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The state of coastal sand dunes of Goa: anthropogenic impacts and management

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Components of this presentation

- Geological evolution and functions of coastal sand dunes
- Examples of human interference on coastal landforms
- Comments on coastal erosion
- Conservation and management needs
Geological evolution of coastal sand dunes
Age of coastal dunes of Goa:
A natural heritage
Functions Of Coastal Sand Dunes

- Nature’s first line of defense
- Serve as sand “banks”
- Sources of beach nourishment
- Dissipate wave energy
- Maintain coastal equilibrium
- Protect coasts from erosion
- Ecological storehouses
- Features of coastal stability
- Guard against sea level rise
- Shield mankind from forces of the ocean
Wave dissipation by sand dunes

1. Typical wave action

Dune

Beach

Erosion line

Waves are generated by deep ocean currents, winds and rotation of the earth.
Human interference on coastal dunes

- CRZ Violations in every respect
- Constructions / Buildings on Dune Fields
- Dune Sand Extraction
- Roads on Sand Dunes
- Beach Shacks
- Uprooting of Dune Vegetation
- Salt Water Extraction / Ingress
- Recreation on Dunes
- Litter on Beaches
IMPACTS OF CONSTRUCTION ACTIVITIES IN CLOSE PROXIMITY TO THE MARINE ENVIRONMENT

The field surveys undertaken during the survey of ecossensitive coastal areas of Goa show trends outlined in the flowchart depicted below:

Source: Sawkar et al., 1998
Human impacts on coastal dunes of Goa
How it started - scenario in 1996
Draft RP vs. Final RP

(Source: Goa Govt. website)

(Source: Goa Bachao Abhiyan)
Example: Natural landforms saved life as houses behind high vegetated dunes are all intact; gaps on dunes however facilitated marine transgression.

(Source: Mascarenhas and Jayakumar, 2008)
Natural protection is the cause of disaster; all houses along the beach were smashed; loss of life was heavy; road to beach served as a pathway for tsunami water.

(Source: Mascarenhas and Jayakumar, 2008)
Coastal erosion – historical
(ongoing work / unpublished data)

<table>
<thead>
<tr>
<th>Year</th>
<th>Site</th>
<th>Impacts</th>
<th>Reference</th>
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<tbody>
<tr>
<td>1932</td>
<td>Caranzalem</td>
<td>Sea wall eroded</td>
<td>Lobo, 1985</td>
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<td>1966</td>
<td>Colva</td>
<td>Beach scarps</td>
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<td>1974</td>
<td>Miramar</td>
<td>Coconut trees collapsed</td>
<td>Untawale, 19xx</td>
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<td>1996</td>
<td>Anjuna</td>
<td>Dunes leveled</td>
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<td>1996?</td>
<td>Rajbag</td>
<td>1m high scarp in dune</td>
<td>Field observations</td>
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<td>2002</td>
<td>Dona Paula</td>
<td>Collapse of a laterite sea cliff</td>
<td>Field observations</td>
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<td>2004</td>
<td>Coco beach</td>
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<td>2005</td>
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<td>2006</td>
<td>Sinquerim Kerim</td>
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<td>Goa Gov website</td>
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<td>2007</td>
<td>Sinquerim Galgibaga Kerim</td>
<td>Casuarina trees</td>
<td>Goa Gov website</td>
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<td></td>
<td></td>
<td>Casuarina trees 1600 m of coast</td>
<td></td>
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<td>2008</td>
<td>Sinquerim</td>
<td>Massive erosion, 60-90 m shift in coastline</td>
<td>Babu et al., unpublished data</td>
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<td>2009</td>
<td>Anjuna, Sinquerim, Majorda, Agonda, Galgibaga</td>
<td>Coastal laterite sea cliff, Dunes ???????, 1m high scarp in dune, Coastal trees uprooted, Casuarina trees</td>
<td>Herald Field observations Herald Herald Herald The Navhind Times</td>
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<tr>
<td>2010</td>
<td>Sinquerim, Utorda, Majorda</td>
<td></td>
<td>Herald, 23 July Herald</td>
</tr>
</tbody>
</table>
Wind direction and intensity
Winds, tides, erosion
Effects of storm waves on:
(1) dune coasts, (2) built-up coasts
Sand dunes: before and after a (natural) extreme event

[Source: USGS]
Severe coastal retreat due to erosion at Sinquerim (2007) (unpublished data)
Sinquerim coast - area eroded

May 2008

Legend
- coastline_06
- coastline_97
- Area Eroded

(unpublished data)
Installation of geotubes or sea walls: Is this the management option?

Candolim 2009

Campal 2008
Scenario 1: A human altered coast- dunes are leveled, forests are cleared, dwellings too close to water line, setbacks lacking

[Source: Mascarenhas, 2006]
Scenario 2: Drastic landform changes after extreme events – breaching of dunes, formation of new water bodies, demolition of sea front structures, uprooting of sea walls

[Source: Mascarenhas, 2006]
Scenario 3: Restoration of a damaged coast – dunes are rebuilt, forests are extended, roads are redesigned, buildings are relocated, adequate buffer zones are designated

[Source: Mascarenhas, 2006]
The lost dune at Miramar
Dune restoration
< SOFT OPTIONS >
Natural coastal ecosystems, hazard rating, adaptation

(Source: Pilkey et al., 2000, modified)
In Summary

Considering the inherent natural protective ability of coastal landforms,

I fervently appeal to the media to make a very strong case for coastal sand dunes of India

So that these features can be preserved for posterity
That’s All Folks
THANK YOU