

## The Effect of Topography on Settlement Patterns in The Nusa Penida Island, Bali, Indonesia

I Kadek Merta Wijaya<sup>1</sup>, Syamsul Alam Paturusi<sup>2</sup>, Ngakan Ketut Acwin Dwijendra<sup>3</sup>, I Made Adhika<sup>4</sup>

<sup>1</sup> PhD. Student of Engineering Science Doctoral Study Program, Udayana University, Indonesia and Lecturer in Architecture Department, Warmadewa University, Indonesia,

<sup>2,3,4</sup> Department of Architecture, Udayana University, Indonesia

<sup>1</sup> amritavijaya@gmail.com, <sup>2</sup>syamsul@unud.ac.id, <sup>3</sup> acwin@unud.ac.id, <sup>4</sup> adhika@unud.ac.id

### Abstract

Nusa Penida Island's physical condition is an area with dry, calcareous, and steep topography, valley also hilly. Nusa Penida Island consists of 16 villages scattered in clusters in the northern and southern regions with coastal and hilly areas. The settlements in the south of the part have an organic settlement pattern following the pattern and height also the type of soil from the topography of the area. This research aimed to examine the topographical aspects of villages' settlement patterns in the southern part of Nusa Penida Island. The method used in this research is qualitative content analysis through an approach to the content aspects of studies on Nusa Penida, empirical conditions, and aerial photography analysis. The sample selection was limited by purposive sampling to two villages, namely Tangled Village and Batukandik Village. The results of this study indicate that there is a harmonious and integrated relationship between settlements and land: (1) the zone of worship (shrines/temples) and residential zones of houses; (2) rocky soil type as an option in residential construction; (3) soil layer with minimal rock content as an alternative to agricultural land; and (4) have an organic settlement pattern..

**Key words:** land harmonization, land hierarchy, organic settlement patterns, Nusa Penida Island, topography

### Introduction

The vernacular settlement pattern is generally influenced by the natural conditions in which the settlement is located [1]–[4]. The natural conditions in focus are the topography, the formation of the building mass, and the building mass's orientation, which adapts to the context of its physical environment. Vernacular communities' settlement culture focuses more on the aspects of the response to the physical environment and local climatic conditions [5]–[7]. This condition causes the architectural formation to be simple and uniform, also with a simple layout. The simplicity of vernacular architectural layout can be divided into two, namely a zone for shrines and a zone for residential dwellings. This context is more prevalent in vernacular settlements on Bali's island, with a strong ancestry concept, thus distinguishing between residential and worship zones [8], [9]. Unlike the vernacular architectural settlements outside Bali's island within the archipelago, the place of worship becomes an integral part of the traditional house [10]–[12]. The sacred space position is placed at the top of the building level, and the human dwelling is at the bottom of the building. The course has a different character from that in Bali. The difference in zoning arrangements is very clearly visible in the residential spatial layout of a residential house. This difference is physically indicated by the height of the land in the vernacular settlement.

The hierarchy of vernacular settlement spaces in Bali is manifested in spatial layouts with different levels of land. The land hierarchy utilizes topography for planning zones for worship and zones for residential dwellings. This phenomenon can be found in the settlement of the people from the southern island of Nusa Penida. Nusa Penida has a dry, hilly valley and calcareous landscape [13]–[20]. People's understanding of the relationship between humans and their creators is interpreted in the settlement layout by placing the worship zone on a higher contour than the residential zone for the residence. Even though the settlement pattern is organic following the direction of contour lines and adjustment to flat land, Nusa Penida's people position them more primarily on high contours. The differs from vernacular settlements in general. It has a clearer and more regular

also uniform sacred and profane orientation. Apart from the spatial hierarchy, topography's influence also affects land selection for residence and dryland agricultural land. Land for settlement is chosen on rocky soil to reduce deep foundations and soil stability when an earthquake occurs, and agricultural land on soil with minimal rocks.

The culture of living on the island of Nusa Penida, which is influenced by topographical conditions, is a fascinating research study. There are no studies on vernacular settlement architecture that discuss the correlation between topographic conditions that affect settlement patterns - its shape, orientation, and zoning arrangement. So far, studies have focused more on the cosmology of vernacular architecture, namely (1) studies of vernacular settlements on spatial planning. [9], [21], [30], [31], [22]–[29]; and (2) vernacular settlement patterns are based on life-giving places such as lakes, seas, or rivers [32]–[34]. While the study on the influence of topography towards the pattern of vernacular settlement has never been studied.

This study was aimed to identify the influence of topography on the architectural spatial pattern of community settlements in Nusa Penida Island. The spatial pattern in focus was the building mass's shape, the building mass's orientation, and the zoning system. This research case was selected in the settlements of the people of Nusa Penida Island in the south. The selection of this case was by purposive sampling by considering (1) the condition of the area in Nusa Penida in the southern part, which is hilly, valley, and calcareous with various contours; (2) has an organic settlement pattern that can be seen from the morphology of the settlement; and (3) have a history as indigenous villages in Nusa Penida. The selected cases were in Tanglad Village and Batukandik Village. The two villages are enough to represent in answering the research objectives.

The research method used is qualitative content analysis [35], [36] through the approach of (1) literature review of vernacular settlement architecture in Indonesia; (2) an observational study of the physical condition of the selected cases; (3) contour studies using visual aerial photographs; (4) research results on the history, social, culture, and physical condition of Nusa Penida Island. This study illustrates the effect of topography on the formation of residential spatial planning in Nusa Penida Island. These influences are the structure of the building mass, the building mass's orientation, the selection of land for the zone of worship and residence, and agriculture.

### **Research Methods**

The research focus is on Nusa Penida's island, separated by the sea from Bali's island in Indonesia. Nusa Penida Island's characteristics are calcareous, dry, valley and hilly and have several villages scattered in clusters [13]–[20]. This location's characteristics were the reasons for choosing Nusa Penida Island as the study of this research. There are 16 villages on Nusa Penida Island divided into two areas: the northern and southern regions. The sample selection was purposive sampling in two villages located in the south part of the island of Nusa Penida, namely Tanglad Village and Batukandik Village (see Figure 1). These two villages' choice was based on the village's status, including the ancient town in Nusa Penida and having unique characteristics of building mass patterns, namely organic. The study's focus in this research is the Nusa Penida community's settlement pattern in the context of building mass structure, orientation layout, and culture in choosing land for places of worship, residential housing, and agricultural land.

The research method used is descriptive qualitative content analysis [35], [36]. This method emphasizes the content meaning of the spatial phenomena of the Nusa Penida community settlement. To analyze content on empirical phenomena, research results, and contour studies through the following research steps: (1) literature study on vernacular settlement spatial planning to determine the development of vernacular research focus; (2) conducting an initial grand tour study on the settlement layout of Nusa Penida Island; (3) finding the gap on the locus and focus of the study; (4) contour studies to identify trends in the settlement arrangement of the Nusa Penida community; (5) coding the results of observations and studies that have been done; (6) triangulating the content produced; and (7) drawing interpretive conclusions.

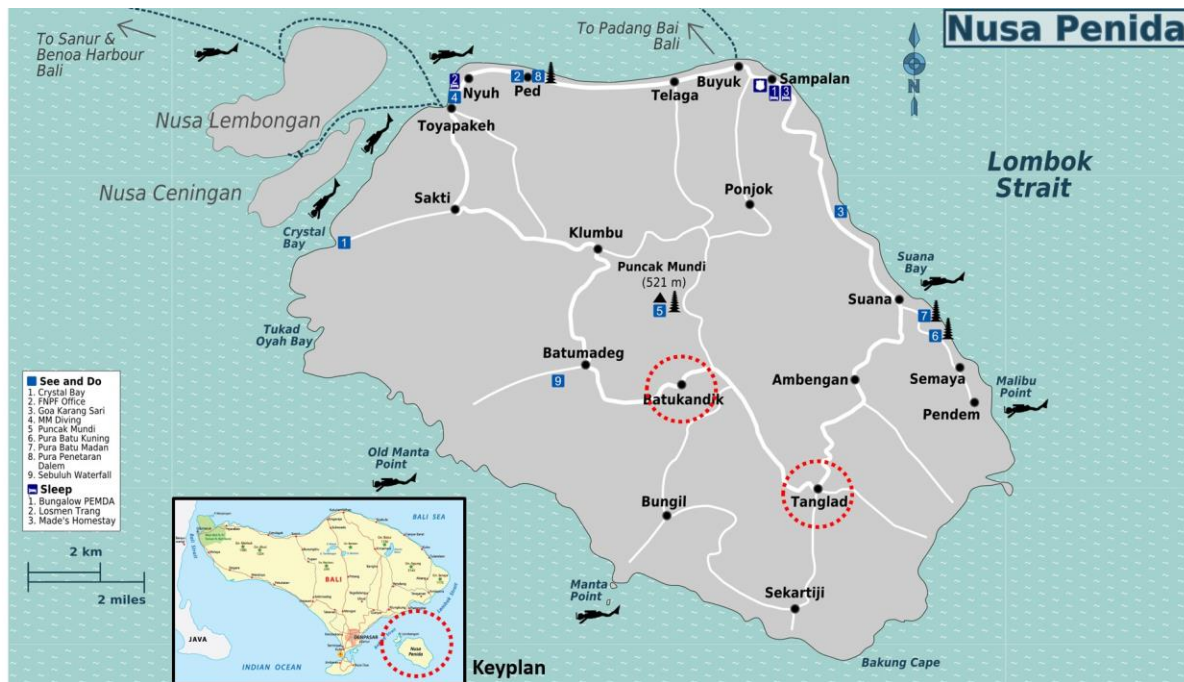


Figure 1. Locus of Research; Tanglad and Batukandik Villages, Nusa Penida

## Results and Discussion

### A. Overview of Nusa Penida Island

Nusa Penida's island consists of 16 villages scattered on the dry, calcareous valley and hilly land. The distance between one town and another is far apart, divided into two parts, namely villages located in the coastal area or the northern part of Nusa Penida Island and villages that occupy the southern part of Nusa Penida [13]–[20]. People who live in the northern part of Nusa Penida Island are generally immigrants from villages in the southern region of Nusa Penida and residents from other areas outside of Nusa Penida Island. According to archaeological and anthropological studies, during the period of the Klungkung kingdom and other kingdoms on Bali's island, the island of Nusa Penida became an island of exile for perpetrators of such crimes. [15], [19]. The means, the inhabitants of Nusa Penida Island are from the indigenous population and those who came from exile due to when Nusa Penida became part of the Klungkung Kingdom.

Nusa Penida has the characteristics of a hilly and valley area which affects the aspects of its settlement. The northern part of Nusa Penida has the character of a coastal area with a sloping contour or topography, and the southern part is a hilly area (see Figure 2 and 3). The topography colours the existing conditions of the villages on the south part of Nusa Penida Island. Usually, the southern towns of Nusa Penida have an organic mass pattern following the contour shape and topographic height. The characteristics of the land that are rocky, calcareous, dry, and contoured affect the villages' physical conditions in the southern part of Nusa Penida. Residential houses fill flat ground between the contour's elevation, and agricultural land tends to occupy steep contoured land that is not rocky. The contour's height forms the basis for residential spatial planning, consisting of three zones, namely places of worship, residential areas, and agricultural land.



Figure 2. The Highest Contour in Nusa Penida is The Puncak Mundi Temple Area



Figure 3. Topographic View of Nusa Penida Island from The South

### **B. Selection of Flat Land as a Place to Construction Buildings**

Nusa Penida Island's topography, which is hilly and sloping, has caused the community to choose relatively flat land as a place to build houses. The availability of mostly flat land is still minimal so that the flat land has a variety of shapes and distances between lands. Each family member can choose ground according to the house's designation; each home has a different form according to the land condition. Distance variants between one place and another were found due to irregular repetition of the distance between contours. In one village, it has various shapes and varying contour elevations.

In contrast to settlements in other areas in Bali, the land for settlements is widely available. The spatial arrangement of concessions will be more comfortable and have a clear pattern. For example, the territory of the Atoni tribe, the Tamkesi village on Timor Island, is a highland settlement that has varied contours in terms of elevation, availability of flat land for development, and rocky geological layers [37].

The first case was in Tanglad Village. The settlement pattern of Tanglad Village is organic following the contours (see Figure 4). Residential building configuration patterns vary and follow the contour line movement. Each residential land has varying heights, so to move from one house to another, you must pass different land sizes. The highest point of Tanglad Village is at the significant intersection or *Catuspatha*; then the pattern flows down each contour line forming an organic design. According to Wijaya (2019a), *Catuspatha* (village centre) has a function as a ritual space for renewal at the village level and as a symbolic "space of balance." This space occupies high topographical land under residential land. The movement of settlement development is

towards the south because the land and area with a relatively large percentage are south. Therefore, the community's method and perception in determining where to live are looking for land that is relatively flat and easy to access. This has an impact on the mass orientation of the building following its contour formation.

Apart from Tanglad Village, another village in the southern part of Nusa Penida is Batukandik Village (see Figure 5). The settlement pattern is similar to that of other village settlements in that it follows the contour's course and height organically. The settlement is in the southern part of an area lower than the village's grand intersection point. The pattern that can be seen clearly in selecting flat land in this village is that the highest land becomes a zone for a shrine or temple on a village scale, while the settlements are on the lower contour. So, it can be concluded that selecting a flat contour as a factor in determining the place or land to build starts from an area with a lower contour elevation. Simultaneously, the higher areas are designated for the function of a holy place or temple. The studies about God and Ancestor as the highest aspect [9], [21], [30], [31], [22]–[29], to the empirical understanding of logic by the people of Nusa Penida in constructing buildings on contoured land is translated in the context of belief and cosmology of the Creator. As the highest aspect in topographic layout, God gets the most elevated land embodied in a worship building or sanctuary (temple).

### **C. Rocky land as an option in constructing buildings**

Nusa Penida Island has a long distance from the Bali Plains, which are separated by the sea. Before Nusa Penida's island became an exile area by the kingdoms in mainland Bali, engineering knowledge was still not much exploring nature; humans were adjusted to their existing conditions. The technology in building houses and shrines is not like today's, more contemporary, be it architecture or construction. This choice was based on the ease in building, especially installing the building foundation. Because the rocky land does not require a certain depth like a contemporary building, it only takes a notch on the shaky ground to stand up well. Land that has minimal rocky character is used as dry land or dryland agriculture. According to Ferdeanty, Sufardi, & Arabia, (2020), rocky soil has a strong binding ability and capacity against loads. Moreover, the type of house on Nusa Penida's island is still relatively simple, so it is not too large.

The settlement in the southern part of Nusa Penida has a rocky land character. Rocky land for constructing buildings and land with little rock content for agriculture. In Tangglad Village, the shaky ground is used for residential areas, but the contours are irregular. Agricultural land tends to be in the southern part of the village and has many contour lines. Land with minimal rocky soil is productive in the planting medium compared to the shaky ground. The rocky land takes longer for the plants to grow and develop. So that land with rocky character becomes an option to build a building (a holy place or a house). The same thing is also found in Batu Kandik Village, which has a linear settlement pattern. In this village, the land used for constructing buildings is rocky, while those that are relatively flat or contoured and have land with minimal rocks are used as a productive place for farming (see Figure 4 dan 5).

### **D. Settlement Patterns Follow Contour Forms**

Nusa Penida's island has hilly land, a valley and dry [15], [19]. This condition causes Nusa Penida Island to have land with many contour lines, forming hilly heights. It isn't easy to get comprehensive and flat land, except for Nusa Penida Island's settlement in the north or the coast. The flat land was not found in large areas but segments. Therefore, settlement patterns appear to spread out and follow the direction of movement or contour curves that look more organic. Unlike the mountainous settlements in mainland Bali, where the linear pattern is more precise, the settlement forms are uniform. According to Putri, Gunawan, & Arifin (2013) and Wijaya et al. (2018), settlements located in contoured areas that still pay attention to the natural environment's context have an organic pattern following the curves of the contour lines.

The Tanglad and Batukandik villages' settlement pattern is organic, following the contour (see Figure 4 dan 5). The village's main road gives the direction of movement of the settlement pattern and as a binding settlement on the road's left and right. Each settlement cluster has a different settlement shape depending on the form of the contour line. The consistency of one building's direction and position is not compact but has body and approach. A clear pattern is the high contour section allocated for the sanctuary or temple area, while the low contour is



issued for residential buildings. The idea is based on the vernacular and common perception of the high lands (hills or mountains) as the gods' home and ancestral spirits, with worship taking place there. [9], [21], [30], [31], [22]–[29]

### E. Hierarchy of Land

The architecture of vernacular settlements usually has a hierarchy of space divided into two sacred and profane zones. Religious zones are identified as worship and secular areas in residential housing [8], [9]. Cosmology is, of course, interpreted in a scientific context as a natural condition in the form of topographical conditions and the concept of belief in everything that is "main" or "great" (God or Ancestor). God or Ancestor becomes the orientation of vernacular society in its spatial structure as a form of the human relationship with its Creator. If it is correlated with the culture of living regarding land selection for development, the "main" one is placed in the best position, such as higher land [26].

This phenomenon occurs in the vernacular settlements' spatial layout on Nusa Penida's island with hilly and valley natural conditions (see Figure 4 dan 5). Two cases in this study indicate that the contours of the topography influence settlement patterns. In zone selection, the highest outline tends to build shrines as the main or great part, and the residential dwellings are in the lower zone against the worship zone. They are respecting and maintaining the sacredness of a place of worship from a secular or profane context. Following Eliade (1957) statement, this sacred value is that the holy atmosphere can be maintained through its management. In this context, management is placing a shrine on land that is higher than the surrounding land.



Figure 4. Tanglad Village Settlement Pattern, Nusa Penida: (a) flat and rocky land for residential housing; (b) higher land than its surroundings; (c) contoured land for agriculture

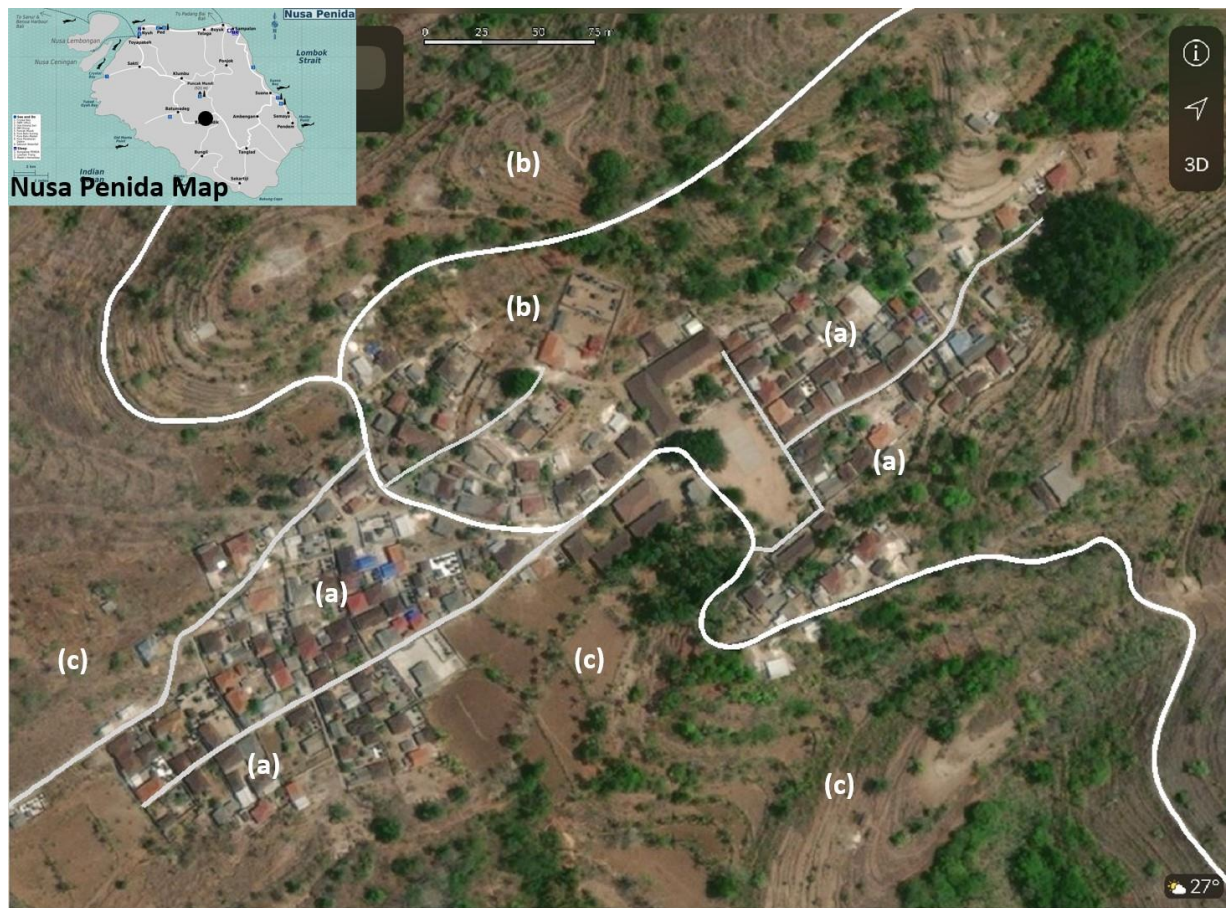


Figure 5. Batukandik Village Settlement Pattern, Nusa Penida: (a) flat and rocky land for residential housing; (b) higher land than its surroundings; (c) contoured land for agriculture

## Conclusion

The community settlement pattern in Nusa Penida has an organic design with contours as a basis for consideration in building a settlement. This organic pattern is a consequence of land use with a hilly topographic character and is flat and lacks a large amount of flat land. The local wisdom of the people of Nusa Penida in applying a culture of living following the land context through an attitude of harmony with the land conditions. Harmonization and integration between settlements with the context of the hilly and sloping ground by (1) using rocky land as a place to build residential dwellings to facilitate the construction of building foundations; (2) choosing land that has minimal rocks and tends to be on flat, contoured land; and (3) placing shrines or shrines on a higher contour towards residential land that is secular.

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