Wave forcing in the Dutch Wadden Sea and the effects on mussel habitats

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Problem definition

Mussel beds are an important part of the ecosystem in the Dutch Wadden Sea. Over the past decades intertidal mussel cover has declined, especially in the Western Wadden Sea. Wave forcing is considered an important process in limiting mussel bed survival in intertidal areas (Brinkman, et.al., 2002). The main objectives of this study are:

(1) Determine the spatial distribution in wave forcing in the Dutch Wadden Sea.

(2) Relate wave forcing to the occurrence of intertidal mussel beds.

(3) Study the differences in wave forcing and mussel bed occurrence between the Eastern and Western parts of the Dutch Wadden Sea.

Methodology

Using SWAN (Booij, et.al., 1999) for 1408 scenarios of wind speed, wind direction and waterlevel the spatial distribution of wave forcing in terms of the near bed wave orbital velocities in the Dutch Wadden Sea is simulated.

The occurrence of each scenario is determined by comparing the scenarios with observations of wind speed, direction and water level in the period 1991-2013.

Based on scenario occurrence the spatial distribution in wave forcing under energetic (95 percentile) and calm conditions (median) is determined.

The spatial distribution in wave forcing is compared with data of mussel bed contours obtained during spring by IMARES in the period 1994-2011.

Fig1. *Modelled near bed orbital velocity in the Dutch Wadden Sea at the 95th percentile*

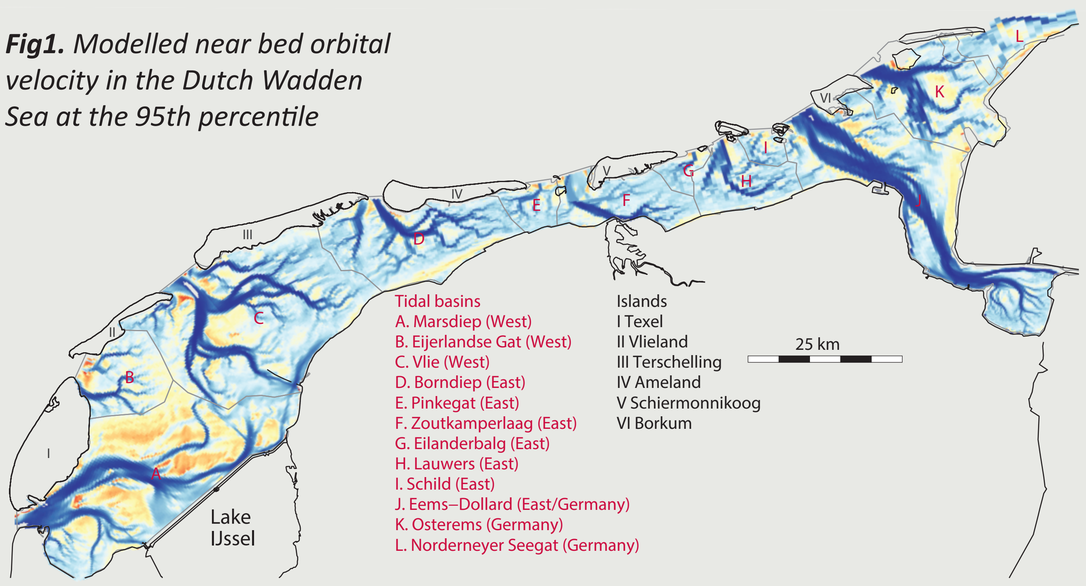


Fig2. *Modelled basin averaged median near bed orbital velocities*

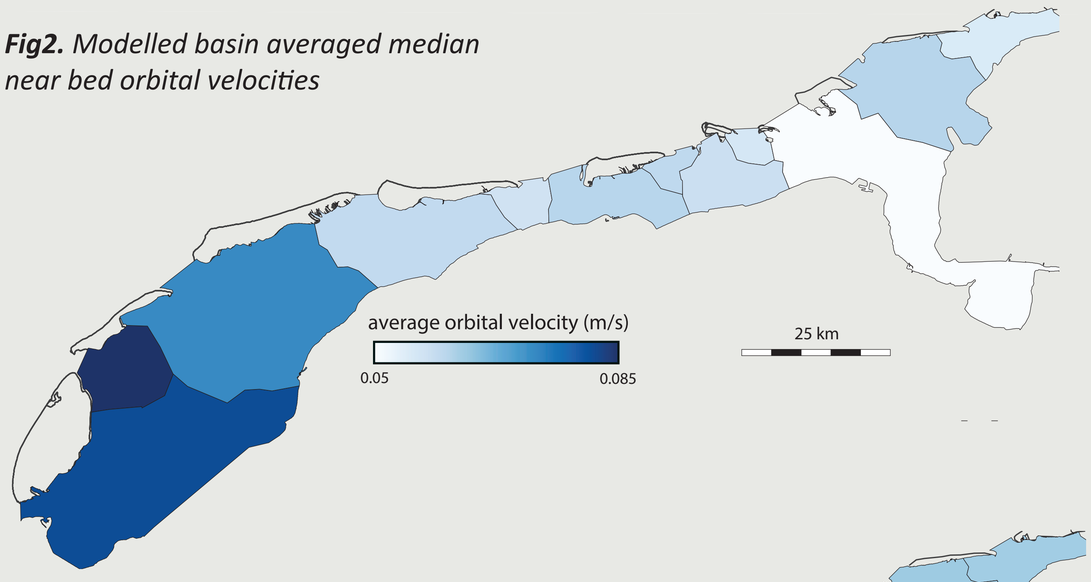
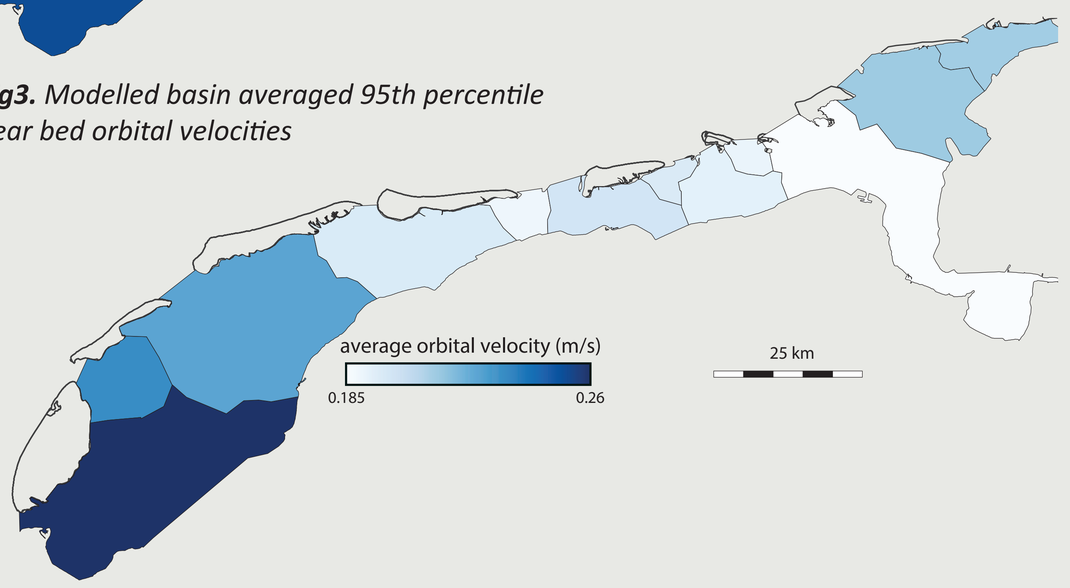


Fig3. *Modelled basin averaged 95th percentile near bed orbital velocities*



Results: Wave climate

Spatial distribution in wave forcing (Fig 1):

- Wave orbital motion is largest at the NE side of tidal channels.
- Wave orbital motion decreases with distance from the inlet.
- Increased wave forcing along the mainland coast in the East.

Wave orbital motion per basin is shown for median (50% of the time in Fig 2) and 95th percentile conditions (18 days a year in Fig 3) .

- Both median and 95th percentile wave orbital velocities are larger in the Western Basins than for the Eastern basins.
- Little difference in relative exposure per basin between median and 95th percentile conditions.

Wave forcing & mussel bed occurence

- Mussel bed occurence on intertidal area decreases with increased wave exposure.
- Little difference in cover for high exposed basins.

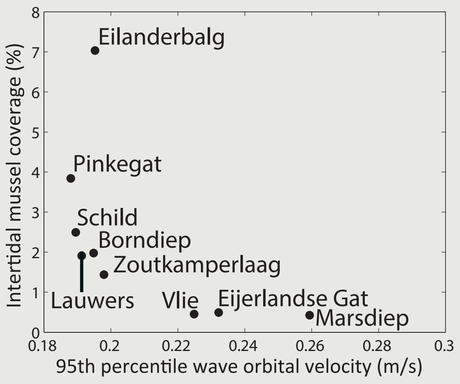


Fig 4. *Basin averaged wave orbital velocties at the 95th percentile against intertidal mussel cover.*

Wave forcing on intertidal mussel beds

- Mussel beds in the West more exposed than East.
- In the West mussel bed locations are less exposed than all the intertidal area.

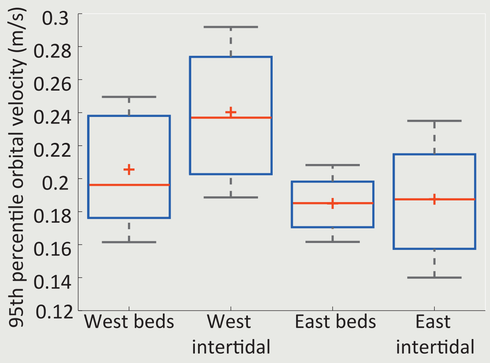


Fig 5. *Spread of wave orbital velocity on all intertidal area and mussel covered intertidal area for the Western and Eastern Dutch Wadden Sea.*

Wave forcing and mussel bed age

- Mussel bed life span increases with decreasing wave exposure.
- Young beds in the West are more exposed than in the East.

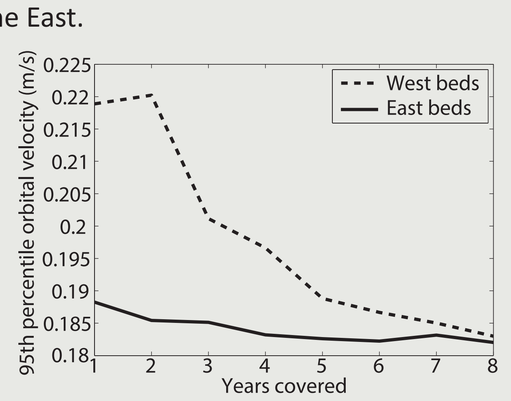


Fig 6. *Average wave forcing on mussel covered area agains amount of years covered.*

Conclusions

1. Decreasing trend in wave forcing from West to East; the basins of the Western Wadden Sea are more exposed than those in the Eastern Wadden Sea.
2a. Mussel coverage is largest in basins with low wave forcing.
2b. High exposed mussel beds have a shorter survival period.
2c. Wave forcing limits settlement and survival of intertidal mussel beds.
3a. For mussel beds that are stable for a long period (>6 years) differences in wave exposure between the Eastern and Western Wadden Sea are small.
3b. In the Western Wadden Sea wave forcing is clear a limiting factor this is not clear for the Eastern Wadden Sea.

References

Booij, N., R. C. Ris, and L. H. Holthuijsen. (1999) A third-generation wave model for coastal regions: 1. Model description and validation." Journal of Geophysical Research: Oceans., 104(C4): 7649-7666.

Brinkman, A., N. M. J. A. Dankers, and M. Van Stralen. (2002) An analysis of mussel bed habitats in the Dutch Wadden Sea. Helgoland Marine Research 56.1: 59-75.

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