

Preliminary Coastal Vulnerability Assessment for KwaZulu-Natal, South Africa



**Bronwyn Palmer¹, Rudy van der Elst¹, Fiona Mackay¹,
Andrew Mather², Alan Smith³, Simon Bundy⁴,
Zane Thackeray⁵, Rio Leuci⁵, Omar Parak⁶**

¹Oceanographic Research Institute, ²eThekweni Municipality, ³School of Geological Sciences, University of KwaZulu-Natal, ⁴Sustainable Development Projects, ⁵Environmental Mapping & Surveying, ⁶Department of Agriculture, Environmental Affairs & Rural Development



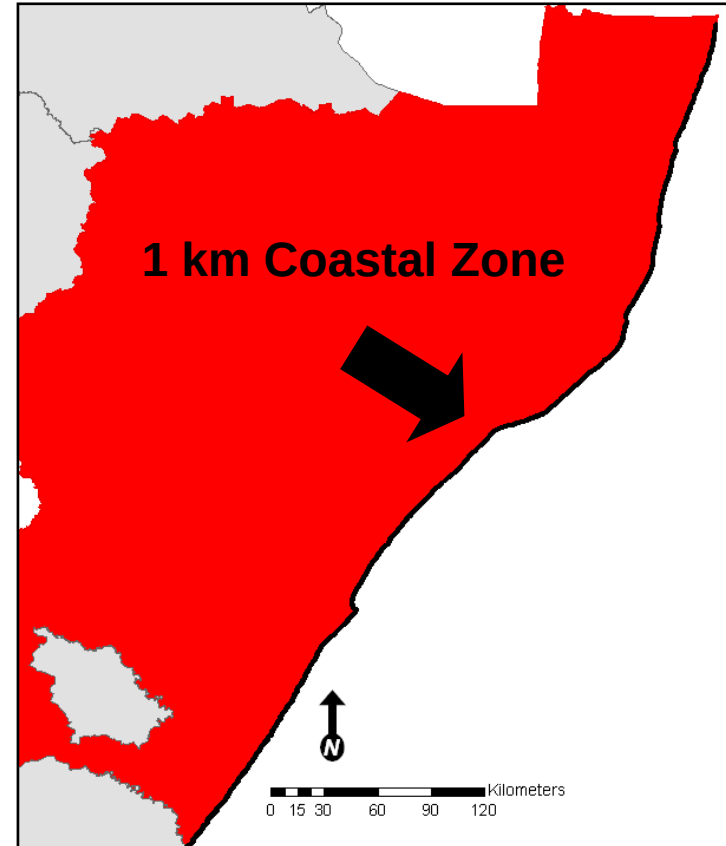
Overview

- Study area in context
- Background and need for assessment
- Aim of assessment
- Methodology applied to determine physical coastal vulnerability
- Social, economic and ecological features in context
- Conclusions
- Way forward



Study Area

- Research focus on one of the four coastal provinces in South Africa
 - East coast of the country
 - KwaZulu-Natal
- Specific focus on the 1km Coastal Zone
- KwaZulu-Natal coast is some 600km in length





Study Area

- The KwaZulu-Natal coast is linear with few bays and no islands or offshore barriers
- About 80% of this coast comprises of sandy shores
- KwaZulu-Natal is a high-energy, erosive, swell-dominated coast





Study Area

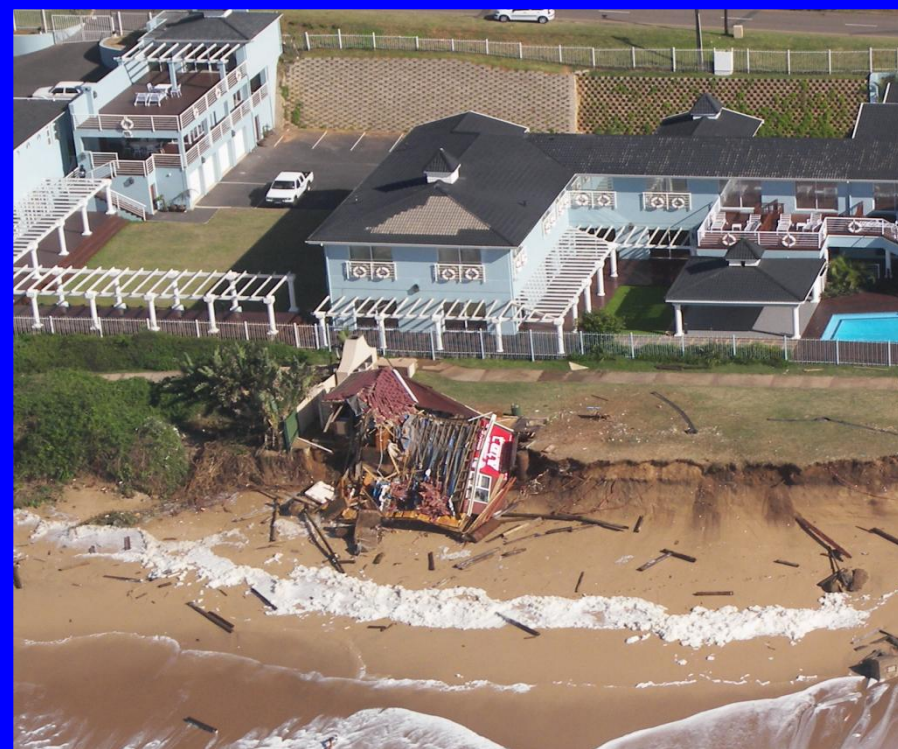
- KwaZulu-Natal is facing the implementation of a new coastal management act
- Challenges of lack of financial and human capacity
- KwaZulu-Natal has 5 coastal districts with varying degrees of capacity
- Provincial government is lead agent for coastal management



Background

- During 2006 and 2007 a number of large swell events occurred on the KwaZulu-Natal Coast
- Notability an event in 2007 resulted in significant damage to properties and infrastructure
 - An extreme wave event coincided with an equinox
 - Resulted in a maximum swell height of 14m

Damage from the 2007 event





Background

- Recurrence interval estimates range from
 - 20 years (based on the historic record)
 - 35 years (based on wave height)
 - 500 years (base on coincidence of tide and storm)



Background

- At the time management actions were only *reactive*
- Need to be more proactive and able to cope with any events of this nature in future
- Climate change predictions are that the east coast of South Africa will be subject to increased frequency and intensity of storms
 - Thus there is a need to identify which areas of coast would potentially be at risk when an event of this nature occur again



Aim of this assessment

- AIM: Identify who and what is at risk
- Determine:
 - *Which* areas are at the highest physical risk to future events of this nature? And
 - *What* social, economic and ecological features are potentially at risk to damage?



Determination of a **Coastal Vulnerability Index (CVI)**



Physical CVI

- Assessment was done as a desktop study
 - Aerial photography captured post 2007 storm event
- Indicator physical parameters were extracted to serve as a basis for physical vulnerability determination
- Five physical parameters used were:

1. Beach width	4. Percentage rocky outcrop
2. Dune width	5. Width of vegetation behind the back beach
3. Distance to the -20m bathy	



Physical CVI

- Physical coastal parameters were extracted as point data from the aerial photographs at 30m intervals
- Data was converted into a more regular grid of 50 by 50m cells along the LAZ
- Sites of known erosion were captured as a separate dataset
 - Results of which were used to inform vulnerability thresholds





Physical CVI – Rating

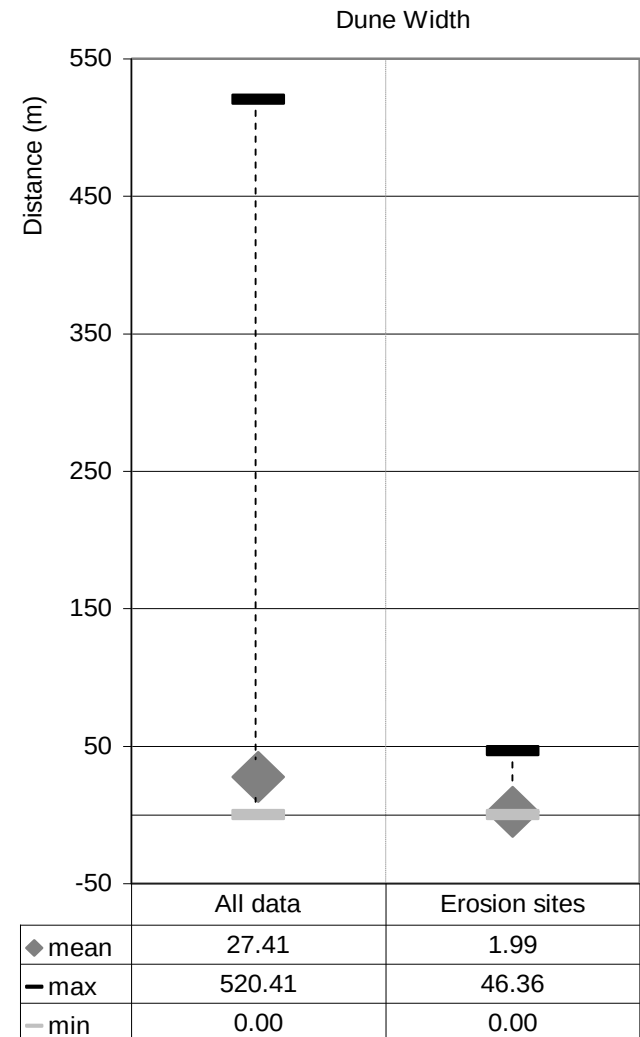
- Each cell was rated per parameter - in terms of its individual vulnerability based on predefined thresholds
- Scoring between 1 and 4 per parameter

Physical Property	Extremely Low (1)	Low (2)	Moderate (3)	High (4)
Beach width	> 150m	100 – 150m	50 – 100m	< 50m
Dune width	> 150m	50 – 150m	25 – 50m	< 25m
Distance to -20m bathy	> 4km	2 – 4km	1 – 2km	< 1km
Distance of vegetation behind the back beach	> 600m	200 – 600m	100 – 200m	< 100m
Percentage outcrop	> 50%	20 – 50%	10 – 20%	< 10%



Physical CVI - rating

- Resulting in draft vulnerability per cell out of possible max score of 20
- Beach width, dune width and distance to the 20m isobath were the most critical indicators
 - Known erosion damage was strongly associated with sites where the values for these parameters was below the mean of the coast
 - Example Dune Width





Physical CVI - rating

- The wider the beach the more wave energy dissipates
- Dune width gives an indication as to sediment available – which will buffer against erosion
- The greater the offshore distance to the 20m isobath the greater the dissipation of wave energy

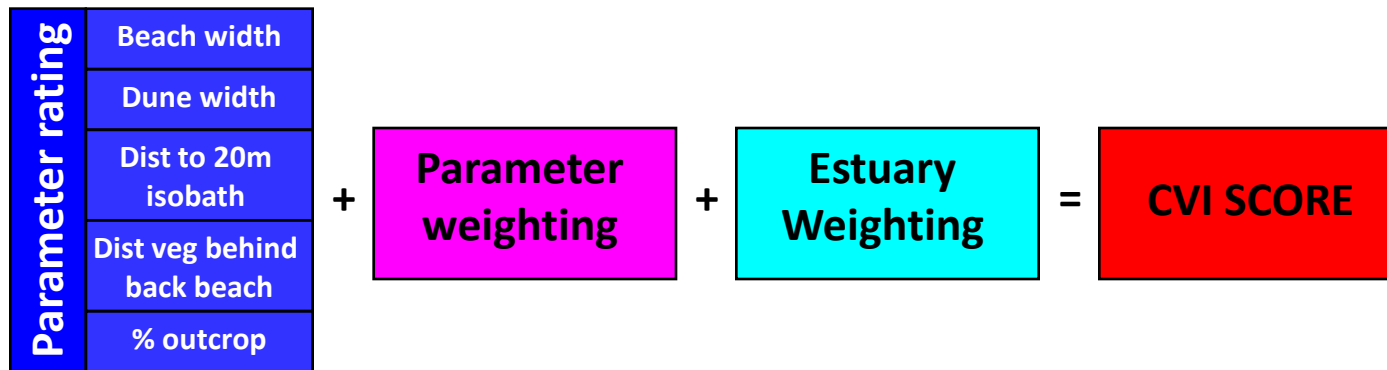


Physical CVI - weighting

- If a site scored high (4) on all three of these parameters it was weighted by a factor of 4
- Estuaries are critical areas
 - Estuarine area in KwaZulu-Natal accounts for 70% of South Africa's estuarine area
- Cells across estuary mouths were weighted by a factor of 4



Total CVI score



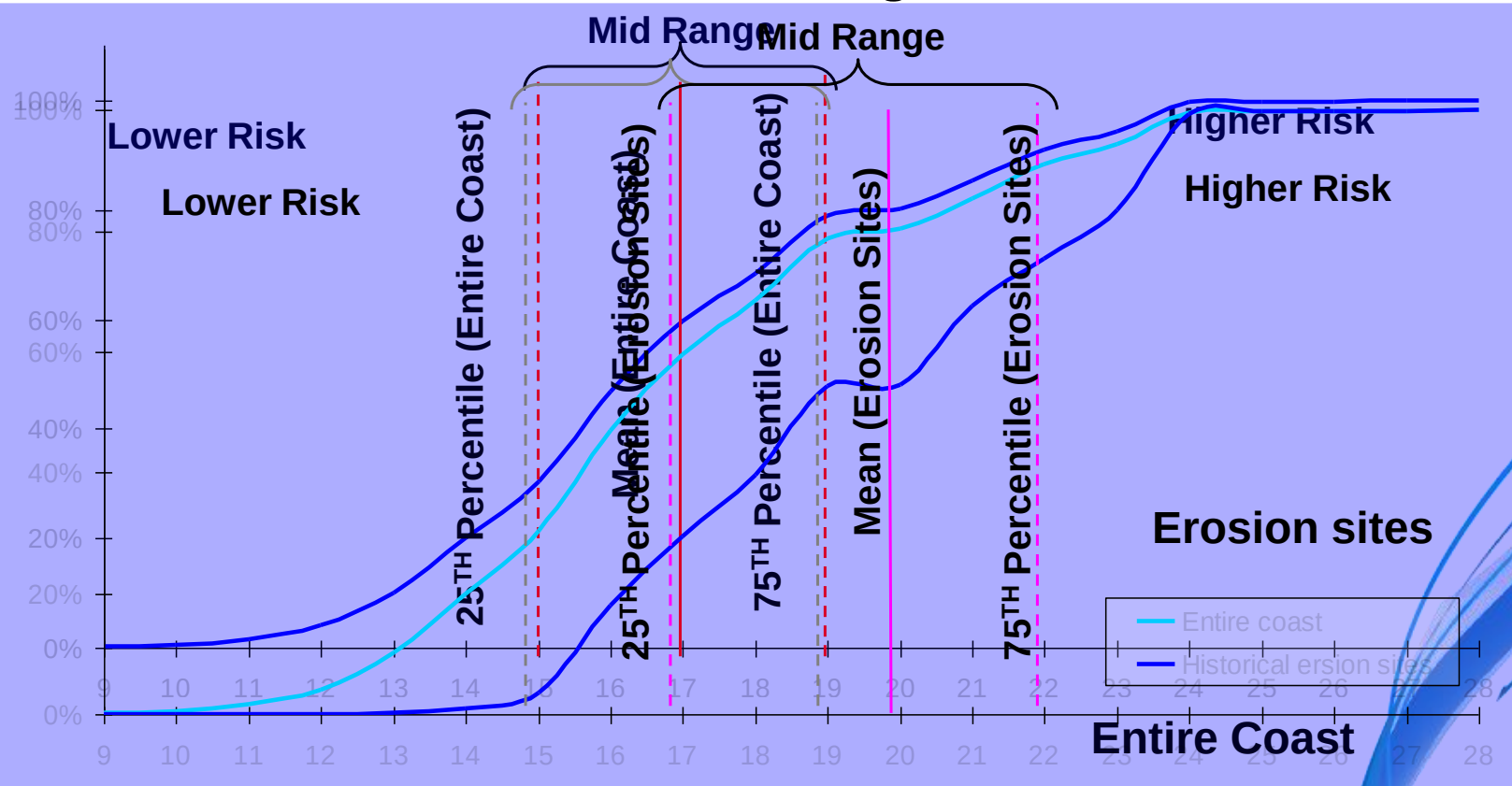
This resulted in a total vulnerability score out of 28

20 (Max) + **4** + **4** = **28 (Max)**



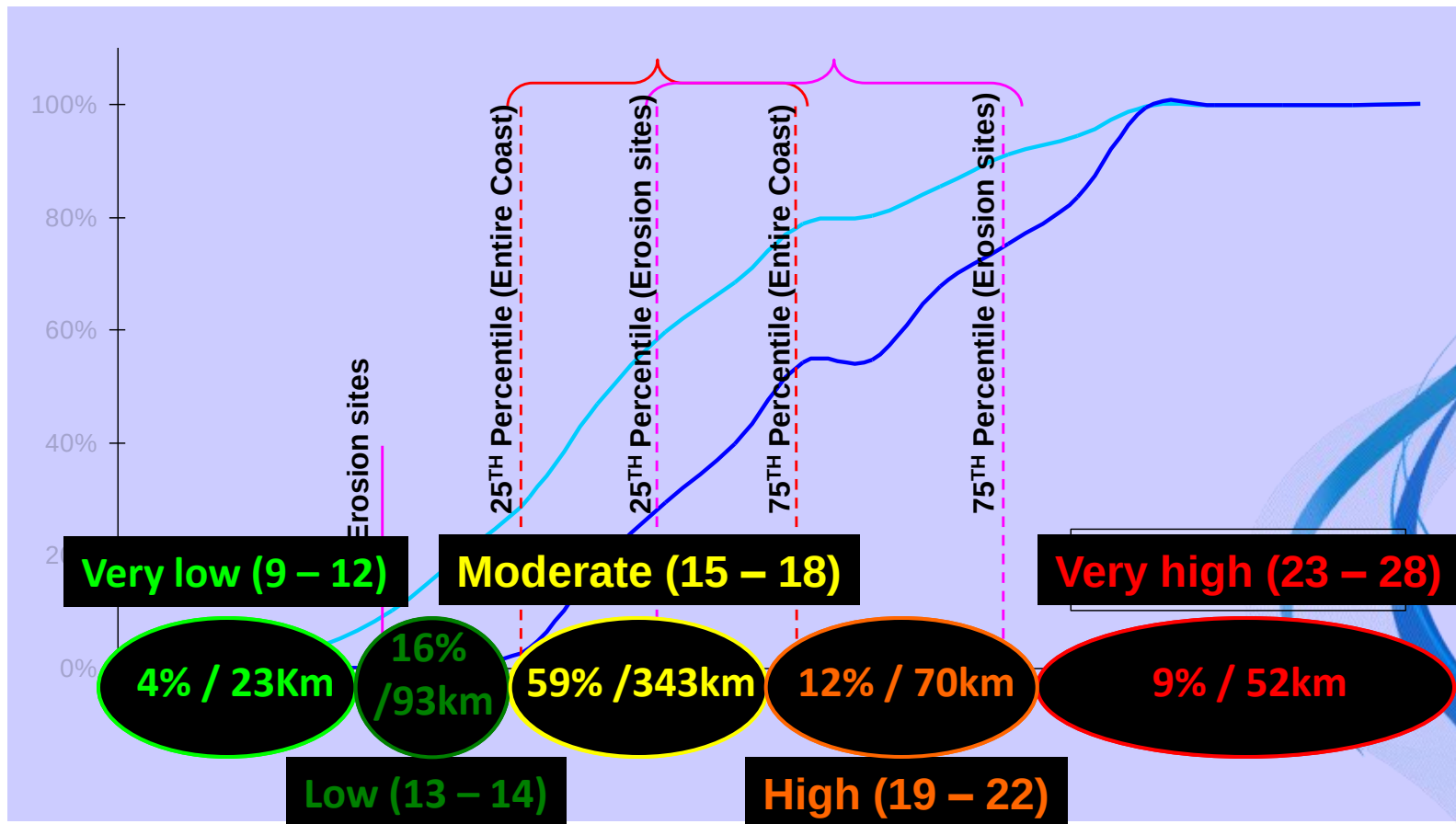
Physical CVI – Ranking

- Distribution of CVI scores for the coast and erosion sites were used to inform ranking





Physical CVI – Ranking





Social, Economic & Ecological components

- Looked at key features of social, economic & ecological importance
- Assessed where features are in relation to cells of ***very high vulnerability***
- Assumed features located in or across the littoral zone are at relatively higher risk if all, or a proportion fall directly within a cell of ***very high vulnerability***



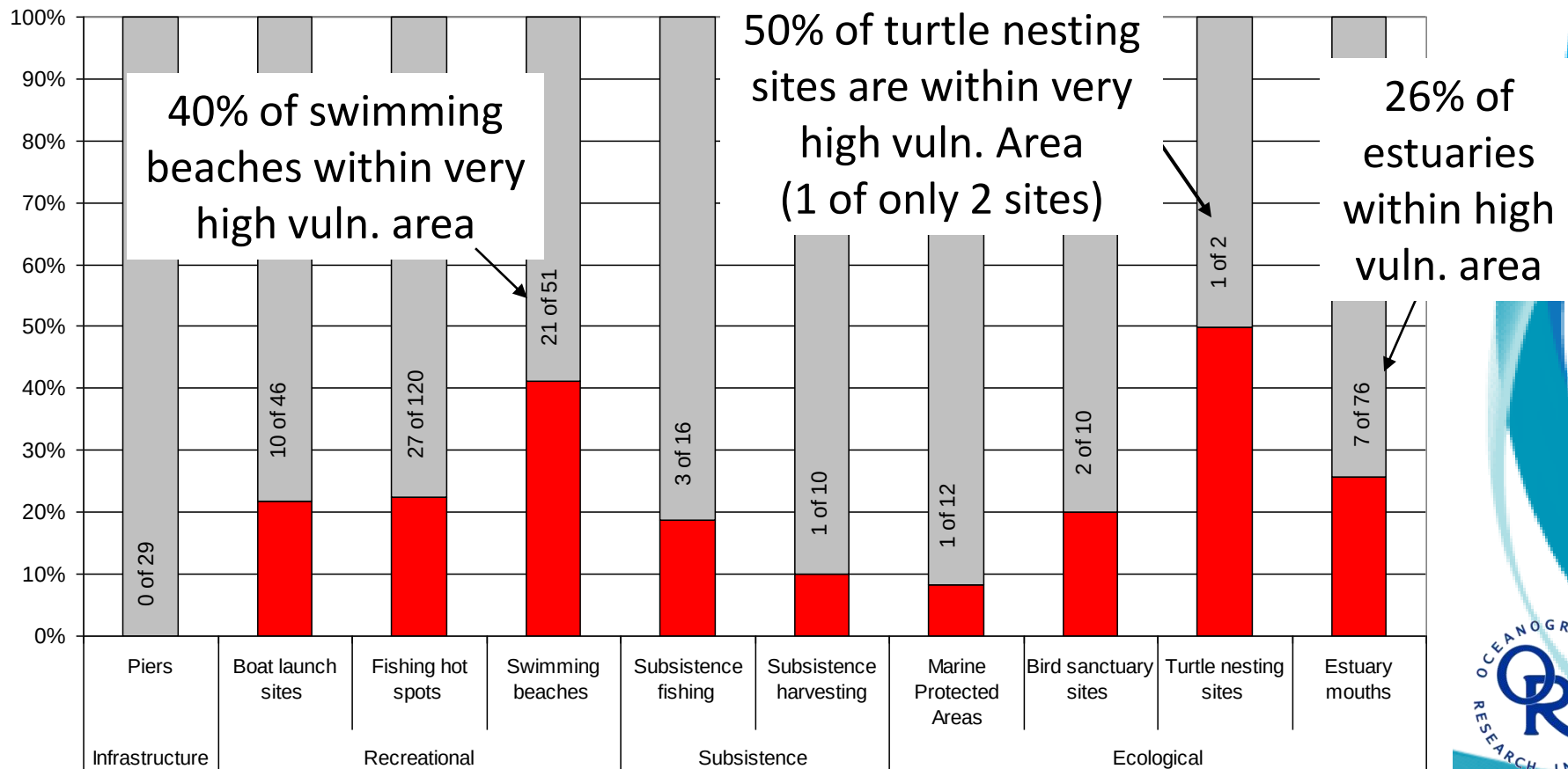
Key features

Economic & commercial activities	Strategic infrastructure	Recreational areas	Subsistence sites	Ecological important areas	Residential properties
Dune mining	Piers [#]	Boat launch sites [#]	Subsistence fishing sites [#]	Marine Protected Areas [#]	Residential erven
Forest plantation	Roads	Fishing hot spots [#]	Subsistence harvesting sites [#]	Bird sanctuary sites [#]	
Sugar cane	Railway lines	Swimming beaches [#]	Subsistence farming areas	Turtle nesting sites [#]	
Commercial & industrial buildings	Lighthouses	Sports facilities		Estuary mouths [#]	
Commercial farms		Coastal Public Property		Protected areas (terrestrial)	

features falling directly in the LAZ



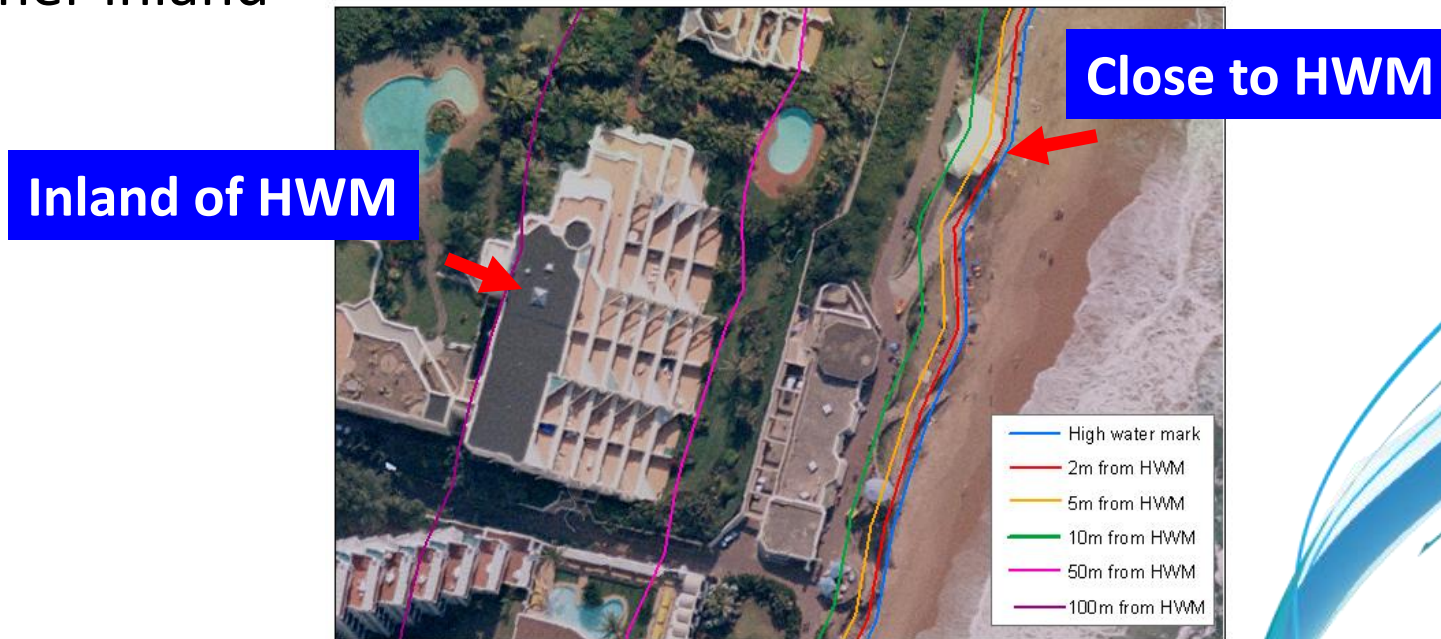
Key features located in the LAZ





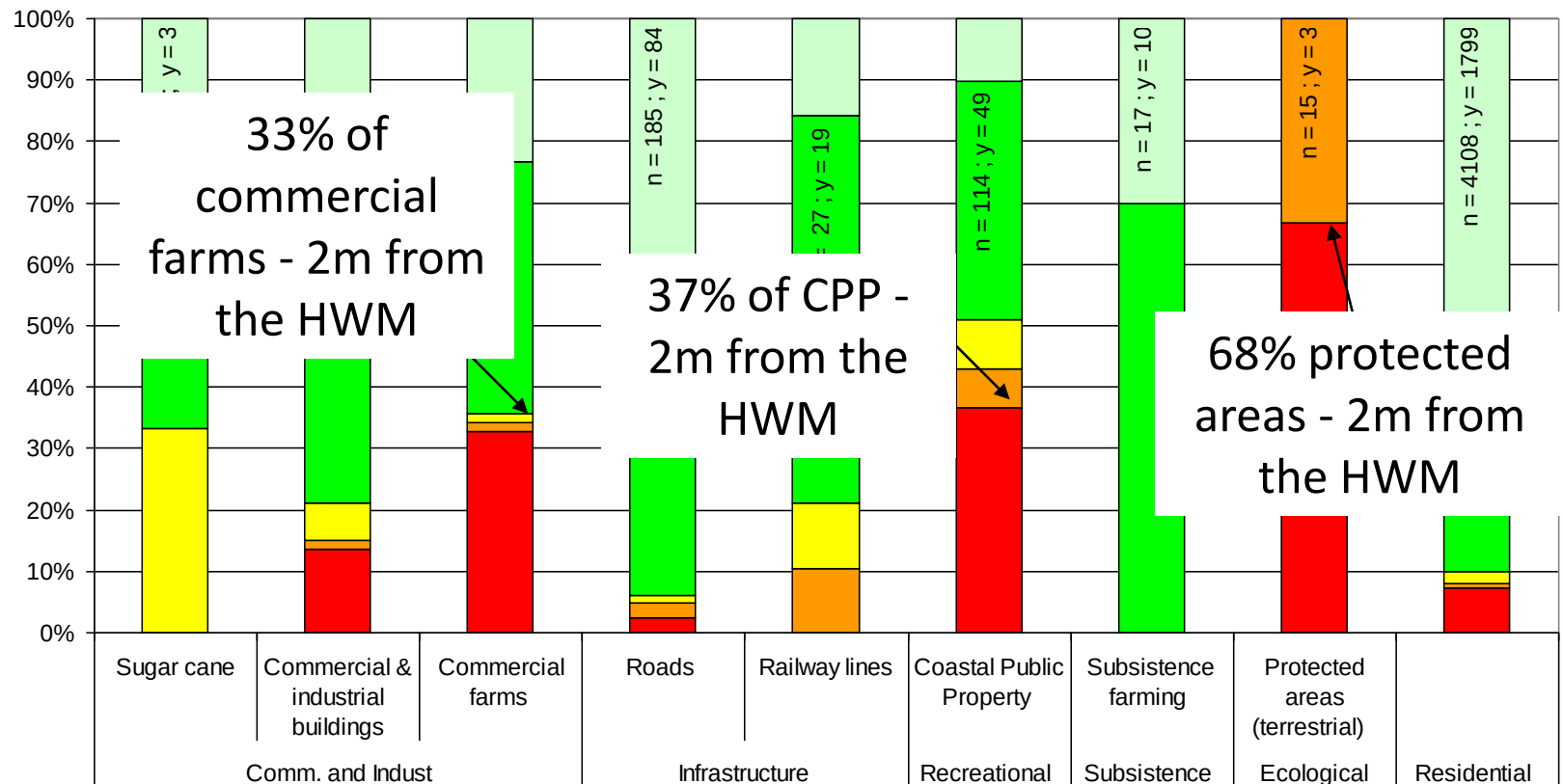
Key features located in the 100m from HWM

- Risk to features located within the coastal zone but inland of the HWM decreases as features move further inland





Key features located in the 100m from HWM



n = number of features within 100m of the HWM
y = number adjacent the cells of very high CVI

2m

5m

10m

50m

100m





Conclusions

- The methodology described is useful in that
 - The indicators used can be derived from remotely sensed data
 - It is a desktop assessment, resulting in it being cost-effective
 - Is easily repeated with new base data
- The selection of parameters, and their respective weighting, can be adjusted to suit local situations and scenario modelling



Conclusions

- This assessment highlights sections of the KwaZulu-Natal coast that are most vulnerable to coastal erosion and extreme events
- Assessment found that:
 - Relative risk proved higher than expected
 - The distribution of risk was strongly correlated with already developed areas
 - A dominant factor contributing to risk was the lack of vegetation behind the back beach (in front of development)



Conclusions

- In some areas social and economically important infrastructure is at risk
 - They are located too close to HWM
 - Often the result of inappropriate coastal development





Conclusions

- Needs to determine the best management options depending on the feature's nature, value, lifespan, and potential impact if lost



leave



Management Options

Retreat / remove
from vulnerable





Conclusions

- Management of risk in urban areas is often complicated as there is little room for retreat
- Where there is no room for retreat and defend is employed – soft engineering options are best
- Example: Vegetation was identified as a dominant parameter
 - This can be effectively managed and maintained



Soft engineering recovery

- Example of re-vegetation post 2007 storm event

March 2007



April 2011





KZN - Coastal Vulnerability Index Ver.1.0 - REGISTERED VERSION

Welcome **GIS Viewer** Media Documents Credits

GIS Tools

Lighthouse 1 : 5 114 ☒ Show Scale Bar

Themes Labeling Options Query Themes Base Map: Orthophoto Manager

Select a District

☐ Keep District Layer

☒ Local Municipalities

Base Maps: CVI Layers - Grouped by District

Restore District Map

Advance Info

[Coastal Places]

About Layers

Economic Commercial

Subsistence Sites

Strategic Infrastructure

Ecological Important Areas

Recreational Areas

Residential Properties

Social, Economic and Ecological Assets Assessment

☐ Umkhanyakude

☐ eThekweni

☐ uThungulu

☐ Ugu

☒ Ilembe

Select a Photo

☒ Show Photo Labels

Photo Database

Active Layer Opacity: 100%

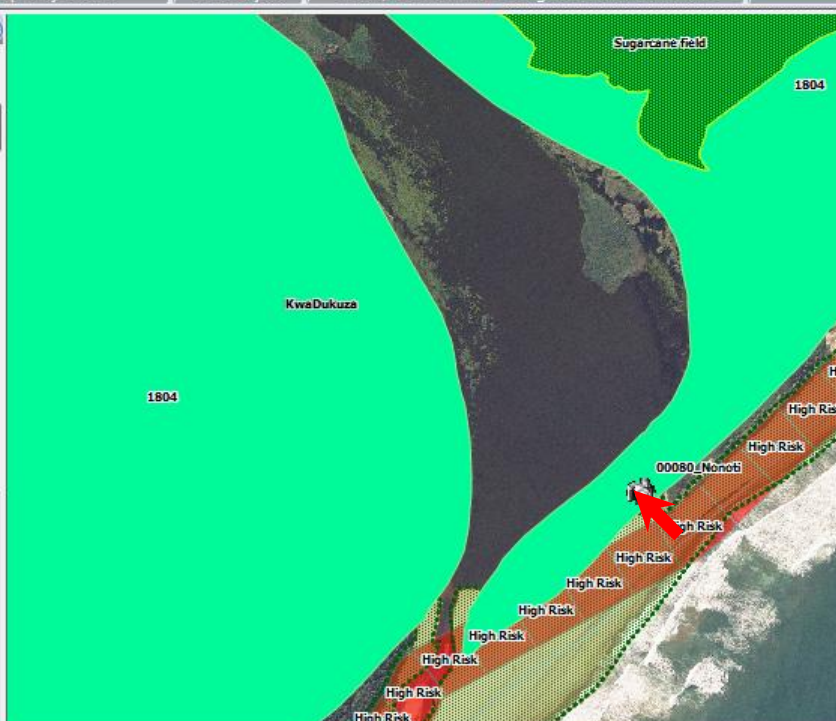
Show/Hide Layer ☒

Interval 100



- CVI: Risk
- CVI: Moderate Risk
- CVI: High Risk
- Subsistence Fishing
- Subsistence Harvesting
- Subsistence Farming
- Farm

UTM, -36° Southern Hemisphere
X:6 756 203.89 Y:345 755.20



Photo

Use mouse wheel to zoom in and out

290 m

Active Layer: LIGHTHOUSE Map Mode: Pan View Scale 1: 5 114.1 District: ILEMBE



Way forward

- 2nd phase of this assessment will refine the zone of impact
- The following will be taken into account:
 - coastal elevation,
 - predicted sea-level rise and
 - shoreline change
- This information coupled with future modelling will result in the determination of coastal set-back lines for the KwaZulu-Natal Province

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agriculture, environmental affairs
& rural development

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PROVINCE OF KWAZULU-NATAL

Specialists are thanked for their invaluable input

THANK YOU

