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Enabling Delta Life

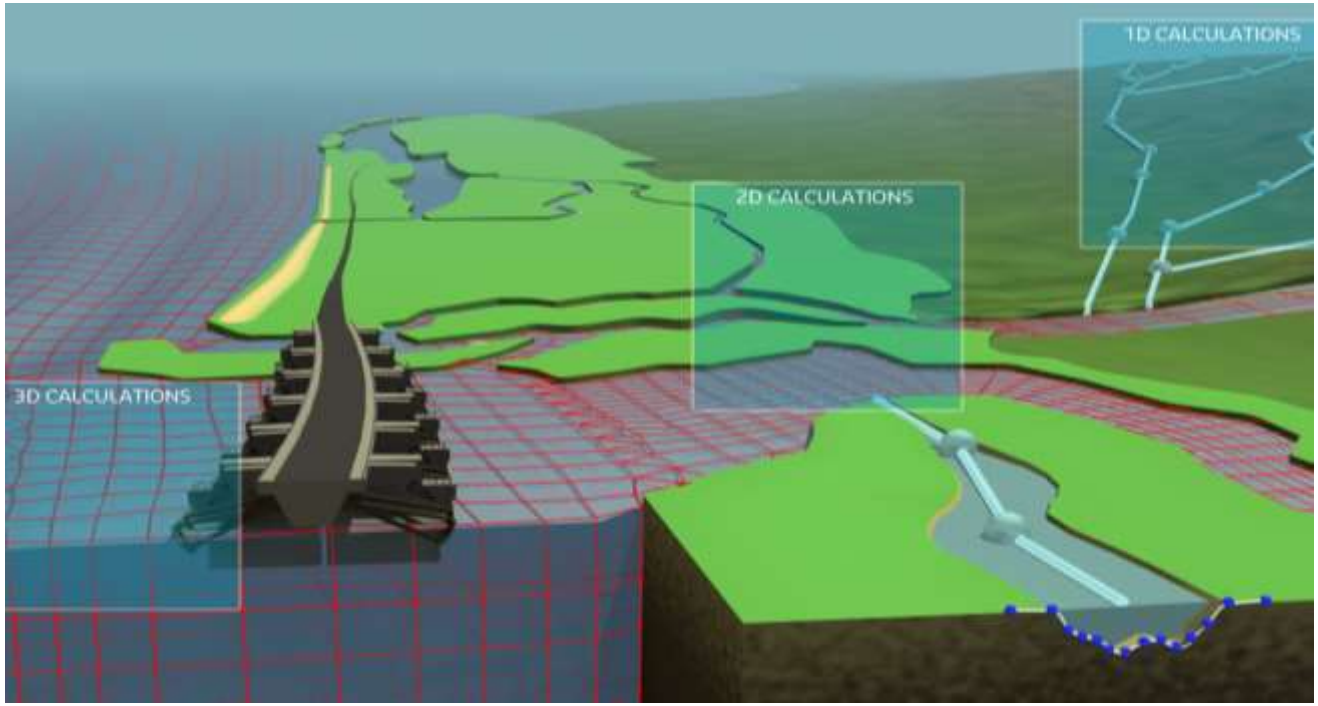
Uncertainty in 3D sediment transport modelling

Implications for management

SedNet 2017

SedNet

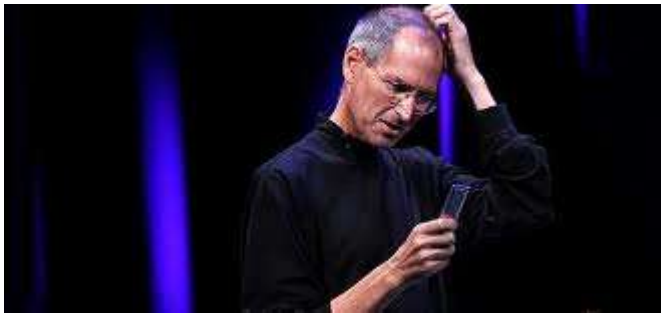
Environmental modelling & uncertainty



- Large-scale
- Complex physical processes
- Interacting timescales

- Scientific basis for policy decisions

Need inform decision makers about model uncertainties



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Considerations.....

1. What are the clients requirements with respect to management?
2. To what level is uncertainty an issue?
3. What effects of uncertainty on a policy-level should be indicated?
4. Why is uncertainty being reported? To conform to good scientific practice? Is it required by law or requested by the stakeholders?
5. Who is the target audience?

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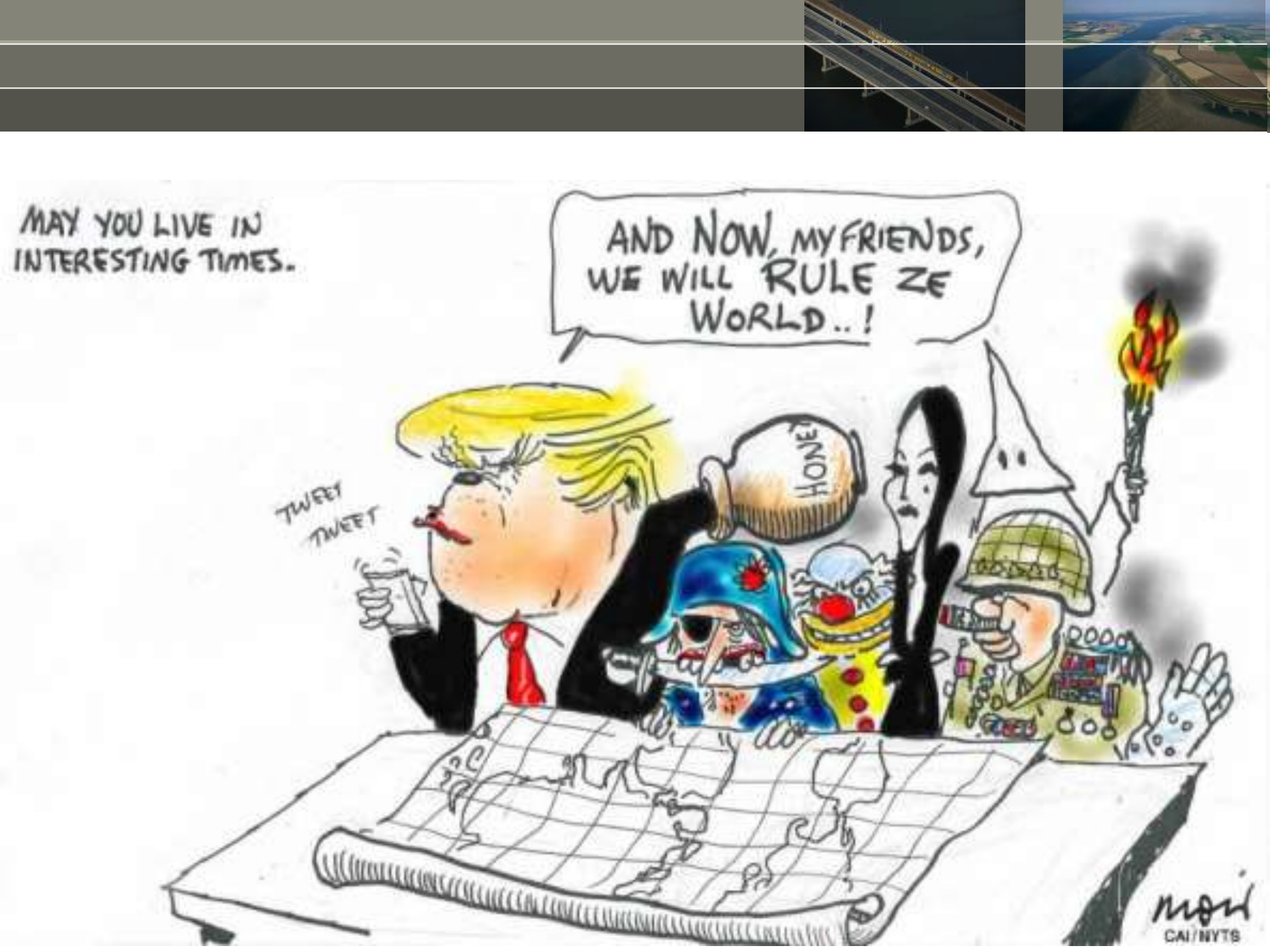
MAY YOU LIVE IN INTERESTING TIMES.
AND NOW, MY FRIENDS, WE WILL RULE ZE WORLD..!
TWEET TWEET
HOME
CAI/NYTS

Dealing with uncertainty

According to Lipshitz and Strauss (1997) decision makers distinguished three types of uncertainties:

- Inadequate understanding
- Incomplete information
- Undifferentiated alternatives

Five Strategies of coping:

1. Reducing uncertainty
2. Assumption based reasoning
3. Weighing pros and cons of competing alternatives
4. Suppressing uncertainty

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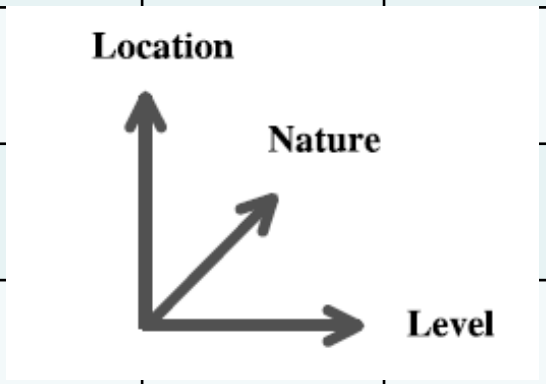
Walker *et al*., (2003) Uncertainty Matrix (modified from Refsgaard *et al*., (2007)

Source of uncertainty		Taxonomy (types of uncertainty)				Nature	
		Statistical	Scenario	Qualitative	Recognized ignorance	Epistemic	Stochastic
Context							
Inputs	Initial conditions						
	Boundary conditions						
Model	Model structure/code						
	Underlying physics						
	Parameters						
Model outputs							



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Model outputs							

Case study: Eems estuary, The Netherlands

- Eems estuary is highly impacted by human activity
  - ➢ Dramatic changes in the past 500 years e.g. intertidal areas greatly reduced (40%)

- Land reclamation
- Dredging of waterways
- Port construction

↓

- Tidal amplification
- Increasing estuarine circulation
- Increasing flood-dominance of tidal asymmetry

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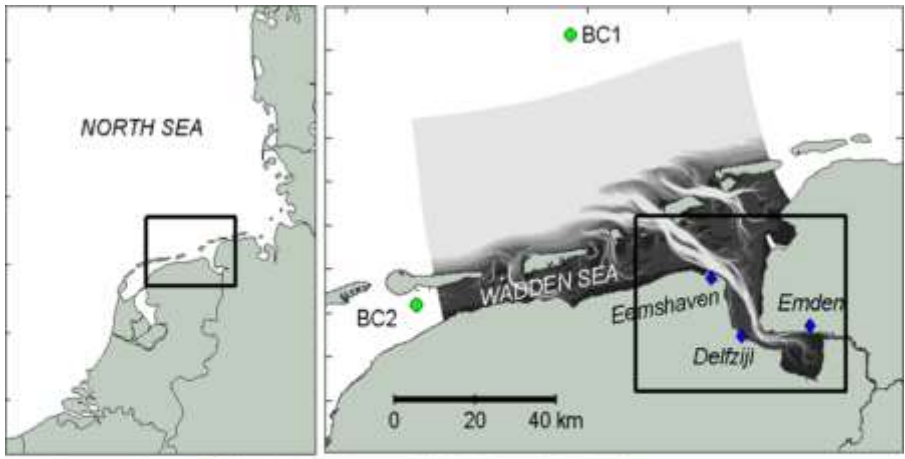
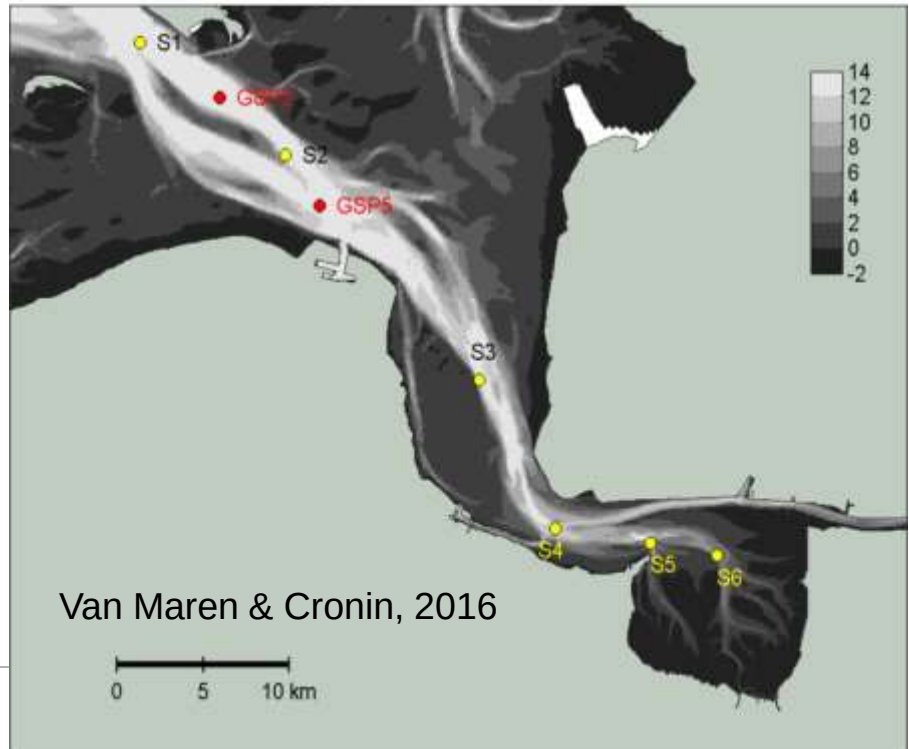
- Increased residual transport
- Leads to **high suspended sediment concentrations**





Van Maren & Cronin, 2016

Why model?

Aim: to explore measures to reduce the suspended sediment concentration (SSC) and therefore improve ecological status of the estuary (WFD)

Measures:

1. Restoration of the tidal channels
2. Modified dredging and disposal activities
3. Enlargement of intertidal areas

Model may be able to reproduce present day sediment dynamics with sufficient accuracy but maybe not future SSC as a result of measures

== **EPISTEMIC** uncertainty → **uncertainty related to parameter values** or physical processes

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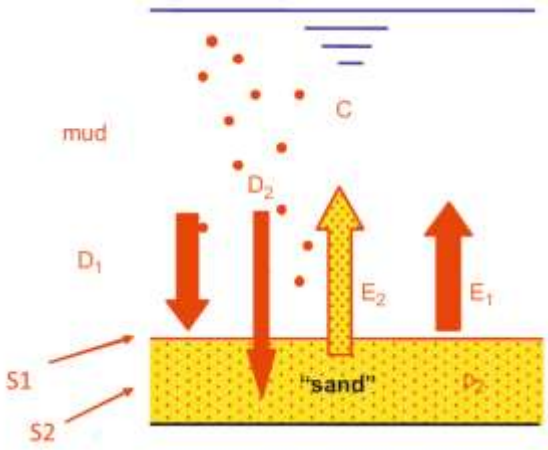
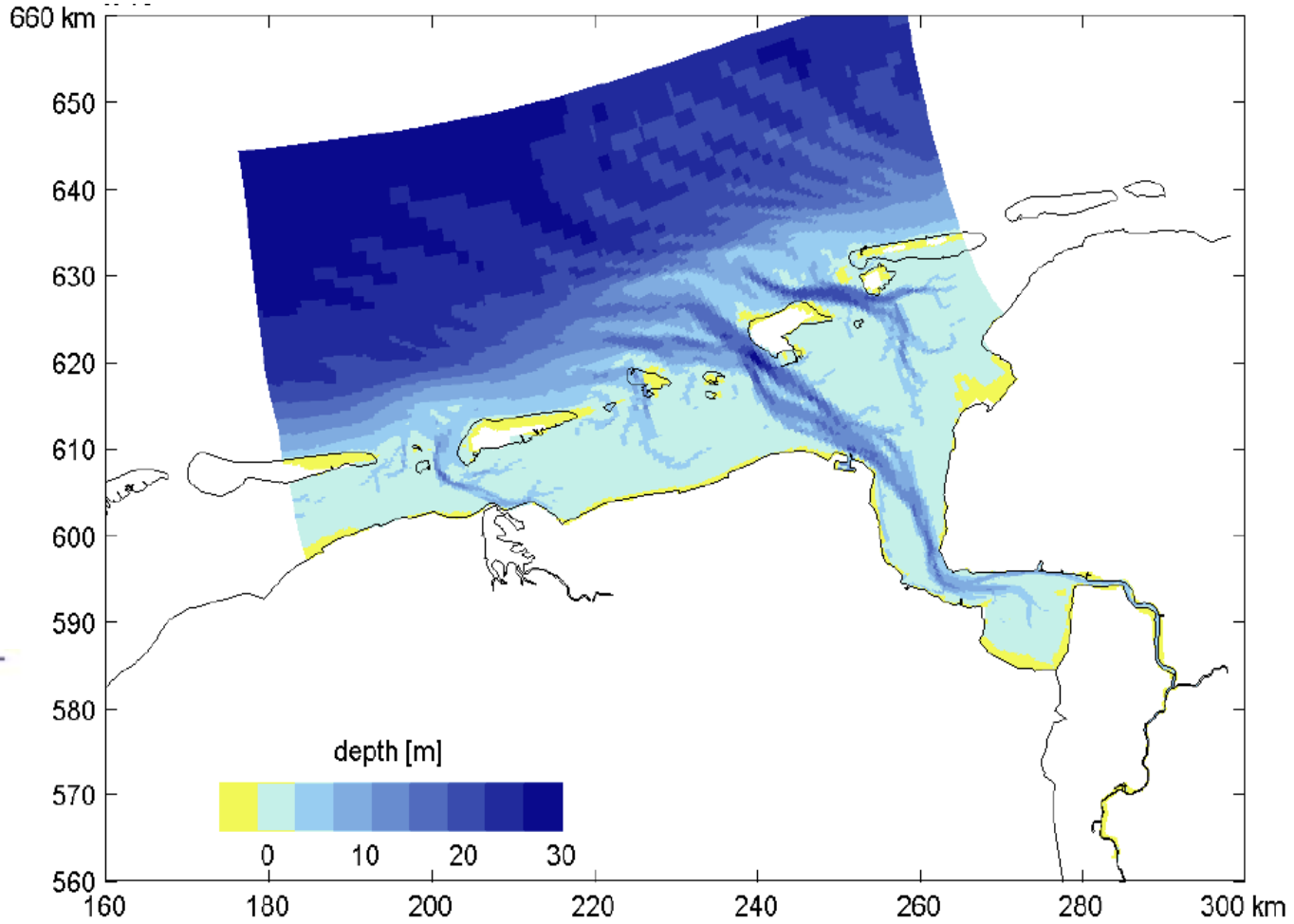
Model application

Coupled FLOW-WAVE model (Delft3D)

Sediment transport modelled using Delft3D-WAQ





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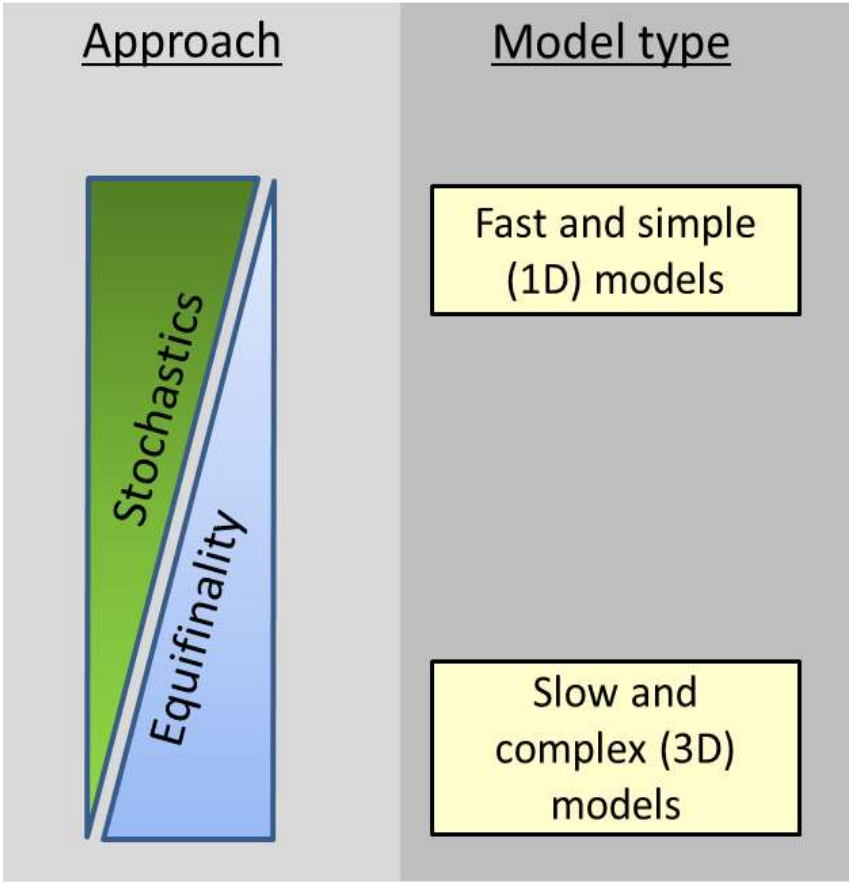
Equifinality

Several combination of parameter values that capture observations equally well



- Some believe equifinality reduces the applicability of a model (e.g. Oreskes et al., 1994)
- 3D sediment transport models - computationally expensive → stochastic simulations not feasible
- Paradox – the more complex – the more equifinali parameter sets
- Hypothesis of this work: equifinality may not necessarily increase the uncertainty of predictions
- What is the influence of parameter uncertainty & equifinality on this model application?

Uncertainty reduction

Step 1

- Starting from baseline model create multiple calibration sets
- Ensure parameters stay in realistic range

Step 2

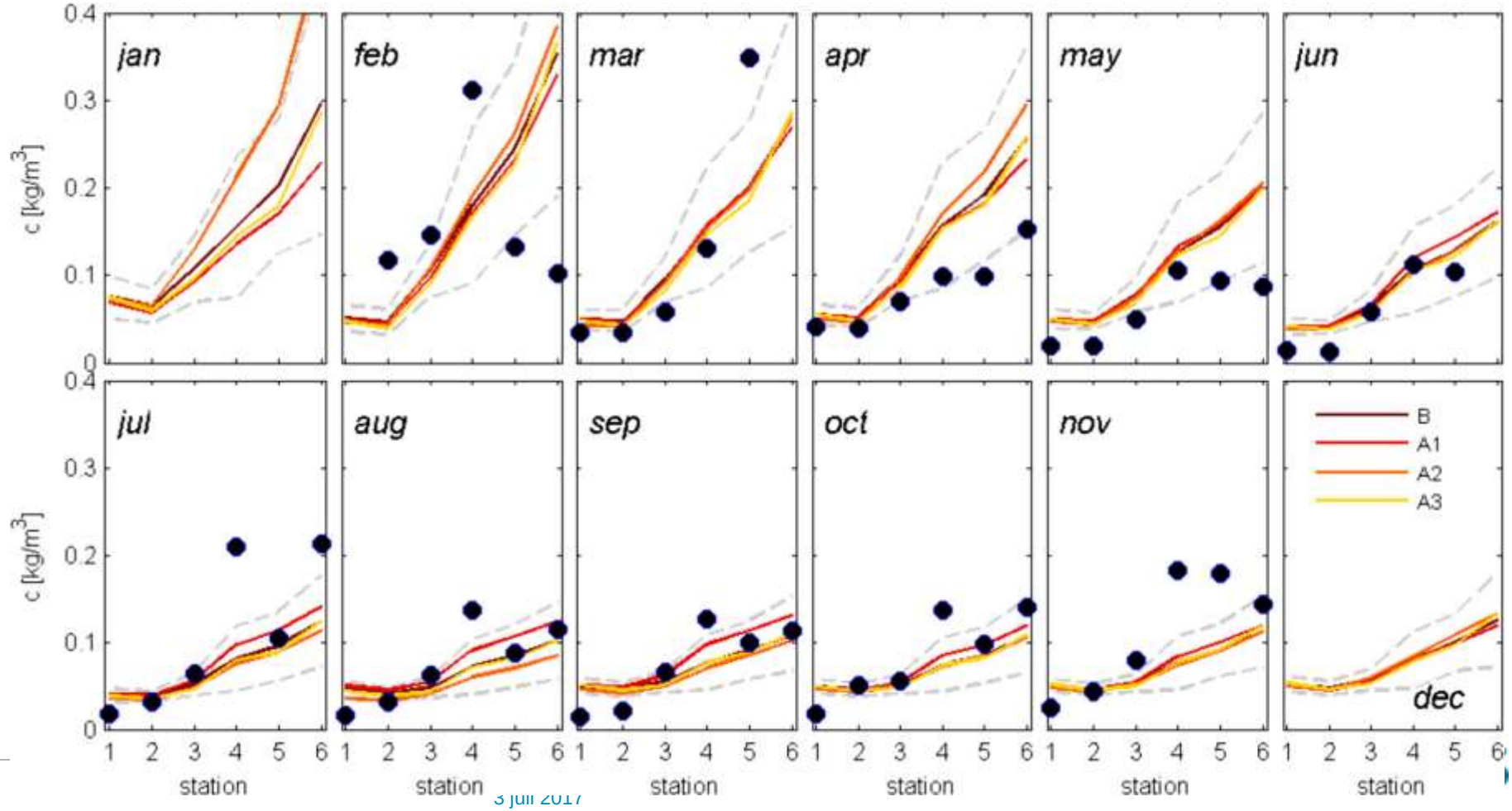
- Sensitivity analysis
- Fine tuning of different calibration sets
- 3 final sets chosen

Step 3

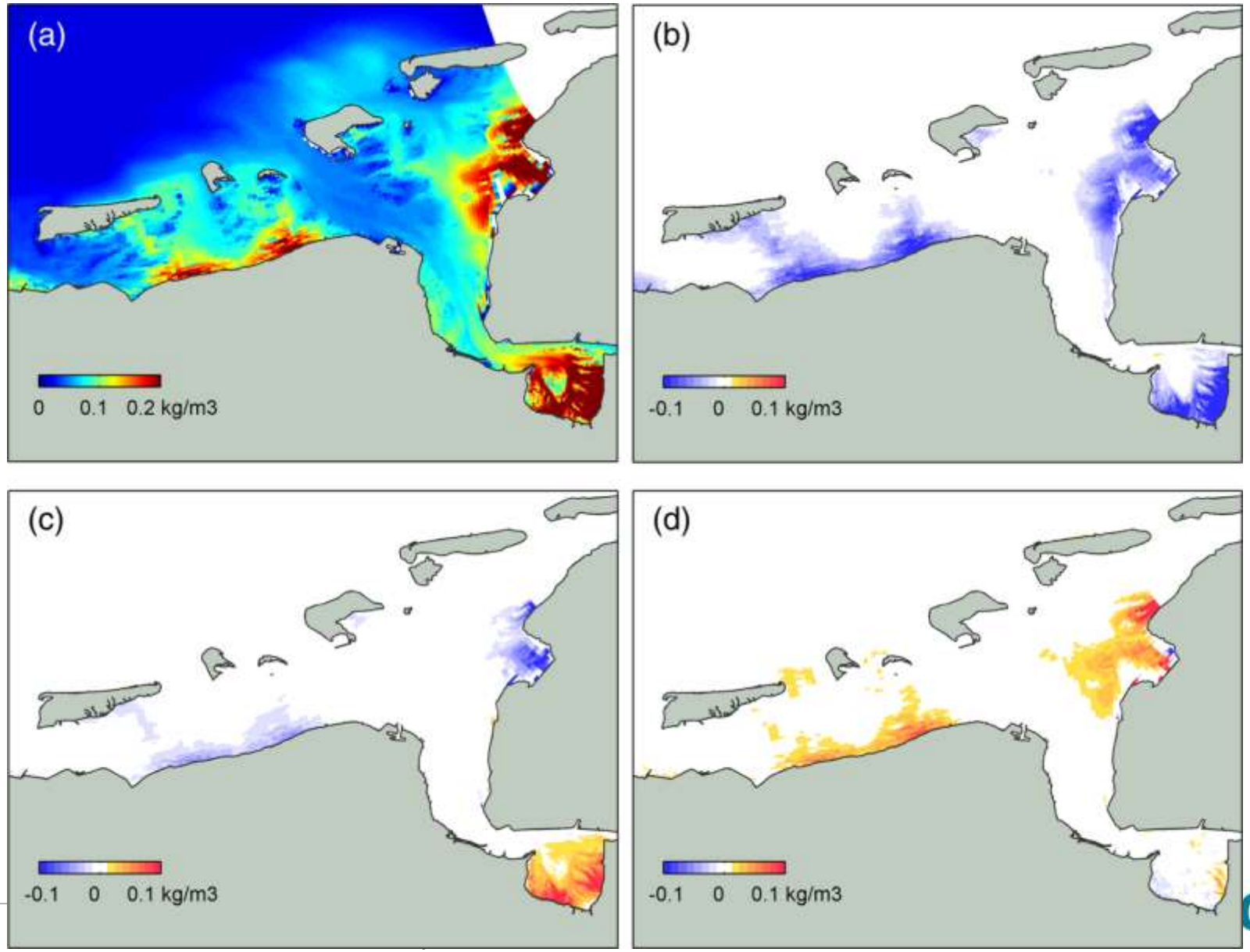
- Model run for baseline model + each equifinal set: 3 alternatives
- Run for 2 intervention scenarios

Equifinality: model evaluation

Modelled sediment dynamics for each alternative compared with measured SSC

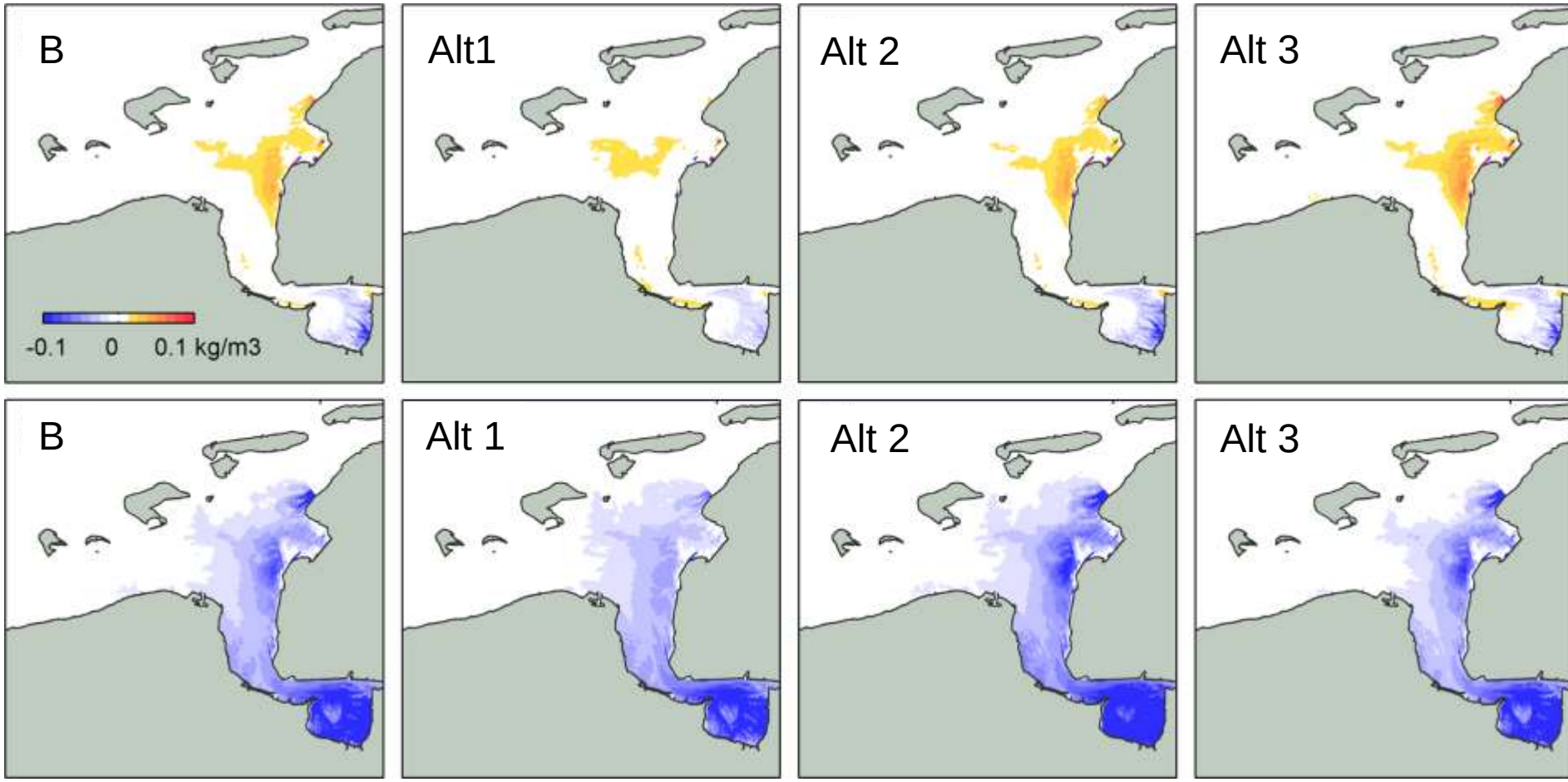


Model evaluation



Effect of equifinality on predictions

Channel Restoration



Offshore Disposal

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Conclusions

- **Epistemic uncertainty** → imperfect description of physical parameters
- Despite all the uncertainties associated with modelling – still need to make management decisions
- This work investigated if **equifinality** influences model predictions
- Demonstrated that uncertainty in certain model parameters does not have a significant effect on the predictive capacity of the model (in this case!)
- The analysis revealed where more field data and process knowledge needed – on the tidal flats!


THANK YOU

For more information see this paper:

Uncertainty in complex three-dimensional sediment transport models: equifinality in a model application of the Ems Estuary, The Netherlands

Ocean Dynamics (2016) No. 66

Bas van Maren and Katherine Cronin

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