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Progress report by PhD Students

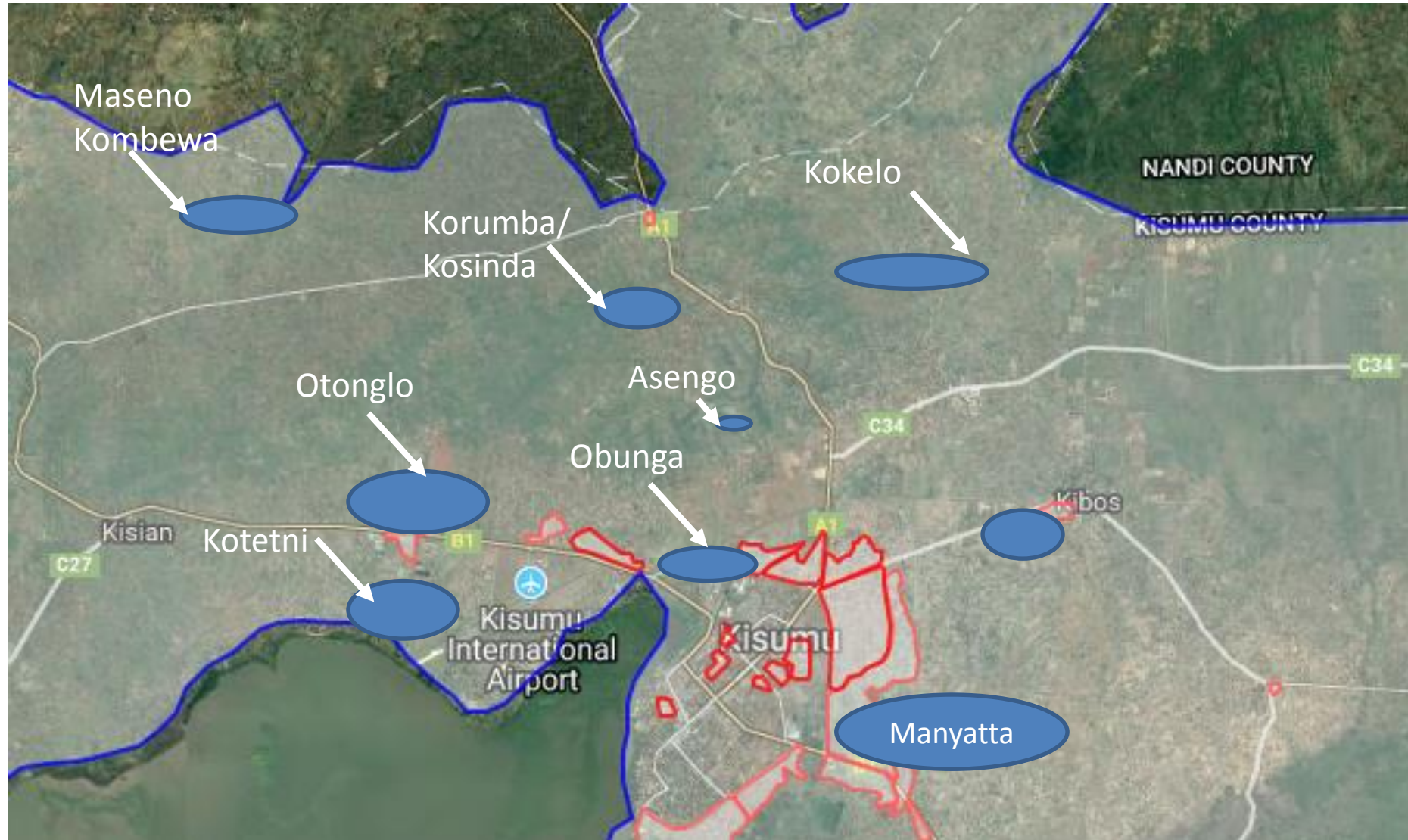
The Geometry, Hydrogeochemistry and Vulnerability of Kisumu Aquifer to Contamination

Japhet Rugendo Kanoti
Department of Geology
University of Nairobi
Kenya

Presentation outline

1. Introduction to the study area
2. Objectives of the study
3. Methodological approach
4. Preliminary Results
 - Geology /geophysics
 - Physical-chemical results
 - Water chemistry
 - Water contamination
5. Conclusion

Introduction to the study area



Objective of the study

- Delineate the aquifer geometry and borehole capture zones in Kisumu and estimate the aquifer characteristics
- To establish groundwater quality and evaluate how groundwater chemistry is modified by rock-water interactions through chemical analysis of water samples
- To determine environmental isotope signatures in groundwater
- Evaluate degree of contamination/pollution by pit latrines

Preliminary Results

Geology

- The revision of geological map of Kisumu that was done in 1952 has started
- The mapping so far has identified a rock – Archean Greeschist rock unit that is missing in the 1952 geological map
- This rock unit (grit) has strong influence on groundwater flow and occurrence
- VES has been conducted and sites for piezometers and their depths determined
- ERT techniques to be used to determine the depth (thickness) in some selected sites.

Preliminary Results

Physical-chemical results

- Monthly physical-chemical data collection started in November 2016 and continues
- Data collected so far indicate seasonal variations of some parameters
- NB: most springs turn into seasonal rivers during rainfall seasons and therefore difficult to sample.
- Challenge in monitoring some boreholes that were not fitted with airlines and sampling points. E.g. Wandiege borehole

Kokelo Borehole

No.	Date	Temp°C	eC(μS/cm)	DO(mg/L)	pH (Units)	Salinity (PSS)	DO%	Turbidity (NTU)
1	28/11/2016	23.00	491	2.79	6.92	0.24	35.4	5.5
2	28/01/2017	25.00	500	1.78	6.71	0.24	21.1	4.1
3	01/03/2017	24.00	500	3.89	6.90	0.24	41.1	6.2
4	06/04/2017	24.62	507	6.99	6.76	0.25	52.6	8.6
5	28/04/2017	24.54	504	3.90	6.90	0.24	45.2	9.6
6	01/06/2017	23.90	506	4.08	6.95	0.25	51.6	5.1

Kudho springs

No.	Date	Temp°C	eC(μS/cm)	DO(mg/L)	pH (Units)	Salinity (PSS)	DO%	Turbidity (NTU)
1	06/12/2016	27.26	201	2.12	6.54	0.10	26.5	225.0
2	28/01/2017	29.77	252	3.84	7.07	0.12	53.5	6.4
3	02/03/2017	27.68	188	2.16	6.25	0.09	31.1	456.0
4	05/04/2017	27.45	152	1.17	6.47	0.08	14.8	211.0
5	27/04/2017	27.00	149	2.12	6.48	0.07	25	220.0
6	01/06/2017	26.10	185	0.96	6.49	0.09	11	102.0

Kosinda springs

No.	Date	Temp(°C)	eC(μS/cm)	DO(mg/L)	pH (Units)	Salinity (PSS)	DO%	Turbidity (NTU)
1	07/12/2016	24.22	105	1.83	5.65	0.05	23.1	17.6
2	28/01/2017	24.94	105	4.43	5.59	0.05	41.7	15.1
3	02/03/2017	24.81	104	1.3	5.53	0.05	16.06	77.8
4	06/04/2017	24.68	104	1.42	5.52	0.05	13.6	25.3
5	28/04/2017	24.69	104	1.95	5.66	0.05	15.3	57.4
6	01/06/2017	24.24	101	1.14	5.55	0.05	11.5	17.2

Mbeme Shallow well

No.	Date	Temp°C	eC(μS/cm)	DO(mg/L)	pH (Units)	Salinity (PSS)	DO%	Turbidity (NTU)
1	24/11/2016	27.62	1003	2.96	7.35	0.5	42.4	3.2
2	28/01/2017	27.90	1023	4.48	7.34	0.51	62.5	2.4
3	01/03/2017	27.95	1043	3.67	7.36	0.52	47.2	9.5
4	06/04/2017	28.95	1071	4.97	7.64	0.53	52.9	4.3
5	28/04/2017	27.37	1081	5.61	7.51	0.54	56	10.6
6	01/06/2017	28.24	1102	4.01	7.57	0.55	44.5	4.4

Preliminary Results

Water chemistry

- Water sampling is scheduled for November-December (rain season), February-March (dry season), May-June (rain season) and August-September (dry season)
- The aim is to determine seasonal variation in water chemistry that can be attributed to rock-water interaction
- The preliminary results show that water chemistry is good and is unlikely to affect human health.
- However, elevated values of iron, fluoride and bicarbonates were noted in a few well and springs.

Chemical Data

	Site Name	EC ($\mu\text{S}/\text{cm}$)	Ca	Mg	K	Na	NO3N	NO3	S	SO4	Fe	Mn	Cl	HCO3	Fl	CaCO3
1	4ksm 1 (Wandiege)	1280	0.78	0.14	8.94	321.0	0.74	3.28	30.4	91.1	0.00	< 0.01	47.4	693	3.79	2.52
2	4ksm 2 (Nyamasaria)	99	9.43	2.68	2.00	10.6	1.15	5.09	1.14	3.42	0.58	0.71	5.64	56.1	0.39	34.6
3	4ksm 3 (Mbeme)	1210	36.30	2.87	15.50	248.0	0.39	1.73	17.7	53.00	0.00	< 0.01	41.2	714.0	7.29	103.0
4	4ksm 4 (Kibos Shallow Well)	1710	188	34.50	8.59	162.0	13.6	60.20	59.9	179.00	0.00	0.02	177	602.0	0.91	611.0
5	4ksm 5 (Kibos River)	110	8.70	2.65	1.24	12.2.0	1.00	4.43	1.55	4.64	0.27	0.46	4.28	48.3	0.32	32.6
6	4ksm 6 (Kokelo Spring)	140	11.00	3.54	2.52	14.8	0.28	1.24	1.30	3.89	1.54	0.14	3.47	80.1	0.37	42.0
7	4ksm 7 (Kokelo B/Hole)	560	64.40	21.60	0.45	36.1	1.49	6.60	2.03	6.08	0.00	0.72	7.09	401.0	0.84	250.0
8	4ksm 8 (Kudho)	200	4.82	1.64	8.92	34.9	1.72	7.61	2.94	8.81	13.20	0.087	19.90	74.5.	1.06	18.8
9	4ksm 9 (Korumba)	160	3.02	0.89	7.09	28.5	1.89	8.37	0.076	0.23	0.72	0.00	2.77	89.6	0.29	11.2
10	4ksm 10 (Kosinda Springs)	110	2.85	0.73	6.14	16.0	2.51	11.10	0.26	0.78	0.044	0.037	4.76	48.2	0.36	10.1
11	4ksm 11 (Asengo)	150	4.86	1.24	7.69	22.9	3.86	17.10	1.31	3.92	0.087	0.013	7.96	68.6	0.43	17.2
12	4ksm 12 (Kogweno)	430	28.20	5.56	17.00	43.0	1.49	6.60	14.0	41.90	0.00	0.062	48.10	119.0	0.85	93.3
13	4ksm 13 (Kodiaga Jane)	800	61.10	10.5	19.70	80.9	42.6	189	9.38	28.10	0.23	0.00	18.60	217.0	3.13	196.0
14	4ksm 14 (Maseno Kombewa)	61	5.28	1.62	2.56	4.96	0.60	2.66	0.72	2.16	0.75	0.38	6.30	46.6	0.39	19.8
15	4ksm 15 (Wandega Ndegwa)	220	18.40	10.00	0.56	19.1	0.60	2.66	0.46	1.38	3.39	0.017	5.98	159.0	0.97	87.0
16	4ksm 16 (Kisiani Bridge)	75	5.29	1.59	2.69	9.2	1.86	8.23	1.42	4.25	0.18	0.50	10.30	69.5	0.45	19.7
17	4ksm 17 (Upper Otonglo Jane)	720	44.30	7.63	8.08	111.0	0.25	1.11	8.40	25.20	0.00	0.00	27.70	431.0	1.44	142.0
18	4ksm 18 (L Victoria-Otonglo)	160	11.10	3.46	5.86	17.0	4.57	20.20	0.87	2.61	0.39	0.37	6.73	83.5	0.67	41.9
19	4ksm 19 (Lower Otonglo 1)	1400	88.30	9.85	19.70	173.0	2.75	12.20	11.4	34.20	0.00	0.032	331	195.0	0.99	261.0
20	4ksm 20 (Lower Otonglo 2)	1060	69.20	7.73	22.00	156.0	2.10	9.30	34.8	104.00	0.00	0.00	78.70	466.0	2.85	205.0
21	4ksm 21 Upper Otonglo	1050	97.80	12.40	29.90	94.5	1.79	7.92	31.2	93.50	0.024	0.00	125	349.0	1.73	295.0
22	4ksm 22 Kodiaga (Bernard)	1200	109.00	21.10	11.80	141.0	2.18	9.65	25.5	76.40	0.00	0.00	77.60	613.0	1.85	359.0
	Upper limits (KEBS)	1500	150 ppm	100 ppm	12 ppm	200 .ppm	42.6 ppm	50 ppm	133 ppm	400 ppm	0.3 ppm	0.5 ppm	250 ppm	250 ppm	1.5 ppm	300 ppm

Preliminary Results

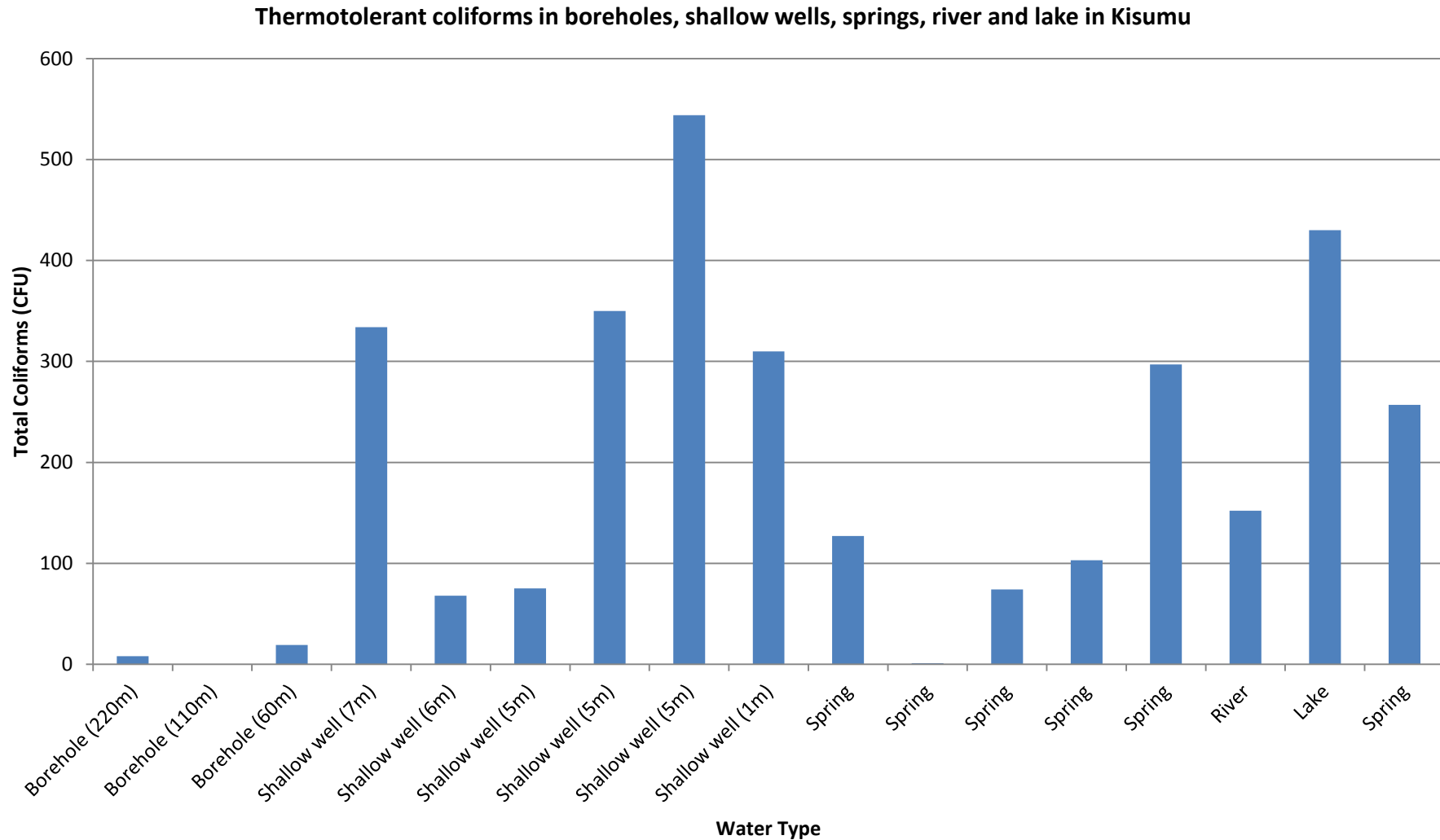
Water contamination

- Water samples collected and analysed in the field using portable field kit during the scheduled sampling campaign.



- Shallow wells contamination higher during rain season. Deep boreholes not contaminated with thermotolerant colliform bacteria.

Comparative contamination of groundwater sources in Kisumu (December, 2016)



Conclusion and way forward

- Data collection going on well
- Monthly data collection to continue
- Data analysis and interpretation to commence soon
- Scheduled sampling and bacteriological studies to continue
- Geological mapping to be completed before the year ends
- ERT to be conducted in August/September
- Two journal paper before December 2017
- The main constrains/drawbacks include
 - ✓ Delays in actualization of Piezometers and rainfall station
 - ✓ Some boreholes do not have airline and sample collection points
 - ✓ Very high turbidity in rivers during rainfall storms
 - ✓ Analytical equipment for analysis yet to be procured
 - ✓ Isotope studies not yet done

Thank you