

Understanding the cumulative impacts of coastal development on marine ecosystems:

Land-use change scenarios and Bayesian networks

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National Environmental
Research Program
TROPICAL ECOSYSTEMS *hub*

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ARC Centre of Excellence
Coral Reef Studies

Urban
Development



Great Barrier Reef
World Heritage Area

Agriculture



Mining, Ports and
Shipping



Urban
Development



Agriculture



Mining, Ports and
Shipping



Land reclamation

Recreational boating

Commercial and recreational fishing

Agricultural run-off

Land clearing

Dredging

Shipping

Anchorage

Urban
Development



Coral Reefs

Reef Fish

Agriculture



Dugongs

Mining, Ports and
Shipping



Seagrass

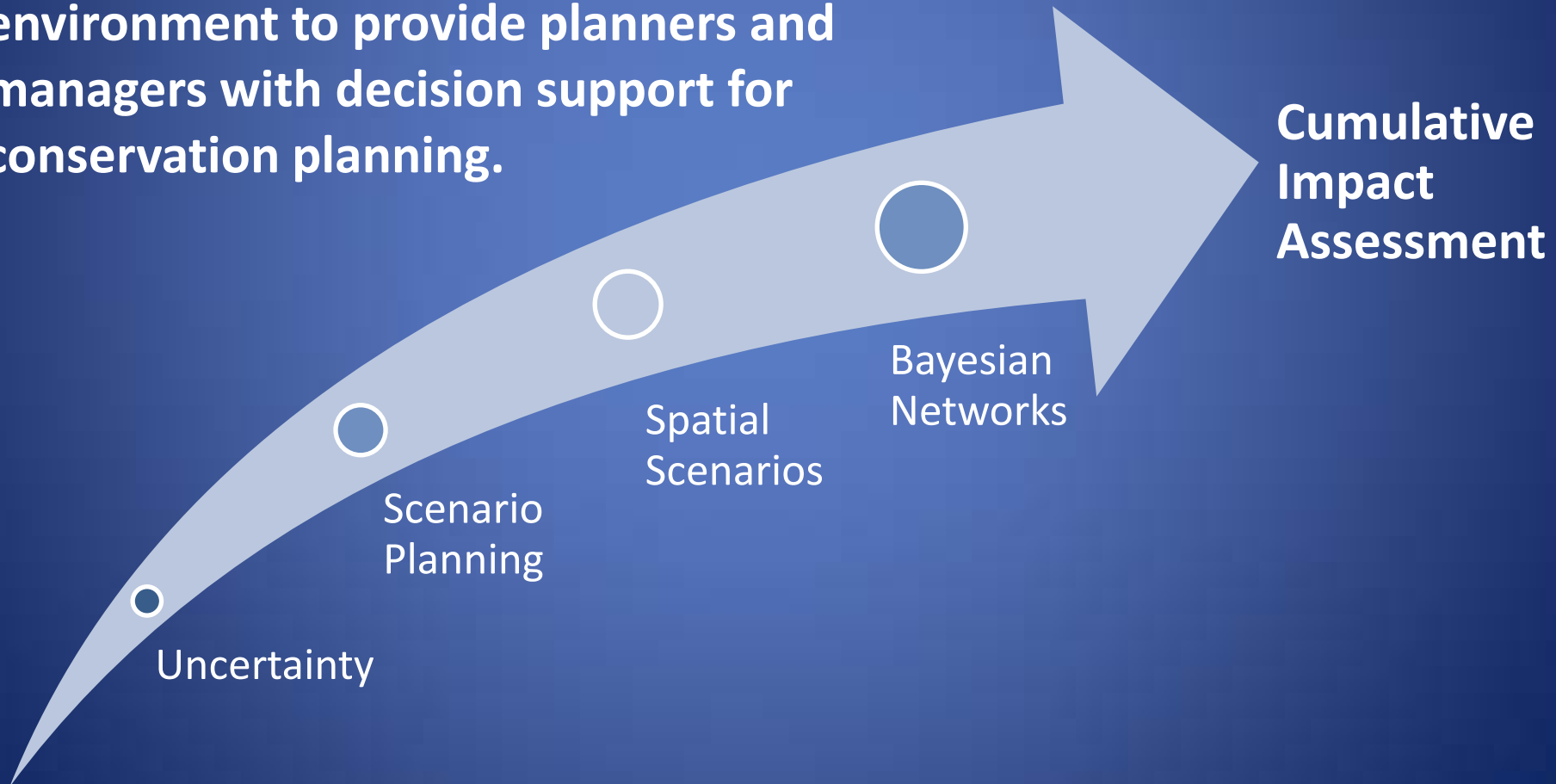
“Quantitative understanding of cause-and-effect relationships, both now and under a range of future scenarios, will greatly improve understanding of impacts and their cumulative effects — this currently constitutes a major information gap...”



**Great Barrier Reef Region Strategic
Assessment Report 2014**

Great Barrier Reef Marine Park Authority

Aim: To develop a systematic process for assessing the cumulative impacts of coastal development on the marine environment to provide planners and managers with decision support for conservation planning.



Introduction

Uncertainty

Scenario
Planning

Spatial
Scenarios

Bayesian
Networks

Ways Forward

Uncertainty

Uncertainty



What development will
occur in the future?



What is the response of marine species
and ecosystems to multiple stressors?

Uncertainty



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Scenario Planning

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8 spatially explicit land use change scenarios
created in Geographic Information Systems (GIS)

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4 Scenario Streams

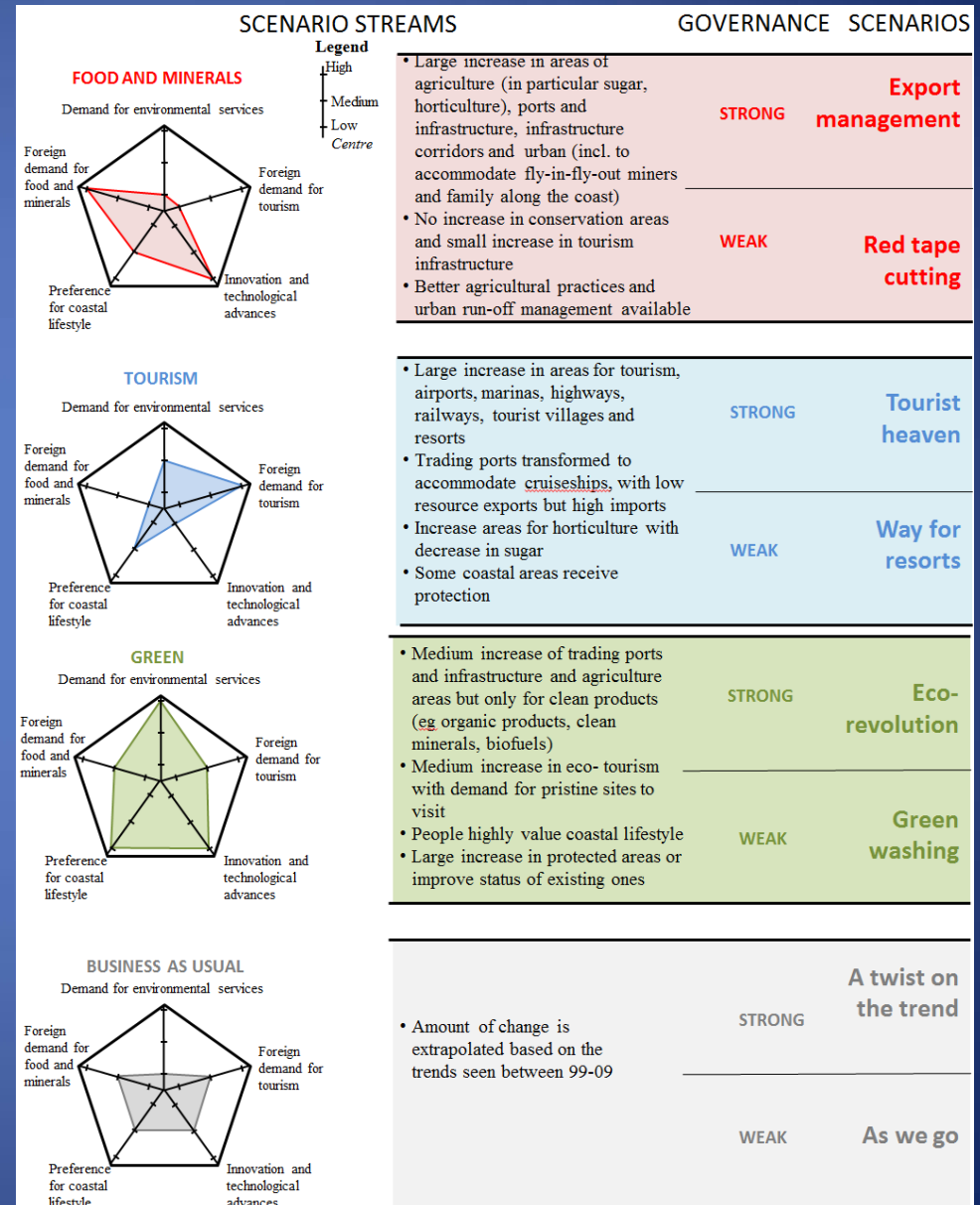
- Food and Minerals
- Tourism
- Green
- Business as Usual

5 Drivers of Change

- Demand for environmental services
- Foreign demand for food and minerals
- Preference for coastal lifestyle
- Innovation and technological advances
- Foreign demand for tourism

2 Types of Governance

- Strong
- Weak



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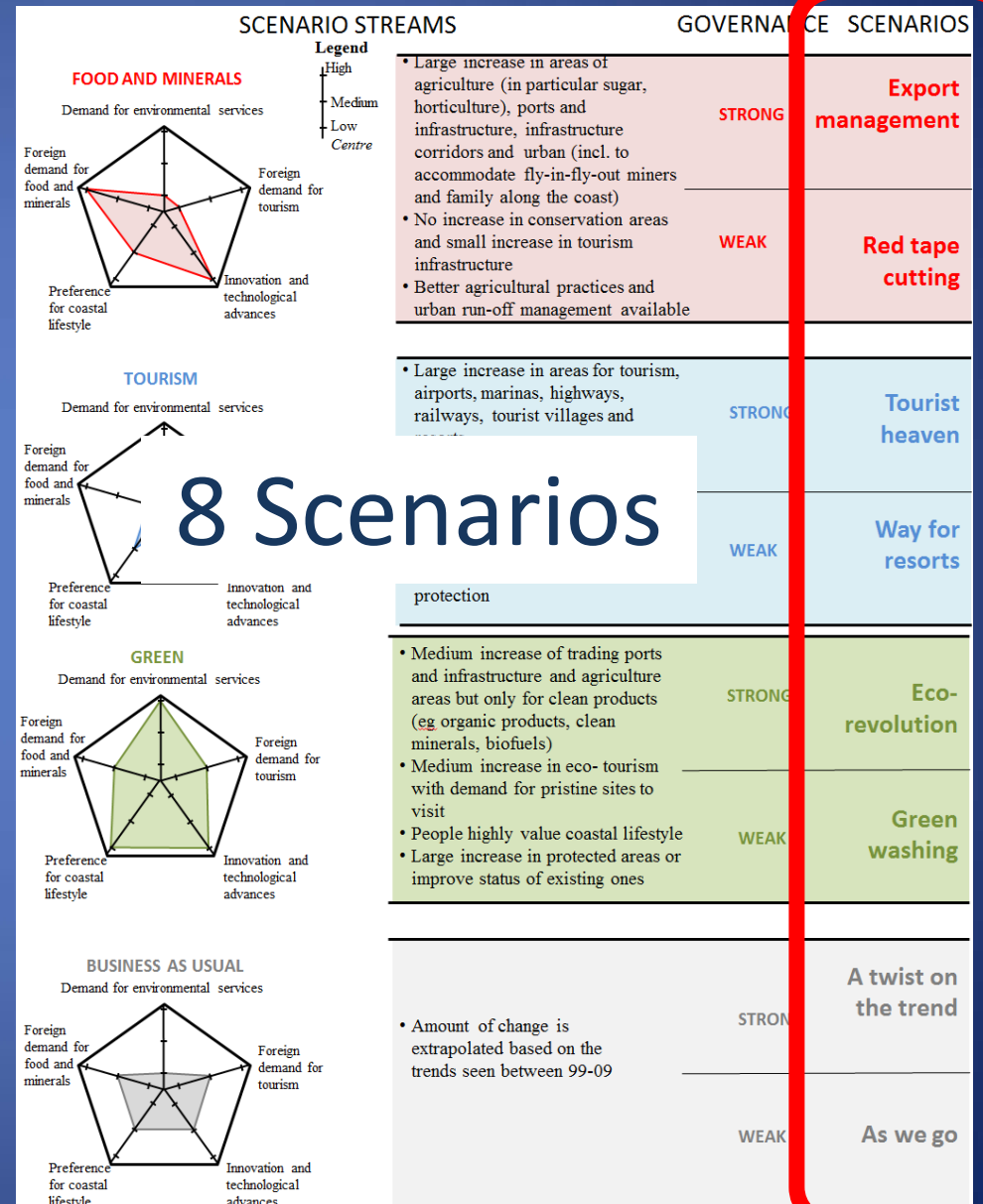
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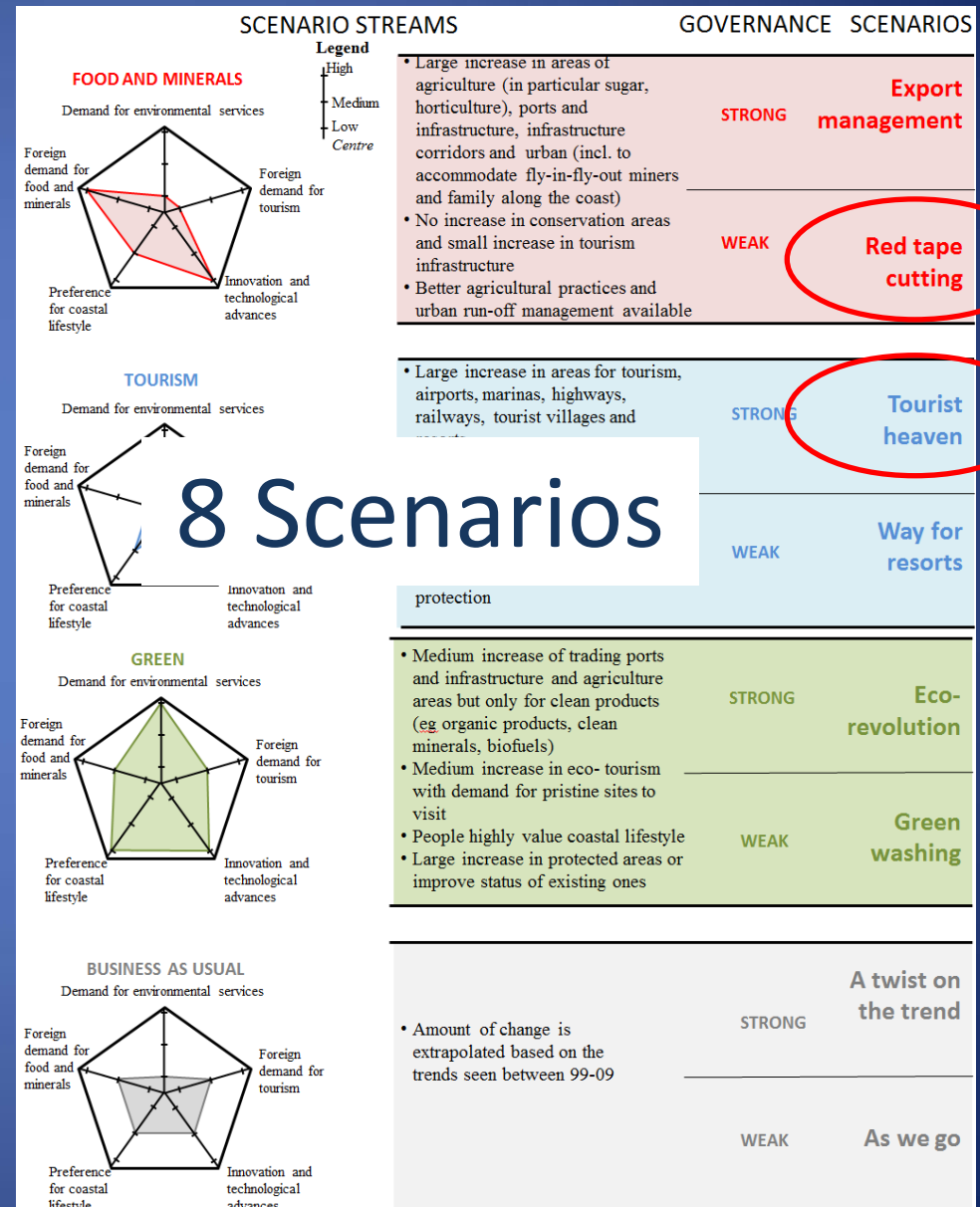
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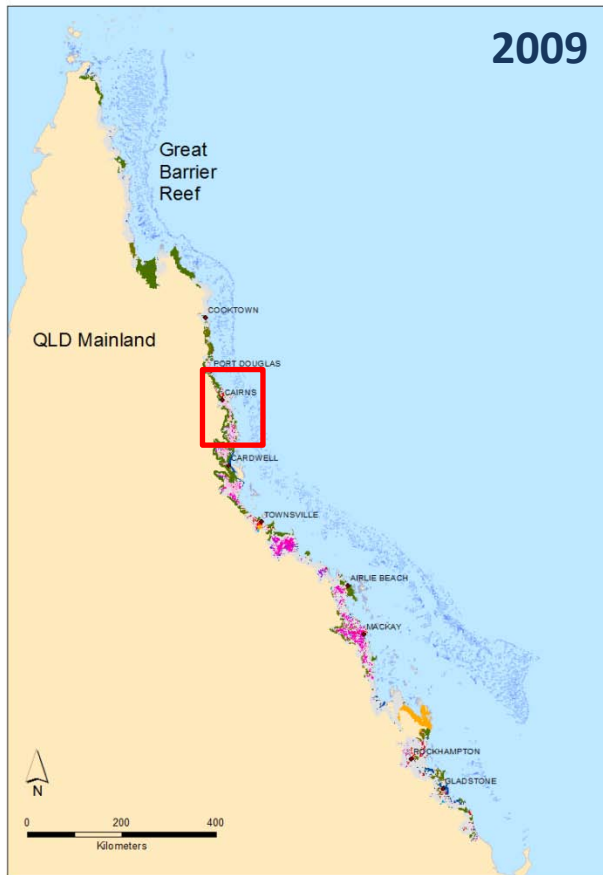
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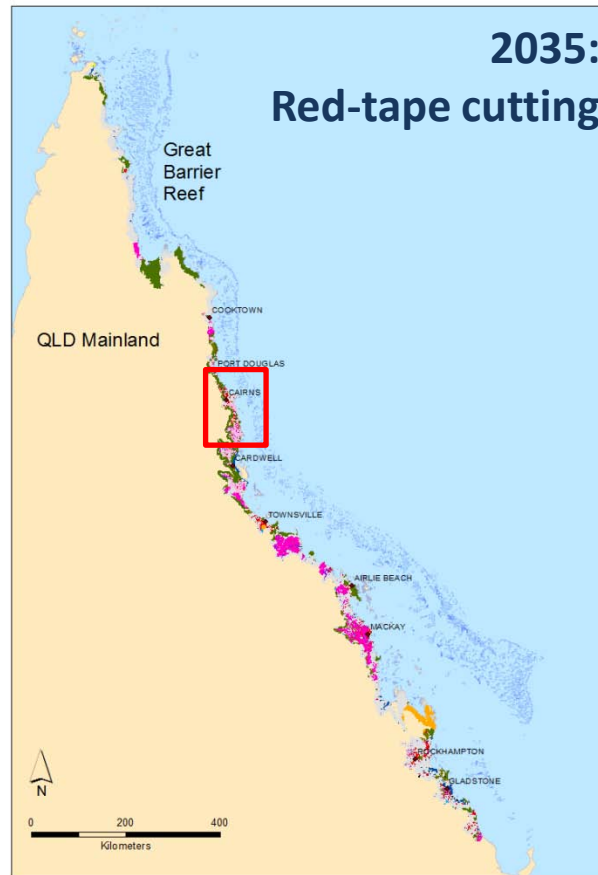
**Cumulative
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2009



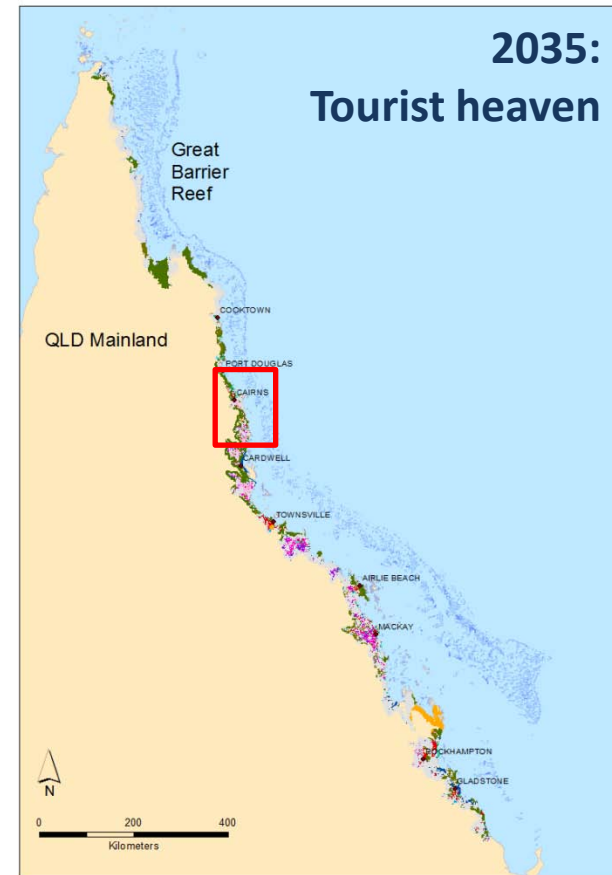
2035:

Red-tape cutting



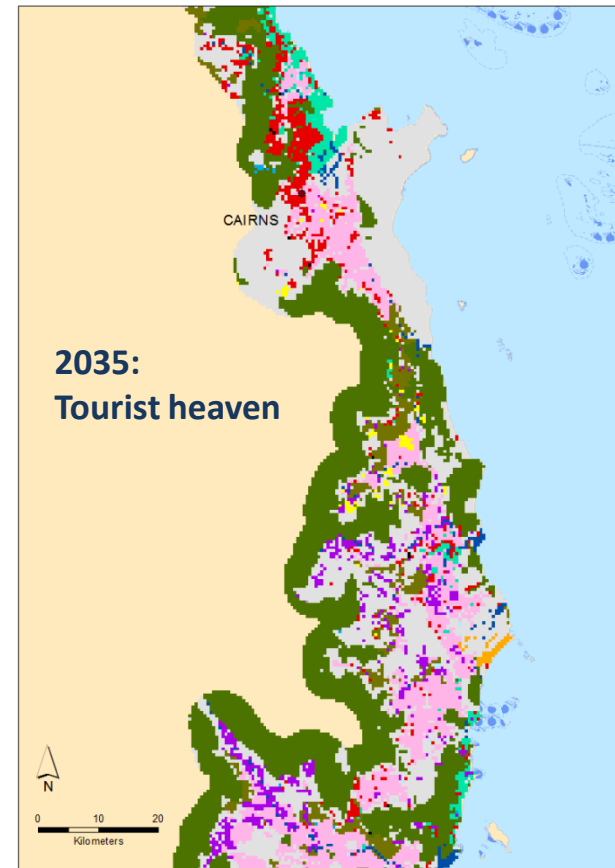
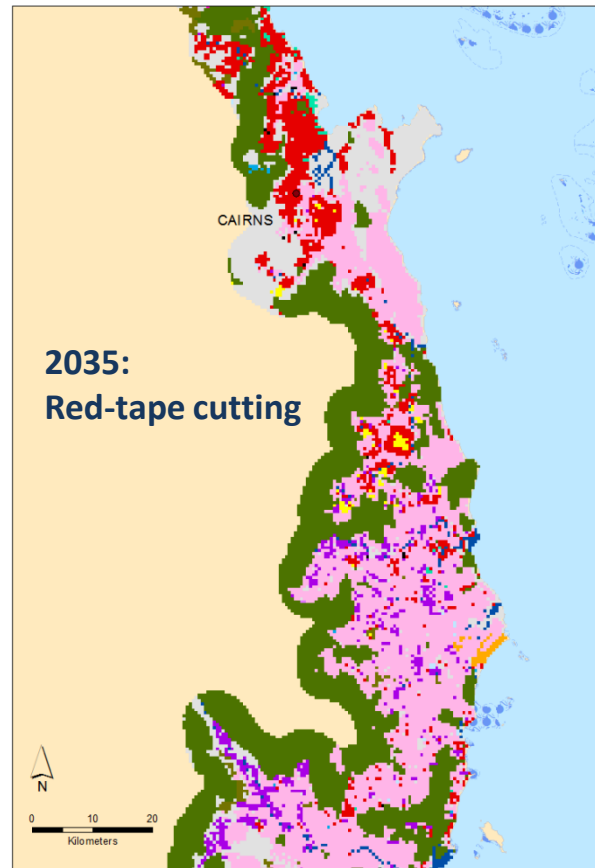
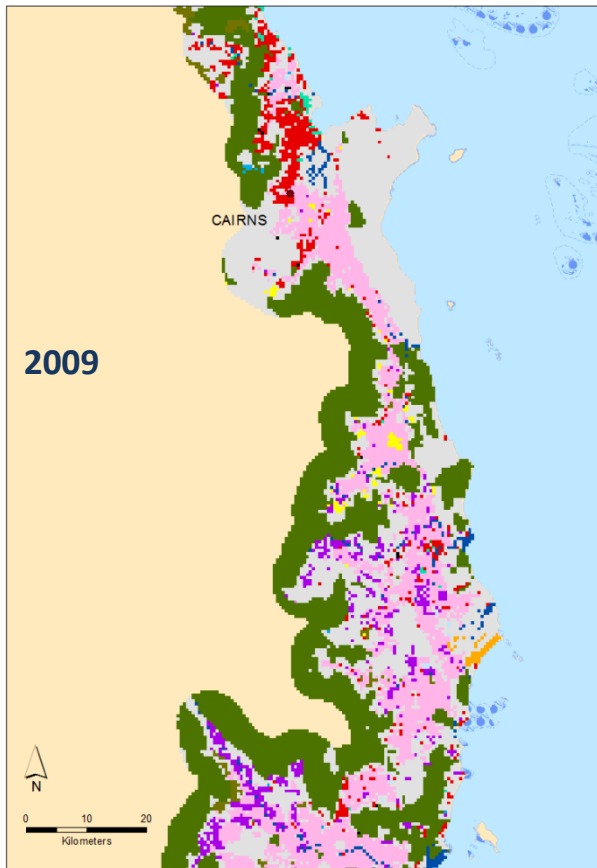
2035:

Tourist heaven



Land use

Aquaculture	Irrigated sugar cane
Conservation	Mining
Defence	Others
Rain-fed horticulture	Ports
Rain-fed sugar cane	Tourism
Forestry	Urban
Intensive animal production	Rivers and lakes
Irrigated horticulture	Man-made water storage

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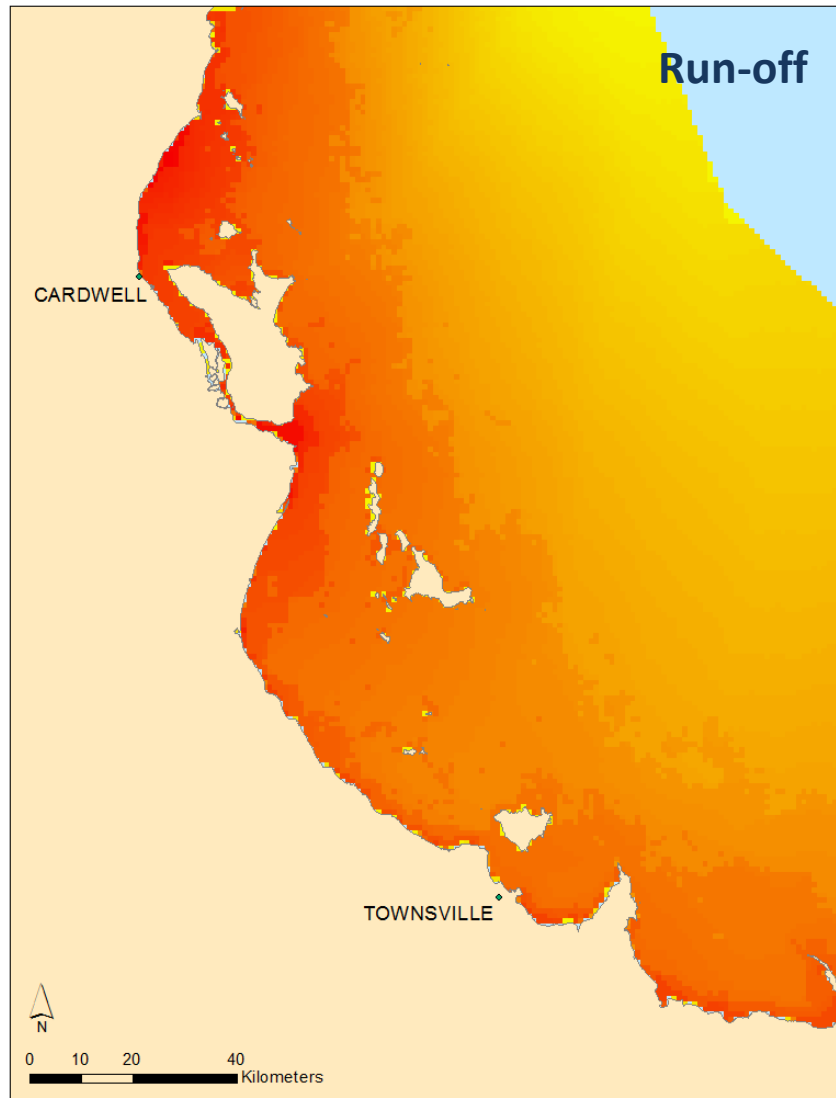
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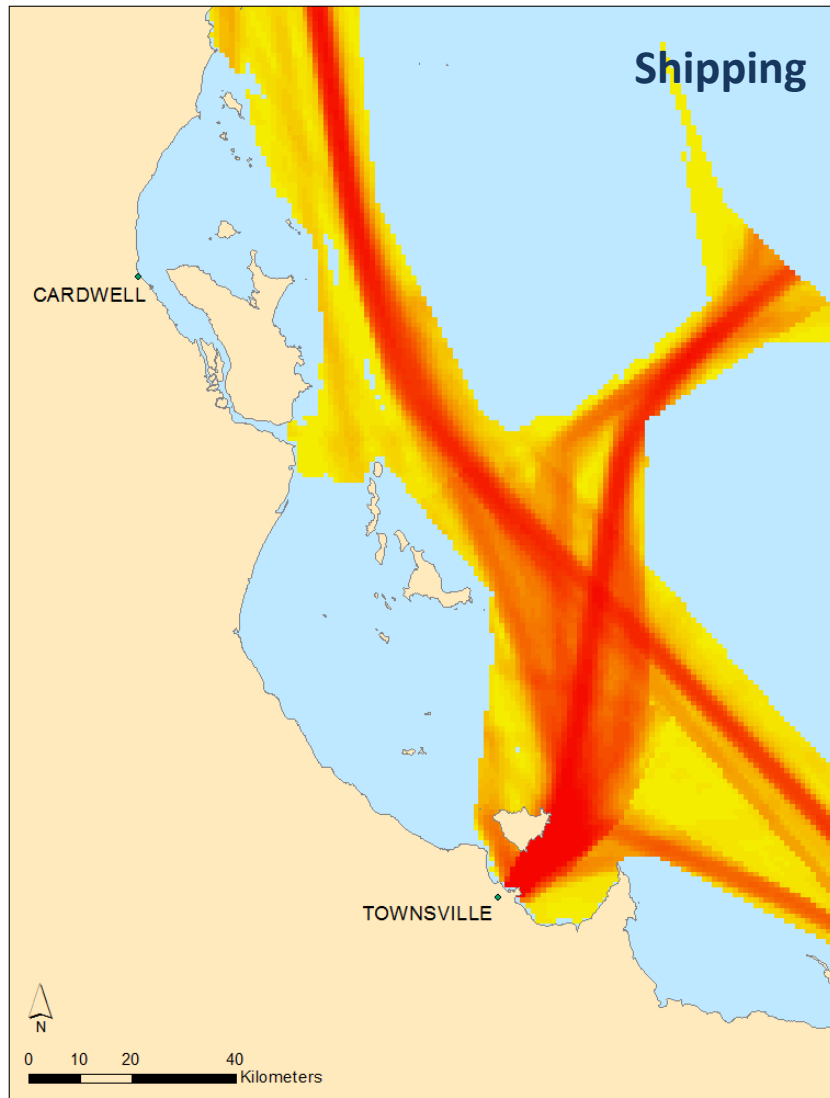
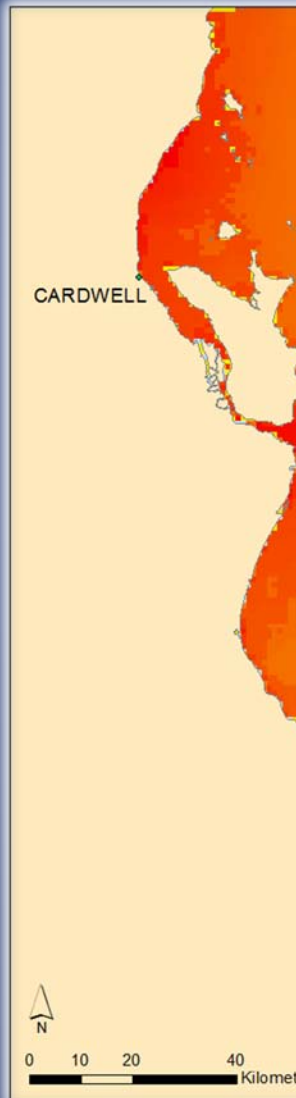
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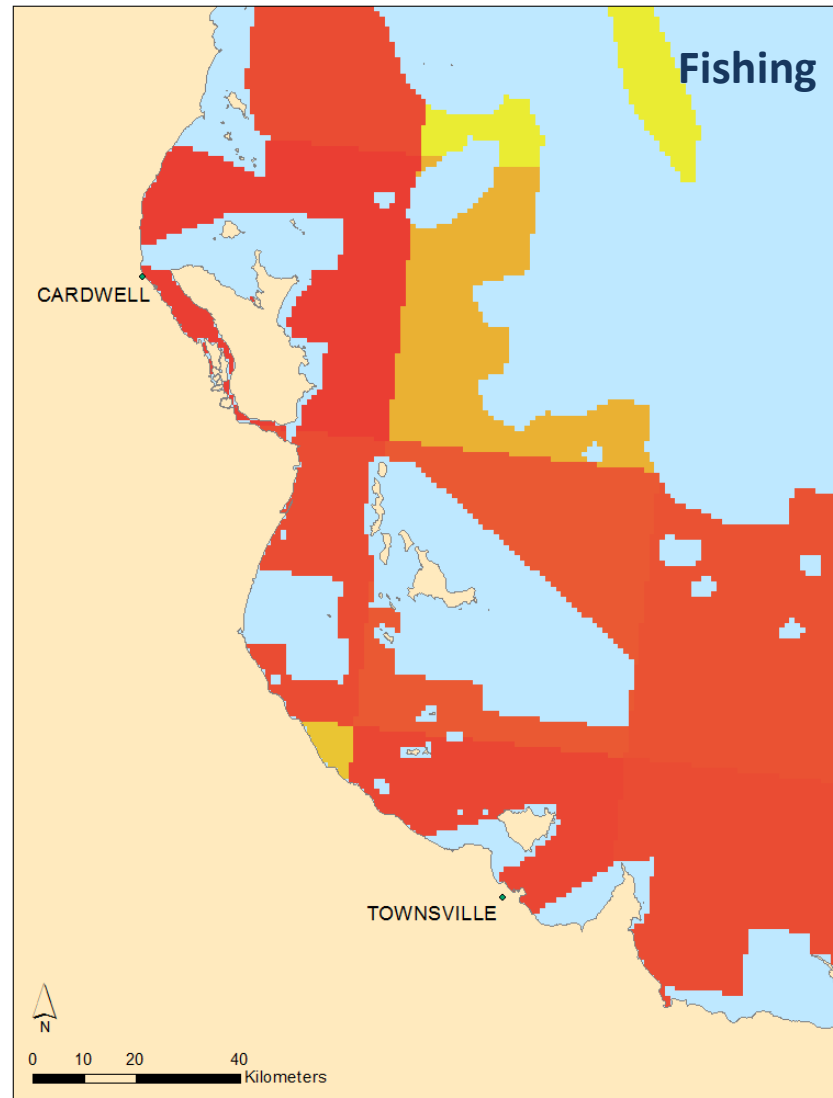
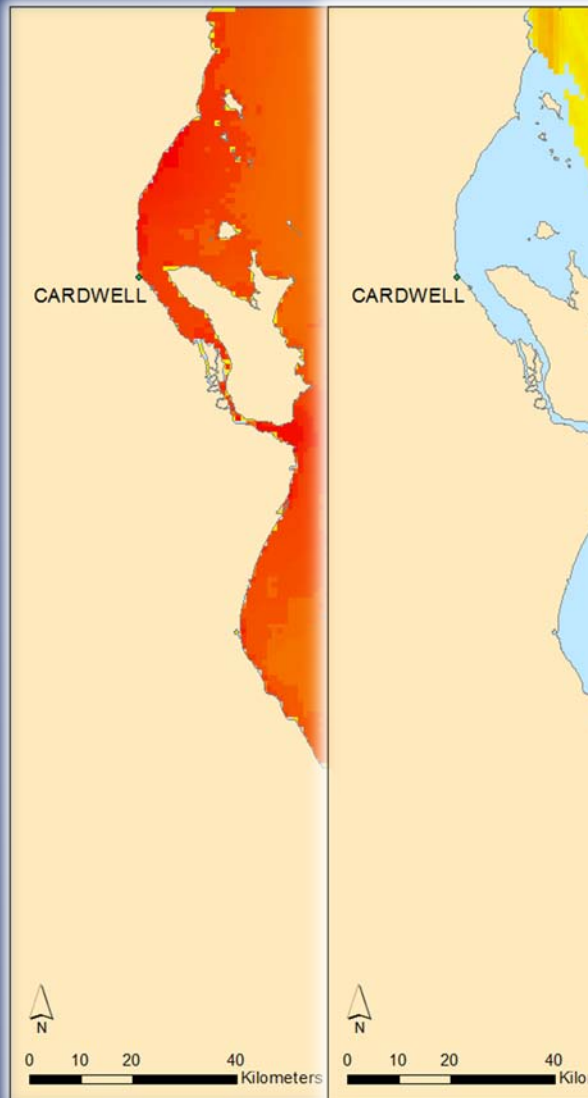
Marine Stressors



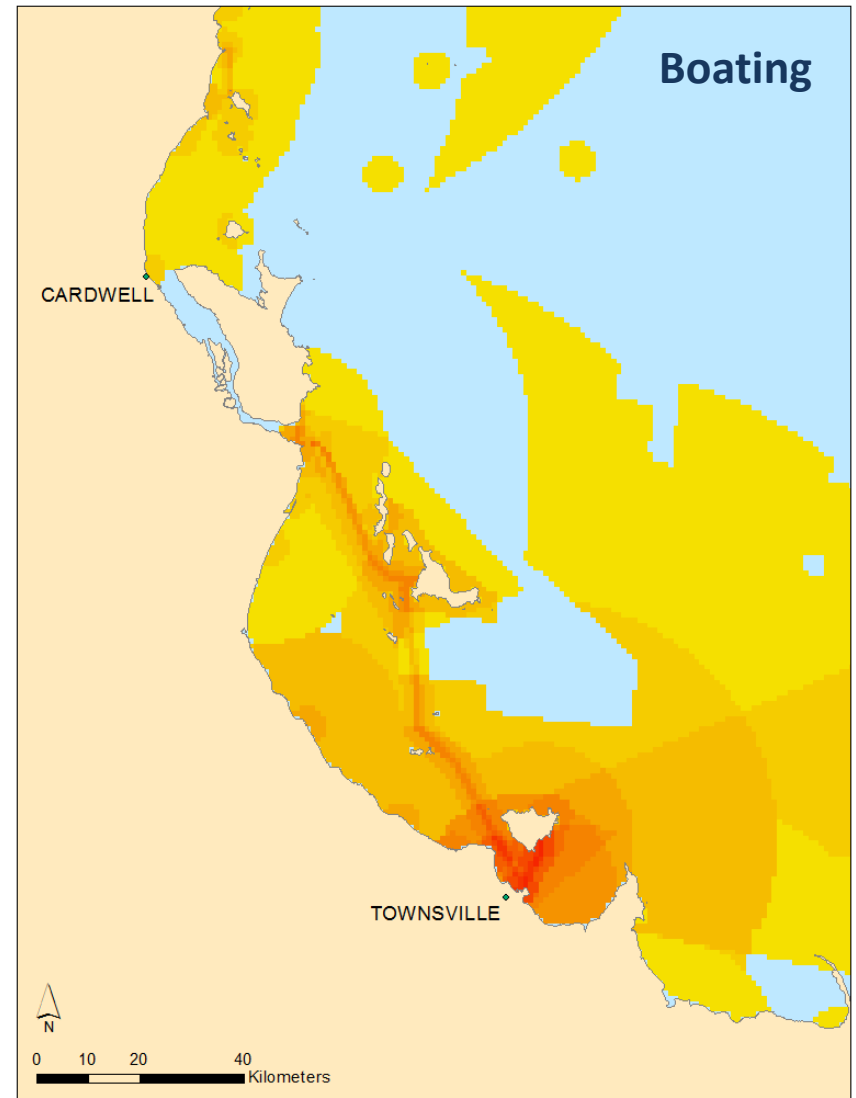
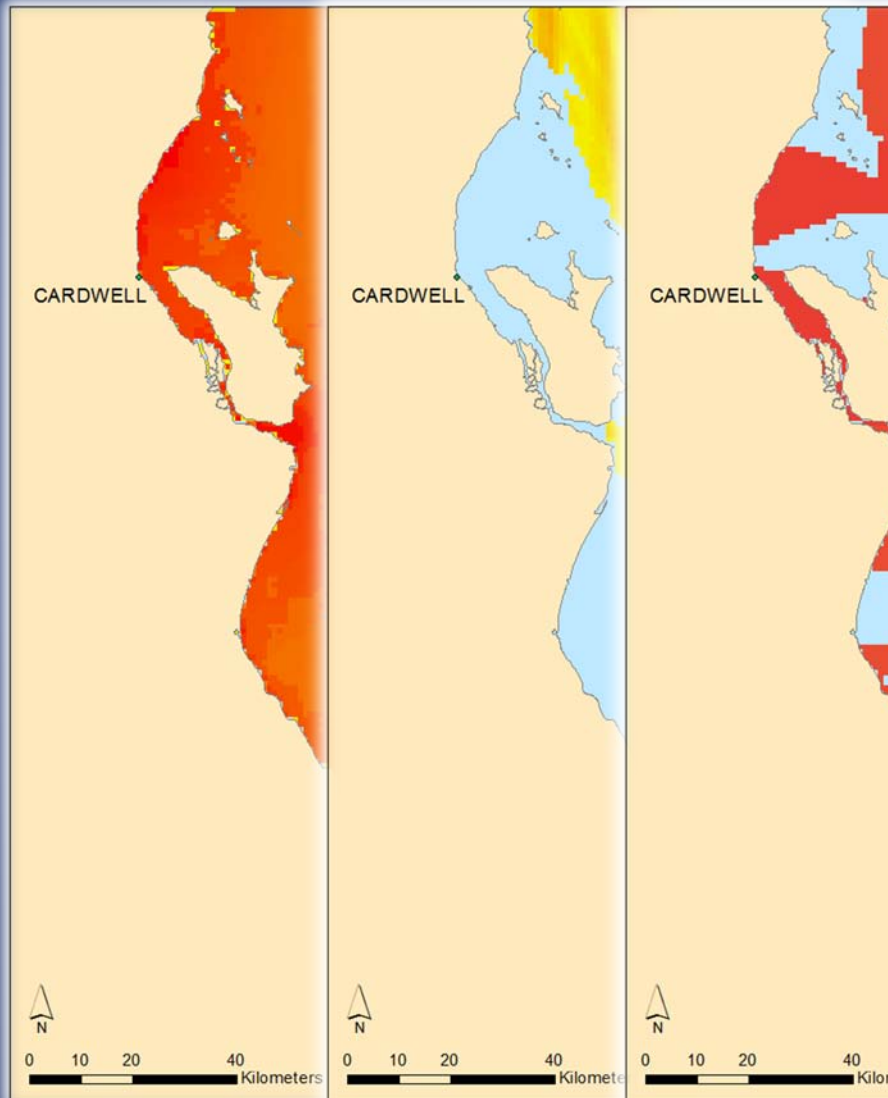
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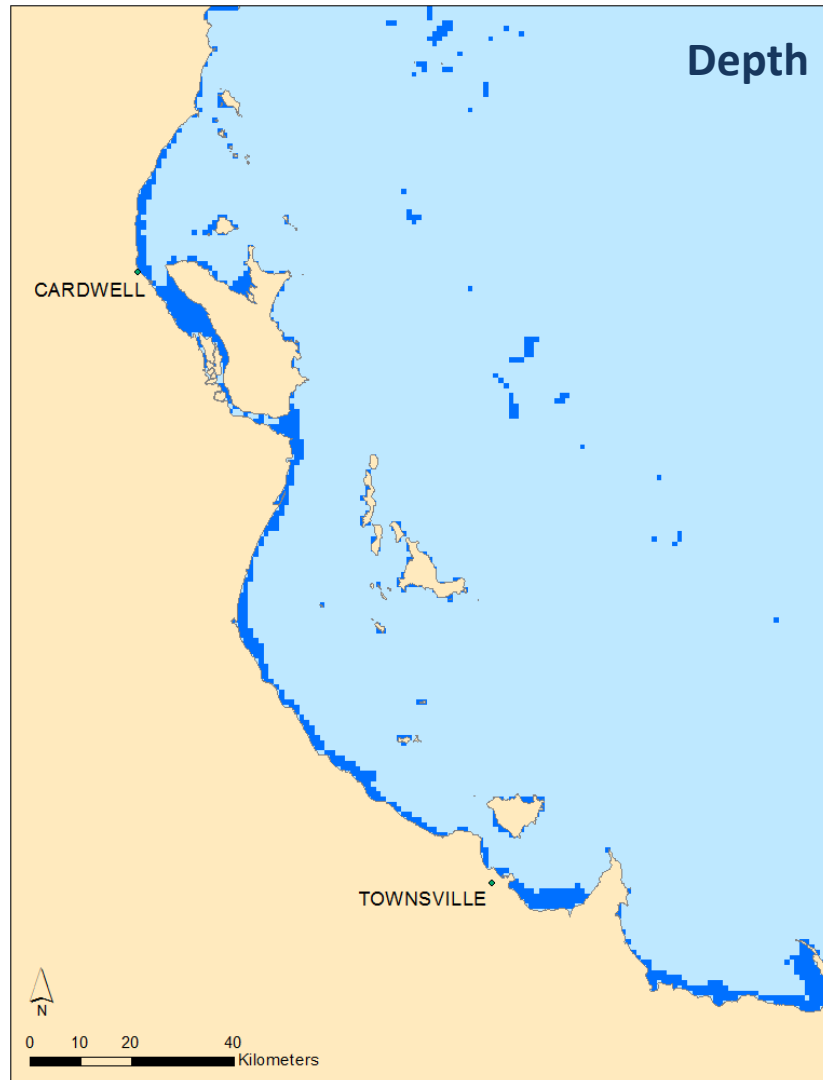
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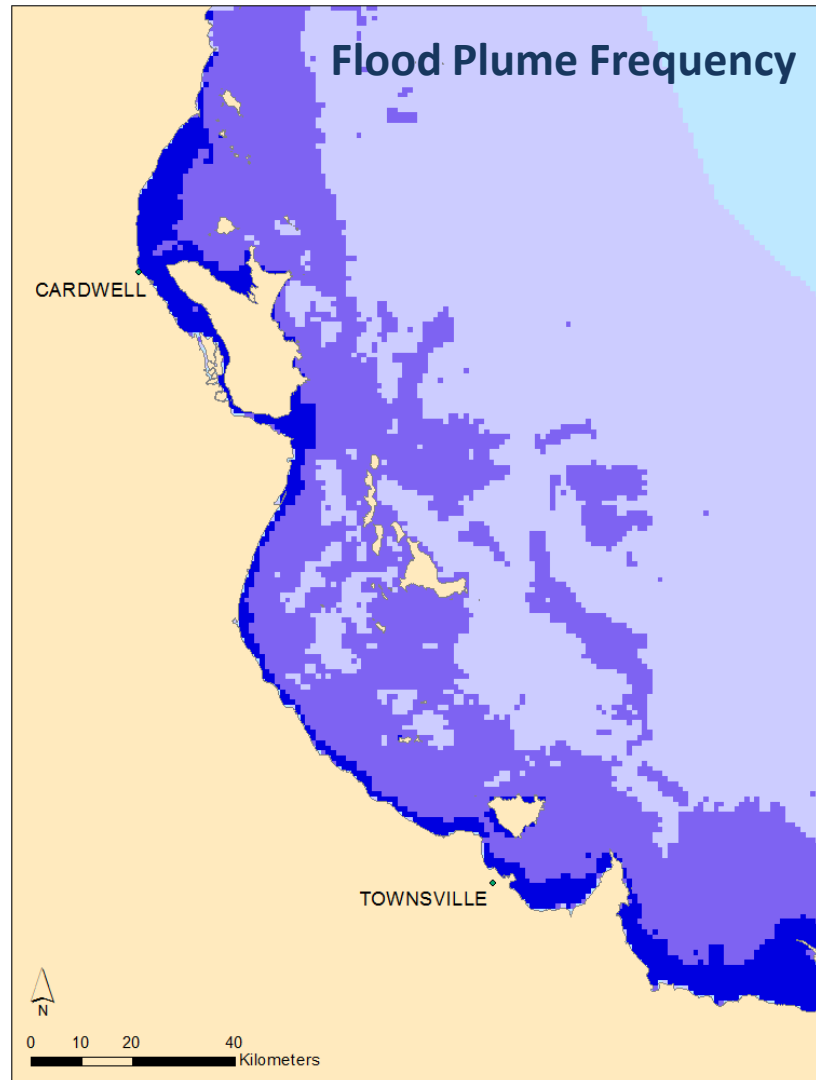
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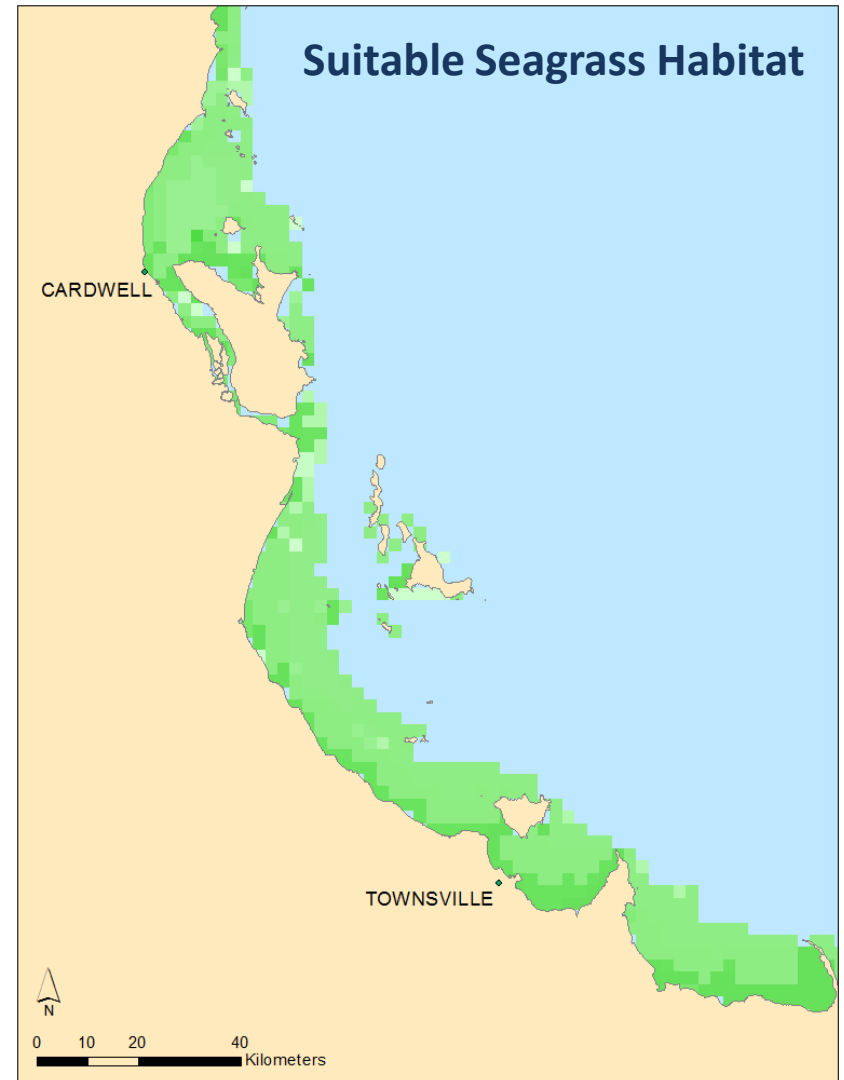
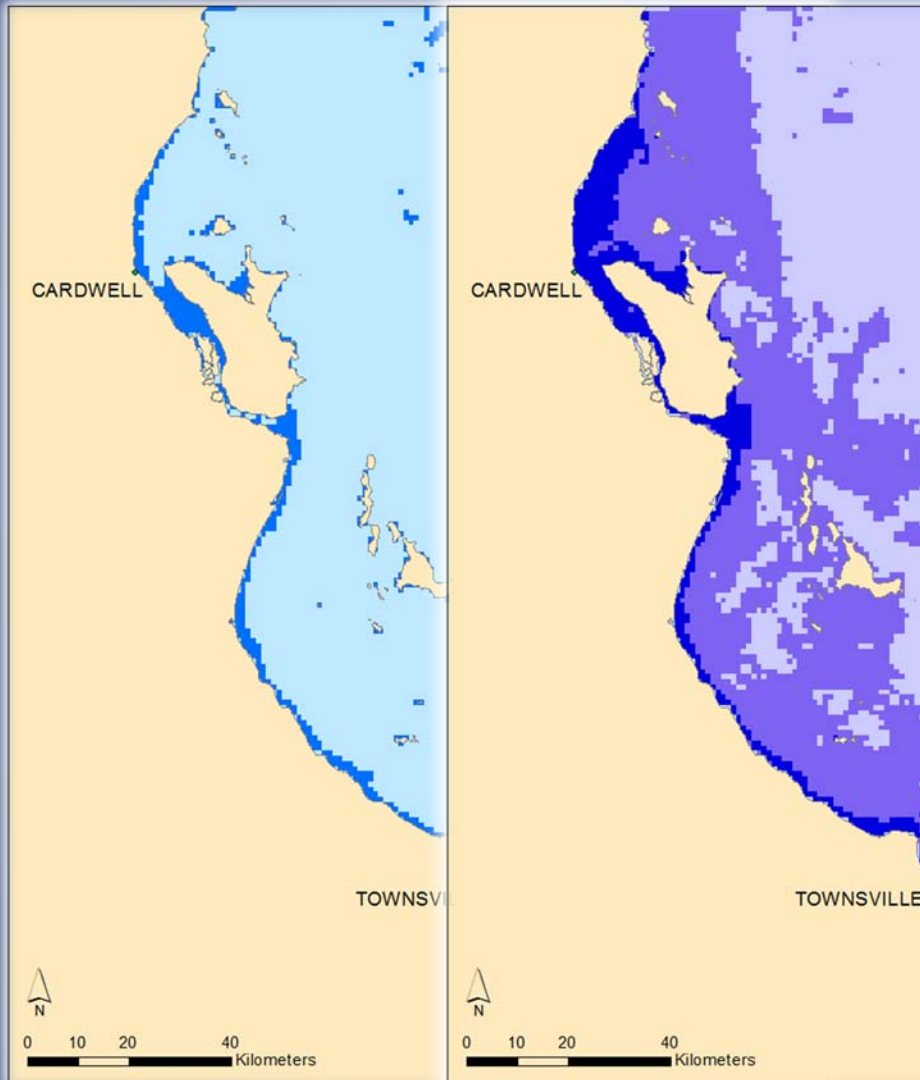
Environmental Parameters



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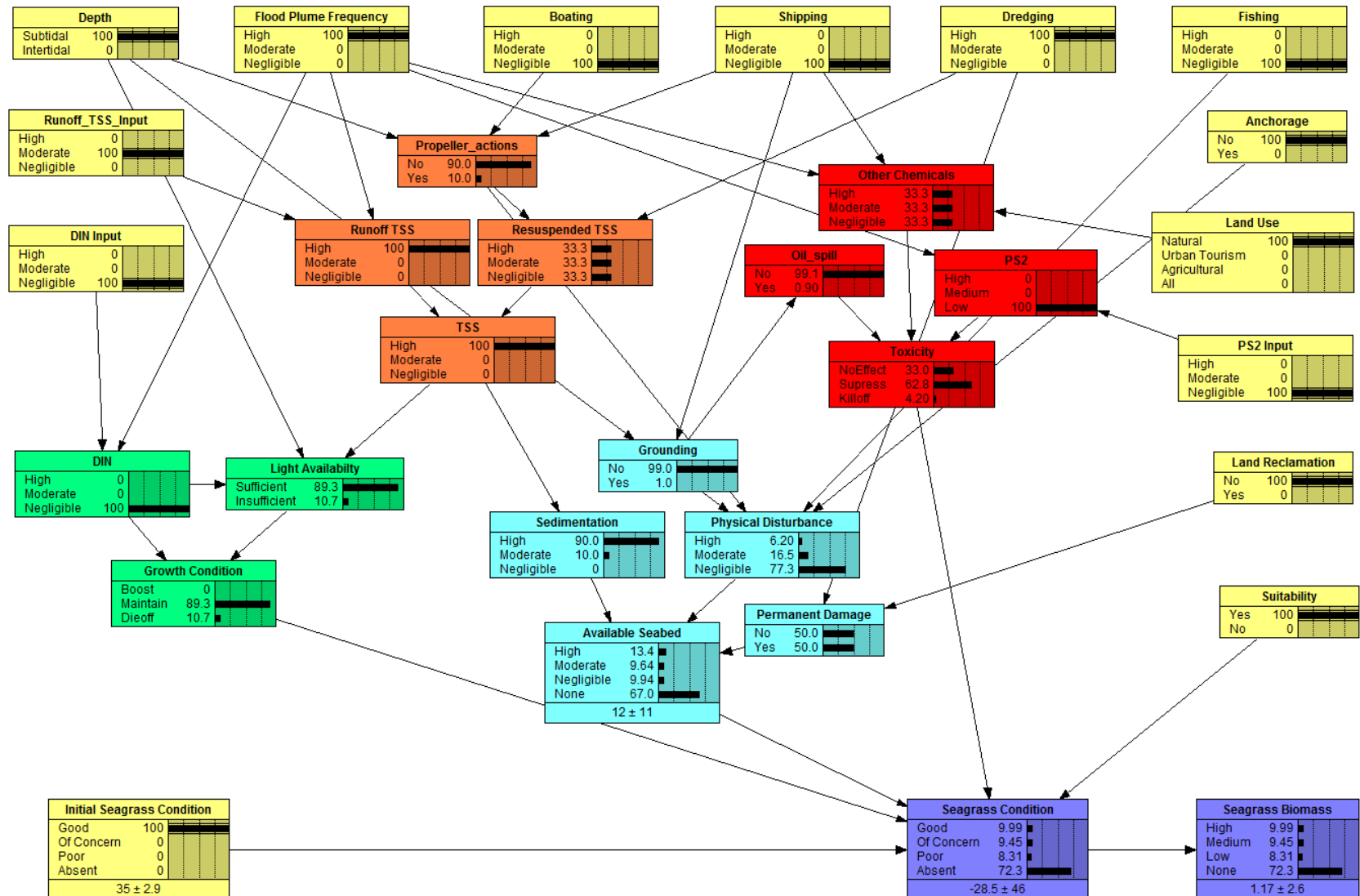
GIS-BN Tool



**Cumulative
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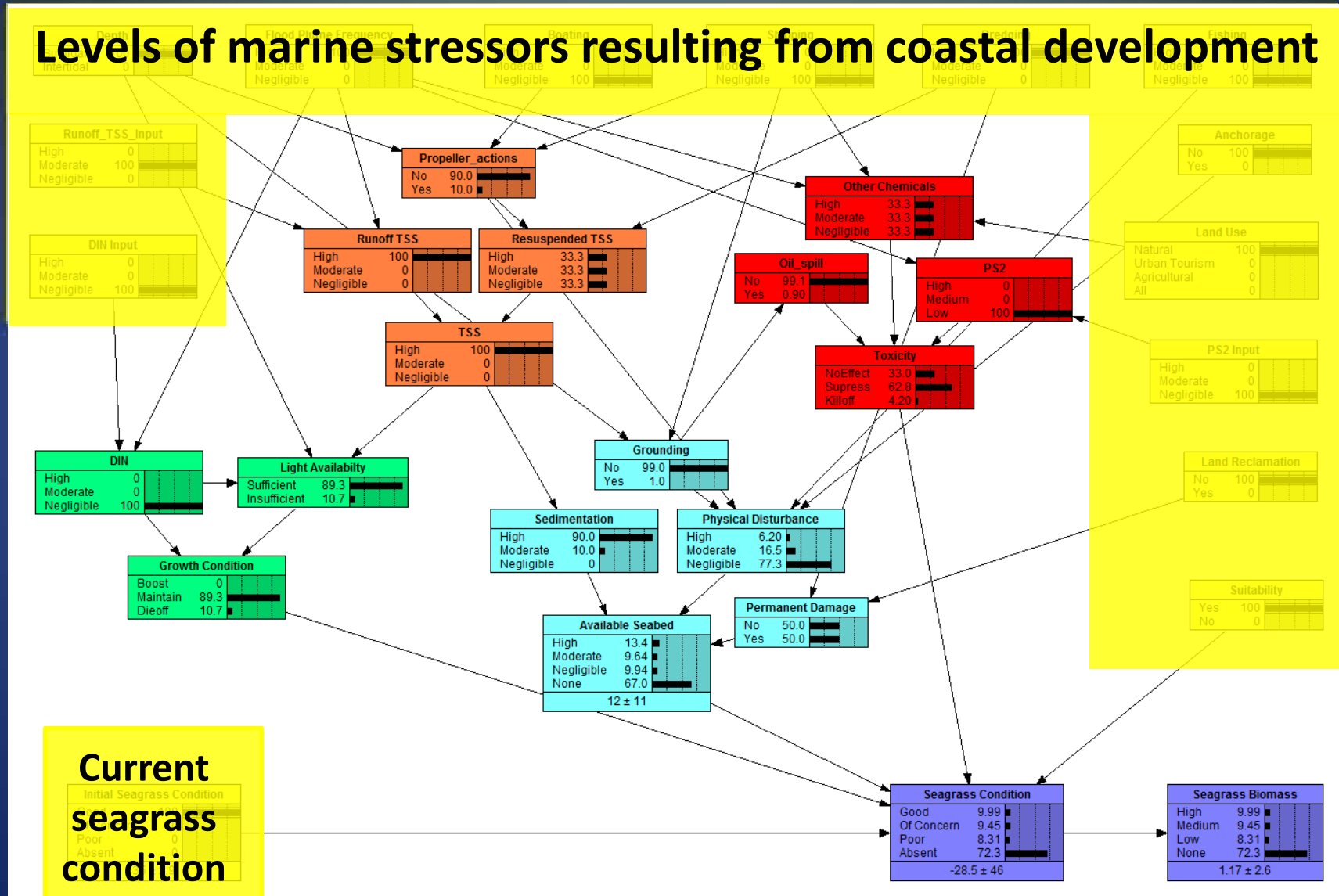


Seagrass Bayesian network

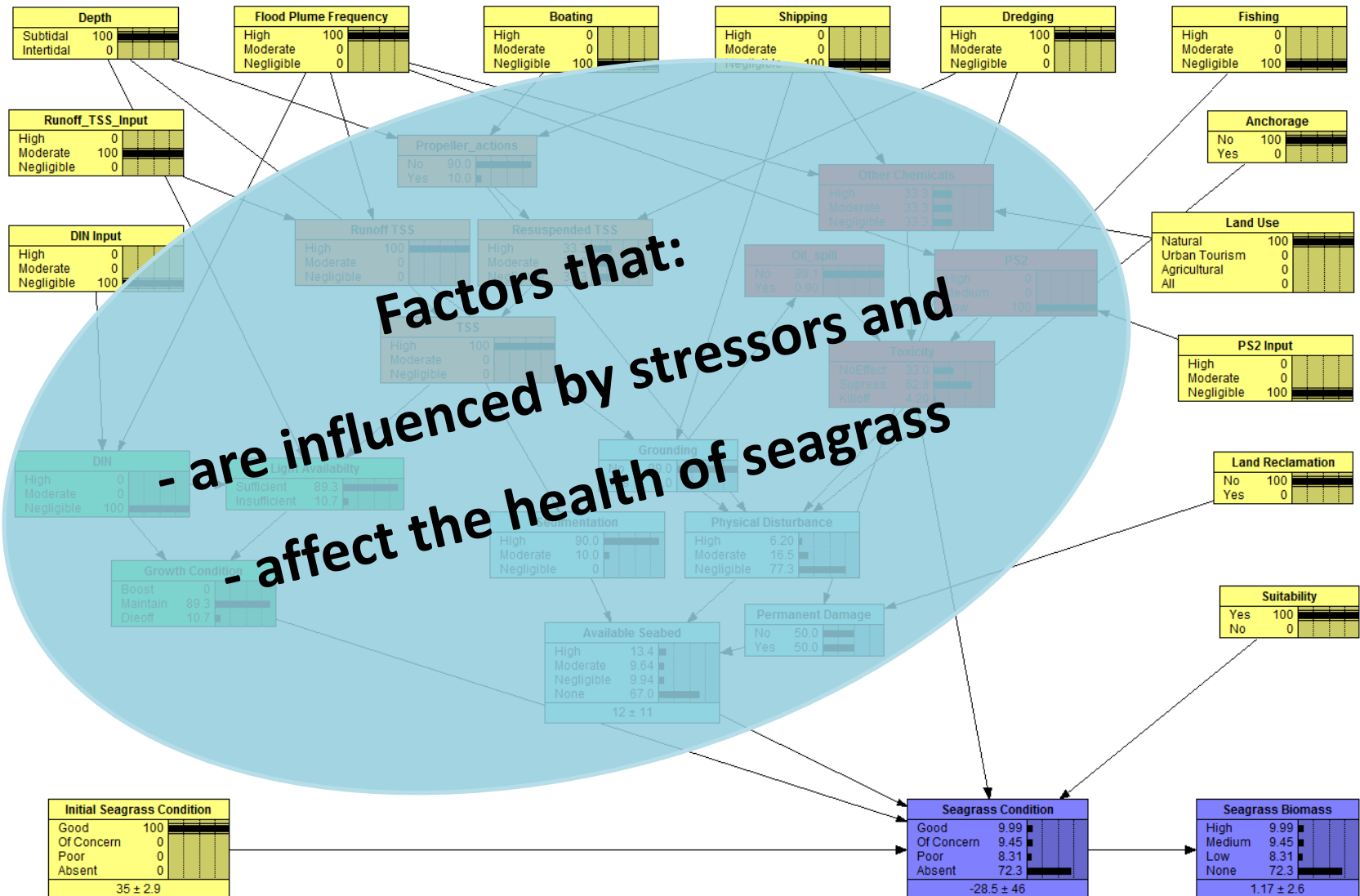


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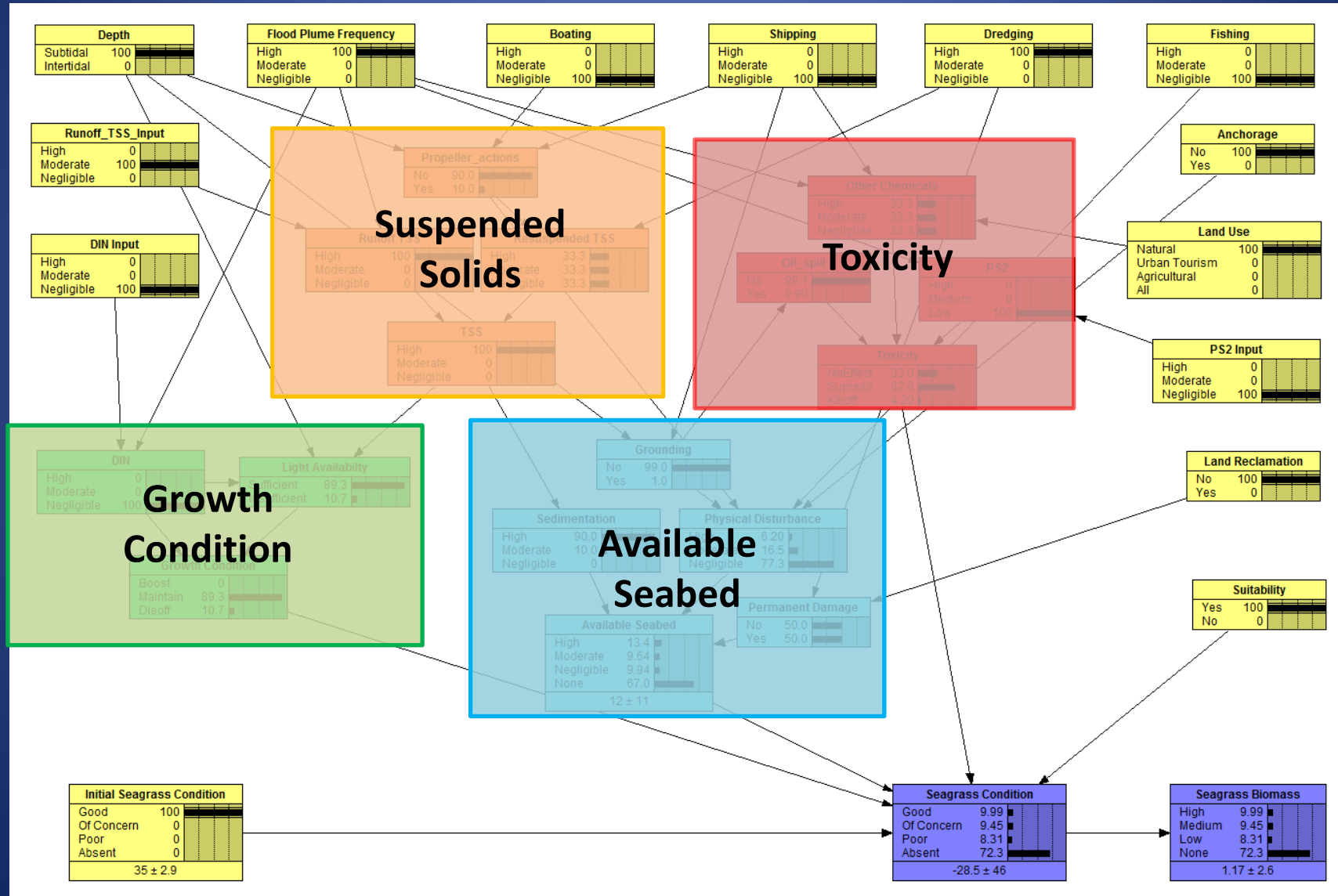
Levels of marine stressors resulting from coastal development



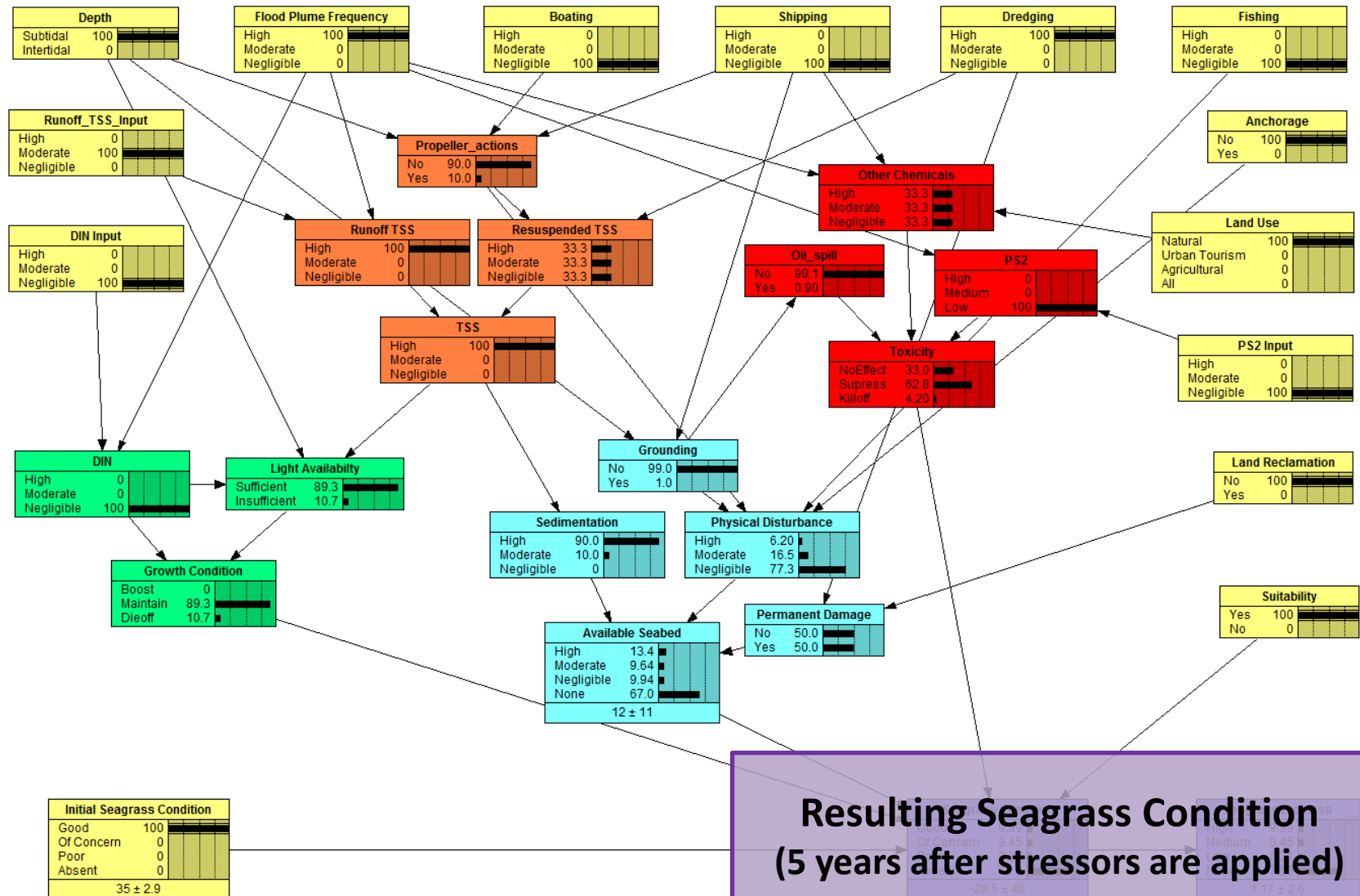
Seagrass Bayesian network



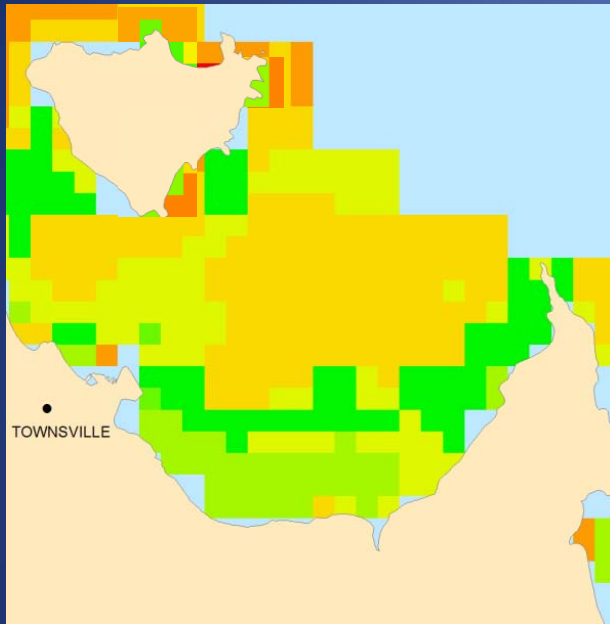
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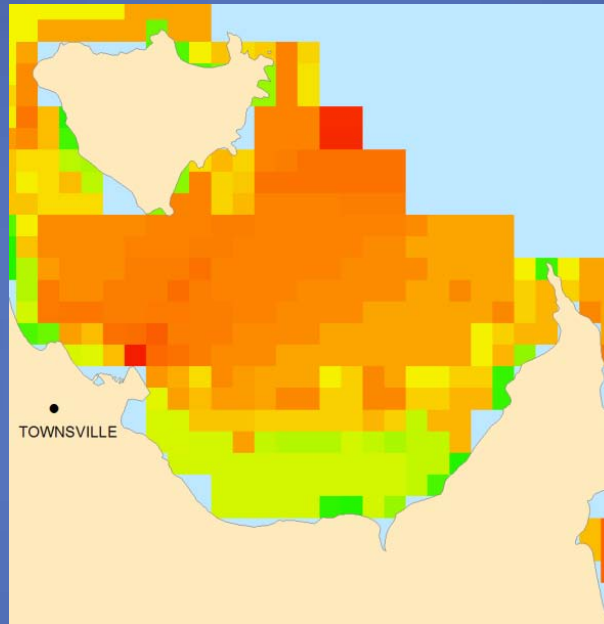
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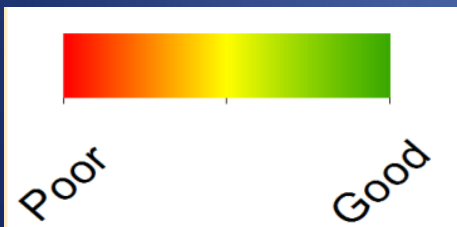
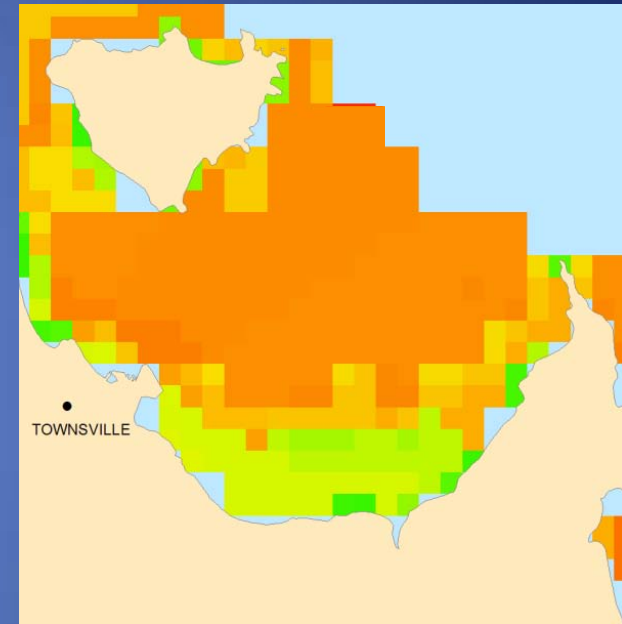
2011
(Current)



2035
Red-Tape Cutting



2035
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**Cumulative Impact
Assessment**

Support for Decision Makers

- **Understand cumulative impacts** arising from a range of scenarios.
- **Make decisions** to avoid scenarios that have more severe impacts on the GBR.
- **Protect areas** threatened by a number of stressors in each scenario.
- Respond to future development with more **targeted and finely-tuned management**.



Ways Forward

- Potential for Bayesian Networks to be developed for a range of **scenarios**, **species** and **ecosystems** at a variety of spatial scales, from whole-of-GBR to local areas across Australia.



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- Potential for Bayesian Networks to be developed for a range of **scenarios**, **species** and **ecosystems** at a variety of spatial scales, from whole-of-GBR to local areas across Australia.
- By using the best available **data**, **models** and **expert advice**, the task of assessing cumulative impacts of coastal development on marine ecosystems can be **streamlined**, and made **explicit** and **consistent**.



Thank you

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Thanks to many people and organisations that have contributed to this project. Particular thanks goes to Mirjam Maughan, Craig Shephard, Donna Audas and Sean Sloan.

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