



Scientific Committee on Health and Environmental Risks

SCHER

Opinion on
Model implementation and quantification of the eutrophication
risk associated with the use of phosphates in detergents
(INIA report – Green Planet Report)



The SCHER adopted this opinion at its 20th plenary on 29 November 2007

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SCHER

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1. BACKGROUND

(A) "Model implementation and Quantification of the Eutrophication Risk associated to the use of phosphates in detergents" (INIA/Green Planet Report)

In 2003, CSTEE adopted a scientific opinion on the environmental impact (reduction in eutrophication) that would result from banning sodium tri-polyphosphates (STPP) in household detergents. The opinion concluded, inter alia:

- *"that a quantitative assessment of the extent of eutrophication in EU waters in relation to phosphorus load from different sources, and in particular in relation to STPP contribution, should be performed on the basis of existing experimental and modelling information".*

In order to further elucidate this issue, the relevant CEFIC sector group, CEEP (European Detergent Phosphate Industry) volunteered to carry out a study entitled: "Development of a European Quantitative Eutrophication Risk Assessment of Polyphosphates in Detergents", in collaboration with Green Planet Environmental Consulting SL and INIA (Spanish National Institute for Agriculture and Food Research and Technology). This report was completed in October 2006.

2. TERMS OF REFERENCE

(1) SCHER is requested:

- (i) to assess the overall scientific quality of the report and comment on the methodology and the assumptions used for the development of this probabilistic risk assessment model.
- (ii) to comment whether the developed model is considered sufficient for the purpose of providing an assessment of the risk from eutrophication due to detergents phosphates that was identified in the 2003 CSTEE opinion.

(2) SCHER is requested to comment whether the field data (303 European data items on sensitive zones, such as lakes and reservoirs) were appropriately selected and adequately assessed in this study in order to properly describe the eutrophication risk at the regional level in the EU. In particular, the following issues should be addressed:

- (i) whether the selection of lake field data is adequate given that for some regions, e.g. the Northern European-countries, field data for deep lakes is lacking.
- (ii) whether the omission of coastal waters is a significant limitation for the overall assessment of eutrophication in the EU and, if so, how these waters should be considered in a pan-European risk assessment.

(3) SCHER is requested to comment whether criteria used in the development of the model are appropriate to describe the risk.

(4) SCHER is requested to assess the exposure assessment methodology and in particular:

- (i) whether the selection of the certain catchment characteristics allows an accurate calculation for a generic river basin of estimated concentrations in water bodies.
- (ii) whether all relevant and significant sources and pathways where phosphates in detergents can be released into the aquatic environment have been considered (e.g. sewage overflows or small settlements not connected to sewerage and wastewater treatment).

- (iii) whether the estimations, based on average emission coefficients were considered appropriate for large river basins (and the emission scenario based on diffuse and point P sources was a sufficient approach for this quantitative risk assessment) given that more detailed regional models have been developed for some river basins (e.g. Danube) or catchment seas (e.g. Baltic Sea).

(5) SCHER is requested:

- (i) to comment whether the results obtained for the generic scenarios and for the pan-European estimation (by use of Monte Carlo analysis) are consistent, representative and comparable to other approaches.
- (ii) to assess the conclusions, in particular:
- "additional eutrophication risks related to detergent phosphates are very variable in different regional situations as a result of the characteristics of hydrology, population density and agricultural intensity among other factors."
 - "the difference between the total risk and the risk without P-based detergents is typically around 2-8% based on the Mediterranean effect assessment and around 0.4-2% based on the Atlantic-N&Central shallow effect assessment."
- (iii) to comment on whether or not the study (in combination with the other information readily available to SCHER) indicates that the use of phosphates in detergents contributes significantly to the eutrophication risk at the European level.
- (iv) if current information is insufficient, to identify what other information, methodologies, studies and data should be considered to answer the questions whether the use of phosphates in detergents contributes significantly to the eutrophication risk at the European level.
- (v) to comment on the report recommendation that reduction of the high level of variability in the models results may be achieved using data currently being collected by European Union in the inter-calibration process of the WFD implementation.
- (vi) to comment on whether evaluation of the additional material supplied concerning the Danube and the Baltic Sea would lead to different conclusions than those reached in the INIA/Green Planet Report.

3. OPINION

3.1. Question 1

(1) SCHER is requested:

- (i) *to assess the overall scientific quality of the report and comment on the methodology and the assumptions used for the development of this probabilistic risk assessment model.*

3.1.1 General comments

In the INIA-report considerable emphasis is put on the Water Framework Directive (WFD) and its criteria to distinguish between the good and less than good status of surface waters. Given the differing aims of the WFD and the specific aims of the document under consideration, SCHER feels it is pertinent to focus its assessment on the probabilistic model developed in the report. Given the complexity of the WFD and its interpretations among European regions (for example, varying definitions of Good Ecological Status), SCHER recognizes that further work is required to enhance the specific relevance of the INIA model to the WFD.

Statements below are focused on the development of the INIA model and its stated aim of assessing the risk associated with the use of phosphates in detergents.

SCHER recognizes the complexity of the type of assessment attempted in this report.

SCHER is also aware of the problem that the conventional methods for Risk Assessment (RA) of chemicals as described in the Technical Guidance Document (TGD, 2003) do not apply in the case of a risk assessment for the eutrophication process. Hence as there is no recognized guidance on how to perform a quantitative risk assessment of substances causing eutrophication, SCHER is of the opinion that the methodology proposed in this report may contribute to development of guidance for these types of assessment.

SCHER recognizes that this research attempted to integrate two types of research areas: i.e. eutrophication modelling and environmental risk assessment. The techniques, methods, evaluation and validation criteria used in these respective disciplines differ. As such, the importance and impact of these different approaches on the overall result of the exercise needs careful consideration.

The developed model presents a novel tool to assess, in a quantitative manner, the risks of eutrophication due to phosphorus release. The concept and its application to eutrophication phenomena are considered innovative.

It is recognized that as with all generic models and approaches a number of simplifications and assumptions are required to allow its application in a pan-European context. The outcome of modelling exercises should not be compared to existing more site-specific, river basin-based models as both approaches differ in complexity and purpose.

Although some of the assumptions (e.g. catchment hydrological characteristics, per capita phosphorous usage) on which the generic scenarios are based may be criticised (see below), the approach (concept) – within the limitations given by the authors - is scientifically valid.

However, SCHER is of the opinion that the overall quality of the study is diminished as a number of key points are not or are not adequately addressed in the report. These include: (1) a limited data base to develop the model which may not be representative of European lakes and (2) the limited data base used for the validation of the developed approach and current proposal.

SCHER notes that these limitations are mentioned in the INIA report. For these reasons – which are elaborated on hereunder – SCHER is of the opinion that, prior to the application of the model and the use of the results, the science presented in this report should be further developed. The data already available to the EC and Members States - but not provided due to confidentiality - should be used for calibrating and validating the proposed model.

3.1.2 Specific comments

The overall scientific quality of the report is diminished for the following reasons:

- 1.** The model is developed to predict phosphorus (P) concentrations - as a function of basin characteristics - in river water flowing into a lake. It does not take into account the lake processes affecting P fate and distribution which determine the actual P concentration in lakes. Lake phosphate concentrations are usually substantially lower (sometimes more than one order of magnitude lower) than the concentration in inflowing rivers.

SCHER suggests that therefore the trophic classification based on the results of the model is overestimated. Indeed, in all examples described in the report, phosphorus concentrations are unrealistically high in comparison with actual concentrations of the majority of European lakes. As a consequence of this overestimation, a significant reduction of the phosphorus load would, in most cases, not lead to a

significant reduction of the probability of the eutrophication risk. There is the need for an additional model capable to cover the discrepancy between river and lake P concentrations.

SCHER notes that the expanded (second) report has partially addressed this issue. In this report risk estimations are presented which are based on monitoring data. As such these estimations do not suffer from the above mentioned deficiency. SCHER suggests that further work should be performed in this area to allow a more realistic Pan-European evaluation.

2. SCHER is of the opinion that the database of sites selected for the study is limited and is not representative of European lakes. It lists 120 lakes in total covering 303 "field cases", 75 of which were Spanish and 44 Italian reservoirs.

A more comprehensive literature search is required to select datasets representative of the full range of type and status of European lakes. Because of the limited datasets the accuracy of the risk characterisation in section 2 of the report is reduced.

3. Figure 2, page 24 in the report, shows the relation between river flow and catchment area. The calculated regression line is subsequently used for the determination of the triangular distribution mentioned on page 92.

SCHER is not convinced that based on these data the best estimation for this distribution is a triangular distribution. A more realistic fit should be possible using additional and appropriate assumptions.

4. SCHER notes that various values for the contribution of phosphorous originating from detergents are available in literature. Using the Paris Commission (1992) value of 2.7 g P/person/day and subtracting 1.5 g P/person/day arising from human metabolism (this report referenced to Lasevils and Berrux (2000) then the contribution from detergents is 1.2 g P/person/day. This value is markedly higher than the value of 0.84 g P/person/day used in the first report and consequently may have led to an under-estimation of the risk of eutrophication due to phosphorous in detergents.

SCHER notes, however, that in the second report, this value has been adjusted and is now in line with that used in other EU reports on detergents.

5. In order to improve the datasets the authors should try to obtain data from EUROWATERNET and the WFD intercalibration exercise as well as the REBECCA project, where possible. The INIA reports mention that these data were requested.

SCHER considers that these data are essential for a correct risk assessment.

- (ii) *SCHER is requested to comment whether the developed model is considered sufficient for the purpose of providing an assessment of the risk from eutrophication due to detergents phosphates that was identified in the 2003 CSTEE opinion.*

3.1.3 Conclusions

SCHER is of the opinion that, considering the possible uncertainty associated with the assumptions and the limited dataset used to develop the model (identified above), there will be uncertainty associated with the characterization of the risk from eutrophication due to detergents. The present model may thus have limited applicability in an EU-wide context.

As effect data from other European regions are already available to the EC, the committee suggests recalculating the effect assessment curves using these data.

Although SCHER notes that the P-contribution per person/day value used in the second report has been used in other EU reports on detergents, the committee suggests that the

scientific basis of this value (and its associated uncertainty) is examined in more detail. This is important since the P-contribution value feeds linearly into the model, and as such is crucial to the determination of the eutrophication risk.

3.2. Question 2

SCHER is requested to comment whether the field data (303 European data items on sensitive zones, such as lakes and reservoirs) were appropriately selected and adequately assessed in this study in order to properly describe the eutrophication risk at the regional level in the EU. In particular, the following issues should be addressed:

- (i) *whether the selection of lake field data is adequate given that for some regions, e.g. the Northern European-countries, field data for deep lakes is lacking.*

As indicated above, SCHER is of the opinion that the database of sites selected for the study is limited and is not representative of European lakes. It lists 120 lakes in total covering 303 "field cases", 75 of which water bodies were Spanish and 44 Italian reservoirs. Additionally, it is not clear if all sites considered were examined to ensure that they were phosphorus limited sites.

A more comprehensive literature search needs to be carried out to select a dataset representative of the type and status of European lakes. Furthermore, the use of two geographic based lake ecotypes/ecoregions is not sufficient for Europe.

SCHER suggests that the dataset can be improved through the use of additional data obtained from EUROWATERNET, the WFD intercalibration exercise and the REBECCA project.

Because of the limited datasets, the SCHER is of the opinion that the accuracy of the risk characterisation presented in the report may be limited.

- (ii) *whether the omission of coastal waters is a significant limitation for the overall assessment of eutrophication in the EU and, if so, how these waters should be considered in a pan-European risk assessment.*

SCHER considers that the release of total phosphorus (TP) from detergents in coastal waters and their potential effects in these water bodies were not sufficiently considered to allow an in-depth risk assessment for these types of waters.

As the report did not provide evidence that coastal ecosystems have a similar (or less) sensitivity to eutrophication than freshwater systems (which would then be covered by the freshwater regional model), SCHER is of the opinion that conclusions on coastal waters are inappropriate.

SCHER would like to suggest that a further examination of this issue is made in the light of (1) potential differences in (freshwater vs. coastal) ecosystem sensitivity, (2) coastal waters being the ultimately recipient of the majority of the TP originating from freshwater draining into the sea, and (3) large areas of EU coasts being densely populated (with resulting nutrient releases).

It is further suggested that using coastal water and freshwater monitoring data, exposure models/scenarios are developed which can calculate/predict TP concentrations derived from detergents for coastal areas (taking into account variables such as population density, coastal water exchange rates, sewered vs. non-sewered areas ...). These exposure data may then be combined with data on the effects of marine eutrophication (for which there is a considerable body of information available in literature) to produce a risk characterisation for coastal waters, adapting the methodology developed for assessing freshwater systems.

3.3. Question 3

SCHER is requested to comment whether criteria used in the development of the model are appropriate to describe the risk.

3.3.1 General comments

As the report states that a simplistic mass balance is the basis for the model description SCHER is of the opinion that the criteria used for establishing the model are considered sufficient. A greater level of detail is not considered necessary for improving the model. It is a good feature that the model is not more complex than required to answer the question posed.

Nevertheless, it is the opinion of the SCHER that a better basis for the validation should have been used as the variability of the European fresh and marine water is much wider than those used in the validation of the model.

3.3.2 Specific comments

1. All predicted annual mean total phosphorus concentrations in lakes in section 2 are very high and are characteristic of hypertrophic waters, i.e. very excessively enriched with phosphorus. These high in-lake concentrations have the effect of diminishing the significance of inputs of phosphorus from individual sources. This limitation was addressed in the updated (second) report in which additional estimations based on monitoring data were presented.
2. Only one example was used to validate the model. Once the TP contributions from all sources had been estimated, a simple mass balance equation was used to estimate TP concentration:

$$TP = (\text{diffuse} + \text{point} - \text{STP recovery}) / \text{cumulative water}$$

The capability of the model to estimate the contribution from point sources was checked by comparing estimated values with annual average TP concentrations from 10 stations on the River Danube and its tributaries. The model predicted higher in stream TP concentrations at 6 of the 10 stations. Predicted values at the other four stations were only slightly lower than those actually measured. The report states that the results, obtained in this comparison, indicate that the model offers acceptable predictions (page 29).

In addition, two other studies were carried out to validate the model. In the first, in which two Spanish catchments were considered (the rivers Ebro and Tajo), it was concluded that monitored and predicted results were in good agreement. The second study (Poland) suffered from a lack of monitoring data. Generally, the report concludes that there is insufficient data for a proper validation of the model.

SCHER supports this conclusion and is of the opinion that more work should be carried out to demonstrate the usefulness and accuracy of the proposed methodology. Indeed, a more critical assessment of the general applicability of the model to a range of sites with varying sensitivity to eutrophication is required, using both lower TP values and specific values for mlp(G-) (i.e. most likely probability of the percentage of sites with less than good status). As stated in the report, a real value for mlp(G-) is essential. However, the value used (33%) in the example runs of the model may be inappropriate (i.e. may be too low) for some areas within Europe, as are the high TP values. Both these input values require further assessment. Clearly, the authors were hindered by the lack of data available from the different eco-regions, especially for critical ecosystem types such as Northern region lakes.

3.4. Question 4

SCHER is requested to assess the exposure assessment methodology and in particular:

- (i) *whether the selection of the certain catchment characteristics allows an accurate calculation for a generic river basin of estimated concentrations in water bodies.*

SCHER is of the opinion that the type of catchment characteristics used in the report is appropriate. However, the report would benefit from a more comprehensive description of how these characteristics were derived and how they were used to estimate P concentrations in generic river basins.

- (ii) *whether all relevant and significant sources and pathways where phosphates in detergents can be released into the aquatic environment have been considered (eg. sewage overflows or small settlements not connected to sewerage and wastewater treatment).*

Not all sources and pathways where phosphates from detergents can be released into the aquatic environment have been considered separately and/or sufficient in detail. However, the contributions of e.g. sewage overflows and non-sewered populations have indirectly been accounted for through the use of a low P-removal value (20%) at the STP.

SCHER is of the opinion that this indirect assessment may not cover all European areas/countries. For example, the input of TP from detergents into water bodies may be considerable in rural areas where households are not connected to the sewerage and wastewater treatment.

- (iii) *whether the estimations, based on average emission coefficients were considered appropriate for large river basins (and the emission scenario based on diffuse and point P sources was a sufficient approach for this quantitative risk assessment) given that more detailed regional models have been developed for some river basins (e.g. Danube) or catchment seas (e.g. Baltic Sea).*

The report states that "expert judgement in addition to statistical analyses were employed for the selection of the most likely values" for export coefficients without giving detail of the latter. SCHER is of the opinion that, while these coefficients were derived from measurements at "relatively large River basins", these average or "most likely" values may not be appropriate for risk assessment in smaller catchments, as mentioned in the report.

The model developed can be considered as a generic, basic model that may answer general questions in the context of the risk of eutrophication for the European Union as a whole. After this type of initial assessment, more detailed or complex models suited to a specific water body should be used; e.g. as was done for the Danube or the Baltic Sea.

This type of tiered risk assessment procedure is recommended by SCHER.

3.5. Question 5

SCHER is requested:

- (i) *to comment whether the results obtained for the generic scenarios and for the pan-European estimation (by use of Monte Carlo analysis) are consistent, representative and comparable to other approaches.*

As indicated earlier the developed model presents a novel tool to assess, in a quantitative manner, the risks of eutrophication due to phosphorus releases. The concept and its application to eutrophication phenomena should be considered innovative. Like with all generic models and approaches, a number of simplifications and assumptions needed to be made to allow its application in a pan-European context. The assumptions on which

the generic scenarios are based may be criticised. However, while the approach (concept) – within the limitations given by the authors - is scientifically valid, the type of information which obtained from the modelling exercises is dependent on the model parameters which (in the INIA report) are insufficiently substantiated and explored given the variation encountered in the EU. The limited validation exercise performed in the report indicates that the model provides predictions which are comparable to field observations.

Although these results may be acceptable from a modelling point of view, SCHER is not convinced that all aspects of the eutrophication process are sufficiently covered by the report/model to – in its present state – accurately predict the risk of eutrophication due to P in detergents.

Furthermore, SCHER is of the opinion that although the generic scenarios are scientifically defensible, further research into some of the assumptions and default parameters may be needed to improve the predictive capacity of the model and its applicability. As mentioned above, a large amount of information is already available to the EC but has not been used for the improvement and validation of the model due to confidentiality issues.

(ii) *to assess the conclusions, in particular:*

- *"Additional eutrophication risks related to detergent phosphates are very variable in different regional situations as a result of the characteristics of hydrology, population density and agricultural intensity among other factors."*

SCHER supports this statement. In any generic scenario simplifications, generalisations and assumptions need to be made. Consequently the results from these type of generic modelling exercise may differ considerably depending on the (among others) factors mentioned above. It is noted that the authors explicitly state in their discussion section *'For specific river-basin assessments the simplified model is not adequate.'*

- *"the difference between the total risk and the risk without P-based detergents is typically around 2-8% based on the Mediterranean effect assessment and around 0.4-2% based on the Atlantic-N & Central shallow effect assessment."*

As mentioned above the accuracy of these predictions is a function of the input data, the assumptions made in the model and the characterisation of the generic scenario.

SCHER is of the opinion that as the values selected for some key factors driving (e.g. uncertainty associated with P output) may not be sufficiently representative for all EU situations, the final aquatic TP concentration from detergent and the resulting risk for eutrophication may be underestimated. The second report offers additional suggestions for covering some of these issues.

SCHER is of the opinion that more model validation using monitoring data is required before the estimations of total risk can be supported. This can be accomplished by using the available, but apparently confidential, data in the effect assessment.

(iii) *to comment on whether or not the study (in combination with the other information readily available to SCHER) indicates that the use of phosphates in detergents contributes significantly to the eutrophication risk at the European level.*

The report, based on quantitative estimations, concludes that P in detergents contributes to the overall eutrophication risk of phosphorous.

Considering the uncertainties and limitations identified in this opinion, SCHER is of the opinion that more work is needed to accurately estimate the magnitude (and significance) of the eutrophication risk at the European level.

- (iv) *if current information is insufficient, to identify what other information, methodologies, studies and data should be considered to answer the questions whether the use of phosphates in detergents contributes significantly to the eutrophication risk at the European level.*

In order to improve the datasets the authors should obtain data from EUROWATERNET and the WFD intercalibration exercise as well as from the REBECCA project. Care should be taken in using these data, because they were derived using different sampling and analytical methods and may not be comparable in many instances.

- (v) *to comment on the report recommendation that reduction of the high level of variability in the models results may be achieved using data currently being collected by European Union in the inter-calibration process of the WFD implementation.*

This type of data is crucial for the further refinement of the present assessment. The SCHER recommends that the respective EU services and member state data holders support this effort to compile a dedicated database.

- (vi) *to comment on whether evaluation of the additional material supplied concerning the Danube and the Baltic Sea would lead to different conclusions than those reached in the INIA/Green Planet Report.*

A number of points may be learned from the Danube and Baltic Sea studies:

- These studies also confirm that many factors play a role of varying importance in the description of the eutrophication process and the effects thereof. The variation in results is large and it is not easy to understand why a certain ecosystem reacts in a particular way. For instance, the Danube study reveals that the influence of year-to-year variation is much larger than the expected effect from the limitation of TP input.
- Although reduction of phosphorous from different input routes may lead to a rapid reduction of Cyanobacteria blooms, the release of phosphorous from the sediment may be a substantial source, therefore limiting the positive effect.
- Knowledge on the eutrophication process in marine waters is an additional area that has been clarified to a large extent by the Baltic and Danube studies. Marine ecosystems were not considered in the INIA-study. Especially the contribution of the behaviour of nitrogen fixing bacteria to the eutrophication process should not be neglected.

Therefore, it is the opinion of the SCHER that the results of the Baltic and Danube studies should be evaluated and considered as potential additional information on the effects of risk management measures in the context of reduced P input into the EU surface waters.

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