope of the path, the velocity, and tidal. It is one of the methods to reveal the function of the river for people's lives.
7. Merge all the map layers to figure out the interconnecting of all attributes. The analysis stacked ethnic maps to focus the major riverway connecting the settlement areas of different ethnic groups. The stacking maps display the influence of geographical conditions, riverways, and ethnic culture on the distribution and transformation of the vernacular architecture in the areas.

Interpretation of the architectural transformation was done by comparing the transformation of the houses with the original house (Malay, Rejang, Besemah, and Komering houses). The analysis took into account the influence of heterogeneous societies and geographical situation, and local river utilization to the architecture transformation. The analysis of the house type from each ethnic group aimed to recognize the socio-cultural and geographical conditions of each location that influenced the shape, space, and function of the house

3. Results and Discussion

Vernacular architecture results from the adaptation of local communities to the local geographical conditions. The study of architectural forms became one of the earliest studies of cultural geography. The geographical study of a building is quite significant in cultural geography (Krafl, 2010). Observing architecture provides data that describes socio-cultural, daily activities, natural resource potentials, and natural disaster constraints faced in the area. Vernacular architecture has forms of elements that are in the physical realm and elements of meaning that are in the abstract realm. The element is related to engineering, namely how to build, construction techniques, material

selection, and other technical matters. Each form has a function value and meaning value that is created by the local community's custom (Mentayani & Muthia, 2012). In cultural geography studies, architecture is 'data' which is re-valued as 'social-historical assets' (Jacobs, Cairns, & Strebel, 2012). Architecture can be a very interesting and provocative object of study because architecture is formed from various influences of attention and interests from various economic, social, political and environmental importance (Jacobs et al. 2007) (Krafl 2009).

The merged layer demonstrated the influence of the riverway and ethnic region on the house's architecture in settlements along the riverside. The mapping results show that the riverway has more determination to fuse the adjacent architecture than the resistance of the ethnic cultures. The aligning house along and proximity to the one riverway showed similarity in the architecture. The architecture movement spread across ethnic boundaries. The blended architecture type also spreads through the adjacent tributaries through the main river route.

Musi River, the largest river in Sumatra connecting almost all rivers in Southern Sumatra, flows from a water spring in Bengkulu Province and ends in an estuary in the capital city of South Sumatra, Palembang. Musi

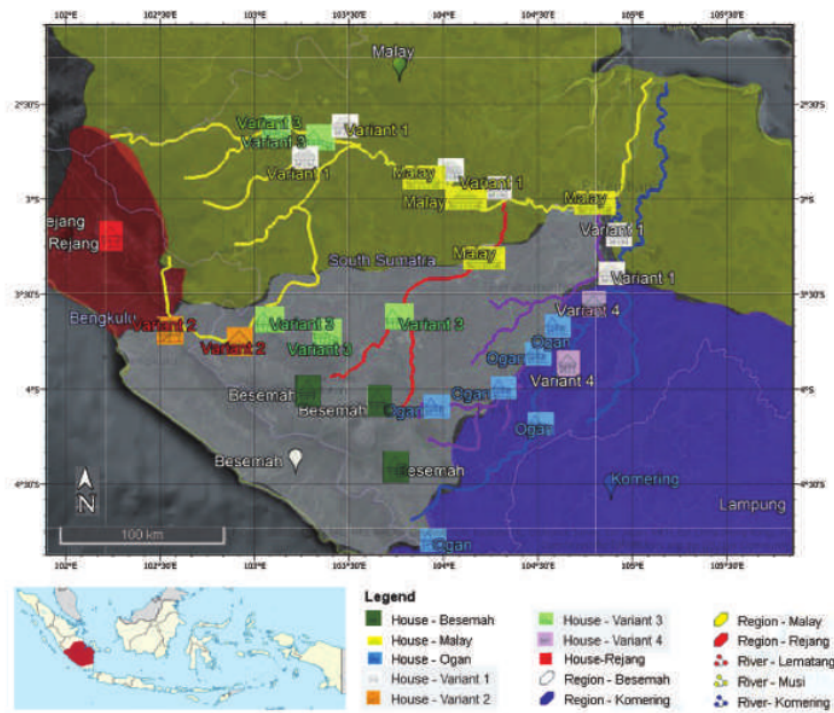


Figure 2. Map of the distribution of ethnic groups and the vernacular architectures along the four the river banks.

tributaries flow from South Sumatra to Jambi province linking both provinces. In addition to connecting the two provinces, Musi also links the settlements of the four ethnic groups in South Sumatra. It flows from the Besemah and the Rejang districts in the upstream and the Malay and the Komerling districts in the downstream area. The Malay inhabited most of the area along Musi, so the architecture influenced almost all houses in the settlements of the other ethnics. The characters of the Malay architecture blended into the Besemah architecture, the Rejang, and the Komerling houses. The mixed-architectures created three new variant houses. Variant 2, transformed from the Rejang house, spread on flat plains in a foothill where the river was wide enough for boat transportation. The influence of the Malay architecture on variant 2 can be seen in larger spaces and wider windows (see variant 2 in Figure 3). The second variation is found in variant 3, a modification of the Besemah house that was influenced by the Malay architecture. It was an altered variation with additional rooms. The house was expanded with a modified roof with a low sloping degree and tiered floors (see variant 3 in Figure 3). The last transformation was variant 1 on the houses with the Komerling architecture lined along the Komerling and Ogan rivers. The architecture of these houses was switched to the Malay style on a location adjacent to the Musi riverway. These were the Malay houses in smaller sizes (see variant 1 in Figure 3). All the new variants have the shape, material, detail, and room division affected by the Malay architecture.

The river connected settlements and became a way for the dissemination of the architecture. The modification and transformation occurred on the house architectures of settlements along the river. The Lematang and Ogan rivers are two other major rivers in South Sumatra connecting agriculture in the highlands with trading in the lowlands. The Besemah district occupied an area around Lematang and the Ogan Rivers. Both rivers merge into the Musi River before flowing into the sea. The Besemah district coincided with the Malay district in the area between the Lematang and Musi streams and was bordered to the Komerling district by the Ogan River. The Komerling River was the largest trading route connecting Palembang to the inland areas in Lampung. It also connected Besemah district in the upstream, Komerling in the middle, and Malay in the downstream. Komerling district expanded along the Komerling River which along with the Ogan River flow in parallel until the trading center in Palembang. The distance between the two rivers is only about 10km with several connecting tributaries. The close distance between rivers stimulated the spreading of the Komerling architecture along the area. Almost all settlements in the Besemah district along the Ogan River adopted the Komerling architecture (see Figure 2). The Besemah architecture also blended with the Komerling architecture in variant 4. It was a combination of the exterior style of the Besemah house with the interior

style of the Komerling house (see variant 4 in Figure 3).

The trade through the riverway combines external culture with local culture (Budhisantoso, Bale, & Suprapti, 1995). The type of local houses experienced significant modifications, one of which reflected in a more complex of the room function progressing from the previous modest house. The highland houses were built on dry land in a comfortable climate where people were more active outdoor. The house was small in size with only one room that mainly used for a short resting during the day or sleeping at night (Jumhari & Hariadi, 2014). Contrary to the highland house, the lowland houses were built on wetlands. Lowland people did more indoor activities than the highland people did; therefore, they needed a large house to accommodate many activities that sometimes involving many people. However, the phenomenon of house expansion occurred not only in the lowlands but also in the highlands. In variant 2 and 3, the highland people built larger houses to separate the functions of rooms according to the activities.

Contact with external culture had an influence on the function, form, and meaning space of the architecture. Form follows meaning was the character of the vernacular architecture that gradually shifted to the following form functions. There are several combinations and transitions between the functions and meanings found in the variant house type. The simplicity of the form and space in the highland house is seen in the room with no separating partitions for many activities and partitioned room for specific activities. The vernacular architecture distinguishes the value of space from its setting and level. Every ethnic culture produces distinctive meanings and settings of space. The Besemah house consisted only of one room with leveled floors. There were no large pieces of furniture such as a cabinet, table, and chair. The storage consisted of shelves placed against the wall. People sat on the floor with mats that were replaced according to their activities. The leveled floor had a symbolic meaning related to the position of a guest based on the status in the family feast. The place closest to the door with the highest-leveled floor was a sitting area for outermost guests, and the most inward with the lowest leveled floor was for the most honorable guests. The transitional form of function and meaning of space can be seen in the Komerling house where there were partitions for a private room and a public room. The Komerling house had some public rooms with a simple beam to separate the main and the living room. The private of bedroom area was divided into three units about 5m<sup>2</sup> in size each. On the contrary, in the Rejang house, space for certain activities is more real than symbolic meaning. The partition separates the type of activity in a certain room. The setting of space was more complex in variant 2, a modification of the Rejang house which is bigger and with more rooms. The most complex architecture was the Malay house, which had a lot of rooms with

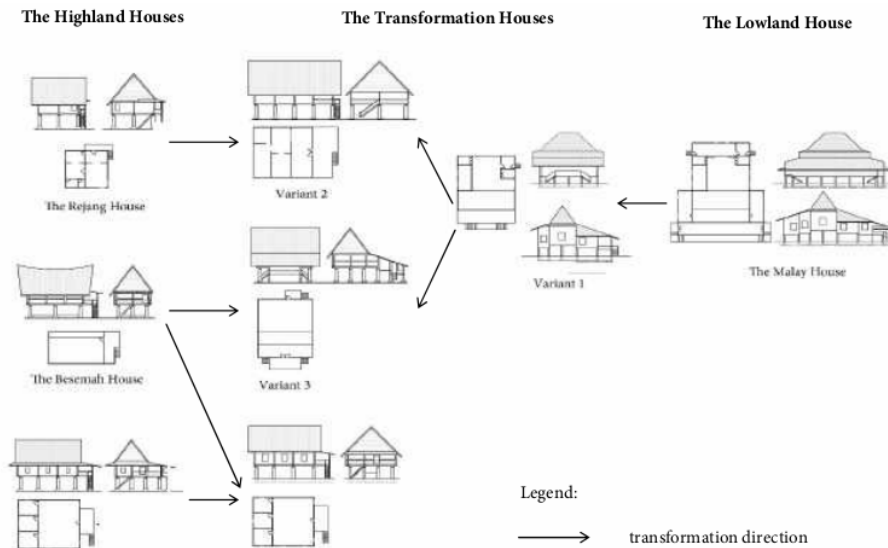


Figure 3. The house types and its transformation

different functions. Each Malay house had a large room for living, family, dining, bedroom, and kitchen. Each room had a different floor level. The difference floor levels were also intended to accommodate the different status of guests at a feast. The terrace was the lowest level intended for the lowest guest. The most honorable guests sat at the highest level in the most spacious space at the center of the house. The different levels also noticed in variant 3 that was the transformation of the Besemah house that resembled Malay house in a simpler form. It was the highland house with a multi-leveled floor and a much wider roof.

The variations form of the vernacular architecture not only occur in the function of space but also in the shape of the building. The progress took place along the riverway from simple to complex form, from the highland to the lowland. The expanding house required a more varied roof and it was done by modifying the saddle-style with one angle into two or more angles. The Besemah roof used outward-slanting gable showing traditional ideas. The shaping roof turned into a functional reason at Rejang house. The roof arch reduction to a simple gable at the Rejang house showed a more functional form than a symbolic one. The Komerang house expanded followed by adding the roof surrounding the outer walls. The Malay house had the most extensive and complicated roof in the form of a pyramid blending aesthetics, symbols, and building structures considerations. The shape is not only set up from the complexity in function but also in meaning.

Although the style of vernacular architecture was influenced by external cultures that entered through the riverway, the vernacular architecture adapted to

local climate and geographical circumstances. The temperature in the highland is relatively cold, especially at night. As a consequence, the highland house had a narrow room with a few small windows. The size of the room and the openings keep the room warm. The influence of external cultures brought a modification of the architecture of the house, particularly in providing an indoor comfort temperature. It was shown in the increase in the number of windows at Variant 2; however, the window size was smaller than the one at the lowland house. The adaptation was also found in the Variant 3 in the highlands. Even though the size and level of floors on variant 3 resembled the lowland house, the walls were lower with some small windows. Another adaptation can be seen in the Komerang house at the foothill. The temperature at the foothill is warmer so the house required a more spacious indoor area and a cross-ventilation to remove heat. It also required a ceiling to block the radiation heat from the roof. In Variant 4, the window size was wider and the wall was also higher. The Malay house was built on the wetland in the lowlands. The climate was hot and humid, so it required more space with cross ventilation to drive away from the heat and humidity.

The highland house had a structure foundation that moved along the earthquake movement. The foundation posts were thick round wood standing on a river rock and they were bounded by transverse beams at the Besemah house and without the transverse beams at the Rejang house. In the lowland house, the post foundation stood on soft soil with river tidal. The foundation posts were much smaller than the posts at the highland house. The house looks floating on soft

soil. Stiffness and the cross-sectional bond between piles that resemble a raft formed the floating power. Variants of the highland house built in lowlands were adjusted to the structural concept of the soft soil foundation (variant 4), and the lowland houses built on highlands were adjusted to the earthquake-resistant foundation (variants 2 and 3).

Differences in daily activities have created different space priorities in architecture. Space with more priority is usually decorated with ornaments. Relief embellished the exterior facade of the highland houses. It particularly laid on beams and poles facing the street. The carving motive was different for each house. Contrary to the exterior, the interior was simple without ornament. Inter-cultural fusion creates a transition type of architecture. Unlike the Komerling house in the highlands, the house at the foothill toward the lowlands encountered the switch of the ornament placement by installing most of the ornaments inside the house. The reliefs were carved on the partitions between the bedroom and the center areas. There were a few carvings on the external walls placed on the main doors and windows. The ornaments switched from carvings to decorative details on the connection of building structures: on the joints of the doors, windows and on beams to poles. The house was the transition from the highland type to the lowland type. Unlike the highland house, the interior of the lowland house was luxurious and spacious. The ornaments were placed on the interior walls on certain locations, such as bedroom doors and living room partitions. At the lowland house, the external facade was simple without ornament.

#### 4. Conclusions

The architecture became the locus in this study to analyze the cultural geography. The architecture is a product of politics, economy, and culture that are processed by people's daily activities during the period. This study observed vernacular architecture to reveal the social culture, economy, climate, potential of natural resources, and disasters in a definite area. The analysis by observing, comparing, and categorizing the vernacular houses into the typology discovers the conditions that forced the forms. The complete analysis of spatial data by positioning the architecture on the map to confirm the cultural geography of the area. This study promotes mapping spatial data with the multiple attributes analysis method that arranges the field observation data using GIS in analyzing the cultural geography for large areas to reveal the interrelationships between various attributes.

Riverway as transportation routes has a very influential role in the dissemination of vernacular architecture. It is more influential than the boundary culture of the local ethnicities. The local architecture of the highland house along the Musi River coalesced with the Malay architecture shows the prominent spreading. A similar indication is also shown in the spreading of

the architecture along the Ogan River. Although the ethnic belongs to the Besemah group, the house shows a Komerling architecture.

Vernacular architecture is one of the tools to identify the culture of a certain ethnic group. The riverway has given access to plenty of influences that change the position of vernacular architecture as an ethnic identity. In South Sumatra, the new combination of structure and construction shows the progress of the highlands house in the room size and partition, the roof material and shape, the opening number and size, and the ornaments. The application of new building technology triggered variation in the vernacular architecture that was designed according to local climate and resources. However, the changing in house size and the use of partitions were more determined by the changing in community activities. It created a more complex need of than just size, number, function, and symbolic meaning of the room. It needed a wider space with a number of rooms. It also specifies the function of the room from a simple-multifunctional to a single function.

The amount of external influence is determined by the proximity to the number of the riverway. Vernacular architecture evolves along with riverway transportation as a link between ethnic cultures. The vernacular architecture transformed from a simple house on the highland in the upstream river area to complex architecture in the lowlands in the downstream area. The highlands are area isolated from riverway transportation. The highland river is narrow, rocky, and shallow with high steepness that is not suitable for transportation routes. The architecture emerges without an influx from an external culture. In the lowland, the architecture is much influenced by the external culture that arrived through trade. The cultural assimilation created new technology, diverse forms, and complex functions of a house. The highland settlements that spread down to the foothill come close to the river for a transportation route to exchange goods through trade. It directly exposes the external influences that change the simplicity of the highland architecture that was indicated in the more complicated form of the house describing the complexity of the combination culture in the ethnic group.

This paper proposes a GIS-based approach that integrates field observations on the architecture as locus research of geospatial. Geospatial with method stacking of the multi-layer maps is a daily practice in urban planning and building site design. The method of analysis through mapping not only can collect data in a large amount, complex, and complicated but also analyze and visualize geospatial information in various situations. The GIS allows chronological tracking of architectures based on interpretations of information represented in graphs that connect points of several parameters. This paper discusses the benefits of GIS-based analytical tools in cultural geography research



to promote more instrumental technology with increasingly refined methods for various research fields in the future.

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