Research Article

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Topographical Determinism and Cultural Landscapes: a GIS-based Spatial Analysis of the Religious Triad in Nha Trang City, Vietnam

Minh Hieu Nguyen
Faculty of Industrial Fine Arts, Ton Duc Thang University, Ho Chi Minh City, Vietnam;
nguyenminhhieu@tdtu.edu.vn

Phuong-Thao Hoang-Thi
Faculty of Civil Engineering, Ton Duc Thang University, Ho Chi Minh City, Vietnam

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Abstract

This study examines the spatial relationships among three religious landmarks in Nha Trang, Vietnam: the Ponagar Cham temple complex, Long Son Pagoda and its hilltop Buddha statue, and the Catholic Stone Church. It combines interpretation of historical cartography, reported Google Earth Pro measurements, and a cultural reading of mountain–water landscapes. The supplied architectural azimuths are 81.64° for Ponagar, 123.92° for the Buddha statue, and 348.04° for the church. Treating the orientations as undirected lines yields an intersection triangle with interior angles of 93.60°, 44.12°, and 42.28°. Its reported sides of 1,986 m, 1,919 m, and 2,846.9 m are internally consistent with those angles and describe an approximately right, approximately isosceles configuration. These calculations establish geometric consistency, but not intentional coordination, intervisibility, statistical exceptionality, or a causal mechanism of topographical determinism. The spatial interpretation suggests that elevated sites, estuarine settings, religious practices, and successive building interventions contributed jointly to the prominence of the selected monuments. Shan Shui is used as an interpretive vocabulary for mountain–water relationships rather than as a measurable physical force. The findings support examining religious heritage beyond individual property boundaries, with attention to hill profiles, public viewpoints, and historically meaningful landscape relationships. Historical map identification, georeferencing error, axis-selection uncertainty, and the chronology of the current structures remain important limitations. Conservation recommendations therefore concern the assessment of potential view corridors and cumulative development effects, rather than assuming that the projected triangle is already a verified historical or visual network.

Keywords: urban morphology; topographical influence; GIS spatial analysis; Shan Shui; religious heritage; cultural landscape

1. INTRODUCTION

Nha Trang is a coastal urban area in Khánh Hòa, south-central Vietnam, whose religious landmarks occupy a landscape of hills, rivers, and coastal plains. The study area is shown in Figure 1. Its geographical setting provides opportunities for maritime exchange, settlement, and the establishment of prominent architectural sites, but geography alone does not explain the timing or form of urban development. General urban history offers a useful perspective on the interaction of environment, institutions, and built form [1]. The city's monuments can also be understood as persistent elements through which different historical periods remain legible within a changing urban fabric [2]. These theoretical works provide concepts for interpretation; they are not documentary sources for particular events in Nha Trang's history.

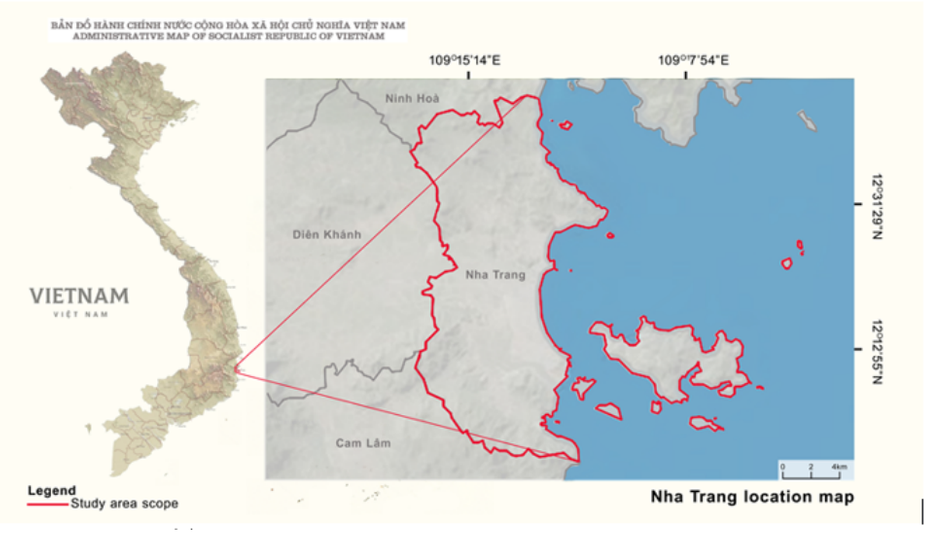


Figure 1. Location and reported extent of the Nha Trang study area.

The mapped extent defines the context for this case study; it is not a sampling frame demonstrating that every religious site within the urban area was considered.

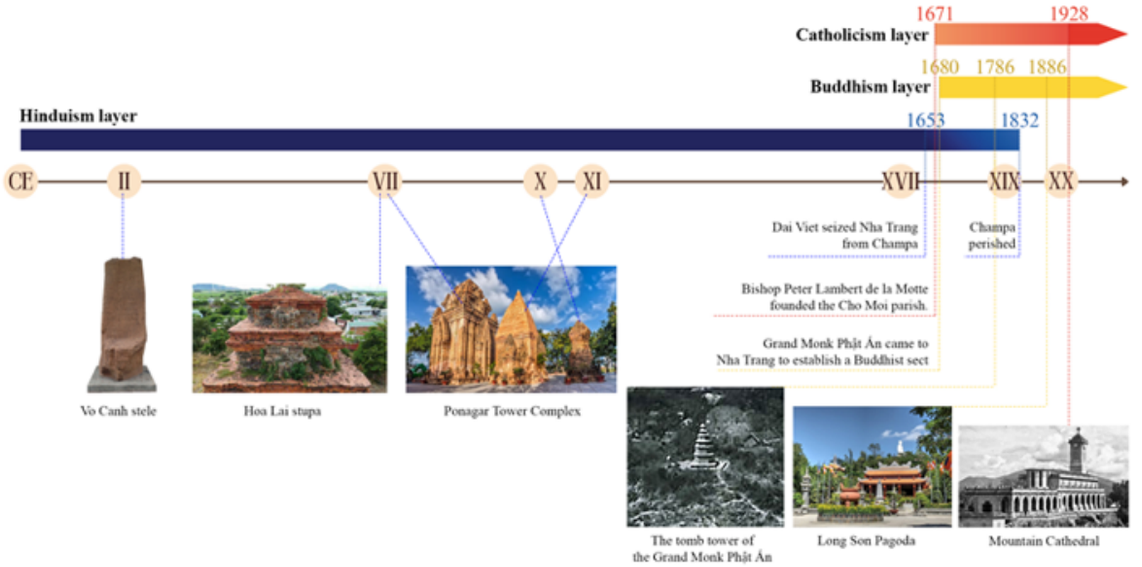


Figure 2. Comparative chronology of the religious traditions and monuments selected for the Nha Trang analysis.

The chronology distinguishes institutional histories, but the orientation used in the calculation must be dated to the particular surviving building or statue, not simply to the beginning of its religious tradition.

The historical sequence presented in Figure 2 distinguishes three religious traditions represented by the selected sites. Ponagar is a Cham sanctuary associated with Hindu religious traditions and continuing local worship; Long Son is a Buddhist complex founded in the nineteenth century; and the Stone Church represents a substantial Catholic building intervention initiated in the twentieth century. Their different histories make

them suitable for a comparative study of siting and orientation, although they do not exhaust Nha Trang's religious diversity. Official heritage documentation dates the Ponagar complex broadly to the eighth through thirteenth centuries [3]. The three sites occupy elevated ground or hillsides, providing a shared morphological characteristic that can be investigated without assuming a common religious doctrine or a coordinated urban design.



Master plan of Ponagar Tower complex in 1909 (*H. Parmentier, 1909*)



Master plan of Ponagar Tower complex in 2023



View 1 perspective which show the current state of 4 Kalans



View 2 perspective which show the Great Hall columns (10) and the Gate Kalan (11)

Legends:

1 - Gate Kalan
2 - Great Hall columns
3 - South West Kalan
4 - Main Kalan Entrance hall
5 - Main Kalan
6 - East Kalan
7 - Small East Kalan
8 - South West Kalan
9 - Relic Vault (completely disappeared)
10 - South Kalan (completely disappeared)
11 - South East Kalan (completely disappeared)

Figure 3. Historical plan and recent views of the Ponagar complex. The plan is attributed to Parmentier [5]; the supplied photographic credit identifies Makarenko Sasha.

Ponagar occupies Cu Lao Hill near the Cai River estuary. Its position brings a monumental complex into relation with river movement, coastal access, and the surrounding settlement. Scholarship on Cham towers provides an appropriate basis for discussing the architectural and historical significance of the sanctuary [4].

The eastward orientation of its principal tower is relevant to the present comparison, but an architectural direction should not automatically be equated with a precisely dated solar alignment or a documented intention to connect with another monument. Establishing such claims would require building-specific evidence and a distinction between successive construction phases. The historical plans and recent views assembled in Figure 3 allow the arrangement of towers to be considered across different representations. Parmentier's descriptive inventory is a direct source for early twentieth-century documentation of Cham monuments [5]. It supports historical architectural comparison, while changes in surveying practice, restoration, and image perspective must be considered before asserting exact morphological continuity.

The comparison supports discussion of plan organization and architectural setting. Differences in date, scale, restoration, and camera perspective prevent direct inference of exact positional stability from these images alone.

Long Son Pagoda provides a contrasting relationship between religious architecture and terrain. According to the Government Committee for Religious Affairs, Thích Ngộ Chí established the pagoda on Trai Thuy Mountain in 1886 under the name Dang Long and moved it to the foot of the hill after a storm in 1900 [6]. This account corrects the suggestion that the original foundation occupied low ground. The relocation illustrates how religious institutions respond to environmental disturbance while remaining attached to a recognizable landscape setting. The main hall and associated buildings use the hillside as a spatial backdrop, while paths and stairs connect lower and upper parts of the complex. A mountain-backed arrangement is therefore visible as a relationship between buildings and terrain. Its interpretation as geomancy is a cultural reading that requires supporting historical testimony rather than an automatic consequence of the physical arrangement.



Figure 4. The Long Son complex in relation to Trai Thuy Hill, showing the lower buildings and the upper Buddha landmark.

The hilltop Buddha statue introduces a vertical landmark distinct from the lower main hall. Its position gives it a prominent role in representations of the urban skyline and in the experience of visitors ascending the complex. Official tourism information describes the white Buddha as approximately 24 m high, although publications may differ in whether their dimensions include the pedestal [7]. The source manuscript reports a hill elevation of 38.4 m; the vertical datum and survey supporting that value were not supplied. Figure 4 illustrates the relationship between the hillside complex and the statue. The reported orientation of the statue is east-southeastward, rather than directly eastward. Lynch's analysis of urban imageability helps explain how a recognizable landmark may contribute to orientation and collective perception [8]. It does not establish that the statue is visible from every part of the basin or that its gaze creates an unobstructed corridor to the sea.

The illustrated arrangement separates the lower institutional complex from the hilltop landmark. This distinction matters because the analysis uses the statue direction rather than an independently measured main-hall axis.

The Catholic Stone Church adds another historical layer to the same urban landscape. The building is asso-

ciated with Louis Vallet and with construction beginning on September 3, 1928. Local tourism documentation places the church on a small rocky rise known as Bong Mountain and describes substantial excavation to prepare the site [9]. The source manuscript associates the principal construction phase with 1928–1933, but the dates of consecration, later completion, and associated works should be distinguished when interpreting historical images. Earlier Catholic communities are relevant to regional religious history, yet their existence does not imply that the present church orientation was established before the building itself. The church is considered here as a prominent urban monument shaped by both construction decisions and the opportunities provided by an elevated site, rather than as evidence that every religious tradition must occupy a particular kind of hill.

The extent of earthmoving at the church site differs from the architectural adaptations described for Ponagar and Long Son. The tourism account reports that approximately 500 explosive charges were used to create a building platform [9]. This is a documentary claim about site preparation, not a quantity independently verified through excavation records in the present study. Such intervention complicates a simple opposition between architecture that follows nature and architecture that dominates it: a modified hill remains both a terrain feature and a constructed setting. The church's reported axis, 348.04° from true north, is approximately north-northwest–south-southeast. Christian liturgical traditions provide relevant comparative context, but eastward orientation is not a universal rule whose apparent departure proves topographical necessity. The layout in Figure 5 suggests a relationship among the church, its narrow site, and adjacent public space. Demonstrating the reasons for that layout would require plans, correspondence, or other evidence of the designers' decisions.

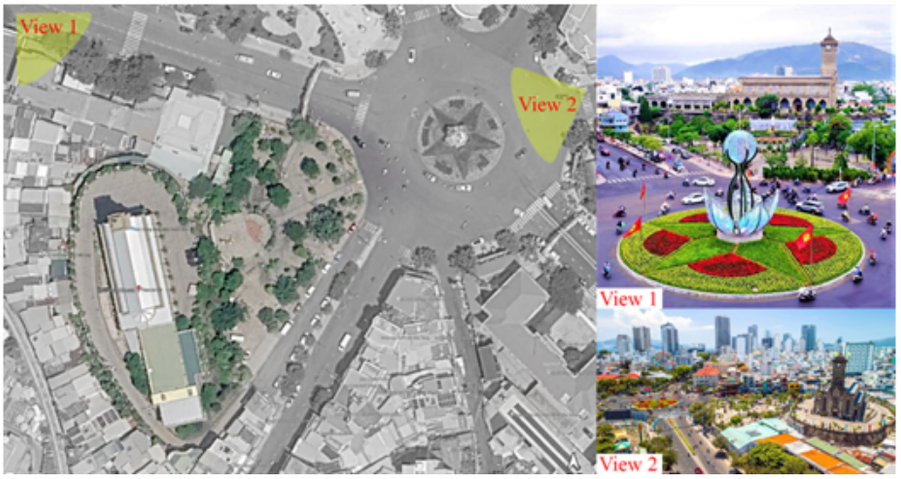


Figure 5. The Stone Church, its prepared hilltop site, and adjacent urban space.

The site relationship provides a basis for considering terrain and urban access together. It does not establish which factor was decisive in the design process without associated historical documentation.

Together, the three complexes illustrate different ways of occupying and modifying elevated terrain. Ponagar relates a tower sanctuary to an estuarine hill; Long Son links a hillside institution with a prominent upper landmark; and the church combines a prepared platform with a strong architectural profile. These observations support comparing the sites within one landscape, while preserving differences in chronology, ritual use, construction technique, and patronage. They do not show that the three traditions were unconsciously directed by a single natural mechanism. The useful analytical question is whether the present orientations and topographical settings form a coherent spatial configuration and, if so, what that configuration can reasonably contribute to landscape interpretation. The concept of a religious triad is therefore used as a selection and comparison device, not as a claim that these monuments constitute an exclusive or universally recognized religious system.

Urban morphology supplies several complementary approaches to this problem. Conzen's town-plan analysis examines the historical relationships among streets, plots, and building fabric [10]; Whitehand explains the development and application of that tradition [11]. Kostof's comparative urban history broadens attention to the interaction of urban patterns, institutions, and landscape [12]. Building typology and spatial configuration add further perspectives through the work of Caniggia and Maffei and of Hillier and Hanson [13, 14]. These approaches address different analytical scales and should not be treated as interchangeable methods. Moudon's account of urban morphology as an interdisciplinary field and Oliveira's synthesis provide a basis for combining historical description with analysis of physical form [15, 16]. In the present study, the common concern is the relationship between individual monuments and their wider urban setting, rather than the application of a complete town-plan or space-syntax analysis.

GIS expands the possibilities for locating heritage sites, comparing historical representations, and measuring spatial relationships. A review by Liu and colleagues documents the breadth of GIS applications in cultural heritage conservation [17]. Historical map analysis nevertheless requires critical assessment of map content, scale, distortion, and positional reliability. Jenny and Hurni show why extracting information from old maps involves evaluating geometric accuracy rather than assuming that a georeferenced image is metrically reliable [18]. These publications replace the incomplete and unverified author–year citations in the supplied manuscript. They support the general methodological rationale without demonstrating that a particular workflow was implemented for Nha Trang. The present comparison draws on the authors' reported orientations and image assemblages, while explicitly identifying the information needed to reproduce the historical overlay and its measurement accuracy.

For Ponagar, the relevant literature includes architectural inventories and studies of Cham religious monuments. Such works establish historical and typological context, but they should not be criticized for failing to answer a research question they did not pose. The present study uses their documentation to connect the sanctuary's site and orientation with a wider urban comparison. It does not claim that all previous scholarship has treated Cu Lao Hill in isolation, nor that no earlier map has represented several religious monuments together. A defensible contribution lies in making the selected axes and their geometric interpretation explicit, so that the resulting proposition can be checked and compared with alternative explanations. This is a narrower and more testable aim than asserting that the study has discovered an entirely unprecedented sacred configuration.

For Long Son, the distinction between the pagoda institution, the main hall, and the hilltop statue is especially important. They form a connected complex but are not identical analytical objects. The foundation date of a pagoda cannot automatically date the orientation of a later statue, and a hilltop viewpoint should not be substituted for the orientation of the main hall without explanation. This study selects the statue because it is the most prominent upper landmark in the supplied spatial model. That selection is legitimate for a comparison of landmark orientations, but it limits claims about the historical geometry of the entire Buddhist complex. Future archival and field investigation should establish the statue's construction chronology and the stability of its position before using the present axis to reconstruct earlier urban relationships.

For the Stone Church, architectural form, liturgical organization, colonial administration, and site engineering all potentially bear on orientation. Describing the building solely as Gothic Revival would leave some of these relationships unexplored, but asserting that scholarship has never considered them would require a documented literature search. Here, the church is analyzed as an elongated building on modified high ground, using the orientation reported in the source manuscript. Its association with terrain is treated as a plausible morphological interpretation rather than a demonstrated rejection of liturgical practice. Comparable care is needed with terminology: "Stone Church" is retained as an established local name, without assuming that every part of the structure is built from dressed stone or that the name describes a uniform construction system.

The research question is therefore: what spatial relationship emerges when the reported axes of these three selected religious landmarks are represented together, and how far can that relationship support an interpretation of topographical influence? The analysis separates three tasks. First, it describes the sites and their landscape settings. Second, it evaluates the angular geometry implied by the reported orientations and checks its consistency with the stated side lengths. Third, it considers implications for cultural landscape conservation. This sequence prevents a geometric observation from being mistaken for evidence of a shared intention or a universal law of religious siting. Topographical determinism remains a proposition to be examined critically, while the observed arrangement is interpreted within a broader account of cultural choice, environmental opportunity, and historical change.

Two conceptual perspectives organize the interpretation: mountain–water landscape traditions and the study of emergent urban relationships. Neither perspective replaces historical evidence or measured topography. Mountain–water imagery helps articulate culturally meaningful relationships among hills, rivers, settlement, and ritual places. An emergent configuration, by contrast, describes an arrangement arising from components whose combination need not have been designed as a whole. These perspectives can coexist, but a visually appealing pattern is not sufficient evidence that it emerged through one specific process. The study accordingly distinguishes an interpretive vocabulary, the measurements used to construct the spatial diagram, and the causal explanations that remain open to further investigation.

Shan Shui, literally mountain and water, is used here to describe relationships among elevated landforms and water bodies within a culturally interpreted landscape. It is related to, but should not be collapsed into, every practice described as feng shui. Bruun's historical and sociological treatment of feng shui provides an appropriate reference for understanding these traditions as situated systems of meaning [19]. Terms such as qi, auspicious node, and guardian animal belong to that interpretive register. They are not treated as physical

forces measured by GIS. The local descriptions of "four waters returning" and "four sacred beasts gathering" are considered through Quách Tấn's regional account, Xứ trầm hương, originally published in 1969 [20]. A cultural reading may identify meaningful forms in terrain without establishing a closed hydrological circuit or a measurable concentration of spiritual energy.

Emergence provides a second perspective on how separately developed sites may acquire a recognizable relationship at a later date. Batty's account of cities as networks and interacting systems encourages attention to relationships rather than isolated objects [21]. However, an emergent arrangement is not necessarily unplanned in every component: each monument may result from deliberate choices even when their combined geometry was not coordinated. Likewise, topography can constrain access, construction, drainage, and visibility without uniquely determining a building's position or direction. The term topographical influence is therefore preferable when discussing the evidence, while determinism is reserved for the stronger hypothesis considered in the title. The study tests internal spatial consistency, not the exclusivity of an environmental cause.

The analysis considers the hills of Cu Lao, Trai Thuy, and Bong as potential spatial anchors within the coastal plain. Their elevation and distinctiveness may have offered practical and symbolic advantages to different institutions. Yet the distribution of alternative hills, patterns of land ownership, routes of access, political authority, and opportunities for construction also matter. Without comparing selected and unselected sites, it is not possible to determine whether these three locations were inevitable choices or simply three historically successful choices among several possibilities. The framework therefore retains the explanatory value of landscape while avoiding the assumption that mountains and water independently directed human decisions across different centuries.

The contribution of this paper is a transparent comparison of the three reported axes and a critical interpretation of their approximate triangular relationship. The analysis asks whether this representation adds useful information to the understanding of religious landmarks as a shared cultural landscape. It does not equate the geometric triangle with religious syncretism in doctrine, ritual, or institutional life. Spatial co-presence and overlapping visual settings can coexist with distinct religious identities. Conversely, communities may recognize important relationships not captured by an axis diagram. The proposed religious triad should therefore be understood as one analytical representation of the city, open to correction through field observation, archival research, and the perspectives of people who use and maintain the sites.

The remainder of the paper first defines the spatial terms, sources, and measurement conventions. It then describes the landforms and architectural orientations used in the comparison, before examining the resulting geometry. A separate discussion considers alternative explanations, uncertainty, and conservation implications. The conclusion answers the research question at the level supported by the supplied evidence and identifies the additional documentation needed for historical and visibility-based validation.

2. METHODS: SPATIAL INTERPRETATION AND ARCHITECTURAL AXES

2.1. TERMINOLOGY AND CULTURAL INTERPRETATION

The terminology distinguishes physical observations from cultural interpretations. A hill, river, building centerline, or orientation can be represented geometrically, whereas a sacred animal, auspicious position, or spiritual association requires interpretation through texts, images, and social practice. These categories should inform one another without being treated as equivalent measurements. The study does not claim that relabeling a geomantic concept makes it an objectively verified ecological variable, and it does not assign the status of traditional ecological knowledge without documentation of a specific knowledge community and its practices.

Mountain–water relationship refers to the arrangement of elevated terrain, rivers, and coastal water in the setting of a religious landmark. It supplies a landscape context for describing site selection, access, backdrop, and openness. It does not imply that terrain dictates a single possible urban form. Physical evaluation would require elevation data and hydrological mapping, while cultural evaluation requires evidence of how the relationship has been understood by particular communities.

Architectural axis refers to an orientation attributed to a building or landmark, represented as a horizontal line through a specified reference point. For Ponagar and the church, the relevant object is a principal building orientation; for Long Son, it is the facing direction of the hilltop Buddha. A projected axis is not automatically a view corridor. A corridor requires identified observers, targets, and intervening terrain or buildings. This distinction is maintained throughout the geometric analysis.

Topographical anchor denotes an elevated or otherwise distinctive site that contributes to the monument's setting. The term is descriptive and does not assert that the site optimizes stability or visual dominance without comparative evidence. The traditional term auspicious node is retained only when discussing a cultural

attribution. Similarly, the study's use of religious triad identifies three selected landmarks, rather than a pre-existing administrative classification, a complete inventory of religious sites, or a proven shared sacred system.

These definitions support comparison while preserving differences between interpretive and metric evidence. Geometric consistency can be assessed from numerical orientations and lengths. Historical intention requires documentary evidence; intervisibility requires observation or a three-dimensional analysis; and community significance requires engagement with relevant people and institutions. No one form of evidence can substitute for all the others. The present method combines the available sources while identifying these boundaries explicitly.

2.2. GIS SOURCES AND HISTORICAL CARTOGRAPHIC COMPARISON

The source study reports the use of Google Earth Pro to locate the three monuments and measure their orientations [22]. It also presents a comparison of map images labeled 1933, 1968, and 2026. The supplied text does not identify the imagery acquisition dates, coordinate reference system, control points, transformation method, or residual errors for the historical overlay. These omissions limit reproducibility and prevent treating a visual overlay as a demonstrated high-accuracy reconstruction. The year of access to a platform should be distinguished from the acquisition year of the imagery displayed within it. Similarly, the version of Google Earth Pro describes software, not the provenance or positional accuracy of every image used in the project.

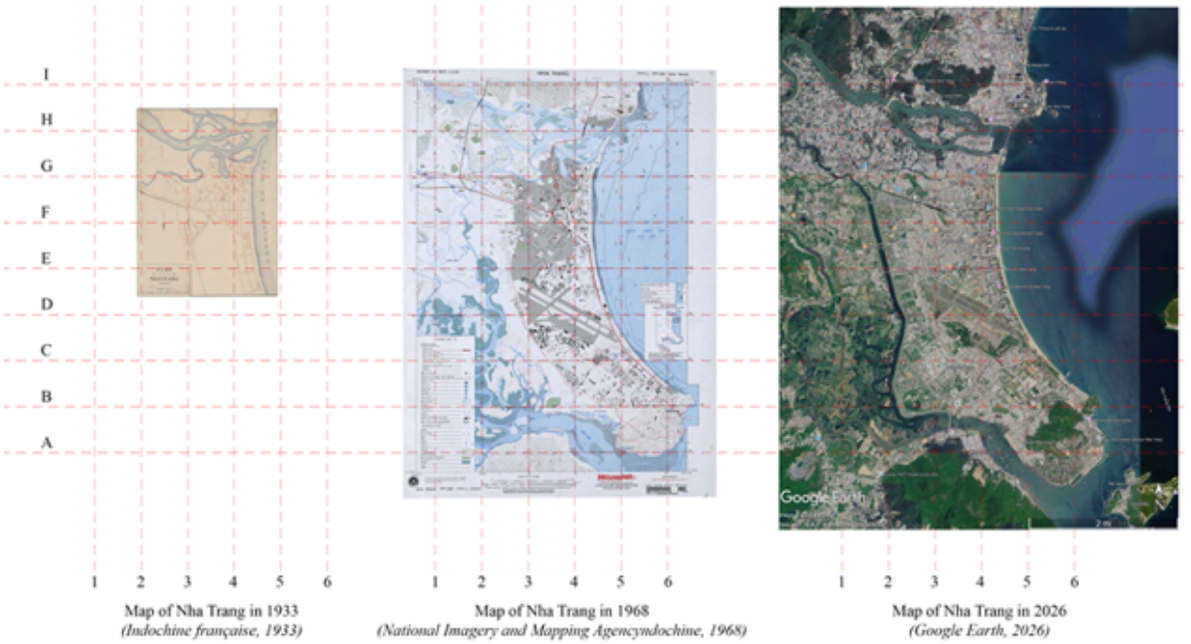


Figure 6. Historical and recent map images labeled 1933, 1968, and 2026 in the supplied material. The original sheet identities, image acquisition dates, and registration accuracy require confirmation.

The map comparison should be treated qualitatively until the source sheets and registration procedure are documented. No residual-error statistic or independent accuracy test accompanies the supplied assemblage.

The cartographic assemblage in Figure 6 provides a visual comparison of urban change and the continuing prominence of selected landforms. It cannot, by itself, demonstrate that hill boundaries or monument coordinates remained perfectly unchanged. The original bibliography identified maps of Huế, which cannot support a local reconstruction of Nha Trang and have been removed. A catalogued 1968 Nha Trang map at 1:12,500 offers a relevant archival reference [23], but identifying a suitable map is not evidence that it is the exact sheet reproduced in the supplied figure. The precise source of the image labeled 1933 and the edition of the historical sheet used must be confirmed. Until then, the overlay supports qualitative interpretation, while historical positional accuracy remains unquantified.

2.3. MOUNTAIN–WATER INTERPRETATION OF THE WIDER LANDSCAPE

The regional landscape is interpreted through the expression "four waters returning, four sacred beasts gathering" associated with local geomantic description [20]. The Cai River to the north, the Quan Truong system to the south, and the coast to the east provide the principal water-related features considered in the supplied diagram. Figure 7 represents their arrangement within the study's mountain–water reading. Cửa Lớn and Cửa Bé should not both be translated as "Grand Gate": their names distinguish a large and a small opening.

Their exact drainage connections should be established from a hydrological source rather than inferred from symbolic language. The figure is consequently interpreted as a cultural and spatial diagram, not as verification of a closed circulating water network. Claims about underground rivers or continuous north–south hydraulic connections are excluded because supporting survey evidence was not supplied.

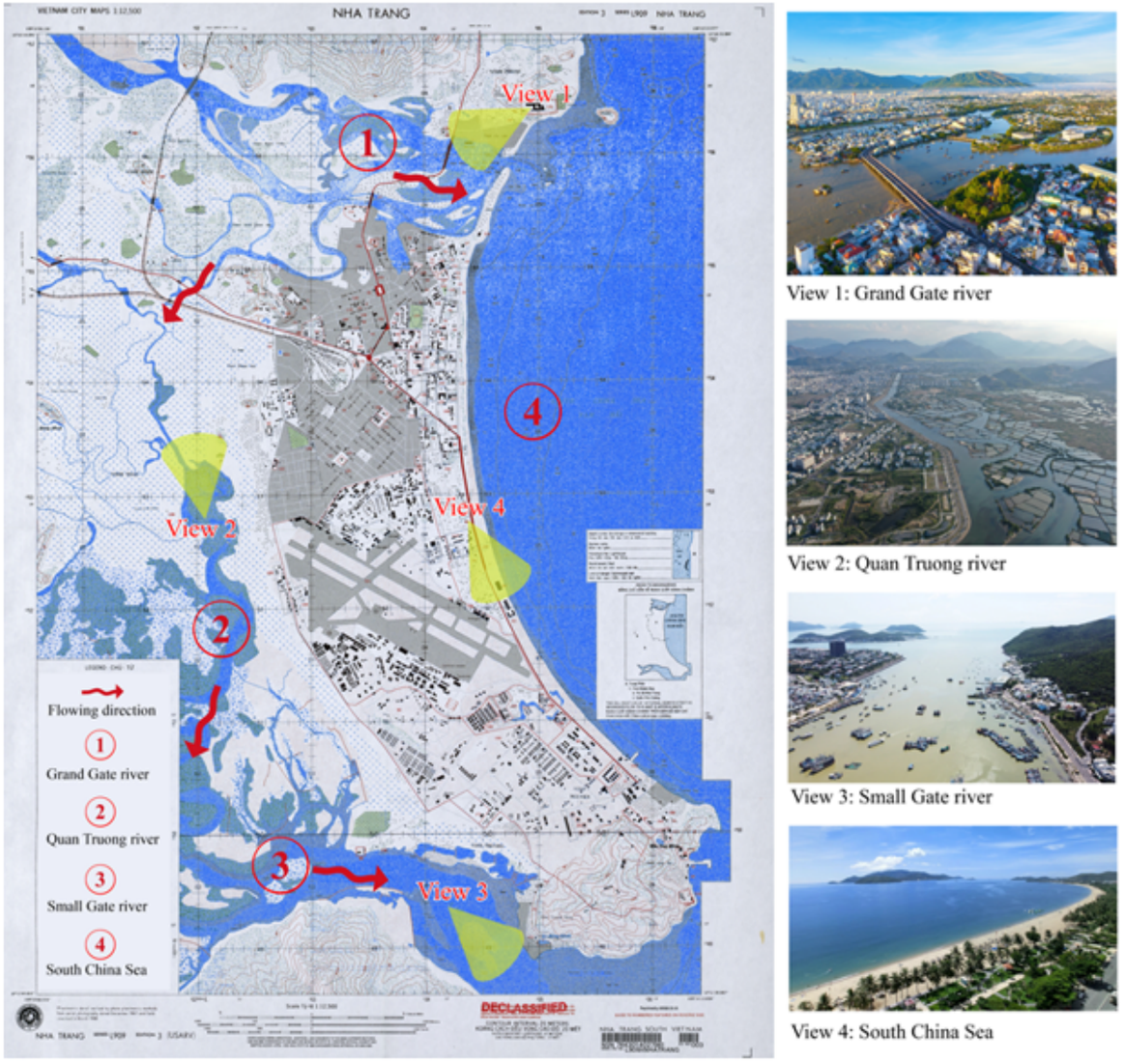


Figure 7. Interpretive diagram of river and coastal relationships associated with the mountain–water reading of Nha Trang.

The diagram conveys a mountain–water interpretation. Its symbolic coherence does not verify a closed hydraulic circuit, underground connectivity, or a measured flow of spiritual energy.

Within the geomantic interpretation, water and elevated terrain are associated with gathering, protection, and continuity. These meanings help explain why particular landforms may become prominent in local accounts of place. The four animal images discussed in the source manuscript are associated with Trai Thuy, Hoa Son, Canh Long, and Sinh Trung. The expression "sacred beasts" is retained as a translation of this cultural classification rather than as an empirical category of landforms. The analysis does not assume that qi is a physical field generated by river circulation. Instead, it examines how a symbolic vocabulary links recognizable hills with religious institutions, remembered landscapes, and narratives of environmental transformation.

Trai Thuy Hill is represented by the reference coordinate 12°15′07″ N, 109°10′51″ E. In the source interpretation, its outline evokes an auspicious bat associated with a jade ring. The comparison in Figure 8 places this symbolic image beside a satellite representation of the hill. The analogy is useful as evidence of a way of reading landscape shape, but its cultural circulation and historical date require documentation. The hill also contains several Buddhist institutions, making it important to distinguish the broader religious concentration from the specific hilltop statue selected for the triangular analysis. A shared hill does not imply that every institution on it has the same orientation or contributes equally to the proposed geometric relationship.



Figure 8. Satellite representation of Trai Thuy Hill alongside imagery used to communicate the auspicious-bat landscape analogy.

The visual analogy depends on an interpreted outline and viewing direction. Its historical significance should be established through regional documentation and community knowledge rather than resemblance alone.

Hoa Son is discussed in the manuscript as a historically connected rocky landform later separated by urban works into the features associated with the church site and neighboring high ground. The church reference coordinate is 12°14′48″ N, 109°11′16″ E. The local interpretation compares the former landform with a tortoise and associates it with a Buddhist stupa, producing the image of a golden tortoise bearing a tower. Figure 9 assembles these elements as a historical landscape narrative. The detailed account supplied for the monk Phật Ấn, including an asserted lifespan, lunar date, dynastic year, and subsequent relic rites, contains chronological questions that cannot be resolved from the available references. Rather than present those details as established facts, the present text retains the landscape association and identifies the need for a monastery record, inscription, or independently documented chronology. The existence of a meaningful local narrative remains distinct from verification of every event attributed to it.

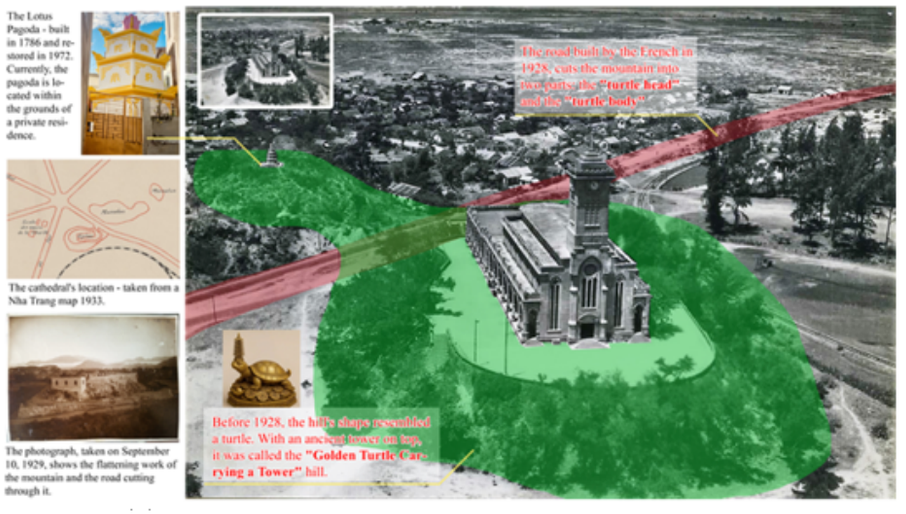


Figure 9. Interpretive assemblage of Hoa Son Hill, the stupa narrative, the church, and reported changes to the landform.

The division and preparation of the hill illustrate how an urban landscape may be transformed while retaining symbolic associations. Roads, excavation, building platforms, and new construction can alter a landform's outline and the relationship between its parts. In geomantic language, such alteration may be described as disruption of a guardian form; in morphological analysis, it concerns changes to terrain, circulation, and the setting of existing structures. These are different descriptions of the same place and should not be confused with a measured loss of spiritual energy. Nor should colonial intervention be reduced to an unqualified cultural opposition between a

destructive West and a harmonious East. Different actors modified terrain for particular objectives, and those decisions require historical explanation. The church's present position remains related to the hill, but that relationship alone does not demonstrate that its final axis was topographically inevitable.

The juxtaposition identifies a landscape narrative potentially relevant to conservation. The sequence and dates of individual terrain changes still require archival corroboration.

Canh Long is represented in the supplied account by the coordinate 12°12′16″ N, 109°12′33″ E and the image of an azure dragon playing with water. Its projecting coastal ridge provides a recognizable basis for this analogy. Figure 10 juxtaposes photographs with an AI-generated interpretive illustration. The synthetic illustration is used only to communicate the metaphor; it is not a topographic survey, historical reconstruction, or independent record of the site's original form. The source describes administrative, research, and recreational uses around this coastal landform. Those functions provide context for its cultural landscape importance, but the present analysis does not establish the historical boundaries of such uses. Canh Long is excluded from the three-axis calculation because no corresponding religious landmark axis was defined, not because its landscape significance is necessarily less important than that of the selected sites.



Figure 10. Canh Long coastal terrain and an AI-generated illustration of the azure-dragon analogy. The synthetic image is interpretive rather than survey evidence.

The photographic setting and synthetic analogy play different evidential roles. Only the former can document visible conditions at the time of capture, subject to its own date and provenance.

Sinh Trung Hill, represented by 12°15′22″ N, 109°11′21″ E, is interpreted through the image of a white elephant associated with an adjacent water body. The manuscript calls this configuration "the white elephant rolling up the lake." Figure 11 presents the hill and historical landscape material used in that interpretation. As with the other animal images, resemblance depends on a chosen viewpoint and on the cultural account through which the shape is read. The elephant's religious associations may be relevant to regional interpretation, but they

do not establish a unique function for this hill within either Hindu or Buddhist practice. The present discussion therefore treats the image as a locally attributed landscape analogy whose historical sources, terminology, and continuing recognition should be documented separately from the geometric calculations.

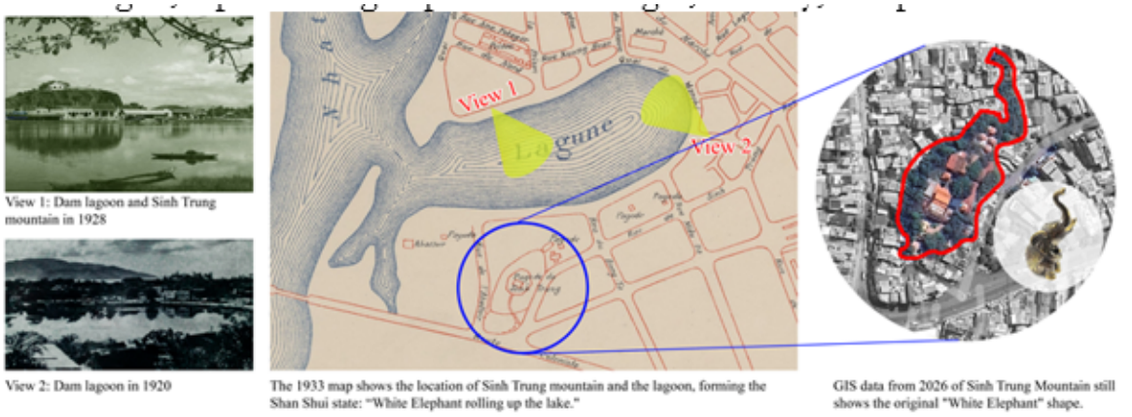


Figure 11. Sinh Trung Hill and lagoon-related historical material used to illustrate the white-elephant landscape analogy.



Figure 12. Historical and recent views of the lagoon and market setting. The date and provenance of the older aerial material require confirmation; the supplied credit identifies Vietnamnomad for View 1.

The historical and recent views assembled in Figure 12 suggest substantial transformation around the lagoon and present market area. They provide a reason to investigate the relationship between water infilling, urban expansion, and changing views of Sinh Trung Hill. However, the claim that a supplied image is an aerial photograph taken before 1900 requires authentication of its date, author, and photographic process. The available collage does not justify that date on its own, and no specific pre-1900 aerial record is cited. The images should instead be read as a historical–contemporary comparison with incomplete provenance. Sinh

Trung contains a religious site but is not included in the selected triad. That exclusion limits the geometric model: it does not show that the hill lacks importance, only that no fourth architectural axis was analyzed in the supplied calculation.

The combined materials suggest a relationship between elevated ground and a remembered water setting. They do not establish the extent or timing of lagoon alteration without additional records.

The images motivate investigation of landscape transformation but do not independently authenticate the older photograph or quantify the land area affected by infilling.

The wider landscape discussion identifies several hills and water-related features that could matter to a cultural reading of Nha Trang. It also demonstrates why the selected triad should not be mistaken for a complete explanatory map of the city. Hills outside the calculation, altered lagoons, religious institutions on shared terrain, and roads cutting through former landforms all complicate the idea of a fixed original configuration. Geomantic imagery offers a vocabulary for discussing these relationships, whereas a physical explanation requires independently documented terrain and historical processes. The transition to axis analysis therefore narrows the question deliberately: it examines the numerical geometry implied by three reported orientations, without presuming that every aspect of the wider landscape converges on the same triangle.

2.4. REFERENCE POINTS AND REPORTED ARCHITECTURAL AXES

The three reference positions are shown in Figure 13. They correspond to the principal tower at Ponagar, the hilltop Buddha at Long Son, and the church's sanctuary area. The coordinates supplied in the source manuscript are rounded to whole arcseconds and do not constitute independently surveyed control points. Moreover, an apparent highest point in a photograph may not coincide horizontally with the point used to digitize an architectural centerline. The following coordinates identify the intended analytical objects; they should be accompanied by GIS point files and a description of their measurement before they are treated as reproducible survey positions.



Figure 13. Reference features associated with the three reported monument coordinates.

The reference point for Ponagar is reported as 12°15′54″ N, 109°11′43″ E, associated with the principal Kalan tower. The analysis attributes an architectural azimuth to this tower rather than treating every structure within the complex as having an identical centerline. A documented digitization procedure should identify the endpoints used to define its direction and distinguish the principal tower from neighboring buildings or restored elements.

The reference point for Long Son is reported as 12°15′07″ N, 109°10′51″ E, associated with the hilltop Buddha. This selection makes the comparison one of landmark-facing directions rather than a uniform comparison of temple buildings. It is retained because it is the object used in the source calculation, while recognizing that an alternative axis through the lower main hall would answer a different spatial question.

The reference point for the church is reported as 12°14′48″ N, 109°11′16″ E, associated with the sanctuary area. Ancillary buildings and residential quarters are excluded from the intended main axis. The supplied wording also refers to a vault apex, making it important to clarify whether the selected point is a ground-plan position, a roof feature, or a photographic landmark. Its final GIS definition should use one consistent horizontal

reference.

Each reference feature must be translated into a consistent horizontal GIS point before line intersections are calculated. The apparent top of a structure in a photograph is not sufficient to define that operation.

2.4.1 Ponagar tower orientation

The principal Ponagar tower has a reported azimuth of 81.64° clockwise from true north. This is 8.36° north of due east, so it should be described as broadly eastward rather than exactly aligned with the east–west cardinal axis. Figure 14 illustrates the orientation attributed to the tower. Its relationship to entrance form and ritual organization is relevant to Cham architectural interpretation [4], but any claim of alignment with a specific sunrise requires a date, horizon profile, and solar calculation. In the present geometry, the numerical azimuth defines a horizontal line through the supplied reference point. It does not establish the full extent of a sacred route, an uninterrupted sea view, or a historically documented connection to the other selected landmarks.

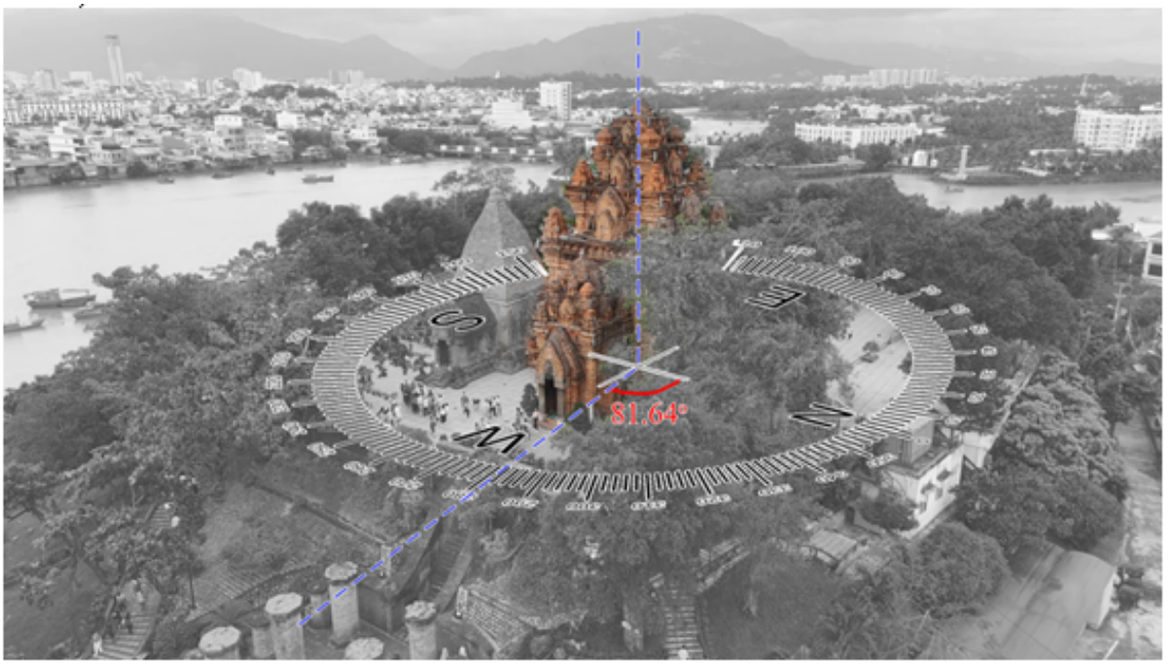


Figure 14. Reported orientation of the principal Ponagar tower, with an azimuth of 81.64° from true north.

The stated value is close to, but distinct from, due east. Two decimal places describe the reported number and should not be interpreted as a demonstrated measurement precision.

2.4.2 Hilltop Buddha orientation

The hilltop Buddha's facing direction is reported as 123.92° clockwise from true north, approximately east-southeast. Figure 15 shows the orientation represented in the source illustration. The direction is associated with the statue's frontal presentation rather than with a surveyed ray originating from its eyes. Its elevated position plausibly contributes to broad views and urban prominence, but the exact field of view cannot be established from the azimuth alone. Terms such as mountain-backed or water-facing are used descriptively when supported by the setting; they should not be converted into evidence of an intended citywide spiritual projection without additional testimony or design documentation.

The facing direction defines one orientation for comparison. It does not delimit a visible corridor or demonstrate that a distant target can be seen from the statue.

2.4.3 Stone Church orientation

The church has a reported azimuth of 348.04° clockwise from true north. For an undirected building axis, this is equivalent to 168.04° in the opposite direction. Figure 16 represents this axis relative to the north reference. The orientation can be discussed in relation to the elongated prepared site, but the numerical fit alone does not demonstrate that terrain forced the designers to abandon a universal liturgical rule. Both ends of an undirected line are used in the subsequent intersection geometry. A separate account would be needed to establish which

end represents the entrance, altar-facing movement, or a historically meaningful outward view.



Figure 15. Reported facing direction of the Long Son hilltop Buddha, with an azimuth of 123.92° from true north.

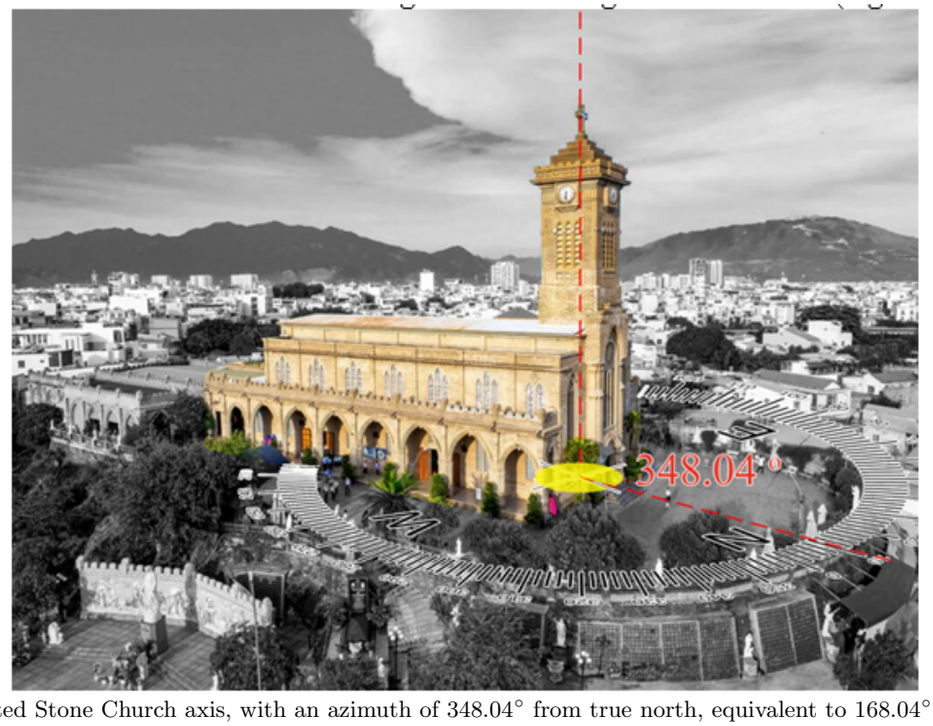


Figure 16. Reported Stone Church axis, with an azimuth of 348.04° from true north, equivalent to 168.04° as an undirected line.

Using an undirected axis permits intersection calculations in both directions. Historical interpretation of the church entrance or liturgical movement requires a directional convention stated separately.

2.5. GEOMETRIC CONSTRUCTION AND LIMITS OF THE CALCULATION

An architectural orientation can be represented by a straight line through a horizontal reference point. If (x_i, y_i) denotes that point in a suitable local metric coordinate system and θ_i is its azimuth clockwise from north, the associated line is

$$L_i(t) = \begin{pmatrix} x_i \\ y_i \end{pmatrix} + t \begin{pmatrix} \sin\theta_i \\ \cos\theta_i \end{pmatrix}, \qquad t \in \mathbb{R}. \tag{1}$$

Allowing both positive and negative t makes this an undirected line, not a ray restricted to the front of a building or statue. This convention explains why the church orientation of 348.04° may be replaced by 168.04° in the angular construction. Pairwise intersections define three analytical vertices when the lines are neither parallel nor concurrent. The triangle's angles depend on their relative directions, whereas its lengths depend on both the directions and the chosen reference positions. A reproducible GIS implementation should therefore archive the reference points, digitized axis endpoints, projection, and intersection coordinates together.

The formula clarifies the geometry of the supplied interpretation; it does not document an independently reconstructed GIS measurement. The available material contains rounded coordinates, final azimuths, and stated lengths, but no editable spatial layers or axis endpoints. Consequently, the present verification checks whether the angles and lengths agree with one another. It does not substitute a newly generated coordinate system for an undocumented original one or assert that the reported distances have been independently surveyed. This boundary is important because the apparent precision of the numbers exceeds the information provided about positional and directional uncertainty.

Whole-arcsecond coordinates also limit the resolution of reconstruction. At Nha Trang's latitude, an arcsecond represents a distance on the order of tens of meters, while two decimal places of azimuth imply a much finer directional specification. These different reporting resolutions are not necessarily incompatible if the original GIS retained higher precision, but that higher-precision dataset must be supplied to reproduce the calculation. The point chosen at a tower, statue, or sanctuary also matters: replacing it with another feature shifts a projected line even when its azimuth is unchanged. The study therefore treats the reported distances as author-supplied measurements and the geometric check as a separate analytical step.

An additional limitation concerns the distinction between a line on a map and a visible relationship in three-dimensional space. A planimetric line may pass through terrain, vegetation, or tall buildings. Establishing a view corridor would require an observer height, target height, terrain surface, building model, and an assessment of obstructions. A building's frontal direction may also differ from a visitor's principal approach or the direction from which the monument is most recognizable. No viewshed analysis or verified intervisibility test was supplied. The term projected axis is accordingly used for the numerical construction, while view corridor is reserved for a potential conservation subject requiring further assessment.

3. RESULTS: GEOMETRY OF THE SELECTED RELIGIOUS TRIAD

The spatial construction shown in Figure 17 uses intersections of projected architectural lines, rather than a triangle whose vertices are the monuments themselves. This distinction changes the meaning of the result: the intersection vertices are analytical points and need not correspond to buildings, historic public spaces, or observed meeting places. The calculation uses 81.64° for Ponagar, 123.92° for the Buddha, and the church's equivalent undirected orientation of 168.04°. Their angular differences define the shape of a potential triangle. The locations of its vertices and its scale additionally depend on the reference coordinates and projection used. Numerical agreement among angles therefore cannot independently validate the placement of those vertices on the map.

Using the stated line orientations, the interior angles are calculated as

$$\alpha = 180° - (168.04° - 81.64°) = 93.60°, \tag{2}$$

$$\beta = 168.04° - 123.92° = 44.12°, \tag{3}$$

$$\gamma = 123.92° - 81.64° = 42.28°. \tag{4}$$

The values sum to 180°. The source reports side lengths of 1,986 m, 1,919 m, and 2,846.9 m. Applying the cosine rule to those lengths gives approximately 44.125°, 42.279°, and 93.596°, respectively, which agree with the reported angular set after rounding. This is an internal numerical consistency check using supplied values, not an independent remeasurement of the map or the original GIS project.

The triangle is approximately isosceles because the two shorter sides differ by 67 m, or about 3.43% of their mean length. It is approximately right because its largest angle differs from 90° by 3.60°. These departures

should be stated explicitly rather than replaced by the exact geometric label "isosceles right triangle." Figure 17 communicates the proposed construction, but its visual persuasiveness is not a statistical test. No tolerance for approximate similarity was specified in advance, and no distribution of alternative site or axis combinations was examined. The result therefore establishes the reported shape while leaving open how unusual that shape is within Nha Trang's wider set of possible religious and topographical relationships.

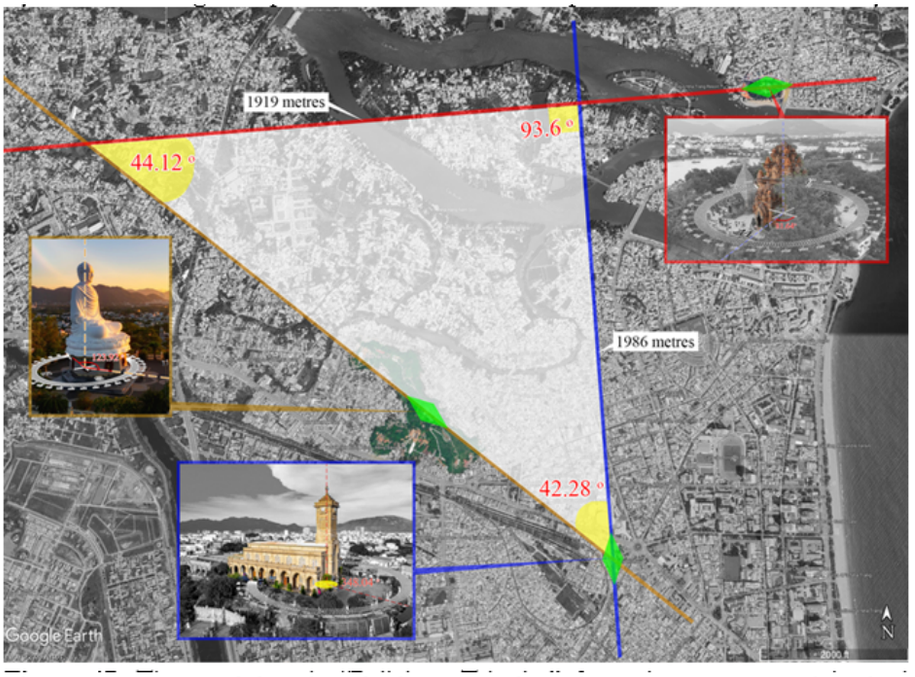


Figure 17. Projected-axis construction of the selected religious triad, producing an approximately right and approximately isosceles triangle.

The numerical construction identifies a shape among the selected lines. It does not establish that the intersection vertices were historical places or that the three monuments are mutually visible.

The different institutional histories of the monuments do not, by themselves, demonstrate the absence of all coordination or knowledge of earlier sites. Later builders could have known existing landmarks even without sharing their religious practices, while the present axes may reflect construction or alteration later than the foundation dates of the institutions. The source provides no documentary evidence of a common citywide plan, but absence of such evidence is not proof that every spatial relationship was unintentional. The defensible result is that a triangle can be constructed from the supplied contemporary orientations. Its historical emergence requires a chronology of the particular structures and directions used, rather than a comparison of religious origins alone.

The siting of all three landmarks on elevated or hillside ground is consistent with topography contributing to their prominence. Elevation can affect visibility, access, drainage, and the cost of construction, while also acquiring religious and political meaning. However, the supplied comparison does not isolate these mechanisms or show that terrain explains the exact azimuths. Architectural convention, available land, surrounding roads, patronage, and later redevelopment remain plausible contributors. The religious triad can therefore be interpreted as an interaction of landscape and human decisions. It is not a demonstrated physical manifestation of an inevitable geomorphological order, and the numerical triangle should not be used to attribute causal agency to metaphysical forces.

Within a Shan Shui interpretation, the three sites participate in a shared mountain–water setting despite their distinct religious traditions. This common setting can support a useful landscape narrative without implying that doctrine has been transcended or merged. A diagram of relationships among monuments is one way to represent the city; ritual routes, community attachments, seasonal festivals, and everyday patterns of access could produce other equally meaningful representations. The present geometric result is strongest when understood as a starting point for comparison rather than a complete statement of the city's spiritual identity.

Spatial coherence must also be distinguished from religious syncretism. Ponagar's continuing use, Buddhist institutions around Trai Thuy, and the Catholic congregation belong to specific histories and communities. Their landmarks can share views, urban space, and topographical settings without sharing theological commitments. Conversely, cultural interaction may occur through practices not visible in the three-axis model. The term

spatial syncretism is used cautiously to describe the coexistence of distinct architectural traditions within one interpreted landscape. It does not establish a fused religious system, an interfaith design intention, or a single community interpretation. These distinctions preserve the potential value of the geometric observation while avoiding conclusions that exceed the available historical and social evidence.

4. DISCUSSION AND CONSERVATION IMPLICATIONS

The interpretation synthesized in Figure 18 brings together the three elevated landmarks and their projected relationships. Its principal contribution is comparative: it encourages the sites to be considered within a wider cultural landscape rather than solely as independent architectural objects. The figure remains an interpretive synthesis, not a demonstration that topographical determinism caused the arrangement. The descriptive result and the explanatory proposition must remain separate. The reported orientations produce a numerically coherent approximate triangle; the reasons for those orientations, the historical timing of their coexistence, and their significance to different communities require additional forms of evidence.



Figure 18. Landscape interpretation of the three selected religious landmarks and their projected geometric relationship.

The synthesis connects geometry with cultural interpretation while retaining the distinction between a measured orientation and a proposed explanation of site selection.

A landscape approach to conservation is supported by established scholarship and international heritage guidance. Bandarin and van Oers discuss the management of historic urban landscapes, while Taylor and Lennon bring together approaches to cultural landscape management across different settings [24, 25]. The Venice Charter already recognizes the relationship between monuments and their settings [26], and the Xi'an Declaration addresses the conservation of heritage surroundings [27]. UNESCO's 2011 Recommendation includes topography, hydrology, built form, and visual relationships within the historic urban landscape [28]. These sources replace incomplete citations and correct the suggestion that earlier conservation principles addressed only isolated buildings. The present study adds a local spatial interpretation to that established concern; it does not inaugurate the idea that heritage significance extends beyond a monument's walls.

The recent views in Figure 19 show dense development around the selected landmarks and motivate closer assessment of their changing settings. New buildings can obscure hill profiles, interrupt familiar views, and alter the relationship between a monument and surrounding public space. Yet the supplied photographs do not measure the amount of obstruction or establish a citywide trend in ground elevation. Claims that lagoons and canals have been filled should be tied to dated maps, administrative records, or other site-specific evidence. The relevant conservation question is therefore how particular developments affect recognized heritage values and everyday experience. The numerical triangle may help frame potential relationships for investigation, but no line in the diagram should automatically be designated a protected corridor before visibility and cultural significance have been assessed.

The views indicate relevant development pressures at particular locations. A quantified assessment would

require dated images, building heights, and specified public viewpoints.

Future planning should consider maximum permissible building heights, setbacks, and development envelopes where evidence shows that these measures would protect significant landmark views or hill profiles. A requirement for minimum building height would not serve the stated conservation objective. Any proposed restriction should be based on identified viewpoints, terrain and building models, existing land uses, and the views of relevant communities and heritage managers. The aim is to assess cumulative effects on a living urban landscape rather than to freeze every part of the city around an inferred geometry. The present findings support further geomatics-based investigation and a broader discussion of religious heritage settings, while leaving the boundaries and legal form of any protection to a documented planning process.



Figure 19. Recent views illustrating the surrounding development context of the selected religious landmarks.

4.1. ALTERNATIVE EXPLANATIONS AND SELECTION EFFECTS

Three selected, nonparallel lines generally define a triangle. The existence of a triangular figure is therefore not, on its own, an unexpected discovery. What requires interpretation is the degree of similarity to a proposed ideal shape and the historical relevance of the chosen axes. The present configuration is close to, but not identical with, a right isosceles triangle. Without a predefined tolerance and a comparison set, the label approximate remains descriptive. Other combinations of monument points, entrance axes, statue directions, street alignments, or hill summits might produce different figures. A future comparative analysis should document why particular objects and orientations were selected before evaluating the apparent regularity of their intersection.

The comparison also combines different architectural objects. A tower entrance, a statue's facing direction, and a church centerline need not have been chosen through the same kind of decision. Treating them as equivalent axes is useful for one diagram, but creates a selection rule that should be stated openly. If the lower pagoda hall were used instead of the Buddha statue, or if an entrance approach replaced a building centerline, the geometric result might change. Such alternatives are not grounds for dismissing the present interpretation; they identify the sensitivity checks needed before claiming a robust citywide structure. No numerical results for these unperformed alternatives are asserted here.

The chronology presents a further explanatory question. The age of a religious tradition, the foundation of an institution, the construction of the surviving structure, and the establishment of its current orientation are four different dates. Only the last two directly establish when the current spatial arrangement could have existed. A historical reconstruction should identify these dates for each selected object and then compare them with changes in terrain and the surrounding street network. The present manuscript does not contain enough documentation to establish a complete sequence. Its geometric result therefore concerns the reported current arrangement, while its historical narrative remains a contextual interpretation that requires further source work.

4.2. EVIDENCE NEEDED FOR CONSERVATION ASSESSMENT

The cultural value of a landscape relationship need not depend on whether a geometric pattern is statistically rare. A familiar view, a ritual approach, or a hill profile can matter because people recognize and use it. Conversely, an unusual map pattern may have limited practical significance if it is invisible, historically undocumented, and unrecognized by the communities concerned. Conservation assessment should therefore combine spatial measurement with site histories, public experience, and the perspectives of the institutions responsible for each monument. The triad offers a focused topic for such work rather than a ready-made boundary for regulation.

The immediate priorities are documentary and spatial. Historical map sheets should be identified by title, edition, scale, repository, and catalogue reference. Current imagery should be recorded with provider attribution and acquisition date where available. Point and line layers should preserve the original measurement precision, and the method should distinguish true-north bearings from map-grid directions. Repeated digitization or independent measurements would help establish how stable the axis estimates are. These are requirements for a future reproducible assessment; they are not presented as procedures already completed in the source study.

The visual material also needs differentiated treatment. Historical plans, recent photographs, satellite images, annotated collages, and an AI-generated illustration cannot all serve as equivalent evidence. Plans may document an earlier arrangement, photographs may record a viewpoint at a particular moment, and synthetic imagery may explain a metaphor. Dates, authorship, transformations, and reproduction permissions should accompany each type where applicable. Retaining the supplied figures allows the argument to be followed, but does not authenticate every date or attribution embedded within the images. In particular, the older aerial material and the map labeled 1933 require source confirmation before they support a precise chronology of landscape change.

5. CONCLUSION

The reported architectural orientations at Ponagar, the Long Son hilltop Buddha, and the Stone Church generate a triangle with interior angles of 93.60°, 44.12°, and 42.28°. The stated lengths of 1,986 m, 1,919 m, and 2,846.9 m agree with this angular geometry after rounding. These results answer the geometric part of the research question: the selected axes form an approximately right, approximately isosceles configuration. The triangle connects projected lines, however, rather than locating the monuments at its vertices or proving their mutual visibility. Its internal consistency does not establish intentional coordination, historical continuity, or a uniquely topographical cause.

The landscape interpretation suggests that elevated sites and mountain–water relationships provide a productive context for comparing monuments from different religious traditions. Terrain contributes to the opportunities and constraints within which institutions build, while historical actors, architectural practices, and later interventions also shape the resulting form. The stronger proposition of topographical determinism is therefore not demonstrated by the supplied evidence. Shan Shui is most defensible here as a cultural language for interpreting landscape relationships, rather than as a measurable force explaining the exact geometry.

For conservation, the study supports assessing the selected monuments together with hill profiles, water-related settings, public viewpoints, and surrounding development. It does not establish an automatic requirement to preserve every projected line as a protected corridor. Future work should verify historical map provenance, document measurement uncertainty, date the relevant structures, test actual visibility, and consider alternative site and axis selections. A completed assessment should also include the knowledge and priorities of the communities associated with the landmarks. This combination would allow the proposed triad to contribute to a historically grounded and socially meaningful approach to Nha Trang's cultural landscape.

Author Contributions

All authors contributed equally to this study, read and approved the final manuscript, and agreed to its submission for publication.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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