Environmental Determinants of Enteric Infectious Disease

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Mortality

Globally, diarrhea kills 2,195 children every day

- This is 1 out of 9 child deaths, worldwide
- It is more than AIDS, malaria, and measles combined
- It is the second leading cause of death in children less than five years old

Liu et al. (2012)
Worldwide distribution of deaths caused by diarrhea in children under 5 years of age in 2016.
Morbidity

Impaired **cognitive development**

**Stunting**

Reduced **vaccine response**

[https://borgenproject.org/what-causes-stunting/](https://borgenproject.org/what-causes-stunting/)
EID are preventable and treatable

In some cases, **vaccines** are available

Improved Water, Sanitation and Hygiene (**WASH**) infrastructure and behavior is critical

Those suffering from diarrhea can be treated with **oral rehydration therapy**
Project goal

Establish the feasibility of Earth Observation-informed EID risk mapping, monitoring, and prediction systems
Risk is environmentally mediated

https://www.cdc.gov/healthywater/global/diarrhea-pathways.html
But it’s complicated

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<th>EID</th>
<th>Seasonality</th>
<th>Rainfall</th>
<th>Air Temp.</th>
<th>Humidity</th>
<th>Soil moisture</th>
<th>Wind</th>
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<th>Surface pressure</th>
<th>Solar radiation</th>
<th>Travel</th>
<th>Water exposure</th>
<th>Eating/food habits</th>
<th>Indoor crowding</th>
<th>Animal contact</th>
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We need detailed data on infections.
Paired with data on environment

None of these infection studies included collection of data on climate or environment.

Earth Observations offer an opportunity to fill this gap.

Colston et al. (2018)
Objectives

Develop process-informed statistical models to predict EID burden

Use objective regionalization to create a global EID-oriented classification system

Apply statistical models and regionalization to generate global maps of the potential burden and dominant seasonality of each EID

Implement a map-based data server and visualization platform
Accomplishments

PY1:
1. Evaluated EO performance at MAL-ED sites, and published results collaboratively with MAL-ED site PIs (Colston et al., 2018)
2. Generated a preliminary rotavirus prediction model based on MAL-ED site data and Earth Observations

PY2:
1. Published the results of the rotavirus model collaboratively with site PIs (Colston et al., 2019)
2. Performed preliminary regionalization based on rotavirus predictors
3. Built template visualization app in Tethys
4. Participated in NASA’s pilot commercial data buy program
Rotavirus infection probability as a function of deseasonalized anomalies in hydrometeorological variables, pooled across all MAL-ED sites.
Rotavirus transmission pathways

- Host factors
- Precipitation
- Soil moisture
- Temperature
- Pressure
- Humidity
- Virus survival on soil and surfaces
- Contact rates
- Waterborne dispersal
- Airborne dispersal

Main effect
Interaction

-10 days - 9 days - 8 days - 7 days - 6 days - 5 days - 4 days - 3 days - 2 days - 1 day Day 0
Tethys App
Pilot Commercial Data Buy Program

WorldView

NDVI

Average NDVI

n = 248

Frequency

0.07 0.09 0.11 0.13 0.15 0.17 0.19 0.21 0.23 0.25 0.27 0.29 0.31 0.33 0.35 0.37 0.39 0.4

0 10 20 30 40 50 60 70 80

10 meter buffer

100 meter buffer
Pilot Commercial Data Buy Program

We do see **household-scale variability** in NDVI, NDWI, and other variables within sites.

We are just beginning to analyze relationships with EID cases.

This has been **harder than anticipated**.

- It is difficult to get geolocated household level data across sites
- It has been difficult to find data buy imagery for our period of analysis
Next steps

Complete regionalization for *rotavirus* and port to the Tethys app, share results with MAL-ED collaborators

Finish the risk models for *Campylobacter* and pathogenic *E. coli*

Perform household scale risk analysis for the commercial data buy program

Challenges:

The household scale analysis might not meet expectations

Communicating uncertainties in the regionalized prediction models
ARL

Current: ARL 4

**Expectation:** ARL 5 by end of calendar year: delivering results to partners in October

**Goal:** ARL 7
Thank You