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Southern African Coastal Vulnerability Assessment

Dr Christo Rautenbach

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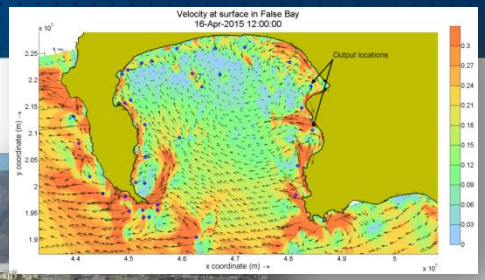
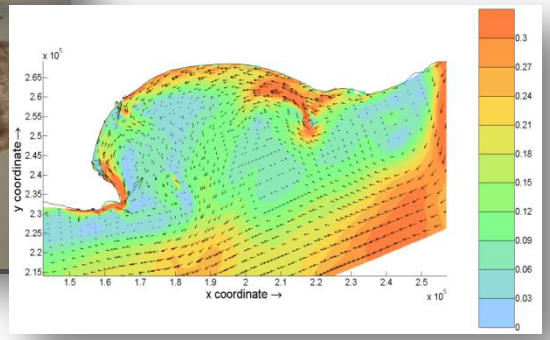
Content layout

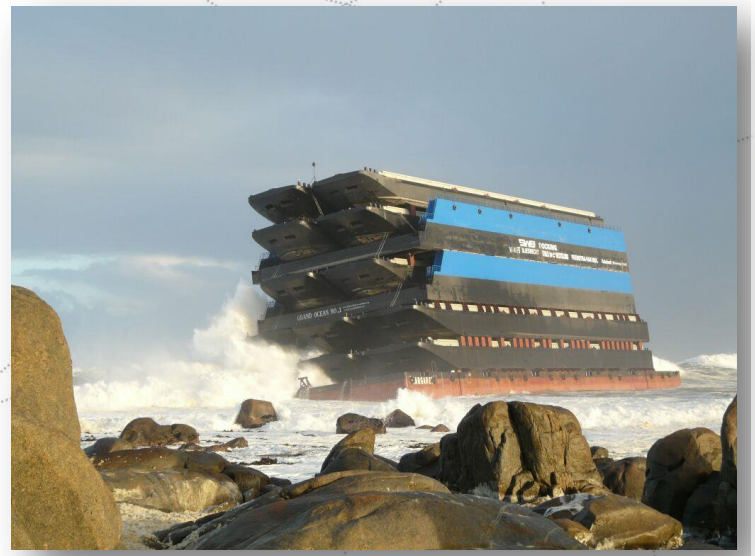




- Introduction to coastal vulnerability
- Climate change
- Consequences on the coast
- Vulnerability and risk on coastal zones
- Adaptation measures
- Technology solutions

The team…

Introduction



Severe weather conditions:

- Potential delays at ports
- Impacts on tow-operations
- Impact on coastal infrastructure
- Present problems may increase due to climate change (e.g. SLR, storminess)
- Need to quantify how much worse it will become due to climate change. (e.g. coastal setback lines)

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Climate change

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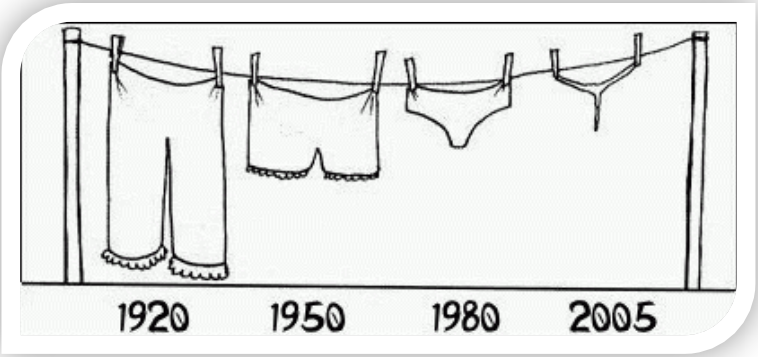
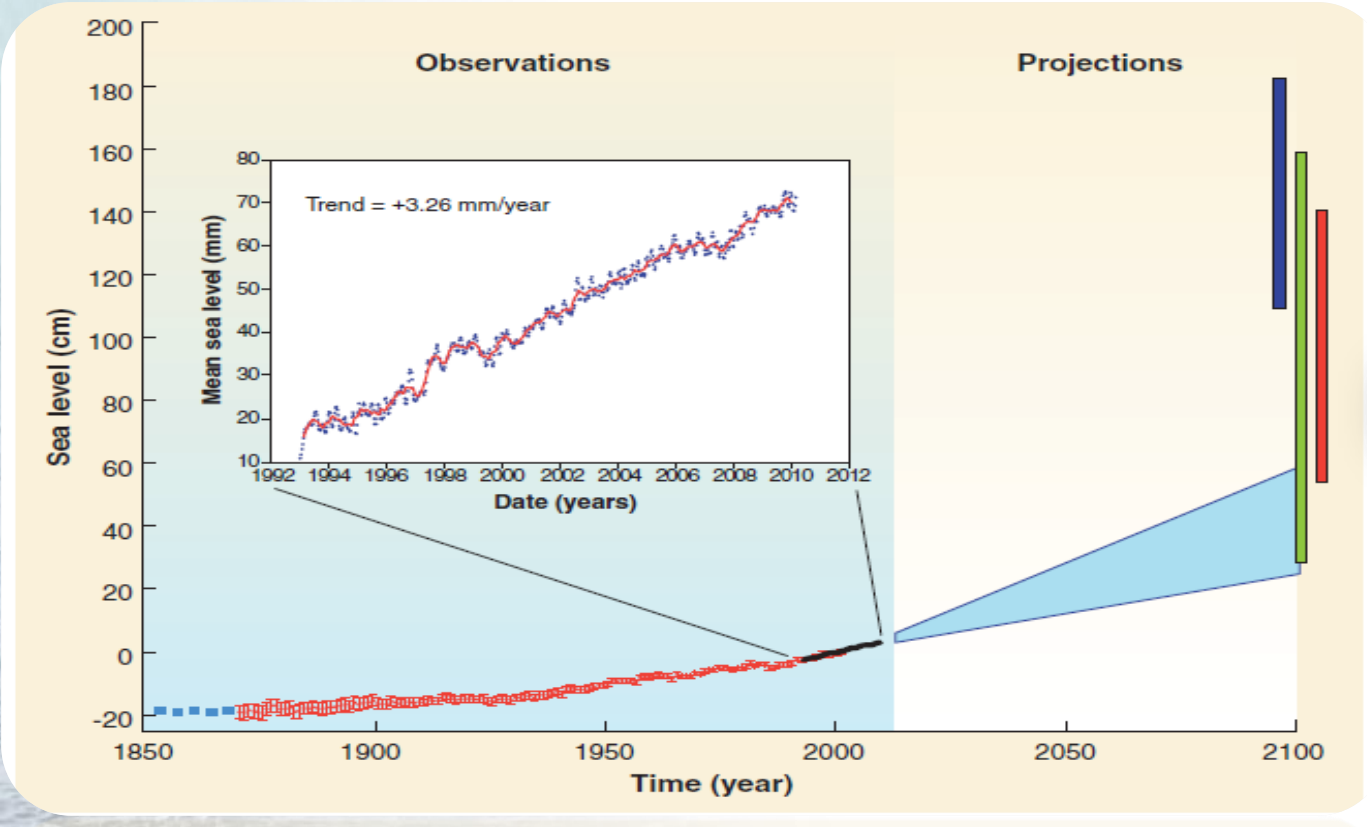
Sea level rise

Present global sea level rise (since 1993)
= **3.3 mm± 0.4 mm/y**

Literature: wide range of SLR scenarios, but most "physics/process based" projections (since 2007)
for 2100 ~ 0.5 m to 2 m range



Proof of global warming?



Sea-Level Rise and Its Impact on Coastal Zones
Robert J. Nicholls, *et al.*
Science **328**, 1517 (2010);
DOI: 10.1126/science.1185782

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Consequences on the coast

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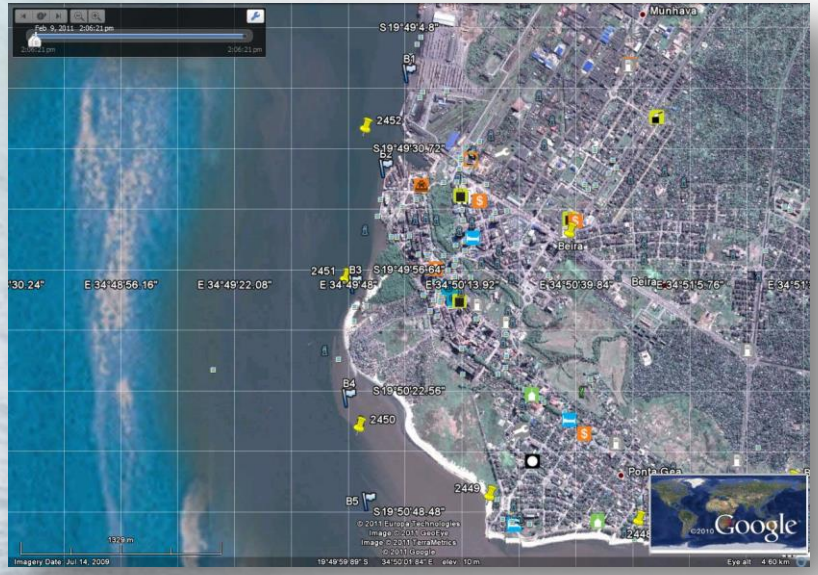
Some important potential consequences of global warming on southern African coast:

- **Potential changes in ocean winds & local wave regime -** direct wave impacts
- **Extreme inshore sea water levels due to SLR & storms -** flooding & inundation
- **Coastal erosion** & under-scouring **due to SLR & sea storms**
- **Complexities, thresholds, & non-linearities** - e.g. sand transport
- **Combination of extreme events** (sea storms during high tides + sea level rise)

will have greatest impacts - these will increasingly overwhelm existing infrastructure.

Southern WIO coastal zone very vulnerable to climate change impacts:



To prevent (more of) this: High seawater levels, wave run-up, flooding, erosion

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Vulnerability and risk of coastal zones

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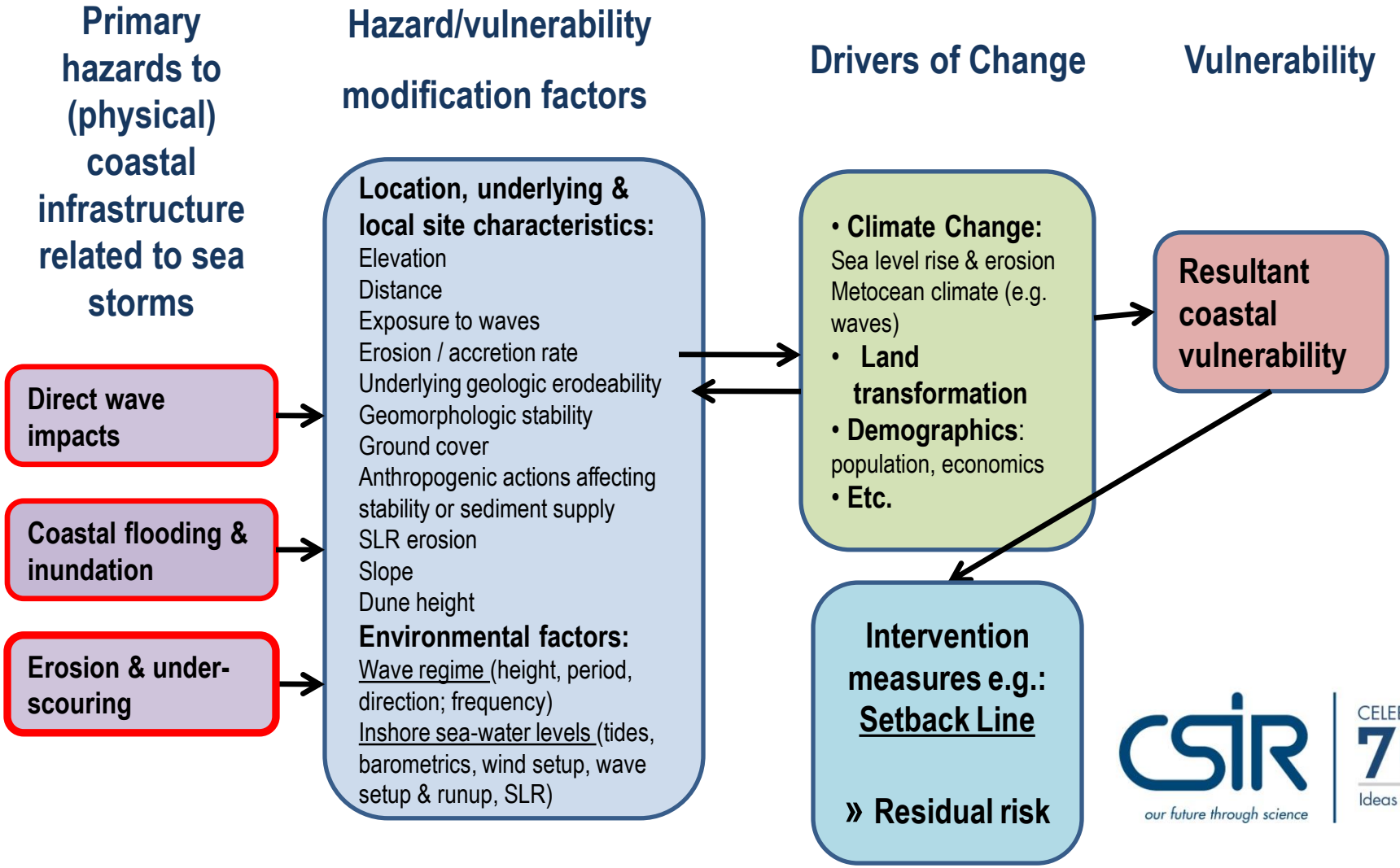
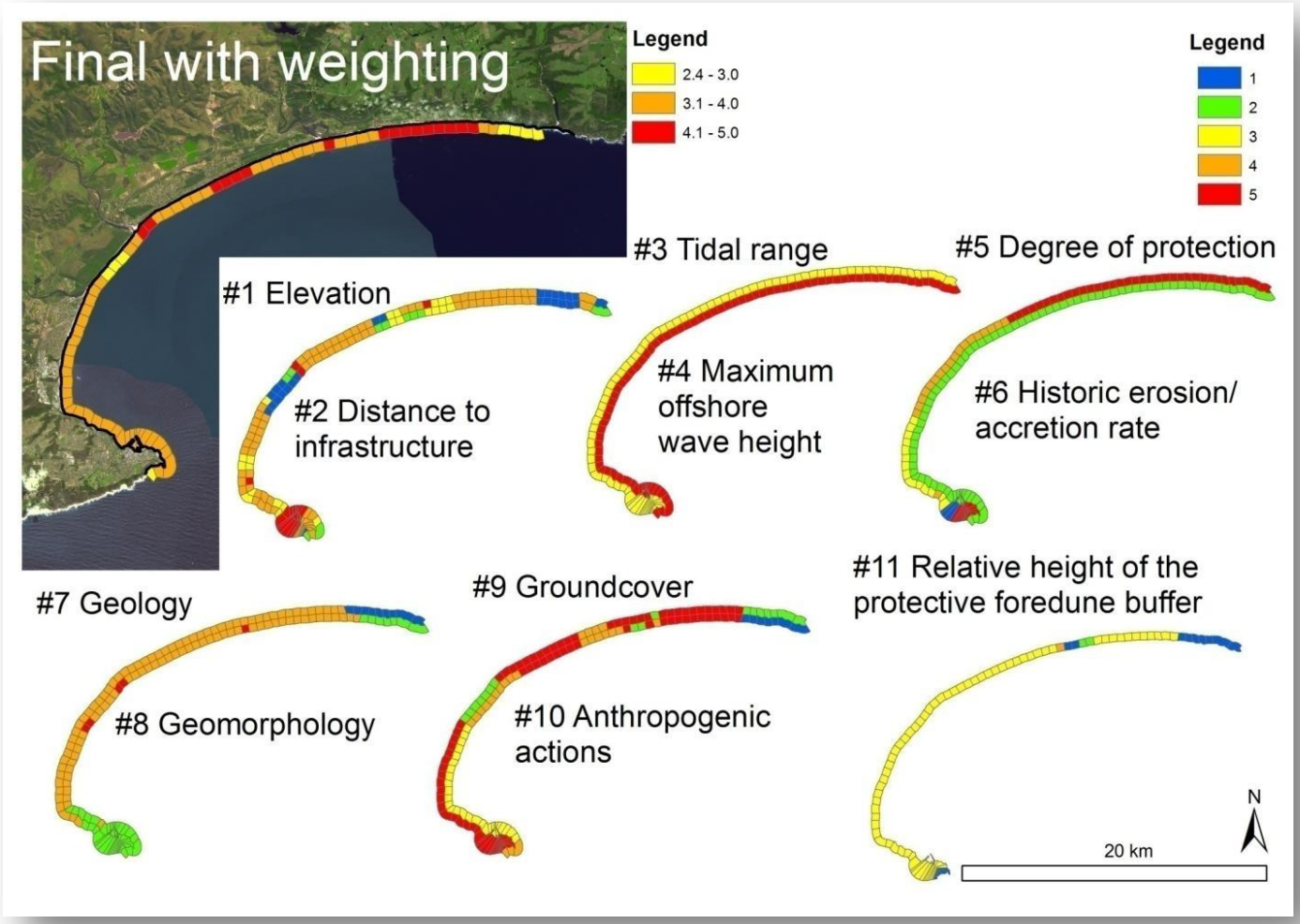
Coastal hazard/vulnerability assessment & mitigation

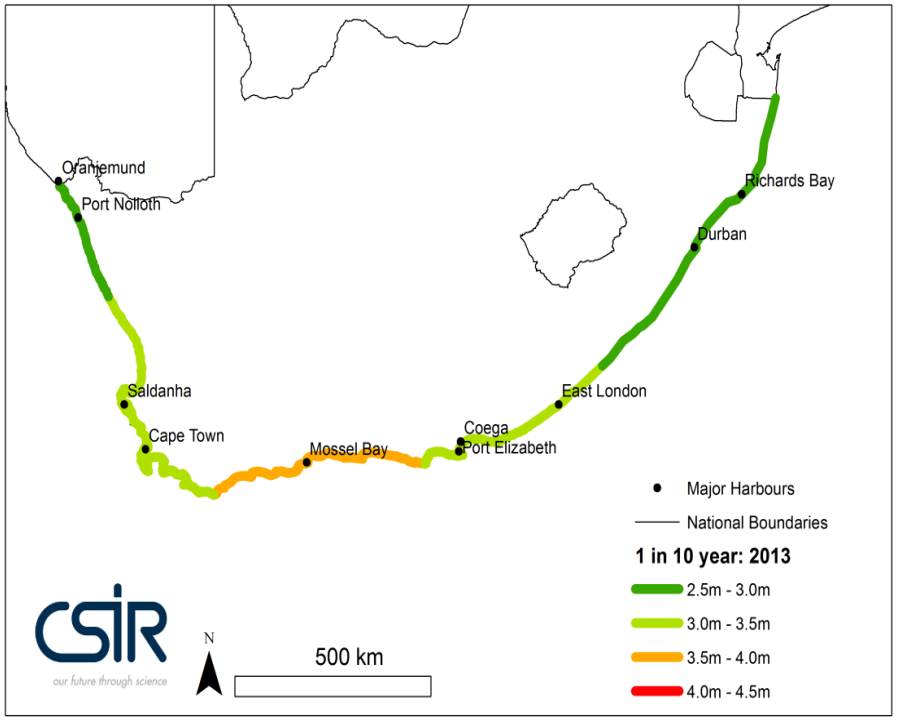


Example: Mossel Bay Vulnerability Mapping

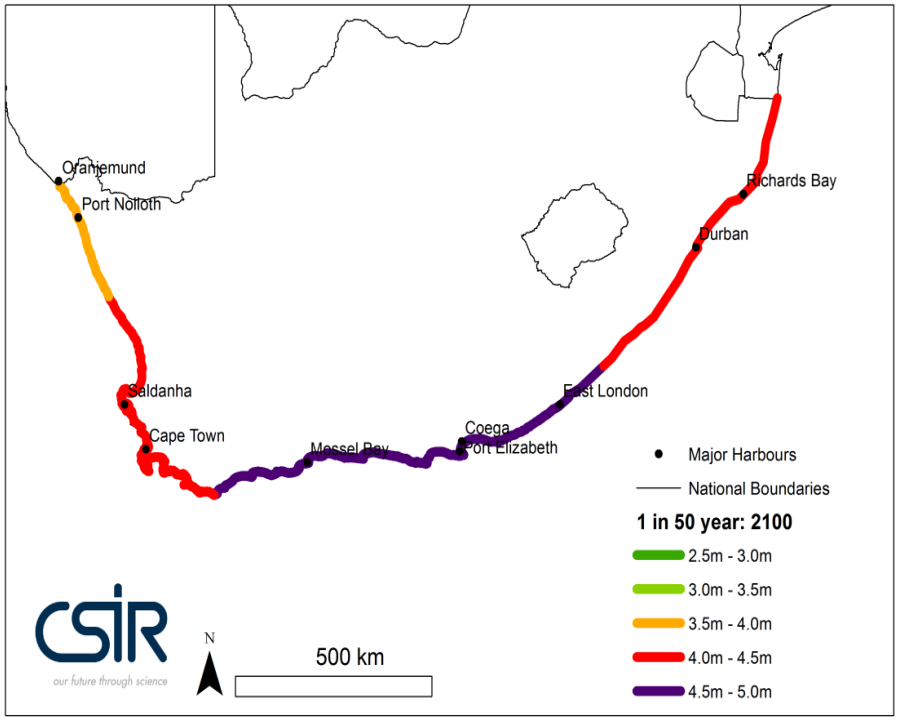


→ Extreme SA "storm surge" levels
(i.e. excluding wave run-up)

SA regional coastal storm surge levels for 1-in-10 year wave return period and 0 m SLR scenario



SA regional coastal storm surge levels for 1-in-50 year wave return period and 1 m SLR scenario



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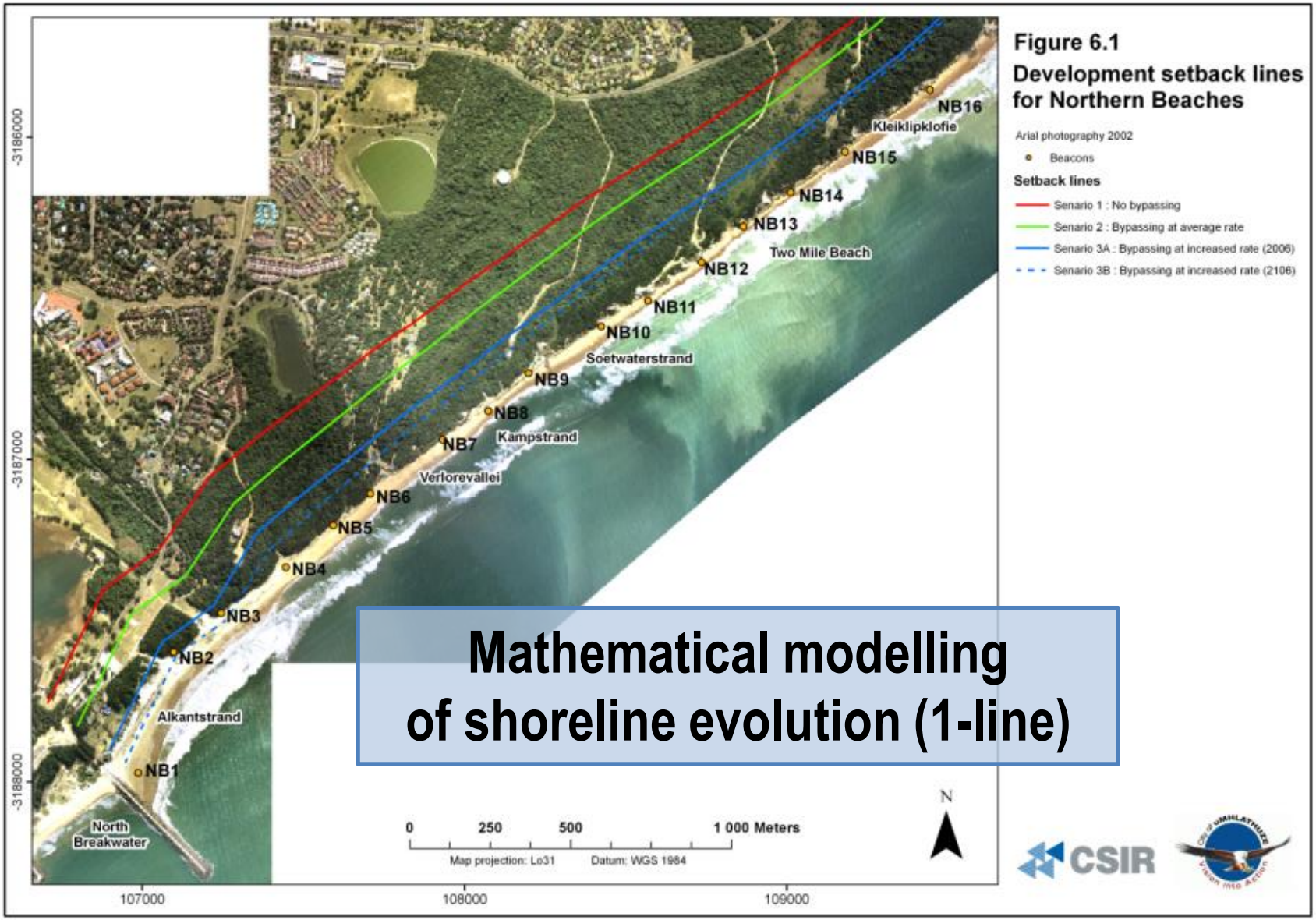
Quantification of risks to coastal areas and development: wave run-up, erosion, climate change.

Illustration of predicted combined effects of **potential shoreline erosion with Bruun's rule and higher wave runup** for a 0.5 m rise in sea level and a 1-in-20-year sea storm on the Blaauberg coast.

Examples of coastal development setback lines determined for Richards Bay.



MOZ example: mapping of areas vulnerable to SLR erosion, preliminary setback line for new developments

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Adaptation measures

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What can be done about the risks?

‘NO REGRET’ ADAPTATION MEASURES

Adaptation to change or hazards

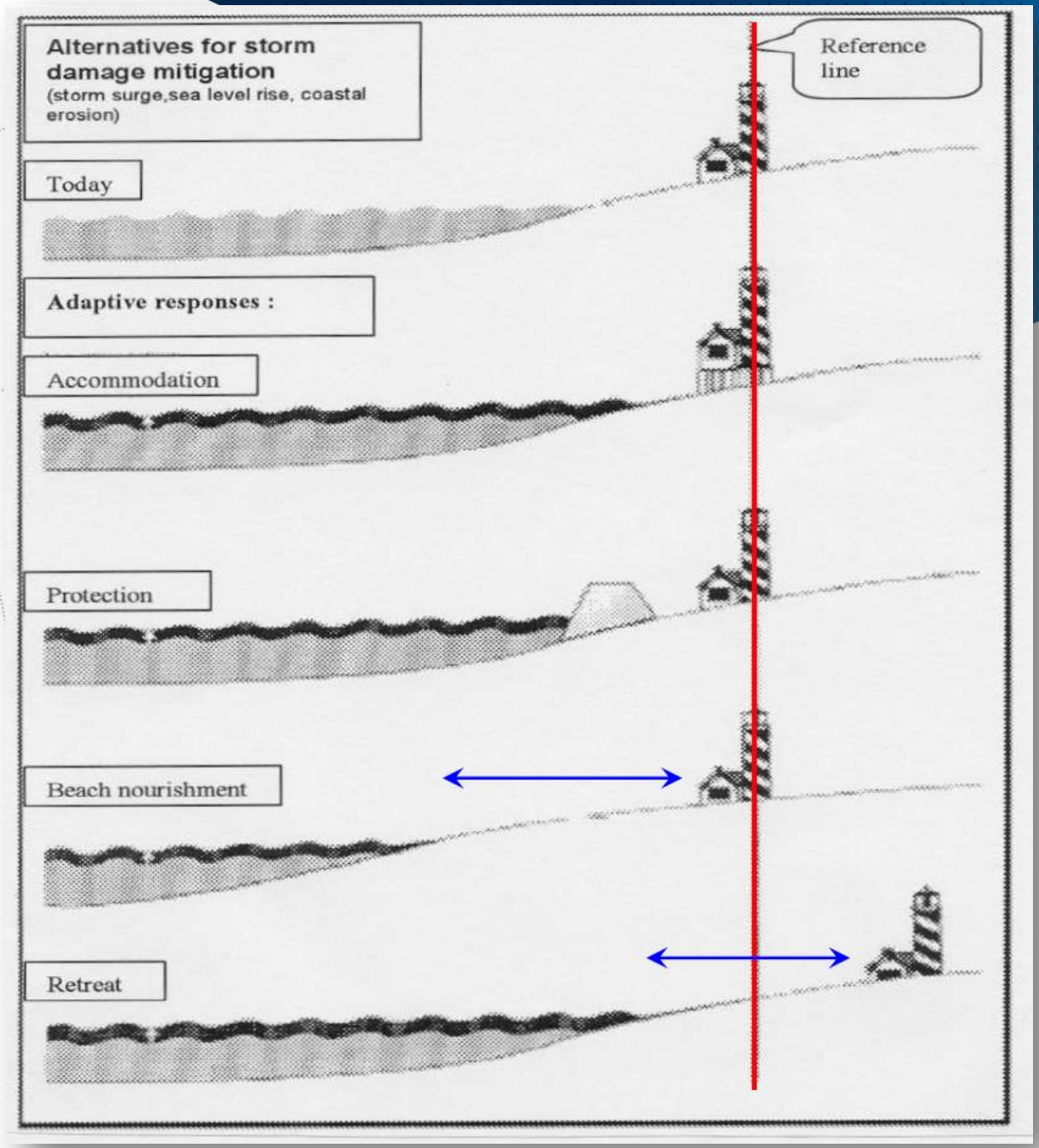
- Southern African states: very little adaptive capacity + ability to halt coastal impacts on a large scale virtually non-existent.
- Adaptation would reduce impacts by factor 10 to 100 - minor cost compared to damage avoided.
  - » **Set & implement adaptation measures sooner rather than later!**
- To mitigate detrimental impacts of climate change:
  understand adaptation options available to s. African society –
  considerably different from developed county approaches.

PURPOSE & APPROACH
To adaptation measures

- Conservative / precautionary principle
  - ✓ Authorities: pro-active approach to protect lives, livelihoods and infrastructure (Prevention is better than Cure)
- Sustainable solutions
  - ✓ Durable and low cost to the Municipality and / or State

» **'NO REGRET' ADAPTATION MEASURES**

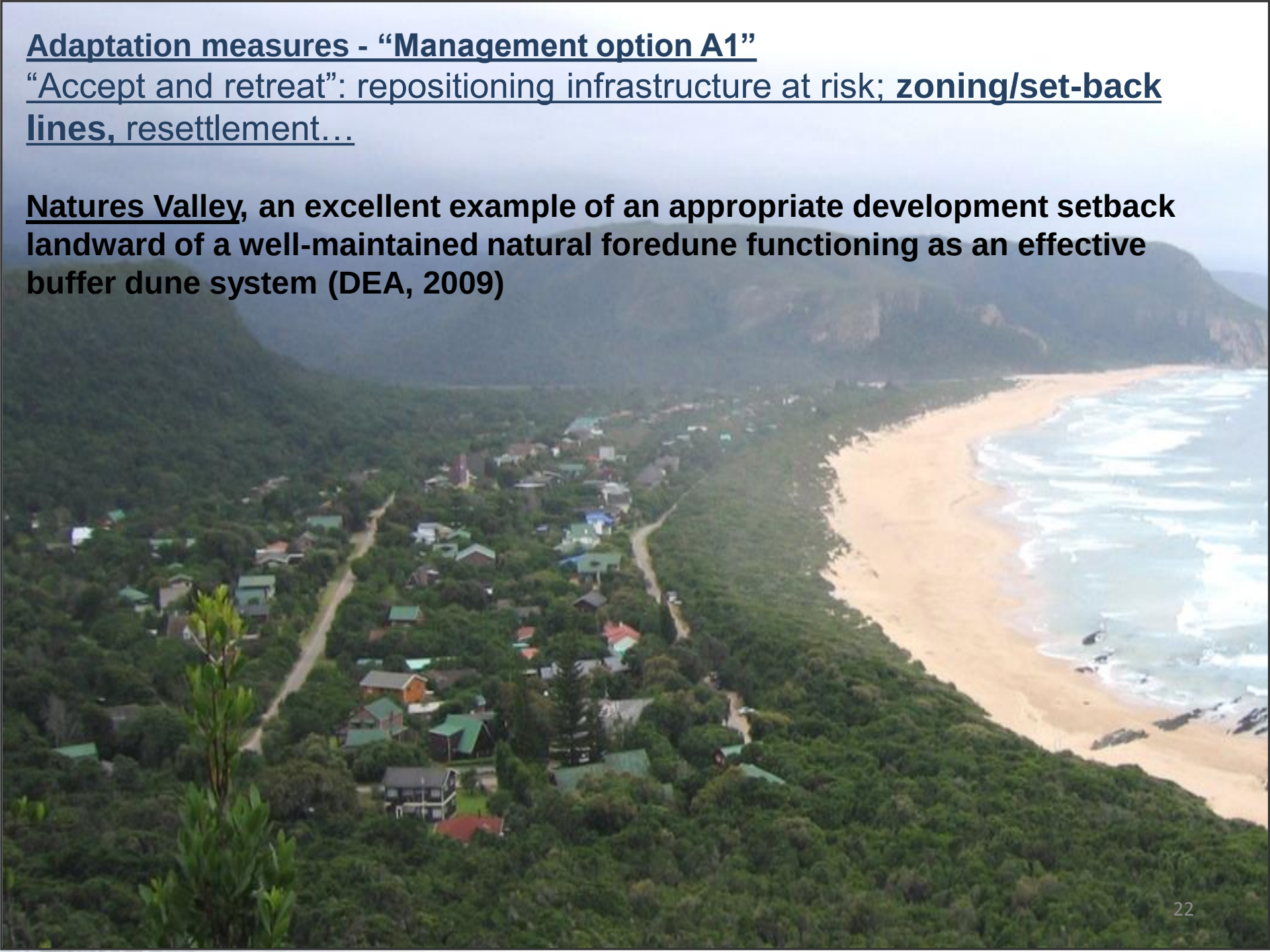
Coastal protection measures



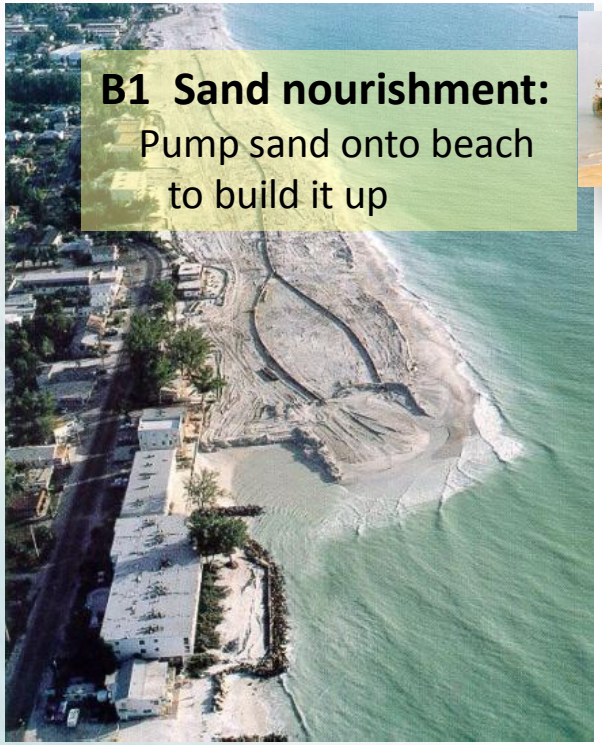
Adaptation measures - "Management option A1"

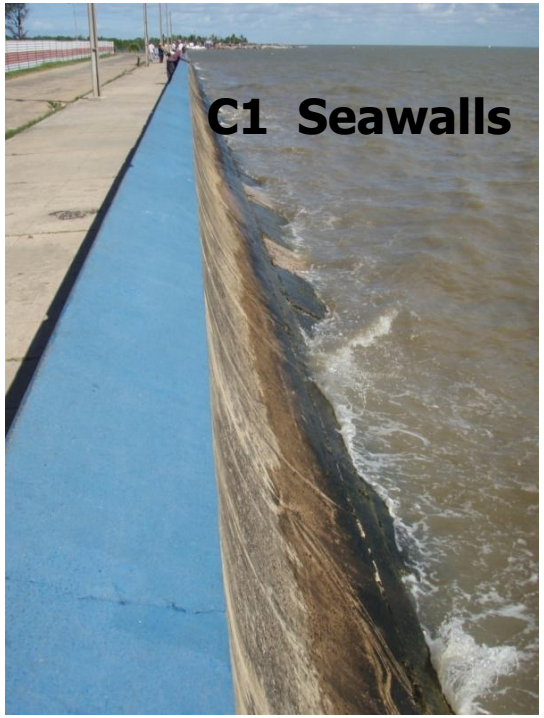
"Accept and retreat": repositioning infrastructure at risk; **zoning/set-back lines,** resettlement…

Natures Valley, an excellent example of an appropriate development setback landward of a well-maintained natural foredune functioning as an effective buffer dune system (DEA, 2009)



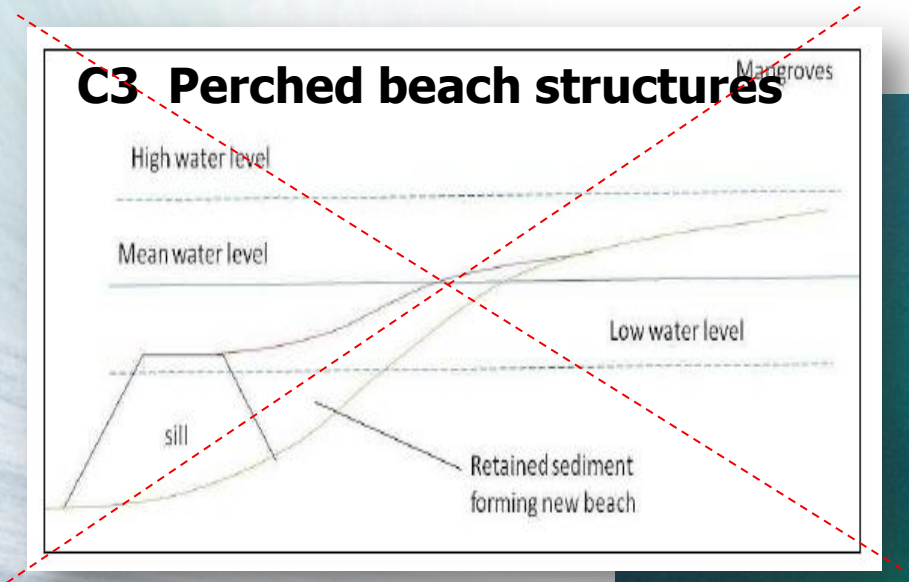
Adaptation/ protection options





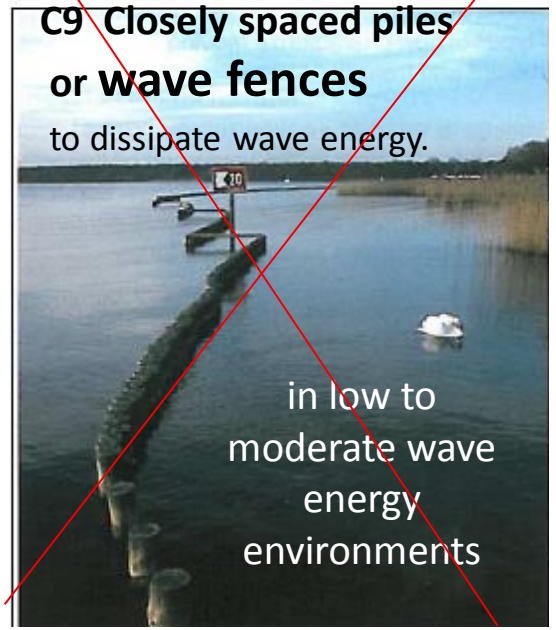
C2 Dikes

Adaptation /protection options

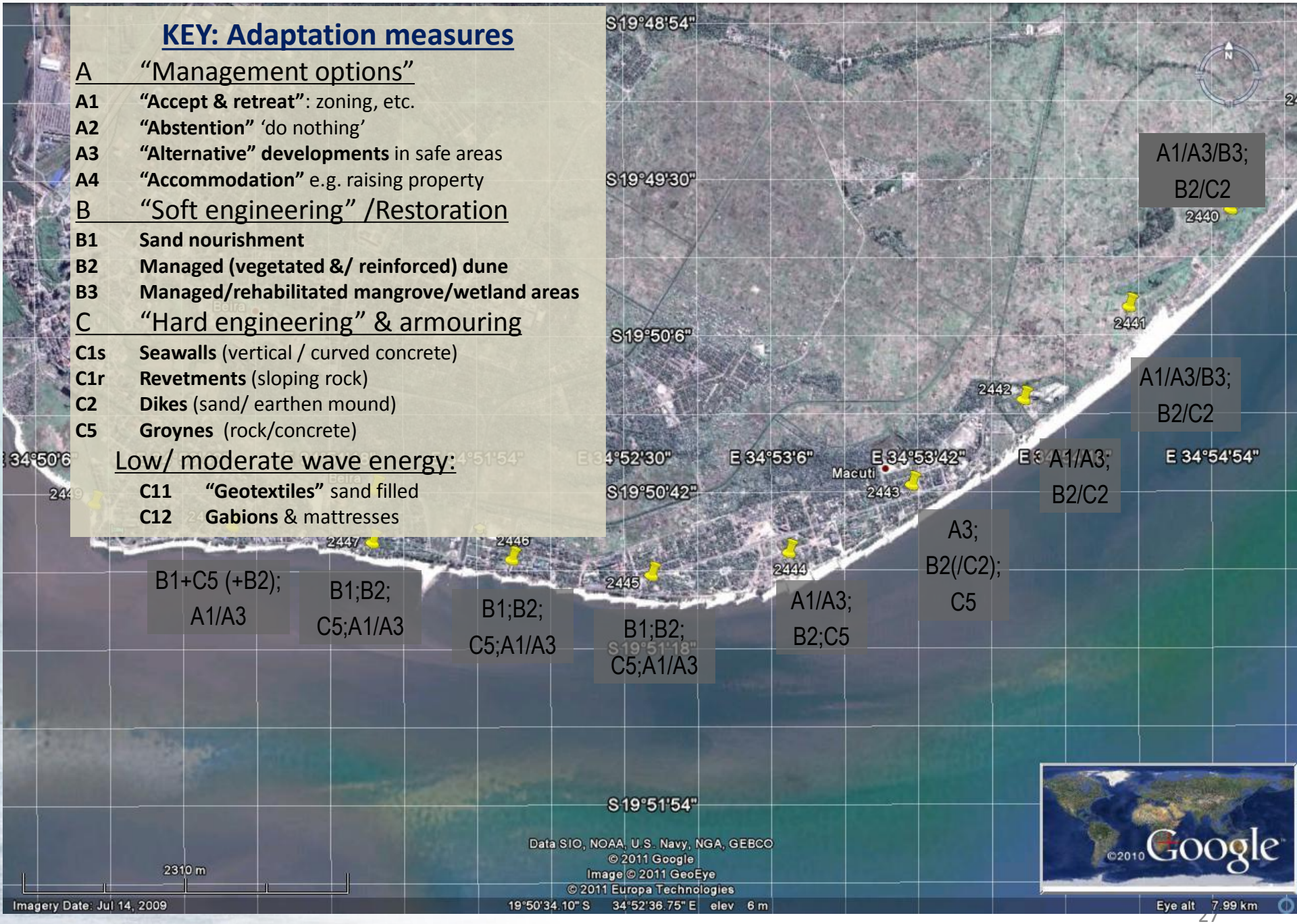


C4 Shore-parallel structures
artificial surf: zone reefs

Adaptation/ protection options



Mozambique example: Site specific analysis and recommended prioritised adaptation actions


KEY: Adaptation measures
A "Management options"
A1 "Accept & retreat": zoning, etc.
A2 "Abstention" 'do nothing'
A3 "Alternative" developments in safe areas
A4 "Accommodation" e.g. raising property
B "Soft engineering" /Restoration
B1 Sand nourishment
B2 Managed (vegetated &/ reinforced) dune
B3 Managed/rehabilitated mangrove/wetland areas
C "Hard engineering" & armouring
C1s Seawalls (vertical / curved concrete)
C1r Revetments (sloping rock)
C2 Dikes (sand/ earthen mound)
C5 Groynes (rock/concrete)
Low/ moderate wave energy:
C11 "Geotextiles" sand filled
C12 Gabions & mattresses
S19°48'54"
S19°49'30"
S19°50'6"
S19°50'42"
S19°51'18"
S19°51'54"
E 34°52'30"
E 34°53'6"
E 34°53'42"
E 34°54'54"
Macuti
2440
2441
2442
2443
2444
2445
2446
2447
A1/A3/B3; B2/C2
A1/A3/B3; B2/C2
A1/A3; B2/C2
A3; B2(/C2); C5
A1/A3; B2;C5
B1;B2; C5;A1/A3
B1;B2; C5;A1/A3
B1;B2; C5;A1/A3
B1+C5 (+B2); A1/A3
2310 m
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2011 Google
Image © 2011 GeoEye
© 2011 Europa Technologies
©2010 Google
Imagery Date: Jul 14, 2009
19°50'34.10" S 34°52'36.75" E elev 6 m
Eye alt 7.99 km

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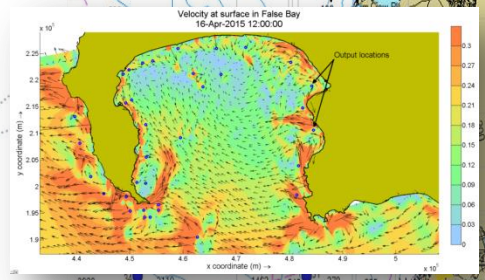
Off-shore to near-shore wave transformation

NCEP (National Centres for Environmental Prediction)



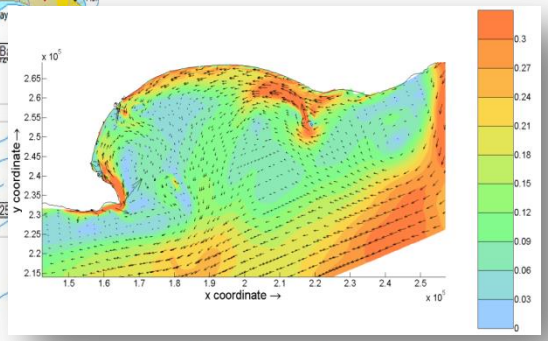
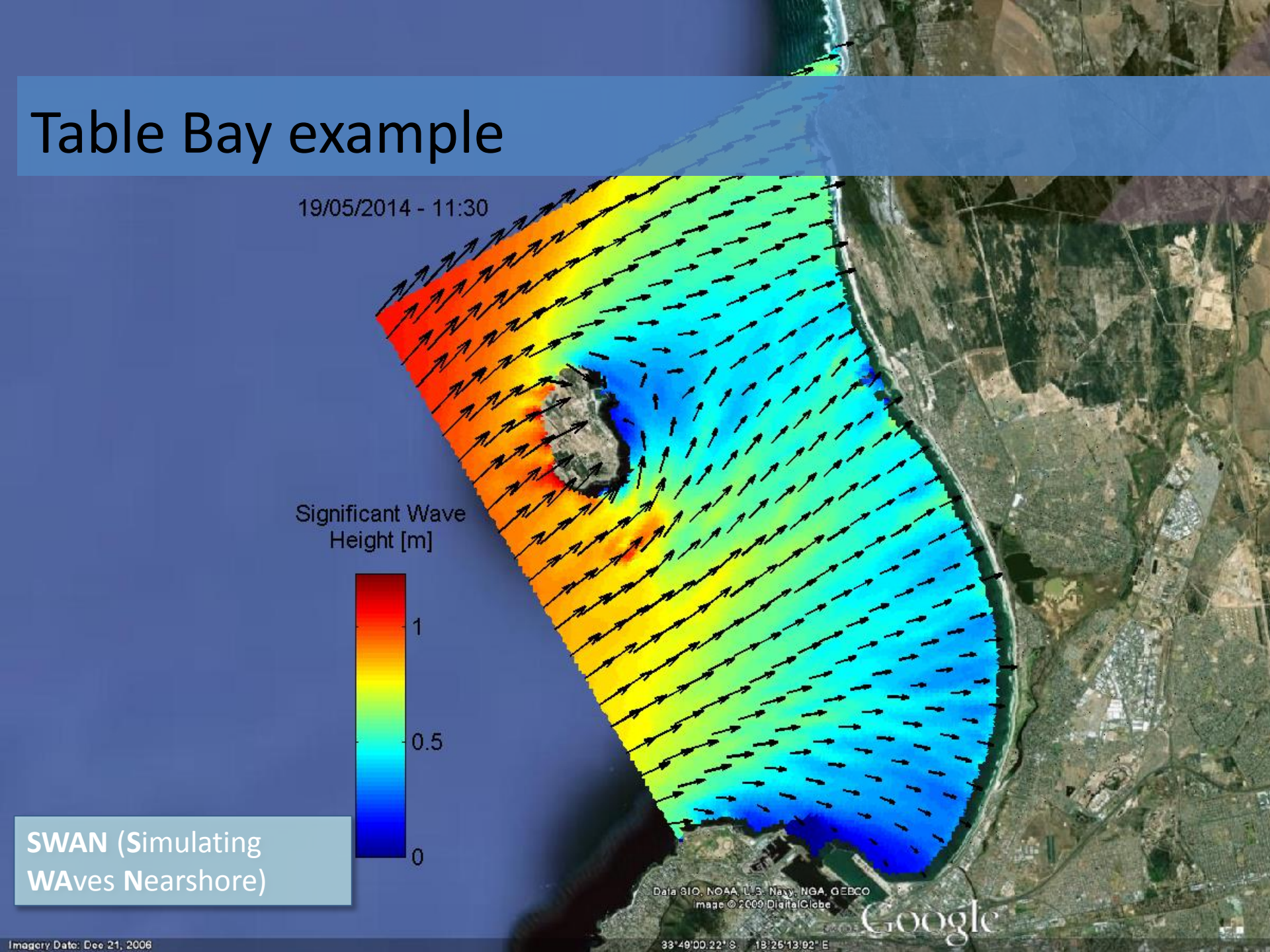
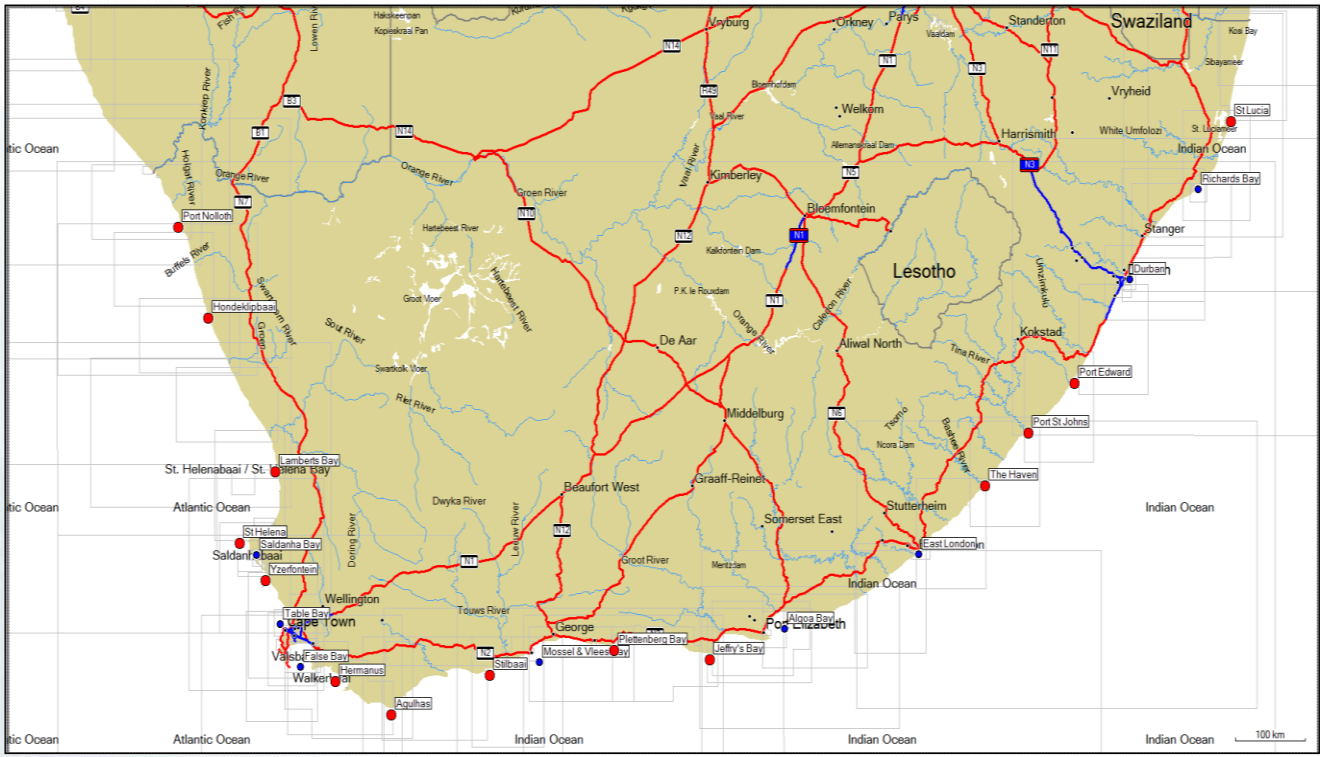


Table Bay example



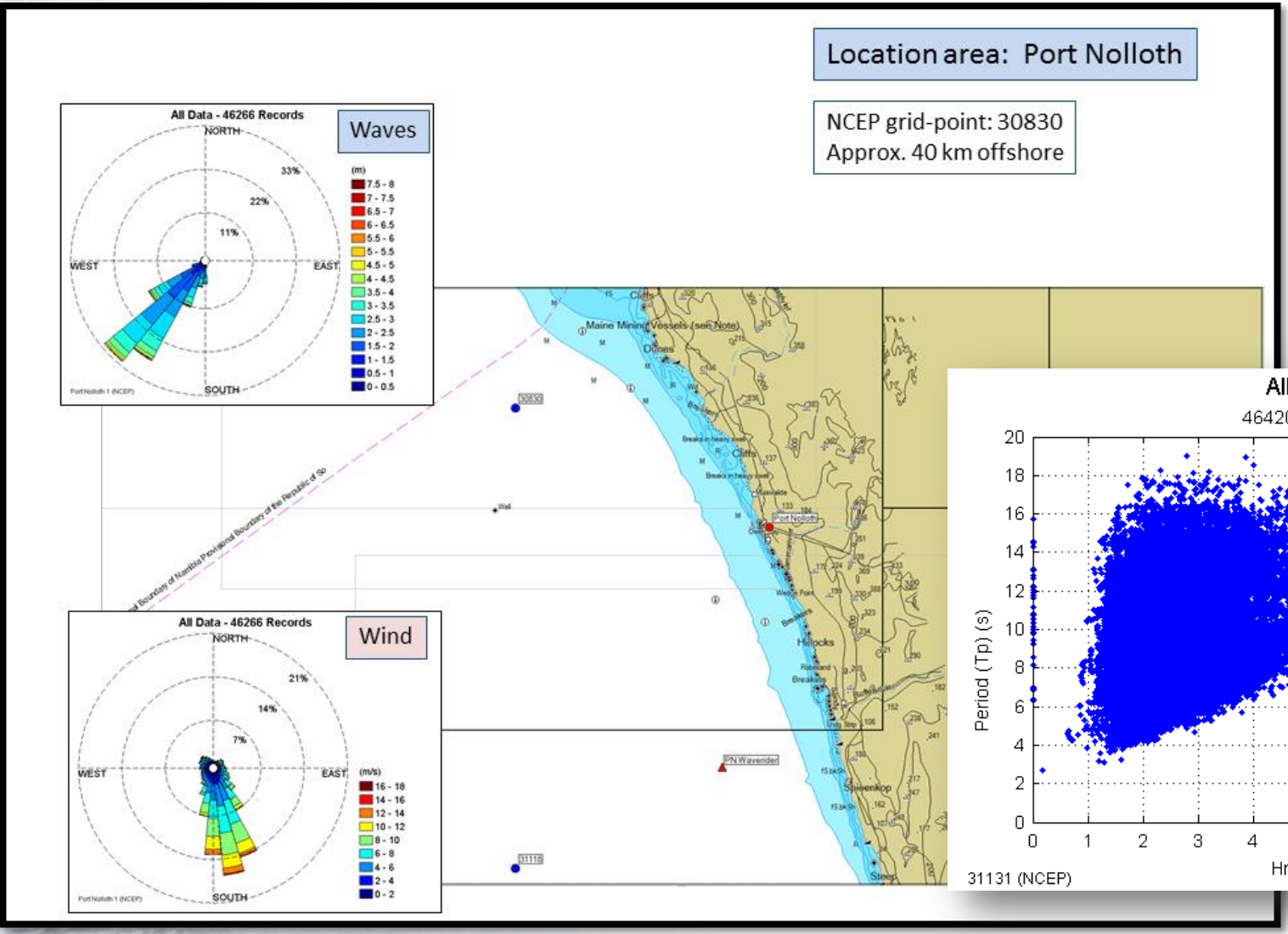
SWAN (**S**imulating **WA**ves **N**earshore)

Model locations



- The runs of numerical wave models are completed (23 in total around the coast).
- Provide medium resolution inshore wave climate data at 0.5 km resolution. Each model ~ 100 km

Off-shore wave climate obtained from historical to current record of NCEP data transformed to nearshore through look-up table (transformation coefficients).



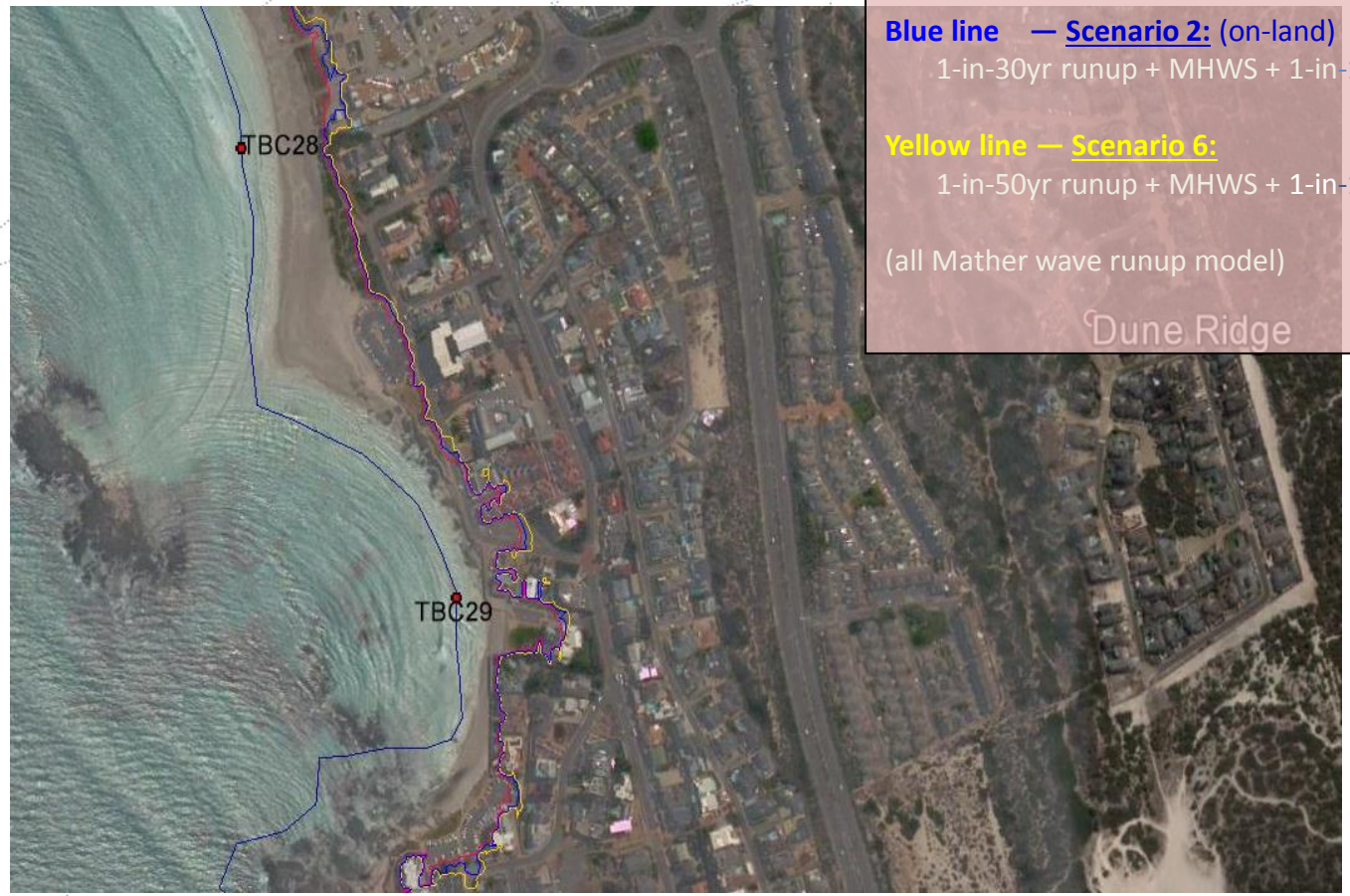
Quantification of risk to coastal areas and development: potential coastal flood lines

Red line — **Scenario 1:**
1-in-10yr runup + MHWS + 1-in-10yr residual + 0.35m SLR

Blue line — **Scenario 2:** (on-land)
1-in-30yr runup + MHWS + 1-in-10yr residual + 0.35m SLR

Yellow line — **Scenario 6:**
1-in-50yr runup + MHWS + 1-in-10yr residual + 1.0m SLR

(all Mather wave runup model)



COASTCAM

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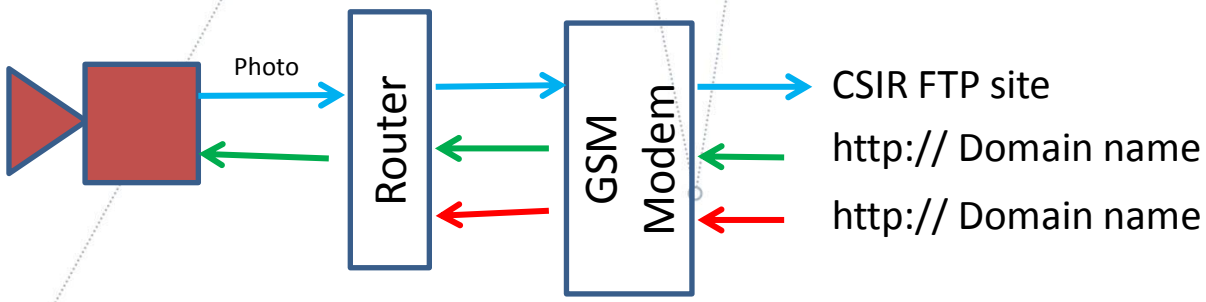
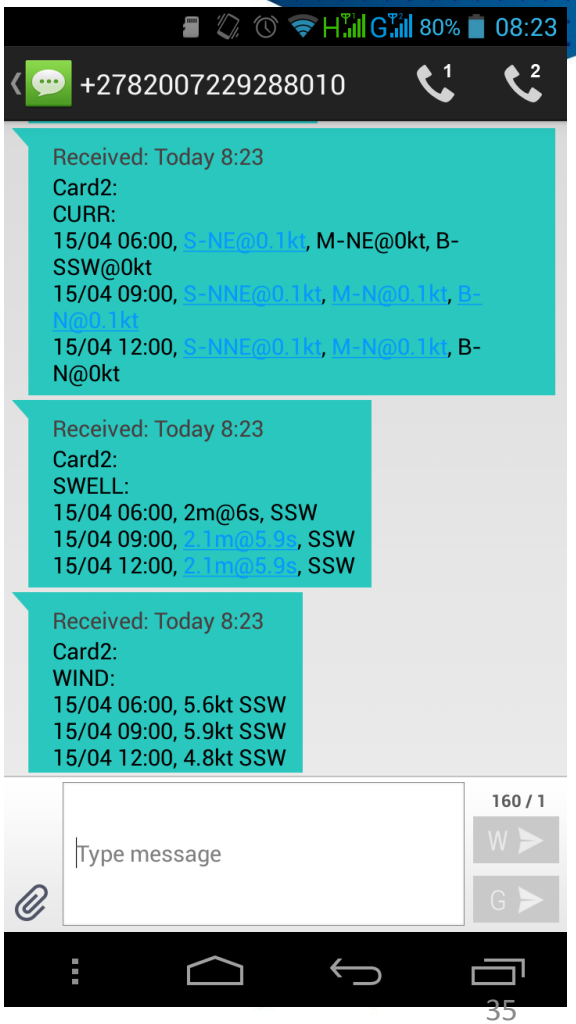
- There are currently 2 pilot sites; **Fish Hoek** & **Yzerfontein**
- The Fish Hoek camera is mounted indoors while the Yzerfontein camera is mounted outdoors
- A 3rd site, namely Port St Johns is currently being set up
- Data communication & site maintenance :

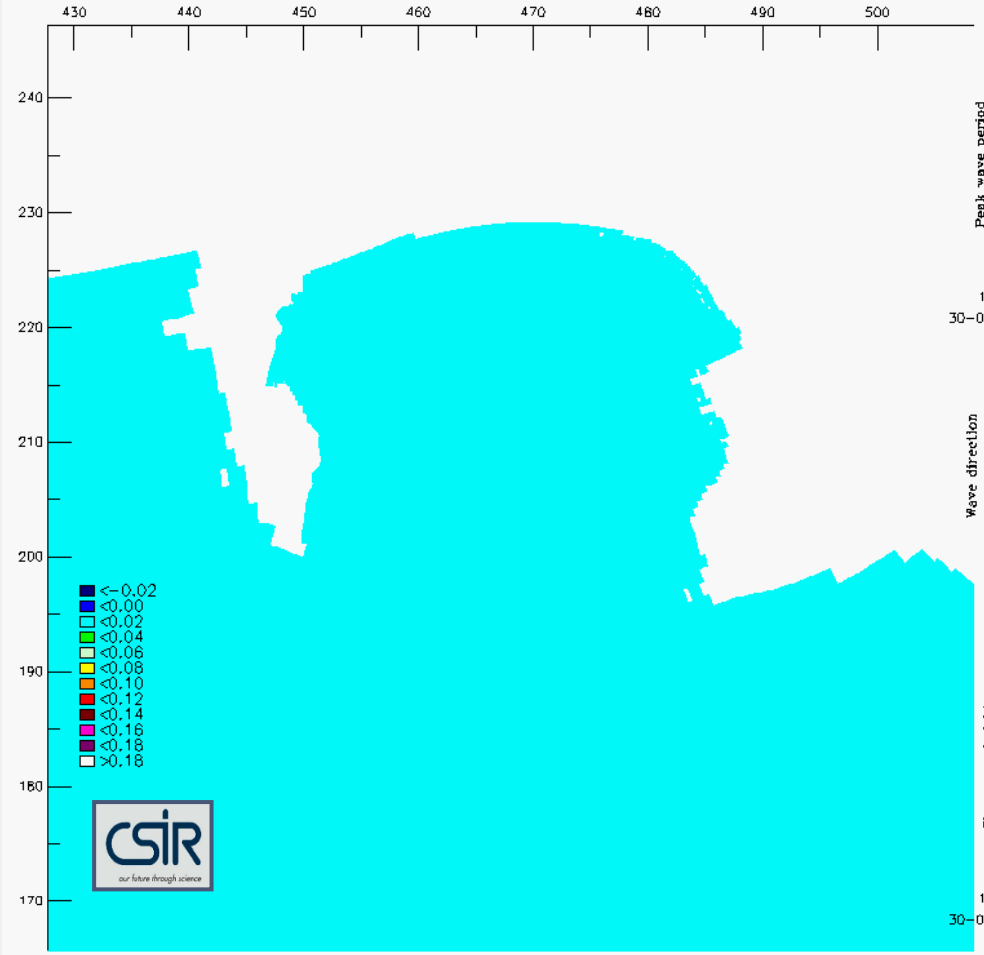


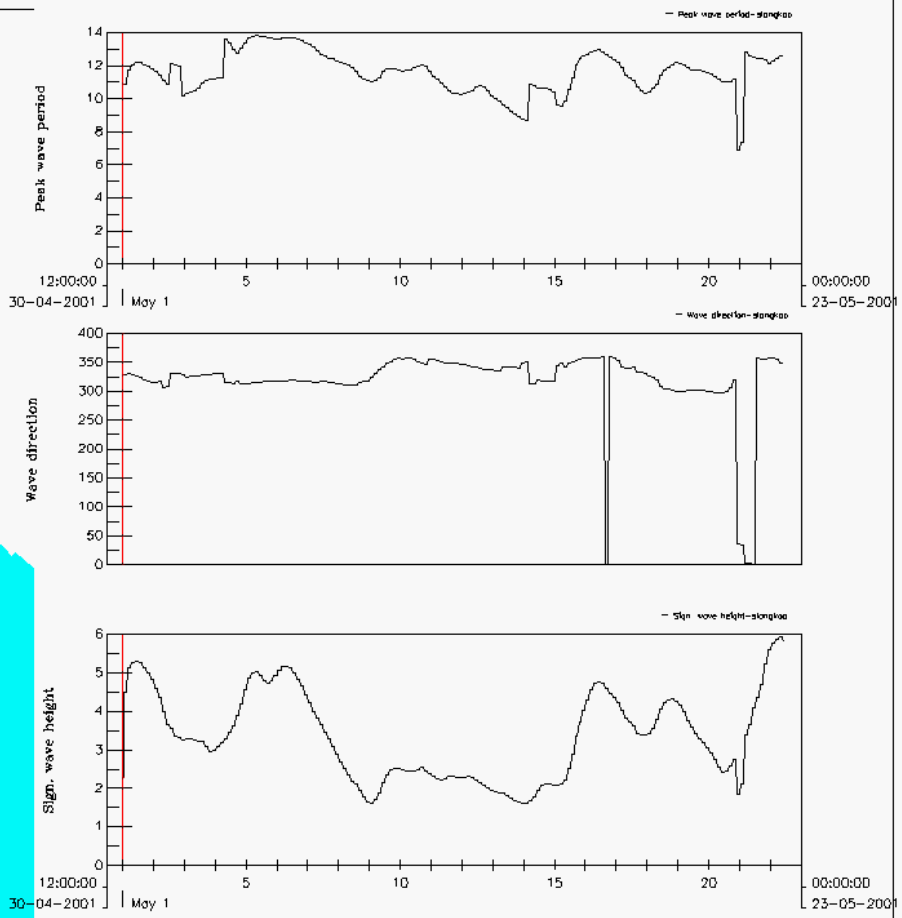
Operational forecasting

- Forecasts informing public for recreational use and safety.
- Including monitoring via **COASTCAM**

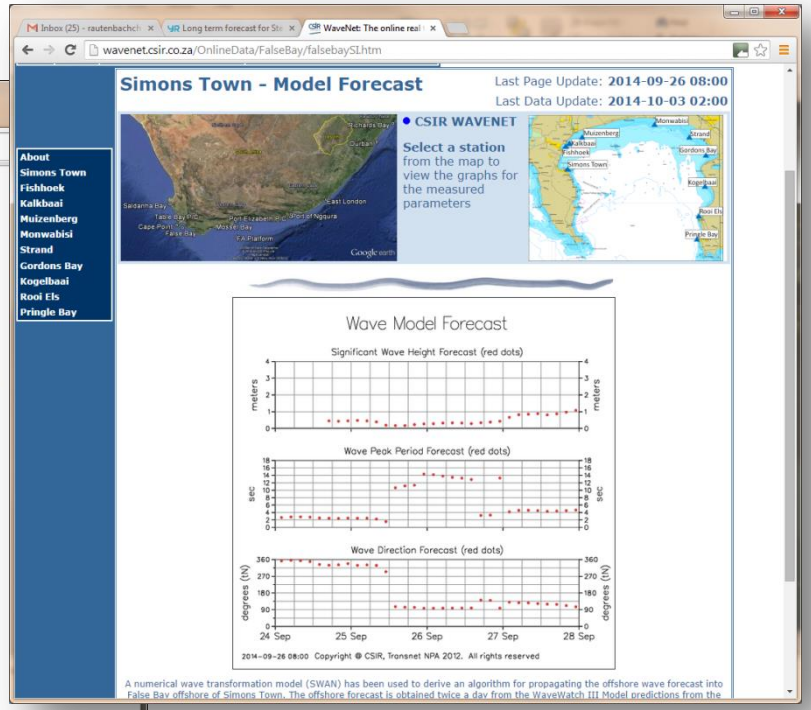


Operational forecasting model example





False Bay on Wave-net



http://wavenet.csir.co.za/

Thank you