

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/22695> holds various files of this Leiden University dissertation

Author: Verschoor, Aletta Johanna

Title: The power of biotic ligand models : site-specific impact of metals on aquatic communities

Issue Date: 2013-12-04

References

- Adams Kszos L et al., **2003**, Toxicity of lithium to three freshwater organisms and the antagonistic effect of sodium, *Ecotox.*, 12, 427-437.
- Akaike H, **1981**, Likelihood of a Model and Information Criteria, *J. Econometrics*, 16, 3-14.
- Allen ES, **1969**, Effect of timed release on the bioavailability of ascorbic acid: Ascorbicap vs. non-timed dosage forms, *Current Therapeutic Research - Clinical and Experimental*, 11, 745-749.
- Allen HE et al., **1996**, The importance of trace metal speciation to water quality criteria *Water Environment Research*, 68, 42-54.
- Baas J et al., **2009**, Prediction of Daphnid Survival after *in situ* Exposure to Complex Mixtures, *Environ. Sci. Technol.*, 43, 6064-6069.
- Baden SP et al., **2003**, Manganese accumulation by the antennule of the Norway lobster *Nephrops norvegicus* (L.) as a biomarker of hypoxic events, *Mar. Environ. Res.*, 55, 59-71.
- Bates, B, **2010**, Linear mixed-effect models using S4-classes, Available from: <http://cran.r-project.org/web/packages/lme4>.
- Beltman DJ et al., **1999**, Benthic invertebrate metals exposure, accumulation, and community-level effects downstream from a hard-rock mine site, *Environ. Toxicol. Chem.*, 18, 299-307.
- Benjamini Y et al., **1995**, Controlling the discovery rate: A practical and powerful approach to the multiple testing, *J. Roy. Stat. Soc. B*, 57, 289-300.
- Bere T et al., **2012**, Effects of cadmium stress and sorption kinetics on tropical freshwater periphytic communities in indoor mesocosm experiments, *Sci. Tot. Environ.*, 432, 103-112.
- Bernard D et al., **2008**, Origin of nickel in water solution of the chalk aquifer in the north of France and influence of geochemical factors, *Environ. Geol.*, 53, 1129-1138.
- Bielmeyer GK et al., **2007**, Validation study of the acute biotic ligand model for silver, 26, 2241-2246.
- Blacksmith Institute, **2012**, The world's worst pollution problems: Assessing health risks at hazardous waste sites, <http://www.worstpolluted.org>.
- Bossuyt BTA et al., **2004**, Using the biotic ligand model for predicting the acute sensitivity of cladoceran dominated communities to copper in natural surface waters *Environ. Sci. Technol.*, 38, 6177-6192.
- Bryan SE et al., **2002**, Comparison of measured and modelled copper binding by natural organic matter in freshwaters, *Comp. Biochem. Physiol. C*, 133, 37-49.
- Burton GA et al., **2005**, *In situ* exposures using caged organisms: a multi-compartment approach to detect aquatic toxicity and bioaccumulation, *Environ. Pollut.*, 134, 133-144.

- Carballeira C et al., **2012**, Identification of specific malformations of sea urchin larvae for toxicity assessment: Application to marine pisciculture effluents, *Mar. Environ. Res.*, 77, 12-22.
- Carroll J et al., **1979**, Influences of hardness constituents on the acute toxicity of cadmium to brook trout (*Salvelinus fontinalis*), *Bull. Environ. Contam. Toxicol.*, 22, 575-581.
- Cheng T et al., **2005**, Measurement and computation of zinc binding to natural dissolved organic matter in European surface waters, *Anal. Chim. Acta*, 542, 230-239.
- Clements WH et al., **2012**, How Do Aquatic Communities Respond to Contaminants? It Depends on the Ecological Context, *Environ. Toxicol. Chem.*, 31, 1932-1940.
- Clifford M et al., **2010**, Development of a biotic ligand model to predict the acute toxicity of cadmium to *Daphnia pulex*, *Aquat. Toxicol.*, 98, 1-7.
- Courtney L et al., **2002**, Assessing the influence of water and substratum quality on benthic macroinvertebrate communities in a metal-polluted stream: an experimental approach, *Freshwater Biology*, 47, 1766-1778.
- Crane M et al., **2007**, Review of aquatic *in situ* approaches for stressor and effect diagnosis, *Integr. Environ. Assess. Manag.*, 3, 234-245.
- Crutzen PJ et al., **2000**, The "Anthropocene", *Global Change Newsletter*, 41, 17-18.
- De Coen W et al., **2006**, Ecological impact assessment of metallurgic effluents using *in situ* biomarker assays, *Environ. Pollut.*, 141, 283-294.
- De Laender F et al., **2005**, Simulation of spatial and temporal variability of chronic copper toxicity to *Daphnia magna* and *Pseudokirchneriella subcapitata* in Swedish and British surface water, *Human Ecol. Risk Assess.*, 11, 1177-1191.
- De Schamphelaere KAC et al., **2002a**, Refinement and field validation of a biotic ligand model predicting acute copper toxicity to *Daphnia magna*, *Comp. Biochem. Physiol. C*, 133, 243-258.
- De Schamphelaere KAC et al., **2002b**, A biotic ligand model predicting acute copper toxicity for *Daphnia magna*; The effects of calcium, magnesium, sodium, potassium, and pH, *Environ. Sci. Technol.*, 36, 48-54.
- De Schamphelaere KAC et al., **2003**, Development and field validation of a predictive copper toxicity model for the green alga *Pseudokirchneriella subcapitata*, *Environ. Toxicol. Chem.*, 22, 2454-2465.
- De Schamphelaere KAC et al., **2004a**, Effects of dissolved organic carbon concentration and source, pH and water hardness on chronic toxicity of copper to *Daphnia magna*, *Environ. Toxicol. Chem.*, 23, 1115-1122.
- De Schamphelaere KAC et al., **2004b**, Bioavailability and chronic toxicity of zinc to juvenile rainbow trout (*Oncorhynchus mykiss*): Comparison with other fish species and development of a biotic ligand model, *Environ. Sci. Technol.*, 38, 6201-6209.
- De Schamphelaere KAC et al., **2004c**, Development and field validation of a biotic ligand model predicting chronic copper toxicity to *Daphnia magna*, *Environ. Toxicol. Chem.*, 23, 1365-1375.
- De Schamphelaere KAC et al., **2005**, Bioavailability models for predicting acute and chronic toxicity of zinc to algae, daphnids, and fish in natural surface water, *Environ. Toxicol. Chem.*, 24, 1190-1197.
- De Schamphelaere KAC et al., **2006**, Cross-phylum comparison of a chronic biotic ligand model to predict chronic toxicity of copper to a freshwater rotifer, *Brachionus calyciflorus* (Pallas), *Ecotoxicol. Environ. Saf.*, 63, 189-195.

- De Schamphelaere KAC et al., **2008**, Reduction of growth and haemolymph Ca levels in the freshwater snail *Lymnaea stagnalis* chronically exposed to cobalt, *Ecotoxicol. Environ. Saf.*, 71, 65-70.
- De Schamphelaere KAC et al., **2010**, Cross-phylum extrapolation of the *Daphnia magna* chronic biotic ligand model for zinc to the snail *Lymnaea stagnalis* and the rotifer *Brachionus calyciflorus*, *Sci. Tot. Environ.*, 408, 5414-5422.
- De Zwart D et al., **2006**, Predictive models attribute effects on fish assemblages to toxicity and habitat alteration, *Ecol. Appl.*, 16, 1295-1310.
- Deleebeeck N et al., **2005**, Development and validation of biotic ligand models for predicting nickel toxicity to fish, daphnids and algae. Draft final report 26 May 2005, Laboratory for Environmental Toxicology and Aquatic Ecology, Ghent University, Belgium,
- Deleebeeck NME et al., **2007**, A bioavailability model predicting the toxicity of nickel to rainbow trout (*Oncorhynchus mykiss*) and fathead minnow (*Pimephales promelas*) in synthetic and natural waters, *Ecotoxicol. Environ. Saf.*, 67, 1-13.
- Deleebeeck NME et al., **2008a**, The acute toxicity of nickel to *Daphnia magna*: Predictive capacity of bioavailability models in artificial and natural waters, *Ecotoxicol. Environ. Saf.*, 70, 67-78.
- Deleebeeck NME et al., **2008b**, A novel method for predicting chronic nickel bioavailability and toxicity to *Daphnia magna* in artificial and natural waters, *Environ. Toxicol. Chem.*, 27, 2097-2107.
- Deleebeeck NME et al., **2009a**, A single bioavailability model can accurately predict Ni toxicity to green microalgae in soft and hard surface waters, *Water Research*, 43, 1935-1947.
- Deleebeeck NME et al., **2009b**, Effects of Mg²⁺ and H⁺ on the toxicity of Ni²⁺ to unicellular green alga *Pseudokirchneriella subcapitata*: Model development and validation with surface waters, *Sci. Tot. Environ.*, 407, 1901-1914.
- Denmark, **2008**, European Union risk assessment report. Nickel and nickel compounds. Prepared by The Danish Environmental Protection Agency, on behalf of the European Union.,
- Di Toro DM et al., **2001**, Biotic ligand model of the acute toxicity of metals. 1. Technical basis, *Environ. Toxicol. Chem.*, 20, 2383-2396.
- Diamantino T et al., **2000**, Toxicity of sodium molybdate and sodium dichromate to *Daphnia magna* Straus evaluated in acute, chronic, and acetylcholinesterase inhibition tests, *Ecotoxicol. Environ. Saf.*, 45, 253-259.
- Doi H et al., **2007**, Stream Macroinvertebrate Community Affected by Point-Source Metal Pollution, *Internat. Rev. Hydrobiol.*, 92, 258-266.
- Doig LE et al., **2006**, Influence of dissolved organic matter on nickel bioavailability and toxicity to *Hyalella azteca* in water-only exposures, *Aquat. Toxicol.*, 76, 203-216.
- Doig LE et al., **2007**, Nickel speciation in the presence of different sources and fractions of dissolved organic matter, *Ecotoxicol. Environ. Saf.*, 66, 169-177.
- Dushenkov V et al., **1995**, Rhizofiltration: The use of plants to remove heavy metals from aqueous streams, *Environ. Sci. Technol.*, 29, 1239-1245.
- Dwane GC et al., **1998**, Testing a humic speciation model by titration of copper-amended natural waters: Humus as an Environmental Factor, *Environ. Int.*, 24, 609-616.
- [EC] European Commission, **2000**, Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, Available from: <http://circa.europa.eu>.

- [EC] European Commission, **2008**, Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, Available from: <http://eur-lex.europa.eu/>.
- EC, **2010**, European Union Risk Assessment Report. Zinc metal, Office for Official Publications of the European Communities,
- [EC] European Commission, **2011**, Common implementation strategy for the Water Framework Directive (2000/60/EC) Guidance document No. 27. Technical guidance for deriving environmental quality standards, Available from:
- ECI, **2008**, Voluntary European Union risk assessment report. Copper, copper II sulphate pentahydrate, copper(I)oxide, copper(II)oxide, dicopperchloride trihydroxide. http://echa.europa.eu/chem_data/transit_measures/vrar_en.asp,
- Esbaugh AJ et al., **2012**, Multi-linear regression analysis, preliminary biotic ligand modeling, and cross species comparison of the effects of water chemistry on chronic lead toxicity in invertebrates, *Comp. Biochem. Physiol. C*, 155, 423-431.
- Finney LA et al., **2003**, Transition Metal Speciation in the Cell: Insights from the Chemistry of Metal Ion Receptors, *Science*, 300, 931-936.
- Frimmel FH et al., **1999**, Basic characterization of reference NOM from central Europe - Similarities and differences, *Environ. Int.*, 25, 191-207.
- Fukunaga A et al., **2011**, Assessing the nature of the combined effects of copper and zinc on estuarine infaunal communities, *Environ. Pollut.*, 159, 116-124.
- Garnier J-M et al., **1997**, Kinetics of Trace Element Complexation with Suspended Matter and with Filterable Ligands in Freshwater, *Environ. Sci. Technol.*, 31, 1597-1606.
- Goodyear KL et al., **1999**, Bioaccumulation of heavy metals by aquatic macro-invertebrates of different feeding guilds: a review, *Sci. Tot. Environ.*, 229, 1-19.
- Grosell M et al., **2002**, Sodium turnover rate determines sensitivity to acute copper and silver exposure in freshwater animals, *Comp. Biochem. Physiol. C*, 133, 287-303.
- Grosell M et al., **2009**, High net calcium uptake explains the hypersensitivity of the freshwater pulmonate snail, *Lymnaea stagnalis*, to chronic lead exposure, *Aquat. Toxicol.*, 91, 302-311.
- Guthrie JW et al., **2005**, Complexation of Ni, Cu, Zn, and Cd by DOC in some metal-impacted freshwater lakes: a comparison of approaches using electrochemical determination of free-metal-ion and labile complexes and a computer speciation model, WHAM V and VI, *Anal. Chim. Acta*, 528, 205-218.
- Hamilton S, **2004**, Review of selenium toxicity in the aquatic food chain, *Sci. Tot. Environ.*, 326, 1-31.
- Hatano A et al., **2008**, Toxicity of copper and cadmium in combinations to duckweed analyzed by the biotic ligand model, *Environ. Toxicol.*, 23, 372-378.
- Hédouin L et al., **2006**, Allometric relationships in the bioconcentration of heavy metals by the edible tropical clam *Gafrarium tumidum*, *Sci. Tot. Environ.*, 366, 154-163.
- Heijerick DG et al., **2002a**, Biotic ligand model development predicting Zn toxicity to the alga *Pseudokirchneriella subcapitata*: possibilities and limitations, *Comp. Biochem. Physiol. C*, 133, 207-218.
- Heijerick DG et al., **2002b**, Predicting acute zinc toxicity for *Daphnia magna* as a function of key water chemistry characteristics: Development and validation of a biotic ligand model, *Environ. Toxicol. Chem.*, 21, 1309-1315.

- Heijerick DG et al., **2005a**, Effect of varying physicochemistry of European surface waters on the copper toxicity to the green alga *Pseudokirchneriella subcapitata* Ecotox., 14, 661-670.
- Heijerick DG et al., **2005b**, Development of a chronic zinc biotic ligand model for *Daphnia magna*, Ecotoxicol. Environ. Saf., 62, 1-10.
- Hendriks A, **1994**, Monitoring and estimating concentrations and impact of microcontaminants on species in the Rhine delta, Water Sci. Technol., 29, 223-232.
- Hendriks AJ et al., **2001**, The power of size. 2. Rate constants and equilibrium ratios for accumulation of inorganic substances related to species weight, Environ. Toxicol. Chem., 20, 1421-1437.
- Hessen DO et al., **2000**, Calcium limitation in *Daphnia magna*, J. Plankton Res., 22, 553-568.
- Heugens EHW et al., **2006**, Population growth of *Daphnia magna* under multiple stress conditions: Joint effects of temperature, food, and cadmium, Environ. Toxicol. Chem., 25, 1399-1407.
- Janssens de Bisthoven L et al., **1998**, Experimental induction of morphological deformities in *Chironomus riparius* larvae by chronic exposure to copper and lead, Arch. Environ. Contam. Toxicol., 35, 249-256.
- Jezierska B et al., **2009**, The effects of heavy metals on embryonic development of fish (a review), Fish Physiol Biochem, 35, 625-640.
- Jho EH et al., **2011**, Extended biotic ligand model for prediction of mixture toxicity of Cd and Pb using single metal toxicity data, Environ. Toxicol. Chem., 30, 1697-1703.
- Kamo M et al., **2008**, An application of the biotic ligand model to predict the toxic effect of metal mixtures, Environ. Toxicol. Chem., 27, 1479-1487.
- Keithly J et al., **2004**, Acute and chronic toxicity of nickel to a cladoceran (*Ceriodaphnia dubia*) and an amphipod (*Hyalella azteca*), Environ. Toxicol. Chem., 23, 691-696.
- Komjarova I et al., **2009a**, Multimetal interactions between Cd, Cu, Ni, Pb, and Zn uptake from water in the zebrafish *Danio rerio*, Environ. Sci. Technol., 43, 7225-7229.
- Komjarova I et al., **2009b**, Effect of Na, Ca and pH on simultaneous uptake of Cd, Cu, Ni, Pb, and Zn in the water flea *Daphnia magna* measured using stable isotopes, Aquat. Toxicol., 94, 81-86.
- Lebrun JD et al., **2011**, Waterborne nickel bioaccumulation in *Gammarus pulex*: Comparison of mechanistic models and influence of water cationic composition, Aquat. Toxicol., 104, 161-167.
- Lock K et al., **2006**, Development and validation of an acute biotic ligand model (BLM) predicting cobalt toxicity in soil to the potworm *Enchytraeus albidus*, Soil Biol. Biochem., 38, 1924-1932.
- Lock K et al., **2007**, Development and validation of a terrestrial biotic ligand model predicting the effect of cobalt on root growth of barley (*Hordeum vulgare*), Environ. Pollut., 147, 626-633.
- McGeer JC et al., **2003**, Inverse relationship between bioconcentration factor and exposure concentration for metals: Implications for hazard assessment of metals in the aquatic environment, Environ. Toxicol. Chem., 22, 1017-1037.
- Millennium Ecosystem Assessment, **2005**, Ecosystems and Human Well-being: Biodiversity Synthesis, World Resources Institute,
- Muyssen B et al., **2006**, Mechanisms of chronic waterborne Zn toxicity in *Daphnia magna*, Aquat. Toxicol., 77, 393-401.

- Muyssen BTA et al., **2005**, Inter- and intra-species variation in acute zinc tolerance of field-collected cladoceran populations, *Chemosphere*, 61, 1159-1167.
- Newman MC et al., **1991**, Allometry of metal bioaccumulation and toxicity, in: *Metal ecotoxicology, concepts and applications*, Lewis Publishers, Inc., 91-130.
- NIST, **2004**, NIST standard reference database 46 Version 8.0,
- Niyogi S et al., **2004**, Biotic ligand model, a flexible tool for developing site-specific water quality guidelines for metals, *Environ. Sci. Technol.*, 38, 6177-6192.
- Niyogi S et al., **2008**, Effects of water chemistry variables on gill binding and acute toxicity of cadmium in rainbow trout (*Oncorhynchus mykiss*): A biotic ligand model (BLM) approach, *Comp. Biochem. Physiol. C*, 148, 305-314.
- Norwood WP et al., **2007**, Interactive effects of metals in mixtures on bioaccumulation in the amphipod *Hyalella azteca*, *Aquat. Toxicol.*, 84, 255-267.
- OECD, **2008**, Test No. 211: *Daphnia magna* Reproduction Test, OECD Guidelines for the Testing of Chemicals, Section 2, OECD Publishing.
- Pagenkopf GK, **1983**, Gill surface interaction model for trace-metal toxicity to fishes: Role of complexation, pH, and water hardness, *Environ. Sci. Technol.*, 17, 342-347.
- Paquin PR et al., **2002a**, The biotic ligand model: historical overview, *Comp. Biochem. Physiol. C*, 133, 3-35.
- Paquin PR et al., **2002b**, Extension of the biotic ligand model of acute toxicity to a physiologically-based model of the survival time of rainbow trout (*Oncorhynchus mykiss*) exposed to silver, *Comp. Biochem. Physiol. C*, 133, 305-343.
- Patrick Wm Jr. H et al., **1977**, Physicochemical factors regulating solubility and bioavailability of toxic heavy metals in contaminated dredged sediment, *Journal of Environmental Science and Health - Part A Environmental Science and Engineering A*, 12, 475-492.
- Peijnenburg W et al., **2007**, Metal-specific interactions at the interface of chemistry and biology, *Pure Appl. Chem.*, 79, 2351-2366.
- Petelet-Giraud E et al., **2009**, Natural versus anthropogenic sources in the surface- and groundwater dissolved load of the Dommel river (Meuse basin): Constraints by boron and strontium isotopes and gadolinium anomaly, *J. Hydrol.*, 369, 336-349.
- Peters A et al., **2011a**, Development of biotic ligand models for chronic manganese toxicity to fish, invertebrates, and algae, *Environ. Toxicol. Chem.*, 30, 2407-2415.
- Peters A et al., **2011b**, Regulatory consideration of bioavailability for metals: Simplification of input parameters for the chronic copper biotic ligand model, *Integr. Environ. Assess. Manag.*, 7, 437-444.
- Phillips DJH et al., **1994**, *Biomonitoring of trace aquatic contaminants* Chapman and Hall.
- Pickard J et al., **2001**, Acute and sublethal toxicity of thallium to aquatic organisms, *Bull. Environ. Contam. Toxicol.*, 66, 94-101.
- Playle RC et al., **1993**, Copper and cadmium binding to fish gills: Estimates of metal-gill stability constants and modelling of metal accumulation, *Can. J. Fish. Aquat. Sci.*, 50, 2678-2687.
- Playle RC, **2004**, Using multiple metal-gill binding models and the toxic unit concept to help reconcile multiple-metal toxicity units, *Aquat. Toxicol.*, 67, 359-370.
- Posthuma L et al., **2002**, *Species sensitivity distribution in ecotoxicology*, Lewis Publishers.

- Posthuma L et al., **2008**, Mixture extrapolation approaches, in: Extrapolation practices for ecotoxicological effect characterization of chemicals, CRC Press, New York, 135-186.
- Ragas AMJ et al., **1999**, Assessing model uncertainty for environmental decision making: A case study of the coherence of independently derived environmental quality objectives for air and water, *Environ. Toxicol. Chem.*, 18, 1856-1867.
- Rainbow PS et al., **1986**, Comparative metal analyses in amphipod crustaceans, *Hydrobiologia*, 141, 273-289.
- Richards JG et al., **1998**, Cobalt binding to gills of rainbow trout (*Oncorhynchus mykiss*): An equilibrium model, *Comp. Biochem. Physiol. C*, 119, 185-197.
- Römkens P et al., **2002**, Contribution of agriculture to the heavy metal loads in The Netherlands, in: Agricultural effects on ground and surface waters: Research at the edge of science and society, IAHS Press, 337-342.
- Rubach MN et al., **2010**, A new method for ranking mode-specific sensitivity of freshwater arthropods to insecticides and its relationship to biological traits, *Environ. Toxicol. Chem.*, 29, 476-487.
- Salminen R, **2006**, Geochemical Atlas of Europe. Part 1 - Background Information, methodology and maps., Geological Survey of Finland.
- Sanders B et al., **1983**, Free cupric ion activity in seawater: Effect on metallothionein and growth in crab larvae, *Science*, 222, 53-55.
- Sarkar D, **2008**, Lattice. Multivariate data visualization with R UseR!, Springer.
- Sauvé S et al., **2000**, Critical Review. Solid-solution partitioning of metals in contaminated soils: Dependence on pH, total metal burden and organic matter, *Environ. Sci. Technol.*, 34, 1125-1131.
- Schaller J et al., **2011**, Invertebrates minimize accumulation of metals and metalloids in contaminated environments, *Water, Air, & Soil Pollution*, 218, 227-233.
- [SCHER] Scientific Committee on Health and Environmental Risks., **2007**, Risk assessment report on zinc. Environmental Part, opinion adopted at its 20th plenary on 29 November 2007, Available from: http://ec.europa.eu/health/ph_risk/committees/04_scher/docs/scher_o_069.pdf.
- [SCHER] Scientific Committee on Health and Environmental Risks., **2009a**, Risk assessment report on nickel and its compounds. Environmental Part, opinion adopted at its 27th plenary on 13 January 2009, Available from: http://ec.europa.eu/health/ph_risk/committees/04_scher/docs/scher_o_112.pdf.
- [SCHER] Scientific Committee on Health and Environmental Risks., **2009b**, Risk assessment report on copper and its compounds. Environmental Part, opinion adopted by written procedure on 12 February 2009, Available from: http://ec.europa.eu/health/ph_risk/committees/04_scher/docs/scher_o_115.pdf.
- Schlekat CE et al., **2010**, Cross-species extrapolation of chronic nickel Biotic Ligand Models, *Sci. Tot. Environ.*, 408, 6148-6157.
- Schmidt T et al., **2010a**, Development of a new toxic unit model for the bioassessment of metals in streams, *Environ. Toxicol. Chem.*, 29, 2432-2442.
- Schmidt TS et al., **2010b**, Development of a new toxic-unit model for the bioassessment of metals in streams, *Environ. Toxicol. Chem.*, 29, 2432-2442.
- Schoderboeck L et al., **2011**, Effects assessment: Boron compounds in the aquatic environment, *Chemosphere*, 82, 483-487.
- Schwartz ML et al., **2007**, Development and validation of a chronic copper biotic ligand model for *Ceriodaphnia dubia*, *Aquat. Toxicol.*, 84, 247-254.

- Semple KT et al., **2004**, Peer Reviewed: Defining Bioavailability and Bioaccessibility of Contaminated Soil and Sediment is Complicated, *Environ. Sci. Technol.*, 38, 228A-231A.
- Sigg L et al., **2006**, Comparison of analytical techniques for dynamic trace metal speciation in freshwaters, *Environ. Sci. Technol.*, 40, 1934-1941.
- Slaveykova VI, **2007**, Predicting Pb bioavailability to freshwater microalgae in the presence of fulvic acid: Algal cell density as a variable, *Chemosphere*, 69, 1438-1445.
- Sunda WG et al., **1978**, Effect of chemical speciation on toxicity of cadmium to grass shrimp, *Palaemonetes pugio*: importance of free cadmium ion, *Environ. Sci. Technol.*, 12, 409-413.
- Tessier A et al., **1995**, Metal speciation and bioavailability in aquatic systems, John Wiley & Sons, New York.
- The Netherlands, **2008**, European Union risk assessment report on zinc and zinc compounds. Final report, Part 1 Environment; prepared by The Dutch National Institute for Public Health and the Environment (RIVM), on behalf of the European Union,
- Tipping E, **1994**, WHAM - A chemical equilibrium model and computer code for waters, sediments, and soils incorporating a discrete site electrostatic model for ion-binding by humic substances, *Computers and Geosciences*, 20, 973-1023.
- Tipping E, **1998**, Humic ion-binding model VI: An improved description of the interactions of protons and metal ions with humic substances, *Aquatic Geochemistry*, 4, 3-48.
- Tipping E et al., **2011**, Humic ion-binding model VII: a revised parameterisation of cation-binding by humic substances, *Environ. Chem.*, 8, 225-235.
- UNEP, **2013**, Environmental Risks and Challenges of Anthropogenic Metals Flows and Cycles, A Report of the Working Group on the Global Metal Flows to the International Resource Panel., http://www.unep.org/resourcepanel/Portals/24102/PDFs/Environmental_Challenges_Metals-Full%20Report.pdf
- [US-EPA] United States Environmental Protection Agency., **2007**, Aquatic life ambient freshwater quality criteria—Copper revision. No. EPA-822-R-07-011, Available from: <http://www.epa.gov/waterscience/criteria/aqlife.html>.
- van Genderen E et al., **2008**, An evaluation of the bioavailability and aquatic toxicity attributed to ambient copper concentrations in surface waters from several parts of the world, *Integr. Environ. Assess. Manag.*, 4, 414-424.
- Van Laer L et al., **2006**, Speciation of nickel in surface waters measured with the Donnan membrane technique, *Anal. Chim. Acta*, 578, 195-202.
- Van Leeuwen HP et al., **1995**, Risk assessment of chemicals: an introduction, Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Van Sprang P et al., **2009**, Environmental risk assessment of zinc in European freshwaters: A critical appraisal, *Sci. Tot. Environ.*, 407, 5373-5391.
- Van Sprang P et al., **2011**, Delivering a practical methodology to account for metal bioavailability in the Water Framework Directive (Poster presented at SETAC). http://www.wca-environment.com/wp-content/uploads/2011/05/wca-arche_SETAC2011_biomet_WE149_May-2011_A01.pdf.
- Verboost PM et al., **1989**, The Movement of Cadmium Through Freshwater Trout Branchial Epithelium and its Interference with Calcium Transport, *Journal of Experimental Biology*, 145, 185-197.

- Verschoor AJ et al., **2011**, Spatial and temporal variation of water type-specific no-effect concentrations and risks of Cu, Ni and Zn, *Environ. Sci. Technol.*, 45, 6049-6056.
- Verschoor AJ et al., **2012**, Multimetal accumulation in crustaceans in surface water related to body size and water chemistry, *Environ. Toxicol. Chem.*, 31, 2269-2280.
- Vijver MG et al., **2008**, Uncertainty of water type-specific hazardous copper concentrations derived with biotic ligand models, *Environ. Toxicol. Chem.*, 27, 2311-2319.
- Vijver MG et al., **2011**, Response predictions for organisms water-exposed to metal mixtures: A meta-analysis, *Environ. Toxicol. Chem.*, 30, 1482-1487.
- Villavicencio G et al., **2005**, Biotic ligand model prediction of copper toxicity to daphnids in a range of natural waters in Chile, *Environ. Toxicol. Chem.*, 24, 1287-1299.
- Villavicencio G et al., **2011**, Application of an acute biotic ligand model to predict chronic copper toxicity to *Daphnia magna* in natural waters of Chile and reconstituted synthetic waters, *Environ. Toxicol. Chem.*, 30, 2319-2325.
- Vink JPM, **2002**, Measurement of heavy metal speciation of redox gradients in natural water - sediment interfaces and implications for uptake by benthic organisms, *Environ. Sci. Technol.*, 36, 5130-5138.
- Vink JPM et al., **2005**, SOFIE; an optimized approach for exposure tests and sediment assays, in: *Water Encyclopedia*, John Wiley, New York, 418-423.
- Vink JPM, **2009**, The origin of speciation: Trace metal kinetics over natural water/sediment interfaces and the consequences for bioaccumulation, *Environ. Pollut.*, 157, 519-527.
- White SL et al., **1985**, On the metabolic requirements for copper and zinc in molluscs and crustaceans, *Mar. Environ. Res.*, 16, 215-229.
- Yu R-Q et al., **2002**, Trace metal assimilation and release budget in *Daphnia magna*, *Limnol. Ocean.*, 47, 495-504.
- Zamuda CD et al., **1982**, Bioavailability of dissolved copper to the American oyster *Crassostrea virginica*. I. Importance of chemical speciation, *Mar. Biol.*, 66, 77-82.
- Zitko V et al., **1976**, A mechanism of the effects of water hardness on the lethality of heavy metals to fish, *Chemosphere*, 5, 299-303.

