



AFRIWATSAN: “Sustaining Low-Cost Water Supply and Sanitation Systems in Africa”

Seminar report by AfriWatSan Kenya
Team, University of Nairobi

Seminar held at Department of Geology, University of Nairobi,
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1. Introduction

A half-day seminar on the findings to date of the Kenya team in the AfriWatSan project “*Sustaining low-cost water supply and sanitation systems in Africa*” was held at the Department of Geology, University of Nairobi on Friday 11th May 2018 from 10.am to 2pm.

AfriWatSan is a consortium of the University of Nairobi (UoN), University College London (UCL), Cheikh Anta Diop University (UCAD) and Makerere University. It is a 5-year (2015-2020) capacity-strengthening and cross-disciplinary research collaboration tackling the fundamental challenge of sustaining low-cost water supply and sanitation systems that conjunctively use the subsurface as both a source of safe water and a repository of faecal wastes. It seeks to develop the scientific evidence required to inform policies and practices that sustain the quantity and quality of urban, low-cost water supply and sanitation systems exploiting the sub-surface in Sub-Saharan Africa. The project is funded by the Royal Society Capacity Building Initiative and the UK Department for International Development (DFID). In Kenya, the researchers are drawn from the University of Nairobi’s Department of Geology, the Department of Construction and Civil Engineering, the School of Public Health, and the Institute for Climate Change and Adaptation.

The aim of the seminar was to: disseminate the findings of the AfriWatSan postgraduate students (PhD and MSc.) to date; assess two MSc. proposals from the School of Public Health (UON) and (UCL), in readiness to carry out fieldwork. The seminar was moderated by Prof. Daniel Olago, the Principal Investigator of the AfriWatSan Kenya component, assisted by the co-Principal Investigators Dr. Richard Ayah and Dr. Simeon Dullo. The audience comprised of academic staff, technical staff and undergraduate/postgraduate students mostly from the Department of Geology, University of Nairobi.

Students made presentations on various topics they are currently studying.

2. The Presentations by Students

- a. **Heavy rainfall and faecal groundwater contamination: Laura van der Marel** - MSc student at the Department of Geography, University College London.



Laura van der Marel - MSc student at the Department of Geography, University College London, presenting her proposal.

Laura presented her study proposal on “Heavy rainfall and faecal groundwater contamination – comparative analysis of culture-based and real-time methods in Kisumu, Kenya”.

The main objective of her research is “*To study the present-day relationship between heavy rainfall and contamination with enteric pathogens*”. She will be evaluating the performance of a newly developed method of measuring contaminants known as TLF (Tryptophan-Like Fluorescence). This will be compared to the traditional method TTC (Thermo-tolerant Coliforms), which is time consuming and takes time to give a result, since it requires culturing for 18 hours and use of reagents as well as qualified personnel to conduct the tests.

Laura will collect part of her data in informal settlements of Kisumu County, Kenya as well as in the UK.

- b. **Contamination of surface water and groundwater sources with thermotolerant coliforms: Japheth Kanoti** - PhD student, Department of Geology, University of Nairobi

The objective of the study was “*To determine contamination of surface water and groundwater sources with thermotolerant coliforms*”.

Kisumu City, located on the eastern shores of Lake Victoria is supplied with water from Dunga water works that pump and treat water from Lake Victoria and, from Kajulu water works located along river Kajulu. Water from these two sources is supplemented with groundwater self-supply systems such as wells, boreholes and springs. These alternative sources are threatened by land use

changes, settlements and agriculture and contamination from on-site sanitation facilities. This study investigated the spatial distribution of thermotolerant coliform bacteria in surface water and groundwater in Kisumu, and related this with the human activities, land uses and sanitation practices. Water samples were collected and analyzed for thermotolerant coliforms using a portable kit supplied by IAEA. The samples were incubated at 44°C for 18 hours and the resulting colonies counted. The study has revealed that surface water, shallow wells and springs in Kisumu are highly contaminated with thermotolerant coliforms, while deep boreholes are free from contamination. The study further revealed that the levels of contamination increased during the dry season when the groundwater yields are low. The study concluded that further investigation should be carried out to determine how the sub-surface can be used sustainably as a source of water and as a repository of human waste. There is need to educate the local community on sustainable sanitation practices. The study recommends a combination of rigorous source protection strategies and extraordinary source monitoring to detect contamination.



Japheth Kanoti - PhD student, Department of Geology, University of Nairobi

c. Modelling the impacts of climate variability on water and sanitation infrastructure in Kisumu by: **Calvince Ouko Othoo** - PhD student, Institute for Climate Change and Adaptation, University of Nairobi

A summary report of a presentation made on May 17th 2018 at the Department of Geology, College of Pure and Biological Sciences, University of Nairobi. The presentation covered background study and preliminary findings of the first objective “Characterizing the facilities by function and technology type and determine their bearing on ground water quality in the proximity”. The main objective of the wider study is to model the impacts of climate variability on water and sanitation infrastructure with an aim of integrating the outcome in the management of water and sanitation infrastructure in Kisumu City to withstand impending climate risks. The specific Objectives include: a) characterizing sanitation facilities by function, type, and technology in the informal settlement areas of Kisumu City, b) analyzing the proximity distance between water sources and sanitation facilities in 0-15m, 15-30m radii and finally, c) make recommendations for sustainable future water and sanitation planning for urban informal settlements.



Calvince Ouko Othoo - PhD student, Institute for Climate Change and Adaptation, University of Nairobi

To achieve the first objective, participatory interviews and surveys research design were employed and questionnaires and sanitary assessment checklist were used to collect data. Data was analyzed in ArcGIS 10.3.1 and MS Excel to generate descriptive findings and associations. Preliminary findings indicate the dominance of shallow wells and traditional pit latrines as primary water sources and sanitation, respectively; of the 95 water sources surveyed, 89.4% were shallow wells. The minimum and maximum depth of shallow wells showed Obunga = 0.6-1.8m, Nyalenda A= 1.2-9.1m, Nyalenda B= 0.6-9.1m, Manyatta B=3.0-16.8m, respectively (n=84), against a control site min-max depth of 4.5m- 45.7m, respectively in the peri-urban Kisumu. 31.5% and 68.4% of sanitation facilities surveyed (n= 511) existed within 15m and 30m proximity radius to the nearest water sources, respectively - raising questions of potential contamination to nearby shallow wells. Nyalenda A presents a greater concern since about 62.1% of the facilities are in 15m proximity to water sources. Given projected climate change concerns for Kisumu, the situation might be worse. This calls for participatory sensitization approach to stir attitude and planning change to realign the sanitation locations within the recommended safe distances.

At the end of the presentation, questions were asked and the following were some of the questions asked: a) what procedures were used to characterize sanitation facilities into types and technologies, b) what standard reference protocol used in categorizing sanitation facilities. Answer provided is the WHO guidelines on sanitation location and improved sanitation alternatives.

d. Investigation of contamination of community groundwater sources with antibiotics in Informal settlements in Kisumu by: Kellen Joyce Karimi - PhD student, School of Public Health, University of Nairobi

The study proposal is on “Contamination of community groundwater sources with antibiotics, in informal settlements in Kisumu City, Kenya”.

Antibiotics have been classified as emerging contaminants, and little is known about their levels in groundwater sources in Kenya. The antibiotics were detected in a shallow well in one informal settlements of Kisumu City and include sulfamethoxazole, trimethoprim and metronidazole, prompting this particular research. The particular antibiotics are used for the prevention of opportunistic infections among people with compromised immunity e.g. HIV patients, a disease prevalent in the region where the study will be implemented.



Kellen Joyce Karimi - PhD student, School of Public Health, University of Nairobi

The objective of the research is “*To Investigate contamination of community groundwater sources with antibiotics in selected informal settlements of Kisumu, County.* The study will determine the level of contamination of groundwater contamination with the antibiotics, comparing the different water sources and determine antibiotic resistance in water samples drawn from groundwater sources in the study site. Antibiotic use will also be determined. This will be preceded by a mapping of water sources in the study site to determine the total number of water points then a representative sample of the water points for purposes of analysis.

Comment

The study is of public health importance with discussions around emerging contaminants especially pharmaceutical products starting to gain audience in Africa and the world over.

Q & A

Q: What measures is the researcher taking to ensure the detection of the compounds of interest is not influenced by transformation compounds?

A: The compounds of interest are stable, and do not dissolve in water, therefore their availability is not affected.

e. Potential Health Risks through drinking water from Heavy metal contaminated groundwater sources in informal settlements of Kisumu by: Grace Muthoni Kaluai
- MPH student, School of Public Health, University of Nairobi

The study was on: “Potential Health Risks Through Drinking Water from Heavy Metal Contaminated Groundwater Sources in Informal Settlements of Kisumu East County”. She presented preliminary results that answer one of the specific objectives “*To determine the population at risk of exposure to select heavy metal in contaminated groundwater*”.



Grace Muthoni Kaluai - MPH student, School of Public Health, University of Nairobi

Heavy metal contamination of groundwater sources is a global issue with millions at risk of developing chronic diseases. Residents in informal settlements with poor access to clean water and sanitation rely on groundwater. However, unplanned housing, excessive application of agrochemicals, improper sewage and waste disposal happen out without regard to safety of

groundwater. Heavy metals exposure through drinking contaminated water has been implicated in developing chronic diseases. The objective of the study was to determine levels of select heavy metals in groundwater sources used for drinking water, and the potential health risks from exposure among residents in the informal settlements of Kisumu East County.

She presented preliminary results that answer one of the specific objectives “*To determine the population at risk of exposure to select heavy metal in contaminated groundwater*”.

A descriptive cross sectional study using quantitative methods was carried out in peri-urban and urban settlements of Kisumu East. A questionnaire adopted from School of public survey tool and approved by KNH-UoN ERC. The tool was administered to 355 households using both ground and surface water sources. Socio-demographic information, water source, use, availability, treatment options and disposal practices of household were recorded. Distance to waste disposal sites, farms and sanitation facilities were assessed. Data Entry and Analysis was carried out using Statistical Package for Social Sciences (SPSS) to compare quantitative variables –Chi test, ANOVA and correlation

The results of data collected in 2017 showed that about 65% (n=232) used a groundwater as a source of water for domestic use, which include cooking, while the 66% (n=234) used the same water as an alternative to surface water for drinking. Around 27% (n=97) used agrochemicals for farming and 10% (n=33) disposed old batteries in pit latrines. Children below 5 years were likely to drink groundwater than surface water. There were self-reports of presence of a chronic disease by groundwater users, with more females than males reporting a chronic disease and disease increased across the age groups.

The study concludes that despite groundwater being an affordable and reliable source in informal settlements, there are unmonitored human activities that lead to increased risk of heavy metal contamination. The risk of floods and presence of sanitation facilities near water sources. The next step will be to sample water for laboratory analysis for $As^{3+/5+}$, Pb^{2+} , Cd^{2+} , and Hg^{2+} species and carry out the human health risk assessment.

Q n A

Q: Whether gold mining process can be considered as a source of mercury -**A:** Gold deposits are not found in the study area of interest.

Q: If use of cosmetic products among women can be included in questionnaire as a source exposure to mercury **A:** This was a valid point as many skin products are laced with mercury compounds and continued use does contribute to renal diseases. Improper disposal of these products could contribute to groundwater contamination.

Comments by the PIs:

- i. Change the chi-test table results Heading-Groundwater vs Surface water instead of Non-groundwater.
- ii. Consider incorporating the Uganda's sanitation health risk assessment tool in the questionnaire
- iii. Including gender as a bias on self-reporting disease.

f. Building resilience to the impact of climate extremes on water supply in urban informal settlements: a case study of Kisumu City by Tinashe Masimbe - MCCA student, Institute for Climate Change and Adaptation, University of Nairobi

The study was on “Building resilience to the impact of climate extremes on water supply in urban informal settlements: a case study of Kisumu City”.

The Manyatta, Nyalenda, Otonglo and Obunga informal settlements in Kisumu city are depicted by poor housing and land use planning and a poor waste management system. Access to water is obtained mainly through communal stand pipes, individual connections, tanks, or boreholes and natural sources such as rivers, springs. The risk of water contamination is high because of poorly sited pit latrines, and is exacerbated by frequent flooding and the downward slope of the land. The urban poor living in informal settlements are at particularly high risk from the impacts of climate hazards such drought, flooding and related water-borne diseases, in large part due to where they live in low lying areas near Lake Victoria basin. The main objective of the research was to work with the communities to develop effective disaster risk reduction and climate change adaptation strategies to reduce vulnerability of urban informal settlement dwellers to climate extremes that impact safe water supply.

The data collection methods used included; 333 household questionnaires analyzed with SPSS software, identification and quantification of vulnerability, 3 focus group discussions with between 15-20 participants each, 9 key informant interviews with local leaders, NGO's and government institutions, and analysis of climate trends from 1987- 2016.



Tinashe Masimbe - MCCA student, Institute for Climate Change and Adaptation, University of Nairobi

Results show an increasing trend of rainfall over Kisumu city from (1987-2016). The trend also shows inter-annual variability of rainfall which showed increased or decreased rainfall patterns which result to drought and flooding. Warming is reflected in the rise of both minimum and maximum temperatures over the period 1987-2016, with the minimum temperatures rising at a faster rate than maximum temperatures. Majority of the respondents (83%) reported that flooding greatly impacts clean water supply because of pipe bursts which contaminate water. Above half (62%) of the respondents also reported drought as a driver of water resource conflict especially amongst women who use water more frequently during dry spells for household use. The respondents (62%) reported typhoid as the dominant health problem during dry spells, since they have to access unsafe well water that has been microbially contaminated because of poor onsite sanitation. Almost all the respondents (97%) mentioned malaria as the most common disease related to flooding. The overall results show that the Kisumu city urban informal settlement dwellers are highly vulnerable to climate extremes. The Kisumu county government has not put strategies in place to manage climate extremes. The county government still has not maintained, updated or replaced critical infrastructure for water supply and sanitation and maintenance of the

water pipes. However, it needs to invest in critical climate resilient water supply infrastructure. Old and worn out infrastructure and pumping plants need to be rehabilitated

g. A health risk assessment of nitrate contamination in groundwater: a case study of urban informal settlements in Kisumu: by Elver Mwara - MPH student, School of Public Health, University of Nairobi

Study Title: “Health risk assessment of nitrate contamination in groundwater: a case study of urban informal settlements in Kisumu, Kenya”



Elver Mwara - MPH student, School of Public Health, University of Nairobi

Non communicable diseases (NCDs) are a challenge to development, especially in developing countries. The four leading causes of NCD related deaths are cardiovascular diseases, cancer, chronic respiratory conditions and diabetes, some of which have been associated with long term nitrate ingestion. Groundwater is the preferred source of drinking water among the fast growing urban population in developing countries due to its lower cost. This water is at great risk of contamination as a result of on-site sanitation, especially in overcrowded urban settlements.

The objective of this study is to determine levels of nitrate in groundwater sources and establish risk of developing diseases secondary to exposure. The study design will be cross sectional in nature. The outcome variable is the risk of development of disease. The exposure variables include concentration of nitrogen compounds in water, socio-demographic factors (age, sex, socio-economic status), length of stay within the area and water intake rate.

The study area includes Kibos, Obunga and Nyalenda “A” informal settlements in Kisumu City. In these three areas, a total of 82 groundwater sources have been mapped using the snowball

method with a GPS machine. The next step is to collect data from households and groundwater sources once approval has been obtained from the ethics and research committee.

Next steps

Results will be published in peer reviewed journals and abstracts submitted for presentation in the IAH (International Association of Hydrologists) conference in Daejeon, Korea from 9th to 14th September 2018.

Abstracts submitted and accepted for poster presentation include;

1. A determination of proximal relationship between groundwater sources and sanitation facilities in selected informal settlements of Kisumu City, Kenya.
Karimi KJ¹, Kaluai GM¹, Mwaru EM¹, Kanoti J², Dulo S², Ayah R², Olago D²
2. Groundwater users at risk of heavy metal exposure from contaminated drinking water in informal settlements of Kisumu City, Kenya.
Kaluai GM¹, Ayah R², Mwanthi AM², Karimi KJ², Olago D², Dulo S²
3. The distribution of thermotolerant coliforms in groundwater in Kisumu City, Kenya.
Kanoti J¹, Olago D¹.