Coastal archaeological heritage in relation to geomorphology of cliffs, West coast of India

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Abstract

Coastal cliffs are the most conspicuous geomorphic features that mark the west coast of India. A profile of a coastal cliff shows 8 to 12 meters of massive laterite exposed at the top, and grades into a layer of gravelly laterite below. The seaward flanks often expose fresh country rock composed of Precambrian meta-sedimentary and meta-volcanic rocks with basic intrusives at sea level.

Several forts of historical importance are located atop sea cliffs of Diu, Goa and Kerala. The rocky coasts are affected by marine erosion, being acute in areas influenced by direct wave attack. Crumbling cliffs, observed at several places, are evidences of marine erosion. Some forts are presently found at vulnerable edges of precipices, a few being in the process of collapsing into the sea, and presently in ruins.

Coastal historical assets offer a tremendous potential in terms of heritage tourism. However, appropriate policies devoted to the conservation or restoration of ancient coastal monuments are lacking. As a consequence, the coastal archaeological legacy is on a decline. Therefore, an aggressive revamp of existing conservation strategies, or formulation of a fresh national policy on coastal (man-made) heritage is called for.

Introduction

Along the west coast of India, strategically located forts mark heritage sites of historical importance. With some exceptions, a majority of the forts are located atop sea cliffs (Table 1). Most of the forts are found to be abandoned, are seen in various stages of disintegration, and some are crumbling. Coastal geomorphology, lithology of rocky coasts, location of structure and near-shore geological processes are some of the factors that seem to influence the stability of cliffs, and hence of forts.

With the above hypothesis in view, this paper is a preliminary attempt to establish the link between geomorphology and archeology, the coastal hill top forts in particular, and stresses the lack of efficient coastal policies in the conservation of coastal archeological heritage.

Geomorphology of coastal sea cliffs

The west coast of India comprises a system of sandy beaches and rocky shores interspersed within low-lying estuarine plains. In general, the coastal hilly terrain manifests itself in the form of plateau-topped headlands with gentle, steep or sometimes abrupt slopes, vegetated or bare, that protrude into the sea (Rao et al., 1985). Coastal cliffs are the most conspicuous geomorphic features that characterize several strips along the west coast of India.

Aerial photographs and satellite imageries supported by ground truth reveal the presence of coastal cliffs and plateaux with seaward slopes at Keri, Vagator, Anjuna, Baga, Aguada, Dona Paula – Siridao, Mormugao, Chicolna, Quittol, Cabo de Rama, Agonda, Palolem and Polem (Figure 1). Similarly, in addition to prominent precipices of Diu, Bekal, Kasargod, Varkala and Kovalam are some of the notable cliff coasts of Kerala. Pocket beaches are interspersed between rocky cliffs. The hill slopes are found to be thickly or sparsely vegetated but rarely bare (Figure 2). Some selected rocky coasts along the west coast of India are discussed below.
Figure 1. Geomorphological map showing rocky shores, coastal hills and cliffs along the coast of Goa.
GLIMPSES OF MARINE ARCHAEOLOGY IN INDIA

Table 1. Geomorphological setting of some of the coastal forts based on field evidences.

<table>
<thead>
<tr>
<th>Fort / place</th>
<th>Height above sea level (m)</th>
<th>Geomorphological setting and rock types</th>
<th>Geological processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diu (eastern tip of island)</td>
<td>25</td>
<td>Open sea, vertical precipices, sea caves at the base of overhanging cliffs, sandstone formations</td>
<td>Heavy wave activity, severe erosion, crumbling rock faces</td>
</tr>
<tr>
<td>Malvan, Maharashtra</td>
<td>0</td>
<td>About 1 km from the coast, surrounded by water, basaltic rocks</td>
<td>Minor erosion along open sea</td>
</tr>
<tr>
<td>Terekhol, Goa</td>
<td>-40</td>
<td>Flat top, gentle seaside slopes, thick vegetation, rocky cliff base composed of laterite</td>
<td>Loose boulders indicate presence of erosion (Tiracol estuary)</td>
</tr>
<tr>
<td>Chapora, Goa</td>
<td>75</td>
<td>Circular plateau, steep seaward slopes, sparse vegetation, sandy beach on sea side and rocky base on river side, a laterite peninsula</td>
<td>Erosion noticed along rocky river bank (Chapora estuary)</td>
</tr>
<tr>
<td>Aguada, Goa</td>
<td>65-80</td>
<td>Undulating plateau, abrupt gradients, pre-Cambrian quartzites and dolerite dykes found at the base</td>
<td>Intense wave activity proved by sea arches, caves and terraces</td>
</tr>
<tr>
<td>Reis Magos, Goa</td>
<td>&lt;20</td>
<td>River bank, laterite slopes</td>
<td>Riverine regime</td>
</tr>
<tr>
<td>Cabo de Rama, Goa</td>
<td>-40</td>
<td>Open sea, rugged slopes, sparse vegetation, laterite boulder coast, sandy coves present</td>
<td>Erosive activity evidenced by detached boulders strewn at the base</td>
</tr>
<tr>
<td>Bekal, Kerala</td>
<td>40</td>
<td>Open sea, bare slopes, laterite and pink granite boulders at the base of cliff</td>
<td>Negligible erosion along sea coast</td>
</tr>
</tbody>
</table>

Figure 2. Schematic vertical sections of two selected cliffs: A steep seaward face, devoid of vegetation, with quartzites exposed at the base as in Aguada, Goa; (B) A gentler slope with thick vegetation as in Tiracol, Goa.

The coast of Diu is made of sandy beaches along the western half compared to irregular rocky coast that terminates at the eastern tip of the island. Impressive projecting cliffs and wave cut benches and platforms characterize the coast. The littoral zone consists of miliolitic sedimentary formations (Merh, 1995).

In Maharashtra, the exposed coastal sections show that the rugged sea cliffs are almost entirely composed of Deccan basalts. The seaward flanks are generally steep and devoid of vegetation. The coast of Maharashtra needs to be investigated with further field studies from a morphological viewpoint.
GLIMPSES OF MARINE ARCHAEOLOGY IN INDIA

In north Goa, laterite topped hills occur within larger lowlands (Figure 1). Coastal promontories rise to a height of about 60 m with steep seaward slopes (Pl. 47) and gentler inland gradients. The seaward flanks often expose fresh country rock composed of Precambrian meta-sedimentary and meta-volcanic rocks with basic intrusive at the base (Figure 2A). These hard and compact rocks are overlain by softer laterite formed due to weathering and alteration of pre-existing rocks.

In comparison, the south Goa rocky coastline is markedly different, being indented and crenulated with the hill ranges dominating the coastal scenery. Rock types include schists, gneisses, granites and basic intrusives that stand out as resistant landforms. Dyke controlled protuberances are also identified.

In Karnata, headlands are identified at Baindur, south of Bhatkal, Kumta – Honnavara and a minor rocky projection at Someswar, south of Mangalore. The cliffs rise 40 to 60 meters above sea level. The steep cliff faces are represented by rounded boulders of granites and gneiss (Radhakrishna and Vaidyanadhan, 1994).

In Kerala, the rock types around Kasargod consist of laterites (usually at the top), partially weathered, hornblende and bitotite gneisses (below the laterites) and mostly pink granite at the bottom (KS Jayappa, personal communication). The rocky coast of Kovalam in the south is also composed of granites and gneisses overlain by laterite. In comparison, at Varkala, the entire 2 kilometer long linear sea cliff, around 25 meters in height, is composed of hard laterite (Pl. 48) underlain by loose, soft, light yellow clayey material at the base (Nair, 2005). A narrow sandy beach is found in front of the cliff marked by abrupt vertical gradients.

Sea cliffs form by under cutting due to marine erosion followed by subsequent collapse of large rocky boulders (Woodroffe, 2002). The cliff base at Diu (Pl. 49), Aguada and Varkala are some typical examples of large chunks of rock strewn at the base. Marine processes are therefore constantly shaping these landforms. As such, sea arches, sea caves, sea stacks and notches are seen at various places. The lower portions of the cliffs also exhibit wave cut terraces and platforms.

A representative section of a coastal cliff of western India varies from place to place, and is dependent on the lithology of the area:

(a) In Goa, the sea cliffs range in height from 20 to 85 meters. A typical profile of a coastal cliff of Goa shows 8 to 12 meters of massive laterite exposed at the top of the section (Fernandes, 2003). This rock grades into layers of gravelly laterite, below which clayey laterite of varying thickness is normally found. At sea level, the base of cliffs generally reveal (i) original igneous or metamorphic basement rocks (Figure 2A), as identified at Baga, Aguada and south Goa, or (ii) laterite/clay as observed at Anjuna and Cabo de Rama coasts (Figure 2B). The seaward flanks can be abrupt (Aguada), steep (Cabo de Rama) or gentle (Tiracol). The sea facing slopes are mostly vegetated but often bare (Figure 2).

(b) The profiles of cliffs at Varkala in Kerala with laterite/clay base resemble those of Goa, whereas the granitic slopes at Kovalam (Kerala) and Someshwar in Karnata are similar to the crenulated granite – gneiss coast of south Goa.

(c) In Diu, cliffs rise abruptly with thickness of around 25 meters above tidal flats. The entire vertical section is made up of sandstone (Pl. 47).

(d) The coast of Maharashtra exclusively exhibits Deccan Trap formations from the top to the base. Further site-specific geomorphological studies are needed in this region.

Ancient forts in relation to coastal geomorphology

All the majestic forts located at strategic locations atop the coastal headlands form impressive sights at several places of western sea front India (Table 1). The fort of Diu (Pl. 49), Tiracol, Chapora, Aguada and Cabo de Rama forts in Goa, Bekal fort in Kerala (Pl. 50) are some examples of hill top heritage sites. In comparison, the Sindhudurg fort at Malvan in Maharashtra is found at sea level.

Based on the geomorphological characteristics described above, some interesting aspects merit detailed discussions and need scientific investigations:
(a) Lack of setbacks
An intriguing feature from a geomorphological viewpoint is that no setbacks can be identified in case of hill top forts. Several large sea front heritage structures are perched precariously at the edges of cliffs. Cabo de Rama and Diu forts (Pl. 49) are typical examples. Whereas our ancestors observed coastal setbacks as proved by palatial mansions away from low sandy shores, and behind coastal sand dunes, most of the forts are built atop cliffs, close to the seaward edges, at heights ranging from <20 to around 75 meters above sea level. The reasons for the lack of safe setback or buffer zone between the seaward precipices and sea facing walls of forts are not known.

(b) Original location of forts
It would appear that heritage structures were once located away from cliff edges, but are now closer to the water line due to cliff collapse. However, considering the present vulnerable location of some coastal forts, we do not find any geological or historical evidence showing that forts were formerly built away from cliffs.

The forts of Goa are located on laterite plateaux. Of these, the Tiracol fort in north Goa is relatively away from the water line, with an intervening gently sloping, thickly vegetated seaward flank, and hence appears stable. The Aguada fort offers a similar setting, except for the northern boundary wall, which is exposed to direct wave attack. In comparison, the fort at Cabo de Rama is presently found at the edge of a laterite rock face, with parts of sea facing fort walls having crumbled into the sea below. Similarly, the fort of Diu is precariously found at the extreme edge of a sandstone cliff (Pl. 49), with fort walls having collapsed into the sea.

(c) Geomorphological processes and investigations
Most of the sea cliffs along the west coast of India show various degrees of erosion. Depending on the nature and composition of rock types, the base of precipices often reveals various stages of erosive processes. Overhanging cliffs are common. Geological erosive processes are evidenced by the frequent, often localized failure of rock masses as observed in Diu, parts of Goa and Varkala. Similarly, sea caves undermined by wave action are identified directly under the fort of Diu. As a consequence, the large chapel at the southern corner within the fort has collapsed almost 25 meters down into the sea (Pl. 49). Large remnants of fort walls can presently be identified away from the coast, into the sea at Diu.

The sea cliffs are in the process of retreat due to marine erosion (Rao et al., 1985). The Anjuna and Varkala sea cliffs (Pl. 48) with soft clay base are examples where active erosion is observed. The rates of recession of coastal cliffs depend on elevation, rock types and its resistance, structural features, incident wave energy and vegetation.

Erosion is acute in areas influenced by direct wave attack as evidenced by large cracks, boulders and wave cut terraces at the base. Anjuna and Dona Paula in Goa (Nagi, 2002), Varkala in Kerala (Nair, 2005), and Diu are examples of collapsing rock faces of sea cliffs.

Studies to identify coastal geomorphological processes and rates of cliff collapse and retreat are in its infancy, at least for Indian coastal cliffs. Prevailing coastal geological processes, erosive activity, rates of erosion, zones of imminent failure (Nordstrom, 2000) and stretches prone to hazards such as cliff slumping are key factors that can determine the reasons why coastal forts presently find themselves so dangerously close to the water line.

Coastal policies and archeological heritage
Knowledge about geomorphology is imperative for a sustainable development of coastal zones that comprise sensitive ecosystems (Woodroffe, 2002). In our case however, man-made heritage that offers immense tourism potential is of primary concern. This aspect needs due consideration.

Multiple uses of the coastal zone triggers competition and conflicts among human uses. Another aspect of discord is the antagonism between commercial uses and the need for conservation of coastal assets. A heritage of environmental resources, historical and archaeological sites, could allow a substantial development in the sector of heritage tourism (Lezzi, 2001). Coastal man-made heritage of India represents
the country's greatest resources, even if, at the moment, historical sites show signs of degradation. In India, an economic valuation of coastal archaeological heritage, the forts in particular, has rarely been attempted.

Considering the value of these coastal assets in terms of heritage tourism, it is found that appropriate conservation or restoration policies are lacking. The Archaeological Survey of India has declared 3606 monuments of national importance based on Ancient Monuments Act (Anonymous, 1958). Although this national instrument is in force for nearly 50 years, it appears that not much headway is made in restoring ancient forts to their former glory.

The regional plan for Goa 2001 (D'Souza, 1988) had merely stressed about the need for the conservation of artificial heritage. In 1991, the Government of India declared coastal stretches influenced by tidal action up to 500 m from the High Tide Line, as Coastal Regulation Zone (CRZ). The Coastal Regulation Zone (CRZ) of 1991 (MEF, 1991) considers heritage sites as CRZ I; however, no conservation strategies are proposed. An independent National Coastal Zone Management Authority (NCZMA) was reconstituted in 2001 (MEF, 2001) as an implementing, controlling and monitoring authority. Surprisingly, coastal heritage areas were beyond the purview of this apex body.

Although coastal historical sites are offered protection, the CRZ Notification (MEF, 1991) does not consider coastal hill slopes and cliffs of littoral states under the purview of the act. Accordingly, these ecosystems are not regulated (Mascarenhas, 1999, 2000). This is the reason why uncontrolled anthropogenic activity along sea cliffs and slopes is observed at numerous places, the Varkala sea cliff being a prominent example. Rapid development on coastal hill tops is bound to have negative impacts on, and clash with, cliff top heritage conservation sites.

The country also witnessed the emergence of several policy documents. The National Conservation Strategy and Policy on Environment and Development (NSCPED) (MEF, 1992) laments that coastal areas are degraded, but is silent on the conservation or restoration measures of coastal historical sites. Subsequently, the Science and Technology Policy (STP) 2003 was unveiled in concurrence with scientists, technologists, politicians and citizens (Sen, 2003). Man-made coastal heritage does not feature in this document. In comparison, the National Environment Policy (NEP) of 2004, presently in draft stage (MEF 2004) stresses about the conservation of man-made coastal heritage and its sustainable use through its tourism potential. Heritage sites with "incomparable values" would merit stricter standards.

The Regional Plan for Goa 2011 (Anonymous, 2003) is the most recent document devoted to the resources of Goa. The document outlines detailed strategies for conservation including framing of a policy on heritage buildings more than 100 years old. A radius of 100 m is declared as conservation zone.

Although the effort on archeological heritage is commendable, certain flaws are noticed. Whereas the Tiracol and Cabo de Rama forts are owned by the Government, Chapora fort is classified as private. In comparison, the Aguada fort, categorized as a protected monument, is under the charge of central government, and hence not listed in the regional plan for Goa 2011. Multiple authority over the conservation of forts seems to one of the causes responsible for the deterioration of man-made heritage structures of Goa. Nevertheless, prohibition on the location of industries in Murud -

In view of the above, it appears that the existing instruments are found deficient in the wake of heritage conservation. Except for CRZ (MEF, 1991) that protects near shore ecosystems by regulating development, the country does not have a coastal (man-made) heritage conservation policy. Such discrepancies merit attention and call for a dialogue particularly in view of the fact that the sea front forts are in various stages of degradation and some in ruins. Herein lies the need to examine whether new regulations have to be formulated, or whether existing strategies need a revamp.

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References


Plate 47. A 40 meter high cliff within the Zuari estuary at Dona Paula, Goa; large cracks make such precipices vulnerable to collapse (Photo: H. Nagi);

Plate 48. The cliff at Varkala, Kerala, is in the process of continuous erosion as the base is composed of soft clay (Photo: A. Mascarenhas)
Plate 49. Forts atop sea cliffs: (4A) The chapel (in the background) within the fort of Diu on the verge of collapse due to severe erosion of sandstone cliffs (Photo: A. Mascarenhas);

Plate 50. The seaside wall of Bekal fort (Kerala) on a granite bedrock appears relatively stable (Photo: Kerala Tourism).