Collaborative Earth-Observation Infrastructure for Coastal and Coral Reef Monitoring & Management

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BIOPHYSICAL REMOTE SENSING GROUP
Aim for today’s talk....

To outline lessons learnt in establishing and sustaining coordinated observational science capabilities, especially those linked to satellite monitoring in coastal and coral reef environments.
Australia has a lot to learn from the international ocean colour science community:
Contents

• Some context for the talk.....

• Introduction

  Designing sustainable and collaborative, long term scientific infrastructure

• Starting the Design of National Collaborative Infrastructure

• Coastal and Coral Reef Monitoring and Management: Needs + Status

• Establishing Collaborative National Research Infrastructure

• Lessons Learnt and Moving Forwards
• Some context ....... what we try to do:
• Some context ……Engaging ecosystem science
Some context ... ......Engaging ecosystem science communities
Some context ....... Australian marine and terrestrial ecosystems
Some context ....... Australian marine and terrestrial ecosystems

Nitrogen, phosphorus and herbicides in groundwater flows to the Reef
Overview of transport, transformation and attenuation processes

Lana Baskerville and Heather Hunter. From: Hunter, HM (2012). Nutrients and herbicides in groundwater flows to the Great Barrier Reef lagoon: processes, fluxes and links to on-farm management.
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• **“IDEAL”** components of sustainable collaborative long term research infrastructure:

• Identifiable and accessible “community(ies)”

• Clearly defined goals, understanding and use of science

• Agreed processes for cooperation and collaboration

• Accessible and verified protocols for collection + sharing data

• Variety of funding sources

• Established and maintained links with government, industry and community

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• Lessons Learnt and Moving Forwards
• Building national collaborative research infrastructure assumed versus reality?

• Existing cooperative networks were in place and engaged with key groups across science and management.

• Methods/protocols for data collection, analysis, and distribution were established.

• Common data and meta-data file formats were in place and able to be expected.

• People would cooperate and collaborate to develop systems for collection and sharing of data.

• Funding, rewards and national/inter-national priorities aligned with collaborative research infrastructure and research.
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Monitoring coasts and coral reef waters: Jurisdictions and overlaps - spanned by infrastructure:

[Map Image: Australia's network of Commonwealth marine reserves]
Monitoring coasts and coral reef waters: Jurisdictions and overlaps: terrestrial-coastal-marine
• **Requirements for coastal and coral reef science and monitoring in Australia**

• Water surface properties
• Water column properties
• Benthic features + properties

• **Sources:**
  • Image
  • Field
  • Modelled
<table>
<thead>
<tr>
<th>WATER QUALITY INFORMATION</th>
<th>WATER QUALITY VARIABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary production and eutrophication status</td>
<td>CHL</td>
</tr>
<tr>
<td>Aquatic carbon content, carbon fluxes</td>
<td>CPC (cyanobacterial pigment)</td>
</tr>
<tr>
<td></td>
<td>CPE (cyanobacterial pigment)</td>
</tr>
<tr>
<td></td>
<td>Surface algal blooms</td>
</tr>
<tr>
<td>Aquatic carbon content, carbon fluxes</td>
<td>CDOM</td>
</tr>
<tr>
<td>Erosion, re-suspension and deposition</td>
<td>TSM (ΣCHL+NAP)</td>
</tr>
<tr>
<td>Aquatic carbon content, carbon fluxes</td>
<td>K_d</td>
</tr>
<tr>
<td>Light climate information related to the combined effects of</td>
<td>Transparency</td>
</tr>
<tr>
<td>algae, CDOM and suspended matter</td>
<td>Turbidity</td>
</tr>
<tr>
<td>Ecological condition</td>
<td>Emergent macrophytes</td>
</tr>
<tr>
<td></td>
<td>Submerged macrophytes</td>
</tr>
</tbody>
</table>

CHL=chlorophyll; CPC=cyano-phycocyanin; CPE=cyano-phycoerythrin, CDOM=coloured dissolved organic matter; TSM=total suspended matter; NAP=non-algal particulate matter; $K_d$=vertical attenuation of light
Operational sensors coastal and reef environments:
• Suitable spatial and temporal scales
• Monitoring and managing coasts and coral reef waters
• Monitoring and managing: Citizen science
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• Lessons Learnt and Moving Forwards
• Guided by:

• National research infrastructure priorities
• National research priorities
• Relevant management agency priorities
• Political priorities
• National discipline based coordination
• International discipline based coordination
• Australia’s Terrestrial Ecosystem Research Network (TERN)
• TERN’s approach to building collaborative infrastructure

- Collection Methods
- Processing + Analysis
- Data Curation + Publishing
- Data Searching
- Analysis + Synthesis
- Modelling
- Policy + Management

- Instruments + Sensors
- Data Storage
- Data Sharing
Australia’s Integrated Marine Observing System

- Designed through national science planning, developed by regional science Nodes
- IMOS - National collaborative research infrastructure
- For sustained observing of the marine environment
- Integrated from open ocean to coast
- Integrated across physics, chemistry and biology
- A ‘virtual fleet’
- Research Vessels
- Satellite Remote Sensing
- Calibration & validation, national product suite
- Implemented through national, multi-institutional Facilities, with all data shared

AODN - Marine data from IMOS & other holders
- Australian Ocean Data Network
- Marine data that are discoverable, accessible, usable and reusable
- Data for Model Development, Model Validation, Data Assimilation, Obs System Design

IMOS Information Infrastructure
- Ocean & Coastal MODELLING
• Monitoring and managing our coasts and coral reef waters: Jurisdictions and overlaps - spanned by infrastructure:

IMOS Research Themes

1. Multi-decadal ocean change

2. Climate variability and weather extremes

3. Major boundary currents and inter-basin flows

4. Continental shelf processes

5. Ecosystem responses
   productivity, abundance, distribution

- Global Energy Budget
- Global Hydrological Cycle
- Global Circulation
- Global Carbon Cycle

- Pacific Ocean
- Indian Ocean
- Southern Ocean

- Fluxes
- Drivers
- Dynamics

- East Australian Current
  (+Tasman Outflow, Flinders Current, Hiri Current)
- Leeuwin Current
- Indonesian Throughflow
- Antarctic Circumpolar Current

- ENSO, IOD, SAM, MJO
- Cyclones, ECL’s

- nutrients
- microbes
- plankton
- nekton
- apex predators

- benthic
- pelagic

- eddy encroachment
- upwelling, downwelling
- cross shelf exchange
- coastal currents
- wave climate
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Establishing Collaborative National Research Infrastructure requires:

1) People

2) Data Collection

3) Data Processing, Storage and Publication

4) Integration, Analysis and Synthesis

5) Linkages
• People……

....... in a collaborative, coordinated, networked approach to ecosystem science using a multi-disciplinary community of skilled personnel, alongside development and sharing of knowledge and skills.
• Data collection

......that expands on existing data collection infrastructure and processes to collect data on essential ecosystem variables across time and space.
• Data processing, storage and publication,

....... to ensure it is discoverable, accessible, reusable and citable (ensuring it contains enough contextual information to determine if the data are fit for use).
• Integration, analysis and synthesis

.........activities that extend capabilities for integration and processing of data at various levels to provide data products required for ecosystem science.
• Linkages

......focus on ‘soft’ infrastructure, particularly in knowledge brokering, to provide an effective interface between science, policy, management and industry to:

(1) improve uptake of science in policy-making and management processes; and

(2) enable policy and management needs to inform the design and implementation of science activities.
What did work?

• coordinated data collection;
• collect data relevant to key science + management questions;
• standards for data collection, checking and storage formats;
• flexible, and standardised meta-data that is fit for purpose;
• appropriate data licensing;
• data publishing procedures to Australian and international standards;
• discipline- or application-based code and model libraries; and
• a capacity for translating the results of science so that they are relevant, use-able, and have maximum impact for policy and management.
What did not work?

• directly imposing new data collection, processing and distribution guidelines;
• excessive reporting;
• progress without consultation and discussion;
• limited time for evaluation and critiques;
• accepting the current situation without constructive criticism;
• not developing shared goals; and
• accommodating “excessive egos” and “rock star” scientists and top down academic/discipline hierarchy.
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Moving forwards – sustaining long term science

• Coastal and coral reef environments are in a unique “space”

• Institutional and discipline gaps and overlaps

• Work still needed in terrestrial, coastal and marine communities
Moving forwards – sustaining long term science

- Global shift to collaborative data, algorithms and participatory resources:
Overall GEO WQ Task Goal: Develop, implement and maintain a global inland and coastal water quality monitoring and forecasting service. This task will be facilitated by a newly implemented GEO Water Quality (GEO-WaQ) Community of Practice. The goal of this component is to develop an international operational water quality information system based on Earth observation.
Moving forwards – sustaining long term science (incl. infrastructure)

- Recognise and build on existing areas and programs
- Work across government levels for > 5 years support
- Communicate and engage clearly + openly
TERN is supported by the Australian Government through the National Collaborative Research Infrastructure Strategy and the Super Science Initiative.
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- All Australian State and Territory Governments
Questions?

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