The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-M-9-2025
30th CIPA Symposium “Heritage Conservation from Bits:
From Digital Documentation to Data-driven Heritage Conservation”, 25–29 August 2025, Seoul, Republic of Korea

Geospatial Analysis for Decoding Architectural Configuration of Ruins of a Coastal Fort: The Case of Fort Vijaydurg, Konkan, India

Mrudula Mane [1], Drashti Nakrani [2]

[1] Faculty of Architecture, CEPT University, Ahmedabad, Gujarat, India - mrudula.mane.phd22@cept.ac.in
[2] Department of Archaeology, University of York, York, UK - fll523@york.ac.uk

Keywords: Viewshed Analysis, Ruins, Architectural Configuration, Coastal Forts, Vijaydurg, Konkan

Abstract

Documentation and architectural interpretation of ruins of historic buildings is a complex process. Architectural interpretation based on inadequate documentation can result in an undervalued understanding of historic significance and, consequently, flawed or failed conservation projects. The Konkan region in western India has faced challenges in scientific conservation due to a lack of documentation and inadequate architectural interpretation. This coastal belt comprises over 170 forts, many of which are in various stages of ruin. The paper focuses on Fort Vijaydurg in southern Konkan as a case study. Vijaydurg played a pivotal role in withstanding the expansionist agendas of the European trading companies of the eighteenth century. The paper presents a methodology for combining viewshed analysis, 3D photogrammetric output, archival research, and field observations to investigate the role of architectural elements in a fort, particularly those in a state of ruins. The methodology enables the deciphering of the logic behind site selection and the rationale for the spatial configuration of a fort. The empirical results can strengthen the historic significance. The paper contributes to the study of the forts of Konkan by rethinking ways of engaging with the surviving ruins. The methodology can be extended to the ruins of coastal heritage sites worldwide.

1. Introduction

1.1 Research Premise

Worldwide, numerous historic buildings are in ruins (Ashurst, 2007). Many of those ruins are also part of complex topographic settings. Realistic documentation of such historic buildings, which captures the correlation between topography, built form, and ruinous condition, is a challenging task. The documentation challenges affect the quality of drawings, maps and visual records. The Charter adopted by ICOMOS on the Principles for the Recording of Monuments, Groups of Buildings and Sites (1996) considers documentation as one of the principal ways to give meaning, understanding, definition, and recognition to the values of historic built environments. Documentation provides evidence and rationale for past creations. Hence, the documentation process is the foundational aspect of the heritage conservation discourse.

The quality of documentation impacts the interpretation of the surviving ruins and subsequent stages of conservation. Implications of the inadequate interpretation are seen, especially in the case of forts. Among various types of historic ruins in the world, one of the largest categories is probably forts – the once-mighty constructions now surviving as broken, dilapidated, and decaying remains from the past. Broadly, forts can be defined as structures constructed at strategic locations for the region's defence, offence, vigilance, or marshal governance. Military historian John Keegan considers forts as one of the means by which settled inhabitants of resource-rich regions sought to preserve what they had won from nature (1994, p. 139). Keegan demonstrates the universal nature of this phenomenon through cartographic visualisation of the World Fortification Zones (p. 145). Martin Brice (1990), Robert Harbison (1993), and Hirst (2005) also put forward similar definitions of forts before expanding on the architectural systems and meanings of the fort constructions. Over the period, the actions of humans and nature transform forts into ruins.

The Konkan region (Figure 1) in western India is a heavily fortified coastal belt. While forts in this region are often associated with the seventeenth-century conflicts between the Mughal Empire (1526-1857) of Delhi, Adilshahi Sultanate (1490-1686) of Bijapur and the Maratha Kingdom (1674-1818) of Konkan, the coastal forts were also instrumental in keeping a check on the initial phase of the European expansionist agenda along the Indian Ocean Rim. A network of coastal forts defended the resource-rich region for more than 100 years, thereby delaying the process of colonisation in the region.

Fort's architectural configuration is one of the pivotal factors that contribute to its performance. The war tactics of the era and the enemy influence the configuration. In the case of Konkan, popular and academic attention is given to the Mughal-Maratha conflicts. The encounters between European trading companies and Maratha naval powers have not been adequately investigated from an architectural lens. The paper argues that the architectural configuration of Konkan's coastal forts resulted from the peculiar topographic settings and the encounters between regional powers and European trading companies, not only due to the Mughal-Maratha conflicts. Fort Vijaydurg (Figure 2), rebuilt around 1660-65 by the Marathas, is investigated as a case study for this research. The results of the geospatial analysis of the fort, juxtaposed with field observations and historical records, provide empirical evidence to support the argument and challenge the established narrative, despite the current ruinous condition of Vijaydurg.

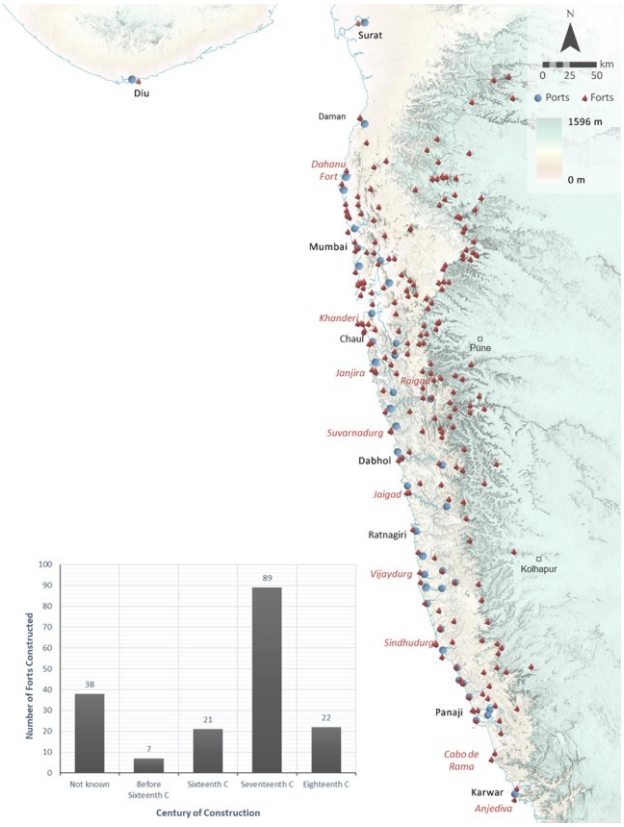


Figure 1. The geographical expanse of the Konkan region in western India. The Red Triangle depicts the location of forts, and blue circles represent estuarine and riverine ports. The bar chart illustrates the number of forts constructed between the 16th and 18th centuries. © Authors

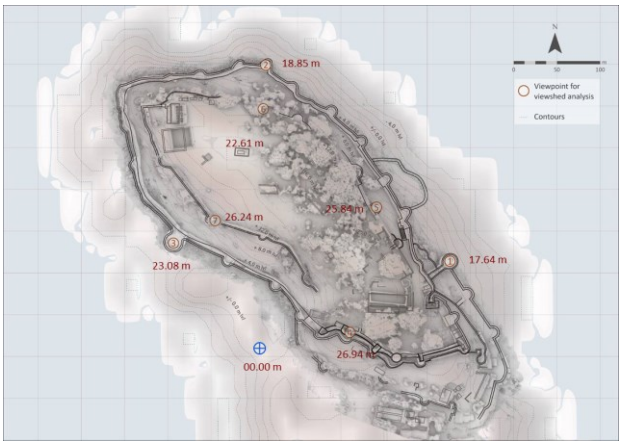


Figure 2. The layout and 3D photogrammetric model of Fort Vijaydurg is georeferenced with a Digital Elevation Model generated in ArcGIS. The map depicts location and assumed heights of the viewpoints considered for viewshed analysis. © Authors

1.2 Research Question and Implications

The specific question for investigation is: How can geospatial analytical tools be applied to the architectural interpretation of historic ruins situated in complex topographic situations?

The research implications are twofold: first, for the Konkan region, and second, for studying the historical significance of coastal ruins worldwide. The research draws attention to Konkan's role in the global history of colonisation during the early modern era, utilising empirical methods. Konkan is not the only coastline where evidence of encounters between regional powers and Europeans has survived. Regions along the Gulf of Persia, the Red Sea, and Africa, especially the former colonies of European Empires, are also left with architectural evidence in ruinous conditions. The methodology established in the paper can be extended to similar coastal ruins to re-evaluate their historical significance.

2. Methodology

2.1 Integrated Approach

The research methodology is based on an integrated approach (Figure 3). The four methods – GIS-based study, photogrammetry, historical research and field observations are simultaneously implemented to study the correlation between topography, built forms, past events and the current ruinous condition of the coastal fort chosen as a case study.

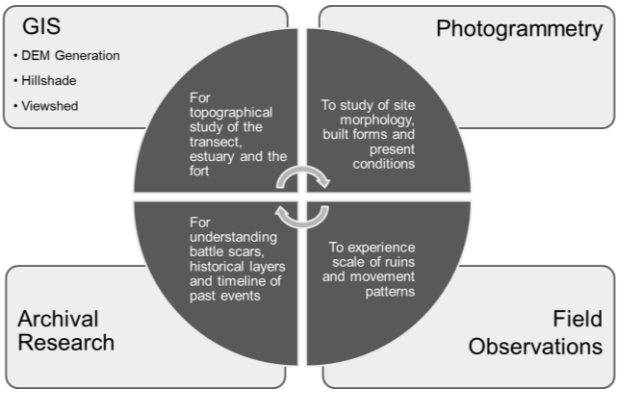


Figure 3. Integrated approach to research methodology

The region's Digital Elevation Model (DEM) is generated in ArcGIS Pro V.3.4.2 to serve as a base for data integration. The DEM was used to generate a multidirectional Hillshade to visualise the region's topography using the raster functions (Refer to Appendix I for detailed workflow). A 3D photogrammetric model is created by processing close-range aerial photographs in Agisoft Metashape Professional version. The DEM and 3D model of the fort are instrumental in understanding the morphology of the promontory on which the fort is situated, as well as the fort itself. After integrating the two datasets, geodesic viewshed analysis is performed from the seven viewpoints. Viewshed analysis is performed for two situations: 1. An observer positioned at the natural ground level, and 2. An observer positioned at the top of the architectural elements at the exact location (Table 2). The geoprocessing tool 3D Analyst's Geodesic Viewshed was used to perform the viewshed analysis, as it considers the Earth's curvature and topography using the DEM (ESRI, n.d.).

Comparison of visibility from two levels helps to analyse the built form's locational and construction logic. For the built forms in ruinous conditions, the heights of the complete structures were assumed for performing the viewshed analysis. The assumed heights are derived by observing the surviving parts of the structure and by examining archival sources, such as maps, lithographs, and aquatint photographs. The integration of archival 2D maps into ArcGIS Pro enables the analysis of historical data within a broader context (Gupta, Rajani, 2020).

2.2 Data and Tools

For generating a landscape base, a 12.5 m resolution DEM of the 2007 ALOS PALSAR dataset was used. The 12.5m DEM is the highest resolution data available for the region and around the site. Furthermore, the contours were generated from the 12.5 m DEM using the geoprocessing tool 'Contour' at 2 m intervals. A 3D photogrammetric model is generated by processing 1234 aerial photos. The drone data collection was conducted in two phases – first in winter and second in summer. The second phase of data collection captured the maximum height of the outer fortification walls visible during summer. To integrate photogrammetric output with the DEM model, a tiled model was built in Agisoft Metashape, exported as a scene layer package file (.slpk), and imported into ArcGIS Pro. The (.slpk) format enabled the visualisation of a georeferenced model along with textures in ArcGIS Pro into a 3D Local Scene.

2.3 Limitations

2.3.1. Data Collection: Seasonal variations at the site are a significant aspect to consider for the coastal sites (Table 1). The drone data and field observations were collected in two seasons – winter and summer- to manage issues associated with high vegetation growth, exposure of external fortification walls due to tidal water levels, and high wind velocities. Hence, the photogrammetric model comprises differential datasets from the winter and summer seasons.

Season	Data Collection Feasibility	Advantage	Limitations
Monsoon (June to Sept)	Nil	None	Heavy rains, high water level covering external fortification walls and dense vegetation growth
Winter (Oct to Jan)	Fair	Better visibility due to clear air, Consistent natural light	Medium vegetation growth, Higher sea water level covering the fortification walls
Summer (Feb to May)	Good	Favourable tidal water conditions to capture outer fortification walls, Minimum vegetation growth	Harsh pre-monsoon wind conditions and dusty air for drone data collection

Table 1. Seasonal advantages and limitations of data collection

2.3.2. Data Processing: As mentioned, datasets are in various formats. Additionally, some datasets span different periods. The topographic profile established that these datasets are being used for the photogrammetric model generated in 2025. The viewshed analysis results acquired from the varied datasets are used to understand the visibility from the fort during the seventeenth and eighteenth centuries. Hence, differential datasets leave a margin of error in understanding morphological changes over the period. Another limitation of viewshed analysis is the inability to include real-world variable factors, such as weather and vegetation (Dodd, 2023). The lack of time and access to the relevant sea level change data made it difficult to account for the margin of error in the analysis. However, georeferencing of the archival map over a DEM in GIS aligns well with the present-day coastline (Figures 4 and 5). Based on these georeferenced maps, it is considered that, despite transformations in the built form, there are no significant changes in natural elements such as the coastline and topography.

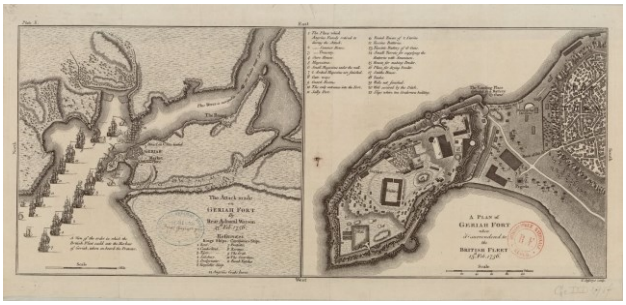


Figure 4. The 18th-century survey map of the Vaghotan Creek and the fort. © *Bibliothèque nationale de France.* Illustration by cartographer Jefferys Thomas (1771).

Figure 5. Archival maps (Figure 5) are georeferenced with DEM in GIS. The DEM illustrates present-day topography. Left: Profile of Vaghotan Creek. Right: Vijaydurg fort and land connection to the town. © Authors

3. Case Study – Ruins of Fort Vijaygurg

3.1 History, Heritage and Conservation:

Fort Vijaydurg is situated on a promontory in the estuarine region of the Vaghotan River. It is also known as *'Gehria'* after the nearby village *'Giriye.'* The place where the promontory and the village are situated was an active port at least since the first century CE. One of the earliest written records of maritime trade connections in the Indian Ocean World is the first-century CE Greek account, *Períplous tis Erythrás Thalássis* (The Periplus of the Erythraean Sea). The record mentions 11 ports from the Konkan region (Schoff, 2021). Vijaydurg is mentioned as *Byzantium* in the record (Tripati, 2015). The port remained active until the eighteenth century, providing a strong incentive for various ruling and trading powers to compete for its possession. Konkan acted as an entry and exit point for the market towns situated in the hinterland and across the Indian Ocean (Jagtap, 2023; Subramanian, 2008). The network of forts ensured safe passage for the transportation of goods. Hence, whoever governed the fort could also govern the trade network. Vijaydurg was part of the trade network along with Vaghotan and Kharepatan as riverine ports (Figure 6). Jefferys Thomas' map of the Vaghotan creek also mentions that the river was

navigable up to forty miles (Figure 4). Kharepatan port is situated at the same point. Both the riverine ports had connections with Bawada *Ghat* and Phoda *Ghat* in the Sahyadri mountain range. In the regional language, *Ghat* means a mountain pass. These Ghats led to the landlocked market towns in the east, such as Karad, Kolhapur and Bijapur.

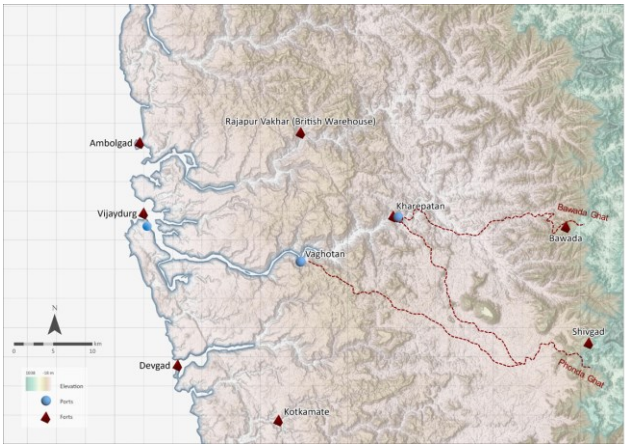


Figure 6. Transect of Vaghotan River. Vijaydurg is part of a fort network that acts as an interface between maritime and land trade routes. Triangles indicate locations of forts; circles depict ancient ports, and red lines represent probable land routes between riverine ports and mountain passes. © Authors based on historical accounts from Apte, 1973; Jogalekar, 1996

The precise year of establishment of the fort is not known. However, written records are available from the late sixteenth century onwards. A letter to the Governor General of the Dutch East Indies from November 1665 mentions the place as *"fortress of Girira the one built of a rocky promontory at the mouth of Vaghotan River"* (Mehendale, 2016, p. 281). The mid-seventeenth-century records state that the founder of the Maratha rule, Shivaji Raje Bhosale (1630-80), seized the fort from the Adilshahi Sultanate of Bijapur, situated in the hinterland of India. Shivaji revived and expanded the fort (Shintre, 2010; MacDougall, 2014). According to oral history, the Adilshahi fort was approximately 5 acres in size, and Shivaji expanded it to 16 acres. Today, most of the surviving remains are attributed to the period of Shivaji and his successors.

As a result of the maritime competition, in the early eighteenth century, Vijaydurg became the stronghold of the Maratha Naval frontier. In the first half of the eighteenth century, the fort was in possession of Maratha Naval Admirals Kanhoji Angrey (till 1729) and Tulaji Angrey (1730 – 1756), who withheld the British East India Company's advances (Apte, 1973; Deshpande & Mujawar, 2021; Mehendale & Shintre, 2010). The fort played a central role in a series of naval and amphibious battles during this period. British East India Company unsuccessfully attacked the fort at least nine times between 1717 and 1755 (Keay, 1993).

In a decisive battle of 1756, the fort was surrendered to the EIC because of internal conflicts between the Maratha Naval Admiral and the Maratha Prime Minister. (Biddulph, 1907; Keay, 1993). After the third and last Anglo-Maratha Battle in 1818 (Cooper, 2003), the fort fell into complete disuse and started its journey towards becoming a ruin of its former self. Figure 7 provides a comparison between the complete form of the fort during its active years vs. surviving ruins after two centuries.

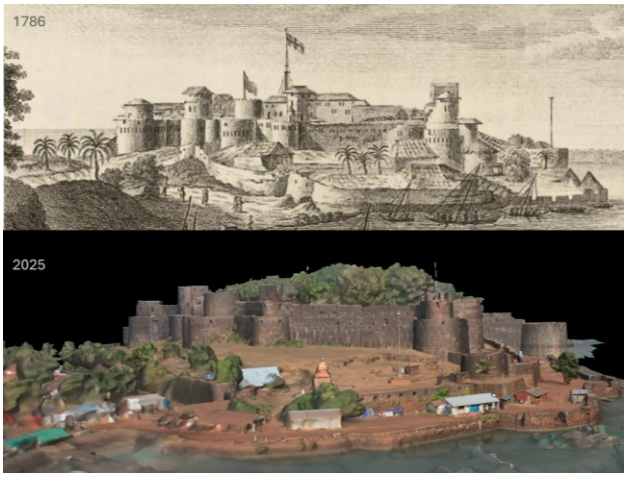


Figure 7. Loss and Survival of Vijaydurg's Architectural Elements over 238 Years. ©Lithograph by Ives Edward, 1786, in the collection of Christie's. Orthoimage extracted from the photogrammetric model by the Authors.

In the twenty-first century, the fort has become a popular tourist destination, making it more susceptible to rushed conservation efforts under public pressure. However, no detailed records have survived apart from a few maps, lithographs and aquatint photographs that can be used for scientific conservation. The map in Figure 4 is the most detailed map available so far. A contemporary Maratha map by the Peshwas, most likely copied from a British map, provides some additional details, such as the names of the bastions (Apte, 1973; Gole, 1989), but it does not provide information about the style, features, or functions of the architectural elements. In recent times, the governments of Maharashtra and India aim for the status of a World Heritage Site for the selected coastal forts of Konkan (UNESCO, 2024). Vijaydurg features prominently in the dossier prepared for series nomination, making it a significant heritage site for the locals. Hence, the need for architectural interpretation is more pertinent than ever before.

3.2 Ruins

The surviving remains of the fort mainly consist of outer and inner fortification walls (Figure 2). The fortification walls follow the profile of natural contours. The inner layer is constructed at a higher level, and the outer layer is constructed at a lower level. The outer layer is constantly exposed to the ocean waves and winds. There was a third layer of fortification wall towards the land side. However, most of the third layer is lost today. Only the traces of a few lower stone courses are visible on site. A moat running from the beach to the creek provided additional protection to the fort. The moat is now barely identifiable due to deposition debris and vegetation growth. The fortification walls are intercepted with bastions of varied diameters and heights. A total of 27 bastions are identifiable in the outer layer. The inner layer is broken and lost at multiple points. Some of the bastions in the outer layer were provided with multistorey towers. The towers were constructed above the finished top level of the bastions. As evident in the eighteenth-century illustration (Figure 7), the towers were capped with either conical or sloping roofs. None of the towers' roofs has survived to present times. In some cases, the upper floors are also lost. Only a handful of the buildings inside the fort have survived. Moreover, only two structures still have their roof intact. Numerous structures are buried under debris, soil deposits and decades of vegetation growth.

3.3 Viewpoints and Visibility

From the surviving remains, a total 7 locations were identified for conducting viewshed analysis (Figure 2 and Table 2). Four locations are part of the outer fortification, and three are of the inner. The rationale for selecting these seven locations was to analyse the architectural elements spread across the fort and which are at different stages of ruination.

The bastion at **viewpoint 1** is circular in plan. The bastion is called *Bara Tophecha Buruj* in the regional language, which means the bastion with 12 cannons. It is built away from the outer fortification wall and is connected by a tunnel. The height of this bastion is lower than that of most of the other bastions of the fortification wall. In its elevation, the bastion is built with a slight angle of repose to achieve the stability of the form. The masonry indicates that apart from the upper four stone courses, the rest of the bastion is a one-phase construction. Stones used in all the lower courses are of uniform size and dressing. This bastion provides visibility over the entrance of the estuary and also a view of the northern walls from the external side. There is no substantial difference between the visibility of the estuary and the northern bank from the ground level and the top of the bastion. However, the top of the bastion allows additional visibility of the ocean on the north-west side.

The bastion at **viewpoint 2** is semi-circular in plan. The bastion is called *Vyankat Buruj*. It is built at the location where the northern wall turns towards the east. For ships approaching from the north, Vyankat Buruj would appear as the outermost bastion. The masonry indicates that apart from the upper four stone courses, the rest of the bastion is a one-phase construction. Stones used in all the lower courses are of uniform size and dressing. The bastion facilitates visibility in three directions – north, west and east. The protruding shape and height of the bastion augment the visibility in the west and east. Bara Tophecha Buruj (V1), located in the eastern direction, falls within the viewshed of Vyankat Buruj. Visibility from natural ground level provides limited vision in the west and east directions.

V**iewpoint 3** is located at the largest bastion of the fort, known as Darya Buruj, which translates to "Ocean Bastion." The bastion is almost circular in plan and is part of the outer fortification wall. Its diameter is 23.31 M. A wide and long fortification wall on both sides flanks the bastion. Similar to Bara Tophecha Buruj (V1) and Vyankat Buruj (V2), here too the masonry indicates a one-phase construction, apart from the top few courses. Stones used in all the lower courses are of uniform size and dressing. The lowermost courses are built with large blocks of more than 1 cubic meter. These lower courses are heavily damaged, and many stone blocks are missing or dislodged. As the name indicates, the bastion overlooks the ocean. Visibility is drastically augmented due to the bastion's height, which is 15.63 M. The ground level allows only a funnel-shaped visibility of the ocean and beach. In comparison, the bastion provides a broader view of the ocean, beach and the land behind the beach. The old marketplace was situated in the area behind the beach.

The structure at **viewpoint 4** is known as *Madicha Buruj,* which translates to either a multistory bastion. At this location, a three-storey tower is built on a bastion. Currently, the tower is in ruinous conditions while the bastion appears to be stable. Only the shell of the tower walls has survived; intermediate floors and the roof were probably lost sometime in the nineteenth century. The roofs depicted in the lithograph from 1786 are no longer visible in the photograph from 1855. The tower is almost square in plan with three straight walls and one curvilinear wall parallel to the outer fortification layer. Masonry consists of laterite stones of smaller sizes than the stones used for bastion construction. The tower is provided with multiple window-like openings at each level. Traces of wooden structural members are visible in interiors. Each level is identifiable by a distinct stone course that slightly projects outward from the finished surface of the wall on the external side. No evidence of a staircase or ladder has been found to survive. Due to its current state of ruin, the upper two levels cannot be accessed or understood in their entirety. In its complete form, the tower must have been the tallest structure inside the fort. The height of the tower facilitates an unobstructed 360° view from openings at each level. The natural ground level at this location would have allowed funnel-shaped visibility only in two directions. Almost the entire fort, beach, coastal waters, part of the ocean, market, town, and the areas beyond the town are in the tower's viewshed. The dockyard, which was previously thought to have been communicated with from the tower (MacDougall, 2014), is not visible from V4. Nevertheless, part of the creek is in the viewshed. It is plausible that ships would have been moored in the viewshed area to receive signals from the tower.

The structure at **viewpoint 5** is in similar conditions to the tower at viewpoint 4. It is a two-storey tower built on a pre-existing fortification wall of the inner layer. The tower is in ruins with a collapsed roof and a lost upper floor. The walls of the tower are still standing amidst the growth of vegetation. A noticeable feature of this structure is the broad flights of stairs built perfectly perpendicular to the tower and fortification wall. All the other staircases in the fort are built parallel to the fortification wall and have a very minimal footprint. Whereas, the staircase leading to the tower has a wide footprint and is in direct alignment with the house of the Maratha naval admiral who resided in the fort during the first half of the 18th century. The difference in masonry of the fortification wall and the tower is identifiable. The stones of the tower are of smaller size and are more crudely placed than the fortification wall. The tower primarily overlooks the mouth of the estuary. Due to its height, the tower would have had almost a 360° view of the fort and its surrounding perimeter. The ground-level view from the exact location is limited only to the north-east side of the fort.

The location of **viewpoint 6** is in the same zone as viewpoint 2. However, it is on higher ground than V2. The location is overgrown with heavy vegetation. The bastion is identifiable only through the surviving profile of lower stone courses and the adjoining sections of fortification walls. The upper part of the bastion is wholly lost. It is part of the inner layer and was built along the natural scarp, and its shape appears to be roughly semi-circular. Stone sizes of the surviving portion of the bastion are similar in size, shape and finishing. The visibility profile of V6 is similar to that of V2. While the external visibility remains similar, V6 has more visibility over internal areas of the fort due to its location. The bastion at **viewpoint 7** is part of the inner fortification wall. Only part of the bastion has survived today. The surviving remains suggest that the bastion must have guarded a gateway on its east side. Masonry consists of even-sized, well-dressed, well-seasoned laterite stones. The natural elevation of this location is on higher ground of the promontory. Hence, although the height of the construction is limited, the effective height of the top of the bastion is comparable to that of the multistorey tower at V4. The top surface of the broken bastion facilitates fair visibility in all directions. It also overlooks Darya Buruj at location V3. The natural ground level allows limited visibility only in the south-west direction.

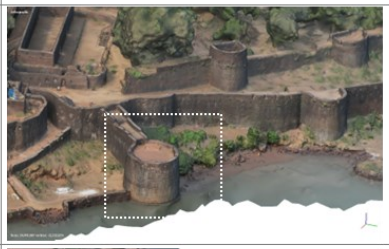
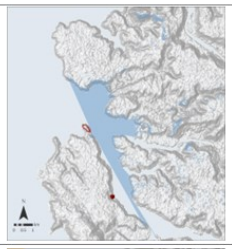
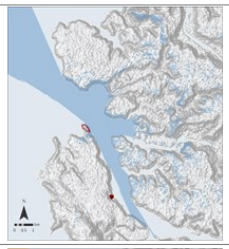
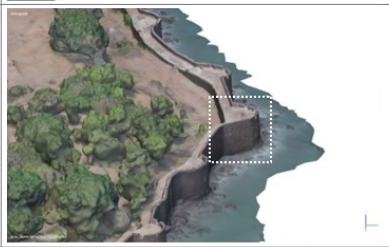
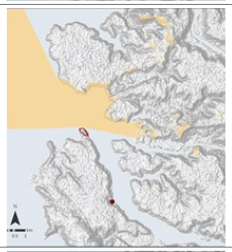
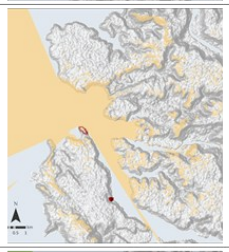
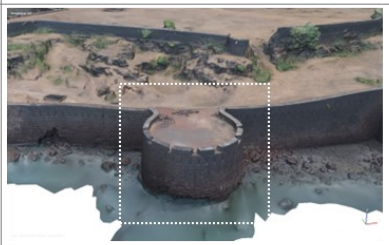
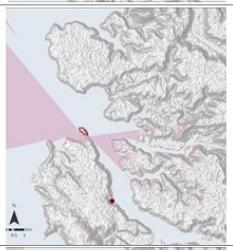
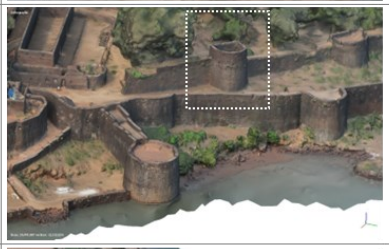
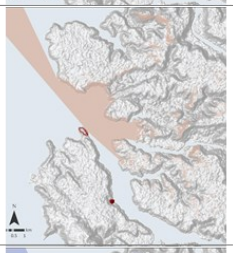
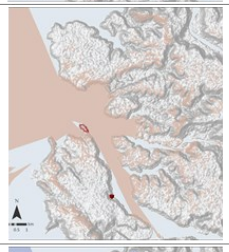
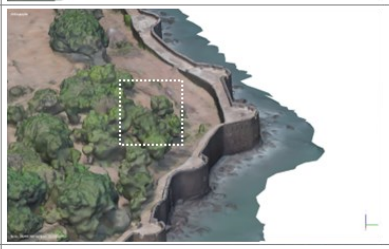
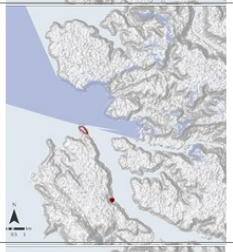
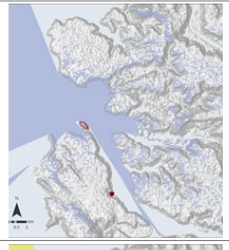
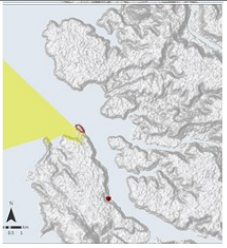
Viewpoint and Condition	Architectural Element (Photogrammetric Output)	Viewshed from Natural Ground Level	Viewshed from the top of Architectural Element	Primary Function
V1 *Bara Tophecha Buruj* Fair Condition		+ 2.00 m lvl 	+ 17.64 m lvl 	Offence
V2 *Vyankat Buruj* Fair Condition		+ 2.00 m lvl 	+ 18.85 m lvl 	Vigilance and Communication
V3 *Darya Buruj* Damaged but Stable Condition		- 2.00 m lvl 	+ 23.08 m lvl 	Offence
V4 *Madicha Buruj* Dilapidated condition		+12.00 m lvl 	+ 26.94 m lvl 	Vigilance and Communication
V5 Tower on bastion in front of *Angrey's Wada* Dilapidated condition		+ 6.00 m lvl 	+ 25.84 m lvl 	Vigilance and Communication
V6 Lost Bastion near Shrine Collapsed and almost lost condition		+ 10.00 m lvl 	+ 22.61 m lvl 	Vigilance
V7 The broken bastion near Darya Buruj Dilapidated condition		+ 2.00 m lvl 	+ 126.24 m lvl 	Defence

Table 2. Results of the viewshed analysis from the identified locations. The bright colour patches indicate the area visible from the viewpoint under consideration.

3.4 Findings: Viewshed Analysis

The visibility profile from each viewpoint is analysed in the following section.

In case of **viewpoint 1**, although good visibility is provided from the top of the bastion, other taller bastions in its vicinity can facilitate similar or better visibility. The location, layout and height of the bastion suggest that the primary purpose of the bastion must have been to attack the uncharted ships entering the estuary. Its name indicates that the bastion was provided with 12 cannons. The height of the bastion must have been suitable for the close-range firing of cannonballs in the estuarine region. A taller bastion could not have provided the required trajectory and would have increased the risk of cannonballs landing too close to the fort. The *Vyankat Buruj* at **viewpoint 2** must have acted as a point of vigilance to keep an eye on the coastal traffic in a north-south direction and on ships entering and exiting the estuary. It would have also acted as a communication point to give an advanced signal to the Bara Tophecha Buruj (V1) to prepare for the attack in case any uncharted movement is observed entering the estuary. The primary function of the bastion at **viewpoint 3** also seems to be offence rather than visibility. The layout and height of the bastion would have enabled attacks on the enemy ships approaching the beach. The protruding and circular shape could have allowed firing in more than 270º perimeter. No other large bastions are constructed in the close vicinity, which has allowed such visibility and attacking range.

The 360° visibility from the tower at **viewpoint 4** makes it an ideal device for vigilance. Its enclosed layout is not suitable for housing heavy firearms. Hence, it can be deduced that the tower was primarily for vigilance, rather than for offence or defence. Its sheltered location, away from the coastline, safeguards it from potential attacks by ships in the ocean. Plus, the third layer of fortification wall in this area would have protected manual scaling of the bastion. The georeferenced map (Figure 5) indicates the location of the market south of the fort. The tower must have kept an eye on movements in the market area. **Viewpoint 5** follows the same construction logic as viewpoint 4. The tower here must have also been an ideal surveillance device. Tower's proximity to the Admiral's house, its height and prominent access suggest that it might have served as an exclusive observation tower for the Admiral. The builders of the tower utilised the pre-existing section of the inner fortification wall to achieve the desired height.

The bastions at the location of **viewpoints 6 and 7** are part of the inner fortification wall. By comparing their visibility profile with V2 and V3, respectively, it can be deduced that V6 and V7 were sufficient for the surveillance purpose. However, the inner layer of fortification left too much space on the external side. Due to the natural slope of the promontory, it would have been possible to reach the fortification wall very easily from the ocean side. Hence, the outer fortification wall was likely built to address this vulnerability. The discovery corroborates the oral history of the fort's expansion in the mid-seventeenth century. The map in Figure 4 depicts a break in the fortification wall at the location of V7, similar to the present-day situation. Hence, it can be assumed that after the construction of the outer wall, inner bastions must have become redundant, leading to accelerated deterioration and loss we see today.

A spatial pattern emerges (Figure 8) from the investigation of architectural elements – The tall features were built towards land and the Creekside, and the low height vigilance features were built towards the oceanside, and the attacking features were built in the intermediate area.

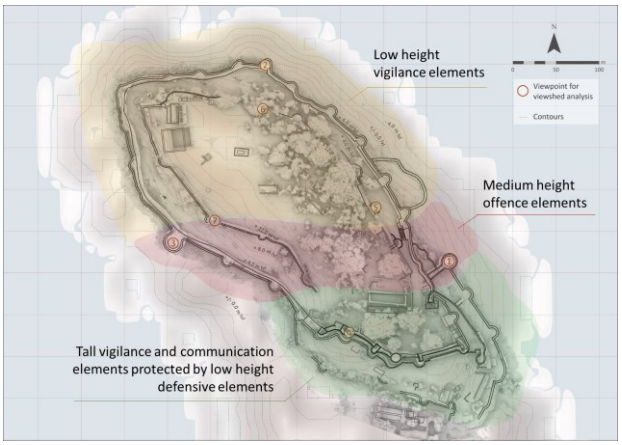


Figure 8. A pattern in the spatial configuration of Fort Vijaydurg. © Authors

The historical records indicate that the estuarine region was primarily associated with transoceanic trade activities (Jagtap, 2022). The records also suggest that the Mughals and Adilshahi were not active in the transoceanic trade from the Konkan coast in the late seventeenth and eighteenth centuries. During this period, the joint venture European trading companies had entered the trade network. The viewshed analysis suggests that there was a heightened need for continuous vigilance over trade activities and associated movements while maintaining the fort ready for attack at crucial entry points. The dual need likely led to the vertical expansion of the bastions, the construction of towers, and the encompassing of potential landing points in the seventeenth and eighteenth centuries.

4. Conclusion – Reassessment of Significance

Article 4.2 of the ICOMOS Guidelines on Fortifications and Military Heritage identifies 'territorial and geographical value' as one of the essential components of the significance assessment (2020). The guidelines suggest that identifying these values may consider the locational logic and spatial configuration in the background of the territory to be defended. The above research attempted to reassess the territorial and geographical value of a coastal fort in the Konkan region by employing an integrated approach. Geographical value is pivotal to the study of fort ruins. The tools also enable the investigation of ruined and partially existing architectural elements. Geospatial analysis can provide empirical evidence of the geographical value, but only when methodically juxtaposed with the historical records and field observations. The integration of the topographic model with the architectural model is insightful for understanding human interventions on the natural form. On their own, the geospatial analytical tools are not sufficient for decoding historic ruins.

In the seventeenth and eighteenth centuries, when European trading companies were aggressively attempting to establish a foothold on the Konkan coast to enter the pre-existing trade network, regional powers resisted them from their coastal forts. The Vijaydurg pattern is also observed at Chaul and Dabhol in the Northern Konkan. Hence, the findings challenge the prevailing narrative, which overlooks the aspects of the historical economy and the impact of the arrival of European powers in the Indian Ocean. The reassessment of popular

narratives with empirical tools is essential because such narratives influence conservation strategies. Inadequately informed conservation strategies may erase the architectural evidence of the coastal region's geopolitical and economic role in the early modern era.

Acknowledgements

The Archaeological Survey of India (Mumbai Circle) is acknowledged for granting permission to document Fort Vijaydurg and for facilitating access and on-site arrangements for the authors. The enquiry undertaken in the above paper is part of the on-going PhD research of the first author at the Faculty of Architecture, CEPT University, Ahmedabad. CEPT University's Doctoral Office and Doctoral Advisory Committee is acknowledged for their support and guidance in research development. Authors are grateful to Dr. Pallavee Gokhale, a Data Science and GIS expert, for sharing her expertise on challenges about data integration.

References

"*Centrally Protected Monuments/Sites: State-Wise and Circle-Wise*." 2023. Archaeological Survey of India. 2023. https://doi.org/chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://asi.nic.in/wp-content/uploads/2023/08/List-of-Centrally-Protected-Monuments-and-Sites-March-2023-1.pdf.

"Gazetteers of the Bombay Presidency, 1883." 2006. Gazetteer Department of Government of Maharashtra, Bombay. 2006. https://gazetteers.maharashtra.gov.in/cultural.maharashtra.gov.in/english/gazetteer/Kolaba District/home.html.

"*Guidelines on Fortification and Military Heritage.*" 2020. ICOMOS.

ICOMOS. 1996. "*Principles for the Recording of Monuments, Groups of Buildings and Sites*."

"*Serial Nomination of Coastal Fortifications along the Konkan Coast, Maharashtra.*" 2024. UNESCO World Heritage Centre. 2024. https://whc.unesco.org/en/tentativelists/6703/.

Ashurst, John. 2007. *Conservation of Ruins.* Routledge.

Biddulph, John. 1907. *The Pirates of Malabar; and An Englishwoman in India Two Hundred Years Ago*. London: Smith, Elder & Co. https://archive.org/details/piratesofmalabar00bidd/page/n9/mode/2up.

Brice, Martin. 1990. *Forts and Fortresses: From the Hillforts of Prehistory to Modern Times -the Definitive Visual Account of the Science of Fortification*. New York and Oxford: Facts on File.

Cooper, Randolf G. S. 2003. *The Anglo-Maratha Campaigns and the Contest for India: The Struggle for Control of the South Asian Military Economy*. Cambridge University Press.

Dodd, James. 2023. *"Establishing a Method for Visibility and Viewshed Analysis for Late 4th Century Fortifications in Gallia Belgica and the Germanic Provinces."* Germania: Anzeiger Der Römisch-Germanischen Kommission Des Deutschen Archäologischen Instituts, no. 101: 39-75-39–75. https://doi.org/10.11588/GER.2023.108243.

Gupta, Ekta, and M B Rajani. 2020. *"Geospatial Analysis of Historical Cartographic Data of Kollam Fort."* Journal of the Indian Society of Remote Sensing 48 (September). https://doi.org/10.1007/s12524-020-01181-w

Harbison, Robert. 1993. "Fortification, Ideal Cities, Ruins." In Built, the Unbuilt and the Unbuildable: In Pursuit of Architectural Meaning, 67–130. London,New York: Thames & Hudson.

Hirst, Paul. 2005. "The Defence of Places: Fortifications as Architecture." In *Space and Power: Politics, War and Architecture,* 179–97. Polity Press.

Jagtap, Neelambari. 2023. "Ports, Markets, Commercial Networks, and Politics: Case of Tal (South) Konkan in the 17th Century." In *Connecting the Indian Ocean World*, edited by Radhika Seshan and Ryuto Shimada, 83–92. Routledge India. https://doi.org/10.4324/9781003362487-8.

Jogalekar, Sadashiv. 1996. *Sahyadri (Maharashtra Stotra)*. 2nd ed. Shubhada-Saraswat Prakashan.

Keay, J. 1993. *The Honourable Company: A History of the English East India Company.* HarperCollins.

Keegan, John. 1994. "Stone Interlude: Fortification." In *A History of Warfare,* 77–152. New York: Vintage Books.

MacDougall, Philip, ed. 2014. "Vijaydurg: The Strongest Place in All India." In *Naval Resistance to Britain's Growing Power in India, 1660–1800: The Saffron Banner and the Tiger of Mysore,* 106–32. Worlds of the East India Company. Boydell & Brewer.

Mehendale, Gajanan. 2016. "War on Two fronts" in *Shivaji His Life and Times.* 225-97. Param Mitra Publications.

O'Driscoll, James. 2017. *"Landscape Prominence: Examining the Topographical Position of Irish Hillforts Using a Cumulative Viewshed Approach."* Journal of Archaeological Science: Reports 16 (December): 73–89. https://doi.org/10.1016/J.JASREP.2017.09.033.

Mehendale, Gajanan, and Santosh Shintre. 2010. *Shivachhtrapatinche Aarmar.* Param Mitra Publications.

Schoff, Wilfred (Trans.). 2021. *The Periplus of the Erythraean Sea: Travel and the Trade in the Indian Ocean by a Merchant of the First Century*. Dev Publishers & Distributors.

Subramanian, Lakshmi., ed. 2008. *Ports, Towns, Cities: A Historical Tour of the Indian Littoral.* Marg Publications on behalf of the National Centre for the Performing Arts.

Tripati, Sila. 2015. "An Overview of Maritime Archaeological Studies in India." In *Maritime Contacts of the Past: Deciphering Connections Amongst Communities*, edited by Sila Tripati, 783. Delta Book World.