

# Satellite observations and forecasting can mitigate effects of toxic algae blooms

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In Norway, a national harmful algae bloom (HAB) monitoring service operates each year during the main bloom season from March to October. This ALGEINFO service publishes weekly information on a public web-site (<http://algeinfo.imr.no>) about the algae bloom situation along the coast of Norway.

During alert HAB situations, an operational co-ordination centre is established to perform analysis of the bloom, make decisions and disseminate information to the authorities, the industry (fisheries, aquaculture), the public and mass media.

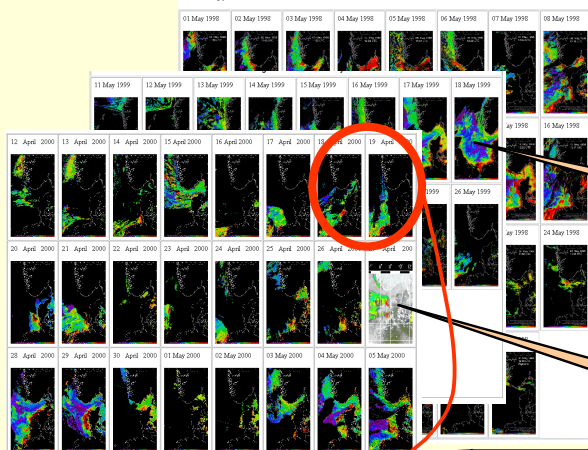
It appears that the **early warning** and **prediction** capability of the current monitoring system are limited due to the small number of offshore measurement stations and the trans-boundary nature of algae bloom.

To facilitate successful mitigation actions, an additional service based on **daily analysis of Earth Observation (EO) data** and **numerical forecasting** have been implemented in order to overcome the above limitations. The main component is the provision of daily information on algae blooms at a regional scale, based on the analysis and interpretation of ocean colour EO data. This information is made available to experts through a web-site at the Nansen Center ([www.nrsc.no/Decide-HAB](http://www.nrsc.no/Decide-HAB)).

A main constraint on the system and service is the delay of accessibility to the information. An important part of the information flow, including EO data reception and processing, data transfer and daily update of the web site, has been automatized in order to ensure the delivery of information about the bloom situation within 6 hours after data acquisition by the satellite.

Daily analysis of SeaWiFS-derived products

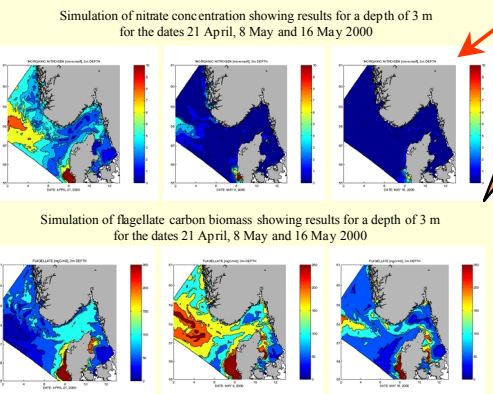
SeaWiFS-derived chlorophyll pigment concentration database covering March - July 1998



March - July 1999

March - July 2000

The bloom of the flagellate, *Chattonella* sp., was first observed by satellite off the western coast of Denmark on 18 April 2000, and confirmed two days later by *in situ* measurements. The 3D coupled physical-ecosystem model NORWECOM, used to predict the bloom development, was initialized using SeaWiFS-derived chlorophyll pigment concentration from 18 and 19 April.



Results of simulations indicated that as of 8 May the highest concentrations of flagellates (dominated by *Chattonella* sp.) at a depth of 3 m were still located primarily along the coast of Denmark. A high-concentration band extended also from the northern tip of Denmark westward through the Skagerrak. The overall distribution of the HAB corresponded well with satellite observations of distributions for sea-surface temperature and chlorophyll. The simulation also indicated that nitrate in surface waters would be rapidly depleted by the growth of the bloom. Based on the weather forecast for the area, prediction for HAB development indicated that the bloom would enter a phase of decline by 16 May and would not present an immediate threat to aquaculture installations along the southern coast of Norway. This forecast was immediately communicated to the Fisheries Authorities. The prediction was consistent with SeaWiFS and NOAA-AVHRR image obtained from May 14, and with *in situ* measurements.

- Capability of Decide-HAB service**
- Ability to give early warning about potentially harmful algae blooms
  - Information is directly accessible on a web-site
  - Information is updated on a daily basis under cloud-free conditions and thus complements the weekly updated ALGEINFO service
  - Better integration of the regional dimension of the HAB events, including open-ocean monitoring
  - Potential improvement of regional co-operation with neighbouring countries
  - An archive of 300 SeaWiFS images of bloom conditions during 1998 - 2000
  - Integration of EO products with numerical forecasting modelling has the potential to improve the quantitative predictions of development and decay of identified blooms.

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In Norway, a national harmful algae bloom (HAB) monitoring service operates each year during the main bloom season from March to October. This ALGEINFO service publishes weekly information on a public web-site (<http://algeinfo.imr.no>) about the algae bloom situation along the coast of Norway. During alert HAB situations, an operational co-ordination centre is established to perform analysis of the threat, make decisions and disseminate information to the industry (fisheries, aquaculture), the public and mass media. It appears that the **early warning** and **prediction** capability of the current monitoring system are limited due to the small number of offshore measurement stations and the trans-boundary nature of algae bloom.

To facilitate successful mitigation actions, additional services based on **daily analysis of Earth Observation (EO) data** and **numerical forecasting** have been implemented with the financial support of the European Space Agency in order to overcome the above limitations. The main component is the provision of daily information on algae blooms at a regional scale, based on the analysis and interpretation of EO data. This information is made available to experts through a web-site at the Nansen Center ([www.nrsc.no/Decide-HAB](http://www.nrsc.no/Decide-HAB)).

A main constraint on the system and service is the delay of accessibility to the information. An important part of the information flow, including EO data reception and processing, data transfer and daily update of the web site, has been automatised in order to ensure the delivery of first level information within 6 hours after data acquisition by the satellite.

The bloom of the flagellate, *Chattonella* sp., was first observed by satellite off the western coast of Denmark on about 18 April 2000, and confirmed two days later by *in situ* measurements. The 3D coupled physical-ecosystem model NORWECOM, used to predict the bloom development, was initialized using SeaWiFS-derived chlorophyll pigment concentration from 18 and 19 April.

Results of simulations indicated that as of 8 May the highest concentrations of flagellates (dominated by *Chattonella* sp.) at a depth of 3 m were still located primarily along the coast of Denmark. A high-concentration band extended also from the northern tip of Denmark westward through the Skagerrak. The overall distribution of the HAB corresponded well with satellite observations of distributions for sea-surface temperature

and chlorophyll. The simulation also indicated that nitrate in surface waters would be rapidly depleted by the growth of the bloom. Based on the weather forecast for the area, prediction for HAB development indicated that the bloom would enter a phase of decline by 16 May and would not present an immediate threat to aquaculture installations along the southern coast of Norway. This forecast was immediately communicated to the Fisheries Authorities.

The prediction was confirmed by SeaWiFS and NOAA-AVHRR image analysis and *in situ* measurements.

The demonstration experiment run between March and July 2000 enabled us to demonstrate the capability of the DeciDe-HAB monitoring service:

- Ability to alert authorities about potentially harmful algae bloom
- Information is directly accessible on a web-site
- Information is updated on a daily basis and thus complements the weekly updated ALGEINFO service
- Better integration of the regional dimension of the HAB events is achieved
- Potential improvement of regional co-operation with neighbouring countries can be obtained
- An archive of 300 SeaWiFS images of bloom conditions is maintained
- Integration of EO products with numerical forecasting modelling has the potential to improve the quantitative predictions of development and decay of blooms.

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