

Hydrodynamic modelling of ecosystem effects of offshore wind installation

Applicability of Delft3D to the Nantucket Shoals region

Dr. ir. Yorick Broekema

01-06-2023

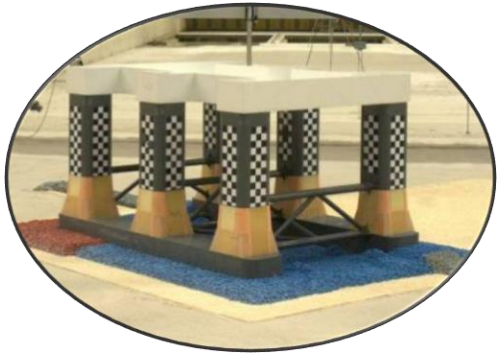
About Deltares

Deltares is an independent institute
for applied research in the field of
water, subsurface and infrastructure.

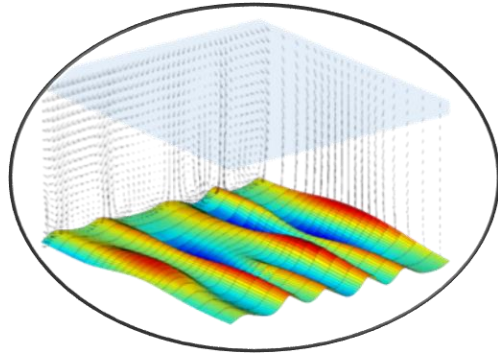
Our mission is 'Enabling Delta Life'.



Deltares & offshore wind



Scour & scour protection



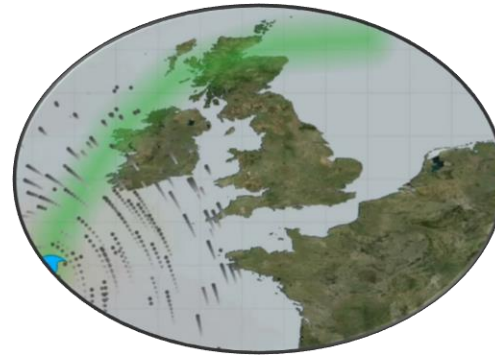
Seabed morphology



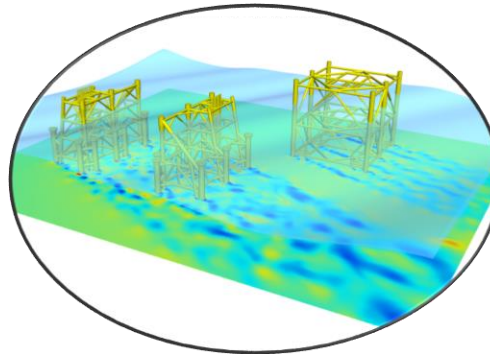
Operational forecasting



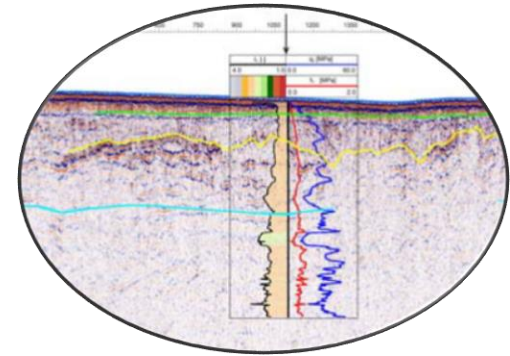
Corrosion &
Water replenishment



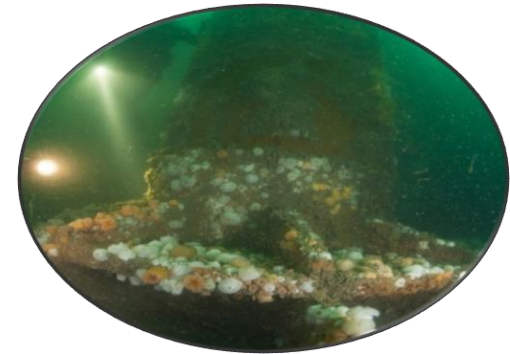
Metocean



Hydrodynamic loads



Geotechnics



Ecological impact
(positive/negative)



Stakeholder engagement

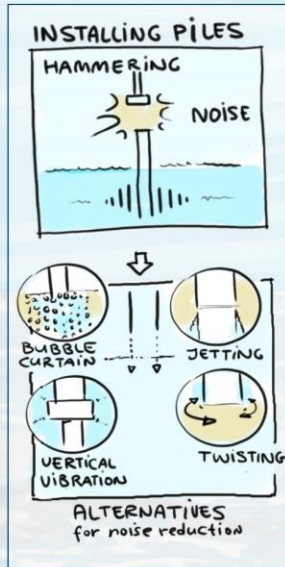


Multi-use

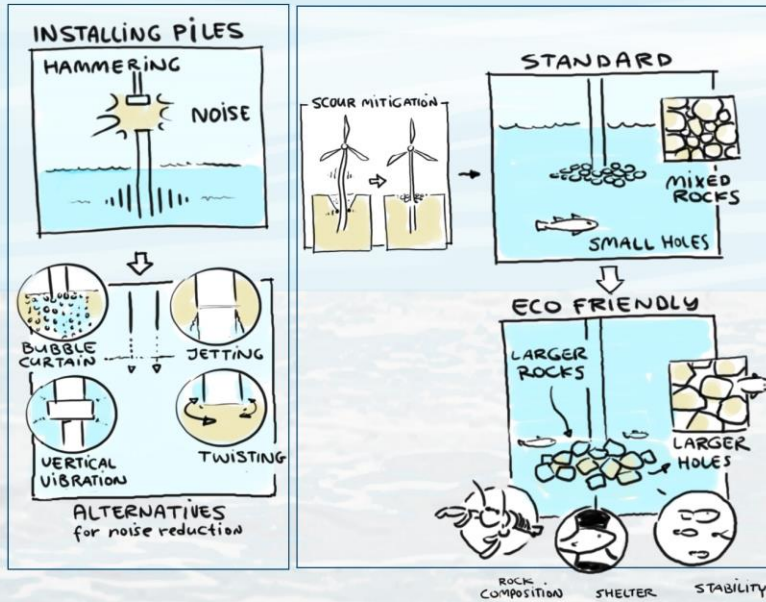
NATURE-INCLUSIVE DESIGN OF WINDFARMS



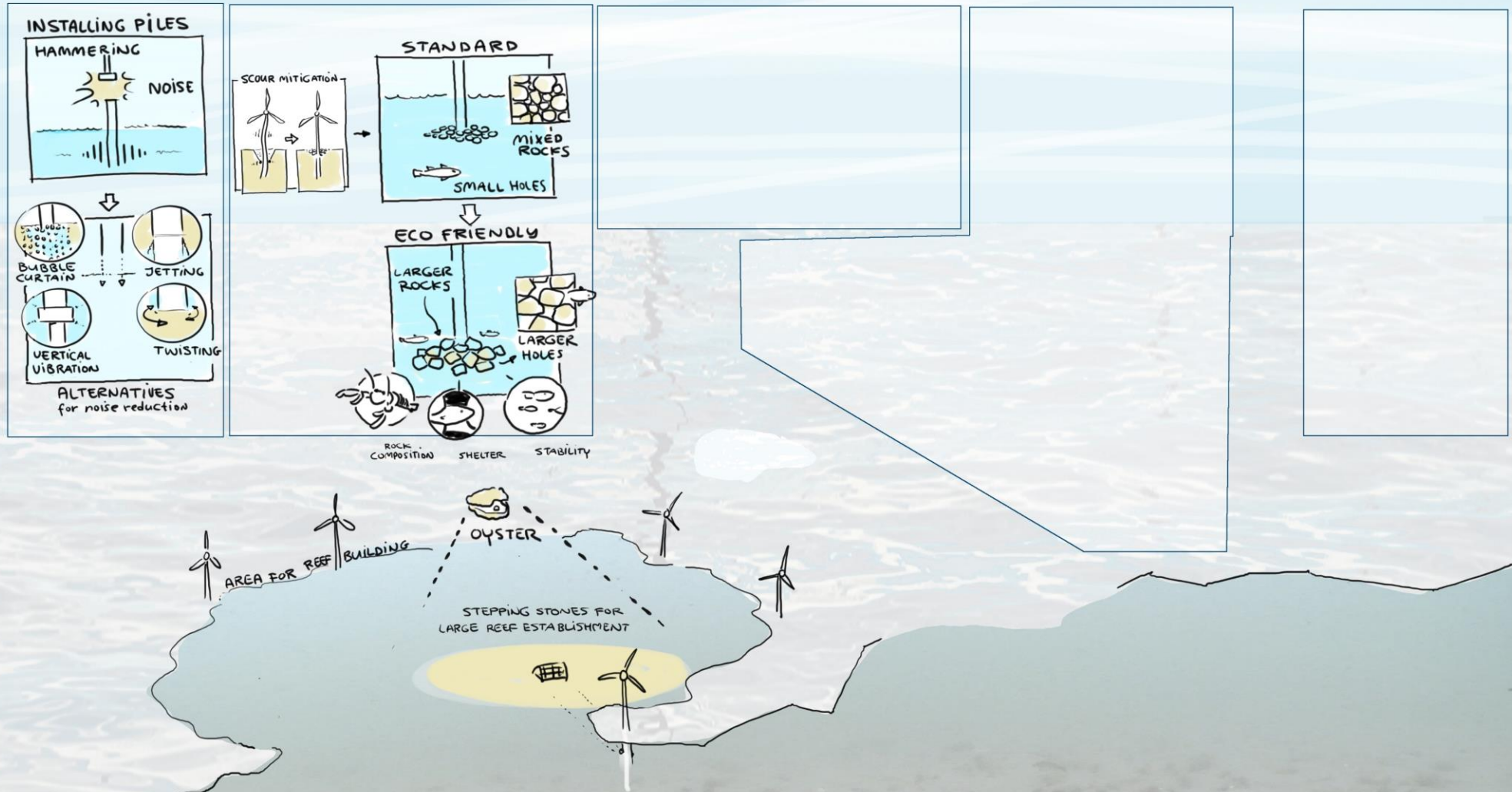
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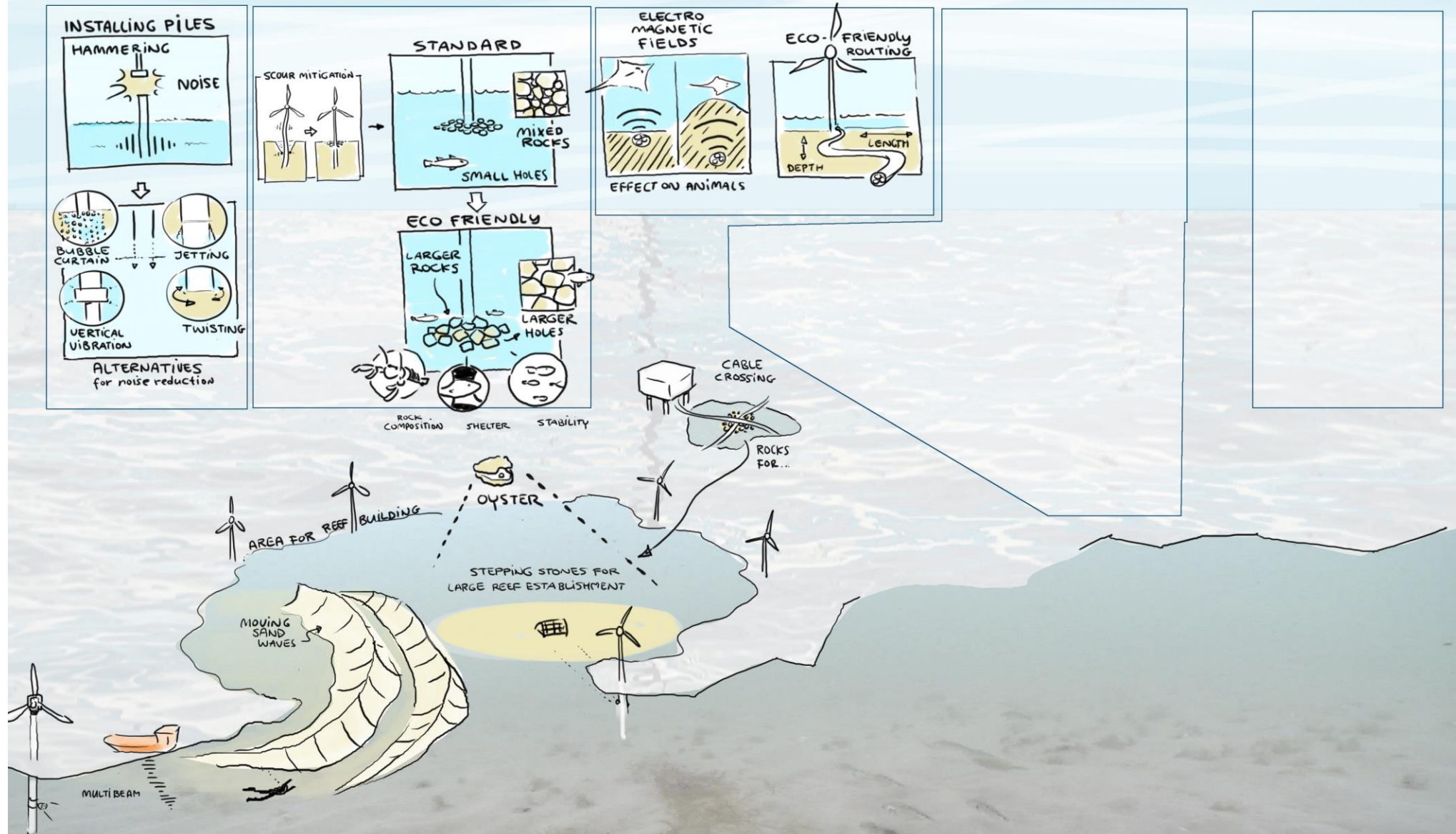
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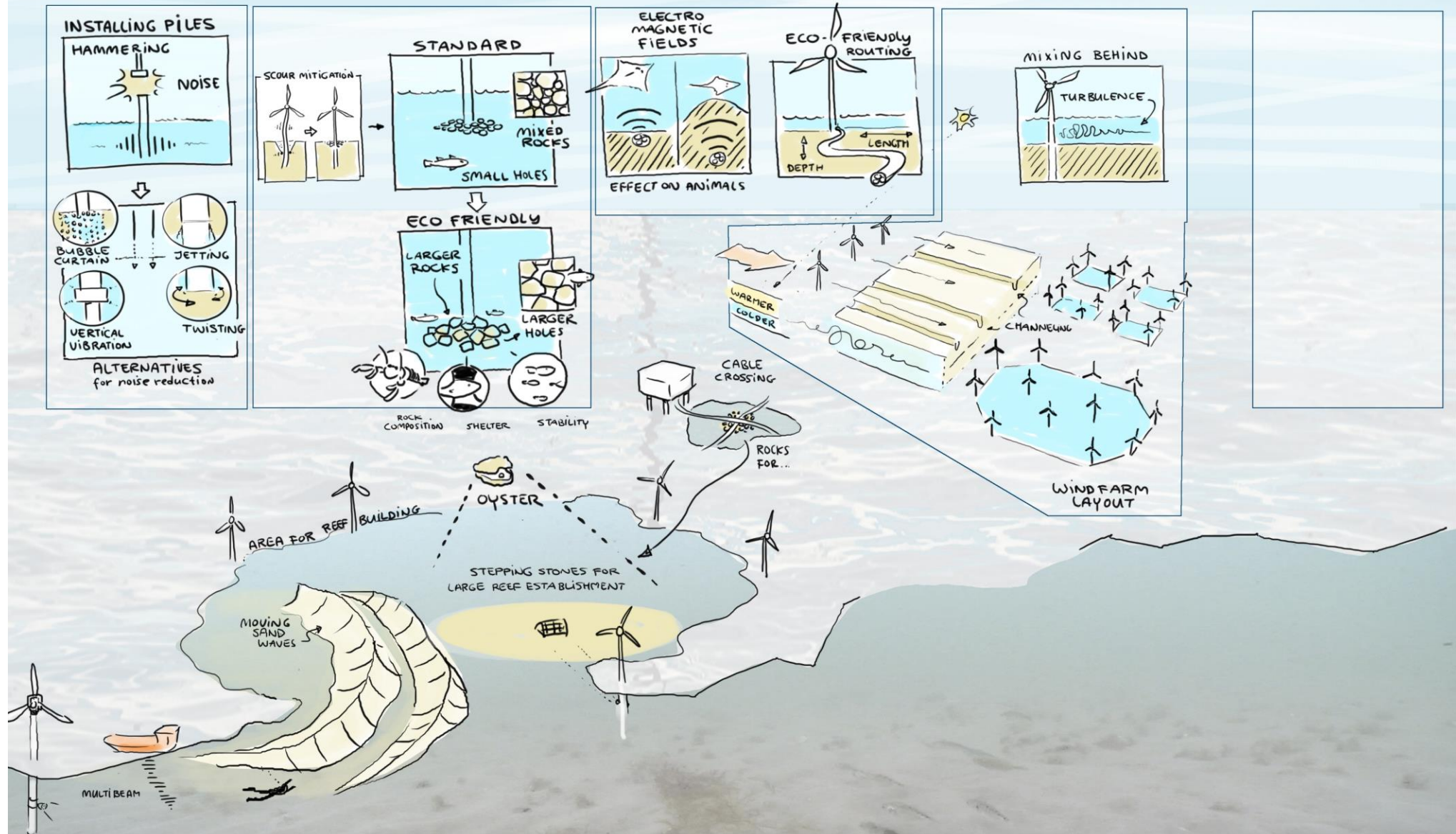
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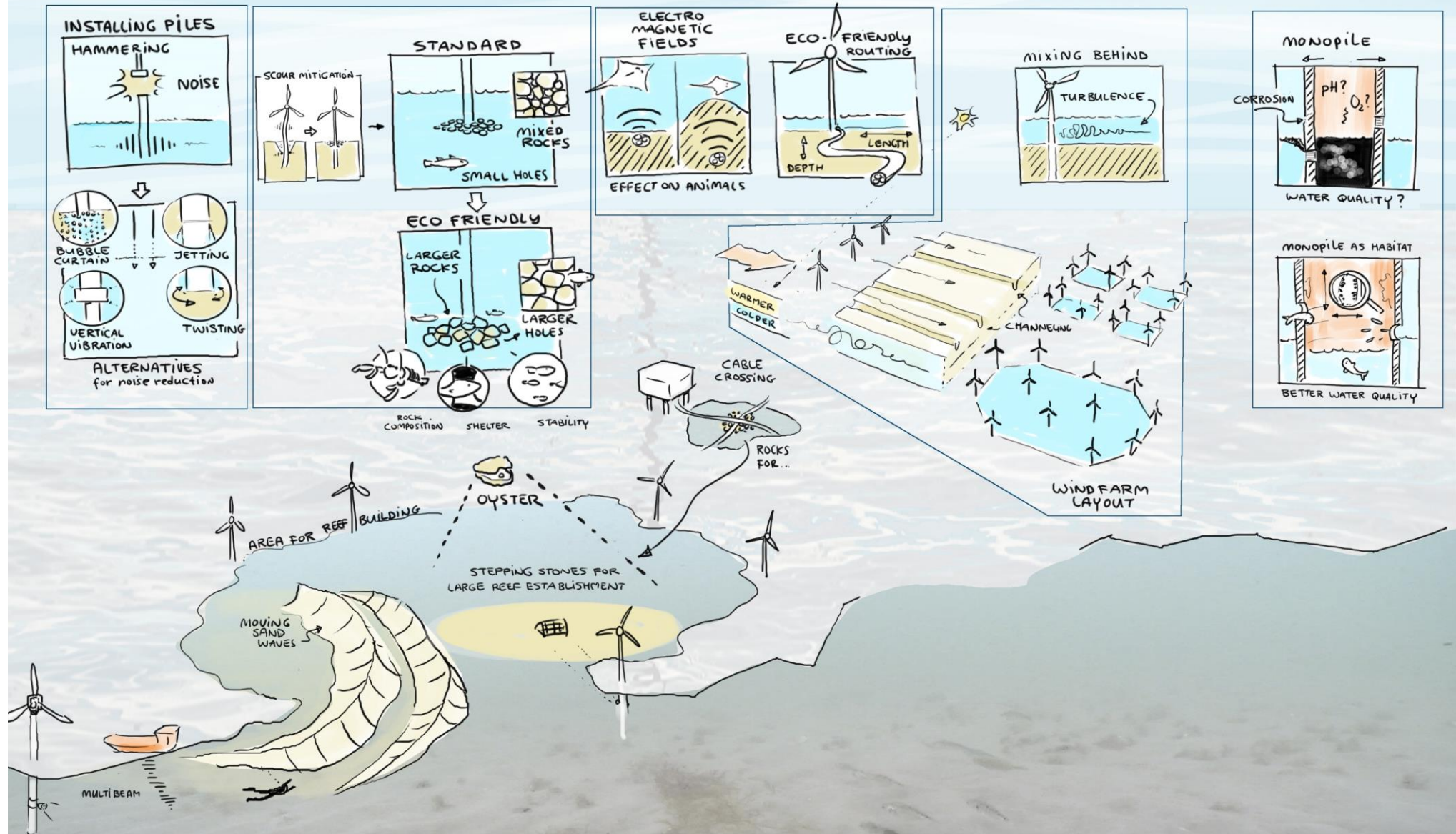
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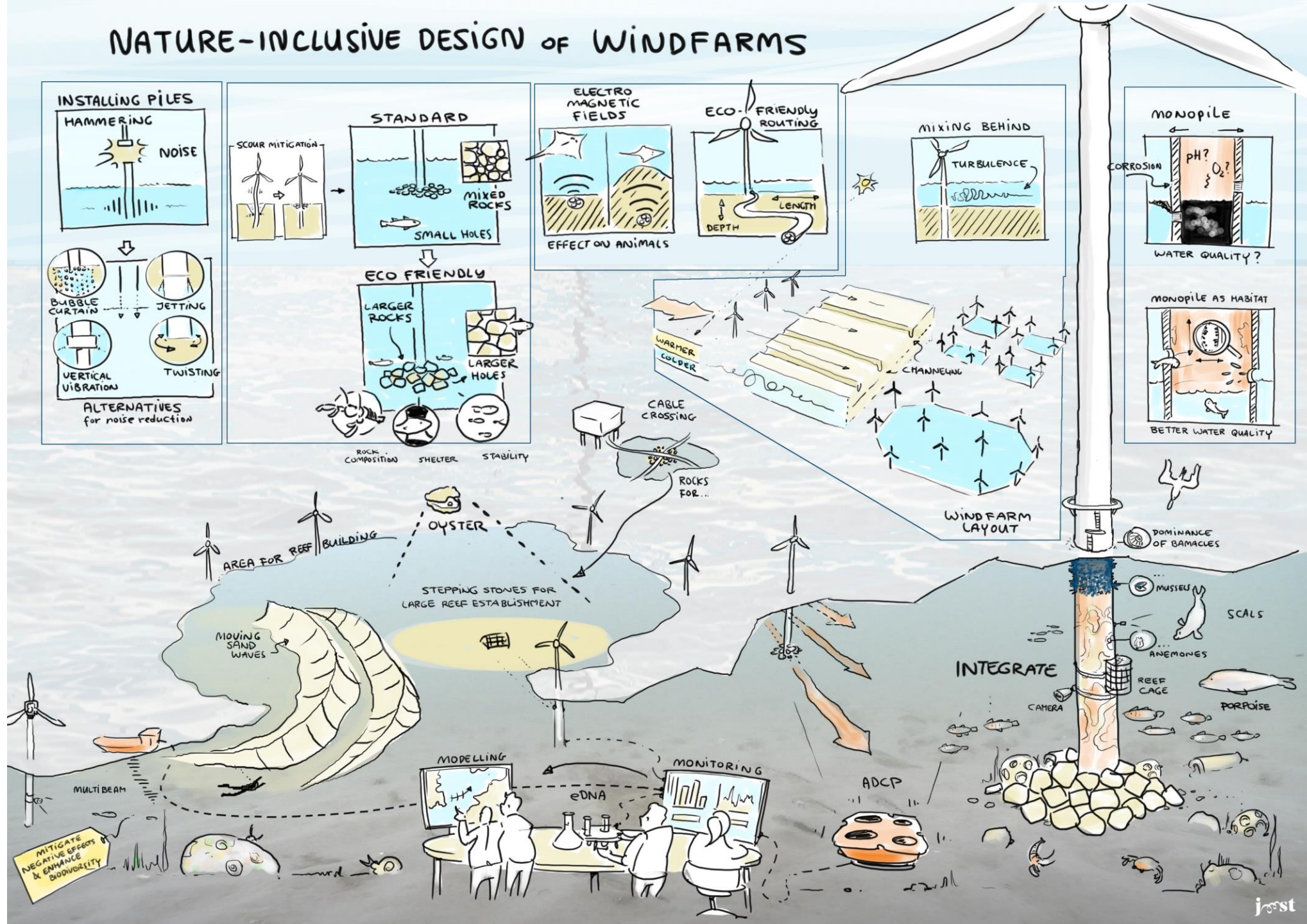
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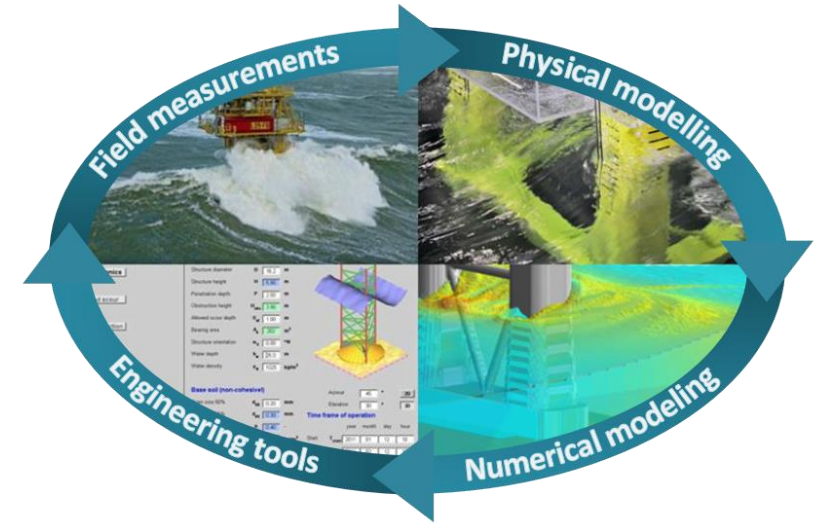
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Hydrodynamic modelling: approach

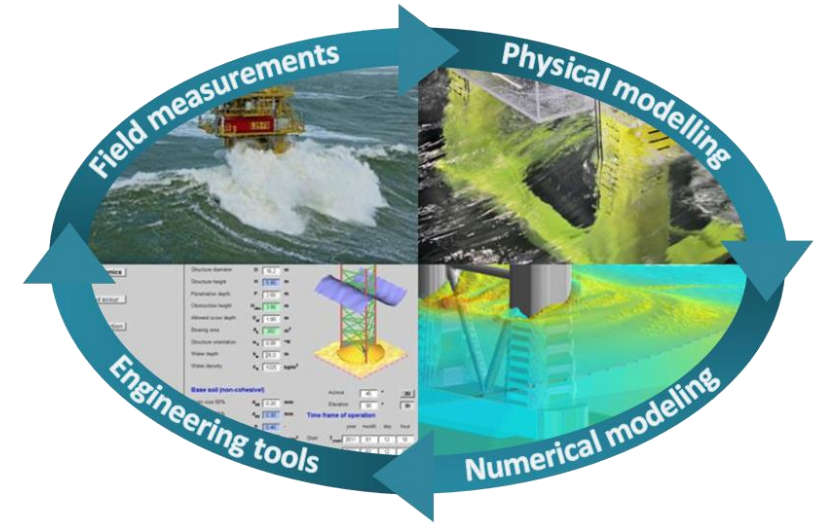
Hydrodynamic modelling: approach

- Various types of models can be utilized to assess impact



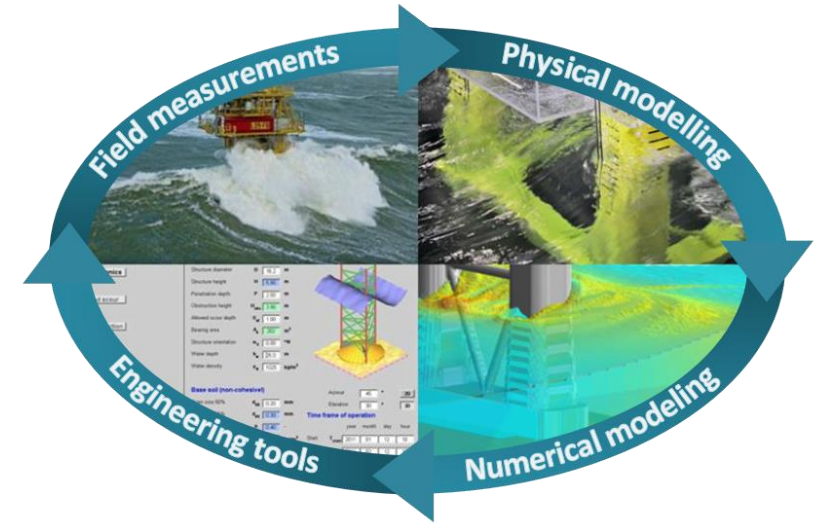
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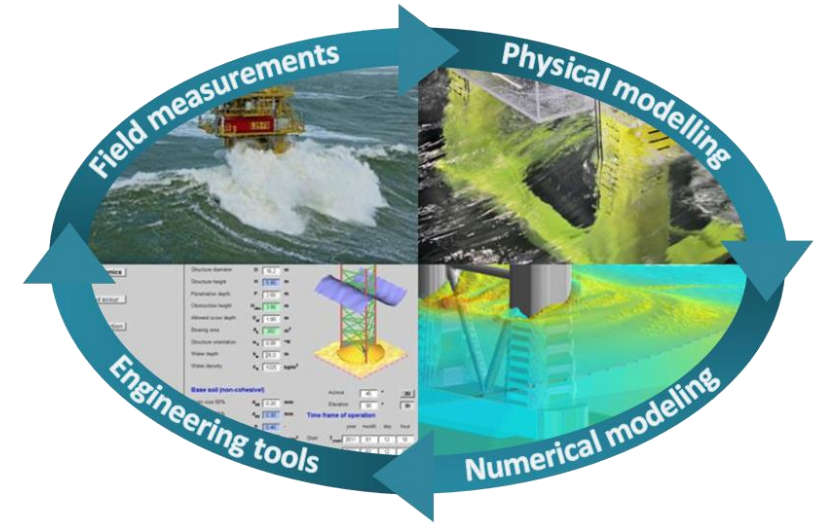
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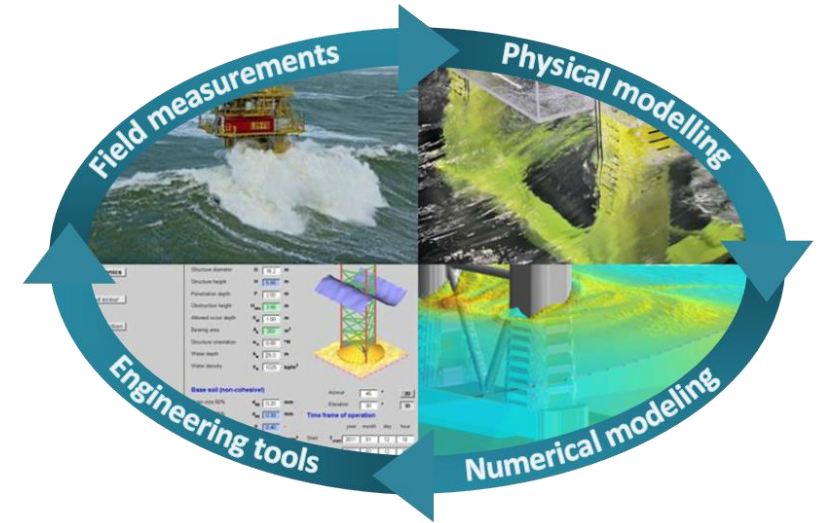
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- Various types of models can be utilized to assess impact
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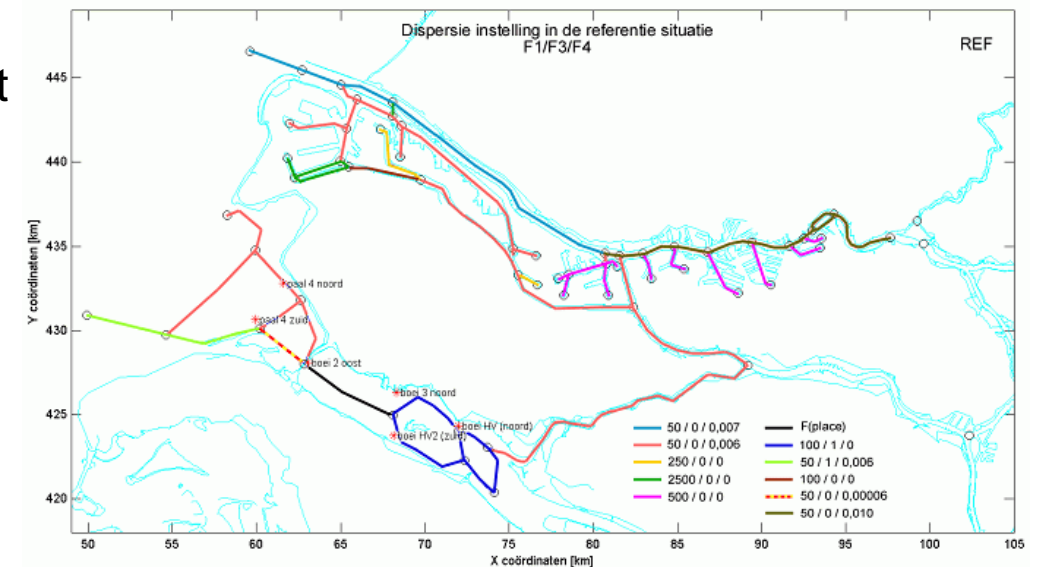
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- Different numerical model approaches exist, varying in complexity and detail



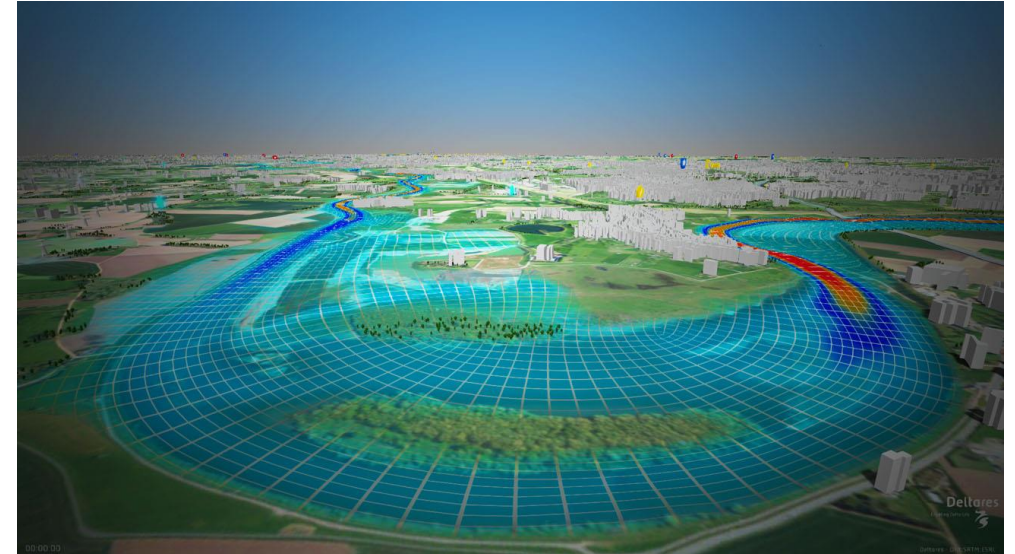
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 - 1D network models (i.e., rivers, channels)



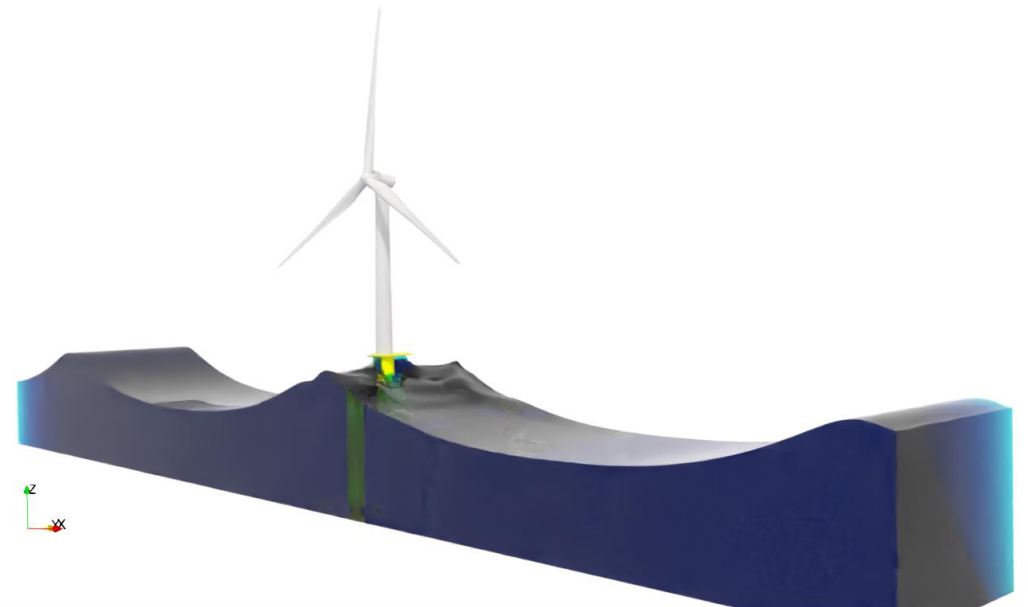
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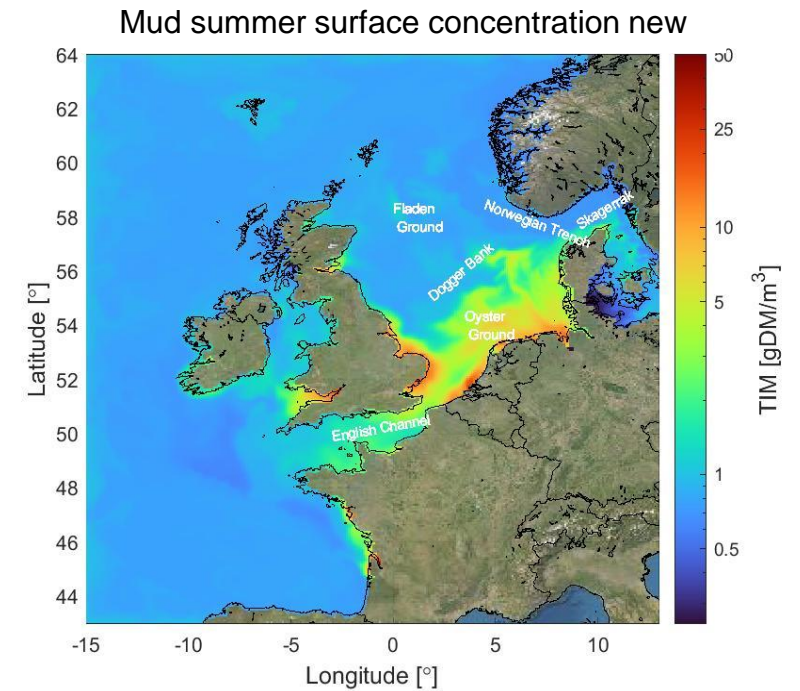
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 - Simple if we can, complex if we have to!



Hydrodynamic modelling: Delft3D FM Suite 2D3D

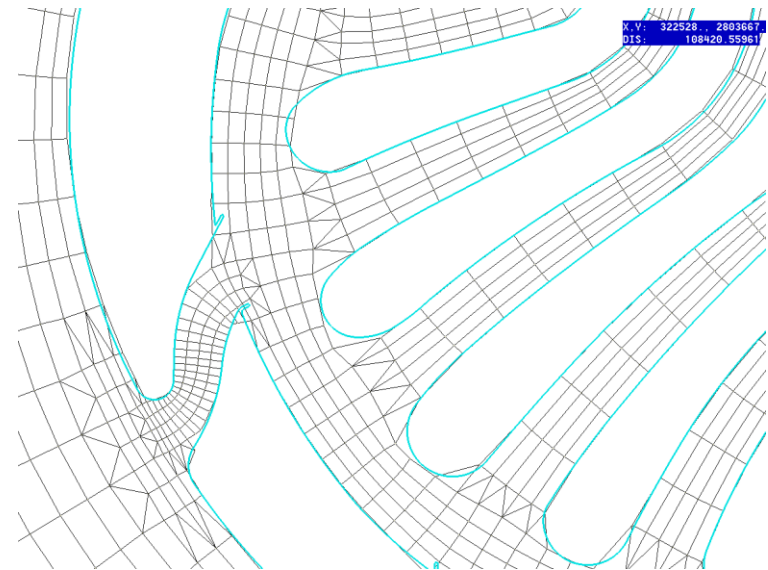
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- Multi-dimensional hydro-morphodynamic simulation program which calculates non-steady flow and transport phenomena resulting from tidal and meteorological forcing



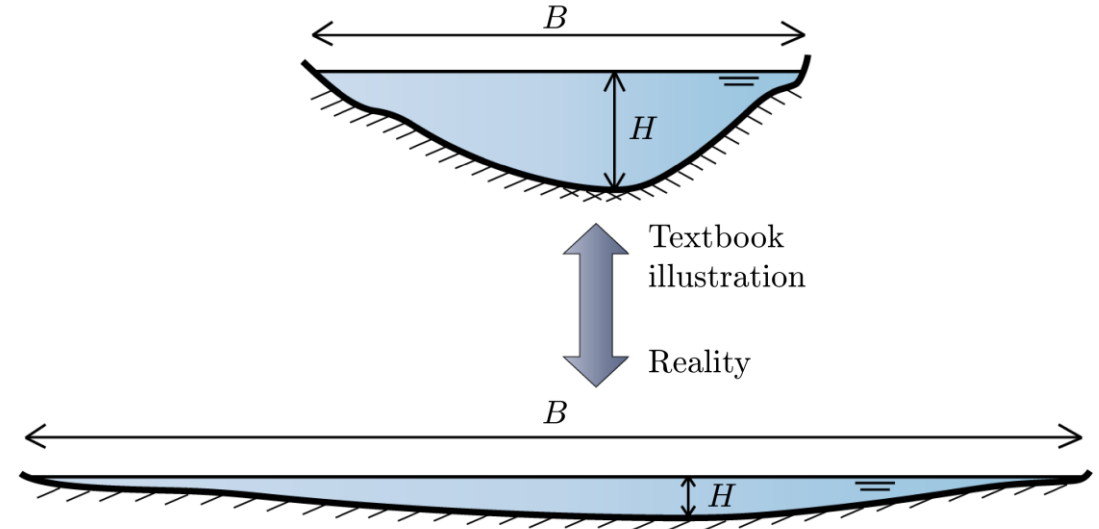
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 - high flexibility & good performance in terms of computational speed and accuracy



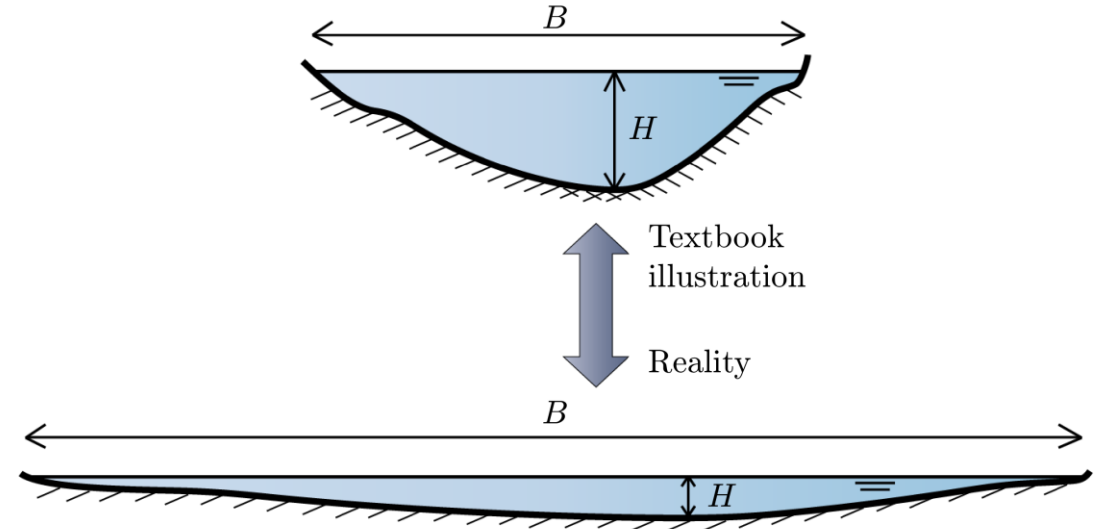
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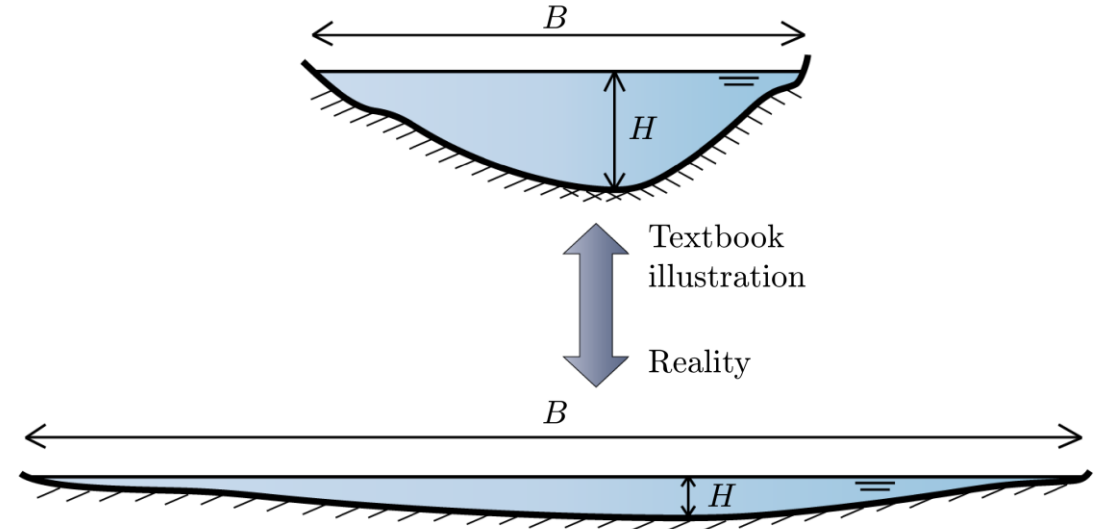
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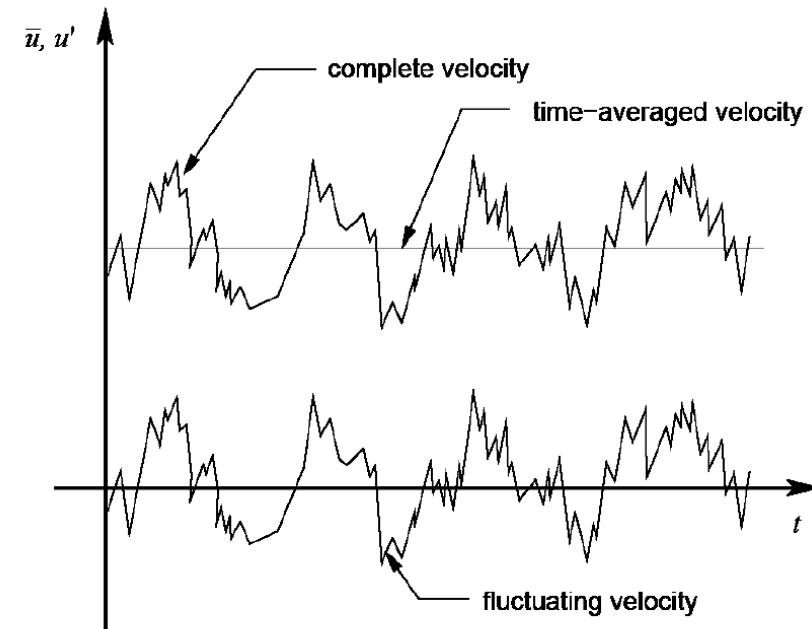
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- Bottom boundary and free-surface boundary
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- Sediment transport and morphology



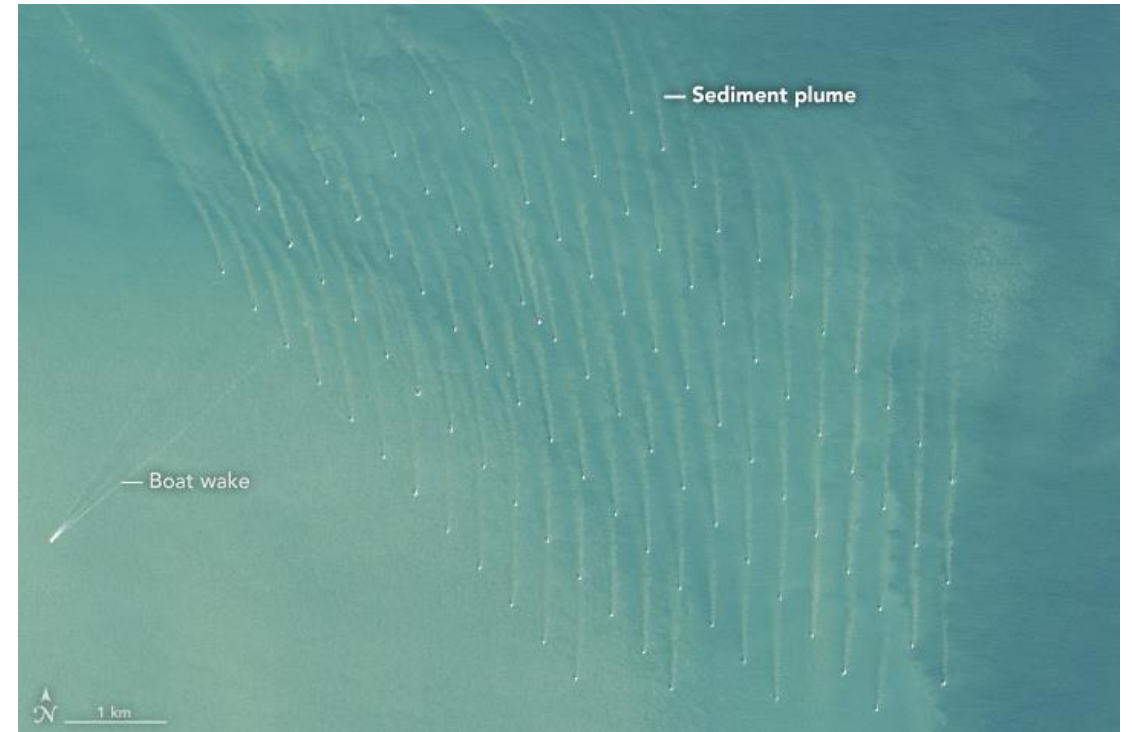
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 - Non-cohesive and cohesive

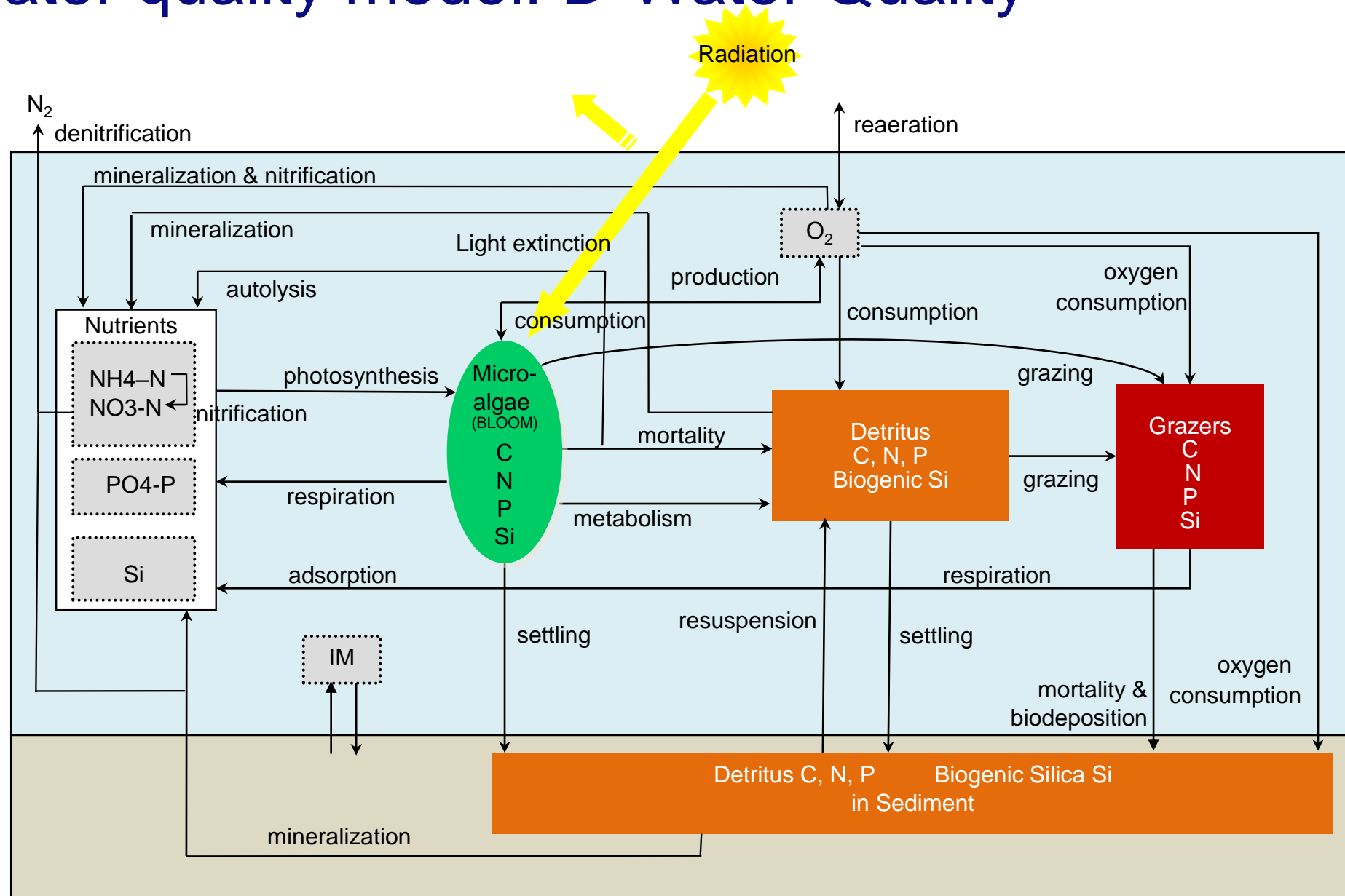


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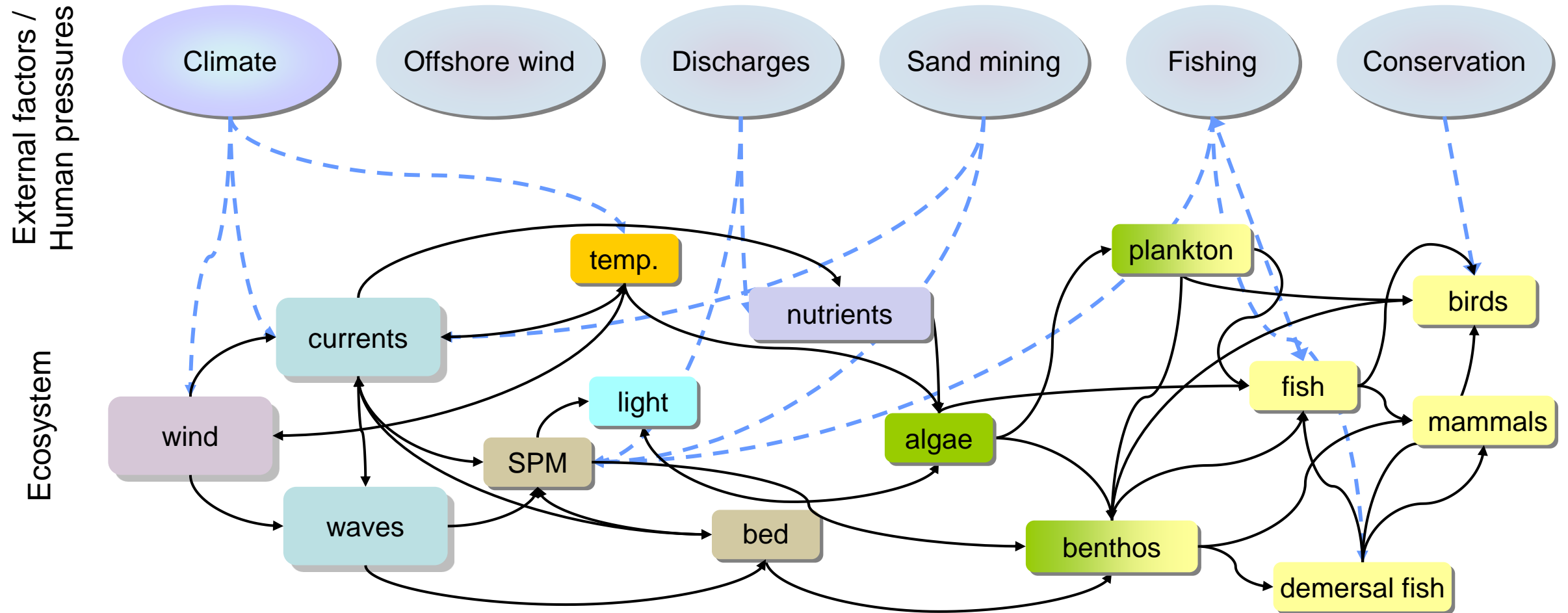
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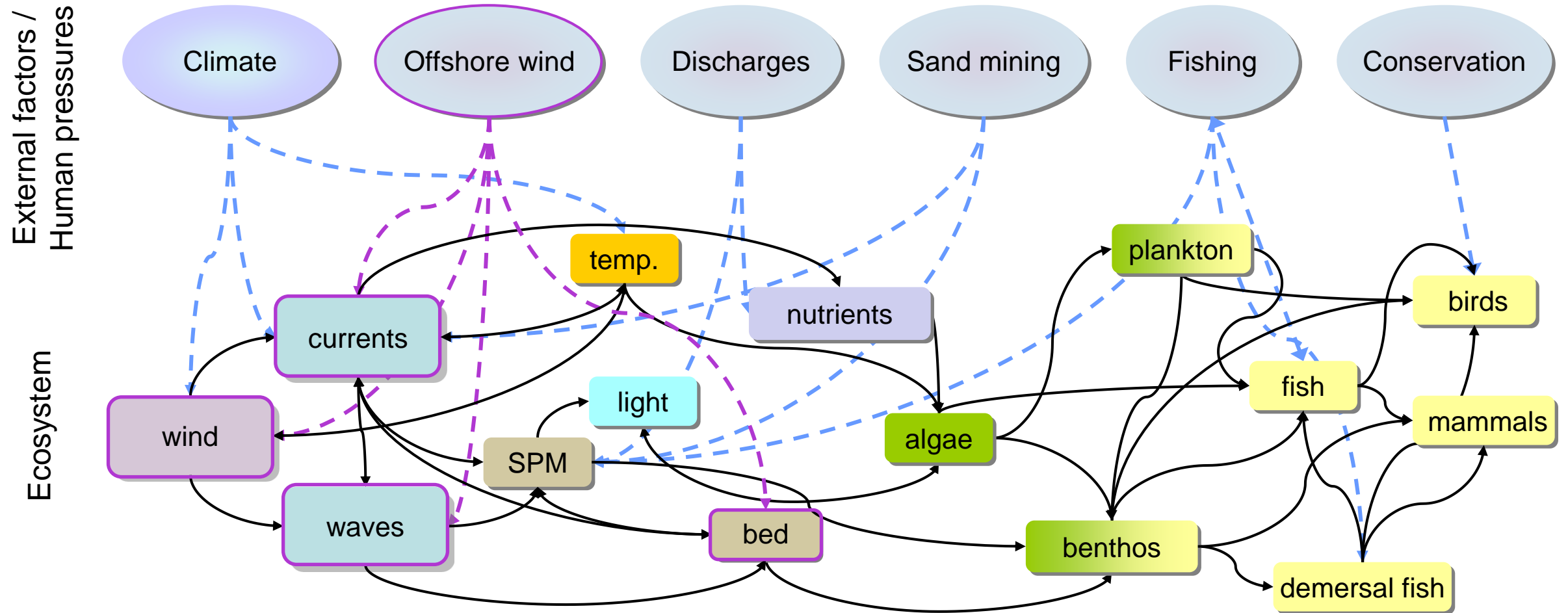
3D Water quality model: D-Water Quality



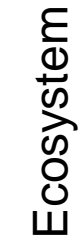
Chain of effects



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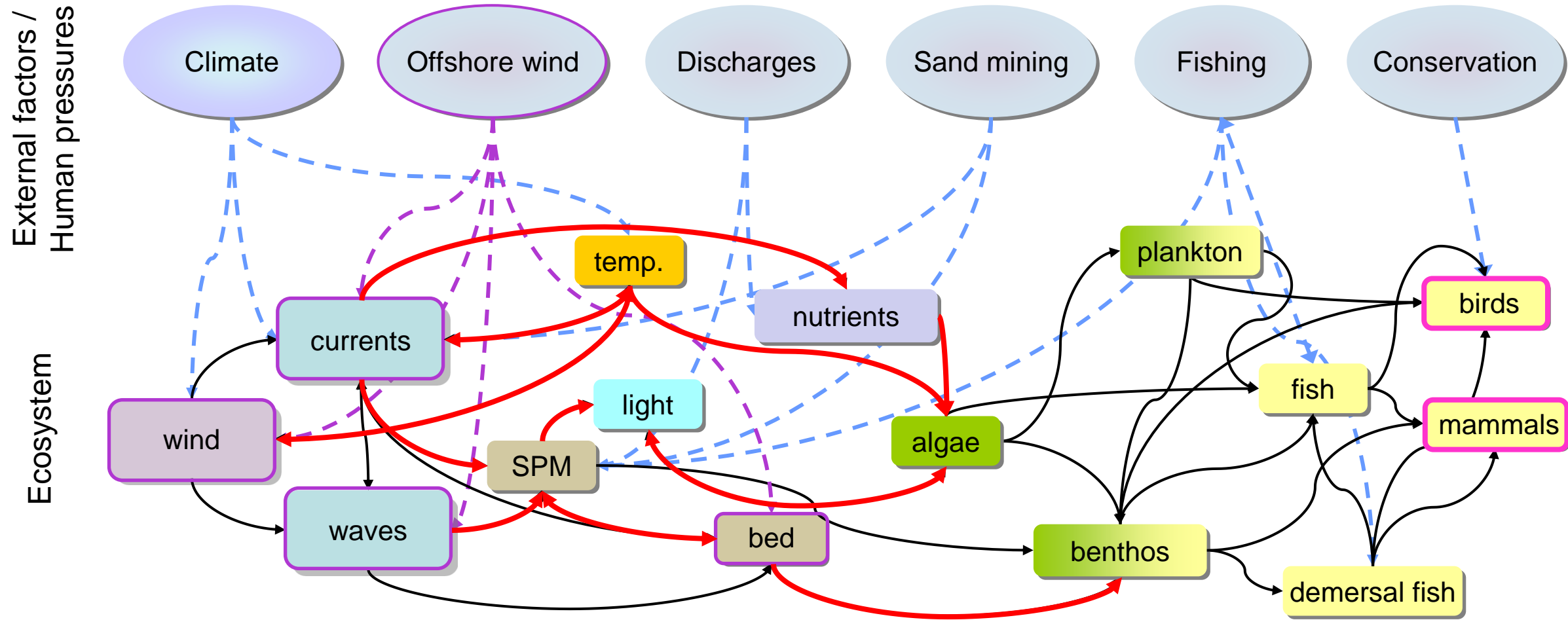


External factors / Human pressures

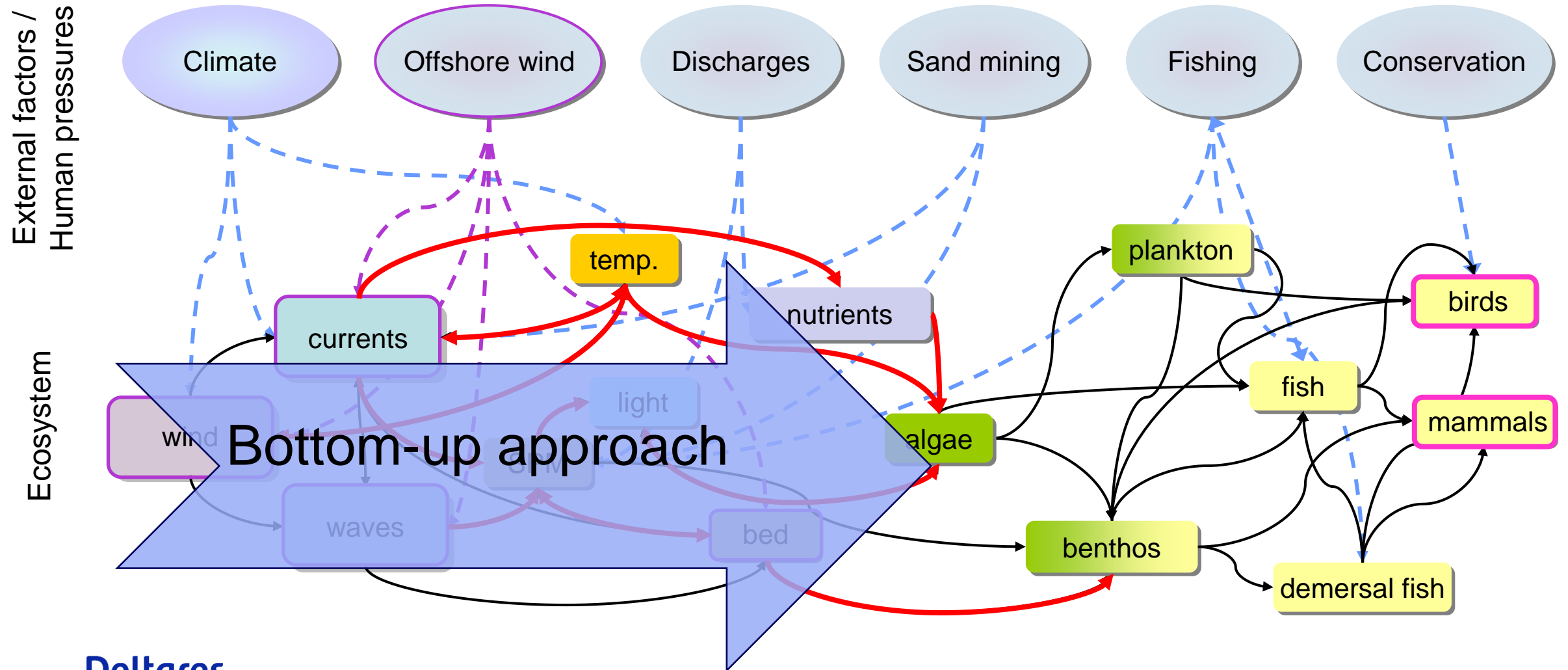


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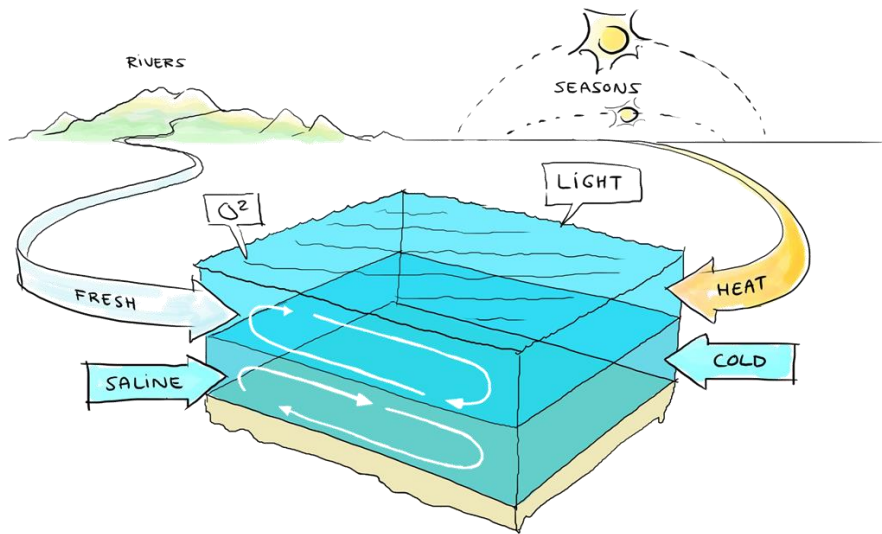
Quantification of ecosystem effects

- Many different processes acting on many different length- and time-scales

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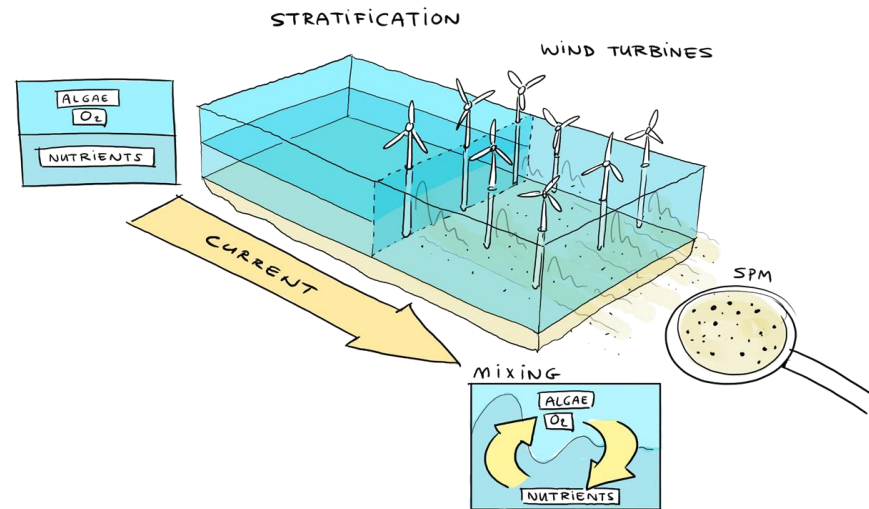
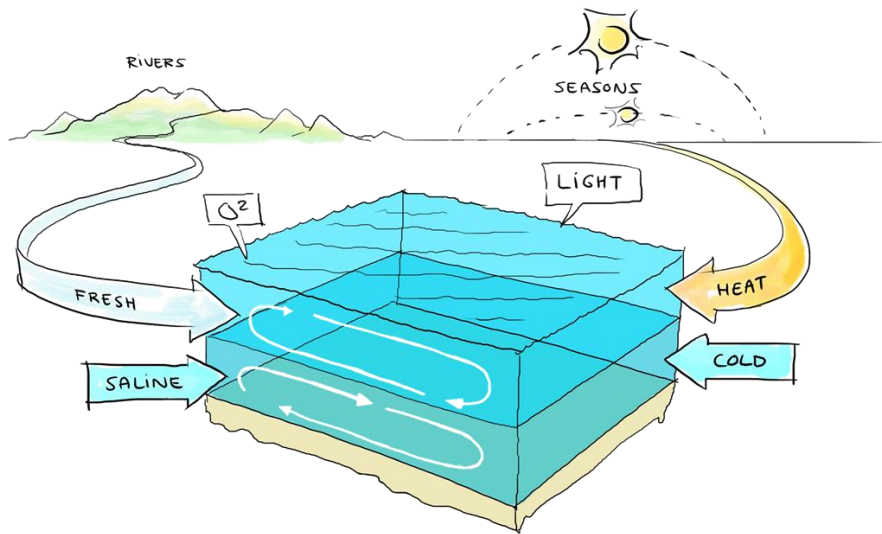
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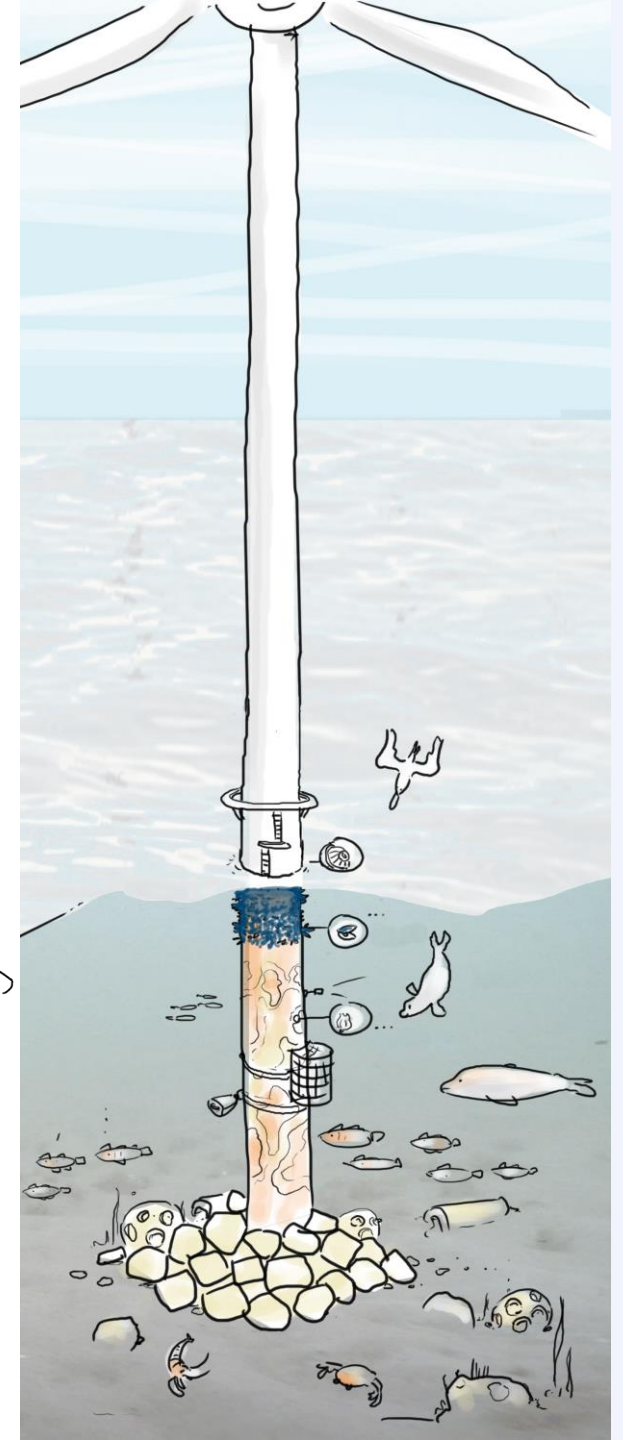
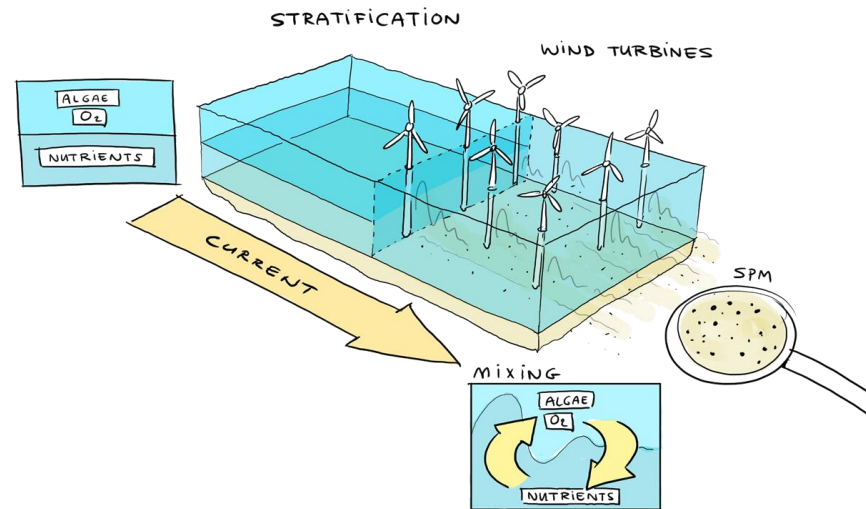
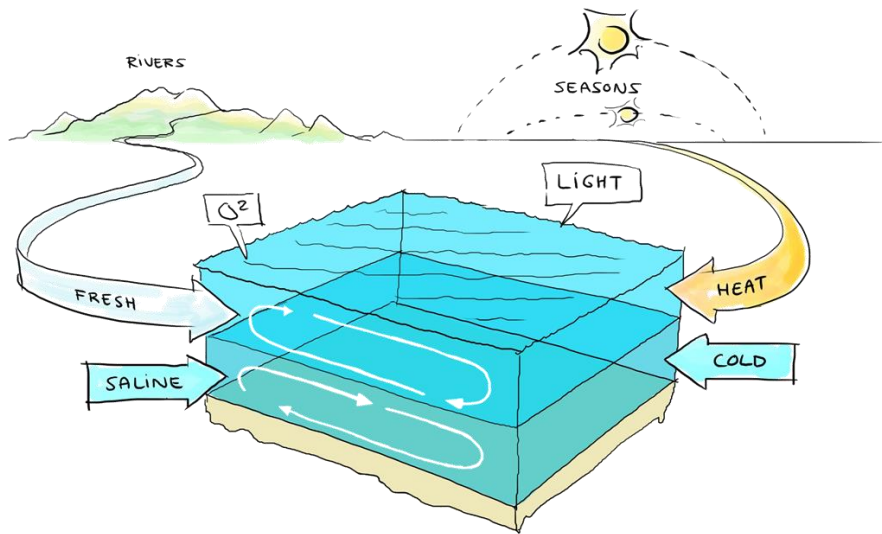
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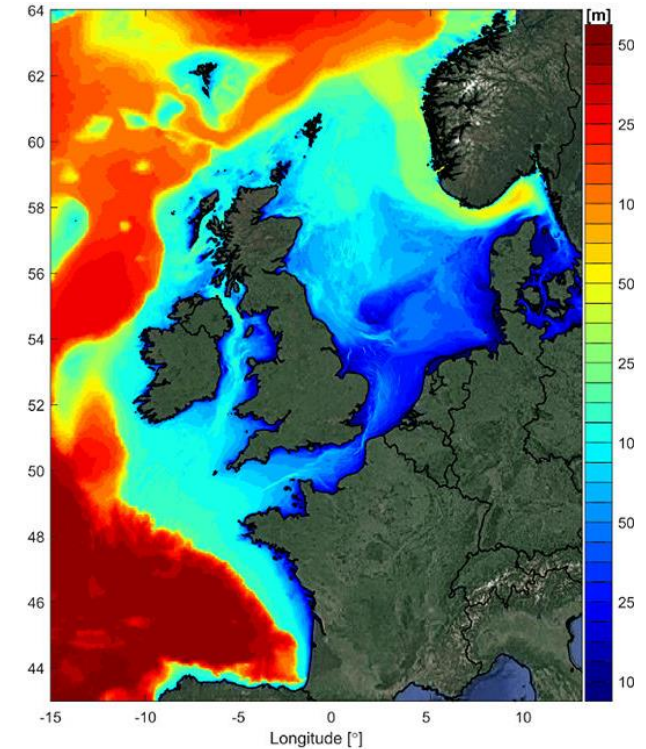
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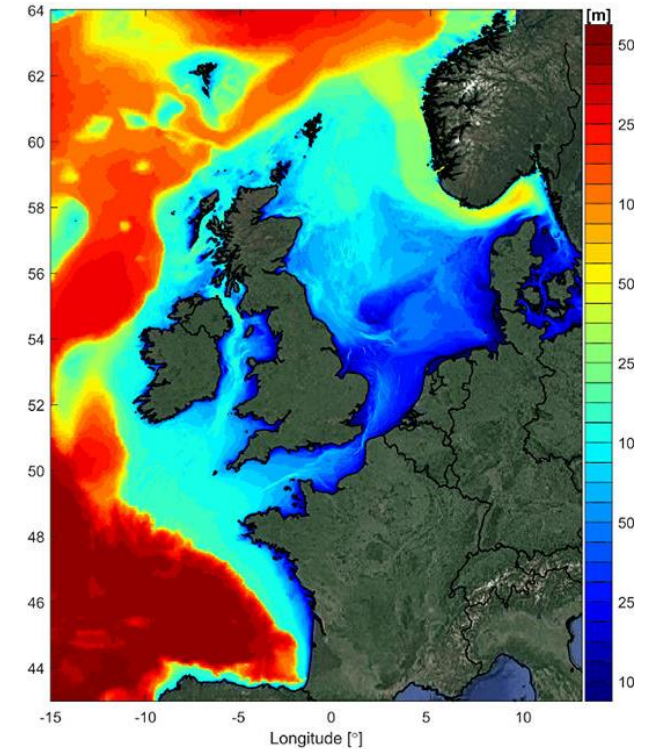


Quantification of ecosystem effects: application Delft3D



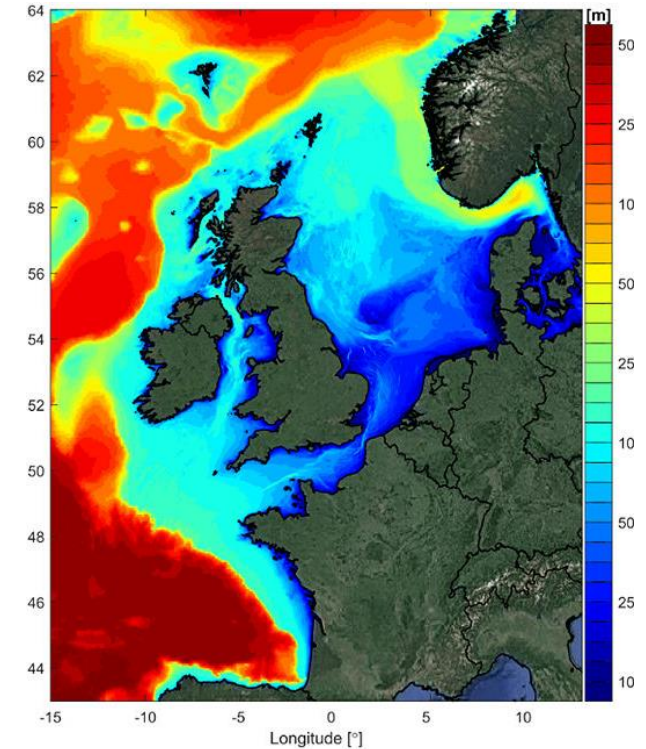
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- Example application: Dutch Continental Shelf Model (DCSM)



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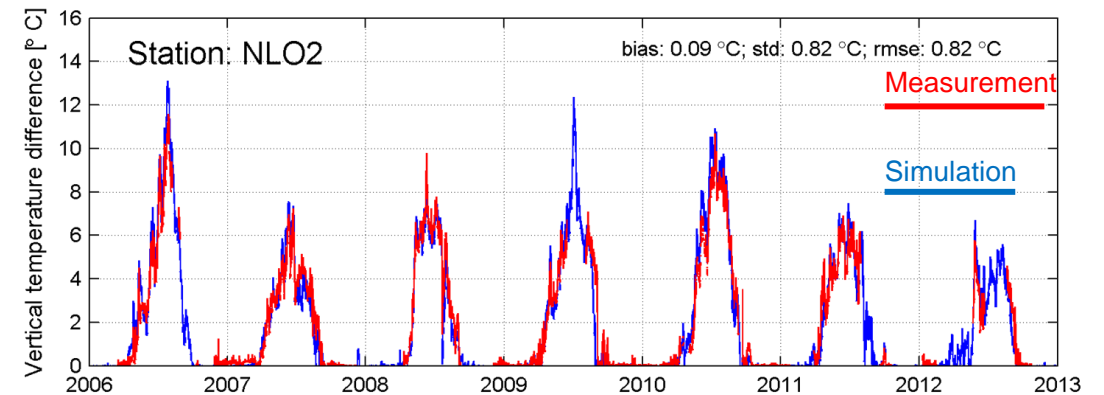
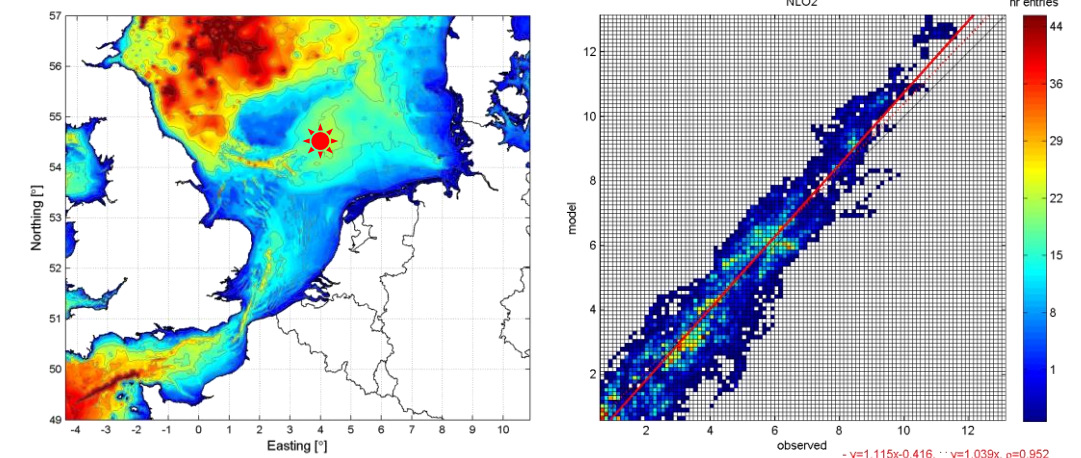
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 - Temperature & salinity stratification

Temperature stratification (surface minus bottom)

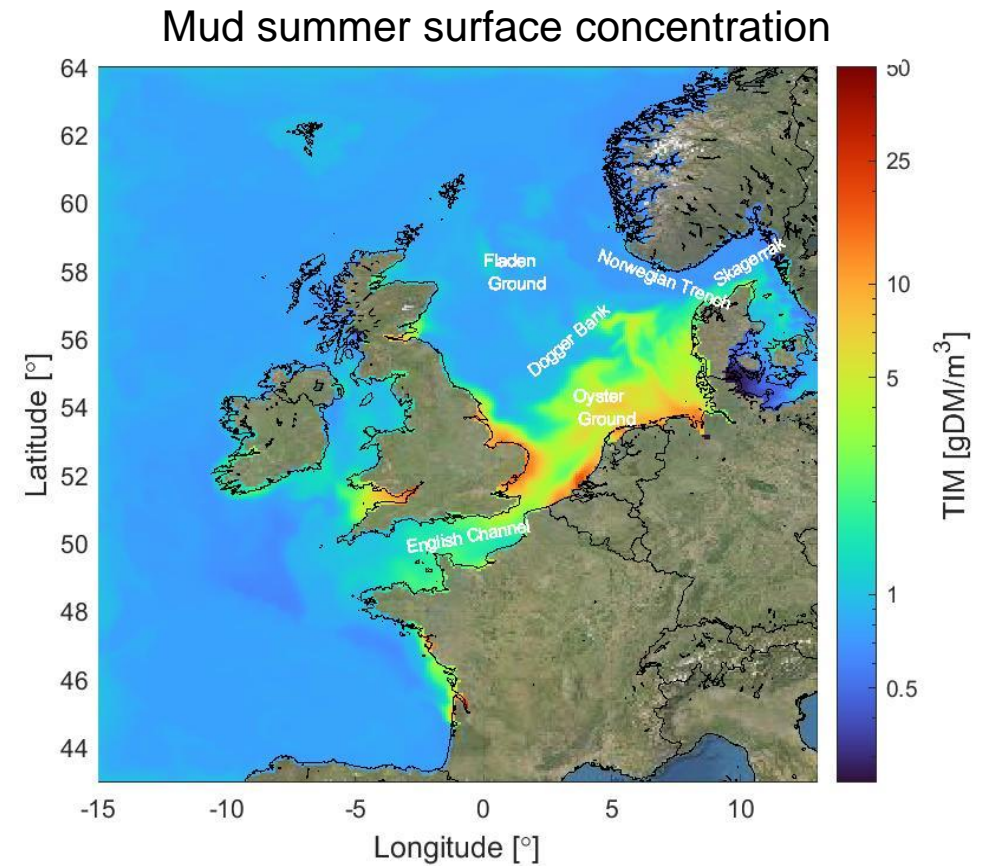


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- Example application: Dutch Continental Shelf Model (DCSM)
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 - (Fine) sediment concentration

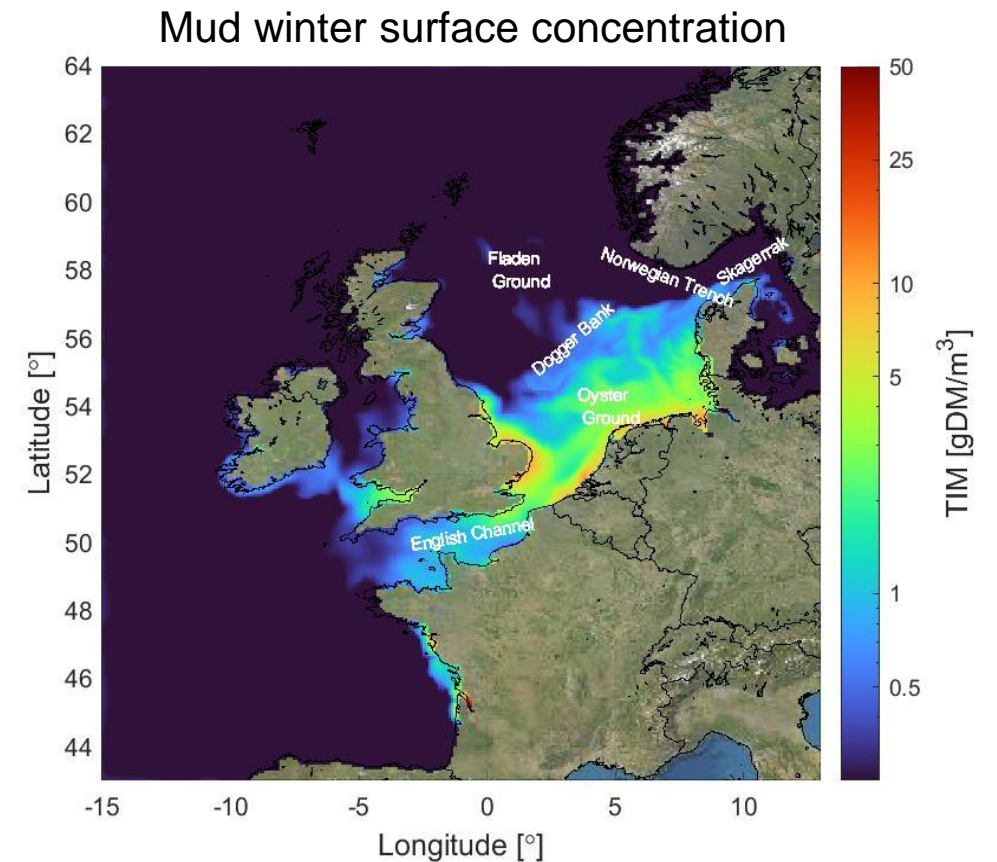
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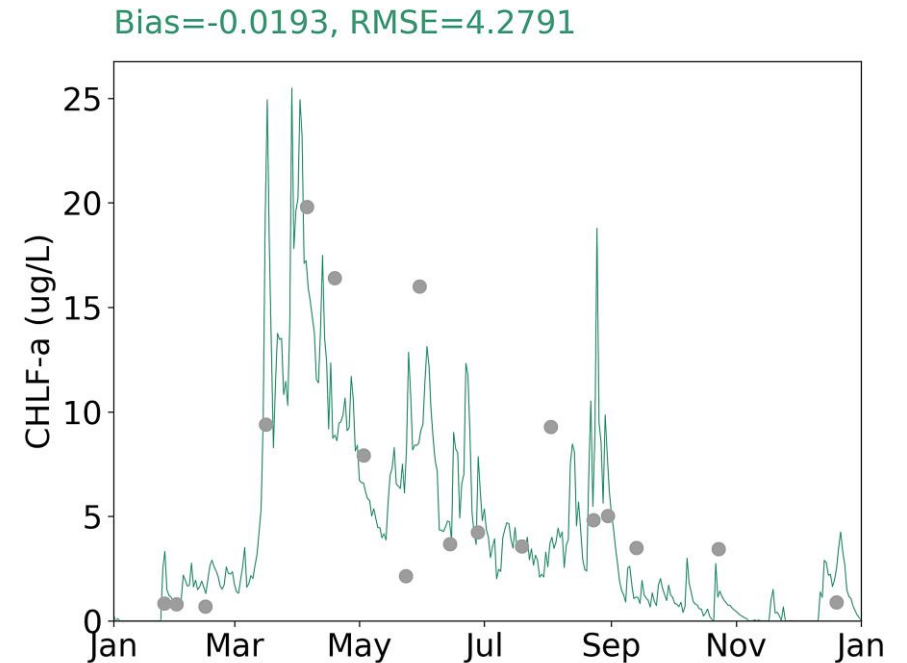
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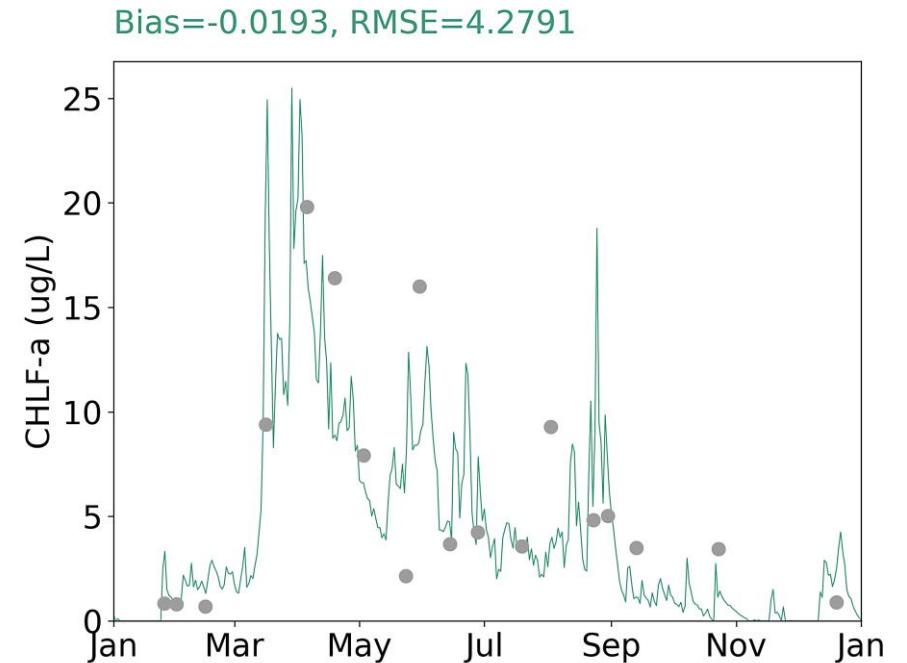
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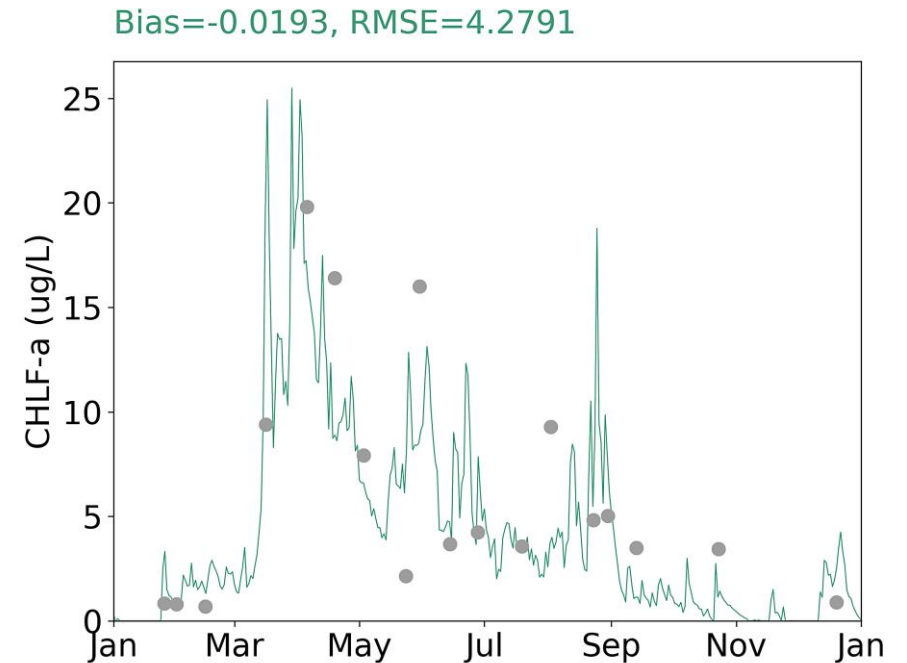
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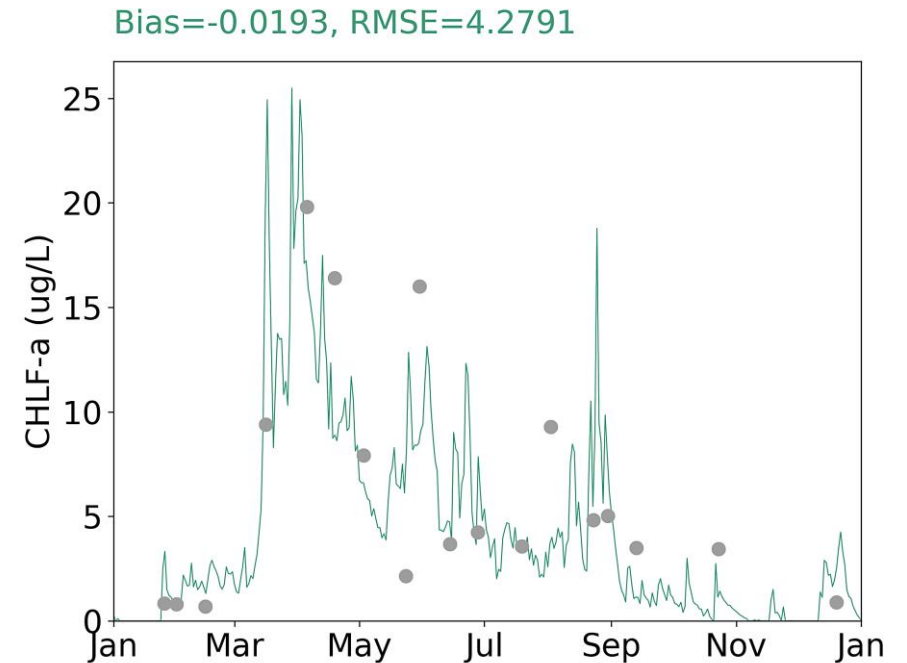
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- Direct coupling with impact of wind wakes to be implemented



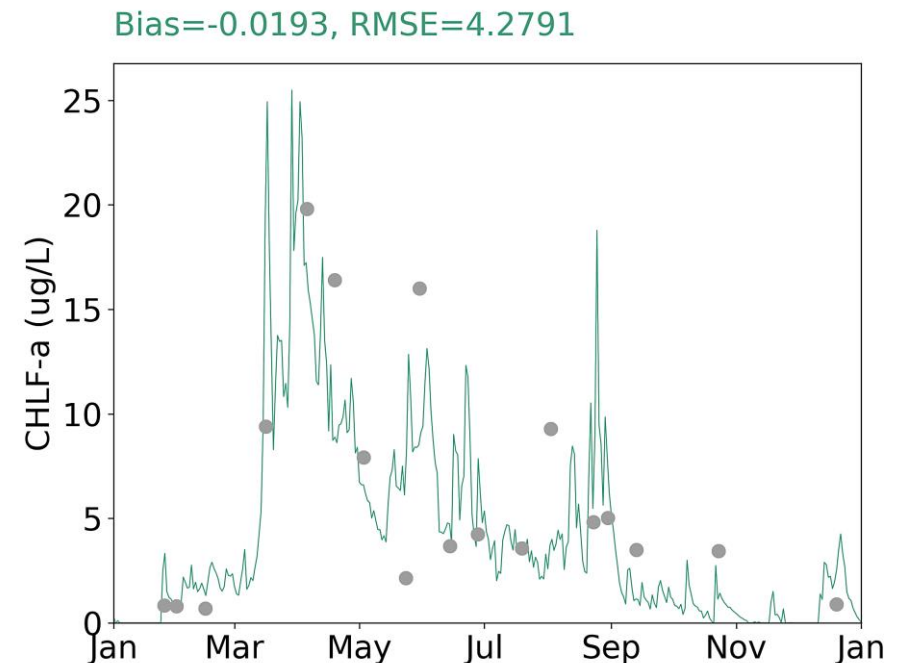
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- Incorporate zooplankton



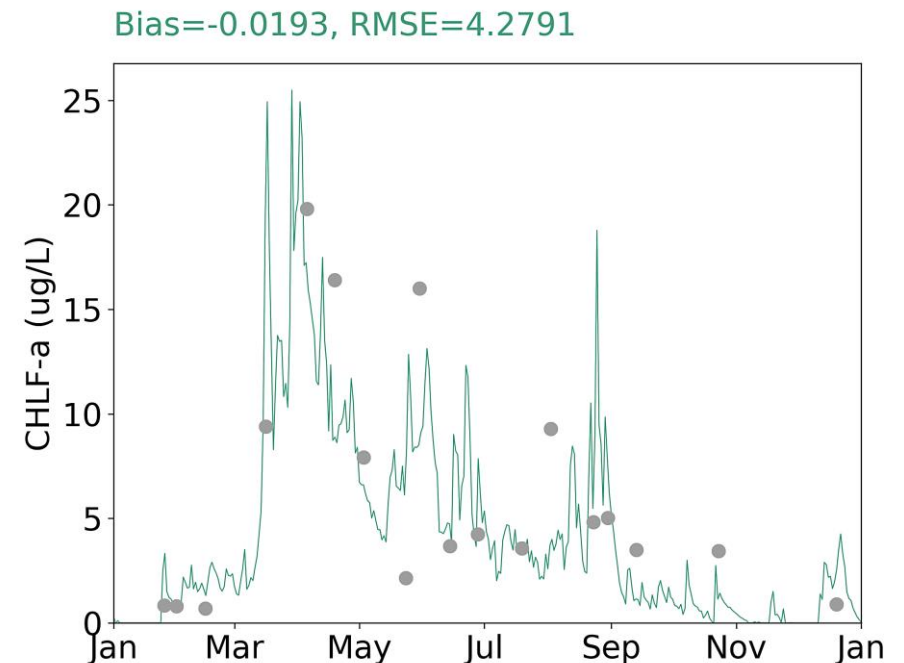
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- Incorporate zooplankton
- Reduce gap between bottom-up and top-down



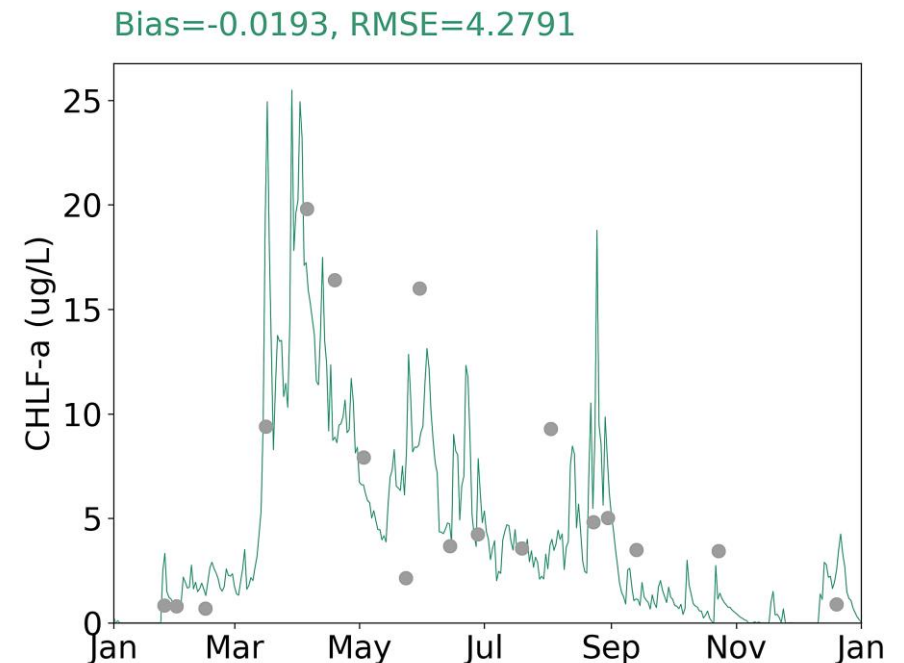
Quantification of ecosystem effects: application Delft3D

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 - 3D model, grid resolution 0.5x0.5 NM
 - Temperature & salinity stratification
 - (Fine) sediment concentration
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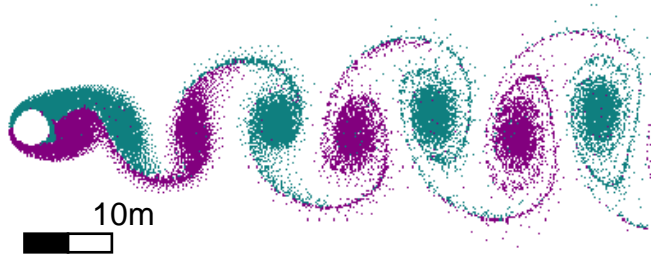
Parameterization of the impact of foundations

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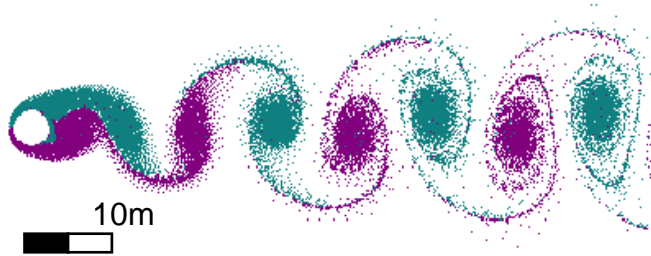
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Structural scale

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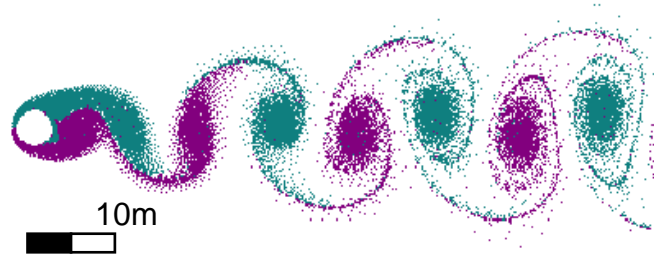
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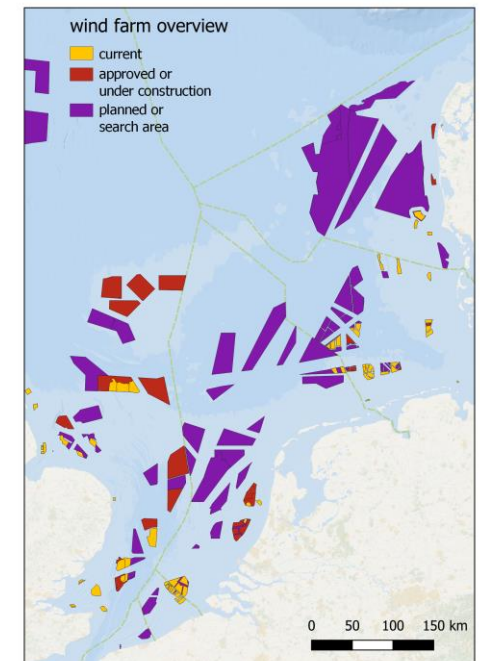
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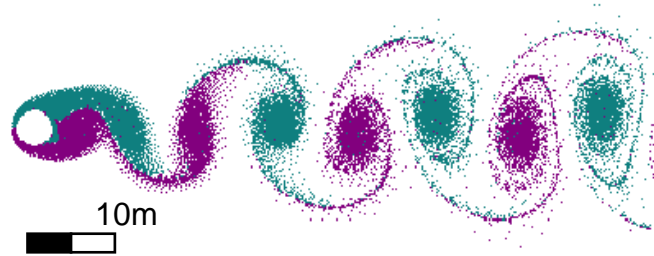


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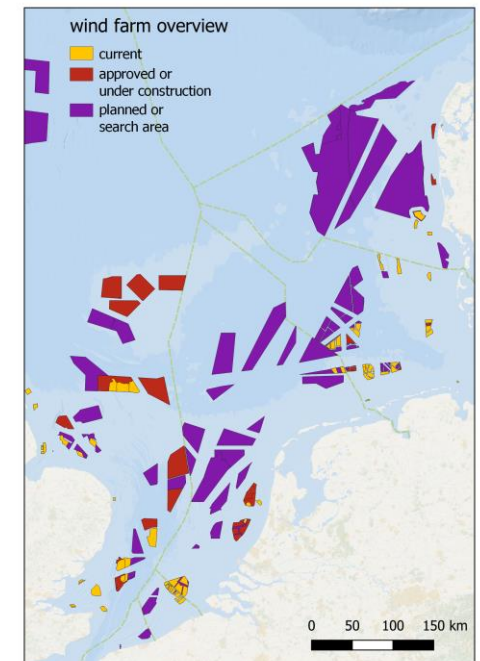
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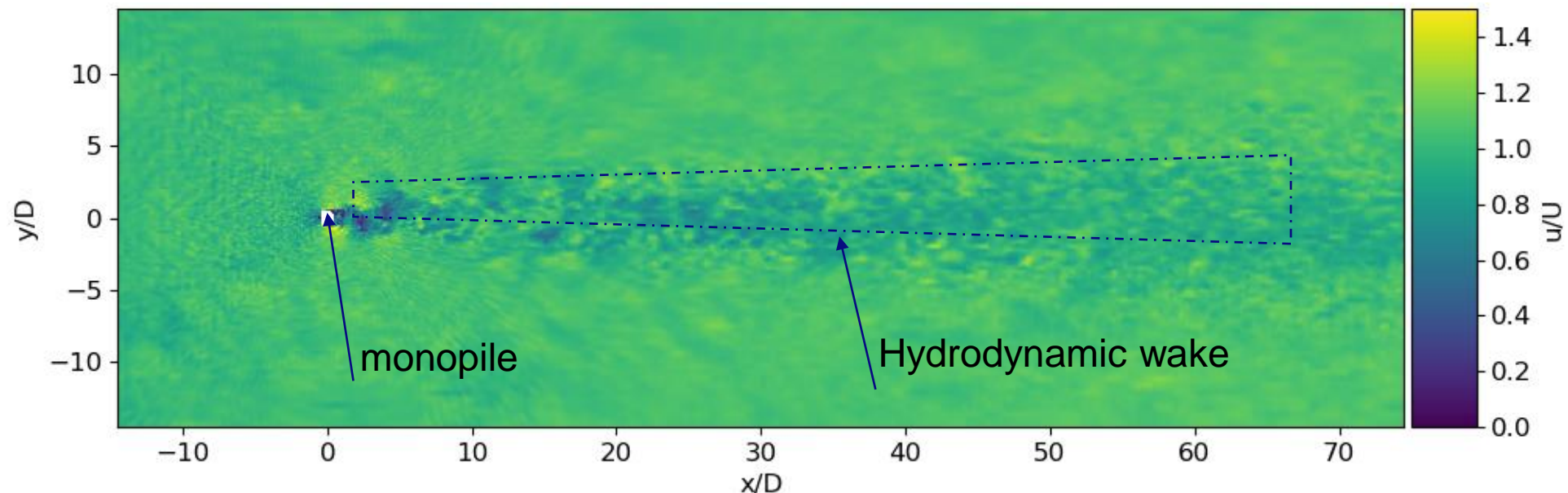
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- Use a more detailed local model as a research tool for parameterization

Flow field: current from left to right

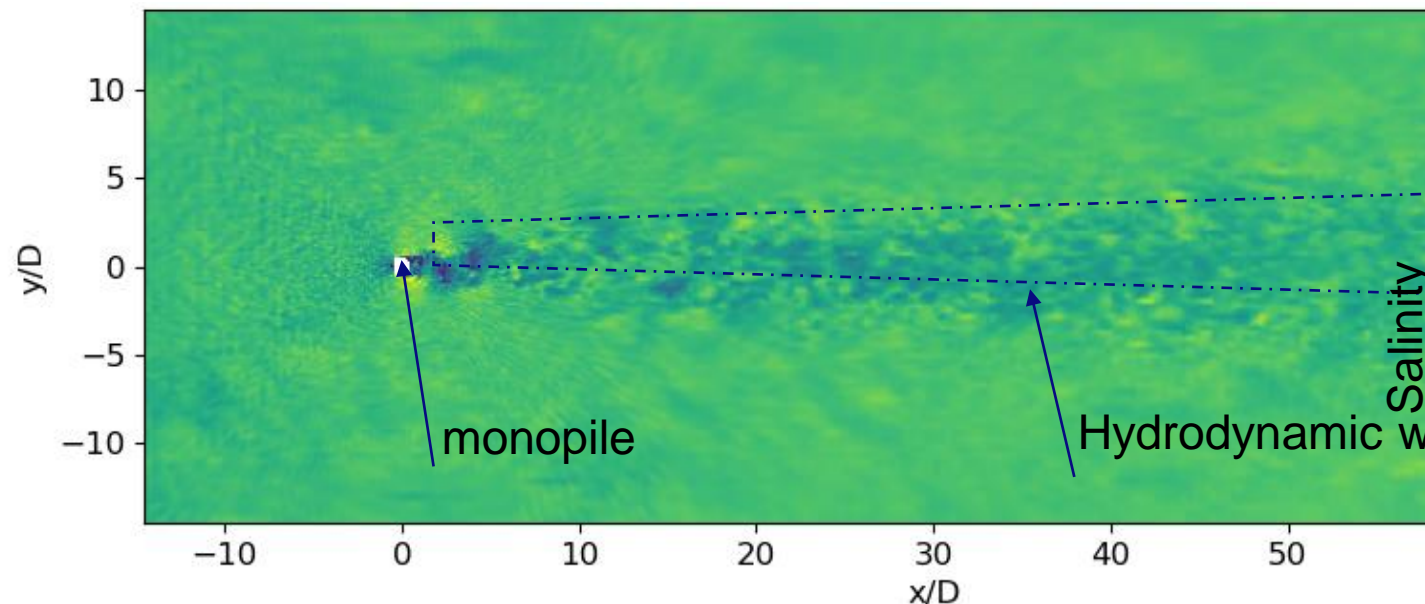


Parameterization of the impact of foundations

Measurement campaign Erik Hendriks
In cooperation with NIOZ and UGent

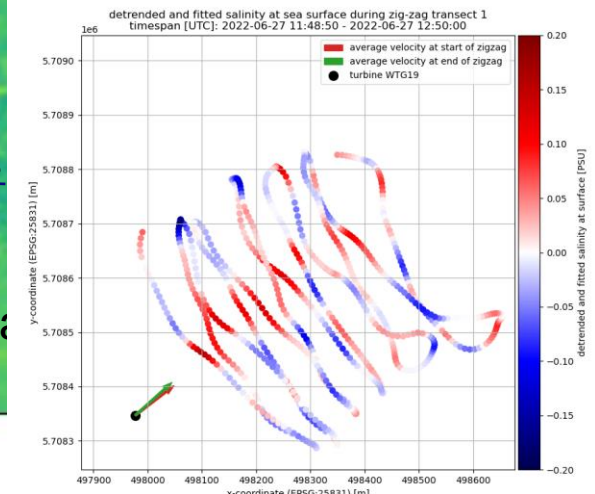
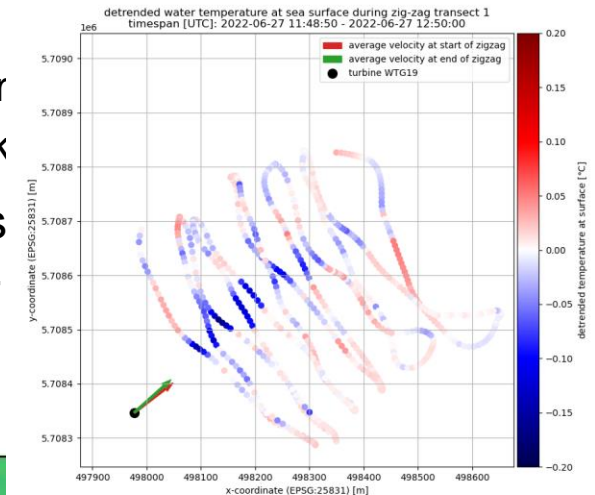
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Deltares

Temperature

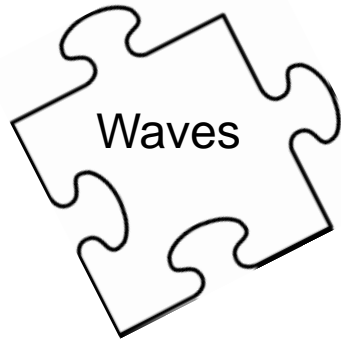


Quantification of ecosystem effects: approach

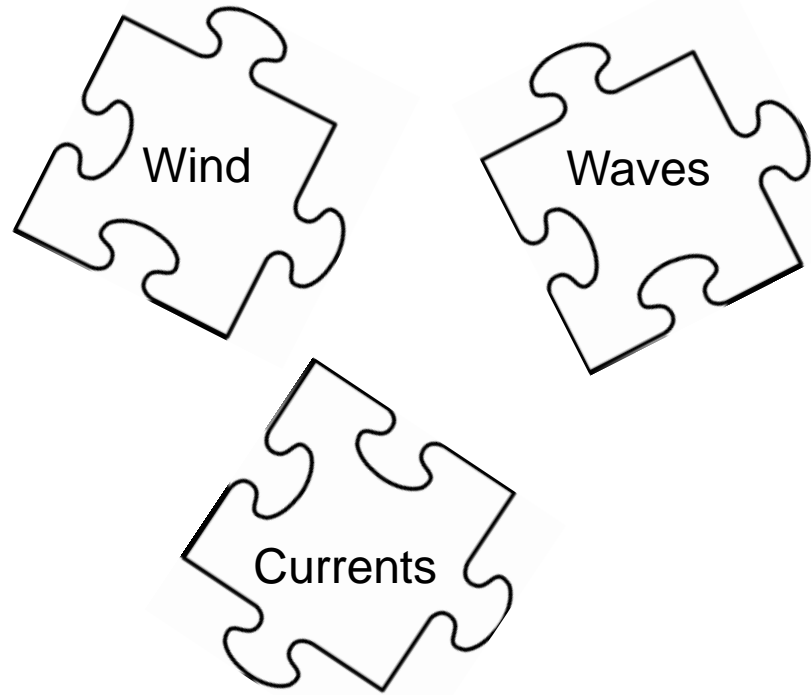
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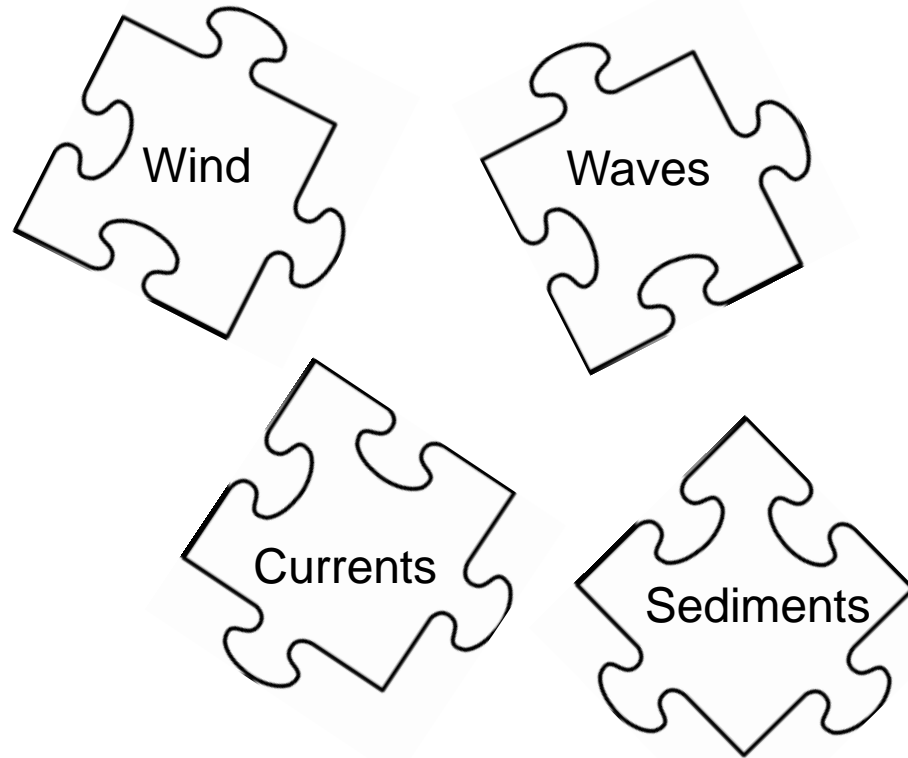
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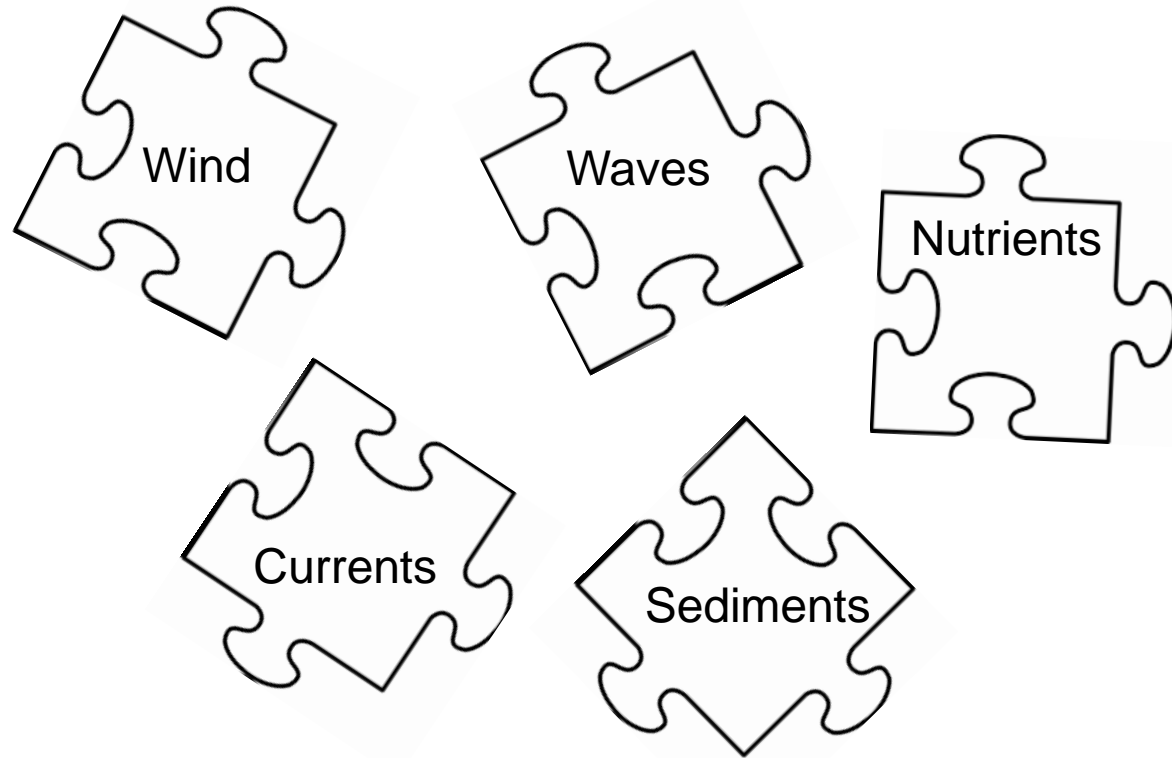
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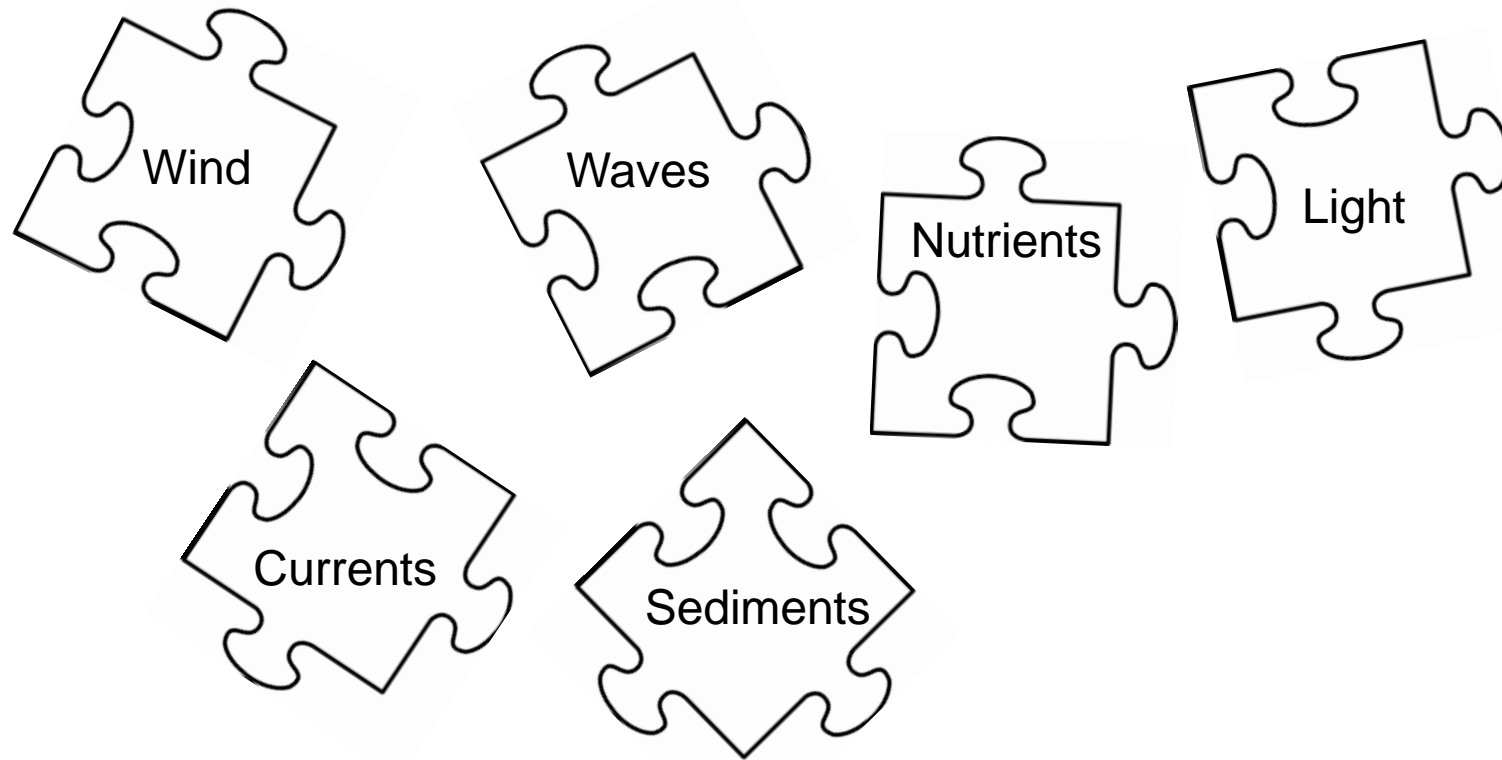
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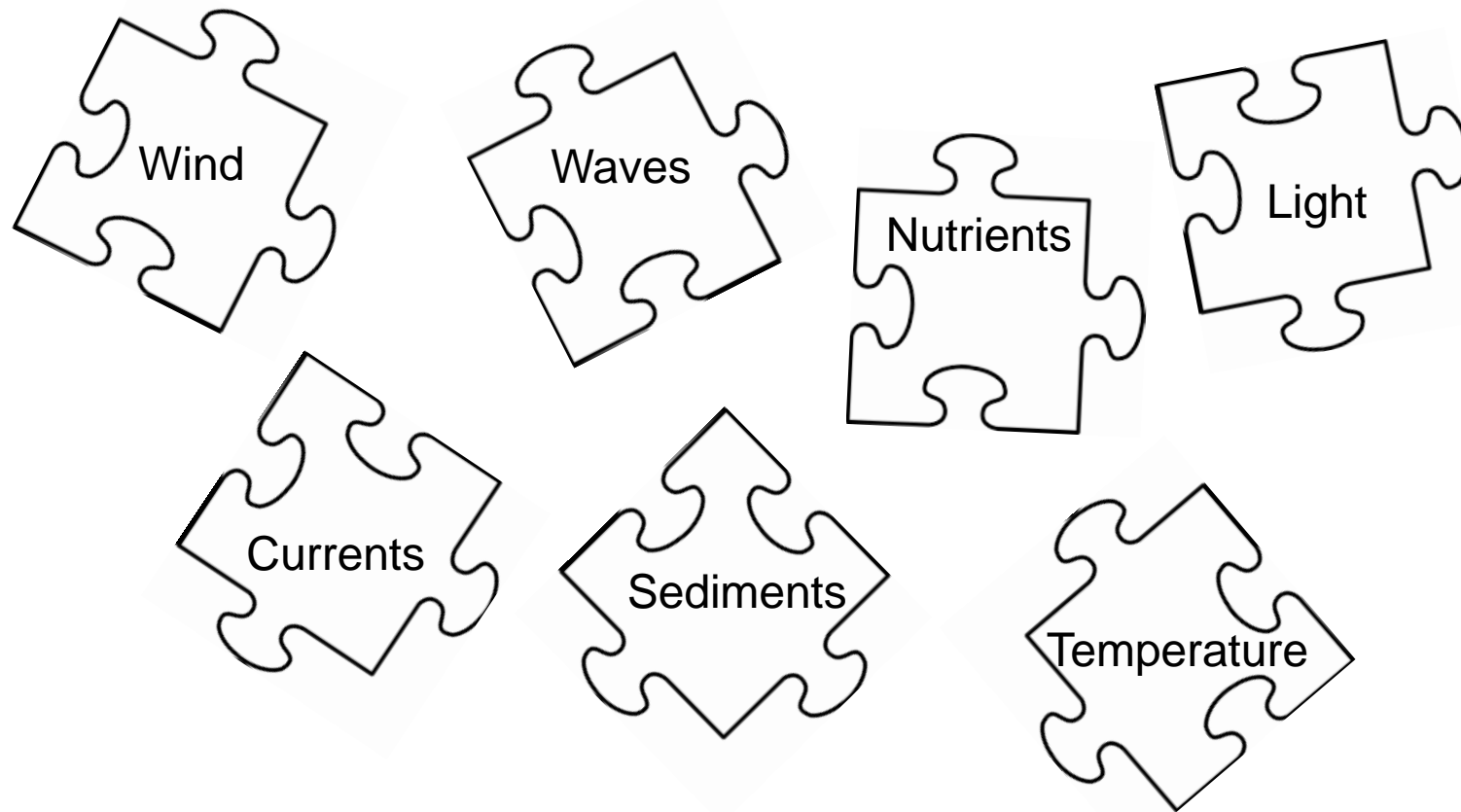
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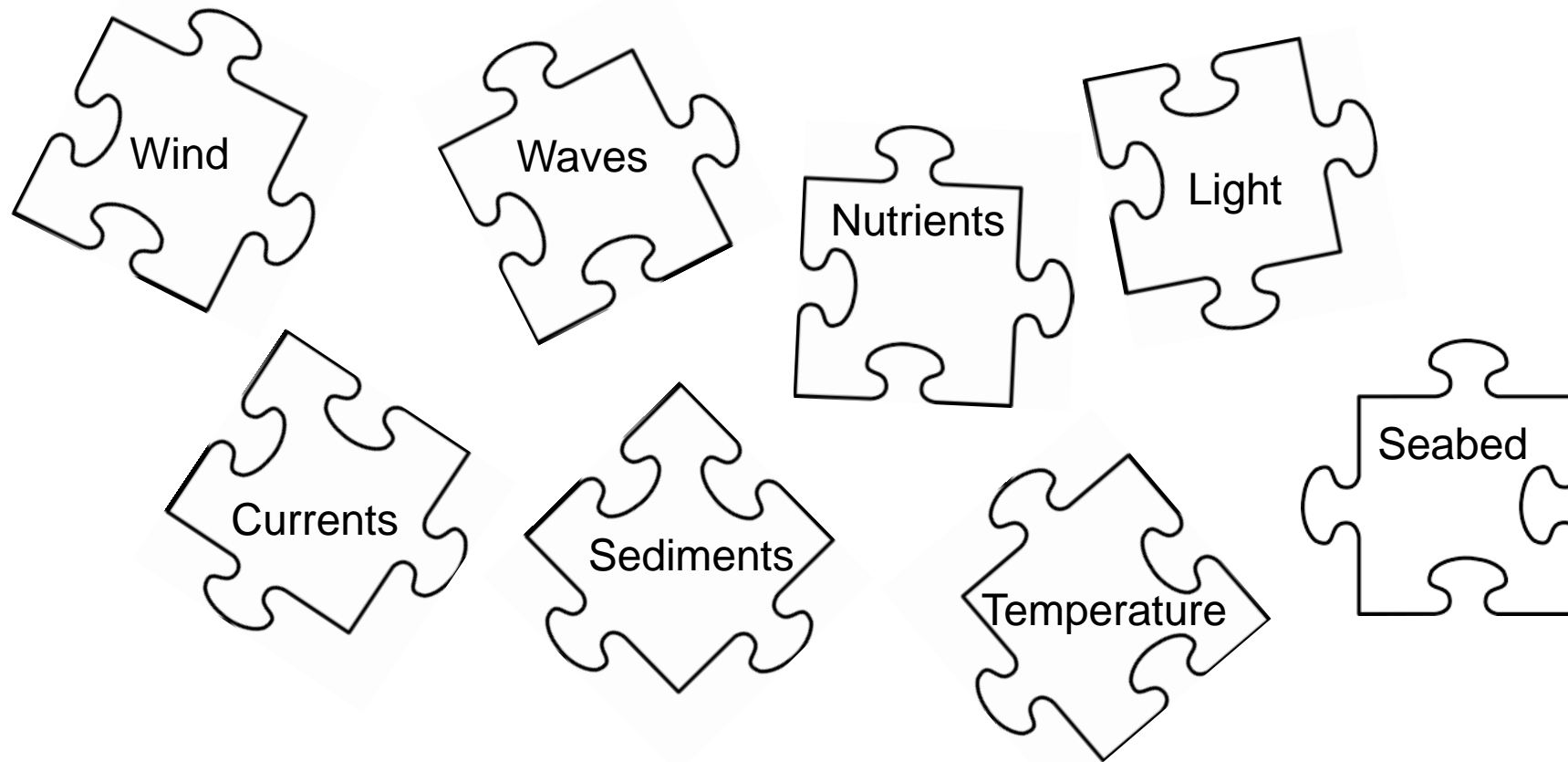
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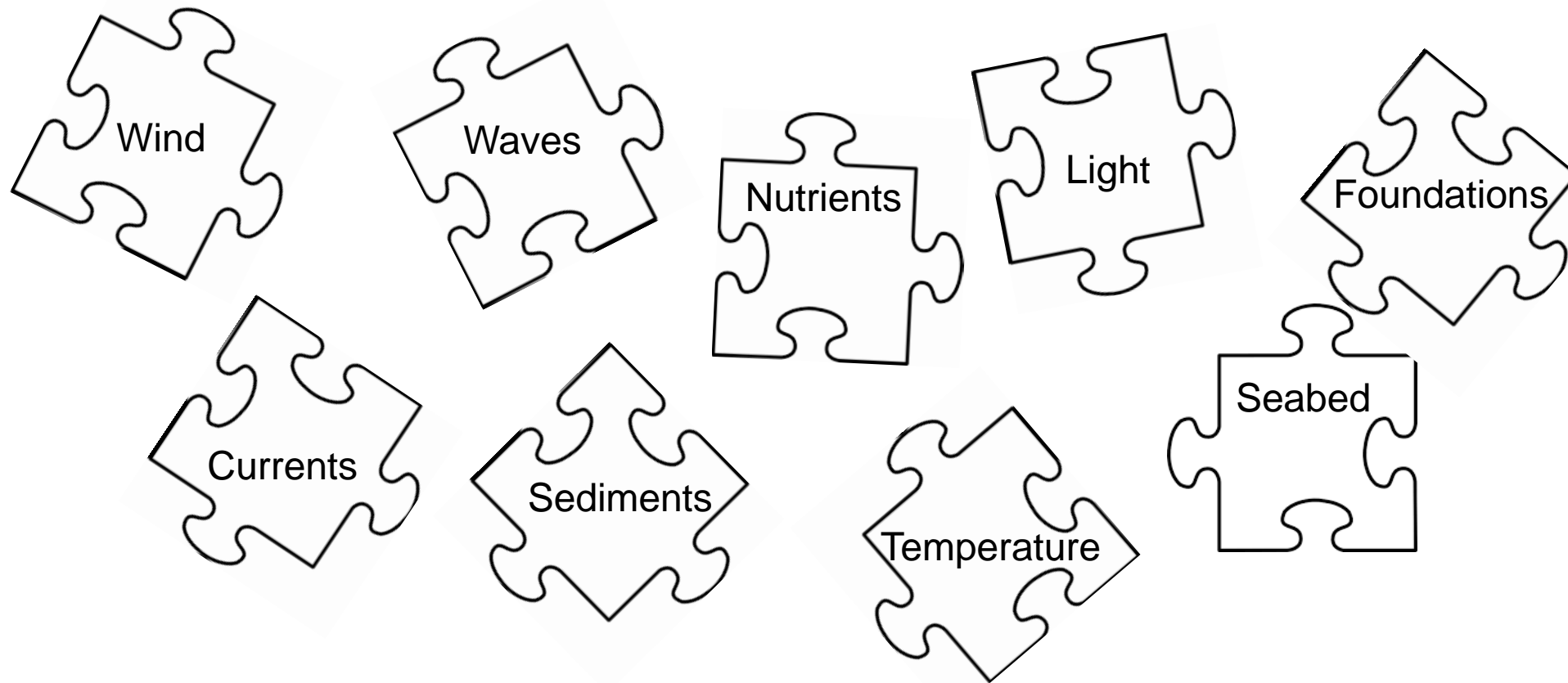
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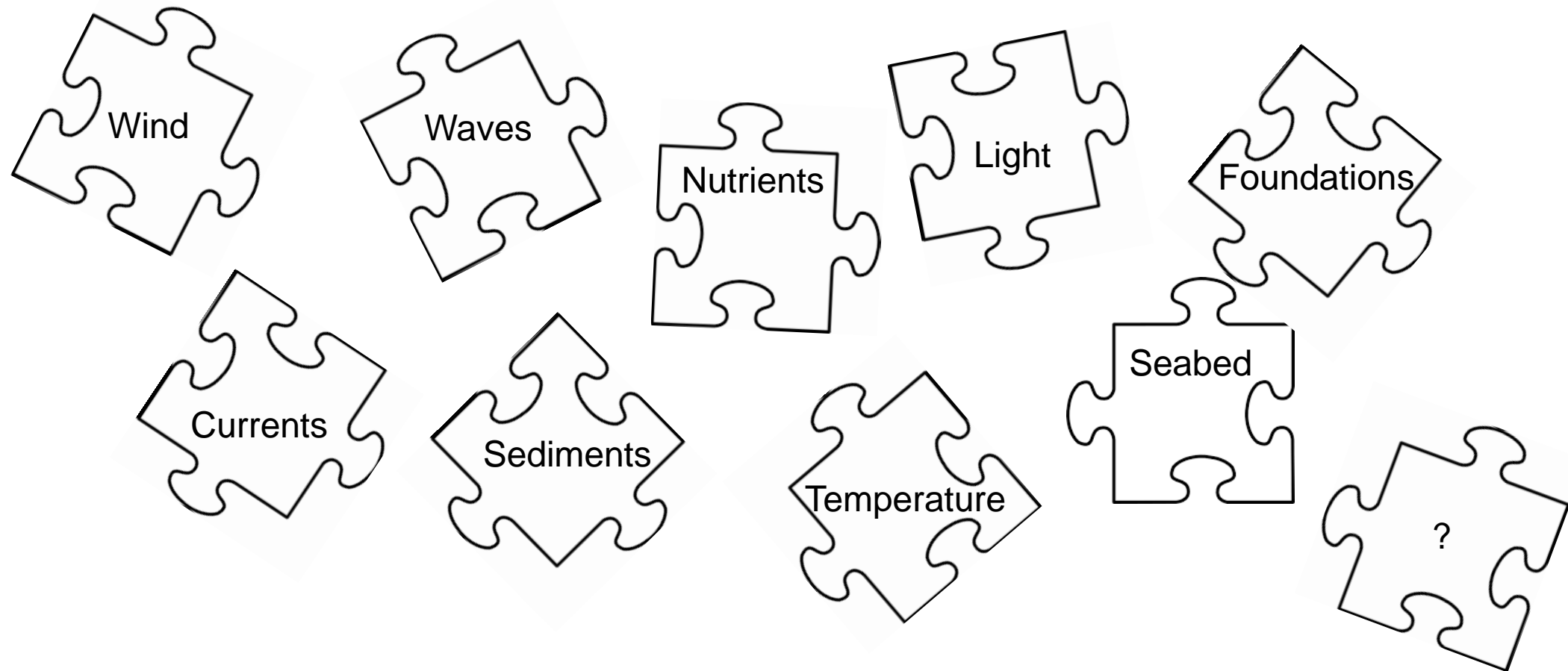
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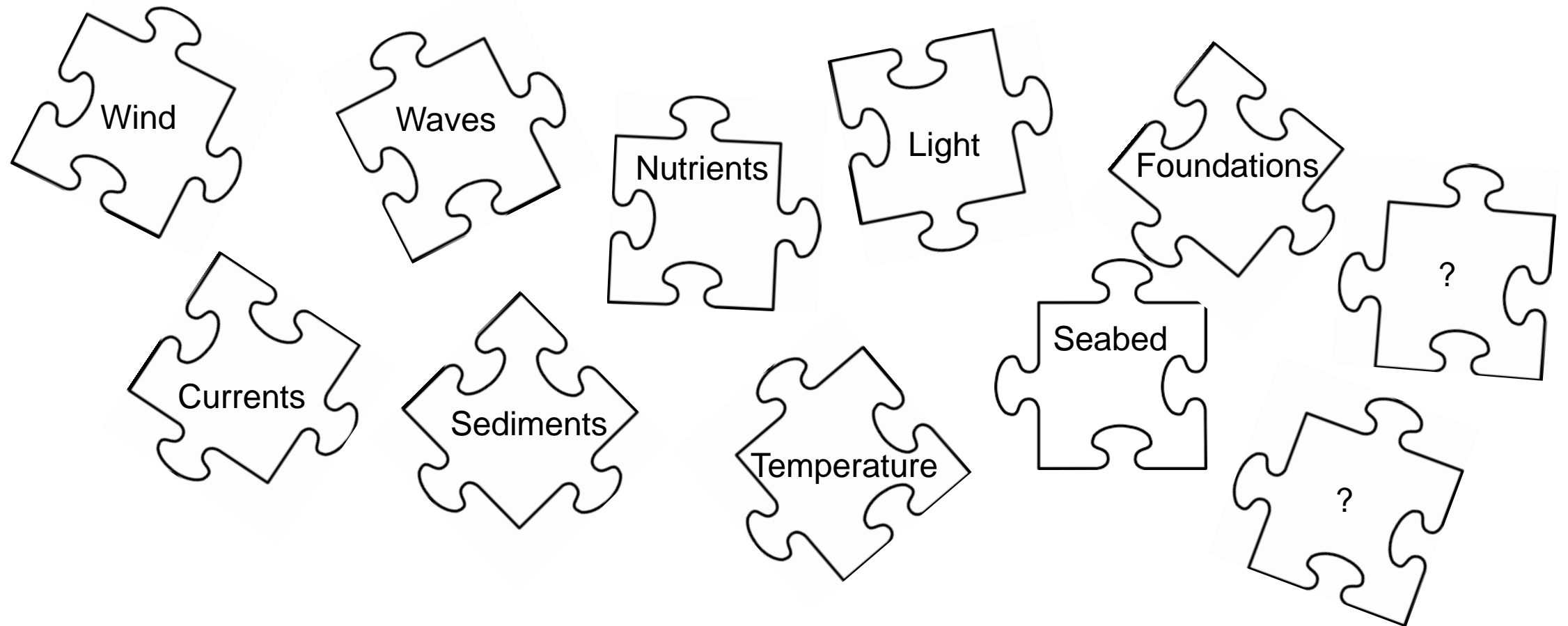
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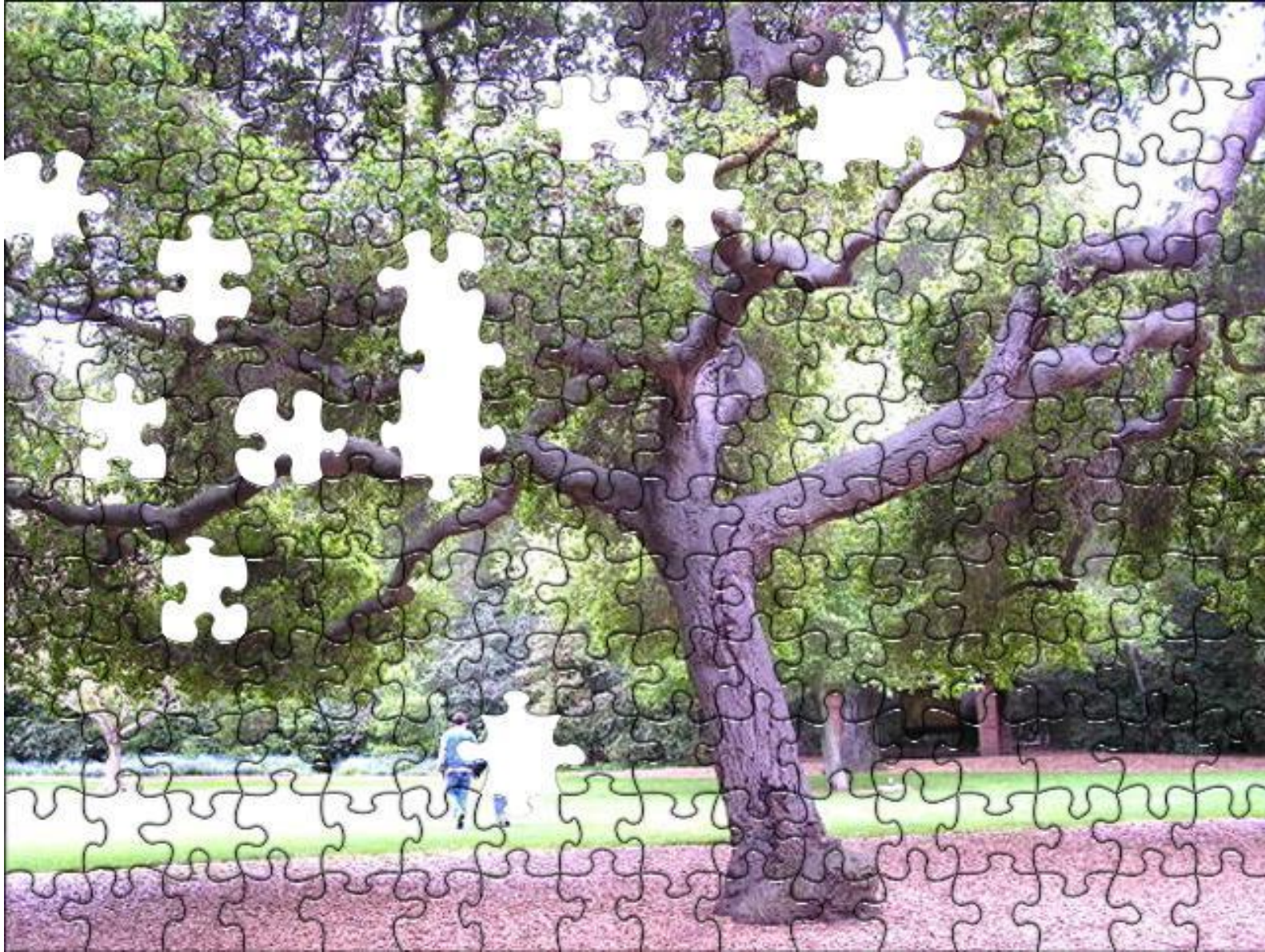
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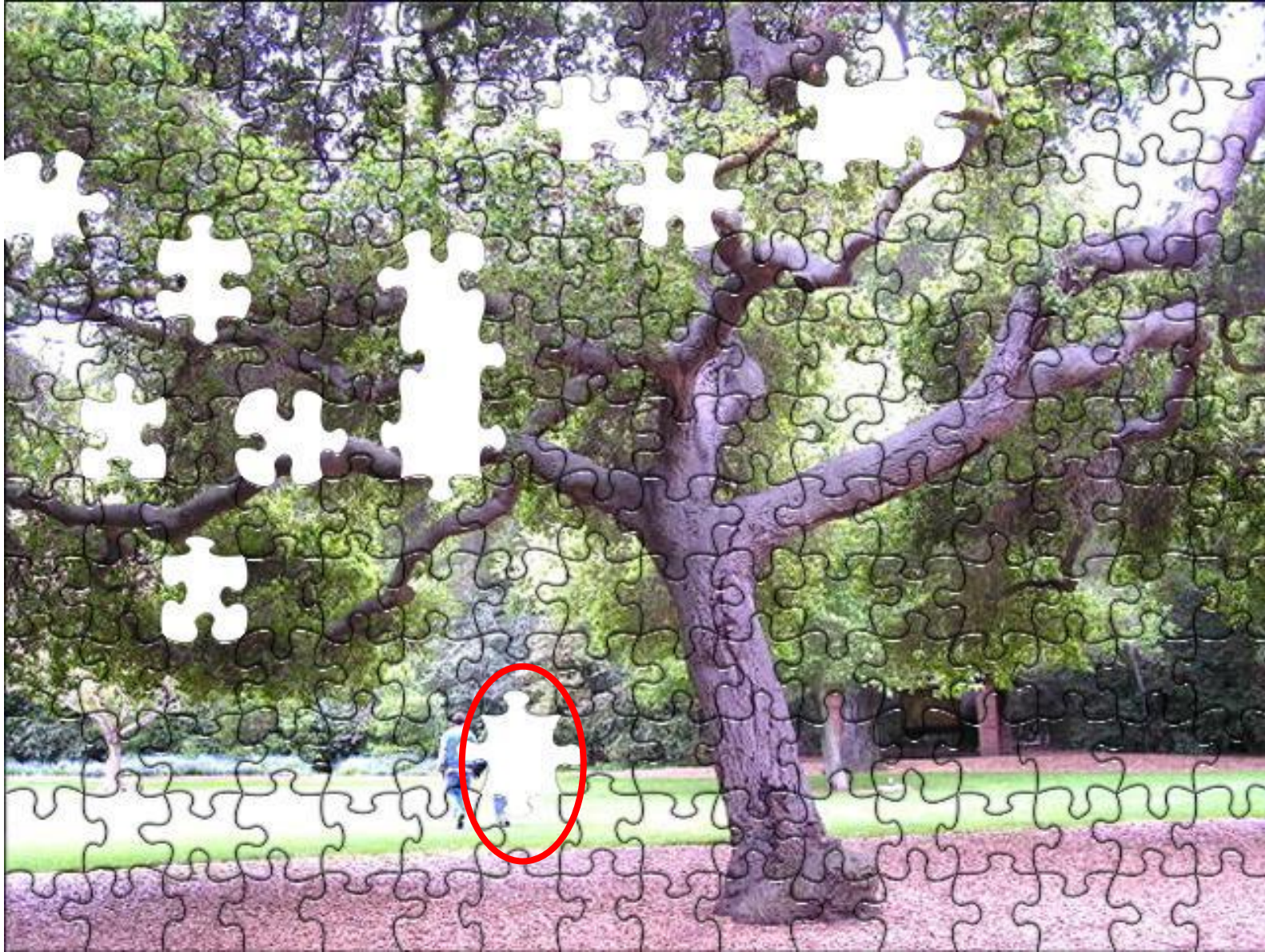
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Quantification of ecosystem effects: approach

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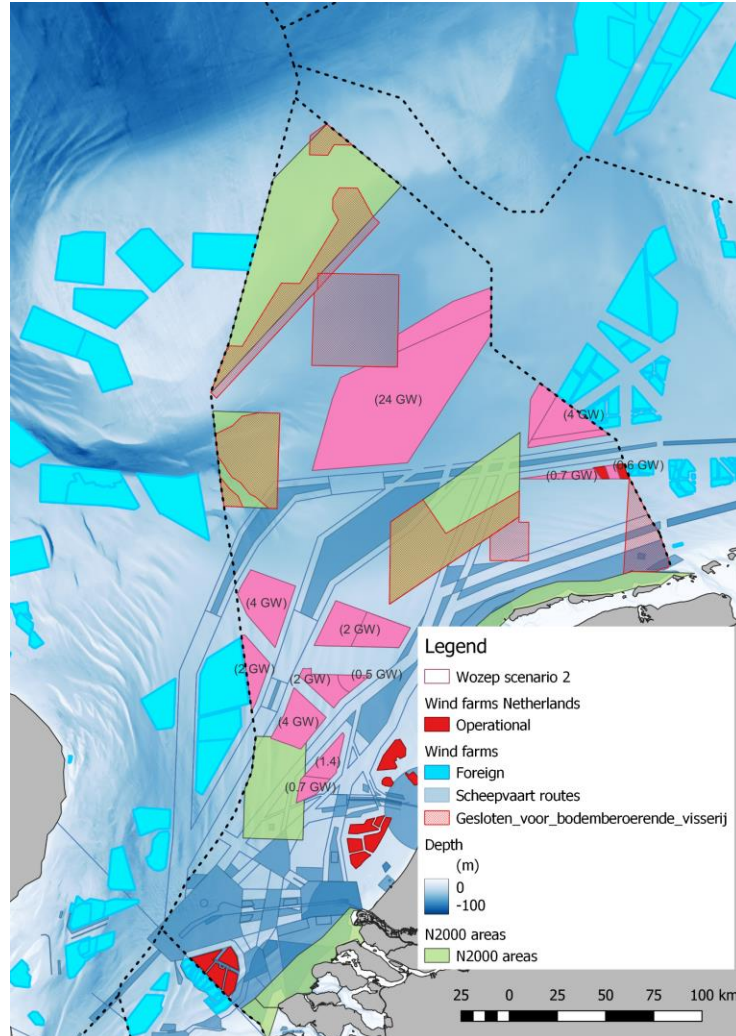
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Quantification of ecosystem effects: approach

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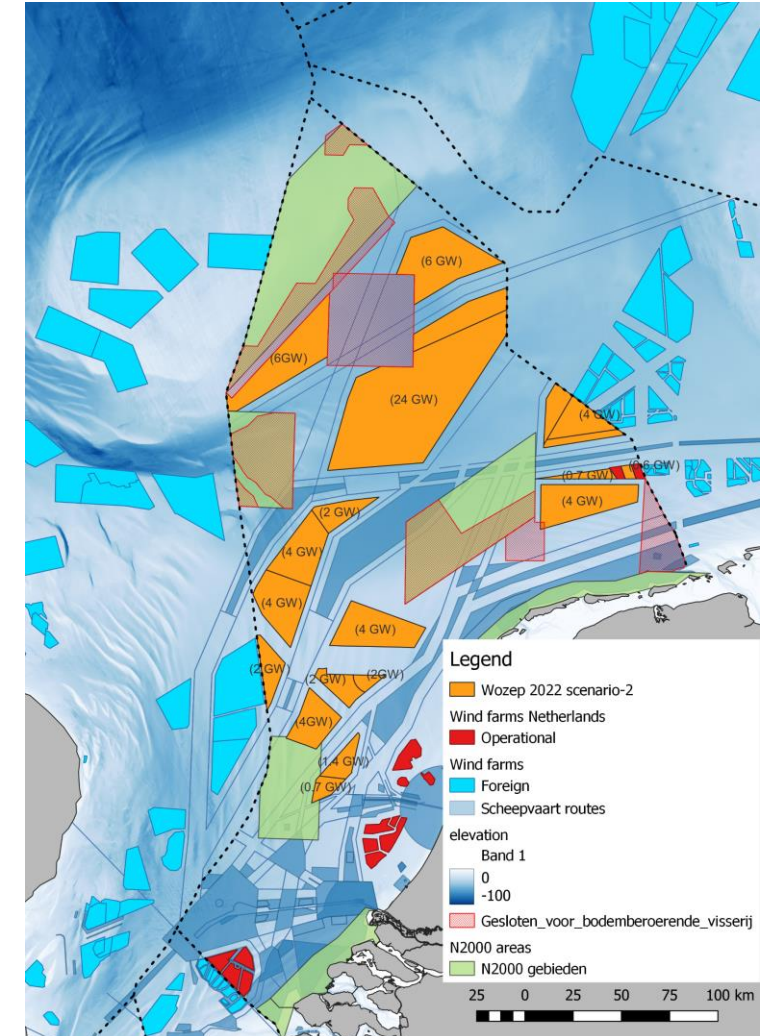
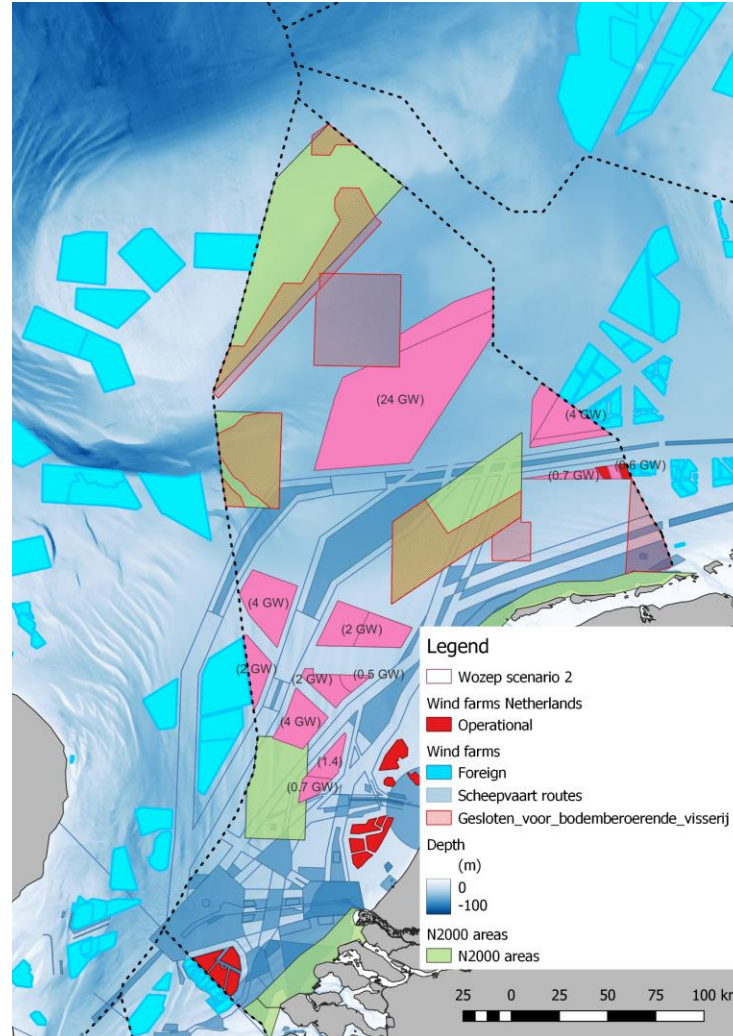
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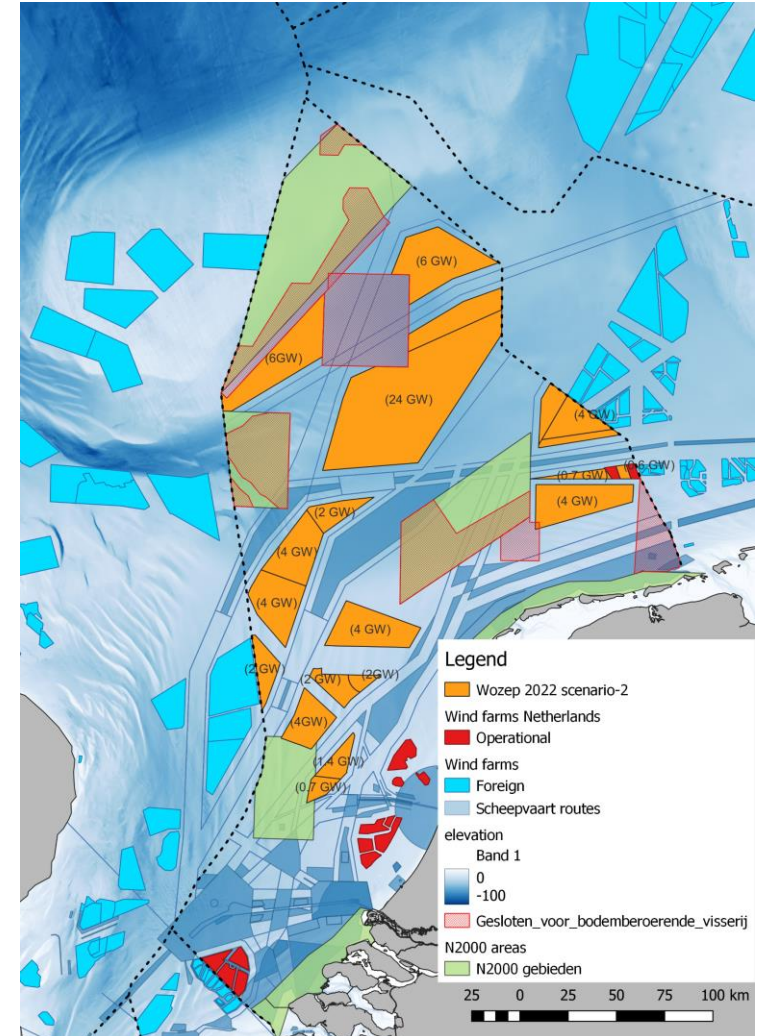
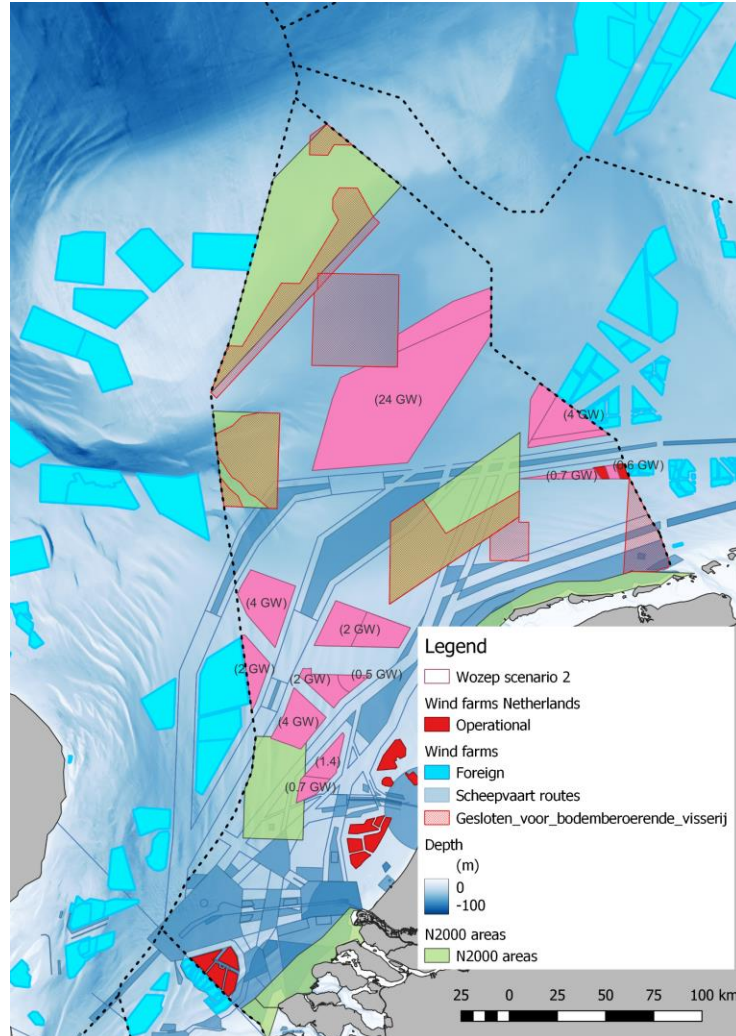
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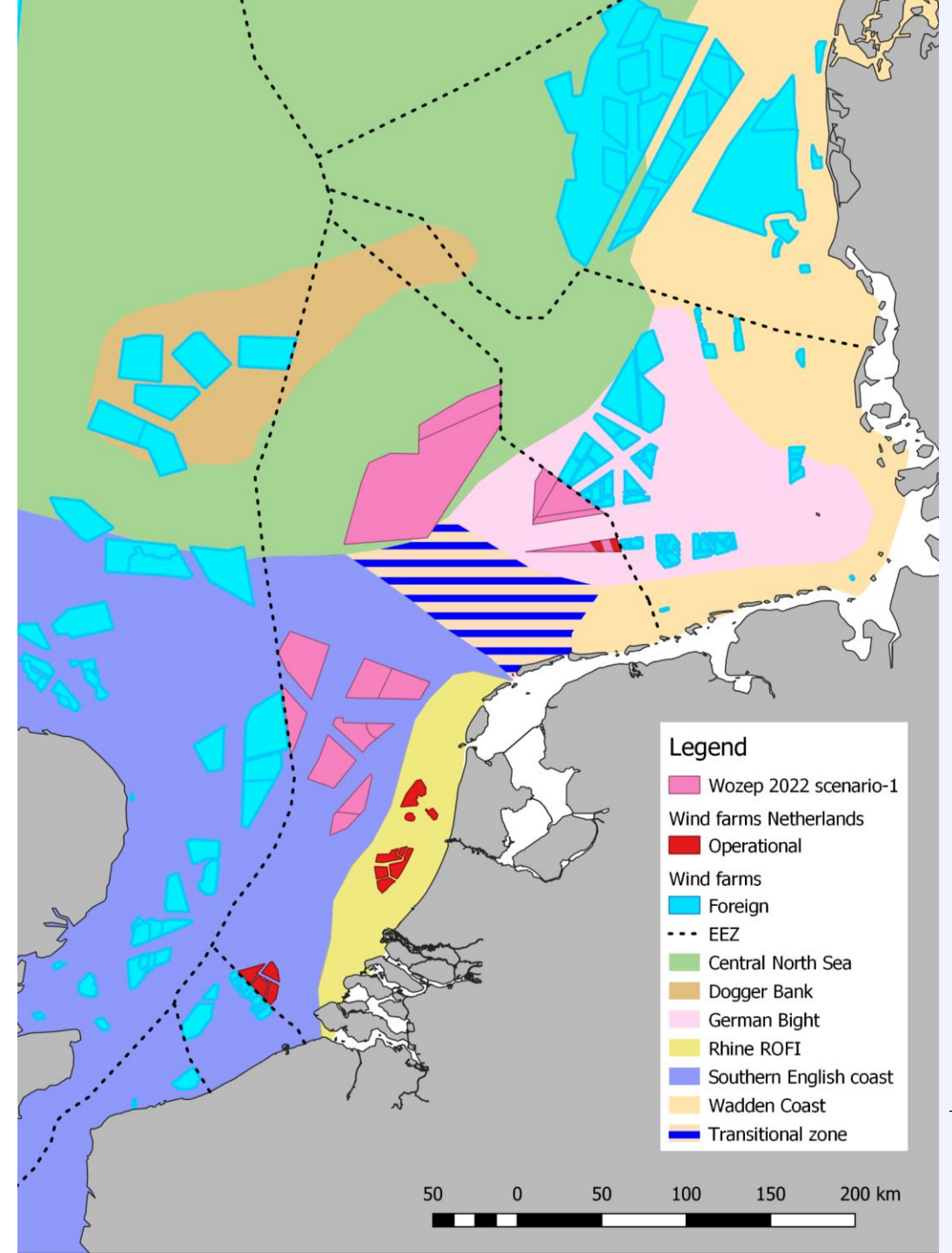
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- Comparison to a reference scenario gives a really good impression on impact of offshore wind developments



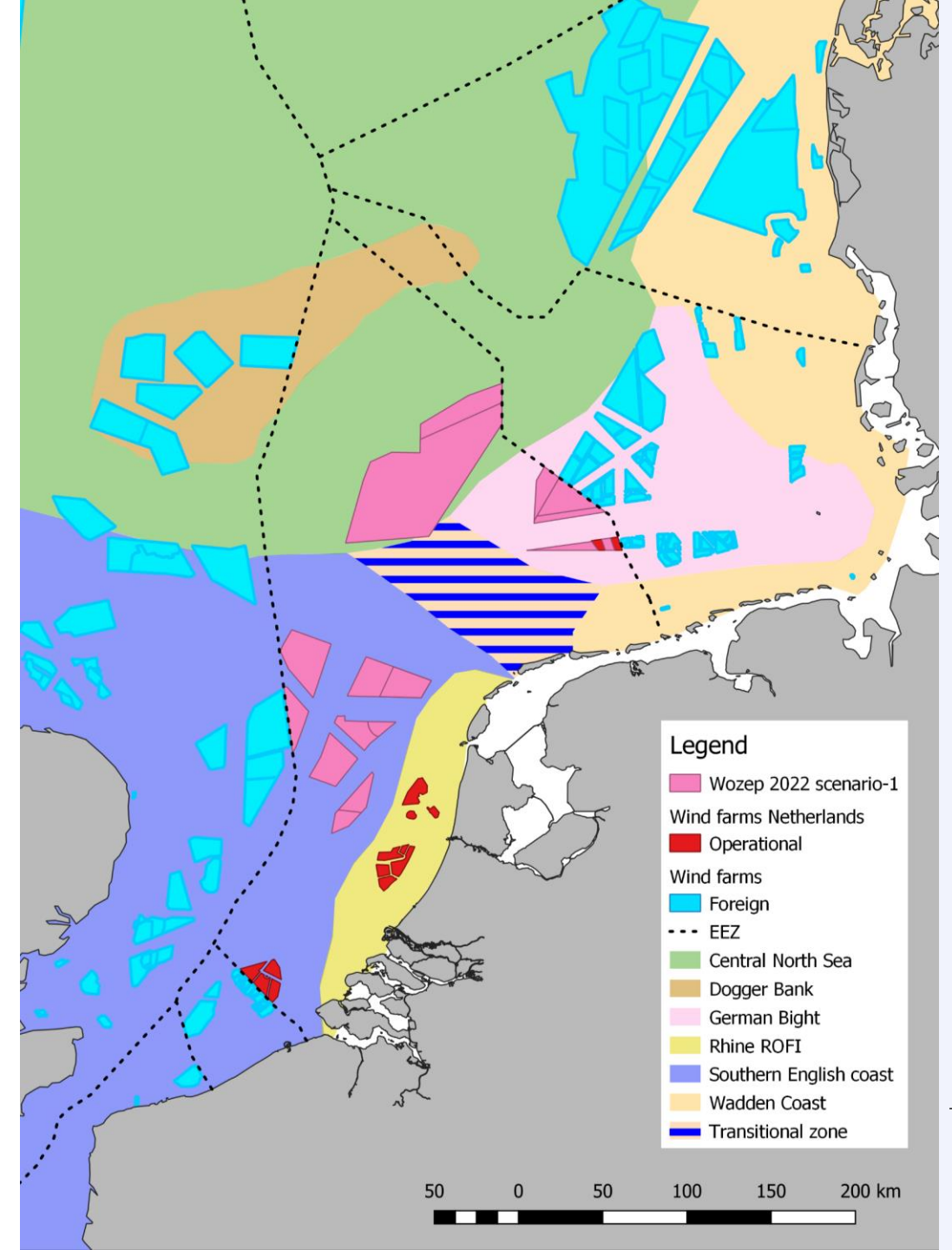
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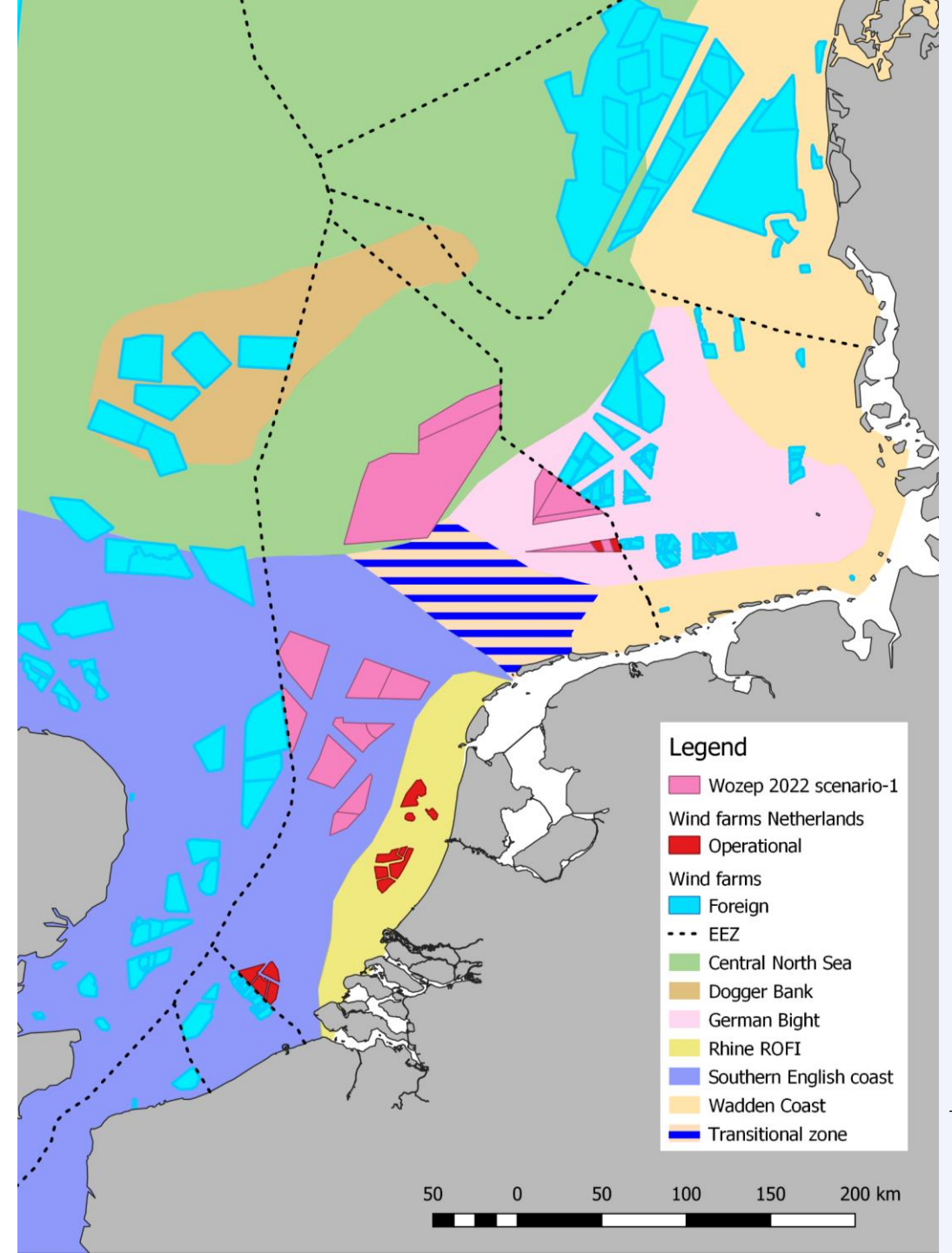
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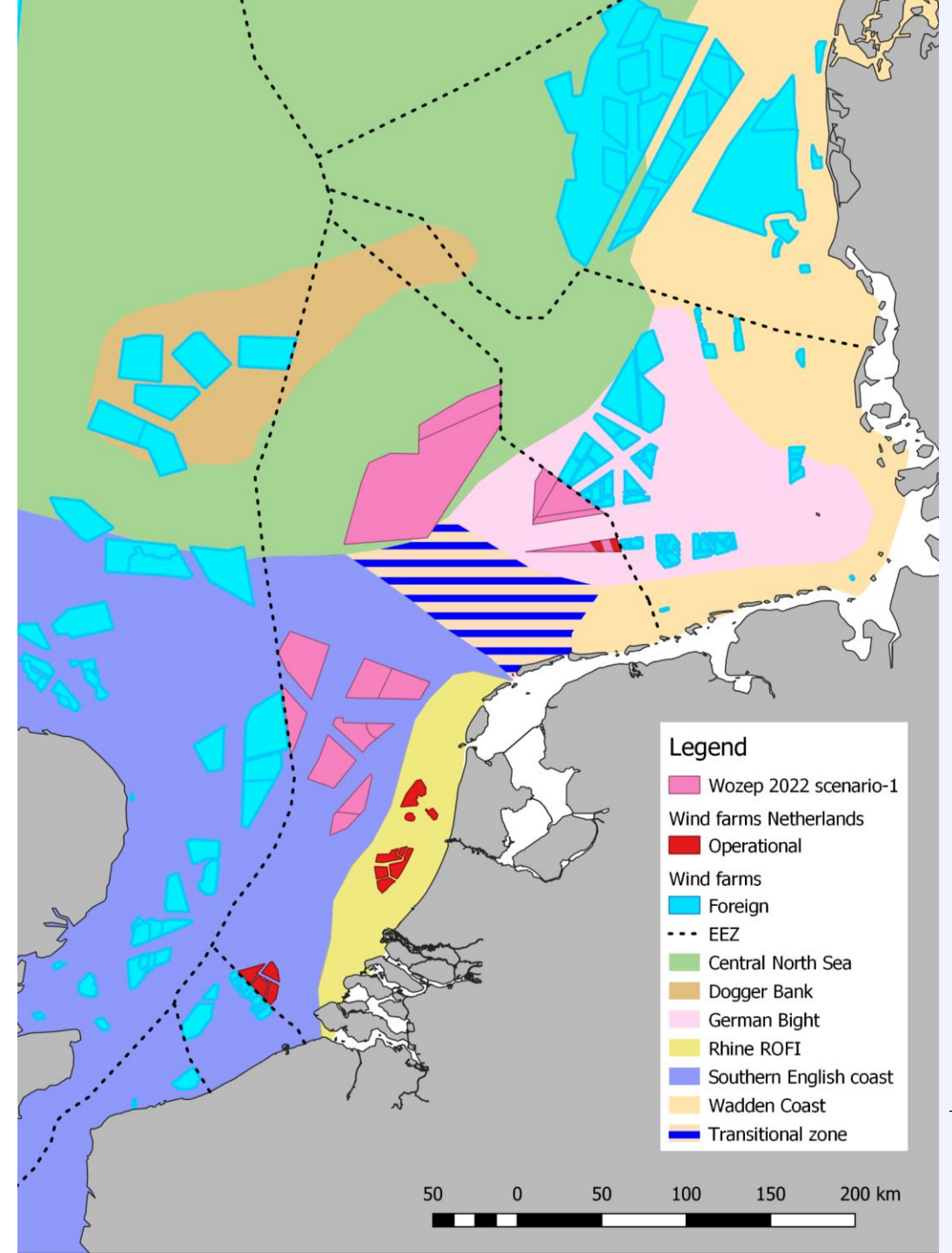
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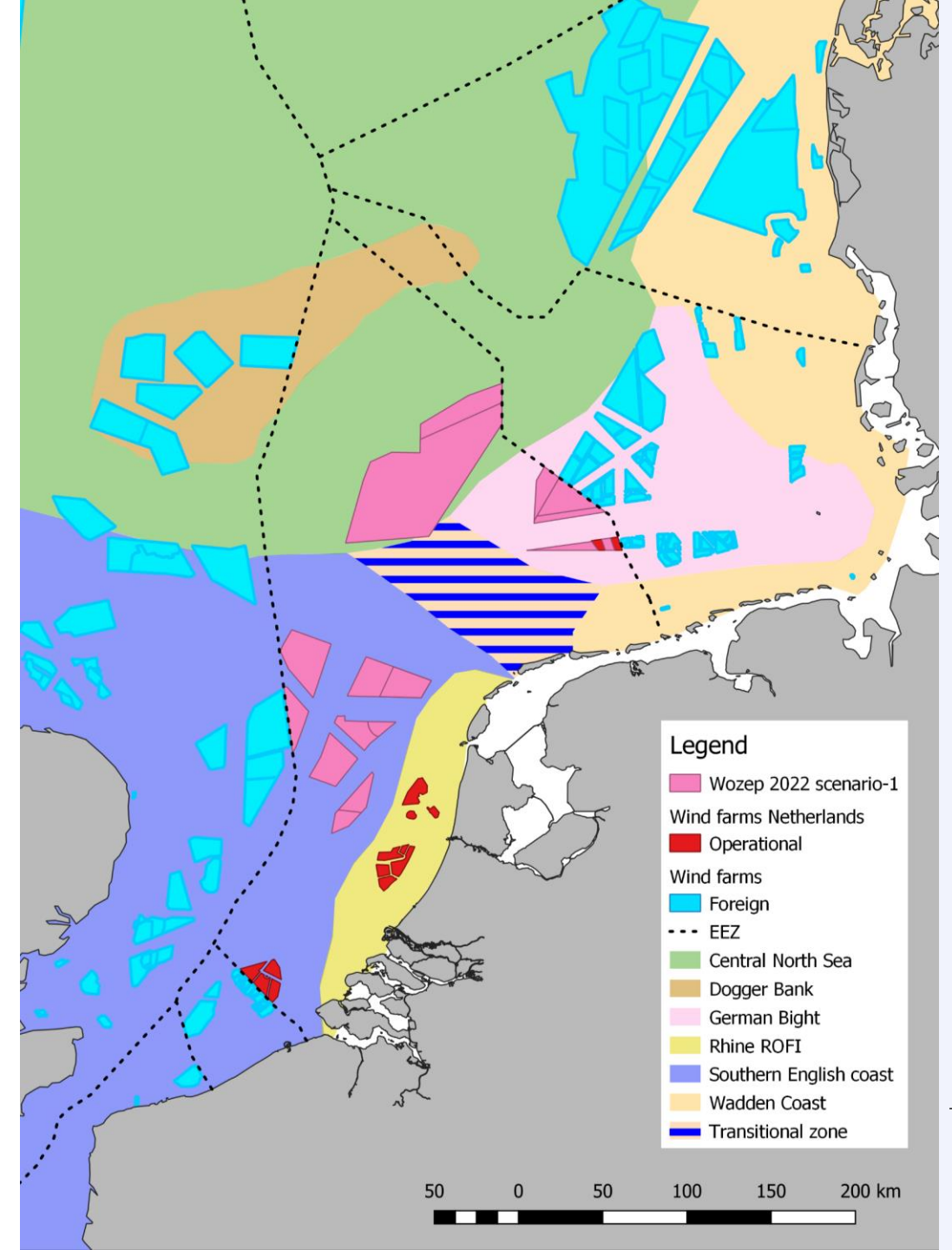
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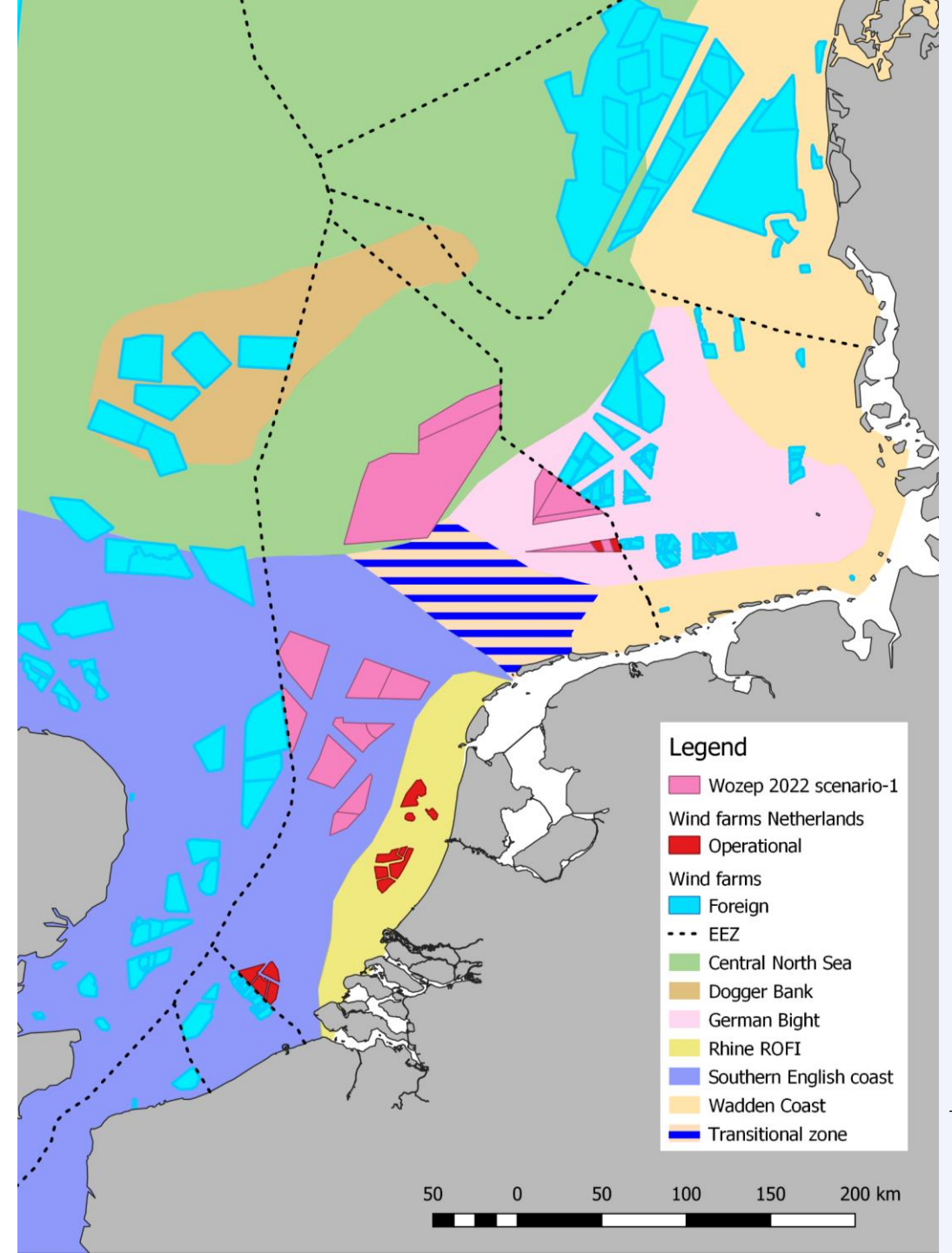
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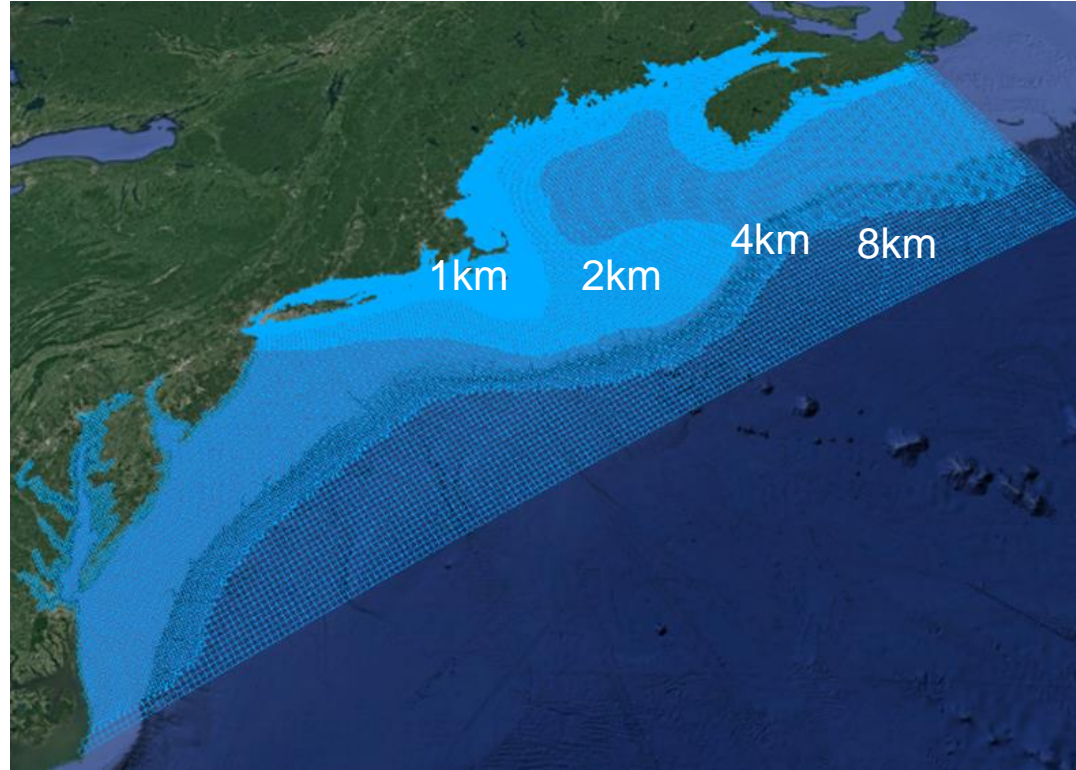
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Application Nantucket: Massachusetts bay model

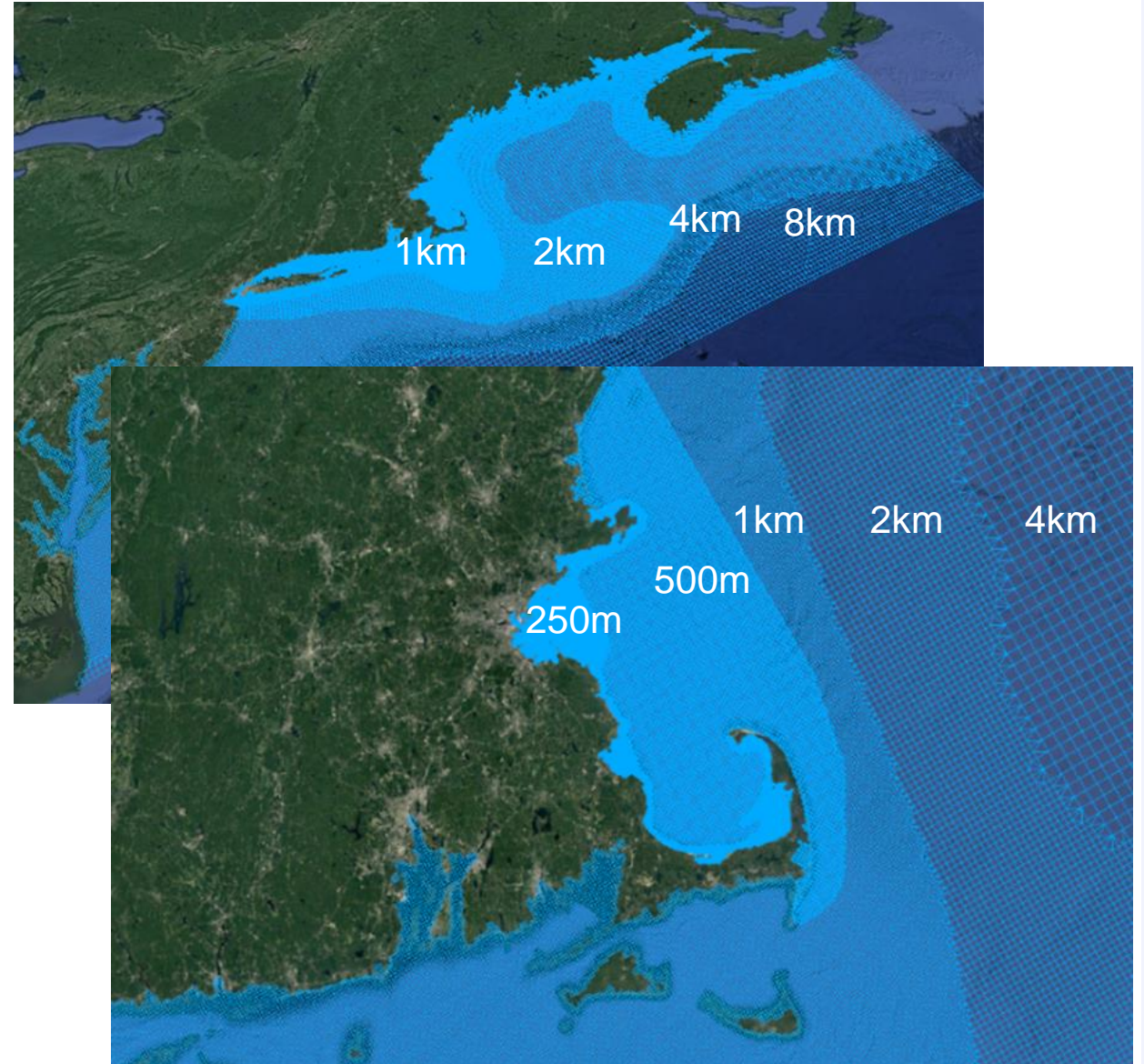
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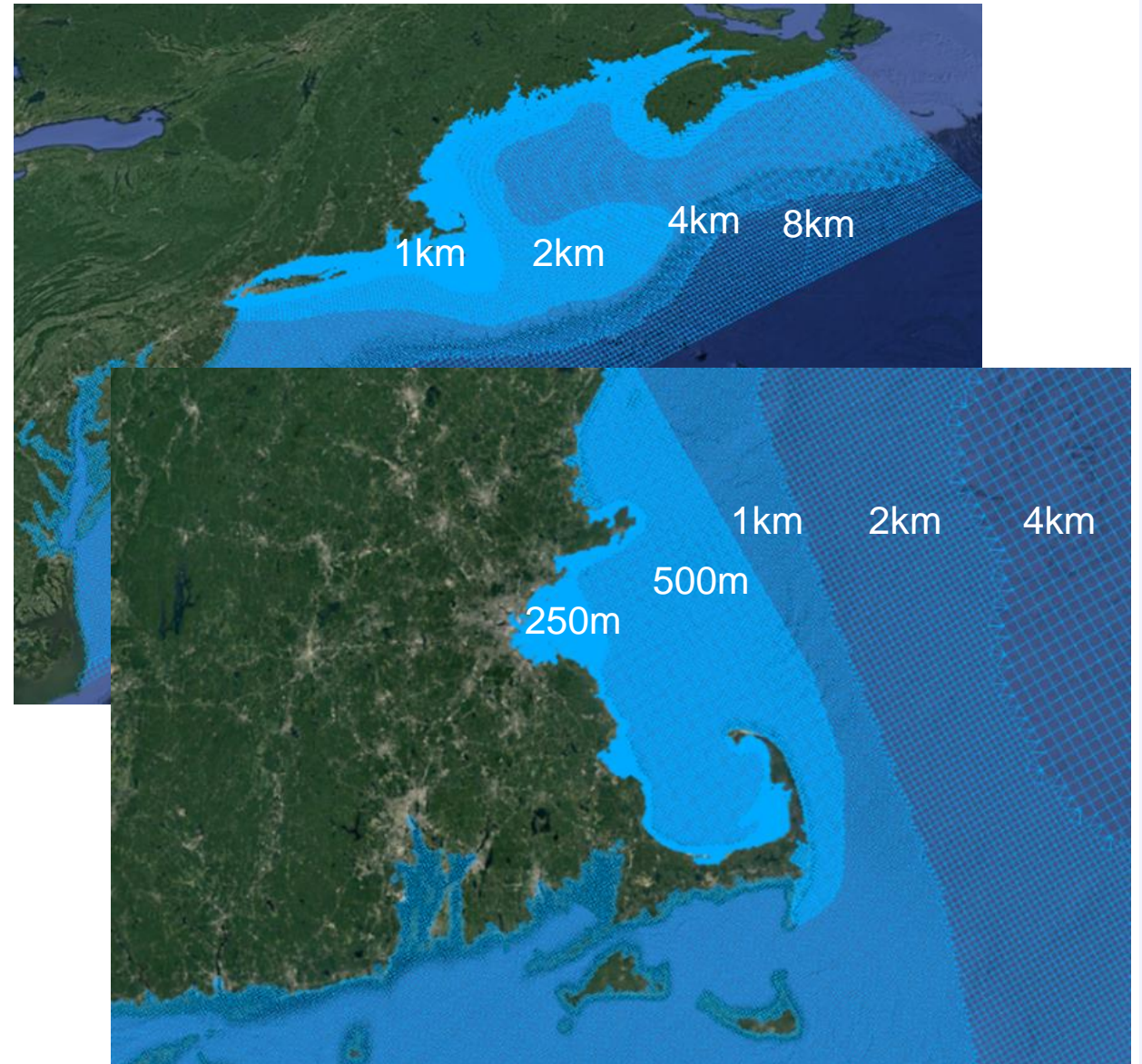
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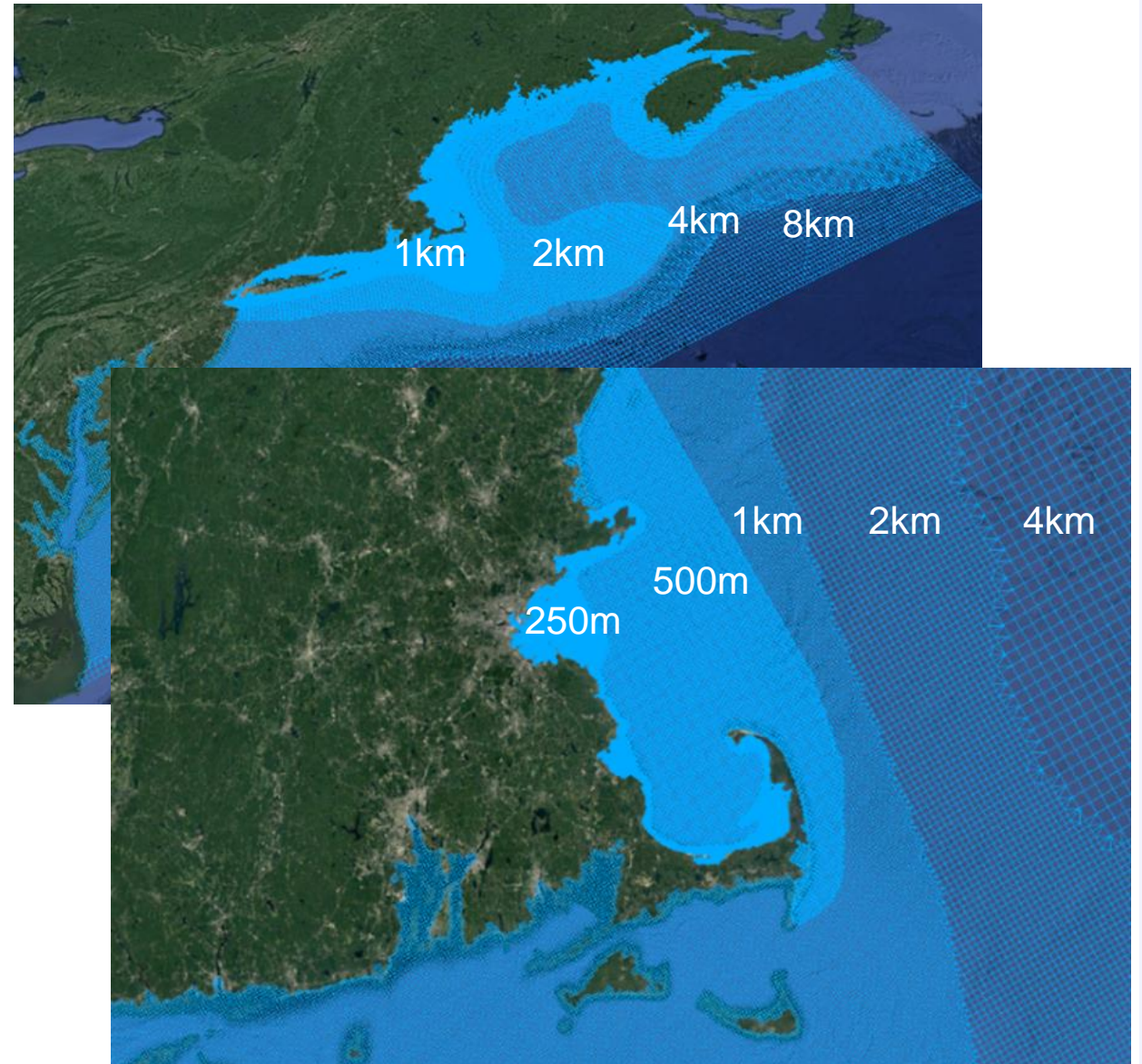
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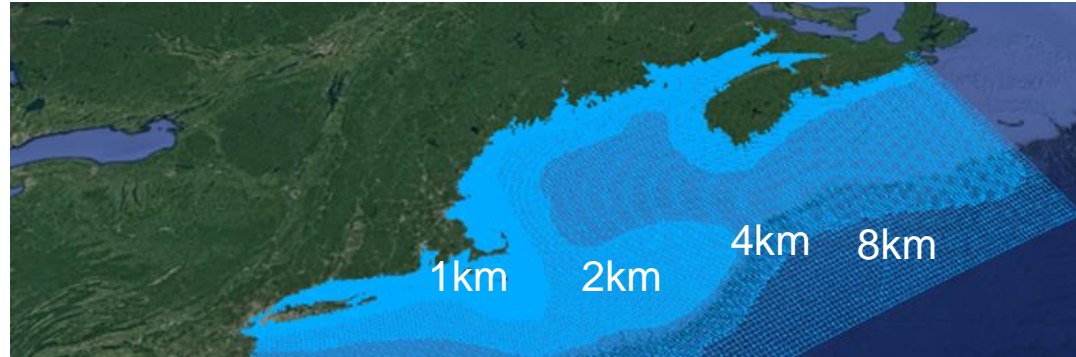
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- Equipped with a full water quality module
 - Assess impact on zooplankton of offshore wind development (with a direct link to the North Atlantic Right whale)



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 - Stakeholder engagement is equally important to technology



Contact

🏠 www.deltares.nl

✉ Yorick.Broekema@deltares.nl

in [linkedin.com/in/ybbroekema](https://www.linkedin.com/in/ybbroekema)

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