

IWAS – Q1
Szenarien- und Systemanalyse
Statusbericht
06.12.2012
Magdeburg

IWAS@AGU

Greetings from the Annual Fall Meeting of the American Geophysical Union

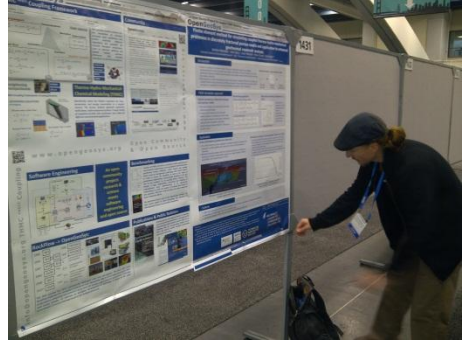
IWAS Q1: Szenarien und Systemanalyse
Olaf Kolditz, Christian Benhmer, Lars Bilke, Frank Blumensaat, Norbert Böttcher, Cornelia Burmeister, Jens-Olaf Delfs, Thomas Fischer, Tatjana Diniz Gonçalves, Agnes Gröbe, Thomas Kalbacher, Peter Krebs, Rudolf Liedl, Dirk Pevik, Karsten Rink, Jochen Schanze, Dennis Söhn, Johanna Trömpel, Marc Walker, Holger Weis

Motivation
Numerical modeling of interacting flow and transport processes between different hydrological compartments, such as the atmosphere/land surface/vegetation/aquifers/groundwater systems, is essential for understanding the complex water processes, especially if quantity and quality of water resources are in acute danger. In semi-arid areas and regions with environmental constraints, the computational models used for spatial and scenario analysis in the framework of an integrated water resources management are highly demanding. In particular, advances in computational mathematics have revolutionized the variety and the nature of the problems that can be addressed by environmental scientists and engineers. It is equally true that for many hydro compartments, there exist many numerical simulation codes, but traditionally their development has been isolated within the different disciplines. A new generation of coupled tools based on the profound scientific background is needed for integrated modeling of hydro systems. The objective of the IWAS toolbox is to develop innovative methods to couple and extend existing modeling software to address coupled processes in the hydrological models for the analysis of hydrological systems in a specific region. This involves, e.g. the provision of models for the prediction of water availability, water quality and/or the ecological situation under changing natural and socio-economic boundary conditions such as climate change, land use or population growth in the future.

Modelling Regions
CS has been working in all model IWBs regions including aspects of climate change, waste water treatment, groundwater and surface water management and development of future scenarios. The model scenarios are given in the left figure. As an example we show the hydrological model for the South-Wabian peninsula including the water flow from data acquisition (Figure below), groundwater recharge is extracted from both ground truth and satellite data. The large scale groundwater model is developed based on a large number of available wellbore data. With this model e.g. the long-term impact of groundwater abstraction can be simulated.

ToolBox and Workflows
Within the first project phase IWAS-1 the development of individual modules for hydrological compartments (Figure below) was on the basis of the available (Kalbacher et al. 2012; Blumensaat et al. 2012; Pevik et al. 2012). In the second project phase IWAS-2 comprehensive workflows have been established and applied to several model regions. A coupled model approach has been developed for the model region in the Elbe catchment. It combines the effects of climate and land use changes on the availability of surface and ground water resources and allows estimating water quality impacts on different temporal scales (Figure below). A second margin is dealing with water management particularly in arid areas in order to optimize water use for agriculture e.g. in the Oman (Jorandani et al. 2012; Weis et al. 2012).

Outreach: IWAS Topical Issue
Interdisciplinary and applied research in water resources management is promoted by the International Earth Sciences Journal (IWSJ) including calls for corresponding topical issues, e.g. IWAS and Catchment Research. Other outreach concepts include scientific visualization and using Internet platforms such as YouTube (<http://www.youtube.com/user/IWASonline>) and OpenStax (<http://www.openstax.org>).



AGU FALL MEETING

San Francisco | 3-7 December 2012

IWAS Q1: Szenarien- und Systemanalyse

Q1 Projekt-Struktur:

↳ Verknüpfungen: Q1#R

Q1 Schwerpunkte in IWAS I und IWAS II:

↳ “From Modules to Work Flows”

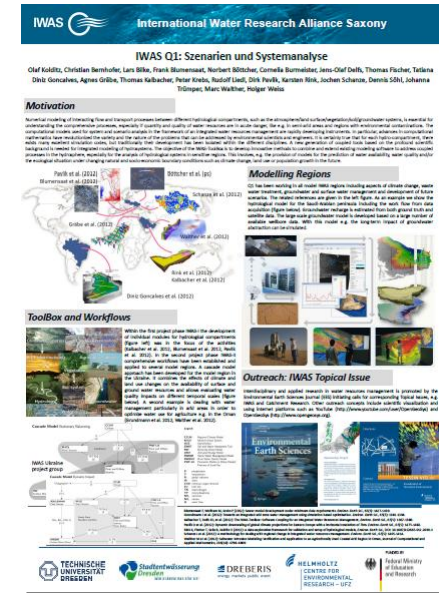
Q1 Beispiele:

↳ Highlights, Umsetzung der Work Flows in R1, R2A

Q1 Outreach:

↳ Visualisierung des IWAS Saudi Arabien Modells

Q1 Poster Session und Workshop



IWAS Q1: Projekt-Struktur & Akteure

MOD1#R1: (Frank Blumensaat, Peter Krebs)

Urbane Hydrology (Ukraine) [-> [R1 Vortrag Thomas Berendonk](#)]

MOD2#R1: (Dirk Pavlik, Dennis Söhl, Christian Bernhofer)

Regionale Klimamodellierung (Ukraine) [-> [Q1#R1 Vortrag Christian Bernhofer](#)]

MOD3#R2: (Marc Walther, Rudolf Liedl, Agnes Gräbe, Tino Rödiger, Christian Siebert, Thomas Kalbacher, Olaf Kolditz) [-> [R2 Vortrag Rudolf Liedl](#)]

Wasser Ressourcen (A: Oman, B: Saudia Arabia, C: Middle East)

MOD5#R3: (Agnes Gräbe, Tatiana Diniz Goncalves, Holger Weiss, Olaf Kolditz)

Wasser Ressourcen (Brasilia) [-> [R3 Vortrag Carsten Lorz](#)]

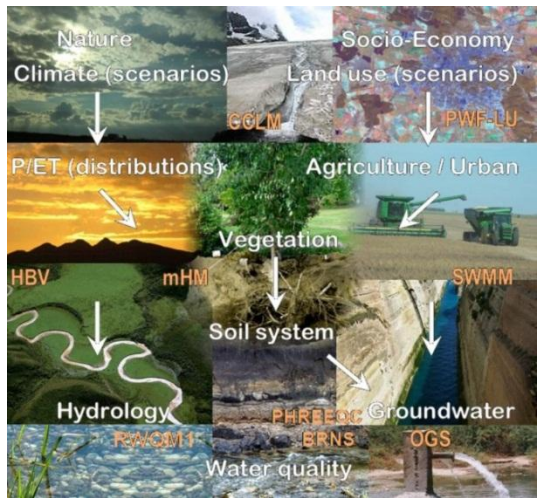
MOD6#R123: (Thomas Kalbacher, Jens-Olaf Delfs, Florin Radu, Norbert Böttcher, Karsten Rink, Thomas Fischer, Carolin Helbig, Olaf Kolditz)

IWAS ToolBox: Work Flows: Data Integration – Simulation - Visualization

MOD7#R1: (Cornelia Burmeister, Johanna Trümper, Jochen Schanze)

Szenarien des regionalen Wandels

IWAS Q1 Konzept: From Modules to Work Flows



The IWAS-ToolBox: Software coupling for an integrated water resources management

Thomas Kalbacher · Jean-François Delle · Hailong Shi · Weiqing Wang · Marc Walthert · Luis Samaniego · Christoph Schneider · Holger Bauer · Andreas Hinkel · Florian Ceder · Fug Sun · Ake Hildbrandt · Rudolf Liedl · Dietrich Bechtold · Peter Koehn · Ulf Gburek

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Abstract Numerical modeling of interacting flow and transport processes between different hydrological compartments, such as the atmosphere/land/surface/vegetation/soil/groundwater system, is essential for understanding the comprehensive processes, especially of quantity and quality of water resources in its wide range, like e.g. in semi-arid areas and regions with environmental constraints. The computational models used for system and scenario analysis in the framework of an integrated water resources management are rapidly developing instruments. In particular, advances in computational mathematics have revolutionized the variety and the nature of the problems that can be addressed by environmental scientists and engineers. It is certainly true that for each hydro-compartment, there exist many excellent simulation codes, but traditionally their development has been isolated within the different disciplines. A new generation of coupled models based on the profound scientific background is needed for integrated modeling of hydro-systems. The objective of the IWAS-ToolBox is to develop innovative methods to combine and extend existing modeling software to address coupled processes in the hydro-system, especially for the analysis of hydrological systems in sensitive regions. This

Keywords Coupling · Modeling · Surface-subsurface · Soil-root water flow · Reactive transport · Density-dependent flow

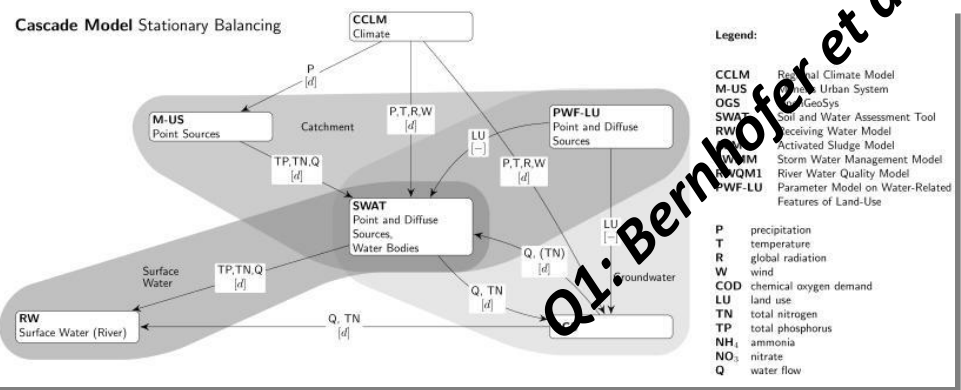
Introduction

One possibility for an integrated hydro-system modeling is the compartment approach, which distinguishes between the different hydrological compartments. The computation of the individual processes in each compartment may require very different temporal and spatial discretization, using different geometric models and different numerical methods (finite differences, finite elements and finite volumes) and the central question arising is the method of coupling compartments and processes. Many individual simulation tools, which have been mainly developed for more specialized purposes, already exist for each hydro-compartment and the fundamental idea of the IWAS-ToolBox is to select and combine such existing modeling software to address coupled processes in the hydro-system.

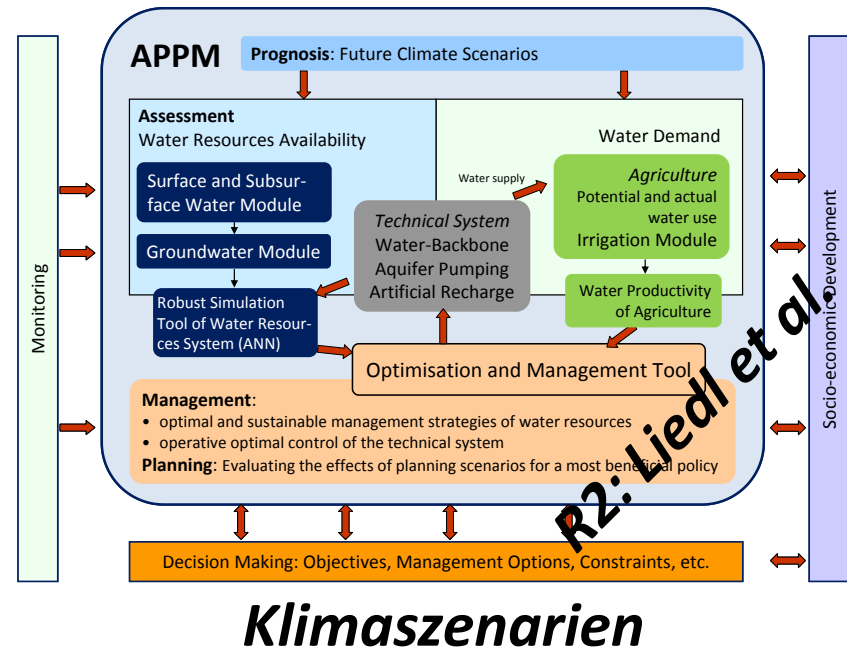
The hydro-systems addressed in this paper can be roughly subdivided into compartments of surface water, soil and aquifer (Fig. 1). The corresponding hydrological processes are flow in lakes, rivers and surface runoff; infiltration flow in soils and groundwater flow in porous media. In addition, the water may transport natural anthropogenic and non-transportive components and interacts with the atmosphere as well as the biosphere.

IWAS-II Work Flows and Applications:

- R1: Modell-Kaskade: Urbane Systeme
- R2: APPM: Landwirtschaftliche Systeme



IWAS-I ToolBox: (Weiter)Entwicklung von Modulen für einzelne Kompartimente und softwaretechnische Lösungen für die Kopplung (z.B. OGS#SWMM)



IWAS Q1 Konzept: Parameterisierte Zukünfte

Methodik zur Generierung ganzheitlicher IWRM Szenarien

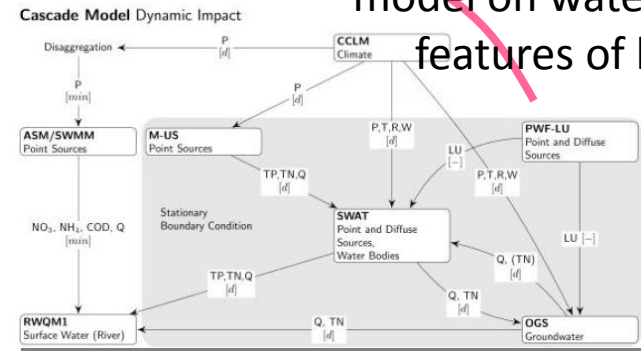
PWF-LU (Parameter model on water-related features of land use)

Aufgabenstellung: Funktionen der Zukünfte

Strategische Planung von Akteuren

1. Abgrenzen und Beschreiben des Systems
2. Gekoppelte Modellierung zur Systemsimulation
3. Formulieren und Parametrisieren von Szenarien und Handlungsalternativen
4. Komposition von Zukünften
5. Ex ante-Analyse und Bewertung der Zukünfte

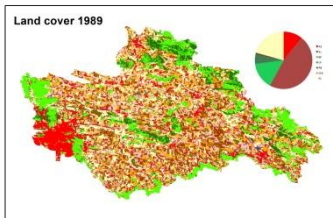
Transfer: Verwendung der Zukünfte



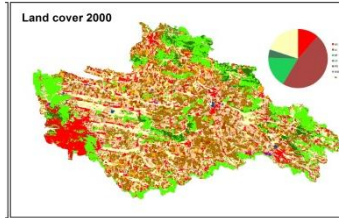
Regionaler Wandel Gesellschaftlicher Wandel -> Landnutzungsszenarien

Konzeptioneller Ansatz erlaubt eine umfassende Parametrisierung von grundlegenden Storylines für die gekoppelte Wasser- und Stoffhaushaltsmodellierung [IPCC-Szenarien A1, A2, B1 und B2]

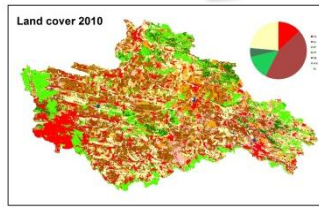
Für Landnutzungswandel wurde ein Modell zur Projektion von wasserhaushaltlich relevanten Landnutzungsparametern konzipiert und programmtechnisch umgesetzt



Accuracy 84,5 %, Kappa 0,8



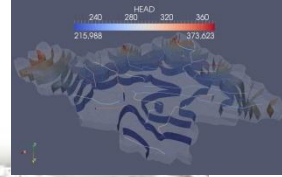
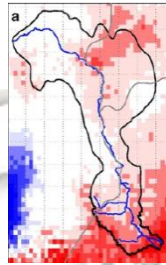
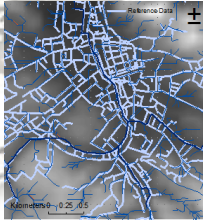
Accuracy 92,1 %, Kappa 0,89



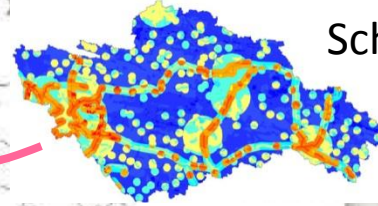
Accuracy 92,6 %, Kappa 0,89

Auf Basis von Langzeit-Landsat-Daten eine Methodik zur Differenzierung von städtischen / landlichen Gebieten, CORINE Klassifikation für Ukraine.

Pavlik et al. (2012)
Blumensaat et al. (2012)

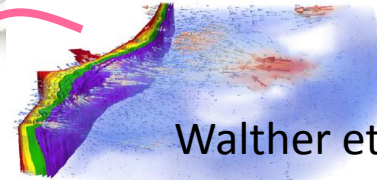
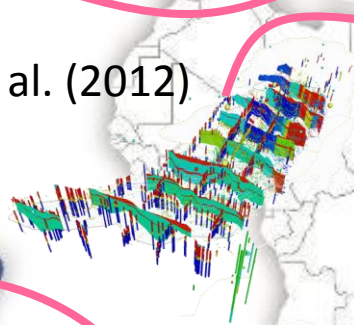


Böttcher et al. (pc)

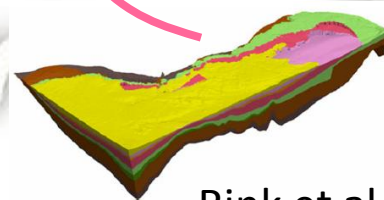


Schanze et al. (2012)

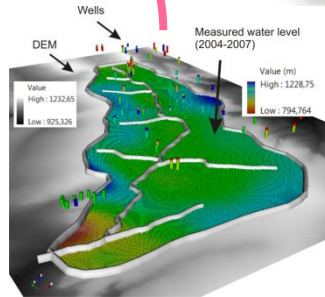
Gräbe et al. (2012)



Walther et al. (2012)
Grundmann et al. (2012)



Rink et al. (2012)
Kalbacher et al. (2012)



Diniz Goncalves et al. (2012)

Konkrete Empfehlungen für die Planung wasser-technischer Anlage und die Wasserbewirtschaftung auf der Basis von **Szenarien** mit Hilfe von **Simulationen**

Q1 Beispiele (Poster session):

- Q1#R1: Klima -> Wasserdargebot -> Urbane Hydrologie
- Q1#R2A: Klima -> landwirtsch. Wasserbewirtschaftung
- Q1#R2B: Klima -> Grundwasserbewirtschaftung
- Q1#R2C: Klima -> Grundwasserbewirtschaftung
- Q1#R3: Demografischer Wandel -> Grundwasser

IWAS International Water Research Alliance Saxony

IWAS Q1: Szenarien und Systemanalyse

Claf Kolditz, Christian Bernhofer, Lars Bika, Frank Bismarck, Norbert Böhm, Camilla Bormann, Jens Claf Oelß, Thomas Fischer, Yelena Dieß, Gudrun Heß, Agnes Oelß, Thomas Kalkbrenner, Peter Kalkbrenner, Rudolf Jank, Dirk Poth, Kerstin Röß, Ineschen Schöler, Dennis Sill, Johannes Timpel, Marc Wäldner, Holger Wöls

Motivation

Forecasting of changing flow and transport between different hydrological compartments, such as the atmosphere, the surface hydrological system, is essential for understanding the environmental system, especially in terms of water resources and water quality. For a given catchment area, hydrological environmental consequences, the environmental system can be described by the hydrological cycle. However, the hydrological cycle is a complex system, which is not fully understood. The hydrological cycle is a complex system, which is not fully understood. The hydrological cycle is a complex system, which is not fully understood.

Modelling Regions

On the one hand, it is essential to model the hydrological cycle in order to assess the environmental consequences of climate change, water resources, groundwater and surface water management and development of these systems. The model results are given in the form of maps. As an example we show the hydrological cycle for the catchment area of the city of Dresden. The hydrological cycle is a complex system, which is not fully understood.

ToolBox and Workflows

The tool box consists of the software packages, which are used for the hydrological modelling. The tool box consists of the software packages, which are used for the hydrological modelling.

Outreach: IWAS Topical Issue

The IWAS Topical Issue is a collection of papers, which are published in the journal of Hydrological Sciences. The IWAS Topical Issue is a collection of papers, which are published in the journal of Hydrological Sciences.

Environmental Earth Sciences

The Environmental Earth Sciences is a journal, which publishes research results in the field of hydrology and water resources. The Environmental Earth Sciences is a journal, which publishes research results in the field of hydrology and water resources.

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IWAS International Water Research Alliance Saxony

IWAS Q1#R3: Groundwater Flow Model of the Piripuu Watershed, Federal District of Brazil

Tatiana Diniz Gonçalves, Agnes Oelß, Thomas Fischer, Claf Oelß, Holger Wöls

Motivation

In order to understand the groundwater dynamics and to improve the management of water resources in the Federal District of Brazil, this study proposes a 3D groundwater model representing the groundwater level and flow system. The selected field site was the Piripuu watershed. The development of the model was based on existing geological, hydrological, geomorphological, climatological and hydrological data. Geological and hydrological data were used to generate the 3D groundwater flow model. The 3D model element of the domain was generated by Groundwater Modelling System (GMS) software, based on the top of the water table, and the simulation of the flow behavior was implemented in the framework of the scientific software OpenGeoSys (OGS). With the 3D mesh approximated boundary conditions, average infiltration data and hydrological parameters were incorporated. Moreover, the steady state model was calibrated using available data of the water level from wells into GMS software. The results showed the distribution of the groundwater table in the model domain, where the highest values occurred in the west and lowest values were found in the southeast of the basin.

Study Site and Hydrogeology

Piripuu watershed is located in the Brazilian Central Plateau. In the region of Piripuu, structural domains delineated by gentle NW-SE of the basin and dip gradient of 0.8%. The highest elevation (2,220 m) is located in the northwestern corner of the area, while the lowest point is in south-eastern border (elevation of 893 m). It covers an area of approximately 120 km², mostly located in the 12° 30'N of the latitude through its main spring is located in Gole do Forno (Fig. 1, left). The study area is centered at 17° 27' 30" South latitude and 47° 27' 30" West longitude and covers an area of 24 km x 24 km.

Data and Model Set-Up

A comprehensive data set was collected and integrated into this study containing information about:

- Climate strong seasonality, but dry season (about 80% of annual rainfall, between October and April) and cool and dry season from May to September; average annual precipitation is 1,500 mm
- Geology: Piripuu watershed is bounded on the northeast and southwest by faults from Foz de Iguaçu, which put laterally the Paraná Group on the Eastern Opará (Fig. 2).
- Hydrogeology: Carman and Farias-Oliveira (2006) classified the potential of groundwater resources of the Piripuu basin as: (1) High (Aquifers and fractured Lower Aquifers) (Fig. 3).

Methodology and Results

Based on the available hydrological and hydrogeological data, a numerical model was developed and the model results have been compared with the available data. A number of groundwater wells was available for model validation, a corresponding groundwater contour map has been generated. In addition, the hydrogeological model-making the tool available for future water resource management purposes. The hydrological model-making the tool available for future water resource management purposes. The hydrological model-making the tool available for future water resource management purposes.

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IWAS International Water Research Alliance Saxony

Scarce water resources and scarce data: Estimating recharge for a complex 3D groundwater flow model in arid regions

Agnes Oelß, Yossi Guterman, Yosi Ridiger, Claf Oelß

Motivation

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You Tube

OpenGeoSys hat ein Video hochgeladen vor 12 Stunden

Angeesehen 14 Aufrufe

IWAS - Saudi Arabia
IWAS Modellregion Saudi-Arabien
http://www.iwas-initiative.de

OpenGeoSys hat ein Video hochgeladen vor 2 Monaten

Angeesehen 95 Aufrufe

3D Groundwater Model: Western Dead Sea
Development of a 3D groundwater flow model of the western Dead Sea as escarpment of the Dead Sea (Israel - West Bank), using the

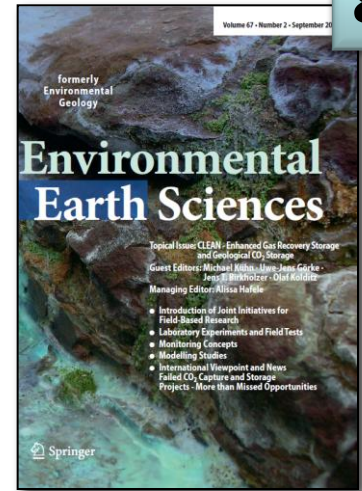
OpenGeoSys hat ein Video hochgeladen vor 8 Monaten

Angeesehen 392 Aufrufe

Water Challenge Beijing
Water Resources Management in Mega-Cities: Water Challenge Beijing

IWAS Q1 Outreach: Wiss. Publikationen

- Blumensaat F et al. (2012): Sewer model development under minimum data requirements. *Environ. Earth Sci.*, 65(5),
- Delfs JO et al. (2012): Coupling hydrogeological with surface runoff model in a Poltva case study in Western Ukraine. *Environ. Earth Sci.*, 65(5): 1439-1457.
- Delfs JO et al. (2012): Coupling two-phase subsurface flow with overland flow to assess the impact of the gas phase on surface runoff. *Environ. Earth Sci.*, submitted.
- Grundmann et al. (2012): Towards an integrated arid zone water management using simulation based optimisation. *Environ. Earth Sci.*, 65(5)
- Gräbe A et al. (2012): Numerical analysis of the groundwater regime in the Western Dead Sea Escarpment. *Environ. Earth Sci.*, 69(2), DOI: 10.1007/s12665-012-1795-8.
- Helbig C et al. (2012): iEMSs
- Kalbacher T et al. (2012): The IWAS-ToolBox: Software Coupling for an Integrated Water Resources Management, *Environ. Earth Sci.*, 65(5): 1367-1380
- Kalbus E et al. (2012): IWAS - Integrated Water Resources Management under different hydrological, climatic and socio-economic conditions, *Environ. Earth Sci.*, 65(5): 1363-1366.
- Kolditz O et al. (2012): International viewpoint and news: Data and modelling platforms in environmental Earth sciences. *Environ. Earth Sci.*, 66:1279–1284
- Pavlik D et al. (2012): Dynamic downscaling of global climate projections for Eastern Europe with a horizontal resolution of 7km. *Environ. Earth Sci.*, 65(5).
- Rink K et al. (2012): Visual data management for hydrological analysis. *Environ. Earth Sci.*, 65(5): 1395-1403
- Rink K et al. (2012): A Data Exploration Framework for Validation and Setup of Hydrological Models, *Environ. Earth Sci.*, 69(2), DOI: 10.1007/s12665-012-2030-3.
- Schanze J et al. (2012): A methodology for dealing with regional change in integrated water resources management. *Environ. Earth Sci.*, 65(5)
- Schütze N et al. (2012): Optimal planning and operation of irrigation systems under water resource constraints in Oman considering climatic uncertainty. *Environ. Earth Sci.*, 65(5).
- Walther M et al. (2012): Saltwater Intrusion Modeling: Verification and Application to an Agriculturally Used Coastal Arid Region in Oman, *Journal of Computational and Applied Mathematics*, 236(18): 4798–4809

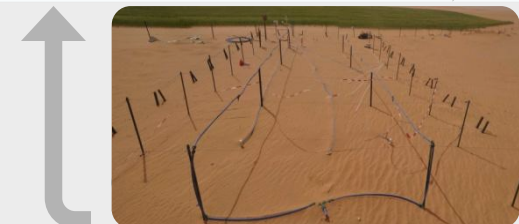
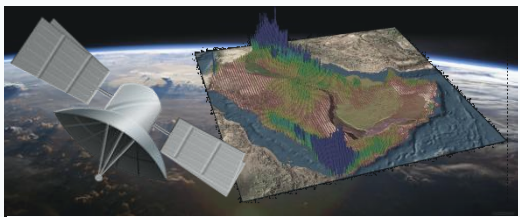


EES Topical Issues:

- **IWAS (67/2)**
- **Catchment research (69/2)**
- **IWAS II***



IWAS Q1 Outlook: Datenintegration Bsp. Saudi-Arabien



OpenGeoSys Data Explorer - 5.0.0(XR/TF/AB) - FirstFloor

Stations: Show all stations

Station Name	x	y
Boreholes		
Udayah-1	60397.	24727.
Wa-1007	77124.	22708.
Wa-627	88931.	28648.
WuTad-WW1	11145.	26368.
WuTad-WW2	11184.	26368.
WW1-4	82973.	23877.
Zaynan	10244.	22937.
4-NE-49	64504.	31194.
4-5-100	87907.	27862.
4-5-104	93827.	26468.
4-5-105	88333.	25040.
4-5-106	77536.	23399.
4-5-73	88506.	28722.
4-5-75	88666.	30942.
4-5-80	80504.	30563.
4-5-81	70839.	30648.
4-5-82	78426.	29897.
4-5-86	80461.	30790.
4-5-91	95790.	24954.
4-5-93	99167.	25940.
4-5-99	83750.	23803.
6.2-A	92803.	21522.
7-5-21	99395.	20518.
7-5-50	72405.	20249.

Borehole 4-S-80
Depth: 633.4

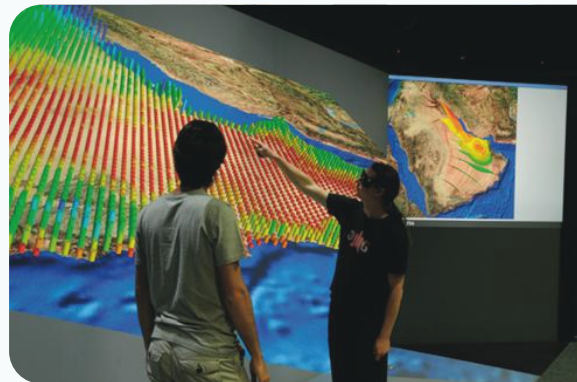
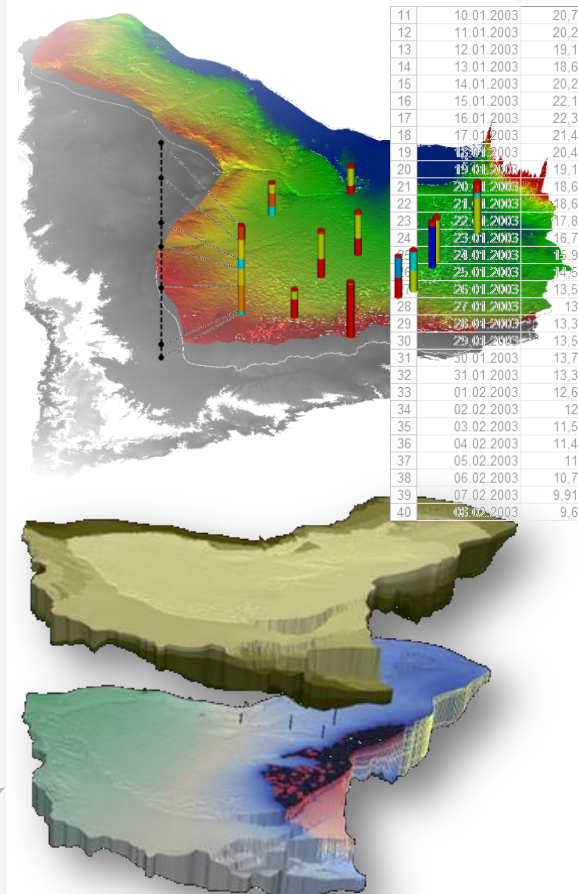
Observation Station

Time: 01.01.2002 20.02.2002 11.04.2002 31.05.2002 20.07.2002 08.09.2002 28.10.2002 17.12.2002 05.02.2003

Y-axis: 0, 2, 4, 6, 8, 10, 12, 14

Legend: Ground Water Level Station

OpenGeoSys.org

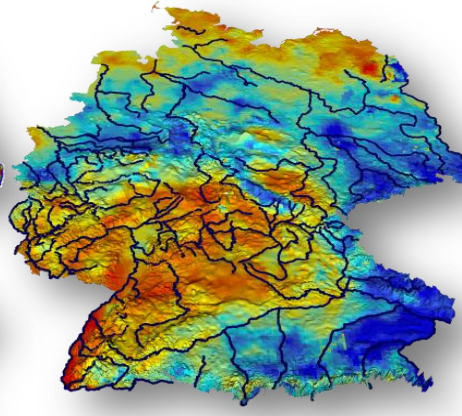
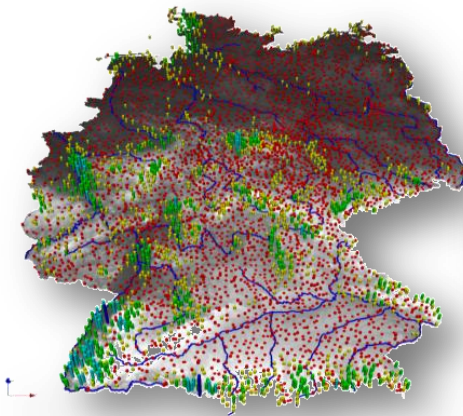
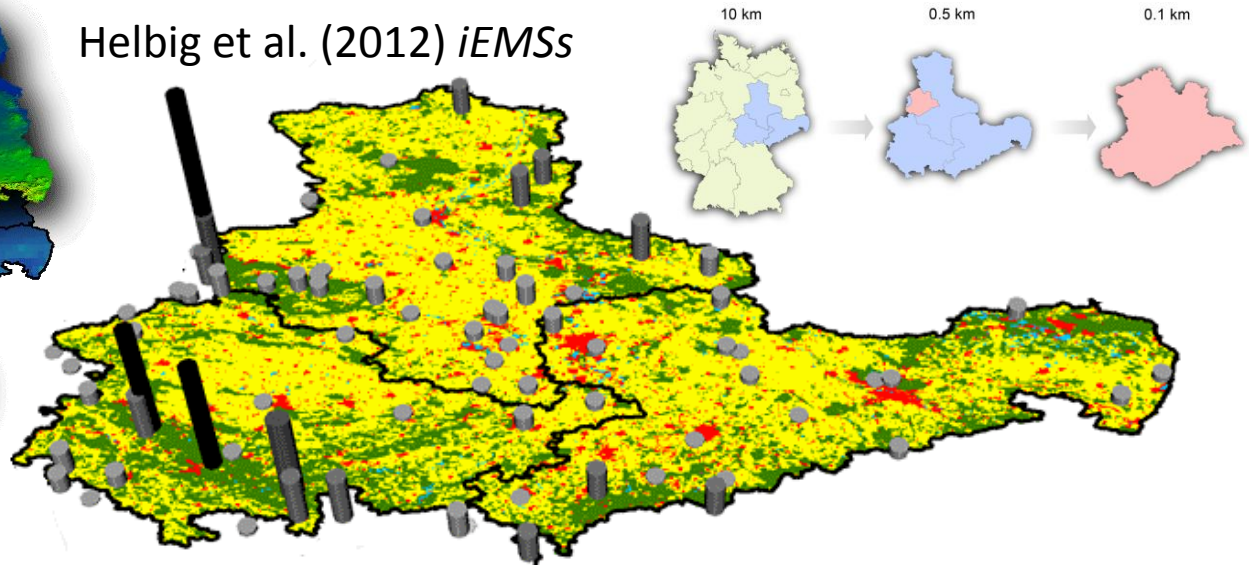
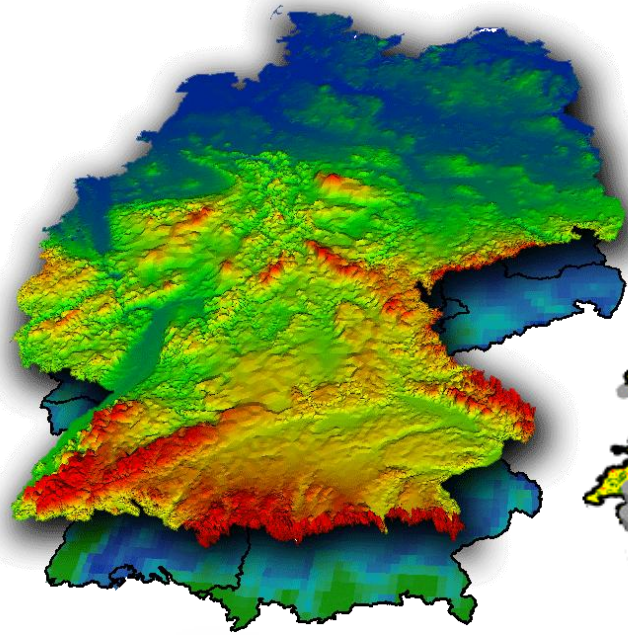


IWAS Q1 Outlook: Datenintegration (Klima, Wasser, Landnutzung, ...)

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(Bsp. TERENO -> Übertragung auf IWAS#R1)

Helbig et al. (2012) *iEMSs*



Szenarien- und Systemanalyse:

- Klimadaten und-projektionen
- Hydrologie: Bodenfeuchte
- Landnutzungsszenarien
- Demographische Daten
- Administrative Skalen: Bund, Land, Kommune, Einzugsgebiete

Anschlussfähigkeit von IWAS

Übertragbarkeit der Methodik auf andere Regionen

YouTube

IWAS - Saudi Arabien

OpenGeoSys Abonnieren 3 Videos



IWAS Modellregion Saudi-Arabien

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<http://www.iwas-initiative.de>

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95 Aufrufe
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OpenGeoSys hat ein Video hochgeladen vor 8 Monaten

Water Challenge Beijing
392 Aufrufe
Water Resources Management in Mega-Cities: Water Challenge Beijing