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Biogeosciences Discussions

Interactive comment on "Impact of change in climate and policy from 1988 to 2007 on environmental and microbial variables at the time series station Boknis Eck, Baltic Sea" *by* H.-G. Hoppe et al.

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Reply to the first reviewer, reply to the second reviewer, reply to both reviewers.

Reply to the first reviewer

Dear Dr. Wasmund

I thank you, also on behalf of the co-authors, for the helpful comments on our ms. and answer as follows:

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Concerning the first paragraph of your review: “Climate change gets high public attention”, however, policy change is also effective, particularly on the environment of a semi-enclosed marine region as the Baltic Sea. We coined the key word “policy change” as a factor interacting with “climate change”. In this paper “policy” is used as a synonym of “human impact on the environment”. Our data show clearly that policy, in this case being combined with system change in some countries, had a positive effect on the Baltic Sea. Whether policy during the past 20 yr was generally right or wrong may cause quarrel, but this was not in the scope of our study.

Concerning comments on the Abstract: Certainly it was a pity that the study of most bacterial variables was stopped in 2007. But the selected 20 yr period was the most exciting; extending it to previous or successive periods (from literature) would have resulted in an even longer paper as it is – but see our comments at the end of this letter of reply.

Concerning the lines 20ff: Indeed, this sentence can be misunderstood. The correlations shown in Table 3 concern mainly similarities of seasonal patterns of the compared variables, while the long term trend is hidden. The sentence reads now: “The long term seasonal patterns of all variables correlated positively with temperature. . .”. Indeed we were aware of this misunderstanding and therefore specified the meaning of the correlations on p. 18668, l. 5ff.

Concerning the Introduction, p. 18657, line 26: As suggested by the reviewer, the start of HELCOM has been re-dated to 1979. 1979 as the starting year of the HELCOM time series was also mentioned by Wasmund et al. 2006, this reference is now added in this place and Nausch et al. 2011b omitted.

Concerning the study area, p. 18659, line 9: Here you raise an interesting question. We took a close look at the data series of T and S. Strong T/S stratification from late spring until fall is manifest. The rest of the year is characterized by a more continuous but low increase of salinity and a decrease of temperature in the depth profile. This cannot be interpreted as a firm stratification. During this seasonal period nutrients from the bottom may penetrate the upper layers. Concerning T/S stratification, H.-P. Hansen derived from a very detailed TS study (HELCOM, 1996): “During the summer months TS stratification at about 15 m leads to uncoupling of the TS patterns above and below. During winter mixing, S shows nearly homogeneity over the water column.”

Concerning section 2.1., study area, sampling: The reviewer is right, sampling was in most years monthly but in some years it was more frequent in certain months. As you have recognized, the total number of samplings can be found in the Tables. We precised now the strategy of sampling in the Methods section.

Concerning p. 18660, line 21: In the files available to me primary production was generally presented as mgC m-3 h-1. The unit used in the original version of the ms. was not correct. We changed it now in the text, tables and graphs. Here we show the values of primary production for the 1-2 m surface layer in terms of potential primary production (measured in an Gargas - incubator, Gargas 1975). The equation for calculating primary production was published in HELCOM (1984, page 83ff). Primary production was measured only in 9 of the 20 years of study. The data correlated well with chlorophyll and therefore we show them in the paper.

Concerning comments on the Results: We thank you for positive review and understanding of our figures. While writing the paper we were aware that correlations (Table 3) reflect mainly the seasonal and not the long term trends of variables. Therefore we declared on p. 18668, lines 5ff: Effects of change in climate and policy are not well reflected (by the correlations) because they are superimposed by the wide amplitudes of seasonal cycles.

Concerning the Discussion, p. 18676, line 17, line 25 ff, line 29: The reviewer is right, data from Kiel Bight are not shown in Wasmund et al. 2011a. Nevertheless, on p. 5, 5th paragraph on the right side, I found a remark that in the Lübeck Bight (Fig. 3) and Kiel Bight no significant trends in the spring chlorophyll values were found. However,

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there was a strong decrease of chlorophyll in the Mecklenburg Bight, particularly for the maximal values during spring. This agrees well with our findings from Boknis Eck. Generally, the paragraphs concerning the citations of the papers of Wasmund et al. - from p. 18676, line 12 to p. 18677, line 6 - were rewritten including the suggestions of the reviewer.

P. 18678, line 10: “Wikner” instead of “Winkler” has been corrected in the text as well as in the references list.

Your concluding remarks: We thank you for the acknowledgement of the extensive work of the co-authors who raised the data. The first author was asked to publish the data because most of the co-workers were no longer present in the Geomar.

Concerning your comments: "..the causal relationship to the political changes is simply postulated, is hard to prove and remains speculative, and.." Furthermore: "As the time series shown starts with the years of political change (around 1989), it cannot be excluded that the negative trend existed already before 1988 and no trend break occurred around the year 1989." “For example, Wasmund et al. (2011b) found no trend breaks in Kiel Bight. If the neighbouring Mecklenburg Bight is considered, also there is no trend break noticed in the chlorophyll (Wasmund et al., 2011b)." Furthermore: "The arguments become weaker if the biological factors react with delay of different length. If for instance bacterial parameters react only 10 years after the political change (p. 18679, line 17), it is hard to prove that a causal relationship exists. Instead, no stepwise trends but oscillations seem to occur (Figs. 10 and 16), that can hardly be explained with political changes as politics did not change in an oscillating manner."

Reply to these comments: If Wasmund et al. 2011b found no trend break in the values observed in the Kiel Bight and the Mecklenburg Bight we accept this finding but it may be due to specific regional conditions. It is well known that the Baltic Sea is divided by sills in several basins and temporal shift of eutrophication may be retarded. Furthermore, the slopes of regressions between time and variables may be different for the periods before and after 1998.

At the end of chapter 2.5 "Data analysis" we have specified how we interpret the linear and polynomial regression/trend lines: "We interpreted the mostly negative linear trends of variables as a consequence of the after-effects of political change while we attributed the curves of the polynomial trends to changes and variability of climatic factors." Climate factors mean in this case salinity. Salinity showed specific polynomial patterns which were roughly reflected by chemical and biological variables. Thus these variables were influenced by policy change and partly also by climate factors.

Concerning change of literature citation as mentioned by you: Former citation of Wasmund et al. 2011 has been changed to 2011a and specified as suggested. Citation of Wasmund et al. 2011b is now involved as a new citation.

Finally, we think that our study shows a rare historic political event which will hardly recur this way. Thus it is not appropriate as a model for prediction of future developments. We guess that the development will slow down gradually and stabilize at a more of less low level of eutrophication. We think that progress in environmental improvement due to political change is obvious. We do not say that this is inherent with the socialistic system but rather with economics - environmental protection costs money.

Reply to the second reviewer

Dear Prof. Vuorinen

You wrote: 1) General comments, “This paper is distinguished because it comments on political and societal changes and their effects in the coastal ecosystem. It falls short in proving the connection, but environmental data and its presentation are correct, the approach is welcome and actual, and the message is clear.” We reply: We thank the reviewer for his positive opinion on our paper. Concerning the shortcoming of the connection between policy and the environmental data: This point was also annoted by the other reviewer. Therefore we have combined our arguments in a special paragraph

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at the end of the individual replies to the reviewers.

2) "Specific comments" page 18656 lines 5 to 8 and page 18681 1 to 5. “Just a comment: It is interesting to think that the controlling environmental effects: political/economic changes and the global climate change (at least partly), actually both may be anthropogenic. Maybe you should ponder that too.” Reply: We agree with the reviewers comment. We have learned in the recent decades that climate can well be influenced by human activities and human activities can be regulated by policy. The impact of policy/economy on climate will be considered in the revised manuscript in an appropriate place.

Does the paper present novel concepts, ideas, tools, or data? “Yes, ideas and data.” Reply: You restrict your agreement to ideas and data. However, is the consideration of political changes in a scientific paper not a new viewpoint or even a new concept – even if the presentation of this aspect in the paper was not sufficient, as you say? We are aware that it is a critical concept; however, in case of the Baltic Sea we found it to be appropriate or even a key to understand the environmental changes during the period of observation.

Page 18662 lines 15 to 18: Wording "We interpret" is okay, and should be used also in the abstract. Reply: This suggestion has been considered in the abstract.

Are the results sufficient to support the interpretations and conclusions? “Yes, but see general comments.” Reply: c.f. our arguments at the end of this letter.

Does the title clearly reflect the contents of the paper? “Well, they really don’t show the impact, they just give it as an interpretation.” Reply: c.f. our arguments at the end.

9. Does the abstract provide a concise and complete summary? “Yes, but see general comments.” Reply: c.f. our arguments at the end.

All the other items are answered by the reviewers with “yes” - the authors thank the reviewer for his acknowledgement of our work.

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Changes introduced by the authors: "Continuous efforts of the western states may have supported this development". "Western states" was replaced by "western and northern border states".

Reply to both reviewers

Here we reply to comments of both reviewers concerning the relevance of impacts due to political change. The period before system change was not covered by our data set. Therefore we could not directly ascertain whether a trend break in the environmental conditions occurred already before political change. Here we add some arguments from the literature which show clearly that conditions improved most strongly in the years following political system change.

The Baltic Sea water has a relatively short turnover time (residence time) of about 25 years (for comparison, Lake Konstanz 5 yr, Black Sea 140 yr), covering round about the study period. Water is supplied by the North Sea, ground water, rivers and precipitation. North Sea surface water intrusion into the deep layers is not much cleaner than Baltic Sea water, but river water, the main source in the Baltic Sea water budget, is comparatively much more polluted. To understand the contribution of rivers to eutrophication one has to consider water purification and use of fertilizer on land, and this is a matter of policy. It has to be noted that all the big rivers enter the Baltic Sea in the south eastern countries. Progress in the infrastructure in these countries therefore has especially a high impact on the enclosed Baltic Sea. We hope that the references (2 Tables, 5 Figures) are relevant for supporting our interpretation of the results of this study.

The figures 1a and 1b show that strongest reductions of nitrogen and phosphorus inputs from point sources and agriculture within the Baltic Sea catchment area occurred in the south-eastern border states. The GDR is not separately shown but included in Germany after 1989 (personal communication, Claus Hagebro, claus@ices.dk). The relatively low values for Germany show that environmental conditions in the GDR were

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probably more advanced than in the other south-eastern border states. Reference: Figures 17 and 18 in HELCOM (2005). In this place it should be mentioned that the contribution of the formerly socialistic states to Baltic Sea eutrophication differed greatly. But altogether, the environmental standard of these states was most likely lower than that of the other border states.

Figure 2, a document from the "Ministerium für Landwirtschaft, Umwelt und Verbraucherschutz Mecklenburg-Vorpommern", (2008) informs about the state of waste water purification in this federal state of Germany, translated: "In 1990 there were considerable deficits in Mecklenburg-Vorpommern concerning waste water purification. The efficiency of the existing purification plants was insufficient. The connection of the population to central public purification plants was 64 percent; today it is more than 86 percent“.

Within this web page, open: "Kommunale Abwasserbeseitigung in Mecklenburg-Vorpommern - Lagebericht 2011 - Bericht gemäß Richtlinie 91/271/EWG". - Have a look at Abb. 1-1: Klassifizierung der Fließgewässer hinsichtlich Orthophosphat (classification of rivers with regard to orthophosphate). It can clearly be seen that substantial improvement of quality of river water started and continued progressively with system change.

Figure 3 shows the long-term change of the nitrogen surplus (indicator of agricultural pollution impact; the difference between all nutrient inputs and outputs on agricultural land) of the field balance on arable land separately for the four Federal States located in the German Baltic Sea catchment area. “These nitrogen surpluses have decreased by 40% (in Schleswig-Holstein) to 50% (in Mecklenburg Western-Pomerania, Brandenburg and Saxony) since its peak in 1987. For the Federal States Schleswig-Holstein and Mecklenburg-Vorpommern, which represent the main part of Germany of the Baltic Sea catchment, a similar development for the nitrogen surplus in the agricultural areas could be observed up to the end of the eighties.“ Reference: Figure 1 in HELCOM (2003), Page 38.

Furthermore, “Since 1990 this development is quite different. Caused by the political and economic changes in Mecklenburg-Vorpommern and in the other Federal States of the former GDR the nitrogen surplus decreased dramatically mainly because of reduction of livestock and lower application rates of mineral fertilizers. Since 1993 the nitrogen surplus is increasing again up to a level of 60 kgN/(haÂůa) at the end of 90’s. In Schleswig-Holstein a more continuous decrease from 130 to 95 kgN/(haÂůa) can be observed over the whole decade.” (HELCOM 2003).

Figure 4 within the paper of Eriksson et al. (2007) shows the nitrogen budgets of the Polish agriculture from 1960 to 2000: “Implications for riverine nitrogen loads to the Baltic Sea from transitional countries”. A clear breakdown is documented in the years after political change. Because these streams provide the vast contribution of fresh water to the Baltic Sea they contribute substantially to the state of eutrophication.

Figure 5 shows the development of inorganic N- and P-concentrations at Boknis Eck (0-10 m water depth) before our study took place; reviewed by Bange et al. (2011). A close look at Figure 4 in this publication reveals that a trend brake occurred for P-sources around 1990 and for N-sources some years later probably around 2005.

In addition: Some early satellite pictures (not shown) from the eastern Baltic Sea area showing chlorophyll and particle load of river plumes you can find in Horstmann et al. (1986): “The influence of river water on the south-eastern Baltic Sea as observed by Nimbus 7/CZCS imagery.”

Table 1, derived from Table 5, p. 67 in HELCOM (2003) shows clearly a strong reduction of the N and P input into the Baltic Sea immediately after political change, in this case of Poland.

Table 1: Riverine pollution load discharged to the Baltic Sea from Poland (Load, tons/a).

Nitrogen - Year 1988: 243 Year 1995: 202 Year 2000: 188 Phospate - Year 1988: 17 Year 1995: 13 Year 2000: 12

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Table 2 was calculated from our own complete data set (phosphate, 0-25 m depth) reaching back to 1957. After increases of phosphate until 1988 and especially during the last years before 1988, there was a trend break afterwards. We assume that the slopes would be even more pronounced if the equations were calculated exclusively from the surface layer because river fresh water is mainly mixed within this layer.

Table 2: Temporal change of phosphate (μM) in the water column at the time series station Boknis Eck.

Phosphate in the water column from 1957 to 1988: y = 0.000095x + 1.606 Phosphate in the water column 1986 to 1988: y = 0.000223x + 1.109 Phosphate in the water column 1988 to 2007: y = -0.000073x + 1.236

References

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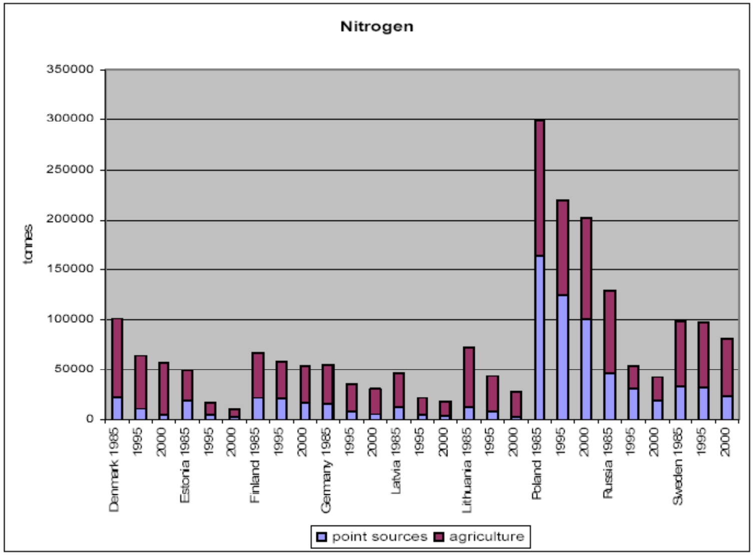

Fig. 1a: Figure 17 in HELCON (2005): Nitrogen inputs from point sources and agriculture within the Baltic Sea catchment area by HELCOM countries in 1985 and in 2000. Source: C. Hagebro, 2004. Agricultural impact on the water environment. HELCOM Presentation.

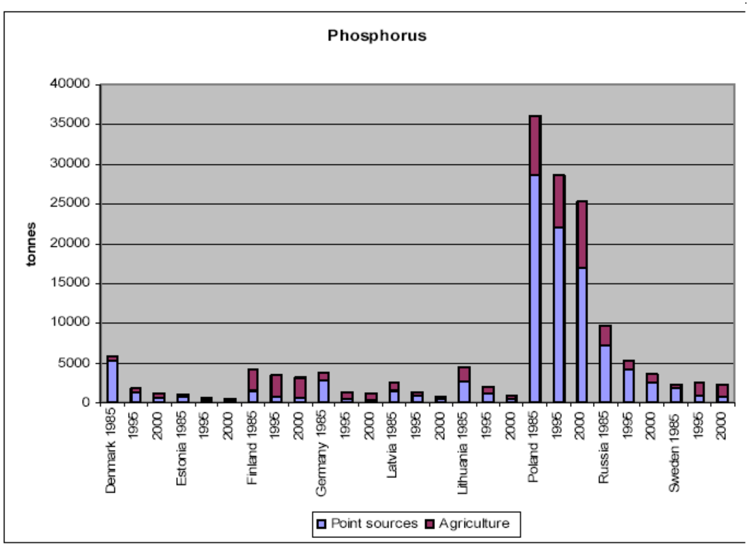

Fig. 1b: Figure 18 in HELCON (2005): Phosphorus inputs from point sources and agriculture within the Baltic Sea catchment area by HELCOM countries in 1985 and in 2000. Source: C. Hagebro, 2004. Agricultural impact on the water environment. HELCOM Presentation.

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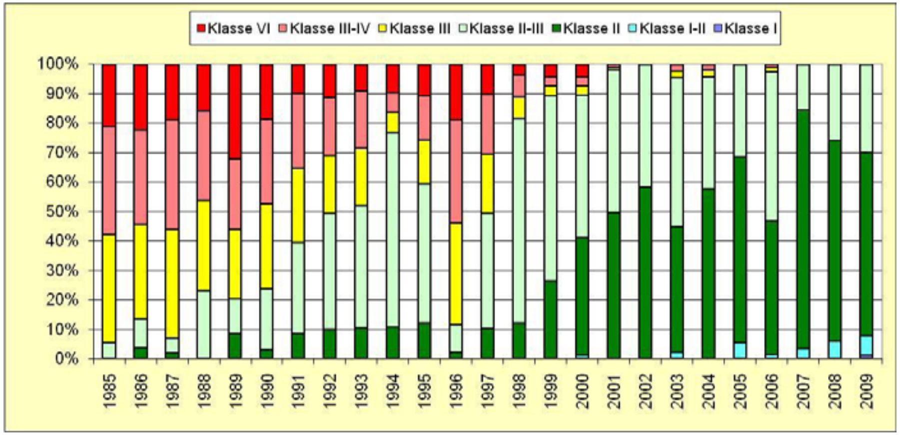

Fig. 2: Classification of rivers with respect to orthophosphate. Fig. 1-1 in "Ministerium für Landwirtschaft, Umwelt und Verbraucherschutz Mecklenburg-Vorpommern: Abwasserbeseitigung" (2008).
http://www.regierung-mv.de/cms2/Regierungsportal_prod/Regierungsportal/de/lm/Themen/Wasser/Abwasserbeseitigung/index.jsp

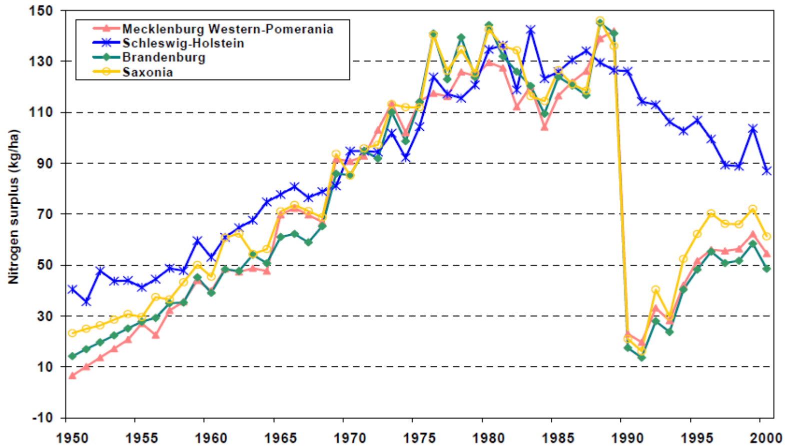

Fig. 3: Figure 1 in HELCOM (2003): Development of Nitrogen surpluses of farmland (surface balance) in the Baltic Sea area from 1950 to 2000. Nitrogen surplus (kg/ha) Mecklenburg Western-Pomerania, Schleswig-Holstein, Brandenburg and Saxonia.

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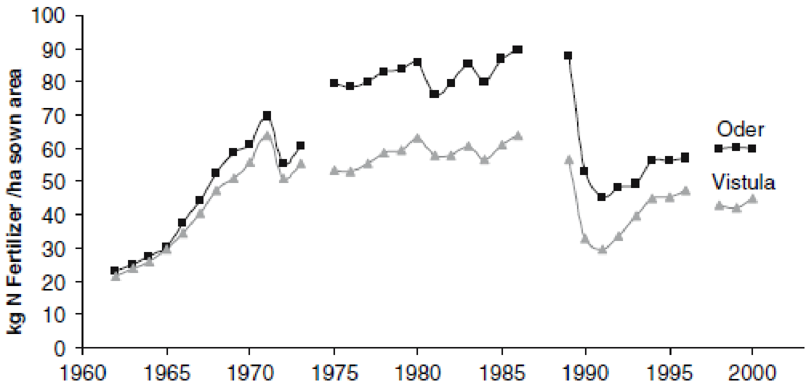

Fig. 4: Fig. 5 in Eriksson et al. (2007): The yearly consumption of nitrogenous fertilizer (kgN ha^{-1} sown area $year^{-1}$) in Oder and Vistula from 1962 to 2001.

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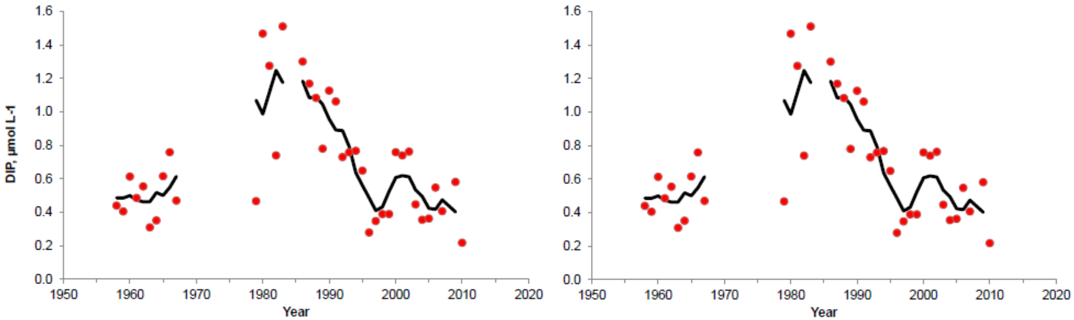

Fig. 5: Fig. 4 in Bange et al. (2011): Mean winter concentrations (red circles) of total dissolved inorganic nitrogen (DIN), left panel, and dissolved inorganic phosphate (DIP), right panel. The black solid lines indicate 5-year moving averages.