

**Proceedings of the
Early Career Researchers in Water, Sanitation and Hygiene
Conference 2013**

Hosted by Cranfield University

In partnership with Engineers without Borders (Cranfield) & Silsoe Aid for Appropriate Development (SAFAD)

Kindly supported by Borealis & Mott Macdonald

21 November 2013

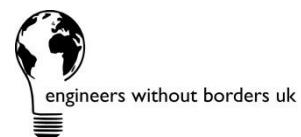


Table of Contents

Presentations

Session 1a: Water Safety Plans

P.1 A review of water safety plans implementation

P.1 Catchment Management for the River Nar

P.3 Water Governance and Issues: From Water Safety Plans Perspective

Session 1b: Faecal Sludge Technology Treatment and Re-use

P.4 Scale down of industrial wastewater treatment systems to meet the challenges of sewage treatment

P.4 Faecal sludge as a feedstock for anaerobic digestion and the re-use of its outputs

P.5 Ecologically engineering anaerobic digesters to cope with high solids waste from pit latrines

Session 2: Technologies in WASH

P.6 The transforming waste consortium: A socio-technical approach to sanitation in peri-urban environments

P.7 Developing a safe simulant for faecal sludge

P.8 Reinventing the toilet

P.10 De-mystifying geospatial technology; a case study in capacity building in GIS and GPS

Session 3: Improving access to WASH

P.10 A Realist Evaluation of an action research building capacity in WASH technology assessment

P.11 Seasonal access to water and sanitation in Kermi village, Humla District, Nepal

P.12 Appropriate technology, targets and discourse: A case of contested development in rural Bihar, India

P.12 Lessons from the Pakanae water supply

Poster Presentations

P.13 Yussif Abdul-Rahaman (Pumping is Life, Ghana)

P.14 Emmanuel Sachikumba (University of Zambia)

P.15 Ruth Kennedy-Walker (Newcastle University)

P.15 Nazmun Naher (WaterAid, Bangladesh)

P.15 Simeneh Gebeyehu (UNHCR-Ethiopia)

P.16 Kirsty Upton (Hydrogeologists without Borders - UK)

Session 1a: Water Safety Plans

Lessons from success stories, transferable or not? A review of water safety plans implementation

G. Oluwasanya, A. Parker, S.J.T. Pollard

Cranfield Water Science Institute, Cranfield University, UK

Water safety plans was introduced nearly a decade ago in international guidance documents as an effective preventative risk management means of ensuring safe water provision from source to tap. Since the introduction, WSP has been applied globally in mostly the developed nations and developed largely for public utilities. The level of WSP implementations in developing countries and for small systems generally, lags behind. United Kingdom is one of the early adopters of WSP. Major actors in the UK water industry are also involved in shaping the pathway to WSP introduction. This paper thus reviews WSP implementation in the UK with the aim to identify transferable lessons to particularly, public utilities in developing countries. Semi-structured interviews of key informants across 7 UK water companies was conducted. The study also captured the views of key informants from other relevant agencies such as the regulatory agency, academic and research institutions, Aid agency and independent industry professional consultants. Findings reveal regulatory-driven requirement as an overarching key component to WSP implementation aside the issues of management and organisational buy-in. WSP implementation driven by regulation however comes with a price. Transfer of lessons from success stories may also be subject to local regulation and/or the lack of it.

Catchment Management for the River Nar

*S. Pipe¹, F. Elwell¹, S. Eyre², J. Sandberg²

¹ *Mott MacDonald* ² *Anglian Water*

*Corresponding author: sarah.pipe@mottmac.com

Introduction

With an increasing trend in the financial and carbon cost of treating drinking water, and regulatory drivers such as the Water Framework Directive (Article 7) and Drinking Water Safety Planning, water companies are seeking alternative methods of water treatment. The pesticide metaldehyde, the active ingredient in the majority of slug pellets, is of particular concern as it is not always effectively removed by conventional water treatment. Therefore, Anglian Water is assessing the potential of using catchment management as an alternative to water treatment to improve raw water quality and manage the risk of noncompliance with drinking water standards.

Mott MacDonald is assisting Anglian Water to develop tools to evaluate the potential effectiveness of catchment management on metaldehyde concentrations in raw water abstracted from rivers or reservoirs in the Anglian region.

The project aims to answer the questions:

- What land management practices should be promoted and where would they be most effective?
- What impact on raw water quality would different practices have?
- How soon would the impacts be seen?
- Can we avoid the need for additional raw water treatment?

This case study focuses on the procedures and results for the River Nar catchment in Norfolk.

Approach

The SWAT¹ (Soil & Water Assessment Tool) modelling software was used to simulate catchment hydrology and metaldehyde concentrations in each catchment supplying a surface water sourceworks via a river intake and/or a reservoir. A range of publicly available datasets were used to build the SWAT models, including: topography, land cover, soil type, climate, crop rotations and pesticide application.

Following model calibration and verification against recorded flow and metaldehyde concentration data, catchment management scenarios were run and compared to the current catchment conditions. Management techniques included metaldehyde substitution for another product on a randomly selected proportion of the arable land, metaldehyde removal on high risk areas of the catchment (arable land on clay soils, steep slopes, or next to a watercourse), and reduction in metaldehyde dosage rates.

The River Nar catchment has a high distribution of light loamy and sandy soils throughout the catchment, indicating that the risk of metaldehyde running directly off the land and into watercourses would be low. Although a low risk is expected on these permeable soils (on a permeable chalk aquifer and more impermeable superficial deposits in the upper regions), peak metaldehyde concentrations over the regulatory limit are still observed in the raw water intake on this river. For this reason, catchment management techniques could help reduce metaldehyde peak concentrations in this catchment.

Discussion

The project has produced robust and technically defensible simulations of contaminant concentrations at the sourceworks under current and possible future conditions (such as changes in agricultural practices and potential land use changes).

These tools allow Anglian Water to better understand the link between the management of catchments and contamination of surface water. The model outputs are being used to inform Anglian Water's Business plan for future capital investment, and could pave the way to reducing energy and carbon-intensive treatment, saving cost and better protecting the environment in both the short- and long-term.

1 <http://swat.tamu.edu/>: USDA Agricultural Research Service (USDA-ARS) and Texas A&M AgriLife Res

Water Governance and Issues: From Water Safety Plans Perspective

H. Hasan¹, A. Parker¹, S.J.T. Pollard²

¹ *Cranfield Water Science Institute, School of Applied Sciences, Cranfield University, Bedfordshire, MK43 0AL, UK.*

² *Centre for Environmental Risks and Futures, School of Applied Sciences, Cranfield University, Bedfordshire, MK43 0AL, UK.*

Malaysia is a newly industrialised country with good health care access and drinking water coverage for its geographically and ethnically diverse population of 28.5 million. Since its independence in 1957, the national water governance is somehow complicated. Although Malaysia is a *de jure* federal state, it is often considered as a *de facto* unitary state due to the fact that water services were legally an exclusive responsibility of the states. The water sector was reformed in 2003 by strengthening the role of the federal government compared to the state governments although this only applies to some parts of the nation. Also, the legal framework for the water sector which was enacted in 2006 focuses mainly on quantity rather than quality and the protection of drinking water sources.

In response, Water Safety Plans (WSPs) were introduced in 2008. Over the next two years, this research will investigate the institutional arrangements and stakeholder engagement that are supporting or hampering the implementation of WSPs. This will include understanding the gaps and overlaps of the institutional responsibilities and capacity throughout the water supply chain and mapping the stakeholders. In a broader view, the role of water security and Integrated Water Resources Management (IWRM) in WSPs will be assessed.

This will be achieved through a case study research method which will be applied through within-case analysis and cross-case analysis for two locations (the UK and Malaysia). It will involve archival analysis as well as collective case study methods such as questionnaires and semi-structured interviews. The research data will be analysed qualitatively to effectively build a body of evidence to support the research project.

Keywords: *Water Safety Plans (WSPs); Institutional arrangements; Stakeholder engagement; Water security; Integrated Water Resources Management (IWRM); Case study research method; Malaysia; UK.*

Session 1b: Faecal Sludge Technology Treatment and Re-use

Scale-down of Industrial Wastewater Treatment Systems to Meet the Challenges of Sewage Treatment in the Peri-Urban Environment

S. Connelly¹, S. Gu Shin¹, W. T. Sloan¹, G. Collins^{1,2}

¹*Infrastructure and Environment, School of Engineering, The University of Glasgow, UK*

²*Microbiology, School of Natural Sciences, National University of Ireland Galway, Ireland*

The global population is predicted to reach 10 billion by 2083. On top of this, 56% of the global population is predicted to live in an urban setting by 2025. This urgently presents the need for new, and holistically-engineered, water and energy infrastructures. The expanded granular sludge bed (EGSB) bioreactor is a high-rate, biological wastewater treatment system that offers the potential to convert waste water to a renewable energy (methane gas) and an effluent rich in scarce nutrients such as phosphorus and nitrogen. As a high-rate system the EGSB additionally offers decreased plant footprint and cost as compared to traditional AD technologies. It thus presents an attractive solution for sewage treatment and energy provision in urban and peri-urban environments where demand for small scale, locally managed services is high. Currently, the EGSB is successfully used to treat high-strength wastes at industrial scales in the Global North. Direct applicability of the EGSB to sewage treatment in peri-urban environments however is hindered by a lack of scientific understanding of the microbial community that underpins the treatment in relation to both substrate type and robustness of the technology at smaller scales.

The impact of scale-down on microbial community dynamics and function in EGSBs is studied here using two alternate scale-down models operated in triplicate under near-identical conditions to three existing full-scale reactors. Good correlation with respect to performance was demonstrated between the full-scale and lab-scale studies. Activity testing conducted throughout the trial however indicates that scaling has a strong influence on the spatial distribution of microbial activity in the reactor system, which suggests vital opportunities towards engineering reactor scale-down for improved performance to meet the particular challenges of sewage treatment in the Global South.

Ecologically Engineering Anaerobic Digesters to Cope With High-solids Waste from Pit Latrines

R. Dillon¹, S. Connelly², S. Gu Shin², E. Porca¹, W. T. Sloan², G. Collins^{1,2}

¹*Microbiology, School of Natural Sciences, National University of Ireland Galway, Ireland*

²*Infrastructure and Environment, School of Engineering, The University of Glasgow, UK*

Sustainable, affordable waste treatment systems for the provision of cleaner water and basic sanitation are urgently required in developing, peri-urban communities. Anaerobic digestion (AD) of sewage and other wastes is an attractive option for waste conversion, which can be applied for sanitation technologies and can produce renewable fuels.

Breakdown of waste material occurs through a succession of microbial processes mediated by several different trophic groups of microorganisms. This microbial food chain that develops in the bioreactor produces clean water and valuable biogas.

Very little is known about the composition of the microbial communities underpinning bioreactors, or about the location of each trophic group in a bioreactor. By intervening in the ecology of an AD bioreactor, and 'eco-engineering' the system, the flow of carbon and energy through the bioreactor might be manipulated to allow for the growth of desirable microbes in specific regions of a bioreactor. For example, the position in an AD system of hydrolyzing bacteria, which initiate the degradation of large molecules, might be strategically important for the digestion of high-solids wastewaters, such as sewage from pit latrines in developing countries.

Layers of sodium-alginate beads of different density were placed in an AD bioreactor, with the densest at the bottom, to provide a matrix for the attachment of microbial cells. Our hypothesis was that the upwards flow of wastewater entering the system would influence the pattern of attachment, with hydrolysing bacteria colonizing the densest beads at the bottom as these would be the first trophic group to encounter the incoming waste and the largest compounds. This first layer would provide substrates for the next trophic group on the next layer of beads, and so on.

Splitting the community into distinct 'layers' will allow for the analysis of carbon flow through an anaerobic bioreactor. Following the trial, we are now embarking on a campaign of molecular microbial ecology to establish the species present at every layer and whether distinct trophic groups were successfully partitioned over space in the bioreactor.

Faecal Sludge as a Feedstock for Anaerobic Digestion and Nutrient Recovery of its Outputs

C. Rose

Cranfield Water Science Institute, Cranfield University, UK

Peri-urban areas of low income countries have limited infrastructure in regards to sewage treatment facilities and the populations of these areas largely rely on small scale on-site sanitation facilities. There are numerous different types of on-site sanitation systems in low income countries, however, most eventually reach their capacity and the faecal sludge that has accumulated requires collection and treatment before disposal/re-use in order to be safe for both humans and the environment. Unlike conventional water borne sewage the physical, chemical and biological characteristics of these waste streams are largely unknown, which resultantly makes the selection and development of treatment technology and the re-use of its outputs a challenge. Similarly the re-use potential of these waste streams is not fully utilised and more work can be done in order to utilise a valuable end product within target communities

This research aims to;

- Establish loading rates and the physical and chemical composition of faeces and urine as well as factors causing variation. The impact of this data on treatment mechanisms was then assessed.

- Conduct a full characterisation of four different types of faecal sludge from two different locations in Africa and determine the applicability of anaerobic digestion as a treatment method.
- Optimise drying beds for additional nutrient recovery of ammonium and phosphate and create an amended end product for agricultural application.

The progress of the project will be presented to the conference and will discuss the characterisation of faeces and urine and how these findings may impact treatment technology. Fieldwork undertaken in Lusaka, Zambia will be drawn upon to provide working examples of faecal sludge characterisation work and the challenges of faecal sludge management in peri-urban areas of low income countries.

Keywords: Sanitation, faeces, urine, faecal sludge, anaerobic digestion, wastewater characterisation, pit latrines.

Session 2: Technologies in WASH

The Transforming Waste Consortium: A Socio-technical Approach to Sanitation in Peri-urban Environments in Developing Countries

G. Collins^{1,2}, R. Kennedy-Walker³, S. Connelly², S. G. Shin², V. Nguyen⁴, J. Mukherjee⁴, C. Rose⁵, R. Dillon¹, C. Morciano¹, R., S. Parsons⁵, A. Parker⁵; E. Cartmell⁵, J. Amezaga³, D. Raffo⁶, L. Mehta⁷ and C. Biggs⁴

¹*Microbial Ecophysiology and EcoEngineering Laboratory, School of Natural Sciences & Ryan Institute, National University of Ireland Galway, University Road, Galway, IRELAND*

²*Infrastructure and Environment, School of Engineering, University of Glasgow, Oakfield Avenue, Glasgow G12 8LT, UK*

³*Devonshire Building, School of Civil Engineering and Geosciences, Newcastle University, Newcastle-upon-Tyne, NE1 7RU, UK*

⁴*Department of Chemical and Biological Engineering, The University of Sheffield, Sir Robert Hadfield Building, Mappin Street, Sheffield, S1 3JD, UK*

⁵*Cranfield Water Science Institute, Building 39, Cranfield campus, Bedfordshire, UK*

⁶*School of Architecture and Design, University of Ulster, Belfast BT15 1ED, UK*

⁷*Institute of Development Studies Library Road Brighton BN1 9RE UK*

Peri-urban areas in developing countries are characterized by poor infrastructure and access to formal water and sanitation services. There, initiatives, such as 'Community-Led Total Sanitation' (CLTS), have emerged to tackle the sanitation challenge. A key CLTS lesson is that sanitation is a social as well as technical challenge. In light of this, we comprise a team of natural and social scientists, which has come together to address this pressing problem by pooling our talents, interests and expertise. We have developed "socio-technical" approaches to help address this problem. Our consortium, and technology, is based on anaerobic digestion (AD), which is an established technology, particularly for the treatment of industrial wastewaters. However, the challenges facing the team are two-fold:

- (1) The sanitation system in the peri-urban environment is not based on a formal sewerage network of pipes with sewage transported by flushing water.

Instead, a high-solids waste is present. A major challenge is to 're-engineer' AD biofilms, and systems, to efficiently - and rapidly - digest high-solids wastewater.

(2) Cultural and social issues have impeded some of our initial progress. For example, some of the proposed systems, and the way these would be used, were not acceptable to local people.

Our progress, which we will report to the WASH event, has centered around technical and socio-technical activities:

(1) Hydrolytic, syntrophic and methanogenic microbial cells were immobilized on innovative, 'eco-engineered', mobile surfaces so that the AD community was strategically deconstructed and trophic groups spread along a spatial gradient for optimized sewage treatment. Laboratory-scale treatment trials with high-solids waste were initially successful.

(2) We engaged with local people and integrated social science with the engineering, and science, involved. In this way, a 'user-centered' prototype is being developed. We are moving to on-site testing in Lusaka, Zambia in summer 2014.

Developing a Safe Simulant for Faecal Sludge

J. T. Radford

Mott MacDonald

The fact that 2.5 billion people lack access to improved sanitation is well publicised, but there are an additional 2.1 billion who use facilities that do not safely dispose of human waste. An increasing proportion live in informal settlements, forecast to house half of the world's urban population, some 3 billion people, by 2030. Providing sustainable sanitation services in high-density urban areas remains a serious challenge with few proven solutions. The most common practice is for pits to be emptied manually by people immersed waist-deep in faecal sludge, scooping it out by the bucket-load.

Various technologies have been developed that promise safe mechanised pit emptying, and they are currently either tested on faecal sludge, which is hugely variable and has obvious associated health and safety risks, or on an 'ad-hoc' simulant that, in the opinion of the tester, approximately replicates the properties of faecal sludge. In both cases almost no information is available on the actual physical properties of the sludge, which can range from a watery consistency to a strong soil. This makes it difficult to evaluate the effect of design changes, and compare the performance of technologies produced by different organisations around the world.

A machine was therefore designed to measure the shear strength of faecal sludge within a latrine, producing a continuous profile of strength with depth, and the results of an initial trial on 30 pits in Uganda will be presented. That data, combined with other mechanical properties of faecal sludge, have been used to inform the development of a safe, synthetic simulant to replicate the pumping behaviour of faecal sludge and a simple, low-cost strength test has also been developed. This simulant is currently being used by Water for People in Uganda to benchmark the performance of different manual pit-emptying technologies, as well as by firms developing the Bill and Melinda Gates Foundation's Faecal Sludge Omni-Ingester.

Reinventing the Toilet: Using Pervaporation Membranes and Hydrophilic/Hydrophobic Condensing Media to Produce Pathogen Free Water In situ

*B. Martin, B. Jefferson, P. Jones, A. Parker, E. McAdam

Cranfield Water Science Institute, Cranfield University, Cranfield, Bedfordshire, MK43 0AL UK

*Corresponding author: b.d.martin@cranfield.ac.uk; +44(1234) 750111 ext 3336

More than 2.5 billion people lack access to proper sanitation, leading to devastating human and environmental health impacts. As part of the Bill and Melinda Gates Foundation's challenge to Reinvent the Toilet, a system comprising pervaporation membranes linked to hydrophilic and hydrophobic nanoparticle coated condensing media has been trialled. The use of dense pervaporation membranes completely rejects pathogens and allows the selective removal of water (as a vapour) from human urine and faeces. Water flux, trading off against power requirements, is expected to approach $0.5 \text{ L.m}^2.\text{h}^{-1}$ (Figure 1).

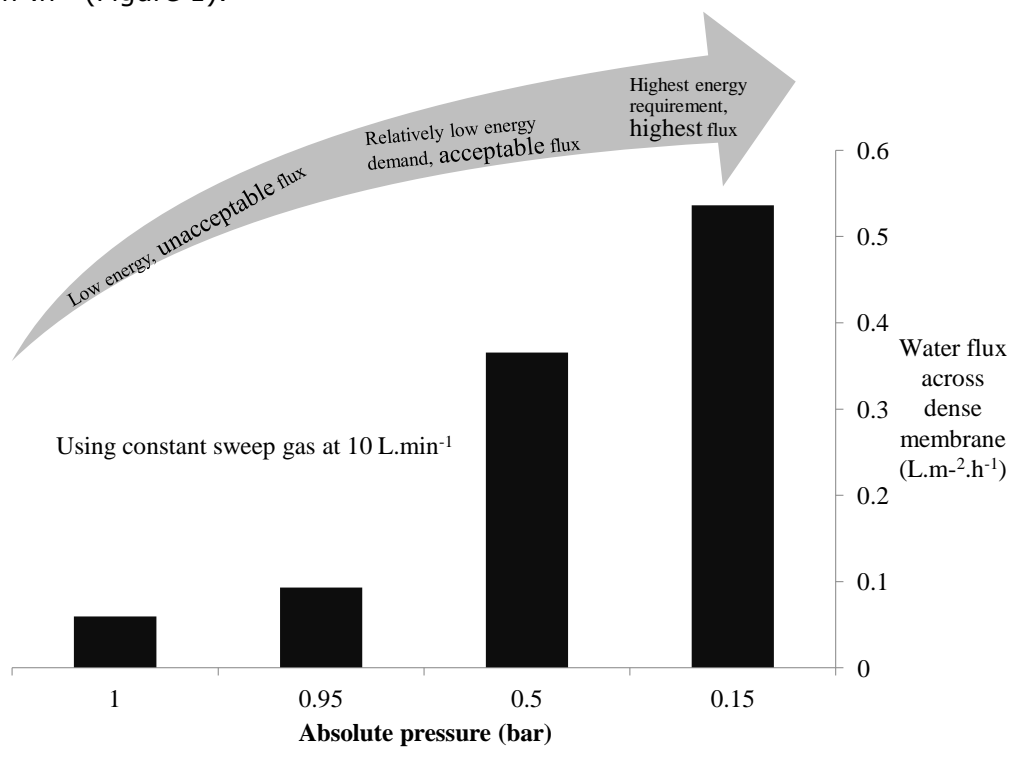


Figure 1: Water flux across dense membrane, balanced against energy demand

One of the key desirable outputs from the toilet is "useful" water – for cleaning floors, washing clothes, or even for cooking and drinking. The water leaving the pervaporation membranes must be condensed from the vapour phase, ideally using no energy. The current system seeks to exploit both hydrophilic and hydrophobic silver/thiol nanoparticle coatings applied to glass beads between 5 and 10 mm in diameter packed into a column, to condense water with little or no temperature differential. The hydrophilic surfaces adsorb water molecules from the vapour stream, and the

hydrophobic surfaces help ensure the water drains away to a collection reservoir (Figure 2).

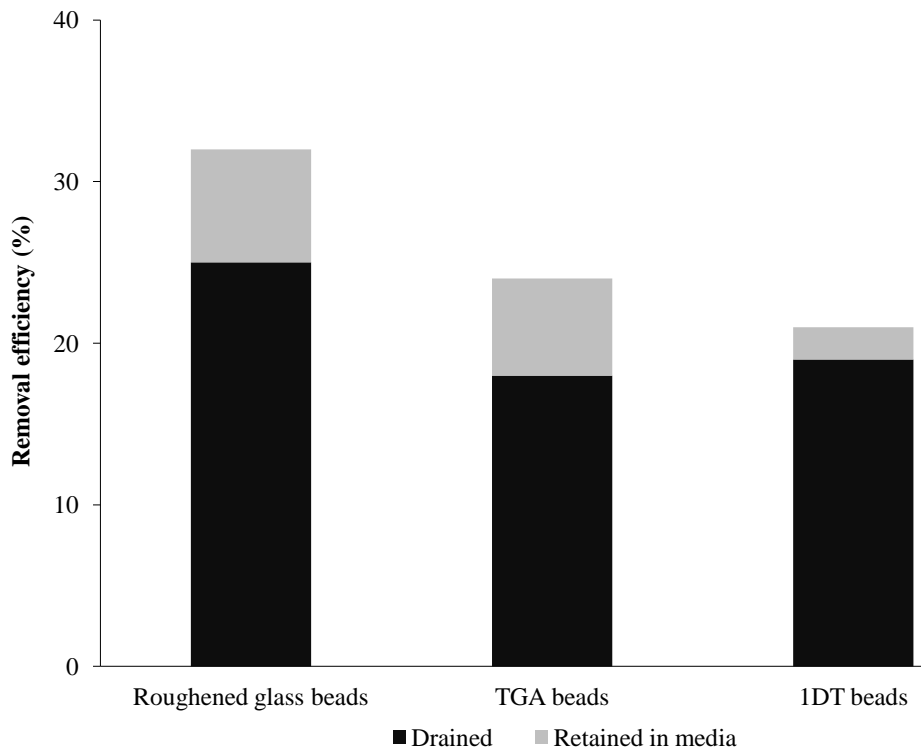


Figure 2: Condensing performance for roughened glass beads, hydrophilic glass beads (TGA), and hydrophobic glass beads (1DT)

While roughened glass beads perform surprisingly well, capturing over 30 % of the water vapour stream, nearly a quarter of this total remains bound to the surface. Both hydrophilic and hydrophobic treatments resulted in similar removal efficiencies of around 20 %, but the hydrophobic coating allowed a proportionally greater drained : retained ratio than the hydrophilic, of 10:1 in comparison to 3:1.

The key finding is that the use of pervaporation membranes combined with novel nanoparticle coated condensing media can produce pathogen free water, at a rate of around 10 litres per day from a single toilet used by ten people. The low energy demand of such a system and its off grid application means that it could help provide a real solution to the sanitation problem.

De-mystifying Geospatial Technology; a Case Study in Capacity Building in GIS and GPS

M. Waterkeyn

Mott MacDonald: International Development Division

Matthew Waterkeyn presents his research in GIS/GPS capacity building, sharing experiences from research projects in Nairobi with WSUP, and Zimbabwe. The presentation covers the following three points:

- A] how important it is to represent project data geospatially and graphically at a project level,
- B] the use of GIS and GPS at a grass-roots level is feasible, even when working outside technical disciplines (actually provides an excellent platform for inter-specialisation communication),
- C] the use of geospatial technology to assist in WASH related research should be the norm, not the exception, in much the same way as we now take the internet/ email/ mobile phones/ spread sheets/ word processing etc. for granted.

This presentation serves to demonstrate the value of relatively complex geospatial technology as a visual communication and data management tool, even when applied at a grass roots level and how it is particularly useful in the role of inter-disciplinary communication and research.

Session 3: Improving access to WASH

A Realist Evaluation; Investigating the Impacts of an Action Research Project Aiming to Build Capacity in Water Sanitation and Hygiene Technology Assessment and Introduction in sub-Saharan Africa

S.Taylor, A. Parker

Cranfield Water Science Institute, School of Applied Sciences, Cranfield University

While great progress has been made towards achieving the Millennium Development Goals (MDGs) relating to water and sanitation globally, it appears that in some regions of the world, progress has been slower than in others. Sub-Saharan Africa, as a region, has only seen a 4% increase in the proportion of the people accessing improved sanitation facilities since 1990, one of the lowest rates of increase in the developing world (WHO/UNICEF JMP 2011). There is a similar story relating to access to water; sub-Saharan Africa is behind the rest of the world, with coverage rates estimated to be around 65% (WHO/UNICEF JMP 2013 Update report).

One factor contributing to the low coverage of water and sanitation in the region is the high breakdown rates of WASH technologies. Figures in the regions of 30-40% of decentralised water systems being non-functional at any one time, are commonly cited and this situation has not improved over last two decades (RWSN, Evans 1992). The introduction of technologies which are not suitable to context can be identified as a major reason for the poor performance in WASH technologies in the region. All too often, technologies are introduced without any formal assessment and hence fail to take into consideration important aspects such as; user acceptance, affordability, operations and maintenance and environmental issues. A further problem lies in the introductory processes: although there is no shortage of new and existing WASH technologies with the potential to address the needs of the population, few are taken to scale and many remain in a continual piloting phase.

The Water Sanitation and Hygiene Technology (WASHTech) project aims to address these issue by conducting an action research project, working with WASH sector stakeholders in Burkina Faso, Ghana and Uganda to develop tools which can be used to assess, and aide the introduction of WASH technologies. This research is employing

qualitative research methods to investigate the impacts of the WASHTech project and more broadly; how capacity building projects of this nature can contribute to achieving sustainable WASH services in sub-Saharan Africa.

Seasonal Access to Water and Sanitation in Kermi Village, Humla District, Nepal

*N. Greene, L. Boshier, M. Smith

*Water, Engineering and Development Centre, Loughborough University,
LE11 3TU, UK*

*Corresponding author: Nicola.greene@gmail.com

Seasonality is one of the most neglected dimensions of rural poverty (Chambers 2009; Devereux & Sabates-Wheeler 2009). Temporal poverty is frequently analysed, but the trends examined are typically inter-year (i.e. year to year). Little attention has been paid to the intra-year variations which may drastically change an individual's, a family's, or a community's experience of poverty.

Studies which examine seasonal access to water and sanitation in low income populations are lacking, though it has been noted that many water problems are cyclical and attributable to seasonal changes in weather (Almedom et al. 1997; Kar & Bongartz 2006; Action Against Hunger 2009; Coulter 2010).

This research examines seasonal access to water and sanitation in mountainous communities of Humla District, Nepal. The field work for this research carried out over the course of 9 months. A case study of Kermi village will be presented.

A range of qualitative methods were employed to determine seasonal fluctuations in ease of access to water and sanitation based on a comprehensive village level assessment of infrastructure present, and analysis of the effects of prevailing environmental conditions and seasonal household activities.

The result is an insight to the range of a community's level of access to water and sanitation over the course of a typical calendar year; demonstrating that statistics taken at the same time each year may prove misleading in an assessment of access to water.

This finding has implications for best practice data collection in areas with seasonal climates and confidence attributed to existing data in these areas. Furthermore, the extent to which 'snap shot' data is relied upon by development professionals in the allocation and implementation of projects is called into question.

Keywords: seasonality, water access; mountain regions

**Appropriate technology, targets and discourse:
A case of contested development in rural Bihar, India**

P, Hutchings¹, A. Parker, P. Jeffrey.

Cranfield Water Science Institute, School of Applied Sciences, Cranfield University

¹ Corresponding author. Email: p.t.hutchings@cranfield.ac.uk

With consultation on-going regarding the next generation development goals, the politics of water targets are increasingly studied at a macro-scale. Conventionally, the emphasis is on understanding how negotiations between experts – scientists, policy-makers, practitioners – lead to specific guidelines and standards that drive global policy. However, this paper seeks to consider how these processes manifest at the local level by studying the politics of drinking water technology in four communities in North Bihar, India. The divide between improved and unimproved technologies as outlined by the UNICEF and World Health Organisation Joint Monitoring Programme represent a point of contestation, as borehole hand pumps replace the open ring well in West Champaran district. The links between notions of appropriate technology and the discourse of targets are analysed, with the unintended outcome of technologically deterministic targets leading to the adoption of improved technology but the degradation of community water management practices. This in turn breeds resistance against state-led development by grassroots practitioners, which drains precious energy from the sector that could be better utilised responding to the myriad water governance problems facing this flood-prone area. Building on document analysis, key informant interviews and Rapid Rural Appraisals, the paper presents a sympathetic critique of technologically-based water targets. The findings hold implications for the current dialogue regarding the next generation development targets, with greater attention to the wider institutional landscape in which technology is introduced being of central concern.

Key words: Rural water supply; Water Targets; Discourse; Institutions; Technology; India

Lessons from the Pakanae Water Supply

D. Mistry

Mott MacDonald

Pakanae is a small, rural community located in the Hokianga region of the North Island, New Zealand with a population of 250. From 1926 to 1999 the community had a raw water supply. In 1999 there was a major flood event in the Hokianga. During this event the pipes feeding water to the community were washed away. Subsequent to the flood, the Ministry of Health visited to identify public health risks. These investigations revealed that Pakanae and surrounding communities were dependent on raw water supplies that were being contaminated from diffuse water pollution. As a result, the local hospital was given a grant to implement a treated water supply in 2000.

The Pakanae water supply was implemented by a group of 15-20 volunteers over a period of two years. Trust between the local hospital and community meant that the Pakanae Water Board was given a unique amount of autonomy over the implementation of the water supply. This resulted in the implementation of a chemical free system. At the time it was considered as experimental and unreliable by engineers contracted by the hospital.

This thesis assessed how the community implemented and maintained its water supply. The autonomy that the Pakanae Water Board had over the construction of the supply has been critical to the long-term success of the project as it engendered a sense of ownership which has resulted in the water board investing in maintenance and upgrades over the last decade.

Lessons from Pakanae can help to contribute to community-based projects which are increasingly popular amongst non-governmental organisations. Whilst popular, long-term issues of maintenance and stakeholder participation have been the subject of significant scrutiny. Lessons from Pakanae suggest that devolving authority to the community can result in disagreements between technical and local experts. Viewing these differences as a basis to establish meaningful relationships as opposed to obstacles to progress provides non-government organisations or the state with an opportunity to pass ownership of the project to the community.

POSTERS

Willingness to Pay for Improved Water Services: a Cross sectional study of households in Mamprusi District, Northern Ghana

Y. Abdul-Rahaman

Pumping is Life Ghana

Willingness to pay for water supply services is an expression of the demand for a service and it is strong pre-requisite for cost recovery in rural water supply. The study examined rural households' willingness to pay for improved water supply services in West Mamprusi District. The study looked at the basic water requirements of rural households and their satisfaction levels with sources of water for different water domestic water uses and hence their willingness to pay for improved water supply services from public stand pipes, private connection and boreholes.

To achieve these objectives the study segmented rural water consumers into three clusters: Sweet, Brackish and Arid clusters. Across all the clusters, a total of 420 household heads, representing 14 rural communities were interviewed. They were selected using stratified random sampling technique. The proportional allocation formula was used to determine the respective samples of communities forming a strata and the samples of households forming a community and a hence a stratum. Households were then randomly selected in the respective communities where household heads representing their households were interviewed using household questionnaires. The study relied on both primary and secondary data. Primary data was obtained from

administered questionnaires, whilst secondary data was obtained from reports, journals and the internet.

Households used different water sources to meet their water requirements for cooking, drinking, washing clothes, washing utensils, building and animal dinking. Traditional water sources included wells, streams, dams and rivers, whilst the improved water sources were public stand pipes, private connection and boreholes.

The study showed that households were not satisfied with the water supply services from traditional sources, and were however, willing to pay for water supply services from the improved sources.

Rural households' willingness to pay varied from cluster to cluster. The sweet water cluster had the least willingness to pay bids whilst the brackish and arid clusters had high willingness to pay bids. Therefore, the study could not reject the null hypothesis that rural households' willingness to pay bids is high in communities with less water supply sources at the 95% confidence level.

The study concluded that rural households were willing to pay for services from improved water sources subject to the eight (8) constraints identified by the study as sex of household head, available labour supply for household water collection, number of reliable substitute water sources, household education status, household wealth index, household major occupation and the distance (price) of substitute water sources. Therefore to maximize and sustain rural households willingness to pay for services from improved water sources, it is recommended that stakeholders in rural water sector, provide enough marketing services by way of sensitization and hence respond to the demands of the households taking quality of the services into serious consideration.

Water Accessibility at Household Levels in Chililabombwe District: A Case Study of Fitobaula Settlement

*E. Sachikumba, I. Nyambe, W. Mafuleka

The University of Zambia, IWRM Centre, Zambia

*Corresponding Author: emmanuel.sachikumba@gmail.com

Zambia is endowed with a great variety of natural resources. For instance, Zambia has good climate with favourable rainfall pattern; this provides sufficient recharge for the surface and ground water resources. In spite of the sufficient surface and ground water resources, accessibility to water at household levels is problematic both in quality and quantity.

The study examined water accessibility as well as water quality at household level. The investigation involved fifty households and the data was collected by the use of questionnaires (to assess accessibility) and laboratory tests (for ascertaining water quality). In addition to this, government departments such as the health, agriculture, forestry and education as well as the municipal council were interviewed on the topic under study. The study was descriptive in nature where clustered sampling procedures

were used to come up with the households which were to participate in the study. Simple random methods were deployed as a sampling technique to select respondents.

The key findings were that; accessibility to water household levels is still a challenge in the settlement as most of the point sources (shallow wells, the stream and the river) were found to be contaminated. In addition to this, it was found that there was no direct relationship between the economic performance of a household and the accessibility to water. The study also observed that there were opportunities among the people in the settlement as they were increasingly getting into the education system and adult literacy was being encouraged in the settlement. Furthermore, the settlement has groundwater resources which indicate that there can be sufficient water provision for the settlers on the settlement.

Though access to drinking water at the household level in peri-urban areas is problematic, exploitation of ground water with suitable technologies can be of significant importance.

Crowd-sourced spatio-topological sanitation network modelling in informal settlements

R. Kennedy-Walker

Newcastle University

Safe collection and treatment of sewage are critical to reduce health hazards in rapidly-urbanizing informal settlements. Road-based treatment-transportation schemes are widely used where piped sewerage networks are not available. These schemes often require small vacuum pump trucks ('Vacutugs') to service toilets in areas with restricted access or poor road infrastructure. However, due to their limited speed and capacity Vacutug schemes can be costly and time-inefficient. One solution, to reduce total sewage transportation time is to use neighbourhood Vacutug deposit points ('transfer stations'), from which accumulated sewage is collected and transferred by large tanker to treatment. This study presents a novel technique, employing spatial network analysis to optimise the location of transfer stations and minimise total sewage transport time for the informal settlement of Kibera in Nairobi.

School going girls' experience on Menstruation Hygiene Management

N. Naher

WaterAid Bangladesh

Dushtha Shahthya Kendra (DSK) with the cooperation of WaterAid Bangladesh developed the integrated WaSH facility in the school named Shahid Zia Girls' Laboratory institute in 2012. Earlier the school didn't have any toilet facility and the question of menstrual hygiene management (MHM) during the school time was beyond their

thinking. The headmistress, teacher and the students knew only about toilet by name of WaSH facility. At the beginning they expected only a good toilet for girls' student and it seems that they would be more than happy if getting it only instead of their filthy, unhygienic and non-secured toilet in the school campus. But we WaSH activist believe and do more than it by name of delivering WaSH services for the change agent in the society.

After having all the administrative procedure DSK started the development work in order to bring a positive change. They have constructed a separate complex consists of three chambers and safe drinking water facility. The special chamber which has been given for the special time of the student includes standing wash basin, towel rail, mirror, waste bin and obviously running water and electricity. The locked door complex, filter unit to purify the supplied water, hand wash basin certainly becomes as a bonus for the student viz a viz school authority. The complex has been painted so colorful to give aesthetical beauty with hygiene message. As we mentioned integrated WaSH facility that's why waste bin and awareness programme for solid waste management is a mandatory component under the same scheme. Not only that the tree plantation programme giving the soothing beauty along with the developing awareness among student on the importance of green environment.

The students are so delighted after having such nice environment and toilet facility with privacy. Now they can change or check their physical status during the period and not worry at all if they have menstrual blood spot in the school dress.

However, only a clean toilet with all necessary sanitary components is not the solution for MHM which has been discovered during discussion with student. Most of the student doesn't know about the precaution before having period, how to use sanitary napkin, health tips such as carrying napkin when requires to stay long time outside, using thick napkin at first two days, maintaining personal calendar, how to keep cloth and dry etc. They believe in social taboo till now like not to have shower at the first date of period, don't show the cloth to other during handling and keeping it in the secret place etc. Nearly 30% of the total student suffers by irregular period and neither they share it with elders nor going to doctor. After having such complete sanitation facility in the school till now several students don't come in the school during the period simply for psychological believes whether they have important class or exam. Though they don't have any physical problem, lack of sanitary materials, lacks of privacy or changing facility during the school time etc. then also they don't feel to move during period. It requires rigorous awareness programme in the family and society to come out from the confined box.

WaSH: The Importance of Good Groundwater

Kirsty Upton

Hydrogeologists without Borders UK

Groundwater is the largest distributed source of fresh water on Earth. In many parts of the world it provides a safe and reliable domestic water supply and helps support agriculture through irrigation. Groundwater systems are often highly complex: the properties of an aquifer can vary considerably over short distances and with depth; the processes by which aquifers are recharged are often poorly understood; and the way in

which an aquifer interacts with surface water features can vary in both time and space. Exploitation of groundwater as a sustainable resource requires a detailed understanding of many surface and subsurface processes to ensure that effective water management and protection strategies are implemented, and that boreholes are designed, sited, drilled and completed appropriately.

Developing groundwater sources is an important part of many WaSH projects, yet few hydrogeologists are employed within the humanitarian sector. This often results in groundwater sources failing or becoming contaminated and can mean that insufficient data are collected to inform future projects. The UK chapter of HWB is made up of around 250 groundwater professionals who donate their time and expertise to support the better use and management of water resources in developing countries. HWB-UK has two principal mandates: (1) to provide technical support to humanitarian organisations; (2) to support teaching programmes in developing countries. To date HWB-UK members have undertaken work for ECHO, Concern Worldwide, MSF and Oxfam. This work has ranged from answering relatively simple queries to undertaking more detailed desk studies in support of WaSH projects in, for example, South Sudan, Myanmar and Haiti.

Groundwater has a key role to play in alleviating poverty in underdeveloped regions of the world. HWB-UK is working to develop stronger links with humanitarian organisations to help ensure that groundwater sources are managed in a way that is both sustainable and cost-effective.