Australian National University

MODSIM 2019

Towards methods for tracing uncertainty management through a decision support network

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Uncertainty sources

Uncertain future
- climate
- markets

Uncertain system
- hydrology
- ecosystems
- agriculture

Uncertain values
- social
- environmental
- economic

Uncertainty managers prioritise uncertainties & select fit-for-purpose methods to address them

Monitoring & decision support

e.g. Decide what to collect, how to interpret uncertain data sources

Water resource governance

e.g. Decide how to prepare for different uncertain threats & implementation challenges

Water resource users

e.g. Decide how to account for uncertain policy & operating conditions

Managed outcome

Uncertainty management positive & negative impacts

Water use, positive & negative impacts

“uncertainty management” is a process that involves different **notions** about certainty and uncertainty **being pulled into** the broader process of modelling and its surrounding activities, including data collection and decision making.

“Notions” about certainty and uncertainty

Water availability is 101-105% of what is required

There is enough water

Innovation

According to best available science

Pilot

Model validation & testing

Feasibility study

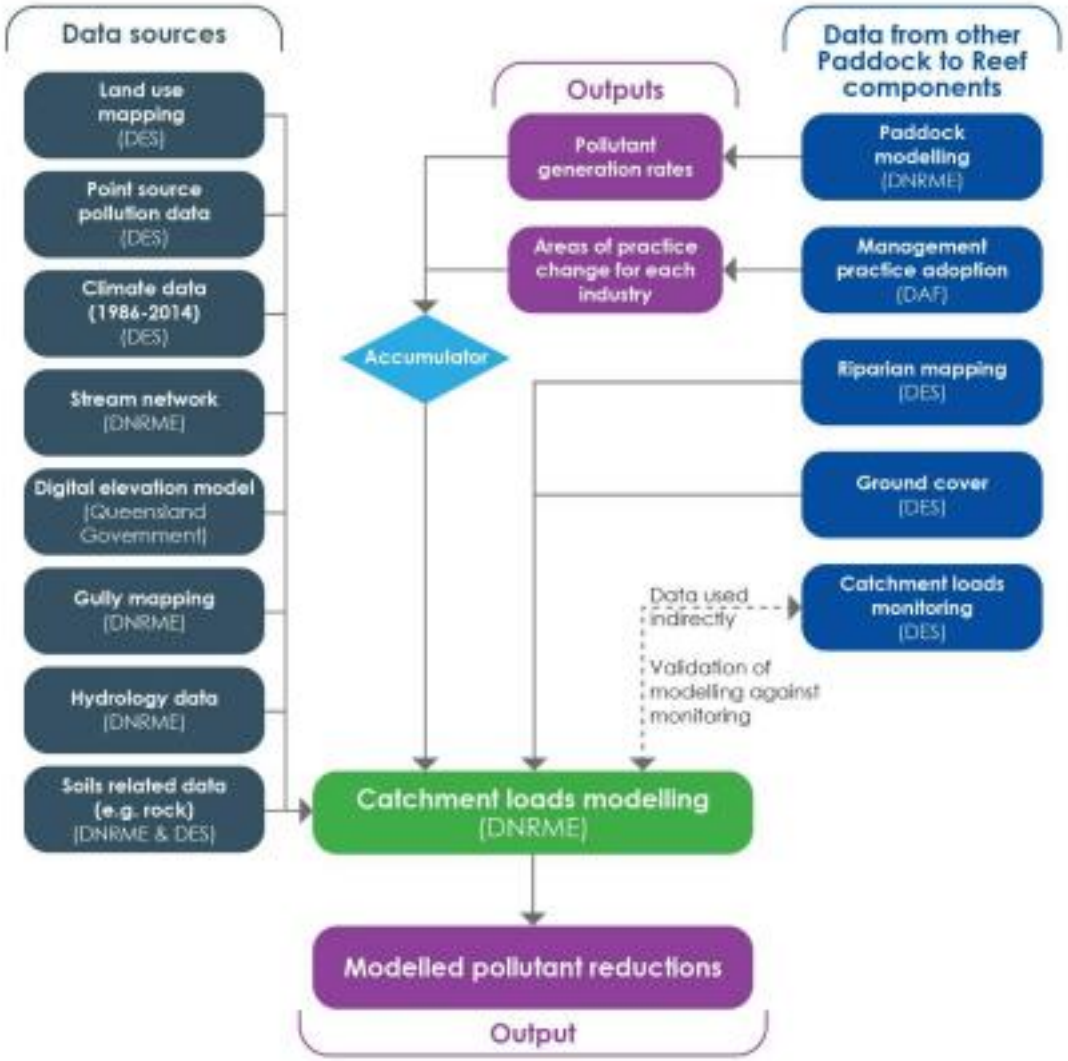
Notions activated are most visible when they are mobilised in communication

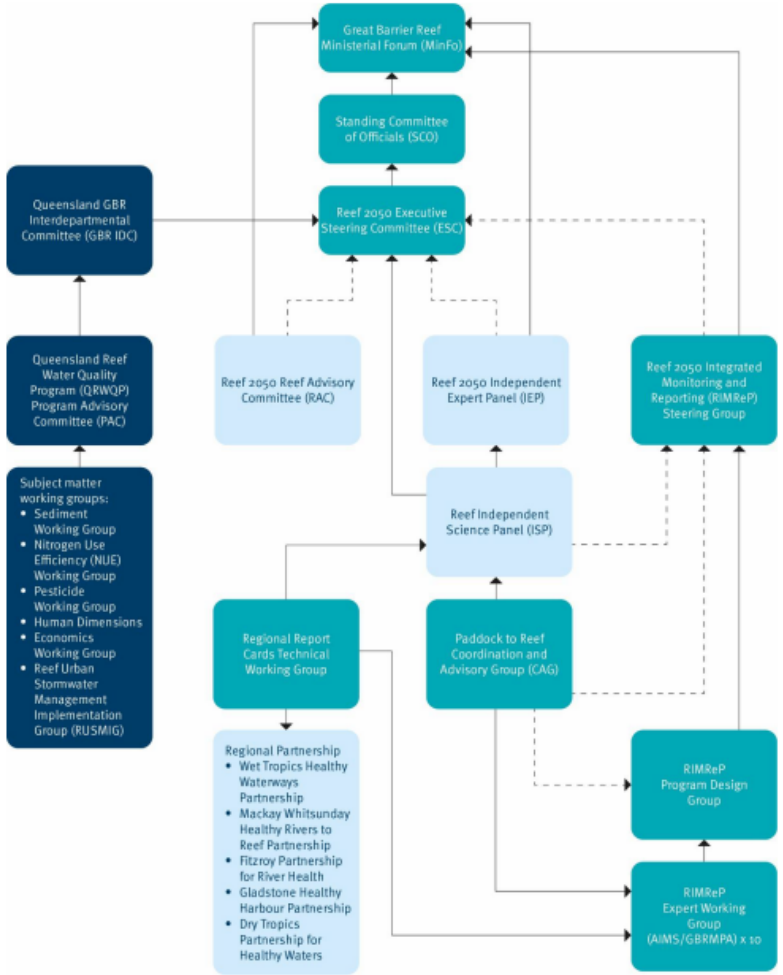
How should I handle uncertainty in my analysis?	What useful statement can I make given uncertainty?	What do we need to know about uncertainty in the conclusion?	How does uncertainty affect how I use this information?
Research under uncertainty	**Deciding what you can conclude**	**Communicating your conclusion**	**Action based on your conclusion**

Uncertainty everywhere → You → Audience → Decision

← Contestation & negotiation e.g. peer review

Great Barrier Reef Report card





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Reef 2050 WQIP

The Office for the Great Barrier Reef (OGBR)

Paddock to Reef program oversight

Paddock to Reef program

P2R Coordination and Advisory Group

Report card catchment loads modelling

DES, DAF, DNRME, … SSIMR SKIP data management tool

DNRME/DES catchment and paddock modelling: Dynamic SedNet, APSIM, Howleaky

Production of report card

Media
Parliament
…

Interactive tool development
Review by Independent Science Panel (ISP)
Technical reports internal and external reviews

Phase 3 Paddock to Reef Program Design document

Queensland Water Modelling Network

Independent program reviews by tender, and advisory panels

Australian National University

Ministerial priorities
Department budgets

Reef 2050 WQIP

The Office for the Great Barrier Reef (OGBR)

Paddock to Reef program oversight

Anticipating reactions

Paddock to Reef program

P2R Coordination and Advisory Group

Report card catchment loads modelling

New data preparation and collection

… management tool

Adopting new modelling methods

t and
paddock modelling. Dynamic
SedNet, APSIM, Howleaky

New messaging

Production of report card

Integration of new information

…

Interactive tool development
Re **Feedback and Approvals** e Panel (ISP)
Technical reports internal and external reviews

Pha
Des

Shifting focuses for phase 4

Que
Mod

New research agenda, method development

Effect on life expectancy in China of PM2.5 air pollution due to coal heating policy

1950-1980 free coal for winter heating in the north

- Chen et al. 2013 PNAS says >2.5 billion life years lost
- Pope & Dockery 2013 PNAS commentary

Gelman 2014 Research & Politics critiques polynomial regression

Ebenstein et al. 2017 PNAS revisits analysis

Gelman 2018, 2019 blog criticisms

- “Air Quality Life Index”
- Washington Post

Zhang et al. 2014 Sustainability

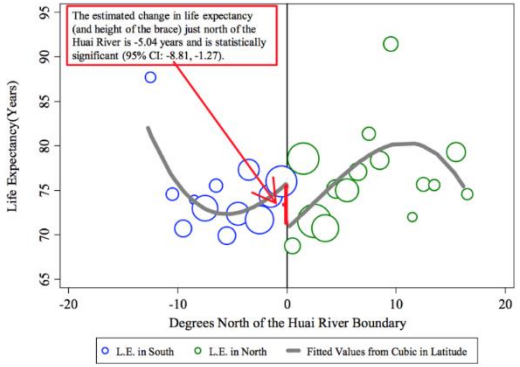
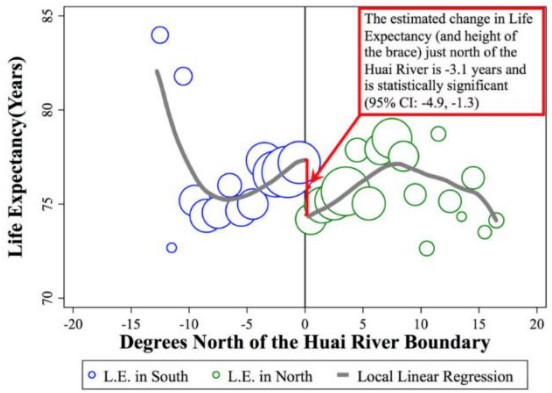
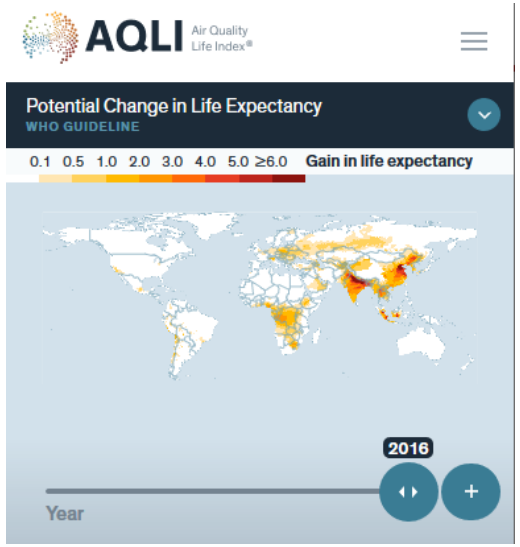


Fig. 3. The plotted line reports the fitted values from a regression of life expectancy on a cubic in latitude using the sample of DSP locations, weighted by the population at each location.





How many years do we lose to the air we breathe?

>2.5 billion
life years lost

It's a big number already

long-term exposure to an additional 100 μg/m3 of TSPs is associated with a reduction in life expectancy at birth of about 3.0 y (95% CI: 0.4, 5.6)

Uncertainty quantification
Degree of belief
Demonstrate robustness

Follow-the-contract

quasi-experimental empirical approach

Chen et al. 2013 PNAS

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dramatic and interesting

long-term exposure to an additional 100 µg/m3 of TSPs is associated with a reduction in life expectancy at birth of about 3.0 y (95% CI: 0.4, 5.6)

Ends-justifies-the-means?

are the results plausible? Are they coherent with other epidemiological studies?

New-view-on-existing-result

Demonstrate-Robustness

quasi-experimental empirical approach

adept use of a well-developed regression discontinuity approach

Validate-and-Defend

Chen et al. 2013 PNAS

Pope & Dockery 2013 PNAS commentary

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quasi-experimental empirical approach

With regard to the health effects of air pollution there remains much to be learned.

Step-towards-a-goal

important contribution to this evidence base

Build-the-foundations

begs to be better understood

Suggest-a-new-research-agenda

How many years do we lose to the air we breathe?

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journals should recognize … analyses … are often inconclusive; relax the implicit rule under which statistical significance is a condition for publication

Step-towards-a-goal

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Uncertainty quantification
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Demonstrate robustness

maybe it doesn't matter because it's a crisis so it's better to have falsely-precise numbers than none at all

Just-a-possibility?

quasi-experimental empirical approach

[methods] do not accurately convey uncertainty.

statistically significant but substantively dubious, and are sensitive to model choice

Gelman 2014; 2019

Chen et al. 2013 PNAS

https://www.washingtonpost.com/graphics/2018/national/health-science/lost-years/

How many years do we lose to the air we breathe?

The next year, the Chinese government responded to public outcry and launched a “war on pollution.”

Ends-justifies-the-means?

>2.5 billion life years lost

It’s a big number already

These numbers are a warning, however, not a death sentence.

Restrict-scope-of-applicability

long-term exposure to an additional 100 μg/m3 of TSPs is associated with a reduction in life expectancy at birth of about 3.0 y (95% CI: 0.4, 5.6)

Those numbers are startling, and that’s the point. University of Chicago researchers wanted to make air quality measurements less abstract and more relatable — and what is more relatable than years of life?

Just-a-possibility?

quasi-experimental empirical approach

the team was able to link PM2.5 concentration to life expectancy

Validate-and-Defend

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Validate-and-Defend

Implications for collaboration

- Concepts for thinking about information flows & uncertainty
- Opportunities/benefits:
  - Rooted in reflecting on current practice
  - Emphasis on impact of information and systemic change
- Challenges:
  - How much detail to think about; what should remain unsaid?
  - Work needed on whether and how to formally describe