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Where Science Meets Policy

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VERBAL ABSTRACTS

(Alpha Order by Title)

Updated 10-10-18

Title: 15 Years of Water Safety Plans Development and Implementation in Uganda

Authors: Christopher Kanyesigye, National Water and Sewerage Corporation, Juliet Nakanjako, National Water and Sewerage Corporation, Sara Marks, Sandec, Eawag, Giulliana Ferrero, UNESCO-IHE

Submission: Uganda was among the countries that pioneered Water Safety Plans (WSPs) development and implementation, with the first WSP dating back to 2002. The objective of this study was to analyse the current status of WSPs implemented in Uganda by the National Water and Sewerage Corporation, in order to draw lessons on how to increase WSP uptake across the country. This study consisted of review of the 20 WSP documents, semi-structured interviews of staff and stakeholders focus group discussions involving operational staff and field visits to 4 operational towns. Results show that 20 WSPs were developed over the last 15 years, but their development was largely incomplete. Moreover, a high degree of diversity among WSP development and implementation was observed. Some (4/20) WSPs did not cover the entire water supply chain. Most of the systems analysed focussed mainly on the front end of the WSP i.e., team for mation and system assessment, but failed to include all of the 11 WSP modules. Monitoring of control measures, as infor med by the WSP, was implemented only in 6 out 20 systems and WSP verification took place only in the for m of internal (5/20) and external (2/20) auditing. The barriers noted were inadequate awareness and mistaken perception, competing management priorities, uncoordinated staff transfers, unclear reporting mechanisms and lack of indicators for monitoring WSP effectiveness. Conversely, the enabling factors that emerged were top management commitment, stakeholder involvement, staff competence and financial availability.

Title: A Cultural Theory of Drinking Water Risks, Values and Institutional Change

Authors: Johanna Koehler, University of Oxfor d, Steve Rayner, University of Oxfor d, Jacob Katuva, University of Oxfor d, Patrick Thomson, University of Oxfor d

Submission: Global progress towards the goal of universal, safely managed drinking water services will be shaped by the dynamic relationship between water risks, values and institutions. We apply Mary Douglas' cultural theory to rural waterpoint management and discuss its operationalisation in pluralist arrangements through networking different management cultures at scale. The theory is tested in coastal Kenya, an area that typifies the challenges faced across Africa in providing rural communities with safely managed water. Drawing on findings from a longitudinal study of 3500 households, we examine how different management cultures face and manage operational, financial, institutional and environmental risks. We further model the panel data with sensor data from daily handpump usage and community responses to a new maintenance service provider to examine (1) which factors trigger community, individualist or bureaucratic management cultures to contract a professional maintenance service provider; (2) how is institutional change in maintenance systems linked to

the level of service delivery; and (3) does environmental legacy influence the decision to contract? The predictors of behaviour change correspond well with global targets on gender and equality, water quality and financial sustainability. This research makes the case for cooperative solutions across systems where current policy effectively separates communities from the state or markets. The contribution of this research is both a theoretical and empirical case to consider pluralist institutional arrangements that enable risks and responsibilities to be re-conceptualised and re-allocated between the state, market and communities to create value for rural water users.

Title: A Different Beast: Measuring the Impact of a Large-scale Urban Water Infrastructure Investment in Dar Es Salaam, Tanzania: Findings from a Six-Year Impact Evaluation

Authors: Carina Rosado, Social Impact, Inc., Danae Roumis, Social Impact, Inc., Olga Rostapshova, Social Impact, Inc., Jeffrey Alwang, Virginia Tech

Submission: Like many cities in Sub-Saharan Africa, Dar es Salaam's water infrastructure had not kept pace with the dual pressures of population increase and urbanization. To address this and expand the water supply from the city's largest water treatment plant, the Millennium Challenge Corporation and Government of Tanzania invested in large-scale infrastructure upgrades. We report on the results of a rigorous multi-year impact evaluation conducted alongside these interventions in Dar es Salaam. Our findings are some of the first to emerge, globally, from rigorous evaluation of large-scale water infrastructure projects. The infrastructure interventions dramatically increased water supply to Dar es Salaam and influenced a three-fold increase in the rate of new domestic connections in areas served by the water treatment plant. Our findings show that the supply increases led to a substantial increase in the reliability of water supply in Dar es Salaam – average daily service hours increased from about 9 to 18 hours per day – and improved water quality at household taps. Overall, households have shifted toward greater reliance on network-provided sources over time. Our results show that improvements in water supply, quality, and reliance on network-supplied water have together led to a substantial increase in the percentage of households that are able to meet recommended benchmarks for daily per capita water consumption, and a substantial decrease in the amount of time households spent collecting water from supplemental, and often more expensive, sources. We discuss these and other major results from the evaluation, while highlighting important lessons learned that will be of interest to donors, implementers, and researchers involved in large-scale water infrastructure programs.

Title: A Global Assessment of Non-tariff Customer Assistance Programs in Water Supply and Sanitation

Authors: David Fuente, University of South Carolina, Joe Cook, Washington State University, Dale Whittington, University of North Carolina at Chapel Hill and Alliance Manchester Business School, Michael Matichich, Jacobs Engineering Group Inc.

Submission: A key strategy for adapting to changing water availability and rapid urbanization is a move towards full cost recovery tariffs for water and sanitation services. Because these services are substantially underpriced in most places, this strategy implies that careful attention must be directed at programs to help the poor manage water affordability. In this paper, we systematize these “customer assistance programs” (CAPs) by defining their major elements and develop a typology that highlights the connection between CAPs and water scarcity. We then present a broad review of evaluations and case studies of CAPs from both industrialized countries and low- and middle-income countries (LMICs). Although several researchers have documented that increasing-block tariffs are a poor targeting mechanism for directing subsidies to the poor, there are relatively few careful evaluations of “non-tariff” CAPs, including subsidies to connect households to the network. We also highlight the issue of directing subsidies to poor households who may share a meter or pay for water through their rent.

Title: A Multidimensional Approach to Measuring Sanitation Uptake

Authors: Radhika Menon, 3ie, Neeta Goel, 3ie

Submission: Measuring progress toward ending open defecation (SDG 6, Target 2) poses several challenges. Eliminating open defecation requires the use of toilets, and toilet use is difficult to measure because it cannot be directly observed. Drawing on a portfolio of impact evaluations, we present a range of tools and approaches for measuring latrine use. In this regard, we present a standardised set of survey questions and observation guidelines, based on best practices and ground testing. We also present the initial results of an independent study which measures latrine use among a subset of impact evaluation samples to increase confidence in the validity of latrine use measurements. We also present novel complementary methods for measuring sanitation-related stress and well-being. Finally, we also discuss Evidence Gap Maps as a tool for assessing available evidence on and identifying knowledge gaps in approaches to ending open defecation. We conclude with several recommendations for evaluators, users and funders of evaluations to ensure the validity of their measurements of toilet use, and to map the existing evidence toward achieving SDG 6.

Title: A Primary School Based Intervention to Engage Parents for Supporting Handwashing Among Their Children: Practical Experience from an on-going Randomised Trial in North West Tanzania

Authors: Elialilia Okello, Mwanza Intervention Trials Unit, Tanzania, Kenneth Makata, Mwanza Intervention Trials Unit, Onike Mcharo, Mwanza Intervention Trials Unit, Safari Kinung'hi, Mwanza Intervention Trials Unit, Saidi Kapiga, Mwanza Intervention Trials Unit, Robert Dreibelbis, London School of Hygiene and Tropical Medicine

Submission: Introduction: Poor hand hygiene contributes to the acquisition of intestinal worms and other intestinal infections. School based de-worming campaigns with effective antihelminths are followed by quick re-infection, suggesting a need to combine mass treatment with effective hand hygiene behavior change interventions. Methods: This sub-study explored parental engagement activities included in the Mikono Safi trial. The main trial is cluster randomized trial of a school-based handwashing and hygiene intervention. Trial outcomes - infection prevalence and observed and reported handwashing will be available in 2019. Parental engagement sessions are part of the intervention, designed to raise awareness of the burden and adverse consequences of soil transmitted helminth infections and trigger an emotional response in parents to motivate behaviour change. This was accomplished through giving parents laboratory worm results from their own child's stool samples followed by a facilitated discussion of hygiene and distribution of an informational brochure. Findings: Parents' attendance rates were high at engagement sessions, ranging from 56-90% of invited parents. Most parents knew common types of intestinal worms but were not aware of modes of transmission or the link between hand hygiene and worm infection. Only a small number of parents knew the correct steps for hand washing with soap. The tests results generated mixed emotional reactions. Most parents were keen to obtain information on worm treatment and possible changes they could make at home to prevent future infection. Conclusion: These findings are preliminary but they indicate parents' willingness to support improved hand hygiene for their children. Follow-up data collection in July 2018 will further explore the success of these parental engagement sessions in encouraging behavior change.

Title: Access Points - Ten Years of Design Learnings from Drinking and Handwashing Stations in Schools

Authors: Nicholas Ellington, Splash International

Submission: One component of Splash's program has been the installation of thousands of drinking and handwashing stations over the last ten years, primarily in schools in Kolkata, Kathmandu, and Addis Ababa. The long-term functionality of access points like stations is as important as the long-term functionality of water purification systems. However, in the WASH sector there has been relatively little work done on research and design of drinking and handwashing stations in comparison to water purification systems. This session will highlight Splash's experience from the use and abuse of drinking and handwashing stations in schools as well as how we have used this information to decrease implementation costs and timelines while strengthening our

entire WASH program. Over 10 years, we have installed multiple station designs and materials, from cast-in-place concrete and tiles, to locally hand-made fiberglass. Now, Splash is completing the first production run of mass-manufactured drinking and handwashing stations made of recycled plastic. We have taken this latest re-design opportunity to use a formalized human-centered design approach, along with rapid prototyping, and study results of built-in behavioral nudges' impacts in diverse cultural settings. This session will provide details on the weaknesses of our past stations as well as the unique improvements in materials and methods that Splash has developed and tested.

Title: Access to Household Water Quality Information Leads to Safer Water: a CRCT in Rural India

Authors: Joe Brown, Georgia Institute of Technology, Robert Dreibelbis, London School of Hygiene and Tropical Medicine

Submission: Household-specific feedback on the microbiological safety of drinking water may result in changes to water management practices that reduce exposure risks. We conducted a randomized, controlled trial in India to determine if information on household drinking water quality could change behavior and improve microbiological quality as indicated by *Escherichia coli* counts. We randomly assigned 589 participating households to one of three arms: (1) a messaging-only arm receiving messaging on safe water management (n = 237); (2) a standard testing arm receiving the same messaging plus laboratory *E. coli* testing results specific to that household's drinking water (n = 173); and (3) a test kit arm receiving messaging plus low-cost *E. coli* tests that could be used at the household's discretion (n = 179). Self-reported water treatment increased significantly in both the standard testing arm and the test kit arm between baseline and follow-up one month later. Mean log₁₀ *E. coli* counts per 100 mL in household stored drinking water increased in the messaging-only arm from 1.42 to 1.87, while decreasing in the standard testing arm (1.38 to 0.89, 65% relative reduction) and the test kit arm (1.08 to 0.65, 76% relative reduction). Findings indicate that household-specific water quality information can improve both behaviors and drinking water quality.

Title: Achieving and Maintaining Incremental WaSH Improvements in Health Care Facilities: A Case Study from DR Congo

Authors: Jason Lopez, Save the Children, Francois Kangela, Save the Children

Submission: Quality healthcare provision depends on functioning water, sanitation, and hygiene (WASH) systems, yet health systems' challenges impede the creation of sustainable, best practices in WASH and create a barrier to saving lives. Only an estimated 2% of healthcare facilities (HCFs) in low- and middle-income countries provide complete WASH and waste management services. Approximately 16% of patients acquire an infection during their stay at a health facility and infections account for 22% of neonatal, and 11% maternal mortality. Furthermore, the establishment of clean and desirable HCFs is an essential component to achieving several Sustainable Development Goals (SDGs), including SDG 3 and 6. Through USAID's Maternal and Child Survival Program (MCSP), Save the Children developed the Clean Clinic Approach (CCA) to improve WASH, and infection prevention and control (IPC) in HCFs. CCA works with national ministries of health to develop criteria by which HCFs can attain "Clean Clinic" status. It then works with individual HCFs to help them make incremental improvements toward Clean Clinic status. From 2015-18, MCSP worked with the Democratic Republic of Congo's Ministry of Health to develop and implement a "Clean Clinic" program in 35 HCFs in Tshopo and Bas-Uélé provinces. The 35 HCFs increased their baseline assessment "Clean Clinic" score from an average of 48% to 80%, and have maintained these gains for more than a year. Unlike previous infrastructure and training models, the CCA was successful because it institutionalizes motivation and accountability systems needed to facilitate and maintain incremental WASH and IPC improvements in HCFs. The presentation will also

discuss the process for establishing management, accountability, and information systems that are required to maintain those improvements over time.

Title: Adolescent Girls' and Young Women's Preferences for Menstrual Hygiene Management Products in Uttar Pradesh, India: A Discrete Choice Experiment

Authors: Kristen M. Little, Population Services International, Ellen Janssen, Johns Hopkins Bloomberg School of Public Health, Mahasweta Satpati, PSI/India, Aprajita Singh, Population Services International India, Vivek Sharma, PSI/India, Bethany Caruso, Rollins School of Public Health, Emory University, Patrick Aylward, Population Services International

Submission: Background: Access to menstrual hygiene management (MHM) products remains uneven, especially for adolescent girls and young women (AGYW) in rural areas. To better meet their needs, we sought to describe AGYW's preferences for MHM products in Uttar Pradesh (UP), India. Methods: We conducted a discrete choice experiment (DCE) with attributes for MHM product price, size and shape, protection against leaks, where purchased, ability to stay in place, and texture. A respondent was eligible if she was between the ages of 13-24, had reached menarche, had lived in the area for ≥6 months, and was willing to give consent. Analysis was performed in Stata. Results: From Oct 22-Nov 14, 2017 we recruited 1,200 participants from a rural (N=598) and an urban site (N=602) in Lucknow, UP. Respondents averaged 18.2 years old, and most were currently in school (60%). Most reported having ever bought a commercial pad (87%), a proportion that was higher among urban than rural AGYW (92% vs. 83%, $p < 0.001$). Compared to a regular length pad without wings, AGYW had higher odds of choosing a regular length product with wings (aOR: 2.4; 95% CI: 2.2-2.6). Relative to a product that only stays in place while not moving, AGYW had >3 times the odds of selecting a product that stayed in place during moderate to heavy activity (aOR: 3.2, 95% CI: 2.9-3.5). Preferences were largely similar between AG and YW, while rural AGYW appeared to be slightly more price-sensitive than their urban counterparts when comparing a 10 pack of pads at ₹36 versus a pack at ₹6 (Rural aOR: 2.3; Urban aOR: 1.5, $p < 0.001$). Conclusions: Most AGYW in Lucknow had experience with commercial MHM products. Product preferences were largely driven by the presence of wings, protection against leaks, and ability to stay in place. While price was also an important predictor of product preference, the strength of these preferences suggests that product quality is vital to meeting the needs and desires of Indian AGYW.

Title: An Alternating Dual-pit Solution for Fecal Sludge Management

Authors: Greg Lestikow, iDE, Tyler Kozole, iDE Cambodia

Submission: Since 2009, iDE Cambodia has delivered nearly 300,000 latrines to customers in rural Cambodia. Between 2008 and 2014, national sanitation coverage has increased from 33.7% to 55.9%. While this progress is undeniably a positive trend, millions of rural households with access to a latrine still do not have sustainable access to fecal sludge management technology or services. iDE Cambodia is cognizant of this pressing public health issue and has been gathering insights and developing solutions to address the problem. iDE Cambodia has asked thousands of its clients the question "How do you intend to manage your fecal sludge?" and has generated notable insight on public perceptions, with significant variation in responses between factors including geographical area and time of the year. In the past year, iDE has supplemented this knowledge base with two additional surveys nested within a pilot for a potentially viable fecal sludge management technology: an alternating dual pit (ADP) upgrade product. Survey participants have been asked about their history of latrine pit emptying, future FSM intentions, willingness to pay, and perception of fecal sludge. Survey data has been complemented with sales and delivery data for the ADP product, illuminating variation between customer reporting and actual willingness to invest in FSM technology. iDE has also collected data on latrine pit fill rates, which is key to understanding regional, seasonal fluctuation in pit levels and indication of when peak

demand could be expected for FSM products. Results of iDE Cambodia's research are encouraging, generally showing a high degree of public awareness of FSM issues and a demand for affordable solutions. iDE proposes to present on these findings, with insights geared towards stimulating the FSM market in Cambodia and other rural developing contexts. If SDG 6 is to be achieved, FSM must be addressed with data-driven strategies, and iDE hopes to contribute to this effort.

Title: An Evaluative Framework for Urban WaSH Sector Functionality: Results of a Baseline Assessment in Six Countries

Authors: Sam Drabble, Water & Sanitation for the Urban Poor, Jonathan Stokes, Water & Sanitation for the Urban Poor, Nerea Ajuriagogeascoa, WSUP

Submission: Progress towards SDG6 is contingent on the development of city-level and national enabling environments, capable of supporting at-scale service provision. Without key enabling factors, water and sanitation utilities and municipalities will not be positioned to deliver services at the scale required, including to the most vulnerable. New monitoring tools are required which respond to this reality by evaluating sector functionality and identifying priority areas for strengthening. WSUP has developed the Urban WASH Sector Functionality Framework (SFF) for this purpose: the SFF comprises individual frameworks for water and sanitation, each with 21 predominantly qualitative indicators across 7 areas: sustainability; commitment; policy/mandates; financial flows; investment planning; capacity; and attitudes/behaviours. National-level assessments consist of an initial participant survey followed by a workshop bringing together key stakeholders – ministries, utilities, municipalities, regulators, asset holders and civil society – to finalise indicator scoring through negotiated consensus. To calculate overall quantitative scores, 0 is allocated for zero indicator score; 0.33 for low score; 0.67 for medium score; and 1 for high score. This presentation will detail results from a pilot of the framework, conducted by Oxford Policy Management in 6 countries: Bangladesh, Ghana, Kenya, Madagascar, Mozambique and Zambia. We will present results across countries at the aggregate level (scores ranged from 0.32 in Madagascar to 0.6 in Mozambique); for water and sanitation (water scored higher across all focus countries, averaging 0.55 against 0.40); for the 9 sub-areas; and for selected individual indicators. We will also present stakeholder perspectives on major changes experienced over the past 3 years and future changes expected to 2020, indicating the expected direction of travel; and discuss the implications of these findings for sector-wide system strengthening activity.

Title: Applying User-centered Design to Find Local Solutions to WaSH Challenges in Ethiopia

Authors: Monte Achenbach, PSI Ethiopia

Submission: In Ethiopia, few products and services to improve WASH are available and affordable to households outside of major cities. Local businesses, such as hardware retailers and masons, can access supply chains from the cities, but products are expensive and may not be appropriate for the local context. However, with the right designs and technical capacity to fashion their own products from locally available materials, the array of possible solutions grows tremendously. In a collaboration between the PSI-led project, USAID Transform WASH, and the MIT Design Lab, a user-centered design 'summit' trained community members in Hawassa, Ethiopia, to fashion products using local knowledge, materials, and feedback. The summit addressed an array of challenges: expense and weight of cement toilet slabs, need for improved superstructures, sanitation for children, women's lack of involvement in construction, and a dearth of attractive hand washing solutions. During the summit, participants gathered from across disciplines in the community, including health extension workers, construction business owners, teachers at the local vocational college, and members of households, to learn the design process and prototype solutions. One prototype that has since been refined and is being

introduced to the Ethiopian market is a cement toilet slab using less expensive bamboo reinforced cement, and the summit-designed hand washing station is undergoing further development for market introduction with the support of an MIT student. An evaluation of the summit found significant changes in knowledge and self-confidence of participants in using the design process to take action in their communities. Furthermore, the dynamics of group interaction shifted from self-contained to much more open networks. UCD approaches may sustain themselves and achieve better long-term outcomes when diverse actors with varying levels of experience collaborate to solve communities' design challenges.

Title: Are Households Credit Constrained? Evidence from an RCT on Sanitation Loans in Rural India

Authors: Britta Augsburg, Centre for Evaluation of Development Policies, Institute for Fiscal Studies, Bansi Malde, University of Kent, Bet Caeyers, Centre for Evaluation of Development Policies, Institute for Fiscal Studies, Sara Giunti, Centre for Evaluation of Development Policies, Institute for Fiscal Studies

Submission: This paper contributes to the understanding of poor households' ability (or lack thereof) to finance sanitation investments. Increasingly, development agencies have postulated credit as a promising solution to address under-investment in areas such as education and health; investors showing a paternalistic preference as to what funds should be invested into. We use a randomised controlled trial in rural India, combined with unique secondary data sources, namely administrative data on loan uptake and credit bureau data on total formal household borrowing, to (i) estimate the slope of households' sanitation credit demand curve, and to (ii) establish that the newly introduced formal financial service expands and complements, rather than substitutes available sanitation financing options. By further (iii) demonstrating that the additional borrowing is indeed invested into toilet construction our study lends credibility to the movement of addressing social issues through the introduction of new financial tools.

Title: Arsenic Safe Union Concept – a Harmonised Approach to Arsenic Mitigation in Bangladesh

Authors: Boluwaji Onabolu, UNICEF, Nargis Akter, UNICEF, Furqan Ahmed, UNICEF, Kamrul ahmed, UNICEF

Submission: Bangladesh has made significant progress in increasing access to improved water sources (98%) however 19.7 million people are still exposed to arsenic concentrations above the GoB standard and 38 million above the WHO guideline. Elite capture of water points, poor involvement of local government and absence of a common approach have been challenges. In response, An Arsenic Safe Union Concept was developed by UNICEF and The UNICEF-Department of Public Health Engineering & the project was implemented between January 2016 and December 2017 in 15 most arsenic contaminated unions in three arsenic prone districts in Bangladesh. The ASU project used the community as the unit of intervention instead of individual water sources. Vulnerability risk assessment used to select intervention unions; area wide water quality testing to determine scope of need and appropriate water supply options; transformation of pre-intervention data of source water quality into GIS maps for evidence based decision making and intervention site determination, pro-poor selection criteria and geo coded water point installations to reduce political interference in siting, mobile to web data capture. In addition to the increased access to safe water and improved sanitation, 100% of water points were tracked and shown to have been successfully installed in poor households, in the most arsenic prone areas and arsenic contamination reduced from 14% to 2%. The Arsenic Safe Union Concept has been adopted and scaled up by government and is now being used in a \$240m million GoB funded arsenic mitigation drinking water project.

Title: Assessing Equity of Rural Sanitation Coverage Increases and Slippage: A Four Year Evaluation Across 11 Countries

Authors: Joshua Garn, University of Nevada, Reno, Paschal Apanga, University of Nevada, Reno, Matthew C. Freeman, Emory University

Submission: Background: There is need for informed program learning in order to not leave vulnerable groups behind while increasing sanitation coverage worldwide. SNV and its partners have developed and implemented the Rural Sustainable Sanitation and Hygiene for All (SSH4A) approach, which aims to increase sanitation coverage area-wide using an integrated model focusing on: 1) demand creation, 2) sanitation supply chain strengthening, 3) hygiene behavioral change communication, and 4) governance. The current study assesses program equity and program impacts over 4 years, across 11 countries primarily located in Southeast Asia and sub-Saharan Africa, with 8,224,108 people living in the program areas. **METHODS:** We administered repeated cross-sectional structured household surveys at baseline, and at annual follow-up rounds. We compare the prevalence of improved sanitation between baseline and at each of the annual follow-up rounds. We assessed trends in equity of coverage across vulnerable groups by stratifying results by the vulnerable groups of interest: age of household members, sex of household head, wealth quintile, and disability within household. **RESULTS:** At each of the four rounds of data collection, we collected data from ~20,000 respondents across 11 countries. Overall, sanitation coverage increased 37 percentage points from baseline to the final follow-up (95% CI: 36-38); these impacts varied across countries. We observed increases in coverage among all four of the vulnerable groups. Increases in coverage over time were generally comparable, comparing vulnerable groups to non-vulnerable groups, except for SES. While households with low SES showed considerable increases in coverage over time (+23%, 95% CI: 23%-26%), sanitation uptake was higher among higher SES households (+45%, 95% CI: 44%-47%). **CONCLUSIONS:** Our findings are relevant in a global context, and provide a deeper understanding of how to equitably increase sanitation coverage among vulnerable groups.

Title: Assessing the Status of WaSH Services and Infection Prevention Readiness in Delivery Rooms and Postnatal Care Wards: Results from a Survey of 41 Health Facilities in Guatemala and Nigeria

Authors: Stephen Sara, Maternal and Child Survival Program (MCSP)

Submission: Background: Limited data exists on the status of WASH services and critical infection prevention and control (IPC) readiness within health care facilities (HCFs) and within specific wards. In 2017, the JMP published standards for basic WASH service provision in HCFs. Standard indicators for specific WASH and IPC needs within delivery rooms and postnatal care spaces have yet to be developed and tested. **Methods:** Drawing on the JMP indicators, emerging delivery room indicators and peer-reviewed literature, USAID's Maternal and Child Survival Program developed and tested a comprehensive WASH and IPC survey tool for use in outpatient wards, labor and delivery wards, and postnatal care wards. The tool was tested in 41 HCFs with high birth rates in Guatemala and Nigeria in the spring of 2018. **Results:** Access to WASH services was low. Cleaning and IPC protocols were largely absent. Only 27% of facilities reported that at least some staff had received training in cleaning in the past 24 months. Results from the labor and delivery room survey showed that 72% of delivery rooms had running water, 20% had a functional handwashing station with soap, 20% had a functional bathing area and 90% safely separated health care waste. Most delivery rooms had a stock of sterile gloves, sterile cord cutting instruments, and sterile cord ties/clamps, but only 18% had a functional handwashing station with soap. Postnatal care survey results showed that 22% had a functional handwashing station with soap, 66% had a stock of sterile gloves, and 45% had hygiene promotional materials in the ward. **Discussion:** Even where basic WASH infrastructure is functional at the facility, access to basic WASH services and IPC supplies at critical points of care is low, undermining the quality of care, particularly for mothers and neonates. The indicators within this tool should be integrated into routine data collection and quality improvement systems in order to improve and maintain WASH and IPC in HCFs.

Title: Bacterial Contamination on Community and Household Latrine Surfaces in Kathmandu, Nepal

Authors: Shannon McGinnis, Water Health and Applied Microbiology Lab, Temple University, Aurora Trainor, Temple University, Dianna Marini, Aerosan Toilets, Prakash Amatya, Aerosan Toilets

Submission: According to the WHO, approximately 761 million people worldwide rely on shared sanitation facilities. These facilities improve access to sanitation infrastructure in developing countries, which is an important part of the 2030 United Nation's Sustainable Development Goals. However, these facilities may also facilitate disease transmission and are often considered less sanitary than household latrines and currently do not "count" towards meeting the SDGs. In order to assess the cleanliness of community latrines, this study measured bacterial contamination on surfaces of community and household latrines in Kathmandu, Nepal and compared them to public toilets at Temple University in the US. Swabs were collected March 4-8, 2018 from latrine slabs, sink handles, latrine door handles, handles on anal cleansing taps, and from money paid for latrine use. A total of 86 samples at two community toilet sites were collected from dirty (after a full day of use) and clean (morning before use) surfaces. In addition, 23 surfaces were swabbed at household sites in Nepal and 23 surfaces at University toilets in the US. Concentrations of total coliforms and E. coli were quantified using membrane filtration. Dirty community latrines had significantly higher concentrations of total coliforms and E. coli than household latrines. However, results showed that cleaning practices at the community latrines significantly reduced bacterial concentrations on the majority of surfaces (all except sinks at handwashing stations). In addition, clean community latrine surfaces had the same or lower levels of bacterial contamination than household latrines. These results suggest that more frequent cleaning of community latrines would reduce overall bacterial contamination and should be an important consideration for future community sanitation projects.

Title: Beneficial and Detrimental Effects of Social Identity for Reducing Open Defecation: A Cluster-randomized Trial of CLTS in Ghana

Authors: Jennifer Inauen, Eawag, Miriam Harter, Eawag

Submission: Worldwide 2.4 billion people practice open defecation (OD), which can lead to diarrheal diseases – a major cause of child mortality. Community-led total sanitation (CLTS) can reduce OD by prompting community members to build latrines, but with varying success. Social identity theory suggests that feeling part of a community (i.e., social identity) may be an important contributor to CLTS success. It is assumed that greater social identity relates to greater striving towards a common goal like eradicating OD by building latrines. This study tested the role of social identity in CLTS effectiveness. A cluster-randomized trial was implemented comparing CLTS intervention arms with a control arm in rural Ghana. 3125 households in 132 communities were interviewed by structured questionnaires. Latrine coverage, OD frequency, and social identity were assessed before and after the implementation of CLTS. Regression analyses indicated significantly greater latrine coverage (67.5%) and significantly lesser OD (-14.8%) compared to the control arm (7.9% and -3.2%). The effect was moderated by baseline social identity. In the CLTS arms, communities with higher levels of social identity showed larger latrine coverage after CLTS, and greater decreases in OD than those with lower social identity. Conversely, higher social identity was related to lower latrine coverage and higher OD in the control arm. The results corroborate earlier findings on the importance of the social context in improving sanitation situations. Whereas social identity seems to promote the success of community-led sanitation approaches, it seems to hamper latrine construction when no interventions are taking place.

Title: Can Government Subsidies and Micro-credit Complement Each Other in Tackling the Sanitation Challenge?

Authors: Bet Caeyers, Centre for Evaluation of Development Policies, Institute for Fiscal Studies, Britta

Augsburg, Centre for Evaluation of Development Policies, Institute for Fiscal Studies, Bansi Malde, University of Kent, Susanna Smets, World Bank

Submission: This study analyzes the potential of interacting public and private approaches to improving sanitation coverage in low-income settings. More specifically, we demonstrate the likely potential of micro-credit to serve as bridge-funding for accessing sanitation subsidies, particularly as offered under India's flagship rural sanitation program Swachh Bharat Mission – Gramin, or SBM(G). We use survey data from a randomized controlled trial where sanitation micro-credit was randomly introduced in communities where SBM(G) was active to establish that improved access to micro-credit led to an increase in toilet coverage that was significantly larger than the upward trend observed in control sites where loans had not yet been introduced. High impacts of sanitation loans are observed not just for subsidy ineligible households, but also for households in principle eligible for the government subsidies. This observation, combined with descriptive evidence of average toilet costs that are double the amount of the subsidy and of reports of there being significant delays in subsidy disbursements, suggest that micro-credit is used by households as a means to cover funding gaps. We also observe a highly significant correlation between access to micro-credit and SBM(G) applicants' probability of successfully receiving a subsidy (within the time frame of the study). These findings derived from our household survey data are confirmed by SBM administrative data matched to our study sample.

Title: Can Nutrition Messaging be Integrated Into CLTS Programming for Improved Sanitation and Nutrition Childcare Practices? Evidence from an RCT in Kitui, Kenya

Authors: Lilian Lehmann, IDinsight, Gerishom Gimaiyo, IDinsight, Jeffery McManus, IDinsight, Shiva Singh, UNICEF

Submission: Background: Child undernutrition is a persistent problem in sub-Saharan Africa, especially in rural areas. In Kenya's Kitui County, 46% of children under 5 are stunted. Sanitation and nutrition programs have sought to reduce child undernutrition in Kitui County and similar settings, though they are typically implemented separately. In 2016-17, Kitui County government and UNICEF piloted a combined sanitation and nutrition program - SanNut - overlaid onto Community-Led Total Sanitation (CLTS), which added emphasis on toddler sanitation and hygiene, and nutrition messaging to standard CLTS. Methods: IDinsight conducted a clustered randomized controlled trial to evaluate the impact of the SanNut intervention on: caregiver knowledge, household sanitary and hygiene practices, sanitation outcomes, and nutrition outcomes. 309 treatment villages were randomly selected to receive the SanNut intervention while 295 control villages only received the CLTS intervention. 8 households per village were randomly selected from all households with children under 5 years for the endline survey for a total of 4,322 households. Results: SanNut led to modest improvements in sanitary knowledge and practices emphasized by the program, especially safe handling of child faeces – a recognized gap in CLTS. Caregivers in treatment villages were 3.4 pp more likely to mention lack of handwashing after handling child faeces as a potential cause of diarrhoea than caregivers in control villages ($p = 0.02$). Households in the treatment group were 1.9 pp more likely to have a handwashing station with soap and water than households in control village. They reported 2.9 pp lower incidence of child diarrhoea than households in control villages ($p = 0.02$). CLTS outcomes, including latrine use and maintenance and general sanitation conditions in the homestead, were similar in treatment and control groups, suggesting that the additional SanNut messaging did not crowd out or improve CLTS objectives.

Title: CLTS or Smart Subsidies? Both!

Authors: Milan Thomas, Georgetown University, Susanna Smets, World Bank, Lisa Cameron, University of Melbourne, Paulo Santos, Monash University

Submission: Evidence on the effectiveness of Community-Led Total Sanitation programs (CLTS) and household latrine subsidies in promoting hygienic practices has been documented in a number of studies, reviewed in Garn et al. (2016). However, less is known about how collective and individual financial incentives can interact to improve sanitation for the poorest households. We investigate this question in two provinces of South Laos, where over half of our panel of 2,400 households practiced open defecation at the beginning of the study. We ran a randomized controlled trial encompassing 160 villages, which were distributed evenly among one control and three treatment groups (40 villages in each). In all four groups, households were exposed to CLTS. In the treatment groups, we augmented CLTS with different packages of financial incentives to test their impacts on hygiene and latrine adoption. In Treatment Arm 1, we implemented smart subsidies targeted to the poorest 30% of households and provided promoter commissions. In Arm 2, village-level open defecation elimination rewards were offered. Arm 3 included all incentives in Arms 1 and 2. Comparisons are made against the counterfactual of CLTS without financial incentives. We focus on how the interventions promote hygienic behavior across the wealth distribution. To enable more nuanced analysis of the incentives' effectiveness, we collected community- and household-level data on social capital (as in Cameron and Shah 2017). Finally, we exploit the experimental data to assess the impact of hygiene on child health (diarrhea, stunting, wasting). That allows us to draw conclusions on the cost-effectiveness of the interventions. This study provides critical evidence on the importance of small financial incentives as complements to demand triggering campaigns and their role in promoting equity in areas where sanitation coverage remains low.

Title: Continuous Quality Improvement (Cqi) Methods for Water, Sanitation, and Hygiene (Wash): Improving Household Water Quality and Handpump Repair Times in Northern Ghana

Authors: Michael Fisher, University of North Carolina at Chapel Hill, Osborn Kwena, University of North Carolina at Chapel Hill, Ramaswamy Rohit, University of North Carolina at Chapel Hill

Submission: Continuous, safely managed water is critical to health and development, but rural service delivery faces complex challenges in low- and middle-income countries (LMICs). Because conventional efforts have largely failed to address such challenges, we report the first application of continuous quality improvement (CQI) methods to improve the microbial quality of household stored water (HSW) and the functionality of water sources in four rural districts of northern Ghana, as well as the impacts of interventions developed through these methods. Conventional CQI methods and tools were adapted for WaSH applications, and a local CQI team was formed and trained. Baseline data were collected and analyzed to identify determinants of service delivery problems. The CQI team randomized communities, developed an improvement package, piloted it in intervention communities, and used uptake survey data to refine the package. The final improvement package comprised safe water storage containers as well as refresher training for community WaSH committees and replacement of missing maintenance tools. This package significantly reduced contamination of HSW ($p < 0.01$), and this effect persisted two years after implementation. The package reduced repair times relative to baseline ($p < 0.05$), but differences between intervention and control arms were significant only at midline. This work demonstrates the value of CQI methods for addressing complex rural water supply challenges in LMICs. Further work will address approaches to adapting and scaling solutions developed using CQI methods to additional rural contexts.

Title: Cross-Subsidies for Improved Sanitation in Low Income Settlements: Assessing the Willingness to Pay of Water Utility Customers in Kenyan Cities

Authors: Ranjiv Khush, Aquaya, Rachel Peletz, Aquaya, Charisma Acey, University of California, Berkeley, David Levine, University of California, Berkeley, Guy Norman, WSUP

Submission: Most residents of the developing world do not have access to safely managed sanitation services,

and large financial investments are required to address this need. Here we evaluate surcharges on water/sewerage tariffs as an option for supporting these investments in low-income neighborhoods. We investigated willingness-to-pay (WTP) for a pro-poor sanitation surcharge among customers of two urban water utilities in Kenya. Applying qualitative and quantitative methods, we conducted semi-structured in-depth interviews, focus-group discussions, and a double-bounded contingent valuation method for measuring WTP. We varied scenarios quasi-experimentally to study the effects of messaging and surcharge characteristics and evaluated factors associated with WTP. Our study finds that mean WTP was 290 KES (USD 2.9) per month, about 8% of the average water bill; median WTP was 100 KES (USD 1). In a multivariate analysis, WTP was significantly higher among customers that were younger, wealthier, shared toilets, and had higher water bills. WTP was also higher among customers that trusted the utility and distrusted the county government. Of our randomized scenarios, only the bill type was found to significantly influence WTP; WTP was higher if the surcharge was presented as a proportion of the customers' last water bill vs a flat amount. Our findings suggest that in a sector that struggles to provide universal access to sanitation services, cross-subsidies may offer a means to support financing of safe sanitation for low-income households. These results indicate there are opportunities for cross-subsidies in urban Kenya that may be relevant for a wider understanding of surcharge payments that support basic services for low-income citizens.

Title: Design and Baseline Findings of a Cluster Randomized Trial to Assess the Sundara Grama Behavior Change Intervention to Increase Latrine Use in Rural Odisha, India

Authors: Bethany Caruso, Rollins School of Public Health, Emory University, Gloria Sclar, Rollins School of Public Health, Emory University, Parimita Routray, Rollins School of Public Health, Emory University, Fiona Majorin, London School of Hygiene and Tropical Medicine, Corey Nagel, University of Arkansas for Medical Sciences, Thomas Clasen, Rollins School of Public Health, Emory University

Submission: Background:Sustainable Development target 6.2 aims to end open defecation by 2030. In India, where 60% of those practicing open defecation reside, the government has built over 67 million household latrines under the Swachh Bharat Mission. Yet, numerous studies demonstrate that latrine ownership does not equate to use. To increase latrine use in rural Odisha, India, we developed a low-cost behavior change intervention based on formative research and behavioral theory. This presentation shares details of the intervention, the impact evaluation design, and baseline findings. **Methods:**We are conducting a cluster randomized controlled trial (CRT) with 66 villages (33 intervention, 33 control). The primary outcome is latrine use, including safe disposal of child feces, assessed among all latrine-owning households in each village. Secondary outcomes of interest include behavioral drivers of latrine use and child feces disposal. Six additional villages are engaged in qualitative research to assess community perceptions of the intervention and spillover in non-trial villages. Baseline data collection is complete and qualitative research is commencing. **Findings:**We surveyed 5853 households at baseline (I: 2843, C:3010). In both intervention and control villages, 68% of households owned one or more latrines, of which 76% were reported to be used for defecation; 59% of household members in intervention villages and 58% in control villages reported using the latrine the last time they defecated and 20% of households in each arm reported disposing child feces into the latrine. **Conclusions:**Despite access, the use of latrines for defecation and for child feces disposal was poor, further justifying the need for behavioral interventions above and beyond facility construction alone. Findings from this trial will inform behavior change interventions and evaluations in India and beyond, contributing to efforts to end open defecation by 2030.

Title: Development and Pilot Testing of a Tool to Cost Environmental Health Services in Health Care Facilities

Authors: Darcy Anderson, Ryan Cronk, UNC Water Institute, Jamie Bartram, UNC

Submission: Coverage of water, sanitation, and hygiene (WaSH) in health care facilities (HCFs) remains low, with nearly 40% of facilities in low- and middle-income facilities lacking at least one component of basic WaSH. Beyond WaSH, HCFs raise additional specific needs for environmental health services (EHS), such as medical waste disposal and cleaning of surfaces and medical equipment. HCFs are increasingly an area of focus for achieving universal WaSH coverage under the Sustainable Development Goals. However, many countries lack a financing plan or dedicated budget for EHS in HCF. Understanding the costs of providing EHS is critical for budgeting for and delivering sustainable services. We developed and pilot tested a costing tool designed to evaluate the expenditures associated with providing the following services: water supply, sanitation, medical waste disposal, surface and medical device cleaning, handwashing at sanitation facilities, and provider handwashing and personal protective equipment use at the point of care. We conducted a systematic review of the costs of EHS in HCFs. The purpose of this review was to determine the expenditures associated with establishing and maintaining EHS, and to estimate the total per facility and per patient costs of establishing and maintaining EHS. This systematic review was used to inform the development of a costing tool and pilot testing in Malawi. We developed our costing tool using qualitative interviews to identify what infrastructure and activities are necessary to establish and maintain EHS, and to identify categories of essential expenditures. Expenditure categories were used to develop an Excel-based costing tool. This costing tool was piloted in 13 facilities to collect costs data and to evaluate the accuracy, usability, and relevance of the tool. Here, we present the results our systematic review, pilot data, and a critique of the current body of costing literature and recommendations to improve future costing studies.

Title: Development and Testing of a Household Water Insecurity Measure That is Cross-Culturally Equivalent

Authors: Sera Young, Northwestern University, Godfred Boateng, Northwestern University, Shalean Collins, Northwestern University, Amber Wutich, Arizona State University, Joshua Miller, Northwestern University, Zeina Jamaluddine, American University of Beirut, Hugo Melgar-Quiñonez, McGill University, Edward Frongillo, University of South Carolina, HWISE Consortium

Submission: Introduction: Water security the ability to access affordable adequate reliable and safe water is imperative for human health and wellbeing and implicit in the Sustainable Development Goals. Because no cross-culturally validated measure of household water insecurity exists however global epidemiologic data on the prevalence severity and changes in household water insecurity are unavailable. Methods: To develop and test such a measure we formed the Household Water InSecurity Experiences (HWISE) Consortium (<http://sites.northwestern.edu/hwise/>). Sites were selected to represent maximum variation in urban/rural water delivery systems climate and water availability for both water excess and insufficiency. An initial set of 32 items (HWISE 1.0) was developed through literature review expert consultation and qualitative work. At each site a questionnaire with water insecurity and other items to assess validation (e.g. distance to water water source perceived stress food insecurity) was translated to local languages cognitive interviews were performed and the questionnaire was revised and administered to approximately 250 households. A revised 29-item questionnaire was developed based on insights from the first iteration of survey implementation (HWISE 2.0). Resultant data were analyzed using both Classic Test Theory and Item Response Theory. Results: To date HWISE 1.0 and HWISE 2.0 questionnaires have been administered in 27 sites in sub-Saharan Africa Asia Latin America and the Middle East (n=6483). Experiences of water insecurity were common in all sites although the variety and frequency varied enormously. Based on cognitive interviewing field experiences during survey implementation and preliminary analyses 10 HWISE items were eliminated for being idiosyncratic. Conclusions: We expect the final scale will illuminate how water insecurity impacts economic nutrition and physical and psychosocial health outcomes globally.

Title: Development of an M&E Framework for Implementing Organizations

Authors: Andrea Hatch Splash International

Submission: As an implementing organization working on WASH programs in multiple types of child-focused institutions in three different urban contexts (Kolkata India Kathmandu Nepal Addis Ababa Ethiopia) Splash has developed an M&E framework that permits both contributions to systems-strengthening measurements and national-level EMIS indicators but also provides detailed actionable information for implementation planning and budgeting and site or infrastructure-specific repair and maintenance needs. This has required alignment of terms and definitions across country contexts the creation of metrics and indicators that are broad enough to apply to many possible infrastructure types but specific enough to pinpoint issue areas and the development of survey tools that allow customization but also comparison across contexts. The distinction between infrastructure presence functionality water availability and user behavior has been key and Splash is regularly administering pre-implementation post-implementation and routine monitoring collections to capture longitudinal data that can be disaggregated as needed. Using a mobile data collection application online database and data visualization software has streamlined these processes and yielded informative interactive and compelling reports.

Title: Development of Recommendations for Fomite Disinfection in Cholera Outbreaks

Authors: Karin Gallandat Tufts University Daniele Lantagne Tufts University

Submission: Fomites are inanimate objects that can become contaminated and transmit infectious agents. Guidelines on how to disinfect fomites in cholera outbreaks while mostly chlorine-based are inconsistent in terms of concentration contact time and recommended practices. We are investigating fomite disinfection in three studies: 1) a systematic review; 2) laboratory experiments; 3) field evaluations. The database search for the systematic review yielded 10555 references and data was extracted from 95 studies that met inclusion criteria. Only one study using the cholera agent *Vibrio cholerae* was identified. Analysis is in process and data relevance to low-resource outbreak settings will be discussed. In the laboratory we are assessing the efficacy of chlorine against *V. cholerae* and the indicator *Escherichia coli* on hard and porous surfaces. Preliminary results indicate that culturable *E. coli* is less resistant than viable but non-culturable *V. cholerae* and therefore not an appropriate surrogate for this testing. Expected results by fall include whether spraying or pouring a 0.2% chlorine solution can inactivate *V. cholerae* on different surfaces within a given contact time. Lastly we have developed a protocol to evaluate household spraying and household disinfection kits in cholera outbreaks in terms of effectiveness as measured by surface sampling in situ and appropriateness. The first evaluation will take place in the Democratic Republic of the Congo in June 2018 and we expect to have preliminary results from at least two evaluations by the time of the conference. In summary the presentation would provide an overview of currently available data on fomite disinfection efficacy laboratory data on chlorine efficacy against cholera bacteria and preliminary results from field evaluations of household disinfection interventions thus providing an example of a comprehensive strategy to develop evidence-based recommendations for low-resource outbreak settings.

Title: Development of Water Sanitation and Hygiene Intervention to Be Integrated with Nutrition and Child Stimulation

Authors: Tarique Huda, International Centre for Diarrhoeal Disease Research, Bangladesh, Jesmin sultana, Abul Kasham Shoab, Mahbubur Rahman, icddr, Helen Pitchik, Peter J. Winch, Johns Hopkins University, Stephen Luby, Stanford University

Submission: We are conducting a pilot trial to assess if group-based delivery of a child stimulation intervention, when integrated with water, sanitation, hygiene (WASH), nutrition, and other interventions results in sufficient uptake of child stimulation behaviors. Here we present data from our baseline assessment of WASH practices and facilities that helped us adapt the WASH interventions for the integrated intervention package and then describe the implementation process. The

assessment team identified 620 study households from 31 rural Bangladeshi villages, used a verbal questionnaire and spot-check to collect information about household possessions, water, sanitation, handwashing and food hygiene behavior/infrastructure along with other nutrition, child stimulation and lead exposure-related information. Out of 620 households 40% had a toilet with a functional water seal. Among the 368 households with a child 6-36 month old, 32% had a child potty, of which 35% disposed the feces from the potty into a toilet. Around one-third of the households had soap and water at a designated handwashing station, 9% of households had had soap and water available close to the toilet and 3% of households had soap and water available close to the kitchen. Among the 66% of households that reported storing drinking water, 32% of households stored this water in a covered container. Overall 31% of households stored all cooked food in a covered container. The data suggests that in these communities there is high risk of in house contamination of food and water, which may lead to increased risk of food and water associated transmission. So WASH component of the integrated intervention should focus on handwashing around food related event, safe food and water storage along with increasing coverage of toilets with a water seal and safe disposal of children's feces. We adopted Household Environmental Assessment and Planning (HEAP) process to introduce and promote the behavioral recommendations.

Title: Drops Grains and Gains: Insights on Water Endowment Climate Shocks and Nutrition in Sub-Saharan Africa

Authors: Esha Zaveri World Bank Aude-Sophie Rodella World Bank

Submission: Stunting is widely recognized as a major impediment to development and despite overall global reductions it continues to remain high in many countries in Sub-Saharan Africa. In addition increases in climate variability further threaten any gains made in reducing its global incidence. Groundwater resources can augment water supply enhance food security and buffer against climatic shocks which in turn can help reduce stunting. To understand the connections between groundwater endowments and stunting we construct a spatially disaggregated health database of 687652 children across 32 countries in Africa spanning over a period of 15 years along with high-resolution remote-sensing data on environmental conditions weather and growing-season vegetation. We also use a meteorological definition of the Sahel informed by the Intertropical Convergence Zone (ITCZ) that allows an accurate delineation of the region to better understand impacts in the Sahel. Using multivariate regression models we find that children in the Sahel are at a higher risk of anthropometric failure (reduced height for age) in response to increases in in-utero climate variability compared to other areas in Sub-Saharan Africa. The adverse effects of climate variability are significant only for households located in low productive groundwater areas but not for high productive groundwater areas. Further we provide suggestive evidence that lower agricultural productivity is one potential reason for high anthropometric failure in low productive groundwater areas. A spatial focus on the role of groundwater thus further contributes to our understanding of malnutrition in climate vulnerable areas and highlights the essential need for fine tuning interventions whether in terms of policy or resource allocation.

Title: Dry Pipes: Associations Between Utility Performance and Intermittent Piped Water Supply in Low and Middle Income Countries

Authors: Emily Kumpel Univ. of Massachusetts Amherst Jessica Kaminsky University of Washington

Submission: At least one billion people around the world access water through piped systems that are supplied only intermittently. Intermittent water supply (IWS) can lead to adverse health effects and high coping costs incurred by households. While IWS is prevalent across all continents there is little understanding of the driving forces leading piped water supplies to operate intermittently. There is a need to better understand how and why IWS occurs and identify strategies to move utilities towards increasing hours of supply. We present the results of analysis using data from 2115 utilities that reported to the World Bank's International Benchmarking Network for Water and Sanitation Utilities in 2014. In this analysis we identified 42 variables with statistically

significant associations with IWS at the utility scale and categorized these under the following themes: physical infrastructure system scale coverage consumer type public water points financial and non-revenue water and metering. Drawing on the literature on intermittent supplies and water management we identify the potential causes and consequences of these relationships to highlight globally relevant factors related to intermittent water supply. For example we found that IWS was more likely when there is less water available from the water infrastructure lower coverage and lower metering rates; however we found no relationship between variables related to non-revenue water and intermittency. Interestingly we found that demand management and/or revenue generation from commercial or industrial customers may be important leverage points for reducing IWS. These insights can help offer directions for future research into the causes of intermittency. We also use this opportunity to provide empirically grounded recommendations for improving global indicators of utility performance related to IWS.

Title: Dynamics of Exclusion in WaSH Sector: Insights from Bangladesh Nepal and Uganda

Authors: Sara Ahrari SIMAVI Angela Van den Broek Simavi

Submission: The WASH SDG programme (2017-2022) is being implemented in six countries by a consortium consisting of the WASH Alliance International (WAI) Plan Netherlands and SNV aiming towards an improved WASH situation for all. The programme uses a socially inclusive and gender transformative approach meaning that long-term broad-reaching measures are taken within its interventions to eliminate barriers to participation for people who have long been marginalised in particular women and girls with understanding that focusing energy on those with the most barriers improve WASH services for all. In order to deepen our understanding on the issue during the inception phase of the programme Simavi as the Lead Implementing Organisation (LIO) of WAI sub-programme in Bangladesh Nepal and Uganda collected information on: •Who are often left behind in the WASH sector (i.e. in WASH policies legislations practices services and participating in wider decision making processes)? •What are the barriers to their inclusion and underlying causes of their marginalization? •How is the current division of WASH related gender roles assigned to women and men? Who controls the resources and takes the decisions? •Level of participation of women and girls as well as socially excluded groups in WASH decision making processes. Data collection then was done through conducting: 1. Gender and Social Inclusion (GESI) Assessment 2. Household Survey 3. Key Informative Interviews Data analysis provided key insights on how exclusion works in each of these countries some of which challenged our previously held assumptions. The purpose of this presentation is to share these findings and our way forward with the audience get their views and invite collaboration from different stakeholders in particular knowledge institutes to further enhance the understanding on the dynamics of exclusion in WASH sector and how they can be overcome.

Title: Effect of a Behaviour-Change Intervention on Peri-Urban Sanitation Quality in Zambia: a Randomized Controlled Trial

Authors: James Tidwell London School of Hygiene and Tropical Medicine Jenala Chipungu Center for Infectious Disease Research in Zambia Samuel Bosomprah Center for Infectious Disease Research in Zambia Roma Chilengi Centre for Infectious Disease Research in Zambia Robert Aunger London School of Hygiene and Tropical Medicine

Submission: Despite gains in sanitation coverage globally the prevalence of peri-urban shared sanitation is on the rise in sub-Saharan Africa and the growth rate of such peri-urban areas is increasing. In many peri-urban areas low quality sanitation is the only option available to tenants who cannot afford to live elsewhere. Only a few studies have rigorously evaluated how to improve sanitation quality and none have examined improving structural quality in addition to cleaning practices. We did an individually randomized controlled trial in a peri-

urban area in Lusaka Zambia between August 8 2017 and March 1 2018. We enrolled 1085 adult landlords on plots where the landlord and at least one tenant household lived. The intervention consisted of a series of group meetings of landlords discussing motivating sanitation quality improvement as a way to build wealth and reduce conflict and the control received no intervention. We measured outcomes one month before the start of the intervention and four months post-intervention through repeated surveys of landlords and tenants. We compared intervention and control groups on an intention-to-treat basis using a difference in differences approach. We found significant increases in inexpensive structural improvements effectiveness of cleaning systems and taking steps towards making more expensive improvements despite the short timeframe of the trial. Ensuring that intervention landlords attended all meetings and low response rates were major challenges though these difficulties of working in a peri-urban setting were anticipated and several different imputation assumptions and exposure adjustments are tested to determine the robustness of the findings. Behavior-change messaging to create demand for improving peri-urban sanitation quality may be a cost-effective tool and should be evaluated in other contexts as a supplement to current widespread infrastructure improvement projects.

Title: Effectiveness of Multi-level Risk Reduction Emergency Response Activities to Ensure Free Chlorine Residual in Household Drinking Water in Southern Syria

Authors: Mustafa Sikder Tufts University Umar Daraz UNICEF Roberto Saltori Daniele Lantagne Tufts University

Submission: Water sanitation and hygiene (WASH) are immediate priorities for human survival and dignity in emergencies. Now at the seventh year of the Syrian war the pre-conflict >95% infrastructure water access has declined to 21%. To provide safe water the WASH response in southern Syria implemented a multi-level risk reduction intervention that aimed to ensure free chlorine residual (FCR) in household drinking water. The activities involved working along the water chain with piped network and chlorination station operators water truckers and households to distribute and train on chlorination. The field activities varied spatially across the region depending on available resources implementing partner capacity access and security and water source. We evaluated the effectiveness of the intervention in this cross-sectional observation study including a total of 24 chlorination station operators 63 well owners/managers 220 water truckers and 1006 households. We found that the interventions were successful in ensuring FCR in household drinking water with between 61-96% of households with FCR ≥ 0.1 mg/L compared to 21% in non-intervention communities. Activities that were most centralized (piped network central agreements with water truckers) led to the highest household FCR results. Household FCR was associated with obtaining water from the operational portions of the piped water system (aOR 3.5 95% CI 1.8–6.7) and response interventions such as distributing chlorine tablets to chlorinate roof-tanks (aOR 6.1 95% CI 3.4–11.0). It is recommended to maintain the piped water network where possible to train and monitor truckers when not and to provide tablets to chlorinate household tank water in insecure areas. This multi-level strategy effectively maintained FCR in household drinking water in Syria. These results will help to optimize current interventions in southern Syria and guide future response design in similar contexts.

Title: Effectiveness of WaSH Interventions in Reducing Health Vulnerability to Climate

Authors: Katrina Charles University of Oxford Lucia Fernández Montoya Elena VILLALOBOS PRATS Diarmid Campbell Lendrum Various international partners In Bangladesh Ethiopia Nepal and Tanzania

Submission: Climate change will have a significant influence on health via different pathways including though changes in the distribution of diseases direct health impacts water scarcity and reduced access to water supply and sanitation facilities. WASH interventions can help to reduce health vulnerability to climate if they ensure water availability and water quality under a range of conditions. In this study we focused on heavy

precipitation and water scarcity conditions that could reasonably be expected to occur within the study period. This paper will present the results from an 18 month programme of empirical field research in Bangladesh Ethiopia Nepal and Tanzania. The aim of the research was to measure the impact of weather events on WASH access water quality and diarrhoea. Data was gathered in eight sites across the four countries from August 2016 to March 2018 including urban and rural areas. Clusters of households were chosen for proximity to an improved water sources; alternative water sources were available and included in the study. Regular visits were made to over 4500 households to assess changes in access to WASH and how behaviour weather and cultural events influenced access. Water quality was monitored in the household and at over 1200 waterpoints. Preliminary analyses highlight the impact of different weather events and extreme events on access to adequate safe WASH. Households widely used multiple water sources with improved sources used for drinking. Women did the majority of decision making and labour around water. Payment for water was common with more than half of improved sources requiring payment. Water quality and diarrhoea rates vary seasonally. Ongoing analyses will provide cross country comparisons on the impact of weather events (drought/SPI; heavy rainfall) on WASH access.

Title: Efficacy of Jerry Can Cleaning Techniques: Methods Development for a Large-Scale Study

Authors: Gabrielle String Tufts University Hanaa Badr Tufts University Daniele Lantagne Tufts University

Submission: Opaque high-density polyethylene (HDPE) jerry cans with a small screw cap opening are commonly distributed for water collection and storage in emergencies. It has been postulated that biofilm growth inside these jerry cans can act as a microbial reservoir leading to deterioration of disinfectant residual recontamination of drinking water and increased disease transmission. As such responders recommend beneficiaries clean jerry cans regularly. Strategies commonly used for cleaning jerry cans include shaking the container with a chlorine solution bleaching powder and/or rocks and sand. While previous studies have compared cleaning methods they lack statistical power and use field based methods only. As it is suspected surface roughness caused by cleaning methods plays a role in biofilm development we are conducting a large study to assess impact of cleaning techniques on biofilm formation chlorine residual and E. coli concentration in various water types. Before completing this study we developed new methods including: growing and enumerating and imaging E. coli biofilms on smooth HDPE coupons first in media then in E. coli spiked water over 10 and 21-day trials. Methods were then developed to create various controlled surface roughnesses on HDPE coupons and grow biofilms in E. coli spiked water. Microbiological enumeration and confocal microscopy imaging results confirmed that E. coli biofilms can grow on HDPE in culture and with water spiked at 10⁶ CFU/100mL. Enumeration of the E. coli concentrations in the biofilms was on the order of 10⁶ CFU/100mL while the concentration in the water was 10⁹ CFU/100mL. Furthermore biofilms preferentially grew in manufactured scratches along the coupon surfaces they averaged 5.2 um thicker at 21 days of growth from 10 days and were thickest on scratched surfaces of lowest roughness (18.1 um thick) compared to the highest roughness (13.0 um). These methods will be applied to the large-scale study.

Title: Environmental Health in Protracted Displacement: A Systematic Literature Review

Authors: Nikki Behnke The Water Institute at UNC Ryan Cronk UNC Water Institute Brittany Cooper The Water Institute at UNC-CH Raymond Tu The Water Institute at UNC Mabel D'Souza The Water Institute at UNC Jamie Bartram UNC

Submission: More than 65 million people have been forcibly displaced worldwide with 20 newly displaced people every minute. Overcrowded camps and poor environmental conditions present challenges related to prevention of communicable diseases and inadequate environmental services have detrimental impacts on the health and wellbeing of displaced persons. Although environmental health and especially water and sanitation

is often among the first considerations in humanitarian emergencies providing sustainable services is a challenge. Refugee and IDP settlements are designed to be a short-term solution to mass displacement but crises often outlast the emergency stage; more than 80% of refugee crises last more than 10 years. Protracted crises—where populations are displaced for longer than two years—require different environmental health guidelines than acute emergencies but the socio-political status of displaced populations makes long-term environmental health service provision a challenge. We conducted a systematic literature on environmental health in situations of protracted displacement. Using PRISMA guidelines we extracted data from over 350 peer-reviewed papers and grey literature. Specifically we analyzed environmental conditions exposures health outcomes obstacles and potential paths for ward for improvement of environmental health in displaced populations. Environmental conditions that were frequently addressed were: overcrowding; low density of public latrines; inadequate menstrual hygiene materials; and the presence of flies mosquitoes rodents or other vectors. Among the most common pathogens and health outcomes mentioned were cholera Hepatitis E typhoid tuberculosis and skin infections. Legal obstacles and a lack of accommodations for persons with disabilities were cited as common challenges. Recommendations included investing in health education programs; greater community engagement; and improved accommodations for persons with disabilities.

Title: Estimating the Burden of Waterborne Disease in the United States

Authors: Sarah Collier CDC Katie Fullerton CDC Kathy Benedict CDC Li Deng CDC Vincent Hill CDC Jonathan Yoder CDC

Submission: Background: The routine treatment of drinking water one of the greatest U.S. public health achievements of the last century has led to our safe reliable water supply being used in many complex ways that can affect disease transmission. Waterborne disease and outbreaks continue to occur in the United States. An estimate of the burden of waterborne disease in the United States will direct prevention activities and set public health goals. Methods: We chose 20 waterborne diseases for which surveillance data billing data or literature estimates indicated domestic waterborne transmission was plausible substantial burden of illness or death was likely and data were available. Adapting previously developed methods we used a series of disease-specific multipliers to adjust the reported/documented number of cases of each disease for under-reporting under-diagnosis proportion domestically acquired and proportion transmitted via water. Sources for multipliers included surveillance data population studies and expert judgment when no other data were available. We estimated the number of illnesses emergency department (ED) visits hospitalizations and deaths and the costs of ED visits and hospitalizations due to waterborne disease transmitted in the United States in 2014. Results: The most common causes of domestic waterborne illness and emergency department visits in 2014 included otitis externa and norovirus. Among the most common and costly causes of waterborne hospitalizations in 2014 were non-tuberculous mycobacterial infections Pseudomonas pneumonia and septicemia and Legionnaires' disease all infections associated with premise plumbing. Conclusions: Millions of domestically-acquired waterborne illnesses from these infections occur in the United States each year and incur billions of dollars in healthcare costs. This analysis highlights the shifting roles of enteric and premise plumbing pathogens in waterborne disease in the United States.

Title: Evaluating the Technical Performance and Sales Viability of a Novel Venturi Chlorine Doser At Drinking Water Kiosks in Kisumu Kenya

Authors: Julie Powers Tufts University Cynthia McMurry Stanford University Sarah Gannon PATH Adam Drolet PATH Linden Klein MSR Global Health Jenna Davis Stanford University Amy Janel Tufts University

Submission: While 92 percent of the global population uses improved drinking water sources it is estimated that only 73 percent of these sources are free from contamination. The novel MSR Venturi chlorine doser uses

the Venturi principle to consistently add liquid chlorine at the point of water collection (e.g. kiosk taps) without moving parts or electricity. We evaluated the technical performance and sales viability of MSR Venturi prototypes at rural and peri-urban water kiosks in Kisumu County Kenya. We offered kiosk owners the choice of four 6-month service packages: standard lease (15 USD/month) standard lease plus chlorine delivery (18 USD/month) lease-to-own (42 USD/month) and lease-to-own plus chlorine delivery (45 USD/month). Kiosks selecting lease options could purchase the device at the end of the study period (168 USD). 24% of kiosk owners given the sales pitch committed to a service package; each package type was chosen by 1-2 kiosks. Six of the seven kiosks paid in full during the 6-month service period; three currently own the device and the remaining three are in the process of purchasing the device. Of 167 treated water samples collected from participating kiosk taps 158 (94.6%) had detectable chlorine residual (mean total chlorine residual: 0.55 ppm). Treated water sales increased during the pilot and amounted to 19% of total water volume sales. The positive increasing sales trend indicated customer demand for treated water. Incremental revenue from treated water alone was not sufficient to cover monthly payments at any of the kiosks. However the kiosks' overall success in completing payments suggest this technology and the service/lease options may be successful in providing safe water to communities. Future distribution should target sales to kiosks with the ability to pay according to all available funding sources not just potential revenue from treated water sales.

Title: Evaluation of a Smart Toilet in an Emergency Camp

Authors: Fiona Zakaria IHE Delft Josip Curko University of Zagreb Ahmed Muratbegovic Systech Bosnia Hector Garcia IHE Delft Damir Brdjanovic IHE Delft

Submission: An experimental prototype of the eSOS (emergency Sanitation Operation System) Smart Toilet® was evaluated in an emergency settlement in the Philippines. The toilet was equipped with sensors and information communication technologies (ICT) for an efficient operation in an emergency setting. This paper presents findings of different aspects that was evaluated in the field testing. The field testing evaluated (1) the toilet's service capacity related to the user frequency/intensity obtaining insight on the usage patterns in an actual post emergency situation (2) the novel features and functionality of the toilet (3) faecal sludge (FS) and urine characteristics; and (4) user acceptance. Operational performance of the toilet was assessed based on data collected from nearly 700 users within a 7-weeks period. The eSOS Smart Toilet has been properly operating during the evaluation period. A methodology to distinguish defecation and urination activities was developed based on determining discharges to faeces and urine tank. The toilet achieved up to 97% savings on water consumption compared to conventional toilets. The application of sensors and ICT features combined with manually obtained data informed comprehensive usages data e.g. 62% of identified users were female users 40% children and 60% of the visits were for urination and 40% and for defecation. Responsive maintenance was achieved ensuring the efficiency of toilet usage. The novel features including UV-light was evaluated gaining feedback for further improvements. FS and urine characteristics were similar to fresh faecal sludge and urine to recommend for effective treatment and safe disposal method. The test toilet was received well by the emergency-camp population. The features that were appreciated the most was the in-built water supply mechanism. The field evaluation generated ideas for further improvements in terms of cost savings services and an overall vision for sustainability.

Title: Evaluation of a Two-Year Community Health Club Program in Rural Haiti

Authors: Jason Rosenfeld University of Texas Health San Antonio-Center for Medical Humanities & Ethics Marie Ruthza Flavienne Vincent Eco-Eau et Jeunesse Haiti Jude Francois Eco-Eau et Jeunesse Haiti Ruth Berggren University of Texas Health San Antonio-Center for Medical Humanities & Ethics

Submission: In 2016 Lakou LaSante a collaboration between University of Texas Health San Antonio and Eco-

Eau et Jeunesse Haiti launched its first rural Community Health Club program in Haiti's Central Plateau near the source of the 2010 cholera outbreak. Over two years 54 community-based facilitators were trained and formed 41 Clubs with over 1500 members benefiting an estimated 9000 people. By February 2018 almost 1100 participants across four communes completed our six-month water sanitation and hygiene (WASH) curriculum. This program was evaluated using a quasi-experimental design with a pre- and post-intervention survey measuring WASH knowledge norms and behaviors in a random sample of intervention communities and matched comparison communities. At baseline 701 respondents (381 intervention households and 326 comparison households) were sampled and 521 respondents (283 intervention and 238 comparison households) were resampled at final (24% loss to follow up). Although analyses of this program evaluation are ongoing a few key indicators are presented. In intervention households hand washing using the 'pour to waste' method (88.7% to 95.1%) and households with clean latrines (51.8% to 72.7%) increased from baseline to final. Intervention respondents also increased their knowledge of key times to wash hands during the day from an average of 1.79 correct responses at baseline to 2.96 correct responses at final. Intervention respondents provided an average of one additional correct response on three other knowledge questions (diarrhea transmission prevention of skin diseases and home-made oral rehydration) at final. These changes were all greater than that of the comparison respondents. Statistical tests of significance will be conducted and reported on these and other key WASH indicators. The results of this evaluation will demonstrate this model's ability to effect change around key WASH knowledge norms and behaviors in rural Haiti.

Title: Exploring the Complexities of Intra-Household Sanitation Use and Occasional Open Defecation: Evidence from a 14-Country Evaluation

Authors: Lisa Fleming UNC Water Institute Ryan Cronk UNC Water Institute

Submission: Background: From 2000 to 2015 the percentage of the global population practicing open defecation decreased from 20% to 12%. However these statistics do not consider occasional open defecation and intra-household differences in open defecation practices. To address this we explore patterns and trends in reported occasional open defecation among household members. Methods: 37105 randomly selected rural households were surveyed as part of a 14-country evaluation conducted. Questions concerning sanitation practices were asked for each member of the household. Logistic regression models were developed to explore relationships between variables. Results: Our study revealed a high rate of occasional open defecation amongst household members which was significantly associated with the type of sanitation facility available for household use and the usability of the facility (e.g. good superstructure condition clean intact doors to protect privacy etc.). We developed an optimistic scenario (all members of the household practice open defecation all of time) and a conservative sanitation use scenario (at least one household member practiced open defecation occasionally). Across all households 33% reported open-defecating all of the time. An additional 34% of households reported having at least one member of the family who open defecates sometimes doubling the rate of open defecation (67%). Of the households who occasionally open defecate they were more likely to have toilets that flush with water (OR = 3.36 CI: 2.64 – 4.29). These types of sanitation facilities were more likely to be unusable (OR: 0.26 CI: 0.20 – 0.33). Conclusion: Strategies to eliminate open defecation focus on latrine ownership and creating social norms but neglect infrastructure maintenance. To sustain sanitation use and ensure householders do not revert to open defecation a focus on maintenance of sanitation facilities should be a priority for policy makers and practitioners.

Title: Factors Predicting Water Sanitation and Hygiene Services in Schools: Evidence from a 14 Country Evaluation

Authors: Ryan Cronk UNC Water Institute

Submission: Universal access to basic water sanitation and hygiene (WaSH) in schools is an important priority for the Sustainable Development Goals (SDGs). Lack of access to adequate WaSH in schools adversely affects student health and educational performance. However there is little evidence describing factors that predict improved WaSH services in schools. 2691 randomly selected schools in rural areas were surveyed as part of a 14-country evaluation. Multivariable logistic regression analyses were conducted to better characterize the factors associated with access to basic water sanitation and hygiene service levels at schools. Although a high proportion of schools had access to improved water sources (78%) and improved sanitation facilities (95%) few schools had basic services for sanitation (15%) improved facilities that are single-sex and usable or hygiene (12%) a handwashing facility with soap and water. Few schools met the WHO student-latrines-provision guidelines (23%) basic needs for menstrual hygiene management (MHM) (<1%) provided accessible sanitation for disabled students (34%) and 44% of schools had water that did not meet WHO recommended microbial water quality guidelines. Bivariate regressions indicated that the primary barriers to basic sanitation services included usability (e.g. missing doors and locks) and the primary barriers to basic MHM is lack of private spaces and inadequate hygiene. Multivariable logistic regression indicated that factors associated with basic water services included schools receiving external financing (OR: 1.87 CI: 1.46 – 2.38) and the presence of an active parent teacher association (OR: 1.54 CI: 1.34 – 2.67). These factors were also associated with basic sanitation and basic hygiene services. Practitioners and education administrators should identify opportunities to enhance financing that supports sustainable WaSH service delivery in schools and achieve universal access to basic services in the SDG era.

Title: Factors That Influence Use of Monitoring Data for Informing Evidence-Based Decision-Making

Authors: Marieke Adank IRC

Submission: The shift from monitoring access to improved water supply facilities under the Millennium Development Goals to also monitoring water service quality accessibility and availability under the Sustainable Development Goals has required data collection on a wider range of indicators. In addition mobile data collection technologies including smart phone applications and sensors have facilitated the collection of big data sets. However although there is broad consensus on the need for evidence-based decision making in the sector the actual use of the increasing amount of monitoring data for informing decision-making processes at different levels is increasingly being questioned. What are the main reasons behind the limited use of monitoring data? This paper addresses this question by presenting an analysis of factors that facilitate and inhibit the use of monitoring data in informing decision-making processes. The factors included in this analysis include data characteristics (quality quantity reliability accessibility of data) capacity (individual organisational and institutional) and motivation (interest incentives institutional culture of data producers and users). The analysis provides insight into 1) the level of influence of these different factors 2) the centrality and importance of pathways and 3) processes and dynamics between the factors (Causal Loop Analysis).

Title: Fecal Sludge Reuse in Indian Agriculture: Perspectives from the Field

Authors: Sharada Prasad CS Zachary Burt Columbia University Isha Ray University of California Berkeley

Submission: In this paper we use a mixed-methods approach developed out of an exploratory study to unpack the ecosystem of fecal sludge (FS) reuse in Indian agriculture by tracing why and how FS reaches a farm and why and how it is used (or not) once it gets there. We estimate farm owners' preferences for untreated FS as well as safely treated fecal sludge-based fertilizer (FSF) and gauge the determinants of workers' willingness to work with FS and with FSF. We find that reusing untreated FS in agriculture as fertilizer is a complex eco-system dictated by environmental social and financial factors. Our study shows that farm owners are already using untreated FS using various tactics to overcome the barriers of workers' lack of willingness to work with human

waste. Both farm owners and workers have positive preferences towards certain characteristics of FSF (i.e. FS that has been at least partially treated or composted as fertilizer as opposed to raw waste). These preferences vary based on the characteristics of the farmer (such as the area of land owned and access to mechanization) and the worker (such as gender and diet). However the practice of the concealed use of untreated FS could be a source of health risk for all the workers particularly as our findings show that almost all workers work without wearing any safety gear. Female workers are disproportionately affected by this practice and they may also expose their family members to these risks when they go home to their domestic and kitchen chores. Though FSF reuse could certainly be a meaningful resource-management option for a country such as India its reuse should be carefully promoted considering that (i) such practices might reinforce social stigmas rooted in India's caste system; and (ii) promotion without safety precautions and regulations could reinforce existing health risks among vulnerable farm laborers

Title: From Emergency to Development: Autonomous Chlorine Production for Water Utilities in Conflict Regions - Insights from Ukraine

Authors: Fanny Boulloud Antenna Foundation Raphael Graser Antenna Foundation Pierre-Gilles Duvernay Antenna Foundation

Submission: Since 2014 the armed conflict in Ukraine led to massive displacement of civilian population destruction of infrastructure and affected water quality. Before the conflict water utilities mainly treated water with chlorine gas or HTH (Calcium Hypochlorite). Both substances are however highly toxic and considered dangerous goods as they can be used in chemical warfare and are therefore under embargo (VD 2018). For water utilities operating in such contexts disinfectant sourcing can thus be very challenging putting at stake both the quality of water and health of populations already under great distress. From February 2015 onwards Swiss Humanitarian Aid (SHA) has organized five humanitarian convoys with water treatment materials and medical supplies to both sides of the conflict line. SHA introduced the WATA™ technology and provided capacity building to Vodadonbassa (VD) the water utility in Eastern-Ukraine for implementing and monitoring the technology. WATA™ is a simple and low-tech solution developed by Antenna Foundation to locally produce active chlorine (0.6% sodium hypochlorite) by electrolysis of saltwater. By end of 2017 58 WATA™ devices were progressively installed in different water utilities permitting the continuous disinfection of water for 300000 people in the conflict region (SHA 2018). Through this intervention water quality was maintained with <1 CFU E. coli/100ml (VD 2018) and increased the autonomy of the water utilities through the reduced dependency on external chlorine provision (SHA 2018). In Q1/2018 Vodadonbassa ordered 28 WATA™ devices for providing safe water to additional 150000 people per day. These experiences offer potential for replication in other emergency situations where the logistics of chlorine sourcing is complex or common chemicals for water purification are under embargo.

Title: Gendering Psychosocial Stress: Open Defecation Among Slum Households in Peri-Urban Bangalore

Authors: Durba Biswas Ashoka Trust for Research in Ecology and the Environment (ATREE) Shweta Joshi

Submission: Rapid urbanisation of rural areas close to large cities can impact people's sanitation behavior. However this transition is uneven and open defecation peri-urban Indian towns can persist. Our research explores the gendered nature of sanitation-related psychosocial stress in a slum within a peri-urban town (Jayanagar) in rural Bangalore. The study uses a mixed-methods approach. Forty men and women were interviewed using a semi-structured questionnaire. Three in-depth case studies were also developed to build a comprehensive profile of psychosocial stress among the slum community. Subsequently 2 additional rounds of FGDs and interviews were also conducted. Field research was undertaken intermittently between May 2017 – May 2018. Findings from our study contribute to the growing research on sanitation-related psychosocial stress

in three important ways: a) our study finds that men and women experienced stress differently. The primary reason for this difference is rooted in the possibility of “indignity” or sexual aggression faced by women while defecating in the open. Under the rigidity of patriarchy this fear of ‘indignity’ not only produced private psychosocial stress in women it also produced a collective psychosocial stress for the whole family as a family’s honor is tied closely to women’s dignity; b) women experience psychosocial stress over the management of sanitation needs of other family members (young children and elderly relatives). Women from economically vulnerable backgrounds are responsible for managing sanitation needs of their own and others in the family; and c) while women practiced multiple coping strategies to reduce exposure to risks even at the cost of their overall health men tended to have fewer and less stringent coping strategies. Given these reasons we find that unlike in rural areas where open defecation is preferred to toilets (Coffey et al. 2014) communities in rapidly urbanizing areas have a preference for toilets over open-defecation.

Title: Global Sensitivity analysis to Advance the Use of Quantitative Microbial Risk Assessment (QMRA) in an Informal Settlement in Kampala Uganda

Authors: Diana Byrne University of Illinois at Urbana-Champaign Stephanie Houser University of Illinois at Urbana-Champaign Kerry Hamilton Drexel University Muwonge Mubasira Community Integrated Development Initiatives John Trimmer University of Illinois at Urbana-Champaign Hannah Lohman University of Illinois at Urbana-Champaign Charles Haas Drexel University, Jeremy Guest University of Illinois at Urbana-Champaign

Submission: Quantitative microbial risk assessment (QMRA) could be an informative tool for decision-making in resource-limited settings by providing a proactive approach to quantifying pathogen-related health risks. Despite its potential advantages QMRA is often challenging to apply in resource-limited communities which lack detailed pathogen data. Using the Bwaise settlement (Kampala Uganda) as an example this work leverages Morris’ and Sobol’s global sensitivity analysis methods to elucidate factors governing the uncertainty and applicability of QMRA as a decision-making tool in resource-limited settings. In Bwaise drinking water caregiver and child hand rinse and soil samples were collected from 46 households in collaboration with Community Integrated Development Initiatives (CIDI) a local organization active in the community. Samples were also collected from 11 water sources 5 drainage ditches and 10 produce items and supplemented with data from >800 household surveys. Preliminary data from 754 surveys indicate 35% of children had diarrhea in the past week and despite availability of piped water household drinking water remains contaminated (average of 23 E. coli per 100 mL for 28 samples). Additional exposure pathways include hands (average of >2300 E. coli for 33 caregiver samples) food soil and drainage ditches. E. coli data will be complemented by pathogen-specific data via qPCR focused on common local diseases including typhoid and cholera. Using data collected at 3 levels – qualitative data from household surveys fecal indicator data and pathogen-specific data – sources of uncertainty will be prioritized and trade-offs between data collection and information regarding health risks (as DALYs) will be quantified. This information will help decision-makers prioritize health interventions and advance the applicability of QMRA in resource-limited settings.

Title: Health Risk Perceptions Are Associated with Domestic Use of Basic Water and Sanitation Services- Evidence from Rural Ethiopia

Authors: Carmen Anthonj UNC Water Institute Samuel Godfrey UNICEF Ethiopia Lisa Fleming UNC Water Institute Jane Bevan UNICEF Ethiopia Ryan Cronk UNC Water Institute Jamie Bartram UNC

Submission: We examine factors associated with the use of basic water supply and sanitation services as part of an integrated community-based nutrition programme which included a drinking water, sanitation and hygiene (WaSH) intervention and emphasise findings related to health risk perceptions. Data were collected from 2658 households in four regions in Ethiopia with a cross-sectional survey in WaSH intervention areas, as

well as in control areas, where the intervention was not implemented. The data were analysed using bivariate and multivariable regression analysis. Awareness of health risk factors related to inadequate WaSH was high in the programme area. The use of basic water and sanitation services was associated with several health risk perceptions: Perceiving water quality as good increased the odds of using basic water services as opposed to believing the water quality was poor (OR 3.94; CI 3.06-5.08; $p \leq 0.001$). Believing that drinking unsafe water was the main cause for diarrhoea increased the odds of using basic water services (OR 1.48; CI 1.20-1.81; $p \leq 0.001$). In the WaSH intervention group, the use of basic sanitation was more likely than in the control group. The use of basic sanitation was associated with households who had previously received sanitation training, as opposed to such who had not (OR 1.55; CI 1.22-1.97; $p \leq 0.001$). Perceiving dirty space as the main cause of diarrhoea (OR 1.81; CI 1.50-2.19; $p \leq 0.001$), and privacy when using a latrine (OR 2.00; CI 1.67-2.40; $p \leq 0.001$), were associated with higher odds of using basic sanitation. Households that indicated a disadvantage of owning a latrine was maintenance costs were less likely to use basic sanitation (OR 0.49; CI 0.38-0.63; $p \leq 0.001$). Risk perceptions were important determinants of use of basic services. The findings point to risk perceptions motivating the application of positive WaSH-related and health-protective ours. This suggests that well-designed health risk communication strategies may be effective for engaging households in healthy WaSH behaviour.

Title: Implementation Science in WaSH: Adaptation of a Successful Household Stored Water Quality Intervention from Ghana to Burkina Faso

Authors: Osborn Kwena The Water Institute at UNC

Submission: Adapting effective local interventions to new contexts presents a unique challenge to WaSH programs and implementers. Continuous quality improvement (CQI) methods offer a systematic approach to characterizing and optimizing the performance of existing solutions in new contexts in order to achieve uptake and impact. We conducted the first known CQI project in the WaSH sector and adapted a household safe water storage intervention from Ghana to Burkina Faso. Ninety-five communities in 6 regions were randomly assigned to either intervention or control arms. Surveys were conducted at the community facility and household level; water samples were collected from all water sources and from 6 randomly selected households within each community and were analyzed for *E. coli* using the compartment bag test. Following baseline data collection a safe water storage intervention (container and training) implemented in Ghana was adapted to the Burkina Faso context. Households assigned to receive safe water storage containers (SWSCs) and training were 50% less likely to have high risk microbial water quality than those in the control arm ($p < 0.05$). Households consuming water from dug wells had significantly higher proportions of samples in the high risk category than households consuming water from boreholes. Households observed to be practicing proper hand hygiene were significantly less likely to be in the high risk category. Uptake of safe storage containers in intervention villages was approximately 87% at follow-up. The intervention was successfully adapted to the Burkina Faso context and was associated with significantly improved microbial stored water quality. Additional improvement cycles may be useful in improving uptake. Integrating treatment options with handwashing along with other improvements may enhance the performance of the SWSC package. This work demonstrates that local evidence and knowledge can be used to adapt a WaSH CQI solution from one context to another.

Title: Is Rural Water Sustainable?: Cases from Latin America

Authors: Paula Burt Fundacion Avina Lil Soto Fundacion Avina Valerie Nuncete Fundacion Avina

Submission: In Latin America over 145000 Community-based Water and Sanitation Organizations (CWSOs) provide safe drinking water to approximately 70 million people in rural and peri-urban areas frequently

neglected by national and local governments. CWSOs are grassroots organizations created by groups of neighbors seeking to address water access issues within their communities. For the last forty years in some Latin American countries rural water public policy has focused on constructing water systems for CWSOs and rarely on investing in the leaders who run them and assuring the quality and sustainability of the service that is offered. Provision of sustainable and well-managed water and sanitation services in rural and peri-urban areas has become a critical factor in development. During the presentation we plan to provide an overview of what rural water supply in Latin America looks like both in areas where water is abundant and where it is scarce present success cases and explore the enabling factors that contribute to the sustainability of rural water systems. Finally we will introduce a powerful solution to the regional challenge of sustainability for CWSOs "Sustainability Centers". Sustainability Centers for CWSOs are not-for-profit social enterprises involving alliances between community government and civil society which provide training technical assistance mentoring and other priority services to improve and maintain high-quality management among member community organizations. Case studies of six sustainability centers will be presented. From this presentation the audience will take away lessons learned that can guide future actions and investments in and outside the region; elements that must be included in rural water public policy; and a methodology to replicate and scale up sustainability centers.

Title: Islamic Faith-based Behavior Change Interventions to Improve WaSH Facilities and Practices in Muslim Communities in Bangladesh Nepal and Indonesia: a Before-After-Control-Impact (BACI) Design

Authors: Mahbub Ul Alam International Centre for Diarrhoeal Disease Research Bangladesh Farzana Yeasmin International Centre for Diarrhoeal Disease Research Bangladesh Supta Sarker International Centre for Diarrhoeal Disease Research Bangladesh Ayesha Afrin International Centre for Diarrhoeal Disease Research Bangladesh Tarique Huda International Centre for Diarrhoeal Disease Research Bangladesh Husna Ahmad Global One Mahbubur Rahman icddr

Submission: Faith-based programmes have potential to promote behavior change for improved health. We designed a Before-After-Control-Impact study to evaluate the effectiveness of a faith-based water sanitation and hygiene intervention. We selected eight villages from Bangladesh four from Indonesia and two from Nepal. Half of the villages in each country received the behavior change intervention and remaining were controls. The intervention was developed from religious textbooks focusing on safe water hygienic toilets child feces management and menstrual hygiene reviewed by community members and delivered by teacher students groups mosque preachers and peer educators. Intervention impact was measured from surveys at baseline and after six months of intervention among 192 respondents from Bangladesh 236 from Indonesia and 248 from Nepal. We estimated the difference in difference (DID) of practices and knowledge proportions to measure intervention effectiveness. In Bangladesh intervention groups were observed to wash both hands with soap more commonly [(DID): 20% 95% Confidence Interval (CI): 01 40] were more likely to own improved toilet (DID: 22% CI: 6 39) gained more knowledge on safe water (DID: 32% CI: 19 39) by 6 months. In Indonesia intervention groups were more likely to own improved toilets (DID: 16% CI: 1 33) children <3years more commonly used a potty (DID: 14% CI: 5 33) caregivers were more likely disposed child feces into pit or toilet (DID: 42% CI: 3 80) and gained knowledge on safe water (DID: 30% CI: 16 34) by 6 months. In Nepal more children <3years used a potty (DID: 15% CI: 6 29) and gained knowledge on safe water (DID: 53% CI: 38 68) by 6 months. The study demonstrated improvement in knowledge and practices in intervention communities compared to control suggesting that mosques and Islamic schools could be effective venues for delivering WASH messages to improve handwashing practices and child feces management.

Title: Learning from Implementing & Evaluating Rural and Urban WaSH Investments

Authors: Shreena Patel Millennium Challenge Corporation

Submission: Since 2005 the Millennium Challenge Corporation (MCC) has invested over \$1B in upgrading rural and urban water systems across 7 developing countries. Each of these investments has or will undergo an independent evaluation to assess the achievement of targeted outcomes. MCC's early WASH investments focused on rural water points and sanitation in order to achieve reductions in waterborne illness. These projects constructed rural water points and community water systems constructed latrines established water user committees and/or provided training on sanitation and hygiene to community members in El Salvador Ghana Lesotho and Mozambique. MCC commissioned independent evaluations of these projects and four quasi-experimental impact evaluations have been completed. These evaluations measured impacts on access to improved water sources water collection times water consumption education-related outcomes health-related outcomes and household incomes. Overall they found that while projects were successful in increasing access to improved water and sanitation and reducing time spent collecting water they did not have statistically significant impacts on higher level outcomes particularly diarrheal illness or incomes. Accordingly the final estimated economic rates of returns decreased as compared to those estimated when the projects were designed. The findings of these evaluations have motivated a number of lessons for MCC related to WASH project design implementation and evaluation. This presentation will share lessons in these areas with the key audiences being donors practitioners and evaluators and will touch on the evaluation and economic modeling approaches undertaken. It is possible that the presentation can incorporate findings from urban water system interventions in Tanzania Jordan Lesotho and Cabo Verde depending on the status of the evaluations by the time of the conference.

Title: Lessons from the Rapid Start Up of Sanitation Market Development in Ethiopia: The Transform WaSH Story

Authors: Monte Achenbach PSI Ethiopia John Sauer Population Services International

Submission: USAID Transform WASH is a five-year project to develop and test market-based models that increase demand for and supply of quality affordable WASH products and services. The aim is to facilitate market access to basic sanitation for up to 400000 households. Global experience suggests that market development approaches do not typically begin to achieve strong sales until the third year of a project. However drawing on this experience PSI and its Transform WASH partners have tested approaches to kick start private sector sanitation sales. This start up process comprised the following steps: a) rapid market assessment; b) selection of existing businesses as partners; c) recruitment of sales agents; d) business model development and adaptation; e) retailer mason and sales agent training; and f) market player linkage workshops. Early results have included the activation of 23 slab manufacturers and 41 sales agents in one region resulting in the sale of close to 1000 toilets. During this start-up period the project has been able to identify limiting factors that prevent rapid uptake of basic sanitation products. These include supply issues (product availability rising prices of inputs import barriers and manufacturer capacity) limited capital for business expansion and lack of consumer awareness of products and purchasing processes. Lessons learned from the rapid start up include importance of hiring staff with deep sales and business experience and knowledge of local markets. Equally critical is market segmentation starting with low-cost simple-to-install and transport products which helps businesses offer households easy inexpensive steps up the sanitation ladder. Creating a sales strategy that allows sales agents to be paid directly by businesses increases sustainability from the outset. Finding ways to make the transaction process between the customer and business as straightforward as possible eases the decision to purchase.

Title: Leveraging Technology Partnerships for Rapid Improvement of Decentralized Waste Water Treatment

Authors: Brian Hawkins Duke University Center for WaSH-AID Edgard Ngaboyamahina Duke University Center for WaSH-AID Sonia Grego Duke University Brian Stoner Duke University

Submission: The global need for improved sanitation and the prohibitive expense of building new sewer infrastructure in lower income countries has driven efforts to develop decentralized approaches to waste water treatment. The Bill & Melinda Gates Foundation's Reinvent the Toilet (RTT) Challenge has supported development of a number of small scale (household to community level) treatment systems utilizing various approaches to decentralized treatment including source separation anaerobic digestion electrochemical processes adsorption microbial fuel cells and ultrafiltration. To date none of these technologies have achieved the goal of a completely off-grid and self-sustaining system. Our team has led an initiative to partner with multiple RTT grantees (including both university-based labs and commercial entities) to accelerate the development and implementation of these technologies. Using our blackwater treatment and recycling system as a test bed we evaluated and directly compared laboratory-scale prototypes of different liquid treatment processes in terms of their efficiencies in removing specific constituents of wastewater (e.g. chemical oxygen demand suspended solids). Using these findings we then performed pilot studies combining one or more processes and measuring the impact of their combination on the overall energy required to achieve disinfection of blackwater. Outcomes of this program have included a better understanding of the complimentary efficiencies of different processes specific recommendations for their combination and application and the conception of a new prototype liquid treatment system combining multiple technologies currently in development with a commercial partner.

Title: Living with Change: Water Emotion and Wellbeing Among the Afar Pastoralists of Ethiopia

Authors: Alison Parker Cranfield University Abinet Kebede IRC Barbara van Koppen IWMI John Butterworth IRC Sarah Cooper Cranfield University Paul Hutchings Cranfield University

Submission: In regions such as the Afar Ethiopia recent political economic and climate trends have stressed the resilient capacity of pastoralist communities leading to acute water insecurity. This paper investigates the wellbeing and mental health consequences of living under this state of environmental change. It presents a novel way of understanding these issues through the development of a locally-derived 'lexicon of emotions' which is used to assess the emotional consequences of acute water insecurity. Emotion theory suggests the frequency and intensity of emotions such as joy anxiety sadness and anger can make life's experience either positive or negative and repeated emotional states are associated with mental health problems such as anxiety and depression. Through a multi-staged qualitative study involving 48 focus groups and interviews the research highlights that worry fatigue and hopelessness are the most commonly given emotions that pastoralists use to describe their water security situation. The research discusses the potential causes and consequences of this situation and also considers how emotions may shape specific secondary dangers in the region such as the violence and conflict over water resources that can occur in the pastoralist regions.

Title: Locals Get Travelers' Diarrhea Too: Diarrhea and Pathogenic E. Coli Along an Urban Rural Gradient in Ecuador

Authors: Karen Levy Emory University Lorena Montero Universidad San Francisco de Quito Shanon Smith Emory University Maritza Paez Universidad San Francisco de Quito Angela Peña-Gonzalez Georgia Tech Juliana Soto Giron Georgia Tech Xavier Sánchez Universidad Central del Ecuador

Submission: Given global urbanization there is a need to understand pathogen transmission between urban and rural areas. In the EcoZUR study we sampled ~100 subjects with diarrhea and age-matched controls at four clinics along a rural-urban gradient in Ecuador in Quito (Pop. 1.62M) Esmeraldas (Pop. 162000) Borbón (Pop. ~5000) and outlying rural communities (Pop. ~10-500). Survey data and stool samples were collected and samples were tested for rotavirus and for pathogenic E. coli. We also characterized a subset of E. coli isolates by multi-locus sequence typing. Our results show differences in both the distribution and virulence of

pathogens by study site. In two urban sites diffuse adherent *E. coli* (DAEC) was the dominant *E. coli* pathotype whereas in the rural sites atypical enteropathogenic *E. coli* (EPEC) was the most prevalent. Infection with DAEC was associated with diarrhea in the urban sites but not in the rural sites. Phylogenetic analysis showed that these associations were not driven by an outbreak of a clonal genotype. Reported travel in the past year to Guayaquil was associated with increased risk of DAEC infection further supporting that DAEC infection is associated with urban areas. Travel in the past year both in and out of Quito was also a predictor for any pathogenic *E. coli* infection and travel in the past year was associated with diarrhea among all participants specifically those from Esmeraldas. Neither improved sanitation nor improved drinking water were significantly associated with diarrhea case status or pathogenic *E. coli* infection but treatment of drinking water was protective against diarrhea particularly in urban sites. Contact with animals was also found to be a risk factor for diarrhea. This study suggests that "travelers' diarrhea" can occur as a result of travel between higher- and lower-transmission locations within a given country. These results suggest that urban areas should be prioritized for diarrhea intervention efforts.

Title: Mental Models Risk Communication to Promote Private Well Testing in Underserved Minority Communities Part II: Randomized-Controlled Trial

Authors: Frank Stillo University of North Carolina at Chapel Hill Erica Wood UNC Chapel Hill Wandu Bruine de Bruin Leeds University Business School Jacqueline MacDonald Gibson University of North Carolina at Chapel Hill

Submission: Prior research has documented the systematic exclusion of some peri-urban African American communities in the U.S. South from regulated municipal water and sanitation service. Research also has documented high contamination risks in the private wells on which these communities rely for their drinking water and low risk awareness due to lack of routine water quality testing. We designed a mental models risk communication to promote private well testing in these underserved communities (see accompanying abstract "Mental models risk communication to promote private well testing in underserved minority communities part I: communication design"). We will present the results of an ongoing randomized controlled trial of this communication to determine its influence on water testing behavior and knowledge among residents of peri-urban majority African American communities in Wake and Gaston counties NC relying on private wells for their drinking water. To implement the randomized-controlled trial 2232 households in these communities were randomly assigned into four groups: control risk communication free water test and risk communication combined with free test. Follow-up surveys to determine the communication's influence on water testing behavior and knowledge (with and without the free water test offer) will be conducted in August 2018. We expect to find a significant increase in private well testing. This study is only the third empirical evaluation of risk communications targeted at private well owners in North America. None of these prior studies used a mental models approach and none targeted underserved minority communities. To our knowledge this study is also only the sixth randomized-controlled trial of a mental models risk communication. As such this research will contribute not only to knowledge of the potential for targeted risk communications to improve private well testing but also to the evidence base for the mental models approach.

Title: Microbiological Testing of a Community-based Biomass-fueled Water Pasteurizer and Procedures for Cleaning Household Water Transport Containers

Authors: Tala Navab-Daneshmand Oregon State University Grace Burlison Oregon State University Catherine Mays Oregon State University Nordica MacCarty Oregon State University

Submission: Worldwide nearly 1.2 billion people pasteurize their drinking water over biomass fires using boiling as a visual indicator. Although this process requires extensive natural resources and poses a health risk to both humans and the environment using biomass to pasteurize water is culturally appropriate and the

potential to improve its efficiency is vast. Additionally without access to clean tap water households need to collect transport and store water in containers during which there is increased risk of recontamination of the water. In this study we performed field and laboratory experiments to test a community-based water purification system – the InStove Water Purifier – to test for drinking water microbiological standards. The Purifier manufactured by Institutional Stove Solutions (InStove) is a continuous-flow biomass-powered system that pasteurizes enough drinking water for upwards of 1000 people per day using little fuel and is easy to operate and maintain. In addition we tested five recommended or commonly-practiced protocols for water container cleaning procedures. Findings demonstrated that the InStove Water Purifier is capable of meeting both US-EPA and WHO microbiological requirements by 6-log removal of *Escherichia coli* and 4-log removal of MS2 bacteriophage while using only 3% of the energy required for boiling on open fire. Results from the container-cleaning testing highlight the importance of using soap and/or bleach compared to water rinse methods to reduce *E. coli* by 6-logs. Therefore the implementation of the InStove Water Purifier combined with proper container cleaning methods could greatly reduce risk of waterborne illnesses among vulnerable populations.

Title: Monitoring City-level Inequalities in Access to WaSH Services: Assessments of Low-income Communities in Five Cities

Authors: Jonathan Stokes Water & Sanitation for the Urban Poor Nerea Ajuriagogeascoa WSUP

Submission: There is limited tracking of inequalities in access to water and sanitation services at the sub-national level. To address this global monitoring challenge Water & Sanitation for the Urban Poor (WSUP) has piloted baseline citywide assessments of low-income communities and informal settlements in Dhaka Maputo Nakuru Antananarivo and Lusaka over 2017/18. This presentation will provide an overview of the spatial sampling methodology appropriate to low-income urban communities and key findings to date. Indicators covering accessibility affordability and quality of water and sanitation services will be presented from data collected through household surveys water quality testing (in some countries) and third-party data from service providers and other actors allowing for generation of full JMP water and sanitation service ladders up to “safely managed” level. The sampling strategy is determined by the distribution of poverty across each city; Lusaka for example was divided into 9 groupings covering all peri-urban areas and two comparative middle/high-income areas each allocated the same sample using a spatial GPS-based sampling approach to distribute surveyed households evenly and generate results of the same precision for each area. All generated indicators can be mapped and compared between grouping of low-income area to visually highlight intra-city inequalities. They can also be stratified by wealth quintile. This will be presented to participants using an interactive dashboard. The presentation will highlight key insights generated by these assessments. In Dhaka for example increased wealth in non-slum areas is correlated to a higher positioning on the JMP sanitation ladder however this was not the case in slum areas - implying that access to JMP “basic” sanitation in slums is constrained by factors beyond household income. The session will conclude with thoughts on next steps for the methodology and future usage of the data by WSUP and others.

Title: Monitoring Progress to Sustainable Service Delivery in Rural and Urban Settings

Authors: Kimberly Lemme Water For People Kelly Latham Water For People Nick Burn Water For People

Submission: Data collection has become more routine in the WASH sector in recent years but measuring sustainability is not as far along. Using an internally developed tool Water For People is measuring the critical elements of sustainable service delivery to track progress of a district managing water services over time. In order to confidently exit an intervention area it is important to track progress regularly on key indicators of essential elements of sustainable service delivery. In this paper Water For People shares lessons learned while

developing a checklist that aggregates data sets into a scorecard to indicate the sustainability of services. This checklist scores the present services and determines the minimum criteria needed for a local government to successfully manage and maintain water service delivery over time without intervention from INGOs or other external support. Following a participatory process involving global and local stakeholders of water service delivery the scorecards were finalized and formally conducted for the first time in early 2017. The indicators fall into three categories – Service Authority Service Provider and Water Resources Management – with eight indicators in total including legal structure financing operations and maintenance management and water resources management plans. As an internal tool this data supports organizational planning and understanding of how to best exit an intervention district. As an external tool this data helps districts to monitor and understand their level of water service delivery. This paper explores the development process the annual execution of the checklist and the data-based results and trends after the first two years.

Title: Nutrient Removal Recovery and Reuse Options for the anaerobic Digestion Pasteurization Latrine

Authors: Brandon Hunter Duke University Aaron Forbis-Stokes Triangle Environmental Health Initiative Lucas Rocha Melogno Duke University Civil & Environmental Engineering Graham Miller Duke University Civil & Environmental Engineering

Submission: The Anaerobic Digestion Pasteurization Latrine (ADPL) is a self-contained and energy neutral on-site faecal sludge treatment system using anaerobic digestion of human excreta to generate biogas and uses the biogas to pasteurize the digester effluent at 65-75 °C to produce a pathogen-free effluent. The ADPL is a simple system with very few moving parts and relies on gravity-induced flows. Full-scale field units have been installed and operated in Kenya India and the Philippines. The anaerobic digestion of minimally diluted human waste removes about 85-89% of the chemical oxygen demand (COD) (Forbis-Stokes et al. 2016). However where local reuse of the sanitized effluent as fertilizer is undesirable residual COD total nitrogen (TN) and phosphorus (P) concentrations must be further reduced to meet environmental discharge or reuse standards. In water-scarce cases additional processes are needed to further treat the anaerobic digester effluent to the point where it can be safely discharged or possibly reused as flush water. We have developed simple trickling filters and anaerobic filters that can provide treatment for fecal sludge digestate and meet these requirements. The tested filter media (biochar coconut husks sunflower seeds zeolite etc.) are low-cost sustainable and can be locally sourced where on-site sanitation facilities are in high demand. Experimental data from the operation of nitrification trickling filters and denitrification submerged filters in the lab (with dog feces and human urine digestate) have shown simultaneous removal of COD TN and P up to 82% 69% and 89% respectively partly meeting the effluent requirements of the draft ISO standard 30500 for non-sewered sanitation systems. Data have also successfully demonstrated the ability to precipitate Ammonium Magnesium Phosphate Hydrate which may be a valuable slow-release solid fertilizer. These laboratory findings were then corroborated by field experiments in Madagascar.

Title: Only Rapid Handpump Repairs Reduce Diarrhoea Morbidity: Evidence From Kenya

Authors: Patrick Thomson University of Oxford

Submission: Shallow groundwater abstracted by handpumps is the primary source of drinking water for many rural communities across the world. This improved or "basic" water source is believed to be generally of potable quality the natural processes making it free from the microbial contamination that can cause a range of water-related diseases. Inevitably handpumps break down. During this breakdown period users may switch to other—less safe—water sources such as open wells springs or streams thereby exposing themselves to pathogens that may cause illness. This study aims to shed some empirical light on this issue by presenting work on handpump breakdowns in rural Kenya. By combining data on handpump downtimes from 200 pumps that

were part of a data-driven rapid repair service with health data from household surveys (n=3590) we examine the relationship between pump downtimes and diarrhoea period prevalence per household. While the repair service reduced average pump downtime by an order of magnitude to less than three days analysis against self-reported diarrhoea suggests that only an extremely rapid repair (within 24hrs) is associated with a reduction in diarrhoea morbidity. Households whose pumps had been repaired within 24hrs were 2.5 times less likely to report diarrhoea than those whose pumps had taken longer to repair. As a comparator no relationship between self-reported cough and speed of repair was observed. These results support modelling work which suggests that even short periods without safe water can have disproportionate adverse health effects. If these results are generalizable beyond this study they have significant policy and operational ramifications. They imply that current community management models that do not achieve rapid pump repairs are unlikely to realise the putative health benefits associated with having an improved source of drinking water based on groundwater.

Title: Operating Model for the Long-term Sustainability of Biosand Filtration in Haiti

Authors: Ashley Thomson Florida Gulf Coast University Ralph Wittebolle Clean Water for Haiti Chris Rolling Clean Water for Haiti

Submission: Biosand Filters (BSF) have been used around the world to provide clean drinking water in developing countries. Clean Water for Haiti (CWH) is a US 501 (c) 3 organization based in Haiti that installs biosand filters primarily in the Artibonite Valley. The principal goal is to improve the health of Haitians by providing safe drinking water. About 57% of the Artibonite's 1.6 million residents collect their drinking water from unimproved open sources. Since 2001 CWH has installed over 25000 filters. While the technology is well known an effective implementation strategy is required to insure the long-term sustainability of a BSF program. The CWH operating model has been developed over a period of 15 years of continuous improvement. CWH manufactures sells and installs BSF to local families at a subsidized price to make the filter affordable to families. Sales are entirely handled by a network of "Promoters". The Promoters are local volunteers who spread the news of BSF around their communities and take orders. Filters are sold because this has proven to ensure that the filters are well maintained. This contributes to the sustainability of the program. Technicians are recruited from the local community and are trained to build install and maintain the filters. Creole is used for all oral and written communication in training programs manuals and during installation and maintenance programs. After the filter is installed follow up visits are conducted at 1 3 12 and 60 month intervals. This provides opportunities for further education maintenance and data collection.

Title: Pathogen Inactivation in Fecal Sludge Through In-situ Accumulation of Carboxylic Acids: Development from Lab Scale to Field Trials

Authors: Lauren Harroff Cornell University Janice L. Liotta Cornell University Emily E. Wangolo Sanergy Tim Egan Sanergy Largas T. Angenent University of Tübingen

Submission: We have developed a bioprocess whereby open cultures of anaerobic bacteria ferment fecal sludge (FS) to accumulate carboxylic acids (CAs). Through a chain elongation pathway we specifically target CAs with longer hydrocarbon chains such as n-butyric acid and n-caproic acid which are more effective at inactivating pathogens. In earlier work we showed that lab-scale batch reactors of undiluted FS could accumulate up to 257 mM n-butyric acid and 27 mM n-caproic acid. We also demonstrated pathogen reduction through experiments with *Ascaris suum* eggs which showed that inactivation was directly controlled by exposure time and the concentration of the undissociated form of CAs. Through more recent work we utilized response surface methodology to further understand the effects of exposure to multiple CAs simultaneously exposure time and temperature on *A. suum* inactivation. From these results we can recommend time-

temperature combinations to reduce *A. suum* viability below 0.1% given known concentrations of CAs. Finally we will present results from ongoing field trials conducted in partnership with Sanergy in Nairobi Kenya. In these trials FS collected from Sanergy's network of Fresh Life Toilets will be fermented in a two-stage batch process in 45 L airtight containers. CAs will be accumulated in the first stage and the fermentation of added banana waste in the second stage will reduce the pH below the pKa of the acids (~4.8) to ensure that the CAs are in the effective undissociated form. *A. suum* eggs contained in small porous chambers inside the reactors will be removed at multiple time points to demonstrate pathogen reduction. After successful demonstration at field scale we hope that CA fermentation will be widely considered in waste treatment strategies either as a standalone process to render FS safe for handling and disposal or as part of a larger strategy to produce value-added products such as a pretreatment step for anaerobic digestion.

Title: Patterns of Environmental Fecal Risk Factors in Rural Bangladesh Identified by Latent Class analysis: Implications for Targeted Interventions

Authors: Sania Ashraf University of Pennsylvania Elli Leontsini Johns Hopkins School of Public Health Peter J. Winch Johns Hopkins University Lawrence Moulton Johns Hopkins School of Public Health Leanne Unicomb International Centre for Diarrheal Disease Research Bangladesh (icddr)

Submission: Fecal oral transmission occurs through complex pathways that are modified by human behavior. Identifying ways to describe existing combinations of risk factors might inform more effective design of water sanitation and hygiene (WASH) interventions. We sought to identify subgroups of fecal exposure risk factors by examining patterns in WASH characteristics in rural Bangladesh. Field workers asked women from 1382 households from 5 districts questions about demographic characteristics income and observed the latrine handwashing station household structure and the presence of animals inside or around the household. Model building used Bayesian information criterion and bootstrapped likelihood ratio tests to inform required number of classes. We explored factors associated with these classes including socio economic status and education. Seven discriminating categorical indicators included latrine type latrine ownership daily child open defecation handwashing station shared courtyard and type of wall and floor. Four sub-groups with increasing fecal exposure risk profiles were identified. Households without any latrines constituted the group with the highest fecal exposure risk (4%). The group (11%) with high conditional probability of individual toilet ownership (84%) with intact water seals (70%) and soap at station (53%) had the lowest risk of fecal exposure. Risky behavioral indicators specially absence of soap and water and daily child open defecation grouped together. We found that unhygienic behaviors clustered with limited WASH infrastructure in households with low socioeconomic status and education. Specific subgroups of households may benefit from different combinations of WASH interventions. Low intensity interventions for those with better infrastructure can programmatically be more cost effective. Analytical approaches as such that incorporate interactions between environmental and socio-economic factors can inform holistic intervention strategies.

Title: Policy Review of the Means of Implementation Targets and Indicators for the Sustainable Development Goal for Water and Sanitation

Authors: Clarissa Brocklehurst UNC Jamie Bartram UNC

Submission: The Sustainable Development Goals adopted by the Member States of the United Nations in September 2016 contain both 'Outcome' and 'Means of Implementation' (MoI) targets. However there is generally weak evidence linking the MoIs to outcomes; they are imperfectly conceptualised and inconsistently formulated; and tracking of their largely qualitative indicators will be difficult. In this paper the MoI targets of SDG 6 on water and sanitation are analysed and critiqued. Improvements are recommended that would inter alia reflect the need for considerable investment to achieve SDG6; the important role of the state including

government leadership and planning; the utility of disaggregation of financial and capacity-building assistance; and the need for people to realize their rights to information voice and remedy. Recommendations are also made for relevant indicators including the adoption of indicators that are applicable to governments in both aid-providing and aid-receiving countries.

Title: Preferences for Menstrual Hygiene Management Products Among Adolescents Girls and Young Women in Addis Ababa and Sendafa Ethiopia

Authors: Kristen M. Little Population Services International Ellen Janssen Johns Hopkins Bloomberg School of Public Health Ephraim Mebrate PSI/Ethiopia Fregenet Getachew Desta PSI/Ethiopia Shannon Rosenberg Population Services International Bethany Caruso Rollins School of Public Health Emory University Patrick Aylward Population Services International

Submission: Background: To better understand the menstrual hygiene management (MHM) market and product preferences we conducted a discrete choice experiment (DCE) among adolescent girls and young women (AGYW) in Addis Ababa and Sendafa Ethiopia. Methods: Participants completed 8 DCE choice tasks that included attributes such as price thickness and length protection against leaks texture and disposability wiper and how well it stays in place. Eligibility criteria included: Age 13-24 reached menarche lived in the study area for >6 months and could provide informed consent. Analysis was performed in Stata. Results: We recruited 890 respondents from Addis Ababa (N=495) and Sendafa (N= 395). Respondents averaged 13.8 years of age and most (66%) were currently in school. Most (96%) reported ever using a commercial pad though this was higher among AGYW in Addis (98%) than Sendafa (93%). The ability of a product to stay in place during moderate/heavy activity (versus only while seated/not moving) was predictive of stated product choice (aOR: 6.0 95% CI: 5.4-6.7) as was a product that provided ≥6 hours of leak protection on the heaviest flow days (versus the lightest flow days) (aOR: 3.1 95% CI: 2.7-3.4). Respondents had significant negative preferences for reusable products (compared to disposable products) (aOR: 0.7 95% CI: 0.6-0.7) but had 2.2 times the odds of selecting a product that came with wipes (95% CI: 2.0-2.4). Conclusions: Use of disposable pads was very common in our sample. Preferences were driven strongly by attributes of product quality including ability to stay in place and protection against leaks. While reusable products are on the market in Ethiopia we found a strong negative preference against these compared to disposables. Interventions to improve access to MHM products should consider product quality and user preferences.

Title: Prevalence and Antibiotic Profiles of Diarrhoea Pathogens in Children Under the Age of 5 Years

Authors: Natasha Potgieter University of Venda Lee Heine University of Johannesburg Tobias Barnard University of Johannesburg Lutendo S Mudau Tshwane University of Technology

Submission: Continuous epidemiological and prevalence assessment of diarrhoeagenic pathogens in rural and peri-urban communities with little or non-existent water and sanitation infrastructures will provide information to health statisticians on the prevalent strains circulating in these communities and this data will add to the knowledge of vaccine and other treatment effectiveness. The study was conducted in the Vhembe District of the Limpopo Province South Africa. Stool samples were collected for 12 months between 2015 and 2016 from children under the age of 5 years suffering from diarrhoea. A total of 275 samples (184 from primary health care clinics and 91 from hospitals) were analysed using BioFire Filmarray Gastrointestinal (GI) Panel. Diarrhoeal causing bacteria collected from stool samples were analysed for antibiotic susceptibility. The most isolated bacteria pathogens were Enteroaggregative Escherichia coli [EAEC] Enteropathogenic Escherichia coli [EPEC] and Enterotoxigenic Escherichia coli [ETEC] Giardia Cryptosporidium Adenovirus F40/41 Norovirus and Rotavirus. Single symptoms were seen in 33% of the patients while multiple symptoms were seen in 67% of the patients. As expected the 115 E. coli strains showed a variety of wild type and acquired antimicrobial

resistance with some strains showing resistance against multiple classes of antibiotics. Of these 56% (n=64) had extended spectrum beta-lactamase resistance. Similarly the *K. pneumoniae* strains showed wild type resistance against several of the antibiotic classes. Approximately 36.4% of the *Enterococcus* strains showed resistance to Vancomycin with again a wide range of wild type resistance reported. Despite this there were strains that showed multiple resistance against various combinations of the recommended antibiotics tested.

Title: Prevalence of Clinically Relevant Bacteria from Surfaces of a Pediatric Burns Unit in South Africa

Authors: Renay Van Wyk University of Johannesburg Petros Muchesa University of Johannesburg Boniswa Khumalo University of Johannesburg Tobias Barnard University of Johannesburg

Submission: Contaminated healthcare surfaces and hands of healthcare workers have been identified as reservoirs that can facilitate infection of patients with multidrug-resistant (MDR) bacteria in hospital facilities. The aim of the study was to investigate the occurrence of bacteria from selected environmental surfaces of a pediatric burns unit in South Africa. According to hygienic standards for disinfection in hospitals swab samples (n=150) were collected from patient files doctor's desks and patient dressing trolleys and bath tubs after daily cleaning. Samples were collected from the examination room general wards intensive care units and dressing rooms. Bacterial isolates were characterized using the VITEK®2 compact System. The detection rate of bacteria in general wards was significantly higher than other selected hospital areas of the burns unit with patient files being more frequently contaminated. The predominant isolates were *Pseudomonas aeruginosa* *Enterobacter cloacae* and *Klebsiella pneumoniae* *Achromobacter denitrificans* *Pseudomonas stutzeri* *Stenotrophomonas maltophilia* *Sphingomonas paucimobilis* *Enterococcus casseliflavus* *Staphylococcus haemolyticus* *Staphylococcus hominis* spp *Staphylococcus aureus* *Micrococcus luteus* and *Staphylococcus sciuri*. The occurrence of these organisms on intimate surfaces has implications on hand hygiene in healthcare settings where cross-contamination can occur from surfaces to hands of health care workers and eventually to vulnerable patients.

Title: Rapid Assessment of WaSH in Health Facilities in an Emergency Context: Experiences from Using the JMP Core Questions in the Rohingya Refugee Camps

Authors: Annie Feighery mWater Anthony Stewart World Health Organization Rosanna Jeffries World Health Organization Komal Saini

Submission: The Rohingya crisis resulted in 700000 people fleeing their homes to live in sprawling refugee camps in rural Bangladesh. It is currently the largest refugee camp on the planet. The Government of Bangladesh and international partners have struggled to provide water sanitation and health services to such a large influx of people to an area with limited infrastructure and outbreaks of disease have occurred including Diphtheria and cholera. One key challenge is keeping an up-to-date registry of the location and condition of healthcare facilities that have been set up by multiple organizations who are operating with little coordination. In response the WHO Global Outbreak Alert and Response Network worked with mWater an NGO that helps WASH organizations collect and visualize data to conduct a rapid assessment that used the most recent version of the JMP core indicators for WASH in health along with other indicators from the WHO's Water and Sanitation for Health Facility Improvement Tool (WASHFIT.org). mWater trained 14 international NGO partners to participate in a mapping of healthcare facilities and conduct surveys to assess their WASH conditions. Only 39% of 141 facilities surveyed had limited water service while 81% had limited sanitation service and 55% did not provide health care waste management. In addition to the service level findings we also share important lessons about adapting the SDG indicators to an emergency context.

Title: Reduction of Illegal Dumping of Manually Emptied Pit Latrine Waste Through Human-centered Design

in Urban Slums in Nairobi Kenya

Authors: Ruth Rosenberg Sanergy Lindsay Stradley Sanergy

Submission: The growing proportion of the global population that lives in densely populated urban areas requires concentrated consideration to achieve SDG 6's call for sustainable equitable sanitation for all. Parts of every city can be served by existing sanitation technologies and services but the value added by increasing access to them is counteracted by the continued inability to manage the waste they cannot capture. In Kenya over 90% of sludge from 8 million slum residents is dumped untreated into waterways[i]. The majority of this sludge comes from pit latrines which fill quickly and are inaccessible by vacuum truck. These latrines must be emptied manually. While the practice of manual emptying is illegal a de facto system has evolved to govern what is often the only viable way to maintain access to sanitation for millions. Replacement of this system is the long-term goal but how might we reduce the negative effects on health environment and economic productivity in the short-term? Human-centered design was employed with 40 manual emptiers. The discovery stage yielded a detailed understanding of the manual emptying process pricing profit margins operating territories challenges faced and unofficially authorized discharge points. Iterative service design targeting manual emptiers as customers led to establishment of a safe discharge site at which containment and transport by an exhauster truck to the wastewater treatment plant are guaranteed. Emptiers pay to bring an average of 8000L of sludge to the site daily despite availability of the free unofficial discharge point 100m away. By designing a service that addresses emptiers' pain points we unlocked willingness to pay thus offsetting the cost of operating the safe discharge site. As cities work toward SDG 6 safely removing manually emptied pit latrine waste from slum communities holds tremendous potential to reduce harm caused by the informal systems that have evolved to address sanitation need.

Title: Reported Walking Time and Measured Distance to Water Sources: Implications for Measuring Basic Service

Authors: Anna Murray charity: water Maeve Kennard University of Southern California Daniele Lantagne Tufts University

Submission: Introduction: To meet the Basic Service provision of the Sustainable Development Goals households must access an improved water source within 30 minutes total collection time. Reported walking time is generally not considered an accurate measure of actual time or distance to water sources. charity: water (CW) is an organization that funds water sanitation and hygiene programs through partner implementing organizations in developing countries. Partners collect and report to CW household monitoring data before and after grant implementation. Methods: From 2014-2017 seven partners across 10 countries conducted surveys at 10 randomly selected households per source (18028 households total). Respondents reported walking time to water sources queuing time trips to collect water and number and volume of containers filled yesterday. Great-circle distance was calculated from household to water source GPS with the Haversine formula. Multiple linear regressions were run on: 1) measured distance versus reported walking time (endline surveys only n=1379 from 7 countries) and 2) collected water volume versus walking time (n=16142 from 10 countries). Results: When adjusting for country distance increased 9.4m per minute increase in reported walking time ($p < 0.001$ $R^2 = 0.27$). Distance was greater for those reporting walking over 30 minutes round-trip versus under (503 vs 151m $p < 0.001$). Further households reported collecting less water per person as walking time increased (from 2.4L less when walking increased 15 min to 5L less when walking increased 120 min) when controlling for source type queuing season and country. Discussion: Reported walking time is moderately correlated with measured distance to water sources and households reported collecting less water with increasing walking time. Simple household surveys demonstrate suitability to approximate distance and access across many country contexts and there is measureable benefit to closer water sources.

Title: Risk Factors for Childhood Enteric Infection in Urban Maputo Mozambique

Authors: Jacqueline Knee Georgia Institute of Technology Trent Sumner Georgia Institute of Technology Rassul Nala Ministério da Saúde Moçambique Oliver Cumming London School of Tropical Medicine and Hygiene

Submission: Enteric infections are common where public health infrastructure is lacking. This study assesses risk factors for enteric infections among children living in low income unplanned communities of urban Maputo Mozambique. Similar studies often relied on symptom-based definitions of diarrheal illness. We studied the association between socio-demographic and environmental risk factors and major enteric infections. We conducted a cross-sectional survey in 17 neighborhoods of Maputo to assess the prevalence of reported diarrheal illness (7-day recall) and confirmed enteric infections in children. We collected stool from children ≤ 48 months for molecular analysis of 15 common enteropathogens together with survey data related to water sanitation and hygiene (WASH) socio-demographics and other environmental factors. We analyzed stool from 755 children living in 425 compounds representing a range of environmental conditions. Prevalence of enteric infections was high (86%) and driven by bacterial (76%) and protozoan (53%) pathogens including *Giardia* and *Shigella*. Most infections (87%) were asymptomatic and not accompanied by reported diarrhea. Prevalence of enteric infections increased with age from 71% to 96% in children 1-11 months and 24-48 months respectively. In adjusted models we found a range of factors to be associated with a lower risk of bacterial and protozoan infections including presence of a latrine superstructure and drophole cover. Exclusive breastfeeding was also associated with reduced risk of infection. We found a high prevalence of enteric infections low prevalence of reported diarrhea and weak associations between enteric infections and environmental risk factors including WASH. While the public health significance of diarrhea is well established the significance of this high burden of apparent asymptomatic infection is unclear.

Title: Risk of Exposure to Fecal Contamination for Adults and Children in Neighborhoods Across Dhaka Bangladesh Using the Sanipath Exposure Assessment Tool

Authors: Suraja Raj Emory University Jamie Green Emory University Yuke Wang Emory University Nuhu Amin icddr Mahbubur Rahman icddr Imrul Hassan DATA Bangladesh Zahidul Hassan DATA Bangladesh George Joseph World Bank Christine Moe Emory University

Submission: Dhaka Bangladesh has experienced rapid population growth and challenges meeting sanitation service demands. Poor sanitation and fecal sludge management can lead to fecal contamination in the urban environment. To understand risk of exposure to fecal contamination an assessment of 10 environmental pathways was conducted using the SaniPath Tool. Data were collected from 10 neighborhoods (6 low-income 2 mixed-income and 2 high-income) throughout Dhaka between April-June 2017. 1000 environmental samples were collected from shared latrines public play areas produce in markets street food open drains flood waters surface waters bathing water municipal water and non-municipal water. Samples were analyzed using IDEXX-Colilert-24[®] Quanti-Tray/2000 for most probable number (MPN) of *E. coli*. Behavior surveys were conducted with households school children and community groups to understand interaction with the environment. Using Bayesian methods these data were used to estimate the percentage of the population exposed and mean dose of fecal exposure (*E. coli*) for each environmental pathway in each neighbourhood. For adults consumption of raw produce was the dominant exposure pathway (i.e. contributes most to total exposure) in 6 of 10 neighborhoods. 78-99% of adults were exposed to fecal contamination through ingestion of raw produce and the mean dose ranged from 104.8 - 107.5 MPN of *E. coli* ingested/month. The most common dominant amongst children (8/10 neighborhoods) was accidental ingestion of drain water from contact with open drains (up to 94% exposed; mean dose of 107.8 MPN of *E. coli* ingested/month). Ingestion of fecal contamination via produce and street food was a high risk throughout Dhaka while exposure to fecal contamination via municipal drinking water was a greater risk for those living in the south of the city. These results can guide city-wide WASH programming to prioritize interventions and increase the potential for public health impact.

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Submission: iDE's sanitation marketing program activates the private sector to produce sell and promote latrines to expand access to underserved households. iDE's Cambodia program has sold over 280000 improved pour-flush latrines significantly making progress against SDG Goal 6 of ending open defecation through adequate and equitable sanitation. New research estimates the extent to which iDE sales have moved the Cambodian population towards an ODF free society as measured by latrine coverage rates. Further we recognize that the sector has mixed evidence measuring the contribution of improved sanitation to positive health outcomes and thus reduced mortality rates as framed in SDG Goal 3. This research provides an additional piece of evidence for consideration as it estimates the health impacts of iDE's sanitation marketing program in Cambodia. A quasi-experimental research study of primary and secondary data sources used difference-in-difference models to measure iDE's causal impacts on changes in latrine coverage at the commune- and district-levels. Difference-in-difference analysis also estimated the effect on health outcomes at the district level. A fixed effects and multivariate regression models estimated the causal relationship between latrines and health specifically looking at rates of diarrhea prevalence among children under five. The study finds that iDE's intervention led to increases in latrine coverage by 17.8 percentage points. We also find significant results that after iDE's intervention rural diarrhea prevalence in target areas decreased by 5.8 percentage points. Finally we find that increased latrine coverage in villages is associated with decreased rates of households experiencing diarrhea. This study shows with statistical significance that iDE's sanitation market development work is directly related to large changes in coverage and a decrease in diarrheal disease thereby substantively making progress towards SDG Goals 3 and 6.

Title: Sanitary Inspections and Water Quality: An analysis of Contamination Sources Pathways and Barriers

Authors: Emma Kelly The Water Institute Ryan Cronk UNC Water Institute

Submission: Sanitary inspections (SI) are a low-cost method to assess the risk of microbial contamination at water points. SIs consist of ten short binary survey questions that assess contamination hazards and barriers allowing water points to be given a risk score from zero (low) to ten (high risk). Although SIs are promoted in the WHO Guidelines for Drinking Water Quality as a tool to assess water safety several studies have suggested that SIs do not adequately represent microbial contamination because they show little or no correlation between overall SI score and microbial water quality. However correlations between sanitary score and microbial water quality do not adequately characterize the complex relationship between contamination factors which include hazards (e.g. fecal matter) pathways (e.g. rainfall) and barriers (e.g. concrete apron). To address this we used data on 3868 water points from an evaluation of World Vision programming in 12 sub-Saharan African countries. In Mali and Ethiopia overall SI score was significantly but not strongly associated with water quality. Five structural components of the water systems are significantly associated with water quality: the presence of a fence the presence of a concrete apron the presence of concrete well walls breakages in the drainage channel or blockages in the drainage channel. Only one environmental hazard was significantly associated with water quality: presence of animal feces within 10 meters of the water point. Incidence of rain within the past 48 hours was the variable which was most strongly correlated with water quality. Including the incidence of rain variable did not increase the correlation between SI hazards and water quality.

Title: Seeding the Sanitation Supply Chain in India - A Light Touch Leads to High Returns

Authors: Kate Sawyer, Water For People

Submission: Open defecation is still a large problem in rural Bihar with only 37% coverage of latrines. The State Government aims to claim 100% Open Defecation Free by April 2019 under the Swachh Bharat Mission which is having a positive impact on demand for latrines. To overcome supply chain constraints Water For People and Basix (Social Enterprise Group) from 2012-2013 seeded the market through capacity building of 8 cement ring manufactures (CRM) an important product in toilet construction with the aim of developing permanent commercially viable supply chains. Two years after the project ended WFP undertook a study on how the market behaved without the external driving force. The study reveals that the CRMs were still in business and for some trade and turnover increased. Moreover 14 self-initiated entrepreneurs started sanitation business in that locality which proves that there is potentiality of this business in that area. A recent 2018 survey found 37 CRMs in the target area and if they built at a similar rate this equates to 18703 latrines being built last year. With each latrine costing a household ~Rps 15000 (\$220) it gives a total investment in latrines of \$4126000. This represents a significant leveraging of funds from an initial investment of \$19281 from Water For People. Such crowding in could only be supported by a substantial demand for cement rings and an increase in the rate of latrine acquisition. Water For People and Basix are working on spreading the process to other areas using lower implementation costs which has caught the attention of JEEViKA – the State’s initiative on rural livelihoods and sanitation. Plans are in development to work with JEEViKA to scale this approach across the state and monitor the impact.

Title: Social and Financial Incentives for Overcoming Collective Action Problems

Authors: Raymond Guiteras rpguiter@ncsu.edu Mehrab Bakhtiar University of Maryland College Park James Levinsohn Yale University A. Mushfiq Mobarak Yale University

Submission: We study the effect of social and financial incentives on communities' ability to overcome collective action problems. Our specific context is a sample of 107 villages (approximately 19000 households) in rural Bangladesh and the collective action problem we study is investment in hygienic latrines and their subsequent maintenance and use. We randomized (1) whether and what type of incentive was provided – a financial reward or a non-financial “social recognition” reward and (2) whether and what type of verbal commitment the households were encouraged to make – a private pledge vs. a public pledge. We measure short-term (3 months) and medium-term (12-15 months) effects and investigate the mechanisms behind the effects. In the short term we find that a financial reward increased the share of households using and maintaining a hygienic latrine by 10 percentage points while the public commitment was roughly half as effective (+4.5 pp). These effects appear to be roughly additive. Neither the social reward nor the private commitment had effects statistically distinguishable from zero in the short term. Our analysis of the medium-term effects is in progress.

Title: Social Network Patterns of Latrine Re-Adoption Following Flood Events

Authors: Katherine Chambers University of Colorado Boulder Sherri Cook University of Colorado Boulder

Submission: The increasing number and impact of natural hazards pose a threat to existing and planned sanitation infrastructure (IPCC 2014). Consequently more research is needed to ensure the continued use and performance of sanitation infrastructure following extreme events (Howard et al. 2016). A review of research trends in infrastructure hazard resilience revealed that the social dimensions are understudied (Opdyke et al. 2017); similarly research on sanitation resilience has largely focused on technical dimensions (e.g. Luh et al. 2017). Research on latrine adoption (defined here as the acceptance and construction of sanitation infrastructure) has suggested that controlling for standard predictors such as education and income individuals are more likely to own latrines if their social contacts own latrines (Shakya et al. 2015). Recent research

examining latrine re-adoption (defined here as the reconstruction and use of sanitation infrastructure following collapse or destruction) has suggested that social factors may predict better rebuilding outcomes (Mosler et al. 2018). However research on latrine re-adoption has not rigorously evaluated the effects of social contacts on decision-making and diffusion of information. This work proposes to fill this gap by conducting a social network analysis of latrine re-adoption and decision-making in Ethiopia's Oromia Region where flooding has taken over 70% of latrines in communities. Data collection and analysis will be performed this summer with preliminary results presented at the Water & Health Conference. Controlled for standard predictors of ownership we hypothesize that individuals' social networks predict latrine re-adoption decisions choices and informational pathways. These results may have implications for sanitation programming in disaster-prone communities.

Title: Status of Water Sanitation Hygiene and Waste Management Services in Healthcare Facilities in Rural Areas of 14 Low and Middle Income Countries

Authors: Amy Guo The Water Institute at UNC

Submission: The Sustainable Development Goals call for universal access to drinking water sanitation and hygiene (WaSH) by 2030. Adequate WaSH services are vital in healthcare facilities as minimum environmental health standards must be maintained in order to provide safe and adequate care to patients. We measured the status of WaSH and waste management in 2035 outpatient healthcare facilities (HCFs) in rural areas of 14 low- and middle-income countries (Ethiopia Kenya Rwanda Uganda Tanzania Malawi Mozambique Zambia Zimbabwe Ghana Mali Niger Honduras and India). A survey was administered at each selected HCF including verbal questions and direct observations about water source characteristics number and condition of sanitation facilities presence of hand hygiene stations and supplies and waste management practices. Water samples were also taken at HCFs wherever water was available. We found that while 86% of HCFs were using an improved water source only 52% used a basic service and 64% of water samples were free of E. coli. Less than 1% of HCFs had basic sanitation service; 55% of HCFs had limited service based on repair or privacy problems and 33% of HCFs were usable but did not meet the needs of women staff or persons with limited mobility. 16% of HCFs had basic hygiene service: while 57% had a hand hygiene station for at least one point of care only 22% had a hand hygiene station within 5 meters of at least one sanitation facility. 84% of HCFs had no waste management service; only 28% had bins appropriate for segregating sharps and medical waste at all points of care and only 36% were treating and disposing of infectious wastes and sharps properly. Areas for improving environmental services in HCFs include provision of water sources on-premises bins and private spaces for menstrual hygiene management hand hygiene stations near sanitation facilities and appropriate bins and treatment methods for medical wastes.

Title: Tailoring the Approach for Implementing an Integrated Intervention Package of WaSH Maternal and Child Nutrition Child Stimulation and Prevention of Lead Exposure for a Trial in Rural Bangladesh

Authors: Farzana Yeasmin International Centre for Diarrhoeal Disease Research Bangladesh, Mahbubur Rahman icddr, Stephen Luby Stanford University Tarique Huda International Centre for Diarrhoeal Disease Research Bangladesh Tania Jahir icddr, Khobair Hossain icddr, Md. Ruhul Amin icddr, Peter J. Winch Winch Johns Hopkins University

Submission: Introduction: Children who are exposed to fecal-contaminated environments exhibit poorer growth and cognitive development. We developed a package of integrated interventions delivered by Community Health Promoters (CHPs) to promote household water sanitation and hygiene nutrition child stimulation and decrease exposure to lead. Method: A pre-pilot phase of exploratory for mative research was followed by a 9-month pilot in 16 villages. In month 4 we conducted 7 focus group discussions (FGDs) and 12

in-depth interviews with mothers and 2 FGDs with CHPs to identify challenges in implementing the intervention package. In 8 villages CHPs provided bi-weekly group sessions with neighboring women and their young children. In 8 other villages the group sessions were held monthly and the CHPs made a personal visit to each participating woman's household monthly. Findings: The qualitative assessment identified difficulties in ensuring regular attendance and managing active young children. Because the men were not included women found it difficult to purchase lead-free/unpolished turmeric slatted lids to cover hot foods and more variety in foods as recommended. We added sessions directly involving male household decision makers. To reduce absenteeism we had participants rotate serving as group leaders to support CHPs in organizing the sessions. We also asked women to bring family members to sessions to assist in childcare. We adopted a storytelling for mat rather than presenting behavioral recommendations directly. We also developed a process for facilitating self-appraisals of the quality of households' WASH called Household Environmental Assessment Plan (HEAP). HEAP allowed households to identify areas for improvement and track their progress towards identified goals. Conclusion: Qualitative assessment was a useful tool in monitoring difficulties with implementation as originally conceived and the tailoring of solutions accordingly.

Title: Targeted Subsidies as a Way to Increase Equity Without Causing Distortions in Market-based Sanitation Programs: Evidence from a RCT in Cambodia

Authors: Chris Nicoletti iDE Reimar Macaranas Causal Design Alicia May iDE

Submission: iDE's sanitation marketing efforts in Cambodia have resulted in over 280000 sales of improved pour-flush latrines. Despite the overall efficacy of this approach iDE recognizes that market actors are not necessarily incentivized to reach the poorest segments of the market. A randomized controlled trial (RCT) in which poor households in treatment villages were offered partial subsidies as well as financing and cash-only options as opposed to control-village households that were offered only financing or cash-only purchase options was used to test which financing mechanism lead to the greatest coverage change among poor households while having the least distortionary effect on the non-poor segments of the market. The study finds the subsidy increased sales for all households in the treatment arm by approximately 5.5 latrine sales per village corresponding to a 66% increase in latrine sales compared to the control group. The effects were driven primarily by gains in sanitation coverage among poor and very poor households. The rate of uptake among very poor households without a latrine was 17% higher in treatment than control; for poor households the treatment uptake rate was 14% higher than control. The study also showed that the targeted subsidy had no impact on the level of sales and/or changes in uptake across non-poor households. A cost-effectiveness analysis (CEA) was used to understand the relative costs and outputs when comparing the treatment and control arms of the experiment. The analysis looks at the cost per latrine sold—for each arm of the experiment – as well as for scaled-up program-wide versions of the treatment and control experimental conditions. This CEA combined with the RCT shows that in a direct comparison of sanitation coverage outcomes the targeted latrine subsidy pilot is able to increase sanitation coverage more efficiently than unsubsidized efforts and is able to do so without adversely affecting sales to non-poor customers.

Title: Technological and Public Health Implications of Emerging Contaminants in the USA Water – Per and Polyfluoroalkyl Substances (PFAS)

Authors: Tony Singh University of Virginia Rekha Singh University of Virginia

Submission: Detection of Per and Polyfluoroalkyl Substances (PFAS) in USA waters have presented huge technological and public health concerns. These compounds have been used extensively in USA for various industrial consumer goods production defense (firefighting) and eventually end up in USA waters and other waste containment systems (landfills). Due to their presence in water and other environmental medias their

exposure has led to elevated level of such compounds in human and animals. Although adverse (toxic) impact of PFAS compounds in animals has been well studied there is still lack of toxicity and health impacts data on most of such PFAS compounds in humans. Detection of PFAS compounds in USA drinking water systems have led a huge resentment among different public communities. Lack of availability of low cost detection techniques availability of effective treatment technologies and management of contaminated sites have further added to the such public health concerns. Being on US EPA high priorates list and consideration of establishing of Maximum Contaminant Level (MCL) tremendous amount of technological advancements has taken place in recent years. However better and more effective tools are required for early detection and mitigation of such PFAS water contamination to protect public health. This PFAS contamination issue may not only require major technological infrastructure investments policy changes but also require public participation.

Title: Technological Field Performance of a New Point-of-use Water Treatment Technology in a Randomized Control Trial in Limpopo South Africa

Authors: Courtney Hill University of Virginia James Smith University of Virginia Elizabeth Rogawski University of Virginia Rebecca Dillingham University of Virginia Pascal Bessong University of Venda David Kahler Duquesne University Joshua Edokpayi University of Venda

Submission: In resource limited settings it has been concluded that point-of-use water treatment was more appropriate than centralized systems as they provide effective low-cost solutions to improving the quality of drinking water. One such technology a silver-impregnated ceramic tablet called a MadiDrop continually disinfects water in household water storage containers by releasing silver into the water for daily treatment of 20 liters for at least six months. Herein we report on the long-term field performance of the commercial product that was assessed as part of a larger randomized control trial examining the effect of point-of-use water treatment devices on linear growth in children. 400 homes in the Dzimauli community of South Africa were randomized to receive a MadiDrop a ceramic water filter a safe water storage container or no intervention. The disinfection efficacy of total coliform and E. coli bacteria for each intervention was examined quarterly over two years through membrane filtration of water samples taken from the intervention. The MadiDrop consistently achieved more than a 2 log reduction of total coliform bacteria in households exceeding the performance of conventional ceramic water filters. Safe water storage containers alone showed negligible improvement in water quality relative to control households. Mean ionic silver concentrations in water storage containers containing MadiDrops were above levels predicted from laboratory testing. The higher-than-expected silver concentrations were determined to be caused by incomplete daily use of stored water. This was confirmed through subsequent laboratory experiments that measured silver release over time in buckets containing MadiDrops in synthetic groundwater where only a portion of the water was replaced each day. Overall MadiDrops were highly effective at reducing coliform bacteria in household water. Given its low cost ease of use and high social acceptance the MadiDrop is a promising technology.

Title: Temporal Variability in Stored Drinking Water Quality: Insights for Water Quality Monitoring

Authors: Angela Harris North Carolina State University Alexandria Boehm Stanford University Amy Pickering Tufts University Mwifadhi Mrisho Ifakara Health Institute

Submission: Measuring E. coli in a single grab sample of stored drinking water is often used to characterize a households' drinking water quality. However if water quality exhibits extreme variability temporally then one-time measurement schemes which have been proposed for tracking household access to safe drinking water by the Joint Monitoring Program may be insufficient to adequately characterize the quality of water that people consume. This study uses longitudinal data collected from 200 households in peri-urban Tanzania to

assess variability in stored water quality and to recommend water quality monitoring strategies. Households were visited 5 times over the course of a year. At each visit information was collected on water management practices and a sample of stored drinking water was collected. Water samples were processed for *E. coli* using standard procedures and water quality was categorized as low medium or high contamination based on the thresholds 0-10 11-100 and greater than 100 CFU/100mL respectively. Water quality was poor for households with 80% having highly contaminated water during at least one visit. There was substantial variability of water quality for households with only 3% of households having the same category of water quality for all five visits. The majority of households (68%) were classified as having both low and high contamination at least once. Households also changed water sources between visits. Only half of the study sample used the same source type for all 5 visits. These data suggest a single sample is extremely limited in characterizing a household's drinking water quality over the course of a year. Based on the observational data collected models will be presented that quantify the limitations associated with various sample schemes. These models provide generalized insight that could be tailored to different environmental contexts with unique distributions of drinking water quality variability over time.

Title: The Causes and Consequences of Inadequate Environmental Health Conditions in Maternity Wards in Health Care Facilities in Malawi

Authors: Hemali Oza, UNC Gillings School of Global Public Health, Ryan Cronk, UNC Water Institute

Submission: Health care acquired infection (HCAI) contributes to neonatal morbidity and mortality and is disproportionately higher in low- and middle-income countries. Evidence from countries in sub-Saharan Africa reveal that many HCFs that provide maternal and neonatal health services have inadequate environmental conditions, which are a major contributor to HCAI. However, there is little evidence on the causes and consequences of inadequate environmental health conditions in maternity wards in low-resource settings. To address this, we conducted a mixed-methods study of 44 purposely-selected HCFs and examined the status of environmental health conditions in maternity wards in Malawi. Through qualitative interviews, health care workers indicated that there are generally not enough beds in maternity wards. Women were observed or reported giving birth on the floor. A private, clean space for women to wash themselves after giving birth was rarely available. The showers designated for this purpose were often used as storage areas for cleaning equipment and thus are not easily accessible by patients and staff. Pregnant women are often advised to bring candles with them to HCFs in case the power goes out when they deliver their babies. Several respondents indicated that maintaining environmental health standards at HCFs is important to set an example for surrounding communities. Community members are more likely to respond positively to health talks and deliver their babies in facilities if they see that the HCF considers environmental health a priority. Implementation of simple, low-cost, and high impact interventions, such as solar-powered portable lighting, adequate cleaning supplies, training on proper cleaning, and training on proper management of maternity settings may contribute to improvements in care. These findings provide valuable evidence for advocacy efforts to encourage actors to make investments that improve the status of environmental conditions in maternity wards.

Title: The Consumer Journey for Menstrual Hygiene Management Products: Insights from Qualitative Research with Adolescents Girls and Young Women in India and Ethiopia

Authors: Maria Carmen Punzi PSI-Europe Shannon Rosenberg Population Services International Ephraim Mebrate PSI/Ethiopia Fregenet Getachew Desta PSI/Ethiopia Mahasweta Satpati PSI/India Aprajita Singh Population Services International India Pranita Achyut PSI/India, Patrick Aylward Population Services International Kristen M. Little Population Services International

Submission: Background: While an emerging body of research has explored the health and social impacts of menstrual hygiene management (MHM) on adolescent girls and young women (AGYW) less is known about the MHM consumer journey. We sought to identify barriers to the hygienic use of menstrual products (including both commercial and improvised products) to capture user insights and identify key influencers and infor

mation resources among AGYW in Ethiopia and India. Methods: We conducted qualitative research including in-depth interviews (IDIs) focus group discussions (FGDs) and diary studies among AGYW ages 13-24 as well as their primary and secondary influencers such as mothers sisters and friends. Interviews were audio-recorded transcribed translated and coded using an inductive thematic approach with informed consent from the participants. Results: The consumer journey to MHM products for AGYW included four main steps: awareness first use continued use and disposal. Awareness of menstruation and MHM was primarily mediated by mothers and older sisters: most girls did not learn about menstruation until after reaching menarche and first product use was heavily influenced by primary information sources. Continued use was driven by several factors including cost ability of product to stay in place and fear of stains. Girls resorted to mixed-use of cloth (at home) and commercial products (outside) for affordability reasons. Structural barriers to MHM include a lack of private spaces for washing stained cloths and of toilets where products can be changed lack of soap and water and challenges with disposal. Conclusions: Observing the customer journey and listening to AGYW's preferences for menstrual products features can help better understand the barriers and facilitators to a healthy MHM market that meets their needs while also opening the floor for conversations about broader reproductive health and hygienic practices.

Title: The Cost of Unsafe WaSH in a Nation in Recovery: A Retrospective Look at Liberia's Diarrhea Burden

Authors: Magdalene Matthews Cyprus International Institute for Environmental and Public Health

Submission: Emerging from crisis countries are faced with competing demands for limited resources. Primary health care must be provided schools rebuilt employment rates increased poverty reduced—all requiring millions in funding to resolve. As a result post-conflict prioritization tends to be skewed towards more visible infrastructure related interventions as opposed to upstream environmental health deliverables. Still recovering from the effects of protracted civil war and more recently Ebola outbreak the competing demands for limited resources in Liberia are enormous. A critical analysis of the environmental health sector is crucial for sustainable development. This study was designed to estimate the national burden of diarrheal diseases attributable to unsafe water sanitation and hygiene (WASH) and explore possible cost effective interventions to minimize the social cost to the economy. Employing the World Health Organization's Comparative Risk Assessment Methodology the analysis shows that in 2011 unsafe WASH caused 6300 deaths mainly in children under 5 and cost the country US\$600 million in total social costs. Of Liberia's 15 counties Maryland bordering the Ivory Coast and Montserrado home to the nation's capital Monrovia showed the highest diarrhea disease burden nationwide. Cost effectiveness analysis suggests that by carefully implementing household water treatment and community led total sanitation (CLTS) at less than \$5million/year the country could potentially save \$370 million in social costs and as much as 228000 DALYS. The value for money for investing in WASH is significant. In conclusion if Liberia is to transition from early recovery to accelerated socio-economic development and potentially meet the Sustainable Development Goal 6 (SDG 6) target of safe drinking water and dignified sanitation for all environmental health interventions specifically targeting sustainable WASH must be placed high on the national agenda.

Title: The Effectiveness of WaSH Interventions in Changing Behavior in the Poorest Households: Results from a Cluster-Randomized Controlled Trial in Rural Bangladesh (WaSH Benefits)

Authors: Sarker Masud Parvez International Centre for Diarrheal Disease Research Bangladesh (icddr) Musarrat Jabeen Rahman International Centre for Diarrheal Disease Research Bangladesh (icddr) Rashidul Azad International Centre for Diarrheal Disease Research Bangladesh (icddr) Mahbubur Rahman icddr Sania Ashraf University of Pennsylvania Peter J. Winch Johns Hopkins Bloomberg School of Public Health Stephen Luby Stanford University

Submission: Impoverished populations are less likely to practice healthy behaviors. WASH Benefits a large-scale efficacy trial randomly allocated 720 clusters of 5551 pregnant women to a control group single interventions [water (W) sanitation (S) handwashing (H) nutrition (N)] or combined interventions [WSH & WSHN] from May 2012. Interventions comprised enabling hardware and products with behavior change communication. This analysis aimed to identify whether wealth category was associated with differential intervention uptake after 2 years by comparing all intervention households to controls for change from baseline to endline using difference in difference (DID) analysis for each wealth quintile (Q1-lowest to Q5-wealthiest). Among all intervention households an increase in mother's hand cleanliness was observed from baseline (21-24%) to endline (33-42%); a significant increase for Q1-3 [DID range: 11-16%] but not for Q4&5 households [DID range: 5-7%]. Observed water and soap at a handwashing location improved from <20% at baseline to ≥95% at endline in the intervention households; among Q1-3 households [DID range: 81-83%] the increase was significantly greater than for Q4&5 [DID range 39-58%]. Among all quintiles observed visible feces on latrine slabs was significantly less common among intervention households at endline (12-13%) than baseline (31-58%); a greater reduction among Q1-4 [DID range: 19-34%] compared to Q5 [DID: 1%]. More than half of children under 3 were reported to defecate in potties at endline (52-60%) compared to <5% during baseline a significant improvement across intervention households from all quintiles compared to controls. Intervention households from lower wealth categories exhibited greater improvement in targeted behaviors compared with wealthier households. Interventions targeted at vulnerable populations may be more cost-effective and contribute to alleviating existing social disparity in WASH-related behaviors.

Title: The Efficacy of Consumer Handwashing Agents for Removal of Diarrheal and Respiratory Pathogens: A Systematic Review and Meta-analysis of Laboratory Based Studies

Authors: Marlene Wolfe Tufts University Katie Palmer Daniele Lantagne Tufts University

Submission: Respiratory and diarrheal diseases are leading causes of morbidity worldwide and frequent handwashing is recommended to remove or inactivate pathogens to prevent transmission. Despite increasing use of handwashing products by the public it is unclear how efficacious consumer products are and there has been no effort to summarize existing evidence. The objective of this study is to evaluate the efficacy of consumer handwashing products against diarrheal and respiratory pathogens. A systematic review was performed by developing inclusion criteria searching and selecting papers assessing quality and extracting and summarizing results on handwashing efficacy. A Mantel-Haenszel random effects meta-analysis was used to generate a summary log reduction value (LRV) describing the reduction in contamination on hands after handwashing. Overall 31 papers were identified describing efficacy for hand rubs soaps and water against two bacteria and eight viruses. For bacteria hand rubs resulted in a 3.4 LRV (95% CI 3.2-3.7) soap a 2.2 LRV (95% CI 2.0-2.4) and water only a 1.8 LRV (95% CI 1.5-2.2). For viruses hand rubs resulted in a 1.0 LRV (95% CI 0.8-1.1) soap a 1.3 LRV (95% CI 0.8-1.7) and water only a 1.0 LRV (95% CI 0.7-1.4). Results for bacteria were consistent across studies; viruses showed higher heterogeneity. When lower quality studies were removed results did not change substantially. Overall hand rubs and soaps meet United States regulatory requirements by demonstrating a 2-log reduction in bacteria but no handwashing agent met this standard for viruses. However information was more limited for viral than bacterial pathogens. Many emerging infectious diseases (EID) are viral respiratory pathogens and as EIDs increase future research should focus on generating more data on product efficacy against viruses. With more information suitable recommendations for handwashing or alternative interventions can be made for existing and emerging viral diseases.

Title: The Impact of WaSH Access and Household Clustering on Enteric Pathogen Infection in Rural Laotian Communities

Authors: Anna Chard Emory University Howard H. Chang Emory University Karen Levy Emory University Kelly K.

Submission: Recent large-scale studies that focused on household- rather than community-level WASH improvements found limited impact on health. WASH conditions may influence both intra- and inter-household transmission of pathogens but there is limited evidence on the relative importance of these different transmission pathways across pathogens. We surveyed 25 randomly selected households in 50 randomly selected villages in Saravane Province Laos. Stool samples were collected from a school-aged child their sibling <5 years old and their parent and analyzed for 25 enteropathogens using the TaqMan Array Card. All 3 samples were returned from 297 households for a total of 891 samples. We examine the association between household WASH access (improved toilet improved water and soap) on specific pathogen infections and conducted a variance decomposition analysis to quantify the extent to which an individual's log odds of enteric infections were explained by WASH access versus household clustering. TAC analysis will be complete in June 2018; to date 345 (39%) samples have been analyzed. Initial results indicate that giardia (73%) hookworm (70%) EPEC (53%) and rotavirus (42%) were the most prevalent pathogens. None of the household WASH covariates were significantly associated with log odds of giardia hookworm or EPEC infections. Presence of soap was associated with a reduction in log odds of rotavirus (OR: 0.17 95% CI: 0.04 0.61). The relative influence of WASH covariates and household clustering on log odds of enteric infection differed by pathogen. The total variance in log odds of infection explained by WASH covariates were 11% 6% 8% and 18% for giardia hookworm EPEC and rotavirus respectively. Of the remaining variability household clustering explained >99% 47% >99% and 41% of log odds. A more nuanced understanding of pathogen transmission within and between households and variations by pathogen could help better target WASH improvements.

Title: The Link Between Mental Health and Safe Drinking Water Behavior in a Vulnerable Population in Rural Malawi

Authors: Jurgita Sliekene Swiss Federal Institute of Aquatic Science and Technology (Eawag) Hans-Joachim Mosler EAWAG

Submission: Background. Mental disorders particularly depression and post-traumatic stress disorder are common long-term psychological outcomes in emergency contexts arising from conflicts natural disasters and other challenging environmental conditions. In emergencies people suffer not only from the lack of external resources such as drinking water and food but also from poor mental health. Mental disorders can substantially impair daily activities in vulnerable individuals. Water sanitation and hygiene (WASH) behaviors are daily activities that require effort time and strong internal motivation. Therefore questions arise: whether there is a relationship between mental health and safe water collection and if so whether the motivational drivers of this behavior are affected by mental health. Methods. Our cross-sectional study conducted face-to-face interviews with 641 households in rural Malawi. We used a quantitative questionnaire based on the risks attitudes norms abilities and self-regulation (RANAS) approach to measure motivational psychosocial factors. Mental health was assessed using the validated Chichewa version of the self-reporting questionnaire (SRQ-20). Results. Almost a third of the respondents reported poor mental health. We found significant negative association between mental health and self-reported safe water collection ($p = .01$ $r = -.104$). The moderation analysis revealed that poor mental health changed the influence of three psychosocial factors—perceived others' behavior commitment and remembering—on safe drinking water collection behavior. Conclusions. These results imply that populations with a significant proportion of individuals with poor mental health will benefit from interventions to mitigate mental health before or parallel to behavioral change interventions for WASH. This research is especially relevant in emergency contexts as it indicates that mental health measures before any WASH interventions will make them more effective.

Title: The Relationship Between Household Sanitation and Women's Experience of Menstrual Hygiene:

Findings from a Cross-sectional Survey in Kaduna State Nigeria

Authors: Alexandra Shannon PMA2020 Johns Hopkins University Bloomberg School of Public Health Julie Hennegan Johns Hopkins University Bloomberg School of Public Health Linnea Zimmerman Natalie G. Exum Department of Environmental Health and Engineering Johns Hopkins Bloomberg School of Public Health Elizabeth Omoluabi Kellog Schwab Department of Environmental Health and Engineering Johns Hopkins Bloomberg School of Public Health

Submission: Sustainable Development Goal 6.2 highlights the need to “pay special attention to the needs of women and girls”; however there are limited data available that recognize sanitation infrastructure as an essential part of menstrual hygiene management (MHM). This study uses secondary data from 1994 women and girls collected by Performance Monitoring and Accountability 2020 in a state-wide survey in Kaduna Nigeria to analyze the relationship between household sanitation and women’s experience of MHM. In adjusted analyses women had higher odds of using the main household sanitation facility for MHM when they had access to a basic (OR=1.76 95%CI 1.26-2.46) or limited (OR=1.63 95%CI 1.08-2.48) facility compared to an unimproved facility. While this suggests that improving sanitation according to current ladders may support MHM in these facilities safely managed and basic sanitation facilities were not rated more favorably by women than unimproved facilities in terms of privacy (OR=1.02 95%CI 0.70-1.48) safety (OR=1.45 95%CI 0.98-2.15) access to a lock (OR=0.93 95%CI 0.62-1.37) or soap and water (OR=1.04 95%CI 0.70-1.56). Women with no household sanitation facility had higher odds of using their sleeping area (OR=3.56 95%CI 2.50-5.06) or having no facility for MHM (OR=9.86 95%CI 5.76-16.87) compared to an unimproved facility. Women using their sleeping area for MHM had higher odds than those using an unimproved facility of reporting their location was clean safe and private. Notably the sleeping area was lockable for a much higher proportion of women in rural areas than the main household sanitation facility. These findings have important implications for understanding MHM practices and education and policy initiatives that may focus solely on the sanitation facility. While it is evident that household sanitation influences women’s choices for MHM these findings suggest that current indicators are not sensitive to the menstrual needs of women and girls.

Title: The Relationship Between On-site Sanitation Density and Shallow Groundwater Quality: Evidence from Remote Sensing and in Situ Observations in Dakar Senegal

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Submission: Efforts to realise UN Sustainable Development Goal 6 of achieving universal and equitable access to safe and affordable drinking water sanitation and hygiene for all by 2030 in many rapidly urbanising areas of Sub-Saharan Africa rely upon low-cost on-site solutions that conjunctively use the shallow subsurface as both a source of safe water and a receptacle to contain faecal effluent. There remains an absence of scientific evidence and policies to sustain the quality and quantity of groundwater used for urban water supplies with the continued use of the subsurface for low-cost sanitation. Here we examine the relationship between the density of on-site sanitation primarily septic tanks and groundwater quality (nitrate phosphate Escherichia coli) in the shallow aquifer of alluvial sands underlying Dakar Senegal. Groundwater samples were collected from a network of 49 waterpoints whereas on-site sanitation density was mapped with advanced GIS using object-oriented classification and visual interpretation of recent satellite images (Quickbird Geospatial Data) and ground-truthing surveys. The density of on-site sanitation facilities ranges from 1 to 70 per ha and is linearly related ($r^2 > 0.82$) to interpolated nitrate and phosphate concentrations; further point-source concentrations are linearly related to the density of on-site sanitation facilities ($r^2 > 0.80$). Linear relationships ($r^2 \sim 0.70$) are also observed between on-site sanitation density and E. coli counts. Using the WHO guideline value for safe

water based on nitrate concentrations we estimate the safe density of on-site sanitation facilities in the shallow aquifer to be 24 per ha. Replication of these analyses in other conurbations in Sub-Saharan Africa is required to better understand the attenuation capacity of urban aquifer systems in different contexts and to inform the use of low-cost sanitation systems restricting faecal effluent.

Title: Toilet Alarms: A Novel Application of Latrine Sensors and Machine Learning for Optimizing Sanitation Services in Informal Settlements

Authors: Nick Turman-Bryant Portland State University Evan Thomas University of Colorado at Boulder Taylor Sharpe Sweet Sense Inc. Lauren Stover Sweet Sense Inc.

Submission: Waste collection services in informal settlements can be expensive and difficult to optimize given the geospatial and temporal variability of latrine use. Daily servicing to avoid overflow events is inefficient but dynamic scheduling of latrine servicing could reduce costs by providing just-in-time servicing for latrines. This study used cellular-connected motion sensors and machine learning to dynamically predict when daily latrine servicing could be skipped with a low risk of overflow. Sensors monitored daily latrine activity and enumerators collected solid and liquid waste weight data and latrine visit times. Given the complex relationship between latrine use and the need for servicing an ensemble machine learning algorithm (Super Learner) was used to estimate waste weights and predict overflow events to facilitate dynamic scheduling. Accuracy of waste weight predictions based on sensor and historical weight data was adequate (mean error of 20% and 22% for solid and liquid wastes) but there was greater accuracy in predicting overflow events (area under the receiver operating characteristic curve of 0.90). Although our simulations indicate that dynamic scheduling could substantially reduce costs for lower use latrines we found that cost reduction was more modest for higher use latrines and that there was a significant gap between the simulated and implemented results.

Title: Toilet Decision Narratives: Understanding What Residents of Urban Informal Settlements Want from Sanitation

Authors: Sarita Panchang University of South Florida

Submission: While the Millennium Development Goal for halving the world proportion of people without access to safe water was met five years ahead of schedule progress fell short for sanitation. Spreading access to as well as usage and uptake of improved sanitation remains a large challenge especially in India where some of the largest populations of people who openly defecate reside. As sanitation efforts tend to be focused in rural areas the needs of poor residents of cities particularly those who reside in urban slums and settlements are often overlooked. In this study I conduct in-depth qualitative interviews and focus groups with women householders in informal slums and settlements in the city of Pimpri-Chinchwad in Maharashtra India. I explored household decision making surrounding sanitation access and choices to participate in programs that were offering household toilets. As this research occurred alongside the rollouts of two different sanitation provision programs one by the government and one by an NGO this provided an ideal opportunity to learn about what I call the “toilet decision narratives” of these women. Given debates over whether “supply” and “demand” driven programming is more useful I find that among these participants the ideal solution may be somewhere in the middle. These toilet decision narratives pave a way to better understand how to tailor sanitation programming to residents of urban informal settlements and slums thereby reaching an underserved population more effectively.

Title: Towards Complementary Food Hygiene Practices Among Child Caregivers: A Formative Research in Rural Malawi

Authors: Kondwani Chidziwisano University of Malawi The Polytechnic Tracy Morse University of Strathclyde Hans Mosler Swiss Federal Institute of Aquatic Science and Technology (Eawag) Jurgita Sliekene Swiss Federal Institute of Aquatic Science and Technology (Eawag)

Submission: Despite being preventable food-borne diseases remain a global health challenge. A formative study was conducted to inform intervention design to promote complementary food hygiene practices to reduce diarrhoea disease in children under five in Chikwawa District Malawi. Assessment of caregivers' psychosocial factors towards washing utensils with soap keeping utensils on elevated surface and hand washing with soap at critical times was conducted using RANAS model. We conducted 79 observations 10 FGDs and 323 interviews. ANOVA was conducted to estimate differences in means between performers and non-performers of targeted behaviours. Qualitative data were analysed using thematic content analysis. Caregivers had adequate knowledge on the importance of using soap for washing utensils and hands but had not developed the habit. 62% of caregivers never used soap to wash hands before child feeding and 29% were observed using soap to wash utensils whilst the rest used sand/soil maize flour or water only. Sand/soil and flour use was motivated by its ability to remove stains rather than microbes. Caregivers did not recognise the association between domestic animals and diarrhoea. In 73% of the households animals were observed accessing utensils including water for washing them. Perception of social norms was found to be favourable for targeted behaviours. Also Self – reported ability estimates (self – efficacy) were significant. Targeted behaviours were influenced by others' behaviour; therefore interventions should include strategies that use role models in the community performing the recommended behaviour. Combination of local alternatives together with use of soap should be promoted for washing of utensils. Increasing perceptions about risk of microbes in utensils or hands could be done with use of simple technologies such as glowing-germ and paint game. Caregivers' technical know-how on local dish rack construction is essential.

Title: Typologies of Sanitation-Sector Ngos: Organizational Identity Frames of Discourse and Approaches Towards Sanitation

Authors: Jennifer Barr Emory University

Submission: There are innumerable NGOs engaged in the sanitation sector with different constraints motivations and value systems. These factors affect how these actors do or do not seek alliances; what funding they pursue; what kinds of programming they pursue; and their efficacy in different arenas. This project draws on thirteen months of ethnographic fieldwork observation media analysis and over 100 interviews with different stakeholders and actors in the sanitation sector in India and is applicable to the global sector. This paper outlines different parameters and ways to understand the diversity of actors outlining different typologies of these actors that capture their frames of discourse (such as environmental health gender or religious) how they configure their reputations (through presenting themselves as “authentic” authoritative or scientifically valid) and their approaches to sanitation (sanitation as ends sanitation as means sanitation as battlefield). I then explore the ramifications for these different typologies and how this affects organizational strategies.

Title: Untangling the Complexities of Water Source Use Seasonality Quality and Management: Evidence from a 14-Country Evaluation and SDG Implications

Authors: Wren Tracy The Water Institute at UNC

Submission: Universal access to safely managed drinking water is important for human health and development and is recognized in international policy through Sustainable Development Goal 6. Achieving this ambitious goal in rural areas of low- and middle-income countries where access to safely managed services is low will require a better understanding of patterns of household water source use seasonality collection and

storage behaviors quality and source management arrangements. To explore this we used 37105 household surveys and 6395 stored water samples from a 14-country evaluation of World Vision programs. Bayesian networks and multivariable mixed effects logistic regression models were used to characterize relationships. Use of a different main source in the wet and dry season was most common in Kenya (29% of households) and least common in Zambia (3% of households). Across all 14 countries 25% of households reported use of a secondary water source and 39% of those secondary water sources were unimproved. Households that reported the existence of a community water committee and pay for water through multiple types of resource mobilization (fees goods labor) were more likely to have water available from a basic water service. Households that reported discontinuous service and breakdowns for their main water source were more likely to use a secondary water source. 31% of household stored water samples were low risk (<1 E. coli CFU/100 mL). Households that pay for water and treat water were more likely to have safe stored water at home; households raising fowl near the home were less likely to have safe stored water. These results reveal important water management factors and water use patterns that are masked by national and international statistics on household water access. Our results inform management strategies to increase access to safely managed water services such as improving water source functionality and encouraging alternative resource mobilization.

Title: Using Network Analysis to Understand Alignment Toward Collective Action

Authors: Kimberly Pugel University of Colorado Boulder Amy Javernick-Will University of Colorado Boulder Karl Linden University of Colorado Boulder Jeffrey Walters University of Diego Portales

Submission: As a result of an increasing awareness of WASH system complexity the WASH sector has seen an emergence of partnerships coalitions networks collective action groups and collective impact groups that seek to jointly solve these complex problems (Bisung et al. 2014; Boschet and Rambonilaza 2018; Dickin et al. 2017; Harrington 2017; Lienert et al. 2013). Collective action initiatives aim to bring a group of important stakeholders together to establish a common agenda problem definition solution and joint action as a group (Kania et al. 2011; Ostrom 2000). With a diverse range of relevant actors the group can negotiate the complex problem through differing experiences and expertise. However convening diverse perspectives and priorities poses a challenge of reaching consensus and alignment on a single vision and action (Gray 1989 2000). Thus as the international WASH sector moves away from infrastructure-only approaches and towards systems- and network- strengthening there is an increasing need for context-specific tools to visualize and assess alignment within collaborative partnerships. Previous work by the Sustainable WASH Systems Learning Partnership analyzed (a) network analysis techniques which assessed connections and actor's structural position in a network and (b) qualitative analysis of interviews which assessed factors and actions participants prioritized. By combining these methods and overlaying prioritized factors/actions with actors in the network (“(f)actors”) we can better understand where WASH stakeholders align or disagree and why. This presentation applies the (f)actor methodology to four districts in the Sustainable WASH Systems Learning Partnership. The findings are translated into an intervention process that will be monitored for changes as the SWS project progresses.

Title: Validation and Testing of the Rural Water Metrics Global Framework

Authors: Miguel Vargas-Ramirez The World Bank Libbet Loughnan The World Bank

Submission: The issue of rural water sustainability is one of the most pervasive development challenges. However many of the Monitoring and Evaluation systems have focused on coverage expansion with limited emphasis on sustainability aspects. Furthermore the lack of standardized indicators and the myriad of M&E systems pose real obstacles to comparison and analysis of rural water system performance (and its associated management models and delivery mechanisms). The World Bank has recently worked on proposing a Rural

Water Metrics Global Framework based on the analysis of diverse Country led-monitoring systems as well as study of selected projects and successful global monitoring systems that exist in related domains. The framework captures issues of functionality performance and sustainability of rural water systems directly relevant to orienting efforts for success under SDG6. During the session the recent results from the validation and field testing of the Rural Water Global Framework will be presented with an aim to contributing to the harmonization efforts of many global water institutions.

Title: WaSH Conditions in Afghan Healthcare Facilities

Authors: Lindsay Denny Center for Global Safe WASH at Emory University Rosanna Keam World Vision Afghanistan

Submission: WASH in healthcare facilities (HCF) is crucial to ensure quality health services and to prevent healthcare-associated infections. Mothers and newborn babies are especially vulnerable populations; Afghanistan has one of the highest newborn mortality rates in the world (45 per 1000 live births) and a maternal mortality rate of 1291 per 100000 live births (Afghanistan DHS 2015). Yet limited data is available on the conditions of WASH in Afghan HCF and no data have been systematically collected using the new JMP indicators to monitor the progress towards the SDGs. In 2018 World Vision Afghanistan (WVA) in partnership with the Center for Global Safe WASH at Emory University (CGSW) assessed the WASH conditions of 105 HCF in Afghanistan. The purpose of the assessment was to gather evidence to address identified needs and support the Ministry of Public Health (MoPH) in their national SDG data gathering efforts. CGSW's assessment tool WASHCon collects and scores data on WASH conditions and practices from interviews observations and water quality testing. Questions from the tool are based on the JMP indicators and scores are aligned with the JMP ladder for WASH in HCF. Preliminary findings show that: 25% of HCF do not have an improved water source on premises; 1% of HCF do not meet JMP standards for toilets; 27% of points of care and 66% of toilets do not have functional hand hygiene facilities; 58% of HCF report not having sufficient budget for WASH resources. The data from three provinces revealed major gaps. These coupled with the concerns about the management of HCF staff and budgets must be addressed before any behavioral interventions are undertaken. Based on the findings WVA will work with the MoPH to prioritize interventions and seek national government and international donor support to address the most critical needs. WVA will also help the MoPH in their efforts to integrate WASH indicators into their health monitoring system.

Title: Water Sanitation and Hygiene (WaSH) Mobile Health (Mhealth) Messages as an Innovative Tool to Facilitate Behavior Change in Bangladesh and Promote Gender Equity and Social Inclusion: Randomized Controlled Trial (RCT) of the CHoBI7 Mhealth Intervention

Authors: Christine Marie George The Johns Hopkins Bloomberg School of Public Health Fatema Zohura Shirajum Monira International Centre for Diarrhoeal Disease Research Bangladesh Elizabeth Thomas Johns Hopkins Bloomberg School of Public Health and Food for the Hungry Partnership funded by USAID Tahmina Parvin International Centre for Diarrhoeal Disease Research Bangladesh Maynul Hasan Khaled Hasan Md. Sazzadul Islam Bhuyian International Centre for Diarrhoeal Disease Research Bangladesh Camille Morgan The Johns Hopkins Bloomberg School of Public Health Peter Winch The Johns Hopkins Bloomberg School of Public Health

Submission: Household members of diarrhea patients are at a much higher risk of developing infections (>100 times for cholera) than the general population during the 7 days after the patient presents at a health facility. Furthermore the time diarrhea patients and their household members spend at a health facility presents the opportunity to deliver WASH interventions when perceived severity of diarrheal diseases and benefits of WASH are likely highest. We recently developed the Cholera-Hospital-Based-Intervention-for -7-Days(CHoBI7“picture” in Bangla) a health facility based WASH intervention delivered to diarrhea patients and their household

members which promotes handwashing with soap and water treatment for the next 7 days (high risk period). Our previous RCT found CHoBI7 resulted in a significant reduction in cholera. Building on this work we have partnered with the Ministry of Health and Family Welfare to develop and evaluate a scalable approach to deliver CHoBI7 across Bangladesh. Through a 9 month formative research phase which focused on gender equity and social inclusion and included in-depth interviews focus groups workshops and a pilot we have developed the CHoBI7 mHealth module which sends phone based reminders to diarrhea patient households to reinforce WASH messages delivered in health facilities. Our current RCT of 2656 participants is the first to evaluate this type of intervention. Participants receiving the CHoBI7 mHealth module had sustained increases in handwashing with soap during 5-hour observations at our 3 month follow-up (OR: 2.83 95% CI:1.89-4.23) and a significant reduction in stored drinking water samples in the WHO very high-risk category (OR: 0.47 95% CI:0.29-0.75) compared to the control arm. Furthermore we observed that over 80% of female participants reported receiving CHoBI7 phone messages in the past two weeks. These promising findings show that the CHoBI7 mHealth module can increase handwashing with soap and improve water quality.

Title: Water Sanitation and Hygiene Indicators in Displaced Person Settlements

Authors: Brandie Banner The Water Institute at UNC-CH

Submission: There are an estimated 65.3 million forcibly displaced persons worldwide. Rapid population growth increasing political instability and the imminent threat of climate change are likely to increase the magnitude of this crisis globally. Although displaced person settlements are usually designed to be temporary solutions the average lifespan of a refugee camp is 17 years. As more displacement situations move into the protracted phase there is an urgent need for humanitarian actors to stop providing merely emergency aid but also infrastructure for sustainable development. This is especially true of water sanitation and hygiene (WaSH) services which are one of the first needs addressed in emergencies. We used quantitative and qualitative methods to understand the current state of four key United Nations High Commissioner for Refugees (UNHCR) WaSH indicators as well as how they could be adapted in order to monitor progress towards Sustainable Development Goal (SDG) 6. We collected key WaSH indicator data from 203 displaced person settlements in 30 countries which revealed that only 12.3% of settlements met the Sphere Standard for all four key indicators. Additionally semi-structured interviews with stakeholders at UNHCR the International Organization for Migration and the Joint Monitoring Programme provided insight about the challenges and opportunities for reporting on SDG 6 for the displaced. This research represents the largest data known set on WaSH indicators in displaced person settlements globally representing 5.5 million displaced persons.

Title: Welfare Costs and Climate in Citywide Inclusive Urban Sanitation: Trade-offs and Ways Forward

Authors: Sally Cawood University of Leeds UK

Submission: This paper as part of the Bill and Melinda Gates-funded Climate and Costs in Urban Sanitation (CACTUS) project at the University of Leeds UK examines the welfare effects of different on- and off-site urban sanitation systems. Following a brief overview of conventional approaches to 'welfare' in the sector the paper focuses in particular on the positive and negative effects of different systems for paid/unpaid work and job creation – aspects of welfare that have received relatively limited attention. It is argued that certain trade-offs between welfare costs and climate may (and do) occur with implications for achieving citywide inclusive sanitation. For example between lower operation and maintenance costs and higher levels of unpaid work; job creation and lower efficiency; or higher Green-House Gas emissions (from mechanical emptying) and lower emissions (from manual emptying) but negative implications for health and safety. A multi-criteria decision-making tool the Analytic Hierarchy Process (AHP) is proposed as a potential way in which to compare different systems and ensure the benefits of urban sanitation are equally shared and the costs are not unequally borne.

Title: What are the Psycho-Social Mechanisms of CLTS for Latrine Ownership and How Can CLTS be Improved? Results of a Cluster-randomized Controlled Trial in Ghana.

Authors: Miriam Harter Eawag Jennifer Inauen Eawag Hans-Joachim Mosler Eawag

Submission: Rationale: Open Defecation is connected to poor health and child mortality but billions of people worldwide don't have access to safe sanitation facilities. Community-Led Total Sanitation (CLTS) approaches this fact by implementing participatory activities. The aim of the present study was to test combinations of CLTS with interventions based on the RANAS model of behaviour change and further explain intervention effects through changes on psycho-social determinants. Methods: A cluster-randomized controlled trial with standardized interviews in 3216 households in 134 communities was implemented in rural Ghana. Communities were randomly assigned to four intervention groups: CLTS alone CLTS + public commitment CLTS + household action plan CLTS + public commitment + household action plan and one control group. Multilevel regression analysis and single mediation models were run to test for intervention effects and change mechanisms of CLTS. Results: Latrine coverage significantly increased for all interventions (average of 67.6%) compared to the control group (7.9%). The combinations of CLTS with RANAS-based interventions were not significantly more effective in evoking latrine construction than CLTS alone. The intervention effects of CLTS on latrine ownership were significantly mediated by positive changes on descriptive and injunctive norm self-efficacy action planning and commitment. Conclusion: CLTS has proven to be effective in increasing latrine coverage but the implemented additional activities have to be improved further. Future activities should focus on the visibility of latrine construction and completion the involvement of community leaders and on supporting communities in developing detailed action plans for the construction of household latrines. Further research is needed in testing intervention effects of RANAS-based interventions compared to CLTS alone on long-term perspectives.

Title: Why Do Sanitation Systems Still Not Address User Priorities?

Authors: Allison Davis University of Colorado Boulder Amy Javernick-Will University of Colorado Boulder Sherri Cook University of Colorado Boulder

Submission: Community acceptance can be a vital determinant of success in sanitation and acceptance is less likely to occur if user priorities are unaddressed. There is consensus that systems that do not align with user priorities contribute to globally high failure rates but it is unclear how many sanitation systems fail to meet user priorities. Further the reasons that systems do not address priorities are not known. To address these gaps this work used interviews photovoice and focus groups in 20 resource-limited communities in India to determine 1) user priorities for sanitation 2) how well sanitation systems currently address priorities 3) factors that contribute to well- and poorly-addressed priorities and 4) how sanitation projects can be improved to better address priorities. Priorities were compared with current sanitation systems to evaluate how well technologies addressed priorities. The potential for different technologies to address priorities was evaluated with service provision improvements and added technology capabilities (e.g. water reuse biogas). The causes for well- and poorly-addressed priorities were analyzed using qualitative comparative analysis. Findings indicate that current technologies did not align well with user priorities because of the persistence of supply-driven approaches where technologies were selected without being adapted to the local context. In addition poor-quality (or nonexistent) priority assessments lack of user participation in planning and lack of implementer sanitation experience also led to unaddressed priorities. Conversely user participation in planning implementer sanitation experience and familiarity with a community's norms and culture and completion of a priority assessment sufficiently achieved well-addressed priorities. User priorities should be elucidated prior to technology selection so that systems can be designed and changed to address the most priorities and maximize the benefits to a community.

Title: Women and Girls' Experiences of Menstruation in Low and Middle Income Countries: A Systematic Review and Qualitative Metasynthesis

Authors: Julie Hennegan Johns Hopkins University Bloomberg School of Public Health Alexandra Shannon PMA2020 Johns Hopkins University Bloomberg School of Public Health G.J. Melendez-Torres Cardiff University

Submission: A growing body of qualitative research has described women and girls' experiences of menstruation in low and middle income contexts. These studies have highlighted the challenge that unmet menstrual needs present to dignity and health. However there has been no critical analysis of study quality or gaps in this evidence base. This systematic review addresses this need and aims to synthesize qualitative literature to date. Through thematic meta-synthesis we will draw new insights compare findings across contexts and inform evolving quantitative and intervention research. Systematic searching was undertaken in eleven academic databases supplemented by grey literature and hand searching. A total of 6883 titles and abstracts were double screened. Following full-text screening 71 eligible studies reported in 81 citations were included. These studies represent 31 different low and middle-income countries. Research questions and populations were iteratively coded; 50 focused on the menstrual experiences of women and girls 11 on experiences of menstrual health interventions or products 7 on experiences of disorders or pain and 3 on menarche narratives. This presentation will focus on the quality of studies of women and girls' menstrual experiences and findings of a thematic synthesis of this work including studies in populations of school aged girls (n=31) adult women (n=11) university students (n=3) and humanitarian settings (n=5). We will highlight emergent themes gaps and implications for our understanding of women and girls' menstrual needs. The protocol for this review is registered on PROSPERO: CRD42018089581.