



# Coastal Flood Risk

**Dr Melanie Luck-Vogel**

[mluckvogel@csir.co.za](mailto:mluckvogel@csir.co.za)

Coastal System Research Group

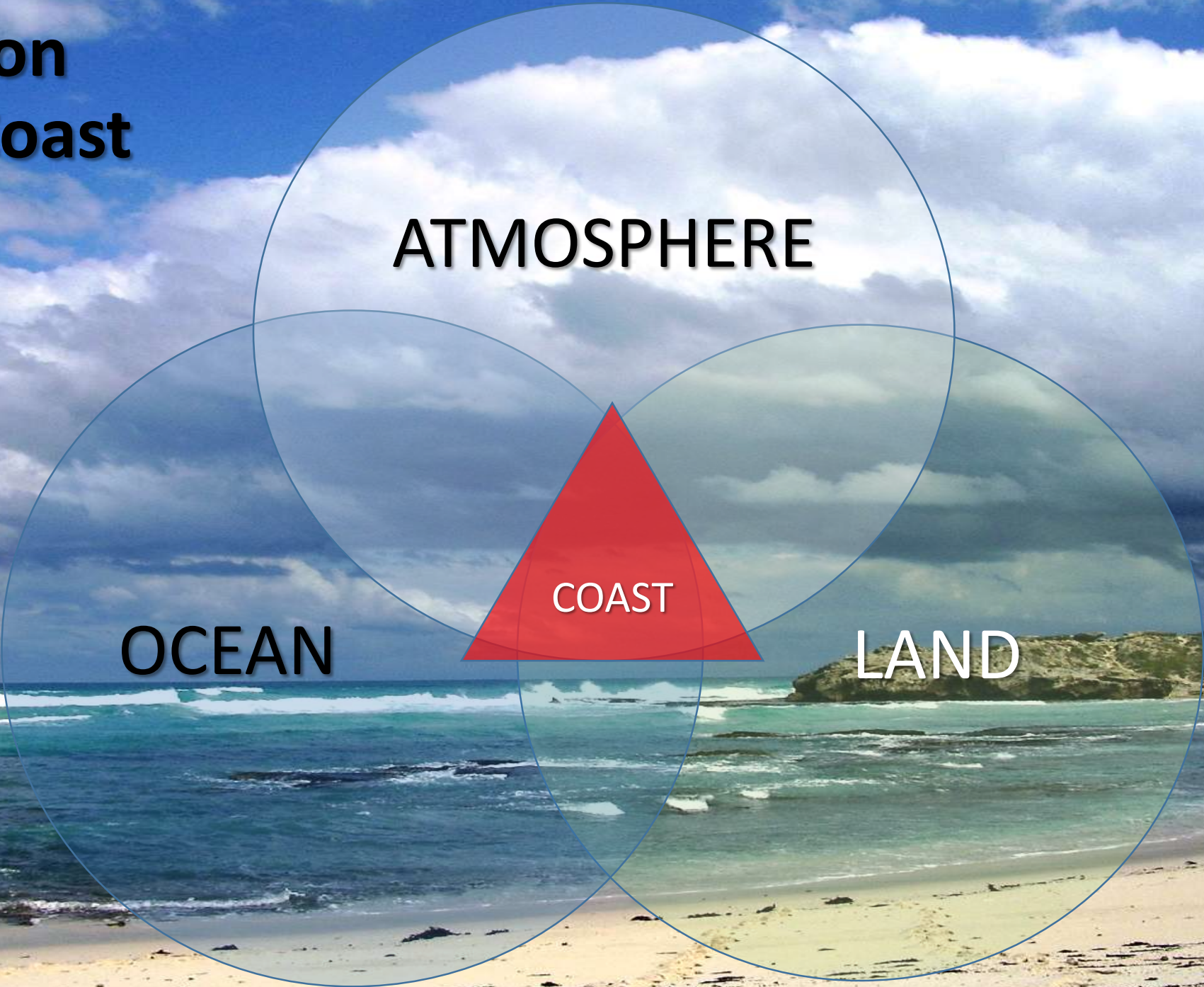
CSIR NRE

Stellenbosch

1 August 2017



# Definition of the Coast



ATMOSPHERE

OCEAN

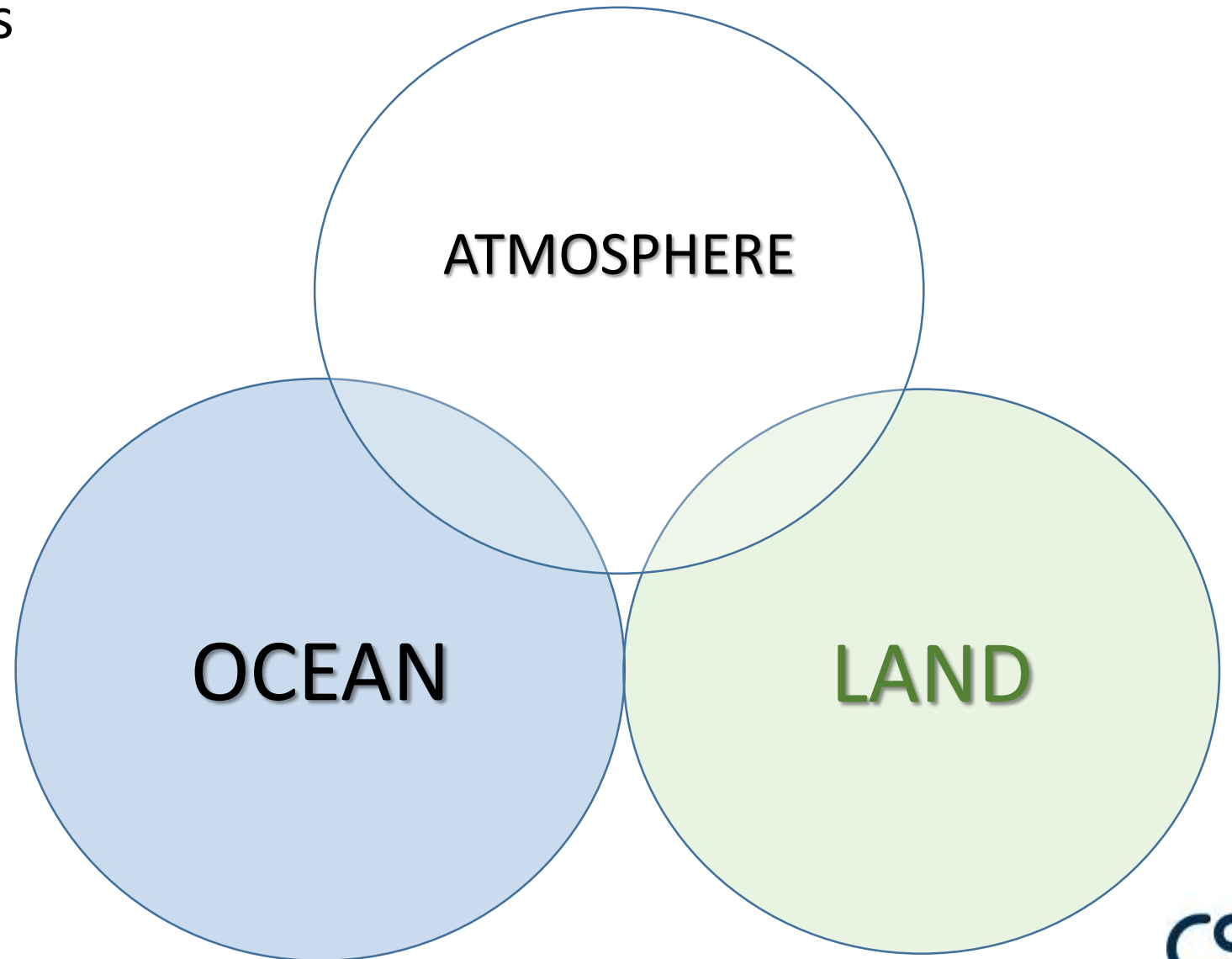
LAND

COAST

# Coasts are highly dynamic and ...

... Shaped by the Ocean's

- **Waves**
- Currents
- Tides





# SA: High wave energy climate (offshore – nearshore)

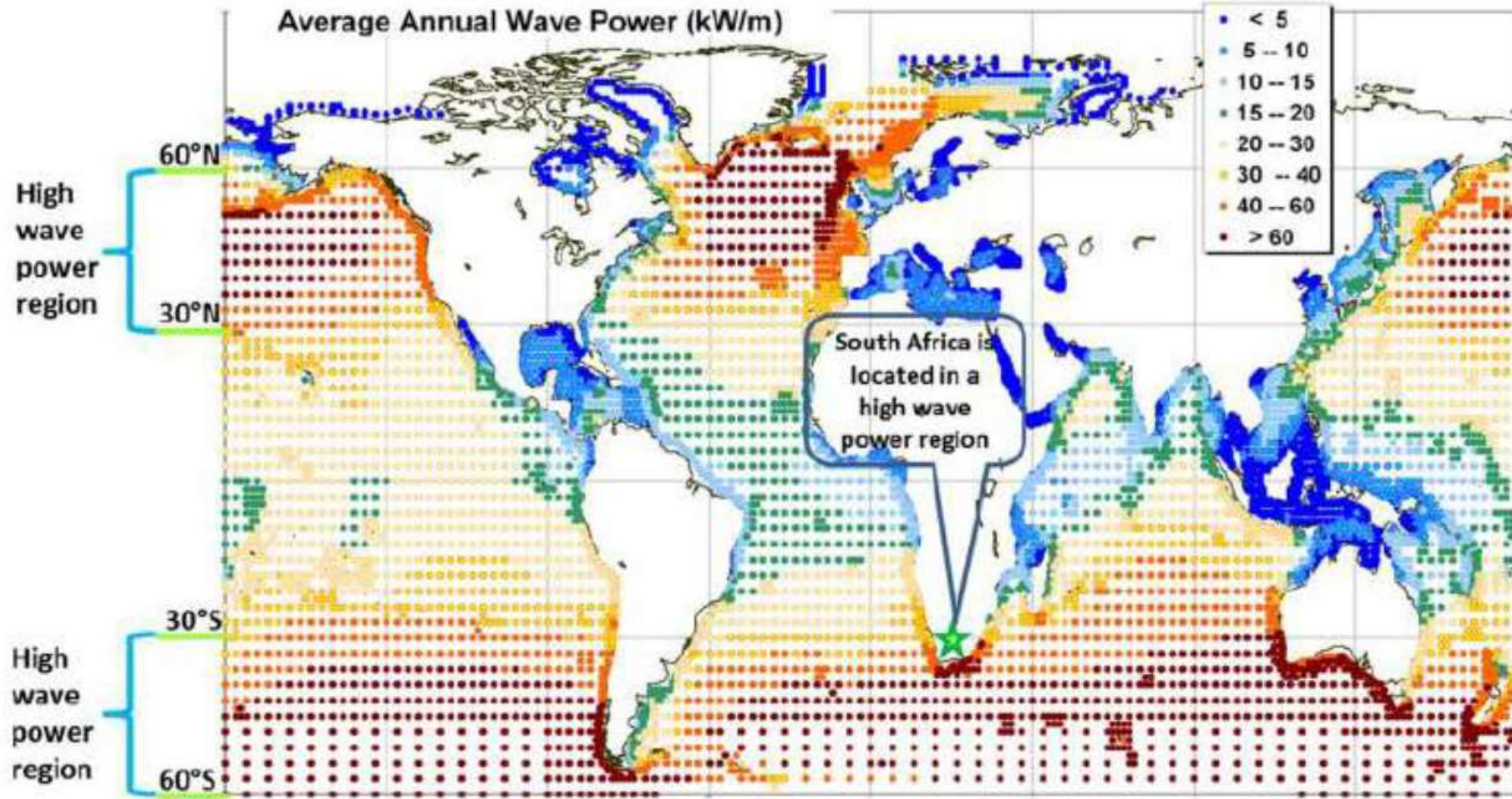


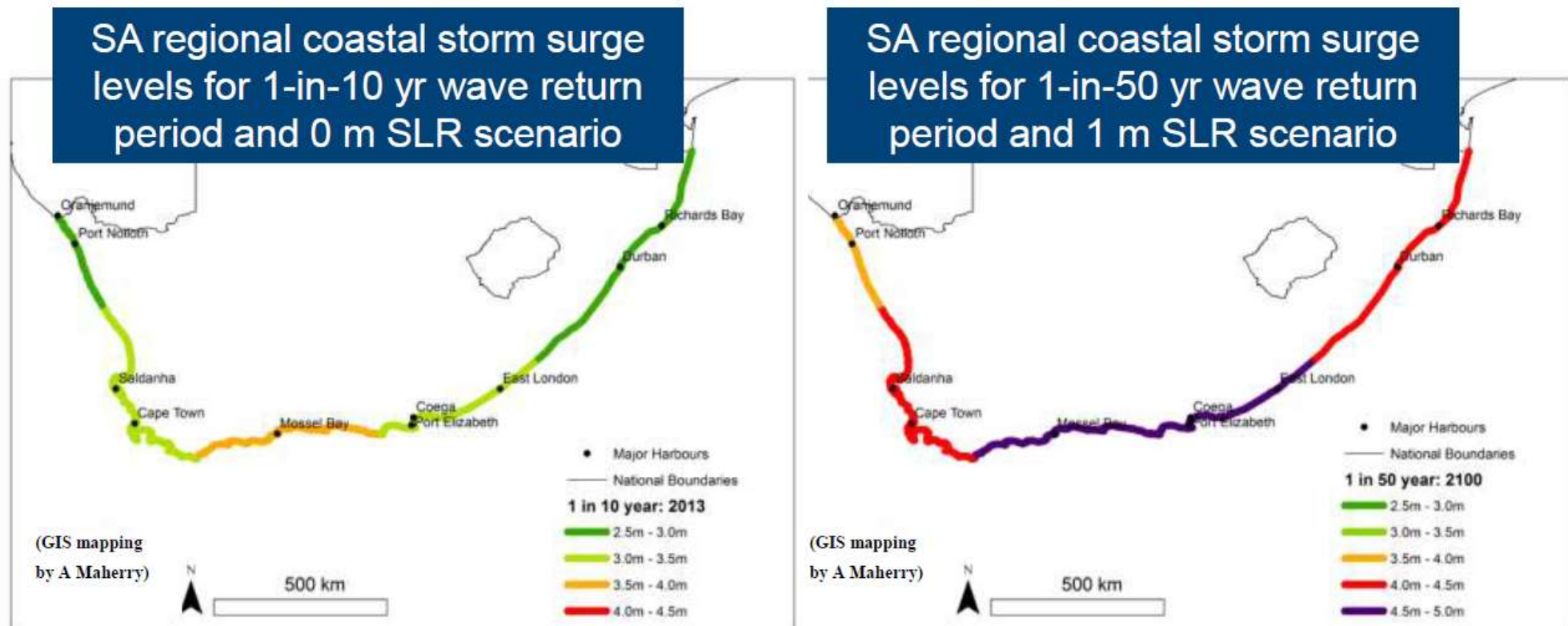
Figure 2-1: Global distribution of mean annual average wave power (kW/m) in deep water (Waves data/OCEANOR/ECMWF)



# → Extreme open coast SA “storm surge” levels

MHWS + residual & setups & SLR,  
but excluding wave run-up  
(some setups not applicable within bays)

## Examples:



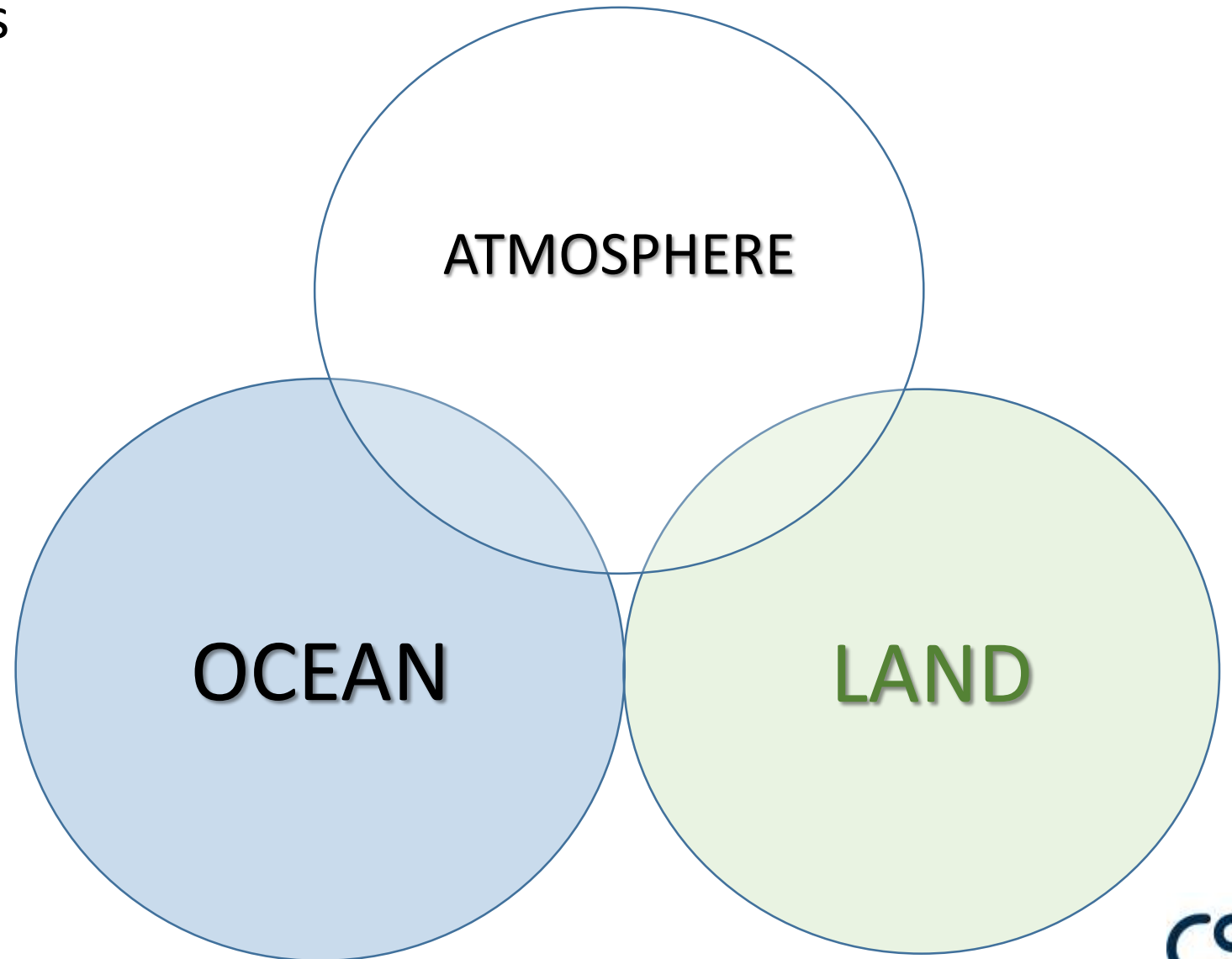
# Coasts are highly dynamic and ...

... shaped by the Ocean's

- Waves
- Currents
- Tides

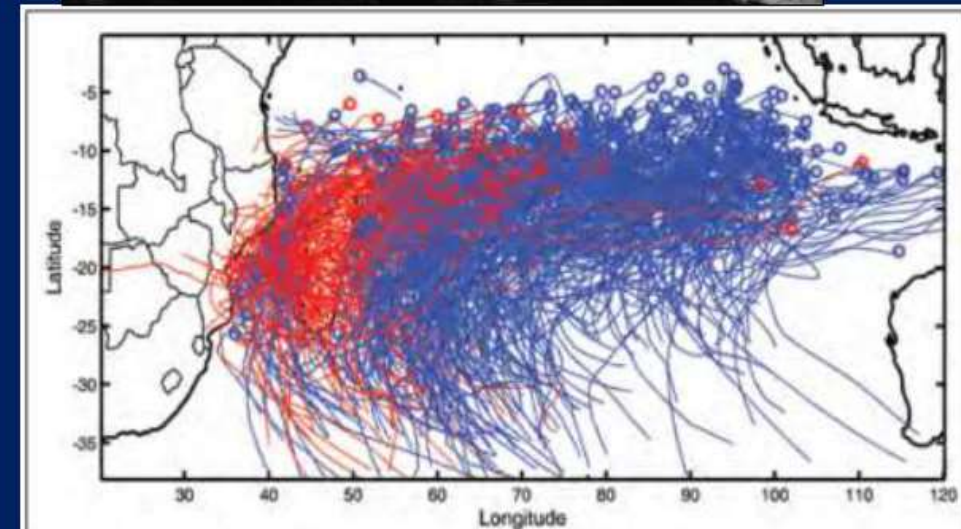
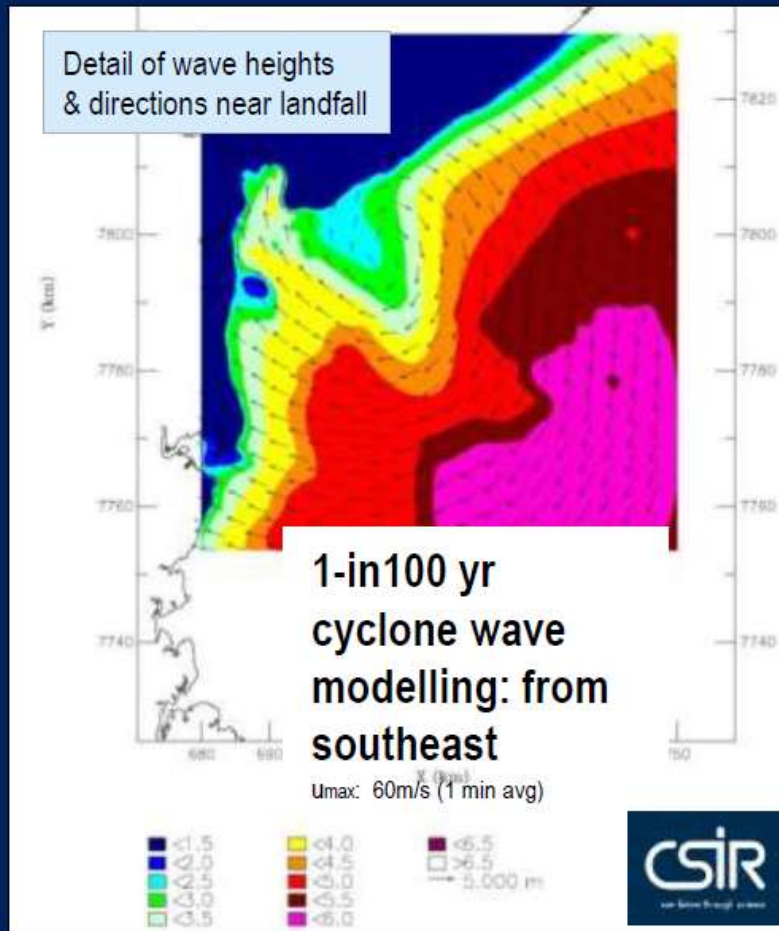
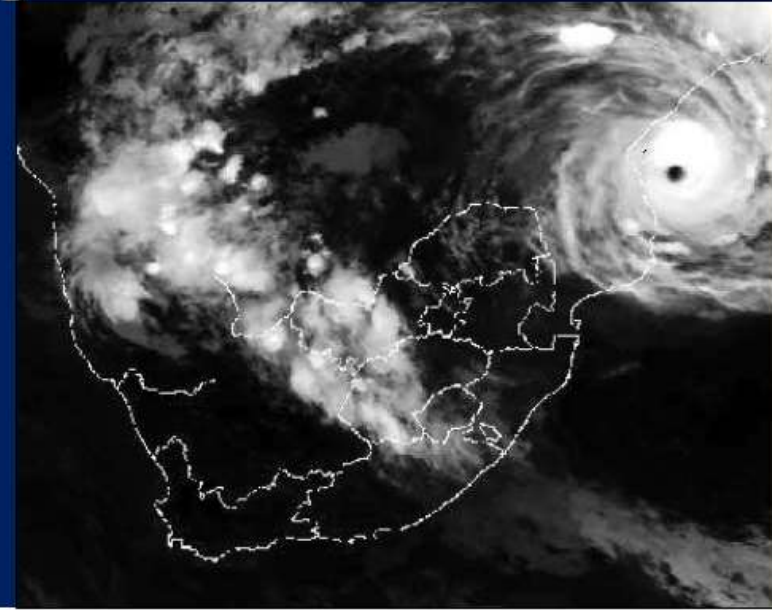
• By the atmosphere's

- **Wind**
- Temperature
- Precipitation and



# Hazards: Winds, waves & flooding generated by cyclones also pose a major threat along the W-Indian Ocean coast

- About 2 cyclones/ year enter Mozambique channel;
- Climate change (CC) projections: cyclones may become more intense (e.g. IPCC, 2007).



Cyclone tracks November to April since 1952 to 2007  
in SW Indian Ocean (Mavume et al., 2009)



# Coasts are highly dynamic and ...

... shaped by the Ocean's

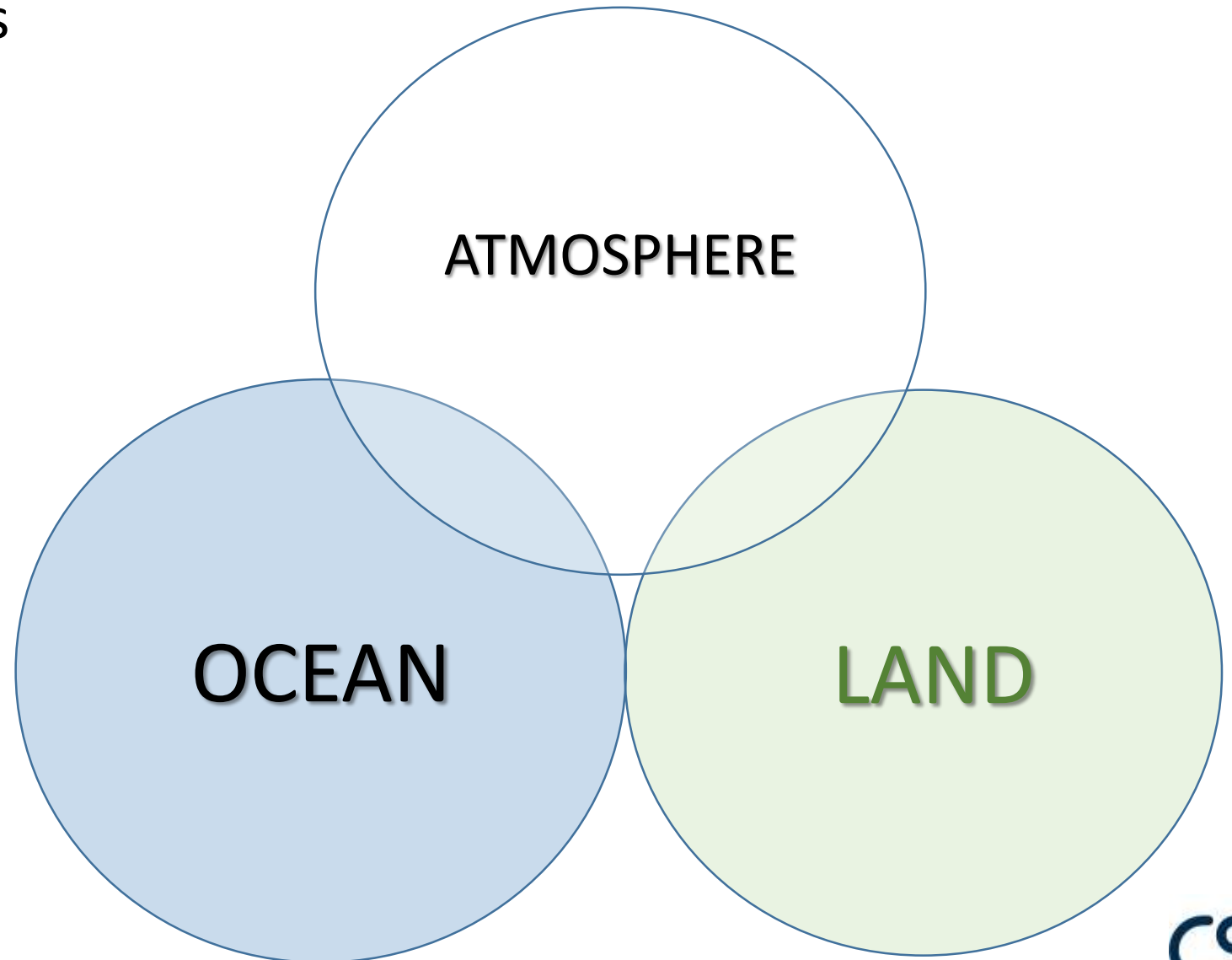
- Waves
- Currents
- Tides

• By the atmosphere's

- Wind
- Temperature
- Precipitation and

• By the Land's

- Geology & **Sediments**
- Rivers
- Vegetation
- **AND PEOPLE**





# To summarise: Primary abiotic coastal hazards in SA

The primary hazards to coastal infrastructure related to sea storms are:

- **Direct wave impacts**
- **Coastal flooding & inundation**
- **Erosion & under-scouring**

Focussing on the abiotic hazards to infrastructure and developments in the SA coastal zone, the main metocean drivers are thus:

- **Waves**
- **Sea water levels**

Primary hazards?  
No problem!

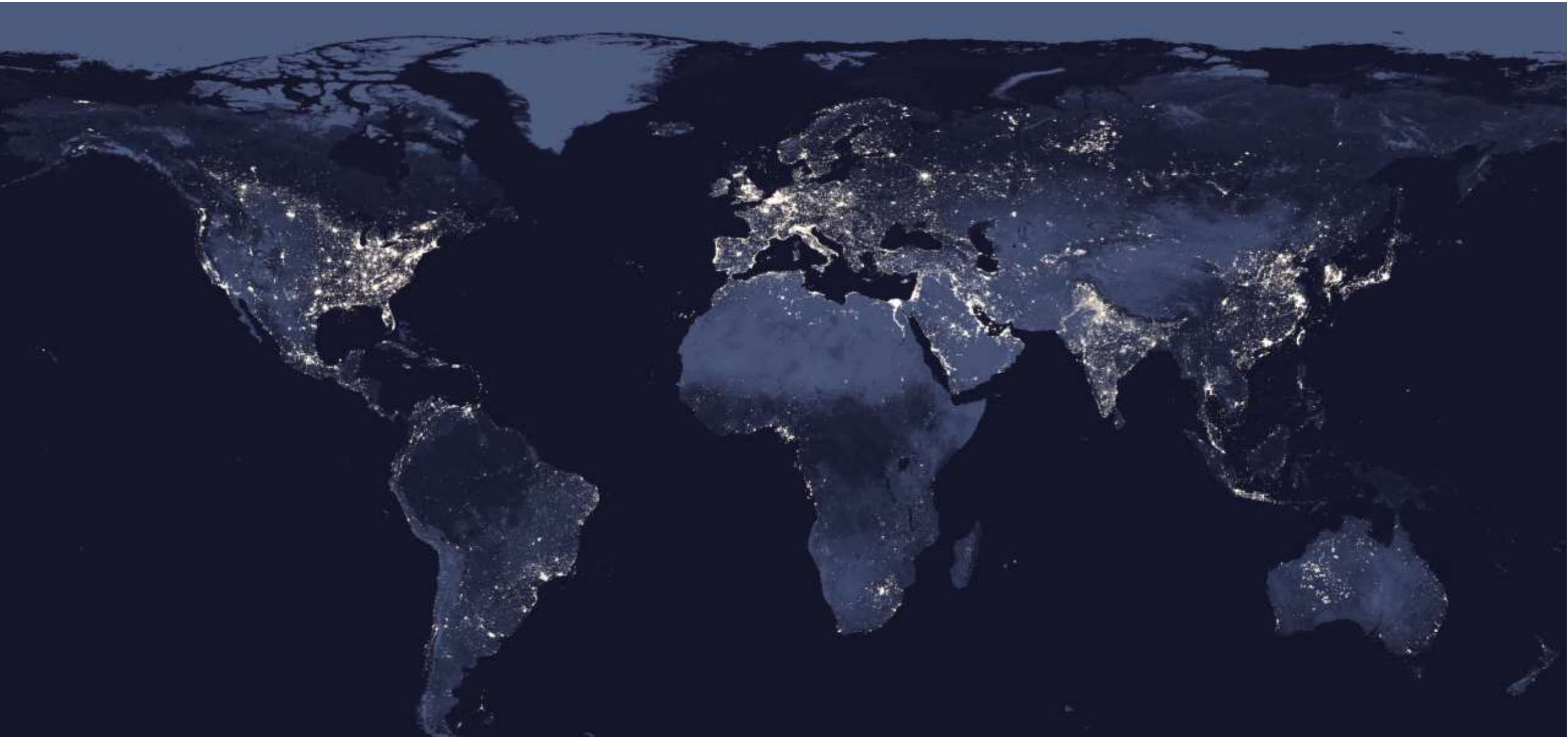
Unless...

4.2 The beach at St. Catherines Island, GA, covered by fallen trees from the bluff, undermined by shoreline erosion. No buildings exist along this stretch of shoreline, hence no shoreline erosion “problem” exists. In other words, we who build buildings next to the shore create the erosion problem!





# People @ Coasts



[https://eoimages.gsfc.nasa.gov/images/imagerecords/79000/79765/dnb\\_land\\_ocean\\_ice.2012.3600x1800.jpg](https://eoimages.gsfc.nasa.gov/images/imagerecords/79000/79765/dnb_land_ocean_ice.2012.3600x1800.jpg)

our future through science

# People & Coasts

- **About 40% of the world's population is situated within 100km of the coastline (Millennium Ecosystem Assessment, 2005).**
  - 60% of SA's economy depends on the coast through, e.g. fishery, aquaculture, ports & harbours, tourism
  - Increased coastal development & population density
  - Extra challenge: CLIMATE & GLOBAL CHANGE
- **Immense risk and management pressures**

... some pictures....



# Example of direct wave impact

Port Elizabeth storm: 3 Nov 2011



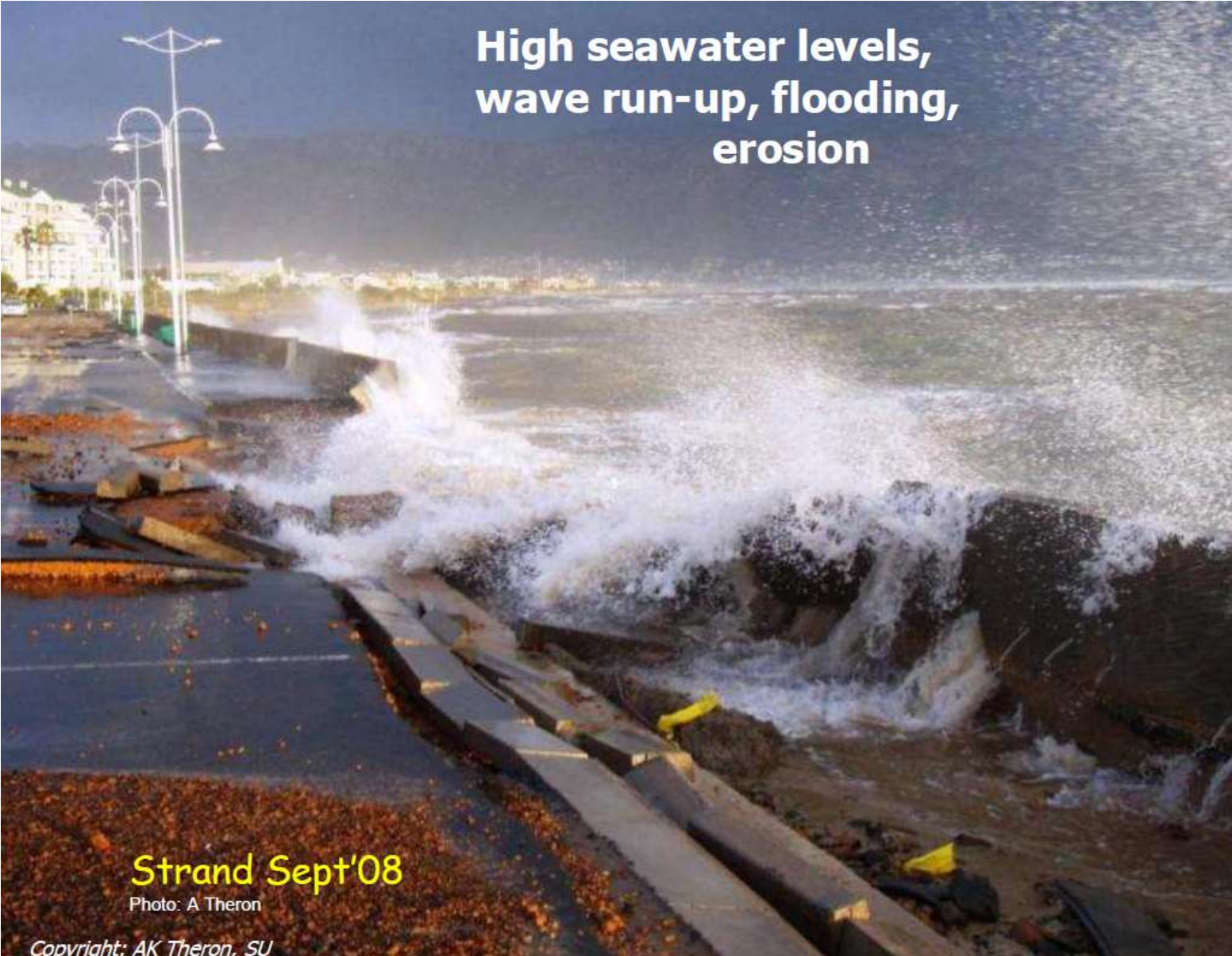
# Example of direct wave impact

Norm for engineering design of coastal structures is  
1 in 100 year event (e.g. storm wave height)





# Storm events causing flooding & erosion of infrastructure





# Storm events causing flooding & erosion of infrastructure



Copyright: AK Theron, SU



# However: Erosion is not the problem!



2007 KZN Storm



Photos: D Phelp



# ... if not erosion, what IS the problem?

Some coastal risks are related to “natural processes” such as SLR and climate change  
but many are MAN MADE through

**Disturbance of natural processes**  
e.g. sediment dynamics

**Inappropriate development**  
in the coastal dynamic zone



# Beach erosion in Durban



Construction of Harbour wall in Durban stopped natural sand flow

- Beaches north of Port are starved of sand
- **Coastal protection measures required!**



# Durban:

Dredging to maintain Port access results in vulnerable coastline.





# Harbour sand bypassing scheme (dredging) feeds DBN Bight beaches (“beach nourishment”)



**Before = vulnerable**





**GOOD MORNING!**  
DBN **26** PMB **25**  
10 05



SWITCHED ON  
Facebook privacy in the open

PAGE 10



NEWS  
On your



SPORT  
Nonu up for the Boks

PAGE 28

**IN BUSINESS REPORT**  
Cosatu chided on inflation

Gold	395.275	3	47.92
100 USD	21 651.48	1	R111.05
100 Euro	8 948.15	1	R111.24

DEPLETION OF SAND POSES EROSION RISK

# Mining threat to city beaches

TONY CAIRNE

SCIENTISTS have warned that some of Durban's main tourist beaches are in danger of being washed away gradually because of rampant river sand-mining operations that supply the construction industry.

tains. The main author of the report, CSIR coastal engineer Andre Theron, stressed that the impact of coastal erosion would be felt over the next few decades rather than immediately but there was already evidence of rapid erosion on some parts of the coast linked to sand-mining and dam construction.

"Based on our assessments... our strong recommendation would be to ban river sand mining from the Thekwini rivers as soon as practicable, while urgently seeking and evaluating other sources of sand." Theron suggested that one option was to dredge sand from beneath the surface of Durban's biggest dams.



**iol property**  
SOUTH AFRICA'S LARGEST PROPERTY WEBSITE

[All Cities and Towns](#) | [Agricultural](#) | [Auctions Marketing](#) | [Home Loans Commercial](#) | [International Johannesburg](#) | [Market Sectional Title](#) | [Durban](#) | [Cape Town](#) | [Residential](#) | [Pretoria](#)

« Cape residents 'forc... | [Main](#) | [Auction of Tshwane...](#) »

Subscribe to our Newsletter

TUESDAY FEB 17, 2015

**Sand mining threatens Durban properties**

The time has come for the government to consider a total ban on any sand mining in South African rivers to curb serious environmental damage and the growing risk of severe erosion damage to coastal cities like Durban.

This is the recommendation from a senior researcher from the South African Institute of International Affairs that could have far-reaching consequences for the country's construction industry and sand-mining companies.

Apart from serious degradation of river systems, there was compelling evidence to suggest that some coastal cities, especially Durban, were at risk of having beaches, property and other facilities washed away by storms and coastal erosion because of unsustainable sand-mining.

"The denudation of Durban's beaches and the erosion of its dunes will cause damage to coastal properties and infrastructure and have a significant impact on the tourism industry," according to a recent policy briefing by researcher Romy Chevallier.

Terms & Conditions apply.  
FNB - a div of FRB Ltd.



# IMPACTS OF DAMS & RIVER/ESTUARINE SAND MINING



Combined impacts of dams & mining  
on 18 rivers' "natural" sand yields:  
≈ total reduction of 66 -70% !

➤ **Implications for Coastal Sand Budgets**

# Natures Valley: Good example of near shore development with low coastal risk



(DEA, 2009; Natures Valley)

Coastal management,  
disaster prevention and management  
need

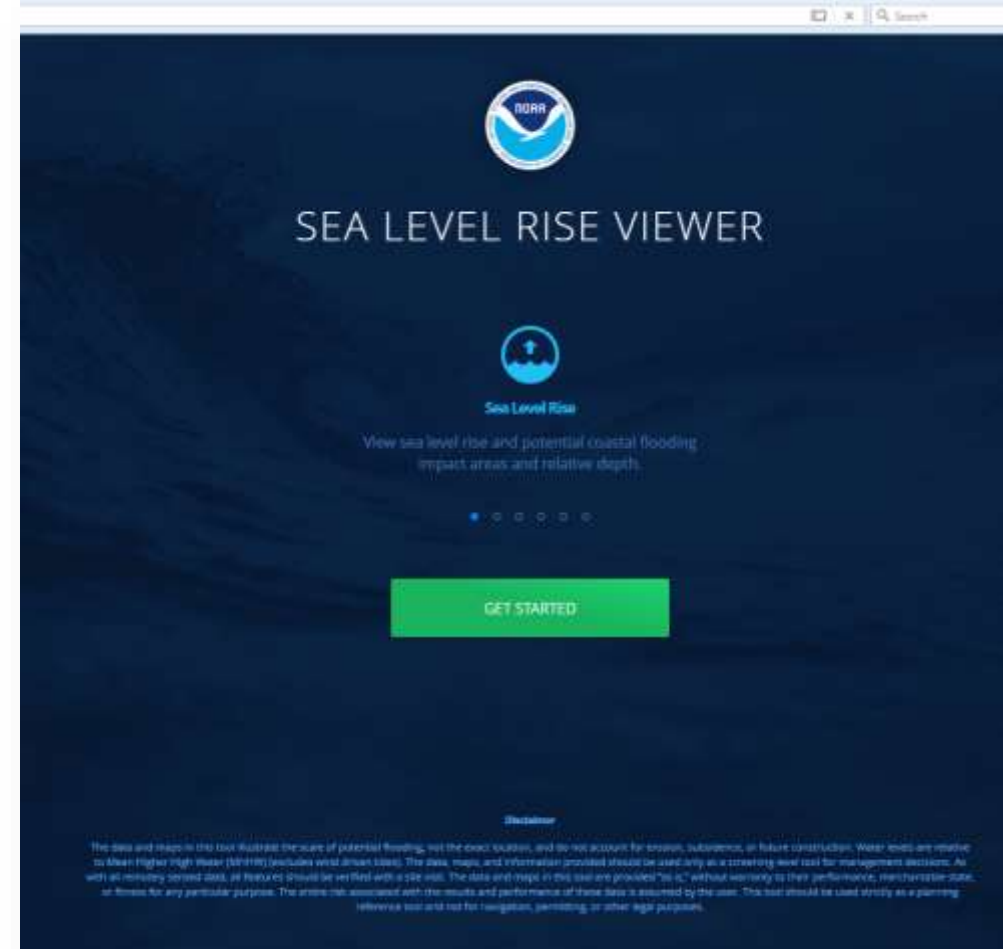
## Decision Support Tools

Some examples...



# NOAA Sea Level Rise Viewer for the USA

<https://coast.noaa.gov/slr/>

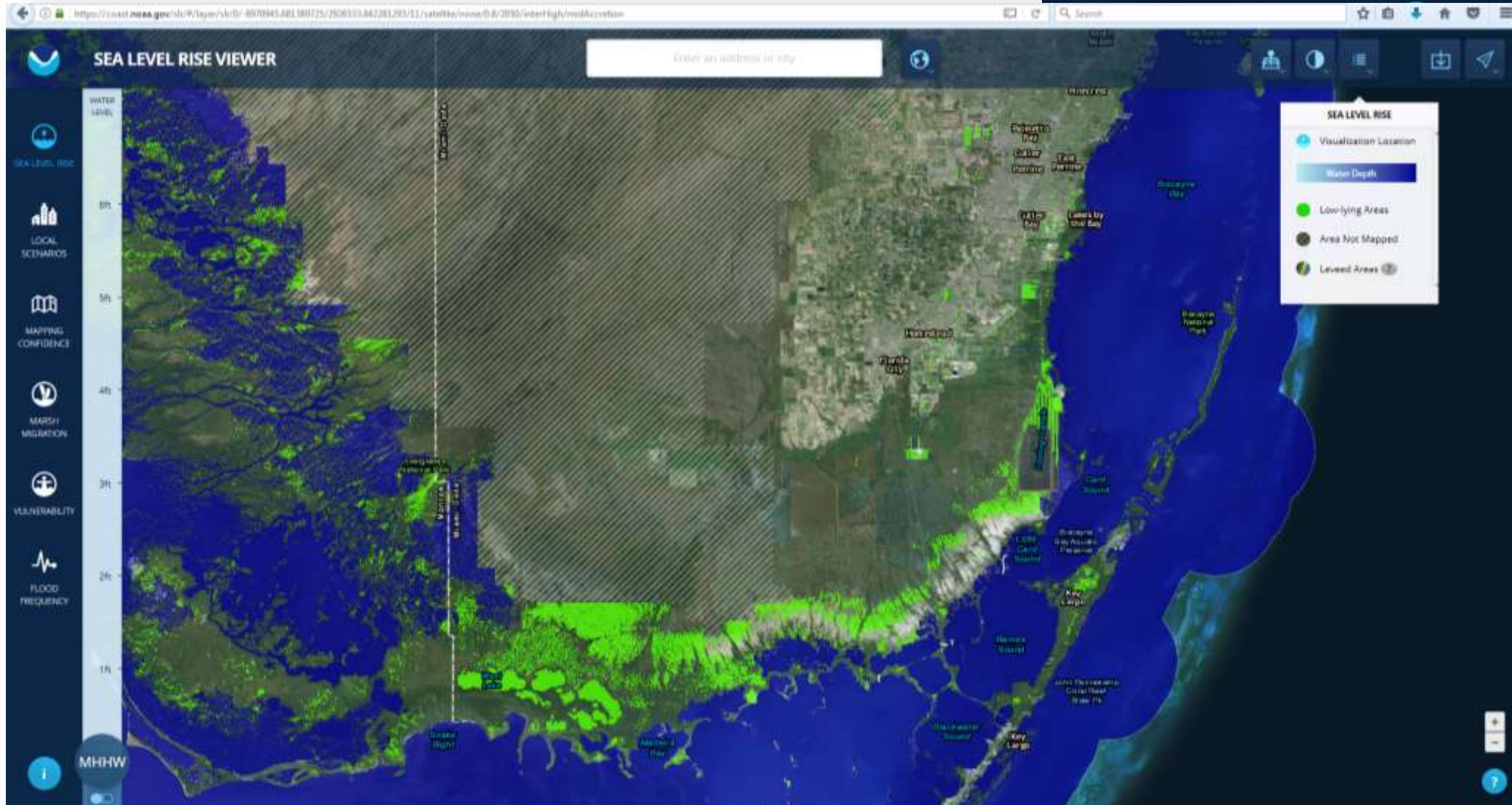


# NOAA Sea Level Rise Viewer for the USA

<https://coast.noaa.gov/slr/>



SEA LEVEL RISE VIEWER



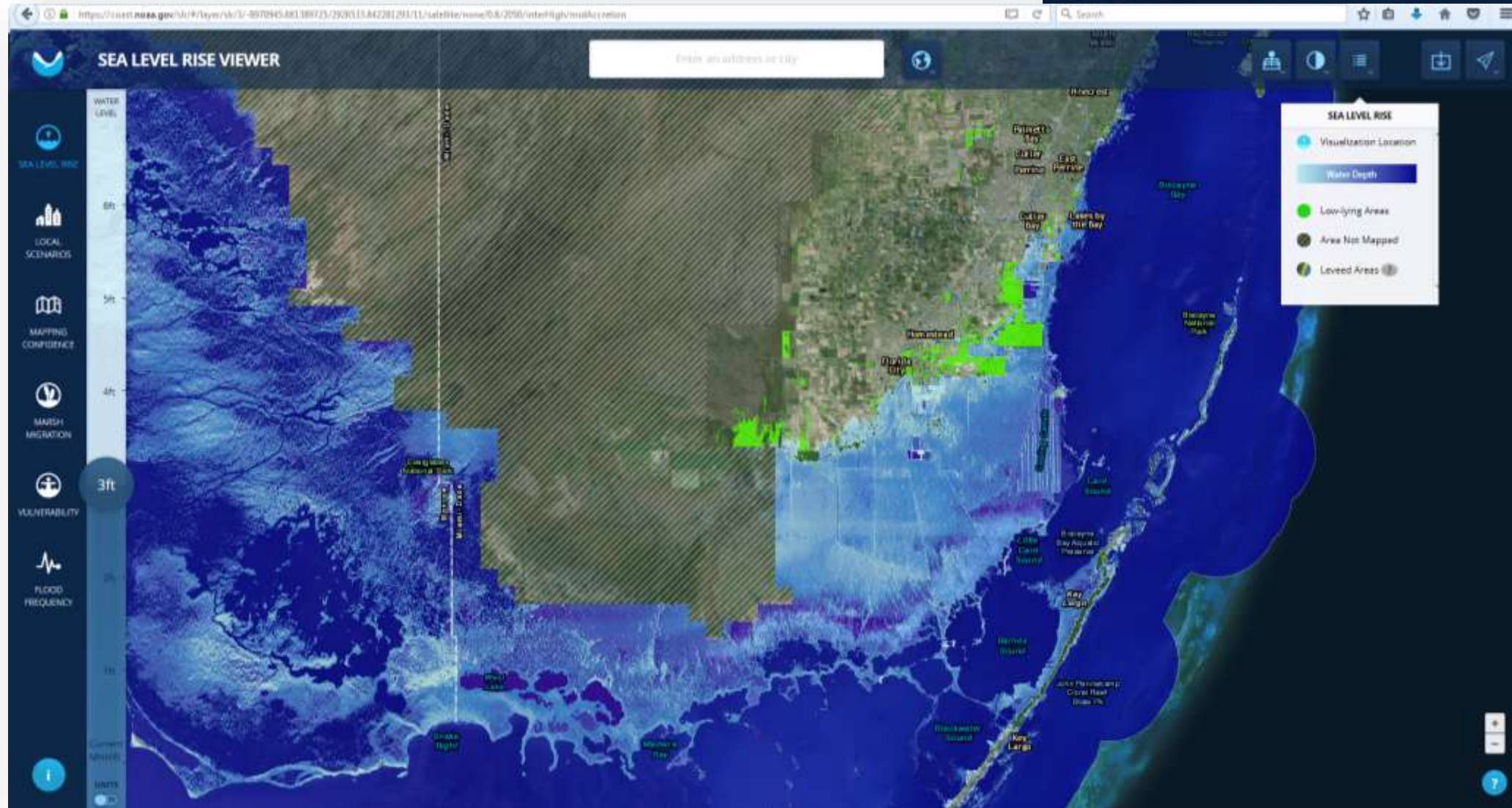


# NOAA Sea Level Rise Viewer for the USA

<https://coast.noaa.gov/slr/>

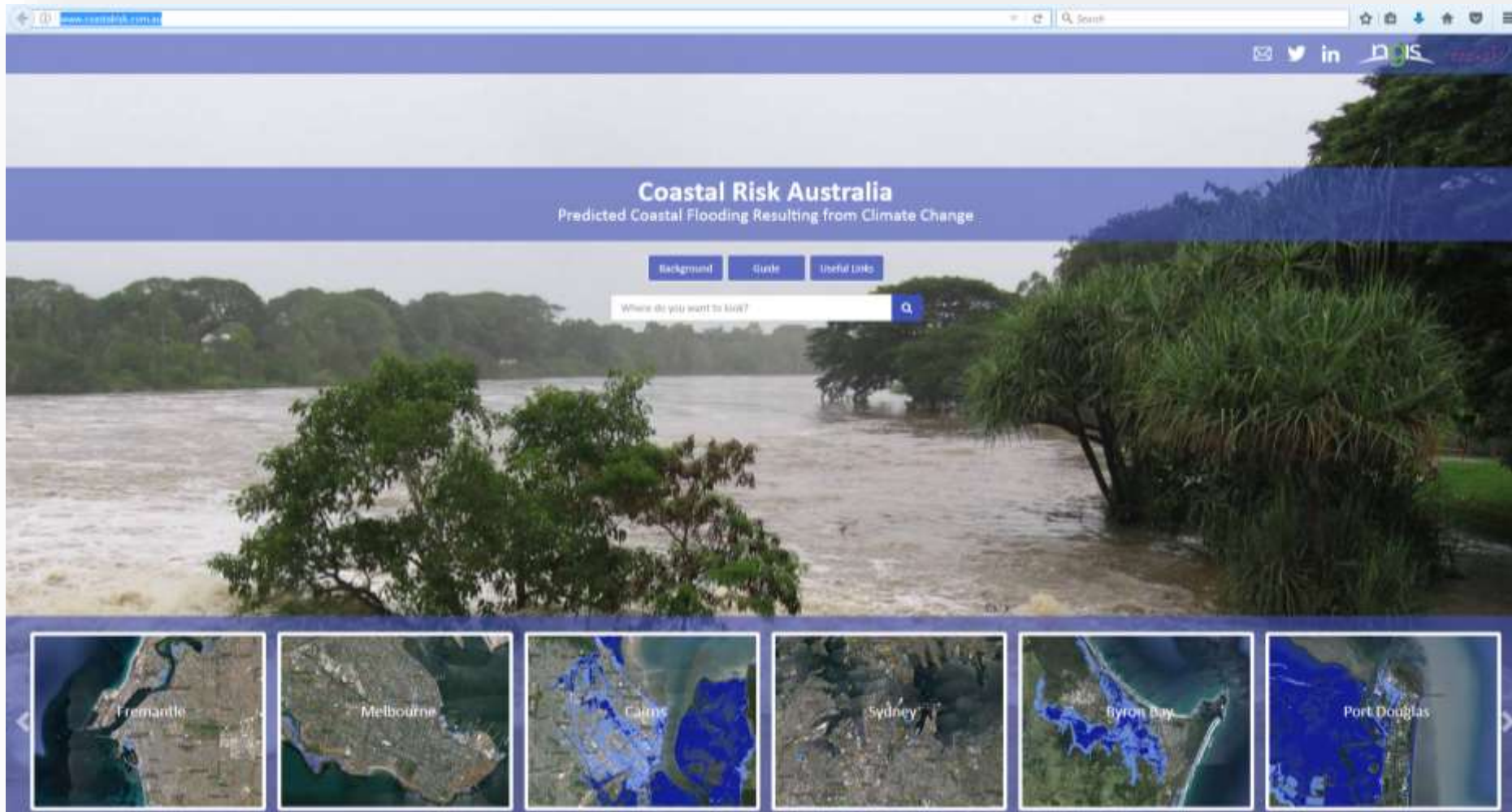


SEA LEVEL RISE VIEWER



# Coastal Risk Viewer for Australia

<http://www.coastalrisk.com.au/>






# Coastal Risk Viewer for Australia

<http://www.coastalrisk.com.au/>

The screenshot displays the Coastal Risk Viewer for Australia web application. The main interface features a search bar at the top left, a 'Predicted' vs 'Manual' toggle, and a slider for sea level rise (set to 2.9m Above Mean Sea Level). The map shows a coastal area with risk overlays in blue and green. A sidebar on the left contains navigation and utility links, including 'Virtual Tide Gauges', 'DEM', 'Background', 'Guide', 'Useful Links', 'Send Feedback', 'Share via Twitter', and 'Share via LinkedIn'. The bottom navigation bar shows thumbnails for other locations like Fremantle and Melbourne. The CSIRO logo is visible in the bottom right corner.

# Inasafe

<http://inasafe.org/>



**InaSAFE**

InaSAFE is free software that produces realistic natural hazard impact scenarios for better planning, preparedness and response activities. It provides a simple but rigorous way to combine data from scientists, local governments and communities to provide insights into the likely impacts of future disaster events.

Estimated number of buildings affected by flood (km)			
Search Area	Count		
Area	1,700		
City	1,000		
Total	27,000		
Destroyed	7,000		
Affected	2,000		
Not affected	1,000		
Not Engineered	10,000		

Estimated number of buildings by structure type					
Structure Type	Affected		Not affected		Total not impacted
	Wet	Total affected	Dry	Total not affected	
Residential	4,000	6,000	2,000	6,000	10,000
Industrial	100	200	200	200	1,000

InaSAFE is free software that was developed jointly by Indonesia ([BNPB](#)), Australia ([Australian Government](#)) and the World Bank ([GDFRR](#)).

InaSAFE is a Free and Open Source Software (FOSS) project, published under the [GPL v3 license](#). As such you may freely download, share and (if you like) modify the software.

**Disclaimer:** InaSAFE has been jointly developed by the Indonesian Government-BNPB, the Australian Government, the World Bank-GDFRR and independent contributors. These agencies and the individual software developers of InaSAFE take no responsibility for the correctness of outputs from InaSAFE or decisions derived as a consequence.

[I'm a User](#) [I'm a Contributor](#)

Search the documentation

Home



# Inasafe

<http://inasafe.org/>

QGIS 2.14.10-Essen - DKI\_Jakarta

Layers Panel

Flood Hazard

InaSAFE 4.1.0

Show question form

**InaSAFE**

Analysis question

In the event of a Flood, how many Structures might be affected?

General report

Estimated number of buildings affected per hazard zone

Hazard Zone	Count
Wet	7,700
Dry	7,600
<b>Total</b>	<b>85,500</b>

Structures

Structures	Count
Affected	7,700
Not Affected	7,600
Not Exposed	70,300

Analysis detail

Estimated number of buildings by structure type

Structure type	Affected		Not affected		Total not exposed	Total
	Wet	Total affected	Dry	Total not affected		
Residential	6,500	6,500	6,200	6,200	65,100	77,700
Education	358	358	384	384	1,600	2,400

Help About Print ... Debug Run

Coordinate 106.7461,-6.0914 Scale 1:75 078 Rotation 0,0 Render EPSG:4326 (OTF)

Manage parcels



environmental affairs

Department:  
Environmental Affairs  
REPUBLIC OF SOUTH AFRICA



science & technology  
Department:  
Science and Technology  
REPUBLIC OF SOUTH AFRICA

# NATIONAL OCIMS

## National Oceans and Coastal Information Management System

Unlocking the potential of South Africa's oceans and coasts through information and decision-support.

MORE ABOUT NATIONAL OCIMS

HOME

ABOUT

DOCUMENTS

DATA

TOOLS

🏠 / About



<https://ocims.dhcp.meraka.csir.co.za/about>

our future through science





# NATIONAL OCIMS

## National Oceans and Coastal Information Management System

Unlocking the potential of South Africa's oceans and coasts through

MORE ABOUT NATIONAL OCIMS

HOME

ABOUT

DOCUMENTS

🏠 / About

## About

### The National Oceans and Coastal Information Management System Project

The National Oceans and Coastal Information Management System (National OCIMS) is a product that will provide access to interactive spatial information which can be used as a tool for improved decision-making, predictive modelling, research and public information.

The National Oceans and Coastal Information System forms part of the Operation Phakisa Oceans Economy Programme, Action Plan endorsed by Cabinet.

The outcomes of Operation Phakisa Initiative 6 is to:

- 1
- 2
- 3

Establish Earth Observation Technology Capacity for the South African Exclusive Economic Zone as well as the continental shelf by 2019/20;

Deliver the National OCIMS by 2019/20; and

Establish and implement the Data and Earth Observation Infrastructure required of the National OCIMS.

This will be achieved through the development of an Information Management System (IMS) that will integrate current and future systems, information and expertise into a user-friendly and cost effective National OCIMS for the benefit of relevant stakeholders.

The National OCIMS project consists of the following components:

# NATIONAL OCIMS

National Oceans and Coastal Information Management System

Unlocking the potential of South Africa's oceans and coasts through

MORE ABOUT NATIONAL OCIMS

HOME

ABOUT

DOCUMENTS

Home / About

## About

### The National Ocean Management System

The National Oceans and Coastal Information Management System provides access to interactive spatial information with modelling, research and public information.

The National Oceans and Coastal Information Management Programme, Action Plan endorsed by Cabinet.

The outcomes of Operation Phakisa Initiative 1.

1

Establish Earth Observation systems for the EEZ and continental shelf by 2019/2020.

2

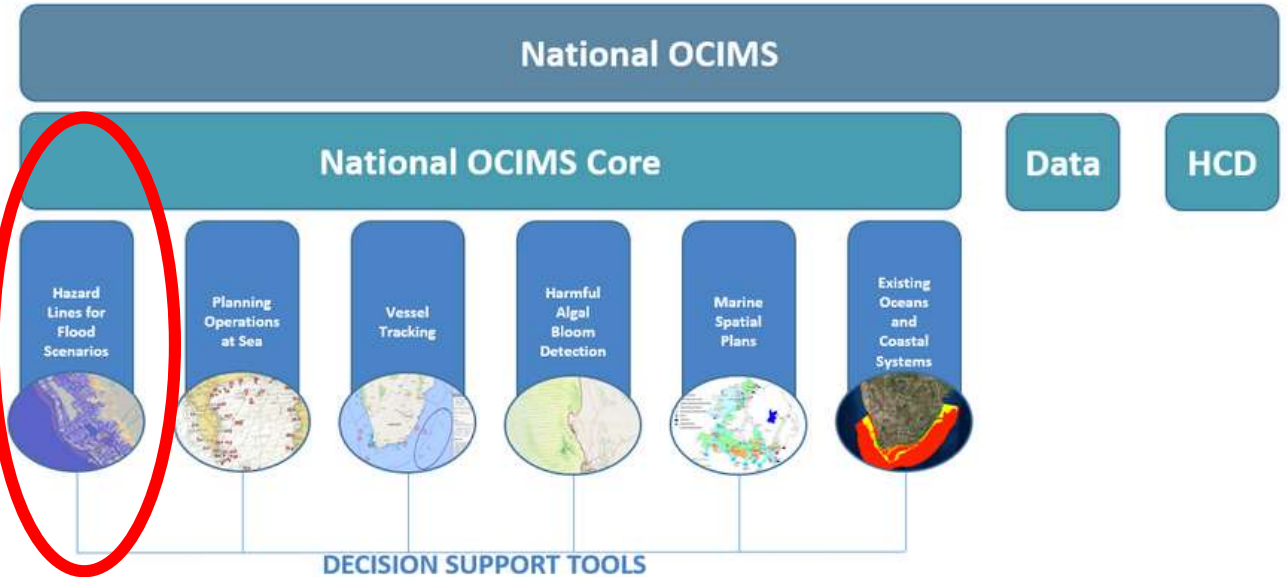
Deliver the National OCIMS.

3

Establish and implement the National OCIMS.

This will be achieved through the development of the National OCIMS and future systems, information and expertise relevant stakeholders.

The National OCIMS project consists of the



- Overall stakeholder interaction and project management;
- The development of a National OCIMS Core that will be implemented as a "system of systems" to provide a single access point to a range of oceans and coastal data, decision support tools and systems in support of ecological conservation and economic development of our oceans and coastal resources;
- The investment in the development of mature localised decision support tools;
- The implementation of an interoperable framework to interact with existing oceans and coastal systems;
- The stimulation of human capital development in oceans and coastal research, development and implementation;
- The provision of access to accurate, complete, current and well maintained spatial information, with the primary objective to identify relevant datasets.

1.5 million km<sup>2</sup>

Exclusive Economic Zone (EEZ) Size

~3900

km of coastline

~20

key departments and institutions in the marine environment with distinct roles and maritime policies

~50

national acts regulating marine governance

## Vision

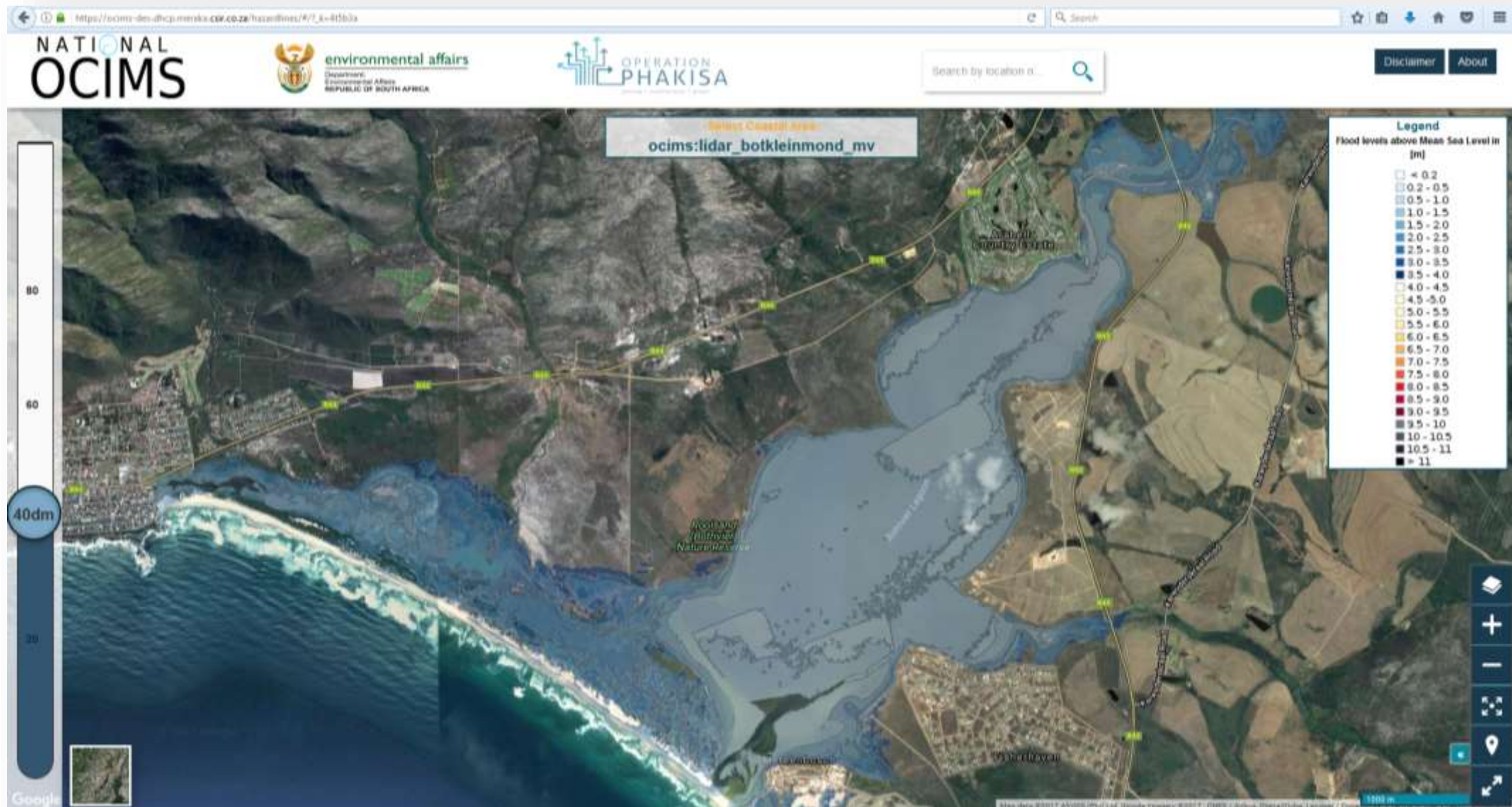
*Develop a locally relevant and globally cognisant technological solution that supports the ecological conservation and socio-economic potential of South Africa's oceans and coasts through information and decision-support for effect*

<https://ocims.dhcp.meraka.csir.co.za/about>



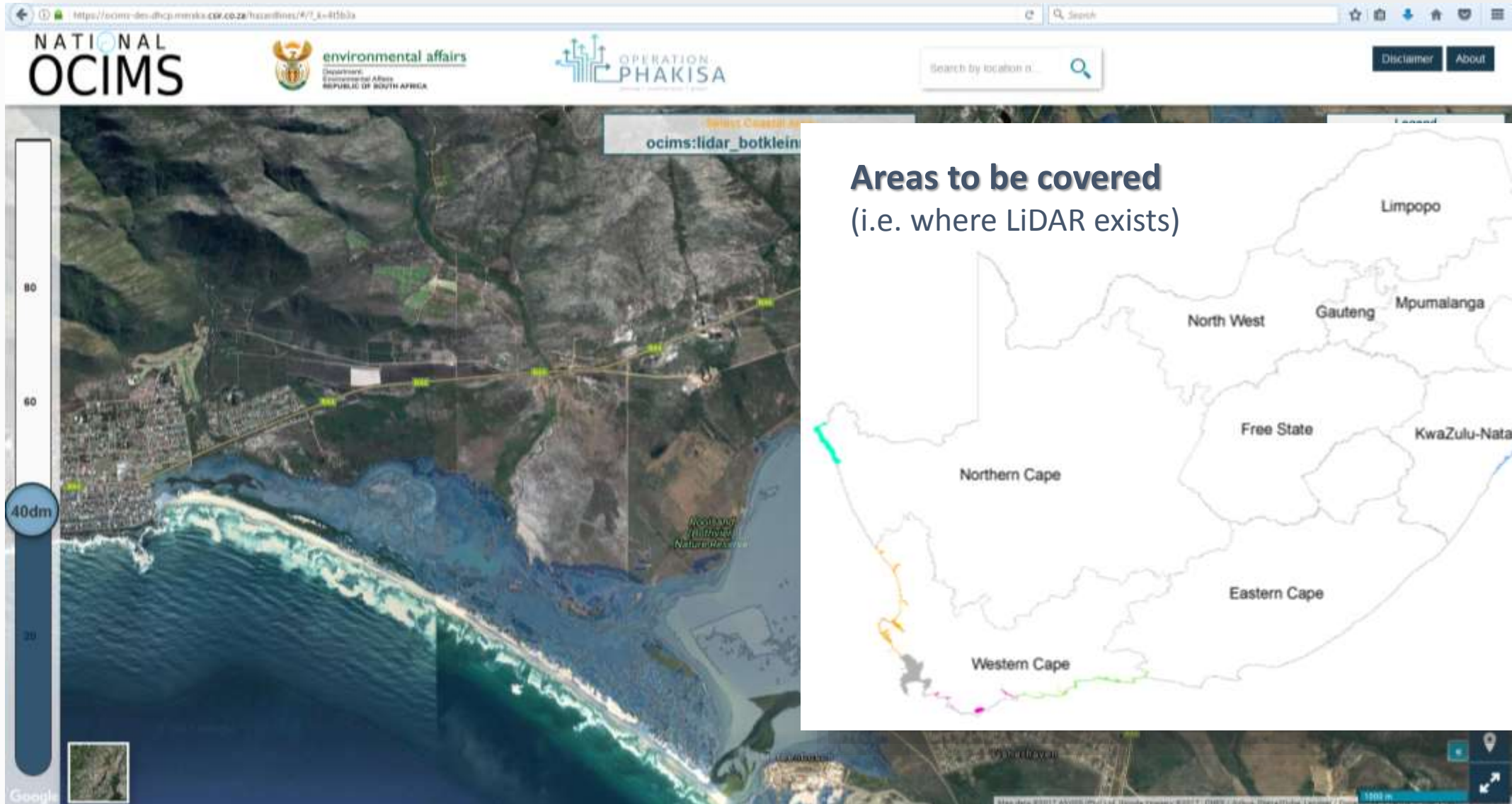
# BETA version of coastal flood risk mapper for SA

<https://ocims-dev.dhcp.meraka.csir.co.za/hazardlines/>



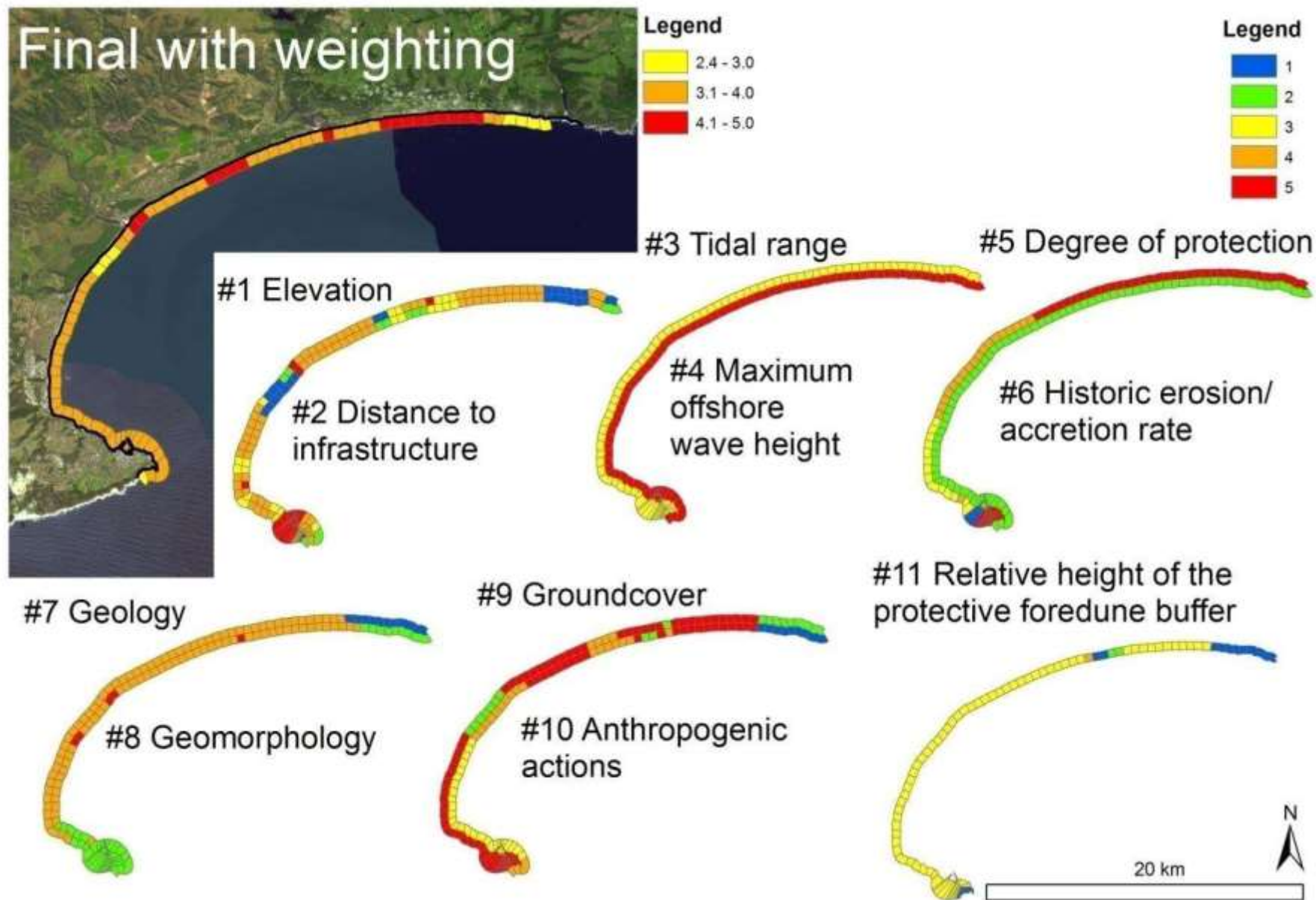
# BETA version of coastal flood risk mapper for SA

<https://ocims-dev.dhcp.meraka.csir.co.za/hazardlines/>

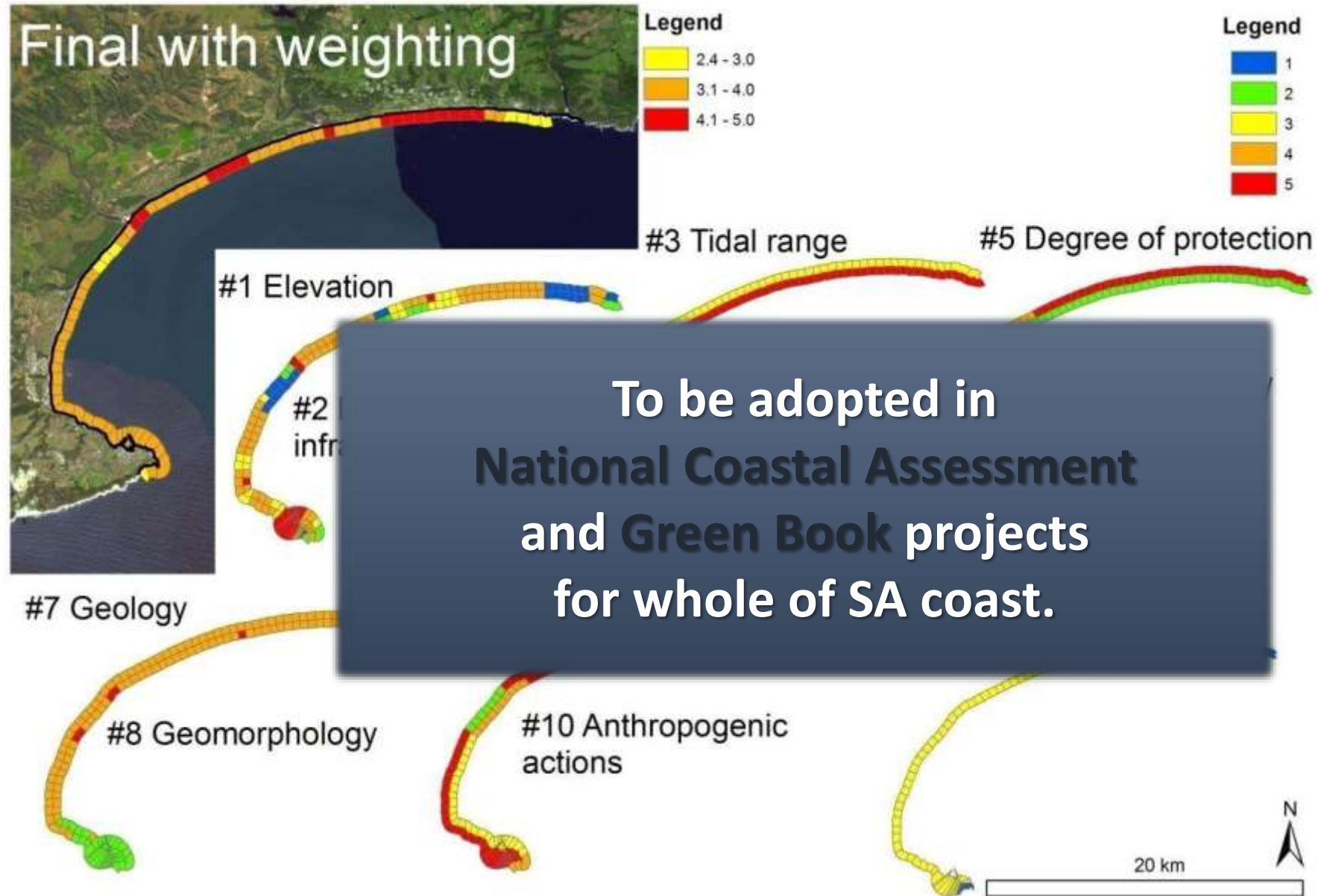




# Advanced Coastal Vulnerability Mapping



# Advanced Coastal Vulnerability Mapping





# Thank you!



For more info:

[mluckvogel@csir.co.za](mailto:mluckvogel@csir.co.za)

[http://www.csir.co.za/nre/coasts\\_and\\_oceans/cs.html](http://www.csir.co.za/nre/coasts_and_oceans/cs.html)