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The Interreg IVB North Sea Region Programme

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Groundwater threshold values derived for protection of associated aquatic ecosystems – a case study

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HYDRO'*ECO 2011*

May 2-5, Vienna, Austria

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CONTENT

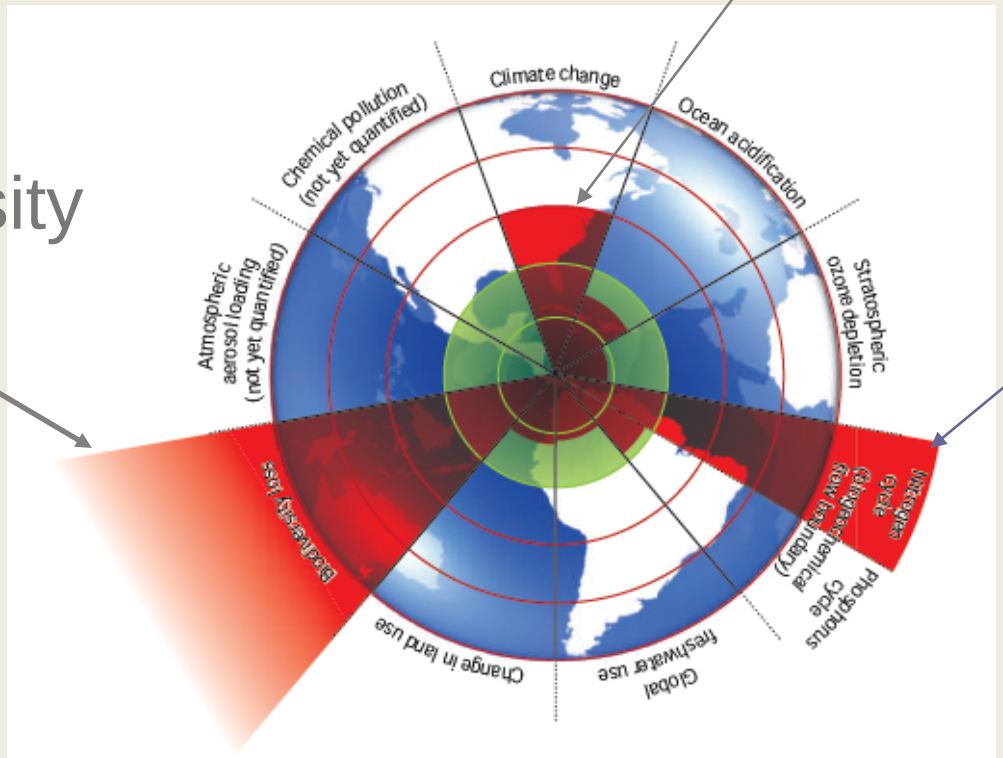
- Ecological status of marine ecosystems
- Required reductions in nitrogen (total N) and phosphorus (total P) loads to Horsens Estuary to ensure good ecological status
- Derivation of groundwater and stream threshold values for N and P based on good status objectives for Horsens Estuary
- Groundwater chemical status in the catchment to Horsens Estuary

Planetary Boundaries:

- **Are transgressed for[1,2]:**

3) Climate Change

1) Biodiversity loss



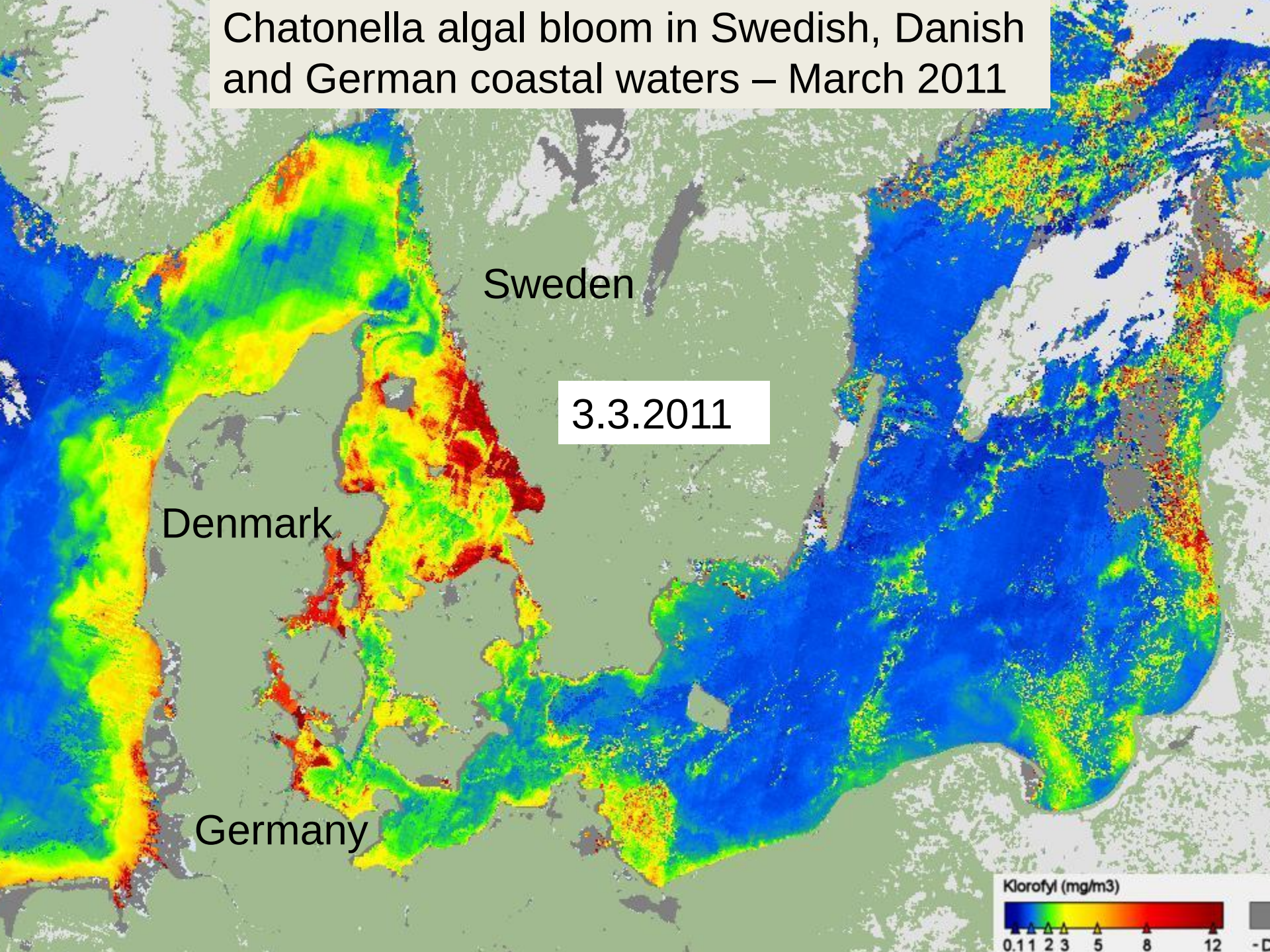
2) Nitrogen cycle

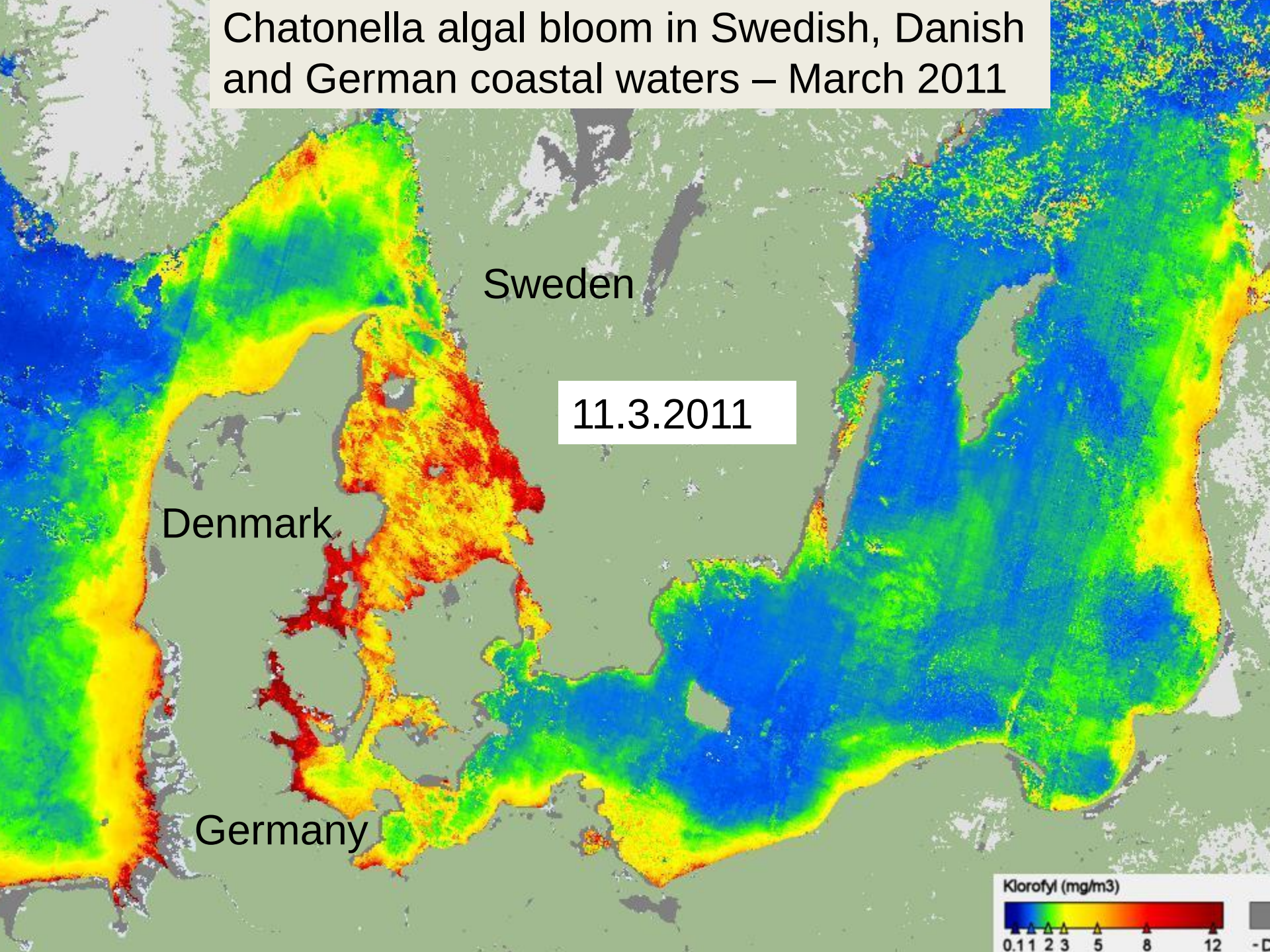
Rockström et al. (~30 env. Scientists from Europe, USA and Australia) suggest to reduce the human N-input to **25 %** of the present input

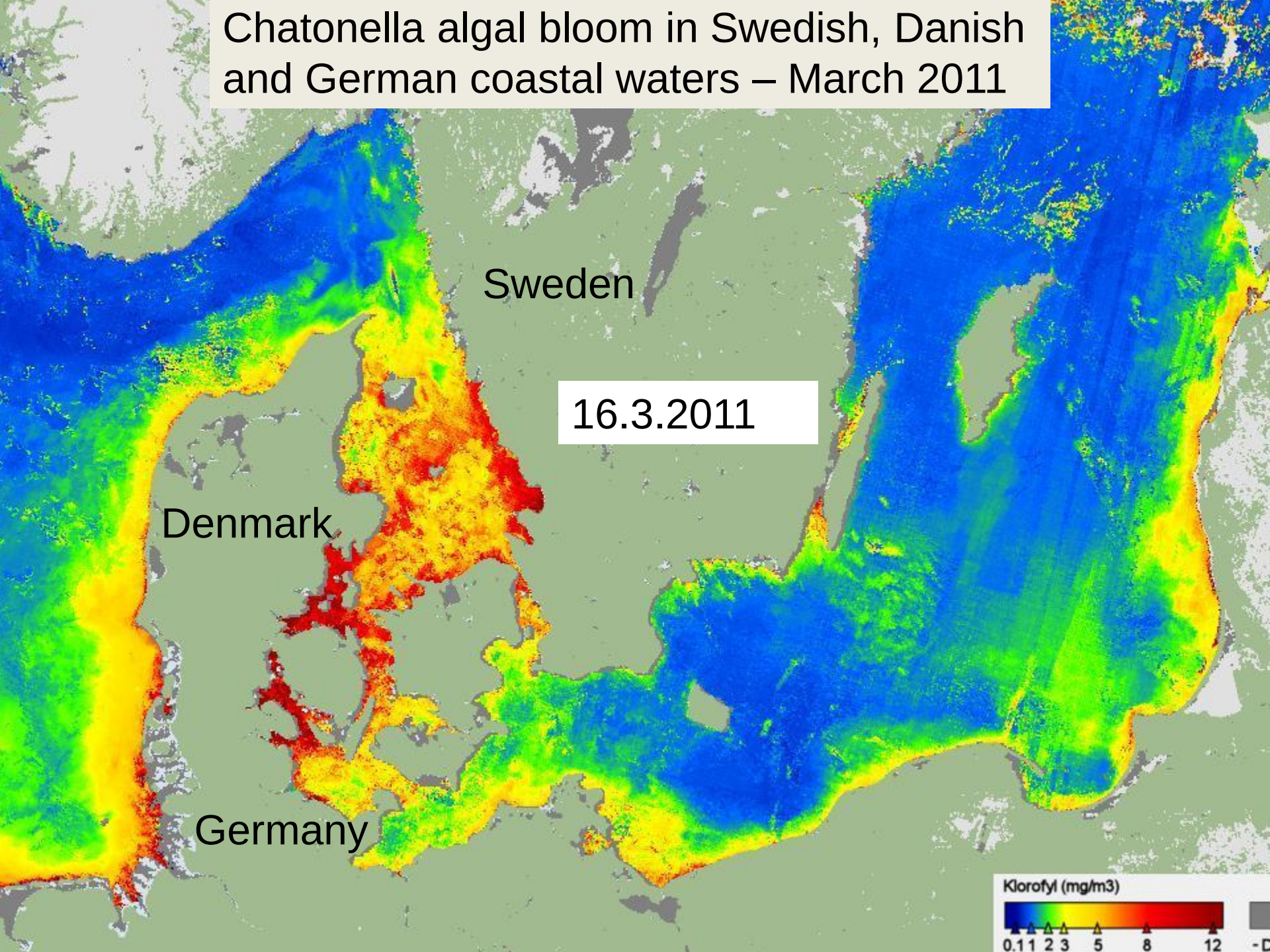
1. Rockström et al., Nature, 461, 472-475, 2009 and

2- Rockström et al., Ecology and Society, 14 (2): 32, 2009.

Chatonella algal bloom in Swedish, Danish and German coastal waters – March 2011




Chatonella algal bloom in Swedish, Danish and German coastal waters – March 2011
Sweden
11.3.2011
Denmark
Germany
Klorofyl (mg/m3)
0.1 1 2 3 5 8 12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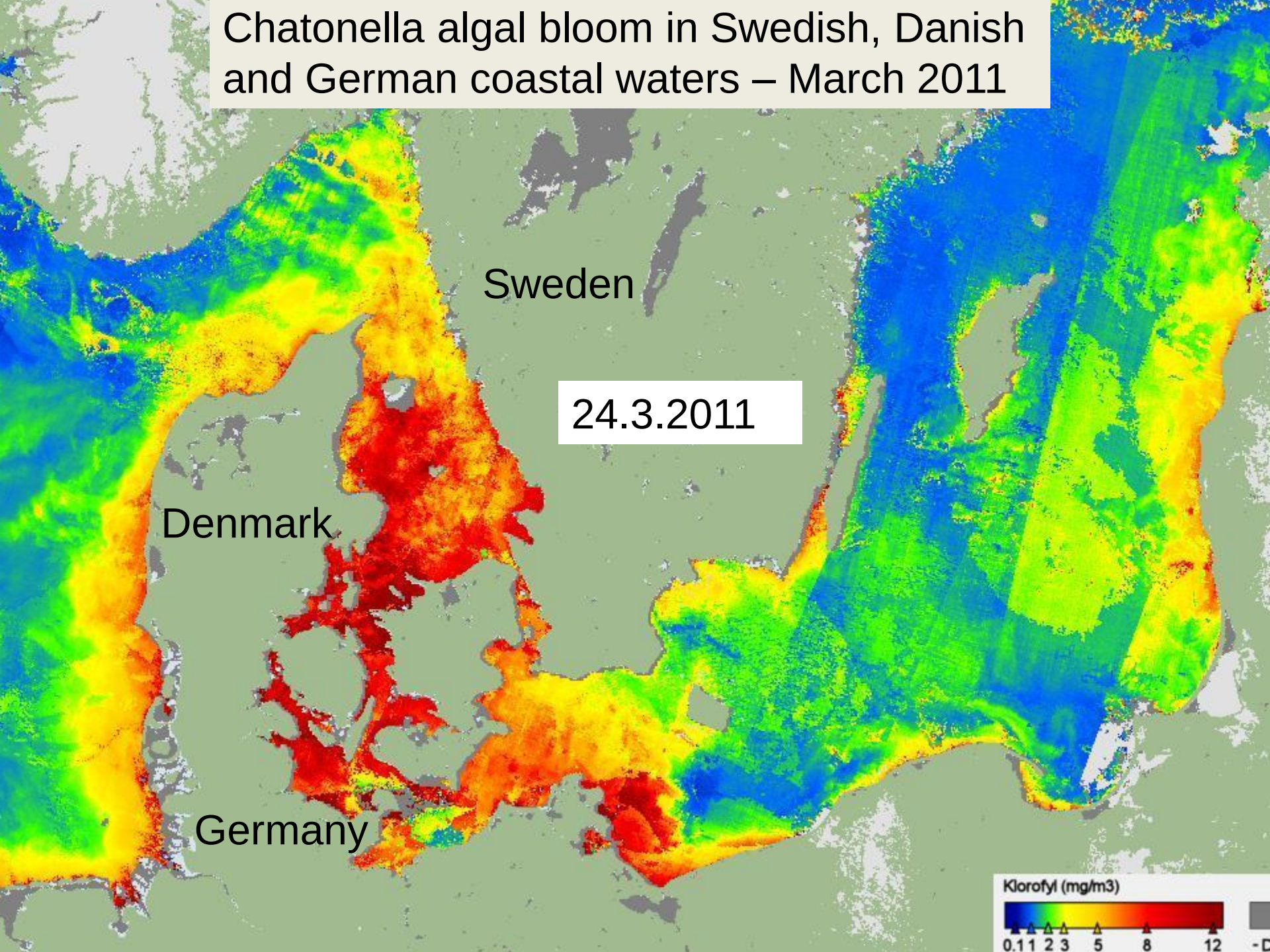
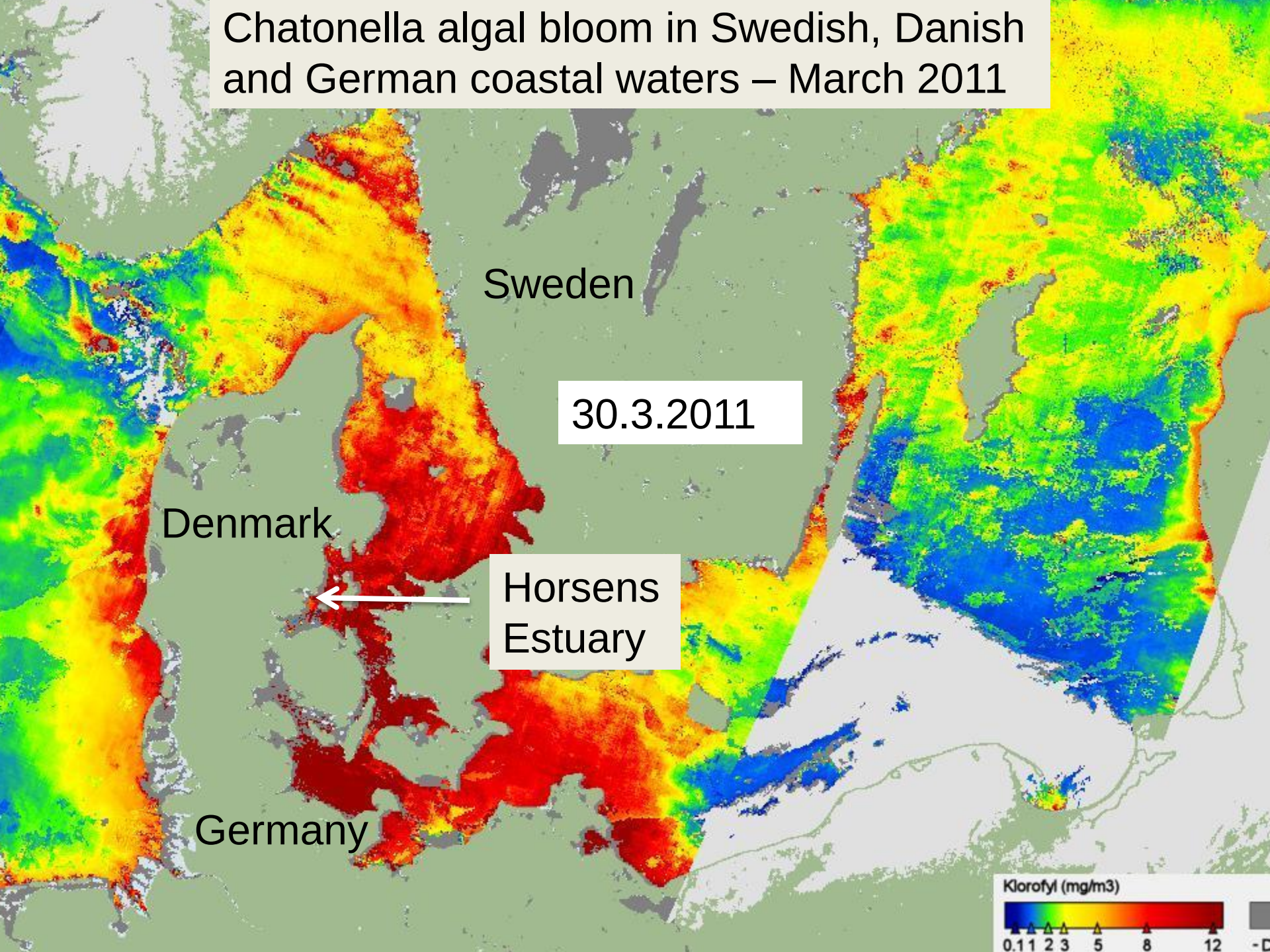
16.3.2011
Denmark
Germany
Klorofyl (mg/m3)
0.1 1 2 3 5 8 12


Chatonella algal bloom in Swedish, Danish and German coastal waters – March 2011
Sweden
24.3.2011
Denmark
Germany
Klorofyl (mg/m3)
0.1 1 2 3 5 8 12


Chatonella algal bloom in Swedish, Danish and German coastal waters – March 2011
Sweden
30.3.2011
Denmark
Horsens Estuary
Germany
Klorofyl (mg/m3)
0.1 1 2 3 5 8 12

Sea Floor Anoxia

(Horsens Estuary, Denmark)

Photo: NERI – Univ. Aarhus / Peter Bondo Christensen

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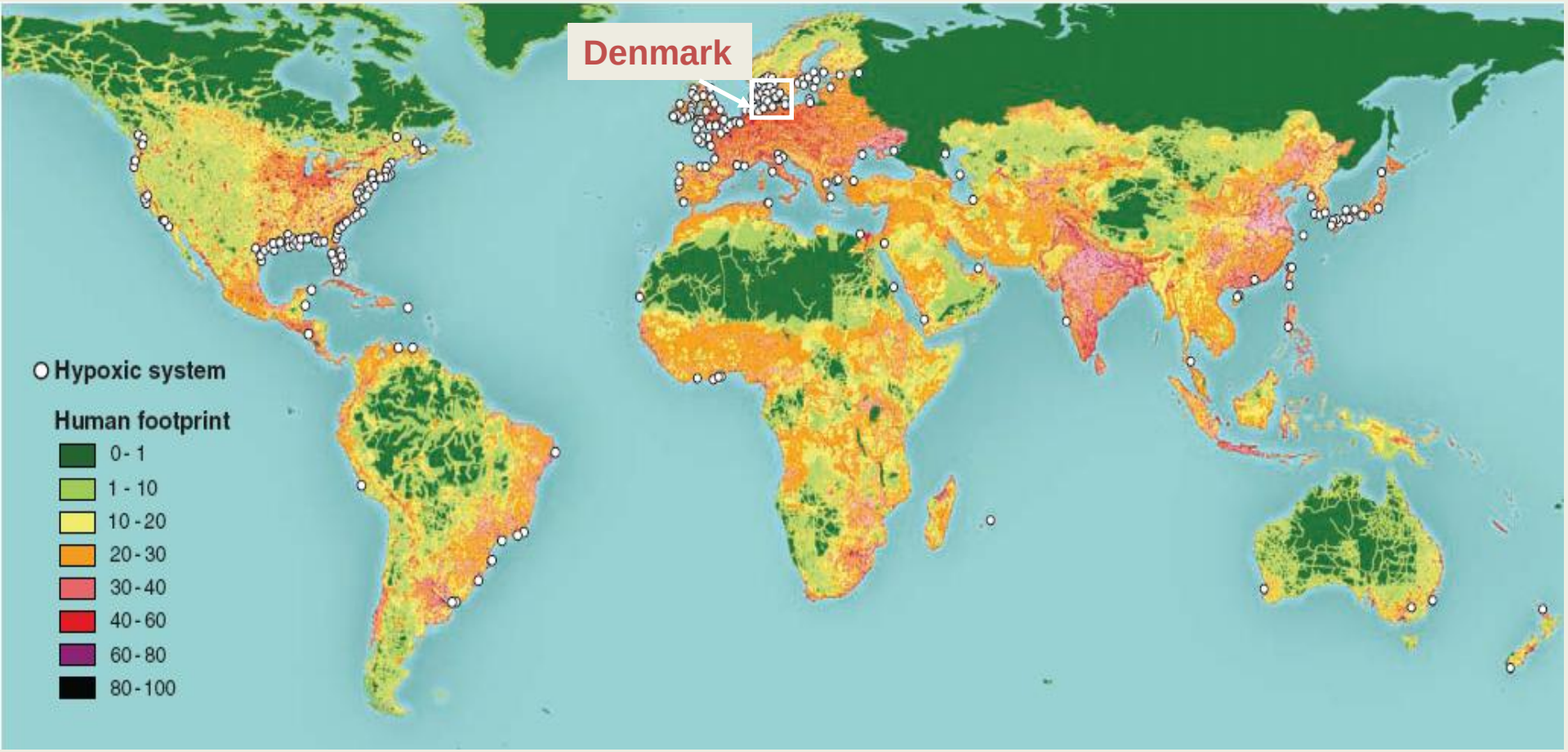
Global review of hypoxia (oxygen depletion) in coastal marine waters



Diaz and Rosenberg, 2008. Science, 321, 926-929

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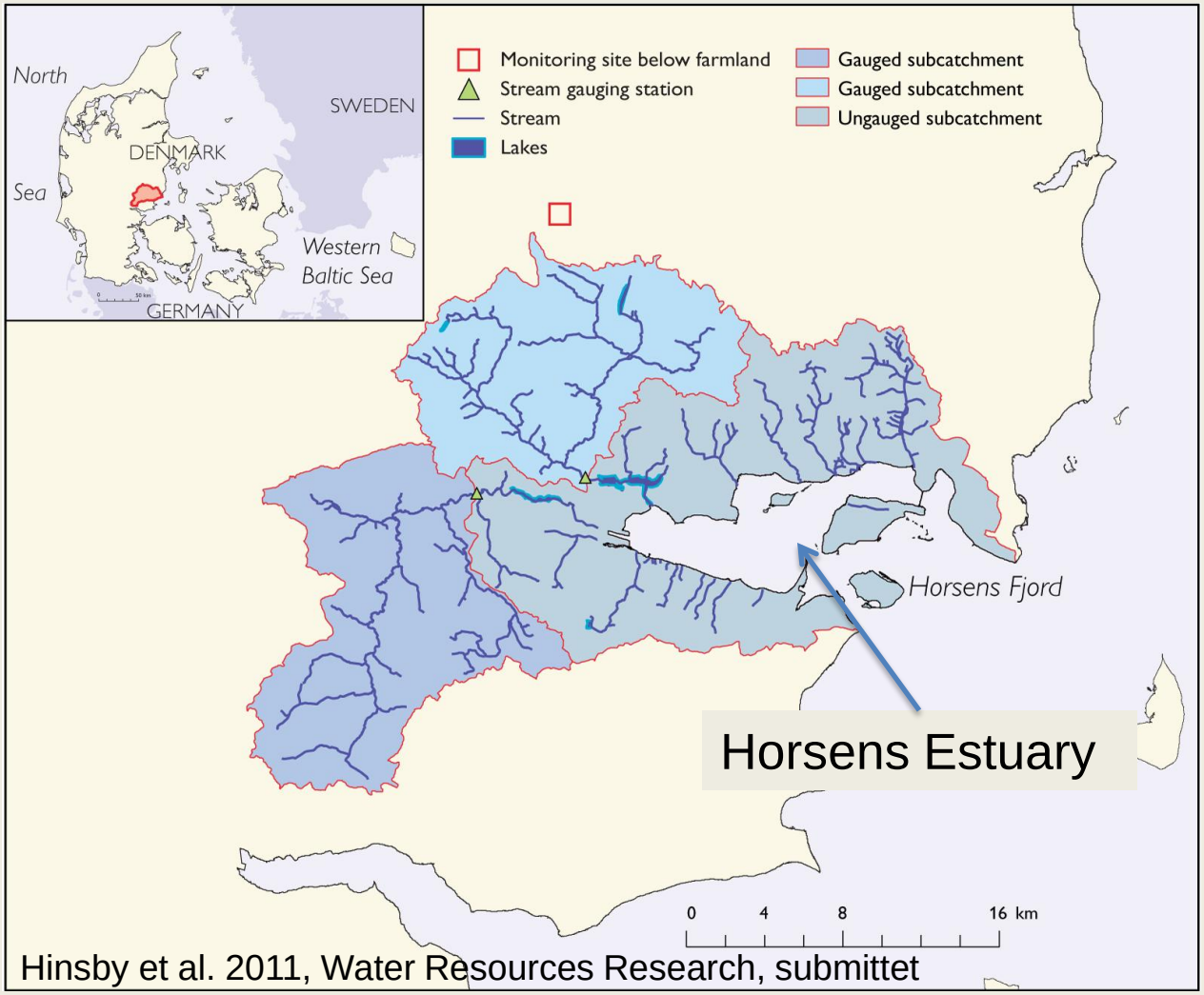
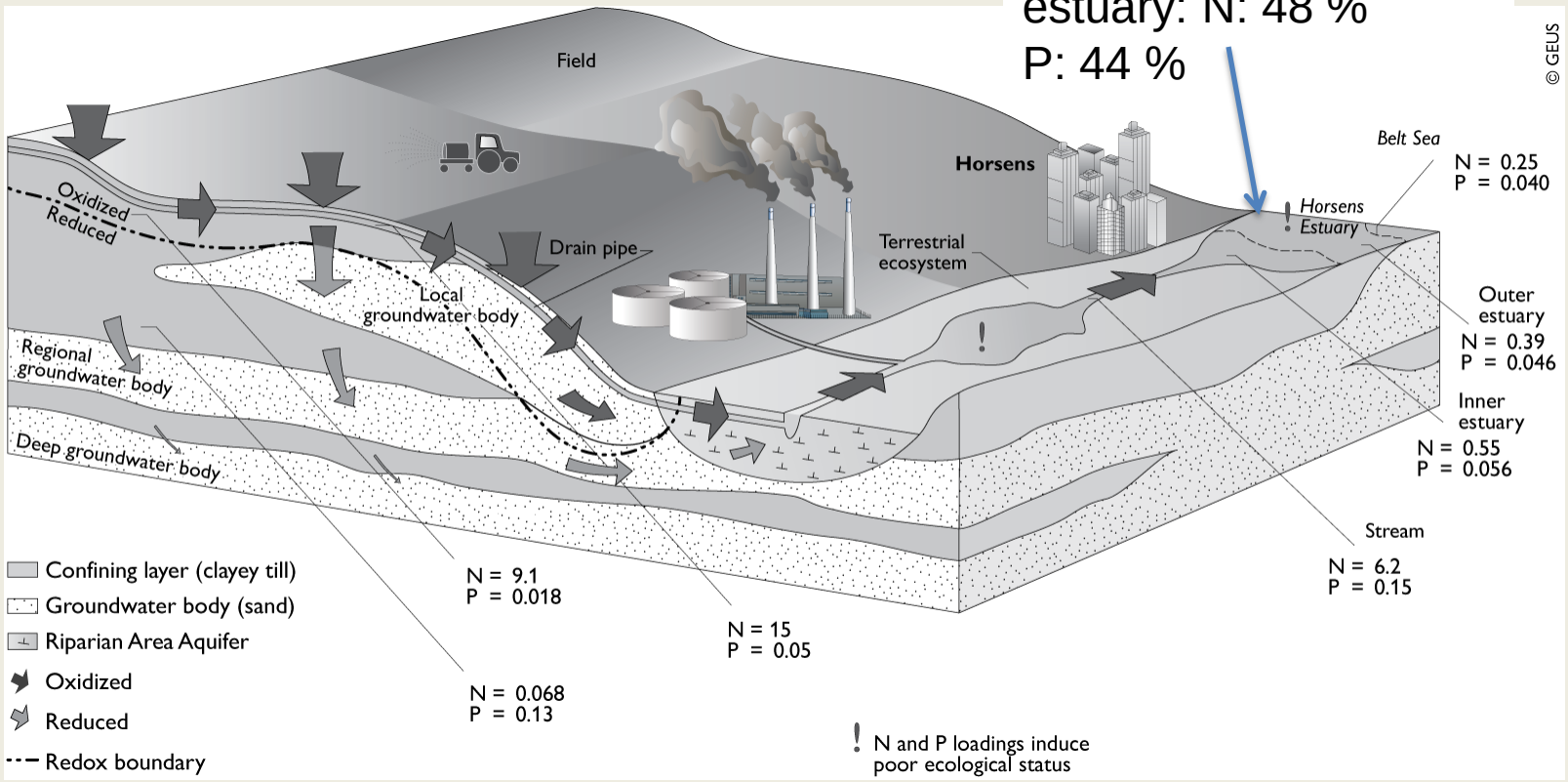
Location of study site



Hinsby et al. 2011, Water Resources Research, submittet

Conceptual model of the catchment to Horsens Estuary

Required reductions to estuary: N: 48 %
P: 44 %



Hinsby et al. 2011, Water Resources Research, submittet

N sources to Horsens Estuary

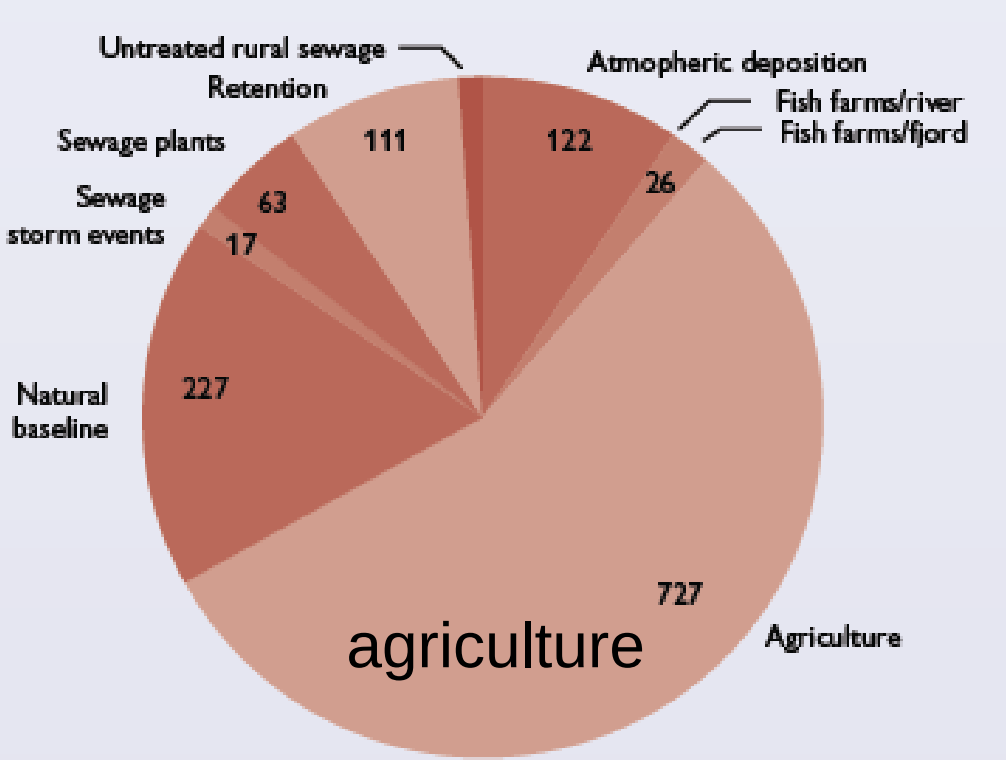
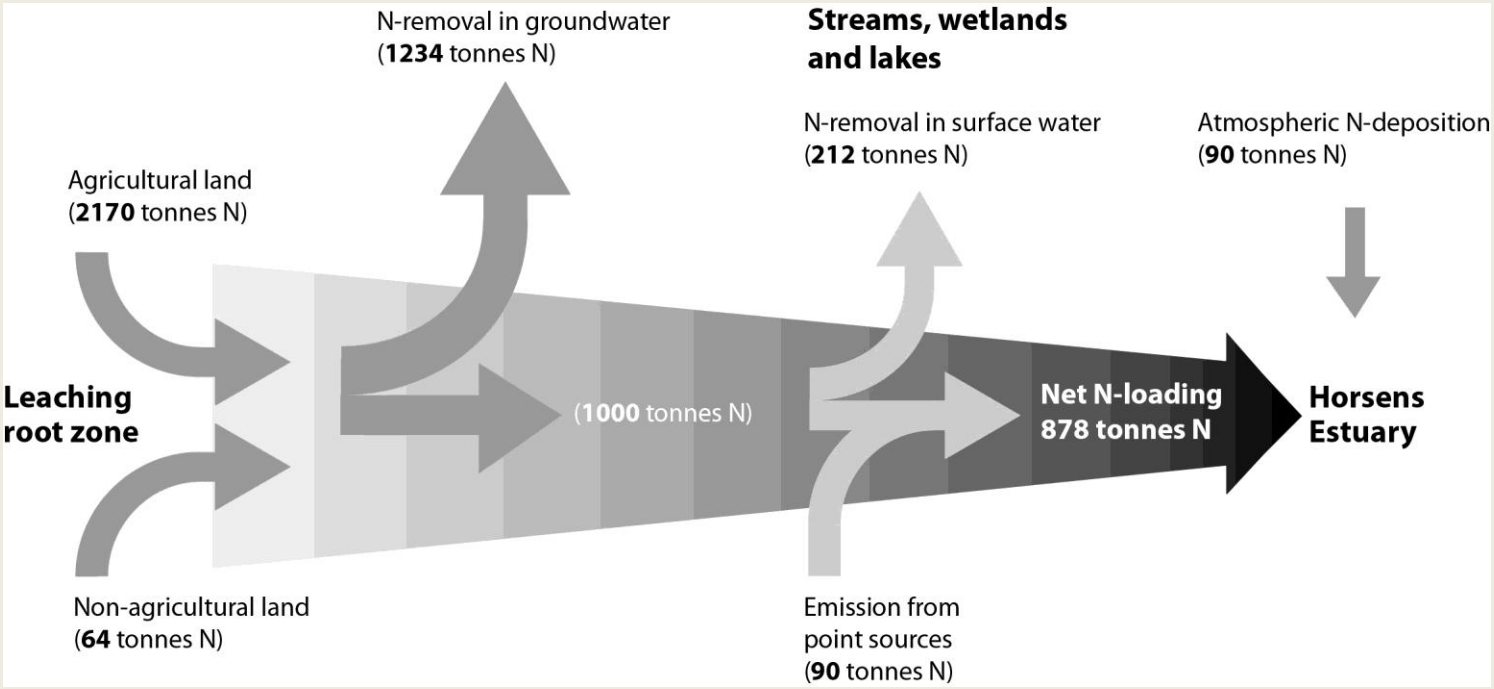


Figure 2. Annual nitrogen loads to Horsens Fjord from different sources (tons).

http://www.cfh-aih.fr/groundwater2008paris/Documents/posters/session1/Hinsby.pdf

N-cycling in study catchment



Hinsby et al. 2011, Water Resources Research, submittet

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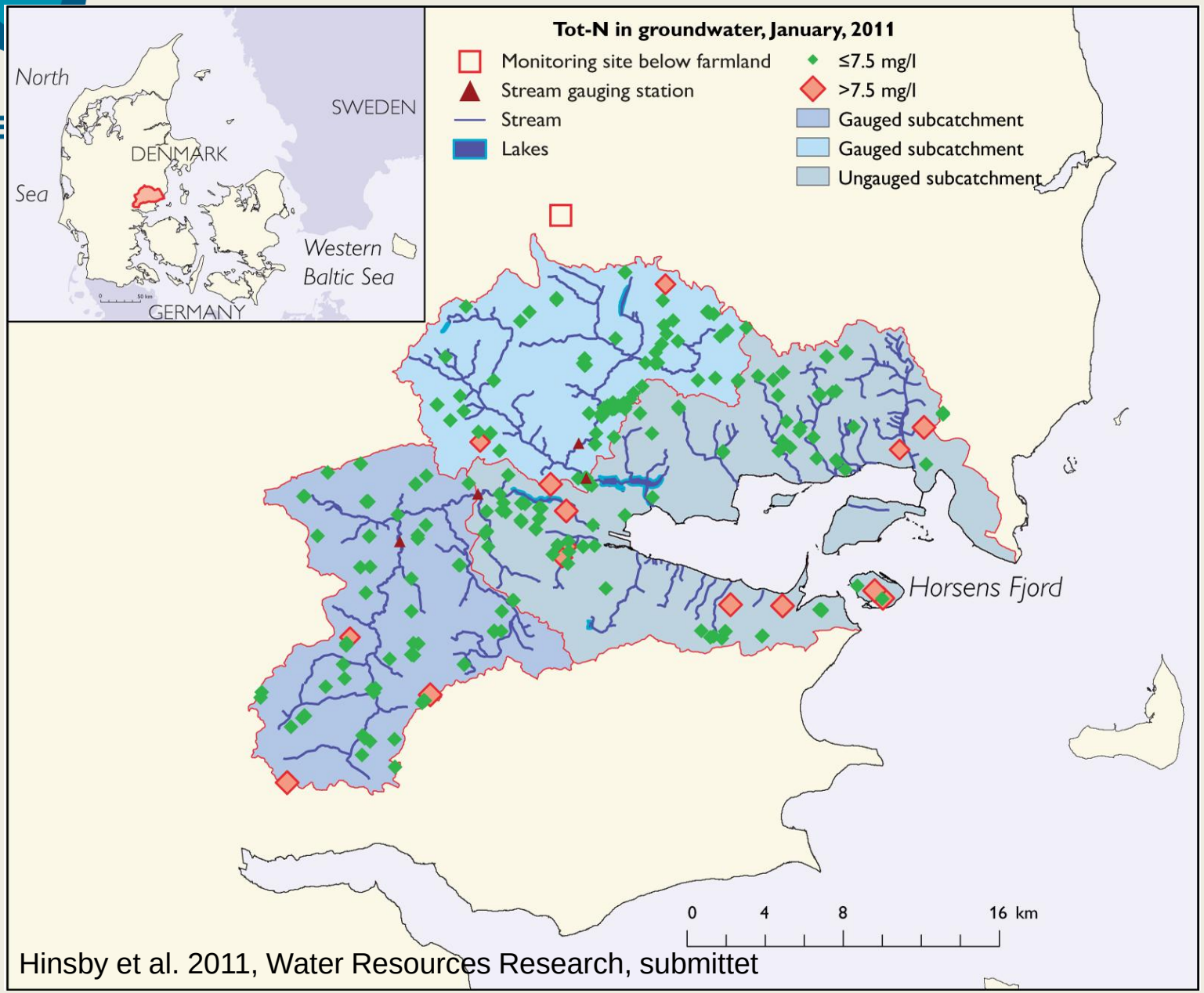
Estimated TVs

Table 6. Groundwater and stream threshold values (TV) for total N and total P computed for the three different scenarios (management options) described in the text. All values are in mg/L.

		TV Scenario 1	TV Scenario X	TV Scenario 2
Groundwater	Total N[a]	6.0	7.5	= 33 mg/L nitrate
	Total P	-?[b]	-?[b]	-?[b]
Streams	Total N[c]	2.9	3.2	= 13 mg/L nitrate
	Total P	0.083	0.084	-

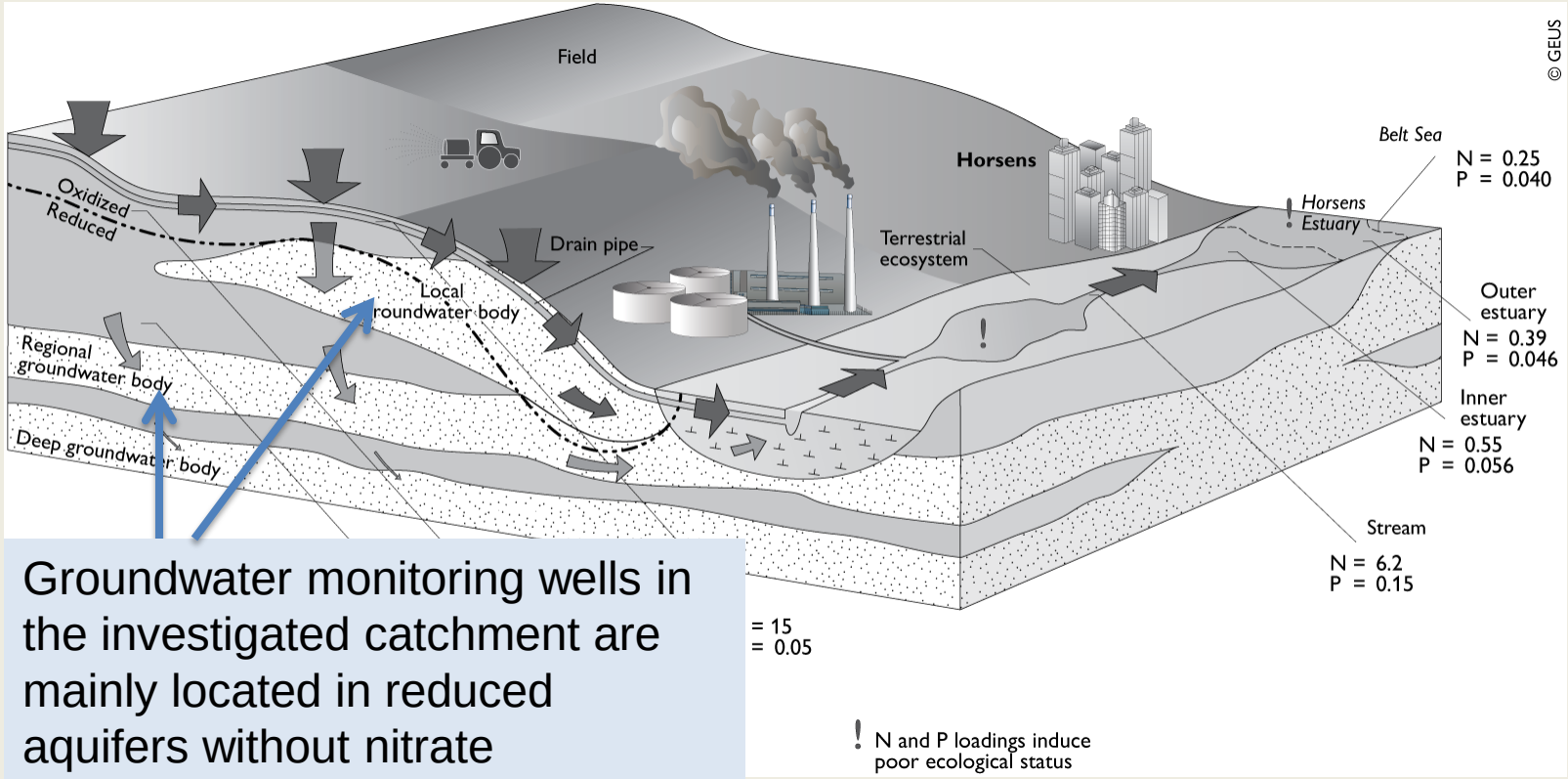
[a]The threshold values for nitrate-N in groundwater equals in practice the value for total-N based on measurements of both at monitoring sites. [b]Estimation still not possible - more research is needed. [c]The threshold value for nitrate-N in streams is about 89 % of the threshold value for total N based on measurements at monitoring sites.

Hinsby et al. 2011, Water Resources Research, submittet



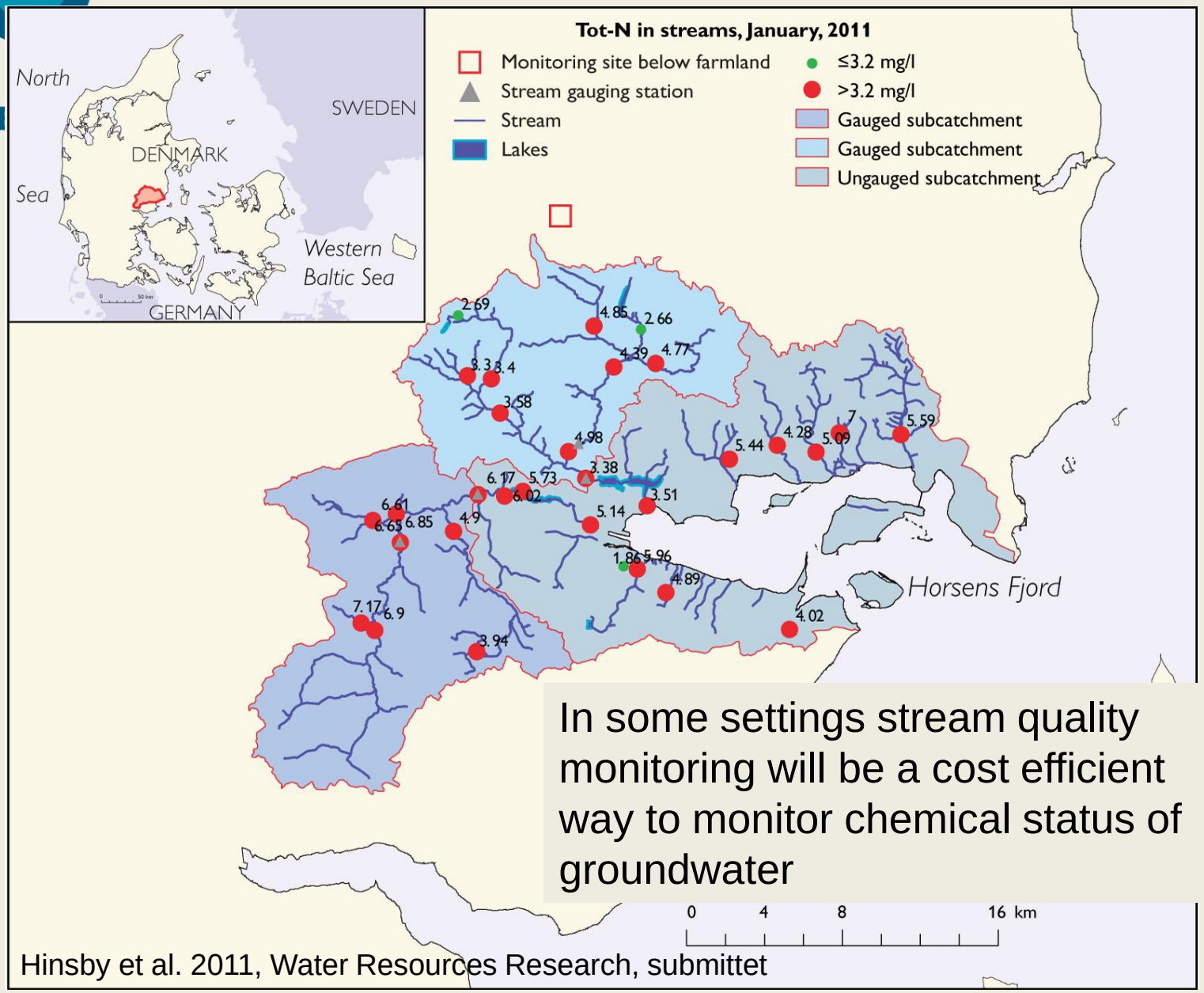
Hinsby et al. 2011, Water Resources Research, submittet

Conceptual model of the catchment to Horsens Estuary



Groundwater monitoring wells in the investigated catchment are mainly located in reduced aquifers without nitrate

Hinsby et al. 2011, Water Resources Research, submittet



In some settings stream quality monitoring will be a cost efficient way to monitor chemical status of groundwater

Hinsby et al. 2011, Water Resources Research, submittet

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Take home message(s):

- There is a strong need for estimation of nutrient loads and corresponding groundwater (and stream) threshold values that will ensure good ecological status of ecosystems

- Important tools for derivation of groundwater and stream threshold values include coupled groundwater and surface water models, a sound physical and biogeochemical description of the interface between groundwater and ecosystems and sufficient monitoring data of relevant parameters in time and space

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Thank you for your attention

☺

Algal bloom (cyanobacteria) in the Baltic Sea between Denmark and Germany, August 2006, Foto: Klaus Hinsby