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RESEARCH ARTICLE

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Earthen–wooden hybrid houses built by the Dai in Dehong Prefecture, South China

Rawiwan Oranratmanee* and Pandin Ounchanum

Abstract

The Dai (or Tai) are an indigenous ethnic group distributed across the upper part of Southeast Asia and South China. Whereas the majority of the Dai living on the Southeast Asian mainland build wooden houses on stilts, Dai populations in South China, especially in Dehong Prefecture, are known for the distinctive architectural style of their hybrid earthen–wooden houses, which stems from their enduring social contact and cultural assimilation with Chinese settlers. This paper, which draws on comprehensive fieldwork conducted in Dai villages in Dehong Prefecture, explores the Dai's hybrid earthen–wooden architecture. Specifically, it examines the development of forms, the relationship between settlement layouts and house plans, as well as building materials, structures and constructions characterising this architecture using data from qualitative surveys, architectural measurements and interviews. The hybrid architecture of the Dehong Dai demonstrates the fusion of two building cultures—earthen and wooden—that has shaped a vernacular architectural identity that is unique to this area. This paper also presents illustrative examples of earthen–wooden houses, thereby contributing to advancing knowledge about this eclectic, hybrid architecture that remains a gap in the academic literature.

Keywords: Vernacular architecture, Hybrid, Adaptation, Cultural heritage, Human settlements, Local materials, Sustainable buildings, Dai, Dehong

1 Introduction

Vernacular architecture reflects the relationships among geography, environment, a social system and cultural values. Vernacular buildings evidence significant variations worldwide, and the development of global vernacular building cultures is contingent on the existence and availability of materials and building technologies, which are based on traditional methods transmitted over several generations (Oliver 1987; Vellinga et al. 2008).

Whereas most parts of the world have developed particular building cultures in relation to the availability of materials and cultural styles associated with building structures, some multicultural areas evidence hybrid built forms that can be attributed to social and cultural exchanges. Earthen buildings, in particular, can be found in most parts of Europe and North Africa as well as throughout South Asia, the Middle East and East Asia. Especially in Asia, earthen structures are generally made of adobe and are built using specific building techniques. By comparison, timber structures are found mostly in the tropical regions, such as South America, South Africa, South East Asia and Oceania. In Asia, timber buildings are mostly constructed according to traditional methods and are based on a post and beam structure.

Earthen and timber building cultures have long been considered ancient building cultures throughout the world (Mileto et al. 2018). Both building cultures are acknowledged to be ancient building prototypes that have a global geographical distribution and that have been sustained over time (Guillaud 2018). Lewis (2019: 3) has observed that 'hybrids of earth and timber' are found in almost every part of the world. Depending on the available materials and cultural traditions, both earthen and timber construction styles entail the use of

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diverse techniques, ranging from palisade and pug, to *lehmwickel*, wattle and daub, through to cane and daub. Angulo-Ibanez (2017), who studied the use of earth and wood construction materials in Spain, observed that whereas earth is ideal for wall construction because of its ability to carry loads and compression, this material lacks sufficient tensile strength and seismic resilience. Its strength as a building material lies in its durability, while its weak points relate to horizontal beams and diagonal braces. By comparison, wood may be less durable than earth, but it has high tensile strength that allows for more flexible forms. In most types of earthen–wooden hybrid architecture, earth is used as wall material on the ground floor, whereas wood is used for structural reinforcement and as the main material on the upper floors and roof structures.

Zwerger (2012: 266), who examined hybrid earthen–timber dwellings in China, found that most domestic dwellings there are made of unfired earth. Specifically, below the ground, dwellings were dug out of loess soil. Walls were made of earthen blocks and rammed earth, whereas other structures and building elements were made of wood. Earthen–wooden hybrid dwellings have survived numerous earthquakes throughout China's long settlement history. Thus, the combined use of earth and wood as building materials offers advantages in terms of being lightweight, tensile-resistant and renewable. This technique also uses low-carbon building materials and construction technologies (Volhard 2016).

This paper aims to explore the diverse forms and spatial planning techniques that account for the production of hybrid architecture in multicultural areas, where different groups meet and exchange building cultures. Specifically, it examines the synthesis of earthen and wooden building cultures through a case study of houses located in Dai villages in South China. In conclusion, it identifies the challenges entailed in the conservation and revitalisation of vernacular built forms in a context of rapid change.

2 Earthen–wooden houses built by the Dai in South China

2.1 Case study

2.1.1 Dai cultural geography

The Dai (or Tai) are an ethnic group living in lowland areas of Northeast India (in Assam and Arunachal Pradesh), Northeast Myanmar (in Shan State), South China (in Yunnan), Northwest Vietnam and most parts of Thailand and Laos. Given that they reside in different geographical areas, the Dai are known by different names locally, including Shan, Lue, Khun, Yuan, Lao and Thai. Although their dialects and cultural practices vary slightly across different locations, the Dai live in similarly constructed wooden houses on stilts. The cultural map depicted in Fig. 1 (on the right), which features Dai houses, shows the homogenous distribution of house forms that comprise the architectural identity of the Dai in mainland Southeast Asia. The present paper explores the hybrid earthen–wooden architecture built by Dai ethnic minorities in Dehong Prefecture, a peripheral area situated between South China and Southeast Asia (see the image on the left in Fig. 1). Architectural hybrids appear to have developed in this peripheral area because of the social, political and cultural interactions between the Dai and the Han Chinese during the 15th century that continued up to the time of the social revolution in the late 20th century. In light of their enduring contact with the Han Chinese, the Dai adapted the Han Chinese courtyard house design and their techniques for constructing earthen buildings, thereby developing eclectic built forms, spatial planning and building technologies.[1]

2.1.2 Dai settlements and houses

Categorised as a lowland peasant group, the Dai have customarily settled in seasonally flooded plains, where they can grow rice using the traditional wet-rice cultivation method. They live in wooden houses constructed on stilts in village hamlets surrounded by rice fields and enclosed by rivers and mountains. A typical Dai wooden house is built within a well-defined compound with several outbuildings surrounded by a garden. The main dwelling house is made of wood, generally teak, which can be found in the tropical rainforests surrounding their settlements. As shown in Fig. 2, the Dai's wooden houses on stilts are based on an open plan and are spatially aligned to their daily life activities, with the structures typically based on the application of a wooden post and beam system that is prevalent in Southeast Asia (Knapp 2000; Oranratmanee 2013, 2018; Waterson 2014; Zhu 1992).

2.1.3 Methods of study

This paper reports on the findings of a three-year research project (2017–2020) conducted in Dehong Prefecture, Yunnan, South China. The first field study, conducted in July 2017, entailed the use of qualitative methods, including a geographic and architectural survey of five settlement areas, 13 villages and 24 houses. This initial fieldwork highlighted the distribution of house forms and led to the identification of some hybrid characteristics of Dai houses (published on the issues regarding

[1] The hybrid earthen–wooden houses of the Dai can be found in areas where two building cultures meet, such as in Northeast India and South China.

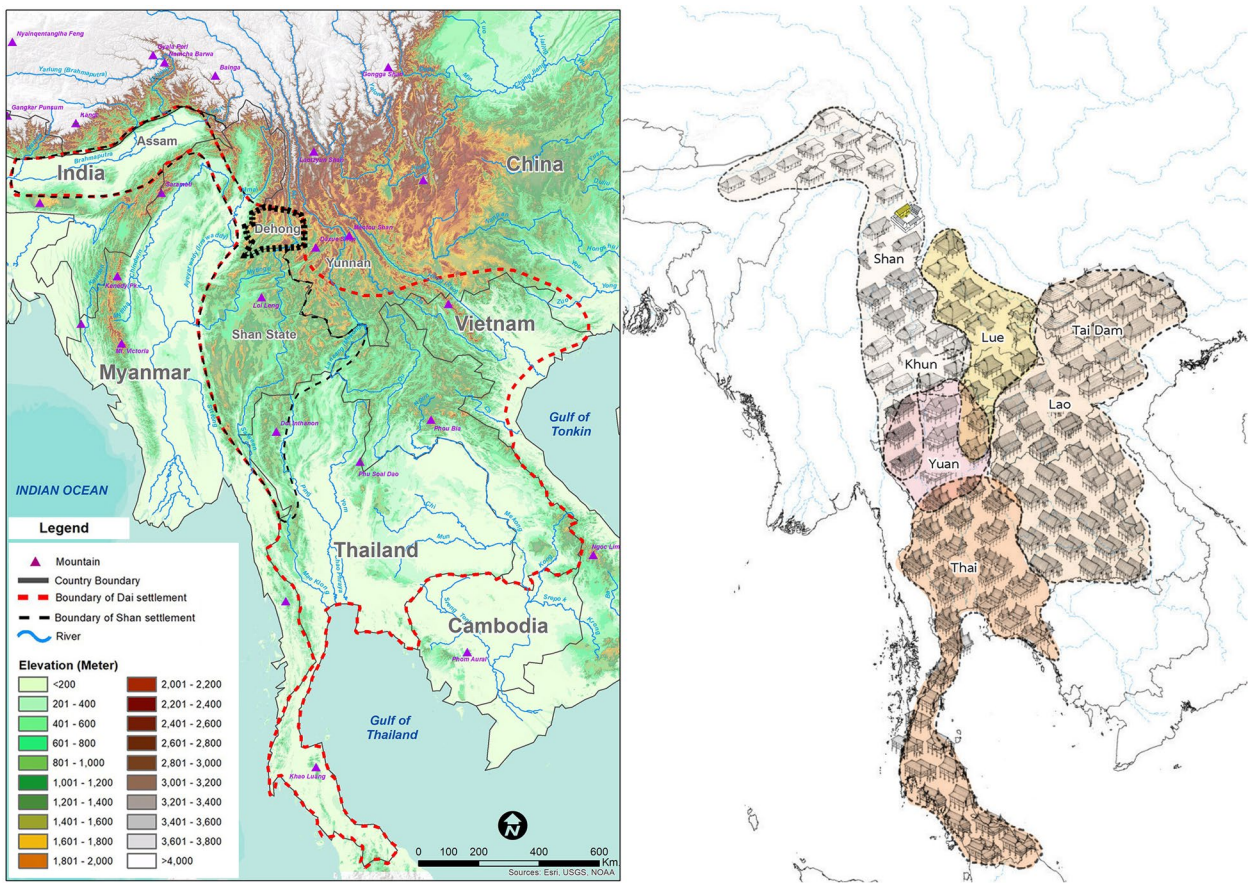

Fig. 1 Left: map of Dai settlements, adapted from Oranratmanee (2020). Right: distribution of Dai house forms (Source: the author)

cultural geography in Oranratmanee 2020). One village where earthen–wooden hybrid houses were most evident was selected for a second field study conducted in March 2018. The purpose of this second field study was to explore the cultural landscape, particularly the hybrid forms of the 76 selected samples of earthen–wooden hybrid houses (published on issues about cultural landscape in Oranratmanee 2021).

In both field studies, in-depth interviews were conducted with several informants, focusing on architectural continuity and changes involving the houses and surrounding landscape. Approximately 100 inhabitants living in the surveyed houses, most of whom were elderly members, were interviewed to elicit information on continuity and changes from the use of wood-based materials for house construction to earthen–wooden hybrids. Interviews were also conducted with 10 local experts, namely village leaders, ritual leaders, Buddhist monks, Dai house craftsmen and Dai/Chinese historians from Dehong and Kunming. These interviews focused on the impacts of the socio-political dynamics relating to continuity and changes within the Dai cultural landscape and houses during the period spanning the era of the Dai sovereign state up to the establishment of the Dai Dehong Prefecture under socialist China. During the interviews, tangible references were made to several historical records, such as family records, photographs, manuscripts and books and chronicles. This paper presents a synthesis of the findings on the development of earthen–wooden hybrid house forms, house plans and spatial arrangements, materials, structural systems and construction emerging from this research project, which are discussed in the following section.

2.2 Analysis of Dai houses

2.2.1 Development of forms

A study of the development of house forms can reveal changes that have occurred over time in relation to the design and construction of Dai houses. Data compiled from a literature review and from interviews indicated that the historical period of Dai settlement in China dates back to the 10th century, which is when the Dai settled in small feudal principalities in river valleys and sustained themselves through agricultural production. Historical

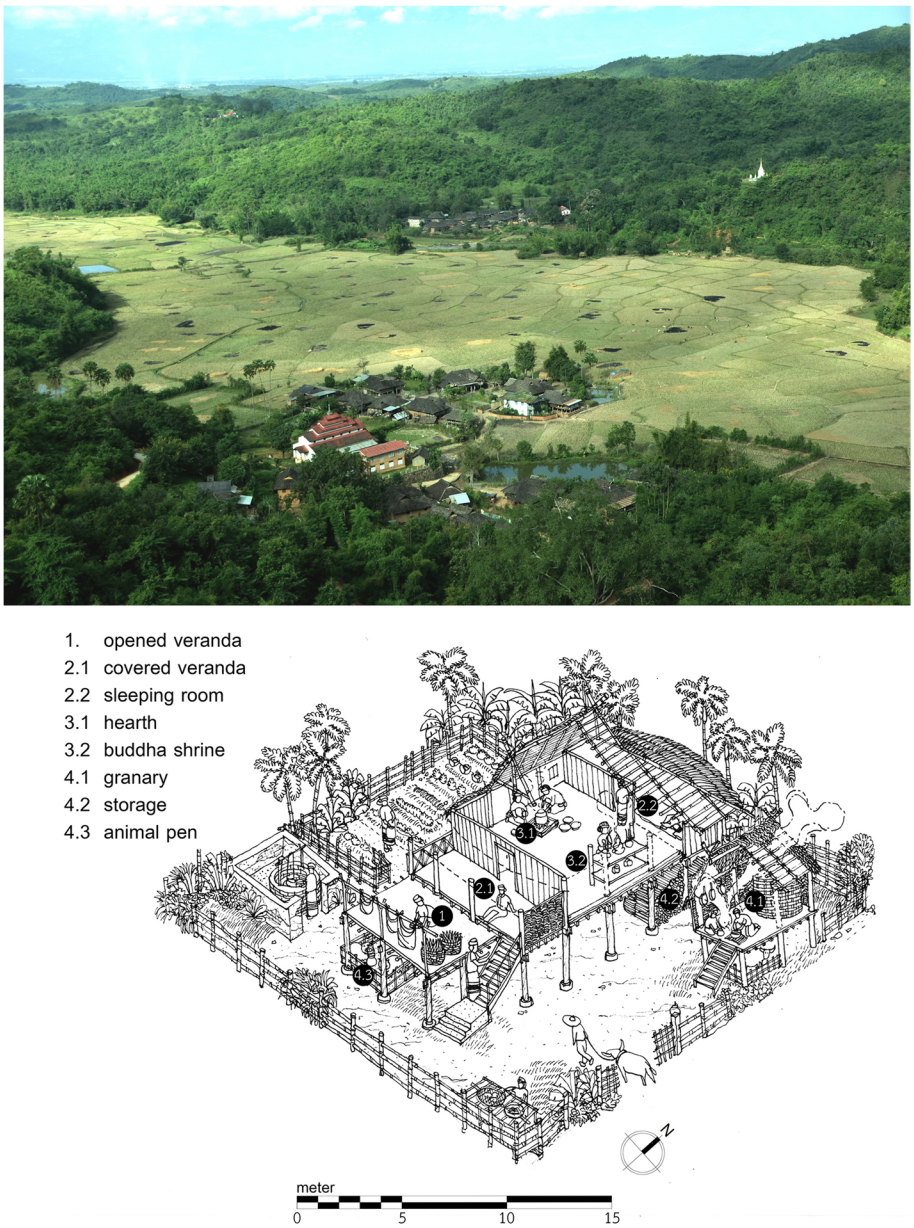

Fig. 2 Top: a Dai settlement. Bottom: sketch of a Dai settlement in Shan State Myanmar (Source: Oranratmanee 2018)

records dating back to the 13th century point to the organisation of Dai settlements in the form of small village hamlets enclosed by wet-rice farmlands (Oranratmanee 2020; Gogoi 1996; Sai Aung Tun 2009; Zhu 1992).

a) Milne (2001) noted that early Dai settlements mostly had wooden houses that were raised above the ground and arranged according to an open spatial layout, featuring spacious verandas in the front that were partially covered with round-ended thatched roofs. This indigenous form is illustrated in Fig. 3(a).

Interviews with residents and local experts revealed that the Dai constructed and lived in traditional wooden houses for a long period prior to the invasions of the Chinese dynasties, which brought about changes in forms, space, materials and construction techniques in the villages. Furthermore, interviewees who elaborated on the development of Dai houses in Dehong also identified evolution patterns that can be discerned in wooden houses constructed during the early stages of their development, as shown in Fig. 3(a–c). The development of wooden houses

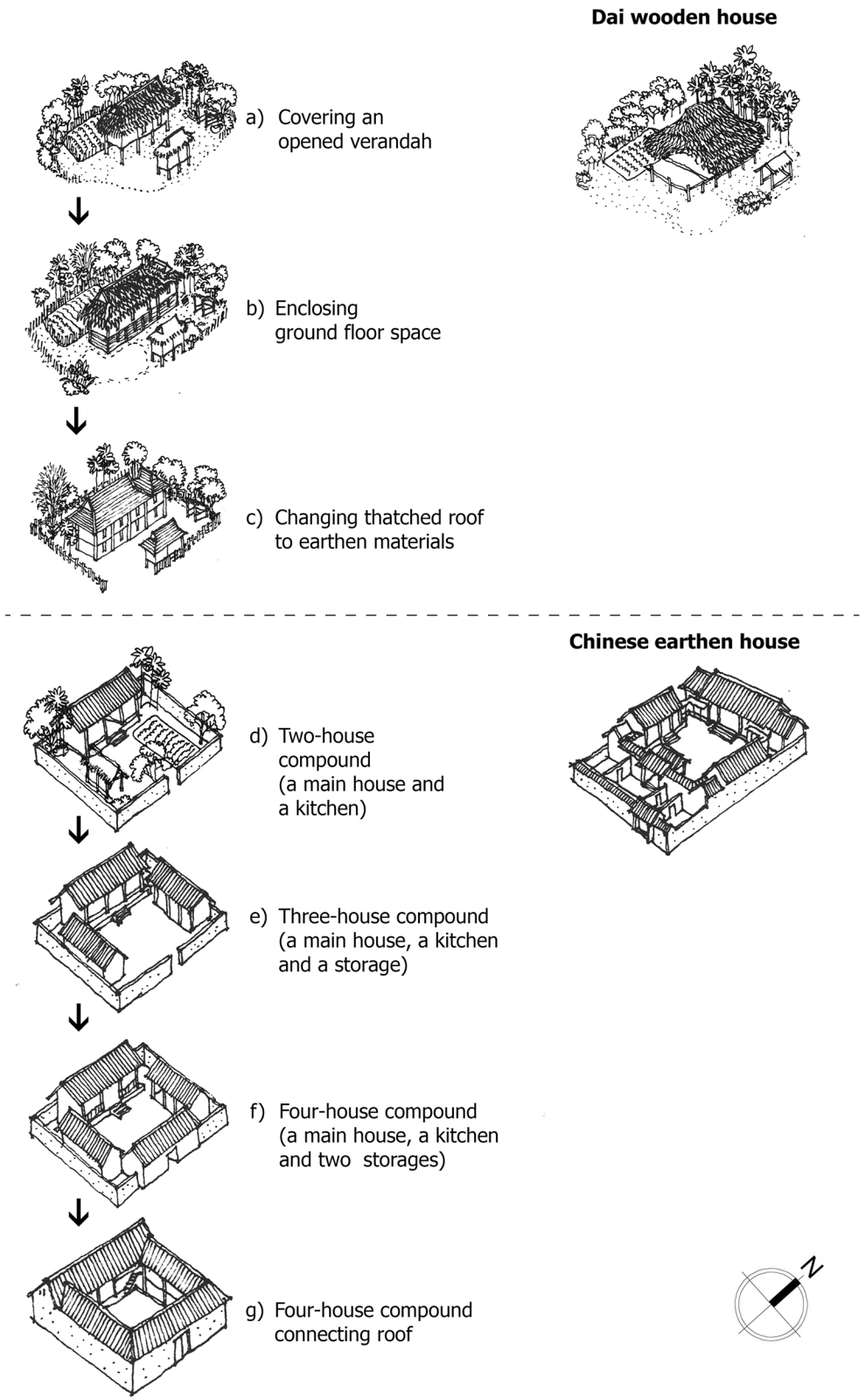

Fig. 3 Development of different house forms in Dehong Prefecture (Source: the author)

reveals at least three patterns of adaptation as follows. The first is the covering of an open veranda with a roof to provide a shaded living space. The second pattern entails the enclosure of the ground floor space using adobe walls to provide storage space, a kitchen, and living space. The final pattern entailed conversion of the thatched roof to earthen roof tiles and enclosure of the land plot with a well-defined fence.

These patterns of adaptation can still be observed today, especially in southern Dehong, where houses on wooden stilts still exist, although there are fewer of these structures compared with the earthen–wooden hybrid houses commonly found in Dehong Prefecture. Earthen materials, including adobe, are still used to build walls and make earthen roof tiles. Notably, the house forms continue to resemble indigenous wooden houses that are commonly found in present-day Dai settlements in Southeast Asia.

b) According to the interviewees, the Dai's earthen–wooden hybrid house form emerged in Dehong in the wake of persistent wars with Chinese dynasties during the 15th and 16th centuries.[2] Over the course of these wars, which continued over several generations, military camp settlements were established adjacent to Dehong. During wartime, some of the Dai fled to Shan State, and some parts of Dehong were occupied by the Chinese military forces. Throughout the subsequent period, which lasted from the 17th century to the 20th century when trade across the Chinese–Myanmar border flourished, increasing numbers of Chinese settlers migrated to Dehong and built their houses in the traditional Chinese courtyard house style. In this way, the Chinese landscape continued to expand into most townships in Dehong. As a result of close and enduring contact with the Chinese arising from social and political interventions as well as cultural assimilation through intermarriages between the Dai and the Chinese, the Dai began to adopt Chinese courtyard house forms along with earthen–wooden building materials and construction technologies. Moreover, the land reforms implemented during the Cultural Revolution changed the configuration of village land plots that were now arranged in a grid-based pattern. Since that time, most of the wooden houses have been demolished and more compounds with earthen–wooden courtyard houses have been built. These compounds of earthen–wooden hybrid houses reveal the following main structural patterns, shown in Fig. 3(d–g). The first entails two-house compounds comprising a main house and a kitchen with a large open space in front. The second pattern entails three-house compounds comprising a main house, a kitchen and a storage building. Lastly, four-house compounds comprise a main house, a kitchen and two storage buildings, and they have connecting roofs.

These patterns of adaptation of earthen–wooden buildings are observable in most parts of Dehong. Houses of small or new families are usually initially constructed as one to two buildings. With increasing demands for space over time, and if the economic well-being of the family permits, new buildings are subsequently built around the same courtyard.

2.2.2 Settlement layout, house plans and spatial arrangements

A study of the layout of a Dai settlement (depicted in the top part of Fig. 4) requires an examination of the integrated relationship between the settlement layout and house plans. The settlement layout depicts an ideal Dai settlement in the lowland river valley surrounded by rice fields and enclosed by mountains. As shown in Fig. 4, a village settlement consists of about 160 houses. There is one main entrance connecting the village to the main road and a sub-entrance connecting it to a smaller road that leads to the highlands and forest. Within the village, there is one main road with smaller connected branches. A continuous line of walls enclosing the house compounds stretches along the roads.

The findings of architectural surveys of approximately 76 houses revealed some common rules relating to the orientation and direction of villages and houses. According to interviewed ritual leaders and craftsmen, the direction of sunrise, the alignment of river valleys and reverence for protective spirits are the main factors determining the orientations of villages and houses. A walk inside the village and a closer look inside house compounds revealed that the village gate, temple gates and house gates are usually east- or northeast-facing, whereas service paths leading to graveyards, the forest beyond the village and the service areas within residential compounds are west- or southwest-facing. River flow and the distribution of water ducts according to the topography are considered in the establishment of settlements and houses, thus ensuring the proper allocation of water for rice fields and daily consumption within the

[2] The wars were not continuous during these years; there were intensive periods of warfare as well as quiet interludes. When fighting ceased during the rainy seasons, soldiers would transform themselves into farmers and grow rice and crops. The practices of Chinese farmers living and farming in Dehong may have led to their cultural assimilation into the local Dai culture.

No.	Symbol	Description
1	①	Court
2		sleeping house
	2.1	middle area
	2.2	parent
	2.3	son room
3		kichen house
	3.1	hearth
	3.2	dinning area
4		storage area
	4.1	rice barm
	4.2	storage
	4.3	animal pen
5	⑤	toilet

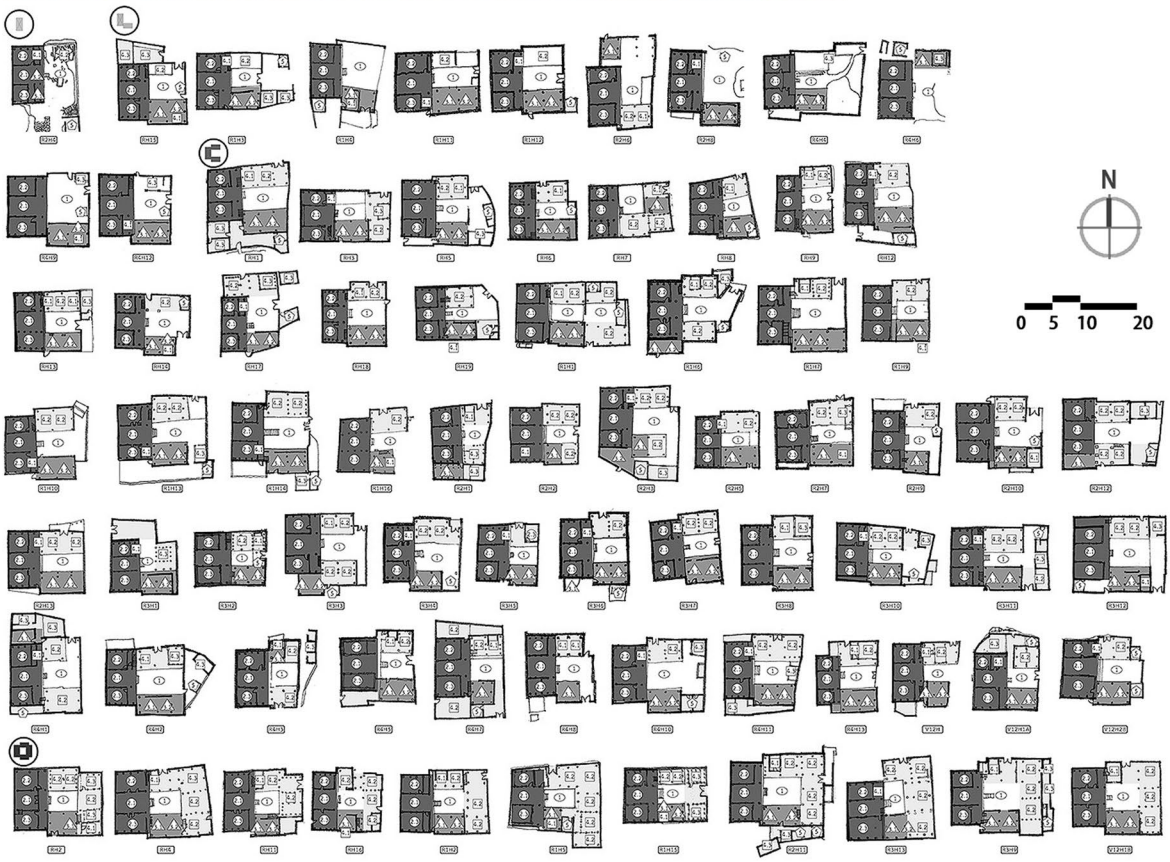

Fig. 4 Layout of a Dai village (top) and house plans (Source: the author)

village. Beliefs relating to designated spiritual places in which to worship ancestral, earth and fire spirits similarly influence village and house construction. As the Dai in Dehong are mostly Buddhists, a Buddhist temple is usually built by villagers as a place where they can perform rituals and religious activities.

An analysis of the house plans (shown in the bottom portion of Fig. 4) revealed four types of house configurations: single houses (I-shaped), two houses (L-shaped), three houses (C-shaped) and four house (O-shaped). The most common type of configuration is a C-shaped structure arranged within a three-sided enclosure facing an open courtyard. The basic structure comprises a main house, a kitchen and a storage space. The main house, which faces east, has three rooms and is located on the western side of a house compound. The kitchen, toilet and animal pens are located on the south side, whereas the storage area is located on the opposite side. The doorway to a house is either oriented to the north or the northeast. Interviews with residents and craftsmen revealed the prevalence of the spatial belief that the east is an auspicious direction. From a more practical perspective, the sun's rays at sunrise can emanate from this direction and warm the house during the winter. A three-roomed house appears similar to a traditional Chinese house in which the central room is the living area and ancestral altar, the room facing north is for the parents and the room facing south is for a married son.[3] Domestic functions and outbuildings remain the same, with most of the Dai residents in Dehong still cultivating rice and crops for a living.

2.2.3 Earthen–wooden materials, structural systems and construction

Figure 5 depicts the house materials and structural systems associated with the earthen–wooden building construction technology. This technology entails the mixed use of materials, with earth used for constructing flooring and external walls and wood used for the construction of posts, beams, roof structures and internal wall partitions. Sun-dried adobe is made of earth, cow dung, straw and husk, and the wood used in houses is usually hardwood or pinewood obtained from nearby forests. The structure of the main house, which is used for sleeping and as a living area, is customarily built on filled-up ground at a height of 1.20 m. A typical house structure has 20 posts placed on stones and running vertically towards the roof structures. Two beams—one at the bottom and the other at the top—are used to create the horizontal framework of a house. Crossbeams, rafters and purlins are used to support the earthen roof tiles. All parts of the structures are prefabricated, and only wood joints are used. The three-sided external walls of the main house are usually made of adobe, and all interior partitions are made of carved wood. The structures of the kitchen and storage spaces are simpler than those of the main house. Usually, they comprise a simple wooden post and beam structure enclosed by earthen walls. The stove and fire pit, usually made of clay, are raised above the ground.

The building a house is a communal activity involving 60 to 70 men in the village. The dimensions are on a human scale measured by arm and elbow lengths and hand width. The construction date is fixed according to an auspicious day and/or the house owner's birth date and is preceded by a ceremony in which rice, food, tea and liquor are offered to the earth, sky and ancestral spirits. A chicken is then sacrificed as a mark of respect and to ask these spirits for permission to build the house and obtain their blessings. Preparatory work is also carried out, including wood cutting, wood treatment (placing the wooden materials in wet mud for a month) and the prefabrication of wooden walls, bamboo partitions and adobe and roof tiles. Figure 6 depicts the step-by-step construction process, which is described below.

a) Site planning is completed, and the land is filled to the desired level.
b) Digging is performed to reach the first rock foundation, and auspicious objects are placed inside before placing the rock foundation for installing the supporting wooden posts.
c) The posts are erected, beginning with the first row of five posts located at the northern end where the parents' room will be located and continuing to the next position.
d) The two cross-beams (top and bottom) are attached to the support posts in their proper places.
e) An adjacent row of five posts is erected until completion of the house construction.
f) Rafters and purlins for the roof structures are installed, followed by wooden sticks and roof tiles.
g) External earth walls made of adobe are constructed.
h) Wooden interior walls, partitions and house altars (for earth, sky, fire and ancestral spirits) are installed.
i) The kitchen, storage area and toilet are constructed. These constructions can be completed simultaneously depending on the owner's inclination).
j) The courtyard and other earthwork (i.e., the stove and animal pen) are completed.

[3] The Dai also divide a main house into three rooms. The veranda is on the south side; the middle hall accommodates the living area, ancestral post, and a married son's sleeping area; and the north side is reserved for the parents.

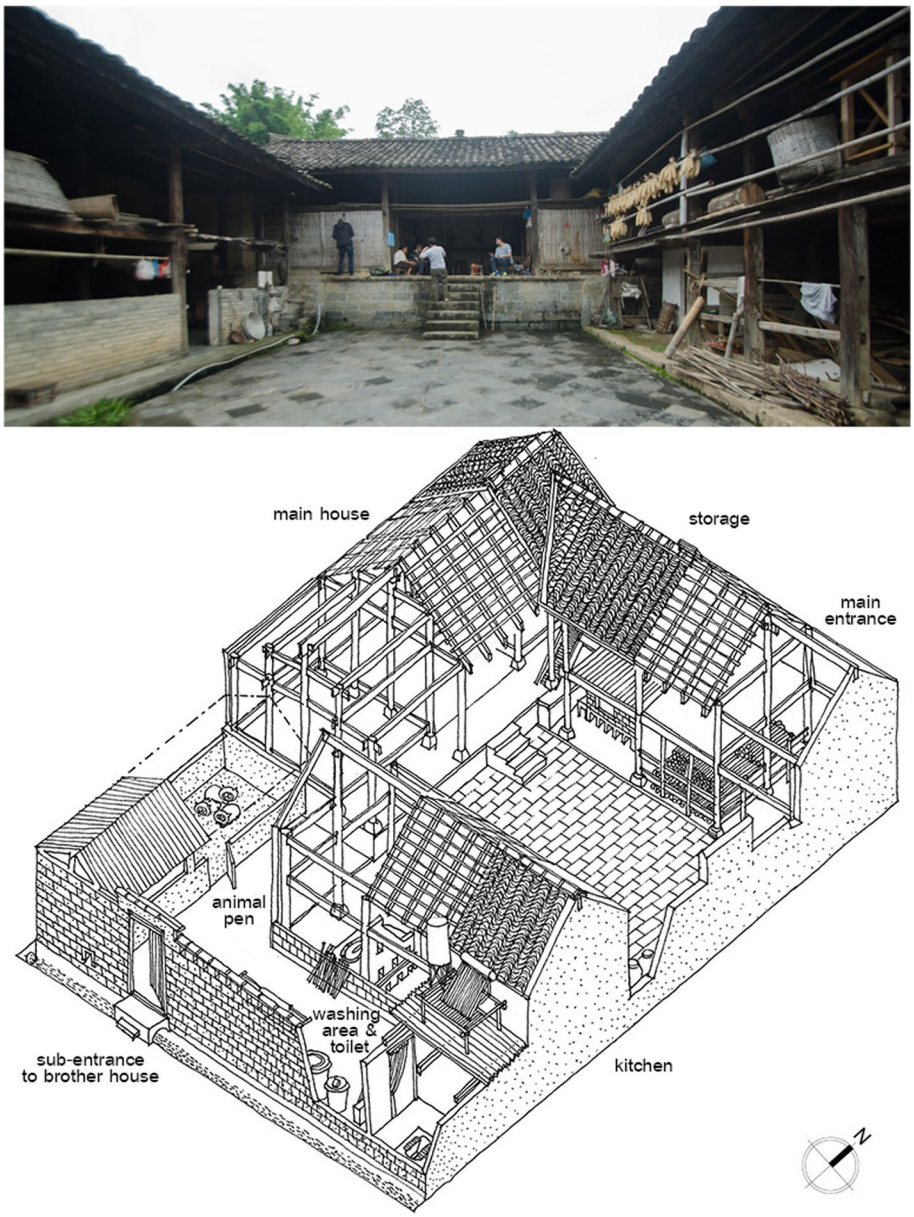

Fig. 5 Photograph and isometric house sketch showing spatial allocation, materials and structures (Source: the author)

After completion of the house construction, a ceremony is conducted to inaugurate the newly built house in the traditional Dai way.[4] This ceremony includes a song with passages about a conversation between the prospective inhabitants and their ancestors, featuring a nostalgic story about the ideal homeland from where the ancestors departed along with their travel companions and their cultural belongings. The song ends with a request by the homeowners for permission to enter and live in the house and receive blessings for their well-being.

3 Discussion

3.1 Typological process of Dai architecture

The typological process of the Dai's earthen–wooden hybrid architecture exhibits the fusion and evolution of built forms, spatial arrangements, materials, structures and construction technologies derived from two distinct building cultures. Because of their proximity to Chinese settlers who were assimilated over a long duration, the

[4] Similar songs sung at ceremonies performed to inaugurate a new house have been found in Dai settlements in India, Myanmar and Thailand.

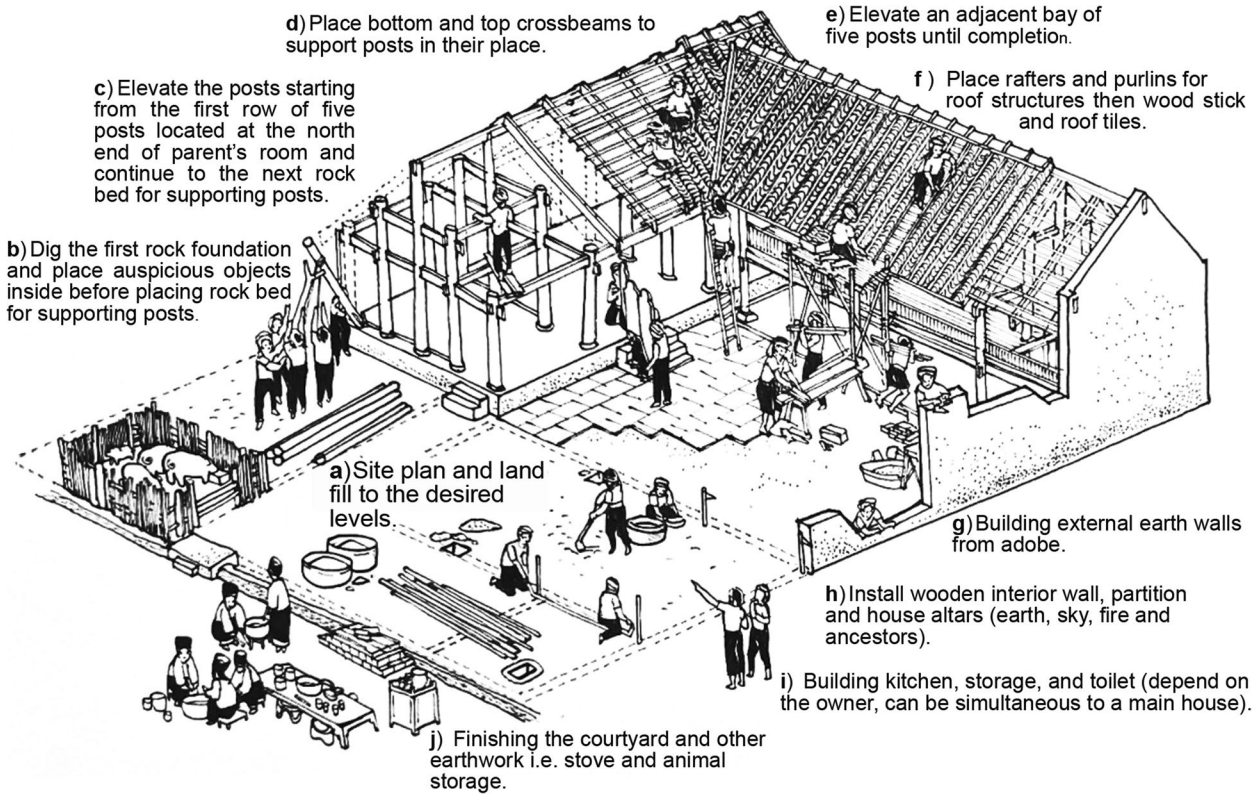

Fig. 6 The process of constructing a house (Source: the author)

Dai gradually adopted Chinese built forms and building technologies. Over the years, the physical appearance of Dai houses began to show an increasing resemblance to Chinese courtyard houses, although the rudimentary concepts relating to the use of space and spatial relations, daily life activities, directional references and rituals and ceremonies still drew on Dai cultural practices.

Furthermore, the adaptation of built forms also relates to cultural assimilation to varying degrees. In particular, the Dehong Dai have lived under the socio-cultural influence of the Chinese for a long time. Members of this group bear both Chinese and Dai names, speak Chinese and Dai languages and even celebrate Chinese and Dai ceremonies. When asked about their family trees and historical records, most contemporary Dai families stated that they have Chinese ancestors who came to Dehong during the civil wars to perform military service. In other words, most of the Dai living in Dehong are mixed-blood Chinese–Dai who embrace both cultures.

3.2 Earth–wood hybrids

Hybrid architecture exhibits the exchange not only of forms but also of skills and building traditions between the Dai and Chinese cultures. For example, the Dai commonly prepare adobe using a traditional sun-drying method that they learnt from the Chinese. They mix soil with water, sand and straw to form a thick clay mass with the consistency of a paste. This thick paste is packed into a wooden frame and allowed to dry under the sun. Once removed from its wooden frame, the adobe brick is left to dry further to increase the stability of the material.

Other types of earthen materials used in construction are fired bricks and tiles. In newly built houses, fired bricks and tiles are used for walls, courtyard floor finishes and roofing. The use of rammed earth in village structures and houses is rare, as it is more often used on walls in urban built structures. In the past, when cross-border trade permitted and transportation of wood was still possible, hardwood, including teak, which was formerly abundant in the Shan State, was typically transported to Dehong. Currently, local pinewood is more commonly used for house construction.

3.3 Appropriate technology

There are many reasons why the earthen–wooden houses of the Dai have evolved over the years and have endured up to the present. A key reason is that the use of hybrid materials combines the advantages of both building materials. In terms of climatic adaptation. Average temperatures in Dehong are relatively lower than those in

other Dai settlements; hence, earthen materials can provide greater comfort across all seasons compared with the use of wood alone. On the one hand, earthen walls and courtyard compounds can ensure security, protection and durability during times of chaotic warfare. On the other hand, wood is an ideal material for structural frameworks and spatial partitioning. Its tensile strength helps to support earthen walls, particularly during storms and earthquakes. When used together as a hybrid built form, earth and wood complement each other well, which explains why they are widely used as construction materials.

3.4 Conservation challenges and the revitalisation of vernacular built forms

Unlike earthen or timber-based architecture, which may possess elusive indigenous characteristics, hybrid built forms tend to raise some issues relating to their cultural authenticity. The Dai in Dehong have developed hybrid earthen–wooden houses as a distinctive building culture that differs from those of the Dai/Tai in other locales. Currently, there is some awareness and concern regarding the conservation of hybrid vernacular architecture, which reflects the ongoing adaptation of architecture to continuing changes. In recent years, revitalisation has been emphasised, which entails embracing the hybrid built forms as local cultural heritage for new purposes, including ethnic tourism.

4 Conclusion

This study, focusing on the vernacular built forms of Dai houses in Dehong Prefecture, contributes to advancing knowledge about the Dai from the time of their early settlement up to modern times. Similar to the cultures of many ethnic minorities residing in multicultural areas situated between China and the Southeast Asian mainland, that of the Dai has undergone adaptation, reflecting Chinese influences. Although their indigenous building technologies are timber-based, the Dai have learned to exchange and adapt, when appropriate, thereby developing a unique hybrid architecture that is distinct from that of their Dai kinspeople in other parts of Southeast Asia and beyond. In Northeast India, for example, similar phenomenon is apparent; Dai who migrated from Myanmar to India appropriated Indian adobe material and the wattle and daub technique for house construction. The exchange of building traditions continues to reflect the collective vernacular knowledge of everyday practices, and further investigations of these processes will enrich theoretical knowledge and daily practice.

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Authors' contributions
RO carried out the research design, field study and writing up of this paper. PO contributed to the graphic representation of this paper. The author(s) read and approved the final manuscript.

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Availability of data and materials
The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials.

Declaration

Competing interests
The authors declare that they have no competing interests.

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Publisher's Note