

Understanding the impacts of short-term climate variability on drinking water source quality: observations from three distinct climatic regions in Tanzania

Danlu Guo¹, Jacqueline Thomas^{2,3}, Alfred Boniphace Lazaro², Clarence Mahundo², Dickson Lwetoijera², Emmanuel Mrimi², Fatuma Matwewe², Fiona Johnson⁴

¹Department of Infrastructure Engineering, The University of Melbourne, Parkville, Australia

²Ifakara Health Institute, Ifakara, Morogoro, Tanzania

³School of Civil Engineering, The University of Sydney, Darlington, Australia

⁴Water Research Centre, School of Civil and Environmental Engineering, University of New South Wales, Sydney, Australia

Contents of this file

Table S1

Table S2

Table S3

Introduction

This Supporting Information contains:

- Table S1 summarizes the sample numbers and the key statistical features of the raw water quality data collected at Buguruni, that were used for analyses in this study.
- Table S2 summarizes the sample numbers and the key statistical features of the raw water quality data collected at Kilombero, that were used for analyses in this study.
- Table S3 summarizes the sample numbers and the key statistical features of the raw water quality data collected at Kondoa, that were used for analyses in this study.

Table S1. Sample numbers and statistical summary (in log scale) of Buguruni water quality monitoring data that were used for analyses in this study. Note that statistics were only shown for samples that were collected as source, see details in Section 4.3 in the main text. Grey cells indicate where no samples were collected/ available to calculate statistics, and dash indicates where no standard deviation can be calculated for a single sample.

Type of water source	Sampling round	Number of samples	Number of source-level samples used for modelling	Number and percentage of non-zero source-level samples for <i>E. coli</i>		Mean and standard deviation of non-zero source-level counts (log) for <i>E. coli</i>		Number and percentage of non-zero source-level samples for Total Coliform		Mean and standard deviation of non-zero source-level counts (log) for Total Coliform	
Borehole (Electric pump)	0	27	27	12	44.4%	0.350	1.407	24	88.9%	2.909	1.892
Borehole (Hand pump)	0	0	0	0							
Piped water (Public tap)	0	3	3	1	33.3%	1.253	-	3	100%	1.105	3.114
Piped water to house	0	0	0	0							
Protected dug well	0	0	0	0							
Unprotected dug well	0	0	0	0							
Borehole (Electric pump)	1	0	0	0							
Borehole (Hand pump)	1	0	0	0							
Piped water (Public tap)	1	0	0	0							
Piped water to house	1	0	0	0							
Protected dug well	1	0	0	0							
Unprotected dug well	1	0	0	0							
Borehole (Electric pump)	2	64	3	3	100%	0.672	0.589	3	100%	4.644	0.471
Borehole (Hand pump)	2	0	0	0							
Piped water (Public tap)	2	58	4	3	75%	1.700	2.228	4	100%	5.049	0.790
Piped water to house	2	133	8	6	75%	1.352	1.082	8	100%	5.373	0.926
Protected dug well	2	0	0	0							
Unprotected dug well	2	0	0	0							
Borehole (Electric pump)	3	65	13	3	23.1%	1.439	1.255	13	100%	5.174	0.643
Borehole (Hand pump)	3	0	0	0							
Piped water (Public tap)	3	85	35	16	45.7%	0.174	0.980	35	100%	4.501	1.511
Piped water to house	3	142	36	8	22.2%	1.264	1.886	34	94.4%	4.770	1.740
Protected dug well	3	0	0	0							
Unprotected dug well	3	0	0	0							
Borehole (Electric pump)	4	78	17	8	47.1%	2.287	1.716	17	100%	5.428	0.715
Borehole (Hand pump)	4	0	0	0							
Piped water (Public tap)	4	51	19	10	52.6%	1.683	0.951	19	100%	5.053	1.439
Piped water to house	4	114	33	14	42.4%	1.611	1.043	33	100%	5.006	0.788
Protected dug well	4	0	0	0							
Unprotected dug well	4	0	0	0							
Borehole (Electric pump)	5	73	14	6	42.9%	1.051	1.478	14	100%	4.187	1.489
Borehole (Hand pump)	5	0	0	0							
Piped water (Public tap)	5	54	19	9	47.4%	1.272	1.308	19	100%	4.288	1.089
Piped water to house	5	116	36	19	52.8%	1.413	1.379	35	97.2%	3.915	1.479
Protected dug well	5	0	0	0							

Unprotected dug well	5	0	0	0							
Borehole (Electric pump)	6	70	22	9	40.9%	1.939	1.552	22	100%	4.426	1.289
Borehole (Hand pump)	6	0	0	0							
Piped water (Public tap)	6	38	8	1	12.5%	0.405	-	8	100%	3.616	1.643
Piped water to house	6	110	37	5	13.5%	0.524	1.146	28	75.7%	2.912	1.486
Protected dug well	6	0	0	0							
Unprotected dug well	6	0	0	0							
Borehole (Electric pump)	7	71	21	8	38.1%	0.834	1.843	18	85.7%	3.516	1.768
Borehole (Hand pump)	7	0	0	0							
Piped water (Public tap)	7	38	7	1	14.3%	-0.693	-	3	42.9%	2.870	0.959
Piped water to house	7	117	41	7	17.1%	0.269	1.066	22	53.7%	2.413	1.849
Protected dug well	7	0	0	0							
Unprotected dug well	7	0	0	0							
Borehole (Electric pump)	8	63	18	5	27.8%	0.674	1.695	13	72.2%	4.355	1.369
Borehole (Hand pump)	8	0	0	0							
Piped water (Public tap)	8	39	14	4	28.6%	0.640	1.308	12	85.7%	2.764	2.250
Piped water to house	8	102	37	12	32.4%	1.125	1.729	27	73.0%	2.587	2.221
Protected dug well	8	0	0	0							
Unprotected dug well	8	0	0	0							
Borehole (Electric pump)	9	69	22	9	40.9%	0.316	1.248	20	90.9%	3.879	1.308
Borehole (Hand pump)	9	0	0	0							
Piped water (Public tap)	9	36	6	4	66.7%	1.007	1.109	6	100%	3.158	1.551
Piped water to house	9	103	34	21	61.8%	0.786	1.487	26	76.5%	4.397	1.514
Protected dug well	9	0	0	0							
Unprotected dug well	9	0	0	0							

Table S2. Sample numbers and statistical summary (in log scale) of Kilombero water quality monitoring data that were used for analyses in this study. Note that statistics were only shown for samples that were collected as source, see details in Section 4.3 in the main text. Grey cells indicate where no samples were collected/ available to calculate statistics, and dash indicates where no standard deviation can be calculated for a single sample.

Type of water source	Sampling round	Number of samples	Number of source-level samples used for modelling	Number and percentage of non-zero source-level samples for <i>E. coli</i>		Mean and standard deviation of non-zero source-level counts (log) for <i>E. coli</i>		Number and percentage of non-zero source-level samples for Total Coliform		Mean and standard deviation of non-zero source-level counts (log) for Total Coliform	
Borehole (Electric pump)	0	0	0								
Borehole (Hand pump)	0	21	21	8	38.1%	1.511	3.146	13	61.9%	2.697	2.229
Piped water (Public tap)	0	20	20	7	35.0%	0.058	0.661	19	95.0%	3.469	2.534
Piped water to house	0	0	0								
Protected dug well	0	36	36	17	47.2%	0.775	1.851	32	88.9%	4.096	1.967
Unprotected dug well	0	5	5	5	100%	3.029	1.060	5	100%	6.775	0.933
Borehole (Electric pump)	1	0	0								
Borehole (Hand pump)	1	99	39	17	43.6%	0.385	1.151	35	89.7%	3.242	1.638
Piped water (Public tap)	1	66	6	6	100%	0.458	1.807	6	100%	5.031	0.794
Piped water to house	1	0	0								
Protected dug well	1	97	37	22	59.5%	1.304	1.625	37	100%	5.049	1.251
Unprotected dug well	1	26	6	4	66.7%	4.140	1.677	6	100%	4.673	2.427
Borehole (Electric pump)	2	0	0								
Borehole (Hand pump)	2	97	38	18	47.4%	0.648	1.416	35	92.1%	3.156	1.458
Piped water (Public tap)	2	63	6	0	0%			2	33.3%	0.000	0.980
Piped water to house	2	0	0								
Protected dug well	2	95	36	20	55.6%	2.481	2.290	32	88.9%	4.145	1.744
Unprotected dug well	2	24	4	4	100%	4.470	1.636	4	100%	5.050	1.057
Borehole (Electric pump)	3	0	0								
Borehole (Hand pump)	3	94	36	17	47.2%	0.235	1.550	32	88.9%	3.489	1.599
Piped water (Public tap)	3	58	6	0	0%			5	83.3%	2.694	2.207
Piped water to house	3	0	0								
Protected dug well	3	88	34	17	50.0%	1.694	2.012	34	100%	3.683	1.764
Unprotected dug well	3	24	4	4	100%	4.093	2.582	4	100%	5.958	0.426
Borehole (Electric pump)	4	0	0								
Borehole (Hand pump)	4	95	37	21	56.8%	1.744	1.708	35	94.6%	4.231	1.370
Piped water (Public tap)	4	55	6	0	0.0%			0	0%		
Piped water to house	4	0	0								
Protected dug well	4	85	32	26	81.3%	3.184	2.062	32	100%	5.189	1.217
Unprotected dug well	4	24	4	4	100.0%	4.450	0.605	4	100%	5.270	0.917
Borehole (Electric pump)	5	0	0								
Borehole (Hand pump)	5	90	32	21	65.6%	2.052	2.067	32	100%	4.617	1.497
Piped water (Public tap)	5	54	6	2	33.3%	1.007	0.851	6	100%	6.012	0.811
Piped water to house	5	0	0								
Protected dug well	5	82	29	25	86.2%	2.980	2.158	29	100%	5.537	1.256

Unprotected dug well	5	22	4	3	75%	5.033	0.747	4	100%	5.982	0.470
Borehole (Electric pump)	6	0	0								
Borehole (Hand pump)	6	92	37	7	18.9%	0.930	1.810	33	89.2%	3.087	1.655
Piped water (Public tap)	6	45	6	0	0%			0	0%		
Piped water to house	6	0	0								
Protected dug well	6	86	34	12	35.3%	1.549	1.839	32	94.1%	4.038	1.535
Unprotected dug well	6	23	4	4	100%	2.383	1.793	4	100%	5.336	0.528
Borehole (Electric pump)	7	0	0								
Borehole (Hand pump)	7	92	34	6	17.6%	2.189	2.338	30	88.2%	3.238	1.778
Piped water (Public tap)	7	51	6	4	66.7%	0.605	0.931	6	100%	4.945	0.423
Piped water to house	7	0	0								
Protected dug well	7	89	36	12	33.3%	1.900	2.349	35	97.2%	3.644	1.620
Unprotected dug well	7	21	4	3	75.0%	5.740	1.946	4	100%	5.109	1.293
Borehole (Electric pump)	8	0	0								
Borehole (Hand pump)	8	91	34	10	29.4%	1.466	2.357	26	76.5%	3.221	1.861
Piped water (Public tap)	8	48	6	5	83.3%	-0.254	0.602	6	100%	4.062	0.540
Piped water to house	8	0	0								
Protected dug well	8	94	41	15	36.6%	2.741	1.672	38	92.7%	3.582	1.428
Unprotected dug well	8	21	4	4	100%	4.925	1.282	4	100%	5.606	0.394
Borehole (Electric pump)	9	0	0								
Borehole (Hand pump)	9	91	35	17	48.6%	2.573	2.715	31	88.6%	3.949	2.481
Piped water (Public tap)	9	54	6	0	0%			4	66.7%	3.755	0.644
Piped water to house	9	0	0								
Protected dug well	9	90	37	31	83.8%	2.253	2.377	36	97.3%	4.978	1.587
Unprotected dug well	9	22	4	4	100%	6.959	2.393	4	100%	9.264	1.607

Table S3. Sample numbers and statistical summary (in log scale) of Kondoa water quality monitoring data that were used for analyses in this study. Note that statistics were only shown for samples that were collected as source, see details in Section 4.3 in the main text. Grey cells indicate where no samples were collected/ available to calculate statistics, and dash indicates where no standard deviation can be calculated for a single sample.

Type of water source	Sampling round	Number of samples	Number of source-level samples used for modelling	Number and percentage of non-zero source-level samples for <i>E. coli</i>		Mean and standard deviation of non-zero source-level counts (log) for <i>E. coli</i>		Number and percentage of non-zero source-level samples for Total Coliform		Mean and standard deviation of non-zero source-level counts (log) for Total Coliform	
Borehole (Electric pump)	0	1	1	0	0.0%			1	100%	2.862	-
Borehole (Hand pump)	0	2	2	2	100%	3.829	0.755	2	100%	6.170	0.887
Piped water (Public tap)	0	3	3	1	33.3%	0.000	-	3	100%	5.718	1.126
Piped water to house	0	0	0	0							
Protected dug well	0	0	0	0							
Unprotected dug well	0	9	9	8	88.9%	5.808	2.660	9	100%	9.194	1.297
Borehole (Electric pump)	1	72	12	8	66.7%	3.117	1.383	10	83.3%	6.681	1.033
Borehole (Hand pump)	1	0	0	0							
Piped water (Public tap)	1	71	12	2	16.7%	2.505	1.267	11	91.7%	6.675	1.202
Piped water to house	1	0	0	0							
Protected dug well	1	2	2	2	100%	3.978	1.795	2	100%	6.310	0.881
Unprotected dug well	1	107	28	28	100%	5.888	1.323	28	100%	8.081	0.408
Borehole (Electric pump)	2	70	11	5	45.5%	2.316	1.092	10	90.9%	4.764	1.067
Borehole (Hand pump)	2	0	0	0							
Piped water (Public tap)	2	71	12	4	33.3%	1.573	1.724	7	58.3%	3.920	2.731
Piped water to house	2	0	0	0							
Protected dug well	2	2	2	2	100%	1.282	0.833	2	100%	4.472	0.849
Unprotected dug well	2	102	24	22	91.7%	5.499	1.298	24	100%	7.892	0.985
Borehole (Electric pump)	3	68	11	4	36.4%	0.850	1.510	11	100%	3.754	0.892
Borehole (Hand pump)	3	0	0	0							
Piped water (Public tap)	3	71	12	5	41.7%	-0.693	0.000	12	100%	2.824	1.754
Piped water to house	3	0	0	0							
Protected dug well	3	2	2	1	50.0%	-0.693	-	2	100%	4.231	0.585
Unprotected dug well	3	107	34	26	76.5%	4.093	2.069	31	91.2%	7.378	2.014
Borehole (Electric pump)	4	69	11	4	36.4%	0.825	1.510	10	90.9%	3.860	1.063
Borehole (Hand pump)	4	0	0	0							
Piped water (Public tap)	4	69	12	2	16.7%	1.007	2.405	11	91.7%	2.533	1.602
Piped water to house	4	0	0	0							
Protected dug well	4	2	2	1	50.0%	0.000	-	2	100%	3.243	0.422
Unprotected dug well	4	102	28	28	100%	4.956	1.617	28	100%	6.750	1.435
Borehole (Electric pump)	5	71	11	8	72.7%	3.572	1.306	11	100%	6.594	1.948
Borehole (Hand pump)	5	0	0	0							
Piped water (Public tap)	5	71	12	5	41.7%	2.130	2.037	9	75%	5.011	1.375
Piped water to house	5	0	0	0							
Protected dug well	5	2	2	2	100%	4.390	0.676	2	100%	5.917	0.477

Unprotected dug well	5	101	27	26	96.3%	6.063	1.545	27	100%	7.562	1.593
Borehole (Electric pump)	6	69	12	3	25.0%	2.238	1.987	11	91.7%	4.627	1.933
Borehole (Hand pump)	6	0	0	0							
Piped water (Public tap)	6	67	12	2	16.7%	-0.144	0.777	12	100%	4.897	1.441
Piped water to house	6	0	0	0							
Protected dug well	6	2	2	2	100%	-0.347	0.490	2	100%	2.441	1.899
Unprotected dug well	6	91	16	14	87.5%	5.794	1.771	16	100%	7.540	1.865
Borehole (Electric pump)	7	69	12	2	16.7%	0.626	0.886	9	75%	2.135	2.271
Borehole (Hand pump)	7	0	0	0							
Piped water (Public tap)	7	69	12	1	8.3%	1.099	-	8	66.7%	1.789	1.890
Piped water to house	7	0	0	0							
Protected dug well	7	2	2	1	50%	0.693	-	2	100%	2.013	0.094
Unprotected dug well	7	89	13	11	84.6%	5.592	1.976	12	92.3%	7.303	1.862
Borehole (Electric pump)	8	68	12	6	50%	1.051	1.595	12	100%	3.892	1.478
Borehole (Hand pump)	8	0	0	0							
Piped water (Public tap)	8	68	12	6	50%	0.877	1.003	10	83.3%	2.925	1.407
Piped water to house	8	0	0	0							
Protected dug well	8	2	2	2	100%	0.693	1.961	2	100%	4.376	0.018
Unprotected dug well	8	88	14	13	92.9%	7.312	1.517	14	100%	8.711	1.891
Borehole (Electric pump)	9	69	11	3	27.3%	2.045	2.507	11	100%	4.562	0.948
Borehole (Hand pump)	9	0	0	0							
Piped water (Public tap)	9	69	12	4	33.3%	1.796	1.864	11	91.7%	4.319	2.070
Piped water to house	9	0	0	0							
Protected dug well	9	2	2	0	0%			2	100%	4.154	1.674
Unprotected dug well	9	91	17	16	94.1%	6.431	1.727	17	100%	8.928	1.025