Dredging and Associated Environmental Aspects:
Real-time and Longer Term Information Gaps

(Focus on Northern Australia)

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&

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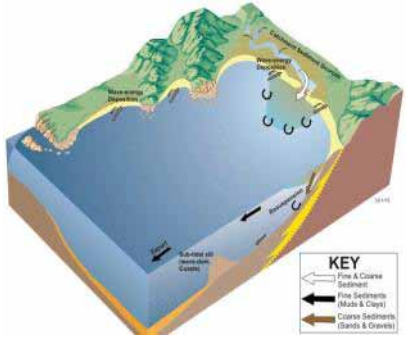


FOO's brief (in prep). includes:

- Systematic and long-term routine measurements
- User-defined outputs
- For the past, present & future
  - (Andreas Schiller et al.)
- Ocean climate variability
  - (Brinkman)

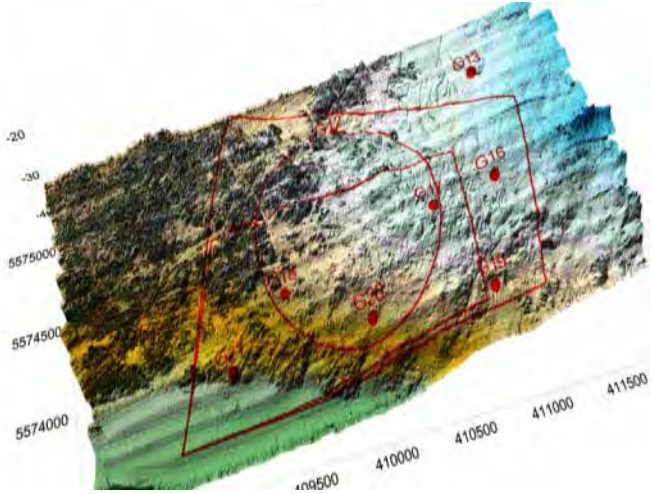
So – can include:

- Dredging activities
- Direct and other impacts
- Habitats
- Regulators as users

Relevance of sediments to end users

Primary control on:

- Habitats: presence, nature and resilience
- Water quality: habitats



- & industrial intakes
- Coastal change, seabed erosion/accumulation
- Underwater visibility
- etc

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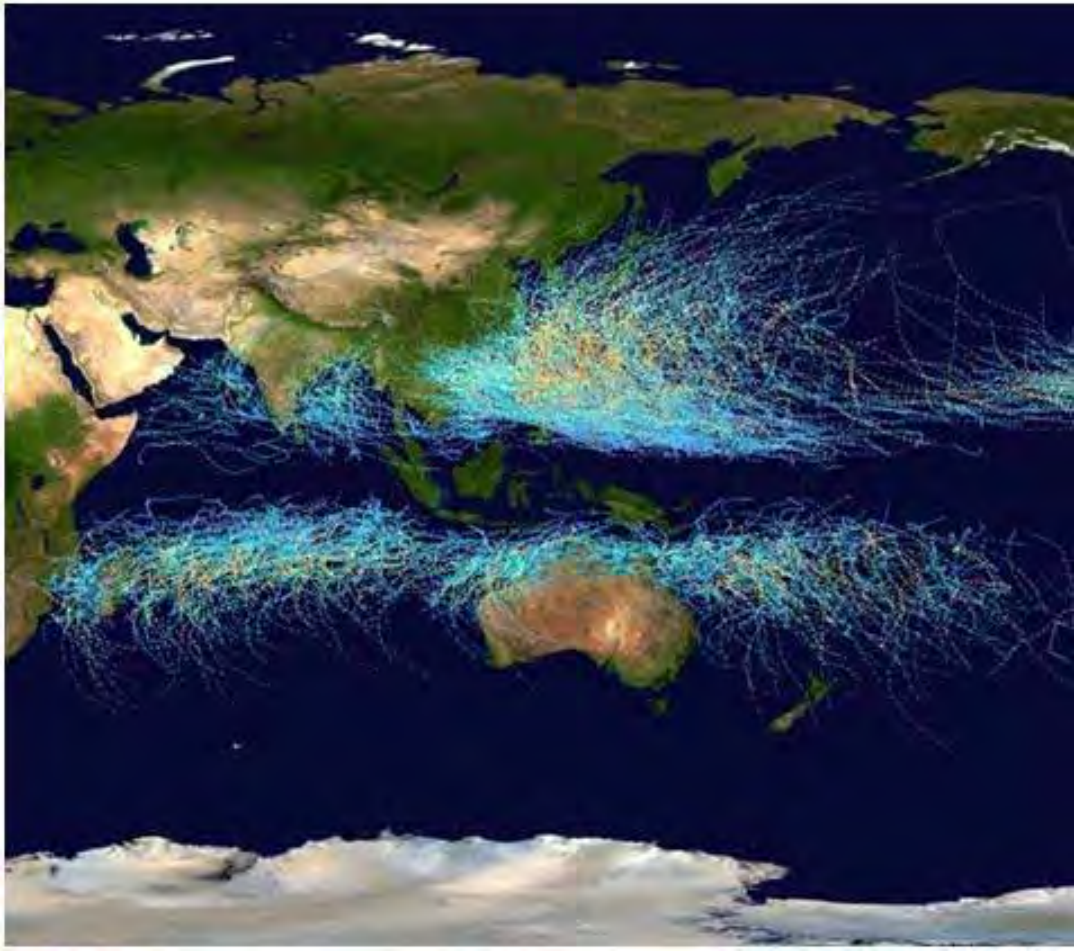
Shelf Currents & Bed Sediment Transport

Mechanisms Driving Currents

Measurements around Australia

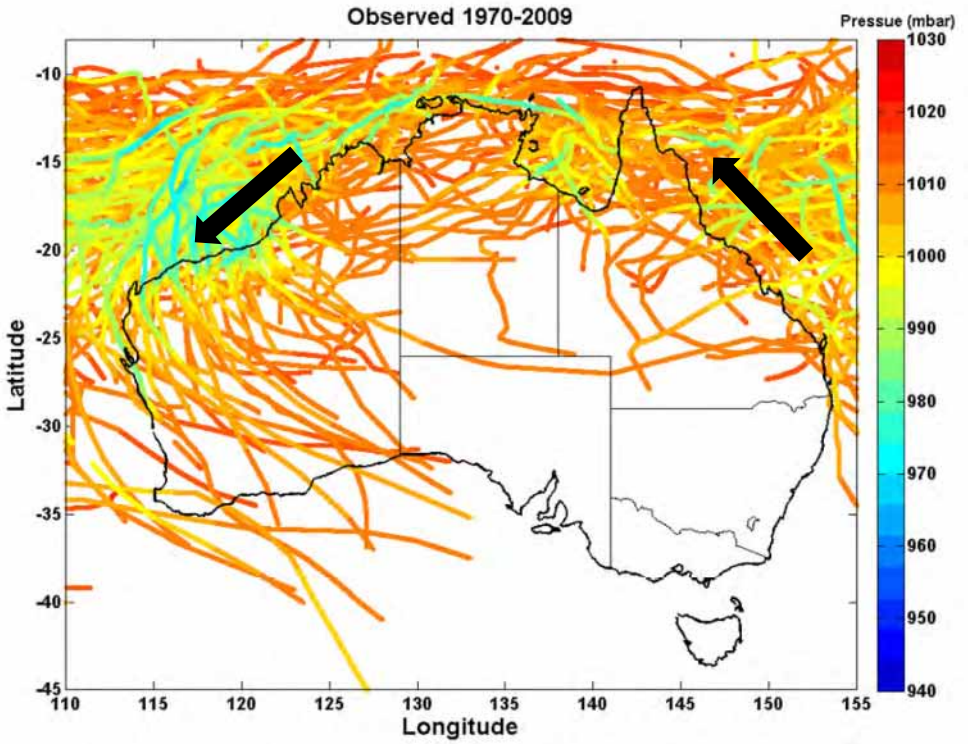
- Tide = 0.1 to 8 m/s
- Regional circulation = <1 m/s
- High-frequency currents (e.g. Solitons) = <1 m/s
- Local wind-induced currents (incl. TCs) = <2 m/s

- Sediment thresholds
- Transport rate = 3rd or 4th power function of flow speed
  - à Tropical Cyclones tend to control bed sediment transport patterns



Australian Tropical Cyclones

- Multi-decadal net bed sediment transport:
  - NW along the GBR shelf
  - SW along the NW Shelf
- Evidence broad & established
- Transport rates less clear



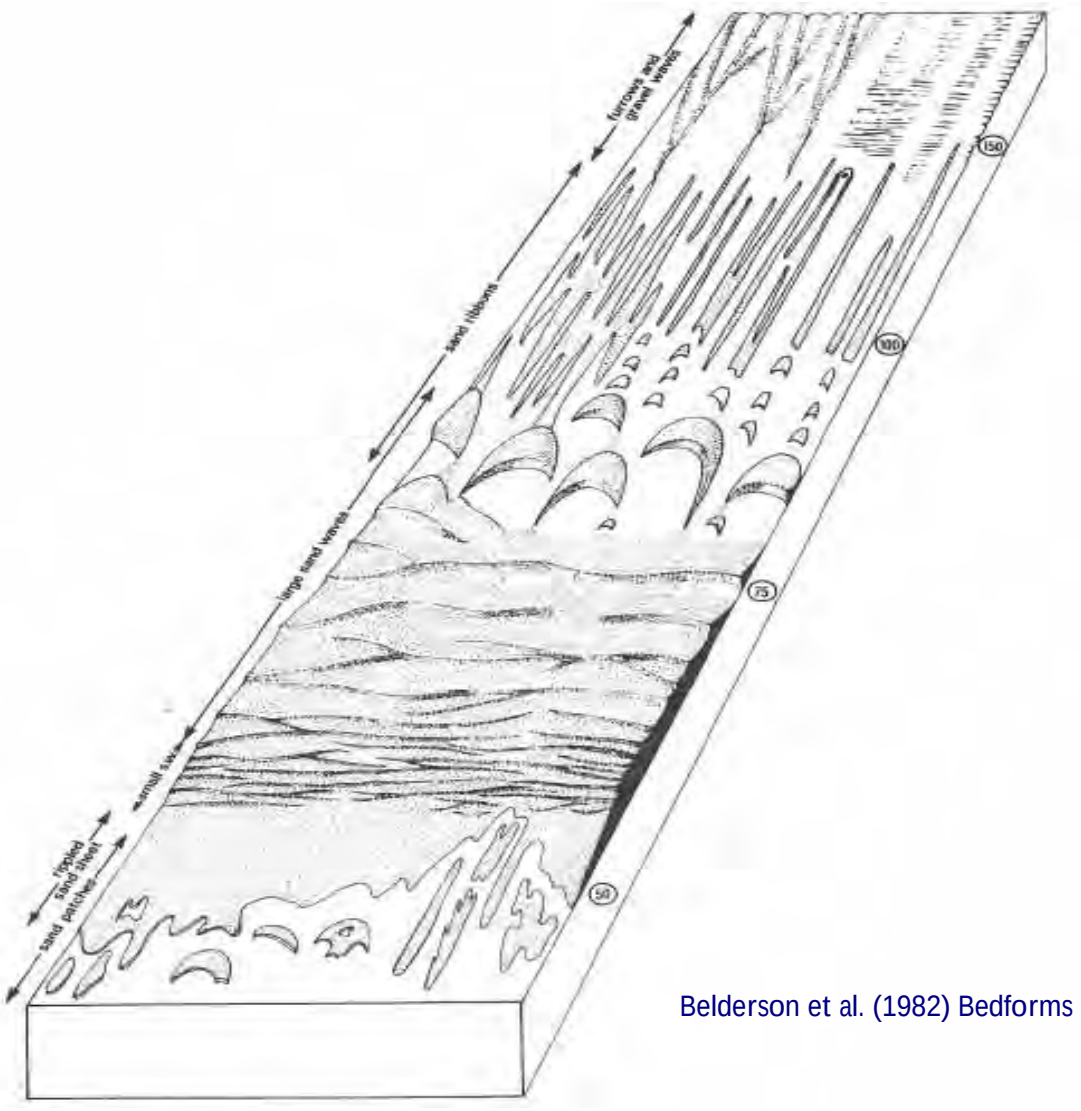
Sedimentary bedforms

Variety = *f* (PSD, flow, sed. thickness)

Mostly sand & gravel & v large:

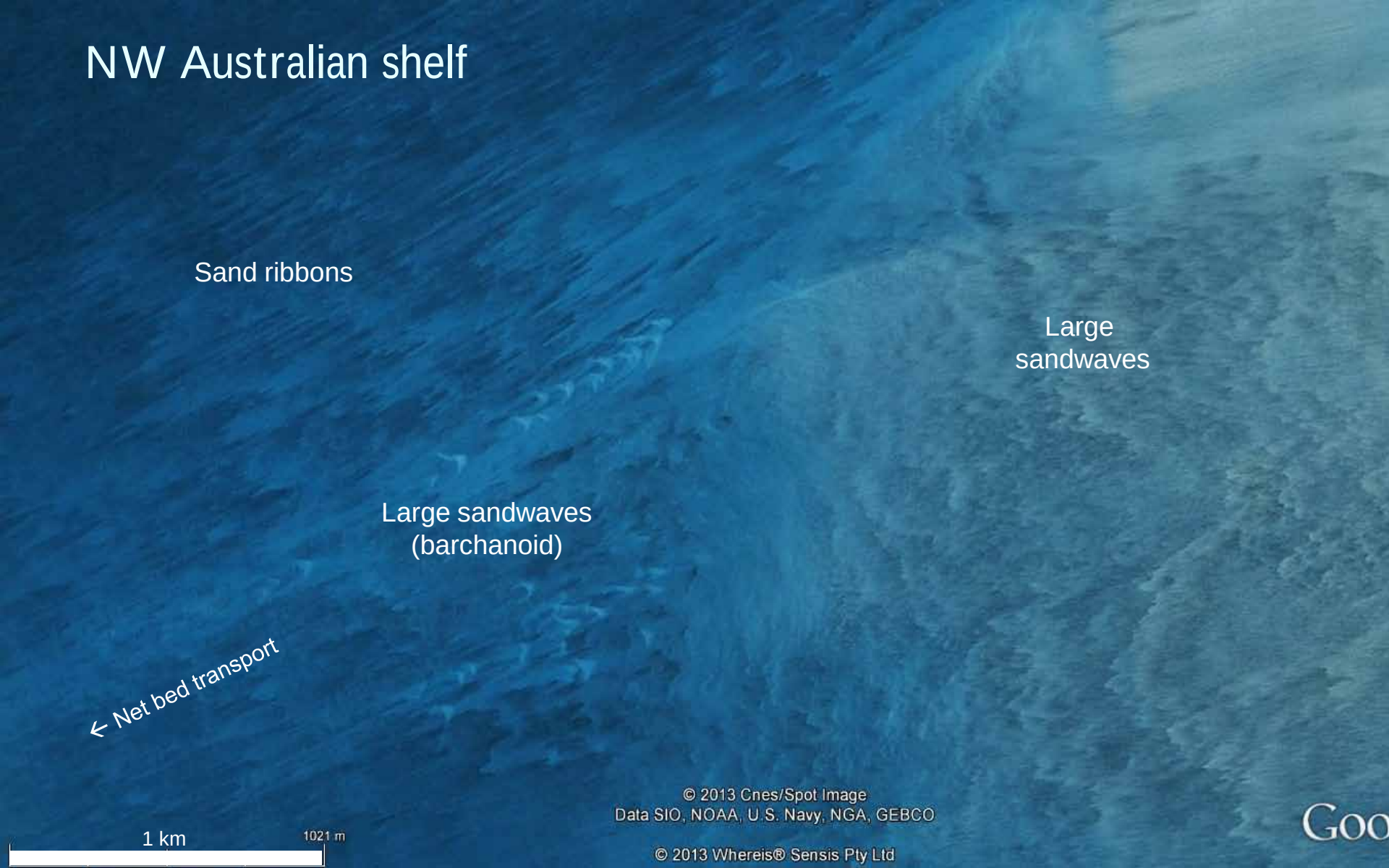
- Height = few dm – 10 m
- Spacing = >10 m – several km

- à difficult to change
- à indicate long-term transport dir.



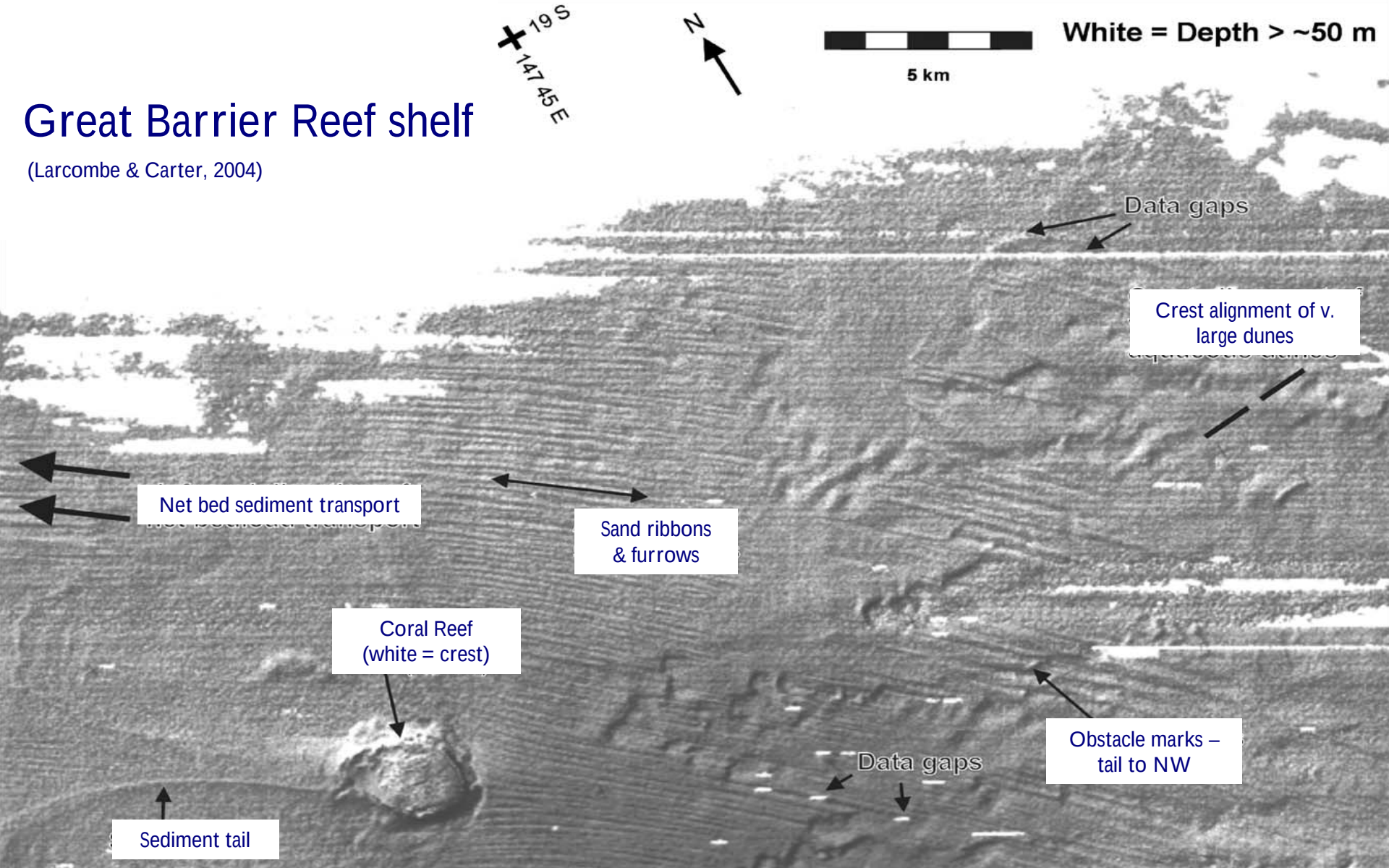
Belderson et al. (1982) Bedforms

NW Australian shelf

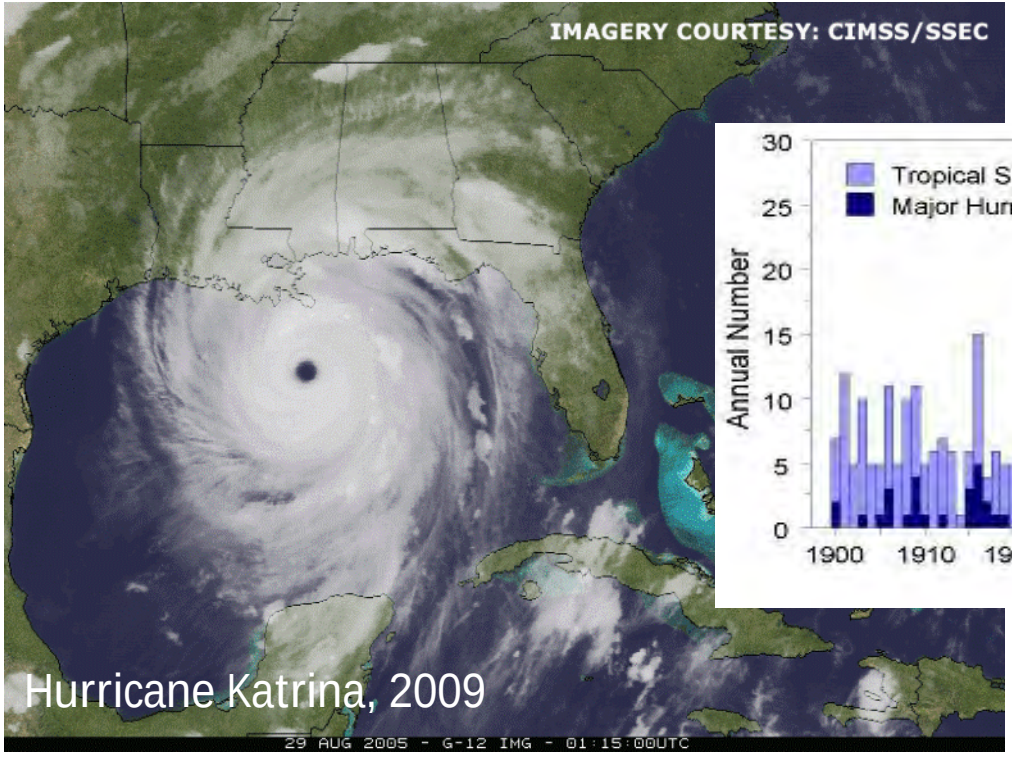


Great Barrier Reef shelf

(Larcombe & Carter, 2004)

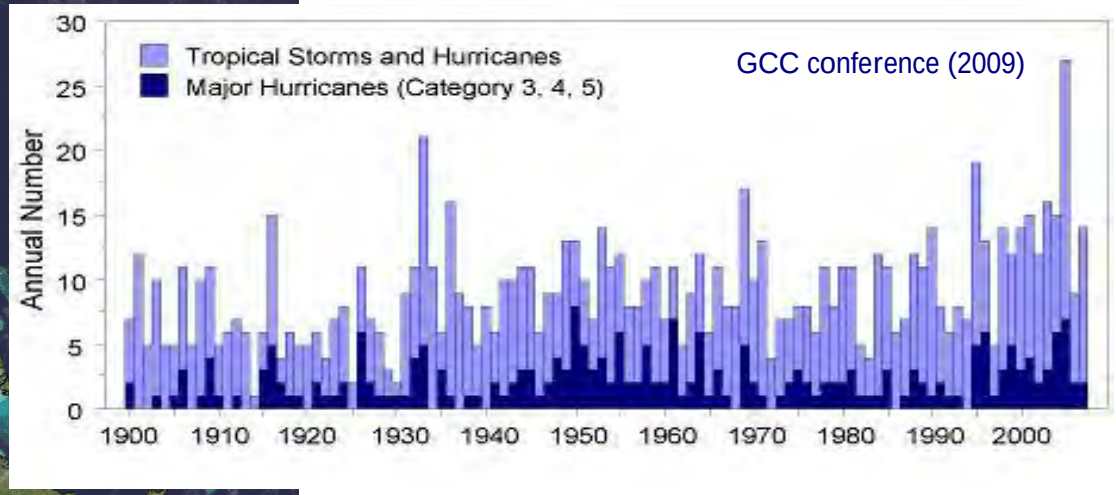


Decadal variations



Hurricane Katrina, 2009

Multi-decadal **clusters** of TC's



Q. So how relevant are measurements and models?

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Measuring Sediment Transport

Turbidity (NTU)

~25 years - mainstay of regulatory and dredge monitoring programs.

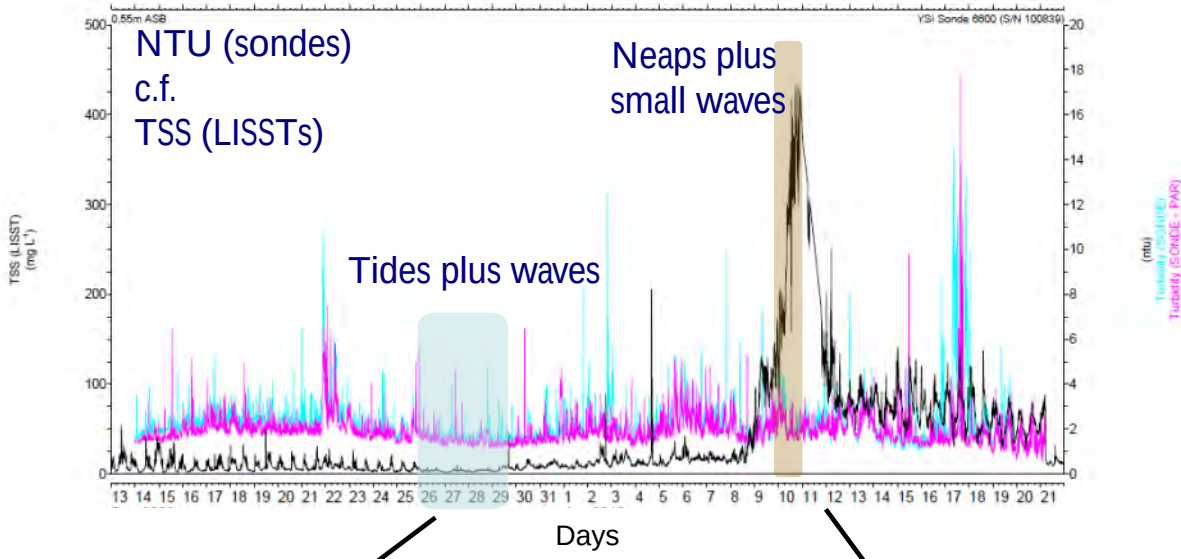
Still useful?

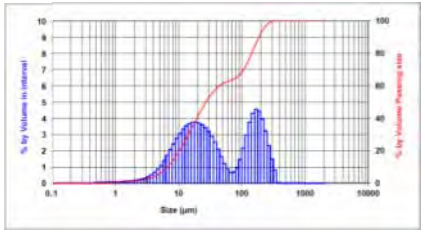
Suspension optical reflectivity is not:

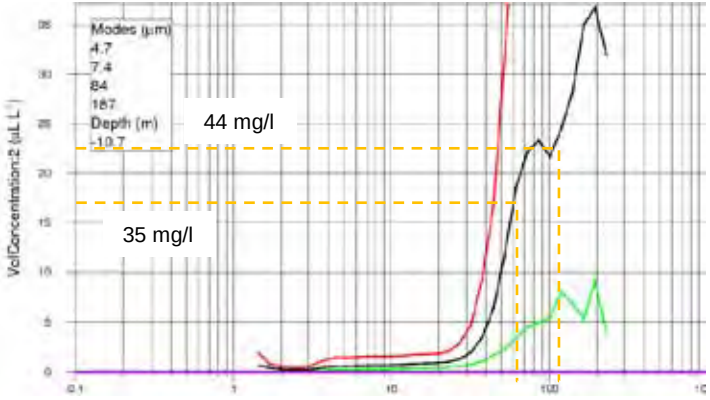
- TSS concentration
- Light availability
- Sediment transport (or rate)
- Sediment flux to the seabed
- etc

Can be blind to major sedimentary events of critical environmental relevance

~Qualitative tool at best







settling
of v. fine sands
(63-125 µm)
at concs. >100x

Sedimentary processes

Appropriate instrumentation (LISSTs)

à In-situ measurements:

§ PSD

§ Settling velocity

§ Volume conc.

Then derive:

§ Particle density

§ TSS conc.

§ Transport rates

§ Sediment flux to the seabed

Why relevant?

- PSD and TSS at FLNG intakes;
- Measured dredge plumes v natural var.
- Understand near-bed visibility
- Provide correct parameters to models…

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Regulation & Dredging

Guideline Documents

Key Federal document on dredging has limited marine geoscience.

Similarly:

- WA guidelines
- GBR/Qld documents & associated influential reports

Quality of advice & nature of outcomes are compromised.

Typical advice wrt measurements

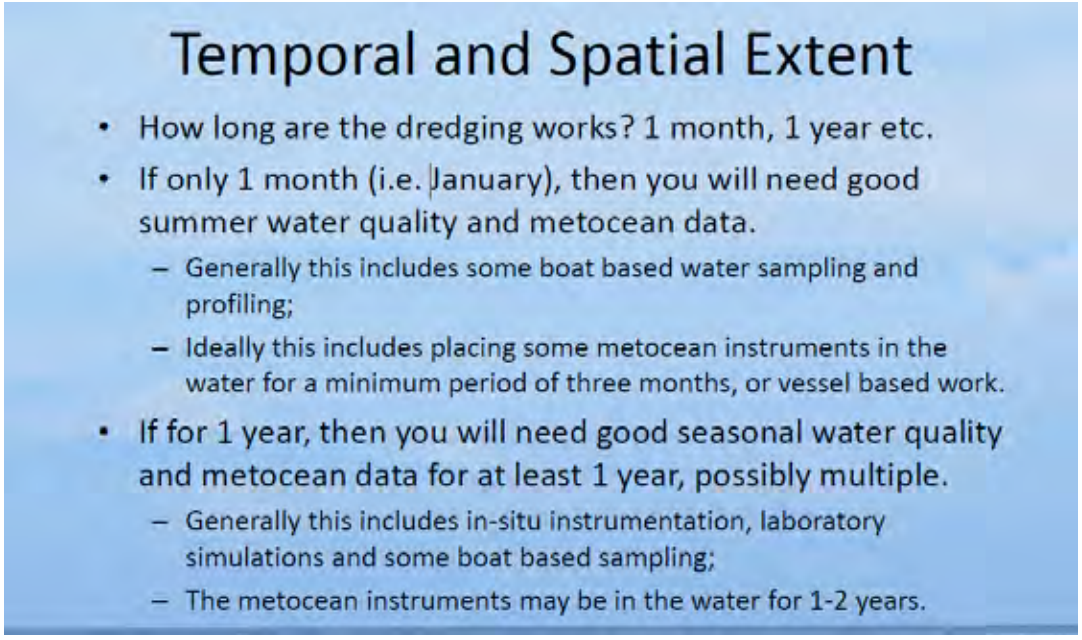
Such advice carries many risks.

- Assumptions about seasonal variation
- & decadal variation
- & oceanographic structure

- Some aspects absent.

As well as being opportunities for the FOO future...

there's no need for this, because there is...

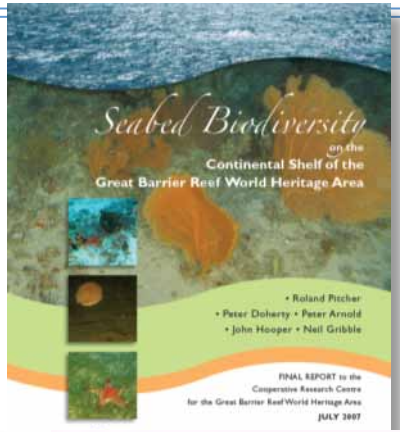


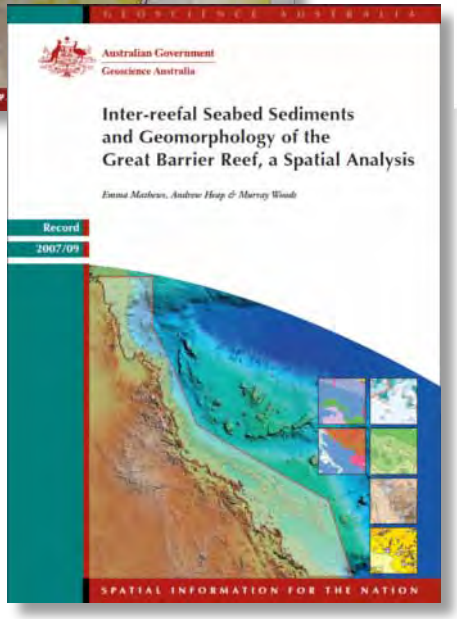
Geoscience & Habitats

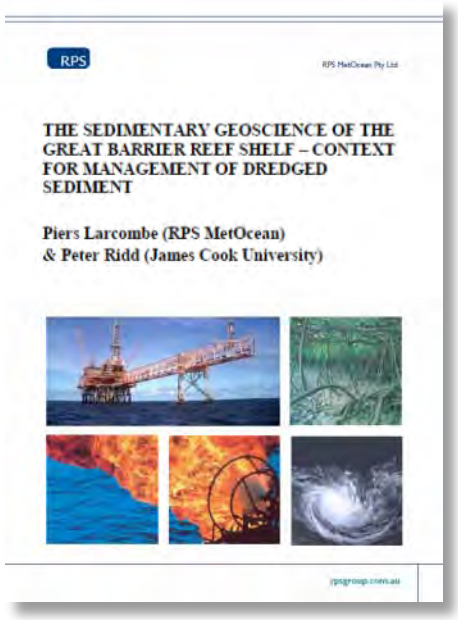
Good underlying marine geoscience information, from:

- National institutions
- International & GBR science literature
- Industry-funded reports

Needs more **sedimentary interpretation**.







Mean recurrence intervals (yr) between major sedimentary events, associated with cyclones, & general accumulation (+) erosion (–) or variable (±).

Measurements of sedimentary science & physical oceanography are relatively opaque to regulators and habitat-focussed science

180-280
Beach ridges ±

360-600 –

Multi-decadal 'stormy' periods (coral rubble)

Beach ridges
180-280
120-150

Inner shelf seabed ±

Middle shelf seabed
360-600

Multi-decadal 'stormy' periods (coral rubble)

360-600

Townsville

120-150 +
180-280 ±
Cheniers ±

Coastline & island perimeter 180-280 –

Pitcher et al. (2007)

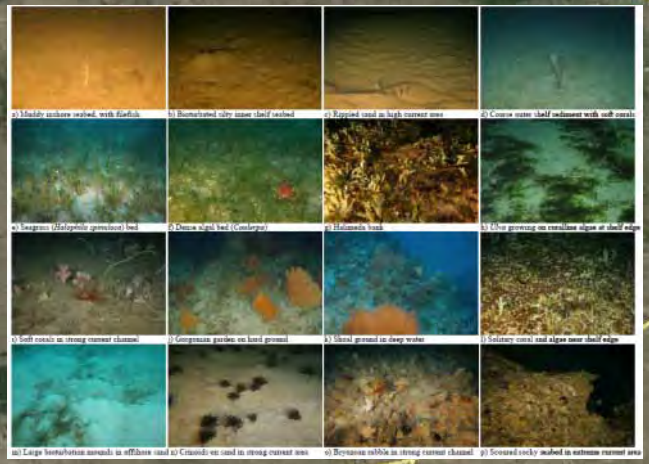


Image Landsat
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Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google earth

(Data sources: Hopley, 1982; Gagan et al., 1988; Nott & Hayne, 2001; Larcombe & Carter 2004; Liu et al., 2014).

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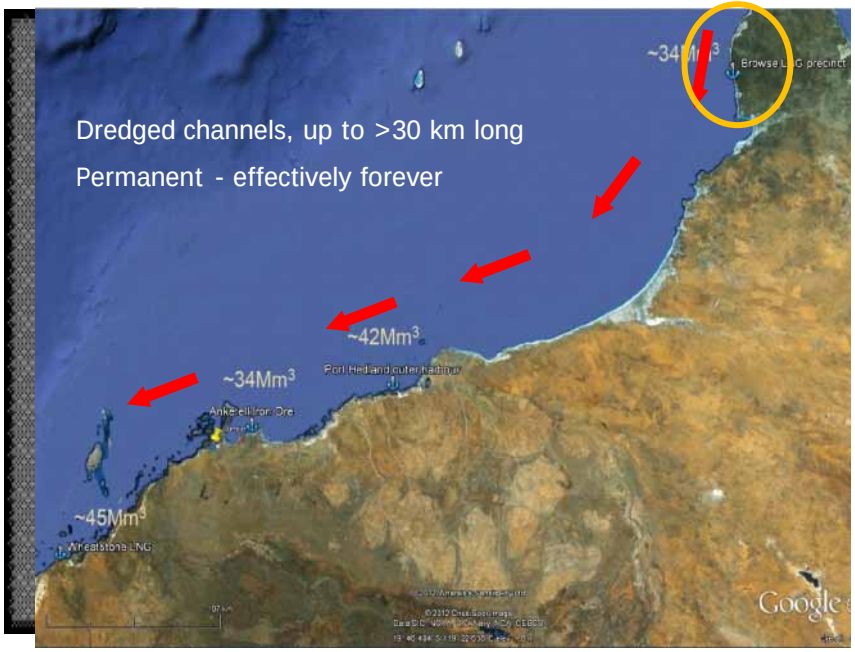
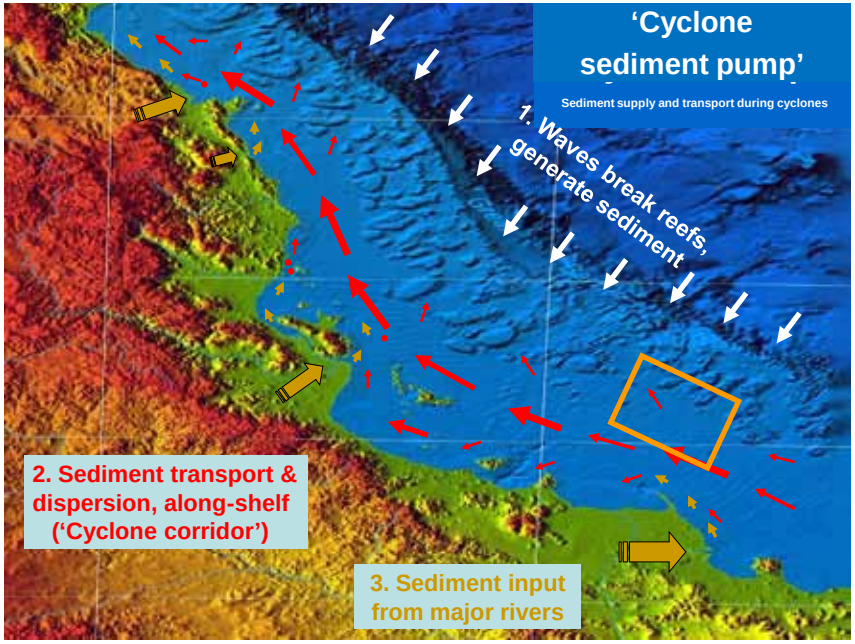
Dredged Channels

Multi-decadal bed sediment pathways

NWS



GBR



James Price Point

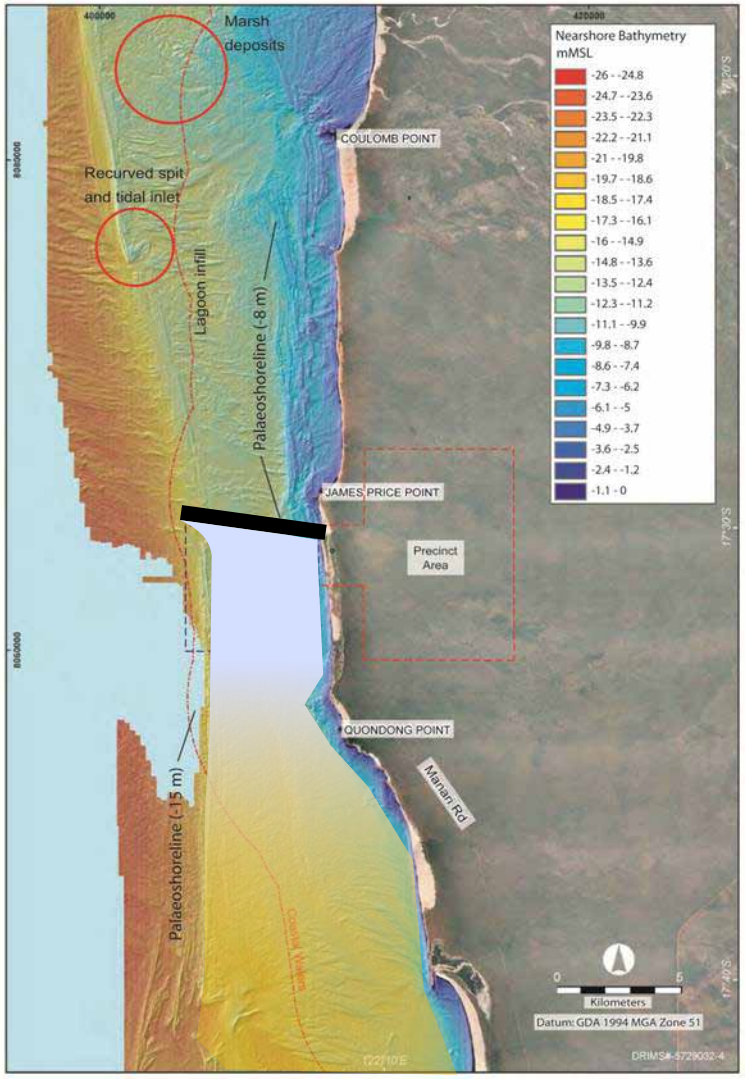
Large bedforms à southward bed sediment transport

Channel cuts **entire** transport pathway

Thin layer of sediments south of the channel might be removed over time.

à Risk of widespread & effectively permanent habitat change in this area

à Would be indisputably caused by the development.



Conclusions

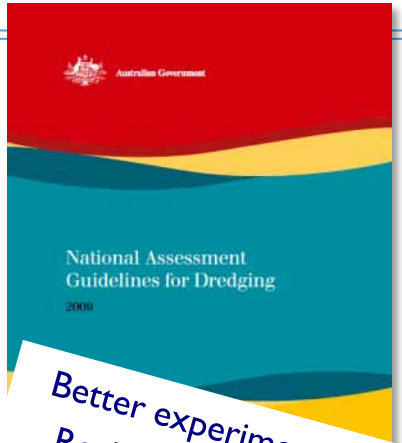
To obtain the desired **robust** outputs relevant to sedimentary issues,

FOO could help promote the **missing requisite science**

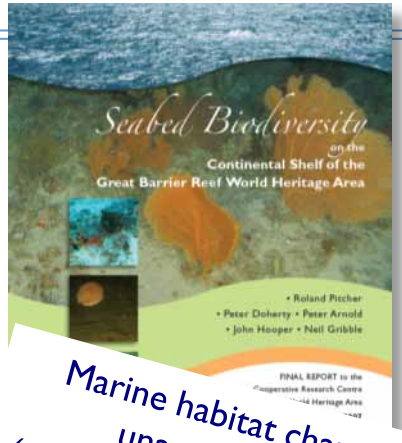
Real-time & Longer Term Information Gaps

- In-situ sedimentary measurements
  - Including context.
  - NTU on national programs is of questionable use
  - Enhance moorings' data for users
  - To TEST models
- Key regions incl. North West Shelf
- Multi-decadal changes
- Uptake by regulators & industry
  - & other marine scientists

National need to address these gaps.

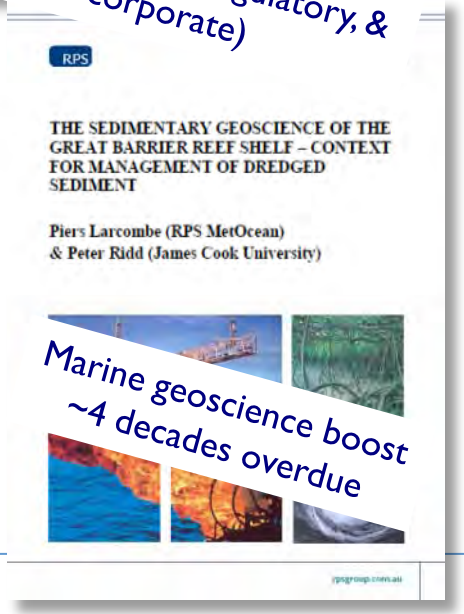


Better experimental design
Real-time measurements
Multi-decadal-scale variations



Marine habitat change = unassessed risk (environmental, regulatory, & corporate)

Sediment transport processes weak, & pathways overlooked



Marine geoscience boost ~4 decades overdue