

Annual Report 2009

Hydrology and Water Resources Core

Head of Core: Prof. Stefan Uhlenbrook, PhD, MSc, habil.

1 Core staff as of 31 December 2009

Position	Name	Appointment (fte)	Research input (fte)	Remarks
Professor	Stefan Uhlenbrook	1.0	0.4	0.8 FTE since November 2009 (0.2 FTE at TU Delft)
Associate Professors	Dr. Pieter de Laat	0.4	0.0	Retired in April 2009
	Dr. Jan Nonner	1.0	0.1	
	Dr. Yangxiao Zhou	1.0	0.1	
	Dr. Jan Willem Foppen	1.0	0.4	
	Dr. Michael McClain	0.3	0.1	Part-time since June 2009
Senior Lecturers	Dr. Raymond Venneker	1.0	0.4	
	Dr. Shreedhar Maskey	1.0	0.4	Staff exchange with TU Delft
	Dr. Thom Bogaard	0.2	0.1	
Lecturer	Dr. Jochen Wenninger	1.0	0.4	
AIO	-	-	-	All PhD researchers are on fellowship basis
TOTAL		7.7	2.3	

2 Research and educational profile

2.1 Research lines

- **Impact of global changes on hydrological processes**

The interactions between the hydrological cycle and the climate system are crucial for the hydrological response of a catchment, as the climate systems define the forcing variables (energy and water input) of the hydrological system. Beside climate change other changes impact the hydrology, for instance, land cover and land use, population (amount, density, age structure etc.), water use etc. There are many feedback mechanisms (e.g. through climate induced land use changes) involved, which are not fully understood. One major challenge that hydrology currently faces is to predict the impact of global changes on hydrological processes and water cycle dynamics. This implies the impact on spatio-temporal variable distributions of both water quantity and water quality.

Fundamental and applied research has to be carried out in this field. The HWR core concentrates on (i) the land surface processes at local and catchment scale (e.g. interception, evaporation and infiltration), (ii) the (re-) distribution of subsurface water, including soil moisture and groundwater, and (iii) hydrological extremes (i.e. floods and droughts). Experimental process studies are carried out (combined hydrometric, geophysical and tracer studies) and process-based models are further developed and applied at various scales (from plot scale to larger river basin scale) and in different hydro-climatic regions. A particular challenge is the up-scaling of local process understanding and the incorporation of these findings into large scale hydrological models to quantify the impact of changes.

- **Physical and biogeochemical processes of groundwater systems**

Another major challenge that hydrology currently faces is to connect the knowledge of quantitative groundwater hydrology, i.e. groundwater dynamics, flow pathways, residence times and mixing of different water compartments etc., with water quality. The HWR core group concentrates in this research line, on the one hand, on the fate and transport of contaminants in hydrogeological systems. Therefore, a good understanding of the water flow and contaminants transport processes is needed. Of particular interest is currently the transport of bio-colloids (i.e. viruses, bacteria, DNA) in the subsurface and its dominating controls (e.g. surface characteristics of bacteria). On the other hand, the state of the groundwater system including the physical properties of aquifers will be investigated, with particular emphasis on observations and monitoring networks.

2.2 Educational programme/specialisation for which the Core is responsible

- MSc Programme of Water Science and Engineering
 - Hydrology and Water Resources specialisation

3 Major achievements

3.1 Research

- 1 PhD researcher graduated (ML Mul, co-promoted with prof Savenije, MAI department) and 6 new PhD researchers have started in 2009.
- 14 publications in A-category journals (according to SENSE criteria) were published in 2009 and even more were submitted or are currently in press.
- 26 papers in journals and 56 publications in total (incl. books, book chapters, conference papers, professional publications etc.) were published in 2009.
- New core-led research projects were approved (i.e. CHE, AGLOCAP, UWIRA, MARAFLOWS, PRoACC and Ecohydrology Erdos China) and set the basis for exciting research in the coming years

3.2 Education

- Graduation of 8 MSc students in the specialisation Hydrology and Water Resources.
- Contribution to the supervision of many other MSc students in other programmes.

3.3 Advisory/Capacity building projects

- Start of the the EEC funded project on capacity building in water programs in higher education in the Caribbean region. The project involving multi-disciplinary staff of UNESCO-IHE started in January 2009 (Nonner, Brandimarte, Sharma, Ploeger, Noorman, Darvis, Kruis)
- Successfully completed the project on the satellite-based water monitoring and flow forecasting system for the Yellow River Basin, China. At the evaluation workshop in March 2009 the results were presented to the YRCC, the Ministry of Water Resources and representatives from other river basins and academia. (Venneker, Maskey)

3.4 Society

- Core members are active members of a number of professional organisations such as IAHS, AGU, EGU, UNESCO-IHE, IFI, WMO-CHy etc.
 - Prof Uhlenbrook serves in a number international science steering committees and is member of the editorial boards of the following journals: Hydrology and Earth System Sciences (since November 2004), Hydrological Sciences Journal (since January 2006) and Hydrologie und Wasserbewirtschaftung (Hydrology and Water Management, in German; since 2008). In addition, he is the editor the volume no. 2 (Hydrology) of the five volumes reference work 'Treatise in Water Sciences', to be published by Elsevier in 2010 (chief editor: Peter Wilderer, TU Munich).
 - Dr. McClain serves on the steering committees of the Freshwater Program of Diversitas, the Global Environmental Flows Network, and the Water Footprint Network.
 - The staff members of the core contributed to the review of papers to a number of key water journals.
 - Half-page article in a German newspaper about prof. S. Uhlenbrook and his water research in developing countries.
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- **Miscellaneous**
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Research

4.1 Research projects initiated during 2009

- Start of implementation of PRoACC - Post-doctoral programme for research on Climate Change Adaptation with special emphasis on the Mekong River basin; 7-8 post-docs were selected and will start in April 2010. Cooperation with many partners in the Mekong countries including, AIT Bangkok, Hanoi WRU etc. (Uhlenbrook, Venneker)
- CHE - Conserving Hydrological and Ecological functions through payment for watershed services, with special reference to South-Central Bolivia; 1 PhD student will start in February 2010. Co-operation with Universiteit Amsterdam, Universidad Mayor de San Simón and Fundación Natura Bolivia (Uhlenbrook)
- UWIRA - Impact of untreated wastewater on natural water bodies: Integrated risk assessment Institute of Environmental and Water Studies at Birzeit University (Birzeit, Palestine), Water and Environmental Studies Institute at An-Najah National University (Nablus, Palestine) and the Palestinian Water Authority (Al-Bireh, Palestine) (Wenninger, Uhlenbrook)
- AGLOCAP - Adaptation to Global Change in Agricultural Practices, with a case study in a Himalayan River Basin in Nepal, in collaboration with Asian Institute of Technology, Thailand, and Depart of Irrigation, Nepal. Two PhD students (one each at UNESCO-IHE and AIT) and one MSc student (AIT) will start in 2010. (Maskey, Uhlenbrook)
- Participate in the project ACCION - Adaptation to Climate Change Impacts on the Nile River Basin; co-supervision on post-doc Dr. Semu Moges (led by Dr van Griensven, HIKM) (Uhlenbrook)
- SSI-2 - Upscaling small-scale land and water system innovations in dryland agro-ecosystems for sustainability and livelihood improvements, funded by DUPC (led by Dr. M.L. Mul, MAI department). Co-supervision of one PhD student and one post doc in collaboration with University of Dar Es Salaam in Tanzania (Foppen, Maskey, Uhlenbrook).
- MaraFlows - Environmental Flows for People and Ecosystems in the Mara River Basin, Kenya/Tanzania, funded by DUPC and USAID at total level of €638,338 over four years; project coordination and co-supervision of 2 PhD students (McClain, Uhlenbrook, O'Keefe); partnering with University of Dar Es Salaam (Tanzania) and Egerton University (Kenya).
- 2 new PhD students from the YRCC, China, started their research in March 2009 which is carried out in the framework of the RWS/YRCC/UNESCO-IHE cooperation agreement (Maskey, Venneker, Uhlenbrook)
- RISK-NAT (2009-2012) - Multi-disciplinary research on mass movement triggering and societal risk prevention; project hosted by TU Delft (Bogaard)
- SAFELAND - Living with Landslide Risks in Europe (FP7 program) ; project hosted by TU Delft (Bogaard, involved via CNRS France).
- Ecohydrology Erdos China - Project was approved by the Netherlands Asian Facility for China programme and the Chinese government. A research catchment will be instrumented to monitor the complete hydrological cycle and its interactions with ecosystems. Two sandwich PhD students with China University of Geosciences will carry out major part s of research activities. The results will provide scientific bases for sustainable water resources management and ecosystem projection in the Erdos plateau of China (Zhou, Wenninger).
- An inception workshop was held at China University of Geosciences to develop the research plan for the UPaRF III research project on allocation of groundwater to groundwater dependent ecosystems (GDE). Partners: China University of geosciences, Hohai University and Markerer University (Zhou).

4.2 On-going research projects/activities (indicating partners, budget and funding source)

- Blue Nile Hydrosolidarity project - In Search of Sustainable Catchments and Basin-wide Solidarities; Transboundary Water Management of the Blue Nile River Basin; funded by NWO-WOTRO and DUPC (led by Prof P van der Zaag, MAI department), co-supervision of 2 PhD students and 1 post-doc (Uhlenbrook, Wenninger)
- SCUSA - Integrated approaches and strategies to address the Sanitation Crisis in Unsewered Slum Areas in African mega-cities (SCUSA), led by Dr. JW Foppen; collaboration with Makerere University and the Kampala City Council in Uganda; supervision of one PhD student and overall project management (Foppen, Uhlenbrook)
- ECOLIVE - Ecology of Livelihoods, Nyando wetland, Kenya, funded by DUPC (led by Dr A van Dam, ER department), supervision of one PhD student (Wenninger, Uhlenbrook)
- **Error! Reference source not found.**; funded by Partners for Water and led by Royal Haskoning, The Netherlands; further partners are RHK-Vietnam, TU Delft, various Vietnamese authorities, co-supervision of one PhD student at TU Delft (Uhlenbrook, Nonner)
- RISKOMAN - Risk-based operational water management for the Incomati River Basin (RISKOMAN), funded by DUPC and led by Prof P. van der Zaag (MAI department); collaboration with Eduardo Mondlane University in Mozambique and Komati Basin Water Authority in Swaziland; co-supervision of MSc students (Uhlenbrook, Wenninger)

- ISOWUE - Experimental investigations of water fluxes within the soil-vegetation system using isotopes to improve water use efficiency, part of the IAEA's Coordinated Research Project (CRP): Quantification of Hydrological Fluxes in Irrigated Lands Using Isotopes for Improved Water Use Efficiency (Wenninger).
- EXACT - Small scale water treatment and artificial recharge project. Total budget: 2.3 million Euro (DUPC funded). Principal partners are the Ministry of Water and Irrigation of Jordan, the Palestinian Water Authority and the Israeli Water Authority (de Laat, Nonner, Petrushevski, Sharma, Krebab).

4.3 Other relevant research activities and participation in relevant events during 2009

- Y. Zhou edited a book on Groundwater monitoring and modelling and submitted to Chinese Science Publishing to be published in 2010. The book contains the results of a capacity building project on China Groundwater Information Centre. The project was finished by the end of 2008. (Zhou)
- S. Uhlenbrook is editor of the volume no. 2 (Hydrology) of the five volumes reference work 'Treatise in Water Sciences', to be published by Elsevier in 2010 (chief editor: Peter Wilderer, TU Munich). The volume no. 2 will consist of 25 chapters (30-40 pages each chapter) written by multiple authors; a significant part of the reviewing and editing process has been in 2009.

4.4 List of on-going and new PhD research projects

	PhD fellow, country	Promotor(s)	Supervisor(s)	Title research project	Start year	Proposal accepted	End year
1	H. Makurira, Zimbabwe	H.H.G. Savenije, S. Uhlenbrook	J. Rockstroem, A. Sezanje	Water productivity in rainfed agriculture: upgrading agricultural output in arid and semi arid tropics through smallholder water system innovations	2004	2005	2010
2	D. Love, Zimbabwe and UK	P. van der Zaag, S. Uhlenbrook	R. Owen, S. Twomlow	Integrated modelling of water resources in the Mwenezi and Mzingwane subcatchments, Limpopo river basin	2005	2005	2010
3	K. Kittiwet, Thailand	B. Schulz, S. Uhlenbrook	S. Suriyadi	Flood management and land use in the Chi River basin, Thailand	2005	2006	2010
4	I. Masih, Pakistan	S. Uhlenbrook	A. Mobin, V. Smaktin, S. Maskey,	Hydrology and water balance analysis for sustaining food security and environmental services in Karkheh River Basin, Iran	2006	2006	2010
5	C.L. Wong, Malaysia	S. Uhlenbrook	R. Venneker	Assessment and modelling of large-scale hydrological variability in Peninsular Malaysia	2006	2007	2011
6	G. Lutterodt, Ghana	S. Uhlenbrook	J.W. Foppen	Effects of surface characteristics of Escherichia coli on transport in saturated porous media	2007	2007	2011
7	B.A.M. Jamil, Malaysia	S. Uhlenbrook	R. Venneker	Modelling effects of land use changes on the hydrological regime in Peninsular Malaysia	2007	2007	2011
8	O. Munyaneza, Rwanda	S. Uhlenbrook	S. Maskey, J. Wenninger, Wali	Water resources assessment and prediction in the Rwandan catchments	2008	2009	2012
9	E. Teferi, Ethiopia	S. Uhlenbrook	Belay Simane, J. Wenninger	Past-present-future land use in the Blue Nile and impacts on hydrology	2008	2009	2012
10	S. Tekleab, Ethiopia	S. Uhlenbrook, H. H.G. Savenije	Y. Mohammed, J. Wenninger	Hydrological processes and modelling in the Blue Nile river basin	2008	2009	2012
11	P. Nyenje, Uganda	S. Uhlenbrook,	J.W. Foppen	Hydrological Implications of improved sanitation in slum areas, Kampala, Uganda	2008	2010	2012
12	P. Khiza, Kenya	S. Uhlenbrook,	J. Wenninger,	Hydrology of Nyando wetland, Kenya	2009	2010	2013

			A. van Griensven	(ECOLIVE project)			
13	Yurong Hu, China	S. Uhlenbrook,	S. Maskey	Climate Change Impacts in the Upper Yellow River	2009	2009	2013
14	Wang, China	S. Uhlenbrook, A Mynett	R. Venneker	Coupling of meteorological models for hydrological predictions in the Yellow River	2009	2009	2013
15	H. Calderon, Nicaragua	S. Uhlenbrook	JW Foppen	Development of innovative tracer methods to observe surface water-groundwater interactions in seasonal rivers	2009	2010	2014
16	C. Orup, Uganda	S. Uhlenbrook	JW Foppen, M. Mul, S. Maskey	Surface water-groundwater interactions in dryland rivers, Pangani catchment, Tanzania	2009	2010	2014
17	Yang Zhi, China	S. Uhlenbrook	Y. Zhou J. Wenninger	Surface water-groundwater interactions in Erdos Plateau, China	2009	2010	2014

4.5 Conferences: oral presentations, posters, invited papers, conference sessions

Prof. S. Uhlenbrook

- 5 November, VU Amsterdam, The Netherlands, invited lecture to introduce the Darcy lecturer 2009
- 27 October-2 November, Entebbe and Kampala, Uganda, WaterNet Conference, keynote speaker, and annual SCUSA project meeting
- 17-22 October 2009, Stellenbosch, South Africa, GWSP Steering Committee meeting, oral presentation
- 7-12 September 2009, Vietnam (Hanoi, Phang Rang, HCMC), Patners for Water project with Royal Haskoning, guest lecture at WRU, Hanoi
- 24-25 August 2009, Stockholm, Sweden, Resilience Center, University of Stockholm, invited speaker (one-day master class) at future of hydrological modeling in semi-arid agriculture workshop
- 22-26 June 2009, Prague, Czech Republic, Water Policy 2009, keynote speaker and chair of a session
- 8-9 June 2009, Munich, Germany, Workshop at TU Munich, invited speaker at science workshop on future of water quantity and water quality modeling
- 26-27 May 2009, Vienna, Austria, Colloquium at TU Vienna, invited speaker
- 14-20 May 2009, Thailand, AIT Bangkok, invited lecture
- April 2009: Co-convener of a session entitled " Hydrological Assessment and Integrated Water Resources Management with special focus on developing countries " together with Nick van der Giesen, Dan Rosbjerg and Pieter van der Zaag of the session at 6th General Assembly of the EGU, April 2009, Vienna, Austria
- 30 March-2 April 2009, Gosslar Hahnenklee, Germany, ERB conference on small catchment research, keynote speaker on capacity building and chair of a session
- 17-21 March 2009, Istanbul, Turkey, WWF 5, speaker at round table discussion on climate change in sensitive regions
- 23 March 2009, Invited lecture at the WorldMUN Conference, Den Haag, The Netherlands

Dr. Michael McClain

- A River Environmental Flow Regime to Support People and Ecosystems in the Mara-Serengeti Ecoregion. Presented at the Second DIVERSITAS Open Science Conference: Biodiversity and society: understanding connections, adapting to change, Oct 13-16 2009, Cape Town South Africa
- Hydro-Ecology and the Management of Water in Agricultural Landscapes. Position paper presented in the European Science Foundation Advanced Workshop: Disciplinary Perspectives on Water Management in Agricultural Landscapes, Sep 9-11 2009, Birmingham, UK. [Invited Lecture]
- Environmental Flows for Sustainable Development, Poverty Alleviation and Biodiversity Conservation, 16 August 2009, Stockholm World Water Week, Stockholm Sweden [Seminar Chair]
- Linking flows, ecosystems and well-being: an introduction. Presented during the The Global Environmental Flows Network Discussion Series – Flows for the environment and human well-being? Mar 17, 2009, Fifth World Water Forum, Istanbul, Turkey.
- An Environmental Flow Regime to Support People and Ecosystems in the Mara-Serengeti Ecoregion. Presentation at the International Conference Ecohydrology for Sustainability in the Context of Global Change, Jul 2-3 2009, Asunción, Paraguay

- Environmental Flows to Maximize the Carrying Capacity of Rivers. Presented at the NecoV Zomersymposium, Jun 18 2009, Delft, The Netherlands.

Dr. S. Maskey

- 20-21 April 2009, Invited paper and participation in the 3rd Yangtze Forum, Shanghai, China.

Dr. J. Wenninger

- 27 October-2 November, Entebbe, Uganda, WaterNet Conference, Improving water use efficiency: Experimental investigations of water fluxes within the soil-vegetation-atmosphere system using stable isotopes, oral presentation
- 04-07 Mai 2009, Vienna, Austria, IAEA, speaker at CRP Meeting.

Dr. Thom Bogaard

- Organiser of international conference: Landslide processes: from morphologic mapping to dynamic modeling. 6-7 feb 2009, Strassbourg, France.
- April 2009: Convenor: Mountain Risks session at EGU, Vienna.
- April 2009: Convenor: Hydrological process knowledge in landslide research session at EGU, Vienna.
- April 2009: Coordinator Young Scientists Outstanding Poster Prize, Hydrological Sciences division, EGU.
- 17 Nov 2009: Invited Lecture at UNIL, Lausanne, Suisse: 'Developments in hillslope hydrology and landslide understanding'.

Dr. J. W. Foppen

- 27 October-2 November: Chair of the Water for People Session, WaterNet Conference, Entebbe, Uganda.

4.6 Research output

1. PhD theses

- Marloes L. Mul, 2009: Understanding Hydrological Processes in an Ungauged Catchment in Sub-Saharan Africa. PhD thesis, UNESCO-IHE and Delft University of Technology; defended on 6 February 2009 (Promoters: H.H.G. Savenije (MAI department and TU Delft) and S. Uhlenbrook)

2. Academic publications

2.a1 In refereed journals (A – category)

- Nyenje P.M., Foppen J.W., Uhlenbrook S., Kulabako R., Muwanga A. 2009: Eutrophication and nutrient release in urban areas of sub-Saharan Africa — A review. *Science of the Total Environment*, 408, 447–455, doi:10.1016/j.scitotenv.2009.10.020.
- Foppen J.W., Lutterodt G., Roeling W.F.M., Uhlenbrook S., 2009: Towards understanding inter-strain attachment variations of *Escherichia coli* during transport in saturated quartz sand. *Water Research*, doi:10.1016/j.watres.2009.08.034
- Lutterodt G., Basnet M., Foppen J.W.A., Uhlenbrook S., 2009: Determining minimum sticking efficiencies of six environmental *Escherichia coli* isolates. *J. of Contaminant Hydrology*, 110, 110–117.
- Gonzales A.L., Nonner, J., Heijkers, J., Uhlenbrook, S. 2009: Comparison of different base flow separation methods in a lowland catchment. *Hydrol. Earth Syst. Sci.*, 13, 2055-2068.
- Mul, M., Savenije, H.H.G, Uhlenbrook, S. 2009: Spatial rainfall variability and runoff response during an extreme event in a semi-arid, meso-scale catchment in the South Pare Mountains, Tanzania. *Hydrol. Earth Syst. Sci.*, 13, 1659–1670.
- Corzo GA, Solomatine DP, Hidayat, deWit M, Werner M, Uhlenbrook S, Price RK, 2009: Combining semi-distributed process-based and data-driven models in flow simulation: a case study of the Meuse river basin. *Hydrol. Earth Syst. Sci.*, 13, 1619-1634, 2009.
- Lutterodt, G., Basnet, M., Foppa, J.W.A., Uhlenbrook, S., 2009: The effect of surface characteristics on the transport of multiple *Escherichia coli* isolates in large scale columns of quartz sand. *Water Research*, 43, 595–604.
- Simbanda, T., Nonner, J., Uhlenbrook, S., 2009: Comparison of groundwater recharge estimation methods for the semi-arid Nyamandhlovu area, Zimbabwe. *Hydrogeology Journal*, 17, 6, 1427-1442, DOI 10.1007/s10040-009-0445-z
- Koch, K., Wenninger, J., Uhlenbrook, S., Bonell, M., 2009: Joint interpretation of hydrological and geophysical data: electrical resistivity tomography results from a process hydrological research site in the Black Forest Mountains, Germany. *Hydrological Processes*, 23, 10, 1501-1513, DOI: 10.1002/hyp.7275.

- van Asch, Th. W. J., J.-P. Malet and T. A. Bogaard (2009): The effect of groundwater fluctuations on the velocity pattern of slow-moving landslides. *Nat. Hazards Earth Syst. Sci.*, 9, 739–749. www.nat-hazards-earth-syst-sci.net/9/739/2009/
- Jongschaap, R.E.E., R.A.R. Blesgraaf, T.A. Bogaard, E.N. van Loo, H.H.G. Savenije (2009). The water footprint of bioenergy from *Jatropha curcas* L.. Comment Letter to the editor. *Proc Natl Acad Sci USA* 106:E92. www.pnas.org/cgi/doi/10.1073/pnas.0907272106PNAS
- Steele-Dunne, S. C., M. M. Rutten, D. M. Krzeminska, M. Hausner, S. W. Tyler, J. S. Selker, T. A. Bogaard, and N. C. van de Giesen (2009). Feasibility of Soil Moisture Estimation using Passive Distributed Temperature Sensing. *Water Resources Research* doi:10.1029/2009WR008272 (published online 19 October 2009)
- Yangxiao Zhou, 2009, A critical review of groundwater budget myth, safe yield and sustainability. *Journal of Hydrology*, doi:10.1016/j.hydrol.2009.03.009.
- Arthington AH, RJ Naiman, ME McClain & C Nilsson. 2009. Preserving the biodiversity and ecological services of rivers: new challenges and research opportunities. *Freshwater Biology* doi:10.1111/j.1365-2427.2009.02340.x.

2.a2 *In refereed journals (B – category)*

- Masih I, Ahmad MD, Uhlenbrook S, Turrall H, Karimi P, 2009. Analysing streamflow variability and water allocation for sustainable management of water resources in the semi-arid Karkheh river basin, Iran. *Physics and Chemistry of the Earth*, 34 (4-5), 329-340. Doi:10.1016/j.pce.2008.09.006.
- Munyaneza O, Wali UG, Uhlenbrook S, Maskey S, McArd J, Mlotha, 2009: Water level monitoring using radar remote sensing data: Application to Lake Kivu, central Africa, *Physics and Chemistry of the Earth*, 34, 722–728, DOI: 10.1016/j.pce.2009.06.008.
- Quilis, R.O., Hoogmoed, M., Ertsen, M., Foppen, J.W., Hut, R., Vries, A.d., 2009. Measuring and modeling hydrological processes of sand-storage dams on different spatial scales. *Physics and Chemistry of the Earth*, 34 (4-5), pp. 289-298.
- Pradzynska, D.M., T.A. Bogaard, M.C. Westhoff (2009). Spatial And Temporal Variability Of Soil Moisture Patterns Related To Preferential Flow Measured Using Distributed Temperature Sensing. *Folia Geographica, series Geographica-Physica*, Vol. 39-40, pp.73-82, ISSN 0071-6715
- Stiefel JM, AM Melesse, ME McClain, RM Price, EP Anderson & NK Chauhan. 2009. Effects of rainwater-harvesting-induced artificial recharge on the groundwater of wells in Rajasthan, India. *Hydrogeology Journal* DOI 10.1007/s10040-009-0491-6.

2.a3 *In refereed journals (C – category)*

- Makurira H, Savenije H.H.G, Uhlenbrook S. 2009: Modelling field scale water partitioning using on-site observations in sub-Saharan rainfed agriculture. *Hydrol. Earth Syst. Sci. Discuss.*, 6, 5537-5563.
- Foppen, J.W., Kansime, F. 2009. SCUSA: integrated approaches and strategies to address the sanitation crisis in unsewered slum areas in African mega-cities. *Re-views in Environmental Science and Biotechnology* 8 p. 305–311.
- Zhou, Y., and W. Li, 2009, Modelling of regional groundwater flow, *Journal of Hydrogeology and Engineering Geology*, Vol. 35, No. 1, pp 1-10.
- Wang L., J. Han, Y. Liu, C. Ye, Y. Zheng, L. Wan, W. Li, Y. Zhou, 2009, Modelling of regional groundwater flow in Beijing Plain, *Journal of Hydrogeology and Engineering Geology*, Vol. 35, No. 1, pp 11-19.
- Li Ning, Zhou Yangxiao, Li Wenpeng, 2009, Modeling of regional groundwater flow of Chaiwopu Basin and River Valley in the Urumqi River Basin, *Journal of Hydrogeology and Engineering Geology*, Vol. 35, No. 3, pp 1-7.
- Huo Chuanying, Zhu Jin, Wei Wenhui, Zhou Yangxiao, Li Wenpeng, 2009, Groundwater flow modelling in the North Plain of Urumqi River Basin, *Journal of Hydrogeology and Engineering Geology*, Vol. 35, No. 3, pp 8-15.
- Wang Qingbing, Duan Xiuming, Fred Kloosterman, Zhou Yangxiao, Li Wenpeng, 2009, Simulation of regional groundwater flow in Jinan karstic spring basin, *Journal of Hydrogeology and Engineering Geology*, Vol. 35, No. 5, pp 53-60.x

2.a4 *Guest editorships special issues refereed scientific journals*

- Arthington AH, RJ Naiman, ME McClain & C Nilsson. 2009. *Environmental Flows: Science and Management*. *Freshwater Biology* doi:10.1111/j.1365-2427.2009.02340.x.
- Van der Zaag, P., Kunstmann, H., Rosbjerg, D., Uhlenbrook, S., van de Giesen, N., Mul, M.L., 2009: *Integrated Water Resources Assessment, with Special Focus on Developing Countries*. Special issue of the international journal *Physics and Chemistry of the Earth*, 34(4-5): 209-340 [ISSN 1474-7065]

2b *In other journals*

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2.c1 *Book chapters in refereed books (A – category)*

- Schultz B., Uhlenbrook S., 2009: Water security: What does it mean, what may it imply? In: Alaerts G.J. & Dickinson N.L.: Water for a Changing World – Developing Local Knowledge and Capacity. Proceedings of the International Symposium, 13-15 June 2007, UNESCO-IHE, Delft, The Netherlands. CRC Press, Taylor and Francis Group, London, UK, ISBN: 978-0-415-47757-4, page 41-56.
- Uhlenbrook S., van der Zaag P., Meganck R.A., 2009: The role of knowledge generation at UNESCO-IHE: Past-present-future. In: Alaerts G.J. & Dickinson N.L.: Water for a Changing World – Developing Local Knowledge and Capacity. Proceedings of the International Symposium, 13-15 June 2007, UNESCO-IHE, Delft, The Netherlands. CRC Press, Taylor and Francis Group, London, UK, ISBN: 978-0-415-47757-4, page 187-200.

2.c2 *Book chapters in refereed books (B – category)*

- Van der Zaag, P., B. Gumbo, E.R.N. Gunawardena, S. Khan, N. Kitaka, J. O’Keeffe, E. Rap, S. Uhlenbrook and A.A. van Dam, 2009: Climate, energy and environmental care: Investigating new collaborative research approaches. Chapter 10 in H. Molenaar, L. Box and R. Engelhard (eds), Knowledge on the Move: Emerging Agendas for Development-oriented Research. International Development Publications, Leiden, 195-222.
- Gustard A, Demuth S, Price R, Uhlenbrook S, 2009: Recommendations and Conclusions. In: WMO “Manual on Low-flow Estimation and Prediction”, Operational Hydrology Report No. 50, 129-133.
- Stahl K, van Lanen HAJ, Uhlenbrook S, 2009: Processes and regimes. In: WMO “Manual on Low-flow Estimation and Prediction”, Operational Hydrology Report No. 50, 36-42.

2.c3. *Book chapters in refereed books (C – category)*

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2.d1 *Monographs*

- Nonner J., 2009: Introduction to hydrogeology. Second edition. CRC Press, Taylor and Francis Group, London, UK, ISBN: 978-0-415-87555-4, 256 pages.

2.d2 *Editorships scientific books*

- Thom Bogaard: Editor of conference proceeding of international conference: Landslide processes: from morphological mapping to dynamic modeling. 6-7 feb 2009, Strassbourg, France. ISBN2-95183317-1-4.

2.e *Proceedings (full papers only)*

- Love, D., Uhlenbrook, S. and van der Zaag, P. 2009: Challenges of regionalising a conceptual model in semi-arid meso-catchments. Proceedings 10th International WATERNET/WARFSA/GWP-SA Symposium, Entebe, Uganda, 28-30 October 2009; CD-Rom; 23 pages.
- Nyenje, P.M., Foppen, J.W., Uhlenbrook, S., Kulabako, R., Muwanga, A., 2009: Hydrological implications of alternative sanitation solutions in urban slum areas. Proceedings 10th International WATERNET/WARFSA/GWP-SA Symposium, Entebe, Uganda, 28-30 October 2009; CD-Rom; 16 pages.
- Wenninger, J, Beza, D.T., Uhlenbrook, S. 2009: Improving water use efficiency: Experimental investigations of water fluxes within the soil-vegetation-atmosphere system using stable isotopes. Proceedings 10th International WATERNET/WARFSA/GWP-SA Symposium, Entebe, Uganda, 28-30 October 2009; CD-Rom; 16 pages.
- Makurira, H., Savenije, H.H.G., and Uhlenbrook, S., 2009. Application of the HYDRUS2D model to interpret sub-surface flow dynamics in improved rainfed farming systems. Proceedings 10th International WATERNET/WARFSA/GWP-SA Symposium, Entebe, Uganda, 28-30 October 2009; CD-Rom; 16 pages.
- Maskey, S. and Ojha, S. (2009): Analysing climate change indicators in the Himalayan region from satellite observations. Proceedings of 3rd Yangtze Forum, Sub-forum on Climate Change and City Water Safety, April 2009, Shanghai, China.
- Munyaneza, O., Uhlenbrook, S., Maskey, S., Wali, U. G. and Wenninger, J., 2009. Hydrological and climatic data availability and preliminary analysis in Rwanda. Proceedings 10th International WATERNET/WARFSA/GWP-SA Symposium, Entebe, Uganda, 28-30 October 2009; CD-Rom; 15 pages.
- Munyaneza, O., Uhlenbrook, S., Wali, U. G., Wenninger, J. and Maskey, S., 2009. Hydrological Instrumentation of Meso-Scale Catchment: A case study of Migina Catchment, Southern Rwanda. Proceedings of the Science, Engineering and Technology session, 6th International NUR Scientific Research Conference, Butare, Rwanda, 19-21 October 2009.

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- Kuntiyawichai, K., Schultz, B., Uhlenbrook, S., and Suryadi, F.X. 2009. Integrated hydrologic, hydraulic, and damage analysis for selection of optimal flood management measures. In: Proceedings of the 7th Annual Mekong Flood Forum: integrated flood risk management in the Mekong River Basin, Bangkok, Thailand, May 13-14 2009.
- Masih I, Maskey S, Uhlenbrook S, , Smakhtin V. 2009. Assessing the benefit of improved precipitation input in SWAT model simulations. In: Proceedings 5th International Watershed Modeling (SWAT) Conference, August 5-7, Boulder, Colorado, USA, 8 pages.
- Bogaard, T.A., J.-P. Malet, Th.W.J. van Asch (2009). Decisive factors for hazard and risk management of slow moving landslides in varved clays. 4pp 1e Journées 'Alea Gravitaire', 17-18 Novembre 2008, Orleans, France.
- Marc, V., E. Garel, T-H. Debieche, A-L. Cognard-Plancq, C. Emblanch, J-P. Malet, S. Ruy, T.A. Bogaard et O. Maquaire (2009). Intérêts du traçage naturel et artificiel pour l'étude in situ des écoulements dans les matériaux très hétérogènes - le cas des marnes noires de Super-Sauze et Draix. 6pp. 1e Journées 'Alea Gravitaire', 17-18 Novembre 2008, Orleans, France.
- Pradzynska, D.M., Bogaard, T.A., Westhoff, M.C. (2009). Spatial And Temporal Variability Of Soil Moisture Patterns Related To Preferential Flow Measured Using Distributed Temperature Sensing. 6pp 1e Journées 'Alea Gravitaire', 17-18 Novembre 2008, Orleans, France.
- Ponton, J., D.M. Pradzynska, T.-H. Debieche, T.A. Bogaard, J.-P. Malet, V. Marc, J. Travelletti (2009). Suivi hydrogéophysique d'écoulements hydriques sur des glissements-coulées argileux par expérimentations d'infiltration provoquée. 8pp. 1e Journées 'Alea Gravitaire', 17-18 Novembre 2008, Orleans, France.
- Malet, JP, Maquaire, O, Schmidtbuhl, J, Jongmans, D, Marc, V, Hantz, D, Richard, D, Grandjean, G, Pezard, P, Asch, TWJ van and Bogaard, TA (2009). Ecoulements préférentiels dans les versants marneux fractures quelle influence pour le déclenchement de glissements de terrain à contrôle hydrologique? Projet écou-pref. In G Grandjean & J.P. Malet (Eds.), Journées alea gravitaire (pp. 13-24). Orléans: BRGM.
- Debieche, T.-H. , V. Marc, C. Emblanch, A.-L. Cognard-Plancq, E. Garel, T.A. Bogaard & J.-P. Malet (2009). Local scale groundwater modelling in a landslide. The case of Super-Sauze mudslide (Alpes-de-Haute-Provence, France). Pp. 101-106. Proceeding conference on Landslide Processes Analyses, Strasbourg Feb 2009
- Krzeminska, D.M. , T.A. Bogaard, T.-H. Debieche, V. Marc, J. Ponton & J.-P. Malet (2009). Quantitative analysis of preferential flow during small scale infiltration tests on an active mudslide, French Alps. Pp. 151-156. Proceeding conference on Landslide Processes Analyses, Strasbourg Feb 2009
- Van Asch, .W.J., L.P.H. Van Beek and T.A. Bogaard (2009). The diversity in hydrological triggering systems of landslides. Page 151-156 In: Rainfall induced landslides, mechanisms, monitoring techniques and nowcasting models for early warning systems. Picarelli, L. P. Tommasi, G. Urcinco and P. Versace (editors). Proceedings of 1st Italian workshop on landslides, 8-10 June 2009.

2.f Scientific reports ordered by an external contractor

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3. Professional publications and products (incl. IP)

- Forslund, A., et al. Securing Water for Ecosystems and Human Well-being: The Importance of Environmental Flows. Swedish Water House Report 24. SIWI, 2009. [M.E. McClain co-author].

4. Publications for the general public (optional)

- An article by S. Maskey in UNESCO-IHE magazine UPDATE (March 2009) on Decision Support System for Wastewater Reuse in Middle-East.
- An article by S. Uhlenbrook in UNESCO-IHE magazine UPDATE (March 2009) on the Post-doctoral Programme on Climate Change Adaptation in Mekong River Basin (PROACC).

5. Other results of scientific esteem and acknowledgement

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6. Unpublished conference papers

- More 30 abstracts were presented posters or oral presentations during international conferences.

5 Education

5.1 Modules of the Master programmes and specialisations coordinated by the Core

Programme	Name of module	Date offered	Name of coordinator
WSE	All modules (# 1-15)	All year.	J. Nonner

5.2 Regular modules in which Core staff members have lectured in 2009

Programme	Name module	Name of lecturer	Topic
WSE	All HWR modules (# 1-15)	All staff members	See Handbook
WSE	Urban Hydroinformatics, # 8	S. Uhlenbrook	Climate change impacts in urban areas
MUI	Urban Water Modeling, # 10	S. Uhlenbrook	Rainfall-runoff modelling
WM and ES	River basin modelling, # 11	S. Uhlenbrook	Land use change impacts in catchments
ES	Environmental Systems Analysis, # 5	S. Maskey	Global spatial data and tools for ecosystem analysis
WSE	European SWAT Summer Course (HI), #13	S. Maskey	Hydrological processes in SWAT
WM	The Water Resources System, # 2	J. Nonner	Groundwater resources

5.3 MSc theses finalised during 2009

Prof. S. Uhlenbrook was the supervising professor for all listed MSc students

Programme	Name student	Title thesis	Supervisor/Mentor(s)
WSE	Sunal Ojha	Analysis of Snow and Glaciers in the Himalayan Region using Remotely Sensed Data	S. Maskey
WSE	Russel M.F. Haque	Validation of TRMM Rainfall Data for Hydrological Applications in Pangani River Basin in Tanzania	S. Maskey
WSE-HWR	Angela Alexandra Arévalo Espinosa	Analysis and quantification of preferential flow on the Super Sauze Landslide	T.A. Bogaard
WSE-HWR	Beza, D. T.	Experimental investigation of water fluxes using isotopes to improve water use efficiency	J. Wenninger
WSE-HWR	Bayou	Estimating groundwater seepage rates at Zegveld, The Netherlands	J. Nonner
WSE-HWR	Bruce	Assessment of groundwater development potential in the Daka catchment, Ghana	Y. Zhou
WSE-HWR	Maksoud	Determining the minimum sticking efficiency of E Coli in groundwater	J.W. Foppen
WSE-HWR	Orup, C.	Transport of phosphorous in the Holocene covering layer in the Zuidplaspolder, The Netherlands	J.W. Foppen
WM-WRM	J-A Bouchard	Hydrological processes in an developed wetland area in Tanzania	J.W. Foppen, M.L. Mul (WM programme)

5.4 Other educational activities (specify type: short courses, tailor made courses, refresher seminars, online courses, and invited lectures)

Type	Name of course / topic	Lecturer
3 days post-graduate course University of Sao Paulo (USP, Sao Carlos), Brasil	Global change impacts on hydrology	S. Uhlenbrook and ME Mendiondo (USP, Brasil)
1 day master-class, Resilience Center, Stockholm University, Sweden	The future of hydrological modelling in semi-arid agriculture	S. Uhlenbrook
0.5 day lecture at National University of Rwanda (NUR), Butare, Rwanda	Water balance and its variation in space and time	S. Uhlenbrook
Tailor made courses for Chinese Group Trainings (2) at UNESCO-IHE	Distributed hydrological modelling for flow forecasting in large river basins Remote sensing based globally available data for hydrological modelling	S. Maskey
5 days tailor made course UNESCO Chair Khartoum, Sudan	Ground water quality and modeling	J.W. Foppen
5 ECTS On-line Course	Sanitation-related Urban Groundwater Pollution	J.W. Foppen
1 day lecture at National University of Rwanda (NUR), Butare, Rwanda	Tracerhydrology and Isotopehydrology	J. Wenninger

6 Advisory / Capacity building

6.1 Advisory projects (indicating partners, budget and funding source)

- Contributions to the NPT project in Rwanda to set up the WREM MSc programme at the National University of Rwanda (Uhlenbrook, Maskey, Wenninger)
- Acquisition mission to Vietnam to initiate a project with the Ministry of Natural Resources and Environment on satellite-based hydrological modelling (Venneker).
- Dutch contribution for a satellite-based modelling project in the Yangtze River Basin was secured; project to be started in 2010, pending on approval from the Chinese site (Venneker, Maskey)
- Integrated Water Resources Management in the Aral Sea Basin (IWRM-ASB) project in collaboration with Scientific Information Centre of the Interstate Commission for Water Coordination of the Aral Sea Basin (SIC-ICWC), Tashkent (de Schutter, Maskey, Prasad)

6.2 Capacity building projects (indicating partners, budget and funding source)

- ASKNet: developing 5 online courses in the field of Water Supply and Sanitation. Budget: 170 kEURO. Funding: UPaRF.
- CapCar - Project on capacity building in water programs in higher education in the Caribbean region with the main partners the University of the West Indies. The project is involving multi-disciplinary staff of UNESCO-IHE and started officially in January 2009 (Nonner, Brandimarte, Sharma, Ploeger, Noorman, Darvis, Kruis).
- A 2-year project on partnership for education and research on water and ecosystem interactions was approved by Netherlands Asian Facility for China programme and Chinese government with a total finance of 545,000 Euros. The project activities include 5 phases: an inception workshop was organised in November 2009. A training course for Chinese researchers will be organized in February to April 2010. A research catchment will be set up in Erdos Plateau in 2010 and research will be carried out for 2 years. A module course on Ecohydrogeology will be developed and implemented at China University of Geosciences and Hohai University. Several pilot training courses will be organized for water professionals in China.

7 Miscellaneous

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