Tutorial 7: Images of Ocean colour in the coastal zone

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Objectives according to DoW

• to introduce the coastal waters

• to get insight in important functional aspects by analysing ocean colour images

• basic aspects of ecosystems and nutrient loading, and why light and turbidity are important for the food web in our highly-productive European waters.
Structure

• Our Scientific Background
• SEOS Cases
Repeatedly evaluated as the best environmental research institute in the Netherlands

14% core finance; 86% projects (EU, NL Governmental Institutes, Netherlands Science Foundation, NGOs, Industry)

Remote Sensing activities
- Fundamental Biology (PP and Fluorescence PhD)
- Radiation Transfer and Inversion (PhD)
- Environmental Policy Support (HAB monitoring EEZ)
- Data-model Integration (Silt and Dredging Port of Rotterdam)
<table>
<thead>
<tr>
<th>Drivers</th>
<th>Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure</td>
<td>Nitrogen run off to Coastal areas</td>
</tr>
<tr>
<td>State</td>
<td>Eutrophication</td>
</tr>
<tr>
<td>Impact</td>
<td>Ecosystem changes Habitat loss</td>
</tr>
<tr>
<td>Response</td>
<td>Policy on the use of fertilizer</td>
</tr>
</tbody>
</table>

**Indicators: Cause-Effect Relationships**

- RS products
- Chlorophyll
- SPM
- CDOM
- Kd
- PP
- Fluorescence
The Ocean Colour Module: Forces

- Biology
- Ecology
- Physics
- Geography
- Teacher expertise
- European Curricula

- HTML Pages

- Bachelors
- New Media
Cases

- Ecosystems: eutrophication
- Health: harmful algae blooms and quality of products such as fish and shellfish
Welcome to the Module Ocean colour in the coastal zone

Did you know that about 21 million euros of damages was caused by an algal bloom reaching the Dutch mussel and oyster fields in 2001?

Introduction

Why is coastal water quality important? Coastal water quality is something that influences our daily lives. Approximately 41% of the world’s population is living within 100 km of the coastline (Martinez et al., 2007). Coastal water quality is affected by human activities such as fisheries. Numerous consumer products such as shellfish are produced in the coastal zone.

Development of an algal bloom
Source: Institute for Environmental Studies (VU-IVM)

In this module you will learn...

... what role of light is for life in the sea and our safety
... what the effect is of discharging an excess of nutrients
... how remote sensing can help to indicate eutrophication
... what the effects of algal blooms are on our health
... how to interpret satellite and airborne images in terms of pollutants
... what can be done to improve our coastal water quality
Index

1. Light and life
   The role of light in water
   - Water
   - Water colours
   - Light for life; photosynthesis
   - The carbon cycle and greenhouse effect
   - Dissolved dead organic material (DOM)
   - Sediment
   - Rivers
   - Attenuation as a danger

2. Ecosystems
   Visualisation of the human impact on coastal ecosystems
   - Biodiversity
   - Coastal ecosystems
   - Food-chains
   - Nutrients & Primary Production
   - Phytoplankton
   - Noctiluca Scintillans

3. Eutrophication & Health
   How algal blooms are related to our food and health
   - Eutrophication
   - Harmful and nuisance algal blooms
   - Phaeocystis
   - Risk assessment
   - Detect Phytoplankton Blooms from Space
   - Help us to warn for algal blooms
   - Measures to protect coastal waters

5. Retrieve your own Chlorophyll
   - A direct link to the North Sea coastal Ecosystem
   - Eutrophication indicator threshold
   - Health: Extraction of CHL values at certain locations

6. Thesaurus
   A short list with difficult names in many languages

7. References
   A list of references of literature and data sources as well as suggestions for further reading.

8. Image Credits
   A list of all images used in the module with indications of their sources

9. Links
   A list of useful external links dealing with the topic (e.g., references, data sources, research projects, case studies)

10. Authors
    A list of the authors who created the learning module about Ocean Colour in the coastal zone.

11. Worksheets
    A list of worksheets and related information for use in class
        (This link is only visible for teachers)
Phytoplankton Growth

Did you know that most algae are so small that sometimes a million of these small plants grow in 1 litre of seawater!
Material

**M 1 Algenwachstum in den Tiefen der Meere**

*M 1a: Lichtverhältnisse in Meerwasser unterschiedlicher Tiefen*

![Graph showing light penetration in different water depths](image)

**M 1c: Absorptionsspektren der fotosynthetisch bedeutsamen Pigmente aus Grün-, Braun-, und Rotalgen**

![Graphs showing absorption spectra of pigments](image)

Coastal Ecosystems

The coastal sea has a high biodiversity of fauna and is of large importance for birds, fish and mammals. A large range of different ecosystems can generally be found in coastal waters, comprising a closely connected system of life in the seabed (benthic), in the water (pelagic) and even above water (birds).

Human Impact

Did you know That human activities are considered to be part of the coastal ecosystem!

Ecosystems

Questions

Q 1. Can you provide a list of activities that take place near your coast?

Q 2. Can you describe for each activity how it might impact an ecosystem. What activity is the most harmful for your coast? Of course every coastal system is different, but here we will provide some general answers:

Large Trawlers
Source: www.nauttek.nl

Fishing, both on the seabed and in the water. Fish and shellfish are a major source of food and large quantities have been consumed. This has resulted in many placed in extinction of species or limiting the reproduction capacity, thereby reducing the health of the population. The fishing on the seabed can strongly reduce the habitat of many benthic life forms.

Nutrient input from air and rivers. By changing the amount of nutrients, the balance of an ecosystem can get disturbed. This can lead to a change in algal composition, loss of biodiversity. This is covered in more detail in the section Eutrophication.

Transport by ships. The direct disturbance of an ecosystem by the presence of ships is limited. However, there are well known negative effects related to spills of oil and wastewater plus the import of invasive species.
Ecosystems

At the "Friese Front" the shelf sea ends and the deep sea begins. At this border nutrient-rich sediments collect at the bottom. This is a highly productive ecosystem with abundant growth of plankton, benthic fauna and flora, fish, birds and mammals.
Eutrophication

Coastal Shelf Seas

Pressure: High N and P load
Pressure: Fisheries
Pressure: Spatial Planning

2nd EARSeL workshop on Education and Training, Chania, June 2009
Algae: harmful blooms

State: Phaeocystis dominance in Spring
Impact: Benthic anoxia and annoyance

Commercial shellfish loss
From Ocean to coast
Connect to Module Marine Pollution
Normalized reflection Spectra

Coriolis Forces
Spectra from the Earth
Ocean Colour: A general introduction

We provide four worksheets plus complementary material for pupils:

- Worksheet Ocean Colour c01-Teacher Instructions Ocean Colour: The role of light in the water" 
- Worksheet Ocean Colour c02-Teacher Instructions Ocean Colour: Phytoplankton growth cycle and Eutrophication" 
- Worksheet Ocean Colour c03 and 04-Teacher Instructions Ocean Colour: Health and Improvement of Coastal Water Quality" 
- Worksheet Ocean Colour c05-Teacher Instructions Ocean Colour: Retrieve your own Chlorophyll by satellite"
Game
GIS functionalities and Earth Observation

Layers
- MWTL Monitoring stations
- Dutch North Sea thematic
  - Oil and gas area
  - 12 miles zone
  - 5 miles zone
  - Dutch part Continental Shelf
  - Shipping lanes
  - Anchoring sites
  - Ridge dumping sites
  - Conventional oil and gas
  - Sand extraction
- Topography
- Chlorophyll concentration

Additional data
- MWTL monitoring data
- Current weather
- Current water data
- Sea water temperature

Chlorophyll concentration (mg/m³)
- 0.0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 5
- 5 - 10
- No Data
Conclusions and Lessons Learned

- Bachelors
- New Media
- Teacher expertise

HTML Pages
Ocean Colour

Biology
Ecology
Physics
Geography

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