

Abstracted from the article  
by Willem Koert, april 2006  
in *Wageningen Update*  
by Claire Mays



Cadmium accumulates  
in the tern's system,  
affecting its reproduction later in life.  
Photo by Ronny Hullegie

## The knock-on effects of environmental toxins

In the near future, nature reserves in the Netherlands will total more than a half million hectares. The government is converting farmland and river forelands into natural habitat. This sounds like music to conservationists' ears, but there is a catch. New nature reserves are burdened with a hidden environmental legacy. "We often find heavy metals, pesticides and veterinary medicines in former agricultural areas," says Jack Faber, project leader at the research institute Alterra, part of Wageningen UR. "In river forelands, we find PAHs, heavy metals, PCBs, and a list that reads like a chemical company's catalogue. A tremendous number of contaminants are circulating in the environment, and more are being introduced every day."

In addition, not much is known about the risk these components pose to the environment, not to mention whether the risks are great enough to require measures. As a result, managers of new

nature reserves do not know when they should take measures. Faber and his co-workers have developed a new model that should help these managers establish priorities.

### In this issue

1. The knock-on effects of environmental toxins
3. NoMiracle Open Workshops
4. Third year activities of NoMiracle
7. NoMiracle Scientific Articles published the first three years of NoMiracle
10. NoMiracle co-ordination

### Harmful effects

The research is part of NoMiracle, an integrated EU project involving 38 European partners. NoMiracle stands for 'Novel Methods for Integrated Risk Assessment of Cumulative stressors in Europe'. All participating projects in NoMiracle revolve around the same problem, which toxicologists, ecologists and public health experts in practice run into time and again: how dangerous are harmful chemicals in the environment in reality? Toxicology often does not know the answer. "Toxicologists test different doses of a single chemical on a laboratory animal, often a mouse or a Japanese quail," says Faber. "Then they study the effects. But in nature, you are dealing with other organisms. We don't know whether, for example, badgers and godwits react the same as laboratory animals under controlled conditions. We can't experimentally expose rare species. They are protected." "The gap in knowledge represents an international problem in nature conservation," says Faber. In his project, Faber is researching why one species reacts more severely to a contaminant than another species. "It's not so much the laboratory determined toxicological sensitivity that predicts the sensitivity of an individual species, but rather the overall ecological vulnerability," says Faber. "Once you know which frog species is the most vulnerable, then you also know which frog species you should protect first."

### Food choice

Faber has therefore developed a model that says something about the vulnerability of species to harmful chemicals. The project leader and his team have built a database based on the work of biologists who have recorded data on species in the wild. "We restricted ourselves to six common chemicals." The analysis published in the report Ecological Vulnerability in Wildlife shows, for example, that the common tern (front page) is relatively vulnerable to cadmium. This is because this species sits high up in the food chain, has a long life and produces relatively few young. Consequently, cadmium, a poisonous metal that accumulates easily in aquatic food chains, has the opportunity to accumulate in the common tern, affecting the bird's reproduction later in life. Other species that

consume lots of energy, and therefore require lots of food, are also vulnerable to cadmium, according to the model.

### Stress factors

Faber and his colleagues are not the only researchers at Wageningen UR participating in the European megaproject NoMiracle. Jan Kammenga and his colleagues at Wageningen University's Laboratory of Nematology are working on research that should bring ecology and toxicology closer together. Kammenga studies the effects of combinations of stress factors in nematodes at the genetic level. In Kammenga's experimental setup, a contaminant is considered to be one of these stress factors. "We would like to know if harmful chemicals are always harmful to the same degree," he says. "Whether a compound is more or less harmful to soil life can depend on the humidity or the temperature. That's why we expose nematodes to a contaminant, but at the same time other stress factors as well. We then measure how the genes react using DNA chips." Wageningen nematologists are quickly closing gaps in basic science with this research. "Conditions are continually changing in the environment. We often don't know what effect varying temperatures and humidities have on organisms at a molecular level. Only when we know more, can we say something about the interaction with harmful compounds."

### Health risks

"NoMiracle is intended to translate toxicological knowledge into the complex reality. Not only that it is important to protect nature, but also to gain a better insight into the health risks people are exposed to", says Hans Løkke, coordinator of NoMiracle. There is a large amount of uncertainty in current models. Not only is little known about the role of ecology and the interaction with other stressors, but the knowledge about the toxicology of chemical mixtures is also in its infancy. Løkke hopes that these knowledge gaps will be filled by NoMiracle within the five year the project is running. "The NoMiracle approach is working," he says. This sort of complex questions can only be solved by large-scale efforts.

#### Information:

Dr Jack Faber, jack.faber@wur.nl

Dr Jan Kammenga, jan.kammenga@wur.nl



By Hans Løkke  
& Morten Strandberg

## NoMiracle Newsletter No. 10

NOvel Methods for Integrated Risk Assessment of  
Cumulative stressors in Europe

# NoMiracle Open Workshops

The first two open workshops of NoMiracle were held in Verbania in 2006, and in Stuttgart in 2007. Reports from these workshops are available from the NoMiracle Home Page. (<http://nomiracle.jrc.it>)

### 3. Exposure & Fate Assessment – Man and Environment, April 1-2, 2008

The 3rd Open NoMiracle workshop, entitled “Exposure & fate Assessment – Man and Environment”, will be held in Leipzig on April 1-2, 2008. Risk assessment depends critically on how to assess the effect-relevant exposure of contaminants. In the EU project NOMIRACLE, novel methods have been developed to characterize the matrix-specific concentration and bioavailability of contaminants, to predict compound partitioning and degradation under natural conditions, and to simulate the multimedia fate of contaminants with explicit consideration of spatial and temporal variation. The new experimental and theoretical methods are expected to improve exposure assessment and through that risk assessment significantly. The workshop will serve as platform to inform industry, governmental authorities and academia about the novel methods and procedures developed, and about their scope in the context of EU-wide regulations concerning the human and environmental hazard and risk associated with chemical substances in the environment such as REACH, the Water Framework Directive, and Directives concerning biocides and pesticides.

### 4. Integrated Assessment of Environmental and Human Health

(Planned September/October 2008)  
The 4th Open Workshop, entitled “Integrated Assessment of Environmental and Human Health”, will be held in Prague/October 2008. The workshop will address two major issues, namely new developments in methods for assessing the effect of mixtures of chemicals and of combinations of chemicals and natural stressors, and how to achieve more effective integration of the risk

analysis of environmental and human health effects. The topics of the workshop will include agents (chemical mixtures, multiple sources, chemicals and other agents), time scales (also intergenerational) and receptors (human and non-human, age groups), endpoints and consequences, and stages of activity (research or testing – assessment – management – monitoring). The topics include investigations on the uptake, elimination and metabolism kinetics of chemicals in test organisms, upon exposure in soil or water, and methods for pharmacokinetics analysis of chemical mixtures. The area of uncertainty analyses will be included, helping elucidate the relative share of the human and non-human components in the overall uncertainty, and the options for integration across receptors and sectors. Further, the development of new methods for comparative risk assessment by integration of mixture toxicity and multiple stressors (i.e., comparison of toxic stress and climate) will be addressed in the workshop, as well as pre-normative research on improving the current state of measurements and testing for testing of combined stressors, and for indicators for monitoring of populations of humans (indoor and outdoor) and species in the environment.

### 5. Receptor-oriented approaches in assessing cumulative exposure of humans and wildlife

(Planned spring 2009)  
The 5th Open Workshop, entitled “Receptor-oriented approaches in assessing cumulative exposure of humans and wildlife”, will be held in the Netherlands in the spring of 2009.

The final main results from NoMiracle will be presented during a workshop held in September 2009 in Aarhus, Denmark.



## Third year activities of NoMiracle

By Hans Løkke

During the third year of the NoMiracle Project the work on establishing the data background for scenario selection and on developing methods for risk scenario selection has been accomplished according to the work plan.

A new procedure for identification of risk hot spots has been developed. It contributes to a clear and measurable determination of the appropriate level of precaution based on the uncertainty level on one side and the seriousness of the harmful effects on the other side. The new approach is also able to elucidate the level of uncertainty that takes into account the entire chain of assumptions governing risk assessment. This new NoMiracle methodology is general and thus applicable in many areas of regulation and policy, where identification of realistic worst case conditions for potential risk is needed. It will be especially valuable in complex problems where determining uncertainty requires more than just a variability check of parameter values. For the long term, the methods developed will be useful in the search for data gaps in understanding of risk levels and thus useful in design of future research and monitoring activities.

### Exposure assessment

Major achievements were attained with regard to both algorithms and models addressing molecular-level processes, and regional-scale multimedia fate predictions. The work has been continued on processes and mechanisms that determine the effective exposure of chemical substances under realistic conditions in the environment. The focus has been on polar and bioactive compounds, which form a great challenge because of their complex potential for intermolecular interaction with environmental matrices.

There are now preliminary novel models and methods available

- to address partitioning into soil organic and biological matter in terms of fundamental interaction forces,
- to characterize well-defined availability aspects of the compound concentrations in different environmental media,
- to predict biodegradability patterns and simulate metabolic pathways, and
- to consider spatial variation for multimedia fate predictions.

In this way, the uncertainty of exposure assessment of contaminants can be reduced already, taking into account the partly preliminary status of the newly developed techniques.

### Effects assessment

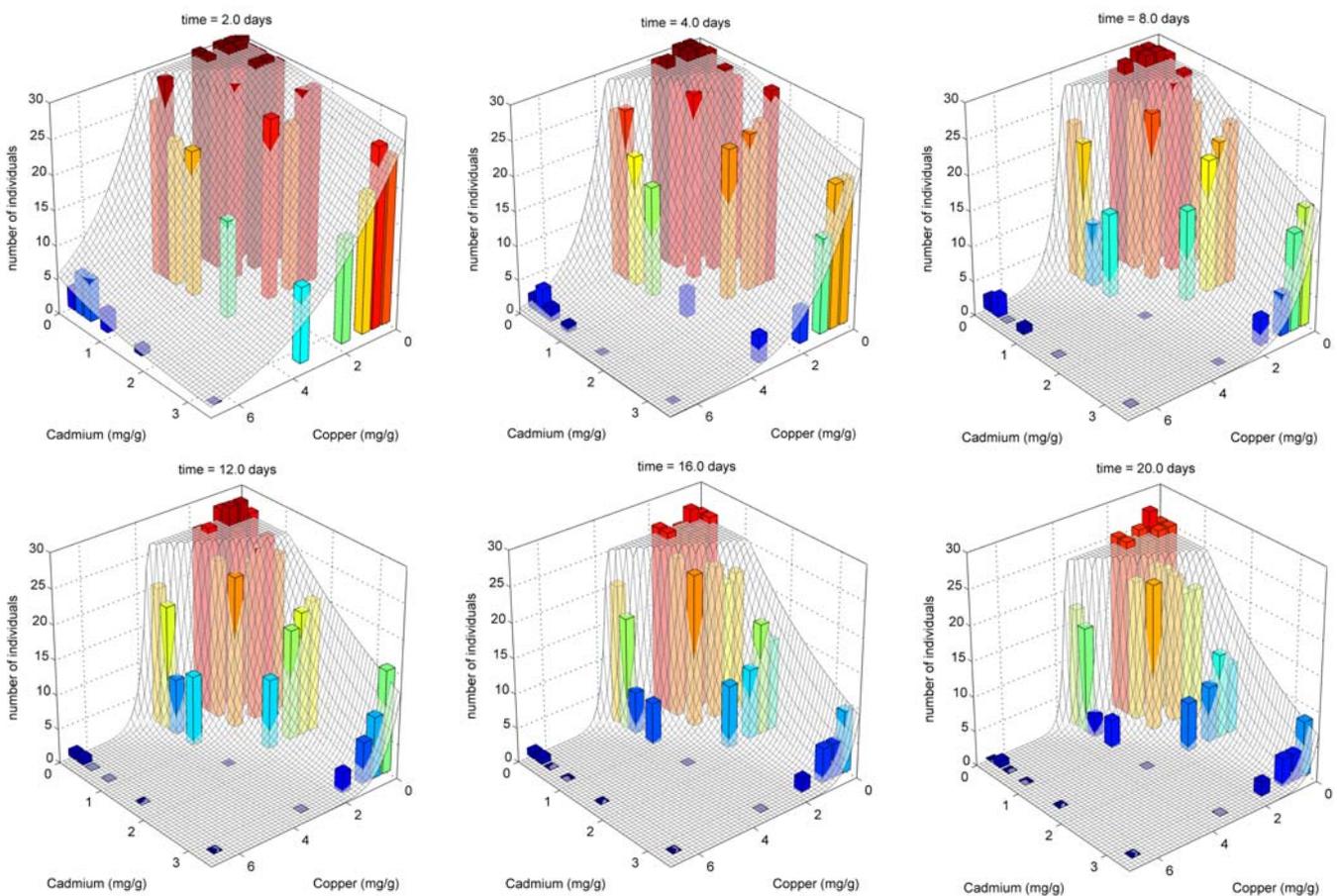
An extensive amount of data has been produced on single chemical and joint effects required to define a basis for estimating uncertainty and variability associated with predictions of the combined effects of chemicals. The measurement of a series of parameters in test organisms/cell systems ranging from bacteria to higher vertebrates enables the identification of dysfunction at all levels of organisation after multiple chemical exposure.

It has been shown that in environmental species, responses to combinations of natural stressors and chemicals can be described by models used for chemical mixtures if experiments are designed appropriately. Since this is a new research direction in environmental science it has taken considerable effort to develop such appropriate and environmentally relevant experimental designs.

The ongoing research on toxicokinetic modelling is developing new approaches, including time series assessment of uptake and effect in different species using resource allocation concepts. An integrated effort is made to elucidate molecular mechanisms of mixture toxicity using various transcriptomic platforms, protein analysis methods and nuclear magnetic spectrometry and gas chromatography-based metabolomics. This approach offers the potential to detect effects occurring at the biochemical level. Such effects may be detrimental to the health of an organism without manifesting obvious outward signs.

### Risk assessment

Based on the results from testing of selected mixtures of chemicals with the array of NoMiracle species and test systems, modelling has shown that the Independent Action model is frequently not the most suitable model to describe the mixture toxicity of chemicals with different modes of action. In these cases, NoMiracle has introduced the dynamic energy budget (DEB) model as a better tool to describe mixture toxicity and at the same time as a tool to integrate toxicological, toxicodynamic and molecular data. A very elaborate database on single component survival data was used to show that it is possible to estimate toxicity



Measured survival (beams) and DEBtox modelled survival (net like structure) of *Folsomia Candida* on compacted soil for a mixture of copper and cadmium, measured in a full factorial design at day 2, 4, 8, 12, 16 and 20. No mixture interaction was shown in contrast to inconsistent results at fixed time points as found with existing models.

parameters from the physical and chemical properties of narcotic compounds. The derived model can predict the effect of a mixture of any number of components, for instance PAHs or chlorinated benzenes, on survival for any point in time, when limited experimental data on the components in the mixture are available. With this approach it is possible to greatly diminish the experimental effort that is needed to describe mixture effects. In addition, a start was made with the experimental setup that is needed for a model to describe endpoints other than survival for binary mixtures. This modelling work aims to develop an easy interpretation of a safe mixture concentration in the form of one parameter: the No Effect Concentration for a mixture. In the short term the models will give a better understanding of the effects of mixtures in terms of underlying biological mechanisms. In the long(er) term the research will help in the understanding of the effects of mixtures in the field situation and contribute to optimising laboratory tests.

The work on individual-based and spatially explicit risk assessment of cumulative stressors has been presented at an internal workshop, and will comprise several initial experiments regarding an algorithm for human and wildlife mobility. The task is of high relevance for the integrated consideration of ecological and human exposure models within NoMiracle. While work is still ongoing, the results to date may have strong implications for the future structure of ecological and human random walk models.

The work dealing with uncertainty and ambiguity in risk management was initiated by successfully completing the survey of risk experts across Europe and beyond. The survey, which itself employed novel representational and data-collecting methods using the internet, achieved such high response quality that it was possible to produce a peer reviewed published report, a scientific contribution and several shorter contributions as well as oral presentations.

The proceedings from the Second Open Workshop at Stuttgart ("Communicating Chemical Risks: The role of risk perception and communication for characterising and managing cumulative stressors", April 2007) give an overview of the area. The workshop assembled experts from NoMiracle, industry, regulation and from projects dealing with related themes to discuss key issues concerning risk communication.

### Activities in the coming two years

The work on new methods for assessing the exposure of chemicals in matrices at different scales will continue with focus on polar and multifunctional compounds, which form a great challenge because of their complex potential for intermolecular interaction with environmental matrices. The very promising results on mixture toxicity and modelling will continue with more elaborate experiments. More work will be dedicated to develop more efficient protocols for testing mixtures with the possibility to reduce testing needs and use of animals for experimental purposes. Based on the experiences of the first years, 2 scenarios are under preparation for testing of models and methods developed in the project. The topics are

- Cumulative assessment of agricultural pesticide application
- Chemical driven effects on children in urban areas

### About NoMiracle

Thirty-eight institutions from 17 countries involving 200 persons work together for 5 years (2004-2009) on the development of better methods to analyse, characterise and quantify the combined risks to health or the environment from multiple stressors. Examples of such cumulative stressors are mixtures of chemicals alone or in combination with biological or physical environmental factors such as pathogens and climatic conditions.

NoMiracle's main science & technology objectives are:

1. To develop new methods for assessing the cumulative risks from combined exposures to several stressors including mixtures of chemical and physical/biological agents
2. To achieve more effective integration of the risk analysis of environmental and human health effects
3. To improve our understanding of complex exposure situations and develop adequate tools for exposure assessment
4. To develop a research framework for the description and interpretation of cumulative exposure and effect
5. To quantify, characterise and reduce uncertainty in current risk assessment methodologies, e.g. by improvement of the scientific basis for setting safety factors
6. To develop assessment methods which take into account geographical, ecological, social and cultural differences in risk concepts and risk perceptions across Europe

## NoMiracle Scientific Articles published the first three years of NoMiracle\*

Morten Strandberg, NoMiracle Secretariat

- Armitage J, Cousins IT, Buck RC, Prevedouros K, Russell MH, Macleod M, Korzeniowski, SH. 2006. Modeling global-scale fate and transport of perfluorooctanoate emitted from direct sources. *Environ. Sci. Technol.* **40**: 6969-6975.
- Armitage JM, Cousins IT, Hauck M, Harbers JV, Huijbregts MAJ. 2007. Empirical evaluation of spatial and non-spatial European-scale multimedia fate models: results and implications for chemical risk assessment. *Environ. Monit.* **9**: 572-581.
- Bindesbøl A, Bayley M, Damgaard C, Holmstrup M. 2007. Life-history traits and population growth rate in the laboratory of the earthworm *Dendrobaena octaedra* cultured in copper-contaminated soil. *Applied Soil Ecology* **35**: 46-56.
- Baas J, Van Houte BPP, Van Gestel CAM, Kooijman SALM. 2007. Modeling the effects of binary mixtures on survival in time. *Environmental Toxicology and Chemistry* **26 (6)**: 1320-1327.
- Diaz-Cruz MS, Barcelo D. 2006. Determination of antimicrobial residues and metabolites in the aquatic environment by liquid chromatography tandem mass spectrometry. *Analytical and Bioanalytical Chemistry* **386**: 973-985.
- Diaz-Cruz MS, Barcelo D. 2007. Recent advances in LC-MS residue analysis of veterinary medicines in the terrestrial environment. *Trends in Analytical Chemistry* **26**: 637-646.

\* The list will soon be available on the NoMiracle web page (<http://nomiracle.jrc.it>)

- Diaz-Cruz MS, Barcelo D. 2007. Analysis of antibiotics in aqueous samples. *Comprehensive Analytical Chemistry*. (Wilson & Wilson's) Volume 50. Analysis, Fate and Removal of Pharmaceuticals in the Water Cycle. D. Barceló and M. Petrovic (Eds.), pp 61-63 Elsevier Science B.V. Amsterdam (The Netherlands) ISBN: 978-0-444-53052-3.
- Diaz-Cruz MS, Barcelo D. 2006. Highly selective sample preparation and gas chromatographic-mass spectrometric analysis of chlorpyrifos, diazinon and their major metabolites in sludge and sludge-fertilized agricultural soils. *J. Chromatogr. A*. **1132**: 21-27.
- Dimitrov S, Dimitrova N, Parkerton T, Comber M, Bonnell M, Mekenyan O. 2005. Base-line model for identifying the bioaccumulation potential of chemicals. *SAR and QSAR in Environmental Research* **16** (6): 531-554.
- Dimitrov S, Pavlov T, Nedelcheva D, Reuschenbach P, Silvani M, Bias R, Comber M, Low L, Lee C, Parkerton T, Mekenyan O. 2007. A kinetic model for predicting biodegradation. *SAR QSAR Environ. Res*, **18**: 443-457.
- Dondero, F, Jonsson H, Rebelo M, Pesce G, Berti E, Pons G, Viarengo A. 2006. Cellular responses to environmental contaminants in amoebic cells of the slime mould *Dictyostelium discoideum*. *Comp. Biochem. Physiol. C*. **143**: 150-157.
- Dorne JLCM. 2007. Human variability in hepatic and renal elimination: implications for risk assessment. *Journal of Applied Toxicology* **27** (5): 411-420.
- Dorne JLCM, Ragas AMJ, Frampton GK, Spurgeon DJ, Lewis DF. 2007. Trends in human risk assessment of pharmaceuticals. *Anal. Bioanal. Chem.* **387**: 1167-1172.
- Dorne JLCM, Ragas AMJ, Løkke, H. 2006. Harmonisation of uncertainty factors in human and ecological risk assessment. *Toxicology (Abstracts)* **226**: 75-76.
- Dorne JLCM, Skinner L, Frampton GK, Spurgeon DJ, Ragas AMJ. 2007. Human and environmental risk assessment of pharmaceuticals: differences, similarities, lessons from toxicology. *Anal. Bioanal. Chem.* **387**: 1259-1268.
- Filipi R, Nesmerak K, Rucki M, Roth Z, Hanzlikova I, Tichy M. 2007. Acute toxicity of rare earth elements and their compounds. *Chem. Listy* **101**: 793-798.
- Frampton GK, Dorne JLCM. 2007. The effects on terrestrial invertebrates of reducing pesticide inputs in arable crop edges: a meta-analysis. *Journal of Applied Ecology* **44**: 362-373.
- Grujthuijsen YK, Grieshuber I, Stöcklinger A, Tischler U, Fehrenbach T, Weller MG, Vogel L, Vieths S, Pöschl U, Duschl A. 2006. Nitration enhances the allergenic potential of proteins. *Int. Arch. Allergy Immunol.* **141**: 265-275.
- Harbers JV, Huijbregts MAJ, Posthuma L, van de Meent D. 2006. Estimating the impact of high-production-volume chemicals on remote ecosystems by toxic pressure calculation. *Environ. Sci. Technol.* **40**: 1573-1580.
- Jager T, Crommentuijn T, Van Gestel CAM, Kooijman SALM. 2007. Chronic exposure to chlorpyrifos reveals two modes of action in the springtail *Folsomia candida*. *Environmental Pollution* **145**: 452-458.
- Kammenga JE, Doroszuk A, Riksen JAG, Hazendonk E, Spiridon L, Petrescu AJ, Tijsterman M, Plasterk RHA, Bakker J. 2007. A *C. elegans* wild-type defies the temperature-size rule owing to a single nucleotide polymorphism in *tra-3*. *PLoS Genetics*, **3** (3): e34.
- Kammenga JE, Herman M, Ouborg NJ, Johnson L, Breitling R. 2007. Microarray challenges in ecology. *Trends Ecol. Evol.* **22**: 273-279.
- Kooijman SALM, Baas J, Bontje D, Broerse M, Jager T, van Gestel CAM, van Hattum B. 2007. Scaling relationships based on partition coefficients and body sizes have similarities and interactions. *SAR and QSAR in environmental research* **18**: 315-330.
- Kühne R, Ebert R-U, Schüürmann G. 2007. Model selection based on structural similarity - Method description and application to water solubility prediction. *J. Chem. Inf. Model.* **46**: 636-641.
- Kühne R, Ebert R-U, Schüürmann G. 2007. Estimation of compartmental half-lives of organic compounds - Structural similarity versus EPI-Suite. *QSAR & Combinatorial Science* **26** (4): 542-549.
- Legind CN, Karlson U, Burken JG, Reichenberg F, Mayer P. 2007. Determining chemical activity of (semi)volatile compounds by headspace solid-phase microextraction. *Anal. Chem.* **79**: 2869-2876.
- Li Y, Alvarez OA, Gutteling EW, Tijsterman M, Fu J, Riksen JAG, Hazendonk E, Prins P, Plasterk RHA, Jansen RC, Breitling R, Kammenga JE. 2007. Mapping determinants of gene expression plasticity by genetical genomics in *C. elegans*. *PLoS Genetics* **2**(12): e222.
- Mayer P, Fernquist M, Christensen P, Karlson U, Trapp S. 2007. Enhanced Diffusion of Polycyclic Aromatic Hydrocarbons in Artificial and Natural Aqueous Solutions. *Environ. Sci. Technol.* **41**: 6148-6155.

- Mayer P, Reichenberg F. 2006. Can highly hydrophobic organic substances cause aquatic baseline toxicity and can they contribute to mixture toxicity? *Environmental Toxicology and Chemistry* **25**: 2639-2644.
- Neher DA, Stürzenbaum SR. 2006. Extra-long PCR, an identifier of DNA adducts in single nematodes (*Caenorhabditis elegans*) *Comparative Biochemistry and Physiology, Part C*, **144**: 279-285.
- Niederer C, Schwarzenbach RP, Goss K-U. 2007. Elucidating differences in the sorption properties of 10 humic and fulvic acids for polar and nonpolar organic chemicals. *Environ. Sci. Technol.* **41**: 6711-6717.
- Paschke A, Brümmer J, Schüürmann G. 2007. Silicone rod extraction of pharmaceuticals from water. *Anal. Bioanal. Chem.* **387**: 1417-1421.
- Pistocchi A, Pennington DW. 2006. European hydraulic geometries for continental SCALE environmental modelling. *J. Hydrol.* **329**: 553-567.
- Reichenberg F, Mayer P. 2006. Two complementary sides of bioavailability: Accessibility and chemical activity of organic contaminants in sediments and soils. *Environmental Toxicology and Chemistry* **25** (5): 1239-1245.
- Schlink U, Herbarth O, Kindler A, Krumbiegel P, Strebel K, Engelmann B. 2005. Mapping of relative risk based on district-wise aggregated data, In: Morel, Benoit; Linkov, Igor (Eds.) *Environmental Security and Environmental Management: The Role of Risk Assessment. NATO Security Through Science Series, Sub-Series C: Environmental Security*, **5** (X), p. 325.
- Schlink U, Steinert C, Richter M, Petrescu C, Suciuc O, Romanita L, Herbarth O. 2007. Environmental health in port and harbour areas: air humidity modifying respiratory health in Drobeta Turnu Severin, Romania. . In: *Managing Critical Infrastructure Risks*, NATO Science for Peace and Security Series C: Environmental Security, Linkov I, Wenning RJ, Kiker GA (Eds.), Springer.
- Schüürmann G, Ebert RU, Kuehne R. 2006. Prediction of physicochemical properties of organic compounds from 2D molecular structure - Fragment methods vs. LFER models. *Chimia* **60** (10): 691-698.
- Schüürmann G, Ebert R-U, Kühne, R. 2006. Prediction of the sorption of organic compounds into soil organic matter from molecular structure. *Environ. Sci. Technol.* **40**: 7005-7011.
- Schüürmann G, Ebert R-U, Nendza M, Dearden JC, Paschke A, Kühne R. 2007. Prediction of fate-related compound properties. In: Van Leeuwen K, Vermeire T (eds): *Risk assessment of chemicals. An Introduction*. 2nd Edition. Springer Science, Chapter 9, pp. 375-426.
- Skovlund G, Damgaard C, Bayley M, Holmstrup M. 2006. Does lipophilicity of toxic compounds determine effects on drought tolerance of the soil collembolan *Folsomia candida*? *Environmental Pollution* **144**: 808-815.
- Soetaert A, van der Ven K, Moens LN, et al. 2007. *Daphnia magna* and ecotoxicogenomics: Gene expression profiles of the anti-ecdysteroidal fungicide fenarimol using energy-, molting- and life stage-related cDNA libraries. *Chemosphere* **67** (1): 60-71.
- Soetaert A, Vandenbrouck T, van der Ven K, Maras M, van Remortel P, Blust R, De Coen WM. 2007. Molecular responses during cadmium-induced stress in *Daphnia magna*: Integration of differential gene expression with higher-level effects. *Aquatic Toxicology* **83** (3): 212-222.
- Sørensen PB, Lerche D, Brüggemann R. 2005. Resources and uncertainties in evaluation of chemicals: basic methodological developments. *Water Sci. Techn.* **52** (6): 235-242.
- Sørensen PB, Thomsen M, Fauser P, Münier B. 2007. The Usefulness of a Stochastic Approach for Multi-Criteria Selection. In: Hryniewicz, O., Studzinski, J. & Szediw, A. (eds.): *EnviroInfo Warsaw 2007, Environmental Informatics and System Research. The 21st International Conference on Informatics for Environmental Protection. Polish Academy of Sciences, Warsaw, Poland, September 12-14, 2007. Vol. 2: Workshop and application papers. Aachen: Shaker Verlag. Pp. 187-194.*
- Tichy M, Rucki M, Hanzlikova I, Roth Z. 2007. The *Tubifex tubifex* assay for the determination of acute toxicity. *ATLA* **35**, 229-237.
- Viarengo A, Lowe D, Bolognesi C, Fabbri E, Koehler A. 2007. The use of biomarkers in biomonitoring: A 2-tier approach assessing the level of pollutant-induced stress syndrome in sentinel organisms. *Comparative Biochemistry and Physiology C-Toxicology & Pharmacology* **146** (3): 281-300.
- Wensem Jv, Faber JH. 2007. Ecosysteembenadering als innoverend concept voor bevordering van duurzame bodemkwaliteit. *Bodem* **17**: 153-156 (in Dutch).

## NoMiracle Newsletter No. 10

NOvel Methods for Integrated Risk Assessment of  
Cumulative stressors in Europe

## NoMiracle co-ordination

Visit NoMiracle and subscribe to  
the Newsletter at: <http://nomiracle.jrc.it>

### For further information contact

NoMiracle Secretariat  
E-mail: [nomiracle@dmu.dk](mailto:nomiracle@dmu.dk)

- Project co-ordinator and Editor responsible  
under the press law\*:

**Dr. Hans Løkke**

National Environmental Research Institute,  
University of Aarhus  
Vejløsøvej 25, P.O. Box 314,  
DK-8600 Silkeborg, Denmark  
Phone +45 8920 1482  
Fax +45 8920 1414  
E-mail: [hlo@dmu.dk](mailto:hlo@dmu.dk)

- Databases and selection of scenarios:

**Dr. Hanne Bach**

National Environmental Research Institute,  
University of Aarhus, Denmark  
E-mail: [hba@dmu.dk](mailto:hba@dmu.dk)

- Exposure assessment:

**Professor Gerrit Schuurmann**

UFZ, Umweltforschungszentrum Leipzig,  
Germany  
E-mail: [gerrit.schuurmann@ufz.de](mailto:gerrit.schuurmann@ufz.de)

- Effects assessment:

**Dr. Dave Spurgeon**

NERC, Centre for Ecology and Hydrology,  
United Kingdom  
E-mail: [dasp@ceh.ac.uk](mailto:dasp@ceh.ac.uk)

- Risk Assessment:

**Dr. Ad Ragas**

Radboud Universiteit Nijmegen,  
The Netherlands.  
E-mail: [A.Ragas@science.ru.nl](mailto:A.Ragas@science.ru.nl)

The integrated project NoMiracle  
is funded by the European Commissions  
Sixth Framework Programme.

EC Scientific Officer for the project:  
Dr. Georges Deschamps

\*Articles in the NoMiracle Newsletter do not necessarily  
reflect the attitude of the NoMiracle Newsletter.

The NoMiracle Newsletter is published by  
National Environmental Research Institute,  
University of Aarhus  
ISSN: 1902-6226