THE ROLE OF ATMOSPHERIC NITROGEN IN THE BALTIC SEA EUTROPHICATION

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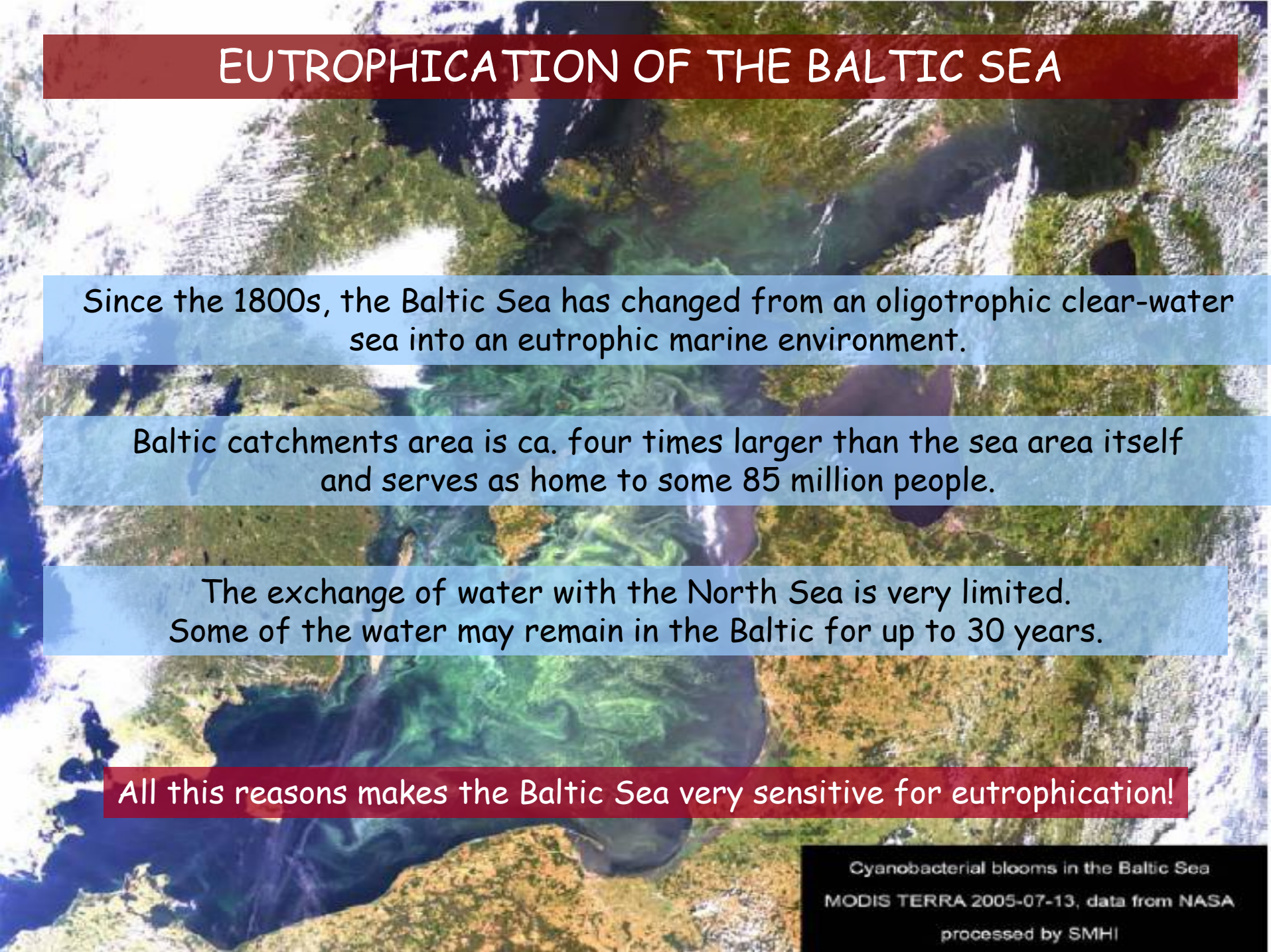
EUTROPHICATION OF THE BALTIC SEA

Since the 1800s, the Baltic Sea has changed from an oligotrophic clear-water sea into an eutrophic marine environment.

Baltic catchments area is ca. four times larger than the sea area itself and serves as home to some 85 million people.

The exchange of water with the North Sea is very limited.
Some of the water may remain in the Baltic for up to 30 years.

All this reasons makes the Baltic Sea very sensitive for eutrophication!

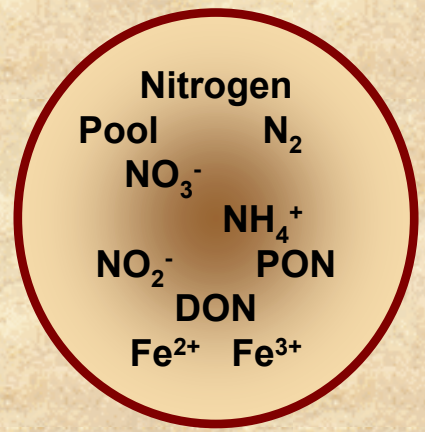


Cyanobacterial blooms in the Baltic Sea
MODIS TERRA 2005-07-13, data from NASA
processed by SMHI

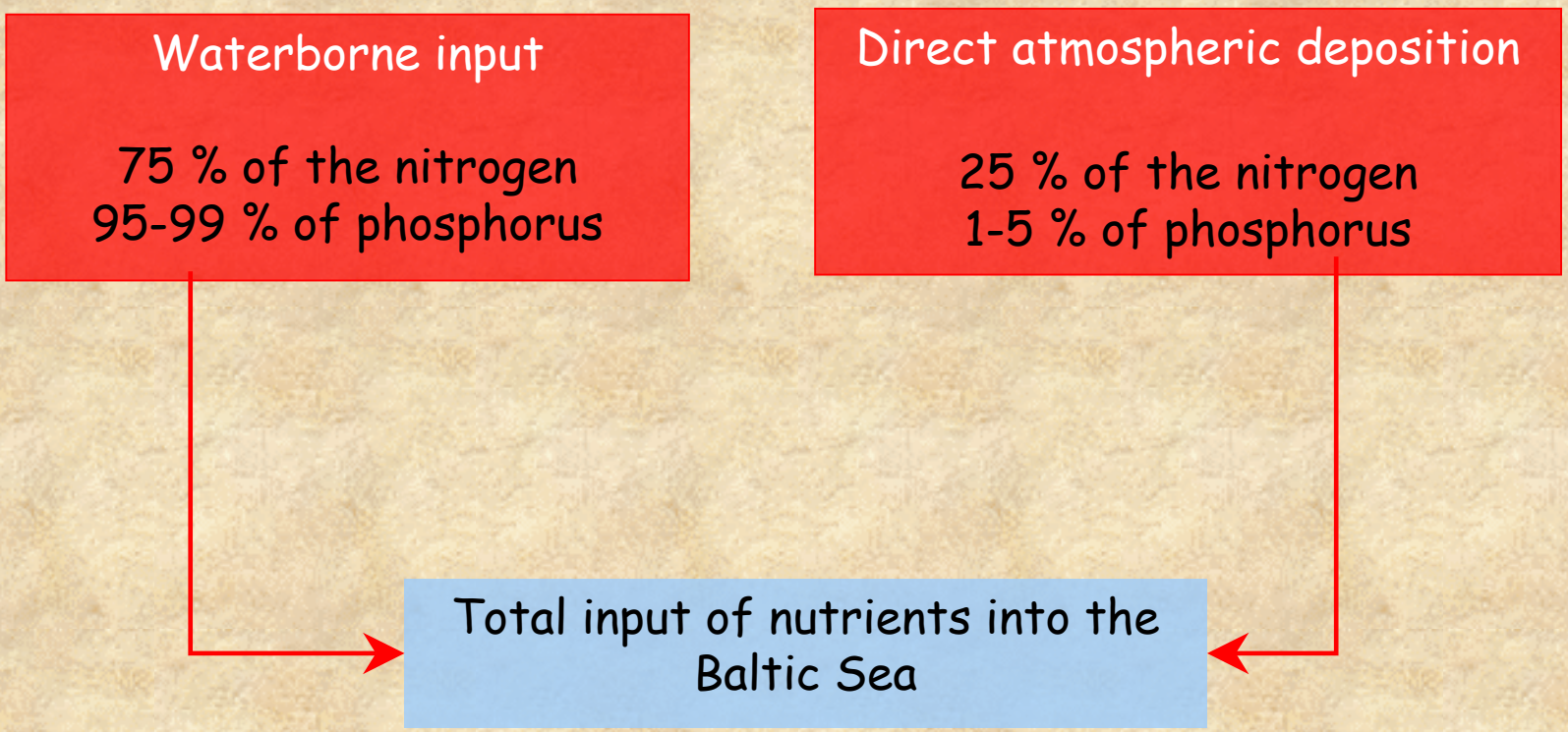
WHAT ARE THE MOST IMPORTANT SUBSTANCES CAUSING EUTROPHICATION OF THE BALTIC SEA?

Besides the discussed nitrogen and phosphorus compounds play an important role in primary production.

Iron is an element essential for biochemical functioning of phytoplankton but we still don't know much about Fe as limiting element.



SOURCES OF NUTRIENTS IN THE BALTIC SEA



SOURCES OF NITROGEN IN THE MARINE ATMOSPHERE

Agricultural fertiliser runoff

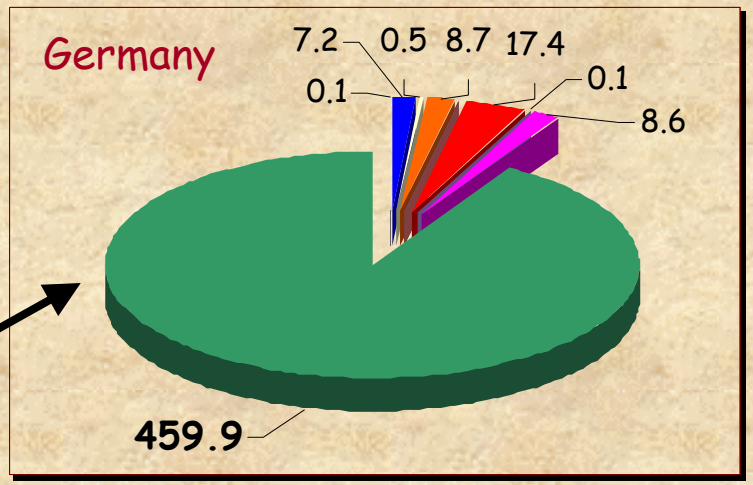
Evaporation from the fields

The combustion of coal and oil, (including transportation, waste combustion and industrial sources)

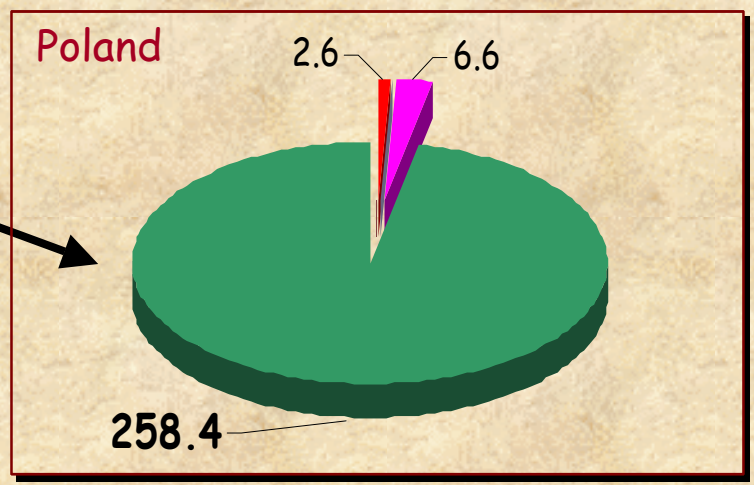
Power generation

Discharges of waste water

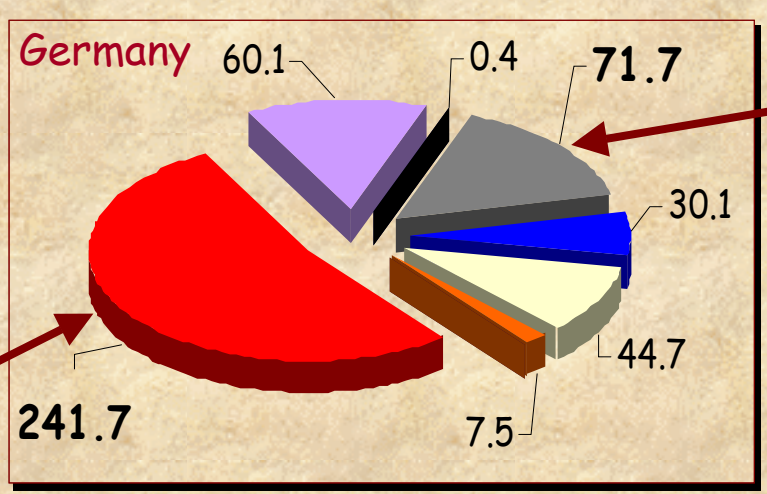
AMMONIA EMISSION MAIN SOURCES [kilotonnes of nitrogen] (HELCOM, 2005)



Agricultural emission

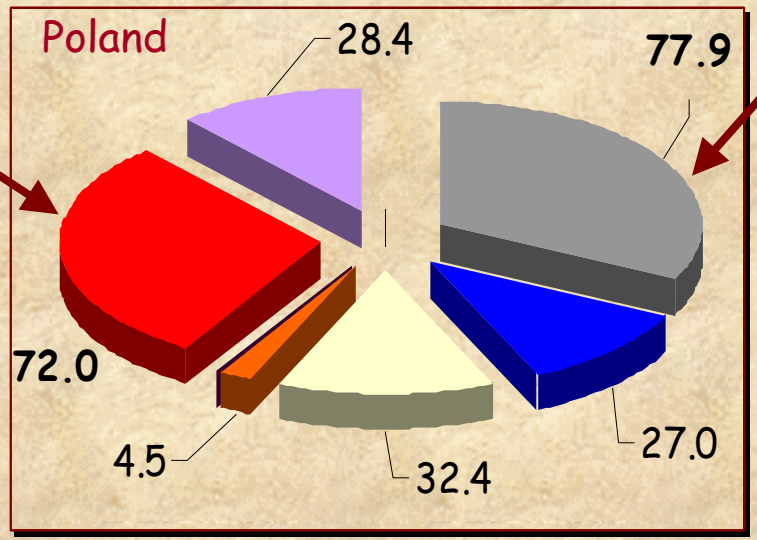


NITROGEN OXIDES EMISSION SOURCES [kilotonnes of nitrogen] (HELCOM, 2005)

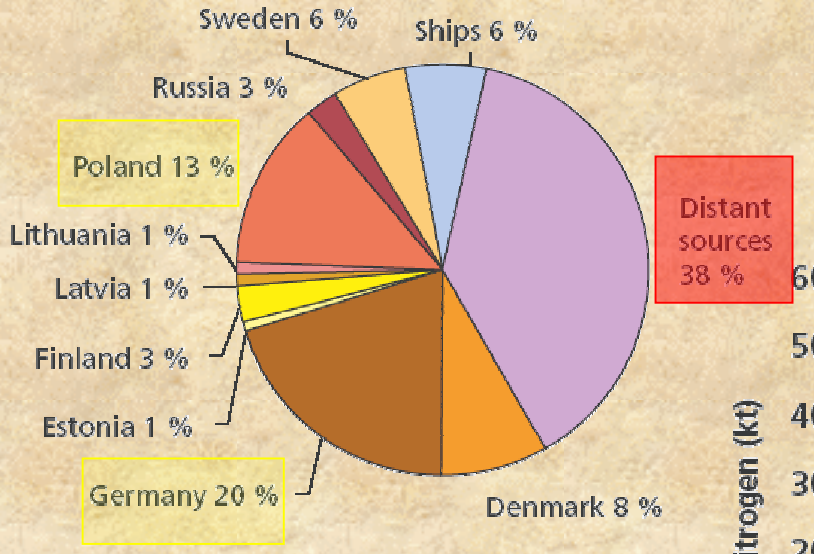


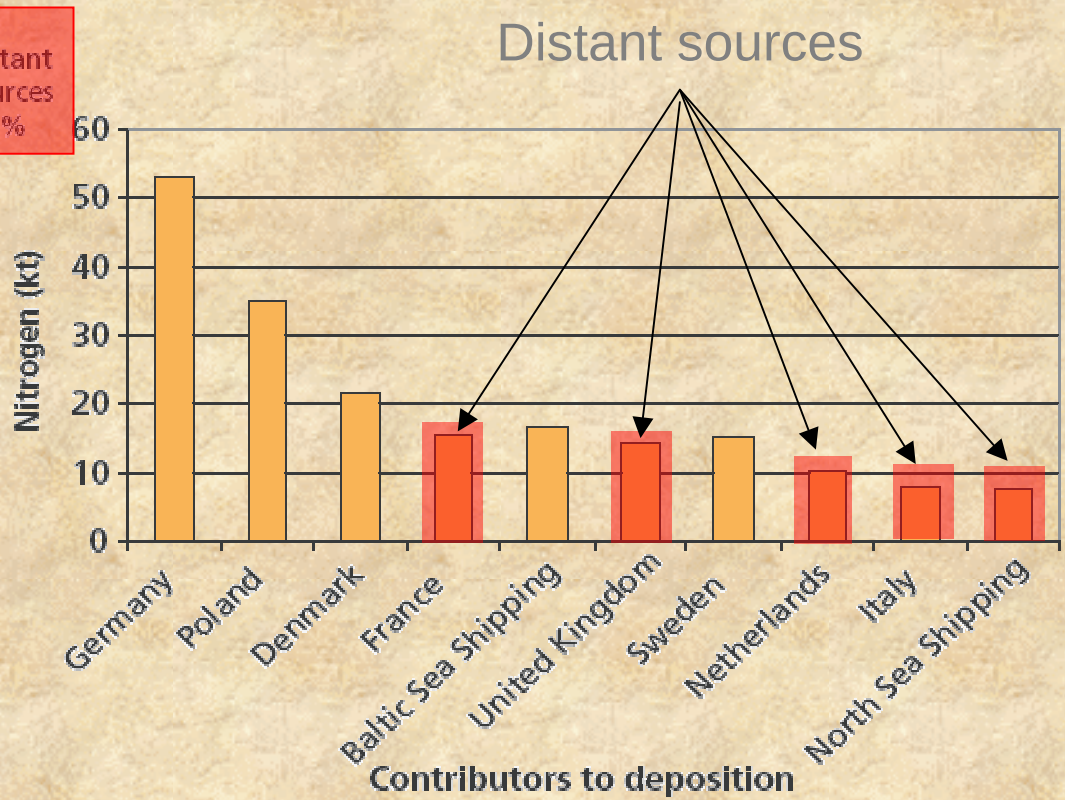
Combustion in the energy and transformation industry

Road transport

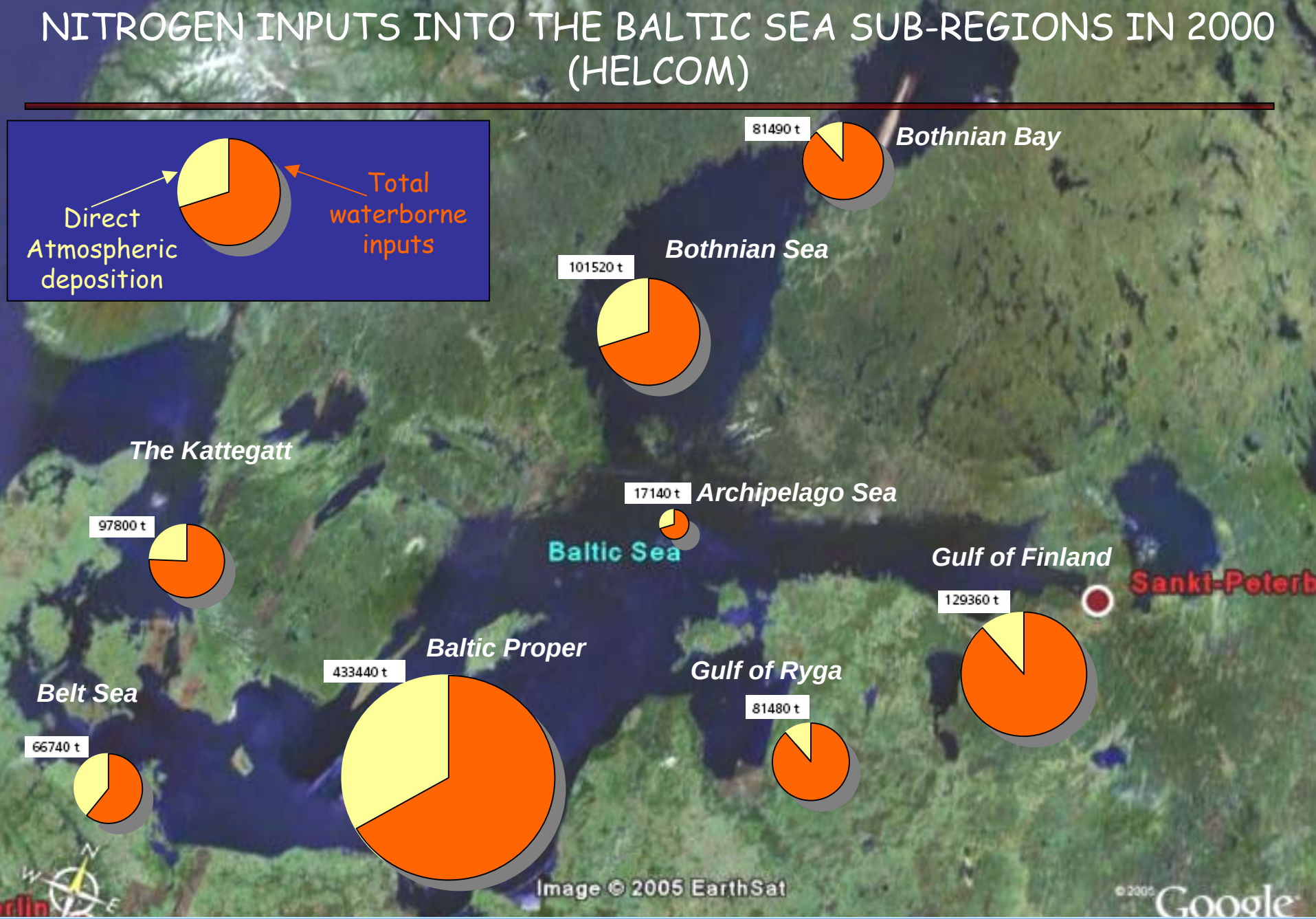


CONTRIBUTORS TO ATMOSPHERIC NITROGEN DEPOSITION INTO THE BALTIC SEA (HELCOM, 2005)





NITROGEN INPUTS INTO THE BALTIC SEA SUB-REGIONS IN 2000 (HELCOM)



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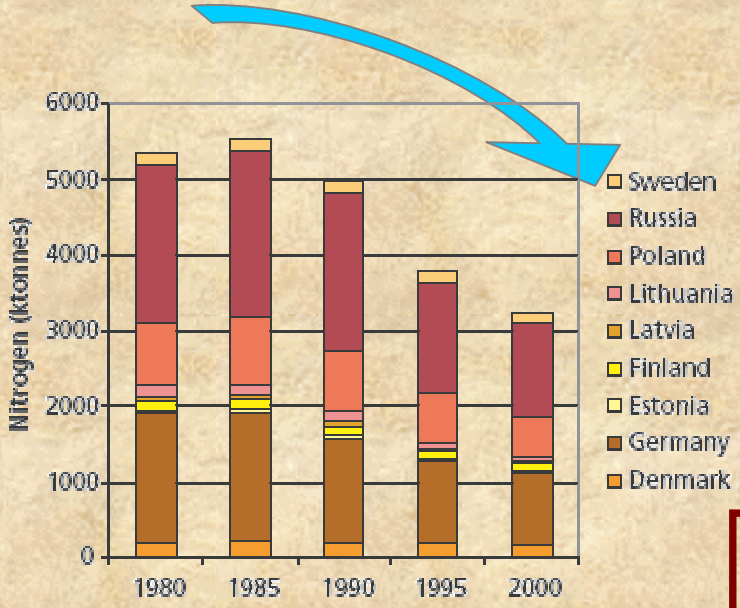
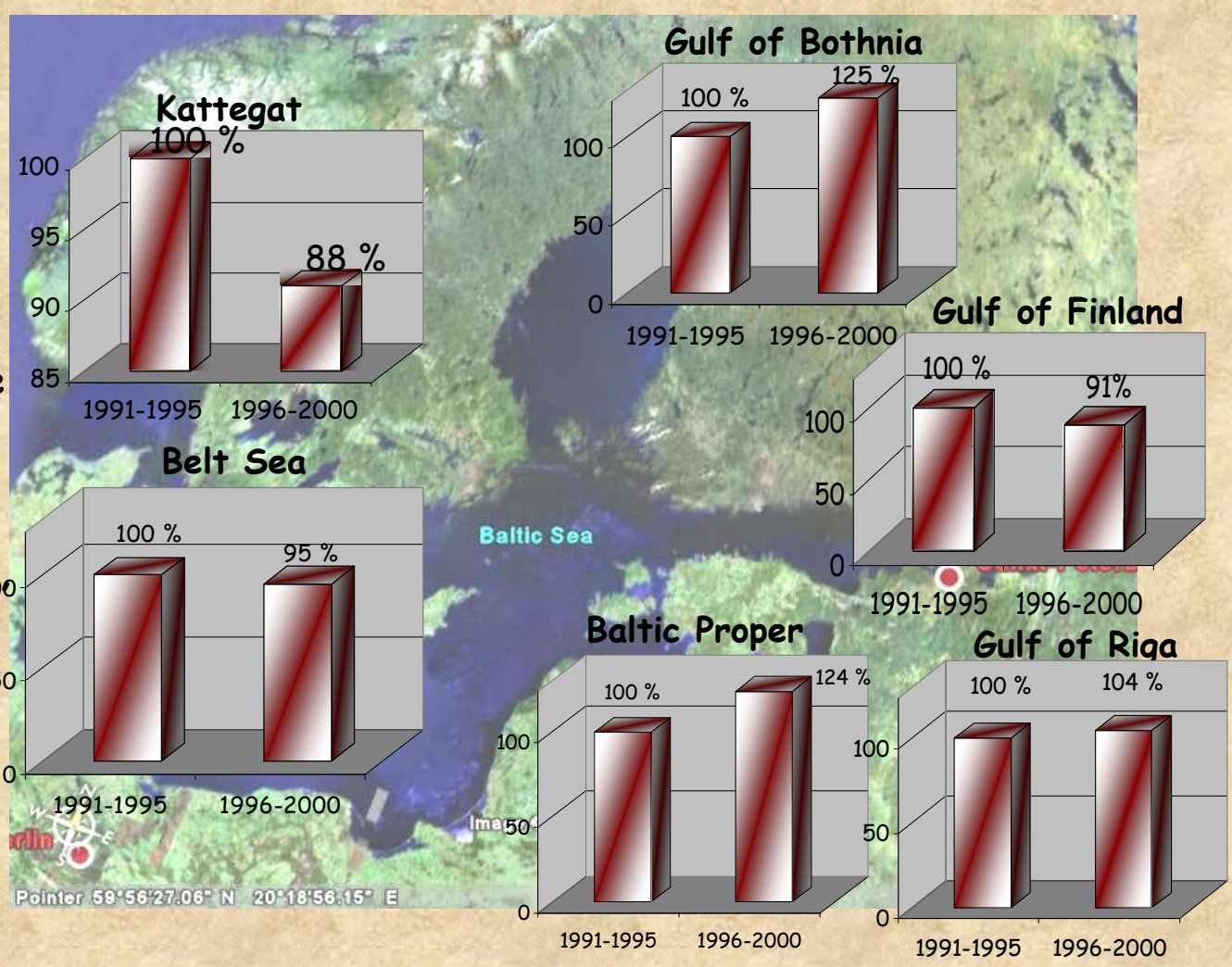
TRENDS IN ANNUAL EMISSION OF NITROGEN TO THE ATMOSPHERE (1980-2000)



But:
dicrease of emissions ≠
dicrease of atmospheric depositions

TRENDS IN ANNUAL DEPOSITION OF NITROGEN INTO THE BALTIC SEA (1991-2000)

1. Atmospheric nitrogen sources are much more difficult to contain.
2. Changing climating condition (precipitation, wind directions).
3. Distant sources.
4. Local sources.



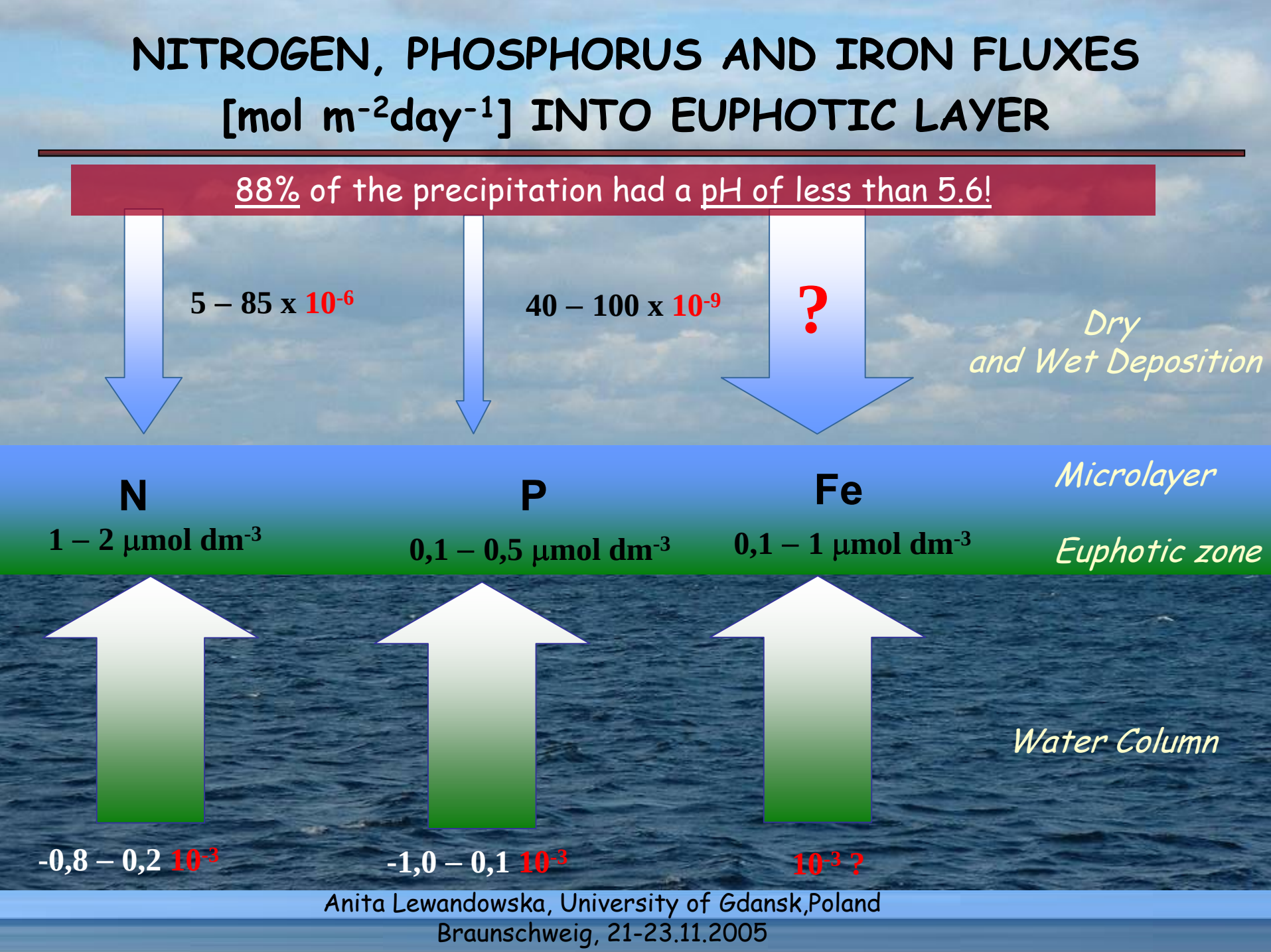

Poland is one of the major countries
that influences the nitrogen deposition into the Baltic Sea
Do nutrients
deposited from the air stimulate
primary production in the Gdańsk Basin?
Gdynia
Szczecin
Image © 2005 EarthSat
Google
Pointer 54°37'51.05" N 16°48'29.69" E elev -5 ft
Streaming 100%
Eye alt 131.78 mi

Can nutrients deposited from the air stimulate primary production in the Gdańsk Basin?

- *Which form of atmospheric deposition (wet or dry) more effectively supplies surface waters in nutrients?*
- *What are the specific conditions under which the enrichment of surface water in nutrients results in an increase of primary production?*
  - *precipitation pH,*
  - *solar radiation level in UV and PAR bands,*
  - *wind speed and direction,*
  - *air humidity and temperature,*
  - *atmospheric pressure?*
- *What is the time lapse of atmospheric input impact?*
- *Are there phytoplankton species stimulated by iron, phosphorus and nitrogen input from the atmosphere?*

NITROGEN, PHOSPHORUS AND IRON FLUXES [mol $m^{-2}day^{-1}$] INTO EUPHOTIC LAYER

88% of the precipitation had a pH of less than 5.6!



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SEMILABORATORY EXPERIMENTS

Spring/Autumn
(Cyclotella meneghiniana)

Summer
(Nodularia spumigena)

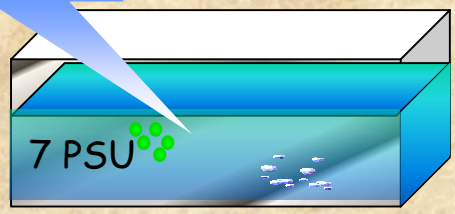
diatom „on fasting" -P, -N, -Fe

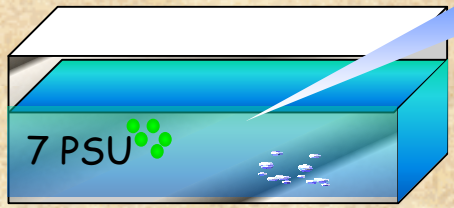
"without rain"

"artificial rain"

diatom „on fasting" -P, -N, -Fe

1)

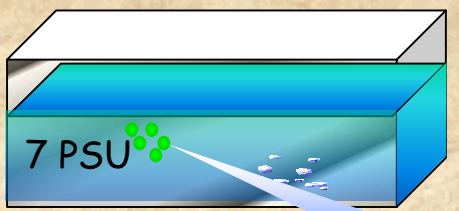




"artificial rain"

"without rain"

2)



background aquarium-diatom

background aquarium-diatom

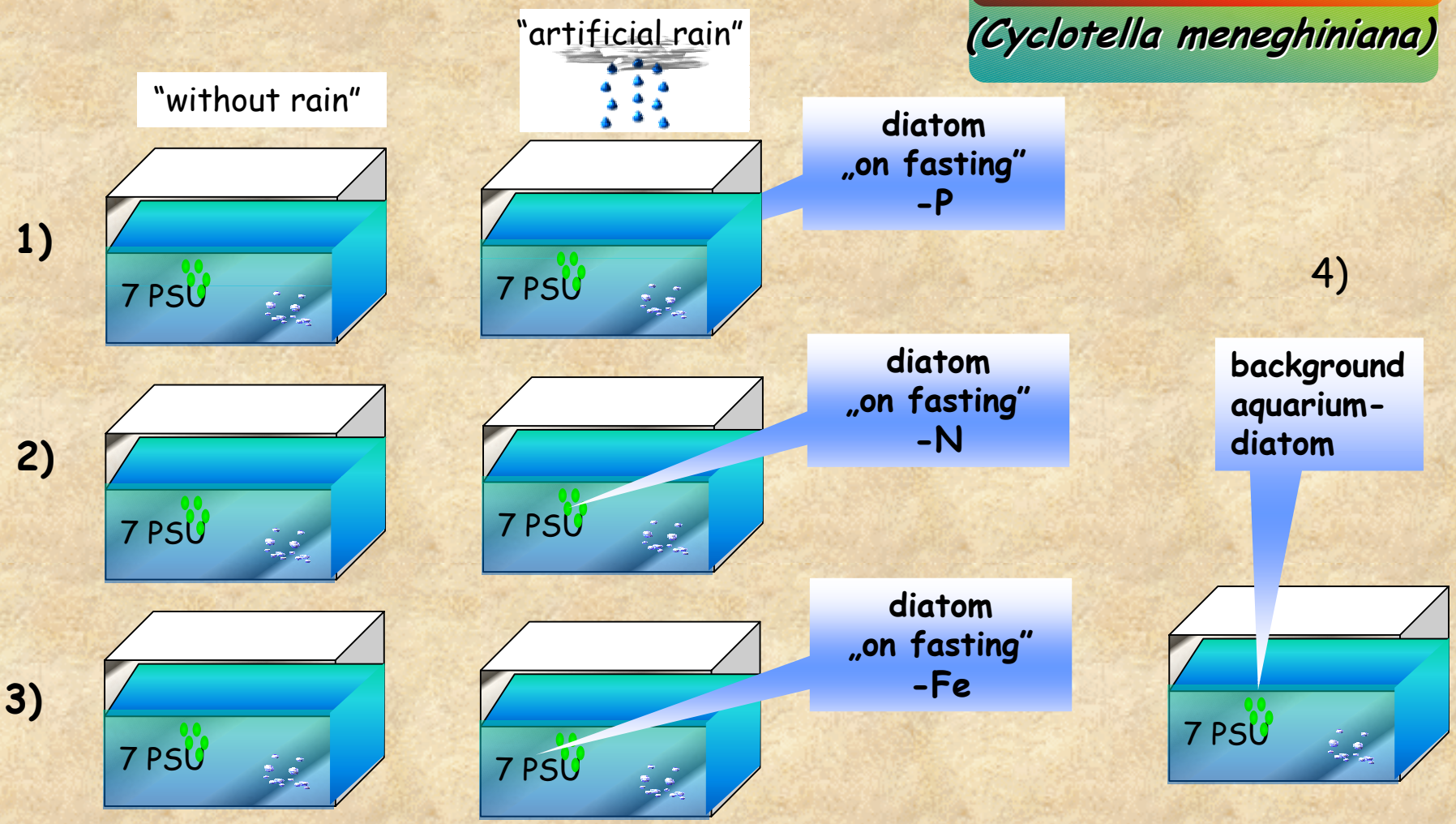
Measurements of:

- T, pH, S
- N_{TOT}, NO_3^-, NH_4^+
- P_{TOT}, PO_4^{3-}
- Fe_{TOT}, Fe(II), Fe(III)
- fluorescence
- chlorophyll - a
- phytoplankton concentration
- meteorological condition
- natural rain, aerosols and gases

LABORATORY EXPERIMENTS

(*Nodularia spumigena*)

(*Cyclotella meneghiniana*)



Conclusions

1. The direct atmospheric nitrogen deposition to the Baltic Sea makes up a large proportion of nitrogen input to sea.

2. Ammonia emission is mainly caused by agricultural activity while NO_x origin from combustion processes and road traffic.

3. Nitrogen originate from emissions to the air from inside as well as outside the Baltic Sea catchment area and from ship traffic.

4. Wet rather then dry deposition will stimulate the primary production.

5. Much more significant source of nitrogen in the Baltic sea coastal and estuarine waters seems to be the recirculation from sediments than atmospheric deposition.

6. More measurements, including semi-laboratory and laboratory experiments are needed to answer the question what is the role of atmospheric nitrogen in the Baltic Sea eutrophication.


Thank You