Data and models to elucidate trends.
The development of a marine research database

Oct 28, 2021
Some background

• All output presented are through the efforts of the Ecological Monitoring, Informatics and Dynamics Group within the Tropical Marine Science Institute of the National University of Singapore

• The group’s main output focus is
  • On high quality cross-disciplinary research relevant to sustainable resource management
  • Applied research with strong focus on operations and management

• Enabling this output is the use of informatics to enable the 3 integrated themes shown
The projects that bring the questions

- Rapid enumeration of nuisance phytoplankton
- Seabed and habitat characterisation
- Multi-metric monitoring of coral reef and other benthic ecosystems
- Ecological monitoring and EIS
- Database integration
What are some questions we seek to answer from the data we have?

• Really?

• Is it easy to answer?
The problem for Singapore’s marine science related questions ...
Can we account for the Indian Ocean’s impact to the Singapore Straits?

Incorporating Indian Ocean

Langkawi

Observation
No tilt

Correlation coefficient

RMSE

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Does this help?

• Putting the seasonal residuals in properly is useful to explain some events ...


Chua MAH, Lane DJW, Ooi SK, Tay SHX, Kubodera T. 2019. Diet and mitochondrial DNA haplotype of a sperm whale (*Physeter macrocephalus*) found dead off Jurong Island, Singapore. *PeerJ*7:e6705 https://doi.org/10.7717/peerj.6705
What is the impact locally?

• When corrected, the residual flow patterns change.
  • Seasonal effect, SW and NE monsoons relatively equal in strength, slightly longer duration of SW Monsoon
  • When expanded to multi-year evaluation, model suggests that a potential exists for an eastward going residual for certain years.
Questions from data?

- Geo-chemical and water quality data have patterns that go with the biological data (luminescence bands)

- Is there a linking physical phenomenon?
Other stressors
- Wakes and waves in Singapore

• Wind waves are traditionally considered unimportant

Surrounded by Malaysia, Indonesia and many small islands

Short wave fetch

Islands, reefs and shallow waters help to dissipate high wave energy

• What about ship wakes?

Effect of ship traffic on hydrodynamics generally insignificant in areas influenced by natural wave energy

BUT becomes critical in confined, calmer and shallower waters
Other stressors –
Modelling with limited data

• If wakes and waves are important, then there is the issue of their interaction with ecology and sediment transport.

<table>
<thead>
<tr>
<th></th>
<th>Sentosa Island</th>
<th>Pulau Hantu</th>
<th>Largest wakes occurs when:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest max. wake height</td>
<td>0.46 m</td>
<td>0.91 m</td>
<td></td>
</tr>
<tr>
<td>$F_L$</td>
<td>0.52</td>
<td></td>
<td>“Hump speeds” ($F_L \sim 0.4 – 0.6$)</td>
</tr>
<tr>
<td>$F_h^*$</td>
<td>0.51 – 0.78</td>
<td>0.57 – 0.81</td>
<td>Trans-critical speeds ($F_h \sim 0.84 – 1.15$)</td>
</tr>
</tbody>
</table>
To carry out something like this requires an integrative platform..
This led to the creation of METIS* in Greek mythology, a titan synonymous with wisdom and deep thought. METIS is a cross-discipline platform for the integration of marine science research. Funded by the National Research Foundation (Singapore) under the Marine Science Research & Development Programme (2016-2021). To register, email TMSI METIS Team.
Vast range of data types

- Biology
- Genetic
- Biochemical
- Physical
- Water quality
- Nutrients
- Acoustic
- Gridded numerical models
- Geospatial (vector, raster)
- Images/video/sound

Types of projects that were funded under the Marine Science R&D Programme

- Adaptation and resilience of coral reefs to environmental change in Singapore.
- Biota effects on the environment: an impact source neglected in EIAs
- Ecologically engineering Singapore's seawalls to enhance biodiversity
- Tropical Model Marine Organisms for Experimental Marine Science
- Physical and biogeochemical effects of sediment transport on coral reefs
- Microbially Induced Corrosion
- Understanding the viral composition of phytoplankton blooms in Singapore coastal waters
- Genomic and Metabolomic Approach to the Discovery of Functional Metabolites from Marine Actinomycetes

But not only that, behind the scenes...

Acquisition, collation and upload of publically available datasets & metadata:
- Electronic online sources
- Digitisation of Historic data museum archives (Also Prof Chou LM's sets)
Let’s do this ...