UNESCO-IHE PhD week

01 - 05 October 2012

Managing Water Resources in a Changing World

SENSE
Research School for Socio-Economic and Natural Sciences of the Environment

UNESCO-IHE
Institute for Water Education

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Overview of the Programme

PhD Symposium

Monday 01 October

08:30 - 09:00 **Welcome and Coffee/Tea**

Studium Generale (Rm. A1b)

09:00 - 09:30 **Opening Address**

09:30 - 10:30 **Plenary Talk by Prof. Ton Dietz:** *Thinking and acting in a trans-disciplinary way*

10:30 - 11.00 **Poster session and coffee** (near Rm. A1)

11:00 - 15:00 **PhD Presentations** – 23 talks (*see separate schedule*)

Session 1 (Rm. A2a): **Water Management**

Session 2 (Rm. A2b): **Aquatic Ecosystems & Environmental Resources**

Session 3 (Rm. A3a): **Hydroinformatics & Knowledge Management**

Session 4 (Rm. A3b): **Land & Water Development**

15:00 - 15:15 **Coffee/Tea break**

15:15 - 16.30 **PhD Movie: Piled higher and deeper** (Rm. A1b)

16:30 - 18:00 **PhD forum** (Rm. A1b)

18:00 - 20:00 **Drinks** (IHE restaurant)

Tuesday 02 October

08:30 - 09:00 **Welcome and Coffee/Tea**

Plenary talks by PhD Alumni (Rm. A1b)

09:00 - 09:25 Dr. Stefania Balica
09:25 - 09:50 Dr. Ilyas Masih
09:50 - 10:15 Dr. Carlos Lopez Vazquez

10:15 - 10:30 **Open discussion**

10:30 - 11.00 **Poster session and coffee** (near A1)

11:00 - 12:30 **Workshop: Spatial Data Infrastructure** by Dr. Ann van Griensven

12:30 - 13:30 **Lunch**

13:30 - 17:45 **PhD Presentations** – 33 talks (*see separate schedule*)

Session 5 (Rm. A2a): **Water & Wastewater Treatment**

Session 6 (Rm. A2b): **Biological Treatment & Resource Recovery**

Session 7 (Rm. A3a): **Hydrology & Water Resources**

Session 8 (Rm. A3b): **Hydraulics & Coastal Engineering**

18:30 **Dinner for UNESCO-IHE PhD students and staff** (walk from the IHE entrance to the restaurant)

Wednesday 03 October

09:00 - 10:30 **Orientation Seminar for new PhD students** (Rm. A1b)

SENSE A1 Course

10:45 - 13:00 **Travel by bus to Apeldoorn** (registered A1 participants only)

13:30 **Start SENSE A1 Course** (Apeldoorn)

Thursday 04 October

Whole day: **SENSE A1 Course** (Apeldoorn)

Friday 05 October

09:00-12:15 **SENSE A1 Course** (Apeldoorn)

Contact Organisers:
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Schedule of PhD Presentations

Monday, 1 October 2012

	Session 1: Water Management Room A2a	Session 2: Aquatic Ecosystems & Environmental Resources Room A2b	Session 3: Hydroinformatics and Knowledge Management Room A3a	Session 4: Land and Water Development Room A3b
	Moderator: Maria Pascual Sanz **Panel: Prof. Ken Irvine (1st half) Prof. Pieter van der Zaag (2nd half)** **Michelle Kooy** **Wim Douven**	**Moderator: Fiona Zakaria** **Panel: Prof. Meine Pieter ven Dyk (1st half), Prof. Ken Irvine (2nd half)** **Raymond Venneker (entire)** **Tineke Hooijmans (1st half), Peter Kelderman (2nd half)**	**Moderator: Aline Saraiva Okello** **Panel: Schalk Jan van Andel** **Giuliano Di Baldassarre** **Biswa Bhattacharya**	**Moderator: Mário Da Silva Duarte Duque** **Panel: Prof. Charlotte de Fraiture** **Abraham Mehari Haile** **Shreedhar Maskey**
11:00	**Etiegni**: Towards Participatory Fisheries Governance: A Case of Lake Victoria (Kenya) Fisheries	**Belachew**: Modeling Instream Industrial Effluents for Optimized Water Quality, the Case of Kombolcha City (Ethiopia)	**Delipetrev**: Cloud hydro information system and web services	**Keita**: Rice Yield Improving Factors in Tropical Savannah of Burkina Faso
11:30	**Obani**: Human Rights, Environment and Development: Focus on the human right to sanitation	**Zapater Pereyra**: Solving the large area demand of constructed wetlands (CW) by means of a "Duplex-CW"	**Bayissa**: Spatio-temporal assessment of drought in Upper Blue Nile Basin: retrospective analysis and seasonal forecasting	**Yihun**: Crop coefficient for specific growth stage of Teff in a semi-arid region Central Rift Valley of Ethiopia
12:00	**Hategekimana**: Fostering good wetland management by bridging the local livelihood perspective with multi-sectoral and multi-scale perspectives.	**Abel**: Fate of bulk organic matter, nitrogen and pharmaceutically active compounds in simulated soil aquifer treatment (SAT) system using primary effluent	**Mukolwe**: Flood inundation modelling and probabilistic flood mapping communication	**Dejen**: Water Delivery and Distribution Performance in Metahara Large Scale Irrigation Scheme in Ethiopia under the Existing Operational Setting
12:30	**Lunch (IHE restaurant)**			
13:30	**dos Santos:** Pro-poor Water and Sanitation Services in Urban Areas: a multi-level analysis of São Paulo city, Brazil	**Ingabire**: Impact of land use on nitrogen cycling and water quality in Rwanda: A case of Migina catchment	**Yan**: Assessing the usefulness of SRTM topography to support hydraulic modelling under uncertainty	**Khisa**: Water flux exchanges in a papyrus wetland in Lake Victoria, Kenya
14:00	**Hamdard**: Assessing the Role of Spatial Planning Tools and Ecosystem Services Based Governance at Meso-scale for Sustainable Integrated Water Resources Management	**Minaya-Maldonado**: Multi-scale analysis and coupling of eco-hydrological model and remote sensing for the alpine grasslands (páramo) in the Ecuadorian Andean region	**Hartanto**: Integrating earth observation and meteorological data, in-situ monitoring, and numerical modelling to reduce uncertainty in water management	**Yekti**: Paddy terraces of Subak irrigation schemes facing a water shortage. An interpretation of fieldwork and first data analysis
14:30	**Abdullah**: Shatt Al Arab Management Model Using Quantitative-Qualitative Simulation	**Rongoei**: Influence of water regime on plant decomposition in a natural papyrus wetland: case study of Nyando floodplain wetland, Kenya	**Almoradie**: Spatial Data Infrastructure and WaterML in a Networked Environment for Stakeholder Participation (NESP) in river and flood management	**Adeboye**: Sustainable Land and Water Use Under Rainfed and deficit Irrigation in Ogun-Osun River Basin, Nigeria
15:15	**PhD Movie (A1b)**			

Tuesday, 2 October 2012

	Session 5: Water and Wastewater Treatment Room A2a	Session 6: Biological Water Treatment and Resource Recovery Room A2b	Session 7: Hydrology and Water Resources Room A3a	Session 8: Hydraulics and Coastal Engineering Room A3b
	Moderator: Loreen Villacorte **Panel: Prof. Maria Kennedy (1st half), Prof. Damir Brdjanovic (2nd half)** **Henk Lubberding (Entire)** **Giuliana Ferrero (1st half), Carlos Lopez Vasquez (2nd half)**	**Moderator: Assiyeh Tabatabai** **Panel: Prof. Piet Lens** **Eldon Raj** **Peter van der Steen**	**Moderator: Veronica Minaya Maldonado** **Panel: Prof. Stefan Uhlenbrook** **Jochen Wenninger** **Ann van Griensven**	**Moderator: Ali Dastgheib** **Panel: Prof. Dano Roelvink** **Luigia Brandimarte** **Rosh Ranasinghe**
13:30	**Bruins**: Characterization and identification of manganese oxides present in naturally coated filter media from conventional aeration-filtration groundwater treatment plants	**Mussoline**: Enhanced Methane Production from the Anaerobic Co-digestion of Rice Straw with Pig Wastewater and Paper Mill Sludge	**Demessie**: Understanding recent land use and land cover dynamics in the source region of the Upper Blue Nile, Ethiopia: spatially explicit statistical modeling of systematic transitions	**Simanjuntak:** Design of Pressure Tunnels Using Finite Element Model
14:00	**Salifu**: Aluminum (hydr)oxide coated pumice for fluoride removal from drinking water	**Chung**: Removal of viral contaminations by hydrothermal carbonization products in water treatment	**Linh**: A new approach representing landscape variability for the SWAT model	**Mwelwa**: The state of the flow and morphology interaction in the hydropower dominated Middle Zambezi
14:30	**Zakaria**: Decision Support System for Sanitation Technical Options in Emergency Situation	**Acheampong**: Effect of operating parameters on Cu(II) biosorption onto coconut shell in fixed-bed columns	**Saraiva Okello**: Are observed stream flow records sufficient to understand natural hydrological process heterogeneity in the Incomati River Basin?	**Ali**: Quantification of water uses along the Blue Nile River network using a one dimension (1D) hydrodynamic model
15:00	**Mawioo**: Novel Concepts and Technologies for Excreta and Wastewater Management in Challenging Emergency Conditions	**Janyasuthiwong**: Biogenic Sulfide Production and Selective Metal Precipitation at low pH for Semiconductor Wastewater Treatment	**Trambauer**: Identifying historic droughts in the Limpopo River basin using a downscaled version hydrological model	**Ali**: Determination of the cross section spacing in 1D hydraulic models
15:30	**coffee and tea (IHE restaurant)**			
15:45	**Welles**: Impact of Salinity on the Aerobic Metabolism of Phosphate Accumulating Organisms	**Cassidy**: Optimization of biological sulphate reduction	**Worku**: Characterising the flow regime in a largely ungauged natural basin: the Omo-Ghibe basin in Ethiopia	**Sembiring**: Nearshore Operational Model for Rip Current Predictions
16:15	**Sanchez-Guillen**: Cost-Effective Municipal Wastewater Treatment by Coupling of UASB and ANAMMOX Reactors	**Jain**: Adsorption of heavy metals by biogenic red elemental selenium	**Mabrouk**: Climate Change and Development Impacts on Groundwater Resources in the Nile Delta, Egypt	**Duarte-Duque**: Le déjener sur L'eau (Luncheon on Water), A Manual for Urban Relief
16:45	**Andreev**: Sustainable management of human excreta through terra preta sanitation approach	**Saad**: Co-existence and Competition between Phosphorus Accumulating Organisms and Sulfate Reducing Bacteria	**Hu**: Downscaling daily precipitation over the Yellow River source region in China: a comparison of three statistical downscaling methods	**Dam**: The long-term performance of process-based morphological models in estuaries
17:15	**Riungu**: Probabilistic Evaluation Framework: A Breakthrough in High Density Slum Sanitation Technology selection?	**Kijjanapanich**: Biological sulfate reduction for remediation of gypsiferous soils using organic substrates as electron donors	**Galvis**: Evaluation of a pollution prevention approach in the municipal water cycle	**Guo**: Role of river flow and tidal asymmetry in fluvial estuarine morphodynamics
18:30	**PhD Dinner**			

PLENARY TALKS

The challenges facing the global community in water resources management are often stated: climate change creates new extremes in both too little and too much water; population growth leads to increased demand, and there are still very critical needs for sanitation. UNESCO-IHE's philosophy – and indeed the philosophy of many water professionals – is that solutions to these challenges must bridge disciplines. For example, we must make advances in engineering to provide cost effective sanitation and drinking water while using research in hydrological and environmental fields to define sustainable use. These activities – among many others like it - must all be responsive to and in collaboration with responsible governance.

How do we actually achieve the goal of working together across disciplines? The plenary speaker, Dr. "Ton" Dietz will address this question using examples from his own work. Most importantly, he addresses how PhD-level scientists can use these concepts in their careers.

Dr. Dietz writes "The existing organisation of universities, with research and teaching programmes, but also the departmental structures, very much results of a 19th and 20th Century 'building era of academia', is being questioned. Many funding agencies and thinktanks are enforcing collaboration. In the 1990s this often took the form of multi-disciplary designs; in the 2000s inter-disciplinary designs and now "trans-disciplinarity" is all over the place. What is it? And what does it mean for you and your future careers?"

Schedule of Plenary Talks

01 October 2012 (Rm. A1b)

09:30 am: *Thinking and acting in a trans-disciplinary way* **by Prof. Tom Dietz**

02 October 2012 (Rm. A1b)

09:00 am: *Flood Vulnerability Index - from Development to Application* **by Dr. Stefania Balica**

09:25 am: *Is there enough scientific support for developing and managing water storage in River Basins?* **by Dr. Ilyas Masih**

09:50 am: *From micro-scale to the real world* **by Dr. Carlos Lopez Vazquez**

Biography of Plenary Speakers

Prof. Tom Dietz

Prof. Ton Dietz is social geographer interested in connecting academic excellence and social relevance while doing research across disciplinary lines. He has worked extensively in East and West Africa on resource management and development, and he is currently the director of the African Studies Center in Leiden. His inaugural address was titled: *Silverlining Africa: From images of doom and gloom to glimmers of hope, from places to avoid to places to enjoy.* Previously, Prof. Dietz was the director of the research school CERES and of the research institute AMIDSt at the University of Amsterdam. He was part of the Board of NWO-WOTRO and currently leads the steering committee of the CoCooN programme (Conflict and Cooperation on Natural Resources). In addition to research and other projects, Prof. Dietz is interested in PhD education and has co-authored a book called, *Effective PhD Supervision and Mentorship*. Among other interests, he also collects postage stamps to examine how they reflect African identity. For more information, please see Prof. Dietz's websites and a list of selected publications below. Website: https://home.medewerker.uva.nl/a.j.dietz and at www.ascleiden.nl.

Selected Publications

T. Dietz (2011). Participatory Assessment of Development in Africa. In N.R.M. Pouw & I.S.A. Baud (Eds.), *Local Governance and Poverty in Developing Nations* (pp. 215-239)

K. van der Geest, A. Vrieling & T. Dietz (2010). Migration and environment in Ghana: a cross-district analysis of human mobility and vegetation dynamics. *Environment and Urbanization, 22*(1), 107-123.

T. Dietz & D. Foeken (2008). The iconography of Tunisian postage stamps. In V. Mamadouh, S.M. de Jong, F. Thissen, J. van der Schee & M. van Meeteren (Eds.), *Dutch windows on the Meditteranean* (Netherlands geographical studies, 376) (pp. 25-33). Utrecht: Netherlands Geographical Studies (376).

Dr. Stefania Balica

Stefania F. Balica, Romanian, born on 23rd of April 1978, has been engaged in research in the field of flood vulnerability for nearly 10 years. Her first contact with the research was during her first year of fieldwork at the Department of Hydro technical Engineering at Polytechnic University of Timisoara (Romania). Then the Fellow continued with research for three years when she worked on a project optimising diversion schemes using non-structural measures (Banat Watershed). During her research study she worked at the same department under the supervision of Professor Gheorghe Cretu, Polytechnic University of Timisoara. Following this the Fellow won ERASMUS scholarship to study Environmental Sciences at Tours (France) and then Rijkswaterstaat fellowship to study MSc at UNESCO-IHE, Delft, the Netherlands in Hydraulic Engineering and River Basin Development. There she studied river dynamics, water resources systems planning and management, flood management, and finalised her degree with a thesis which developed a method to assess flood vulnerability for various spatial scales (supervised by Ir. Klaas Jan Douben). After the Masters the Fellow returned back to Romania to the same University and worked as a researcher in the Department of Hydro-technical Constructions to continue her research, for a period of six months. At this point the Fellow received a prestigious award (Huygens fellowship) to continue her MSc research at UNESCO-IHE as a PhD student, under the supervision of Prof. Nigel G. Wright. Her PhD thesis focused on the application of the Flood Vulnerability Index methodology as a knowledge base for flood risk assessment, focusing on systems components, vulnerability factors and indicators. The methodology was initially developed for

river flooding, but it has since been extended to coastal flooding at various spatial scales. Stefania promoted her PhD thesis on 6th of June, 2012. During the PhD period she spent six months working an internship at Veolia, Technical Direction in Nice, France. Here she was involved in modelling water supply systems using EPAnet. At this moment, Stefania is involved in the online and short course "IWRM as a tool for adaptation to climate change" where she teaches Flood Vulnerability in the context of climate change and as well Coastal Cities Flood Vulnerability Index.

Dr. Ilyas Masih

Ilyas Masih has completed his PhD Degree in June 2011 in Hydrology and Water Resources from UNESCO-IHE Institute for Water Education and Delft University of Technology (TUDelft), Delft the Netherlands. He holds a Masters Degree in Water Resources Management from Centre of Excellence in Water Resources Engineering (completed in 2000), University of Engineering and Technology, Lahore, Pakistan and a Bachelor Degree in Agricultural Engineering from University of Agriculture, Faisalabad, Pakistan (completed in 1997). Dr. Masih is working at UNESCO-IHE as a lecturer in Water Resources Planning since April 2011. At UNESCO-IHE, he is working at the Water Management core group of the Department of Integrated Water Systems and Governance. His educational activities include teaching the subjects related to water resources planning, hydrology, water resources assessment and water systems modeling. His current research engagements are focused on the spatial and temporal variability of hydrology and water resources in river basins, application of hydrological data analysis and modelling tools for better understanding of the hydrological process underpinning the formulation water resources planning and management strategies. While working at International Water Management Institute (IWMI) in Pakistan, Iran and Sri Lanka during 2001 to 2010, he has worked on wide range of water management issues. His work in the Indus Basin, Pakistan was focused on water saving and water productivity at various scales of rice-wheat systems, groundwater assessment, utilization and management, conjunctive management of surface and groundwater resources to reduce soil salinity and improve land and water productivity. His PhD research was on understanding hydrological variability for improved water management in the semi-arid Karkheh Basin, Iran.

Dr. Carlos Manuel López Vázquez

He graduated with a BSc. degree (Civil Engineering) and MSc. degree (cum laude) in Water Sciences (Specialty on Wastewater Treatment) from Autonomous University of the State of México, in Toluca, México. In 2009, he received his doctoral degree on Environmental Biotechnology (cum laude) from Delft University of Technology and UNESCO-IHE Institute for Water Education. For his outstanding academic achievement, he has been awarded different prizes, grants and scholarships. During his professional career and besides being involved in research and education at MSc and PhD-level, he has also taken part in different consultancy projects for both public and private sector concerning municipal and industrial wastewater treatment systems. His main research and teaching interest focuses on cost-effective and environmentally-friendly (biological) wastewater treatment systems; optimization of (biological) wastewater treatment processes; biological nutrient removal (nitrogen and phosphorus); microbial population dynamics in (nutrient removal activated sludge) wastewater treatment; and metabolic and mathematical modelling of activated sludge treatment systems. He is associate editor of Water Science and Technology, and a member of the International Water Association (IWA), Water Environment Federation (WEF) and of the Red de Talentos Mexicanos en Países Bajos.

Towards Participatory Fisheries Governance: A Case of Lake Victoria (Kenya) Fisheries

Etiegni Christine[1] Prof. Irvine K.[2], Prof. Leentvaar J.[2]

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Fisheries contribute immensely to the well-being of millions of people in the world by providing nutrition and contributing to world economies. There is, therefore, a need for proper governance of fisheries recourses. Participatory approach to governance has been proposed to be better than the hierarchical mode of governance. Participatory governance denotes governance approach in which stakeholders/actors are engaged in fisheries governance. Hierarchical mode of governance is state centric and its main feature is top-down approach based on command and control. Lake Victoria, which is the second largest (by surface area) fresh water lake in the world, is under threat from unsustainable use which has led to ecological, social and economic impacts. The lake is a source of livelihood for around 3.5 million people. Fisheries governance in Kenya has undergone major transformations ranging from hierarchical to participatory modes of governance. The institutions for governance have also changed, with the development of a new fisheries policy. It is against this background that this study aims at contributing to the available knowledge on fisheries governance in Lake Victoria by assessing the contribution of co-management and other institutions to Lake Victoria governance. The framework of interactive governance will be used to understand the linkages among the various stakeholders and their contribution to fisheries governance, in Lake Victoria. Survey method will be used to carry out the research. Data collection methods will include review of governance documents, semi-structured interviews, questionnaires, focused group discussions and observations. The anticipated outcome of this research would be the identification of factors that affect Lake Victoria governance, an understanding of how the fisheries resources of Lake Victoria are used and the effectiveness of Beach Management Units (BMUs) in fisheries resource management. BMUs are Lake Victoria user groups that the government involves in fisheries governance. The ultimate goal of this research would be to understand the linkages between research, policy and governance aspects of the lake so as to ensure that research findings are made available to policy makers and policy makers use such findings to make policy decisions for better governance.

Keywords: Lake Victoria, governance, fishers' well-being, participatory, hierarchy, ecological, social, beach management units

Human Rights, Environment and Development: Focus on the human right to sanitation

Obani, Pedi;[1] Gupta, Joyeeta[2]

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Figure 1: Photo of Open Toilets (Source: Times Live)

There are calls for the declaration of a human right to a clean and healthy environment and an incorporation of the rights approach in the climate change debate. Even if such rights were to be endorsed, they would only reflect high level international political commitment which does not automatically translate into tangible benefits for vulnerable groups who suffer the most from environmental challenges. While global challenges such as climate change, dwindling water supplies, and lack of sanitation, highlight the links between the environment and human development, it is still debatable whether and how the human rights approach can ensure the achievement of developmental and environmental objectives at the national to local levels of government. Besides the problems of how to define the normative content of environmental human rights, the rights are not self enforcing and the human rights approach by placing primary responsibility for enforcement on host States and other social actors thereby denies the fundamental principle of common but differentiated responsibility in addressing global environmental challenges. Hence, the main research question is: does the human rights approach guarantee development for vulnerable people and the achievement of global environmental objectives and how far can it be expanded? The sub questions for research are: a) What would environmental human rights imply in terms of content and procedure? b) Has the human rights declaration since 2010 led to enhanced provision of improved sanitation for vulnerable groups? c) Can environmental sustainability and human development objectives be better enhanced by complementing the human rights approach with other legal approaches? d) How far can the human rights approach be expanded on other environmental issues? e) How can the human rights approach and the principle of common but differentiated responsibility be made more compatible on global environmental issues? Using access to sanitation as the single case study, this research aims to contribute to the progressive development of international law on environmental sustainability and human development. The outcomes will highlight the limits of human rights in the absence of economic empowerment and better governance institutions, and recommend other legal approaches for advancing global environmental objectives. Sanitation is an appropriate case study for this research because it is both one of the MDGs target and a human right. Despite the prominence in international development and human rights discourse, 2.5 billion people still lack access to improved sanitation and 1 billion people engage in open defecation (JMP, 2012). Field research will be conducted in sub-Saharan Africa and Europe to compare how sanitation needs have and are being met and to see the role and limits of the human rights approach for addressing global environmental challenges in the absence of economic empowerment and better governance institutions. National policy documents, laws, and legal cases on sanitation will be analysed through content analysis. The outcomes will be triangulated with literature, data from interviews, and media reports.

Keywords: Sanitation, development, human rights, environmental sustainability

Fostering good wetland management by bridging the local livelihood perspective with multi-sectoral and multi-scale perspectives: Governance arenas and networks for wetland management in Rwanda

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Wetland management addresses the rehabilitation, restoration and conservation of aquatic habitats. In countries where wetlands support local livelihoods, wetland conservation faces the challenge of having to combine different perspectives and interests. In Rwanda, wetland degradation has been caused mainly by lack of coordination and conflicting interests among organisations. To better understand these processes the role of governance arena's and how they are related to each other is relevant. Governance arenas are spaces where actors from state, private and civil society organisations cooperate to achieve collective goals. This paper, analyses the wetland governance arenas in Rwanda and their impact in fostering wetland management. The work is based on a review of policy legal documents and interviews with key informants. The results show that different wetlands governance arenas exist in Rwanda. There are different origins for establishment of arenas. There are arenas established through the national planning framework (Poverty Reduction Strategy), those established by the environmental law and local arenas established initiated by the NGOs. Arenas have established the organisations cooperation framework for wetland governance. Arenas identified include the thematic working and sector groups established by the PRS, They operate at national scale and hold planning role. Environmental committee is established by the environmental law and operate at regional scale, and have the advisory. Arenas based on implementation include the Integrated Management of Critical Ecosystems (IMCE).This arena has been created by cooperation between REMA and World Bank. As the first intervention involving the regulator and donor, the IMCE involved private sectors organisations wetland rehabilitation of wetland as requirement of the donors. Private sector organisations were involved the construction of plants nursery and the Kigali Free Trade Zone for the relocation of industries from the Gikondo Wetland. The study found that information exchange and resources exchange influenced positively wetland management. For instance, the inclusion of wetland issues in the national planning framework (EDPRS) is one outcome of these interactions. In addition, the establishment of watershed based is another outcome of process of resources and information exchange. Cooperation between REMA and nongovernmental organisations such as HELPAGE created watershed based arenas. Through these watershed-based arenas civil society, private sectors organisations have acquired new roles and responsibilities related to co-financing, monitoring of and accountability. These roles are oriented to the improvement of wetland conservations and development. Watershed based arenas in at local level promise to solve conflicting interests and improve coordination between development and conservation. Overall, cooperation at different scales of wetland has halted the trends of wetland degradation. However, much is not known on the flows of information, resources and influences bring in the arenas to influence in wetland management outcome. In future study policy network analysis using social network analysis will be applied to quantify the distribution of these variables and their influence on wetland management.

Key words: Rwanda, Wetland Management, Governance arenas, Watershed-based arenas

Assessing the Role of Spatial Planning Tools and Ecosystem Services Based Governance at Meso-scale for Sustainable Integrated Water Resources Management

Hamdard, Masoom[1], Gupta, Joyeeta[2], Douven, Wim[3]

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[2]*IVM Institute for Environmental Studies*

Water, because of its complex nature, has undergone a succession of dominant management frameworks: from the hydraulic paradigm through sectoral management and integrated management to water resource management. In the first half of the last two decades Integrated Water Resource Management emerged as a paradigm shift in the water management arena. However, both in the policy and the scientific arena, there were difficulties in defining and articulating precisely what IWRM is and how best it can be implemented. Recent research shows that empirical evidence of functioning IWRM is limited particularly in developing countries, but also in many developed countries. In the meanwhile, a new paradigm has become important - ecosystem service based governance of natural resources (Aronson et al., 2010; Butler and Koontz, 2005; Milder et al., 2010; Norgaard, 2010; Pascual et al., 2010; Pavlikakis and Tsihrintzi, 1999; Reynolds et al., 2010; Smith and Clay, 2010; Zander et al., 2010). The main assumption of ES based governance is that by increasing the knowledge of how human wellbeing depends on natural resources can provide a good basis for sustainable management of natural resources. Even though the concept has a lot of critique (for example, the distinction between some ES elements like 'process', 'functions' and 'services' are not very clear, Jax ,2010:68; Richter et al., 2003), it is being rapidly endorsed by many countries (UK government has recently announced a £ 40 million research calls on Ecosystem Services, Cook & Spray, 2012).

What remains unanswered so far is how can Ecosystem Services be used as a governance approach to strengthen sustainable water resource management, and what are its specific tools? In particular, how will ES based governance use spatial planning tools? What will ES based governance deliver which IWRM has thus far failed to deliver. What are the appropriate jurisdictional level (Gupta, 2007; Hooghe & Marks, 2005; 2001; Hague and Harrop: 2007: 282) for implementing such governance? What could be the role of spatial planning tools in supporting ES based governance and ultimately sustainable water resources management?

This PhD research tends to provide answers to all the above questions in a four year time frame. It will be undertaken using a literature review, the development of a conceptual framework, content analysis of policy documents, and three case studies. The case study countries - South Africa, Ethiopia and the Netherlands are selected based on their differing level of economic development, history and administrative systems. Two of the case study countries - Ethiopia and South Africa are part of Afromaison project. Afromaison project is a European Union Funded research project for assessing and testing tools and strategies for Natural Resource Management in five African countries. Within this project the PhD proposal intends to contribute to the understanding of the relationships between new paradigms of water management and how spatial planning can contribute to enhancing water management at multiple levels of governance. Much work has been done at national and at local level – but very little at meso-level; the level that links national to local level. Here too, the PhD proposal aims to deliver interesting academic insights.

Pro-poor Water and Sanitation Services in Urban Areas: a multi-level analysis of São Paulo city, Brazil

dos Santos, Raquel[1]; Malheiros, TF[2]; van Dijk, MP[3]; Gupta, J[4] ; Schwartz, K[3]

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[3]*UNESCO-IHE, The Netherlands*
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Source: Exploratory Field Visit (São Paulo/May, 2010)

Modern society faces the challenge to provide water supply and sanitation services in the context of poverty and rapid urbanization. Where service provisions are poor, the underprivileged population is the most affected. This situation may result in negative impacts to society: water borne diseases, environmental pollution, low productivity, social exclusion etc. The scientific literature does not present a clear understanding of what is 'pro-poor policy' or what 'pro-poor policy instruments' are and how to improve these services for the urban poor. However, recent studies suggest that, in addition to technological efforts, pro-poor institutions and incentives are key elements to improve water utility performance in providing water supply for the poor. Against this background this research attempts to increase understanding of institutional arrangements for the provision of water and sanitation services for the urban poor, through a multi-level analysis. The main research question is: "*Are the institutional arrangements on water and sanitation services in place benefiting the urban poor?".* Using an adapted version of Young's analytical framework a multi-level institutional analysis will be carried out, examining policies, incentives, drivers and actors. This analysis will be supported by in-depth literature review to build the research rationale derived from theory; content analysis of water and sanitation policy documents, management instruments and project outputs for better understanding of legal and institutional frameworks, and its implementation process; comparative (and layered) case studies conducted in two slum areas in São Paulo city, which will include field observation of projects already implemented; and semi-structured interviews with key stakeholders. Finally, a triangulation of these research methods will be performed to analyse and discuss the research findings. This analysis will comprise analytical questions such as "why and how does decision making take place in improving water and sanitation services for the urban poor?", as well as conceptual questions such as "how can pro-poor policies and instruments be defined and what does pro-poor policy mean in the water and sanitation field?" This thesis will contribute to a better theoretical understanding of pro-poor policies and instruments and the factors that influence their effectiveness in specific contexts. Based on this multi-level institutional analysis a number of conclusions will be drawn, contributing to a wider body of knowledge, concerning possible alternatives to improve water supply and sanitation services pro-poor.

Keywords: Brazil; multi-level analysis; pro-poor; urban areas; water and sanitation services.

Shatt Al Arab Management Model Using Quantitative-Qualitative Simulation

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The high salinity level in the Shatt Al Arab River is well observed by many researchers and the MoWR in Iraq. The sources of this high salinity are different, such as water utilization in the upstream of the river and deteriorated its quality by discharging high salinity wastewater; the other source may be due to industrial and urban discharge around Basra city which in turn separated into two side, the Iraqi and Iranian side. The third source may be due to ground water exchange, while the fourth one is the flow from Kharun River, the last one is the salinity from sea water due to diffusion process driven by tidal effect.

In order to solve the water salination in Shatt Al Arab River, it is essential first to quantify the salinity of each source. this can be done through the a testing program of measurements at selected points on the river system that should be conducted for at least 6-12 months on weekly basis. A mass balance mixing model could also be adopted in order to check the effect of each source. the selected points of measurements are separated into two parts, the first part are those points which represent salinity measure at the inlet points to the river, others are selected points along the river itself to identify the exact spatial distribution along the river.

The data can be modeled using artificial neural network model for predicting salinity variation along the river. This model can be used later to identify an optimum control of each salinity sources to minimize the salinity in Shat Al Arab. The control optimization model output will be the optimum flow quantities in each salinity source.

The above models will be coupled by a mathematical quantitative-qualitative model to simulate the hydraulic system performance due to different quantitative-qualitative inputs. the model is three or two dimensional, that simulate water quality spatial variation along the river for the existing case, and different other cases of suggested management scale, with the identification of tidal effect with different suggested location of a barrage, the suggested barrage is either fixed one or one with gates that can be closed or opened according to the requirement with optimal operation scheme to minimize salinity level and intrusion to Shatt Al Arab river.

In addition to that the model will checked with air controlled barrier as alternative solution of barrage construction, the schedule and capacity of this system that prevent salt intrusion will be obtained The capacity

Modeling Instream Industrial Effluents for Optimized Water Quality, the Case of Kombolcha City (Ethiopia)

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With the rapidly increasing population and industrialization, Ethiopian water resources suffered degradation. Toxic, radioactive, heavy metals and chemical pollution in the water supply of the industrialized have increased at alarmingly rates. Downstream of pollution discharges, usually subject to inadequate water treatment, public health is endangered and edible vegetables have been found to accumulate some metals at toxic concentrations to human health. Current industrial expansion will exacerbate the situation. Regular water quality monitoring programmes are scarce and data to help understand spatial and temporal patterns of emissions scant. Because a catchment is an integrated system, mitigation measures to protect water resources, subject to both anthropogenic pollution and natural physico-chemical transport, need to operate at a catchment scale. In order to understand the relative roles of land use and industrial emissions, this study will model both industrial emissions and catchment diffuse pollutants (nutrient and heavy metals) into the main stream of the industrial zone catchment in the heavily industrialized city of Kombolcha in Northern Ethiopia. The research will unravel questions related to the effects of pollutant sources, spatial and temporal pollutant distributions, relationship between catchment attributes and stream water quality, so as to identify unsustainable land use practices and waste treatment facilities, impacts on downstream environments, and provide scenarios of catchment land activities (e.g. land use) and industrial waste discharges for improved surface water quality. The study will contribute outputs that can support policy makers to better manage industrial and land-use pollution, in order to preserve the integrity of freshwater resources.

Key words: Kombolcha catchment, Surface water quality, Industrial Effluents, Nutrients, Heavy metals, Pollutants modeling.

Solving the large area demand of constructed wetlands (CW) by means of a "Duplex-CW"

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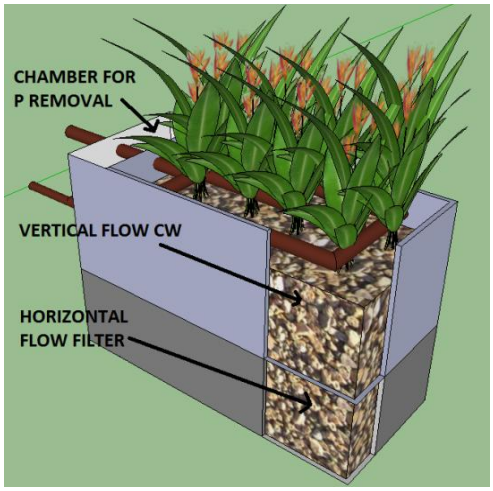

Constructed wetlands (CWs) are one of the lead natural wastewater treatment systems around the world. Throughout the years, many modifications have been applied to those systems in order to improve their performance, but, unfortunately, not much has been done to reduce the large area that those systems required. Hence the aim of this study is to develop a compact CW capable of treating domestic wastewater: the duplex-CW (a vertical flow (VF) CW on top of a horizontal flow (HF) filter and next to a chamber for phosphorus removal, see Figure). The wastewater treatment cycle starts at the VF CW for an oxic treatment, then it flows to the HF filter, the anoxic treatment, and finishes in the chamber for phosphorus removal.

Three duplex-CW (yet, without the phosphorus removal chamber) microcosms were assembled for the purpose of this study. All the HF filters worked similarly (with a retention time (RT) of 3-4 days) while each VF CW worked in a different mode: (i) Fill and drain (F&D, HRT = 1 day), (ii) Stagnant batch (SB, HRT = 6 h - 4 days) and (iii) Free drain (FD, discharging period of ~ 1.5 h). All the VF CW were planted with *P. Australis* and fed in pulses (3 batches of 13 L each, 2 times a week) with primary effluent at a organic loading rate of 16.2 gCOD m^{-2} day^{-1}. Sampling (inlet, VF_{outlet} and HF_{outlet}) and analyses (pH, EC, OD, NH_4-N, NO_3-N, TSS, COD and PO_4-P) were done once a week for a period of 8 weeks.

The water pH showed, in all the cases, neutral values, while EC was maintained in the levels of 1000-1200 µS cm^{-1}.Unexpectedly, PO_4-P removal was very high (85%) in all the systems, and the HF compartments contributed the most, probably due to the high RT. All the systems showed similar organic matter removal, of above 82% for COD and 94% for TSS. Nitrogen forms (NH_4-N and NO_3-N) showed variability among the types of systems: all the VF compartments reduced significantly NH_4-N, mainly F&D system, while no removal was further appreciated in any HF filter. Simultaneously, conversion to NO_3-N occurred in the VF compartments of the F&D and FD systems and it was removed in their respective HF filters. Almost no NO_3-N was found in the SB effluent from the VF compartment, despite the fact that more than 50% of NH_4-N was removed, suggesting that a quick nitrification-denitrification process had occurred. The DO results (>2 mg l^{-1}) suggested that the HF filter is not behaving as an anoxic compartment as expected although NO_3-N removal was encountered.

Overall, the three types of duplex-CWs performed efficiently and similarly when removing organic matter while the SB system showed the best performance in nitrogen removal. Further TN results are needed to elucidate nitrogen removal in the duplex-CW and to find out the system maximum removal capacity in order to increase the efficiency per m^2 and therefore, reduce the CW area requirement.

Fate of bulk organic matter, nitrogen and pharmaceutically active compounds in simulated soil aquifer treatment (SAT) system using primary effluent

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Current surface water withdrawal and groundwater pumping patterns to curb the growing domestic, industrial and agricultural water demand are likely to become unsustainable. As a result, wastewater reuse is increasingly becoming inevitable not only to enhance water supplies, but also to alleviate influx of pollutants discharged to water receptors with poorly treated wastewater. Soil aquifer treatment (SAT) is a low cost natural treatment system in which soil matrix is utilized to remove a wide range of pollutants from primary, secondary and tertiary effluents for subsequent water reuse. Reduction of bulk organic matter, nitrogen and pharmaceutically active compounds (PhACs) from primary effluent during managed aquifer recharge was investigated using five sets of laboratory-based batch reactors. Biologically stable batch reactors were spiked with 2 mM and 20 mM of sodium azide solution to inhibit biological activity. Besides, uninhibited, blank and control reactors were used to probe the effect of microbial activity on attenuation of the selected pollutants. The experimental results obtained revealed that removal of bulk organic matter could be correlated with the active microbial biomass. Addition of 2 mM of sodium azide affected nitrite oxidizing bacteria leading to accumulation of nitrite-nitrogen while ammonium-nitrogen reduction of 95.5% was achieved. Furthermore, removal efficiencies of hydrophilic neutral compounds of phenacetin, paracetamol and caffeine were above 90% in all reactors while pentoxifylline removal was dependent on biological stability of the reactor. However, hydrophobic ionic compounds demonstrated removal efficiency greater than 80% at different microbial activity content.

Keywords: bulk organic carbon; nitrogen; pharmaceutically active compounds; primary effluent

Impact of land use on nitrogen cycling and Water Quality in Rwanda: A case of Migina Catchment

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Anthropogenic activities have nearly doubled reactive nitrogen present on earth over the last century. The excess nitrogen has a cascade of effects, including threatening the water quality of downstream ecosystems sensitive to eutrophication and causing air pollution through nitrous oxide gas production to the atmosphere. In sub-Sarahan Africa, nitrogen dynamics are particularly important to understand because of problems related to N loss from nutrient-depleted soils and the simultaneous eutrophication of water bodies, wetland degradation and lack of food security. This study examines the role of denitrification in N retention in the Migina Catchment, Rwanda.

N budgets determine which parameters of N sources or N losses are important to N retention. A long-standing question in catchment-scale N dynamics is the degree to which denitrification contributes to N retention. The objectives of this study are to: Construct the N budget of the Migina for the years 2008-2014 using secondary data on food, feed, and fertilizer inputs coupled with hydrologic and water chemistry data (Objective 1). Measure spatial and temporal variation of denitrification and study its proximal and distal controlling factors for different land use types including maize, beans, banana, rice, natural wetlands and forests (Objective 2). Denitrification rates will be scaled up at catchment level using DAYCENT and multivariate statistical models (Objective 2, 3 and 4). The estimate of catchment-scale denitrification is compared with the N budget to estimate the contribution of denitrification to N retention.

This research will contribute to our understanding of N dynamics in sub-Saharan African systems. As soil N is lost to downstream ecosystems and fertilization for crop land is expected to increase, this study will help land management, water quality monitoring and wetlands protection.

Keywords**:** DAYCENT, nitrogen, denitrification, land use, N budget, N retention

Multi-scale analysis and coupling of eco-hydrological model and remote sensing for the alpine grasslands (*páramo*) in the Ecuadorian Andean region

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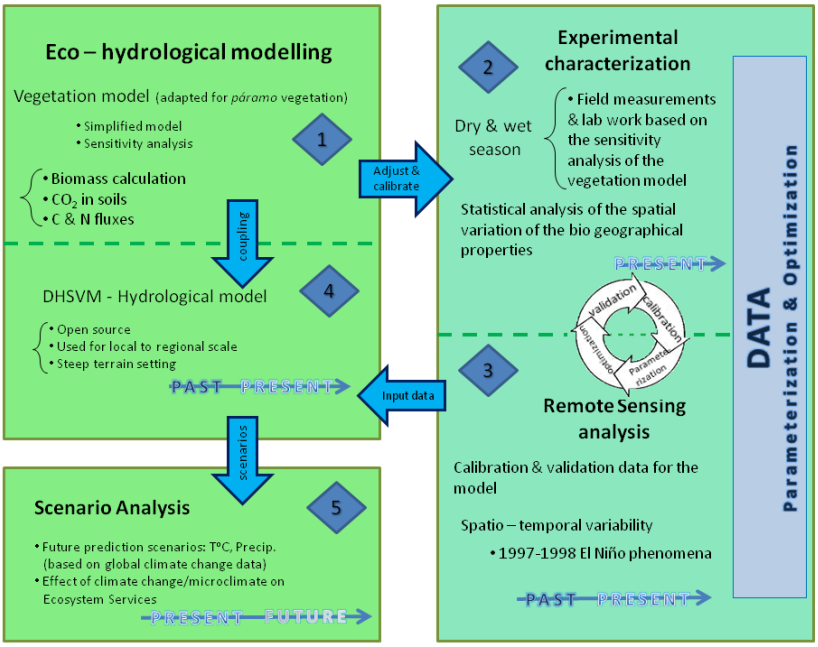
The tropical Ecuadorian highland environments are essential ecosystems that sustain biodiversity, biological processes, carbon sequestration, and water storage and provision. Due to the predominant daily high climate fluctuations these ecosystems are some of the most vulnerable terrestrial ecosystems to global environmental change. Due to its importance, an enhanced and coupled analysis using eco-hydrological tools is crucial for the understanding of the interactions, feedbacks and the functioning of the Andean *páramos* at multiple spatial and temporal scales. For this study the watershed "Los Crespos - Humbolt" was selected due to its typical highland landscape in the Ecuadorian Andean region. This study presents the rationale of the research of the different systems and modelling possibilities at different scales of the biogeographical changes and hydrological vulnerability of the *páramo* vegetation in tropical highlands. This work is carried out in three main steps. Firstly to provide a comprehensive overview of the main features of the *páramo* vegetation in the Andean within the framework of the ecosystem services (carbon storage in soil and water regulation). Later on, analyzing, proposing and discussing the coupling possibilities between patterns of remote sensing data together with meteorological data and experimental field work to obtain indicators of degradation of the *páramo* ecosystem. Lastly, it is presented the identification of ways to evaluate the potential vegetation and water fluxes through eco-hydrological modelling. In this context, the expected results will help to achieve a fair understanding of the impacts of hydrological and climatological changes that could lead to an instability or extreme degradation in the *páramo* region. The work done in this research allowed for the identification of near optimal approach for analyzing the mentioned region with a spatio-temporal coupled model of the regions.



Influence of water regime on plant decomposition in a natural papyrus wetland: case study of Nyando floodplain wetland, Kenya

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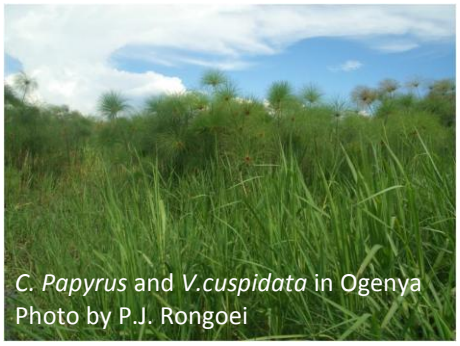
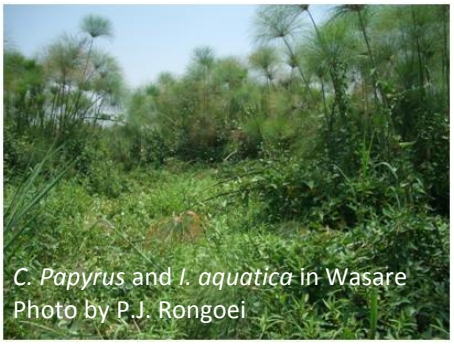


C. Papyrus and *V.cuspidata* in Ogenya
Photo by P.J. Rongoei



C. Papyrus and *I. aquatica* in Wasare
Photo by P.J. Rongoei

Decomposition is an important function in wetlands as it is an important regulator of wetland biogeochemistry and by extension determinant of carbon reservoir particularly soil organic matter in wetlands. As a result, it forms the base for wetland ecosystem food web through nutrient cycling, transport and storage but also form a habitat to numerous life forms. More studies have been done on the decomposition of macrophytes especially under ex situ experiments. However, little is understood on the decay rate of macrophytes in a papyrus-dominated wetland influenced by water regime and disturbance from livelihood exploitation activities. The main objective of this study was to quantify plant decomposition dynamics in a natural papyrus-dominated wetland influenced by hydrology and human exploitation activities. In this study, which covered a period of 112 days (between August and December 2010), in-situ litterbag technique was applied to quantify variation that exists in decomposition rate among the plant species and between transects. Over a period of 56 days, weight loss of plant materials ranged from 11 % to 24 %, 51 % to 77 % and 39 % to 61 % for *I. aquatica,* papyrus umbel and papyrus culm, respectively. Papyrus umbel in Singida transect displayed the lowest decay rate (k=0.004 day^{-1}) while *I. aquatica* showed the highest decay rate in Ogenya (k=0.016 day^{-1}). In addition, fluctuation in water level between sites and between the days of experiments was significant ($p < 0.001$). Conclusively, changes in water and the prevailing physical characteristics of surface water (pH, temperature, conductivity and dissolved oxygen) at the sites might have contributed to the variation in the decomposition rate. Nevertheless, plant types varied in their decomposition rates as they have different characteristics. Therefore, the health of a wetland ecosystem depends on the composition and structure of vegetation present and their rate of decomposition which avails nutrients for primary productivity.

Key words: water depth, *C.papyrus*, *V. cuspidata*, *I. aquatica*, mass loss, decay rate, wetland

Cloud hydro information system and web services

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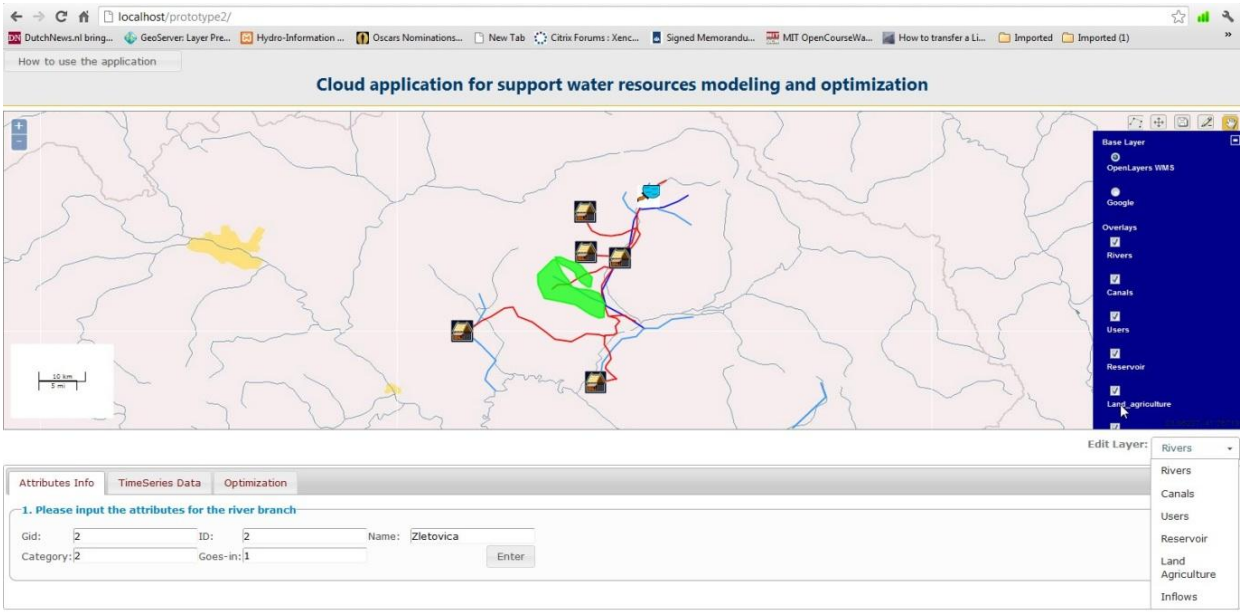
Cloud computing, service oriented architecture and web geographic information systems are the main ideas for developing the cloud hydro information system and the web services. The cloud hydro information system is composed of relational database, middle tier for managing geospatial data, two web interfaces for the specialized services and other software components. Three main web services are developed in the system: (1) web service for managing, presenting and storing of geospatial data, (2) web service for supporting water resources modeling and (3) web service for optimization of water resources allocation. All web services are developed as prototypes and tested for their technical functionalities. The presented cloud hydro information system is a flexible platform for developing new services or upgrading the existing ones. The data, models and services are in the cloud and only a web browser is needed to use the system. Advantages over previous technologies and software solutions are in the availability, accessibility, scalable computation power, interoperability, distributed system components and the provision of internet-based collaboration platform. Link to the prototype cloud application: www.delipetrov.com/his/.



Spatio-temporal assessment of drought in Upper Blue Nile Basin: retrospective analysis and seasonal forecasting

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Retrospective spatial and temporal assessment of drought is investigated for Upper Blue Nile Basin (Ethiopia) using the standard precipitation index (SPI) and Normalized difference vegetation index (NDVI). For SPI based drought assessment, twenty-seven meteorological stations having data length from 1975 to 2003 were used. Among these stations, only five have a long term data record from 1954 to 2009. A procedure was adopted first to test the variation in the drought category under the influence of data length through calculating SPI values for these five stations. Secondly, for NDVI based drought assessment, 459 remotely sensed images (1km by 1km) were processed to assess the vegetation condition over the entire basin. The time lag between the rainfall (SPI) and the vegetation condition (NDVI) was assessed in view of developing seasonal drought forecasting.

The results show that the length of data record, varying from 45 to 26 years, has little influence on drought category. Overall, the tested stations have produced similar drought category regardless of the length of record. Generally, the Upper Blue Nile basin, except the North-Eastern part of the basin, is dominated by mild drought category. The North-Eastern part of the basin is dominated by severe drought and is a known hotspot of historical drought events.

The comparison results of SPI and NDVI further show that there is a two months time lag between the maximum long term average monthly rainfall and average normalized difference vegetation index (NDVI) indicating the potential capability of the NDVI as seasonal drought forecasting tool in the upper Blue Nile basin.

Flood Inundation Modelling and Probabilistic Flood Mapping Communication

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Annually, flood hazards cause loss of life and damage to infrastructure. Consequently, structural and non-structural measures are implemented to mitigate these effects. Flood mapping is applied to show the extent of potential flood hazards and assists greatly in spatial planning and should be as accurate as possible. However, the acknowledgement of uncertainty inherent in hydraulic modelling is an established fact and efforts are focused on the communication of this uncertainty to the users of the end products (Krzysztofowicz, 2001, Montanari, 2007). Challenges in the adoption of uncertainty in the mapping outputs have been hampered by lack of a framework of application and perceived miscommunication (Joslyn and LeClerc, 2012, Ramos et al., 2010). However, efforts are still being applied to overcome the miscommunication (e.g. Leedal et al., 2010).

The study is focused on a stakeholder driven approach to flood inundation modelling and the communication of uncertainty in probabilistic flood maps in Barcelonnette, South France. Hydraulic modelling is carried out using a reduced complexity 2D flood inundation model, Lisflood-FP (Bates et al. 2010), and is based on reconstructing a devastating flood that was experienced in June 1957. Parametric uncertainty and upstream boundary condition inaccuracy are taken into account, under a Monte-Carlo based approach, to cater for uncertainty in hydraulic modelling.

The study is focused on understanding the practical challenges of stakeholder involvement in flood inundation modelling and to pave way for a proposed framework for uncertainty communication in flood mapping. Preliminary interaction with the stakeholders has been done through a series of presentations and meetings. Initial interaction with the stakeholders in the region has shown good understanding of the issues involved and the need for a continuous cyclic interaction (e.g. Refsgaard et al., 2007).

Assessing the usefulness of SRTM topography to support hydraulic modelling under uncertainty

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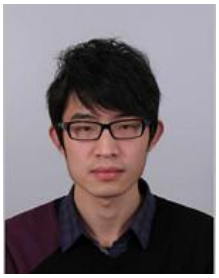

The consequences of recent catastrophic events have highlighted that flood risk prevention still needs to be improved to reduce human losses and economic damages. The desirable topography data based on ground surveys for model building and calibration to support the decision making process in flood risk management are often not sufficient or unavailable. Accurate remote sensing data coming from the Light Detection and Ranging (LiDAR) is expensive and often cannot be directly used. In this connection testing the usefulness of freely and globally available data, such as the Shuttle Radar Topography Mission (SRTM) in supporting hydraulic modelling of floods is of extremely high interest from both a scientific and engineering point of view. However, it is not clear to what extent exactly modellers can trust or make use of these topographic data, particularly under major source of uncertainties which unavoidably affect the hydraulic modelling of floods. Therefore, two studies were carried out to explore the usefulness of SRTM topography: River Po in Italy and River Dee in UK which are characterized by different scales. The comparison between a hydraulic model based on high quality topography and one based on SRTM topography was carried out for each case study by explicitly considering other sources of uncertainty (besides topography inaccuracy), such as parameter and observation uncertainties. The results of this study shows that the differences between the high resolution topography-based model and SRTM-based model are significant, but still within the accuracy that is typically associated in flood studies. Lastly, the limitations of using global topography data for supporting floodplain mapping in medium-small rivers are highlighted.

Integrating earth observation and meteorological data, in-situ monitoring, and numerical modelling to reduce uncertainty in water management

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Information on hydrology has been increasing significantly in the recent years, either on availability, source, type, size, spatial and temporal resolution, or reliability. One type of information that gets lots of attention is the hydrological information coming from earth observation (EO) or so called remote sensing (RS). With the advantages of being able to capture spatial variability, provide global coverage and decreasing procurement costs, EO based data becomes a more common data source in hydrology. Examples of EO products are actual evaporation, rainfall, leaf area index and soil moisture. Another type of data that has gained interest is coming from the meteorological model products. This data becomes important due to the ability to give weather forecasts, which can be used as input to operational models. Together with in-situ monitoring and hydrological modelling, these information sources have been building up modern hydrology and water management.

With many sources of information, it is expected to potentially have a better hydrological end result to support water management. The information on strong spatial variability comes from EO data, accurate forecasts from meteorology, long records from monitoring stations, and integration of these from hydrological modelling. Together this could lead to higher confidence in managing water resources. However, the huge data stream brings its own downside. One of the problems that receive hydrologist attention is the uncertainty. Each of the data sources comes with its own uncertainties. With the merging of those data it is possible that the uncertainty is building up and leads to high discrepancy in the final result. Therefore, there is a need for innovative approaches to integrate all those data and reduce uncertainty.

This research is aiming at developing a hydrological modelling approach that is able to integrate and utilize EO and meteorological products, in-situ monitoring data and numerical hydrological modelling and is able to reduce uncertainty for water management. The integration will be done in various ways; through calibration/validation process, data assimilation, and feedback loops. Some of the integration methods are already available and studied by various researchers, however, the comprehensive integration of more than two data sources and data types is still rare. Feedback loops that give the output back to the data processing are also rarely studied.

The approach should be tested in various conditions, such as different model types, hydrological characteristics, and data sources. A distributed hydrological model is thought to have better capabilities in utilizing EO data, but this type of model also suffers from long run-time and complex calibration. Hence for the other types of models such as lumped models, it also need to be examined how much these will benefit from the additional data sources. The approach will be tested in a well-gauged catchment, as represented by the Rijnland area in Netherlands, and an un-gauged catchment (or limited gauged) as represented by the Umbeluzi Catchment in Mozambique case study. The two case studies also resemble a highly controlled catchment and a natural catchment respectively.

Spatial Data Infrastructure and WaterML in a Networked Environment for Stakeholder Participation (NESP) in river and flood management

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A Networked Environment for Stakeholder Participation (NESP) is seen to address some of the challenges and hindrances in the stakeholder participation in river and flood Management. NESP are web-based computer-aided environments for remote virtual interaction between participating entities such as stakeholders. NESP is envisioned to enable stakeholder participation in river and flood management by providing sharing of information, planning, negotiating and decision support. The recent advancement of ICT (Information and Communications Technology) is foreseen to provide innovative solutions for the development of the NESP. The main objective of this work is research into conceptualisation, design and implementation of an innovative web-based virtual environment for stakeholder participation using the recent advanced ICT technologies.

Five case studies were selected for the application of NESP's, one in Germany, UK, The Netherlands and two in Romania. NESP's development and testing was already done for Germany, UK and the Netherlands. The NESP's for the two case studies in Romania are still underdevelopment.

The NESP's for the Romanian case studies will explore and implement the latest technological advances for collection, archiving and sharing of environmental data using web-based Spatial Data Infrastructure (SDI). Current trends in sharing and accessing spatial data are geared towards the use of Spatial Data Infrastructure (SDI) technology. SDI's are designed for interoperability that publishes data from any major spatial data source using open standards. The environments for this case studies is based on the EnviroGRIDS SDI (GeoServer and GeoNetwork), that is a set of web and grid services through which the system store, manage and query data collections, run applications and map the results. Lately, UNESCO-IHE has also established its own SDI using the GeoServer and GeoNetwork.

There is also a standardized Extensible Markup Language (XML) designed for publishing time series data over the internet via web services, such standard is the Water Markup Language (WaterML 2.0). The WaterML 2.0 is a candidate Open Geospatial Consortium encoding standard for the representation of in-situ hydrological observations data. The NESP's for the Romanian case studies will explore and implement the WaterML 2.0 application schema using the GeoServer web services. It will implement the framework and methods that was newly developed by a team from Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia.

Key words: River and flood management, Stakeholder participation, Internet, Web, Spatial Data Infrastructure, Time series, WaterML.

Rice Yield Improving Factors in Tropical Savannah of Burkina Faso

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Joining the current general effort to improve the yield of rice, a crop of special interest in West Africa due to its socio-economic and political implications, the current experiment was designed to identify the most important factors to increase the yield of this crop. With the intention of limiting the interference of confounding variables that may occur in field measurements in farming plots of valley bottoms in a Tropical Savannah area in Burkina Faso, 12 concrete microplots where constructed. Each microplot has a surface of 1 m² and a 1 m rootzone extracted from the top soil in the area, and this rootzone is limited on the top by a tap for the surface water layer drainage control, and at the bottom by another tap for the subsurface drainage bringing oxygen in the soil profile. Three of the microplots were used as controls, in which the bottom taps were kept closed, and hence reproducing the real farming conditions in valley bottoms of tropical Savannah, victim of iron toxicity limiting rice yields, where the internal drainage is usually null. The remaining 9 microplots were used as treatments with their bottom tap kept open to allow drainage flow within the rootzone. The 9 microplots were separated during the rainy season of 2011 into two groups, one group being irrigated 7 days and the other one 14 days. This separation aimed to differentiate oxygen deficiency in the root zone, driven factor of the development of biochemical reactions toxic to rice and reducing its yield. The rice cultivated was FKR19, a cultivar from Oriza Sativa, the Asian rice. The measurements were performed over 4 months. The dissolved oxygen measured at 3 depths – 10 cm, 20 cm and 30 cm – in the microplots show that the values are slightly higher in the treatments – mode = 1.3 mg/l – than in the non-drained controls – mode = 5.8 mg/l. These values tend to decrease along the season, but the more aerated treatments conserve their improved oxygen concentration in the soil compared with the treatments. At the end of the season, the drop of the aeration reaches a mode of 1.3 mg/l vs. 0.3 mg/l in the controls. The rice yields, under the given fertilisation conditions, are considered to be good with an average of 14 tons/ha in the treatments vs. 12 tons/ha in the controls. The common recognized potential yield for this rice cultivar is 7 tons/ha. Therefore, it seems that not only subsurface drainage, but also the water management and the confinement of the fertiliser in the microplot considerably improve the rice yield.

Crop Coefficient for Specific Growth Stage of Teff in a Semi-Arid Region in Central Rift Valley of Ethiopia

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The crop coefficient (Kc) can be established between evapotranspiration and climate, which is the ratio of crop evapotranspiration (ETc) to reference crop evapotranspiration (ETo). Accurate prediction of crop water requirement is a key to develop efficient irrigation water planning and management. Results about the crop coefficient for irrigated Teff growing in semi-arid region of eastern Ethiopia are not currently available. This study has been initiated to determine specific crop growth stage of Kc and crop evapotranspitation (ETc) for Teff (Eragrostic Tef) at the experimental farm of Melkassa agricultural research centre, located in a central rift valley, semi-arid region of Ethiopia. The relationship between Kc and days after sowing (DAS) and growing degree days (GDD) was also investigated. Two varieties of Teff (Gemechis and kuncho) and four non-weighing lysimeters were used to determine Kc for the experimental year of 2010/11, 2011, 2011/12 and 2012. The average seasonal crop evapotranspiration (ETc) for the experimental years of the research period is ranged from 299.4 to 342.4 mm. Crop coefficient curves and various mathematical relationships were developed for growth period to estimate the crop coefficient for this crop. This calculated Kc values were 0.5, 0.7, 1.1 and 0.6 mm for the initial, developmental, mid season and late season stage, respectively. Furthermore, fifth - order polynomials are presented to predict the Kc values from the days after sowing (DAS) and growing degree days (GDD).

KEY WORDS: Crop evapotranspiration, Crop coefficient, Teff, Lysimeter, Awash rift valley.

Water Delivery and Distribution Performance in Metahara Large Scale Irrigation Scheme in Ethiopia under the Existing Operational Setting

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Water distribution, delivery and hydrodynamics in manually operated gravity irrigation systems is often complex. The nature of the hydrodynamics and its impacts on water delivery is less understood both by operators and system managers. This paper evaluates the existing operations of Metahara large-scale Sugar Estate irrigation system with respect to indicators of adequacy, efficiency and equity, and assesses impacts of hydrodynamic behaviour on water distribution. It also proposes alternative operational rule that would ensure better water distribution and delivery. The irrigation scheme has a total gravity-irrigated area of 10,300 ha for sugar cane; with extensive network of canals whose flow control structures are exclusively manually operated. The system requires continuous operation of control structures to ensure optimum water distribution. However, due to little knowledge of operators of the complex hydrodynamic behaviour of the system, faulty operation often results in non-uniform water distribution in space and time, water losses and inequity within the system.

Results indicated that the average annual irrigation supply is in excess of demand by about 17%, accounting for about 23Mm^3 of unintended diversion. With frequent shortage of water in some parts of the scheme, the excess diversion is apparently lost in the conveyance and distribution systems. The water delivery performance at head, middle and tail offtakes were evaluated based on measured offtake flows. Results indicate the adequacy of water delivery is superior at the tail reach offtakes, followed by head offtakes. Middle reach offtakes, being fed directly from a reservoir whose capacity has reduced by sedimentation, divert insufficient supplies. Similarly, equity is inferior in the middle reach offtakes due to significant fluctuation of reservoir storage and hence water level in the outlet canal during a day, which greatly affects offtake deliveries. Failure of operators to cope with the complex hydrodynamics in the existing operation of the system has caused chaos in water delivery and distribution. Faulty operation of the main intake sluices, flawed operation of reservoir outlet sluices that does not consider storage volume and sedimentation, untimely closure of irrigation offtakes, absence of regular calibration of flow measuring structures at offtakes and hence wrong flow assumptions (25% overestimated on average) are among the major operational flaws. The collective effect of all these was water wastage in the distribution and at tail ends, inequity, shortages and excesses. An alternative non-linear relationship between gate setting and discharge at the main intake has been developed to assist operation. Partial opening of reservoir outlets during irrigation hours helps to maintain steady outflow during the day. Extending the closure time of tail offtakes by 2 hours would reduce run-off losses at tail ends.

Water Flux Exchanges in a Papyrus Wetland in Lake Victoria, Kenya

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Ecohydrological experiments were conducted at a 4,000 ha papyrus wetland and its surrounding area, situated on the eastern shores of Lake Victoria, Kenya. Nyando wetland supports a fragile ecosystem and community livelihoods in one of the most densely populated parts of East Africa. The main objective of the study was to understand groundwater-surface water interactions between the river, lake, and alluvial aquifer in the wetland and surrounding area. Sampling was carried out along two main transects based on the hydrological, ecological and socio-economic gradients. Climate data were collected hourly using a weather station. Pressure sensor transducers were used to log groundwater levels, river and lake stages and temperature data at hourly intervals. Hourly volumetric soil moisture content data were recorded using the ECHO2 sensors at 30 cm, 60 cm and 90 cm depths, installed adjacent to the river, lake and wetland periphery. All data loggers were synchronized to record data on top of the hour. In addition, staff gauges and rain gauges were manually read on daily basis by Observers. Routine *in-situ* water quality measurements were undertaken at the wetland and surface water bodies. Conceptual models were developed for the dominant local scale water exchange fluxes during flood and drought events. Results show that the river and lake are hydraulically connected to the wetland alluvial aquifer and the water fluxes exchanges are controlled by hydraulic heads and prevailing climatic conditions. Understanding these water exchange fluxes provides vital knowledge for the conservation and management of papyrus wetlands in the East African region.

Keywords: Papyrus, Nyando wetland, Conceptual model, Water exchange fluxes

Paddy terraces of *Subak* irrigation schemes facing a water shortage An interpretation of fieldwork and first data analysis

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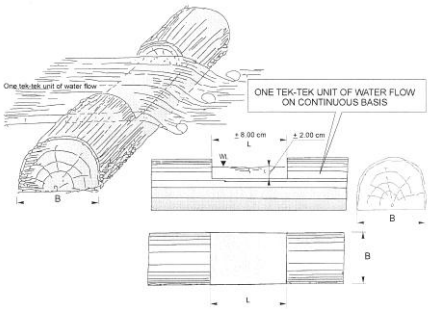

Paddy terraces are typical landscapes of *Subak* irrigation schemes in Bali, Indonesia and several other Asian countries. UNESCO has officially acknowledged Bali's traditional *Subak* agricultural systems in its World Heritage List during the organization's annual meeting in Saint Petersburg, Russia, on June 29, 2012.

A *Subak* irrigation scheme, primarily in Bali Indonesia is an irrigation scheme of which the construction, operation and maintenance is based on agreed principles of technology, management of agriculture and religious community. *Subak* irrigation schemes are based on the continuous flow system called *tektek/kecoran*. The size of one *tek-tek* is approximately 8 cm width and 2 cm height that can supply an area of about 0,3 -0,4 ha. Even though the majority of irrigation infrastructure consists of simple irrigation structures, the indigenous knowledge of institutional management and water sharing have survived to cope with this condition since more one thousand years. As long as the water sharing is agreed upon by all members of *Subak*, although in scientific calculation is not quite accurate, they will accept it as a fair and equitable water sharing. However shortage of water has developed, and *Subak* farmers are facing a challenge to still operate their *tek-tek* system.

The study area is located in Yeh Ho River Basin in South of Bali, which has 124 km^2 of cathment area, 35.5 km of main river length and 5,268 hectares of irrigated fields. The river basin has three systems and several new and old hydraulic structures. In the upstream, a bron captering of Gembrong Spring is utilized for domestic needs since 1987, Aya Weir, *Empelan Benana*, and Penebel Weir. In the midstream, Telaga Tunjung Reservoir has operated since 2006, Caguh Weir, and Meliling Weir. In the downstream, Gadungan Weir has operated since 1938 and Sungsang Weir is the last weir.

The water balance of each weir has been analyzed based on daily discharge data using empirical flow frequency analysis. A popular method of studying the variability of streamflow is through flow duration curves which can be regarded as standard reporting output from hydrological data processing. The same trends of all weirs in the upstream, midstream and downstream prove that most discharge is diverted to the intakes. On the other hand the off-takes are not controlled during the dry season period of June until October in the upstream, May until November in the midstream, and May to December in the downstream. In the wet season, the same trends show that the return flows increase sharply to the downstream.

A conclusion of scientific perspective, there is a significant similarity between *tek-tek* as continuous flow system and no off-takes controlled during the dry season. With no precise measurement in relation to the water intake by each weir, which is associated with the number of paddy fields, accurate study is needed to determine the water balance in the small system, especially in one *tek-tek* system.

Key words: tek-tek/the continuous flow system, shortage of water, water balance, river runoff, no off-takes controlled

Sustainable Land and Water Use Under Rainfed and deficit Irrigation in Ogun-Osun River Basin, Nigeria

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Besides continued land degradation and fluctuating rainfall, South-western Nigeria receives rainfall of high intensity that rapidly erodes the soil and nutrients. Short droughts in August further undermine the crop performance. Soil conservation practices combined with innovative agronomic practices and cultivation of leguminous crops can be very promising to check soil erosion and also retain more water for optimal plant growth. These findings are based on an experiment conducted on a cultivar (TGX 1448 10^{E}) of Soya bean (*Glyxine Max. L. Mer.*) cultivated in a Completely Randomized Design with four replicates during rainy seasons (May-September) of 2011) and (June-October) of 2012 at the Teaching and Research Farms of Obafemi Awolowo University, Ile-Ife, Nigeria. Seven soil and water conservation treatments were applied, namely: Tied Ridges (TR); Mulch (ML); Bund (BD); Tied Ridges and Mulch (TRBD); Mulch and Bund (MLBD); Tied Ridges and Mulch (TRML) and Conventional Method (NC). Guinea grass (*Pernicetum maximum)* was used as mulch material. The results indicate that Tied Ridges and Mulch (TRBD) provided very high leaf area indices and canopy cover up to 94%. Similarly under TR and NC treatments, dry biomass at harvest reached to 4.01 and 5.16 t/ha respectively. Yields at harvest varied from 2.04 to 2.65 t/ha under TR and TRBD treatments respectively. Harvest index (HI) was found to be 49% and 53% with NC and TRBD treatments respectively. Cumulative soil moisture storage ranged from 1981 to 2133mm under NC and TRML conservation treatments. High canopy cover obtained under TRBD indicates that soil water evaporation reduced and soil was better protected under heavy tropical rainfall which is common in the basin. Gains made in conserving water in the root zone and higher yields from cultivation of soya beans substantiate that tying of ridges and use of mulches have high potentials in ensuring sustainable use of land and water resources in the sub-humid tropical area in Nigeria. The field work is in progress and more experiments will also be conducted on deficit irrigation of soya beans during the dry seasons of 2012 and 2013 in the location stated above.

Characterization and identification of manganese oxides present in naturally coated filter media from conventional aeration-filtration groundwater treatment plants

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Groundwater is world-wide the predominant source of drinking water production. In addition to several other impurities (e.g. iron, ammonium, methane), groundwater frequently contains elevated levels of dissolved manganese, which needs to be reduced for both, health and aesthetic reasons. The removal of manganese from groundwater is commonly achieved through aeration-rapid sand filtration. Such treatment approach is the most cost effective but in practice this treatment is frequently associated with several problems. One of the biggest problems is the very long ripening period (several months to more than a year) of virgin filter media, to achieve effective manganese removal. Characterization and identification of filter media obtained from conventional aeration-filtration groundwater treatment plants can help to unravel the controlling mechanisms to start up proper manganese removal easy and quick.

The aim of this study was to provide insight information of the characteristics of coated filter media, obtained from some selected groundwater treatment plants (GWTPs) in The Netherlands and Belgium and to identify the manganese oxide(s) of interest inside of the coating. The coated filter media was obtained from treatment plants based on conventional aeration-filtration systems, with complete manganese removal and without use of strong chemical oxidizers. Used techniques to characterize and identify manganese oxides are: X-ray diffraction, Raman spectroscopy, SEM-EDX and Electron paramagnetic resonance (EPR).

Based on the X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and Raman spectroscopy analysis emerging from this study, it can be concluded that the manganese oxide in the coating of the filter media is poorly crystalline. Furthermore based on Raman spectroscopy and Electron Paramagnetic Resonance (EPR) analysis, the manganese oxide was found to be a Birnessite type of manganese oxide. Finally from detailed EPR analysis and comparison with literature the Birnessite type of manganese oxide was found to be of abiogenic origin, most likely δMnO_2 or “mineral Birnessite”.

Aluminum (hydr)oxide coated pumice for fluoride removal from drinking water

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Removal of fluoride from drinking water is important in order to safeguard public health. The adsorption process is widely considered the most appropriate technology for drinking water defluoridation, if a suitable adsorbent is available. A large number of materials have been tested as suitable adsorbents for water defluoridation. The applicability of most of these materials is, however, limited either due to low efficiency, lack of socio-cultural acceptability and/or applicability only at extreme pH values. In this study fluoride removal behavior of aluminum oxide coated pumice (AOCP) was investigated. AOCP was effective in reducing initial fluoride concentration in model water from 5.0 ±0.2 mg/L to 1.5 mg/L (WHO guideline value) in about 1 hr, using a dose of 10 mg/L. At a neutral pH of 7,which is a more practical condition for application, fluoride adsorption by AOCP was much faster than that of activated alumina (AA) which is considered the best and commonly used adsorbent for drinking water defluoridation (Fig 1). Moreover AOCP exhibited strong fluoride adsorption at pH between 6-9 which makes it possible to avoid the need for pH adjustment with the associated cost and operational difficulties especially in developing countries. The adsorption of fluoride by AOCP conformed reasonably to both the Langmuir and Freundlich isotherm models with a maximum adsorption capacity of 7.6 mg/g. The mechanism of fluoride adsorption by AOCP may probably be due to a combination of specific and non-specific adsorption processes. Aluminium oxides species bound onto pumice particles are stable at pH values typical of natural waters, thus deterioration of treated water due to the release of aluminium may not be a concern. AOCP is thus a promising adsorbent for drinking water defluoridation.

Keywords: Fluorosis; pumice; Aluminum (hydr)oxide coating; Activated alumina; Adsorption.

Decision Support System for Sanitation Technical Options in Emergency Situation

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Natural and anthropological disasters may lead to the displacement of large populations into temporary settlements or camps with over-crowding and rudimentary shelters, inadequate safe water and sanitation, and increased exposure to disease vectors. Majority of diseases that caused higher mortality and morbidity in displacements has strong correlation with the state of environmental sanitation. Those diseases are cholera, diarrhea, worms, skin irritation, eye irritation, to name amongst the many. Without proper sanitation, people in displacement would be very likely to contract these diseases. Some of these diseases are fatal. A recent study by Degomme (2011) on the cause of death in Darfur, Sudan, highlighted the importance of improving sanitation in displacement camps. It found that majority of death occurred not due to the violence but due to diseases that were contracted as the result of overcrowding and unsanitary conditions in displacement camps.

The way an excreta disposal technical option was selected in an emergency response is at the providers' disposal. The providers refer to different relief agencies and local authorities. Carefully planned emergency responses by those stakeholders would result in effective responses, decreasing morbidity and mortality rates that may happen otherwise. There need to be a decision support tool that helps sanitation providers to select which emergency sanitation technical option.

Most of developed decision making tools for sanitation options were intended for the use in development context. Amongst few available decision-support-tools for emergency sanitations were found lacking in terms of capturing the particular requirements of emergency responses, universality, inclusion of some of the latest developed technologies, and user-friendly interface.

This research aims to create a computerized decision support tools for emergency sanitation that incorporate the complexity of emergency, as well as trying to address what were lacking in previous emergency sanitation decision making tools. It hopes to contribute to the better sanitation responses in emergency situations around the world. Currently, the research is at preliminary stage, building the logical framework as the computer program basis.

An example of pit-latrines in a displacement camp, view from outside (left), the squatting pan (right)

Novel Concepts and Technologies for Excreta and Wastewater Management in Challenging Emergency Conditions

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As observed in the past, emergency sanitation has received less focus than its counterpart emergency water supply. Relief agencies and donors are generally more willing to fund expensive water treatment units than to make the expenditure for sanitation systems. Consequently, there has been stagnation of innovations in the emergency sanitation technologies making the traditional approaches like the conventional pit latrine the most popular choice. These approaches have, however, proved inadequate in challenging emergency conditions especially in flooding conditions; poor ground conditions such as high water tables and collapsing or loose soils; urban scenarios with limited land space and high population densities; areas with land ownership issues; and areas that have limited or lack waste treatment and disposal facilities. In addition, the processes of latrine emptying, treatment and disposal of the faecal sludge have presented challenges to the relief workers. Lack of proper treatment and disposal methods have resulted to unsafe practices which pose enormous risk to public health. For instance, crude dumping of untreated faecal sludge was observed in Haiti after the 2010 earthquake that was suspected as one of the causes of the cholera outbreak in the country. Emergency wastewater management is another area that has been overlooked despite the fact that wastewater is generated in emergency healthcare centers and in camps where wet sanitation systems are applied. Generally, there has been lack of initiative to develop innovative wastewater treatment options tailored for application in emergency situations. Furthermore, the choice of optimal solutions from the available sanitation options is challenged by the tendency to use standard practice and/or the intuition of the planner. This can be attributed to the lack of a decision support system founded on a well established selection process which is necessary to guide in identifying the most appropriate sanitation options for specific emergency scenarios.

The proposed study is aimed at addressing the challenges and issues in emergency sanitation as discussed above. The main objective of the research is to contribute in providing a lasting solution to the sanitation issues associated with excreta and wastewater in challenging emergency conditions. The specific objectives of the research are to review the wastewater/excreta treatment and disposal technologies potential for application in emergency relief; to develop a criteria set on which a decision support system for the selection of emergency sanitation options can be based; to develop and test a unit that incorporates desludging and treatment using barrel reactor and vacuum suction, to develop and test the performance of a faecal sludge treatment unit based on microwave irradiation, and to evaluate the performance and applicability of a membrane bioreactor (MBR) system coupled with a unit providing pre-dissolved oxygen (SDOX® unit) for treatment of concentrated blackwater as generated in emergency situations.

Keywords; emergency sanitation, faecal sludge, microwave irradiation, barrel bioreactor, MBR

Impact of Salinity on the Aerobic Metabolism of Phosphate Accumulating Organisms

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Water shortage is an increasingly global problem and therefore there is a need for innovative water management solutions. Direct use of saline water as secondary quality water for non-potable purposes appears to be promising towards reducing water stress in the urban water cycle. In Hong Kong considerable developments were made on the utilization of seawater as secondary quality water and the treatment of saline wastewater. However, there are still several challenges from both the technological perspective and on a fundamental basis. The effect of salinity on biological phosphorus removal in activated sludge systems remains unclear and no processes for biological phosphorus removal from saline wastewater have been developed yet. The objective of this research was to study the effects of salinity on the aerobic metabolism of phosphate accumulating organisms (PAO), the microbial population that is responsible for enhanced biological phosphorus removal (EBPR) in activated sludge systems. The impact of salinity on the aerobic metabolism of an enriched PAO culture was assessed, during short-term exposure to NaCl. All kinetic rates were affected by salinity, being the PO_4 uptake rate and NH_4 uptake rate the most sensitive rates. An increase from 0 to 0.5% salinity caused a 100% inhibition of the PO_4 uptake rate and the NH_4 uptake rate. Above 0.5% salinity a net-PO_4-release rate was observed instead of a net-PO_4-uptake rate. The present study indicates that biological phosphorus removal from wastewater appears to be significantly affected when salinity increases up to 0.2% salinity. This suggests that any replacement of fresh water consumption by saline water for household purposes can lead to deterioration of biological phosphorus removal in the wastewater treatment systems. More research is needed to investigate if PAO can acclimatize to salinity or if more salt tolerant strains can be selected during long-term exposure to salinity.

Cost-Effective Municipal Wastewater Treatment by Coupling of UASB and ANAMMOX Reactors

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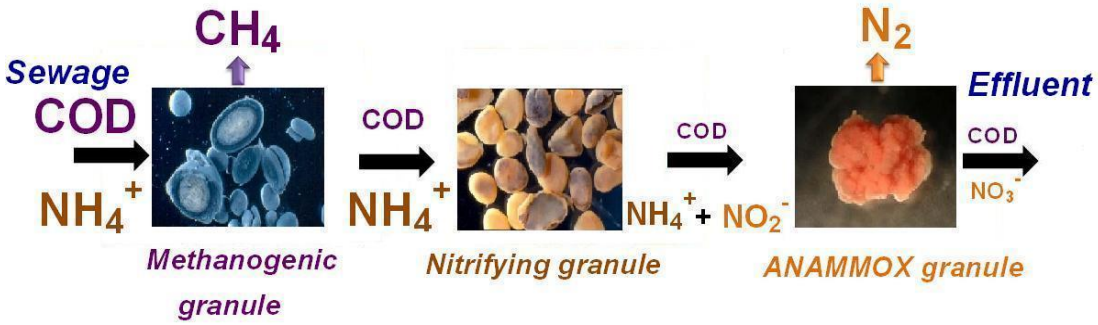

The primary source of Nitrogen pollution in urban zones comes from sewage. The world population living in these areas is 50.1% and it is expected to increase in 2.9 billion inhabitants in year 2050. Nitrogen from treated and untreated sewage is transported by rivers from urban areas to the coasts and some estimations of this riverine nitrogen input include: United States: 12%; Western Europe: 25%; China: 33%; Republic of Korea: 68%. The contribution of the dissolved inorganic nitrogen (NH_4^+ + NO_3^- + NO_2^-) estimated by modeling shows an increment for all scenarios in year 2030. Nitrogen from sewage is one of the primary drivers of eutrophication. A growing tendency to coastal eutrophication of world oceans has been identified and about 500 coastal areas of the planet are suffering from eutrophication. Simultaneously, the global coastal hypoxia (*dead zones caused by low dissolved oxygen concentrations, usually less than 2 mg/L*) has increased over the past 50 years as consequence of nitrogen input from urban sewage. The actual schemes for Nitrogen removal from sewage consist of main and side stream processes. The main stream process (*sewage treatment in the main line of the wastewater treatment plant*) incorporates anoxic and aerobic stages with the aim to induce Nitrogen removal through autotrophic nitrification (*oxidation of ammonium to nitrate*) and denitrification (*reduction of nitrate to dinitrogen gas*). The side stream process (*referred to the treatment of internal process flows, e.g. the reject water from sludge treatment facilities*) is achieved by coupling SHARON and ANNAMOX reactors. SHARON reactor is aerated and 50% of ammonium is transformed to nitrite by aerobic autotrophic ammonium oxidizing bacteria (AOB). In a second reactor the conversion of ammonium and nitrite to dinitrogen gas takes place under anoxic conditions (ANAMMOX process). The main objective of this research is to study the feasibility to achieve the biological removal of carbon and nitrogen in the main stream of sewage treatment by the combination of two wastewater treatment processes in one integrated system: methanogenesis (in a UASB reactor) and ANAMMOX. Three specific objectives have been identified: (i) to determine the effects of the characteristics of the effluent of a UASB reactor on the growth and development of AOB and ANAMMOX bacteria; (ii) to provide relevant information for the development of the design of the UASB-ANAMMOX system and operational guidelines for sewage treatment; (iii) to develop and coupling the mathematical models that describe the performance of the UASB and ANAMMOX

reactors for sewage treatment under diverse operational conditions. With respect to the influence of the characteristics of the effluent of the UASB reactor on ANAMMOX activity, preliminary results have shown a substrate conversion ratio of NO_2^-/NH_4^+ close to the value reported in the literature 1.32, for batch experiments taking into account COD source, C/N ratio and temperature. Also, qualitative assays for testing the influence of the lack of calcium, magnesium and iron in the substrate for ANAMMOX bacteria have demonstrated a disaggregation of ANAMMOX granules during the experiments.

Sustainable management of human excreta through terra preta sanitation approach

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It is more and more recognized today that the conventional waterborne and on-site excreta disposal systems failed to meet the sustainability criteria due to their linear character of pollution and wasting of valuable nutrients. Ecological sanitation cover most of these gaps, by offering easier, decentralized approaches to manage human excreta, reducing the energy and material costs and returning nutrients to the soil. In spite of the huge advantages of Ecological sanitation, there is still insufficient knowledge on what are the best approaches for reducing the handling of excreta, the time required for faeces sanitization and conserving more nutrients for their reuse in agriculture. Terra Preta Sanitation arises as an alternative for improving management of source separated human excreta. This concept was inspired from the Terra Preta soils, which have gained a worldwide recognition for their long lasting fertility. These anthrosols discovered in Amazon River basin were created by pre-Columbian population through intentional and unintentional disposal of charcoal and organic waste, including human excreta. Terra preta sanitation involves lactic acid fermentation and vermicomposting, which ensures short term reduction of pathogens and conserving more nutrients (such as nitrogen and phosphorous) and organic matter in the final product. Among other advantages of terra preta sanitation are smell reduction and minimization of handling.

The current research aims at investigating the application of terra preta sanitation approach for improvement of the management of human excreta in urine diverting dry toilet systems under the conditions of the Republic of Moldova. The study will consist of a pilot stage for identifying the best terra preta like substrates and studying their effects in a two year field experiment. Human faeces are used in combination with cattle manure due to limited available quantity for field application. Also, it is believed that this will increase the acceptance for faeces reuse, as cattle manure is already a common local practice. The obtained terra preta substrates will be compared to stored human

excreta and cattle manure. The results from the pilot experiments demonstrated that adding of charcoal during lacto-fermentation, could not decrease pH to an acceptable level. The earthworms accepted the lactofermented substrate, however, only after its exposure to aerobic conditions. Based on pilot study, a decision was made for field application, to add charcoal at the end of lacto-fermentation by preliminarily charging it with nutrients from urine. During October, the obtained lacto-fermented substrate will be applied to the field and during spring the effect on soil and corn will be investigated.

Probabilistic Evaluation Framework: A Breakthrough in High Density Slum Sanitation Technology selection?

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Despite the effort put in provision of water and sanitation to all people, dismal progress has been made on the MDG sanitation target. Globally, an estimated 2.5 million people were still without improved sanitation in 2010. This is mainly due to high population growth rate with increased rural-urban migration rates where majority of urban migrants settle in informal settlements (slums). In sub-Saharan Africa the incidence of slums is at 62% of the urban residents and is the highest in the world. Provision of sanitation facilities to slum dwellers is met by a lot of challenges that include; poor site conditions, unreliable water availability, high population density, heterogeneous nature of the population with different beliefs, increased poverty levels and lack of land tenure. Decentralized on-site sanitation alternatives have been developed for application in developing countries and decision making support tools (DMST) developed in an effort to help planners in decision making process. Despite these developments, open defeacation, uncontrolled release of excreta in storm water drains, flying toilets and disposal of excreta wrapped in plastic bags in solid waste dumpsites are unhygienic methods of excreta disposal in slums. Thus approaches used in provision of slum sanitation have proved to be inefficient. This is particularly due to poor technology selection approaches that use DMST that were developed for use in rural, urban and peri-urban areas which have very different characteristics from those prevailing in slums. Among all the deprivation experienced in the slums, sanitation requires special focus due to its ability to cause pollution with adverse health implications both within and outside slum settlements.

In order to meet the MDG sanitation target, more research on slum sanitation provision is required. This research aims at addressing the short comings of the currently used approaches in sanitation provision to the unplanned high density slum settlements. The main objective of this research is to develop elaborated adequate sanitation solutions for unplanned high density slum settlements in developing countries. The main objective will be met through a series of specific objectives. An inventory of all sanitation technologies used or with potential for application in slums will be prepared. An understanding of the current slum sanitation approaches will be made by identifying

the roles of various stakeholders in excreta flow chain and also determination of the factors that hinder efficient application of sanitation technologies in slum. A probabilistic evaluation framework will then be developed based on a defined set of criteria and indicators in which sanitation options will be selected on a two stage process involving screening and probabilistic evaluation. The probabilistic evaluation will consist of probability evaluation nodes, route planning nodes and the result node. Methods for quantification of the steps in the probability evaluation nodes will be developed. The input to the probability evaluation framework is a sanitation technology option used or with potential for application in slums where all options will be evaluated on a one by one basis. The results from all the technologies will be compared and ranked based on the performance. To improve the performance of the selected options, methods will be developed to address the low score probability in the sanitation chain. The concept of resource recovery on the probability evaluation will lastly be evaluated.

Key words; Slum sanitation, Excreta, Probabilistic evaluation, DMST, Resource recovery

Enhanced Methane Production from the Anaerobic Co-digestion of Rice Straw with Pig Wastewater and Paper Mill Sludge

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Co-digestion of rice straw with pig wastewater has previously been investigated in dry conditions (i.e. 20 to 30% TS) in two pilot-scale (1 m^3) digesters and a farm-scale (6600 m^3) digester producing optimum methane yields of 214 LCH_4/kgVS in 189 days and 182 CH_4/kgVS in 422 days, respectively. The objective of the on-going research project is to improve the methane yield from the anaerobic co-digestion of rice straw with pig wastewater and anaerobic sludge from a pulp and paper mill treatment process. Eight experimental 1-L digesters defined below:

- Digesters #1, #5: rice and pig wastewater (1:2 wt ratio)
- Digesters #2, #6: rice and paper mill sludge (1:2 wt ratio)
- Digesters #3, #7: rice, pig wastewater, and paper mill sludge (1:1:1 wt ratio)
- Digesters #4, #8: rice, pig wastewater, and paper mill sludge (1:1.25:0.5 wt ratio),

and control reactors (water only, rice straw only, inocula only, autoclaved sludge and rice mixture) are currently undergoing dry digestion (20%TS) for 90 days in a thermostat-controlled room at 35 +/- 2°C. Several intermediate bottles were also assembled so that analysis could be performed throughout the entire digestion period to better understand the mechanism for improved gas production.

As of Day 56, methane yields from the digesters containing paper mill sludge were significantly higher (ranging from 300 to 375 LCH4/kgVS) than those without the paper mill sludge (60 LCH4/kgVS for rice alone and only 9 LCH4/kgVS for Digesters 1 and 5). Methane produced by the inocula was measured separately and removed so the methane yields represent the degradation of the rice straw only. The pH, alkalinity and volatile fatty acid (VFA) results show that none of the eight experimental digesters were inhibited by acidification. The lowest pH observed in the experimental digesters was 6.15 in Digester #1 on Day 14. Alternatively, the control digester with rice straw only did not have a sufficient buffering capacity and was inhibited by acidification with pH ranging from 4.78 to 6.32. The methanogen population in the paper mill sludge is established and capable of immediate digestion, indicated by the inversely correlated relationship between the VFA concentrations and the quantity of paper mill sludge added to the mixture. VFA accumulation and absence of gas production is evident in Digesters 1 and 5, indicating that the methanogen population in the pig wastewater is not sufficiently established by Day 56. Ammonia-nitrogen concentrations are rapidly decreasing in all except Digesters 3 and 7, and the control digester with dead microorganisms. Digesters 3 and 7 currently exhibit stable gas production and will likely out-perform the other digesters by Day 90, indicating that the most favorable microbiological community and nutrient supply for the anaerobic digestion of rice straw is established by a 1:1 wt ratio of pig wastewater and paper mill sludge.

Removal of viral contaminations by hydrothermal carbonization products in water treatment

Part. I - Development of a low cost two-step quantitative reverse transcription polymerase chain reaction assay for rotavirus detection in foul surface water drains

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Hydrothermal carbonization (HTC), as known also wet pyrolysis, is a technology that can produce useful carbonaceous materials from biomass with relatively low energy consumption. In contrast to conventional dry pyrolysis, energy intensive drying process is not necessary in HTC. This research will evaluate the application of HTC materials in water treatment as disinfection agents adsorbing microorganism. Main focus will be given to the removal efficiency investigation of adenovirus and rotavirus which are the major water transmitted human pathogenic viruses. Commercially available HTC materials produced from corn, grass and sugar will be used as test disinfection materials. Basic material characterization will be performed before application to decontamination experiments. Initial design of disinfection unit will be made through testing non-pathogenic indicator microorganism, Escherchia coli (E. coli). Intensive investigations on virus removal efficacy of HTC materials will be carried out by testing several experimental conditions. As the first part of this research, economically affordable virus enumeration methods were developed.

Commercial kits to determine RNA concentrations are expensive, and sometimes too expensive for laboratories working with tight budgets, especially those in developing countries. We developed, tested, and evaluated two low cost two-step home-made reverse transcription quantitative polymerase chain reaction (RT-qPCR) assays aimed to detect rotavirus in surface water samples. A commercial one-step master kit was used for comparison. Our results indicated that the efficiency of the home-made assays was comparable to the commercial kit. Furthermore, the lowest detection limit of all assays correspondend to $10^{-0.2}$ $TCID_{50}$ (50% Tissue Culture Infective Dose) / ml. The home-made assays were able to detect rotavirus concentrations in complex surface waters in a slum area in Kampala (Uganda) and their performance was comparable to the commercial kit. The total costs of the two home-made assays was 11 times less than the selected commercial kit. Although preparing home-made assays is more time consuming, the assays can be useful for cases in which consumable costs are more important than personnel costs.

Effect of operating parameters on Cu(II) biosorption onto coconut shell in fixed-bed columns

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The performance of a fixed-bed column packed with coconut shell for the biosorption of Cu(II) ions was studied at different operating conditions. The fixed-bed column performance was evaluated using column breakthrough data at different flow rates, bed-depths and initial Cu(II) concentrations. The Cu(II) biosorption column had the best performance at 10 mg L^{-1} inlet Cu(II) concentration, 10 ml min^{-1} flow rate and 20 cm bed depth. Under these optimum conditions, the service time to breakthrough was about 60 h, after which the Cu(II) concentration in the effluent exceeded the 1 mg L^{-1} discharge limit set by the Ghana Environmental Protection Agency (EPA) for industrial effluent. The equilibrium uptake of Cu(II) amounted to 7.25 mg g^{-1}, which is 14.5 times higher than the value obtained in a batch system with the same material for the same initial concentration (10 mg L^{-1}). This study showed that fixed bed column systems can improvement Cu(II) uptake by coconut shell significantly.

Keywords: copper; coconut shell; fixed-bed column; biosorption; breakthrough curve

Biogenic Sulfide Production and Selective Metal Precipitation at low pH for Semiconductor Wastewater Treatment

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Metal contamination in water medium is the wide spread issue around the world. Anthropogenic source has more effect than the natural processes, especially with the industrial activities. The growth of these industries is increasing every year which not only resulted in environmental problems but resources depletion. The proper treatment and the resource recovery from the waste stream should be considered. Precipitation of metals is one of the solutions which cover both aspects. The conventional processes are hydroxide and sulfide precipitation, however; sulfide precipitation seems to have higher efficiency because of the less resolubility of precipitates. As a consequence, the biological wastewater treatment technologies with the use of sulfate reducing bacteria (SRB) become popular nowadays. However, the technology still set up as separate processes which are enrich of SRB to produce hydrogen sulfide and forming the insoluble metal precipitates. Thus, there are some limitations like land available, maintenance cost. The combination of those separate parts is become a challenge. Therefore Inverse Fluidized Bed (IFB) reactor has been developed to overcome these limitations. This research aims to evaluate the potential use of the IFB reactor for metal contaminated wastewater treatment.

Optimization of biological sulphate reduction

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The biological sulphate reduction (SR) process is mediated by a group of microorganisms known as sulphate reducing bacteria (SRB). Biological anaerobic reduction of sulphate has been successfully applied for the treatment of sulphate contaminated wastewater from industries on a larger scale for many years as it offers the possibility of an efficient treatment with low operation costs using various organic and easily utilizable carbon sources. The main limiting factor when building a large scale biological treatment process is the electron donor cost. Thus, it is desirable to look for the optimization of sulphate reduction process. In this study two approaches are proposed: the applicability of a cheap carbon source, i.e., methane and the optimization of the electron donor input by using process control.

Anaerobic oxidation of methane coupled with sulphate reduction (SR-AOM) was discovered 37 years ago but the exact nature of the process still remains poorly understood. Researchers have not been able to firmly establish the reaction mechanism, fully understand the factors that control oxidation rates, or isolate the responsible organisms. So far, two groups of microorganisms have been identified to mediate this process: anaerobic methanotrophic archaea (ANME) and sulphate reducing bacteria (SRB). A very important aspect of SR-AOM is its possible application for desulphurization of wastewater where methane can be used as a sole electron donor. Methane is readily available and relatively cheap when compared to the commonly used electron donors for sulphate removal. Additionally, the use of methane would close its cycle of utilization, decrease the emission of one of the most important greenhouse gases and reduce the risk of excess carbon source in the treated effluent. For biotechnological application some challenges need to be overcome. The current research will do so by using different strategies: 1) the use of microbial mats with active AOM obtained from marine sediments as enrichment starting material; 2) the enrichment of the microorganisms in a membrane bioreactor with high biomass retention; 3) the use of alternative substrates for sulphate reducing bacteria (electron acceptors and electron donors); 4) the modification of environmental conditions.

In addition, bioprocess control will be applied using several electron donors in order to optimize their input in the SR biosystem. Controlling the production of sulphide in a bioreactor will be the first step for an automated heavy metal precipitation/recovery. The main objective will be to develop a feasible control strategy for the control of biogenic sulphide production in sulphate reducing bioreactors. Two different strategies will be tested: a PID controller with gain scheduling and a model-based adaptive controller.

Keywords: Anaerobic oxidation of methane, sulphate reduction, biotechnology, bioprocess control

Adsorption of heavy metals by biogenic red elemental selenium

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Heavy metals are present in wastewater of industry such as metal mining, metal fabrication, electroplating and automotive. Long term exposure of higher than tolerance concentration of heavy metal leads to health hazard for humans. Removal of heavy metals from waste water can be achieved through precipitation - filtration, ion exchange and membrane separation. However, these techniques are expensive and require technical expertise. Adsorption is relatively simple and cost effective method for removal of heavy metals from waste water.

Elemental red selenium particles can be used as an adsorbent for the removal of mercury from gases (Fellowes et al., 2011). In this study, we have demonstrated that biogenic produced red elemental selenium particles, size ranging from nanometer to micrometer, can be used to remove the heavy metals zinc, copper, cadmium and chromium. The 90 percent of heavy metal at 50 ppm concentration was removed in first 15 minutes of adsorption experiment indicating strong adsorbent capacity of the material. Total adsorption capacity of elemental selenium was in the range of 0.085 - 0.165 mg of heavy metal per mg of elemental selenium. The adsorption capacity decreased with decrease in pH and with increase in ionic strength of the heavy metal containing wastewater. The isoelectric point of elemental selenium particle was found to be around 3, thus no adsorption was observed at a pH below 3.

This study suggests that elemental red selenium can be used as an adsorbent for effective removal of heavy metals. This technology becomes more attractive when red elemental selenium particles are biologically produced from wastewater.

Keywords: Adsorption, elemental red selenium, heavy metals,

Co-existence and Competition between Phosphorus Accumulating Organisms and Sulfate Reducing Bacteria

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Fresh water shortage is becoming an increasingly global problem. As an alternative natural water resource, seawater was used for toilet flushing and has been practiced in Hong Kong since 1950s to alleviate water stress. After the big progress that has been made on the utilization of seawater as secondary quality water, supported by the development of the SANI process (sulfate reduction, autotrophic denitrification and nitrification integrated), saline sewage is produced containing higher sulfate contents which reached in Hong Kong up to 500 mg/L sulfate. In the novel SANI process, integrated biological carbon and nitrogen removal is achieved for saline sewage treatment showing high removal efficiencies. However, the system has not involved biological phosphorus removal which is required to prevent eutrophication in the surface water bodies.

For the development of a potential SANIP process (SANI plus biological P-removal), it is necessary to assess the effects of sulfur species on the metabolism of phosphorus accumulating organisms (PAO) to evaluate the feasibility of integrating these processes. More precisely, to study the potential of co-existence or competition between PAO and sulfate reducing bacteria (SRB) under altering anaerobic/aerobic conditions with different COD:P:S ratios but under controlled conditions of defined pH, DO, and temperature. This is necessary for the design and operation of wastewater treatment plants (WWTP) treating saline wastewater and performing biological nutrient removal (BNR), with the main objective of reducing the drinking water stress through the direct use of saline water for sanitation while providing satisfactory saline wastewater treatment to limit the discharge of nitrogen and phosphorus into surface water bodies to preserve the ecosystems.

Biological sulfate reduction for remediation of gypsiferous soils using organic substrates as electron donors

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Gypsiferous soils are those which contain significant quantities of gypsum which may interfere in plant growth and can cause many cultivation problems. The accumulation of gypsum in soils results in low water retention capacity, shallow depth to a hardpan, vertical crusting, very low fertility, and consequently, their productivity remains low under irrigation even with application of fertilizers or organic manures. Some abandoned mine areas, especially gypsum mines, are also a source of gypsiferous soils. Moreover, the soil in some mines also generate acid mine drainage (AMD). This AMD has a low pH and high concentrations of sulfate as well as toxic metals. This land cannot be used for agriculture, and there are very few plants and animals. The physical structure such as porosity and permeability of gypsiferous soils can be improved by reducing the soil's gypsum content. This present study aims to develop a bioremediation technology for reduction of gypsum content in gypsiferous soils by using sulfate reducing bacteria (SRB). The organic substrates, including rice husk (RH), pig farm wastewater treatment sludge (PWTS) and coconut husk chips (CHC) were used as electron donor. The sulfate removal efficiency up to 59 % was achieved from the soil mixed with 40 % of organic substrates (Figure 1). This is corresponding to the reduction of gypsum content from 18 to 7.5 % of soil.

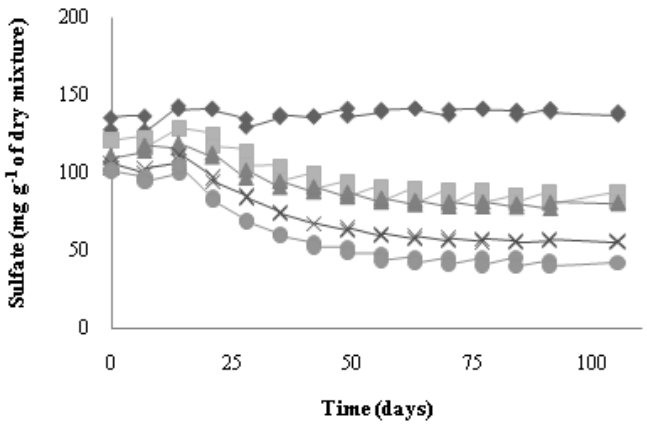

Figure 1. Evolution of sulfate content in soil over experimental time. Symbols stand for: (♦) 0%, (■) 10%, (▲) 20%, (×) 30%, (●) 40% of organic substrates.

Understanding recent land use and land cover dynamics in the source region of the Upper Blue Nile, Ethiopia: spatially explicit statistical modeling of systematic transitions

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The objective of this paper was to quantify long-term land use and land cover change and to identify the spatial determinants of locations of most systematic transitions for the period 1957-2009 in the Jedeb watershed, Upper Blue Nile Basin. Black and white aerial photographs of 1957 and Landsat imageries of 1972 (MSS), 1986 (TM), 1994 (TM) and 2009 (TM) were used to derive ten land use/cover classes by integrated use of Remote Sensing (RS) and Geographic Information System (GIS). Post-classification change detection analysis based on enhanced transition matrix was applied to detect the changes and identify systematic transitions. The results showed that 46% of the study area experienced a transition over the past 52 years, out of which 20% was due to a net change while 26% was attributable to swap change (i.e. simultaneous gain and loss of a given category during a certain period). The most systematic transitions are conversion of grassland to cultivated land (14.8%) followed by the degradation of natural woody vegetation and marshland to grassland (3.9 %). Spatially explicit logistic regression modeling revealed that the location of these systematic transitions can be explained by a combination of accessibility, biophysical and demographic factors. The modeling approach allowed improved understanding of the processes of land use/cover change and for identifying explanatory factors for further in-depth analysis as well as for practical interventions for watershed planning and management.

Keywords: Change detection; Systematic transition; Enhanced transition matrix; Upper Blue Nile basin; spatially explicit; logistic regression

A new approach representing landscape variability for the SWAT model

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The Soil and Water Assessment Tool (SWAT) is one of the river basin scale model that is widely applied across a wide range of river basin scales and conditions for a variety of hydrologic and environmental problems. Hydrological response unit (HRU) is the basic modeling unit in SWAT. The current SWAT approach fails to capture the interaction between HRUs in an upland landscape position and HRUs in lowland position, which is one of the shortcomings of SWAT. The study presents a new SWAT modification which aims at accounting for landscape position and processes in the simulation of flow within subbasin level. In this new approach, the division of subbasin into HRUs is based on the overlay of soil, land use and landscape maps instead of the combination of only soil and land use map in the original SWAT model. The landscape map is created by dividing each subbasin into several landscape units which have different hydrological processes and transport mechanisms. This study illustrates a simple SWAT-landscape modification in which the landscape map is divided into only two units: upland and lowland and the flow routing between two units is established. The flow routing between upland and lowland is simulated separately for different flow components of the SWAT model: surface runoff, lateral flow, tile drainage and groundwater flow. The modified SWAT model was tested in a simple hypothetical case study with a single subbasin and 2 HRUs each of which also represents upland or lowland landscape unit. The test was conducted in 4 scenarios: (i) No landscape, (ii) With landscape – Groundwater dominates, (iii) With landscape – Surface runoff dominates and (iv) With landscape – Tile drainage dominates. The preliminary results showed that the application of flow routing between landscape units results in slight decrease of groundwater flow in scenario (ii) in which groundwater dominates. Nevertheless, when surface runoff is an important contribution, this flow routing results in a small increase of groundwater flow and decrease of surface runoff. Lateral flow and tile flow are also adjusted; however, the changes are insignificant.

Are observed stream flow records sufficient to understand natural hydrological process heterogeneity in the Incomati River Basin?

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The Incomati is a semi-arid trans-boundary river basin in southern Africa, which is water stressed because of high competing demands from irrigated agriculture, forestry, environmental flows and other sectors. The impacts of these demands relative to the natural flow regime can be significant. Hence, there is an opportunity to improve water management, if it can be underpinned by a better scientific understanding of water resources availability and variability. Despite being a relatively well gauged basin (at least in perception) in South Africa, the natural flow regime and its spatial and temporal variability are poorly understood and remain poorly described.

In this study, observed flow data from 104 gauges was screened, and analyzed using the Indicators of Hydrologic Alteration (IHA) software, and various metrics of catchment similarity were compiled and compared to provide a preliminary classification of catchments based on their hydrological behavior. Screening of the gauges revealed that only 14 micro to meso scale catchment (50 to 1060 km^2) have sufficiently long (20 to 65 years) and natural (or little disturbance) flow records. This limits detailed analysis of spatial variability of hydrological characteristics across the Incomati Basin, especially at larger spatial scale of macro catchment level i.e. Incomati River and its major tributaries. Nevertheless, long term analyses were conducted to identify temporal variability and trends. Temporal variability was high with coefficient of variation (CV) of annual flows in the range of 1 to 4. However, trends in the selected indicators of hydrological alteration were found to be insignificant in most cases, with the exception of significantly declining trends in October flows and extreme low flows in the case of 4 gauges. This suggests that the temporal changes in the stream flow are not likely driven by climatic forcing and are rather a response to some other impact. The flow duration curve analysis indicated that quick flow dominates the overall volumetric contribution in stream flow generation in most gauges. The base flow contribution is comparatively low but sustains the stream all year around. The variation of the base flow contribution is also high among the studied catchments. The paper provides detailed discussion the major climatic and physiographic factors controlling the runoff regime of the Incomati Basin and concludes that human demands are major drivers of water stress, particularly in low flows and in time of drought, implying that restrictions are needed in these months.

Identifying historic droughts in the Limpopo River basin using a downscaled version hydrological model

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A state of the art forecasting framework is being developed for meteorological, hydrological and agricultural drought forecasting covering the African continent. With a view to regionalizing this framework, a finer resolution (downscaled) version of the continental scale hydrological model PCR-GLOBWB was set up for the Limpopo river basin, one of the most water stressed basins in the African continent. The downscaled model was used to analyze the history of droughts in the Limpopo river basin in the period 1979-2010 with a view to identifying severe past droughts in the basin. This identification is also helpful for tuning and testing of the model, which will be used in a second stage to predict hydrological and agricultural droughts. Evaporation estimates from the model derived at a spatial resolution of 5 km on a daily time scale were applied for the entire Limpopo basin for the period 1979-2010. PCR-GLOBWB was forced with daily precipitation, temperature and other meteorological variables obtained from the ERA-Interim global atmospheric reanalysis product from the European Centre for Medium-Range Weather Forecasts. Monthly actual evaporation calculated by the hydrological model was used to compute an index derived from the running average of the monthly evaporation anomaly. Agricultural droughts are defined as a lack of soil moisture to fulfill crop demands, and are therefore directly linked to lower values of evaporation than in normal conditions in (semi-) arid areas as a result of lower water availability. The developed index, which represents the deviation of the monthly actual evaporation in a specific year with respect to the long term average is shown to serve as a simple method to identify agricultural droughts. Moreover, it is possible to make a preliminary characterization of the drought severity, indicated by its duration and intensity. Results show that the proposed evaporation-based index (resulting from the PCR-GLOBWB model) may serve as a means for identifying historical droughts in (semi-) arid areas.

Keywords: drought, evaporation, hydrological model, Limpopo

Characterising the flow regime in a largely ungauged natural basin: the Omo-Ghibe basin in Ethiopia

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The Omo-Ghibe basin in Southern Ethiopia is currently largely a natural basin, with very little developments such as water resources infrastructure or irrigation. Despite its size, some 79000 km^2, only a small part of the basin is gauged. Hydrological and meteorological gauges are found primarily in the upper part of the basin in the Ethiopian highlands. The lower part of the basin is largely undeveloped, populated only by nomadic tribes. The Omo-Ghibe River terminates in Lake Turkana. There are no outflows from Lake Turkana, making the Omo-Ghibe basin an Endorheic basin, and therefore very sensitive to changes in the water balance. In recent years the level of development in the basin has been increasing, including the large Ghibe-III dam, now nearing completion, as well as the extensive irrigation areas.

Understanding the natural flow regime characteristics and its extent of change and driving forces are a crucial step in ecological assessment for ecosystem conservation. The natural flow regime concept was introduced and developed in aquatic ecology as a new paradigm of restoration and conservation of the ecological integrity of rivers and its ecosystem and can be used to analyze the spatial and temporal variability of stream flow characteristics.

In this paper an approach is presented where the flow regime in the basin is identified using selected hydrological indices that characterise the variability of the water balance in the basin in terms of magnitude, duration, timing, frequency and predictability of flow and the driving forces climate and anthropogenic activities were identified for their impacts and hydrological responses.

The analysis of the indices using the available historical data statistics and significance test suggest that there are already significant changes to the flow regime, possibly due to land use and land cover change in the basin. Whereas, the trends of rainfall temperature are insignificant and human activities like diversion and abstraction of water, river morphological changes are negligible in the basin.

Key words: Undisturbed basin, hydrological indices, natural flow regime, trends

Climate Change and Development Impacts on Groundwater Resources in the Nile Delta, Egypt

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Climate change; as predicted by several global climatic models, is very likely to have several future impacts, especially in Delta areas. The types of impacts are: sea level rise, spatial and temporal changes in the meteorological circulation, changes in temperatures, changes in rainfall distribution, floods and droughts frequencies, inundation of land, groundwater quality, etc. These impacts may have significant influence on human health and well being, as well as on state of ecosystems and natural resources. At the same time, population increase and development imperatives create additional pressure on available natural resources and the general natural environment. The foreseen combined effects create an obvious need for development of adaptation strategies that can not only mitigate the negative effects of climate change, but can also lead to capacity development for coping with uncertain future changes.

These changes are particularly problematic for the Mediterranean coastal areas, and especially the northern Nile Delta Coast, where both natural and socio-economic resources of tremendous value are located. This study has particular focus on groundwater resources in the Nile Delta. The quality of the groundwater in this area may strongly be affected by the impacts of the sea level rise combined with reduction of Nile flows, by the extent of freshwater/ saltwater interface and by the rate at which the salinity levels are increasing. In addition, the ongoing and future human activities, especially groundwater water abstraction for irrigation and water supply, are resulting in complicated deterioration of the groundwater resources and can consequently cause serious negative social and economic impacts.

The main objective of this study is development of a comprehensive framework for long term planning of exploitation and sustainable management of groundwater resources in the Nile delta that will include robust adaptation alternatives. Based on updated data and knowledge, covering the hydrologic, hydrogelogical, geological and hydrochemical characteristics of the groundwater aquifer in Nile Delta a mathematical model will be developed to serve as a predictive tool for analysis and assessment of future groundwater resources development within pre-defined scenarios of sea level rise. Particular attention will be given to mitigation and adaptation alternatives for most vulnerable areas to sea water intrusion, which will also be identified within the course of this study. The research will also address uncertainties of the model prediction and incorporate them within the long term planning approach.

Downscaling daily precipitation over the Yellow River source region in China: a comparison of three statistical downscaling methods

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Three statistical downscaling methods are compared with regard to their ability to downscale summer (June-September) daily precipitation at a network of 14 stations over the Yellow River source region from the NCEP/NCAR reanalysis data with the aim of constructing high-resolution regional precipitation scenarios for impact studies. The methods used are the Statistical Downscaling Model (SDSM), the Generalized LInear Model for daily CLIMate (GLIMCLIM), and the non-homogeneous Hidden Markov Model (NHMM). The methods are compared in terms of several statistics including spatial dependence, wet- and dry-spell length distributions and inter-annual variability. In comparison with other two models, NHMM shows better performance in reproducing the spatial correlation structure, interannual variability and magnitude of the observed precipitation. However, it shows difficulty in reproducing observed wet- and dry-spell length distributions at some stations. SDSM and GLIMCLIM showed better performance in reproducing the temporal dependence than NHMM. These models are also applied to derive future scenarios for six precipitation indices for the period 2046-2065 using the predictors from two GCMs (CGCM3 and ECHAM5) under the IPCC SRES A2, A1B and B1scenarios. There is a strong consensus among two GCMs, three downscaling methods and three emission scenarios in the precipitation change signal. Under the future climate scenarios considered, all parts of the study region would experience increases in rainfall totals and extremes that are statistically significant at most stations. The magnitude of the projected changes is more intense for the SDSM than for other two models, which indicates that climate projection based on results from only one downscaling method should be interpreted with caution. The increase in the magnitude of rainfall totals and extremes is also accompanied by an increase in their inter-annual variability.

Evaluation of a pollution prevention approach in the municipal water cycle

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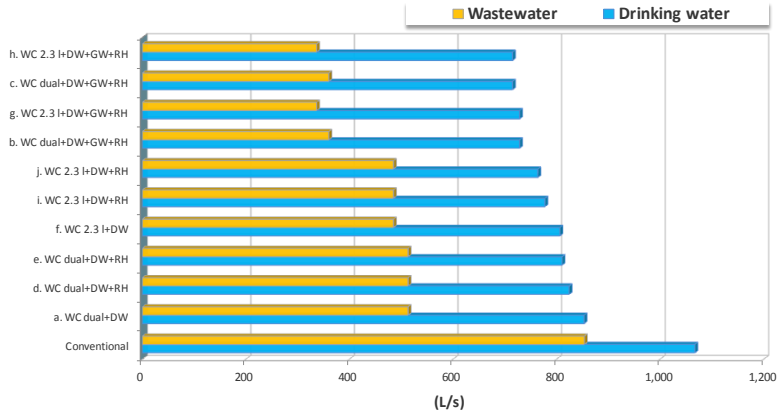
The impact on water resources caused by municipal waste water discharges has become a critical and ever-growing environmental and public health problem. In order to be able to efficiently address this problem, it is important to adopt an integrated approach that includes the decrease and control of contamination at its source. These principles have been successfully applied in the industrial sector and now these concepts are also being applied to integrated water resources management. In this context the conceptual model of the Three Steps Strategic Approach (3-SSA) was developed, consisting of: 1) minimization and prevention, 2) treatment for reuse and 3) stimulated natural self-purification. This paper is focused on the first step. The assessment includes a case study in the expansion area of the city of Cali, Colombia (2.1 million inhabitants). The evaluation of alternatives is done using two different system boundaries: (1) reduction in water supply costs for households and the avoided costs in the infrastructure of additional sewerage and wastewater treatment facilities; and (2) considering only reduction in water supply costs for households and the savings associated with the drinking water infrastructure. The alternatives of minimization and prevention were hierarchized using an analytic hierarchy process and grey relational analysis. A cost-benefit analysis was carried out to compare the best ranked alternatives with the conventional approach, which considers a "business as usual scenario" of high water use, end of pipe wastewater treatment plant and the conventional water supply system with drinking water quality for all uses. The best minimization alternatives for Cali's expansion zone corresponds to those which consider double discharge toilet and the possibility of using rainwater harvesting for laundry purposes. And the other hand the minimization and prevention alternatives considered are viable if these are implemented in more than 20% of the household units.



WC dual: dual flush toilet; WC 2.3 L: high efficiencyu toilet; DW: Drinking water; GW: Grey water; RH: Rain harvesting; Conventional strategy: toilet 6 L/flush-Drinking water all uses

Keywords: Technology selection; Water pollution; Minimization and prevention; Analytic Hierarchy Process; Grey Relational Analysis; Cost-benefit Analysis.

Design of Pressure Tunnels Using Finite Element Model

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This paper is part of the study on the coupled stress-seepage numerical design of concrete-lined pressure tunnels and particularly concentrated on the behaviour of pressure tunnels predicted using finite element model. This study covers the modelling of tunnel excavation, installation of support system, prestressing of concrete lining and the loading of internal water pressure. A circular concrete-lined tunnel, as the most suitable cross-section for pressure tunnels, in a deep homogenous isotropic rock mass subject to a constant in-situ compressive stress is modelled. The jointed rock mass properties are defined based on the Hoek-Brown failure criterion.

The analysis begins with the definition of in-situ principal stresses normal to the longitudinal axis of excavation to predict excavation-induced stresses and deformations. Due to excavation, the stress levels surrounding the excavation are changed. The behaviour of rock mass may not remain elastic anymore and therefore the zone where the plasticity occurs has to be predicted. The mechanical response of the rock mass in the elastic-plastic condition is studied using finite element model and the adequate support system taking into account the stress release in front of the excavation face is designed to anticipate the initiation of plastic failure and instability problems of the tunnel. Once the equilibrium condition around the supported tunnel is reached, a final lining is installed next to the support element and a high pressure cement grout is injected through its radial boreholes. This so-called passive prestressing technique is intended to hinder cracks opening in the lining when the internal water pressure is activated.

While the rock mass is modelled based on the non-linear yield function Hoek-Brown rock plasticity, the support and concrete lining are modelled as elastic material and behave in biaxial stress. During tunnelling process, the redistribution of stresses and deformations is studied by means of phased analysis procedure. Modelling aspects of prestressed concrete-lined pressure tunnels are briefly described and results obtained from numerical models are compared with those calculated using analytical solutions.

Keywords: pressure tunnels, elastic-plastic behaviour, prestressing, seepage.

Le déjener sur L'eau
(Luncheon on Water)**,**
A Manual for Urban Relief

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Department of Water Science and Engineering - WSE
Hydraulic engineering, Coastal engineering and Port development - HECEPD

In year 2007 it was accounted that population living in urban areas reached in number the population living outside urban areas in such fast pace that, in a near future, the world population will be predominantly concentrated in large cities. In a few past human generations, the idea of cities as an anthropogenic occupation of a natural environment has been fully replaced for cities as an anthropogenic environment, struggling for balancing essential natural components. Together with this evidence there is also the acknowledgement that urban morphologies have extensively modified the initial geographies where cities were built.

Very much as local geographic components shape local climates, urban morphologies shape the urban climate and do it in a rather efficacious way. Phenomena as *urban heat islands*, *air flow barriers and traps,* as well as *street canyons* are presently acknowledged as strong components of urban climate; however they are generally associated with unsuitable urban models, ill advised urbanization and deterioration of urban livability. Among present day urban conditions, cities that benefit from the presence of water bodies appear to perform better in terms of urban climate and comfort than other cities, not to mention the many cityscape aesthetical attributes that a presence of water can bring to cities. At the same time some cities by water perform better than others and the reason lies extensively in the characteristics of the urban form of these cities.

On the other hand, much as the presence of water is a rather favorable urban component, it is also the component that can expose cities to increased risk.

This research investigates the efficacious growing capacity of urban mass to shape urban climate in improved terms, by making favorable use of the presence of water bodies. It investigates the many constrains and possibilities of coastal and tidal river basin locations in order to set criteria for urban form to acquire improved urban resilience and livability.

Les Entrelacs 2012

"Le déjeuner sur l'eau", Gaëtan Macquet, Orélie Tixier, 2012

The long-term performance of process-based morphological models in estuaries

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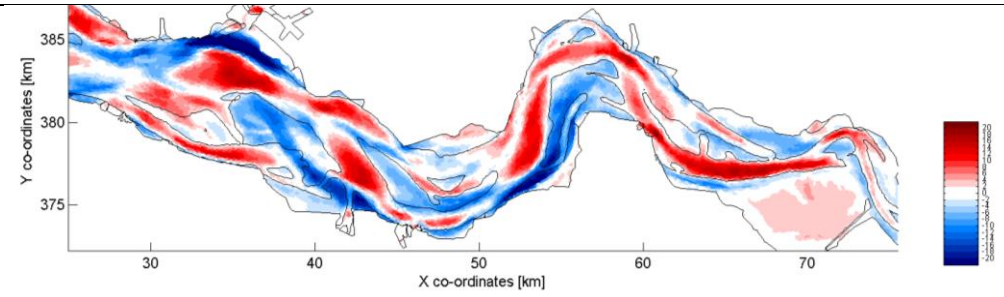
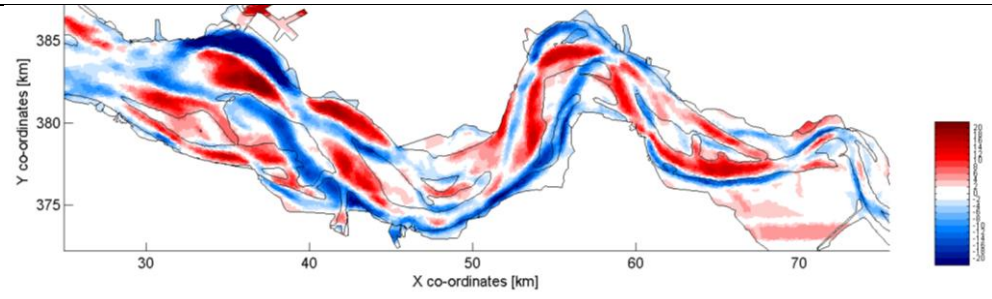
Process-based morphological models are widely used in both science and engineering. Until now hindcasting observed bathymetric changes over time has had variable success. The general assumption has been that these models can only accurately predict for a short timespan (< decade) before the results drift away too far from reality due to limited process description and wrong parameter settings. This view is in line with models that are used in weather forecasting. It is possible to forecast only a few days ahead before the results become unreliable. Developments in recent years show that these models are able to generate realistic channel shoals patterns starting from a flat bed in idealized estuaries and with more realistic plan forms like the Western Scheldt.

This study describes a hindcast of morphodynamic developments in the Western Scheldt estuary from 1860 -1970. This period was chosen because the anthropogenic influence on the estuary was still limited. The hindcast was performed using a basic 2D depth averaged model with one sediment fraction starting with the 1860 measured bathymetry. For every year that a measured bathymetry is available the computed results are compared to the observed bathymetry. The Brier-skill score reflects how good the model results are in comparison to the observed change. The results show that initially the performance is poor, but the results become better over time. The highest brier-skill score, and thus the best result, is reached at the end of the calculation in 1970. The exercise is repeated for the timeframe of 1931-1970 and 1965-2002, the latter included dredging and dumping. All these hindcasts showed the same result: the best performance is reached at the end of the hindcast. The conclusion is that process-based models show significant and increasing skill on the longer term (> several decades) Moreover, model results suggest that the results on shorter time scales should be considered with care.



Calculated bathymetric change 1860-1970



Observed bathymetric change 1860-1970

Role of river flow and tidal asymmetry in fluvial estuarine morphodynamics

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This work investigates the morphodynamics of an estuarine basin with both significant tidal and fluvial processes. Use is a 1D model on the basis of Delft3D module system. The role of river discharge and overtide in generating residual bedload transport and consequent morphodynamic evolution is evaluated. In the absence of river flow, the Stoke's effect and external tidal asymmetry are two key factors in generating residual sediment transport. The Stoke's effect would dominate over the internal tidal asymmetry if there is no external overtide. The introduction of river discharge damps the tidal wave and also modifies the tidal asymmetry. The persistent downward river flow enhances the seaward sediment transport, not only by the residual mean flow but also in interacting with the tidal current. The later term is even much larger in terms of residual bedload transport when the discharge is relatively small. In interacting with a flood tidal asymmetry, the increasing river discharge induces a shift of the flood dominance (by flood tidal asymmetry) to ebb dominance (by river-induced asymmetry). Thus a critical discharge can be figured out on which the river discharge and tidal forcing are exactly counterbalanced. It is found that the equilibrium estuarine bottom profile is deepest with this critical river discharge. When river discharge is below the criterion, the flood dominance import sediment and when the river discharge is above the criterion the fluvial sediment input dominates. Thus in both cases the estuarine basin is filled. There is an upbound of river discharge above which the estuarine basin is shifted to completely dominance in which case it becomes a delta in long runs. Overall this study finds out the effect of interactions between the river discharge and tide in controlling the residual sediment transport and the consequent morphodynamics in the fluvial estuaries.

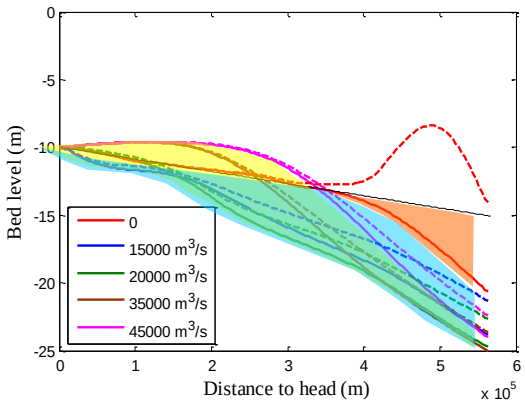

Fig 1 Bottom profiles after 4000 mor-years without external M_4 tide (solid lines) and with M_4 tide (dashed lines) for different discharge cases in a rectangular basin.

Nearshore Operational Model for Rip Current Predictions

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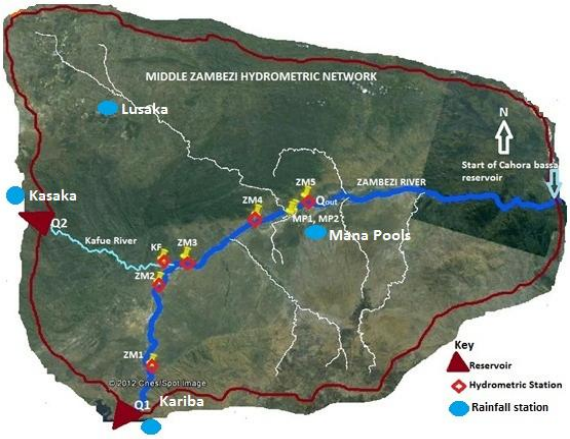
2). UNESCO-IHE Institute for Water Education, Delft
3). Delft University of Technology

Structure of the operational model system



A coastal operational model system can serve as a tool in order to monitor and predict coastal hazards, and to acquire up–to-date information on coastal state indicators. The objective of this research is to develop a nearshore operational model system for the Dutch coast focusing on swimmer safety. For that purpose, an operational model system has been built which can predict conditions up to 48 hours ahead. The model system consists of three different nested model domain covering The North Sea, The Dutch coastline, and one local model which is the area of interest. . Three different process-based models are used to simulate physical processes within the system: SWAN to simulate wave propagation, Delft3D-Flow for hydraulics flow simulation, and XBeach for the nearshore models. The wave model SWAN is forced by wind fields from operational HiRLAM models, as well as two dimensional wave spectral data from WaveWatch 3 Global as the ocean boundaries. The Delft3D Flow Continental Shelf Model (CSM) model is forced by assigning the boundaries with tidal constants (tidal amplitude and phase) for several important astronomical components as well as HiRLAM wind fields. For the local XBeach model, up-to-date underlying bathymetry will be obtained by assimilating model computation and Argus video data observation.

Wave and flow model validation

A hindcast is carried out on the CSM, covering the North Sea and nearby Atlantic Ocean, for the year 2009. Model skills are represented by several statistical measures such as rms error and bias. In general the results show that the model system exhibits a good agreement with field data. For SWAN results, integral significant wave heights are predicted well by the model for all wave buoys considered, with rms errors ranging from 0.16 m for the month of May with observed mean significant wave height of 1.08 m, up to rms error of 0.39 m for the month of November, with observed mean significant wave height of 1.91 m. However, it is found that the wave model slightly underestimates the observation for the period of June, especially waves with peak period greater than 7 seconds and propagate relatively from the North. Further investigations will focus on these findings in order to improve model skill during swimming season. The flow model results are analyzed for the dominant tidal constituents. The results show that for tidal amplitude, differences between observation and modeled are in range of 2 cm to maximum 14 cm. For the tidal phase, all stations considered along the Dutch coastline give differences less than 10 degrees between observations and predictions.

Application of model-data assimilation in updating nearshore bathymetry

An XBeach model for Egmond Beach is constructed, where data model assimilation method will be applied. Updated bathymetry is obtained by assimilating computed wave dissipation obtained from the model against observed wave dissipation obtained indirectly from set of Argus time exposures images. This method is applied for August 2011 method where a surveyed bathymetry is performed using DGPS-jetski. The bathymetry produced by the method shows high potential skill in capturing rip channels features near the shore line. An improvement can be done by adding more observation data that can be related to water depth (e.g wave celerity). Furthermore, a circulation nearshore model XBeach can be simulated using updated bathymetry and evaluate the performance relative to model with surveyed bathymetry, in terms of temporal and spatial variability of offshore ward velocity around the rip channels.

Keywords: operational model, SWAN, Delft3D, bathymetry, Argus, rip currents, XBeach

The state of the flow and morphology interaction in the hydropower dominated Middle Zambezi subcatchment

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A study is proposed for the Middle Zambezi channel and flood plain. The key objective of the research is to analyse the state of the river and its flood plain in terms of flow variation, river and flood plain morphological variation and how these interact with the flood plain vegetation. The study will provide input that will be useful for broadening the understanding of the complex flood plain flow and morphological interactions at a range of spatial and temporal scales. This understanding can feed into decision making frameworks for water resources managers considering water allocation for environmental flows.

The Middle Zambezi sub-catchment can be classified as a hydropower dominated catchment as it falls downstream of the four main existing Zambezi river basin hydropower schemes producing 2,568 MW. Middle Zambezi sub-catchment is also downstream of six proposed hydropower schemes, which will produce a potential of 4,330 MW. This entails that both present and future river flows in this river reach will be hydropower regulated flows.

Preliminary research findings on the state of the sub-catchment flows and morphology will be outlined. Highlights will be given of the following findings: water balance of the river reach, historical map analysis of river channel morphological changes and, bed load sediment characterisation and distribution. A brief on the application of the SOBEK-Rural model will be presented, which combines 1D flow, 2D flood and rainfall-runoff modules to simulate the flows and morphological interactions in the sub-catchment.

Keywords: hydropower dominated, flows, morphology, water balance, environmental flows,

Quantification of water uses along the Blue Nile River network using a one dimension (1D) hydrodynamic model

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Hydrodynamic models, supported by field measurements, are often the most appropriate tool to study the water distribution in river networks, under high and low flow conditions, taking into account water uses, presence of structures, like weir and dams, as well as physical features, like the complex river network geometry. The objective of this research is to study the water distribution along the entire Blue Nile River system to quantify the availability of the water resource at all flow conditions.

A One-dimensional model using Sobek River package was developed for the Blue Nile River network including all water uses for irrigation and hydraulic structures in Ethiopia and Sudan. The model was calibrated and validated for both water levels and discharges. The model performance extensively assessed against field measurements using correlation coefficient and root mean square error.

Calibration and validation show correlation coefficient between 0.93 - 0.999 for water levels and value range between 0.894 - 0.972 for discharge. The root mean square error for calibration and validation result is less than 50% of the standard deviation.

The comparison between modeled and measured water levels and discharges during the calibration period are shown in Figure 1a and Figure 1b for water levels at Hag Abdalla station and discharge released downstream Sennar Dam respectively. This basin hydrodynamic model was able to simulate the water uses for irrigation in Sudan during the high and low flows. Moreover, the model will be able to simulate the water uses after constructing of large dams on the Blue Nile in Ethiopia.

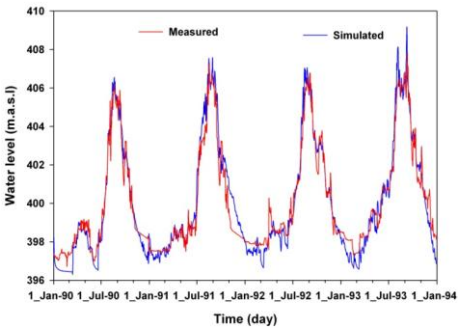

Figure 1 a: water levels at Hag Abdalla station.

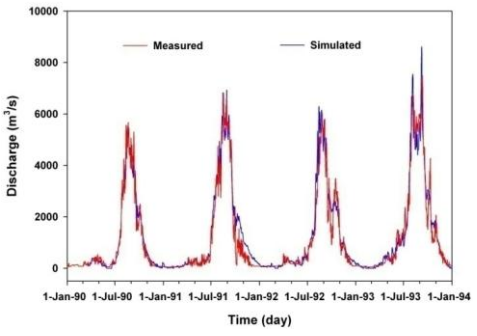

Figure 1 b: Discharge released downstream Sennar Dam

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Determination of the cross section spacing in 1D hydraulic models

Md Ail, Anuar[1,2]; Di Baldassarre, G.[1] and Solomatine, D. P.[1,3]

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[2]Department of Irrigation and Drainage, Jalan Sultan Salahuddin, 50626 Kuala Lumpur, Malaysia
[3]Water Resource Section, Delft University of Technology, the Netherlands

In hydraulic modelling of floods, a certain number of cross sections data are essential for the numerical description of the geometry of the river and the topography of floodplain areas. However, the identification of the optimal number cross sections in different rivers and applications is not an easy task. While too many cross sections increase the costs of topographical surveys, an insufficient number of cross sections data may lead to inaccurate results of the hydraulic models. To date, only a few guidelines are available to assist hydraulic modelers in determining the required quantity and location of cross sections data. The objective of this research is to investigate the impact of cross section data on the results of hydraulic models by comparing the performance of one-dimensional (1D) models, which are developed from various configurations. Also, the influence of cross section spacing in 1D hydraulic modelling of floods is evaluated. The performance of the 1D hydraulic models enabled the evaluation of equations proposed by the literature to determine the cross section. In particular, while confirming some previous studies on the topic, interesting insights are derived from the evaluation of the simulated inundation patterns.

POSTER SESSION

1. **Javier Sànchez Guillén:** Cost-Effective Municipal Wastewater Treatment by Coupling of UASB and ANAMMOX Reactors
2. **Khalid Alnour:** Hydrological Impacts of Land use management in the Blue Nile River Basin /Downstream Tributaries (Rahad and Dinder)
3. **Rohan Jain:** Biogenic production of selenium nanoparticles and their application in heavy metal removal
4. **Aline M.L. Saraiva Okello:** Bridging the gaps between Hydrology, Land use and Water Management using Tracers and Water Resources Modelling in the Incomati Basin
5. **Mawiti Infantri Yekti:** Role of reservoir operation in sustainable water supply to Subak irrigation systems in Yeh Ho River Basin
6. **Veronica Minaya Maldonado**: Multi-scale analysis and coupling of eco-hydrological model and remote sensing for the alpine grasslands (páramo) in the Ecuadorian Andean region
7. **Kun Yan:** Flood Inundation Modelling Under Uncertainty Using Globally and Freely Available Remote Sensing Data
8. **Christine Etiegni:** Towards Participatory Fisheries Governance: A Case of Lake Victoria Fisheries (Kenya)
9. **Eskinder Z Belachew:** Modeling Instream Industrial Effluents for Optimized Water Quality in Data Poor Sub-SaharaCountries, the Case of Kombolcha City (Ethiopia)
10. **Suthee Janyasuthiwong:** Biogenic Sulfide Production and Selective Metal Precipitation at low pH for Semiconductor Wastewater Treatment
11. **Joana Cassidy**: Optimization of Biological Sulphate Reduction
12. **Adrian Almoradie:** Networked Environment for Stakeholders Participation (NESP) in Water Resources and Flood Management
13. **I M Hartanto:** Integrating Earth Observation And Meteorological Data, In-situ Monitoring, and Numerical Modelling to Reduce Uncertainty In Water Management
14. **Patrick Khisa:** Ecohydrological functioning of Nyando Wetland in a changing catchment context
15. **Loreen Ople Villacorte:** Membrane filtration of algal bloom impacted waters: Fouling characterisation and modelling

Cost-Effective Municipal Wastewater Treatment by Coupling of UASB and ANAMMOX Reactors

PhD Fellow: **Javier Sánchez Guillén**

Promoters: **Jules van Lier [1, 2], Damir Brdjanovic[1, 3].** Supervisor: **Carlos Lopez Vazquez[1]**

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Duration: 2011-2015

1. Introduction

Problem Statement

The primary source of Nitrogen pollution in urban zones comes from sewage. Nitrogen from treated and untreated sewage is transported by rivers from urban areas to the coasts. Nitrogen from sewage is one of the primary drivers of eutrophication in the coastal areas and the cause of the global coastal hypoxia. With the promulgation of stricter environmental regulations for nitrogen discharges from sewage and the worldwide financial crisis, it is of vital importance the development of cost-effective and environmentally-friendly wastewater treatment systems.

Main Objective

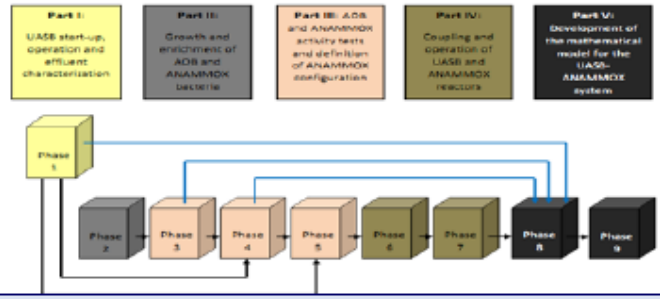
The main objective of this research is to study the feasibility to achieve the biological removal of carbon and nitrogen in the main stream of sewage treatment by the combination of two wastewater treatment processes in one integrated system: methanogenesis (in a UASB reactor) and ANAMMOX. These processes have been successfully applied for wastewater treatment, but they have not been coupled for municipal wastewater treatment.

2. Research Questions and Approach

1. What are the characteristics of the effluent of a UASB reactor that will have a major influence on the aerobic ammonium oxidizing bacteria (AOB) and anaerobic ammonium oxidizing bacteria (ANAMMOX) when treating municipal wastewater?

2. What is the best procedure to couple a UASB and an ANAMMOX (one or two-step) reactor for biological carbon and nitrogen removal from sewage based on the main environmental and operational factors affecting the activities of their dominant bacterial populations?

3. How could a mathematical model be developed to assess the applicability of a UASB-ANAMMOX system to treat municipal wastewater of diverse strength (low, medium and high) under different climate conditions (e.g. at low, moderate and high temperature)?



3. Preliminary Results

Substrate conversion ratio NO_2^-/NH_4^+ obtained from the activity tests with ANAMMOX bacteria based on COD source, C/N ratio and incubation temperature

	Temperature (°C)		
	14	22	30
Control	1.40 ±0.25	1.19 ±0.05	1.35 ±0.11

COD Source	COD to N = 2			COD to N = 6			Average		
	14°C	22°C	30°C	14°C	22°C	30°C	14°C	22°C	30°C
Acetate	1.45	1.26	1.36	1.37	1.32	1.21	1.41	1.29	1.29
25% acetate & 75% Starch	1.50	1.25	1.23	1.24	1.32	1.30	1.37	1.28	1.27
Starch	1.58	1.25	1.43	1.54	1.36	1.17	1.56	1.31	1.30

4. Preliminary Conclusions

1. With respect to the influence of the characteristics of the effluent of the UASB reactor on ANAMMOX activity, preliminary results have shown a substrate conversion ratio of NO_2^-/NH_4^+ close to the value reported in the literature 1.32, for activity experiments taking into account COD source, C/N ratio and temperature.

2. The presence of the organic matter in the effluent of the UASB reactor (acetate as readily biodegradable organic matter and starch as slowly biodegradable organic matter) does not affect significantly the conversion ratio NO_2^-/NH_4^+ by ANAMMOX bacteria at temperatures commonly found in sewage.

Hydrological Impacts of Land use management in the Blue Nile River Basin /Downstream Tributaries (Rahad and Dinder)

Khalid Elnoor Ali Hassaballah hrs_khalid@yahoo,com www.hrs-sudan.sd

Promoter: Prof. Stefan Uhlenbrook, Ph.D.(UNESCO-IHE), **Co-promoter:**Prof. Y.A. Mohamed, MSc, PhD (UNESCO-IHE),
Local supervisor: Prof. Seifeldin Hamad Abdalla, PhD, MSc (Ministry of Water Resources and Electricity-Sudan)

Abstract
Watershed hydrology as widely known is dependent on many factors, including land use, climate, and soil conditions. However the relative impacts of different types of land use on the surface water are yet to be ascertained and quantified. This research proposal attempted to use a comprehensive approach to examine the hydrologic impacts of changing in land use management in the Blue Nile River Basin /Downstream Tributaries (Rahad and Dinder) sub-watersheds and assess the implication on the ecosystem. Statistical and spatial analyses will be applied to examine the statistical and spatial relationships between changing in land use and flow and sediment fluxes.

Problem statement

The Dinder Natural Reserve Park (DNP) is the most distinctive feature of the basin. The drainage system of the park includes river Dinder and Rahad and their tributaries and Mayas. Mayas are meadows formed along the flood plain of the river. They are the major source of water and green fodder for the wildlife during the dry season. During the past two decades the catchment areas of Mayas inside DNP have radically deteriorated due to decrease in the quantities of rivers discharge and rainfall, causing many of them to be subjected to sediment deposition and almost completely dryness . For instance, perennial grasses have been substituted by annuals and the water and food supply available to wildlife has accordingly decreased radically.

The hydrology of the Mayas and the Dinder watershed as well as the interaction between the land use management, land change, hydrology and eco-system is not well understood and more in-depth studies are required. However, recent work suggests that the recent series of years with lower than average rainfall has resulted in the Mayas drying up more often than in the past. This drying of normally persistent water resources could be having serious impacts on wildlife populations that depend on them for water and forage in dry seasons. Thus, the entirely ecosystem of the DNP becomes vulnerable to hydrological change because it's mainly depends on the Mayas.

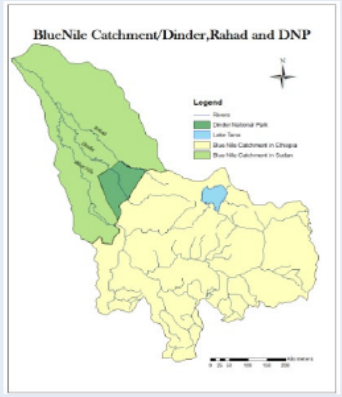


Figure 1: The study Area

Methods and tools

The primarily methodology that will be followed to achieve the research objectives can be as follows;

1- Data Collection: Data that are needed to be collected can be classified in to:

- **a**- Hydrological data (Discharges of rivers, levels).
- **b**- Topographic data (Satellite images to show catchment areas, rivers slope, vegetations, land use changes, etc).
- **c**- Metrological data (Rainfall, temperature, humidity, Evaporation, etc).
- **d**-Data related to the ecosystem (will be defined later).

2- Modeling Approach: After collecting data, completing missing data will be conducted to validate the data. Suitable models (hydrological, eco-hydrological and, morphological model) (which will be determined later) will be used to analyze the data to achieve the specific objectives.

3- results discussion, Reporting and publishing.

Research questions

A number of research questions need to be answered to understand interactions between the hydrology, ecosystem and the morphology of the Dinder/Rahad Rivers. These questions include, most importantly:

1-What are the hydrological similarities and differences between the two river basins?
2-Is there any change in the hydrology (water balance parameters in space and time) of both rivers the Rahad and the Dinder?
3-If so, is it due to the nature (climate change, climate variability, etc) or to manmade activities?
4-How ecosystem depends on the hydrology of the two rivers system?
5-To what extent the ecosystem of the region has changed and what are the hydrology related reasons?
6-What are the future expectation of hydrology , ecosystem and morphology of the two rivers?

Objectives

It is obvious from the above mentioned that the source of problems can be divided in to natural and manmade sources. In general, the overall objective is to study the problem and find the corresponding suitable solutions to mitigate the damages. Few studies and analyses have been carried out on both Rivers (the Rahad and the Dinder). Therefore, conducting a research on the hydrology and morphology of these rivers and correlating it to the relevant ecosystem will enhance knowledge within this area.

Expected contribution of the study:

- The results of the study and in particular the hydrological modeling tool will help for better understanding of the relationship between land use management, the hydrology and its impact on the eco-system.
- Assess the effects of land use management practices on the hydrology, eco-system as well as river morphology.
- The modeling tool will also help in finding out the most advantageous solutions to manage the systems in the Dinder National Park to mitigate the effects of hydrology, river morphology and ecosystem into each other.

Biogenic production of selenium nanoparticles and their application in heavy metal removal

Rohan Jain[1,2] (Nov 2011 – Oct 2014)

Prof. Piet Lens[1], Dr. Eric van Hullebusch[2], Prof. Francois Farges[3]

1. IHE - UNESCO, Delft, Westvest 7, Delft, 2611 AX, The Netherlands; 2. Université Paris-Est Marne-la-Vallée, Institut Francilien des Sciences Appliquées, 77454 Marne La Vallée, Cedex 2, France; 3 Museum National d'Histoire Naturelle, 57 rue Cuvier, Paris, France

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SELENIUM NANOPARTICLES: INTRODUCTION

- Elemental Se (0) (1 – 100 nm) or Quantum dots PbSe, CdSe, ZnSe (1 – 30 nm)
- CdSe may lead to wide range of optoelectronic devices with tailored properties
- Se NPs are used as dietary supplements, antifungal application, anti-cancer orthopaedic implants
- Se NPs are useful in sequestering of mercury and may have potential application in heavy metal removal

Fig. 1. CdSe QDs with size range of 2 to 6.5 nm, with decreasing crystal size the band gap of the crystal increases and the dot gives off more energetic or blue photons

PROBLEM STATEMENT

- **Necessity**: Selenate and selenite present in wastewater has to be treated before discharge as they are toxic in nature
- **Challenge:** No ultimate selenium oxyanion treatment process available; most of the treatment process are ineffective or expensive
- **Opportunity:** Developing a biological process that can reduce selenate and selenite, and produce Se NPs from wastewater

OBJECTIVES and RESEARCH QUESTION

Main objective is to understand the process of biological selenium oxyanion reduction to elemental selenium, which in turn effect the characteristics of Se NPs and thus, their applicability.

Research questions

- What will be the effect of operational parameters on the characteristics of Se NPs?
- What is the potential of Se NPs for heavy metal adsorption?

APPROACH

Production of Se NPs

- Aerobic production of Se NPs
- Anaerobic production of Se NPs

↓

Characterization of Se NPs

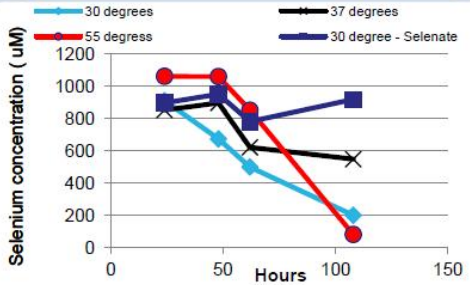
- Size fractionation
- Iso-electric point
- Stability

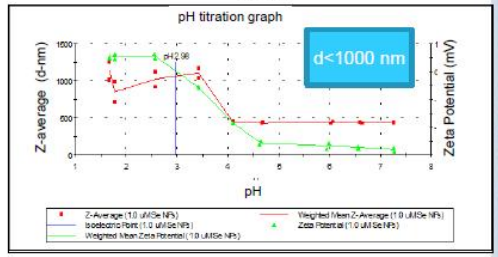
↓

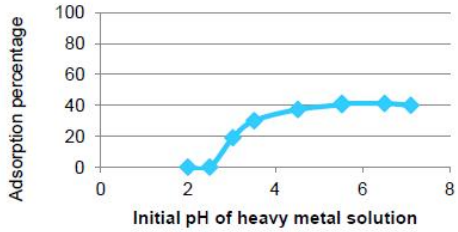
Adsorption of heavy metals by Se NPs

- Kinetics
- Thermodynamics
- Effect of pH & ionic strength

RESULTS and DISCUSSION







- 70% selenite converted either to elemental Se(0) in biomass or methylated and volatilized
- Elemental Se(0) particles are unstable at pH <4.5
- Adsorption is strongly dependent on the initial pH of the heavy metal solution

Bridging the gaps between Hydrology, Land use and Water Management using Tracers and Water Resources Modelling in the Incomati Basin

Aline Saraiva Okello[1] (PhD Sep 2010 to Aug 2014)

Promoters: Prof. Dr. Stefan Uhlenbrook[1], Prof. Dr. Pieter Van der Zaag[1], Prof. Dr. Graham Jewitt[2]; Supervisor: Dr. Ilyas Masih[1]

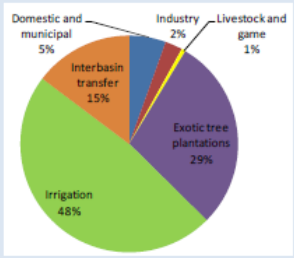
[1]UNESCO-IHE, Delft, The Netherlands; [2]University of Kwazulu-Natal, South Africa

1. Introduction

- Transboundary basin
- Area 46 700km²
- South-Africa 61%
- Swaziland 6%
- Mozambique 33%
- Semi-arid climate
- High hydrologic and climate variability
- High level of water commitment (agriculture, industry, environment, domestic, conservation areas)
- Water scarcity in some areas

2. The Problem

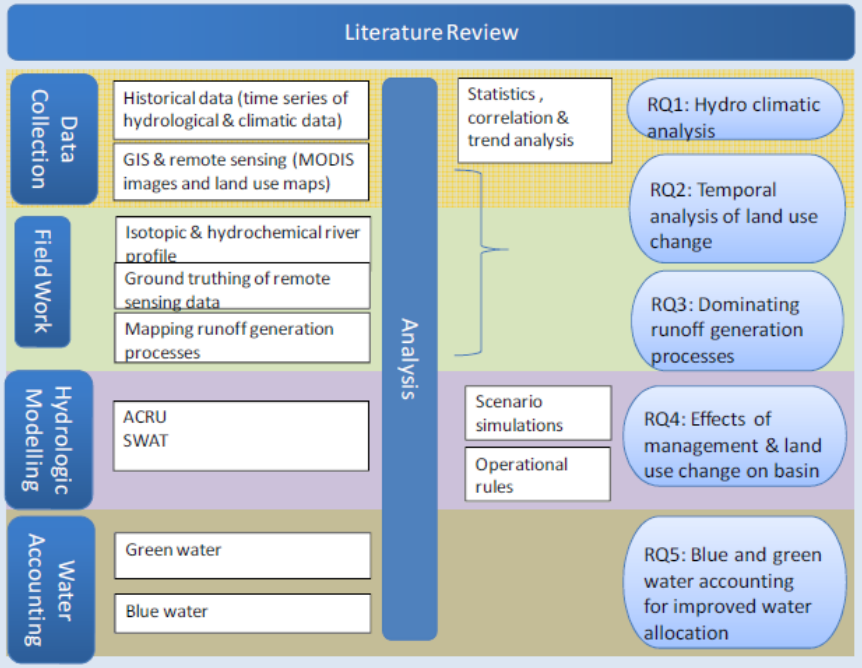
- Closed basin (water demands exceeds available resources)
- Numerous upstream-downstream interactions
- Effective water allocation and management requires good understanding of water availability and reliability
- Poor knowledge of impact of land use changes and water regulation on stream flow
- Potential of improved water management through management of land use and dam operational rules



3. Research objectives

- Analyse hydro-climatic variability and land use changes and its impacts on water cycle dynamics
- Improve understanding of dominant hydrological processes, using tracers and remote sensing
- Assess and apply suitable hydrological model to analyze impacts of land-use changes and water management scenarios
- Enhance water management through extensive and integrated analysis of model scenarios
- Blue and green water partition and accounting

4. Research methods & Expected Outputs



5. Stakeholders and collaborators

This research is carried out within the RISKOMAN project (Risk-based Operational Water Management for the Incomati River Basin). The project aims to assist water managers and stakeholders in identifying, implementing and continuously adjusting efficient water allocation policies in a dynamic and uncertain hydrologic environment.

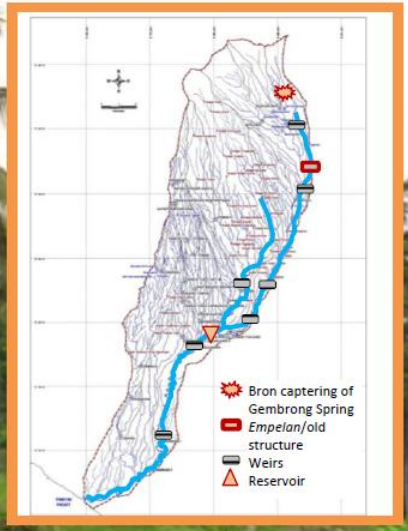
Contact: a.saraiva@unesco-ihe.org

Role of reservoir operation in sustainable water supply to *Subak* irrigation systems in Yeh Ho River Basin

Mawiti Infantri Yekti[1,2], Bart Schultz[1] (Supervisor) and Laszlo Hayde[1] (Mentor)

Context with nature

Paddy terraces are typical landscapes of *Subak* irrigation schemes in Bali Indonesia. The indigenous knowledge has survived to maintain it since more one thousand years. UNESCO has officially acknowledged *Subak* agricultural systems in its World Heritage List during the organization's annual meeting in Saint Petersburg, Russia, on June 29, 2012.



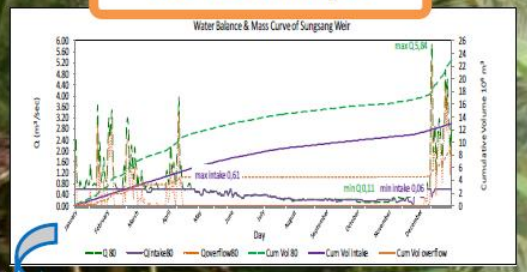
Data collections

Primary data are the cropping pattern of *Subak* based on indigenous knowledge, topography of a paddy terrace sample from reservoir, infiltration rate, soil parameters, *tembuku* and *pengutangan* observation. Secondary data are river basin land use, discharge records, reservoir data, sediment, domestic water need, maintenance and operation budget, paddy price.

Methodology and hypotheses

The water balance of Yeh Ho River Basin in weirs and reservoir is evaluated to ascertain best sharing in the system.
In the small system, supplying from reservoir to one paddy terrace will be detailed to find out the crop water requirement.
It will be observed role of reservoir operation to support sustainability *Subak* agricultural systems using empirical methods, simulation and optimization approach.

First result analysis



Problem statement

- A *Subak* irrigation scheme, primarily in Bali Indonesia which the construction, operation and maintenance is based on agreed principles of technology, management of agriculture and religious community.
- Shortage of water has developed, *Subak* farmers are facing a challenge to still operate their *tek-tek* system which based on the continuous flow system.
- Due to the change in river flow downstream quite significant changes in the process of water sharing, the reservoir was built in the midstream of Yeh Ho RIver Basin (2006) .

Research question

- how can a *Subak* irrigation system result in sustainable productivity and even be further developed under limited water resources and new technologies be applied?
- which reservoir operation can best manage the flow within a river basin, and how would it have to be applied by the river basin agency?
- how do farmers perceive the changes in the operation pattern of the water distribution from the reservoir, while previously the water was distributed by a *empelan*?
- what is the subsistence of the reservoir in terms of water conservation in a river basin?
- how can the reservoir be operated to allocate the irrigation water in an optimum way and how can the related *Subak* irrigation systems best be operated in relation to the reservoir operation?

Preliminary conclusions

- Farmers in *Subak* could operate their *tek-tek* more technical accurately in order to sustain their agricultural productivity and competitive other domestic water needs.
- River basin agency need to standardize the reservoir operation related with *Subak* system

UNESCO-IHE Institute for Water Education

[1] *UNESCO-IHE, Chair Group Land and Water Development, Delft, Netherlands,* [2] *Udayana University, Bali, Indonesia*

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Multi-scale analysis and coupling of eco-hydrological model and remote sensing for the alpine grasslands (*páramo*) in the Ecuadorian Andean region

Minaya Veronica[1], van der Kwast Johannes[1], Corzo Gerald[2], Mynett Arthur[1,3]

[1]UNESCO-IHE, [2]Centro del agua para America Latina y el Caribe, Tecnologico de Monterrey, [3]TU-Delft

PhD 2012-2016

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1. Background

The tropical Ecuadorian highland environments are essential ecosystems that sustain biodiversity, biological processes, carbon sequestration, and water storage and provision. Due to the predominant daily high climate fluctuations these ecosystems are some of the most vulnerable terrestrial ecosystems to global environmental change.

2. Justification

Previous studies in the *páramo* have been carried out at different scales, and important components hardly manage to be integrated with other modeled phenomena without taking into account the spatial and temporal dynamics. Therefore an enhanced and coupled analysis using eco-hydrological tools is crucial for the understanding of the interactions, feedbacks and the functioning of the Andean *páramos* at multiple spatial and temporal scales.

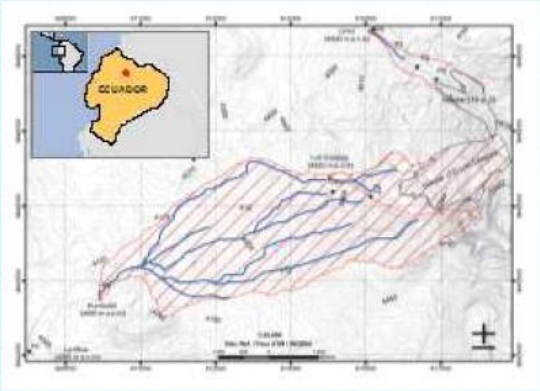


Figure 1: Study area, west slope of the Antisana icecap. (Source: Villacis & Basantes, 2011)

3. Objectives

- To characterize the spatial and temporal water distribution for the vegetation along the *páramo* region
- To find out an appropriate biomass model for natural ecosystems or adapt a new formulation on available models for natural vegetation in the *páramo*
- Identify hydrological and climatological change that could lead to an instability or extreme degradation in the *páramo* region

4. Methodology

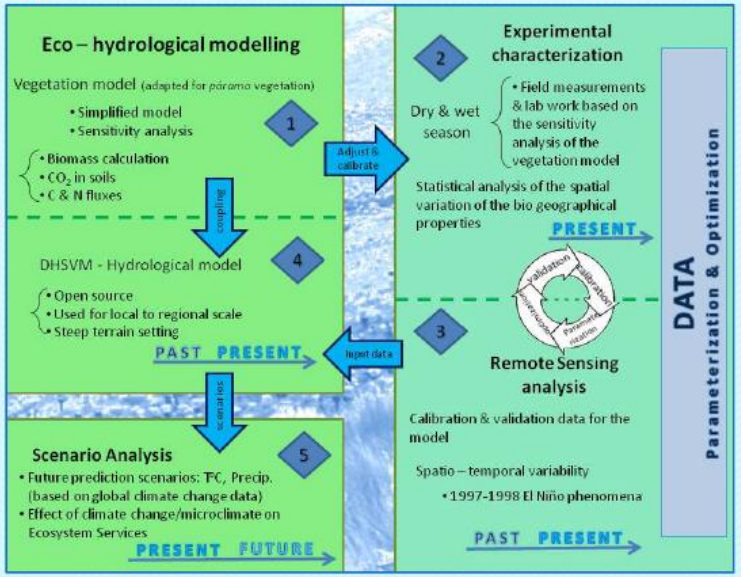
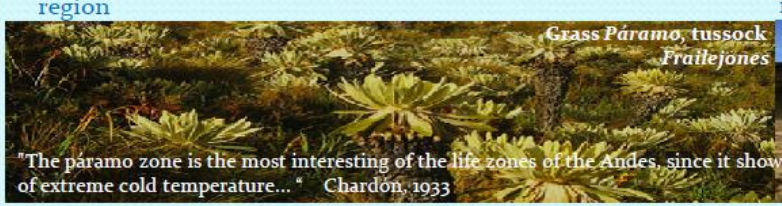


Figure 2: Scheme of the components of the research

5. Expected Results

- Quantify the sensitivity of the main parameters of the *páramo* species and how they respond to local climate (taking into account El Niño phenomena).
- Quantify and qualify the required water to maintain the sustainability of the ecosystem
- Identify the resilience of the natural system from natural/human changes



Grass *Páramo*, tussock
Frailejones

"The páramo zone is the most interesting of the life zones of the Andes, since it shows to the highest degree, the struggle of plant and animal life against conditions of extreme cold temperature... " Chardón, 1933

Ecuadorian *Páramos*

Did you know that..

- Some plants in the *páramo* can absorb up to 40 times their weight in water
- 6 out of 10 species of plant don't grow in any other biome
- The Condor is the typical bird of the Andes, it's the biggest in the world and can fly over 150km/day
- Approx every m² of *páramo* produce 1 lt of water per day

This poster participates in OSP

Outstanding Student Poster Contest

Flood Inundation Modelling Under Uncertainty Using Globally and Freely Available Remote Sensing Data

K. Yan[1], G. Di Baldassarre[1], D.P. Solomatine[1,2], L. Giustarini[3]

[1] Hydroinformatics Chair Group, UNESCO-IHE Institute for Water Education, Delft, the Netherlands
[2] Water Resources Section, Delft University of Technology, the Netherlands
[3] Département Environnement et Agro-biotechnologies, Centre de Recherche Public-Gabriel Lippmann
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UNESCO-IHE Institute for Water Education

1. Objective

Investigate the usefulness of SRTM topography to support flood inundation modelling in view of the other sources of error that are unavoidably associated to the hydraulic modelling of floods, such as the inaccurate estimation of the design flood and parameter uncertainty.

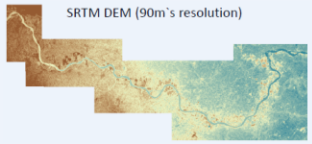
2. Case studies and Modelling tools

- River Po, Italy. 98 km reach of River Po from Cremona to Borgoforte. HEC-RAS (US Army Corps of Engineers, Hydrologic Engineering Center, 2001) is used to compute flood profiles.
- River Dee, UK. 10-km reach between the two EA maintained gauging stations at Farndon and Iron Bridge. A simple raster-based inundation model (LISFLOOD-FP, Bates and De Roo, 2000) is used to simulate the inundation extent.

3. Case study: River Po

LiDAR DEM (2m`s resolution)

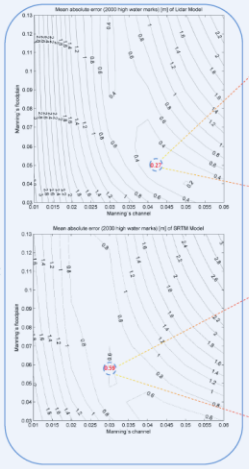
SRTM DEM (90m`s resolution)



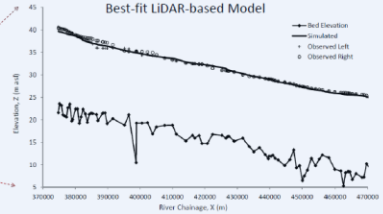
Two models are built based on LiDAR and SRTM topography data.

Calibration data: High water marks

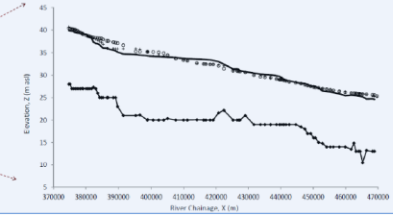
Calibration event: October, 2000 flood event



Best-fit LiDAR-based Model



Best-fit SRTM-based Model



Parameter Uncertainty:

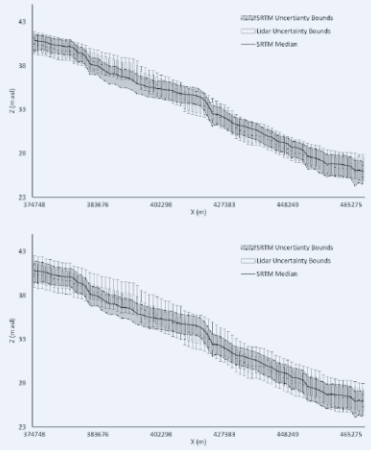
- Select behavioural model
- Calculate likelihood weights:

$$W_i = \frac{\max(c_i) - c_i}{\max(c_i) - \min(c_i)}$$

- Plot weighted percentile design flood profiles

Parameter + Inflow Uncertainty:

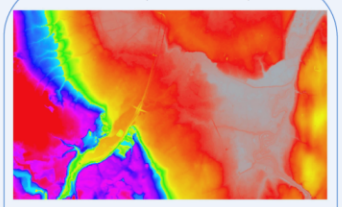
- Feeding all behavioural models using the 5 design flood values



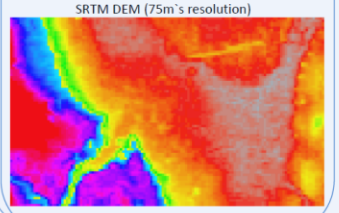
1-in-200 design flood profile prediction by considering : parameter uncertainty (upper panel), parameter + inflow uncertainty (lower panel) ; LiDAR-based Model uncertainty bounds are shown in boxplot (lower and upper quantile are 5th and 95th percentile), SRTM-based Model uncertainty bounds are shown in grey area (dash lines show 5th and 95th percentile)

4. Case study: River Dee

LiDAR DEM (20m`s resolution)



SRTM DEM (75m`s resolution)

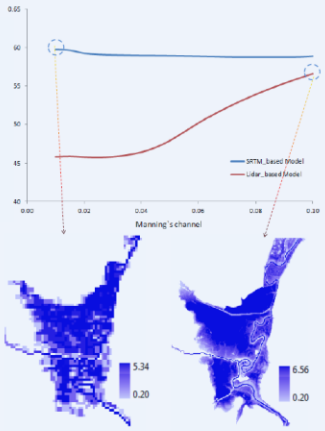


- Calibration data: ERS-2 SAR image

- Calibration event: December 2006 flood
- Performance measure:

$$F = \frac{A}{A+B+C}$$

A: Correct prediction
B: Over prediction
C: Under prediction



Best-fit Inundation map conditioned on 2006 event: SRTM-based (left panel), LiDAR-based (right panel)

Parameter Uncertainty

- Select behavioural model
- Likelihood weight calculation:

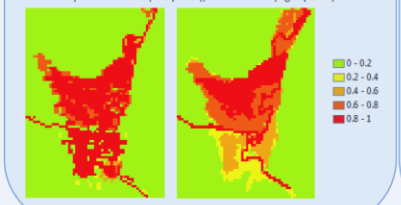
$$L_i = \frac{F_i - \min(F_i)}{\max(F_i) - \min(F_i)}$$

- Weighted average flood state calculation:

$$C_j = \frac{\sum_i L_i w_{ij}}{\sum_i L_i}$$

- Classify inundation probability from 0 to 1

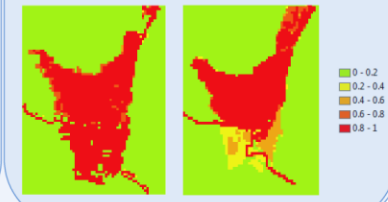
Probabilistic 1-in 100 year flood inundation map considering parameter uncertainty: SRTM based (left panel), LiDAR based (right panel)



Inflow Uncertainty

100 random values equally distributed in the range [1-in-100 year discharge] ±20% were used as the boundary condition for the ensemble simulation. The Manning`s coefficients with the best performance conditioned on 2006 flood event were selected as the model parameters.

Probabilistic 1-in 100 year flood inundation map considering inflow uncertainty: SRTM based (left panel), LiDAR based (right panel)



5. Conclusions

This study is a first attempt to quantitatively evaluate the value of the SRTM topography to support hydraulic modelling with the purpose of predicting design flood profiles and inundation extent in view of the main sources of uncertainty associated to the modelling exercise.

The results indicate that SRTM topography has some value in supporting the prediction of design flood profiles in medium-to-large scale rivers.

Regarding to inundation extent prediction, the results show the value of SRTM topography is not that clear due to the ignorance of embankments.

6. References

Bates, P.D. and De Roo, A.P.J. (2000). A simple raster-based model for flood inundation simulation. *Journal of Hydrology* **236**(1-2): 54-77.

Hydrologic Engineering Center (2001). Hydraulic Reference Manual. US Army Corps of Engineers. Davis, California, USA.

Towards Participatory Fisheries Governance: A Case of Lake Victoria Fisheries (Kenya)

Christine Etiegni[1] (Starting : June 2012, Ending : June 2016)

Prof. Irvine K.[2] (Supervisor) Prof. Leentvaar J.[2] (Promoter), Prof. Mwatete C.[3] (Supervisor)

[1] Ministry of Fisheries Development, Kenya, [2]UNESCO-IHE, Netherlands, [3]Pwani University, Kenya

Introduction

- World natural resources under stress from unsustainable use
- Fisheries resources under threat from pollution, eutrophication, over-capacity, illegal fishing activities
- Some stocks have been depleted (Steel & Hoagland, 2003)
- Participatory approaches to natural resource management (co-management) has attracted world attention
- Co-management adopted in Kenya in 2000 through formation of Beach Management Units (BMUs)

Objective

The main objective of the research is to understand the contribution of co-management on resource exploitation in Lake Victoria (Kenya)

Specific objectives

1. To determine how institutional changes for co-management have affected Lake Victoria (Kenya) fisheries governance
2. To analyze and determine how stakeholders are involved in the participatory process
3. To determine the contribution of co-management to the economic and social well-being of fishers
4. To analyze the functions, responsibilities and co-operation among stakeholders

References

- Bokea C. and Ikiara M. (2000). The Macro Economy of the Export Fishing Industry in Lake Victoria Kenya, 42pp
- Steele J. and Hoagland P. (2003). Are fisheries "sustainable"? Fisheries research, 64(1), 1-3

Fig 2: Beach seining: Unsustainable fishing method

Research approach: Case study of Lake Victoria (Kenya) Beach Management Units

Data collection methods

- Semi-structured interviews
- Focused group discussions
- Participant observations
- Observations

Study area

Fig. 1 Map of Lake Victoria

Background on study area

- Surface area 69,000 km^2
- Kenya (6%), Uganda (45%) and Tanzania (49%)
- 3.5 million people in East Africa depend on the Lake for their livelihood
- In Kenya, Lake Victoria dominates the fishing industry. 95% of fish landed and exported from Kenya comes from Lake Victoria (Bokea and Ikiara, 2000)

Expected outputs

- Better understanding of participatory fisheries governance in Lake Victoria (Kenya)
- 1 PhD thesis
- At least 3 peer reviewed articles

Modeling Instream Industrial Effluents for Optimized Water Quality in Data Poor Sub-Sahara Countries, the Case of Kombolcha City (Ethiopia)

Belachew Z. Eskinder [1] (June1/2012 to June 2/2016)
Prof. Kenneth Irvine [2] (Promoter), Dr. Peter Kelderman [3](Mentor), Dr., Hans Johannes [3](Mentor)
UNESCO-IHE, Institution for Water Education, The Netherlands; Wollo University, Ethiopia

Context and research questions

Sub-Saharan countries are facing water pollution from multiple industrial expansions (Kombolcha, Ethiopia)

Upstream unsustainable land use (e.g. agriculture) practices is further aggravating the water pollutions

Rugged topography also accelerates runoff flows and erosions

Objectives

Characterizing (and modeling) the spatially and temporally expected pollutants (nutrient, sediment and heavy metals loads)

Determining the environmental risks posed on urban agricultur (soils and crops).

Build a suitable GIS digital database for eco-friendly land use practices and regulated point emissions.

Research questions

What are the spatial and temporal effects of catchment land use and industries?

What are the impacts of the industrial effluent pollution loads (the health risk associated in crop tissues)?

How should catchment land ctivities (e.g. land use) and the industrial waste discharges be optimized ?

What policy goals are model predictions intended to achieve?

Hypothesis

- Industrial waste pollutants within a specific catchment conditions can be estimated with increased certainty through focused catchment wide condition water quality monitoring.

- Multiple industrial effluents mixed irrigation water will significantly increase the contamination of soil and plant with potentially toxic elements.

Methods

Input data generation

DEM creations

Sample station fixation

Land use derivation and mapping

Soil land unit and slope classification

Data collection and analysis

Land use analysis

Hydrology and hydraulic data

Surface water quality data

Water quality statistical analysis

Conclusion establishment

- Correlation and Linkage model (Regression modeling, BASINS (PLOAD, QUAL2E), PolFlow)

- Pollutants Impact, Validation calibration, uncertainty and sensitivity analysis

Expected Results

- Spatial and temporal dynamics

- Contribution of different emission sources

Biogenic Sulfide Production and Selective Metal Precipitation at low pH for Semiconductor Wastewater Treatment

S. Janyasuthiwong[a], G. Esposito[b], A. P. Annachhatre[c] and P.N.L. Lens[a]

[a] Pollution Prevention and Control Core, UNESCO-IHE Institute for Water Education, 2601 DA Delft, The Netherlands
[b] *Department of mechanics, Structures and Environmental Engineering, University of Cassino, Via Di Biasio, 43, 03043 Cassino (FR) Italy*
[c] Environmental Engineering and Management, Asian Institute of Technology, PO Box 4, Klongluang, Pathumthani 12120, Thailand

Introduction

Metal contamination in water is a wide spread issue around the world which is caused mainly by industrial activities. As a consequence, the resource depletion occurs due to the demand as raw material. The waste stream of these industries contains various pollutants, mainly metals.

Background

The wastewater of metal related industries usually have high concentration of various types of metals and low pH. The most easiest way to treat this water is metal precipitation with hydroxide (OH^-) or sulfide (S^{2-}). However, sulfide precipitation has more advantages than hydroxide due to the lower solubility of the end products.

$$H_2S + M^{2+} \longrightarrow MS(s) + 2\,H^+$$

Microbiological treatment technology using sulfate reducing bacteria (SRB) exists but using separate processes, sulfide production and metal precipitation, which has several limitations: maintenance cost and land availability. The inverse fluidized bed (IFB) comes as a solution to overcome these limitations by combining the two stages in one. Kijjanapanich *et al.* (2012)[1] hads shown that the SRB in the continuous column have a removal efficiency of 95 % of copper, zinc and iron. Moreover, the IFB reactor fed with lactate shows the efficiency in metal removal and the feasibility of metal recovery (VillaGomez *et al.*, 2011)[2].

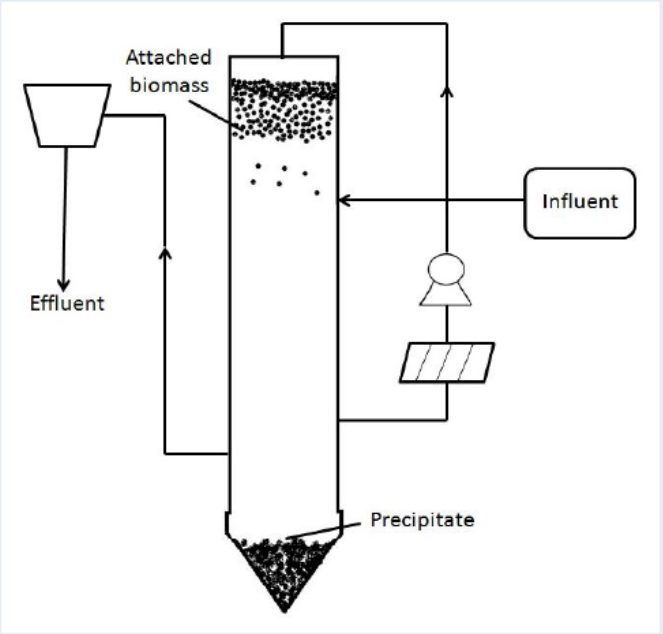


Figure 1. Inverse fluidized bed reactor diagram

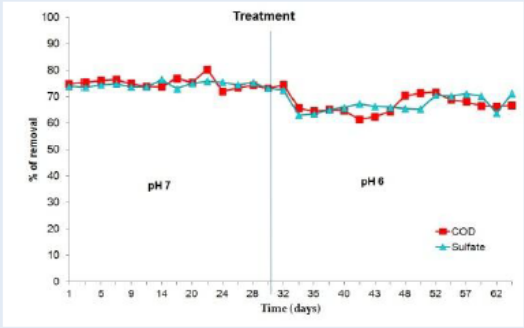
Objective

- To evaluate the potential use of IFB reactors for metal contaminated wastewater treatment
- To evaluate the removal efficiency and the recovery of the metals from the IFB reactor

Approach

- Sulfide production at low pH
- Metal sulfide precipitation with synthetic wastewater
- Application with real wastewater
- Metal transport through biofilm layer

Preliminary result



Conclusion

pH has an impact on the microbial activities, COD removal and sulfate reduction, the efficiency decreases according to the lowering of the pH.

References:
[1] Kijjanapanich P, Pakdeerattanamint K, Lens PNL, Annachhatre AP. Organic substrates as electron donors in permeable reactive barriers for removal of heavy metals from acid mine drainage. Environmental Technology. 2012:1-10.
[2] Villa-Gomez, D., Ababneh, H., Papirio, S., Rousseau, D. P. L. and Lens, P. N. L. Effect of sulfide concentration on the location of the metal precipitates in inversed fluidized bed reactors. *Journal of Hazardous Materials* 192, 200-207

Acknowledgement
This research was financially supported by the Erasmus Mundus Joint Doctorates in Environmental Technologies for Contaminated Solids, Soils and Sediments (ETeCoS[3]).

Optimization of Biological Sulphate Reduction

Cassidy, J.[1], Lubberding, H.J. [1], Esposito, G.[2], Lens, P.N.L. [1]

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[2] *Department of mechanics, Structures and Environmental Engineering, University of Cassino, Via Di Biasio, 43, 03043 Cassino (FR), Italy*

Introduction

Biological anaerobic reduction of sulphate has been successfully applied for the treatment of sulphate contaminated wastewater from industries on a larger scale for many years as it offers the possibility of an efficient treatment with low operation costs using various organic and easily utilizable carbon sources.

Problem Statement

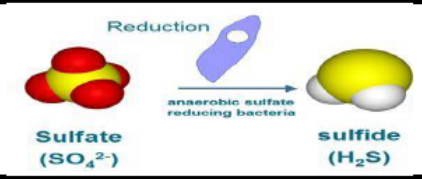
The main limiting factor is the cost of the electron donor. This can be overcome by using a control system or choosing cheaper e^- donors, e.g. methane.

The use of methane will also close its cycle of utilization, decrease the emission of one of the most important greenhouse gases and reduce the risk of excess carbon source in the treatment effluent.

Objectives

- To develop a feasible system for biological sulphate reduction using methane as an e^- donor.
- To develop a feasible control strategy for the control of biogenic sulphide production in sulphate reducing bioreactors.

Biological treatment



Research approach

Anaerobic oxidation of methane coupled to sulphate reduction:

1. Selection and characterization of the best biomass
2. Effect of environmental conditions and alternative exogenous substrates
3. Enrichment of the selected biomass in a membrane bioreactor
4. Phylogenetic and *in situ* activity identification (MAR-FISH)

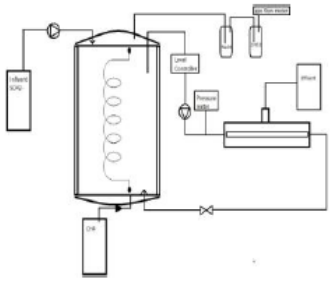


Figure 1. Experimental set-up for the anaerobic oxidation of methane coupled to sulphate reduction

Bioprocess control for biogenic sulphide production:

1. Set up and operation of the reactor (IFB) diversifying the operational conditions
2. Gain-Scheduling adaptive controller
3. Model based adaptive controller
4. Comparison of the efficiency of the two controlling strategies

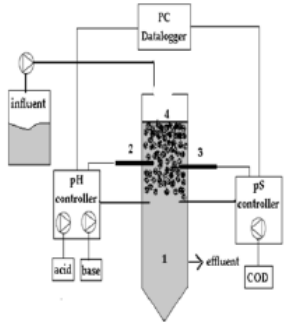


Figure 2. Experimental set-up for the sulphide and pH control strategy.

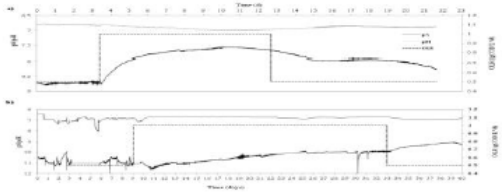


Figure 3. Step response curve for the pS and pH control when organic loading rate is changed by changing the COD (a) and hydraulic residence time (b)

Preliminary results

- pS stability parameters depend on the operational conditions such as flow rate, COD concentrations etc. and control parameters should be calculated for each reactor operational conditions and time.
- The changes in microbial population highly affect the steady states in the reactor and the precise point where the maximum sulphide production is reached and stabilized.
- Response rate was different if the OLR was increased or decreased.

Reference

Villa-Gomez D. K., Cassidy J. , Keesman K., Sampaio R. and Lens P.N.L. (2012) *Evaluation of tuning strategies for sulfide control in bioreactors using a pS electrode.* (in preparation)

Networked Environment for Stakeholders Participation (NESP) in Water Resources and Flood Management

Adrian Delos Santos Almoradie

Promoter: Prof. Dimitri Solomatine, Supervisors: Dr. Andreja Jonoski and Ioana Popescu

UNESCO-IHE Institute for Water Education, Delft, The Netherlands

Background

Development of water resources management (WRM) and flood risk management (FRM) plans and strategies should ideally be carried out in participatory processes through involvement of all stakeholders. Stakeholder participation, however, does not come without challenges and hindrances (e.g. limitation of financial resources, stakeholders' spatial distribution and their interest to participate). The use of networked environment was hypothesized to address in general the challenges and hindrances.

Networked environments are web-based mobile or computer-aided environments for remote interaction between participating entities such as stakeholders.

Main Objective

The main objective of this research is to conceptualize, design, implement and test a set of networked environments (NE's) for stakeholders' participation in water resources and flood management.

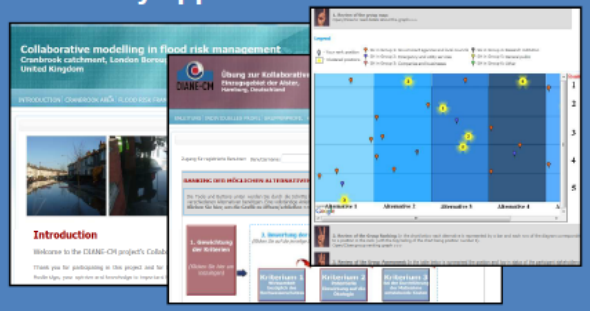
Research questions

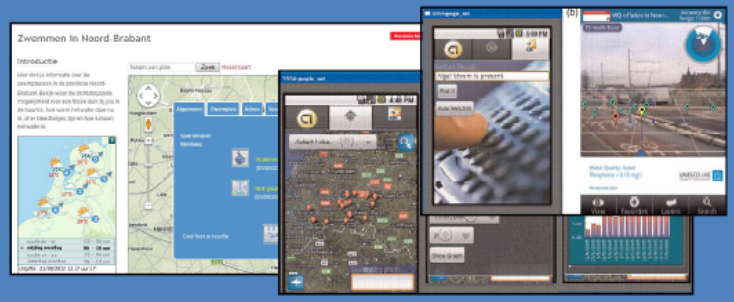
1. What are the main challenges and hindrances of stakeholder participation, and how can they be overcome using the NESP?
2. What are the innovative means to overcome these challenges and hindrances using the NESP?
3. What technologies can be used for the development of the NESP?
4. Are the methods adaptable to different water resources and flood management problems/situation?

Approach

1. Investigate, conceptualize and develop methods for participatory process in a networked environment.
2. Develop demonstrator for NESP's that can be tested and evaluated for specific cases.
3. Apply the methods and technologies to different case studies.

Case study application

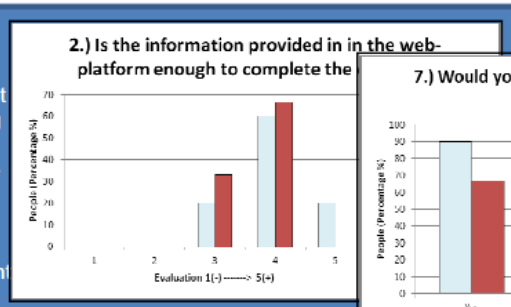




Case study	Participation	NESP	Status	Application
Cranbrook catchment (UK)	Stakeholder collaboration	Web	Finished	http://hikm.ihe.nl/diane_cm/cranbrook
Alster catchment (Germany)	Stakeholder collaboration	Web	Finished	http://hikm.ihe.nl/diane_cm/alster
Noord Brabant lakes (Netherlands)	Public feedback and Professional inputs	Web + mobile	Finished	http://hikm.ihe.nl/Msc/khan/new.html
Somes Mare catchment (Romania)	Public feedback and Stakeholder	Web + mobile	On-going	http://hikm.ihe.nl/...
Danube river (Romania)	Stakeholder	Web	On-going	http://hikm.ihe.nl/...

Initial results and conclusion

1. The NESP demonstrated to be useful in promoting interaction between stakeholders that integrates participation into the decision making process
2. Stakeholders recognize the usefulness of these platforms, however creating a "culture" of using these platform is clearly needed for their more intensive usage in the future.
3. The framework showed to be suitable in different contexts and study area



Publications

1. Jonoski, A., Alfonso, L., Almoradie, A., Popescu , I., van Andel, S.J. and Vojinovic, Z. (2012) Mobile phone application in the water domain. *Environmental Engineering and Manegement Journal*, 11(5), 919-930.
2. Jonoski, A., Almoradie, Khan, K., Popescu , I. and van Andel, S.J. (2012) Google Android mobile phone applications for water quality information management. *Journal of Hydroinformatics (in-press)*.
3. Evers, M., Jonoski, A., Maksimović, Č., Lange, L., Ochoa, S., Teklesadik, A., Cortés, J., Almoradie, A., Simões, N. E., Wang, L. and Makropoulos, C. (2012). Collaborative modelling for active involvement of stakeholders in urban flood risk management. *Natural Hazards and Earth System Sciences Journal*, 12, 2821-2842.
4. Almoradie, Cortés, J. and Jonoski, A. (2012) Web-based stakeholder collaboration in flood risk management. *Journal of Flood Risk Management (in-review)*.

Integrating Earth Observation And Meteorological Data, In-situ Monitoring, and Numerical Modelling to Reduce Uncertainty In Water Management

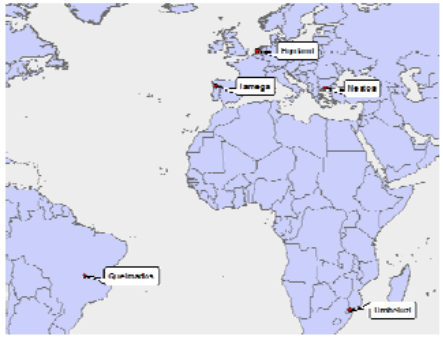
I M Hartanto, S J Van Andel, DP Solomatine
UNESCO-IHE, Institute for Water Education, Delft The Netherlands

Main Objective

To develop innovative methods to integrate earth observation (EO) and meteorological data, in-situ monitoring, and numerical modelling that reduce errors and are able to handle uncertainties in water management.

Potential Case Studies

- Rijnland-Netherlands
- Tamega-Portugal
- Umbeluzi-Mozambique
- Nestos-Greece
- Queimados-Brazil



Data Set :

Earth Observation

- Land Use Land Cover (LULC)
- Actual Evaporation (Eta)
- Leave Area Index (LAI)
- Soil Moisture

In-situ Monitoring

- Precipitation, Temperature, Wind Speed
- Water Level, Discharge

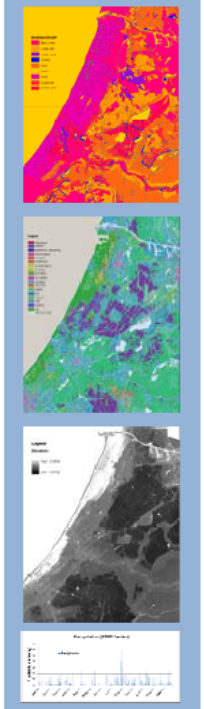
Hydrological model output

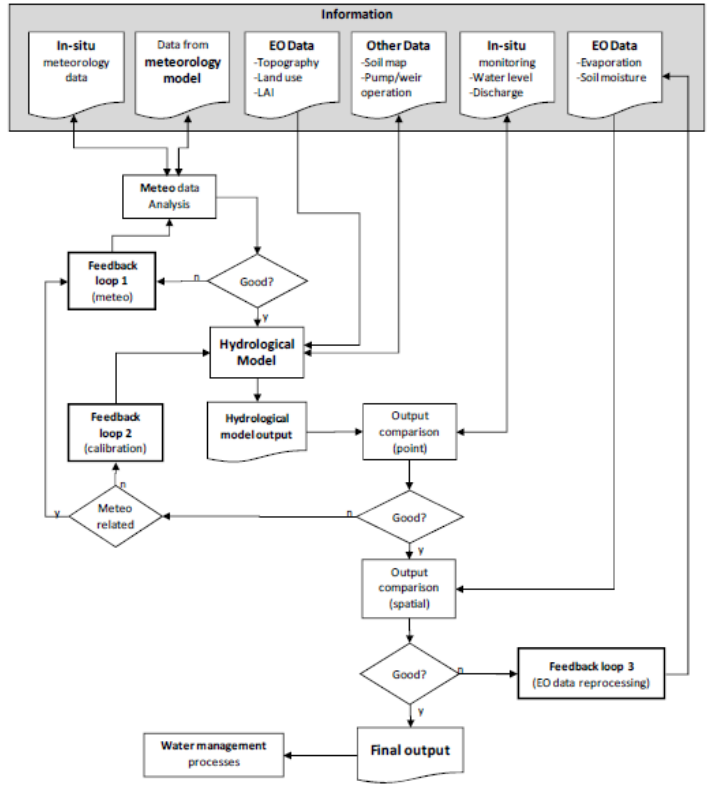
- Output of several hydrological models (SIMGRO, AQUARIUS, SWAT)

Meteorological Data

- Meteorological Model Forecast Products (ECMWF, ETA)

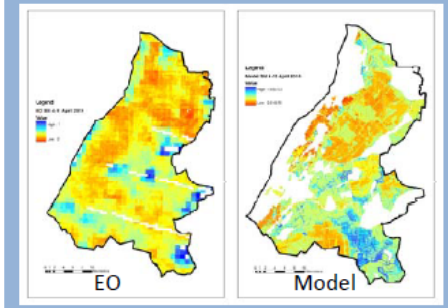
Data



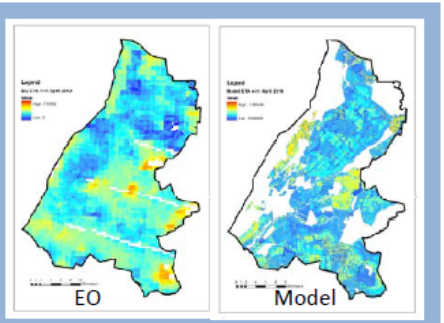


Expected Results:

- Integration of data through feedback loops, data assimilation, calibration/validation
- Assessment of the value of each data type for different model structures and water system
- Assessment of the value of various feedback loops
- Data exchange through auto-calibration and smart-switch of several numerical models
- Assessment of uncertainty propagation throughout the whole process with different methods and different data feeds



Soil Moisture Comparison



Evapotranspiration Comparison

Ecohydrological functioning of Nyando Wetland in a changing catchment context

Patrick Khisa
2009-2013

Promoter: Prof. Stefan Uhlenbrook , J. Wenninge, A. van Griensven

UNESCO-IHE Institute for Water Education

SENSE Research School for Socio-Economic and Natural Sciences of the Environment

Sustainable management of aquatic ecosystems and land use

This research is part of the Ecology of Livelihood (ECOLIVE) Projects targeting the East African Wetlands

Introduction

- Wetland loss estimated at >50% in the last 40 years
- Hydrological & ecological functioning, and support for community livelihood are threathened

Objectives

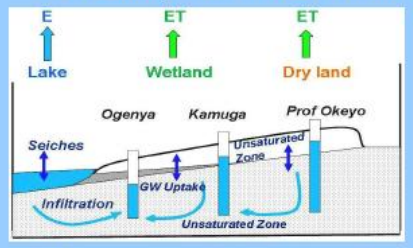
Develop conceptual models that help explain ecohydrological processes in Nyando wetland

Research Question

How does the wetland relate with the lake, river and alluvial aquifer?

Conceptual models

Lake-aquifer interaction



River-aquifer interaction

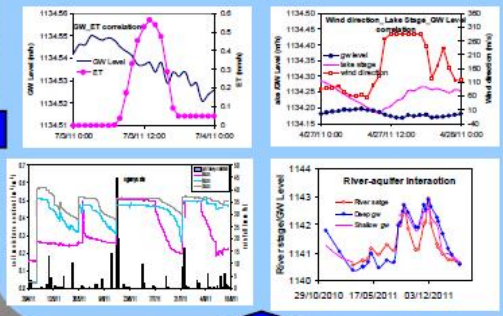
Methods

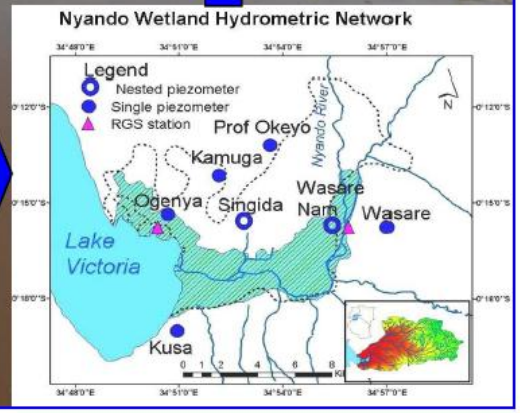
- Experimental investigations
- Conceptual modeling
- Catchment modelling
- Flood modeling

Conclusions

Water table fluctuations indicate ecohydrological processes in the wetland

Preliminary Results





Membrane filtration of algal bloom-impacted waters: Fouling characterisation and modelling

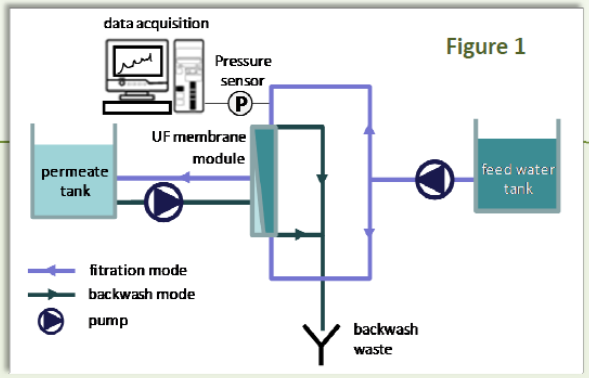
Loreen O. Villacorte, J.C. Schippers, G. Amy and M.D. Kennedy

Algal bloom and water treatment

Algal blooms in surface water are naturally occurring phenomenon which can have catastrophic impacts to the operation of membrane-based drinking and industrial water treatment plants. Sticky substances produced by algae, known as transparent exopolymer particles (TEP), are suspected to cause fouling of membrane filters, hampering water production.

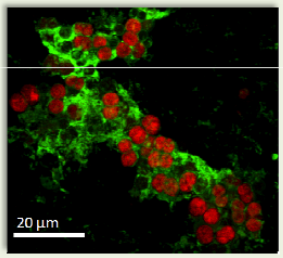
Research objective

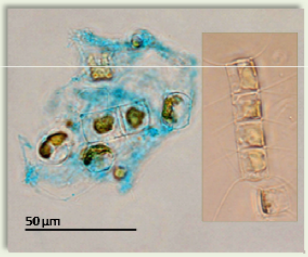
The main objective of this project is to elucidate the impact of algal blooms and TEPs they generated on the operation of membrane-based filtration systems for seawater and freshwater treatment.



Transparent exopolymer particles (TEP)

TEPs are invisible substances released by phyto- and bacterioplankton in the ocean, lakes and rivers. They mainly consists of hydrophilic, negatively-charged biopolymers. Their high stickiness can enhance adhesion of bacteria, algae and other particles onto membrane surfaces, resulting in clogging of membrane pores and rapid decrease of water production or increase of energy consumption during surface water filtration.



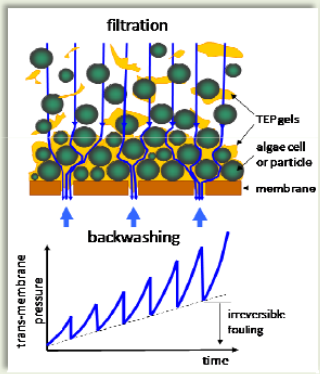


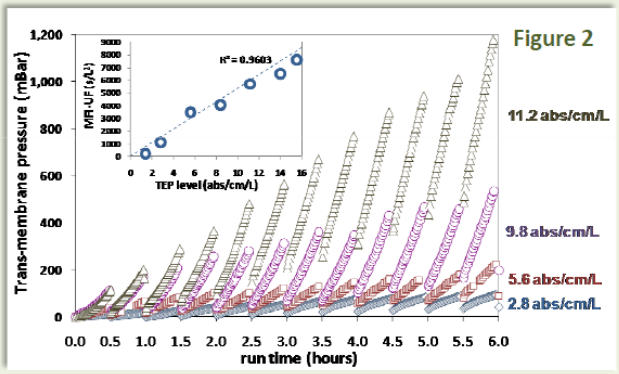
Methodology

Algal blooms were simulated in laboratory batch cultures of 3 types of algae (diatom, cyanobacteria and dinoflagellate). TEP production and membrane fouling potential of each species were monitored. TEPs extracted from algal cultures were fed to a lab-scale membrane filtration system (Fig. 1) to measure their impact on system performace based on pressure increase.

Preliminary findings

Algal culture monitoring showed significant correlation between TEP production and membrane fouling potential. Algal cells have negligible filtration resistance and their concentration does not dictate the fouling potential of the water. TEP fouling in UF membrane filtration system is not fully reversible by hydraulic backwashing (Fig. 2).





Conclusion and outlook

There are "strong indications" that TEPs in surface water have a major role in organic fouling in UF membranes during algal bloom situations. TEP's adhesive character may also enhance particulate fouling and initiate microbial fouling in UF and RO membranes. Hence, mitigating the fouling problem should not only focus on removing algal cells prior to membrane filtration but also minimising the effects of TEPs which these algae naturally produce.

Literature

Villacorte, L. O., Kennedy, M. D., Amy, G. L., and Schippers, J. C. (2009) *Water Research* 43 (20), 5039-5052.

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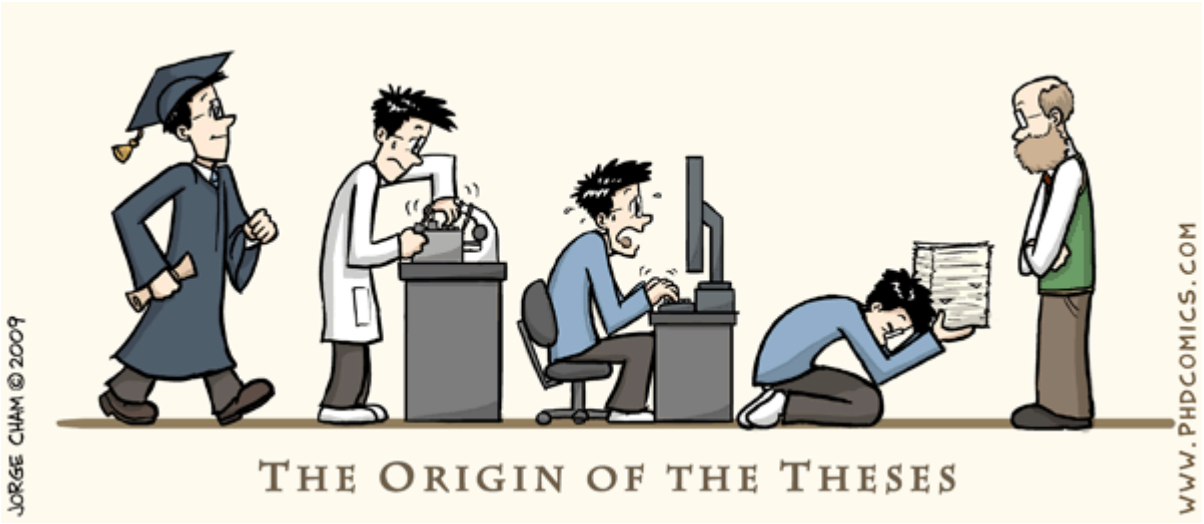
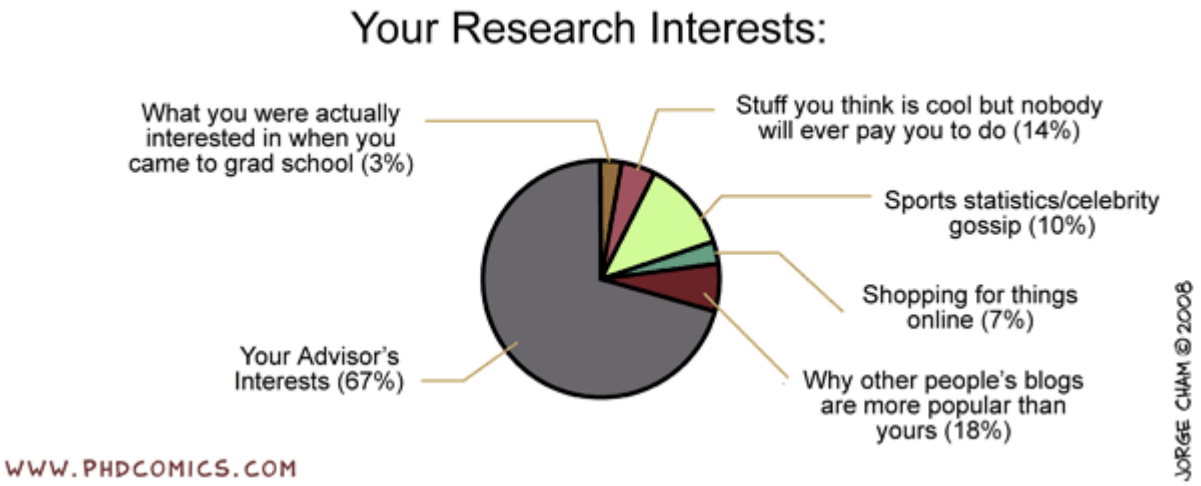
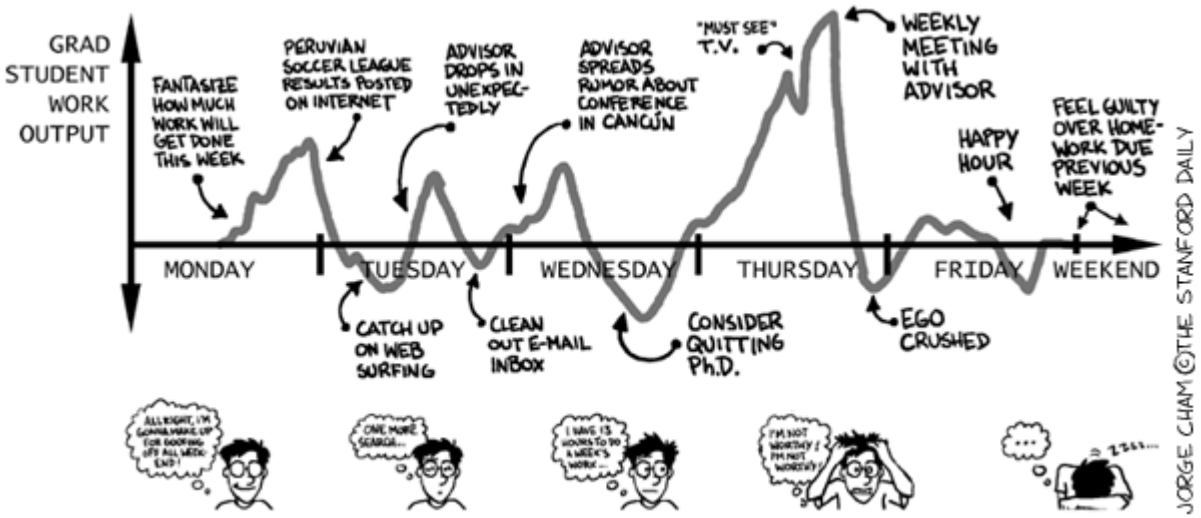
PHD COMICS AND MOVIE







DECIPHERING ACADEMESE

YES, ACADEMIC LANGUAGE CAN BE OBTUSE, ABSTRUSE AND DOWNRIGHT DAEDAL. FOR YOUR CONVENIENCE, WE PRESENT A SHORT THESAURUS OF COMMON ACADEMIC PHRASES

"To the best of the author's knowledge..."	=	"WE WERE TOO LAZY TO DO A REAL LITERATURE SEARCH."
"Results were found through direct experimentation."	=	"WE PLAYED AROUND WITH IT UNTIL IT WORKED."
"The data agreed quite well with the predicted model."	=	"IF YOU TURN THE PAGE UPSIDE DOWN AND SQUINT, IT DOESN'T LOOK TOO DIFFERENT."
"It should be noted that..."	=	"OK, SO MY EXPERIMENTS WEREN'T PERFECT. ARE YOU HAPPY NOW??"
"These results suggest that..."	=	"IF WE TAKE A HUGE LEAP IN REASONING, WE CAN GET MORE MILEAGE OUT OF OUR DATA..."
"Future work will focus on..."	=	"YES, WE KNOW THERE IS A BIG FLAW, BUT WE PROMISE WE'LL GET TO IT SOMEDAY."
"...remains an open question."	=	"WE HAVE NO CLUE EITHER."

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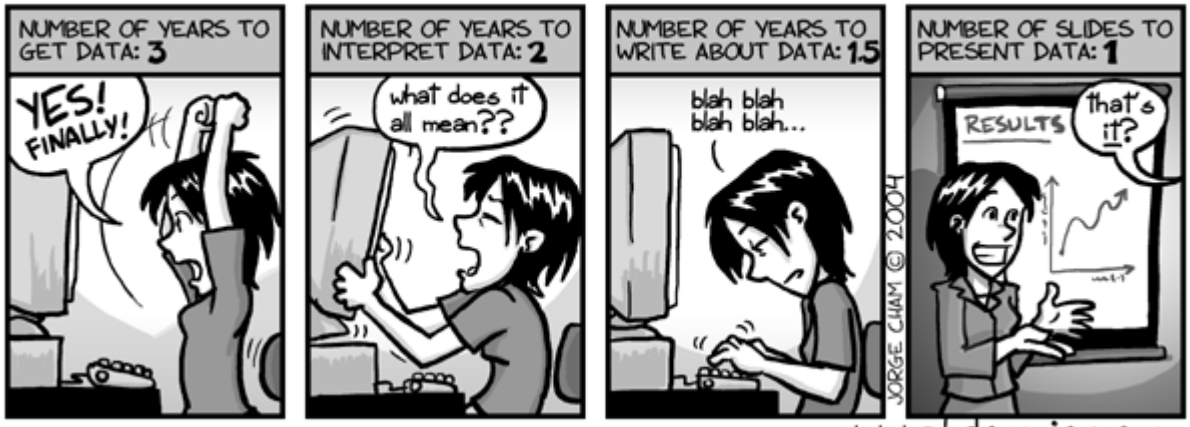

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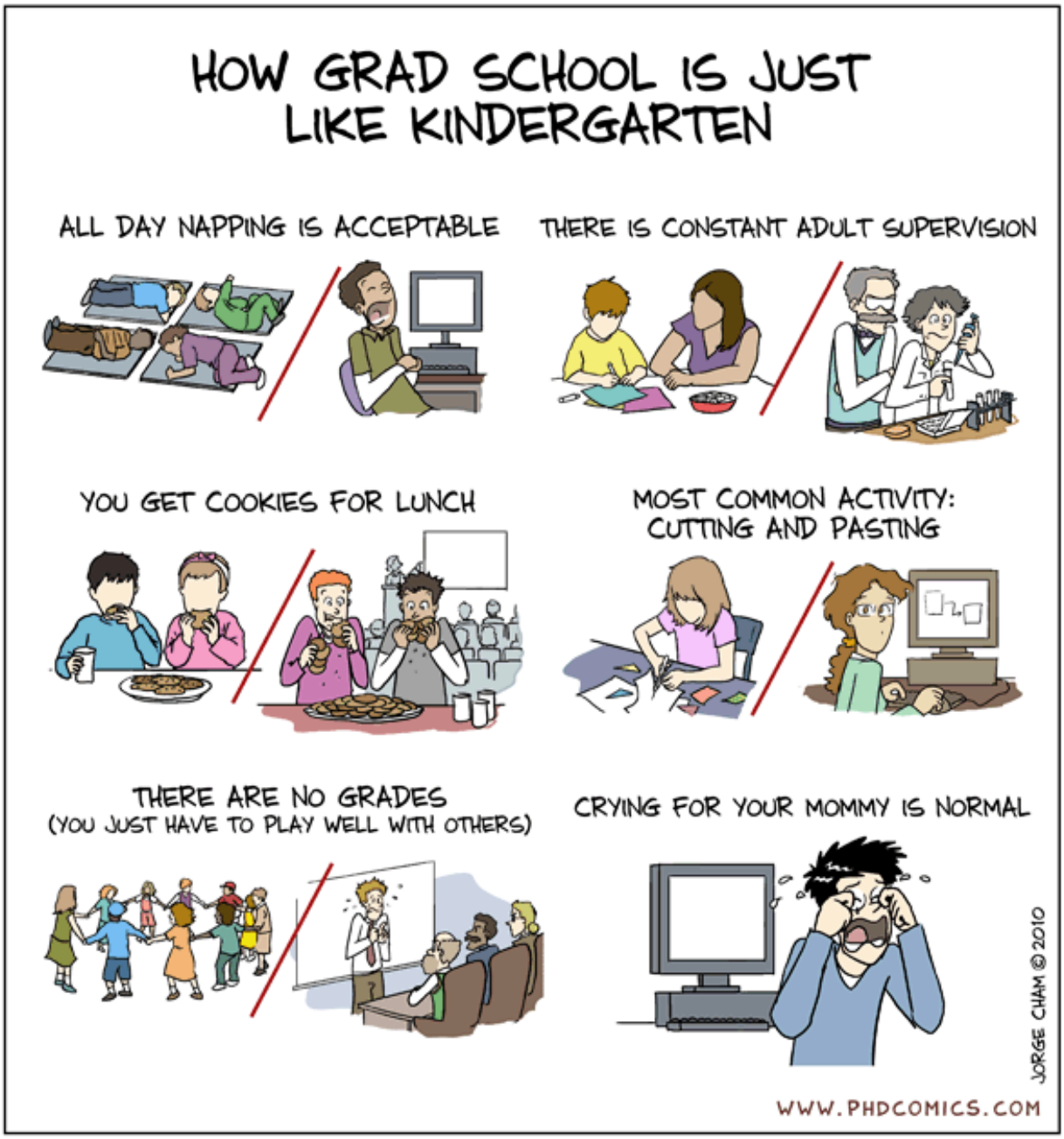
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THERE IS CONSTANT ADULT SUPERVISION
YOU GET COOKIES FOR LUNCH
MOST COMMON ACTIVITY: CUTTING AND PASTING
THERE ARE NO GRADES
(YOU JUST HAVE TO PLAY WELL WITH OTHERS)
CRYING FOR YOUR MOMMY IS NORMAL
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Seminar BINGO!

To play, simply print out this bingo sheet and attend a departmental seminar.

Mark over each square that occurs throughout the course of the lecture.

The first one to form a straight line (or all four corners) must yell out BINGO!! to win!

SEMINAR BINGO

Speaker bashes previous work	Repeated use of "um…"	Speaker sucks up to host professor	Host Professor falls asleep	Speaker wastes 5 minutes explaining outline
Laptop malfunction	Work ties in to Cancer/HIV or War on Terror	"…et al."	You're the only one in your lab that bothered to show up	Blatant typo
Entire slide filled with equations	"The data *clearly* shows…"	FREE Speaker runs out of time	Use of Powerpoint template with blue background	References Advisor (past or present)
There's a Grad Student wearing same clothes as yesterday	Bitter Post-doc asks question	"That's an interesting question"	"Beyond the scope of this work"	Master's student bobs head fighting sleep
Speaker forgets to thank collaborators	Cell phone goes off	You've no idea what's going on	"Future work will…"	Results conveniently show improvement

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