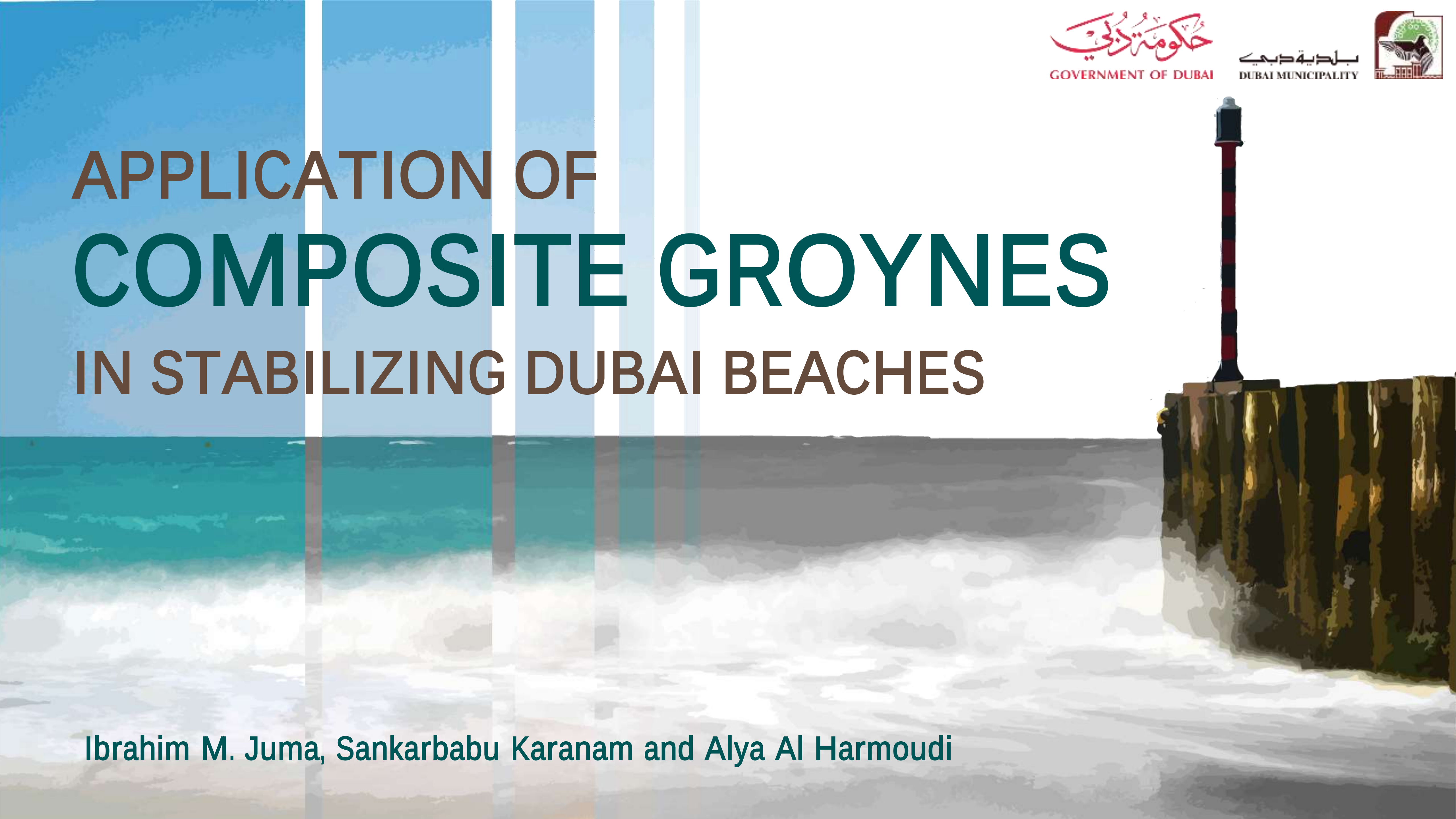
حكومة دبي
GOVERNMENT OF DUBAI

بلدية دبي
DUBAI MUNICIPALITY



APPLICATION OF COMPOSITE GROYNES IN STABILIZING DUBAI BEACHES

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Outline

Dubai Coastal Zone

1

Introduction to Dubai Beaches

Location Map

Dubai Coast

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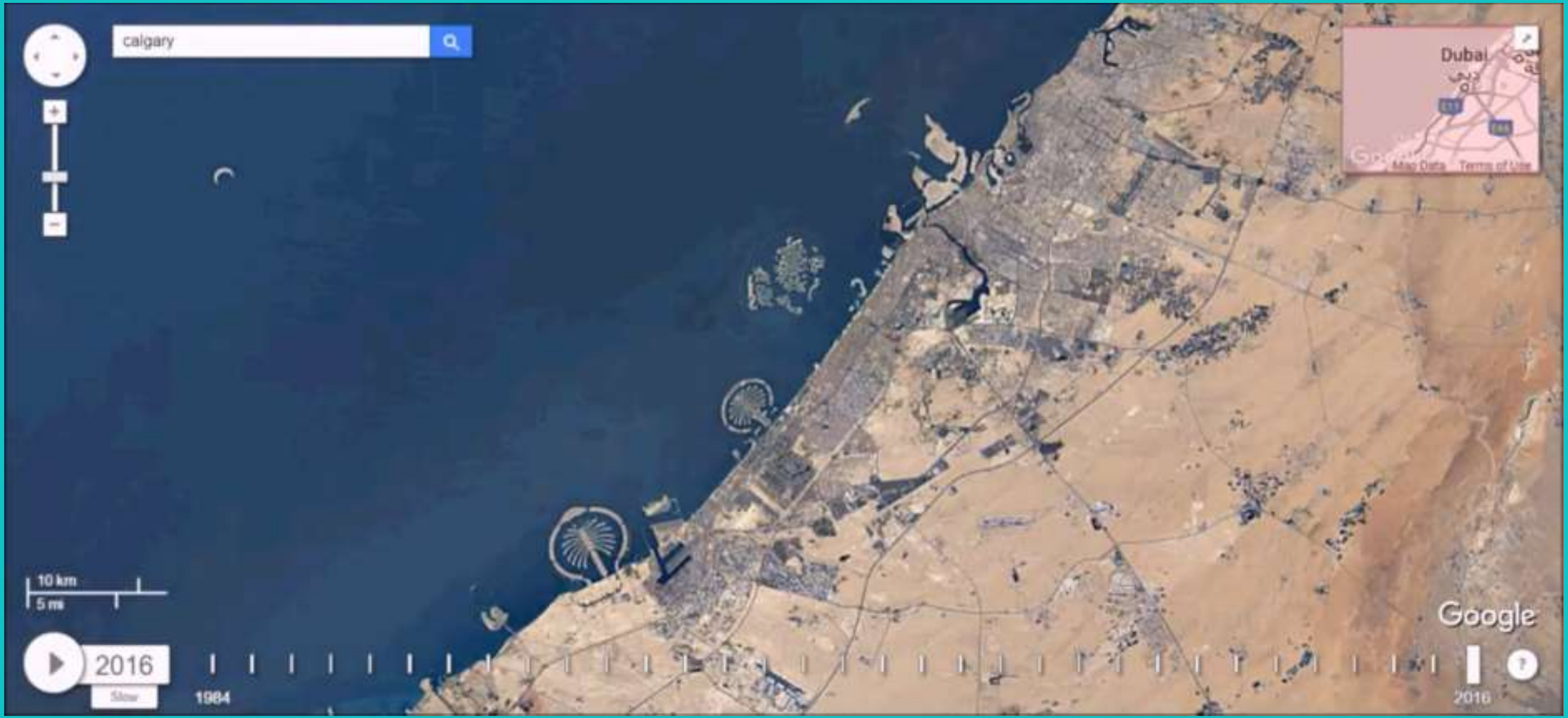
Due to recent (post Year 2000) coastal developments along the Dubai Coast, the length of the coastline has exponentially increased from 75 km to more than 1200 km.



Deira Islands	18.87 km²	Island 2	0.83 km²	HH Island at Al Sufouh	0.02 km²	Palm Jebel Ali	15.28 km²
The World	9.84 km²	R999 Peninsula	0.26 km²	Palm Jumeirah	8.41 km²	Dubai Waterfront	3.12 km²
Dubai Maritime City	2.37 km²	Private Island at Jumeirah	0.13 km²	Dubai Promenade	0.17 km²		
Pearl Jumeirah	0.73 km²	Porto Dubai	0.1 km²	Blue Waters	0.44 km²	**Total**	**64.02 km²**
La Mer	0.71 km²	Burj Al Arab	0.03 km²	Jebel Ali Port	2.7 km²		

Offshore Projects

Impacts of Offshore Reclamation Developments

2

Offshore Reclamation Projects

Impacts

— Pre-ODS
— Post-ODS

* Equilibrium orientation is defined as the beach orientation that gives a net annual littoral drift equal to zero

Case Study 1

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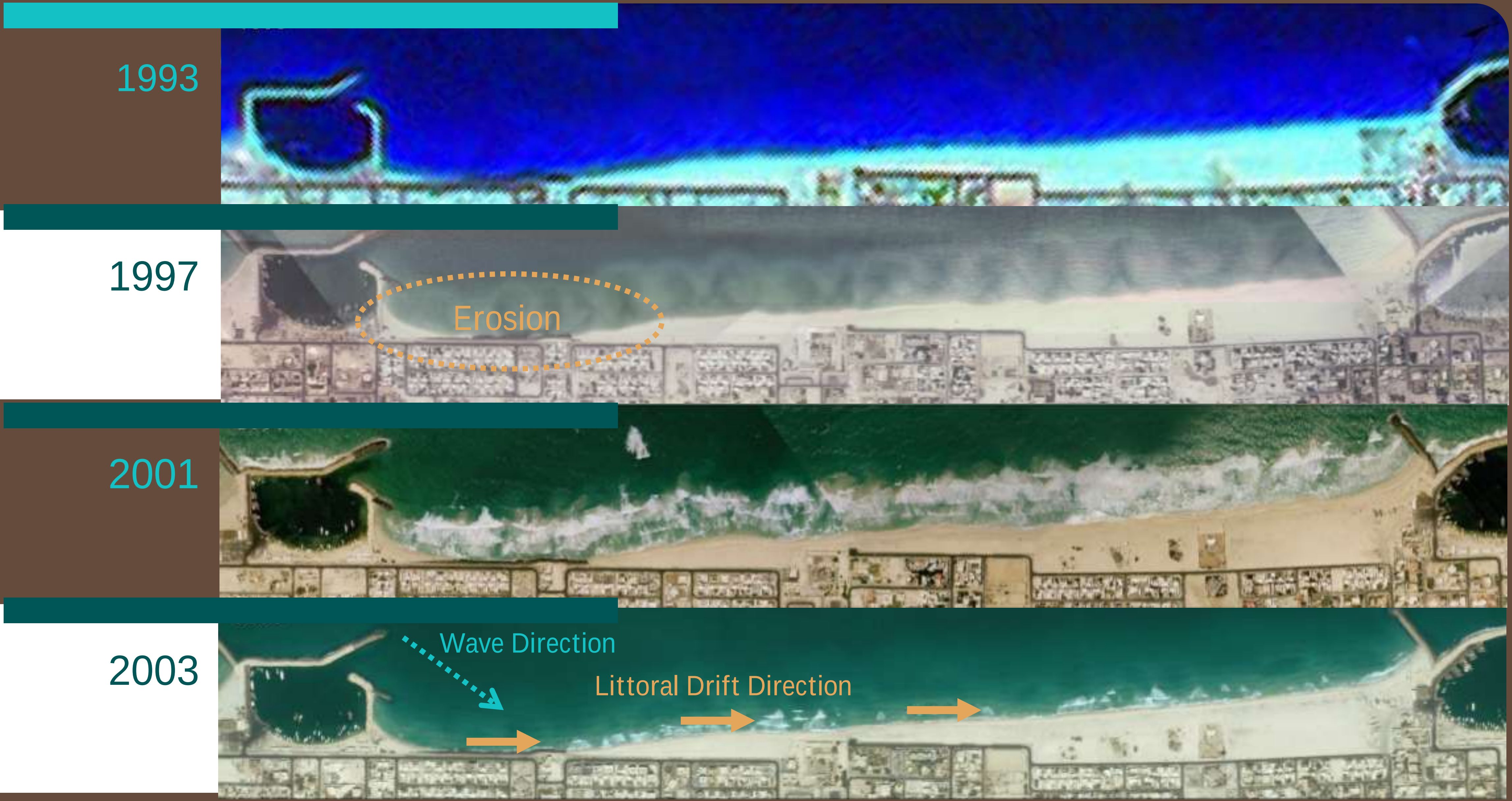
Umm Suqeim Beach

Um Suqeim Beach

Historical Shoreline Evolution



Status of Shoreline

2003

Historical Shoreline Evolution

2004
April

2004
July

2005
April

2005
October

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Status of Shoreline

2004 to 2005

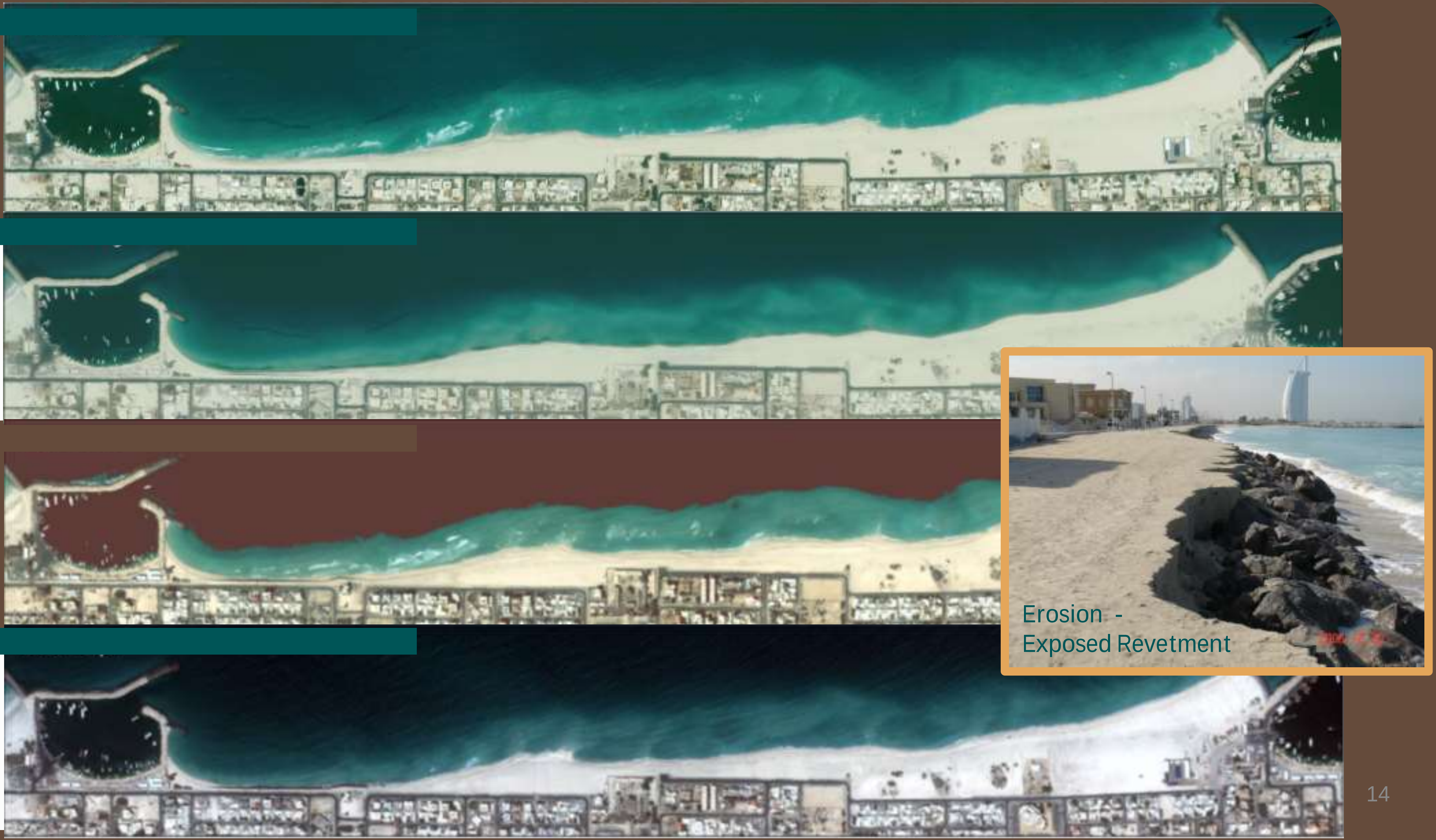
Historical Shoreline Evolution

2006
May

2006
August

2006
December

2007
April



Erosion -
Exposed Revetment

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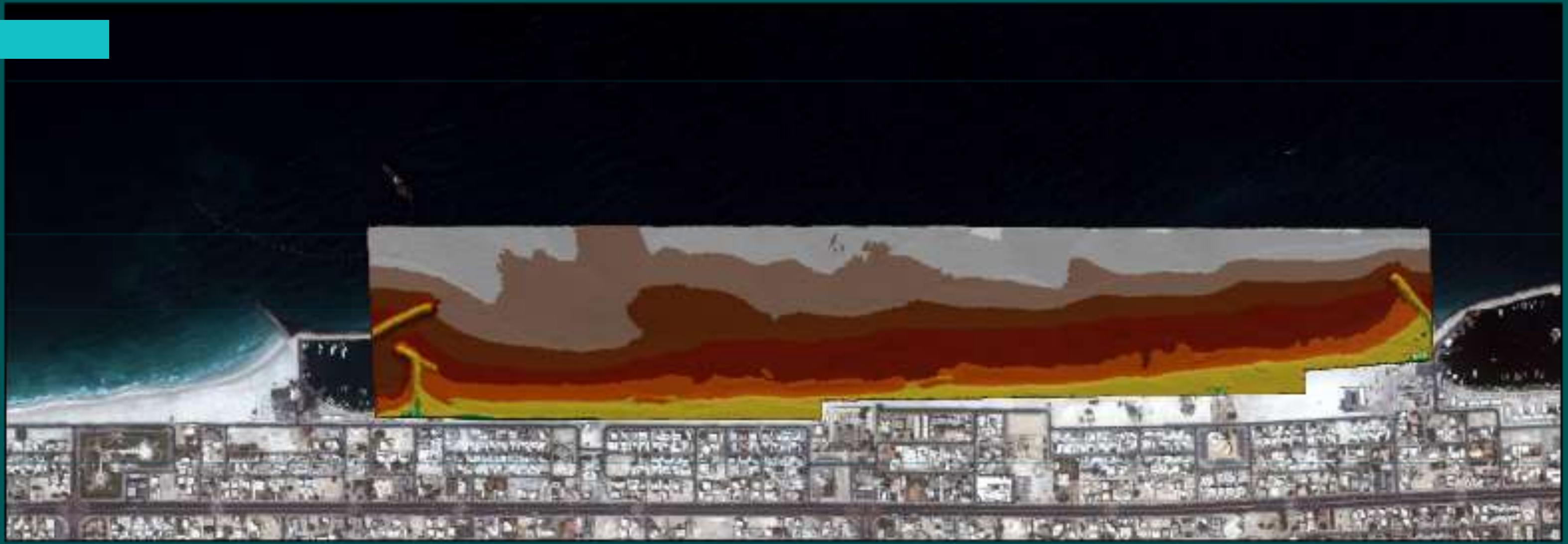
Volume Changes Analysis

Lidar Data 2007 and 2013

2007

Elevation (M DMD)
- 10 - 12
- 8 - 10
- 6 - 8
- 4 - 6
- 2 - 4
- 0 - 2
- -2 - 0
- -4 - -2
- -6 - -4
- -8 - -6
- -8.59 - -8



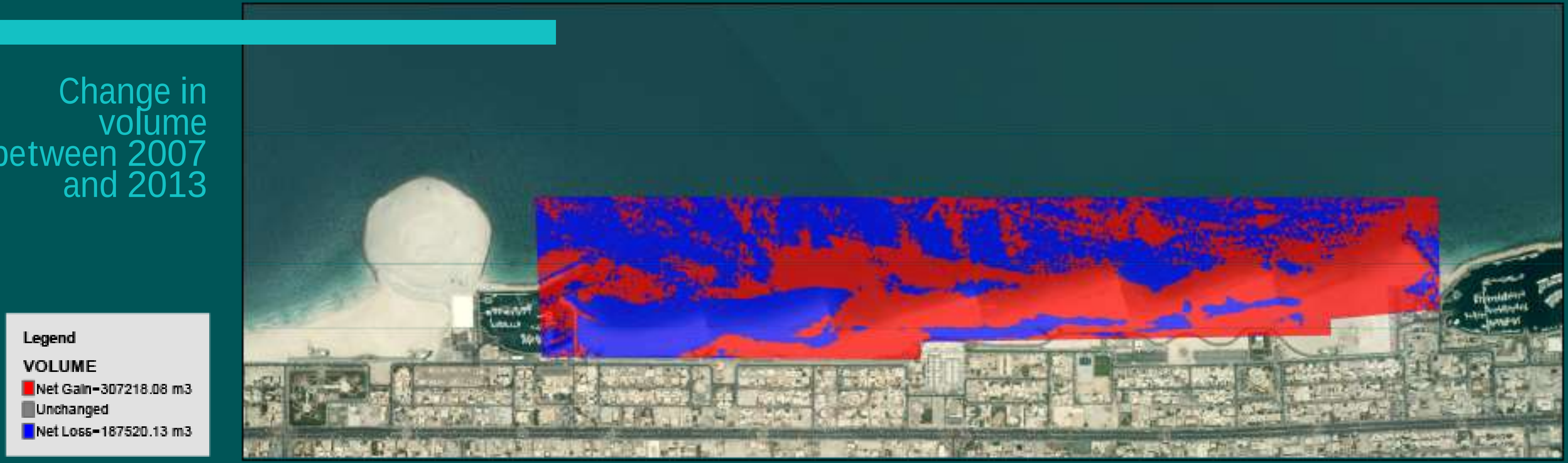
2013

Elevation (M DMD)
- 10 - 12
- 8 - 10
- 6 - 8
- 4 - 6
- 2 - 4
- 0 - 2
- -2 - 0
- -4 - -2
- -6 - -4
- -8 - -6
- -8.392 - -8

Volume Changes Analysis

Lidar Data 2004 and 2007

Change in volume between 2007 and 2013

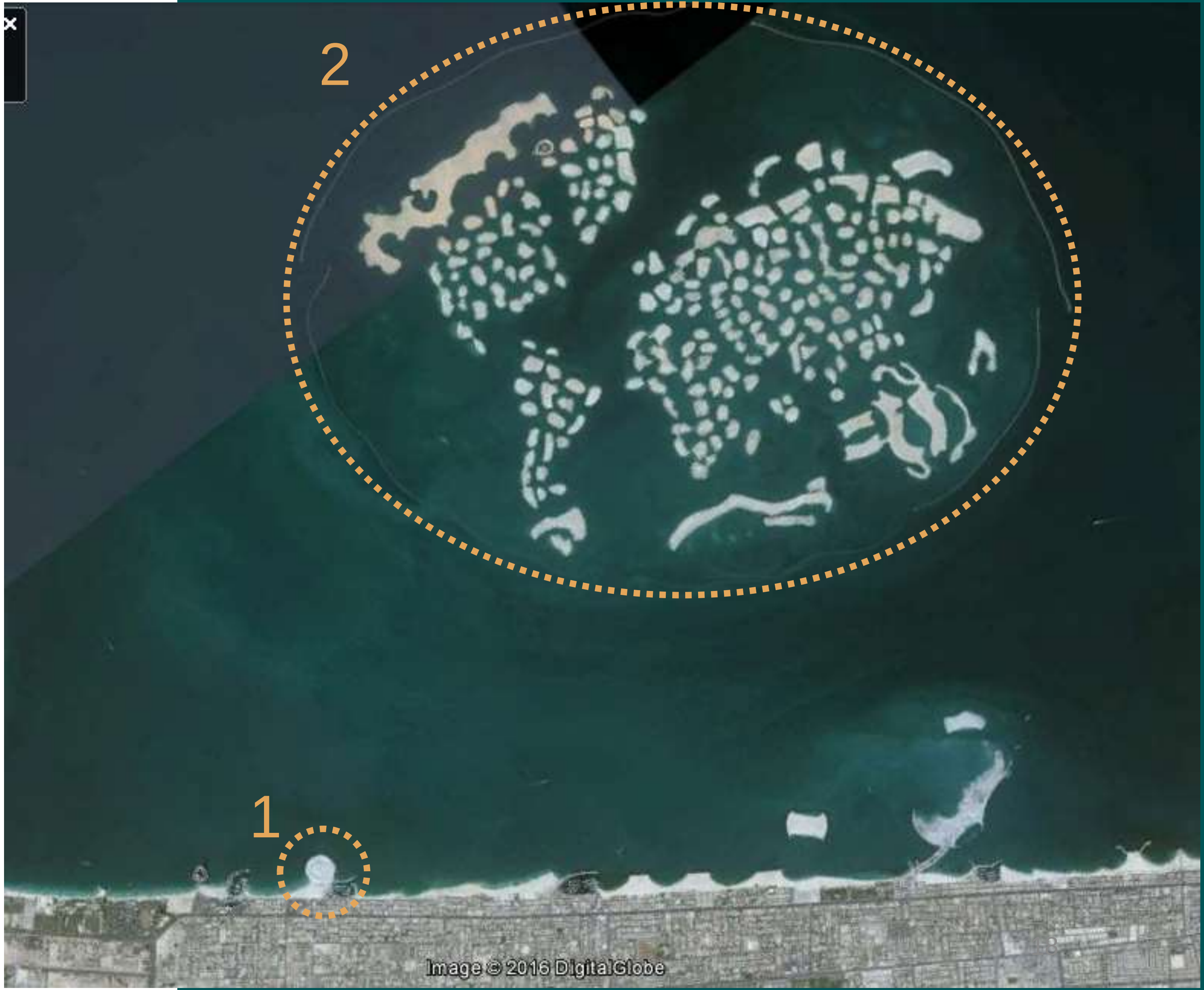


Historical Shoreline Evolution

Causes of erosion

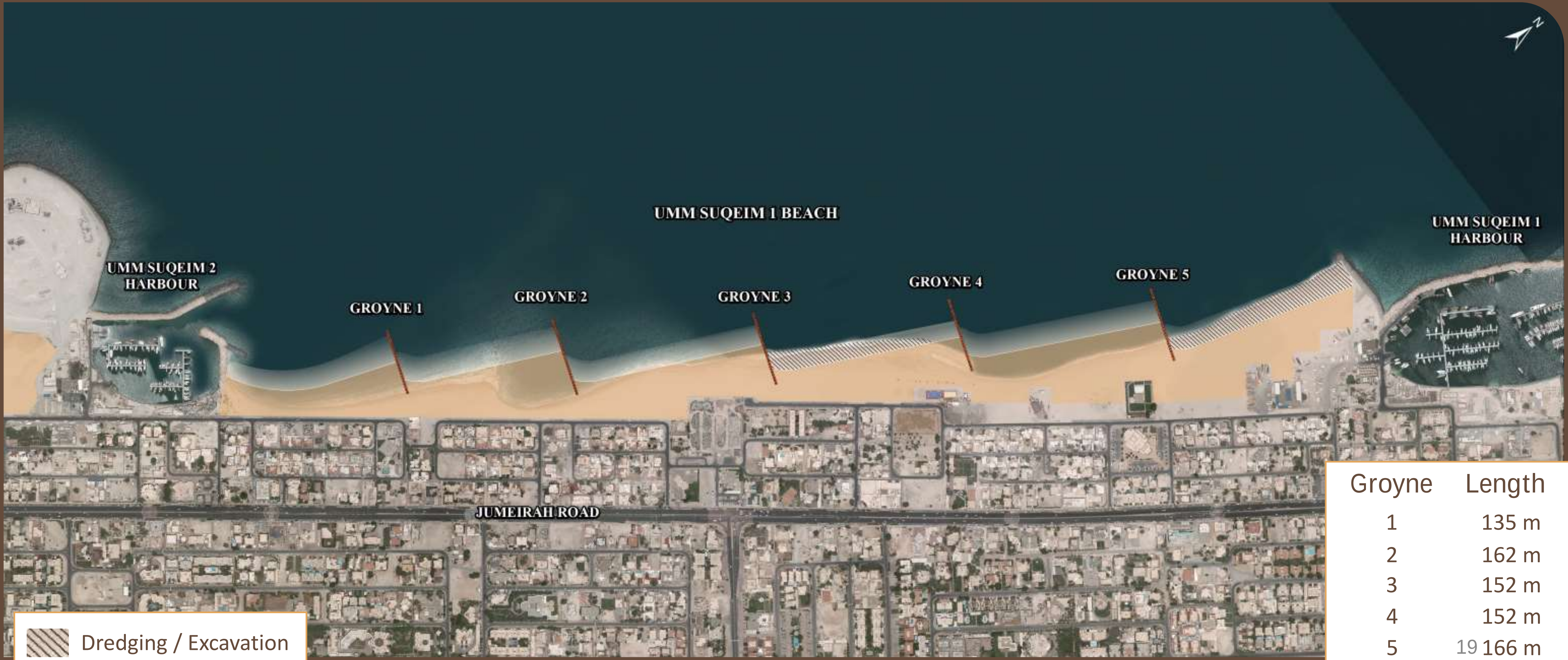
1. Obstruction to littoral drift by the breakwaters of Umm Suqeim 1 fishing harbor

2. Effect of ‘ THE WORLD’ Islands – Change in wave direction and affecting the equilibrium beach orientation



New Stabilization Scheme

Series of Composite Groynes Coupled with Beach nourishment



Groyne	Length
1	135 m
2	162 m
3	152 m
4	152 m
5	166 m

Shoreline Evolution Modeling

Input Data

- Bathymetry →
- Offshore Wave Data →
- Wind →

Wave Model

↓

Nearshore Wave Climate

↓

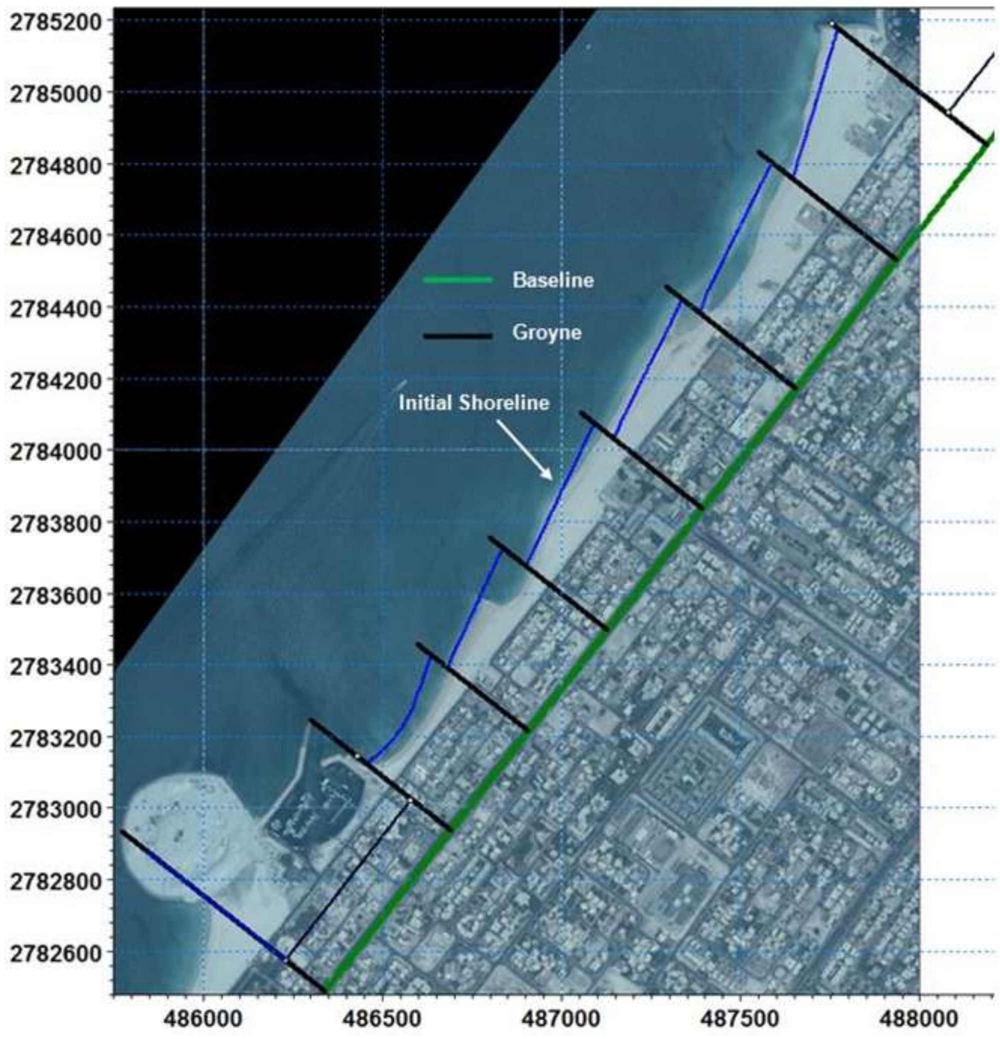
Input Data

- Initial Coastline →
- Cross Shore Profile →
- Sediment Characteristics →
- Coastal Structures →

LITLINE Model

↓

Shoreline Evolution



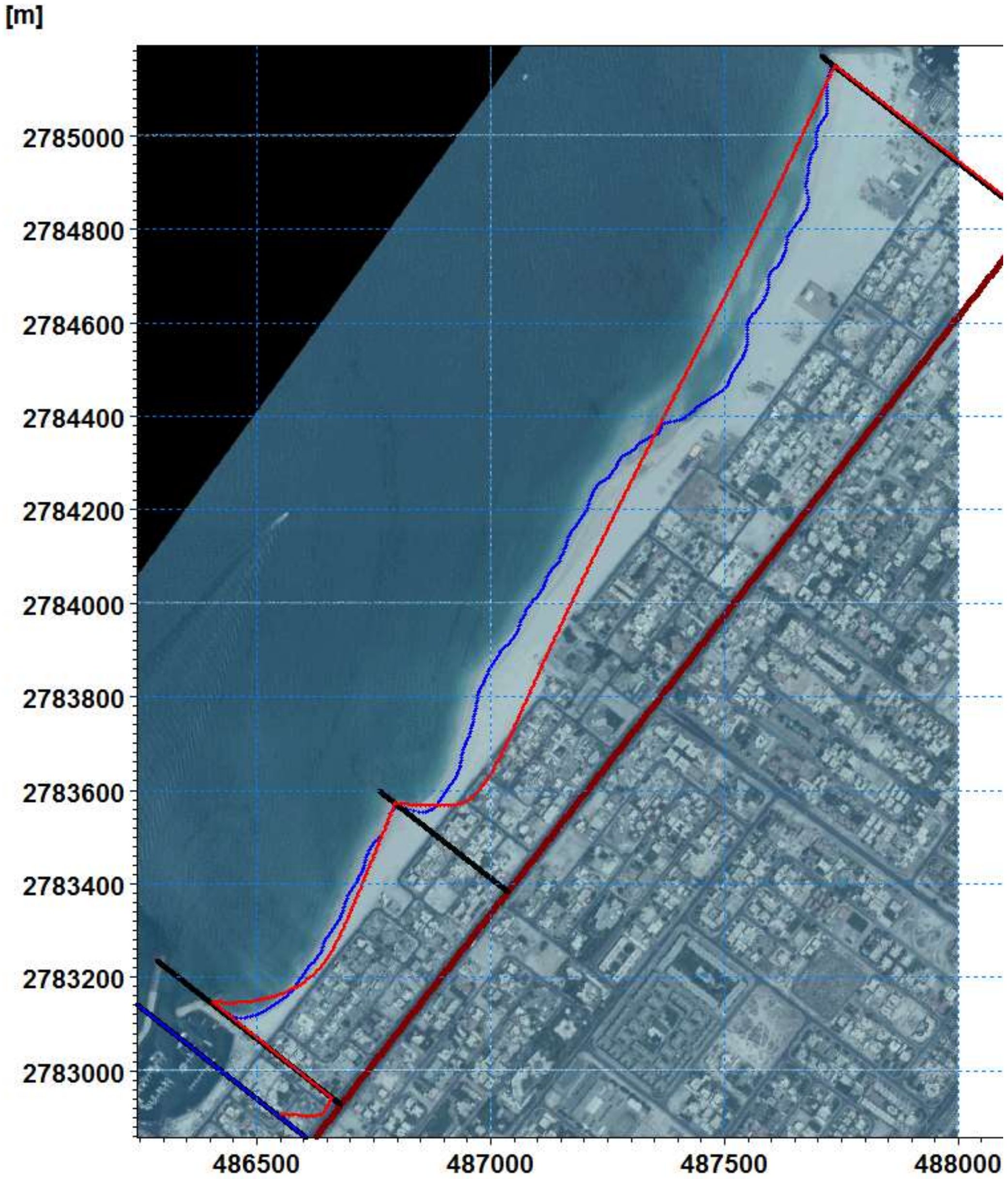
LITLINE model setup

Shoreline Evolution

Do nothing scenario

Initial

10 years

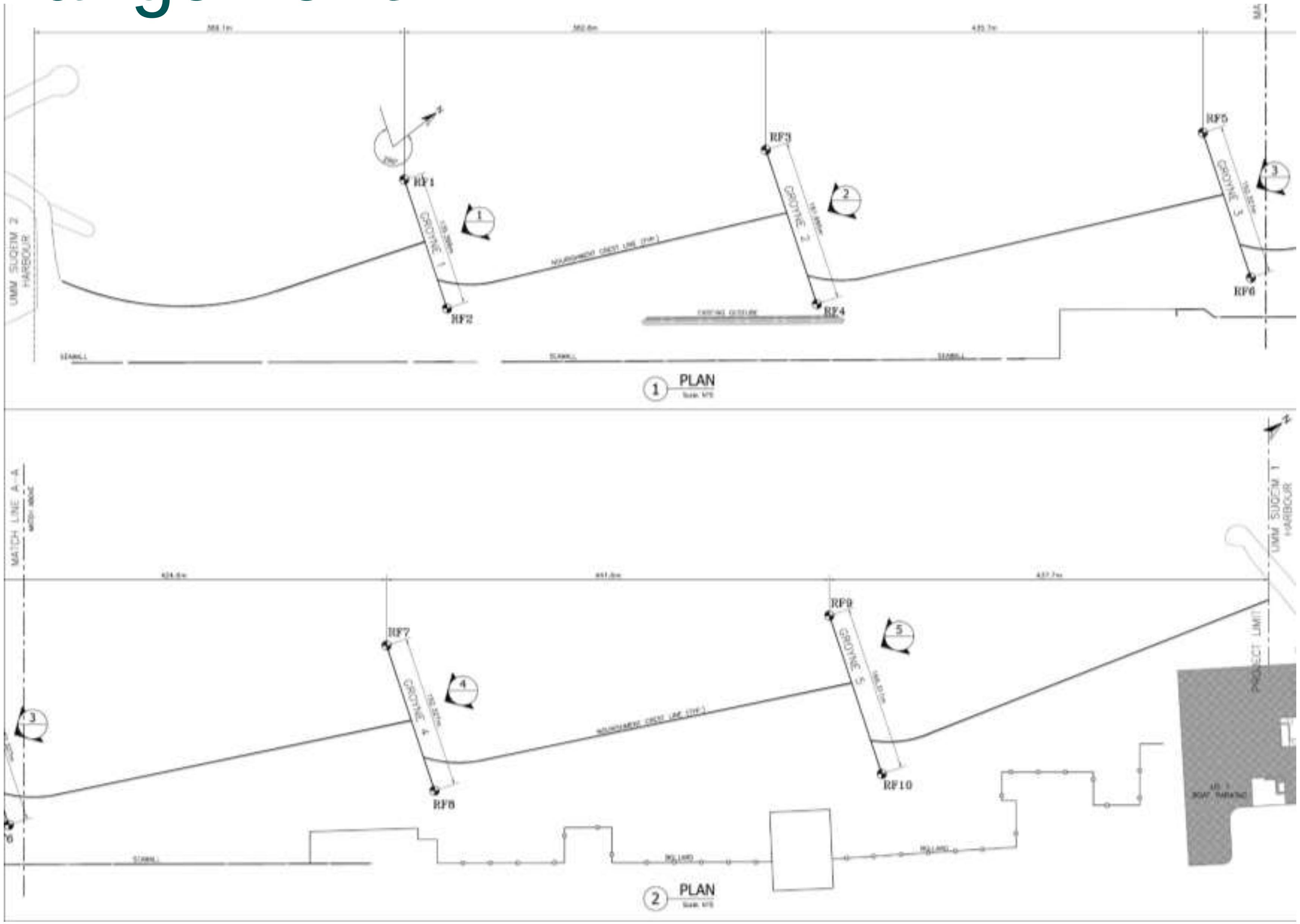


Shoreline Evolution
With Stabilization Scheme

Legend:
- Initial
- 1 Year
- 5 Years
- 10 Years

General Arrangement

Minimum dry beach width is 40 m from the existing corniche



Groynes

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Types of Groynes

Selection of Groyne Type

Types of Groynes

- Rock
- Steel sheetpiles / Tubular piles
- Geotubes
- Timber

Advantages of Timber Groynes

- Less foot print compared to conventional rock groyne
- Aesthetic look

Drawbacks of existing concepts of Timber Groyne

- Limited to shallow water depths, as procuring logs of uniform dimensions beyond certain length (>6m) is impractical
- Frequent maintenance required for the steel fixtures and planks

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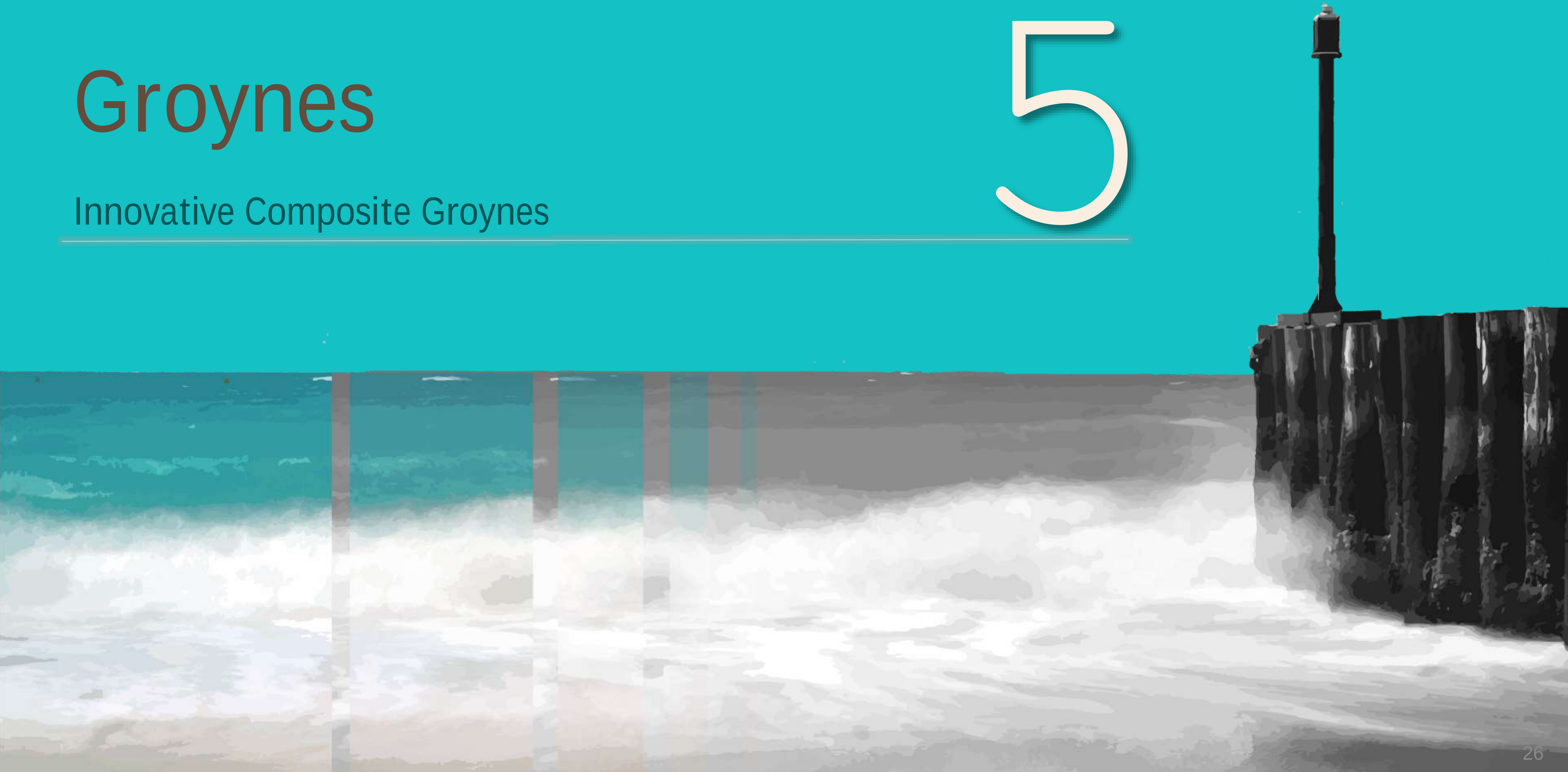
Groynes

Innovative Composite Groynes



Innovative Composite Groynes

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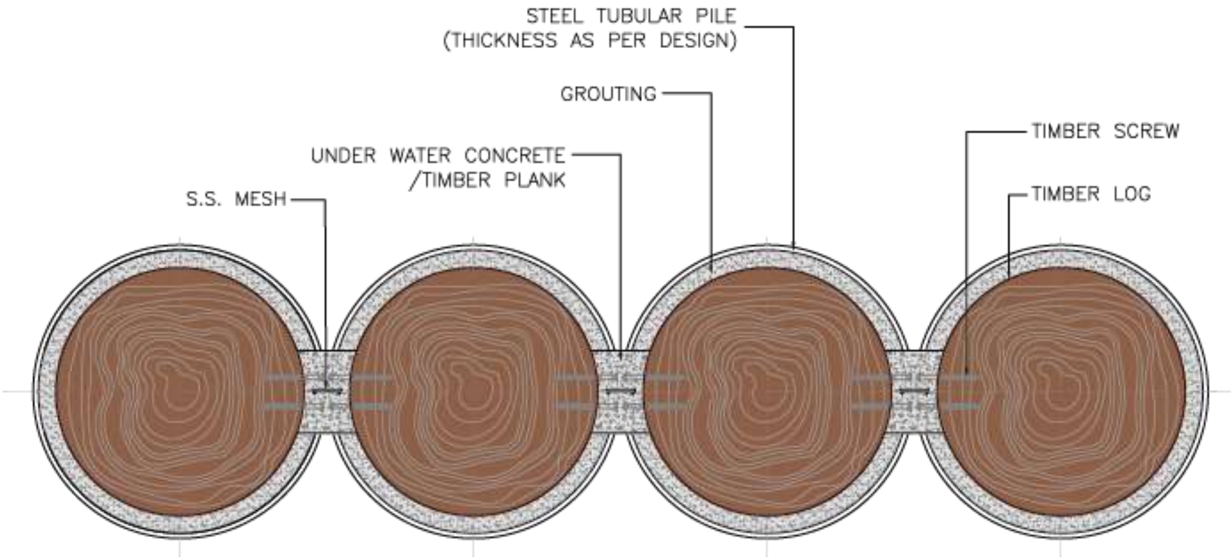
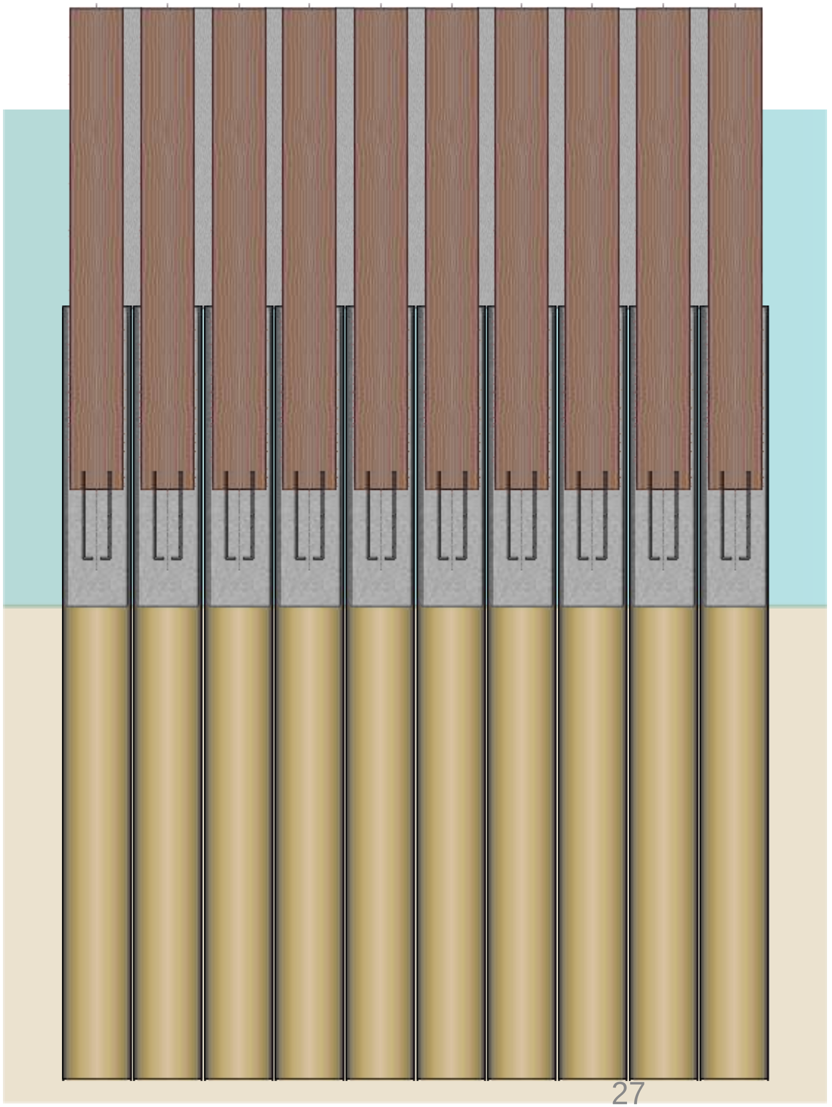
Composite Groynes

- Timber logs fixed to continuously driven steel tubular piles
- Timber logs are plugged through fresh concrete, partially filled inside steel piles
- Gap between successive logs is filled with concrete to form an impermeable groyne

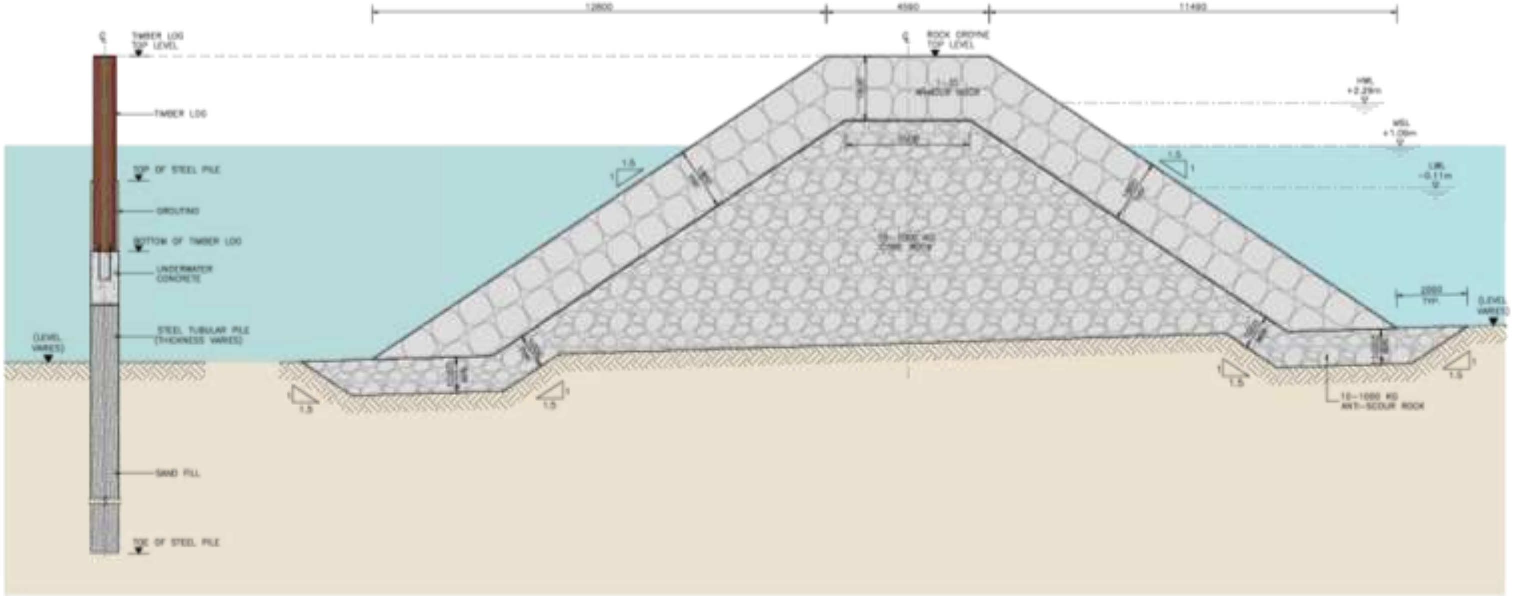


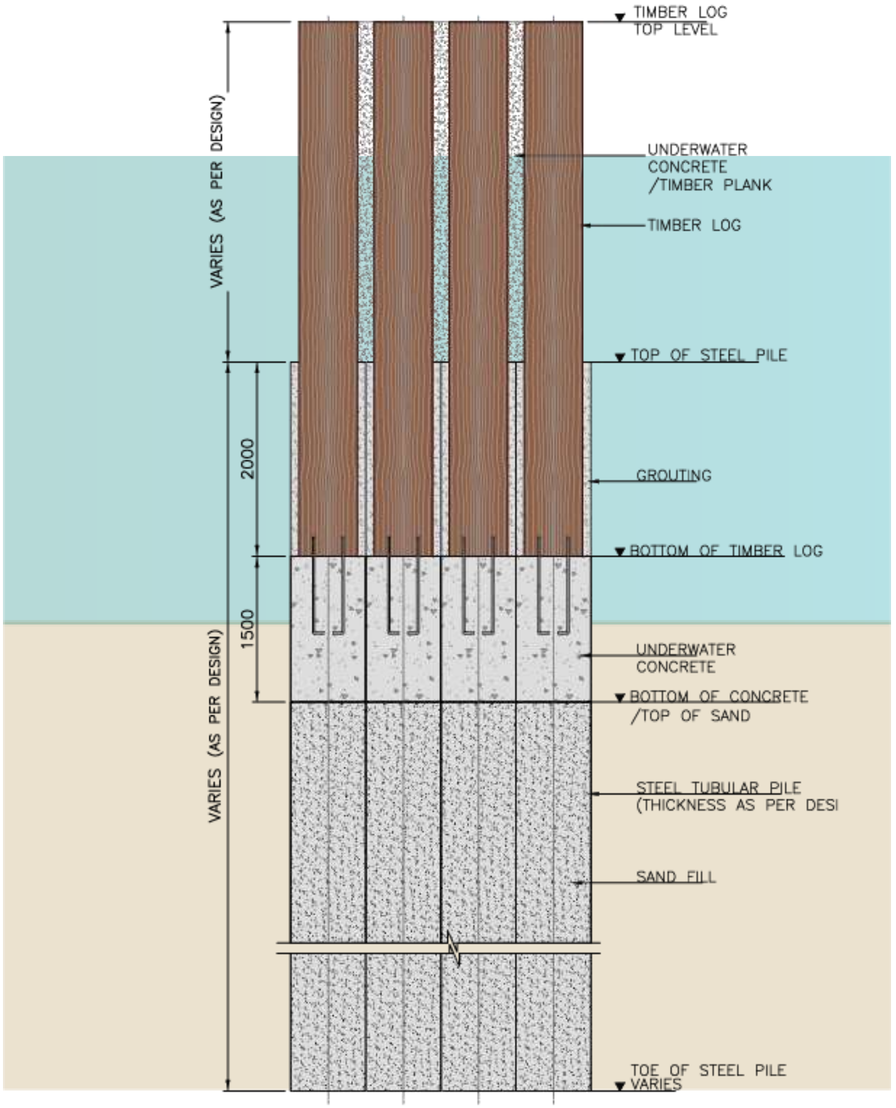


Innovative Composite Groynes

Advantages of Composite Groynes

- Less foot print compared to conventional rock groyne
- Maintain aesthetic look
- Strength derived from steel piles and procuring steel piles of required lengths and mechanical properties is practical.
- Planks & steel fixtures are eliminated – meaning reduced maintenance





Functional Design

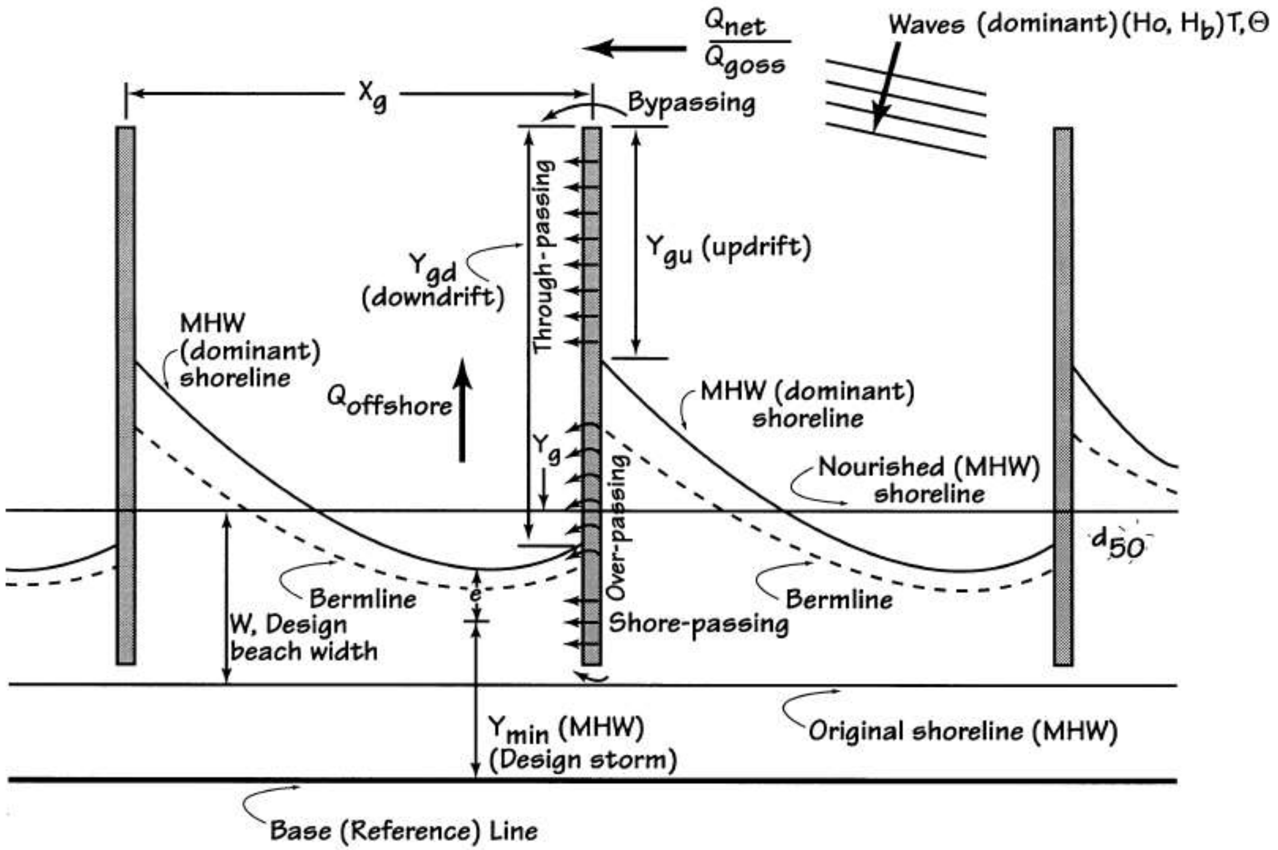
$\frac{\text{Length}}{\text{Spacing}}$ } Xg / Yg = 2 to 3

Permeability → Impermeable

Orientation → Normal to the shoreline

Grain size D_{50} → 0.2mm to 0.3mm (reclamation fill)

Min. dry beach width → 40 m from the existing corniche



Groynes

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Aplication of Composite Groynes

Umm Suqeim Beach

Structural Design of Groynes

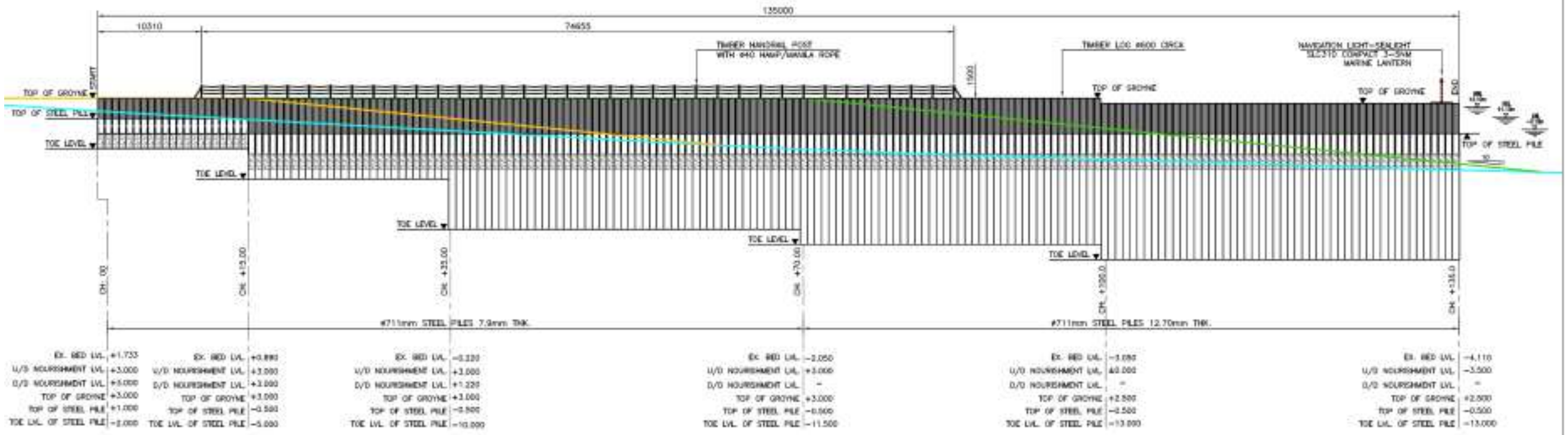
Disturbing Forces

- Active earth pressure from updrift side
- Wave impact – Goda`s Method
- Bed scour (reduction in penetration depth)

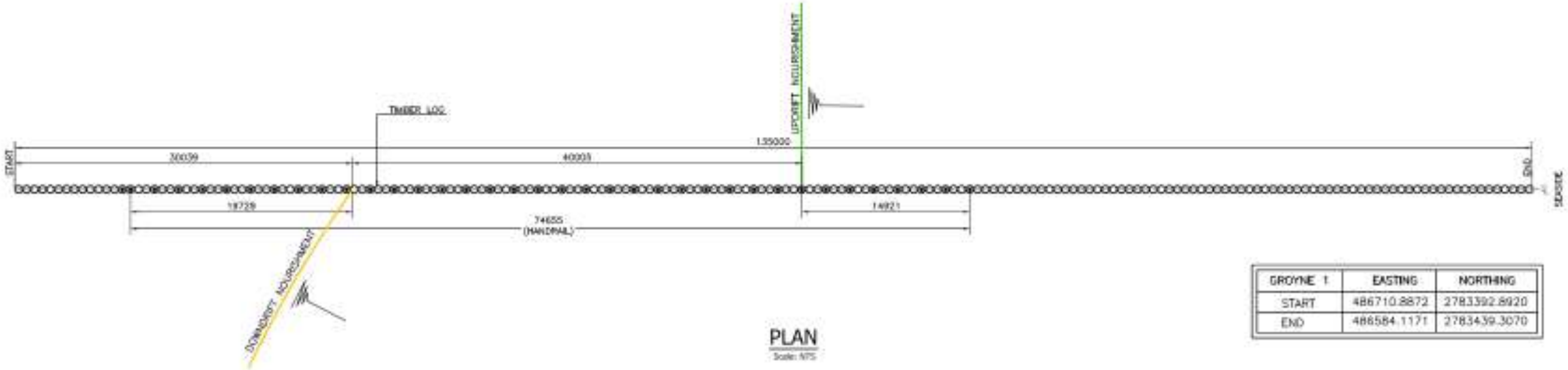
Stabilization Forces

- Passive earth pressure from downdrift side

Design of Composite Groynes



VIEW 1 - ELEVATION
Scale: NTS



GROYNE 1	EASTING	NORTHING
START	486710.8872	2783392.8920
END	486584.1171	2783439.3070

PLAN
Scale: NTS

Construction Sequence

Stage 1 - Temporary cofferdam using steel sheet piles to enable pile driving and timber log installation

Stage 2: Driving Steel Tubular Piles

Stage 3: Preparation of Timber Logs

Stage 4: Fixing Timber Logs

Stage 5: Grouting the gap Between the Timber Logs

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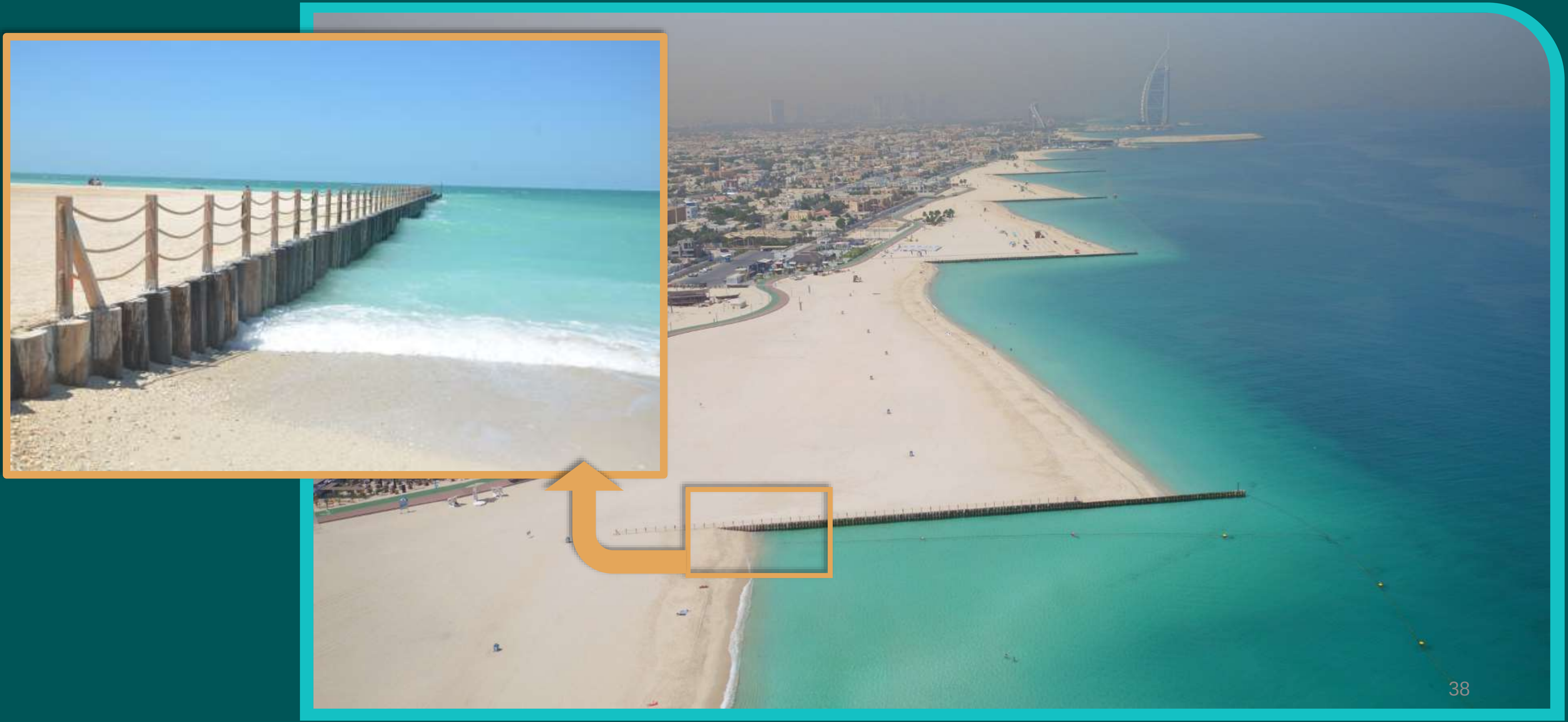
Upon Completion



Upon Completion

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Project Outcome

2014

Pre implementation

2015

Post Implementation

Performance of the Implementation scheme

Shoreline comparison – Predicted vs. Measured – February 2016

Shoreline Monitoring Till Date

Recreational Uses

After Completion of Stabilization Scheme






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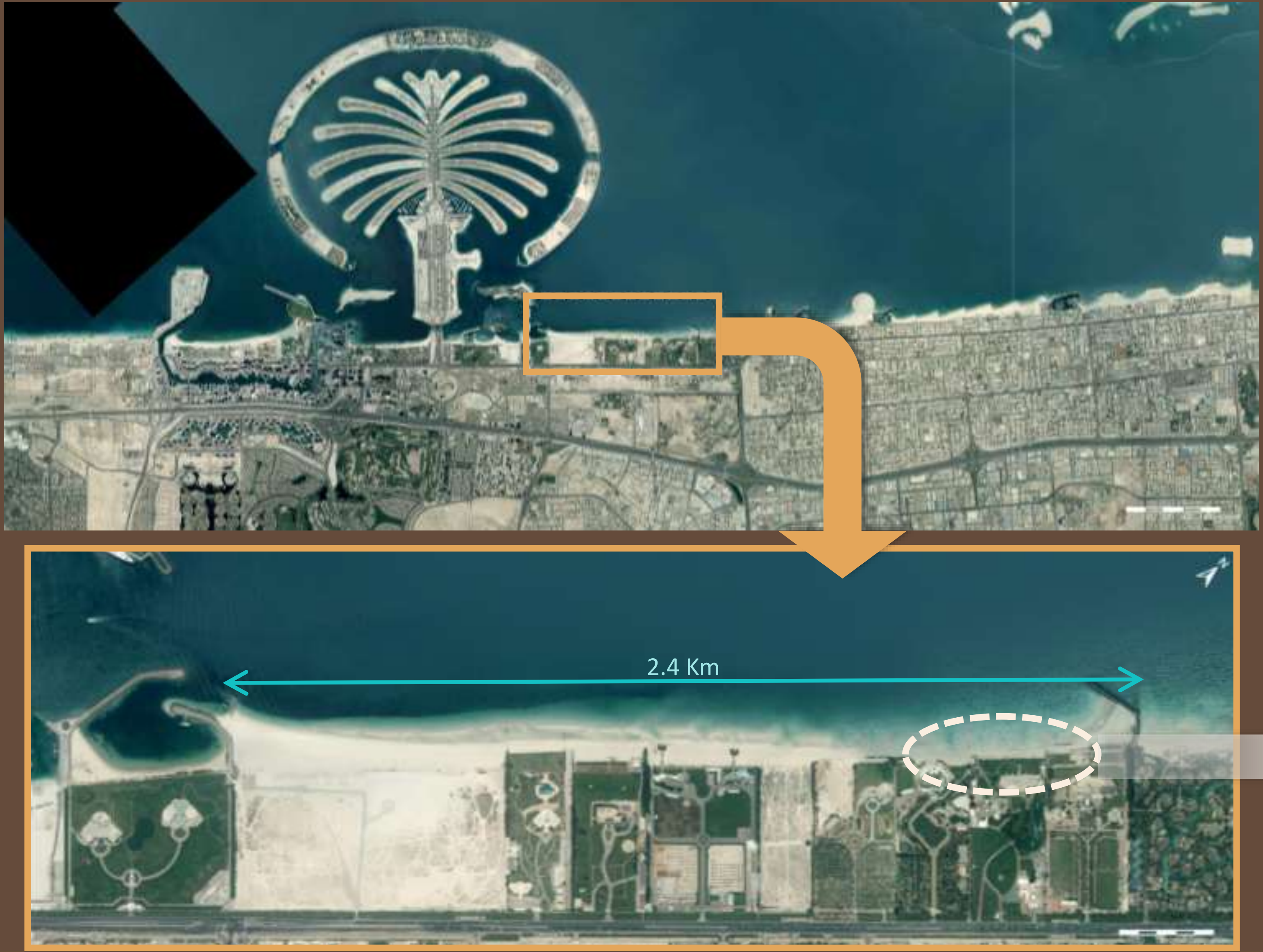
Case Study 2

Al Sufouh Beach

Al Sufouh Beach



Al Sufouh Beach

Do nothing scenario

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Al Sufouh Beach
Stabilization Scheme

Groynes

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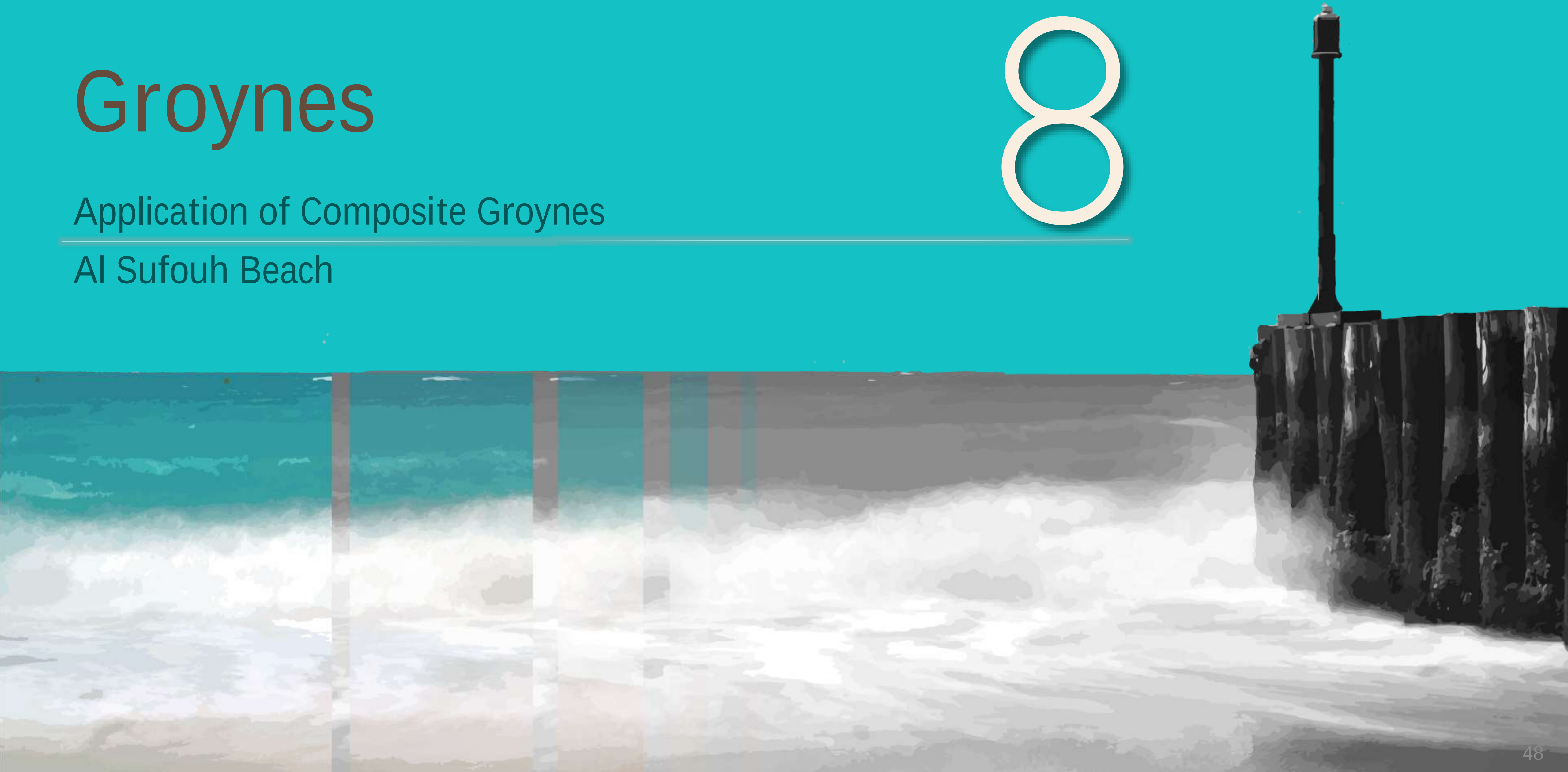
Application of Composite Groynes

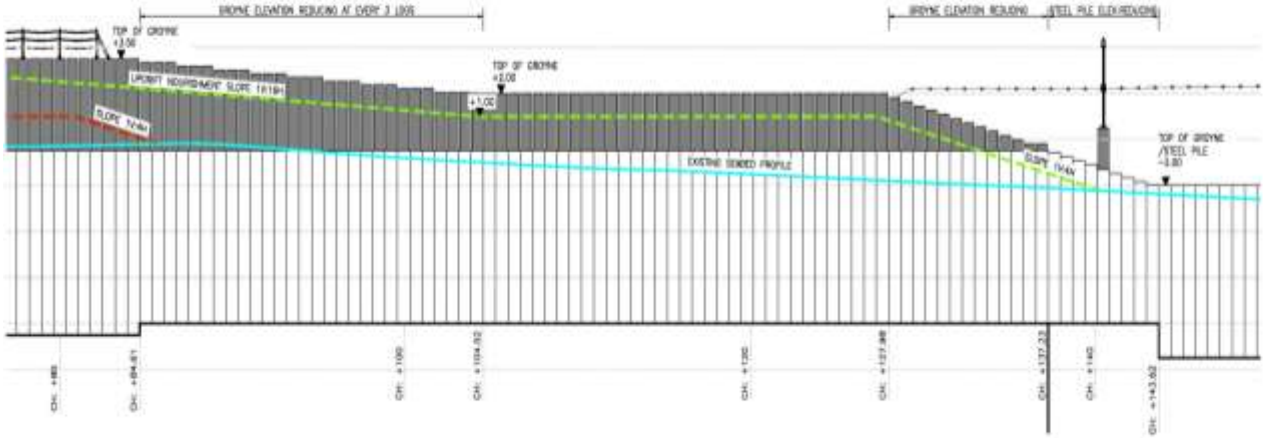
Al Sufouh Beach



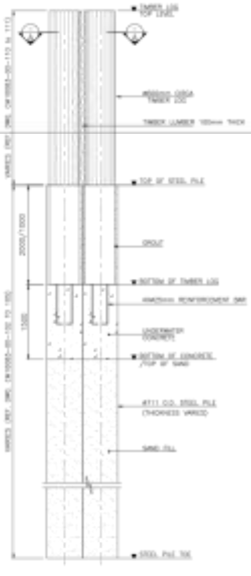
Stabilization Scheme

Design Improvements:

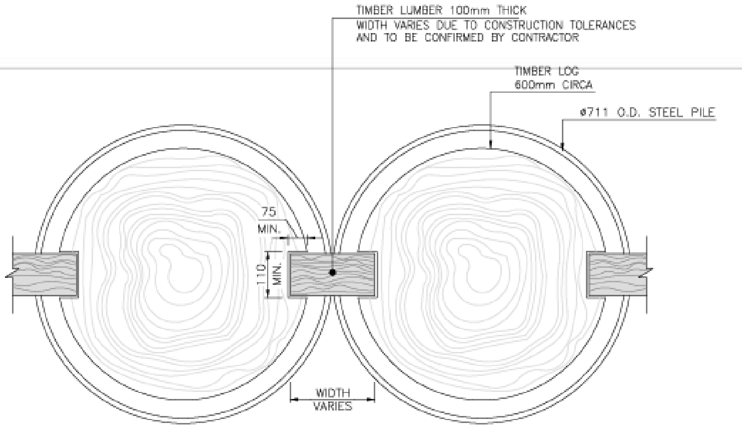
- **Gradually varying type.** Groyne top level follows the proposed beach slope



- Gap between successive timber logs is filled with timber planks **avoiding concrete**



DETAIL 1



SECTION A-A
SCALE 1:15

Construction Progress

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Conclusion

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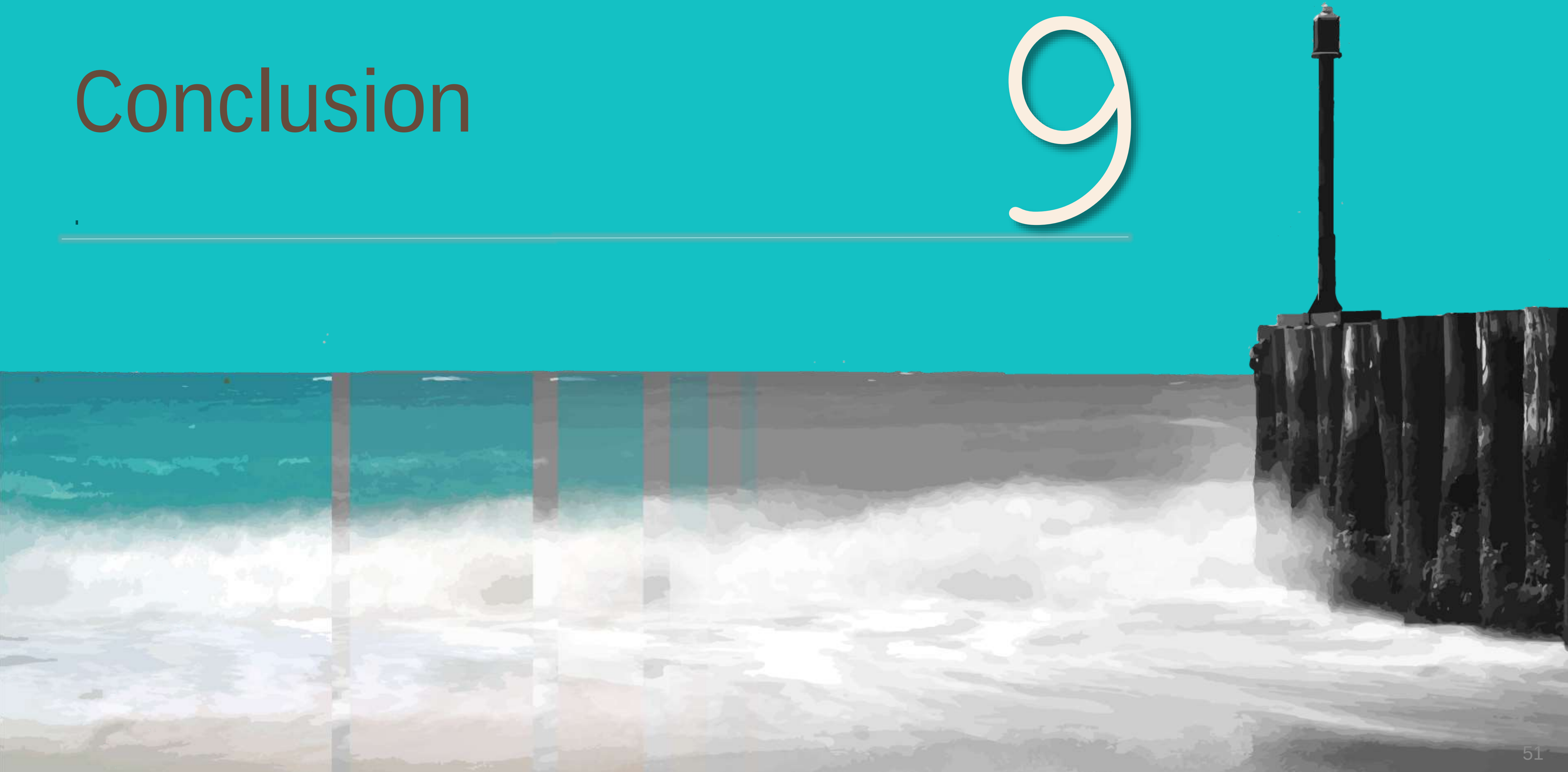

Summary

- The offshore reclamation developments has affected the wave climate and littoral drift causing erosion at several stretches along Dubai coast.
- Stabilization schemes with innovative composite groynes have been implemented successfully at the affected beaches.


Thank you

Timber as a Construction Material

Attractive characteristics

- Renewable source which can be sustainable if managed properly
- Relatively light weight with a good strength / weight ratio
- Attractive appearance and natural durability

Potential Drawbacks

- Natural material with inherent flaws and variability in properties
- Particular properties (large sections, long lengths or high durability) - available in limited quantities from particular species.
- Only renewable over a relatively long timescale, making it difficult to demonstrate sustainability.
- Few sources of tropical hardwoods are currently certified.

Timber Classification

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Hard Wood

- Broad leafed trees
- Eg. Ekki, Greenheart, Oak, Teak, **Balau**

Source

Timber logs of Yellow Balau species are procured from Forest Stewardship Council (FSC) certified suppliers in Malaysia

BS EN 350		BS 5589	Approximate life in ground contact	Examples
Class 1	Very durable	Very durable	> 25 years	Jarrag, Greenheart, Iroko, Ekki
Class 2	Durable	Durable	15 – 25 years	European Oak, Sweet Chestnut, Robinia, Yellow Balau