

The Loss of Austronesian Saddle Roof in the Vernacular Architecture of Java, Indonesia

Kemas Ridwan Kurniawan¹, Aditya Bayu Perdana^{2*} & Indah Widiastuti³

1) Universitas Indonesia, Depok, Indonesia, 2) Telkom University, Bandung, Indonesia,

3) Institut Teknologi Bandung, Bandung, Indonesia

*Email: jimeildotkomm@gmail.com

Received	Accepted	Published
03.11.2023	27.02.2024	29.02.2024

<https://doi.org/10.61275/ISVSej-2024-11-02-36>

Abstract

The Austronesian saddle roof is characterised by an extended ridge line resulting in outward sloping gable-ends likened to buffalo horns and boat sterns. It is one of the most distinctive and widely distributed elements in Southeast Asian vernacular architecture. This paper examines the former existence of the roof in Java, where it has been frequently depicted in the island's prehistoric and Hindu-Buddhist artefacts.

The research employs a literature survey and comparative visual analysis using artefacts and interpretations in published literature as the main data. The artefacts are limited to those found in Java that have not been dated later than Java's Hindu-Buddhist period, which lasted until the 16th century CE.

The examination of the Central Javanese artefacts suggest that the Austronesian saddle has been introduced to Java in prehistoric times and had become a well-established vernacular feature by the time of Borobudur and Prambanan constructions in the 8th to 9th century. This is confirmed by regular representations in reliefs within a variety of narrative settings. Representations have become scarce in the East Javanese artefacts from the 10th century onwards, where consistent representations only persist in stone miniatures. This suggests that the roof-form has been declining in popularity and may have already disappeared from the common use before the 16th century. This could be attributed to two possible factors: environmental factors which caused suitable wood materials unavailable, and cultural factors of the coastal maritime community shifting to the hinterland become an agrarian community.

There is however an exceptional case where the roof is recorded in the 20th century West Java, suggesting that the roof may have survived in isolated pockets before disappearing altogether. The exact historic factors which have made these transformations, however, remain inconclusive due to the fragmentary evidence available. Further studies of their historic development and expand the notion of Javanese vernacular architecture as a dynamic and open-ended entity.

Keywords: Austronesian saddle roof, Historical vernacular architecture, Hindu-Buddhist Java, Disappearance of Vernacular

Introduction

The Indonesian archipelago is well known for its diverse vernacular architecture, defined as built forms arising from the continuous accumulation of folk knowledge and traditions shaped by regional factors such as climate, material resources, and culture (Jagatramka et al., 2021; Pardo, 2023). Thus, vernacular architecture is not static, but continually undergoes transformations resulting from numerous changes within a historical context. Much can be revealed by comparing ancient vernacular forms with more contemporary versions, examining the persisting elements and those that have perished. In the island of Java, Indonesia's most densely populated island, the most popular vernacular roof forms seen today are regular gables or hip roof variations such as *limasan*, *tajug*, and *joglo*. Historical data however show that there have been other roof types in Java which have not continued to the present. One of those is the Austronesian saddle roof. This paper examines the phenomenon of this roof.

The Austronesian saddle roof (hereinafter called the Austronesian saddle) is characterised by an extended ridge line resulting in outward sloping gable-ends, likened by many to buffalo horns or boat sterns. This is one of the distinguishing architectural elements of the Austronesians, a large group of people speaking the Austronesian language family spread throughout the Maritime Southeast Asia and the Pacific islands (Schefold, 2003; Waterson, 2006).

Articulations of the Austronesian saddle roof is found in many places in Indonesia. Some of its more refined forms can be found in the vernacular architecture of the Batak Toba and Minangkabau in Sumatra, as well the Toraja in South Sulawesi. However, the roof type is absent in the island of Java. Curiously, Javanese artefacts dating from the prehistoric period to the Hindu-Buddhist period frequently depict Austronesian saddle roofs embedded in the landscape of the island.¹ Their presence suggests that the Austronesian saddle roof has once been part of the Javanese vernacular architecture before it has mysteriously disappeared. This phenomenon has been noted by scholars such as Pont (1923), Waterson (1990), and more recently Setyawan (2022) within the context of archaeology and anthropology. The majority of literature concerning Javanese vernacular architecture, however, often pays little attention to the historic existence of Javanese-Austronesian saddle roofs. Thus, discussions of developments that has led to present roof forms often veer into contrived assumptions of linear transformations with little historical evidence. Further, they also imply the present forms as being static, timeless relics which undermine their dynamic nature. This paper thus examines superseded Austronesian saddle roof in order to contribute to a more nuanced conception of vernacular transformations in Java.

This paper's objective is to collate scattered discussion and evidence in current literature to answer two questions: when did the Austronesian saddle roof see common use and when did it disappear from Java? What can possibly explain its disappearance?



Borobudur relief, circa 9th century CE,
central Java



Present day Kampung Naga, west
Java



Present day Kebumen, central Java

Fig. 1: Vernacular roof forms. Left: Austronesian saddle. Centre: regular gable roofs. Right: *joglo* roof.

Source: KITLV 28013, 1890-1891; Abdulrohmat, 2018; DARMAS SB, 2022.

¹ The term "Java" refers to the geographic island or an indigenous ethnic group of the same name who formed the majority population of the island. The island is also home to ethnic groups such as the Sundanese, Badui, Betawi, Tengger, and others. Unless indicated otherwise, the authors use the term "Java" and "Javanese" to refer to the island, instead of the ethnic group. West, Central, and East Java refers to the modern day provinces.

Vernacular architectural architecture seen in Indonesia today is the product of countless transformations. According to Jagatramka et al. (2021: 23),² “the major factors that encourage transformations are the changes and advancements in technology, communication, industries, and political scenarios. All these aspects affect the economic and social development of individuals, which lead to changes in the built environment.” Transformations can physically manifest in different aspects of a building, from materials, construction techniques, forms, and spatial planning. Depending on the degree and circumstances, transformations can be viewed in either a negative or a positive manner. Total transformations, in which the major elements are completely replaced within a short period are often viewed negatively as signs of disappearing indigenous knowledge brought by globalisation, especially after the 20th century. Transformations also have occurred before the 20th century, but often in a more gradual manner. The difference in pace is crucial as it provides indigenous people with the time and agency to select, adapt and integrate new elements more thoroughly into existing frames of knowledge. Within this state of continuous transformations, identifying the past, the present, and the upcoming vernacular built-forms becomes crucial to manage the loss of history, information and ethnicity of a region and its people (Jagatramka et al, 2021).

A small, traditional thatched-roof hut, likely a traditional dwelling or storage structure. It features a steeply pitched, conical roof made of dried grass or straw, supported by a wooden frame. The structure is built on a raised wooden platform base.

[illegible]

Fig. 2: Reconstruction of Indonesian traditional houses which have become extinct by the 20th century.
Source: TMnr 15-930a, 1900; Khambali & Lukito, 2023: 44.

⁴ This was part of a government campaign to replace traditional houses throughout Indonesia with standard *rumah sehat* 'healthy houses' conceived by the central government (Khambali & Lukito, 2023).

The Austronesian saddle roof has numerous formal variations, and scholars do not always use consistent terms for this feature. For example, Mead (2018) uses “upswept prow gables” while Schefold (2003) uses “outward slanting gables” and “saddle backed.” This paper refers to the term “Austronesian saddle” as used by Roxana Waterson (1990, 2006) to cover several gable roof variations with extended (prow) or extended and curved (upswept prow) ridges (fig. 3). Saddle roofs often provide large attic spaces between the king post and horizontal beams of the structure, and different traditions either use the space as storage space for heirlooms or more prosaically as granary. The outward slanting gable that comes with extended ridge provides “labile counterpoint to the stable lower parts of the architectonic construction” (Schefold, 2003). The practical function of a curving ridge, held in place by the king posts resting at the centre of tie beams, is less clear. Rather than having a practical function, it is widely assumed to serve a symbolic function. Visually, the ridge extension causes the sloping surface of a roof to form an inverted trapezoid plane when the construction is viewed laterally, as opposed to rectangular planes in the regular gable roofs. In the artefacts, the roof type is identified primarily by this visual parameter.





Regular gable roof	Austronesian saddle roof		Composite
	Prow	Upswept Prow	
			
A roof consisting of two rectangular planes sharing a common ridge.	A gable roof with extended ridge longer than the bottom eaves forming inverted trapezoid planes.	A gable roof with both extended and curved ridge.	Austronesian saddle with secondary lower roof.

Fig. 3: Roof shape terminology used in this paper.

Source: partially adapted from Mead, 2018; Waterson, 1990, 2006.

vernacular roof forms of Java are often conceptualised into four main types. Three of them, *limas*, *tajug*, and *joglo*, are variations of the hip roof. The last type is a variation of the regular gable roofs, all of which are considered as rustic counterparts to hip roofs (Idham, 2018; Prie, 2016; Salura, 2015; Santosa et al, 2023; Wibowo et al, 1998). Some writers such as Pitana (2023) and Sardjono et al. (2022) view these four types as chronological stages within a linear evolution that began with the *limas* and ends with the gable roofs. A major shortcoming in this view is the assumption that contemporary traditions preserve all the historical roof forms, while disregarding the forms that are extinct such as the Javanese-Austronesian saddle roof. An evolutionary scheme that better integrates historical sources can be found in Setyawan (2022). Among his conclusions is the notion that the hip roof variations that dominate Javanese vernacular architecture today only began in the Singhasari-Majapahit period (11th-16th century), while roof forms before this period were dominated by the Austronesian saddle roof.⁵ The reason for this change however is left unclear, as deeper analysis is unfortunately outside the scope of his paper.

Research Methodology

This research employs a literature survey and a comparative visual analysis (adapted from Setyawan, 2022) combined with architectural-historical strategy (adapted from Groat & Wang, 2013) using artefacts and interpretations that have been published as the main data. Artefacts are limited to those found in Java and have not been dated later than Java’s Hindu-Buddhist period, which has lasted from around the 6th to 16th century CE. The research pays close attention to whether the documented artefacts have clear provenance.

⁵ This is not an entirely novel notion, and has been expressed earlier for example by Herwindo (2016)

The research scoured photographs, books, reports, and journal articles on Javanese archaeology to collect representations from Javanese artefacts which have been recognised by previous scholars as representation of wooden buildings. Through the observation of visual parameters such as extended ridges and inverted trapezoid planes, the presence of Austronesian saddles is identified. Many 20th century archival documentation available at the institutions like KITLV (Royal Netherlands Institute of Southeast Asian and Caribbean Studies) and Tropenmuseum that is now accessible through public digital repositories like Leiden University Library Digital Collection are analysed. The use of 20th century documentation is crucial as in many cases, the artefacts in later documentation have considerably degraded due to environmental exposure making detailed visual analysis impossible.

Authors examine the relative date, frequency of depiction, and functional context in the collected representation. Assuming direct correlation between frequency of depiction with real world usage, this could be used to deduce the time frame of Austronesian saddle use and disappearance in Java. Additionally, the authors scrutinise the historical background and other context of the artefacts based on literature from various disciplines (anthropology, archaeology and history). These findings are then compared with existing theories which touch upon the loss of Javanese-Austronesian saddle to determine whether they are conclusive. Authors then matched the description obtained and studied from literature and archives with conditions in the field where Javanese-Austronesian saddle-roofed buildings can still be physically found or as reported in the most recent and contemporary writings.

Findings

Ancient Saddle Depictions in Java

It is unknown exactly when the Austronesian saddle began to be used. Archaeological remains in several Southeast Asian Neolithic sites could only reveal that early Austronesians dwellings were built on piles, but nothing much could be said about above-ground architectural elements such as roofs (Waterson; 1990). Based on their geographic distribution however, scholars concur that Austronesian saddle is an ancient element whose spread is closely linked with the prehistoric migration of Proto-Austronesian speaking people from Taiwan, who began to move into the Philippines then to western and eastern Indonesia around 3000-2000 BCE (Simanjuntak, 2017; Tjahjono & Micsic, 2002). Austronesian saddles only began to be visually attested in the decorations of ceremonial bronze kettledrums, one of the artefacts that heralded Southeast Asian metal age. The earliest type, dubbed as Heger I⁶ or Đông Sơn drums, was produced between 600 BCE to around 200 CE by the Đông Sơn culture centred around the Red River (Hồng Hà) delta of northern Vietnam. These were brought to insular Southeast Asia through ancient trade networks, where local derivations later developed.⁷

Calò (2007) writes that 37 Đông Sơn drums have so far been found in Java and 26 of them are found on the northern coast of central Java, in the areas around present-day Semarang, Pekalongan, and Kendal. The most relevant specimen to our discussion is the drum found in 1909 at the village of Kabunan, Pemalang regency, west of Pekalongan, now kept at Museum Nasional, collection no. 1827. Kabunan is classified by Calò (2007) as Region Specific cluster 1 or 'Red River Valley' drums, a subtype made around the 3rd century BCE to the 1st century CE. All other specimens of this subtype have been found in Vietnam, and Kabunan is likely to be produced there before it was brought to Java. The drum is representative of Đông Sơn tradition at its peak, and its presence in Pemalang suggest that the surrounding area was a major trading centre during the late Metal Age.⁸ The decorations of Kabunan drum have become very faint, but two house images are still visible in its tympan. House images are only known in a few drums and only one other drum in Indonesia has house images – the Makalamau drum found in Sangeang Island, Nusa Tenggara Barat (Heine-Geldern, 1947). The Kabunan house images have a conspicuous Austronesian saddle which strongly resembles the shape of a boat

⁶ Based on the typology established by Heger (1902).

⁷ See Bellwood (1985) and Kempers (1988).

⁸ See also Suleiman (1984).

stern. This is accentuated by far extending ridges that are supported with additional poles,⁹ rather like some of the larger Toraja *Tongkonan* houses and Mamasa *Banua Layuk* houses in Sulawesi.¹⁰

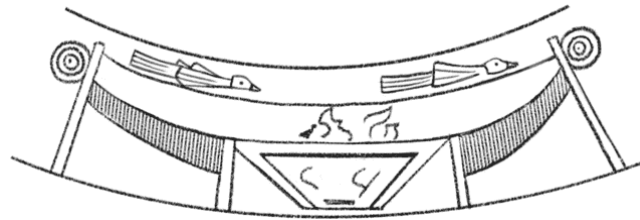


Fig. 4: Austronesian saddle roof depicted in the Kabunan drum.

Source: Ghina Amalia after Calò, 2007: 28.

Due to Kabunan's Vietnamese provenance, it could be argued that the house image therein (and other insular Đông Sơn drums) is not representative of ancient Javanese environment. This is the view held by earlier diffusionist scholars such as Heine-Geldern (1947) and Vroklage (1936) who further argued that they represent Đông Sơn import which only later became Indonesian vernacular architecture. But as mentioned earlier, more recent scholars such as Schefold (2003), Tjahjono & Micsic (2002), as well as Waterson (1990; 2006) dispute this interpretation and concur that Austronesian architectural features like saddle roofs were more likely brought to insular Southeast Asia by earlier Austronesian migrant wave. In other words, the use of Austronesian saddle was already well established in both ancient Vietnam and Java prior to the creation of Đông Sơn drums.¹¹ So far, no other prehistoric finds of Java yielded a similar image, making Kabunan house images perhaps the oldest Austronesian saddle depiction found in Java. The next appearance of the Austronesian saddle is squarely within central Java's Hindu-Buddhist period.

The political landscape of central Java during the 8th to 10th century CE was dominated by the Hindu-Buddhist kingdom of Mataram, who produced impressive legacy of Hindu-Buddhist temple remains locally known as *candi*.¹² The reliefs of Borobudur temple, built ±778 to 850 CE by the Śailendra Dynasty, perhaps contain the most numerous depictions of Austronesian saddle from this period.¹³ The authors here focuses on the narrative reliefs of *Karmavibhaṅga*, *Lalitavistara*, *Jātaka*, *Avadāna*, and *Gaṇḍavyūha*.¹⁴ While these narrative are undoubtedly Indic in their origins, sculptors embellished these scenes with many natural and man-made objects that points to Javanese settings (Santiko, 2014). Sculptors are not trained to make individualistic design choices, but to follow established rules, client demand, and overarching narrative of holy texts that has been laid out by the chief architect. They were, however, permitted a degree of freedom when it was not a matter of strict religious principles, and in such a case it is assumed that they would likely use real life models taken from their own experience and social environments. Rather than researching historically accurate forms to fit the settings of Gautama Buddha for example, sculptors would simply depict local vernacular houses. It is in this aspect that Borobudur reliefs may provide significant information to the vernacular built environment of Hindu-Buddhist Java (Director of The National Research and Development Centre of Archaeology, 2009; Reichle, 2009).

⁹ According to van der Hoop, the style of Kabunan house image is most consistent with the house in Sông Đà (aka Moulié) drum (van Heek Eeren 1958).

¹⁰ See Kis-Jovak (1988) (and criticism in Domenig, 1990) for an overview of *Tongkonan*. See Ansaar & Oesman (2011) for an overview of *Banua Layuk*.

¹¹ The idea that various aspects of traditional Indonesian arts have "Đông Sơn origins" however is still repeated uncritically in numerous writings. See criticism in Barnes et al (2020).

¹² The architecture of which, while undoubtedly influenced by India, also shows distinct local articulations even in the earliest dated *candi*. See discussion and bibliography in Perdana & Kuniawan (2022).

¹³ Due to the limitations of this paper, the authors only showcase a few examples.

¹⁴ For these reliefs, the authors defer to the numbering system used in Bhikku (2019a, 2019b, 2020a, 2020b, 2020c). Whenever possible, the authors use the IAST romanization scheme for Sanskrit terms.

Studies to Borobudur reliefs have been conducted since the 19th century, although the authors agree with Atmadi (1988) that analysis of their architectural depiction tends to be more cursory compared to other elements.¹⁵ More recent studies such as Nawa (2022) and Setyawan (2022) show that Borobudur reliefs use a rich variety of roof types, and Austronesian saddle is one of the most common. It is identifiable by extended straight ridges which form inverted trapezoid planes in a perpendicular and oblique view. It may appear alone or form the upper part of a composite roof. The narrative nature of Borobudur reliefs provides us with clues of the Austronesian saddle's contextual use. As far as the authors' observation, the roof type does not seem to be tied to any particular function or class of user. Many scenes use the roof for generic dwellings,¹⁶ but it is also used in structures with specific functions such as granaries in *Karmavibhaṅga*, a school and palace in *Lalitavistara*, as well as ship cabin in *Gaṇḍavyūha* (fig. 5).¹⁷ Slaves, peasants, royalties, and religious figures alike can be found sheltered by the roof. The latter include Brahmins in *Karmavibhaṅga*, and even Boddhisattva Maitreya in *Gaṇḍavyūha*.¹⁸ This suggest that Austronesian saddle was so deeply embedded in the build environment of Mataram kingdom that sculptors (and more importantly their chief architect) saw no issue in using it for diverse scenes and characters within Indic religious narratives.

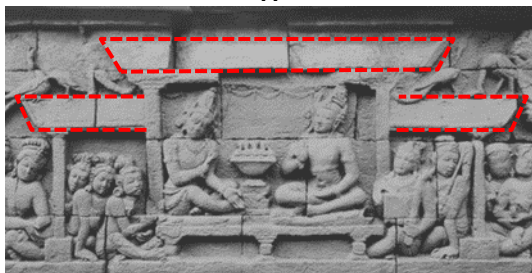
Beside Borobudur, the *Rāmāyaṇa* reliefs of Prambanan temple (built ±850 CE by the Saṅjaya Dynasty) also show similar evidence of local embellishments (Levin, 1999) and clear presence Austronesian saddle. One example is the background building in the scene where Rāma gave chase to the golden deer while Sītā and Lakṣmaṇa stay behind (fig. 6) (Stutterheim, 1989: plate 32). Based on the context of the scene, it is likely that the building is meant to be their home in the Daṇḍaka Forest.¹⁹ Austronesian saddle is also used in places inhabited by non-human characters, for example in the gardens of the Rāvaṇa where Sītā is being held, and in the rākṣasa city of Lāṅka seen in the scene where Hanumān's burning tail torched the city's rooftops (fig. 6) (Stutterheim, 1989: plate 57, plate 58).



A



B



C



D

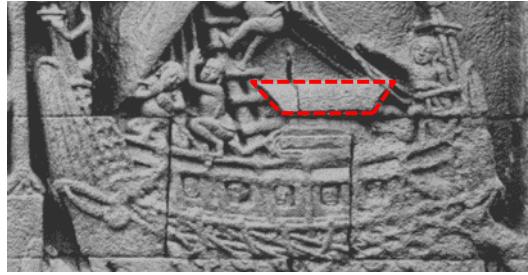
¹⁵ As such, they are sometimes subject to imprecise or otherwise poorly formulated assessments. Dumarçay (2003), for example, inexplicably attributed the Austronesian saddle in Borobudur reliefs as Chinese. Levin (1999) suggests that Austronesian saddle (which she termed "Malay") is only present in the *Karmavibhaṅga* reliefs, when they can be easily found elsewhere.

¹⁶ For example, *Karmavibhaṅga* panel 119, *Avadāna* panel 86. See Bhikku (2019a: 112; 2020b: 170).

¹⁷ *Karmavibhaṅga* panel 47 and 65; *Lalitavistara* panel 37, 38, 43; *Gaṇḍavyūha* panel 41. See Bhikku (2019b: 62; 2020b: 71, 92; 2020c: 56;).

¹⁸ *Lalitavistara* panel 42 and 43; *Gaṇḍavyūha* panel 37. See Bhikku (2019b: 357; 2020c: 61, 62).

¹⁹ Although in later scenes when Sītā is abducted by Rāvaṇa (Stutterheim, 1989: plate 34), the house in the background seems to use regular gable without extended ridge.



E

Fig. 5: Austronesian saddle depicted in various scenes of Borobudur temple. A) *Karmavibhaṅga*, granary used by a monastic community. B) *Avadāna*, commoner dwelling. C) *Lalitavistara*, palace pavilion occupied by King Śuddhodana and Daṇḍapāṇī. D) *Gaṇḍavyūha*, pavilion sheltering Maitreya. E) *Gaṇḍavyūha*, ship cabin used by slave and mariner Vaira.

Source: KITLV 24609, 1890-1891; KITLV 28060, 1890-1891; KITLV 101401, c. 1910; KITLV 102677, c. 1910; KITLV 102377, c. 1910.



A



B

Fig. 6: Austronesian saddle depicted in two *Rāmāyaṇa* scenes of Prambanan Temple. A) Rāma, Sītā, and Lakṣmaṇa's home in Daṇḍaka Forest. B) A building in Laṅka torched by Hanuman.

Source: TMnr 10016190, 1928; TMnr 10016194, 1928-1936

Around the year 929 CE, the Mataram Kingdom moved its centre of power eastward. The exact reason is unknown, and it is a subject of many theories.²⁰ Whatever the reason, the move also represented a shift in the Hindu-Buddhist arts of Java. Compared to the relative naturalism of central Javanese art, eastern Javanese art is marked by artificial stylization that continued to successive post-Mataram kingdoms, starting with Kahuripan, Jenggala-Kadiri, Singhasari, and culminating with Majapahit whose kingdom lasted until 1527 CE (Kinney et al, 2003). In architectural depiction as well, a marked difference can be seen by the increasing absence of Austronesian saddles.

The earliest East Javanese site relevant to our discussion is the Jalatunda baths at Mojokerto, founded in 977 CE by the late Mataram Kingdom. Sixteen relief panels were installed around the terrace overlooking the main basin,²¹ narrating episodes from *Kathāsaritsāgara* and *Mahābhārata*. In panel XV, a building with tiered composite roof consisting of Austronesian saddle top and hip lower portion can be seen in the background (fig. 7). The panel narrates an episode of *Kathāsaritsāgara*, when King Sahasranika (the standing figure in the middle) watched in panic as his wife Mṛgāwatī is abducted by a Garuda (Kinney et al, 2003; Nawa, 2022). Based on the context of the scene, the tiered roof building behind Sahasranika is likely his palace. While the use in a palace indicates established usage, this is the only instance of Austronesian saddle among Jalatunda panels whereas all other buildings are depicted with hip roofs.

²⁰ See Sastrawan (2022) for a recent summation.

²¹ According to Kinney et al (2003) relief I-IV remains in situ, relief VIII-XV is kept in the National Museum of Indonesia, while relief XVI is kept in Trowulan Museum. No trace of relief V-VII has been found.



Fig. 7: Austronesian saddle depicted in two early East Javanese sites. A) Jalatunda baths, Mojokerto. *Kathāsaritsāgara* scene, palace of King Sahasranika during Mrgāwatī's abduction. B) Selomangleng Cave, Kediri. Unknown narrative.

Source: Jerome Robbins Dance Division, 1962; Kinney et al, 2003: 70

Another Austronesian saddle has appeared in the Selomangleng Cave of Kediri, estimated to be built in the 11th century CE. This site is an elaborately carved four-chambered cave that local legends said was once a hermitage belonging to Princess Sanggramawijaya of the Kahuripan kingdom. In the main chamber, there is a carved altar depicting a Buddhist figure and immediately to the right of this is a relief of a scene with an open pavilion at the centre (Kinney et al, 2003). The pavilion uses a composite Austronesian saddle with a strongly curved ridge (fig. 7), a shape not seen in any of the previous Javanese examples. Closer comparison can be found instead on one of the brick images found near Candi Gumpung, Sumatra.²² Proper interpretation to this relief is unfortunately lacking in current literature, and so we have little clue to the nature of the depicted building.

Austronesian saddle is completely absent in reliefs from subsequent East Javanese sites.²³ In the various landscape reliefs from Trowulan for example,²⁴ the authors are unable to find clear examples of Austronesian saddles among the villages, hermitages, temple complexes, or any other buildings depicted therein. There is one instance where the authors identified a gable roof (fig. 8), but the roof in question does not have a clear extended ridge and so likely represents a regular gable. An interesting comparison can be made between the *Rāmāyaṇa* relief of Prambanan with those of Penataran, the main temple of Majapahit royalties which saw continual use from the 12th to the 15th century CE (Kinney et al, 2003: 181, 185-192). The Penataran *Rāmāyaṇa* only uses hip and pyramidal roofs in its depictions. This difference can be neatly summarised by comparing the “torching of Laṅka” scene. In Prambanan, Hanumān torched a building with an Austronesian saddle (fig. 6), in Penataran he torched an open pavilion with a hip roof (fig. 8).



Fig. 8: Buildings depicted in late east Javanese sites. A) Trowulan reliefs. Forest landscape with buildings, cobblestone path, and a stream. B) Penataran temple. *Rāmāyaṇa* scene, a building in Laṅka torched by Hanuman.

Source: KITLV 183378, c. 1910; KITLV 28293, 1867.

²² See Tjoa Bonatz et al (2009: 43).

²³ See types identified by Gaestin (1936).

²⁴ Pure landscape reliefs are comparatively unique in Hindu-Buddhist Javanese art, whose function are discussed by Kieven (2022).

The disappearance of Austronesian saddles in later East Javanese reliefs suggests that the roof type disappeared from common usage by the Majapahit period. However, memory of this roof type may have persisted as it has seen a somewhat longer usage in one specific type of artefact: miniature stone buildings. These are found scattered mostly around the city of Madiun, east Java, although a single stray specimen is found in Sukabumi, west Java.²⁵ They may be hollow or solid, have rectangular or almost-square plan, and an approximate height of 50 cm notwithstanding the built-in pedestals that are sometimes present. In some specimens, Śaka year in Kawi script is inscribed in one of the roof slopes,²⁶ providing us with an approximate span of production between 904 ŚE (982 CE) and 1278 ŚE (1356 CE). In east Java, this corresponds to the late Mataram period towards the middle Majapahit period.



Museum Nasional, D 195



Dusun Sadon, Magetan regency



Museum Sri Baduga, 04.895

Fig. 9: Austronesian saddle in miniature stone buildings of unknown function.

Source: authors; Balai Pelestarian Cagar Budaya Jawa Timur, 2018; Kemendikbudristek, n.d.

The exact purpose of these miniatures is not well understood, nor the reason why Austronesian saddles are consistently used in these miniatures.²⁷ Existing literature sometimes refer to them as houses,²⁸ but more commonly they are referred to as granaries, or *lumbung* in Indonesian. Stutterheim (1956) claims that the first persons to describe them saw similarities with rice granaries used in west Java and the designation stuck.²⁹ Indeed, when they were first reported by Hoepermans (1875) they were already glossed as *batoe lomboeng* (stone granaries) and *padi schuur* (rice storage). When some of the miniatures were brought to the Batavia Museum and catalogued by Groeneveldt (1887), it was categorised under *graantemples* (grain temples). Otherwise however, the authors found no compelling reasons to unequivocally accept granary identification; the miniatures could very well represent a house, place of storage, or any number of other unspecified building types.³⁰

Possible Causes of Disappearance

²⁵ This was reported by Soekatno (1983) and currently kept in Museum Sri Baduga, Bandung, collection no. 04.895.

²⁶ Haryosudibyo (1987) lists the following dated specimens: 904 ŚE (982 CE), 905 ŚE (983 CE), 908 ŚE (986 CE), 915 ŚE (993 CE), 917 ŚE (995 CE), 924 ŚE (1002 CE), 928 ŚE (1006 CE), 950 ŚE (1028 CE), 953 ŚE (1031 CE), 1097 ŚE (1175 CE), and 1278 ŚE (1356 CE). There may have been new findings since then, but no detailed publication is available for the authors to review.

²⁷ In contrast to terracotta building miniatures associated with the Majapahit period which invariably use hip roofs. See Damais (2012: 72).

²⁸ Hoeperman (1875: 151) initially refer to them as *steen huis* 'stone house' and Soekatno (1988) refer to them as *miniatur rumah* 'house miniature'.

²⁹ Stutterheim cited Groeneveldt (1887) and Krom (1913), but the author could not find the specific passage which remark on similarities with west Javanese granary. Stutterheim perhaps extrapolated this from another source or else failed to mention that this is his own conjecture.

³⁰ One reason to doubt the granary identification is the openings in these miniatures; their proportion does not match the small openings in traditional granaries which are essential to minimise spoilage.

The preliminary survey so far shows an abundance of Austronesian saddles depicted in the Hindu-Buddhist arts of central Java, followed by scarcity in the Hindu-Buddhist arts of east Java starting from the 11th century. Assuming a direct correlation between common usage and frequency in visual depictions, this pattern seems to support Setyawan's (2022) notion that Austronesian saddle was the preferred form before the 11th century and saw declining use until they are abandoned altogether. The authors however do not agree with Setyawan's suggestion that that Austronesian saddle was transformed into hip roofs, which later developed into *limasan* and *joglo*. Saddle roofs, regular gable roofs, and hip roofs are all simultaneously depicted in Mataram era reliefs, so it is more accurate to say that they saw parallel use but diverging popularity. While Austronesian saddles were declining in popularity, hip roofs saw sustained use and diversified into current *limas*, *tajug*, and *joglo*. This diversification could be fuelled by the establishment of Islamic Mataram dynasty in central and east Java. Regular gable also experienced sustained use but without much formal change due to its utilitarian use.

There are two tentative theories which could explain the displacement of the Austronesian saddle. The first theory relates to material constraint, which was suggested by Dumarçay (1981). According to Dumarçay, the structure of Austronesian saddle favours long continuous logs (especially for the ridge beam and king posts) which in Java could only be provided by large teak trees (*Tectona grandis*) from old forests.³¹ This became increasingly scarce as the population grew and forests were cleared out for rice fields.³² Dumarçay did not provide solid figures which proved this conjecture, but there are supporting circumstantial evidence. Javanese inscriptions since the 9th century show that both central and eastern Javanese kingdoms continually encouraged forest clearings to construct transportation routes and expand wet-field rice cultivation. The latter especially are important not only to feed the growing population, but also to increase tax revenue, create tradeable surplus, and ultimately assert royal powers (Christie, 2003, 2007; Peluso, 2020; Prasodjo, 2022). Teak forests that were left were subject to logging. Some measures of forest management existed, but they were ultimately incapable of replenishing forests when demand increased. In east Javanese forests, this is compounded by drier climate which makes them highly susceptible to fires during dry seasons (Smiet, 1990). If continuous deforestation in Java were to be blamed for the lack of suitable building materials, then it would make sense for Austronesian saddle usage and their depictions to decline from the later Hindu-Buddhist period until it disappeared altogether.

An interesting comparison could be made with the oral accounts of the Samin Javanese, an indigenous community living near Bojonegoro, north-central Java.³³ In addition to indigenous consumption, the arrival of European colonies puts further strain on Java's already limited teak reserve. Several forests in the northern coast of Java were already depleted in the 1700s and inland deforestation further accelerated in the 1800s when cash-crop cultivation was enforced by Dutch colonial governments (Boomgard, 1992; Peluso, 1991). By the late 1800s, the Samin area contained one of the last remaining old growth teak forests in Java. These were declared by Dutch authorities as government property (King, 1973), then it was quickly depleted until only diminutive teak trees remained in the modern Samin area which can only be made into relatively short logs. The Samin today prefers to build their houses with multiple-angled, regular gable roofs called *srotongan* because they claim such roof shape is the most efficient to be built using limited teak woods (Febrina et al, 2022).

³¹ See also Peluso (2020)

³² Similar explanation is mentioned by Arbi (2008), but it was related to the disappearance of pile construction. Arbi also writes that this notion is held by "many scholars" but did not provide specific references.

³³ Samin is a spiritual and social movement developed as a response to Dutch colonial exploitation in the late 19th to early 20th century. The name is derived from the name of the movement's peasant founder, Surontiko Samin, although current Samin adherents preferred the name Wong Sikep. See Benda & Castles (1969), Febrina et al (2022).



Fig. 10: Photo of large teak tree near Bojonegoro, central Java taken in the 20th century. Trees of similar size are no longer seen in the area today.

Source: TMnr 10012989, 1900-1940

An alternative theory to be explored is changing roof symbolism associated with the transformation from a maritime community to a hinterland, as suggested by Herwindo (2016). By comparing several Austronesian architectural traditions outside of Java, in similar vein to Vroklage (1936), Herwindo shows that the Austronesian saddle during the Mataram period depictions are memories of maritime traditions from the prehistoric Austronesian migrations. While the central Javanese during the Mataram period had already moved to agricultural practices, maritime motifs such as the ship are still preserved as roof shapes. As agricultural traditions became further entrenched in East Java, the boat symbolism in architecture has eventually been lost. Today, this boat symbolism—manifested in the form of Austronesian saddles or architectural elements using ship terms—is the only preserved outside Java.

This interpretation, however, should be approached cautiously. Here, Domenig (1990), Waterson (1990), and Schefold (2003) are significant. In many cases, the perceived resemblance between Austronesian saddles and ships had not come from the indigenous sources but assumed and exaggerated by the outside observers. Domenig shows an example in Kis-Jovak (1988) where a translated ritual chant that likened some parts of granary to *prau* ship is cited as evidence of saddle-ship symbolism in the Toraja community. However, the original chant has no Toraja word whatsoever that might mean ship; the word *prau* in the English translation is nothing but the translator's interpolation. There are also studies such as Manguin (2001) and Waterson (1990: 22) which show that ship terms are used by Austronesian communities simply as "convenient organizing metaphors" to express physical and abstract ideas. Its application in vernacular architecture is also not evenly distributed across the archipelago.³⁴ Thus, according to Manguin (2001), the idea that houses look like boats because their architecture has been influenced by shipbuilding is a misinterpretation. The form of Austronesian saddle is consequence of architectural techniques independent from shipbuilding.

In the case of Java, we must admit that Mataram period society left no records that indicate their own thoughts on Austronesian saddle. While it is plausible for Austronesian saddle-ship symbolism to have existed then, their generic use in reliefs do not indicate specific use or meaning. In other words, Javanese traditions and cultural practices which sustained or led to the disappearance of this roof form are completely unknown. In the absence of additional evidence, we shall note Herwindo's theory here but will refrain from making further speculations.

³⁴ Masri et al (2016) criticised Waterson's opinion, but since their study only discuss a single case, it does not engage nor invalidate Waterson's main point that boat symbolism is not universally applicable across Austronesia.

Late Survival in West Java

It should be noted that our review so far relies on depictions which are not evenly distributed throughout Java. As Nawa (2022) correctly notes, this may not accurately represent the architectural trend for the whole island. In fact, Pont (1923) reports that in his time Austronesian saddle still saw limited use in several Priangan hinterland villages of west Java, between Tasikmalaya, Kuningan, and Garut regencies.³⁵ One of the better documented of these villages is Papandak (fig. 11), located at the foot of Telaga Bodas mountain, approximately 15 km east of Garut. The village was rarely marked on official maps,³⁶ however, it was promoted as a tourist spot in several Dutch travel writings from the early 20th century due to its unique architecture. Colonial administrators even went as far as inscribing Papandak and its surrounding environ as *natuurmonument* (natural monument) in 1916 and again in 1922 (Koster & Noorman, 1922). Pont dubbed the architecture of Papandak and surrounding area as *Grooter Soenda bouworde* (greater Sunda building order). Pont was struck with *Grooter Soenda*'s visual similarity with depictions in central Javanese temple reliefs and surmised that *Grooter Soenda* is the sole surviving example of Austronesian saddle usage once common in Mataram period Java.



Fig. 11: View of Papandak village, Priangan hinterlands, west Java, taken in the early 20th century.
Source: TMnr 60050402, 1910-1940; KITLV 181654, c. 1933.

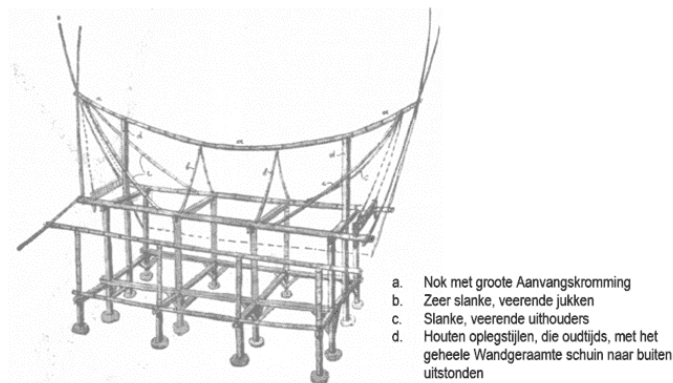


Fig. 12: Diagram of *Grooter Soenda* construction.
Source: Pont, 1924: 252.

Assuming that Pont's assessment is true, it is unclear what made the Austronesian saddle survive longer in this area. Dumarçay's theory of deforestation, however, provided a plausible basis that differentiates Priangan hinterlands with the rest of Java: it appears that the area escaped extensive deforestation from wet-rice agriculture and logging longer than most other areas. Citing reports by de Haan (1910), Wessing (2003) writes that the Sundanese people of Priangan preferred slash-and-burn agriculture and evaded colonial pressures to create wet-

³⁵ In the van Ophuijsen orthography that Pont used, these regencies are spelled as Tasikmalaja, Koeningan, and Garoet.

³⁶ So far, the authors have only found two maps from 1914 which marked its location. One of them is published in Baedeker (1914).

rice fields as late as the 20th century. This made typical Sundanese hamlets smaller than Javanese villages and closer to forests, the utilisation of which was moderated by relatively strong customary rules (*adat*) on sacredness (Hakim, 2022). Colonial exploitation was also limited until the establishment of railway systems that connected isolated Priangan hinterlands with economic centres on the coast.³⁷ In light of these both factors, it made sense for Papandak and surrounding area to be able to retain Austronesian saddle for as long as it did; the area had access to suitable building materials that had become scarce or inaccessible elsewhere in Java since the late Hindu-Buddhist period.

There is, however, an argument against this theory. Photo details and diagrams made by Pont (1924: 252) show that Austronesian saddle construction in *Grooter Soenda* buildings was partially made from bamboo. A material that is quick to grow and plentiful across the island. If Austronesian saddle in Java was originally constructed out of wood, but they can be substituted by bamboos which are easily obtained throughout Java, material constraint that Dumarçay surmised cannot be the only explanation for the roof's sole survival in Priangan hinterland.

Other than environmental transformations, there are various factors which could contribute to this roof's survival in west Java. Geographically, the mountainous terrain of west Java is closer in character to Sumatra than the agricultural plains of central and eastern Java. Politically, west Java was influenced by the Pajajaran and Banten dynasty while central and east Java was influenced by Islamic Mataram dynasty. Chinese carpenters who introduced new building techniques in coastal settlements may have limited influence in hinterland areas, which lead to preservation of older building techniques. While further discussion is outside the scope and methodology of the current paper, examining these factors could be grounds for future research.



Fig. 13: A house in an outer Baduy village with slightly extended ridge (red arrow).
Source: Kuncoro Widyo Rumpoko, 2013.

Unfortunately, *Grooter Soenda* architecture is no longer found today and the exemplary Papandak village has been lost. In 1926, a fire broke out in the village and destroyed more than 200 houses, as reported in the *De Nieuwe Vorstenlanden* newspaper (Anonymous, 1926). The *Binnenlandsch Festuur* (colonial department of regional affairs) provided aid to those affected and it was suggested that future construction should provide more space between buildings to prevent rapid spread of fire. It is unknown whether the suggestion was implemented, but *Bataviaasch Nieuwsblad* reported another fire in 1929 destroying 120 houses and 3 mosques (Anonymous, 1929). The village may have partly survived the second fire but was never fully rebuilt and eventually got depopulated. The latest mention of Papandak is from a 1935 travel column in *De Locomotief* newspaper that still recommended visiting the village for its architecture (Anonymous, 1935).³⁸ In contemporary west Java (administratively Banten and West Java province), traces of Austronesian saddle can sometimes be seen in the form of slightly extended ridge in an otherwise regular gable roof, for example in the houses of Kampung Urug near Bogor, West Java and outer Baduy villages in Banten (figure 13). These

³⁷ Before this, VOC loggings in Priangan hinterland were present in Sumedang but not Garut, Kuningan, and Tasikmalaya.

³⁸ However, the column may have been based on outdated information as it has taken its recommendation from *Gids van Bandoeng*, printed in 1921 before the first and second Papandak fire.

extensions, however, tend to be rare and inconspicuous,³⁹ nothing resembling the dramatic saddles of Papandak.

Conclusion

Reviewing available historical data of the lost Austronesian saddle of Java, the authors are faced with scattered puzzle pieces that are difficult to arrange into a complete picture. It is at least clear that the Austronesian saddle existed within a large time frame. Central Javanese artefacts suggest that the roof type was introduced to Java in prehistoric times and has become a well-established vernacular element by the time of Borobudur and Prambanan constructions in the 9th to 10th century. This is confirmed by regular representation in reliefs alongside other roof types within a variety of narrative settings, from rural to palatial and mundane to sacred. Representation became scarce in east Javanese artefacts from the 10th century onward, where consistent use only persists in stone miniatures. This supports existing notions that the Austronesian saddle saw declining popularity towards the end of Java's Hindu-Buddhist period and may have already disappeared from common vernacular usage before the 16th century. The authors however add a caveat that the form may have persisted in isolated Javanese region that left little documentation, as exemplified by 20th century Papandak village. Thus, our preliminary conclusion is that the popular use of Austronesian saddles in Java spans from before the common era to the 10th century. It then gradually declined in popularity and after the 16th century it only persisted in isolated regions with one exceptional case stretching to the early 20th century.

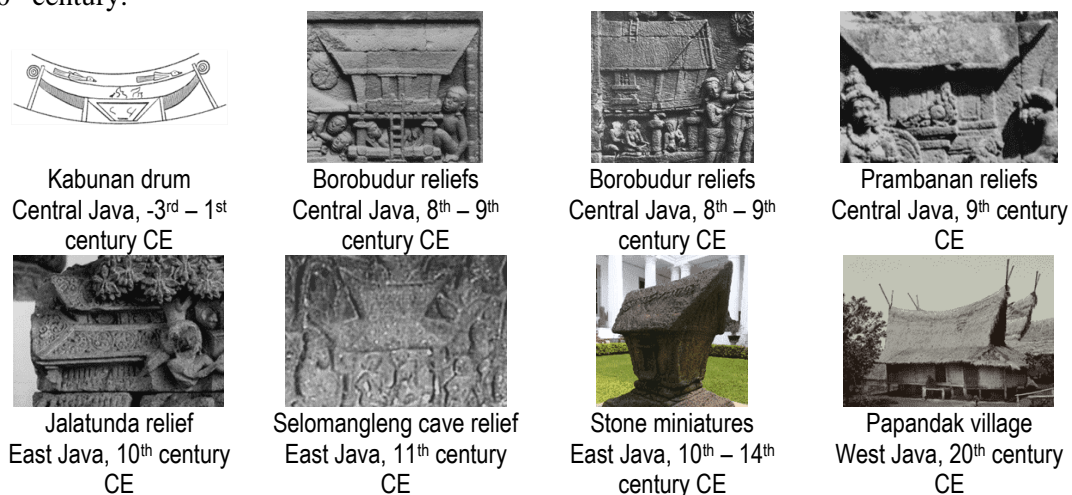


Fig. 14: Appearance of Austronesian saddle which the authors have reviewed.

Changes to vernacular form can be caused by a variety of compounding factors. In the case of Java's Austronesian saddle, one possible factor is the loss of suitable materials. Departing from Dumarçay's conjecture regarding the gradual loss of large wooden logs in Java, indeed one finds records of continuous deforestation since the 9th century in association with continuous wet rice field expansion and logging. This was especially acute in central and east Java but not, it seems, in the Priangan hinterland of west Java. Thus, it made sense for Papandak and the surrounding area to be able to retain Austronesian saddles for as long as it did; the area had access to suitable building materials that had become scarce elsewhere in Java. We conclude however that this is far from conclusive and has not considered in detail other contributing factors such as symbolic cultural transformations, geography, and political influence which could be grounds for future research to expand the notion of Javanese vernacular architecture as a dynamic and open-ended entity.

³⁹ Ridge extension is not discussed or shown explicitly in works such as Salura (2015) and Wessing (2003). Rather than length of the extension, the roof element that received more attention are horn finials (Barendregt & Wessing, 2008).

Acknowledgements

This research is funded by the “Seed Funding: Hibah Profesor FTUI” grant number NKB-1 947/UN2.F4.D/PPM.00.00/2022 from Universitas Indonesia. The authors would like to thank NLP Chandra Dewi, Retno Moerdianti, Fifi Wardhani, and Fajar Ichsan from Museum Nasional, Dwi Pradnyawan from Gadjah Mada University, Gunawan Tjahjono from Universitas Pembangunan Jaya, Rahardhian Prajudi Herwinda from Parahyangan Catholic University, Hélène Njoto and Wayan Jarrah Sastrawan from EFEO, and James Bennet for their inputs during the research of this paper.

References

- Anonymous (1926) ‘Meer dan 200 huizen afgebrand’, *De nieuwe vorstenlanden*. Dag, 21 January. Available at: <https://resolver.kb.nl/resolve?urn=MMKB19:002770023:mpeg21:a00004> (Accessed: 24 October 2022).
- Anonymous (1929) ‘Brand in het Garoetsche’, *Bataviaasch nieuwsblad*. Dag, 7 November. Available at: <https://resolver.kb.nl/resolve?urn=ddd:011072541:mpeg21:a0008> (Accessed: 24 October 2022).
- Anonymous (1935) ‘Naar Telaga Bodas. één tochtje dat in een dag te maken is. In Vulkanisch Gebied’, *De locomotief*. Dag, 27 December. Available at: <https://resolver.kb.nl/resolve?urn=MMKB23:001753109:mpeg21:a00275> (Accessed: 29 November 2022).
- Ansaar & Oesman, O. (2011) *Arsitektur tradisional daerah Mamasa*. Cet. 1. Jakarta: Kementerian Kebudayaan dan Pariwisata, Direktorat Jenderal Nilai Budaya Seni dan Film, Direktorat Tradisi.
- Arbi, E. (2008) ‘Austronesian vernacular architecture and the Ise Shrine of Japan: Is there any connection?’, *Journal of Design and Built Environment*, 4(1). Available at: <https://ejournal.um.edu.my/index.php/jdbe/article/view/4958> (Accessed: 20 February 2024).
- Atmadi, P. (1988) *Some Architectural Design Principles of Temples in Java: a study through the buildings projection on the reliefs of Borobudur Temple*. Yogyakarta: Gadjah Mada University Press.
- Baedeker, K. (1914) *Indien: Handbuch für Reisende*. Leipzig: Baedeker.
- Barendregt, B. & Wessing, R. (2008) ‘Centred on the source: Hamlets and houses of Kanekes (Baduy)’, in *Indonesian Houses*. Brill, pp. 551–596. Available at: https://doi.org/10.1163/9789004253988_019.
- Barnes, R. et al. (2020) ‘Review of Peter ten Hoopen’s Ikat Textiles of the Indonesian Archipelago’, SSRN Electronic Journal [Preprint]. Available at: <https://doi.org/10.2139/ssrn.3695773>.
- Bellwood, P. (2007) *Prehistory of the Indo-Malaysian Archipelago*. 3rd edn. Canberra: ANU Press. Available at: <https://doi.org/10.22459/PIMA.03.2007>.
- Benda, H.J. and Castles, L. (1969) ‘The Samin movement’, *Bijdragen tot de taal-, land- en volkenkunde / Journal of the Humanities and Social Sciences of Southeast Asia*, 125(2), pp. 207–240. Available at: <https://doi.org/10.1163/22134379-90002844>.
- Bhikkhu, Ā. (2019a) *Avadāna: Traditions About the Bodhisattva | Tradisi Sang Bodhisattwa*. Jakarta: Ehipassiko Foundation (Cerita Relief Borobudur).
- Bhikkhu, Ā. (2019b) *Gaṇḍavyūha: The Quest for Awakening | Pencarian Kecerahan*. Jakarta: Ehipassiko Foundation (Cerita Relief Borobudur).
- Bhikkhu, Ā. (2020a) *Jātaka: The Buddha’s Past Birth Stories | Cerita Kelahiran Lampau Buddha*. Jakarta: Ehipassiko Foundation (Cerita Relief Borobudur).
- Bhikkhu, Ā. (2020b) *Karmavibhaṅga: An Analysis of Deeds and Their Results | Telaah Perbuatan dan Akibatnya*. Jakarta: Ehipassiko Foundation (Cerita Relief Borobudur).

- Bhikkhu, Ā. (2020c) *Lalitavistara: The Life of Gautama Buddha / Kehidupan Buddha Gautama*. Jakarta: Ehipassiko Foundation (Cerita Relief Borobudur).
- Boomgaard, P. (1992) 'Forest Management and Exploitation in Colonial Java, 1677-1897', *Forest & Conservation History*, 36(1), pp. 4–14. Available at: <https://doi.org/10.2307/3983978>.
- Bryson, B. (2010) *At Home: a short history of private life*. London: Black Swan.
- Calò, A. (2007) *Transitions of a feathered world : the distribution of bronze drums in early Southeast Asia*. Ph.D Thesis. School of Oriental and African Studies, University of London.
- Damais, S.J.H. (2012) *Majapahit Terracotta: The Soedarmadji Jean Henry Damais Collection*. Jakarta: BAB Publishing Indonesia.
- Director of The National Research and Development Centre of Archaeology (ed.) (2009) *Uncovering the meaning of the hidden base of Candi Borobudur*. Jakarta, Indonesia: Pusat Penelitian dan Pengembangan Arkeologi Nasional.
- Domenig, G. (1990) 'Review Article: Changing Patterns of Architecture and Symbolism among the Sa'dan Toraja (Indonesia)', *Asian Folklore Studies*. Edited by J.I. Kis-Jovak et al., 49(2), pp. 303–320. Available at: <https://doi.org/10.2307/1178038>.
- Dumarçay, J. (1981) 'La faîtière tendue (histoire d'une technique)', *Bulletin de l'École française d'Extrême-Orient*, 70(1), pp. 231–252. Available at: <https://doi.org/10.3406/befeo.1981.3378>.
- Dumarçay, J. (2003) 'Les techniques de construction à Java, du VIIIe au XIVe siècle', *Archipel*, 66(1), pp. 13–28. Available at: <https://doi.org/10.3406/arch.2003.3781>.
- Faisal, G. & Wihardianto, D. (2020) 'Negotiations of Vernacular Shapes and Materials of Talang Mamak Tribal Houses, East Sumatra, Indonesia', *ISVS e-journal*, 7(3), pp. 14–26.
- Febrina, F. et al. (2022) *Arsitektur Samin: Jalin Sedulur, Bangun Saka Kehidupan*. Depok: Departemen Arsitektur, Fakultas Teknik, Universitas Indonesia.
- Galestin, T.P. (1936) *Houtbouw op Oost-Javaansche tempelreliëfs*. Batavia: 'S-Gravenhage.
- Groat, L.N. & Wang, D. (2013) *Architectural Research Methods*. Second Edition. Hoboken: Wiley.
- Groeneveldt, W.P. (1887) *Catalogus der archeologische verzameling van het Bataviaasch Genootschap van Kunsten en Wetenschappen*. Batavia: Albrecht.
- de Haan, F. (1910) *Priangan; De Preanger-Regentschappen onder het Nederlansch bestuur tot 1811*. Batavia: Kolff.
- Hakim, F.N.R. (2022) 'Redefining "Sacred" through the Indigenous Religion Paradigm: Case Study of Sunda Wiwitan Community in Kuningan', *Religió Jurnal Studi Agama-agama*, 12(1), pp. 41–62. Available at: <https://doi.org/10.15642/religio.v12i1.1859>.
- Haryosudibyo, F. (1987) *Replika Lumbung Batu: variasi dan penyebutannya*. Undergraduate thesis. Universitas Indonesia.
- van Heek Eeren, H.R. (1958) *The Bronze-Iron Age of Indonesia*. Leiden: Brill.
- Heger, F. (1902) *Alte Metaltrommeln aus Südost Asien*. Leipzig: K. Von Hiersemann.
- Heine-Geldern, R. (1947) 'The Drum named Makalamau', in *India Antiqua: a volume of oriental studies*. Leyden: Brill, pp. 167–179.
- Herwindo, R.P. (2016) 'A Conversation with the sea in Ancient Hinterland Architecture in Indonesia'. *8th International Seminar on Vernacular Settlements: "Conversations with the Sea: People, Places and Ideas of Maritime Vernacular Settlements"*, Makassar, October. Available at: <https://repository.unpar.ac.id/handle/123456789/1549>.
- Hoepermans, N.W. (1875) 'Het Hindoe Rijk van Doho', in *Tijdschrift voor Indische taal-, land-, en volkenkunde*. Batavia: Bruinig & Wijt, pp. 146–168.
- Idham, N.C. (2018) 'Javanese vernacular architecture and environmental synchronization based on the regional diversity of Joglo and Limasan', *Frontiers of Architectural Research*, 7(3), pp. 317–333. Available at: <https://doi.org/10.1016/j.foar.2018.06.006>.
- Jagatramka, R., Ashwani, K. & Pipralia, S. (2021) 'Transformations of Vernacular Architecture of India: Problems and Prospects', *ISVS e-journal*, 8(1), pp. 23–31.

- Kempers, B. (1988) *The Kettledrums of Southeast Asia: a Bronze age world and its aftermath*. Rotterdam: A. A. Balkema (Modern quaternary research in Southeast Asia, 10).
- Keurs, P. ter (2008) 'Beehive houses on Enggano Island, Western Indonesia', in R. Schefold and P.J.M. Nas (eds) *Indonesian Houses Volume 2: Survey of Vernacular Architecture in Western Indonesia*. Leiden: Brill (Verhandelingen van het Koninklijk Instituut voor Taal-, Land- en Volkenkunde), pp. 465–486. Available at: https://doi.org/10.1163/9789004253988_016.
- Khambali, M.R. & Lukito, Y.N. (2022) 'Rebuilding Tazo Traditional House East Nusa Tenggara by Excavating Collective Memories', *Local Wisdom : Jurnal Ilmiah Kajian Kearifan Lokal*, 14(1), pp. 32–47. Available at: <https://doi.org/10.26905/lw.v14i2.6508>.
- Kieven, L. (2022) "'The wandering poet"; Depictions on ancient Javanese relief panels', *Wacana*, 23(2), pp. 288–336. Available at: <https://doi.org/10.17510/wacana.v23i2.1106>.
- King, V.T. (1973) 'Some observations on the Samin movement of North-Central Java. Suggestions for the theoretical analysis of the dynamics of rural unrest.', *Bijdragen tot de taal-, land- en volkenkunde / Journal of the Humanities and Social Sciences of Southeast Asia*, 129(4), pp. 457–481. Available at: <https://doi.org/10.1163/22134379-90002714>.
- Kinney, A.R., Klokke, M.J. & Kieven, L. (2003) *Worshipping Siva and Buddha: the temple art of East Java*. Honolulu: University of Hawai'i Press.
- Kis-Jovak, J.I. (ed.) (1988) *Banua Toraja: changing patterns in architecture and symbolism among the Sa'dan Toraja, Sulawesi, Indonesia*. The Netherlands: Royal Tropical Institute.
- Koster, S. & Noorman, B.K. (1922) *Verzameling van de voornaamste Ned.-Indische wetten, reglementen en verordeningen etc. van belang voor bestuur, rechterlijke macht en politie*. Bureau tot uitgave van werken op politiegebied. Available at: <https://resolver.kb.nl/resolve?urn=MMKB31:026782000:00169> (Accessed: 24 October 2022).
- Krom, N.J. (1913) 'Oud-javaansche Oorkonden, Nagelaten Transcripties van Wiljen Dr. J.L.A. Brandes', *Verhandelingen van het Bataviaasch Genootschap der Kunsten en Wetenschappen*, LX. Available at: <http://archive.org/details/verhandelengenv601913bata> (Accessed: 19 January 2022).
- Levin, C. (1999) *The Rāmāyaṇa at Loro Jonggrang: Indian Antecedents and Javanese Impetus*. Dissertation for Doctor of Philosophy. Institute of Fine Arts, New York University.
- Manguin, P.Y. (2001) 'Shipshape Societies: boat symbolism and political systems in Insular Southeast Asia', *Techniques & Culture. Revue semestrielle d'anthropologie des techniques*, (35–36), pp. 373–400. Available at: <https://doi.org/10.4000/tc.301>.
- Masri, M. et al. (2016) 'Manifestation of Archipelagic Culture: How significant is it within the Negeri Sembilan Malay Traditional Architecture', *Procedia - Social and Behavioral Sciences*, 222, pp. 557–566. Available at: <https://doi.org/10.1016/j.sbspro.2016.05.214>.
- Mead, D. (2018) *House Construction Terminology*. Sulang Language Data and Working Papers: Topics in Lexicography 24. Sulawesi Language Alliance, p. 27. Available at: <http://sulang.org/resources/topics-lexicography/024> (Accessed: 11 October 2022).
- Nawa, A. (2022) *Kajian Transformasi Arsitektur Kayu dari Era Mataram Kuno sampai Majapahit Studi Didasarkan pada Wujud yang Tergambar di Relief Percandian Mataram Kuno, Majapahit, dan di Antara*. Bachelor of Architecture. Universitas Katolik Parahyangan.
- Pardo, J.M.F. (2023) 'Challenges and Current Research Trends for Vernacular Architecture in a Global World: A Literature Review', *Buildings*, 13(1), p. 162. Available at: <https://doi.org/10.3390/buildings13010162>.
- Peluso, N.L. (1991) 'The History of State Forest Management in Colonial Java', *Forest & Conservation History*, 35(2), pp. 65–75. Available at: <https://doi.org/10.2307/3983940>.
- Peluso, N.L. (2020) *Rich forests, poor people: resource control and resistance in Java*. Berkeley: University of California Press.

- Perdana, A.B. & Kurniawan, K.R. (2022) 'The Vāstu Order as an Alternative Concept for Analysing Javanese Temple Architecture | Tatanan Vāstu sebagai Konsep Alternatif untuk Menelaah Arsitektur Candi Jawa', *SPAFA Journal*, 6, p. q790t38g6i-q790t38g6i. Available at: <https://doi.org/10.26721/spafajournal.q790t38g6i>.
- Pitana, T.S. (2023) 'Aesthetic and Cosmological Harmony in Traditional Javanese Architecture', *ISVS e-journal*, 10(11), pp. 143–153. Available at: <https://doi.org/10.61275/ISVSej-2023-10-11-10>.
- Pont, H.M. (1923) 'Javaansche Architectuur', in R.A.H. Djajadiningrat et al. (eds) *Djāwā Deerde Jaargang - 1923*. Soerakarta: Java-Instituut. Available at: <http://archive.org/details/in.gov.ignca.31962> (Accessed: 29 September 2023).
- Pont, H.M. (1924) 'Javaansche Bouwbeginnselen', *Indisch Bouwkundig Tijdschrift*, 22, pp. 245–253.
- Prasodjo, T. (2022) *The confluence of water and power: water management in the Brantas river basin from the tenth to the sixteenth century CE*. Leiden University. Available at: <https://hdl.handle.net/1887/3254360> (Accessed: 29 September 2023).
- Prie, M.M. (2016) *Pancaran limasan: The brilliance of limasan*. First edition. Jakarta: Red & White Publishing.
- Reichle, N. (2009) 'Unfinished Business: Clues About Artistic Praxis from the Hidden Foot of Borobudur', *Artibus Asiae*, 69(2), pp. 335–356.
- Salura, P. (2015) *Sundanese architecture*. Bandung: Rosda International.
- Santiko, H. (2014) 'The Old-Javanese Everyday Life In The Karmawibhaṅga Reliefs', in Balai Konservasi Borobudur (Indonesia) (ed.) *Proceeding 6th International Experts Meeting on Borobudur 2013*. Cetakan I. *International Experts Meeting on Borobudur*, Borobudur, Magelang, Jawa Tengah: Kementerian Pendidikan dan Kebudayaan, Direktorat Jenderal Kebudayaan, Balai Konservasi Borobudur, pp. 107–117.
- Santosa, A., Rachmawati, M. & Noerwasito, V.T. (2023) 'Material and Cultural Values in Joglo Architecture in Indonesia', *ISVS e-journal*, 10(2), pp. 1–15.
- Sardjono, A.B. et al. (2022) *Puspa Ragam Bentuk-Bentuk Arsitektur Setempat*. Semarang: Tigamedia. Available at: <https://eprints2.undip.ac.id/id/eprint/9297/1/PAK%20AGUNG%20BUDI%20S.pdf>.
- Sastrawan, W.J. (2022) 'Portents of Power: Natural Disasters throughout Indonesian History', *Indonesia*, 113(1), p. 9. Available at: <https://doi.org/10.1353/ind.2022.0001>.
- Schefold, R. (2003) 'The Southeast Asian Type House: common features and local transformations of an ancient architectural tradition', in R. Schefold, P.J.M. Nas, and G. Domenig (eds) *Indonesian Houses: Tradition and Transformation in Vernacular Architecture*. Leiden: KITLV (Verhandelingen van het koninklijk instituut voor taal-, land en volkenkunde, 207), pp. 19–60.
- Setyawan, H. (2022) 'Tipologi atap bangunan berkonstruksi kayu pada relief Candi Borobudur', *Berkala Arkeologi*, 42(2), pp. 137–164. Available at: <https://doi.org/10.30883/jba.v42i2.983>.
- Simanjuntak, T. (2017) 'The Western Route Migration: A Second Probable Neolithic Diffusion to Indonesia', in P. Piper, H. Matsumura, and D. Bulbeck (eds) *New Perspectives in Southeast Asian and Pacific Prehistory*. 1st edn. ANU Press, pp. 201–211. Available at: <https://doi.org/10.22459/TA45.03.2017.11>.
- Smiet, A.C. (1990) 'Forest Ecology on Java: Conversion and Usage in a Historical Perspective', *Journal of Tropical Forest Science*, 2(4), pp. 286–302.
- Soekarno, E.H. (1983) 'Catatan Tentang Peninggalan Klasik Berupa Miniatur Rumah dari Sukabumi', in *Pertemuan Ilmiah Arkeologi III. Pertemuan Ilmiah Arkeologi III*, Jakarta: Pusat Penelitian Arkeologi Nasional, pp. 455–463.
- Stutterheim, W.F. (1956) 'Some remarks on pre-Hinduistic burial customs on Java', in *Studies in Indonesian Archaeology: Publication commissioned and financed by the Netherlands Institute for International Cultural Relations*. Dordrecht: Springer Netherlands: Imprint: Springer, pp. 63–90.

- Stutterheim, W.F. (1989) *Rāma-legends and Rāma-reliefs in Indonesia*. New Delhi: Indira Gandhi National Centre for the Arts: Abhinav Publications.
- Suleiman, S. (1984) 'Maritime Routes in the Classical Period', in *Final report: Consultative Workshop on Research on Maritime Shipping and Trade Networks in Southeast Asia, I-W7, Cisarua, West Java, Indonesia, November 20-27, 1984*, Bangkok, Thailand: SPAFA Co-ordinating Unit, pp. 53-70 (Appendix 4a).
- Tjahjono, G. & Miksic, J.N. (eds) (2002) *Indonesian Heritage: Arsitektur*. Jakarta: Published by Buku Antar Bangsa for Grolier International: Distributed exclusively by PT. Widyadara.
- Tjoa-Bonatz, M.L., Neidel, J.D. & Widiatmoko, A. (2009) 'Early Architectural Images from Muara Jambi on Sumatra, Indonesia', *Asian Perspectives*, 48(1), pp. 32–55. Available at: <https://doi.org/10.1353/asi.0.0009>.
- Vroklage, B.A.G. (1936) 'Das Schiff in den Megalithkulturen Südostasiens und der Südsee', *Anthropos*, 31(5/6), pp. 712–757.
- Waterson, R. (1990) *The Living House: an anthropology of architecture in South-East Asia*. Singapore; New York: Oxford University Press.
- Waterson, R. (2006) 'Houses and the Built Environment in Island South-East Asia: Tracing some shared themes in the uses of space', in J.J. Fox (ed.) *Inside Austronesian Houses: Perspectives on domestic designs for living*. 1st edn. Canberra: ANU Press, pp. 227–242. Available at: <https://doi.org/10.22459/IA.09.2006.09>.
- Wessing, R. (2003) 'The shape of home: Spatial ordering in Sundanese kampung', in *Indonesian Houses*. Brill, pp. 427–460. Available at: https://doi.org/10.1163/9789004483255_016.
- Wibowo, H.J., Murniatno, G., & Sukirman (1998) *Arsitektur Tradisional Daerah Istimewa Yogyakarta*. Jakarta: Departemen Pendidikan dan Kebudayaan RI.
- Wisseman-Christie, J. (1992) 'Trade and value in pre-Majapahit Java', *Indonesia Circle. School of Oriental & African Studies. Newsletter*, 21(59–60), pp. 3–17. Available at: <https://doi.org/10.1080/03062849208729789>.
- Wisseman-Christie, J. (2007) 'Water and rice in early Java and Bali', in P. Boomgaard (ed.) *A World of Water*. Brill (Rain, Rivers and Seas in Southeast Asian Histories), pp. 235–258.

Online Image Sources

- Abdulrohmat (2018) Kampung Naga, Tasimalaya. https://commons.wikimedia.org/wiki/File:Kampung_Naga_Tasimalaya.jpg. Wikimedia Commons. Accessed 30 September 2023.
- Balai Pelestarian Cagar Budaya Jawa Timur (2018) Miniatur Lumbung. <https://kebudayaan.kemdikbud.go.id/bpcbjatim/miniatur-lumbung/>. kebudayaan.kemdikbud.go.id. Accessed 30 September 2023.
- DARMAS SB (2022) Rumah Adat Jawa Berbentuk Joglo di Desa Karang Tanjung Alian Kebumen. https://commons.wikimedia.org/wiki/File:Rumah_Adat_Jawa_Berbentuk_Joglo_di_Desa_Karang_Tanjung_Alian_Kebumen.jpg. Wikimedia Commons. Accessed 30 September 2023.
- Jerome Robbins Dance Division (1962) Java, East: Antiquities. Jalatunda, candi. <https://digitalcollections.nypl.org/items/510d47dd-c616-a3d9-e040-e00a18064a99>. The New York Public Library Digital Collections. Accessed 30 September 2023.
- KITLV 101401 (c. 1910) Bas-relief op de Boroboedoer bij Magelang. <http://hdl.handle.net/1887.1/item:925845>. Leiden University Libraries Digital Collections. Accessed 29 November 2022.
- KITLV 102377 (c. 1910) Bas-relief op de Boroboedoer bij Magelang. <http://hdl.handle.net/1887.1/item:927889>. Leiden University Libraries Digital Collections. Accessed 29 November 2022.
- KITLV 102677 (c. 1910) Bas-relief op de Boroboedoer bij Magelang. <http://hdl.handle.net/1887.1/item:928513>. Leiden University Libraries Digital Collections. Accessed 29 November 2022.

- KITLV 181654 (c. 1933) Huizen te Papandak bij Wanaradja in de buurt van Garoet. <http://hdl.handle.net/1887.1/item:906198>. Leiden University Libraries Digital Collections. Accessed 29 November 2022.
- KITLV 183378 (c. 1910) Reliëf uit Trowoelan bij Modjokerto. <http://hdl.handle.net/1887.1/item:837763>. Leiden University Libraries Digital Collections. Accessed 30 September 2023.
- KITLV 24609 (1890-1891) Reliëf Boroboedoer. <http://hdl.handle.net/1887.1/item:764777>. Leiden University Libraries Digital Collections. Accessed 11 November 2022.
- KITLV 28013 (1890-1891) Reliëf van de verborgen voet van de Boroboedoer. <http://hdl.handle.net/1887.1/item:803474>. Leiden University Libraries Digital Collections. Accessed 30 September 2023.
- KITLV 28060 (1890-1891) Reliëf van de verborgen voet van de Boroboedoer. <http://hdl.handle.net/1887.1/item:805102>. Leiden University Libraries Digital Collections. Accessed 11 November 2022.
- KITLV 28293 (1867) Reliëf met gedeelte van het Ramayana-epos aan de zuidzijde van Panataran, Kediri. <http://hdl.handle.net/1887.1/item:804496>. Leiden University Libraries Digital Collections. Accessed 29 November 2022.
- Kemendikbutristek (n.d.) Miniatur Lumbung Padi Museum Negeri Provinsi Jawa Barat Sri Baduga. https://museum.kemdikbud.go.id/koleksi/profile/Miniatur+Lumbung+Padi_53458. museum.kemdikbud.go.id. Accessed 30 September 2023.
- Kuncoro Widyo Rumpoko (2013) Rumah Tradisional Warga Baduy Luar 2. https://commons.wikimedia.org/wiki/File:Rumah_Tradisional_Warga_Baduy_Luar_2.jpg. Wikimedia Commons. Accessed 27 February 2023.
- TMnr 10012989 (1900-1940) Oude djati-bomen Bodjonegoro Midden Java. https://commons.wikimedia.org/wiki/File:COLLECTIE_TROPENMUSEUM_Oude_djati-bomen_Bodjonegoro_Midden_Java_TMnr_10012989.jpg. Tropenmuseum via Wikimedia Commons. Accessed 30 September 2023.
- TMnr 10016190 (1928) Reliëf op de aan Shiva gewijde tempel op de Candi Lara Jonggrang oftewel het Prambanan tempelcomplex. https://commons.wikimedia.org/wiki/File:COLLECTIE_TROPENMUSEUM_Reli%C3%ABf_op_de_aan_Shiva_gewijde_tempel_op_de_Candi_Lara_Jonggrang_oftewel_het_Prambanan_tempelcomplex_TMnr_10016190.jpg. Tropenmuseum via Wikimedia Commons. Accessed 30 September 2023.
- TMnr 10016194 (1928-1936) Reliëf op de aan Shiva gewijde tempel op de Candi Lara Jonggrang oftewel het Prambanan tempelcomplex. https://commons.wikimedia.org/wiki/File:COLLECTIE_TROPENMUSEUM_Reli%C3%ABf_op_de_aan_Shiva_gewijde_tempel_op_de_Candi_Lara_Jonggrang_oftewel_het_Prambanan_tempelcomplex_TMnr_10016194.jpg. Tropenmuseum via Wikimedia Commons. Accessed 30 September 2023.
- TMnr 15-930a (1900) Model van een huis type bijenkorf. https://commons.wikimedia.org/wiki/File:COLLECTIE_TROPENMUSEUM_Model_van_een_huis_type_bijenkorf_TMnr_15-930a.jpg. Tropenmuseum via Wikimedia Commons. Accessed 9 March 2024.
- TMnr 60050402 (1910-1940) Huizen in Papandak. https://commons.wikimedia.org/wiki/File:COLLECTIE_TROPENMUSEUM_Huizen_in_Papandak_TMnr_60050402.jpg. Tropenmuseum via Wikimedia Commons. Accessed 29 November 2022.