

# Contents

---

<b>Authors</b> .....	<b>ix</b>
<b>Chapter 1 Introduction</b> .....	<b>1</b>
<b>Chapter 2 HYDRO – Climate and water cycle at the basin scale</b> .....	<b>3</b>
KEY OBJECTIVES .....	3
KEY ACHIEVEMENTS .....	4
Framework for probabilistic climate change scenarios.....	4
Water availability predictions.....	4
Spatial downscaling.....	5
Temporal downscaling.....	6
Stochastic ‘weather’ generation.....	6
Non-stationarity and climate change scenarios.....	6
Establishment of a monitoring network .....	6
Catchment Investigations .....	7
IMPLICATIONS AND APPLICATION OF RESULTS .....	8
CONTRIBUTIONS AND POLICY RECOMMENDATIONS FOR RIVER BASIN MANAGEMENT .....	9
Locally/nationally .....	9
In a European context.....	9
OPEN & NEW QUESTIONS FROM HYDRO .....	10
REFERENCES .....	10
<b>Chapter 3 BIOGEOCHEM – Biogeochemical processes in soils and sediments</b> .....	<b>13</b>
KEY OBJECTIVES .....	13
KEY ACHIEVEMENTS .....	13
Particles – and colloid transport.....	13
Sorption processes; organic contaminants.....	14
Sorption processes; inorganic contaminants.....	16
Bioprocesses; organic contaminants .....	16
IMPLICATIONS AND APPLICATION OF RESULTS .....	17
CONTRIBUTIONS AND POLICY RECOMMENDATIONS FOR RIVER BASIN MANAGEMENT .....	18
Locally/nationally .....	18
In a European context.....	19

OPEN & NEW QUESTIONS FROM BIOGEOCHEM .....	19
ACKNOWLEDGEMENT .....	20
REFERENCES .....	20
<b>Chapter 4 FLUX – Mass transfer in river-sediment-soil-groundwater systems .....</b>	<b>23</b>
KEY OBJECTIVES .....	23
KEY ACHIEVEMENTS .....	24
Distribution and fluxes of persistent organic pollutants in AquaTerra catchments .....	24
Fluxes of current use pesticide in the Brevilles catchment .....	25
Geochemical conceptual scheme of the Bitterfeld/Wolfen megasite, Mulde catchment, Elbe Basin .....	25
Temperature as intercompartment water and contaminant fluxes characterization .....	25
Natural degradation processes at the interface between groundwater and surface water at laboratory scale .....	26
Geochemical conceptual scheme of the Brévilles catchment .....	27
Influence of dams on the composition of the suspended and riverbank sediments in the Danube .....	27
Long-term fluxes of dissolved and suspended matter in the Ebro River Basin .....	27
Decomposition of dissolved elements fluxes on the Ebro River Basin (Spain) supported by sulfate isotopes .....	28
Natural versus anthropogenic sources in the Dommel surface and groundwater dissolved load (Meuse basin): isotopic constraints (B, Sr) and Gd anomaly .....	29
Heavy metal sources in the Dommel catchment (Meuse basin): Chemical and isotopic constraints .....	29
Suspended matter of the Meuse River .....	30
Sediment dynamics and Geoacoustic methods .....	30
CONTRIBUTIONS AND POLICY RECOMMENDATIONS FOR RIVER BASIN MANAGEMENT .....	32
OPEN & NEW QUESTIONS FROM FLUX .....	32
REFERENCES .....	32
<b>Chapter 5 MONITOR – Data analysis, monitoring and analytical protocols, and sampling devices .....</b>	<b>35</b>
KEY OBJECTIVES .....	35
KEY ACHIEVEMENTS .....	36
Optimised method for the analysis of pesticides in water and soil .....	36
Liquid chromatography-quadrupole-linear ion trap mass spectrometry (LC-QqLIT MS) method for the analysis of pharmaceutically active compounds in surface and wastewater .....	36
LC-QqLIT-MS method for simultaneous determination of new brominated flame retardants .....	36
Deployment and validation of two types of time-integrating passive sampling devices .....	36
Integration of ultrafast magnetic proxy screening into site characterization .....	38
Optimisation and validation of artificial neural networks to allow early identification of trends from highly variable data sets .....	38
IMPLICATIONS AND APPLICATION OF RESULTS .....	38
CONTRIBUTIONS AND POLICY RECOMMENDATIONS FOR RIVER BASIN MANAGEMENT .....	38
Locally/nationally .....	38
In a European context .....	38
OPEN & NEW QUESTIONS FROM MONITOR .....	39
REFERENCES .....	39
<b>Chapter 6 TREND – Temporal development of environmental media: Properties, processes and stresses .....</b>	<b>41</b>
KEY OBJECTIVES .....	41
KEY ACHIEVEMENTS .....	42
Trends in soil and sediment .....	42
Trends in groundwater .....	43
Modelling and forecasting from catchment to basin scales .....	44
IMPLICATIONS AND APPLICATION OF RESULTS .....	44

CONTRIBUTIONS AND POLICY RECOMMENDATIONS FOR RIVER BASIN MANAGEMENT .....	47
OPEN & NEW QUESTIONS FROM TREND .....	47
REFERENCES .....	48
<b>Chapter 7 BASIN – Integration of research in AquaTerra river basins .....</b>	<b>51</b>
KEY OBJECTIVES .....	51
KEY ACHIEVEMENTS .....	51
Results brévilles .....	51
Results Ebro.....	51
Results Meuse.....	52
<i>Application of the BioChem model: case study Dommel basin .....</i>	<i>52</i>
<i>Ecotoxicological research in the Walloon Meuse river basin .....</i>	<i>53</i>
<i>Dispersion of contaminants from groundwater into surface water:</i>	
<i>the Flémalle test site .....</i>	<i>55</i>
<i>A new hydrological model to deal with climate change impacts assessment:</i>	
<i>the Geer basin .....</i>	<i>55</i>
Results Elbe .....	56
Results Danube.....	56
IMPLICATIONS AND APPLICATION OF RESULTS .....	57
Locally .....	57
In a European and a global context.....	58
CONTRIBUTIONS AND POLICY RECOMMENDATIONS FOR RIVER BASIN MANAGEMENT .....	59
Locally/nationally .....	59
In a European context.....	59
OPEN & NEW QUESTIONS FROM BASIN .....	60
REFERENCES .....	60
<b>Chapter 8 COMPUTE – Modelling methods and strategies .....</b>	<b>63</b>
KEY OBJECTIVES OF COMPUTE .....	63
KEY ACHIEVEMENTS .....	63
Modelling at the bench and hill slope scales.....	64
Modelling at the catchment scale.....	65
Modelling at the river basin scale.....	68
Software tool box .....	73
IMPLICATIONS AND APPLICATION OF RESULTS .....	74
CONTRIBUTIONS AND POLICY RECOMMENDATIONS FOR RIVER BASIN MANAGEMENT .....	74
Locally/nationally .....	76
In a European context.....	76
OPEN & NEW QUESTIONS FROM COMPUTE .....	77
REFERENCES .....	77
<b>Chapter 9 INTEGRATOR – Integration of knowledge .....</b>	<b>79</b>
KEY OBJECTIVES .....	79
KEY ACHIEVEMENTS .....	80
INTEGRATOR 1 – Evaluation and characterisation of stakeholder demand for a	
conceptual model of interaction between the society and soil-water resources.....	80
INTEGRATOR 2 – Implementation in selected case studies.....	81
INTEGRATOR 3 – Development of conceptual models for decision makers and the	
integration of AquaTerra results.....	83
IMPLICATIONS AND APPLICATION OF RESULTS .....	85
CONTRIBUTIONS AND POLICY RECOMMENDATIONS FOR RIVER BASIN MANAGEMENT .....	86
Locally/nationally .....	86
In a European context.....	87
OPEN & NEW QUESTIONS FROM INTEGRATOR .....	87
REFERENCE .....	88

<b>Chapter 10 EUPOL – Linking policy demands and research .....</b>	<b>89</b>
KEY OBJECTIVES .....	89
KEY ACHIEVEMENTS .....	89
IMPLICATIONS AND APPLICATION OF RESULTS .....	91
CONTRIBUTIONS AND POLICY RECOMMENDATIONS FOR RIVER BASIN MANAGEMENT .....	92
OPEN & NEW QUESTIONS FROM EUPOL .....	92
REFERENCES .....	93
<b>Chapter 11 AquaTerra’s achievements and recommendations to river basin management in brief .....</b>	<b>95</b>

# Authors

---

**Hans-Jørgen Albrechtsen**, Danish Technical University, Dept. of Environmental Engineering, Lyngby, Denmark (hja@env.dtu.dk)

**Erik Ansink**, VU University Amsterdam, Institute for Environmental Studies, Amsterdam, The Netherlands (erikansink@gmail.com)

**D. Baes**, University of Liege, Gembloux Agro-Bio Tech (baes.d@fsagx.ac.be)

**Jean-Michel Baltassat**, BRGM, Orléans, France (jm.baltassat@brgm.fr)

**Olivier Banton**, Université d'Avignon et des pays de Vaucluse (UAPV), Avignon, France (olivier.banton@univ-avignon.fr)

**Nicole Baran**, BRGM, Service EAU, Orléans, France (n.baran@brgm.fr)

**Damià Barceló**, CSIC, Institute of Environmental Assessment and Water Research, Department of Environmental Chemistry, Barcelona, Spain and Catalan Institute for Water Research (ICRA), Girona, Spain (damia.barcelo@idaea.csic.es)

**Anthony Bardos**, Cyber Sales Ltd, Reading, UK (anthony.bardos@cybersales.co.uk)

**Paul Bardos**, r3 Environmental Technology Ltd, Dept. Soil Science, Reading, UK (paul@r3environmental.co.uk)

**Johannes A.C. Barth**, Geo-Center of Northern Bavaria, Applied Geology Group, Erlangen, Germany (barth@geol.uni-erlangen.de)

**Jordi Batlle-Aguilar**, Ecole Polytechnique Fédérale de Lausanne (EPFL), School of Architecture, Civil and Environmental Engineering, Ecological Engineering Laboratory, Lausanne, Switzerland (jordi.batlle@epfl.ch)

**Alberto Bellin**, University of Trento, Department of Civil and Environmental Engineering, Trento, Italy (alberto.bellin@ing.unitn.it)

**Enrico Bertuzzo**, Ecole Polytechnique Federale, Laboratory of Ecohydrology, Faculté ENAC, Lausanne, Switzerland (enrico.bertuzzo@epfl.ch)

**Stephen Blenkinsop**, Newcastle University, School of Civil Engineering and Geosciences, Newcastle, UK (s.blenkinsop@ncl.ac.uk)

**Martino Boni**, Università di Padova, Department IMAGE, Padova, Italy (martino.boni@ciclistiamari.it)

**Gianluca Botter**, Università di Padova, Department IMAGE, Padova, Italy (gianluca.botter@unipd.it)

©2010 IWA Publishing. *Advanced Tools and Models to Improve River Basin Management in Europe in the Context of Climate Change (AquaTerra)* by Michael Finkel, Johannes Barth and Peter Grathwohl ISBN: 9781843393726. Published by IWA Publishing, London, UK.

**Madjit Bouzit**, BRGM, Montpellier, France (m.bouzit@brgm.fr)

**Isabella Bovolo**, Newcastle University, School of Civil Engineering and Geosciences, Newcastle, UK (Isabella.Bovolo@ncl.ac.uk)

**Agnès Brenot**, BRGM – Service EAU, Orléans, France (a.brenot@brgm.fr)

**Jos Brils**, Deltares, Utrecht, The Netherlands (jos.brils@deltares.nl)

**Hans Peter Broers**, Deltares, Unit Soil and Groundwater Systems, Utrecht, The Netherlands (hanspeter.broers@deltares.nl)

**Serge Brouyère**, Université de Liège, Département ArGENCo, Secteur Geô, Liège, Belgium (Serge.Brouyere@ulg.ac.be)

**Claudius Bürger**, Hydrogeology Group, University of Tübingen, Tübingen, Germany (claudius.buerger@uni-tuebingen.de)

**Aidan Burton**, Newcastle University, School of Civil Engineering and Geosciences, Newcastle, UK (Aidan.Burton@ncl.ac.uk)

**Tony Chapman**, wca environment ltd, Faringdon, UK (Tony.Chapman@wca-environment.com)

**Dominique Darmendrail**, BRGM, Direction Générale, Orléans, France (d.darmendrail@brgm.fr)

**Sylvia Dautrebande**, (Dautrebande.sylvia@skynet.be)

**Michael Finkel**, University of Tuebingen, Center for Applied Geosciences, Tuebingen, Germany (michael.finkel@uni-tuebingen.de)

**Hayley Fowler**, Newcastle University, School of Civil Engineering and Geosciences, Newcastle, UK (h.j.fowler@ncl.ac.uk)

**Francis Garrido**, BRGM, EPI/ECO, Orléans, France (f.garrido@brgm.fr)

**Martin Gerzabek**, University of Natural Resources and Applied Life Sciences, Vienna, Austria (martin.gerzabek@boku.ac.at)

**Sylvain Gignoux**, Agence National pour la Gestion des Déchets Radioactifs – ANDRA, Châtenay-Malabry, France (Sylvain.Gignoux@andra.fr)

**Jean-François Girard**, BRGM – Natural Risks, Orléans, France (jf.girard@brgm.fr)

**Tilmann Gocht**, Environmental Mineralogy & Chemistry Group, University of Tübingen, Tübingen, Germany (tilman.gocht@uni-tuebingen.de)

**Pascal Goderniaux**, University of Liège, Group of Hydrogeology and Environmental Geology – Aquapôle, Liège, Belgium and Funds for Scientific Research – FNRS, Brussels, Belgium (Pascal.Goderniaux@ulg.ac.be)

**Peter Grathwohl**, University of Tübingen, Center of Applied Geoscience, Tübingen, Germany (peter.grathwohl@uni-tuebingen.de)

**Nina Graveline**, BRGM, Département Eau, Montpellier, France (n.graveline@brgm.fr)

**Alexis Gutierrez**, BRGM, Water Division, Orléans, France (a.gutierrez@brgm.fr)

**Cécile Herivaux**, BRGM, Water Department, Orléans, France (c.herivaux@brgm.fr)

**Jean-Pierre Hermand**, Université Libre de Bruxelles, Brussels, Belgium (jean-pierre.hermand@ulb.ac.be)

**Pei-Chi Hsu**, Hamburg University of Applied Science (HAW), Hazardous Substances and Ecotoxicology, Hamburg, Germany (pei-chi.hsu@haw-hamburg.de)

**G.S. Janniche Gry Sander Janniche**, Technical University of Denmark, Department of Environmental Engineering, Lyngby, Denmark (gsf@env.dtu.dk)

**Kevin C. Jones**, Lancaster Environment Centre, Centre for Chemicals Management, Lancaster University, Lancaster, UK (k.c.jones@lancaster.ac.uk)

**Frédéric Jouin**, BRGM, Orléans, France (jouin.frdrc@gmail.com)

**Jan Joziassse**, Deltares, Soil and Groundwater Systems, Utrecht, The Netherlands (jan.joziassse@deltares.nl)

**Edda Kalbus**, Helmholtz-Centre for Environmental Research – UFZ, Department of Hydrogeology, Leipzig, Germany (edda.kalbus@ufz.de)

**Gerard Th. Klaver**, Deltares, Geo Environmental Research Laboratory, Utrecht, The Netherlands (Gerard.Klaver@deltares.nl)

**Thomas Klinka**, FOOTWAYS, Orléans, France (t.klinka@footways.eu)

**Bart Koelmans**, Wageningen University, Aquatic Ecology and Water Quality Management Group, Wageningen, The Netherlands (bart.koelmans@wur.nl)

**Olaf Kolditz**, Helmholtz Centre for Environmental Research – UFZ, Department of Environmental Informatics, Leipzig, Germany (olaf.kolditz@ufz.de)

**Ruben Kretzschmar**, Swiss Federal Institute of Technology, Department of Environmental Sciences, Zurich, Switzerland (ruben.kretzschmar@env.ethz.ch)

**Georg J. Lair**, University of Natural Resources and Applied Life Sciences, Vienna, Austria (georg.lair@boku.ac.at)

**Alette Langenhoff**, Deltares, Subsurface and Groundwater Systems, Utrecht, The Netherlands (alette.langenhoff@deltares.nl)

**Ingo Lobe**, Helmholtz Centre for Environmental Research – UFZ, Department River Ecology, Leipzig, Germany (ingo.lobe@ufz.de)

**Bruno Majone**, University of Trento, Department of Civil and Environmental Engineering, Trento, Italy (bruno.majone@ing.unitn.it)

**Marco Marani**, Università di Padova, Department IMAGE, Padova, Italy (marco.marani@unipd.it)

**Franz-Josef Maringer**, BOKU – University of Natural Resources and Applied Life Science, Department of Forest- and Soil Sciences – PLUS, Vienna, Austria (franz-josef.maringer@boku.ac.at)

**Annemieke Marsman**, Deltares, Utrecht, The Netherlands (annemieke.marsman@deltares.nl)

**Sandra Meijer**, The REACH Centre Limited, Lancaster Environment Centre, Lancaster University, Lancaster, UK (s.meijer@thereachcentre.com)

**Corinne Merly**, BRGM, Orléans, France (c.merly@brgm.fr)

**Peter Middeldorp**, A&G Milieutechniek bv, Waalwijk, The Netherlands (Peter.Middeldorp@aengbedrijven.nl)

**Romain Millot**, BRGM, Metrology, Monitoring, Analysis Division – MMA/ISO, Orléans, France (r.millot@brgm.fr)

**Claudia Moeckel**, Lancaster Environment Centre, Lancaster University, Lancaster, UK (c.moeckel@lancaster.ac.uk)

**Christophe Mouvet**, BRGM, Orléans, France (c.mouvet@brgm.fr)

**Philippe Négrel**, BRGM – Service EAU, Orléans, France (p.negrel@brgm.fr)

**Philippe Orban**, University of Liège, Belgium (HGULg), Liège, Belgium (p.orban@ulg.ac.be)

**Anibal Perez-Garcia**, University of Tübingen, Hydrogeology Group, Tübingen, Germany (anibal-jose.perez-garcia@student.uni-tuebingen.de)

**Emmanuelle Petelet-Giraud**, BRGM – Service EAU, Orléans, France (e.petelet@brgm.fr)

**Mira Petrovic**, CSIC, Institute of Environmental Assessment and Water Research, Department of Environmental Chemistry, Barcelona, Spain and Catalan Institution for Research and Advance Studies (ICREA), Barcelona, Spain (mira.petrovic@idaea.csic.es)

**Anton Poot**, DHV, Amersfoort, The Netherlands (anton.poot@dhv.com)

**Frido Reinstorf**, Helmholtz Centre for Environmental Research – UFZ, Department of Hydrogeology, Leipzig, Germany and Magdeburg-Stendal University of Applied Sciences, Dept. Water and Waste Management Magdeburg, Germany (frido.reinstorf@ufz.de)

**Huub H.M. Rijnaarts**, Wageningen University, Division Environmental Technology, Wageningen, The Netherlands (huub.rijnaarts@wur.nl)

**Marc Rijnveld**, TNO, Delft, The Netherlands (marc.rijnveld@tno.nl)

**Andrea Rinaldo**, Ecole Polytechnique Federale, Laboratory of Ecohydrology, Faculté – ENAC, Lausanne, Switzerland and Università di Padova, Department IMAGE, Padova, Italy (rinaldo@idra.unipd.it)

**Stéphane Roy**, BRGM, Service EPI, Orléans, France (s.roy@brgm.fr)

**Mario Schirmer**, Eawag – Swiss Federal Institute of Aquatic Science and Technology, Department Water Resources and Drinking Water, Dübendorf, Switzerland (Mario.Schirmer@eawag.ch)

**Christian Schmidt**, Helmholtz Centre for Environmental Research – UFZ, Department of Hydrogeology, Leipzig, Germany (christian.schmidt@ufz.de)

**Diana M.E. Slijkerman**, IMARES, Department of Environment, Den Helder, The Netherlands (Diana.Slijkerman@wur.nl)

**A.F.L. Slob Adriaan F.L. Slob**, TNO, Delft, The Netherlands (adriaan.slob@tno.nl)

**J. Slobodnik Jaroslav Slobodnik**, Environmental Institute, Kos, Slovak Republic (slobodnik@ei.sk)

**D. Steidle Dietmar Steidle**, University of Tübingen, Center for Applied Geosciences, Tübingen, Germany (dietmar.steidle@uni-tuebingen.de)

**Philippe Stollsteiner**, BRGM/EAU/ADM, Orléans, France (p.stollsteiner@brgm.fr)

**Pierre Strosser**, Ecologic Institute, Berlin, Germany

**Claire van der Wielen**, Institut Scientifique de Service Public (ISSEP), Liège, Belgium (cl.vanderwielen@issep.be)

**C.A.M. (Kees) van Gestel**, VU University Amsterdam, Animal Ecology, Amsterdam, The Netherlands (kees.van.gestel@falw.vu.nl)

**Bertil van Os**, Ministry of Education, Culture and Science, Cultural Heritage Agency, Amersfoort, The Netherlands (B.van.Os@cultureelerfgoed.nl)

**Michelle van Vliet**, Wageningen University, Earth System Science and Climate Change group, Wageningen, The Netherlands (michelle.vanvliet@wur.nl)

**Michel Verbanck**, Université Libre de Bruxelles, Dept. Water Pollution Control, Brussels, Belgium (mikeverb@ulb.ac.be)

**Jos P.M. Vink**, Deltares, Group Sediments and river basins, Utrecht, The Netherlands (Jos.Vink@deltares.nl)

**Ate Visser**, Deltares, Delft, The Netherlands (Ate.Visser@deltares.nl)

**Tomas Vogel**, Czech Technical University, Faculty of Civil Engineering, Prague, Czech Republic (vogel@fsv.cvut.cz)

**Wolf von Tümpling**, Helmholtz Centre for Environmental Research – UFZ, Department of River Ecology, Water Analytics & Chemometrics, Leipzig, Germany (wolf.vontuempling@ufz.de)

**Arnaud Wuilleumier**, BRGM, Service EAU, Orléans, France (a.wuilleumier@brgm.fr)

**Mauricio Zambrano-Bigiarini**, University of Trento, Department of Civil and Environmental Engineering, Trento, Italy (mauricio.zambrano@ing.unitn.it)

**Stefano Zanetti**, Università di Padova, Department IMAGE, Padova, Italy (zanetti@idra.unipd.it)