Water quality and environmental risks in peri-urban Dakar, Senegal

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Introduction: In May 2017, the Commune of Djïdia Thiaroye Kao (DJK) and Utah Valley University (UVU) collaborated on a research project that sought to analyze water quality in different sources across the commune. The context of the commune—rising aquifer levels, dense population, seasonal flooding, limited sanitation infrastructure, and varying methods of water access—made water quality questions of central concern. DJK faces three primary challenges in terms of water resources: Firstly, the heavy, uncoordinated and seasonal flooding. These three challenges have roots in similar processes—rapid and informal urbanization, lack of sanitation and water waste facilities, and the inadequacy of infrastructure installations. These problems have solutions at different scales, and the mismatch between local and state priorities can lead to stalled development. In the end, the population of DJK is faced with challenging environmental conditions in their everyday lives, and adapt as best as possible to the peculiarity of their neighborhoods.

Quality of local water resources is of importance to both residents and Commune representatives. Local residents rely on local water sources as supplemental water access points to the urban networked supply system. Water from local sources, such as wells and pumps, if often used for secondary household uses, such as laundry and cleaning. Some households without water taps, such as poor families or squatters, do rely on these local sources for drinking water. In addition, other actors, such as NGOs and the State of Senegal, have infrastructural and development projects underway that rely on potentially contaminated water. Water recycling and garden projects, for example, need to take into account the quality of water and potential contaminants therein. This project assessed the current state of contamination of local ground and surface water resources and how populations dealing with environmental risk every day.

Methods: In collaboration with advisors from the Mayor’s office, we selected 64 sites to sample across the Commune of Djïdia Thiaroye Kao. These sample sites consist of a variety of water sources, including water taps, pumps, wells, and standing water. We targeted those sites and pumps that the population uses for drinking or other household needs, as well as standing water sources, including basins and other areas. Wells and pumps contribute to water access configuration of many households, complementing access to the piped water network. When the piped water network does not function, wells and pumps are used instead. Pumps and wells are being developed as a water resource for large gardening projects. Standing water is used for some gardening of herbs, but otherwise not directly used as a water resource for the population. The contamination of standing water results from natural processes such as spreading of disease or sickness by animals and insects, both of which are abundant in the commune. Also, small children use areas near standing water as play grounds and social spaces, and thus risk contamination. Furthermore, during times of flooding some of this water overflows into neighborhoods and homes. Water samples were carefully collected from water sources, as shown here.

Water Quality Analysis, Biological Contaminants: After water samples were collected using the methods described above, they were analyzed using the ColiplateTM testing system from Bluewater Biosciences. The ColiplateTM system uses a defined substrate technology (DST) method of measuring contaminants. Specifically, the ColiplateTM system measures “metabolic activity as determined by fermentation and the production of gas” by assessing the “ability of organisms to metabolize a specific labeled substrate, thereby releasing a chromogen” (Noble et al. 2003, 301). Water was transferred from sample containers to the ColiplateTM microplate using a sterile syringe. Two hundred L of water was dispensed to each of the 96 wells on the microplate and covered. The microplate was then placed in an incubator (Boekel microplate incubator, Model #206700), set at 35°C, for 24 hours. After 24 hours, the plate was removed and the results from the ColiplateTM read. The Coliplate testing kit provides quantitative measurements of two contaminants: total coliforms and E. coli bacteria.

Results: A total of 64 water samples were taken across DJK. Specifically, we sampled 21 water taps, 17 pumps, 9 wells, and 17 standing water sites. Of the 64 water samples taken, 37 of them were found to be contaminated with coliforms, and 27 did not have any coliform contaminant present. Of the samples with coliforms present, 84% of these were found to have E. coli bacteria. Contamination varied greatly by type of water source, as shown in the table below. Overall, pumps and wells that use local groundwater were found to have high percentages of contaminants, and standing water samples all showed contamination.

<table>
<thead>
<tr>
<th>Water Source Type</th>
<th>Contaminated (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taps</td>
<td>52</td>
</tr>
<tr>
<td>Pumps</td>
<td>100</td>
</tr>
<tr>
<td>Wells</td>
<td>84</td>
</tr>
<tr>
<td>Standing Water</td>
<td>100</td>
</tr>
</tbody>
</table>

Wells: Water from nine wells were sampled for biological contamination. Most wells sampled were used for bathing and washing, and only 7% were found to be contaminated with water when there is a gap in water tap service delivery. One well is a new well and does provide drinking water for nearby families. Wells overall were much shallower than pumps, with an average depth of 4.4m. Overall, the majority of wells sampled had coliform contamination (89%) and E. coli contamination (67% of coliform contaminated wells also were contaminated with e. coli).

Basins and standing water: Standing water is present across Djïdia Thiaroye Kao in designated water catchment basins, as well as low-lying areas. Standing water is sometimes used to water herb gardens, but for the most part residents do not directly use this water. This standing water does pose risks to residents in terms of potential contamination by insects, wind-blown particles, direct contact with water, and overflow during flooding. Overall, we sampled 17 standing water sites across Djïdia Thiaroye Kao. All sample sites were contaminated with both total coliform and e. coli. All standing water samples measured at maximum levels of coliform contamination. E. coli contamination varied more in terms of levels of e. coli detected, but every sample did have e. coli contamination.

Pumps: Pumps across DJK varied in terms of age and location, but all of the pumps sampled rely on local groundwater below the surface at varying depths. Most residents use these pumps as supplementary drinking water points, such as during times of water outages or cuts. Poorer residents without access to the networked water system through water taps do use water from pumps for drinking and household chores. Seventeen pumps were sampled across DJK, and of these 17 only 7 did not have any indication of contamination. The majority of pumps, 59%, did have indications of contamination, though concentrations varied. Of the pumps contaminated with coliform, 70% of these were also contaminated with e. coli.

Conclusions: Groundwater supplying wells and pumps across DJK are both local and regional. The shallower water sources generally tap the unconfined aquifer, which is supplied directly from water infiltration from sources above. The water table is very high, often found at just 3m below the surface, while the deepest parts of the aquifer range from 12m to 20m across the commune (Brandvold 2013). Water in the unconfined aquifer can be contaminated by leaking septic tanks, unlined latrines, basins, household waste water, animal waste, unlined trash disposal sites, and other sources. The clay in soil prevents contamination of all water sources, as evidence by the lack of contamination of some sources. Since this water is supplied from local infiltration, one might assume that deeper water would be more clean. This study, however, found the opposite to hold true—deeper water sources were more contaminated with both coliform and e. coli. While coliform and e. coli both occur in natural waste, unlined trash disposal sites, and other sources. The clay in soil prevents contamination of all water sources, as evidence by the lack of contamination of some sources. Since this water is supplied from local infiltration, one might assume that deeper water would be more clean. This study, however, found the opposite to hold true—deeper water sources were more contaminated with both coliform and e. coli. While coliform and e. coli both occur in natural waste, unlined trash disposal sites, and other sources. The clay in soil prevents contamination of all water sources, as evidence by the lack of contamination of some sources. Since this water is supplied from local infiltration, one might assume that deeper water would be more clean. This study, however, found the opposite to hold true—deeper water sources were more contaminated with both coliform and e. coli. While coliform and e. coli both occur in natural waste, unlined trash disposal sites, and other sources. The clay in soil prevents contamination of all water sources, as evidence by the lack of contamination of some sources. Since this water is supplied from local infiltration, one might assume that deeper water would be more clean. This study, however, found the opposite to hold true—deeper water sources were more contaminated with both coliform and e. coli. While coliform and e. coli both occur in natural waste, unlined trash disposal sites, and other sources. The clay in soil prevents contamination of all water sources, as evidence by the lack of contamination of some sources. Since this water is supplied from local infiltration, one might assume that deeper water would be more clean. This study, however, found the opposite to hold true—deeper water sources were more contaminated with both coliform and e. coli. While coliform and e. coli both occur in natural waste, unlined trash disposal sites, and other sources. The clay in soil prevents contamination of all water sources, as evidence by the lack of contamination of some sources.

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Coastal Aquifers Exposed to Climate Change and Rapid Urban Development. In Identifying Emerging Related Risks in the Area of Dakar, Senegal: Using Chemical and Stable Isotope Analyses to Identify the Sources of Nitrate and the Real Governance of Disaster Risk Management in the Area of Dakar, Senegal.: Using Chemical and Stable Isotope Analyses to Identify the Sources of Nitrate and the Real Governance of Disaster Risk Management in the Area of Dakar, Senegal. 53. Springer International Publishing.


