SMHI

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Spatial distribution of the winter nutrient pool 2012-2013

Key message

In general, the DIN concentrations for the Baltic Sea still remain below those observed in the 1993-2002 period. The concentrations of DIP is however still high.

Results and assessments

Relevance of the indicator for describing developments in the environment

Eutrophication is the supply of excessive amounts of nutrients to an eco-system. The spatial distribution of the primary bio-available nutrients, in the surface waters during the low-productive winter, shows the availability of nutrients for the spring bloom. The winter concentration of nutrients may also highlight problem areas and changes in the spatial distribution may indicate changes in the hydrography, or the effect of remedial work.

Dissolved inorganic phosphorous (DIP) is essential for phytoplankton development. While rivers deliver phosphorus to the Baltic Sea, most of this phosphorus is chemically bound to particles, and is not directly available for biological use. Large amounts of DIP enter the Baltic with inflows of salt water, and phosphorus is also released from bottom sediments during periods of anoxia. Deep water DIP can become bio-available if it is transported to the surface waters, but this transport is hampered by the permanent stratification. After the inflows of winter 2002 – 2003, phosphorus concentrations in the surface water of the Baltic Proper increased significantly.

Dissolved inorganic nitrogen (DIN) is composed of nitrate, nitrite and ammonium compounds, which are also required by phytoplankton. While DIN concentrations are much higher than DIP in surface waters, marine phytoplankton requires 15 - 16 times as much DIN as DIP, often causing a lack of DIN to limit phytoplankton activity. Where DIN is used up, those bacteria that can fix nitrogen from the air can still flourish, making use of the remaining DIP, and causing blooms. Cyanobacteria exhibit this behaviour, and so flourish in the Baltic. Mapping the excess of dissolved inorganic phosphorous (DIP) in winter may hence serve as a warning for areas where cyanobacteria blooms are likely. Some cyanobacteria are toxic. Nitrogen is cycled within the water column and sediment, while ‘fresh’ nitrogen is also supplied, directly or via rivers, by agricultural run-off and sewage discharges, and also through atmospheric deposition.

Silicate is supplied to the Baltic via rivers, as a result of weathering processes and is recycled in the marine system. An excess of silicate is typical of the Baltic, due to the large supply of river water, and the high concentrations present in the deep anoxic water. Excess silicate is not considered problematic in the Baltic.

Assessment

Figure 1-3 illustrates the spatial distribution of the winter nutrient pool for the period December 2012 to February 2013. Data from the eastern part of the Baltic Sea were unavailable for this period at time of writing. Each marker in the maps represents a station and data is averaged for the upper 10 meter from December 2012 to February 2013.

Figure 4 illustrates the difference between last winter (2012-2013) and the period 1993-2002.

Dissolved inorganic nitrogen (DIN)
Typically, there is a gradient in the DIN concentration from the Bothnian Bay in the north, where concentrations are high, to the southern Baltic where concentrations are lower. DIN increases again in Kattegat. In general, concentrations of DIN are higher close to land than offshore, this is unsurprising as the major source of DIN to the Baltic is land run-off. Compared to the decade stretching from 1993-2002, DIN concentrations during winter 2012-2013 were in general lower. In some sea areas, however, as the Northern Baltic Proper, the concentrations were a bit higher.

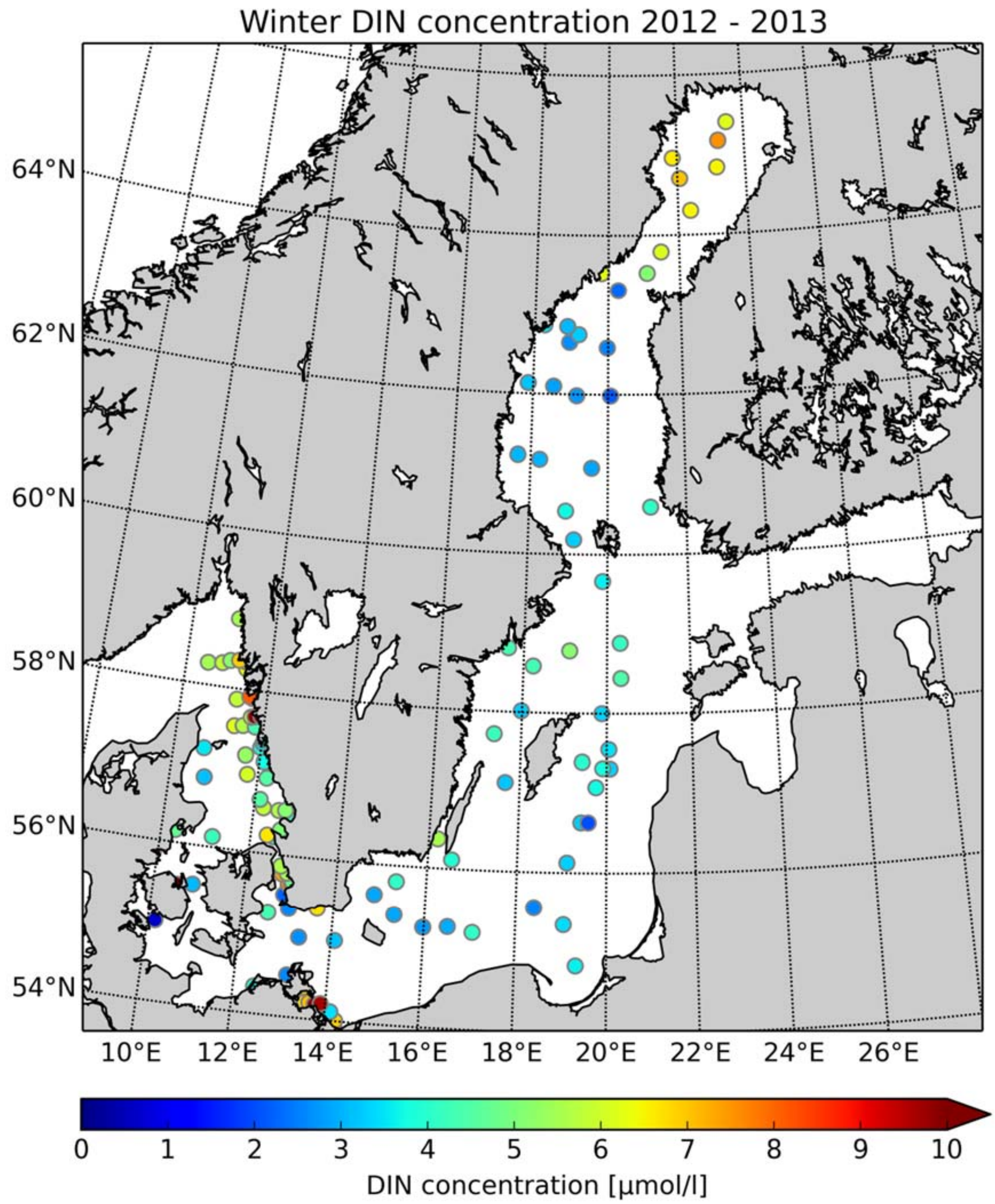

Figure 1. Mean DIN concentrations (µmol/l) in surface waters 0-10 meter: December 2012 - February 2013.

Dissolved inorganic phosphorous (DIP)

The concentrations of DIP are to a certain extent the reverse of the DIN concentrations: concentrations are very low in the Bothnian Bay, and increase southwards towards the Bothnian Sea, the Baltic Proper and the Danish Straits. The highest values are again found closest to land. In the Baltic Proper, this is due in large part to upwelling along the Swedish east coast, from the Hanö Bight northwards. This occurs because the deep waters of the Baltic Proper have very high DIP concentrations, and when the wind blows from the west, the deep water 'wells up' along the Swedish coast. Compared to the 1993-2002 period the DIP levels are in general higher for the winter

2012-2013. In the German coastal water, however, lower levels are found and in the Bothnian Bay there is almost no change.

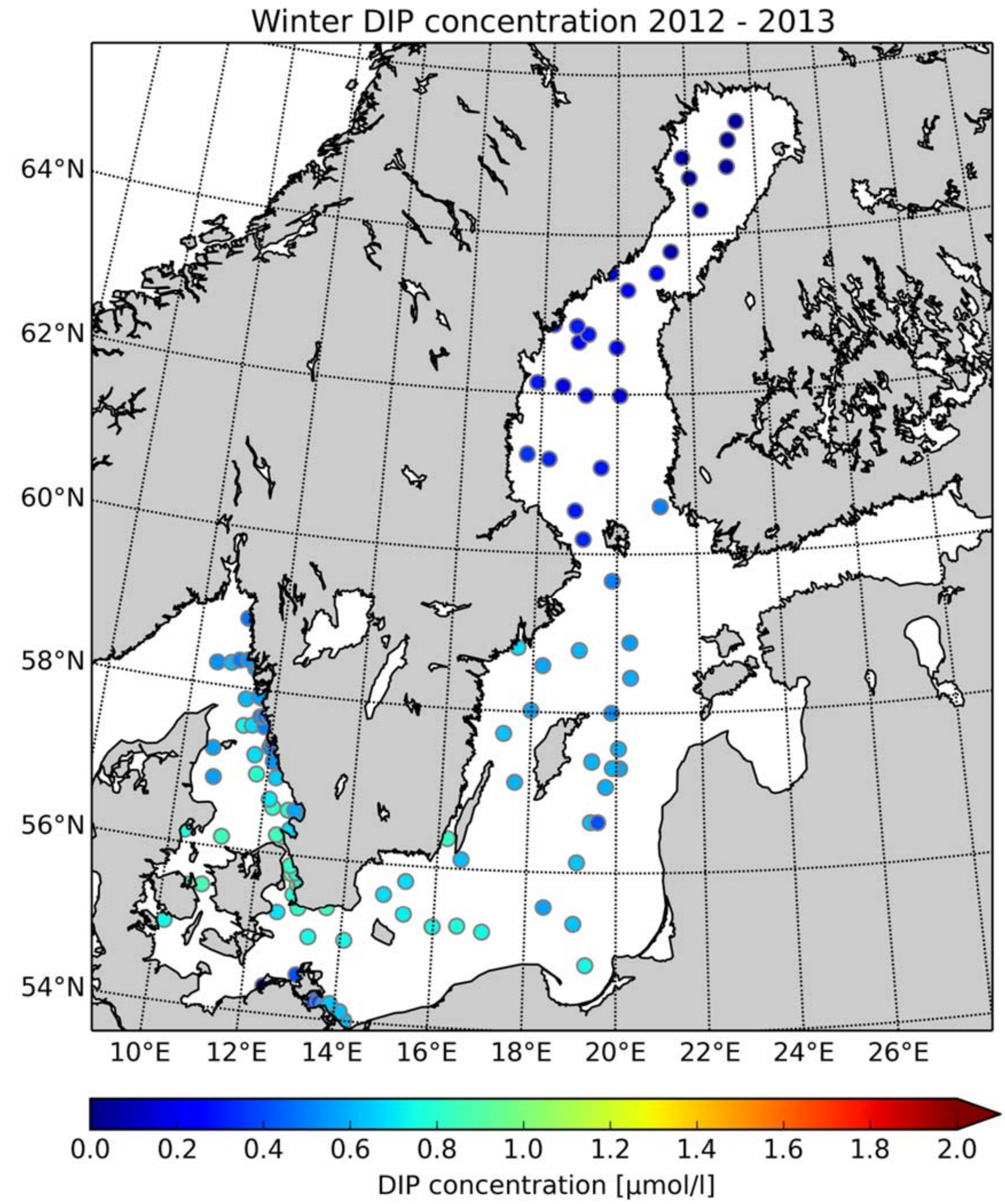

Figure 2. Mean DIP concentrations (µmol/l) in surface waters 0-10 meter: December 2012 - February 2013.

Silicate (Si)

The Si concentrations are, like DIN concentrations, highest in the Bothnian Bay, as the great rivers deliver large amounts to the bay. This is even the case in the Bothnian Sea. In the Baltic Proper, concentrations are higher along the Swedish coast due in large part to wind-induced upwelling (the oxygen-free deep waters of the Baltic Proper contain high concentrations of silicate). High concentrations in the Danish Straits are probably caused more through resuspension of material rather than direct run-off from land. There are also high Si concentrations in the German coastal waters. Compared to the 1993-2002 period the Si levels are in general higher except from Danish coastal waters and the south-eastern parts of the Gotland basin.

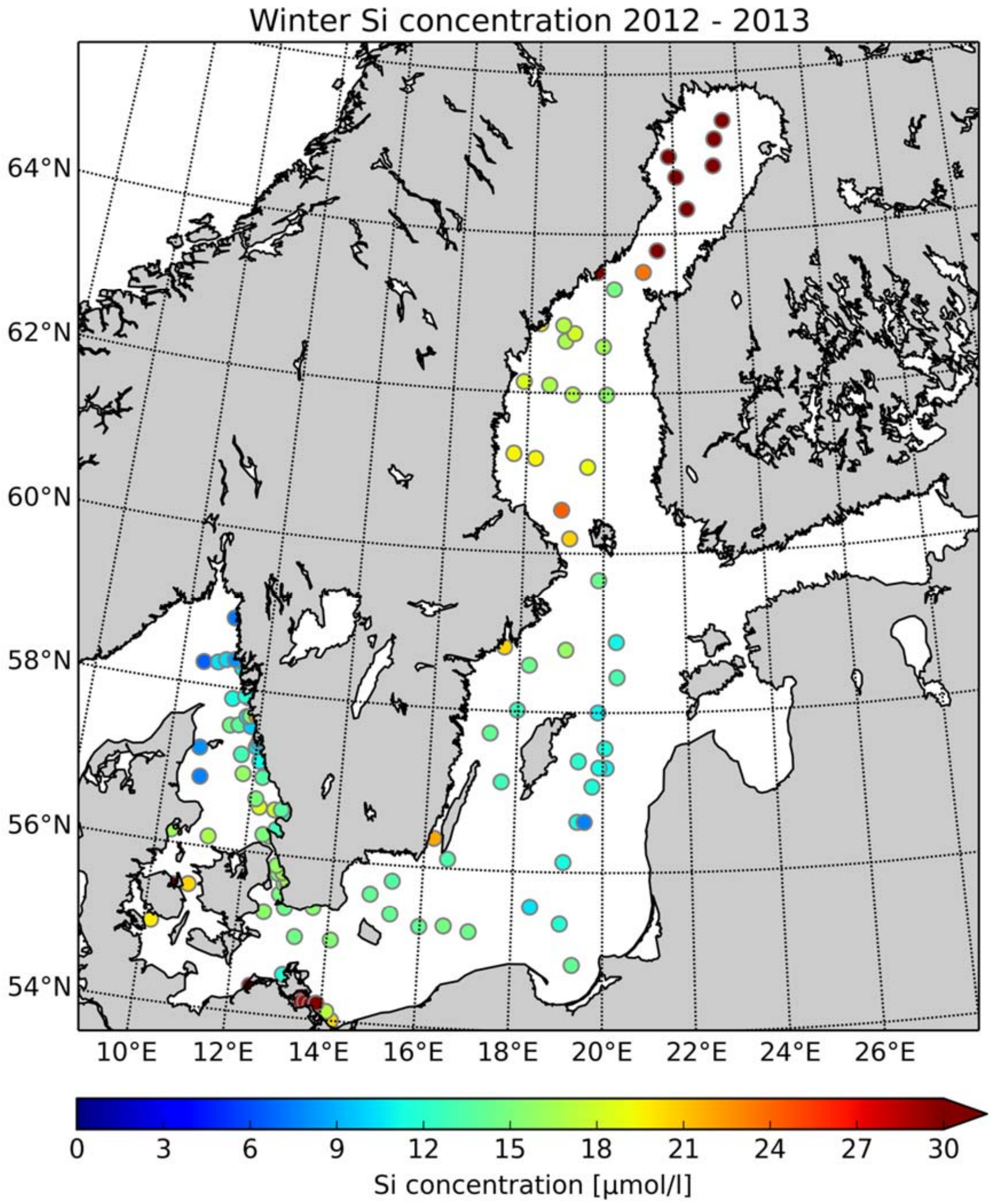

Figure 3. Mean Si concentrations (µmol/l) in surface waters 0-10 meter: December 2012 - February 2013.

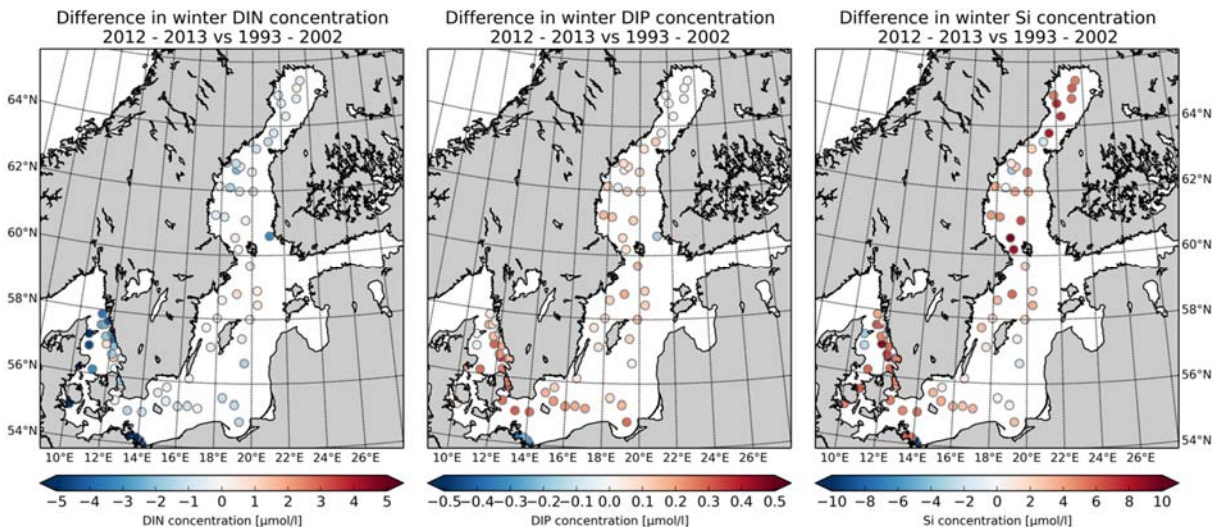

Figure 4. Difference between winter 2012-13 nutrient concentrations (DIN: left; DIP: centre; Silicate: right) and the 1993-2002 means.

Policy relevance and policy references

Eutrophication, the excess of nutrients, is one of the major problems facing the Baltic Sea. A major part of the HELCOM Baltic Sea Action Plan is focused on reducing eutrophication and the negative impacts it has on the Baltic Sea ecosystem. Also European directives such as the Water Framework Directive and the Marine Strategy Framework Directive identify eutrophication as a major hinder which could prevent the Baltic Sea from achieving Good Environmental Status in the near future.

The Helcom COMBINE programme uses nutrient data to help quantify the effects of anthropogenic activities. This Baltic Sea Environmental Fact Sheet contributes to the programme's requirement for information on:

- the winter pool of nutrients
- the supply of nutrients and nutrient limitation in coastal waters

References

Anon., 2000, 'Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (Water Framework Directive)', in Official Journal of the European Union 327, 22 December 2000, pp. 1–73. Available online at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0060:EN:NOT

Anon, 2008, 'DIRECTIVE 2008/56/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)', in Official Journal of the European Union 25.6.2008 L 164/19 - 164/40. Available online at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0056:en:NOT

Helcom COMBINE Manual (Annex C), http://www.helcom.fi/Monas/CombineManual2/CombineHome.htm, December 2003. Data This study used data collected under the HELCOM COMBINE programme, and archived for HELCOM by ICESsupplemented with data collected by SMHI 2007/8.

Data

Data come primarily from the HELCOM data archive held at the International Council for the Exploration of the Sea (http://www.ices.dk). Data collected for the HELCOM COMBINE programme are collected and analyzed according to fixed, agreed techniques which are the same for all HELCOM countries. Laboratories participate in quality assurance consortia such as QUASIMEME and are almost uniformly ISO accredited for good laboratory practice.

These data were supplemented by coastal data collected as part of Swedish regional monitoring programmes and made available by the oceanographic data centre at SMHI through the database SHARK (Svenskt Havs ARKiv).

Surface water values are here defined as the mean over 0-10 m. When analysing the winter period, an average of the months December, January and February is often used. However, the HELCOM data archive does not include any data from 2013 at time of writing; therefor some stations are based on December 2012 data only. In the current fact sheet, this concerns data in Kattegat Danish Coastal waters, Bornholm Basin German Coastal waters, and Arkona Basin German Coastal waters. There is unfortunately no data in the HELCOM data archive from the eastern part of the Baltic Sea at time of writing.

For reference purposes, please cite this Baltic Sea environment fact sheet as follows:

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