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Harmful Algal Blooms Expert System - (HABES)

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Objectives

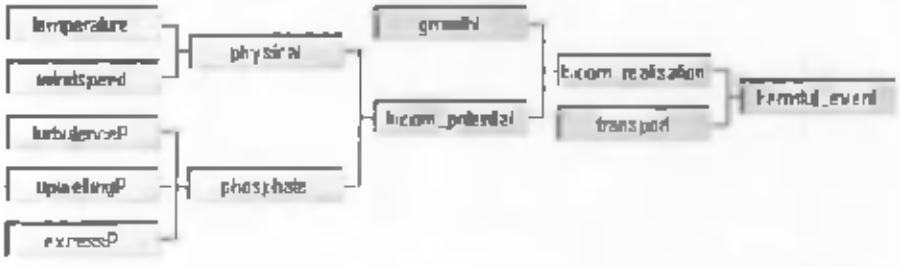
- to improve and extend our understanding of the interaction between physical and ecological factors determining the initiation and fate of harmful algal blooms;
- to provide an expert system and a knowledge base, publicly accessible through internet, based upon existing and newly-acquired knowledge on harmful algal blooms.

Results

Expert system models have been developed and tested with available data across Europe. The following (potentially) harmful algal species have been addressed:

- *Nodularia spumigena*
- *Phaeocystis globosa*
- *Dinophysis acuminata and D. acuta*
- *Alexandrium minutum*
- *Karenia mikimotoi*

The expert system models use simple knowledge rules to quantify cause-effect relations in the chain of processes involved in harmful algal bloom formation and their effects. Uncertainties in the knowledge rules are included in the model predictions by using fuzzy logic.



Example of a model set-up: the model for *Nodularia spumigena*

The biomass development and transport of *Nodularia spumigena* in the Baltic Sea and Gulf of Finland could be simulated accurately (see Figure below). Surface temperature, wind speed and phosphate concentration have been identified as the most critical factors for bloom development of *Nodularia spumigena*.

The timing of harmful algal events due to *Dinophysis acuminata* and *Karenia mikimotoi* along the Irish south-west coast could be predicted correctly in almost all 10 years where data were available. Only in one year it was (falsely) predicted that conditions were suitable, when in fact there was no harmful bloom.

For *Phaeocystis globosa* in Dutch and English coastal waters, the start of blooms was triggered by the underwater light climate. The maximum bloom intensity was related to fresh water input. The occurrence of foam on beaches was related to the presence of blooms, the wind speed and wind direction.

Alexandrium minutum blooms appeared related to nutrient rich enclosed areas, such as harbours in coastal waters near Barcelona. There was some evidence of strong winds and heavy rainfall reducing the probability of harmful events. Unfortunately there were only limited data available for model validation.

Potential exploitation by end users

Harmful algal blooms cause large economic losses every year in aquaculture throughout Europe, due to shellfish toxicity and mass fish mortality. Furthermore some harmful algal blooms lead to closure of beaches to tourists and have devastating effects on aquatic ecosystems. Prediction of blooms and insight in the impact of human activities on the frequency and intensity of blooms are needed to support water managers deciding on mitigating measures.

Within the HABES project the knowledge available on the main harmful algal species in Europe is integrated and made more accessible to coastal managers and policy makers. With the knowledge base and expert systems publicly available through internet, they can estimate the relative importance of different natural and anthropogenic factors affecting harmful algal blooms. The project website: www.habes.net will be maintained at least until 2008.

The knowledge rules in the models and information from literature on the processes in the models are documented in a so-called 'knowledge base' publicly accessible through internet.

The expert system models that have been developed for each of the selected algal species have been made as much as possible generic. This means that the processes in the models have been analysed in different European areas and the controlling processes are similar for all European waters included in the project. On the project website model simulations can be performed online. This allows for sensitivity analyses, for example.

Furthermore the process of model development resulted in a better insight in what knowledge and data are required to allow for better predictability of harmful algal bloom events. One of the conclusions is that high frequency, long term monitoring is required for reducing the uncertainty about relations between anthropogenic forcings and harmful algal bloom events.