Motivation

Climate change may influence the transmission and global burden of diarrheal illnesses. Multiple studies have shown that higher temperatures and increased extreme rainfall events are associated with increased prevalence of diarrheal illness. This is significant because current climate projections predict continued temperature increases, more frequent extreme precipitation events and more heat waves. Diarrhea contributes a large share of the global disease burden, even small increases in risk would represent significant impacts. While multiple studies have shown an association between climate variability and diarrheal illness, it is not clear which transmission pathways are significantly influenced. The goal of this project is to contribute evidence on the association between climate variability and household environmental contamination to begin identifying which transmission pathways are significantly influenced.

Research Questions

- How are variations in temperature and precipitation associated with the following in rural areas of Kenya with limited water and sanitation infrastructure:
  - Household stored water quality (E. coli)?
  - Child hand contamination (E. coli)?
  - Child toy ball contamination (E. coli)?
  - Does household E. coli contamination exhibit seasonal variation?

Methods

1. Extract the following variables for each survey:
   - Precipitation:
     - Total precipitation on day of survey (threshold)
     - Total precipitation during week preceding survey (threshold)
   - Temperature:
     - Max temperature on day of survey
     - Mean max temperature during week preceding survey
   - Contamination:
     - Mean E. coli concentration

2. Perform linear regression analyses between climate variables and E. coli concentration.

3. Perform Poisson regression between climate variables and presence/absence of E. coli in the toy ball rinse samples.

Results

- Stored water (Table 1): Heavy precipitation (day of, week before), no precipitation (day of), and increased temperature (week before) are associated with increased E. coli contamination in stored water.
- Hand rinse (Table 2): Heavy precipitation (day of) is associated with increased E. coli contamination, while increased temperature (day of, week before) is associated with decreased E. coli contamination on hands.
- Toy ball rinse: No precipitation (day of) is associated with increased E. coli contamination on toys.

Conclusions

Temperature and precipitation variability are significantly associated with household environmental contamination, and the association with each pathway (stored water, hands, toys) varies. Overall, these results suggest that climate change will likely lead to increased risk of E. coli transmission, but the risk differential may not be uniform across pathways. These results are limited in that they are bivariate and do not account for the combined exposure of temperature and precipitation. The space-time results are limited because the data was not collected evenly through space and time, so spatial variation may be explained by temporal variation in when households were sampled. These results indicate that climate variability may be an important driver of environmental contamination. These results point to the need for further analysis to account for the combined exposure of temperature and precipitation and to quantify the projected increase in diarrheal risk in terms of current climate projections.

Table 1: Surface Water E. coli Concentration Bivariate Regression Results

<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>Coefficient</th>
<th>P-value</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Precipitation (day of)</td>
<td>-0.024</td>
<td>0.103</td>
<td>↓</td>
</tr>
<tr>
<td>Heavy Precipitation (day of)</td>
<td>-0.031</td>
<td>0.003</td>
<td>↑</td>
</tr>
<tr>
<td>No Precipitation (week before)</td>
<td>-0.038</td>
<td>0.003</td>
<td>↑</td>
</tr>
<tr>
<td>Heavy Precipitation (week before)</td>
<td>-0.045</td>
<td>0.001</td>
<td>↓</td>
</tr>
</tbody>
</table>

Table 2: Hand Rinse E. coli Concentration Bivariate Regression Results

<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>Coefficient</th>
<th>P-value</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Precipitation (day of)</td>
<td>-0.024</td>
<td>0.103</td>
<td>↓</td>
</tr>
<tr>
<td>Heavy Precipitation (day of)</td>
<td>-0.031</td>
<td>0.003</td>
<td>↑</td>
</tr>
<tr>
<td>No Precipitation (week before)</td>
<td>-0.038</td>
<td>0.003</td>
<td>↑</td>
</tr>
<tr>
<td>Heavy Precipitation (week before)</td>
<td>-0.045</td>
<td>0.001</td>
<td>↓</td>
</tr>
</tbody>
</table>

Figure 1: Concept Diagram

Figure 2: Boxplots of Stored Water E. coli Concentration by Month

Figure 3: Stored Water E. coli Concentration Local Cluster Analysis (Space)

Figure 4: Stored Water E. coli Concentration Local Cluster Analysis (Space-Time)

Figure 5: Regression Residuals Local Cluster Analysis (Space)

Outcome: Stored Water E. coli Concentration

Predictor: Precipitation Day of