Annex to Tender specification - Sample problems

Open call for tender EEA/BSS/06/007

Supporting EEA in statistical and probabilistic issues related to spatial integration supporting environmental assessment

Note: These sample problems are provided to give a flavour of the type of questions the EEA is facing. This does not imply that the same problems will be the subject of a specific contract, or that they will necessarily be formulated in the same way. The tenderer is not asked to solve the problems, but to state how he would address the issue and adjust to EEA's requirements.

Problem 1

Uncertainty domain of relationships between driving forces and river water composition in stratified assessments

River water composition at each monitoring point is controlled by the intensity of impacting activities on the watershed and by the run-off. The intensity of impacting activities can be captured by stratification of the elementary catchments according to the distribution of these activities from the river source to the monitoring point. The currently used determinant is a yearly average (that can be computed by season, etc.) calculated per monitoring point. The true error of the average is not known because the estimation variance cannot be simply computed (this requires filtering data with the internal data model in relation with seasonality). As the use of dispersion variants leads to an unrealistic error estimate of the yearly average, this possibility is discarded.

The stratum (i.e. the collection of points sharing the same driving force characteristics on a certain area or a whole area) average is the mean of point averages. This very simple construction of the computation procedure makes it very flexible: the point averages (individual averages) are computed and stored, the stratum averages are prepared after defining the current stratum point composition. **To what extent may the estimation error of the stratum average computed from the dispersion variance of the means be used? Should an estimate of the estimation error of each individual average be included in this calculation? If yes, how can it be computed?**

Making the hypothesis that the development over time of the yearly averages mocks up the trend in river composition response, what forecast method (e.g. linear regression) is the best suitable, considering the uncertainty attached to each value? How can it be included in the model? The aim of the exercise is to assess the date on which, under a certain forecast model, a concentration target shall be met.

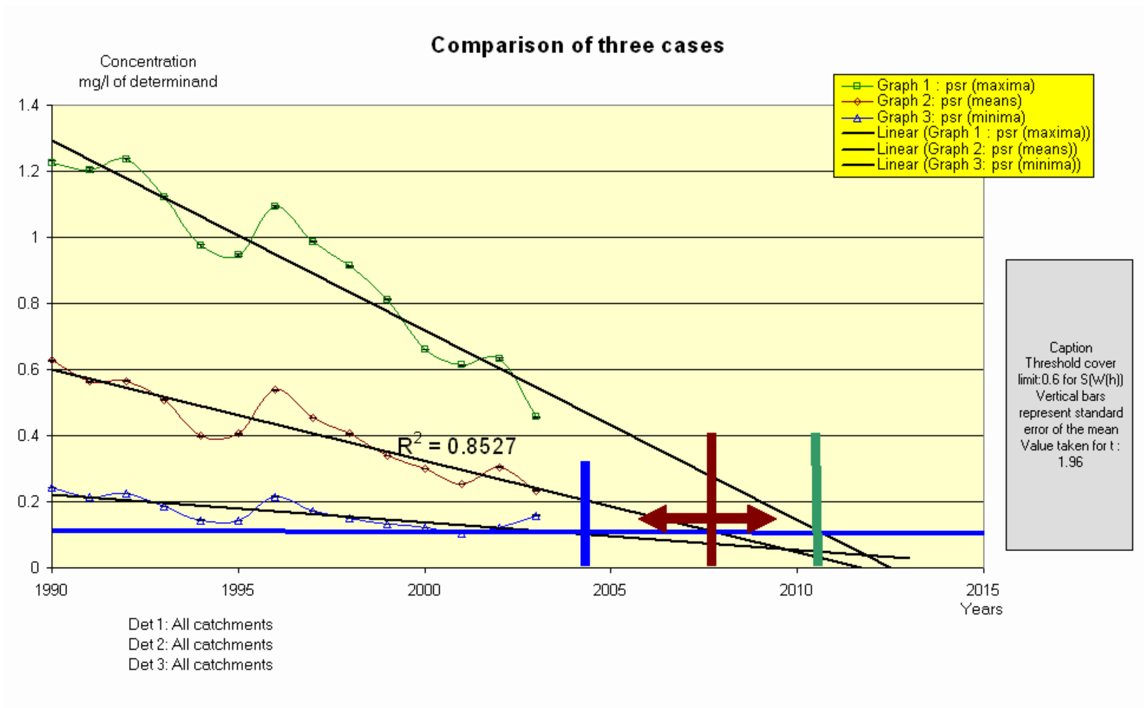

Figure 1: Example of trend calculation showing the different issues within the first problem

Comments: The figure presents results from real data on soluble phosphorus, calculated for France. All strata were included to achieve a stratified average, all "drivers" together (D of DPSIR[1]). The green, brown and blue curves represent the average of point maxima, the average of means, and the average of minima, respectively. Trend lines are superimposed and cut a hypothetic target of 0.1 mg PO4/l in ~2012, ~2007 and ~2004, respectively. The horizontal, double-ended arrow indicates one of the expected responses: uncertainty on both sides of the ~2007 time estimated as year of meeting the target, considering stratum average as determinant of the policy result of phosphate abatement.

The R^2 value is provided by MS Excel and is not necessarily accurate.

All three curves display similar variability that result from hydrological conditions. Filtering has not been applied, but should be considered, including uncertainty on date of meeting target.

The current calculations just consider each individual mean as a single observation, thus making it possible to apply the classical stratum calculation procedures, corrected to take into account the possible discrepancy in the sampling rates across strata (some strata can be present in a certain area where no monitoring exists).

Subsidiary problem 1: The use of yearly averages is not the outcome of a comparison of assessments of the possible determinants. The quantile X% has been suggested, but neither composition method at the stratum level nor error estimate (i.e. no practical use)

[1] DPSIR: Drivers/Pressure/State/Impact/Response assessment framework.

of quantile at the stratum level could be defined. The proxy assessment of upper and lower (no probability value could be guessed) quantiles used are the average of individual maxima and individual minima, respectively, combined at the stratum level.

Subsidiary problem 2: In the comments to Figure 1, the possible filtering by hydrologic conditions is mentioned. Former attempts suggested that the relative effective rainfall (current effective rainfall/long-term effective rainfall) is a good filtering variable, because it is easy to compute and apply accurately to the areas concerned (something that relative river discharge cannot fulfil). This third variable, at stratum level, may, however, add some uncertainty along with cutting the share of non-explained variance. Is the use of supplementary variable worth while, and is the assessment of the range in years of meeting target still calculable economically?

General comments on problem 1: Geostatistics (kriging) have been used quite comprehensively to identify the components of stratum variance. The results were rather positive, but could not be turned into operational recommendations. A major problem is the difficulty of building relevant variograms and to apply them to variable stratum content. If kriging/geostatitics were to be proposed, this should be supported by strong evidence on applicability to the issue to solve.

Supporting documentation to problem 1:

Nixon, S. C., 1997. *European freshwater monitoring network design. Topic Report. Inland Waters n° 10/1996.* Luxembourg. Office for Official publications of the European Communities. 129 pages. (http://reports.eea.eu.int/92-9167-023-5/en)

Leonard, J. and Crouzet, P., 1999. *Construction d'un réseau représentatif. Contribution au réseau "EUROWATERNET" / Qualité des cours d'eau de l'Agence Européenne de l'Environnement. Notes de méthode n° 13.* Orléans. Institut français de l'environnement. 70 pages. (electronic copy available with tender documentation)

EEA, 2001. “Revisiting technical issues related to river quality reporting within the current Eurowaternet process. New insights to assessing sectoral policies efficiency”. (*report type: Draft, writen by Philippe Crouzet, ordered by* 'EEA/EIONET') Copenhagen, 38 pages. (electronic copy available with tender documentation)

Problem two

Accuracy of the Weighted Index of River Quality (WIRQ) developed under the water accounting framework considering a) the possible gaps in annual chronicles and b) variable extent of the domain of accounting

WIRQ is a method to provide a weighted indexing using river reaches as the reference population. It consists of allocating water quality indexes to a quantity of river resource, assessed in standardized kilometres (SRU = standard river unit). The SRU is the length of reach multiplied by a reference discharge value, yielding km.m3.s-1, which mimics the quantity of movement. This unit was suggested by Heldal and Østdahl, and used in further developments. It is the basis of the methodology recommended at the UNECE level to carry out satellite accounts.

In practice, quality indexes computed at monitoring points are propagated along the river courses, making it possible to mimic a comprehensive sampling of all river reaches. Reaches, where quality cannot be propagated by the model, are allocated through a proportional break-down of quality indexes, per class of river size within a sub-catchment.

This methodology aims at analysing the changes and the location of changes, and report in the form of an input-output table. These tables require that the area covered by the input matches the area covered by the output, making it necessary that the quality indexing be identical in both situations.

When the river system is defined, the SRU values can be computed at an annual or monthly level. Each river segment, having its own SRU, can therefore be populated with a quality index value. Quality indexes are derived from data monitored at fixed points and assessed with the assistance of quality indexing (e.g. the SEQ-eau system that is quite comprehensive).

The statistical principles behind the methodology are that:

- The population is the collection of river reaches (a reach is a river segment ~500 metres, in which all characteristics are understood as stable, one single quality at time t, one discharge at time t, etc.);

- River reaches are monitored at certain points that may be distant or close. However, there is systematically an upstream/downstream dependency (values at downstream locations are undoubtedly depending on values at the points upstream);

- Making sound statistics on the reaches population from observations with highly varying degrees of dependency is complex and uncertain. By contrast, extrapolation of values between stations is simple and provides quite accurate results (improving extrapolation method is not part of the tender). Hence, the data preparation stage makes a comprehensive sample in which each individual is populated. Further statistics are easy and quick.

This classical approach poses two sets of questions that cannot be answered without theoretical and practical support.

The first question relates to the system of quality indexing. Quality indexing is always based on a comparison between thresholds and observed values. The rules of scoring differ widely: worst score within a year, average distance between each score and target, etc.

The aim of the EEA is to compute a distance to target, not to perform compliance checking. Distance to target may be reached, for example, by considering the distribution of scores (e.g. 1 per month) instead of the annual scoring, when relevant (obviously, the determinants that are, by definition, monitored once a year are excluded).

This poses the following subsidiary problems:

Subsidiary problem 1: When the monitoring is not 1/month (more or less), what would be a suitable disaggregating/aggregating method to cope with the final target? Could a distribution assessment smooth the information and replace 12 calculations by one calculation on distribution? How to assess the suitability of the approach?

Subsidiary problem 2: Since several monthly quality indexes are considered, how to build the SRU on relevant discharge values instead of long-term values so that the accounts (input-output table) could nevertheless be carried out? Is input-output still an account if the reference changes? How can the relative weight of quality and discharge in the final accounts (standardizing?) be differentiated?

The challenge is not an issue of quality assessment, but providing the correct analysis so that the final outcome could be proposed with an accurate degree of likelihood.

When analysing the possible ways to address this issue, it must be kept in mind that propagating quality is a long calculation process, since recursive algorithms have to be used on trees that may have several hundred (thousand) calculation units. Any suggested process should not add substantial calculation time to the current processes.

Supporting documentation to problem 2:

Heldal, J. and Østdahl, T., 1984. ”Synoptic monitoring of water quality and water resources. A suggestion on population and sampling approaches”. *Statistical Journal of the United Nations*. **Vol ECE2**. pp. 393-406. (provided as scanned copy that should be discarded after preparation of the tender)

Oudin, L.-C. and Maupas, D., 1999. *Système d'évaluation de la qualité des eaux des cours d'eau, SEQ-eau. Version 1*, 2 vols.Vol. 1: *Les études des agences de l'eau n° 64.* Paris. Office International de l'eau. (Annexe A 282 pp., Annexe B 223 pp.), 259 pages.

Oudin, L.-C. and Maupas, D., 1999. *Système d'évaluation de la qualité des eaux des cours d'eau, SEQ-eau. Version 1. Annexes et Grilles,* 2 vols.Vol. 2: *Les études des agences de l'eau n° 64.* Paris. Office International de l'eau. 305 pages.

Crouzet, P., Germain, C. and Le Gall, G., 1999. *Les Comptes de la qualité des cours d'eau. Mise en oeuvre d'une méthode simplifiée de calcul. Développements en cours*. *Etudes et Travaux n° 25.* Orléans. Institut français de l'environnement. 70 pages.

EEA, 2001. “Reporting river quality using the Water Quality Accounts methodology. Application within the Eurowaternet process”. (*report type: Draft, written by Philippe Crouzet*) Copenhagen, 24 pages, (electronic copy available with tender documentation)

Problem 3

Developing the principles of probabilistic assessment of terrestrial habitats in view of preparing ecosystem and habitats accounting

The question of terrestrial habitats accounting is a very difficult issue, which, until now, has been addressed mainly by deterministic approaches. Deterministic approaches are quite promising, but they display the following inconveniences:

- Checking results against observations is relatively difficult because observations have different resolutions and representativeness;

- Plant habitats are static, but fauna is mobile and is not adequately represented by static approaches;

- New observation systems by satellite are not simply incorporated into the model;

- The final result is not adjusted to accounting input-output tables.

A rather different approach, based on defining a probability of meeting certain habitats in a certain area, is being envisaged and poses other kinds of theoretical, practical and data usage problems.

The main goal of the probabilistic approach is to define as accurately as possible a reference population that could be stratified and be used to assimilate the existing observation systems. Even though some observation systems could be marginally improved, it is a prerequisite that the observation systems are an asset, where the design and content is driven by strong forces that make it impossible to adjust them.

Potential main supporting documentation to problem 3:

- CORINE *land cover*, yielding a 25ha (min. 100m width) information on 44 classes of land coverage and its derivatives, among which CORILIS extrapolation calculating the "class temperature", by analogy with "urban temperatures" that express the diffusion of urban masses across the terrain.

- Soil functional maps (resolution not fully defined) providing information on humic content, water capacity, chemical composition (Ca/Si/etc.).

- Natura 2000 sites (nationally designated sites after consultation procedures), CDDA (common database on designated areas), Ramsar sites (wetlands) convention, atlases of species (grid 50×50 km having 1 figure per grid[2]). In all cases, some bias may exist

[2] This data source poses specific problems since species may be depending on land cover types that may be oddly represented in the grid cell. Hence, what is the relationship between grid and terrain?

due to the fact that nature observation partly relies on unpaid volunteers. The possibility of finding motivated volunteers is larger in densely populated areas, making observation biased.

- Satellite monitoring and other sources of continuous (space) and more or less frequent observations on primary productivity, soil moisture, meteorological data, etc.

- Major works that create discontinuities and may affect the probability of habitat presence.

In this last problem, the challenge is to define the issues in such a way that a probabilistic approach could be adequately defined and implemented gradually. Tests on limited areas and groups are envisaged to asses the relevance of existing data to compute probability distributions at the end of 2006.