

HEALTH & AIR QUALITY

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Assimilation of Earth Observation to Improve and Enhance Global Predictive Ability of Forecasting Risk of Cholera Outbreaks

PI Name Antar Jutla

Report Date 04/20/2024



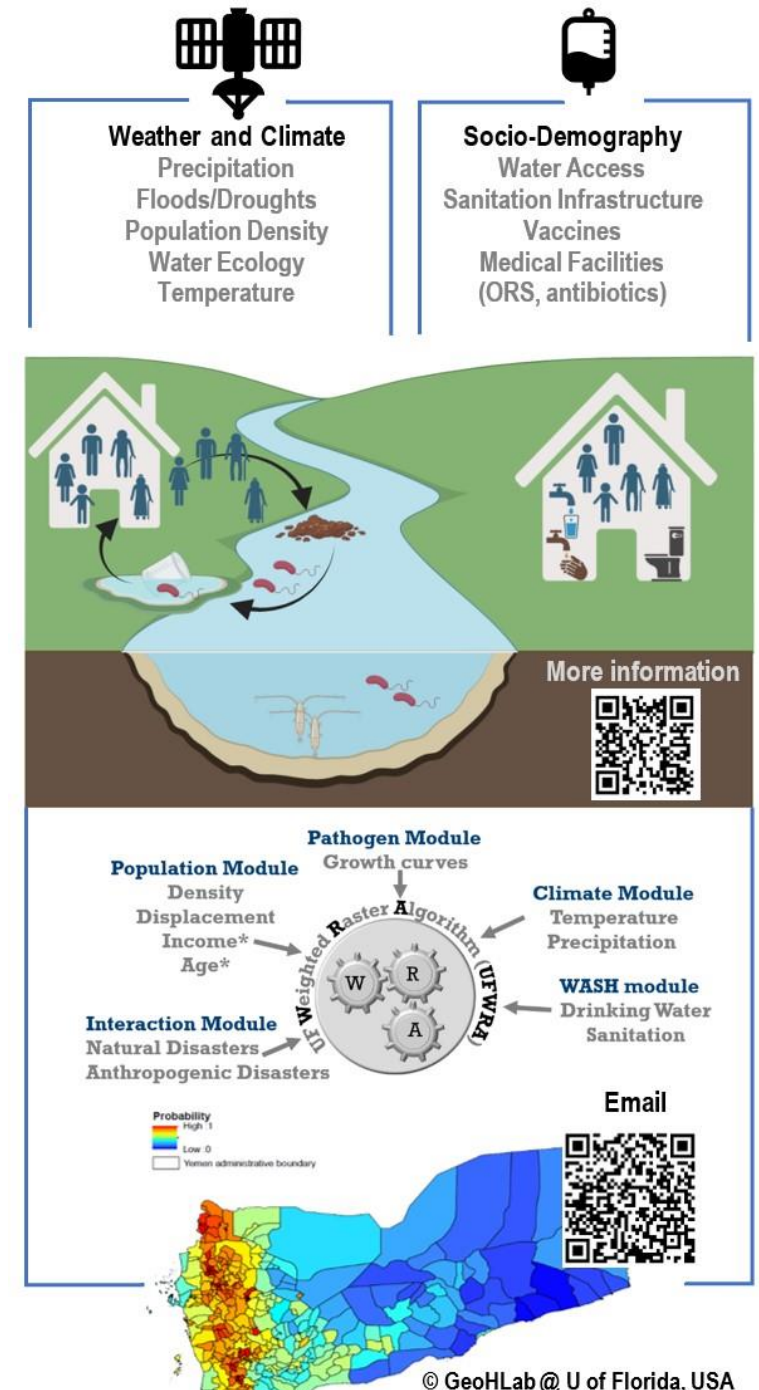
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Project Summary

- Project title: Assimilation of Earth Observation to Improve and Enhance Global Predictive Ability of Forecasting Risk of Cholera Outbreaks
- Short title for project: Cholera Prediction
- Project PI: Antar Jutla
- Solicitation under which the project funding was awarded NNH21ZDA001N HAQ21
- Project Summary
 - Development and deployment of real-time earth observations based global cholera risk prediction and decision-making system.
 - *Proposed research harmonizes and synthesizes role of hydrological, climatic, microbiological and sociological processes for forecasting risk of cholera outbreaks at global scales from satellites and provide an early warning to vulnerable human populations through innovative use of technology and partnerships with authoritative decision-making end-users.*
- Geographic Scope (Focus): Global (country scale)

Goal of the proposal: Development and deployment of real-time earth observations based global cholera risk prediction and decision-making system.

Proposed research harmonizes and synthesizes role of hydrological, climatic, microbiological and sociological processes for forecasting risk of cholera outbreaks at global scales from satellites and provide an early warning to vulnerable human populations through innovative use of technology and partnerships with authoritative decision-making end-users.



Development of an Earth Observation based Global Cholera Prediction System

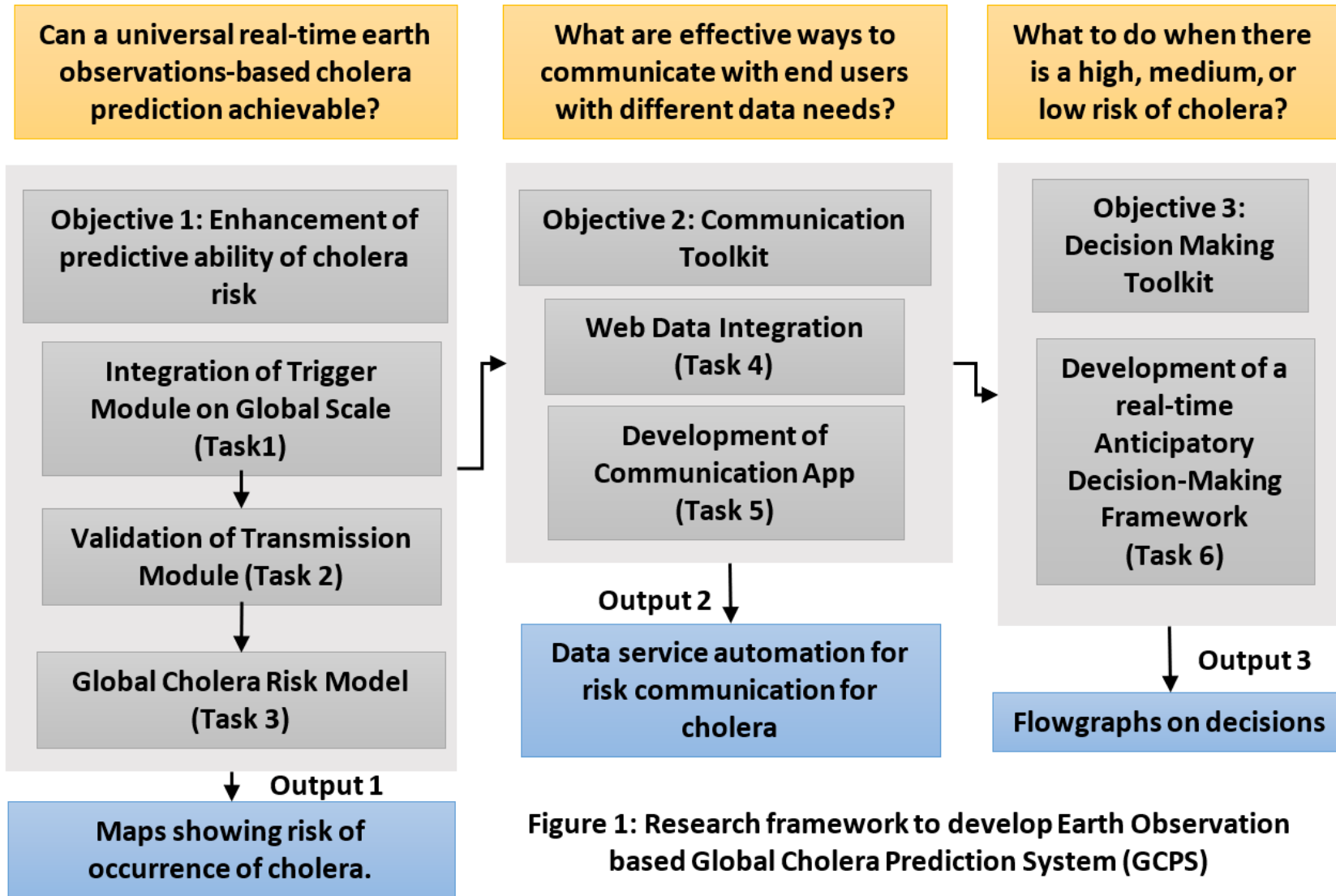
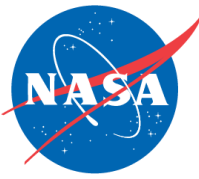


Figure 1: Research framework to develop Earth Observation based Global Cholera Prediction System (GCPS)

Earth Observations, Models, and/or Technologies



Satellite Sensor/Model/Tech.	Product Used	Temporal Coverage and Latency required	Comments
IMERG	3B-DAY-L.M.S	Last 28 days	
TRMM	3B42	1998- 2018	
MERRA	M2SDNXSLV	1980-present	
SEDAC	SEDAC population data	Current	

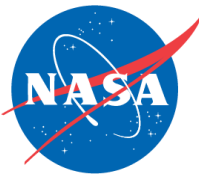


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Project Partners/Collaborators

List project Co-Investigators, collaborators, and other partners

Role	Name	Affiliation	Organization Type
CO-I	Rita Colwell	U Maryland	University
Co-I Research Scientist	Ali Akanda Moiz Usmani	U Rhode Island U of Florida	University
Collaborator Collaborator	Juan Chaves Gonzalez Fergus McBean	UN OCHA UC FCDO	UN UK FCDO



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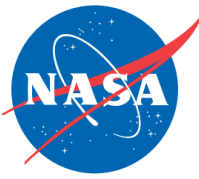
Project End-users & Stakeholders

List organization names and organization types

Organization Name	Organization Type	Decision Making Activity
UN	Intergovernmental Organization	
FCDO	Commonwealth Office	
Malawi Government	Ministry	

Engagement plan and recent updates

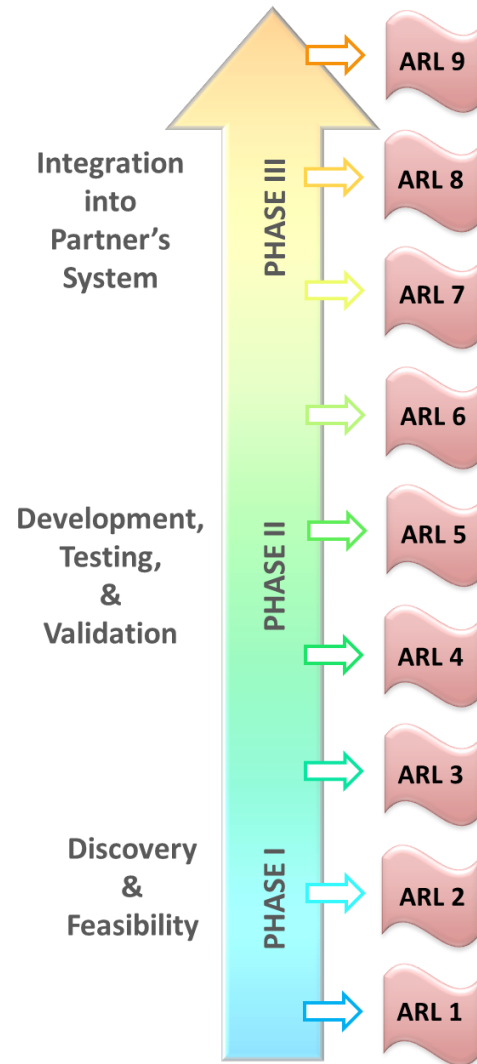
We send out the risk reports of cholera to our stakeholders on a weekly scale and based on their queries and interests we schedule virtual meetings. Cholera prediction dashboard and list have been created to keep the stakeholders and end-users updated with the progress and changes.



Schedule & Milestones

T4: Timeline (UF, UMD, URI)				ARL	Yr1	Yr2	Yr3
	Tasks	Student	Lead	Start to End			
A1	Task 1: Trigger component	UF	UF	7 to 8	xx		
	Task 2: Transmission component	UF	UF	7 to 8	xx	xx	
	Task 3: Global CRM	UF	UF	7 to 8		xx	xx
A2	Task 4: Web Hub	UF, URI	UF	7 to 9	xx	xx	xx
	Task 5: Cholera App	UF, URI	URI	7/8 to 9	xx	xx	xx
A3	Task 6: ADM	UF/URI	UMD/UNO CHA/FCDO	8 to 9	xx	xx	xx
Activities at the End User Organization, UNOCHA*/FCDO							
Promotion of GCPS				8 to 9	xx	xx	xx
Reports on limitations and advantages				8 to 9		xx	xx
Simulated and sustained use of ADM				8 to 9	xx	xx	
Transition and Sustainability plan: Trainer workshops				8 to 9		xx	xx

ARL Performance

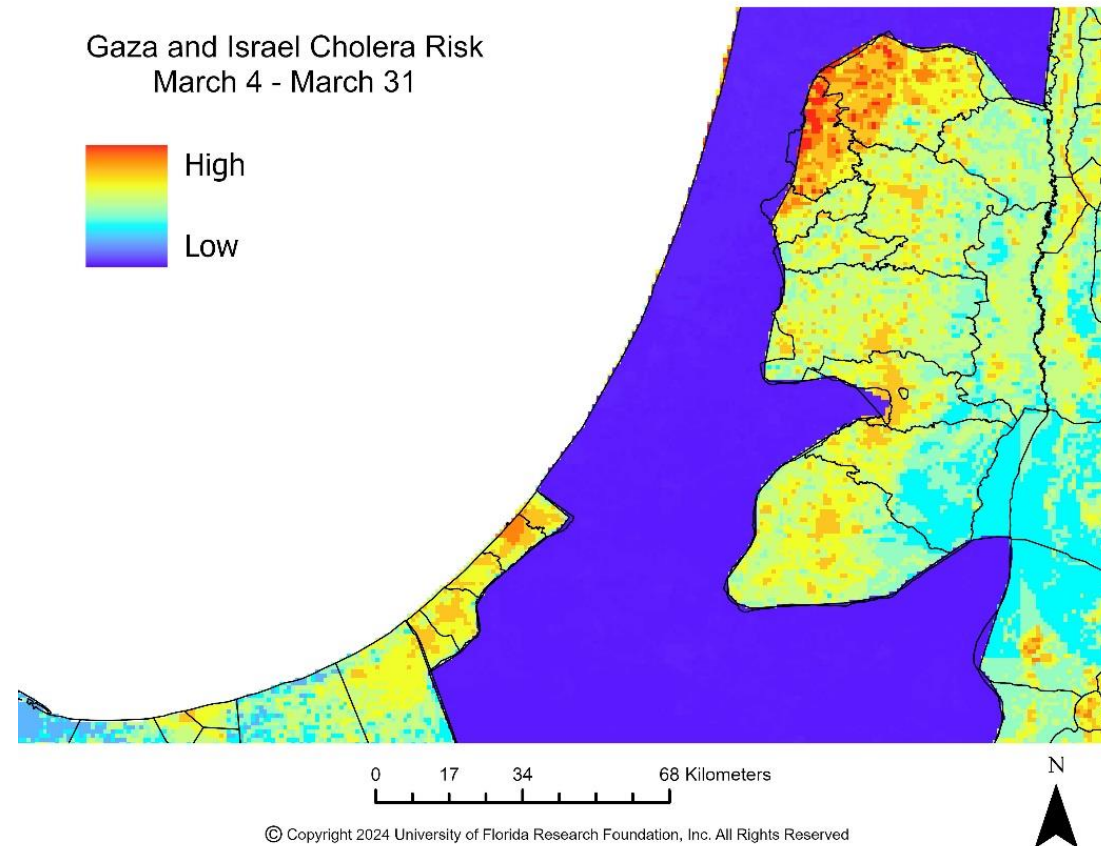


- Start-of-Project ARL = 7 (*Jan 22*)
 - Cholera risk for Yemen were generated and distributing to intergovernmental organizations.
- Goal ARL = 9
- Current ARL = 8 (*April 2024*)
 - Sustainable use within UF systems.

Highlight Image

- We are providing real time support to USAID, FCDO and UNICEF for cholera risk in Malawi

Middle East
Risk



Add short title here

Cholera Outbreaks Linked to Negative Anomalous Precipitation

- Negative anomalous precipitation was present in Ethiopia just before a June 2016 outbreak of AWD
- Similarly, negative anomalous precipitation has been found just before:
 - Ethiopia 2017 AWD outbreak
 - Ethiopia 2020 cholera outbreak
 - Senegal 2004 cholera outbreak
 - Senegal 2005 cholera outbreak

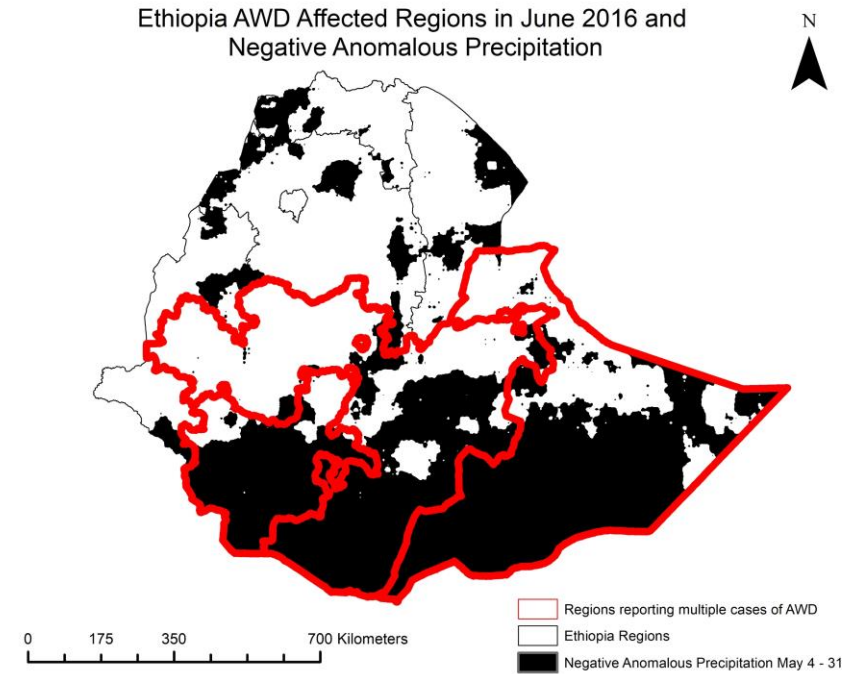
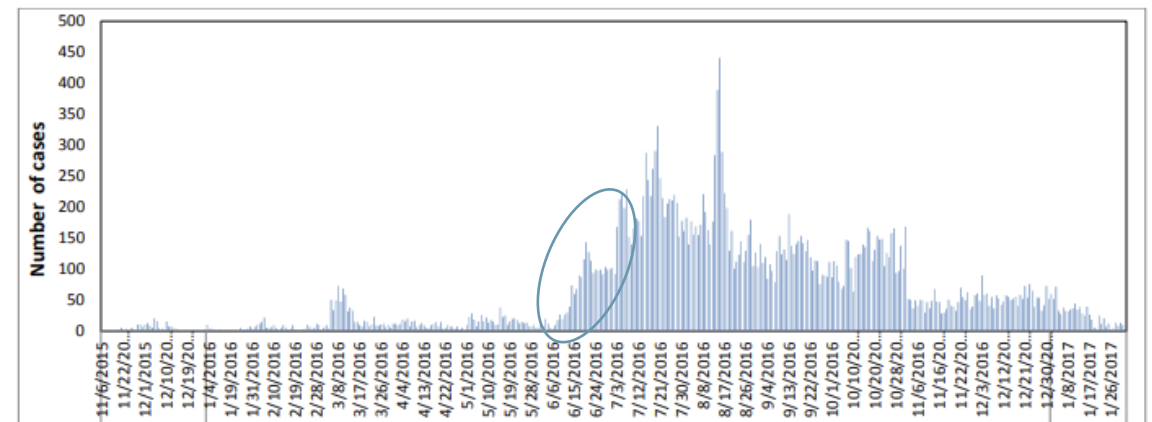
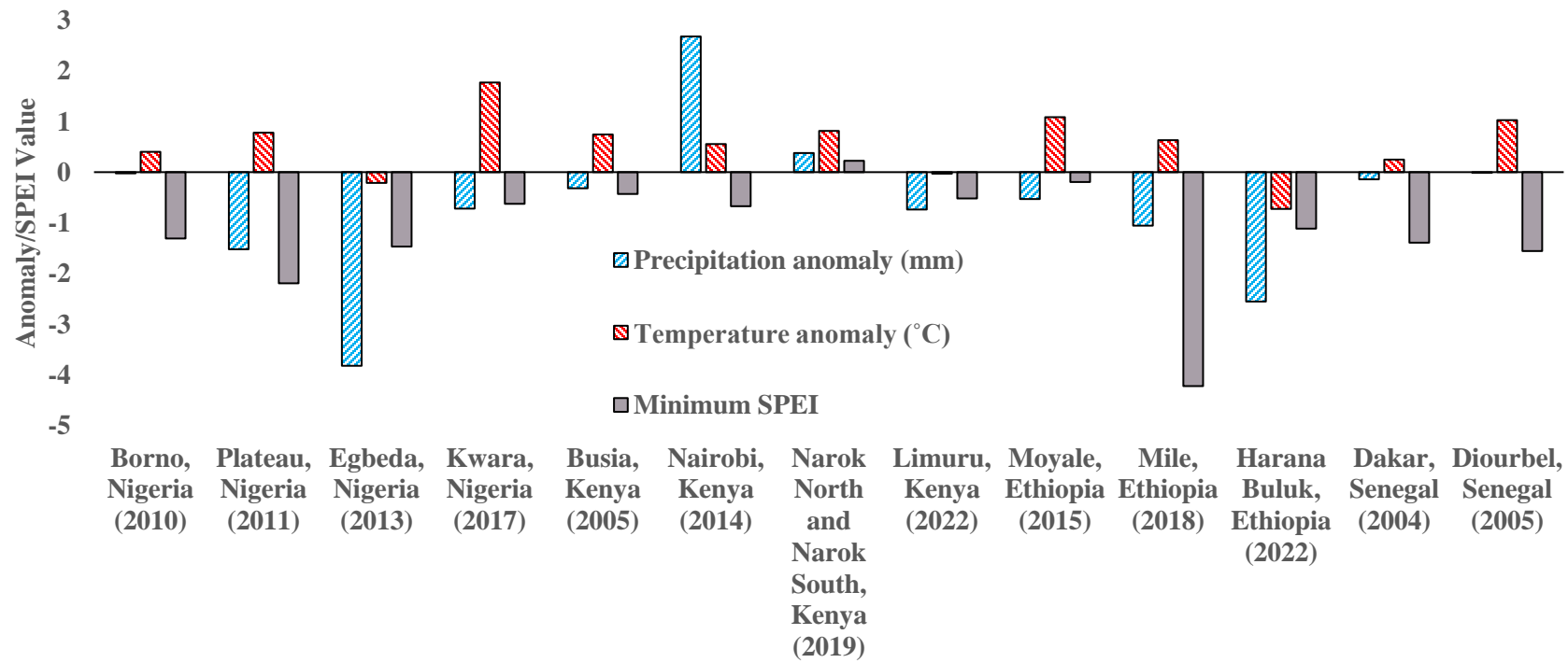


Figure 2: National Epi-curve of AWD Cases as of Week 5 February 2017
(Source: Health Cluster)



Source: UNICEF Ethiopia Humanitarian Situation Report #1 – Reporting Period:
January 2017

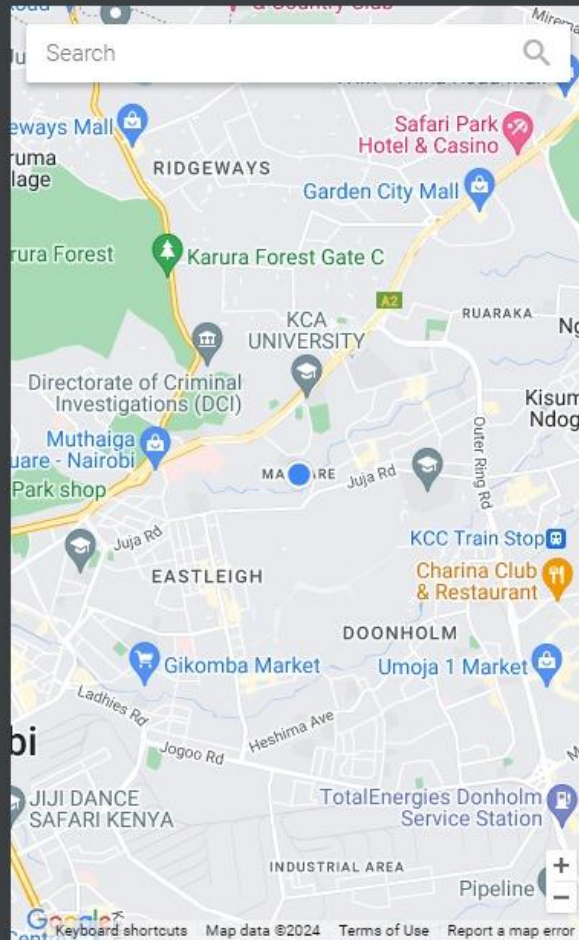


No Drought for previous 3-6 months	Below climatological average for two previous months	Below climatological average	Available and intact	High Risk of Cholera Outbreak	Low Risk of Cholera Outbreak
	Above climatological average for two previous months	Above climatological average	Poor or damaged		
	Air temperature	Rainfall	Water and Sanitation Access		
Drought for previous 3-6 months	Above climatological average for two previous months	Below climatological average	Poor or damaged	High Risk of Cholera Outbreak	Low Risk of Cholera Outbreak
	Below climatological average for two previous months	Below climatological average	Available and intact		



- **The application is being developed on the Flutter platform for Android devices, similar to the CholeraMap Bangladesh application**
- **The Flutter Platform allows seamless development and performance for both Android and iOS devices.**
- **Also allows simulation options for commonly available smartphones.**

Single points Routes



Enable GPS signal

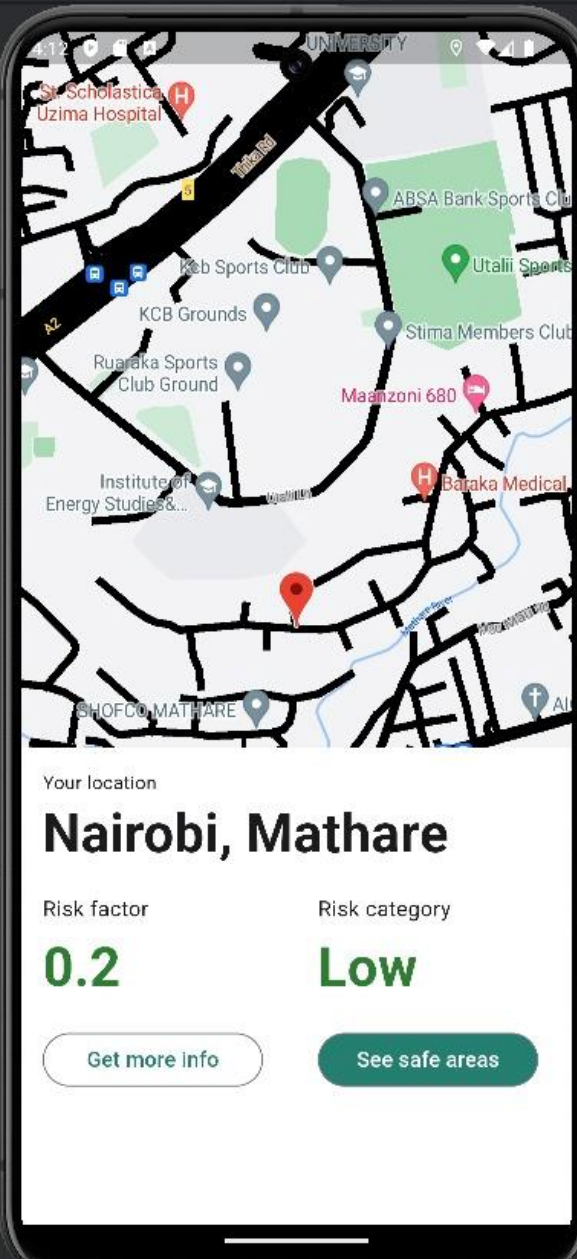
Saved points

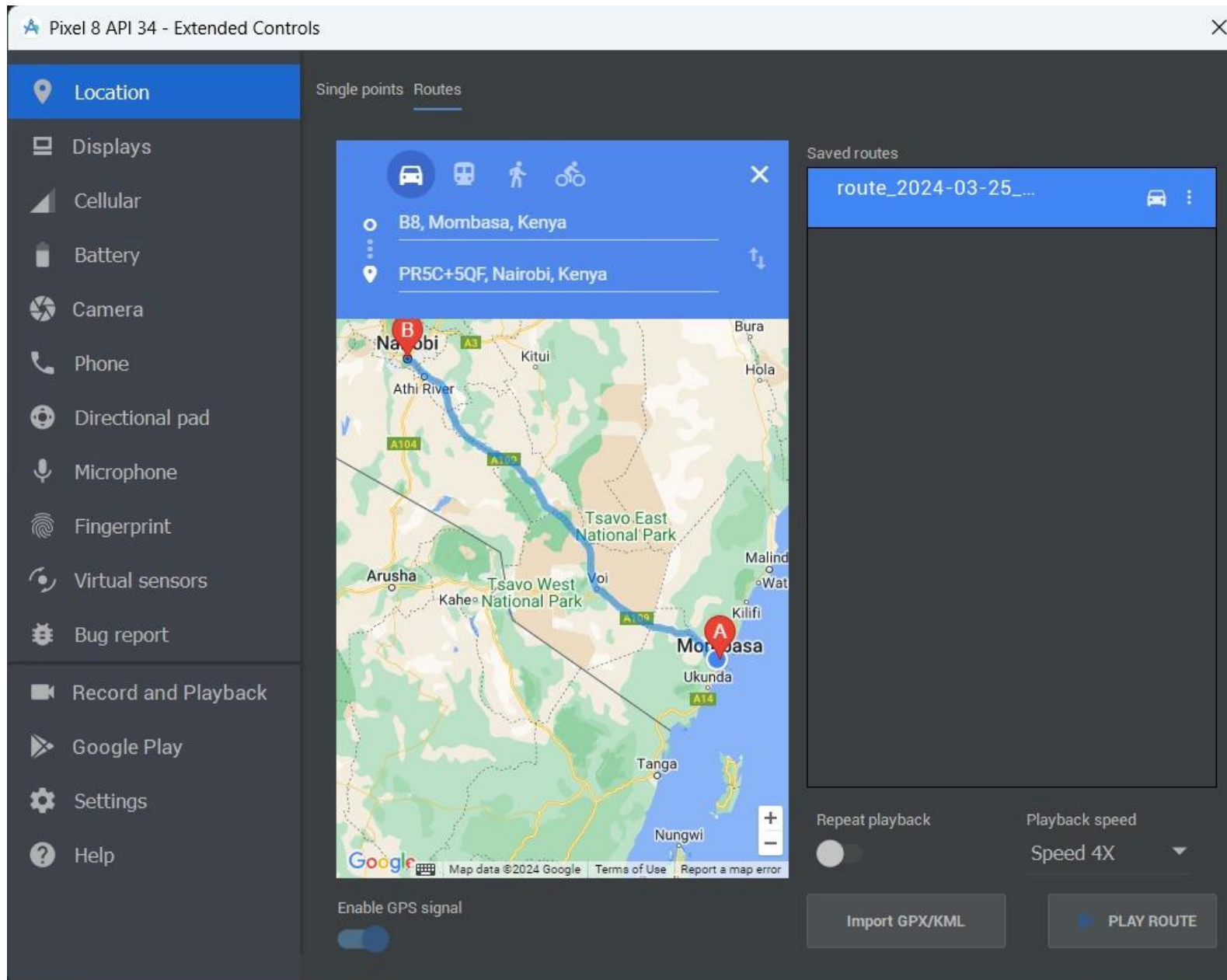
point_2024-03-25_...
-1.2619, 36.8585

This image shows the simulation environment:
Use of set location for retrieval of cholera risk
(Color coded **GREEN** for value 0.2 or a Low value)
for the Mathare slum area of Nairobi, Kenya.

Import GPX/KML

SET LOCATION





The application will also allow the continuous retrieval and display of cholera risk value

Validation of cholera prediction system

- Malawi (2022- 2023)
- Ukraine (2022)
- Yemen (2017-2022)
- Haiti (2010, 2017)
- Zimbabwe (2015)
- Bengal delta (2013)



Get involved

- Accurate prediction of cholera is complex, and requires knowledge of various experts.
- We continue to improve our predictive intelligence system using earth observations and data from microbiology, sociology and epidemiology analyses.

Join us to make cholera history:

- Determine how to make accurate prediction of epidemics.
- Tell us how to overcome pitfalls in our modeling philosophy.
- How do we improve prediction intelligence for cholera?
- Share or contribute data that can be integrated in our algorithms

Scan this QR code to view a video on the cholera model employed in Sudan in 2019.



Technology Services

We offer the following technical services at no cost:

- Live interactive training to understand how to interpret a cholera prediction risk score.
- Risk maps for regions currently not covered in the data system.
- Understanding risk of cholera for human populations at the country, district, and local scales.
- Guidance on collecting water samples to detect cholera bacteria.
- Advice on operability and limitation of the cholera prediction system.

Join Cholera Prediction Consortia

Send email to
cholraprediction_users@lists.ufl.edu

or
Scan



Key Contacts

Dr. Antar Jutla – ajutla@ufl.edu
Dr. Rita Colwell – rcolwell@umd.edu
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Predictive Intelligence System For Cholera



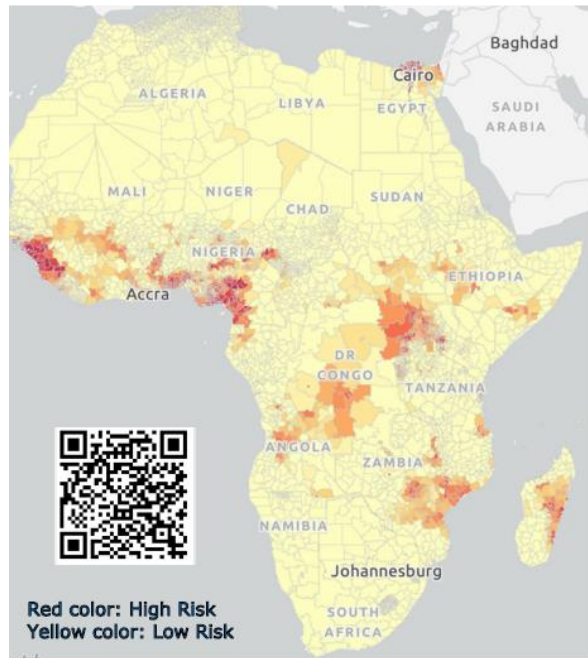
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*Engineering School of Sustainable
Infrastructure & Environment*
UNIVERSITY OF FLORIDA

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UNIVERSITY
OF RHODE ISLAND

Research funded through a grant from NASA. NASA does not endorse any claims in this research/application

Cholera Prediction Hub

The Cholera Prediction Hub is web-based tool that help users in countries worldwide determine the potential risk of cholera.

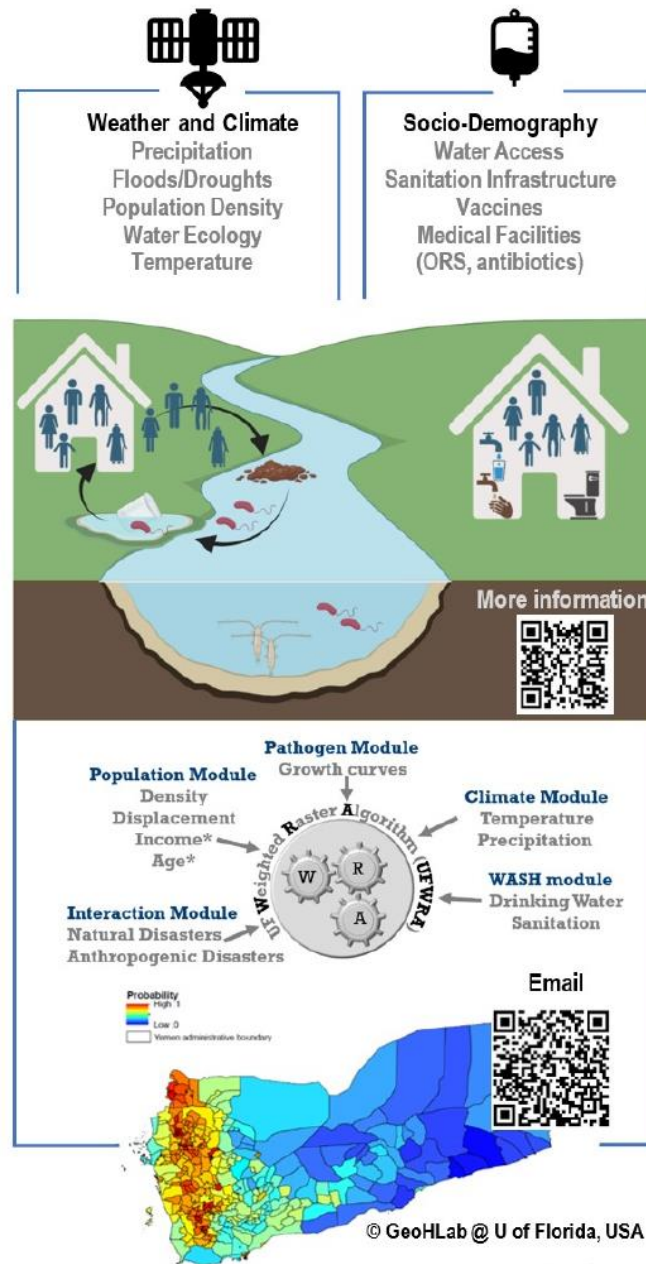


Features and Application

- Indicate regions with risk of cholera approximately four weeks in advance.
- Integrates climate, weather, sociological, demographical, and environmental factors in the algorithm.
- Provides a clear understanding of how disease risk is calculated and derived to inform end users of risk in their region.
- Users include researchers studying water-borne diseases, public and non-government decision-makers, and individuals wishing to learn current vibrio risk in their regions.

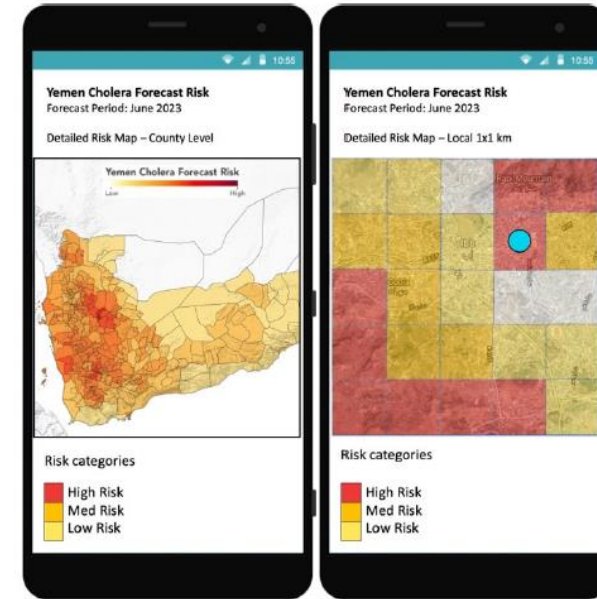
Cholera Prediction

Modeling Philosophy



Cholera Risk Locator App

The Cholera Risk Locator smartphone application allow users to view details of local, regional, and country level risk [high, medium, low] of cholera.



Features and Application

- Provides color-coded, publically accessible, high-resolution 1 km x 1 km information on cholera risk.
- Seamless integration of earth observations [terrain, rivers, ponds] and output from cholera risk algorithm.
- Show nearest pharmacies, safe water points, shops, hospitals, road networks.
- Allows users to customize map layers for visualization.



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Earth Observations and Smartphones
Civil and Environmental Engineering
@ University of Rhode Island, USA

Advanced Water Body Detection

- Collaborated with U of Virginia for development of algorithms
- These water bodies will be used as overlay layers to identify potential locations of water sources.

Optional Materials

- Publications/presentations

1. Usmani, M., Brumfield, K., *Magers, B., Chaves-Gonzalez, J., Ticehurst, H., Sumner, T., Barciela, R., McBean, F., Colwell, R., and Jutla, A. 2023: Combating cholera by building predictive capabilities for pathogenic *Vibrio cholerae* in Yemen. *Scientific Reports*. DOI: 10.1038/s41598-022-22946-y
2. Brumfield, K., Chen, J., *Gangwar, M., *Usmani, M., Hasan, N., Jutla, A., Huq, A., Colwell, R. 2023 Environmental Factors Influencing Occurrence of *Vibrio parahaemolyticus* and *Vibrio vulnificus*. *Applied and Environmental Microbiology*, DOI: <https://doi.org/10.1128/aem.00307-23>.
3. Usmani, M., Magers, B., Brumfield, K., Nguyen, T., Huq, A., Barciela, R., Colwell, R., and Jutla, A. (2022): Predictive Intelligence for Cholera in Ukraine? AGU: GeoHealth. DOI: 10.1029/2022GH000681
4. Jutla, A., *Usmani, M., Brumfield, K. D., *Singh, K., McBean, F., Potter, A., Gutierrez, A., Gama, S., Huq, A., & Colwell, R. (2023). Anticipatory decision-making for cholera in Malawi. *mBio*, e00529-23. <https://doi.org/10.1128/mbio.00529-23>

- 8 Conference/meeting presentations.

- 1 Patent

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