Modelling catchment indicators in the coastal domain

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ICM – Integrated Catchment Management

“a 9 year programme which commenced in July 2000, and whose goal is to conduct multi-disciplinary, multi-stakeholder research to provide information and knowledge that will improve the management of land, freshwater, and near-coastal environments in catchments with multiple, interacting, and potentially conflicting land uses.”

1 from http://icm.landcareresearch.co.nz/
ICM Stakeholder concerns for the coast

- Commercial (Aquaculture, Tourism)
- Recreation/Cultural (Scallops, fishing, safe swimming, marine mammals, birds)

-> requires broad-scale indicators that can be modelled to address a number of issues (e.g. Water quality – sediment, nutrients and bacteria)
Model linkages

- Catchment Model
- River Transport Model
- Water Quality & Flows
- Coastal Models
Coastal models used in ICM

1. Hydrodynamic Model (Currents/Transport)
2. Water Quality Model (e.g. Sediment, Pathogens, Nutrients)
3. Phytoplankton Modelling
4. Foodweb Model (Fishing, Larvae, Aquaculture…)

27th November 2008
Catchment footprint on the coast can be large.
Hydrodynamic Modelling

- Needed for determining spatial transport.
- Calculates currents and physical parameters.
- Tidal residuals show net northward transport from Motueka.
Water Quality Modelling

- Utilises transport information from hydrodynamic model.
- Can estimate transport of suspended particles (e.g. sediment, nutrients, pathogens).
- Can use to predict catchment footprints on the coast to address stakeholder concerns.
Example: Sediment Modelling

Fine sediment plume under southerly winds, Tuckey et al (2005)
Example: Application of bacterial model

Does increased sediment or bacterial loads have a greater influence on numbers of bacteria reaching aquaculture site?

- In summer contribute equally to bacterial numbers.
- In winter bacterial load makes a greater difference.
Phytoplankton Modelling

Solar Energy

Phytoplankton (Organic Energy & Toxins?)

Currents

Food web

Nitrogen
Atomic Number: 7
Atomic Mass: 14.01

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Example: Application of Biophysical Model

What is the impact on algal growth from different land uses?

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Nitrogen Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historical</td>
<td>234,932 kg/yr</td>
</tr>
<tr>
<td>Current</td>
<td>521,353 kg/yr</td>
</tr>
<tr>
<td>Intensive</td>
<td>3,806,154 kg/yr</td>
</tr>
</tbody>
</table>
Spatial Analysis

- Can predict spatial trends.
- Determine high risk areas for monitoring.
- Useful for resource management (e.g. matching new N inputs to N removal)
We can answer questions about how energetic changes may affect high trophic species to address stakeholder concerns.
Example: Application of Food web Model

- Jiang and Gibbs (2005) used food web model to see what level of shellfish culture would start to affect structure of energy flows to ecosystem.

- Model suggests level of culture could be very high in Tasman/Golden Bay (~65 tons/km²) before large changes in food web occur.

- Increased algal production in this model suggests more resources available for aquaculture and wider foodweb, BUT....
An extreme nutrient loading example: Mississippi River

Increasing Nitrogen loads observed in the Mississippi since 1970.

Note: 1000 times higher than loads for Motueka River.

Large areas of coastline affected by hypoxic events during summer.
Model Applications & Considerations

Applications:
- Predictive
- Use to isolate effects on indicators (e.g. anthropogenic vs. climate)
- Can fill in spatial or temporal gaps (e.g. compliance)

Considerations:
- Only as good as knowledge of system and data
- Data requirements for validation (High setup costs?)
- Potential to over fit -> loss of predictive utility.
In Summary

• Application of modelled indicators to aquaculture suggest positive and negative impacts from land intensification.

• Impact assessment will be subject to the questions asked of it, need for collaborations between stakeholders, planners and researchers to find acceptable solutions to present and future issues.

• Coastal modelling tools offer an environment for testing ideas to achieve desired indicator outcomes.

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