SCOPE NEWSLETTER

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Legislation

European Union

Commission legal pressure for water quality

The EU Commission is continuing to press legal action, including fines, against Member States which fail to implement sewage treatment, in particular phosphate remove.

Nutrient criteria and modelling

European Union

EU Eutrophication Risk Assessment conclusions confirmed

EU scientific Committee SCHER validates revised detergent phosphate eutrophication risk assessment.

Phosphorus, sediments

Conditional probability approach to quality criteria

A conditional probability approach has been developed to propose threshold values of biological impact of different pollution factors and so water quality criteria.

Massachusetts

Risk probability modelling of local eutrophication management

A local river ecosystem model combined with probabilistic analysis is used to assess the likelihood of achieving good river quality by different nutrient reduction strategies, including sewage works P-removal

Manager's Guide

Model supported WFD implementation

IWA and the EU have co-published a book targeting water managers presenting the use of models to support water basin management planning and EU Water Framework Directive implementation.

Nutrients and eutrophication

Spain

Upland dams cause eutrophication in hill streams

Monitoring of sites just upstream and downstream of four small upland impoundments in Spain show increases in nutrient concentrations, chlorophyll and biomass and a loss of certain types of biodiversity.

France

Particulate and dissolved phosphorus sources to different river catchments

Diffuse and point sources of phosphorus to three nested watersheds in the Marne catchment, France, show wide variations depending on land use. The exchange of particulate phosphorus to dissolved form was assessed.

Conference

Nutrient Recovery and Management 2011

9-12th January 2011, Miami, Florida

Although nutrient removal systems have been operated in many parts of the world for decades, recent developments have focused attention on nutrient management practices 'inside the fence', i.e. with industrial and municipal wastewater treatment systems. Several water quality initiatives around the world are requiring upgrades from conventional biological nutrient removal treatment to enhanced nutrient reduction. … management of nutrients should also consider solutions that are 'outside the fence' within the receiving waters.

www.wef.org/Nutrient

Call for papers

Chemosphere Special Edition on the phosphorus cycle

Topics may include the following:

- *Global phosphorus resources*
- *Recovery and beneficiation of phosphate ore*
- *Material flow analysis of phosphorus*
- *Forecasting of demand and supply of phosphorus*
- *Reducing phosphorus requirement in agriculture*
- *Soil phosphorus dynamics*
- *Phosphorus and food production*
- *Recovery of phosphorus from wastes*
- *Environmental impacts at various stages of the phosphorus cycle*
- *Natural fluxes of phosphorus*
- *Paleobiogeochemistry*

Submission deadline: 15th September 2010.
http://www.elsevier.com/wps/find/journaldescription.cws_home/362/description#description.

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Sewage treatment legislation

Detergents

Commission legal pressure for water quality

The EU Commission continues to engage legal and other actions and other pressure on Member States to implement sewage collection and treatment. The Commission is both pursuing States which have still not fully implemented the 1991 Urban Waste Water Treatment Directive (UWWT) and also gearing up to legal action against States which are falling behind the objectives of the 2000 Water Framework Directive.

Belgium faces a 15 million € plus 62,000 € per day for failure to implement adequate sewage treatment in 40 agglomerations. Full compliance is not expected until the end of 2013, so Belgium could run up a 100 million € total fine by then, that is around 400 € per household for local taxpayers.

This fine is for failure to implement phosphate removal (concerning agglomerations > 10,000 pe in "Sensitive Areas")

Luxembourg has also been sent a final warning, concerning 9 agglomerations which are also not removing phosphates. Five of these are not expected to have implemented P-removal before 2012/2013. Luxembourg therefore also risks fines for non compliance.

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Final warnings have also been sent to Sweden and Finland, concerning 26 agglomerations in Finland and 17 in Sweden where sewage is not collected and treated (agglomerations of 2,000 – 15,000 person equivalents, for which treatment should have been in place by then end of 2005). This follows similar action taken against Belgium, Luxembourg, Portugal, France and Germany last NovemberEU Commission press releases

The Commission has also begun to put pressure on Member States concerning the **EU Water Framework Directive** 2000/60. This Directive required States to submit river basin management plans by 22nd December 2009, with the aim of achieving "good quality status" by 2015. These plans take the 1991 Urban Waste Water Treatment Directive (see above) requirements as a "given", and are susceptible to require more stringent sewage treatment, or treatment with nutrient removal in smaller agglomerations, wherever this is necessary to achieve the quality objectives. Only 8 Member States had submitted their plans by the 2009 deadline, suggesting that many are likely to also fail to achieve implementation by 2015.

This follows legal actions initiated, or written warnings in late 2008 – 2009 to Greece (12 agglomerations), Spain (343 agglomerations where phosphate removal has not been implemented, 59 agglomerations for other reasons), Italy (229 agglomerations) …

IP/10/835, 24th June 2010: "Waste water treatment: Commission seeks substantial fines for Belgium; sends fresh warning to Luxembourg"
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/835

IP/10/95, 28th January 2010 "Waste water treatment: Commission sends firstwarnings to Finland and Sweden"
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/95

EU Commission update on Water Framework Directive implementation:
http://ec.europa.eu/environment/water/participation/map_mc/map.htm

Nutrient criteria and modelling

Detergent phosphates

EU Eutrophication Risk Assessment conclusions confirmed

The EU official scientific committee SCHER has validated the eutrophication risk assessment of phosphates in detergents carried out by Spanish national research institute INIA in the context of the EU Detergent Regulation. This study updates a first eutrophication risk assessment published in 2006 (see Scope Newsletter 67), using a considerably wider data base: 2600 data points provided by EU Member States via the European Commission Joint Research Centre.

The study develops a risk assessment model for eutrophication at the European level, allowing the comparative assessment of different sources of phosphates and particularly the contribution from phosphorus-based detergents.

It is based on 2007 data provided by the detergent industry (AISE) for phosphate use in domestic laundry and domestic dishwasher detergents, country by country across Europe.

The SCHER scientific committee Opinion concludes that this study shows:

- **Eutrophication is a localised problem and is best addressed by locally adapted approaches**
- **"Overall, the results of model indicate that, at the present time, at pan-European scale the contribution of the P-based detergents is not playing a major role in the eutrophication process."**

The first INIA European eutrophication risk assessment study, published in 2006, was assessed by the EU's official scientific committee SCHER, which considered that the methodology was valid, with some reservations, but that the number of data points used (c 300) was insufficient.

2600 data points provided by JRC

This revised study aimed to address these comments, and in particular is now based on 2600 data points for phosphorus concentration and surface water quality collected by the EU Commission Joint Research Centre (JRC) from Member States in the context of the Water Framework Directive intercalibration process.

The methodology is based on the same principles as the **standard industrial chemical risk assessment methodology** developed by the European Chemicals Bureau (ECB) for assessing the risk of industrial chemicals, but with significant adaptations because of the many different natural and human sources of phosphorus, and the biological complexity of eutrophication.

Validated probabilistic risk assessment

Due to the complexity of the eutrophication phenomena, the study is based on probability approaches. The principles defined under the Water Framework Directive were applied: this Directive establishes the criteria that water bodies must fulfil for considering that they are in good condition regarding their eutrophication status. If the criteria are not fulfilled the water body should be considered in fair, poor or bad eutrophication conditions, or using general terms, in less-than-good conditions.

The study used this approach for establishing a **quantitative eutrophication risk estimator**. For each Total Phosphorous concentration (TP), the eutrophication risk was defined as the likelihood of a sensitive site, susceptible to eutrophication, to be in less-than-good eutrophication status. The eutrophication risk is expressed as a relative value, ranging from 0 to 1 (or 0% to 100% when expressed as percentage). The correction is associated to the maximum expected value, and therefore, it is related to the likelihood expected when the percentage of sites in less than good eutrophication status reach the maximum value for each TP level.

TP is a continuous variable, and all probability distributions are presented as cumulative distributions; therefore, for a certain TP value “x” the associated risk “y” must be understood as following:

if the TP concentration value does not exceed x (TP ≤ x) the expected eutrophication risk will not exceed y (Eutrophication risk ≤ y).

This probabilistic methodology is validated by the EU scientific committee SCHER:

- *"The calculation method of the conditional cumulative distribution function for the two classes of lakes is statistically sound and consistent. The effect of the partitioning on differences in these curves is clearly explained and evaluated in the INIA report. The SCHER is of the opinion that the calculations can be checked and are reproducible."*
- *" ... the calculated risk differences due to given scenarios are consistently calculated and reproducible".*

Results

As expected, **significant differences among different European ecoregions** were observed. The data base allowed estimations for four main regions: Northern, Central/Baltic, Atlantic and Mediterranean. Additional significant differences were observed among ecotypes in the Northern and Central/Baltic ecoregions. The results can be found in the full report.

The risk communication options were adapted in order to present information on the contribution of domestic laundry and of domestic dishwasher detergents, and for the combination of phosphorous emissions associated to both.

Two complementary methods were used for the estimation. A deterministic approach was based on averaged conditions for each ecoregion. A probabilistic approach based on Monte Carlo analysis covered the whole variability expected for each ecoregion and ecotype.

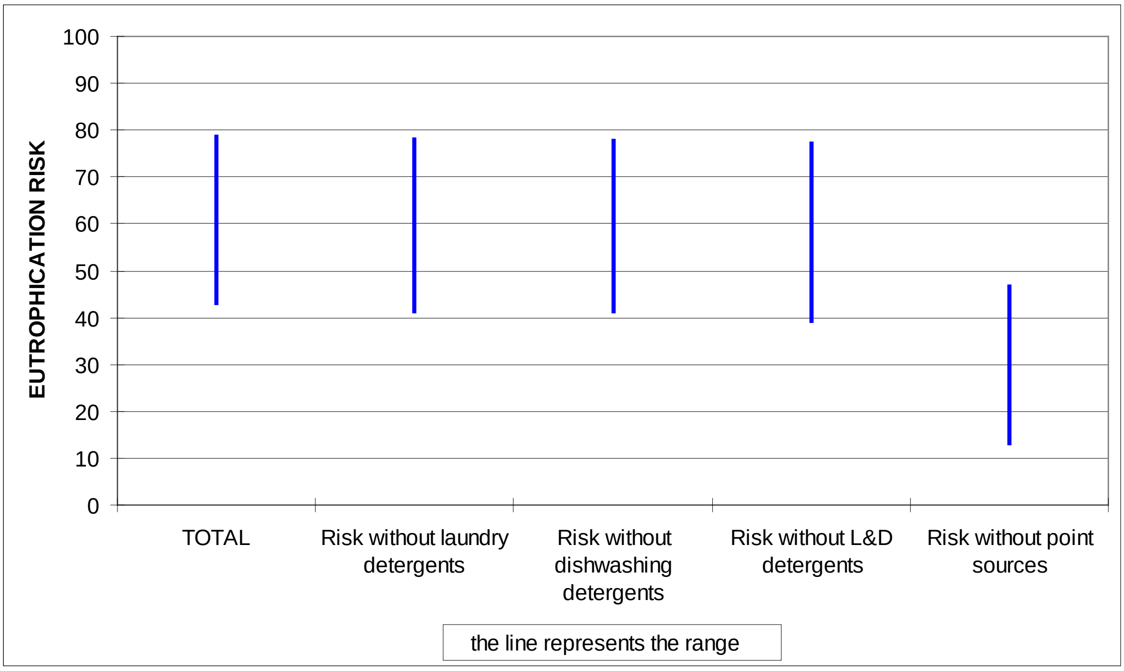
In the deterministic approach the risk is presented by graphs comparing the different risk estimations. The results are summarised in the following figures. The deterministic estimations were conducted for average European values at three phosphorous concentration levels.

Each figure presents five blue vertical lines, representing the values among which the eutrophication risk is expected to range for each assessed scenario. The five scenarios are:

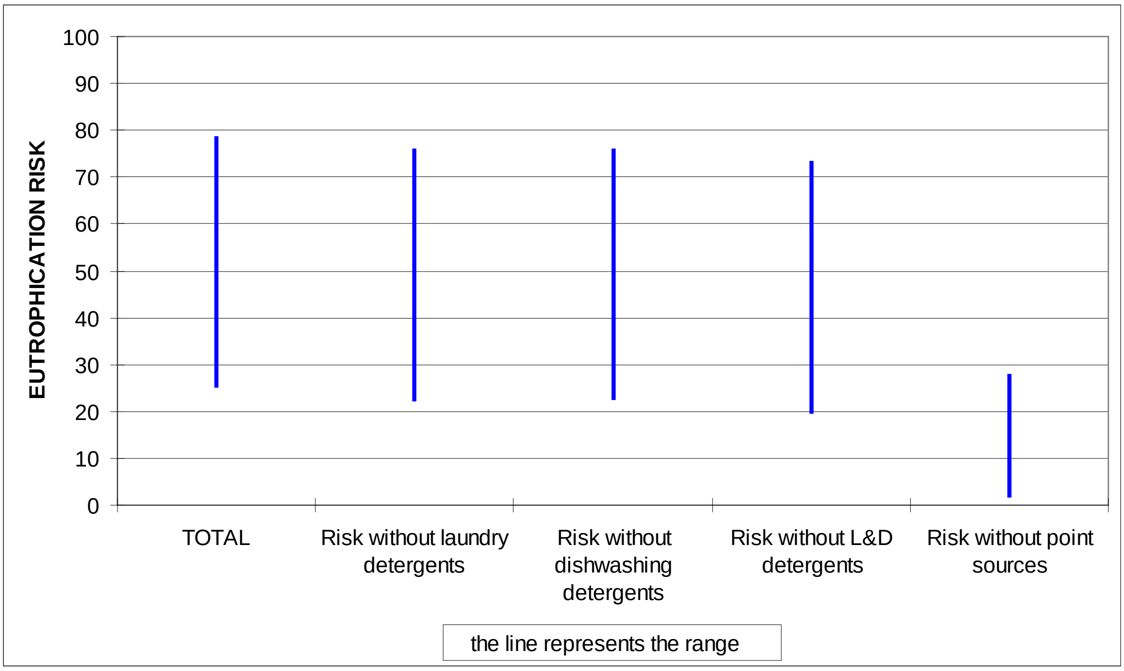
- TOTAL: Overall actual risk estimated for the sum of all current phosphorous emissions
- Risk **without laundry detergents** (expected risk if P-based laundry detergents are not used).
- Risk **without dishwashing detergents** (as above but for P-based dishwashing detergents).
- Risk without both types of detergents (expected risk if both types of P-based detergents are not used).
- Risk without point sources (expected risk if all domestic emissions, including human metabolism and detergents, are removed), that is full and appropriate **sewage treatment**.

Results obtained for the different generic scenarios. The table shows the difference between the total risk and the risk without P-based detergents estimated using the deterministic and probabilistic methods . (This difference is presented for the upper and lower bounds of the risk range).

Ecoregion	**Risk contribution from detergents** Deterministic value for averaged conditions			**Risk contribution from detergents** 10 to 90th percentile for the probabilistic approach		
	Laundry	**Dishwasher**	**Both**	**Laundry**	**Dishwasher**	**Both**
	%	%	%	%	%	%
Atlantic	0.7-1.8	0.8-1.9	1.5-3.8	0.5-2.3	0.6-2.5	1.2-4.9
Central/Baltic	3.0-3.1	3.2-3.3	6.4-6.6	0.0-9.6	0.6-4.8	2.0-10.4
Northern	0.0-3.2	0.0-4.5	0.1-7.9	0.3-3.2	0.6-4.9	1.0-8.0
Mediterranean	0.6-1.6	0.4-1.1	1.1-2.8	0.0-3.2	0.0-1.9	0.5-4.5



Graphic representation of the contribution of P-based detergents to the eutrophication risk estimated for the Atlantic ecoregion using averaged values and a TP concentration of 50 µgP/l.



Graphic representation of the contribution of P-based detergents to the eutrophication risk estimated for the Central/Baltic ecoregion using averaged values and a TP concentration of 50 µgP/l.

Complementary results were obtained through the probabilistic assessments conducted for each ecoregion. The outcome of the estimations conducted for the concentration-risk curves obtained for the whole ecoregion using the chlorophyll a boundaries for establishing the ecological status were used as reference values for the comparison. Minor differences were observed when using the available alternative concentration-risk curves: the ecotype specific curves for the Central/Baltic and Northern ecoregions and the curve obtained using the macrophytes boundary for the Northern ecoregion. These differences do not modify the proposed conclusions.

The general averaged contribution to the eutrophication risk from each type of detergent (laundry or dishwashing) is estimated to be below 5%; and the combined contribution around 4-6%.

Only under extreme conditions, the contribution of detergents to the eutrophication risk may exceed the 10%, using realistic worst case assumptions in terms of point versus diffuse emissions, these extreme conditions could occur rarely at the Pan-European level.

*The quantitative estimations suggest that the contribution of P-based detergents to the eutrophication risk is less than 10% in about 90% of the sensitive water bodies of the Central/Baltic and Northern ecoregions; and in an even larger percentage in the Atlantic and Mediterranean ecoregions.**INIA report published on EU Commission official website:** "Development of an European quantitative eutrophication risk assessment of polyphosphates in detergents. Model validation using the WFD intercalibration data, model re-calibration and pan-European assessment of the eutrophication risk association to the use of phosphates in detergents", INIA/Green Planet, April 2009.*
http://ec.europa.eu/enterprise/sectors/chemicals/documents/specific-chemicals/detergents/index_en.htm

***Official Layman's Summary**:*
http://ec.europa.eu/enterprise/sectors/chemicals/files/docs/2009laymans_summary-inia_report.pdf

***Full report**:*
http://ec.europa.eu/enterprise/sectors/chemicals/files/docs/ceep_study_final_report_042009_en.pdf

***SCHER Opinion**:*
http://ec.europa.eu/health/ph_risk/committees/04_scher/docs/scher_o_116.pdf

Phosphorus, sediments

Conditional probability approach to quality criteria

Paul & McDonald (2005) used conditional probability analysis of data from other 100 US Atlantic streams to derive biological thresholds for sedimentation and corresponding empirical water quality criteria. The US Environment Protection Agency (EPA) has adopted a similar "conditional probability" approach to define phosphorus criteria / standards in the implementation of TDMLs (US Clean Water Act "Total Maximum Daily Loads", see SCOPE Newsletter n°43) for phosphorus discharge limits. Other authors (Lee and Jones-Lee, 2008) are however critical of this approach, suggesting that this method may not be valid as applied, questioning both the biological cause-effect and the validity of the statistical conclusions given the wide variations in the initial data.

Paul & McDonald used conditional probability analysis to assess a data set from 102 stream sites to compare benthic macro-invertebrate data and sedimentation (% fines in sediments). A number of "reference condition" sites were also identified, that is sites showing what were considered to be undisturbed quality for six chemical and biological parameters.

Thresholds

The **"empirical" conditional probability curve of biological impact** in a stream (impacted macro-invertebrate index) for a given level of the pollution metric (sedimentation) were derived from the actual data, higher levels of fines in sediments being generally associated to deteriorated macro-invertebrate status. A threshold for biological impact was estimated by then identifying the change point in the empirical probability curve.

The authors conclude that fines in sediment > 49% gives a near certainty that benthic communities are impacted, and a threshold of 12-15% fines (level at which the probability curve shows a step change, and which corresponds to around 50% of sites having an impacted benthic community.

Other authors have used a **frequency distribution based approach** to derive nutrient quality criteria and TDMLs, see for example papers by Royer, Morgan et al summarised under "Illinois" in SCOPE Newsletter n°71.

Paul & Zheng (2008) **combined a frequency distribution based approach with stressor-response analysis, literature values and expert assessment** to propose nutrient quality criteria for two ecoregions of Pennsylvania. As in the above cited papers, the authors derived the 25th lower percentile of all data sites and the 75th upper percentile of "reference sites", considered as least disturbed (on the basis of watershed land coverage data). The reference site results (19 µg/l total P and 36 µg/l total N) were higher than the whole population derived endpoints of 10 µgP/l and 15 µgN/l.

A **conditional probability approach** as proposed by Paul & McDonald above was also used, based on over 600 data points and comparing benthic macro-invertebrate metrics to nutrient levels. Change point analysis suggested a threshold at 19 µgP/l for three different macro-invertebrate criteria and 35 µgP/l for a fourth macro-invertebrate criteria.

These results were compared with literature values, concluding as recommendation a phosphorus criterion of 25 µg/l total P, assessed as average total phosphorus over the algal growth period of the year.

Lee & Jones-Lee (2008) and Hall and Associates (2008) **question the use of conditional probability methods to derive nutrient criteria**. They suggest that the existence of a statistical relationship between a factor (such as nutrient concentration) and an impact (biological community changes indicative of water quality deterioration) **does not prove that one has a "causal relationship" to the other**, and that this "approach for developing nutrient standards does not consider whether nutrient control will limit plant growth". They question whether it is valid to derive a mathematical (probability) relationship between two such values, in a data set which shows very wide variation ("gun shot scattering") and then use it to define environmental quality evaluation or regulation.

On the other hand, the proponents of these conditional probability methods indicate that "*Uncertainty and natural variability were inherently incorporated into the analysis through the use of data from a probabilistic survey*" (Paul & McDonald 2005).

Lee & Jones-Lee emphasise that **phosphate in surface waters is not "toxic" and that its negative impact on biological communities is not causal but indirect**. In particular, benthic macro-invertebrates used in the above cited studies are not a good indicator of phosphate impacts. They are affected by reduced oxygen concentrations near the stream bottom, but this is often caused by factors unrelated to nutrients, such as canopy cover (shading). They suggest that before using TDMLs derived from such data, it should be further assessed whether nutrients are the key stressor affecting such benthic macro-invertebrate populations.

"Development of empirical, geographically specific water quality criteria: a conditional probability analysis approach", JAWRA (Journal of the American Water Resources Association) paper n° 04095, October 2004, pages 1211-1223 www.awra.org/jawra

J. Paul, M. McDonald, US Environmental Protection Agency, Mail Drop 343-06, Research Triangle Park, North Carolina 27711 paul.john@epa.gov

"Stormwater runoff water quality newsletter", vol. 11, n°9, September 2008. http://www.gfredlee.com/newsindex.htm

G. Lee & A. Jones-Lee gfredlee@aol.com

"Request for a peer review of new EPA Region III approach to developing instream standards for nutrients", J. Hall, jhall@hall-associates.com *21 August 2008.* http://www.gfredlee.com/Nutrients/Hall_Cond_Prob_Eval.pdf

"Development of nutrient endpoints for Allegheny Plateau and Ridge and Valley ecoregions of Pennsylvania: TDML application", prepared for US EPA Region 3 Philadelphia PA. June 2008. www.epa.gov/reg3wapd/tmdl/pa_tmdl/NutrientEndPoint/Nutrient_End_Point_Study_for_Pittsburgh_and_Harrisburg.pdf

M. Paul & L. Zheng, Tetra Tech Inc, 400 Red Brook Boulevard Suite 200, Owings Mills, MD 21117.

Massachusetts

Risk probability modelling of local eutrophication management

This paper combines a simple locally-specific ecosystem model with probabilistic methods to assess the likelihood that specific nutrient reduction actions will enable eutrophication to be controlled. Whereas the 2009 INIA report (see this issue of Scope Newsletter) shows that probabilistic methods enable eutrophication risk assessment at a macro level (Europe-wide), this paper uses comparable methods very differently to address a specific local case.

The area modelled was 40 km of the Upper Charles River, Massachusetts, USA, part of a 130 km river which finally discharges into Boston Harbour.

A phytoplankton – nutrient dynamics model was developed based on around 20 ecosystem compartments and a dozen river sections. The model is considered to be comparable in complexity to commonly used models such as QUAL2E and uses equations to estimate phytoplankton, dissolved oxygen, non living organic carbon and nitrogen, based on 24 uncertain parameters. The model is based on prior estimates of these uncertainties (based on modelling literature) and further uncertainties for emissions of 7 pollution types at 8 different point sources (these include both point sources of pollution and the inflows of the headwater and tributaries which carry various levels of the pollutants).

A number of parameters were measured 3 times on one day of summer and 3 times on one day of autumn at 9 river sites, including total phytoplankton concentration, dissolved oxygen, BOD, organic and inorganic phosphorus, organic nitrogen, nitrates and ammonium, water flow, temperature and depth. At both dates, the river was estimated to be at a near steady state.

Predicting phytoplankton concentrations

The data from the summer day sampling was used to condition the model, and that of the autumn day sampling to assess its predictive capacity. For the summer day, except for isolated exceptions, the model show successful representation of spatial variations of water quality. For the autumn day sampling data, prediction is less accurate, as would be expected, in particular for phytoplankton concentration. Nonetheless, **the uncertainty estimates of the model mean that it is able to predict the confidence with which the phytoplankton quality objectives will be achieved**.

The model sensitivity analysis also enables **identification of sections and parameters where further monitoring data would particularly contribute to improving prediction capacity**. For example, data on specific types of phytoplankton (blue-green, diatoms ...) could give better results than only total phytoplankton.

Results indicate that a "do nothing" (business as usual) scenario results in phytoplankton well above target concentrations, and even that a complete elimination of the upstream CRPCD sewage works point source of phosphorus (100% P-removal) is also unlikely to alone achieve these targets. **Reducing the phytoplankton concentration in the upstream arriving water, for example by increasing flow rate**, shows on the other hand a higher likelihood of controlling eutrophication symptoms.

"Risk-based modelling of surface water quality: a case study of the Charles River, Massachusetts", Journal of Hydrology, 274, pages 225-247, 2003.
www.elsevier.com/locate/hydrol

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Manager's Guide

Model supported WFD implementation

The "water manager's guide" explains to water managers and decision makers the basis of how modelling can be used to support the implementation of the EU Water Framework Directive (WFD) at local water basin or at wider levels.

The 270 page book includes an introduction for non-scientists to **water quality models** work, how they work and their limitations, discussion of how they can be used to simulate different water management strategies or options, including the development of different scenarios for consultation of stakeholders and the public, as is required by this Directive. **Six different case studies demonstrating the application of models to WFD implementation for different water basins across Europe are presented**.

The book first explains the objectives and processes fixed by the Water Framework Directive, in particular the obligations for the participatory planning process: defining programmes of measures and water basin management plans, and ensuring public and stakeholder consultation throughout this process.

Model implementation is presented in four phases:

- **Preparation and checklist** for the iterative process of model use to arrive at decision making
- **Assessment** of current status, definition of necessary monitoring data, evaluation of a baseline scenario
- **Support** for design and evaluation of programmes of measures and water basin management plans, scenario definition for uncertain futures
- Accompanying **implementation and evaluating improvements** achieved

Explanations of how models work for decision makers include an introduction to model processes and tools, issues regarding model results reliability, and a discussion of social learning and participation in complex systems.

Six case studies are presented, in which models were used to define and present WFD implementation scenarios: Marne – Seine – Normandy, France ; Witte Nete Dender – Scheldt basin, Netherlands ; Verbano, Italy ; Lake Peipsi, Russia/Estonia ; Spree river basin, Germany ; Möll river, Swiss Alps. One of these, Lake Peipsi, particularly concerns the issue of eutrophication.

Lake Peipsi

The Lake Peipsi case study particularly looks at eutrophication issues, relating to possible changes in agricultural and sewage works phosphorus and nitrogen inputs to the lake in different development scenarios. In this case, the modelling is used to present widely different macro-economic scenarios for the future. The modelling is useful for this because of the high levels of complexity and variation possible between the different scenarios.

In this case, **point sources are the most significant source of phosphorus to the lake**, and considerable reductions in loading could be achieved by improvements in sewage treatment in cities on both the Estonia and Russian sides of the lake, in particular for the two largest basin cities (Pskov, Russia, 206 000 inhabitants and Tartu, Estonia, 120 000).

The different scenarios considered different social and economic contexts, including business as usual, rapid economic development, crisis (economic decline, collapse in Russia), isolation (no sewage treatment improvement in Russia) and a mixture of development in the EU and collapse in Russia.

The model confirms that short term strategy should concentrate on implementing P-removal in the Pskov sewage works. Also, sewage from small rural settlements should be better collected and treated. The scenarios show that the worst scenario for lake water quality would be economic collapse in Russia, with consequent collapse of sewage treatment.

"Water Framework Directive: Model supported Implementation. A water manager's guide". Edited by F. Hattermann, Z. Kundzewicz. 268 pages, IWA Publishing, www.iwapublishing.com *, 2010*

Nutrients and eutrophication

Spain

Upland dams cause eutrophication in hill streams

The study assessed the eutrophication impact of four upland in-river impoundments, with deep-release of outflow water, in mountain rivers of central Spain: Tormes river (Gredos mountain range, Duermo river basin), Riaza and Erasma rivers (Guadarrama mountain range, also Duermo basin) and Miraflores river (Guadarramas, Tajo river basin), all of which are underlain by siliceous rocks such as granite, resulting in soft waters (low ionic content).

For each river, sampling was carried out over four months July-October (late summer – autumn) in 2001, at two sites: one site 1-3 km upstream from the impoundment, one site 0.5-1.5 km downstream, in both cases in stony riffle zones.

Parameters sampled were: water velocity, temperature, conductivity, dissolved oxygen, pH (9-12 measures for each parameter), and inorganic nutrients (soluble nitrogen, ammonium, soluble phosphates, 4 measures for each site). **Periphyton** (algae, fungi and bacteria on the river floor surface) were sampled once at each site (September – October) by removing 3-5 stones from across the river bed, scraping the stones and analysing the resulting solids. **Macroinvertebrates** were samples once at each site at the same time by collecting 250 µm net samples from the river bottom.

Nutrient increase

Whereas physicochemical parameters for the river waters were not significantly different downstream from upstream of the impoundments (water velocity, temperature, pH, conductivity), **nutrient concentrations were significantly higher downstream** (soluble nitrogen, ammonium and soluble phosphate).

Chlorophyll levels (on the stones) were also significantly higher downstream from the impoundments than upstream, with correlation between nutrient concentrations and periphyton chlorophyll, indicative of eutrophication symptoms. The most significant correlation was between soluble phosphate and chlorophyll.

Biodiversity

The density (biomass) of benthic macroinvertebrates was higher downstream of the impoundments, but taxon diversity was significantly lower downstream. Snails and midge larvae showed the largest increases between downstream and upstream sites. In all cases, macroinvertebrate scrapers and collector-gatherers increased downstream, whereas shredders decreased.

The authors conclude that small, deep-release impoundments situated on upland silicaceous rivers can cause downstream eutrophication, and consequent loss of biodiversity quality, because nutrient run-off from land and forests is inevitable. In order to reduce these detrimental effects, they recommend always removing vegetation before filling such impoundments if they must be created.

"Eutrophication downstream from small reservoirs in mountain rivers of central Spain", Water Research 39, pages 3376-3384, 2005
http://www.sciencedirect.com/science/journal/00431354

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France

Particulate and dissolved phosphorus sources to different river catchments

Detailed phosphorus budgets and mass balances were calculated for three nested catchments of the Marne river, a major tributary of the Seine river (which it joins just upstream of Paris), and the most eutrophic sub-basin of the Seine. This was completed by experimental assessment of the exchangeable particulate phosphorus in the suspended sediment, using the ^{32}P isotopic method.

The **Marne river** has a mean annual discharge into the Seine of 190 m^3/s and its catchment covers nearly 13,000 km^2, or 17% of the whole Seine catchment. A large reservoir (48 km^2, Lac du Der) was impounded upstream in 1974. Population density of the whole basin is 160 persons/km^2, but is highest in the downstream area.

The study also examined the **Grand Morin and Blaise sub-basins of the Marne** (1200 and 600 km^2 surface and 10-12 and 6-8 m^3/s average annual flows respectively). Both have a much lower population density than the Marne basin average, with the Blaise having a relatively high proportion of forest and pasture coverage (58% together) and the Grand Morin more intensive agriculture (64% cultivated land).

Sampling and P budgets

The study is based on one year's monthly sampling from each basin, including total suspended solids, total phosphorus and dissolved phosphate (orthophosphate). **Phosphorus budgets** were calculated by multiplying water flow data by phosphorus concentrations. At the same time data for point source phosphorus discharges were collected (dissolved and particulate P), estimates were made of sediment retention rates in flood plains and reservoir, and of diffuse sources, calculated so as to complete a basin-scale phosphorus budget.

Point sources were estimated to represent 60% of total phosphorus loads to the Marne (465 tonnes P/year), but only 40% for the upstream sub-basins. 60% of point source phosphorus was in dissolved from. Retention of phosphorus in the river systems is estimated to be significant, at 15-30% of input load: 28 tonnes P/year is estimated to be retained in the Lac du Der reservoir and 86-172 tonnes P/year in the Marne river floodplains.

Agricultural and soil phosphorus

The agricultural phosphorus budget was estimated from crop and animal restitutions to soil, export in harvests, atmospheric deposition, and fertiliser use. Input data included land use (surfaces of different types of crops), farm animal numbers, and fertiliser use data supplied by the fertiliser industry, and results of a survey of agricultural soil phosphorus stock carried out over the whole Seine basin. **Fertiliser use showed to be 51 – 70% of total agricultural phosphorus inputs**, depending on the sub-basin.

This survey indicated **very high soil P stocks of 1.8 – 5 tonnes P/hectare**. Net crop phosphorus uptakes were estimated at around 1% of soil phosphorus stock per year whilst an agricultural phosphorus input excess (0.8 – 5 kgP/ha/year) continues to increase the soil phosphorus stock.

These estimates indicate significantly different agricultural phosphorus budgets for the sub-basins, corresponding to **different land use and livestock densities**.

For the whole Marne basin, surface runoff was estimated at an average 0.47 kgP/ha agricultural surface per year (of which 20-30% dissolved phosphate), and drainage P loss at 0.11 kgP/ha drained agricultural land per year (>60% dissolved phosphate).

Exchangeable particulate phosphorus

The exchangeable phosphorus between particulate forms and dissolved phosphate was assessed by mixing suspended sediment from river water samples (dried then re-suspended to minimise biological activity) with various concentrations of potassium phosphate solution, adding radioactive labelled ^{32}P solution, and shaking gently for 3 minutes, 30 minutes and 300 minutes.

These experiments indicate that **the totality of the inorganic particulate phosphate in the river is susceptible to be transformed into dissolved forms** over a horizon of one year, and 80% within one month.

Furthermore, the **dissolved phosphate outflow from the Marne is lower than budgeted**, indicating that some 130 tonnes P/year is transformed from dissolved to particulate forms in the river system.

"Phosphorus budget in the Marne watershed (France): urban vs. diffuse sources, dissolved vs. particulate forms", Biogeochemistry n° 72, pages 35-66, 2005.

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This study was completed by three papers on the P dynamics in the whole Seine River basin and its estuary :

Garnier, J., Némery, J., Billen, G. & Théry, S., 2005.- Nutrient dynamics and control of eutrophication in the Marne River: modelling the role of exchangeable phosphorus. Journal of hydrology, n° 304, p. 397-412.

Némery, J. & Garnier, J., 2007.- Dynamics of particulate phosphorus in the Seine estuary (France). Hydrobiologia, n° 588, p. 271-290.

Némery, J. & Garnier, J., 2007.- Origin and fate of phosphorus in the Seine watershed (France) : The agricultural and hydrographic P budget. JGR-Biogeosciences, n° 112 G03012, doi:10.1029/2006JG000331.

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Nutrient Recovery and Management 2011

Hilton Miami Downtown Miami, Florida: January 9 – 12, 2011

Nutrient Recovery and Management 2011
Inside and Outside the Fence

The Water Environment Federation and the *International Water Association*, in cooperation with the *Florida Water Environment Association* and the *Water Environment Research Federation*, are pleased to announce a Conference covering the latest research and experience in all the management aspects of nutrient removal.

Nutrient removal systems have been operated in many parts of the world for decades and recent developments have focused attention on nutrient management practices ‘inside the fence’, i.e. with industrial and municipal wastewater treatment systems. Several water quality initiatives around the world are requiring upgrades from conventional biological nutrient removal treatment to enhanced nutrient reduction. There has been an increase in interest in watershed approaches to improving water quality, which would suggest that management of nutrients should also consider solutions that are ‘outside the fence’ within the receiving waters.

Abstracts are being solicited on the following issues and cross-cutting topics related to nutrient recovery and management, including but not limited to:

A. Research in Nutrient Removal and Recovery
B. Operations of Nutrient Removal and Recovery Plant
C. Design of Nutrient Removal and Recovery Plants
D. Watershed and River Basin Nutrient Management

http://www.wef.org/Nutrient