Water Research Center (wfz) Stuttgart

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About wfz

The Water Research Center (wfz) Stuttgart was founded in 2007 at the University of Stuttgart. It is an organization of departments for the research of water. With our main focus on the field of water we develop holistic solutions for diverse problems in cooperation with national and international players.

Water is an essential basis for the existence of our ecosystems. The complexity of the natural and anthropogenic water balance still raises issues to be explored. To deal with problems such as water shortage or pollution, we have to understand how the mechanisms of water are working.

Because of the multi-disciplinary structure of the Water Research Center and the strong coupling of the participating departments, we can offer the perfect base for solutions of unsolved issues. Research on water-related areas is done by different methods, such as experimental works, stochastic and numerical models, analytics and effect related tests, climate impact estimation to finally develop effective management strategies for the behavior and transport of materials (solids, nutrients, contaminants).

For more information please visit our homepage or feel free to contact us personally.

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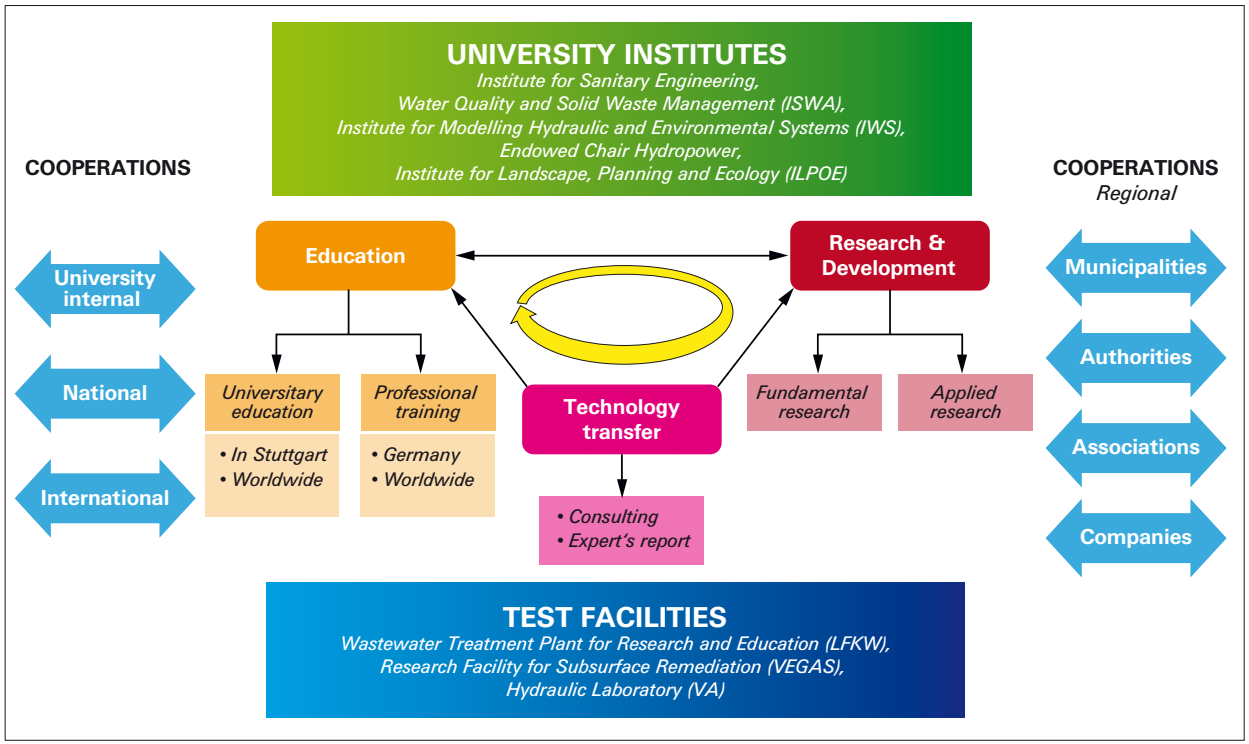
Structure of the Water Research Center Stuttgart



Motivation and Requirements

- Significance of water as base for human life
- Complexity of the system water
- Interactions between different parts of the environment (water, soil, atmosphere)
- Collaboration of experts from different disciplines necessary to solve world wide water related problems:
  - *fundamental and applied research*
  - *education*
  - *technology transfer*

Aims of wfz

- Clustering of knowledge in water related questions
  - *Linkage of research, education and technology transfer*
  - *Integrated, systematic and holistic approach*
  - *From fundamental research to applied research, technology development and implementation*
  - *Networking of laboratories and technical and large scale test facilities*

- National and international cooperation with universities, research institutes, companies…

- Exchange and discussion forum via
  - *Workshops*
  - *Conferences*
  - *Common education programs*
  - *Strong interaction between PhD students*

LSWW

Sanitary Engineering and Water Recycling
Prof. Dr.-Ing. Heidrun Steinmetz

LWW

Hydraulic Engineering and Water Resources Management
Prof. Dr.-Ing. Silke Wieprecht

VA

Laboratory for Hydraulic Modeling
Dr.-Ing. Sven Hartmann

LH2

Hydromechanics and Modeling of Hydrosystems
Prof. Dr.-Ing. Rainer Helmig

LHG

Hydrology and Geohydrology
Prof. Dr.-Ing. Dr. rer. nat. Andras Bardossy

ILPOE

Landscape Planning and Ecology
Prof. Antje Stokman

SE

Urban Drainage
Dr.-Ing. Ulrich Dittmer

AFW

Waste Management and Emissions
Prof. Dr.-Ing. Martin Kranert

CH

Hydrochemistry and Hydrobiology in Sanitary Engineering
Prof. Dr. rer. nat. Jörg W. Metzger

VEGAS

Research Facility for Subsurface Remediation
Jürgen Braun, PhD

LH2/SMH

Stochastic Modeling of Hydrosystems
Jun.-Prof. Dr.-Ing. Wolfgang Nowak, M.Sc.

IHS

Fluid Mechanics and Hydraulic Machinery
Prof. Dr.-Ing. Stefan Riedelbauch

LSWW

Sanitary Engineering and Water Recycling

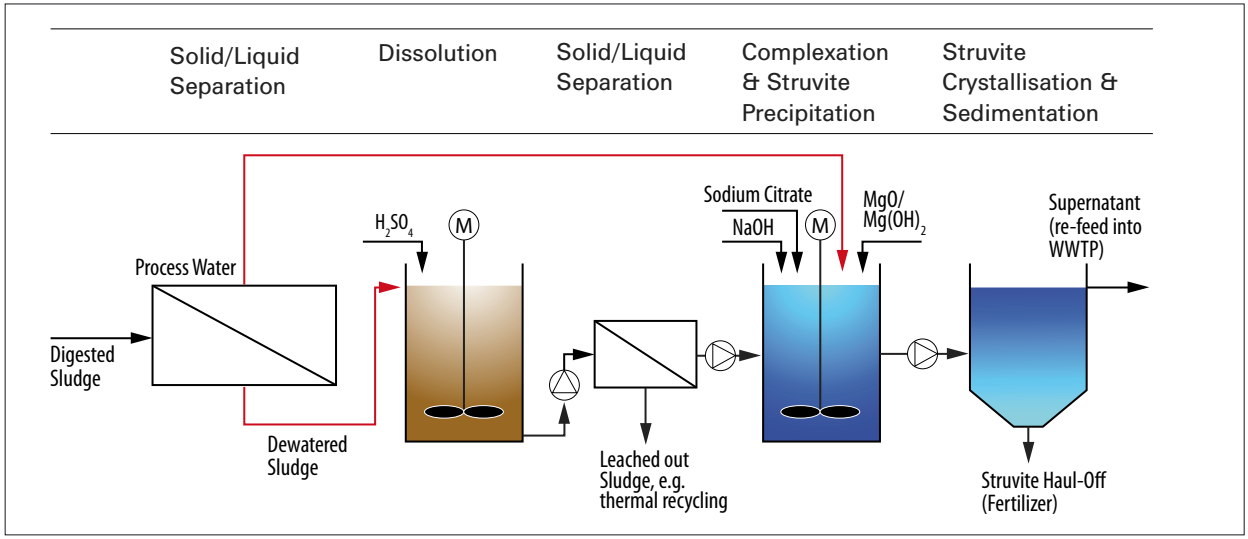
Prof. Dr.-Ing. Heidrun Steinmetz

Core Areas of Interest

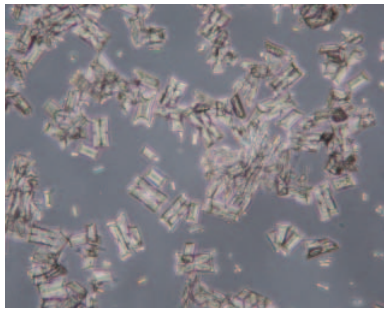
- Process optimization in water and wastewater treatment
  - *Advanced oxidation and adsorption processes for POP removal in municipal and industrial wastewater*
  - *Anaerobic digestion process*
  - *Nanoparticles for water and wastewater treatment*
  - *Energy sufficiency*
  - *In-situ groundwater treatment*
- Resource oriented approaches and technology transfer
  - *Water reuse*
  - *Nutrient recovery (nitrogen and phosphorous)*
  - *Enhanced energy production including biohydrogen production*
  - *Biopolymers from wastewater*
  - *Closing the loop concepts*
  - *Adaptation of conventional technologies to different (climatic) boundary conditions*
- Instrumentation and control strategies
  - *Optimization of wastewater treatment plants through ICA strategies*
- Industrial wastewater treatment
  - *Split flow concepts for several industries (e.g. paper, textile)*
  - *Treatment of membrane concentrates from paper mills*
  - *Elimination of toxic substances*

Facilities
Full-scale wastewater treatment plant for research and education (10,000 p.e)

Climate chamber: adaption of technologies to different climate conditions



Reclamation of Resources Example: Phosphorous recovery from sewage sludge (Stuttgart process)



Pilot plant, fullscale plant and crystals of struvit

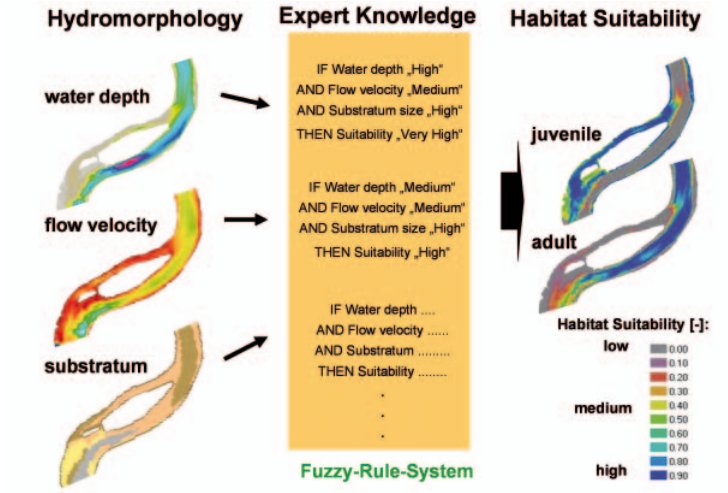
LWW

Hydraulic Engineering and Water Resources Management

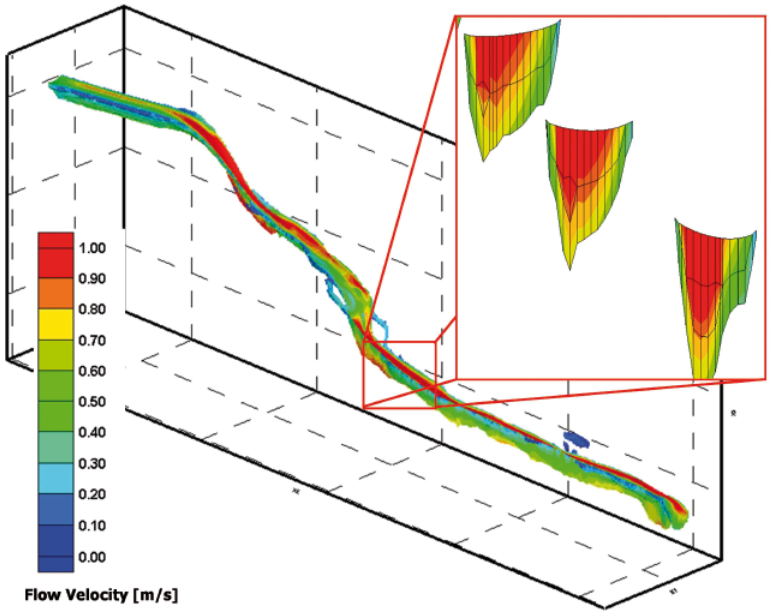
Prof. Dr.-Ing. Silke Wieprecht

Core Areas of Interest

- Sediment management
  - *Reservoir sedimentation, Sediment flushing*
  - *Large-scale sediment management*
- Flood modeling and flood protection strategies
  - *Hydrodynamic-numeric modeling (1D, 2D, 3D)*
- Morphodynamics and revitalization of river systems
  - *Morphodynamic modeling (1D, 2D, 3D)*
- Hydropower
  - *Safety and monitoring of hydraulic structures*
  - *greenhydro*
- Habitat modeling and river ecology
  - *Habitat simulation tool: CASiMiR*
  - *Fish, macrozoobenthos*



Functionality of habitat modeling based on multi-variate fuzzy logic



Three-dimensional simulation of an alpine river section (flow velocity distribution)

VA

Laboratory
for Hydraulic Modeling

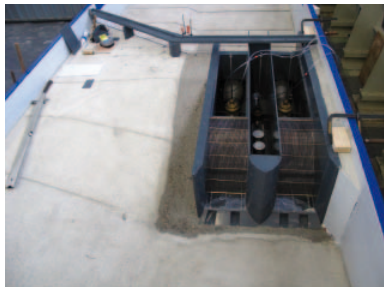
Dr.-Ing. Sven Hartmann

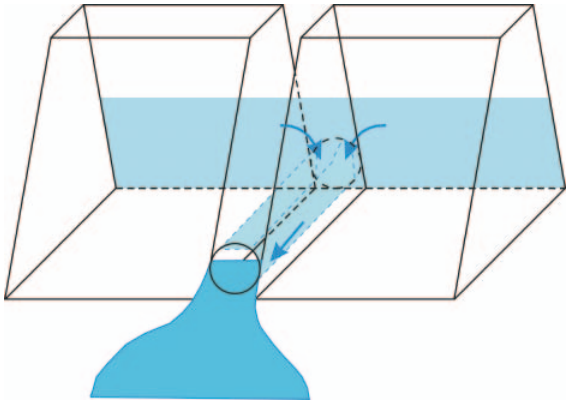
Core Areas of Interest

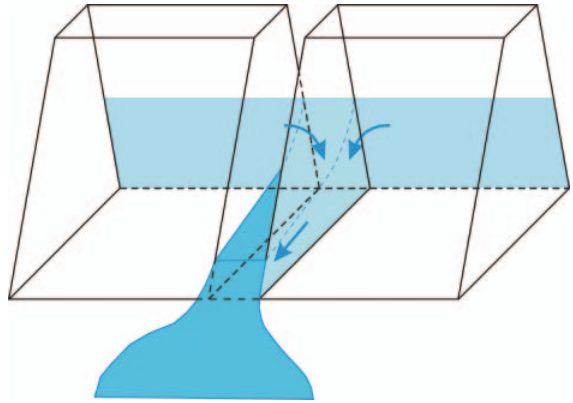
- Sedimentation and erosion processes
  - *Models for assessing and forecasting the impact of environmental key pollutants on marine and fresh water ecosystems and biodiversity*

- Modeling of hydraulic processes
  - *Flood retention basins*
  - *Operation of rescue vehicles in case of flooding*
  - *Dam break processes*
  - *Stability of overflowable dikes*
  - *Physical models of hydraulic structures*

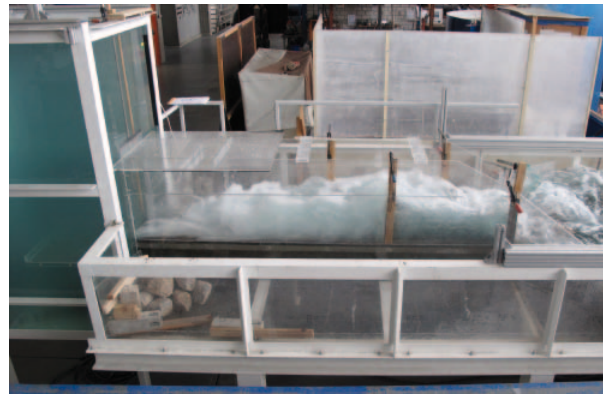
- Energy efficiency
  - *Test rig for hydro power plants*
  - *Energy recovery in water and waste water networks*
  - *Application of pico hydro energy in remote areas*



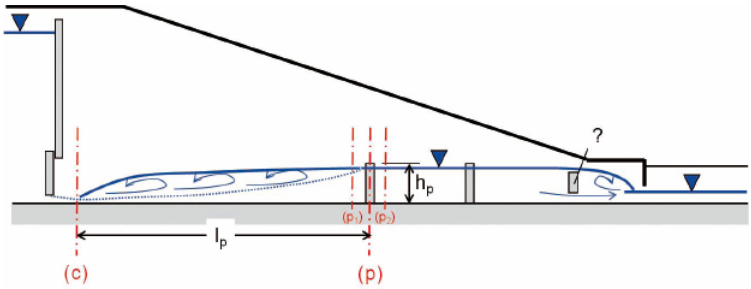


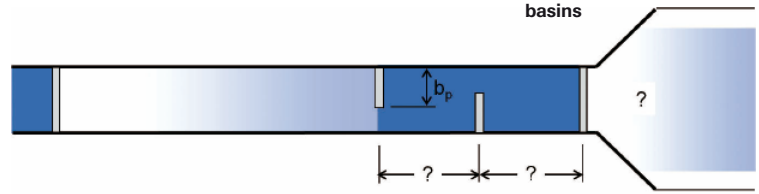


Design options for flood retention basins with migration corridor during low flow conditions



Test stand to optimise the energy dissipation in small sized flood retention basins





Design criteria for energy dissipation in small sized flood retention basins

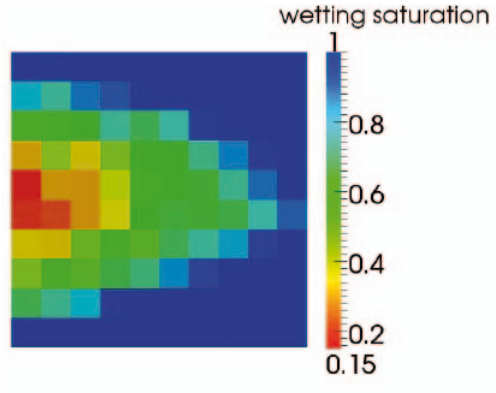
LH2

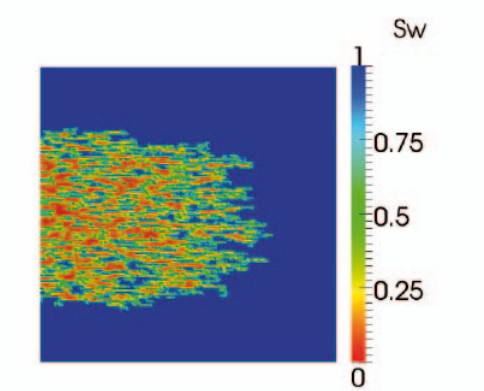
Hydromechanics and Modeling of Hydrosystems

Prof. Dr.-Ing. Rainer Helmig

Core Areas of Interest

- Modeling multi-phase multi-component processes during CO_2 storage in deep geological formations
- Modeling flow and transport through fractured porous media
- Model coupling and flow through complex structures
- Multi-scale-multi-physics modeling
  Stochastic modeling of flow and transport processes in the subsurface

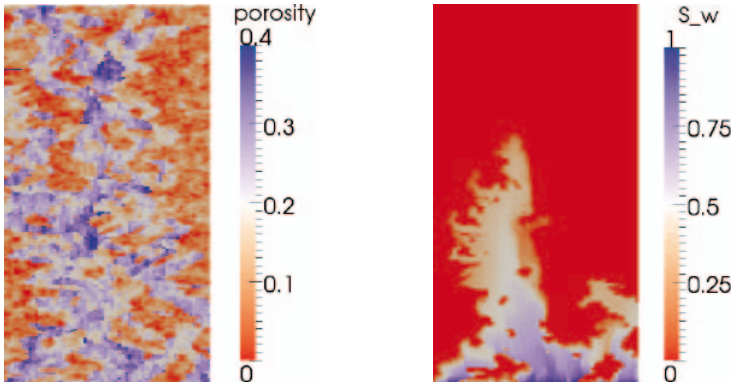




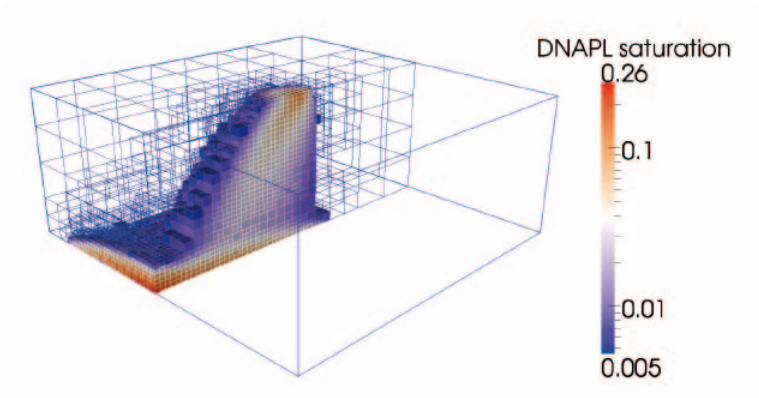
Multi-scale modeling of two-phase flow in hetergeneous reservoirs including capillary effects.

Upscaled solution

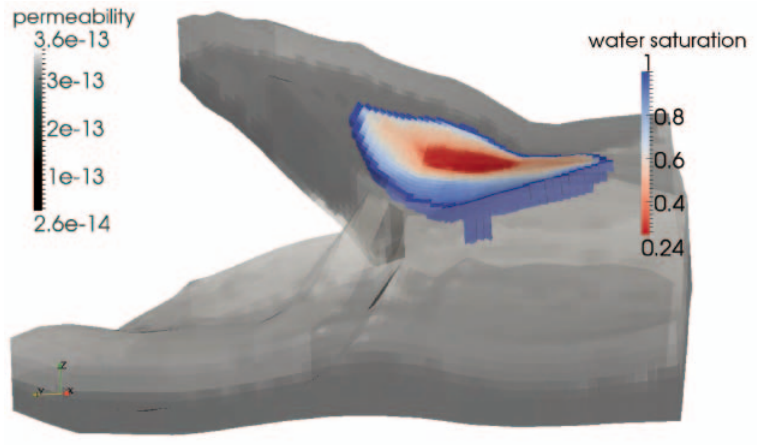
Fine-scale solution



Multi-scale simulation: solution of water saturation in a strongly heterogeneous and channeled porous structure



Simulation of DNAPL flow using adaptive grids



Simulation of CO_2 injection in a geological formation

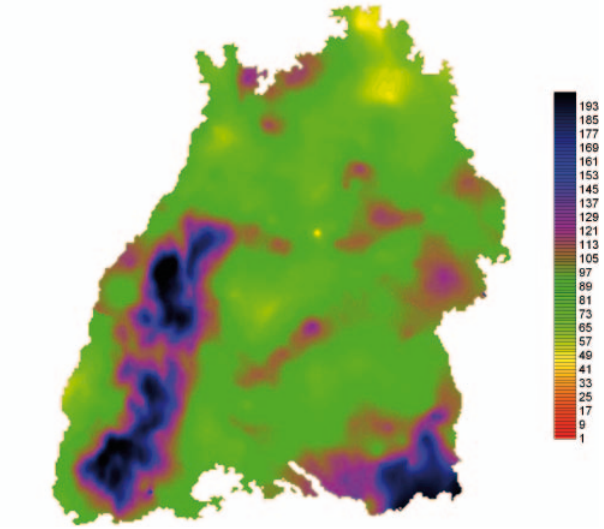
LHG

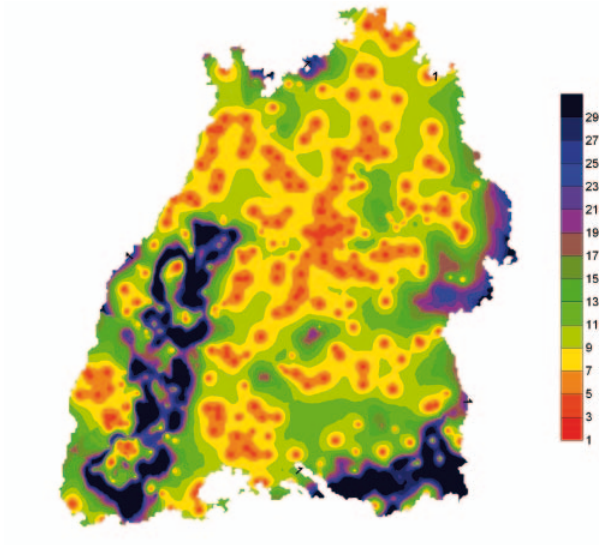
Hydrology and Geohydrology

Prof. Dr.-Ing. Dr. rer. nat. Andras Bardossy

Core Areas of Interest

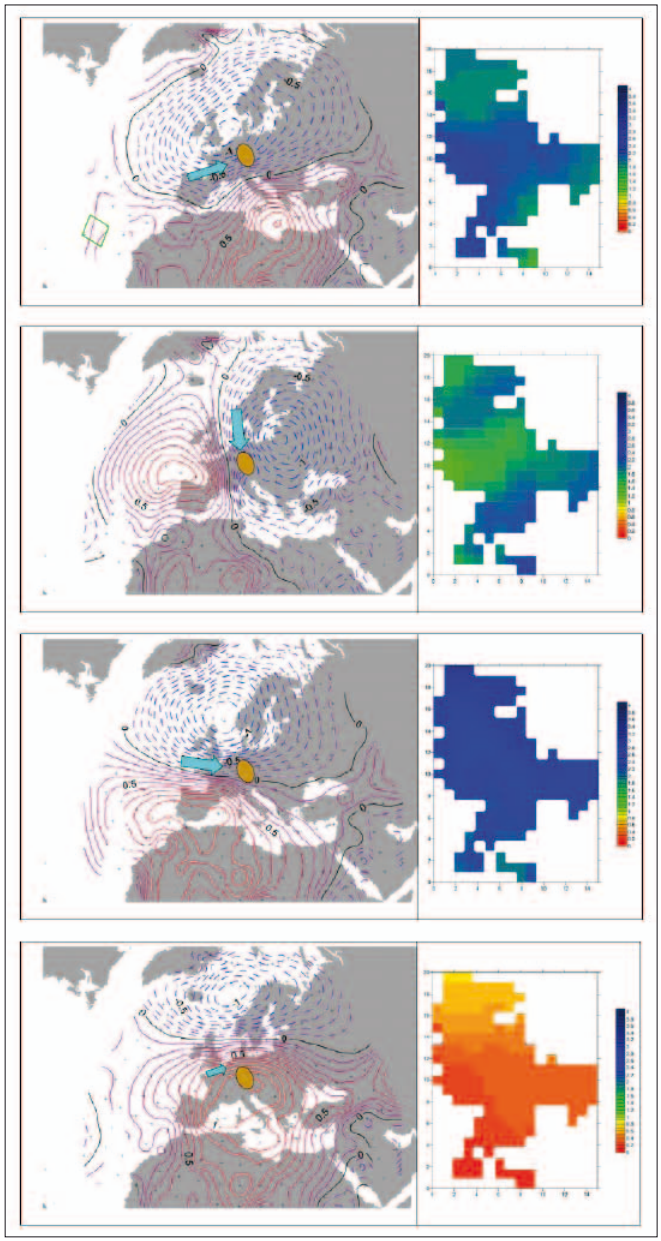
- Precipitation modeling
  - *Space time interpolation and simulation of precipitation*
  - *Combination of remotely sensed and traditional observations of precipitation*
  - *Precipitation nowcasting using radar*
- Rainfall runoff modeling
  - *Model calibration methodologies*
  - *Uncertainty assessment*
  - *Regionalization of hydrological models*
- Climate change related investigations
  - *Analysis of long time series*
  - *Circulation pattern classification*
  - *Downscaling climate scenarios for impact assessment*
- Spatial statistics
  - *Development of copula based spatial models*
  - *Observation network design*





Quantile field by Copula Interpolation

Back-transform to rainfall



ILPOE

Landscape Planning and Ecology

Prof. Antje Stokman

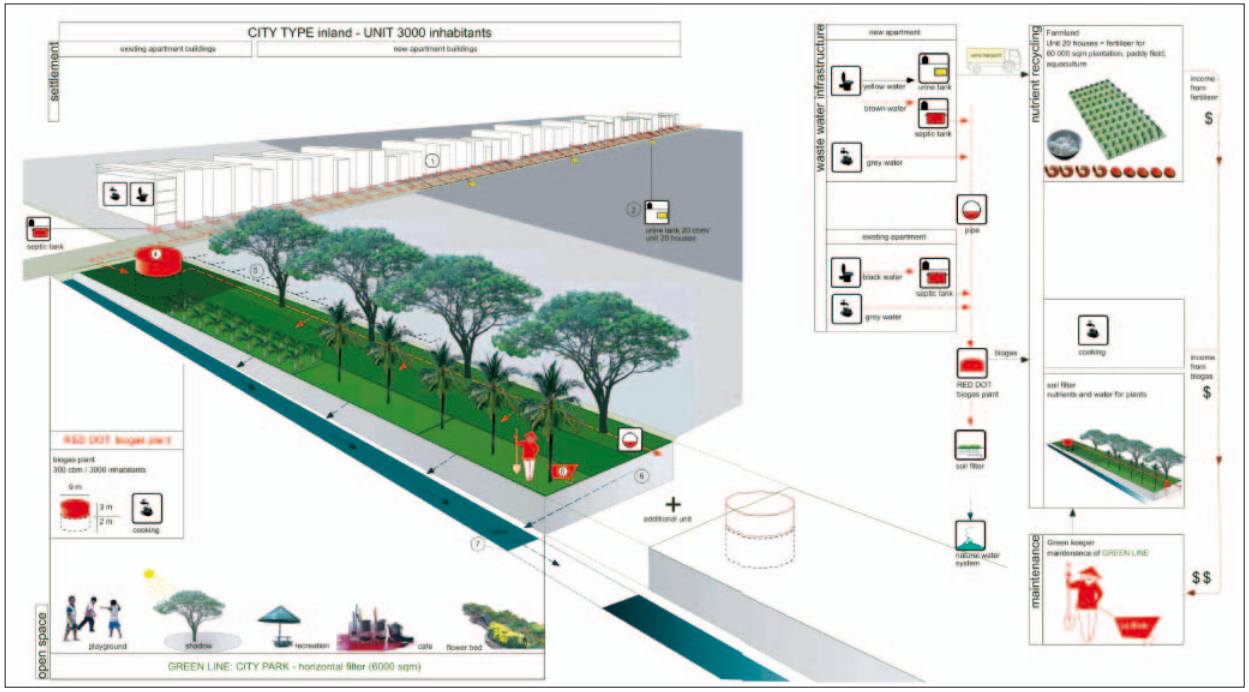
Core Areas of Interest

- Water sensitive urban design
  - *Integrated stormwater management and landscape*
  - *Water-related green infrastructure technologies and strategies (eg. green roofs, pervious pavings, infiltration swales and ponds, wetlands and biofilters)*
  - *Urban design for integrating waste water purification, nutrient recycling and park management/ urban agriculture*
  - *GIS-based system analysis and land-use modeling*

- Multifunctional planning and design of river corridors
  - *Strategies for combining more space for water and new landscape/ urban functions*
  - *Flood adapted construction and urban greening strategies*
  - *Stream restoration, day-lighting and riparian zone design*

- Governance aspects of integrating urban/ landscape planning and water management
  - *Strategic guidelines, manuals and masterplans for cities and regions*
  - *Scenario planning and organization of inter-disciplinary planning processes*
  - *Capacity building and communication strategies*

To embrace a holistic view on integrating water management and urban development, the institute is involved in interdisciplinary projects on water sensitive urban design and multifunctional planning of urban river corridors.



The institute develops spatial strategies to combine water management, urban planning, energy and transportation planning and green infrastructure design into integrated systems for sustainable urban development.

SE
Urban Drainage

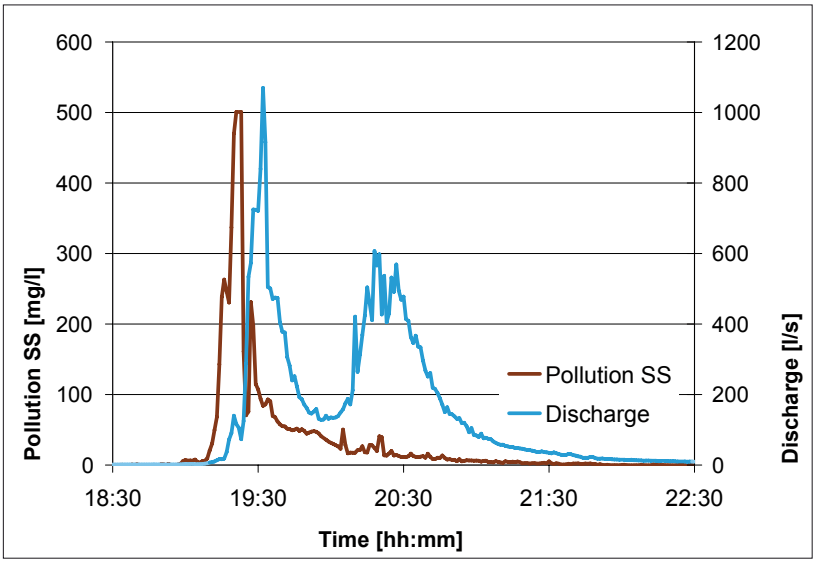
Dr.-Ing. Ulrich Dittmer

Core Areas of Interest

- Stormwater treatment and management
  - *Wetlands and biofilters in combined and separate sewer systems*
  - *Real time control strategies for stormwater management*
- Monitoring of pollutant fluxes
  - *Trace pollutants in wet-weather flow*
  - *Combination of conventional sampling/analysis with online proxy measurements*
  - *Flow measurements under difficult boundary conditions*
- Modeling of pollutant transport
  - *Sediment transport in sewer systems*
  - *Uncertainty in transport modeling*
  - *Reactive transport in biofilters*

Stormwater tank for detention of the first flush

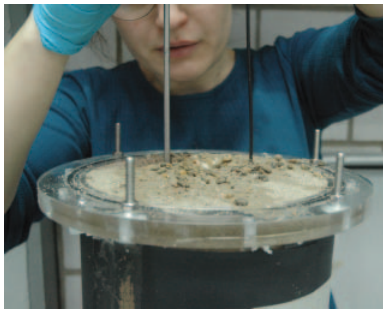
Installation of a monitoring station in an urban water course (online probes and automatic sampler)

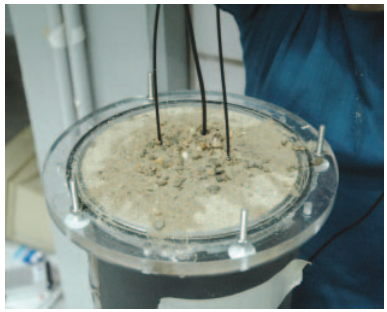


First flush in a stormwater sewer (online measured data)

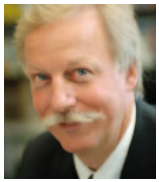
Biofilter for the treatment of combined sewer overflow

Field Work: taking soil samples





Installation of oxygen sensors in lab-scale filter columns. Experiments as a basis for 2D reactive transport modeling



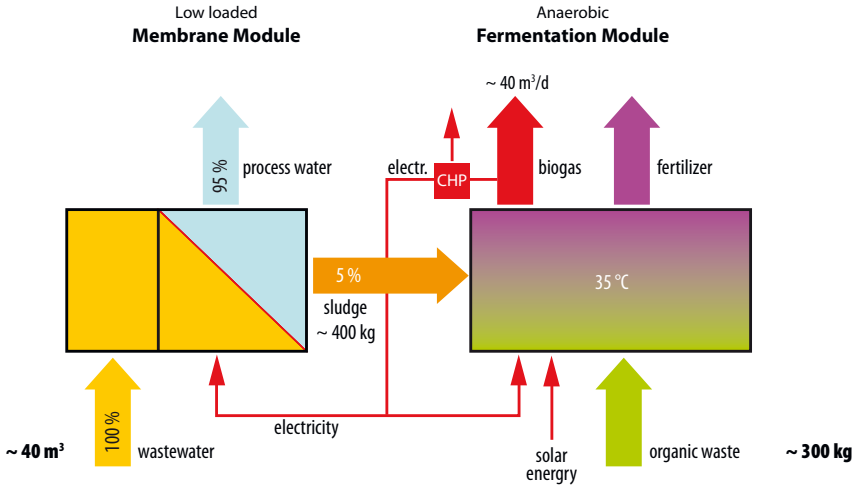
AFW

Waste Management and Emissions

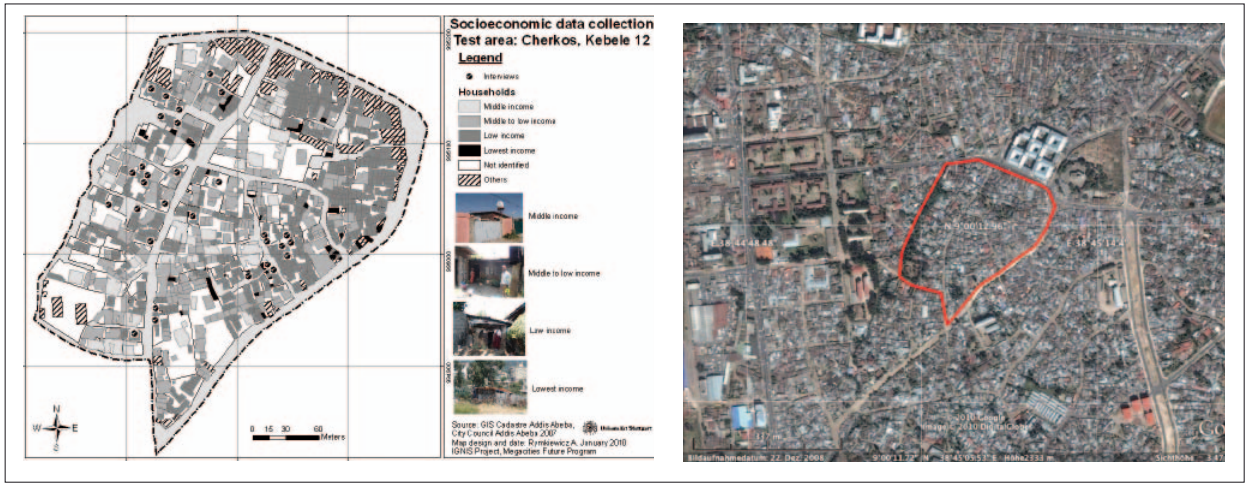
Prof. Dr.-Ing. Martin Kranert

Core Areas of Interest

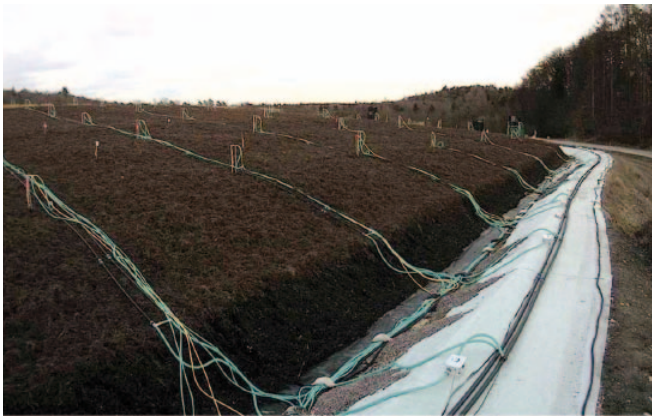
- Decentralized disposal systems for waste water and biological waste (modular systems for tourist regions, islands etc.)
  - *Zero waste models (use of water for irrigation, biogas production, organic fertilizer). Experience is available from MODULAARE-Project (BMBF), cooperation with Prof. Heidrun Steinmetz (see p. 8)*
- Anaerobic digestion of waste
  - *optimization of anaerobic digestion process by control systems, on-line measurements, virtual laboratory, modeling of AD, Experience is available from research projects*
- Concepts for decentralized recycling of ressources (wastewater, renewable energy, ZERO–Waste–models)
- Analyzes of processes, material flow and components
- Research on integration and efficiency

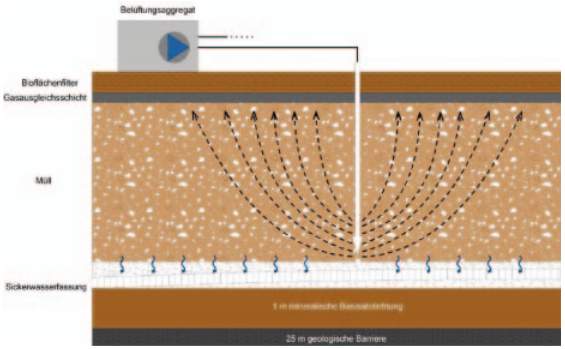


Decentralized disposal systems (tourism centres and resorts)



MSW concepts in future megacities: Socioeconomic characterization and GIS based mapping





Stabilization of old landfills by in-situ aerobisation

CH

Hydrochemistry and Hydrobiology

Prof. Dr. rer. nat. Jörg W. Metzger

Core Areas of Interest

- Water and Environmental Chemistry
  - *Multi-disciplinary research aiming at linking fundamental research to application*
  - *Lectures and practical classes within international BSc and MSc university programs*

- Water and Environmental Analysis
  - *Development of analytical methods (soil, water, sediment, biota, sludge...)*
  - *Determination of inorganic pollutants: heavy metals, elements, ions*
  - *Determination of organic pollutants: single substance analysis, persistent organic pollutants (POPs, polar contaminants,...),*
  - *Determination of sum parameters (TOC, BOD, COD, AOX..)*
  - *Instrumental analysis (GC-MS, LC-MS-MS, ICP-OES, AAS,...)*

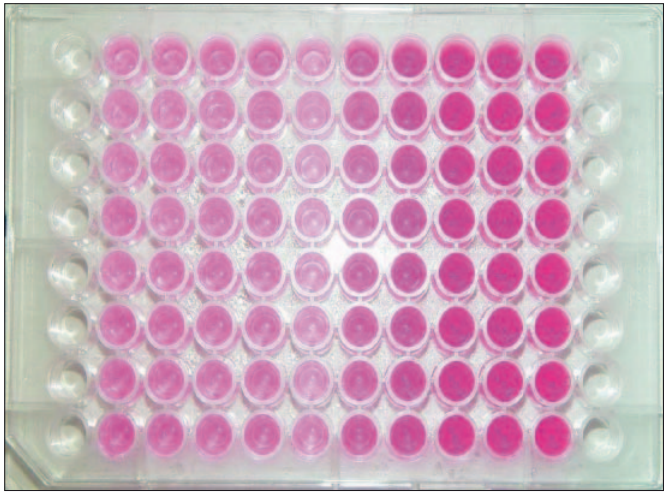
- Analytical Quality Control for Water Laboratories
  - *Proficiency tests*
  - *Training and consultancy on quality assurance in analytical chemistry*

- Micropollutants and Emerging Contaminants
  - *Determination, fate and behaviour in the natural environment (water, soil)*
  - *Behaviour and elimination during water and waste treatment*
  - *Pharmaceuticals, endocrine disruptors, flame retardants, desinfectants, ingredients of personal care products, pesticides, polycyclic aromatic hydrocarbons, polychlorinated dibenzo-dioxins and biphenyls...*

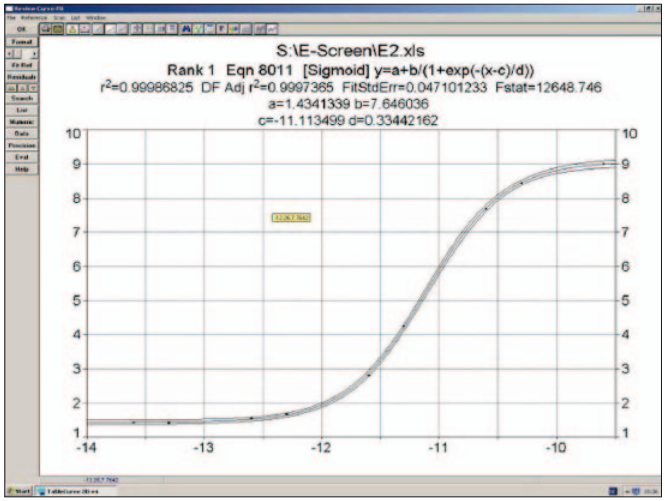
- Effect Monitoring (Eco-/Toxicology)
  - *Determination of endocrine disrupting chemicals (EDC)*
  - *Quantification of estrogen activity (E-Screen-Assay)*

- Strategies for removal of nutrients and micro-pollutants from water
  - *treatment of wastewater from aqua cultures*
  - *elimination of chlorinated hydrocarbons from ground water*

Preparation of waste samples for a proficiency test for water laboratories: stainless steel tank (24 m³) for pasteurization of wastewater, groundwater and tap water.



96-well-microtiter plates containing the cells are used for the sensitive determination of estrogen activity as sum parameter. The obtained dose-response curves allow for the detection of concentrations as low as < 0.1 ng/L estradiol (natural steroid hormone) equivalents.



Determination of endocrine disruptors in environmental samples by the E-Screen assay, a biological test based on cells of a human breast cancer cell line (MCF-7).

VEGAS

Research Facility for Subsurface Remediation

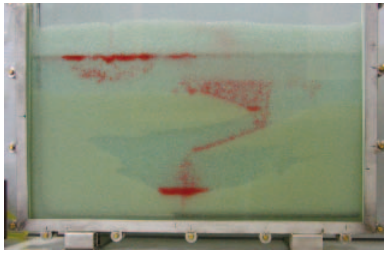
Jürgen Braun, PhD

Core Areas of Interest

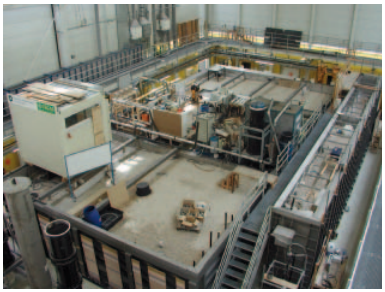
- Research and Development
  - *Fundamental process investigation of multiphase / multicomponent flow, thermal, physiochemical and chemical remediation.*
  - *Batch and column experiments for relevant processes.*
  - *Increase in scale (1D ➞ 2D ➞ 3D), complexity (homogeneous ➞ heterogeneous), soil properties and range of contaminants.*

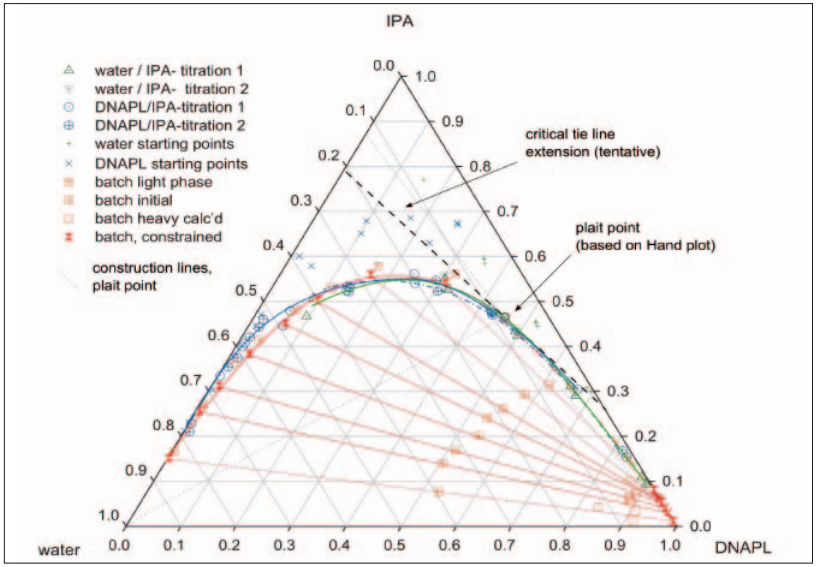
- Monitoring
  - *Innovative, precise and cost-effective technical measuring systems for contaminant zone delineation*
  - *Customized solutions for fast on-site screening measurements for dynamic site investigation.*
  - *Close cooperation with consultants to apply systems for quality control and long-term monitoring during and after remediation.*

- Application and Technology Transfer
  - *Large-scale three-dimensional setups (volume up to 800 m^3) to prove efficiency of technologies and bridge the gap to field applications.*
  - *Closely spaced sampling locations enable high data resolution, online monitoring and mass balance.*
  - *Pilot experiments, scientific guidance of full scale applications*
  - *Short courses for students, regulators, site owners and industry*



Infrastructure: Large Scale Experimental Flumes and Containers





Fundamental process investigation: Ternary Phase Diagram

Monitoring in the Field and Tools

Pilot and Field Applications

LH2/SMH

Stochastic Modeling of Hydrosystems

Jun.-Prof. Dr.-Ing. Wolfgang Nowak, M.Sc.

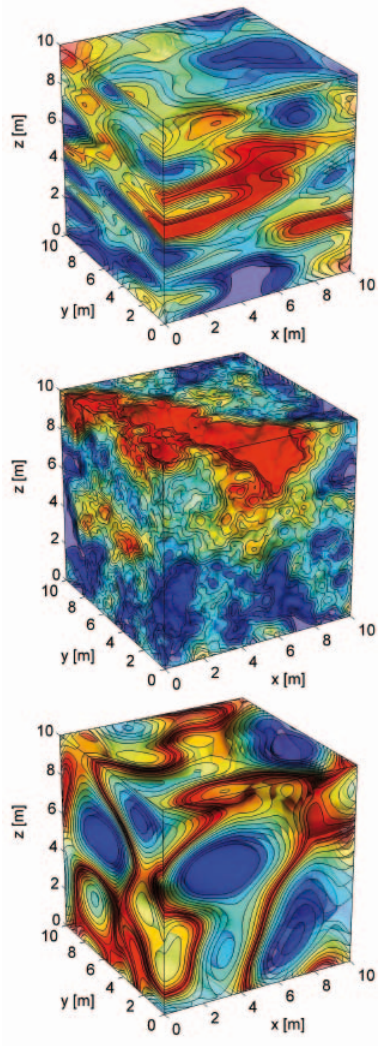
Core Areas of Interest

- Quantifying the uncertainty of prediction:
  - *Analytical solutions for probability distributions of concentrations, dilution and mixing; statistical upscaling*
  - *Numerical approaches (Monte-Carlo, First-Order second moment, Polynomial Chaos Expansion)*
  - *Bayesian geostatistics*

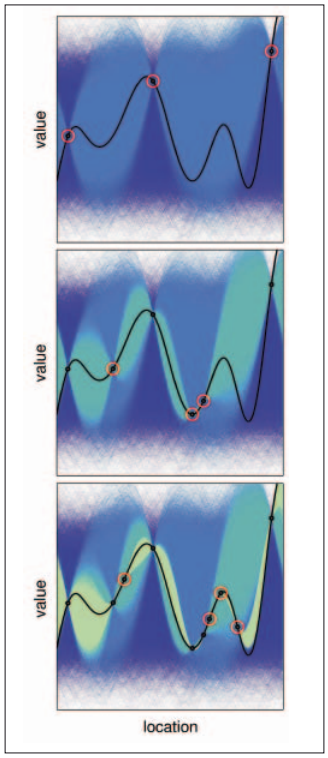
- Optimizing experiments and field campaigns for maximum worth of data
  - *Advancing optimal design theory*
  - *Developing fast algorithms*

- Efficient approaches for data assimilation and stochastic inverse modeling
  - *Improved Ensemble Kalman filters*
  - *Quasi-linear geostatistical approaches*
  - *FFT-based and data-sparse algorithms for kriging*
  - *Statistical filtering*

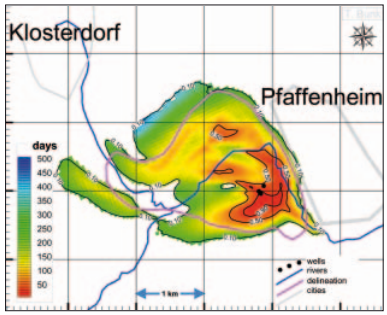
- Robust design and control under uncertainty by response surface methods
  - *Application to real-world problems (contaminant hydrology, wellhead delineation, CO2 storage, Lithium Batteries)*



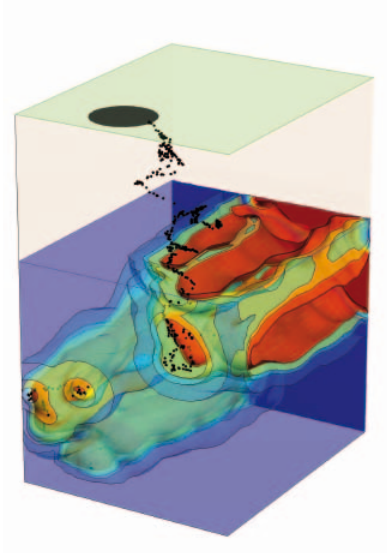
Random fields generated with Bayesian geostatistics.



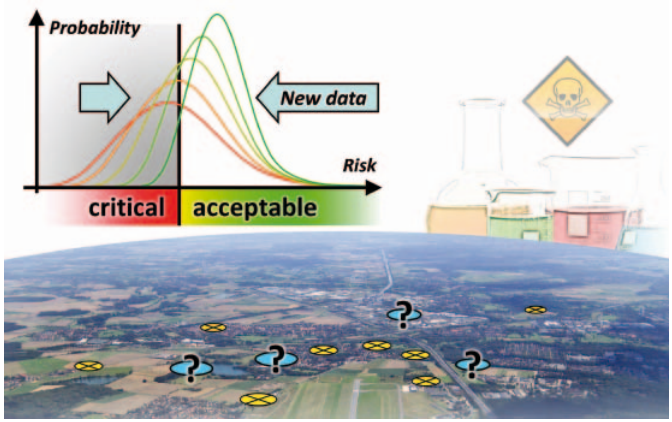
Fast algorithms for kriging and statistical filtering



Probabilistic wellhead delineation



The bizzare shape of subsurface contaminant sources and emerging plumes



Optimizing field campaigns: where to sample for maximum decision confidence?

IHS

Fluid Mechanics and Hydraulic Machinery

Prof. Dr.-Ing. Stefan Riedelbauch

Core Areas of Interest

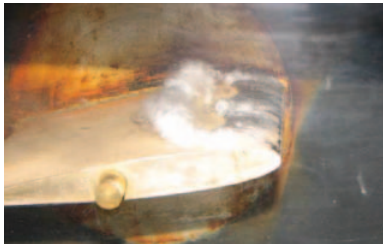
- Hydro Power Plants
  - *Transient behavior of power plants*
  - *Interaction of plant behavior and hydraulic machine*
  - *Energy storage*

- Hydraulic machinery
  - *Design and optimization of hydraulic machines*
  - *Part load behavior*
  - *Over load behavior*

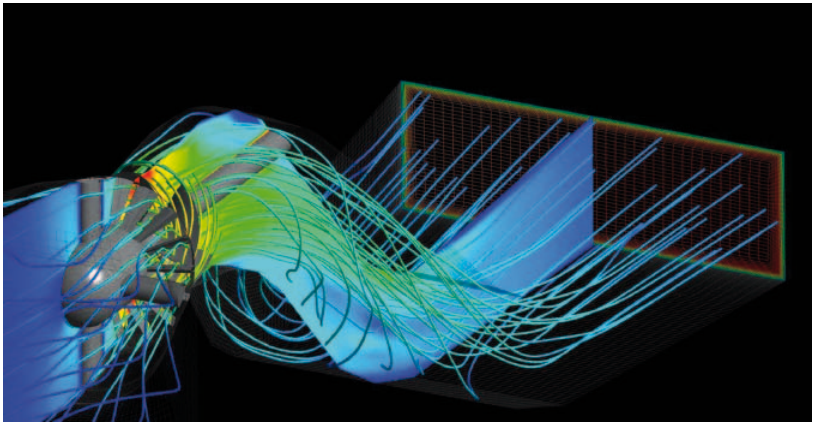
- New renewable energy
  - *Ocean current turbines*
  - *Wave power energy generation*
  - *Kinetic turbines*

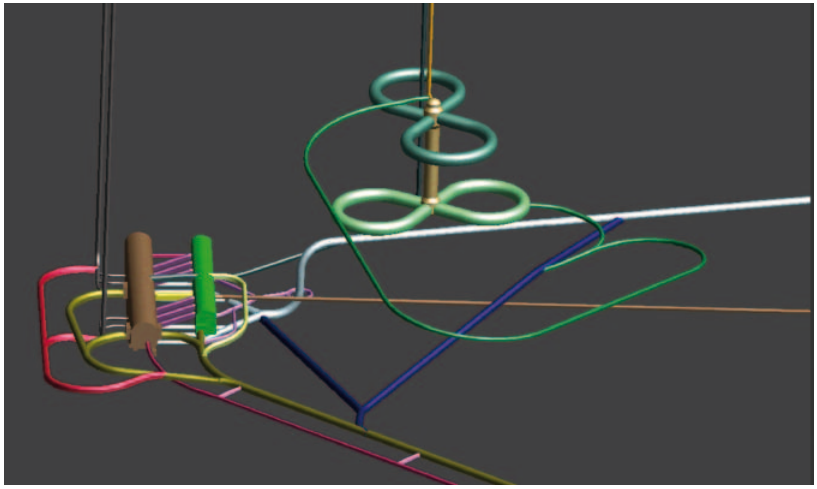
- Fluid Dynamics
  - *Numerical flow field simulation*
  - *Cavitation*
  - *Optimization algorithms*
  - *Two – phase flows*
  - *Experimental investigations*

Investigation of cavitating flow around airfoil

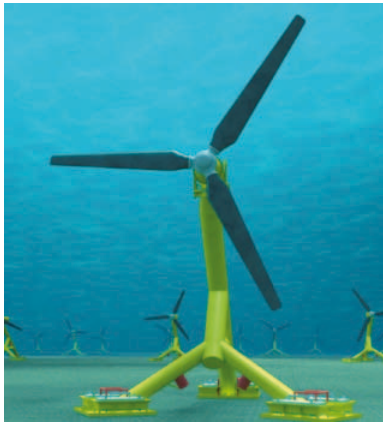


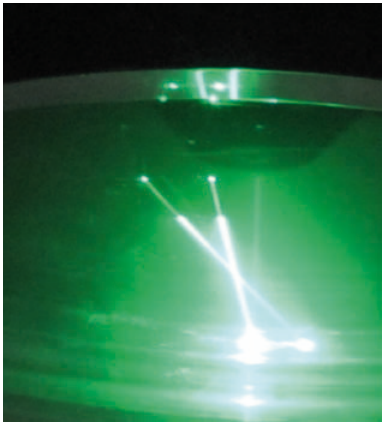
Design and optimization of bulb turbine





Optimization of main water passageway of large pump-storage plant





Development of ocean current turbines

Laser measurements of flow in model turbine

Water Research Center Stuttgart and Education...

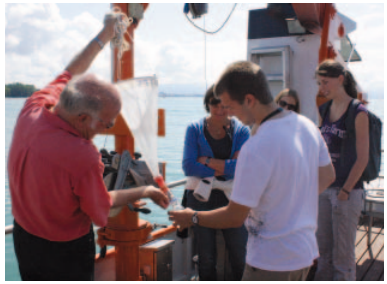
Education of future engineers is a central subject of the University of Stuttgart and the institutions of the Water Research Center.
The wfz partners are involved in international Master Programs, such as

WAREM
(Water Resources Engineering and Management)

WASTE
(Air Quality Control, Solid Waste and Waste Water Process Engineering)

or in the Doctoral Program

ENWAT
(Environment Water)



International M.Sc. Program Water Resources Engineering and Management (WAREM)

- Water Resources Engineering and Management (WAREM) is a two-year Master of Science program beginning in the winter semester of each year. The program consists of three in-class semesters and a fourth semester designated for research and thesis work.

- WAREM is dealing with water in all utilizations, including its protection and management. The three main areas of the program are:
  - *Groundwater Resources Management and Geohydrology*
  - *Hydraulic Engineering and River Basin Management*
  - *Sanitary Engineering and Water Quality Management*

- The ideal candidate for WAREM has an educational background in water related topics, preferably with an emphasis on engineering.

- WAREM offers options for a Master's Thesis in Industry/ Water management institutions, and studying in double degree programs with the University Chalmers (Sweden) or the University MARA in Kuala Lumpur (Malaysia).

- WAREM is a consecutive program linked with the doctoral program ENWAT. It is highly flexible with options for deepening the knowledge in many areas: more than 80 courses are offered.

WAREM
Water Resources Engineering and Management

Contact:
warem@iws.uni-stuttgart.de
www.warem.uni-stuttgart.de

International students during the Great WAREM Excursion, offered each year as standard element of the study program

Quelle: WAREM, Uni Stuttgart


PUMPSPEICHERWERK GOLDISTHAL –
IM EINKLANG MIT DER UMWELT

International M.Sc. Program Air Quality Control, Solid Waste and Waste Water Process Engineering (WASTE)

- WASTE is dealing with environmental protection engineering with special focus on:
  - *air pollution control,*
  - *solid waste and*
  - *waste water technology*
- Ideal candidates have an educational background in Chemical, Civil, Environmental, Mechanical, or Process Engineering or a related field
- WASTE is a two-year Master of Science program beginning in the winter semester of each year. The program consists of three in-class semesters and a fourth semester designated for research and thesis work.
- Options for Master Thesis in Industry/Water management institutions, consecutive program linked with doctoral program ENWAT, flexible program with many electives

Contact
info@waste.uni-stuttgart.de
www.waste.uni-stuttgart.de

Solid waste management

Thermal waste treatment plant, air quality control

Industrial waste water plant in automotive industry

International Doctoral Program Environment Water (ENWAT)

- Hydrology, Water Resources Management, Hydraulic Engineering, Modeling of Hydrosystems, Sanitary Engineering, Water Recycling, Hydrochemistry and -biology, Waste Management, Regional Development Planning, Landscape Planning, Geotechnical Engineering

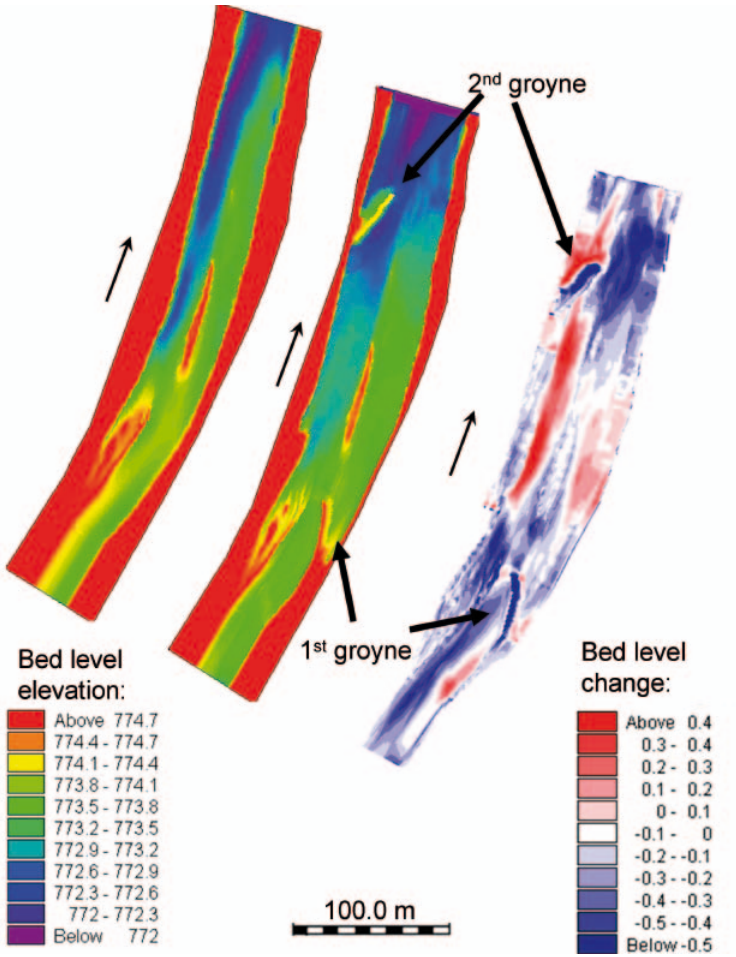
- Required background: MSc. degree in fields related to "Environment Water" or Dipl.-Ing. in Civil or Environmental Engineering

- three year doctoral program with two parts:
  1. before qualifying exam: courses 9-12 ECTS determined in a study plan (3-5 courses) should aid in preparation for research
  2. after qualifying exam: research and doctoral thesis

- program in English, doctoral seminars twice a year to discuss the progress of students individual research. Special seminars by professors from all over the world

Contact:
enwat@f02.uni-stuttgart.de
www.enwat.uni-stuttgart.de/

ENWAT
International Doctoral Program
Environment Water



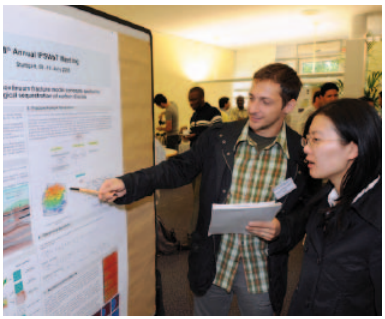
Numerical Simulation of morphologic river bed development after implementation of restoration measures

Cooperation in Master Programs

- Possibility for student´s exchange either for study courses or Master´s Thesis
- Double or Joint degree between the WAREM and WASTE programs of the University of Stuttgart and other universities could be possible

Joint PhD Programs with other universities?

- Exchange of PhD students (double or co-advisorship)
  - *Research on a complementary topic in a group of at least two PhD students*
  - *Each student advised by two professors*
  - *Twinning between University of Stuttgart and international university*
  - *Exchange of PhD students for at least one year to the twin partner university*
  - *Offering common summer schools, workshops or courses for PhD students in Stuttgart and abroad*
  - *Common publications (PhD student together with both advisors)*
  - *PhD exam at resp. home university together with the twin partner (double or joint doctoral degree has to be checked legally)*



International students in Stuttgart funded by the German scholarship program "International Postgraduate Studies in Water Technologies" (IPSWAT)

Quelle: IPSWAT, BMBF

DAAD Deutscher Akademischer Austausch Dienst
German Academic Exchange Service

FICHTNER WATER & TRANSPORTATION

BOSCH

SIEMENS

VOITH

bfg Bundesanstalt für Gewässerkunde

BAW Bundesanstalt für Wasserbau
Kompetenz für die Wasserstraßen

FESTO

BWV

mall umweltsysteme

DFG Deutsche Forschungsgemeinschaft

WEHRLE Umwelt GmbH

Fraunhofer

ZÜBLIN

LAHMEYER INTERNATIONAL

ADIRO

ITT

Bundesministerium für Verkehr, Bau und Stadtentwicklung

Zweckverband Landeswasserversorgung

EnBW

SINTEF

imagination at work

Endress+Hauser

ANDRITZ