

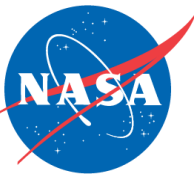
HEALTH & AIR QUALITY

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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 03/27/2023



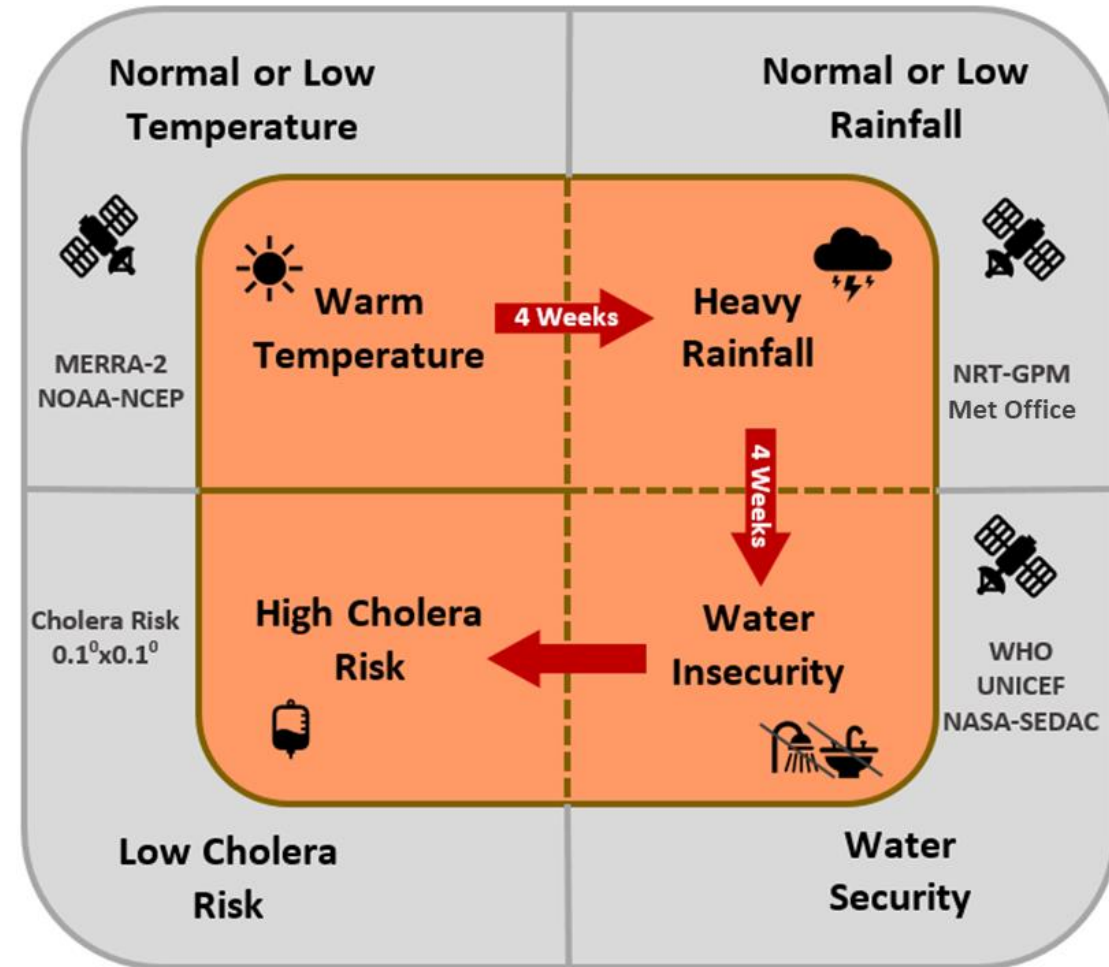
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Project Summary

- 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.



Warm temperature= above climatological average temperature
Heavy rainfall= above climatological average precipitation
Water insecurity=lack of access to water and sanitation access
High cholera risk=probability of cholera greater than 50%

Development of an Earth Observation based Global Cholera Prediction System

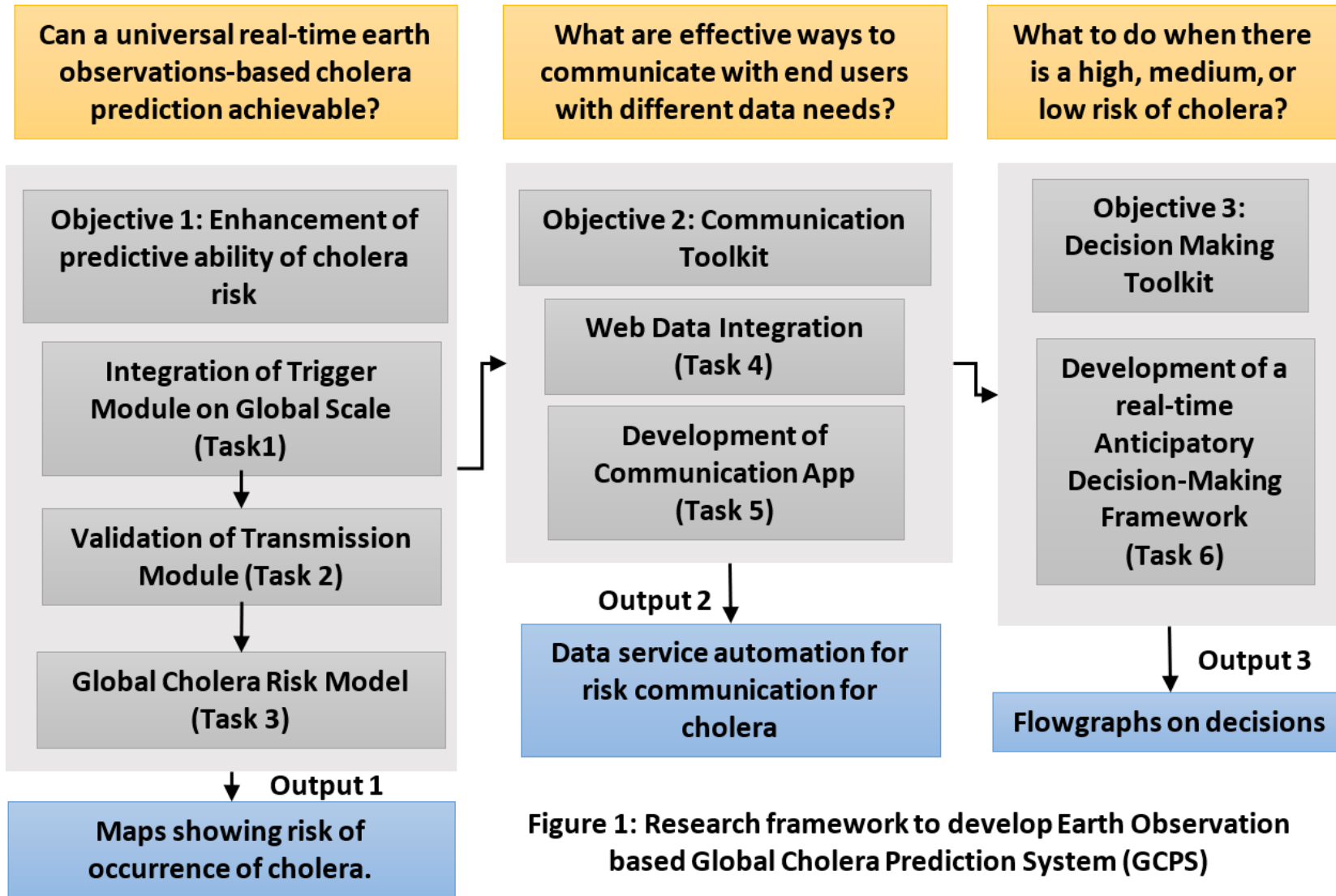
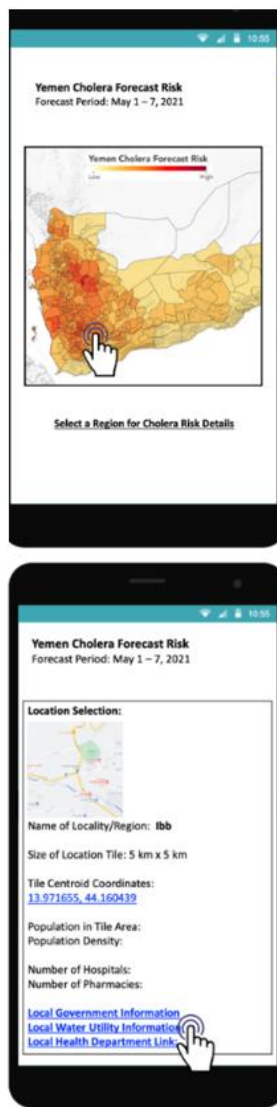
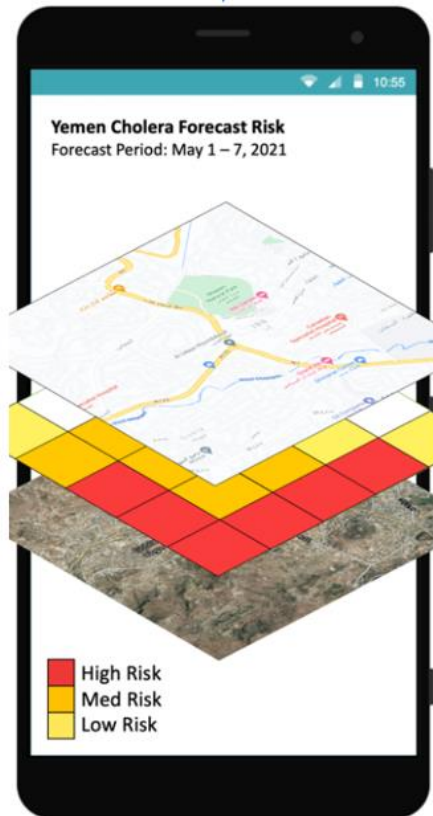


Figure 1: Research framework to develop Earth Observation based Global Cholera Prediction System (GCPS)



Framework Development
Android Studio



- API request to UF**
- Cholera Trigger Risk
- Cholera Transmission Risk
- Population Density
- Relief Camps
- Water Access Points
- Human Mobility

API request to Google
Google Earth Layer:

- Elevation
- Transportation Network
- Satellite Rainfall
- Water Resources
- Hospitals
- Pharmacies
- Water Access Points

Static Information Tiles

What to do when cholera risk is high?
Native language support (through End Users)

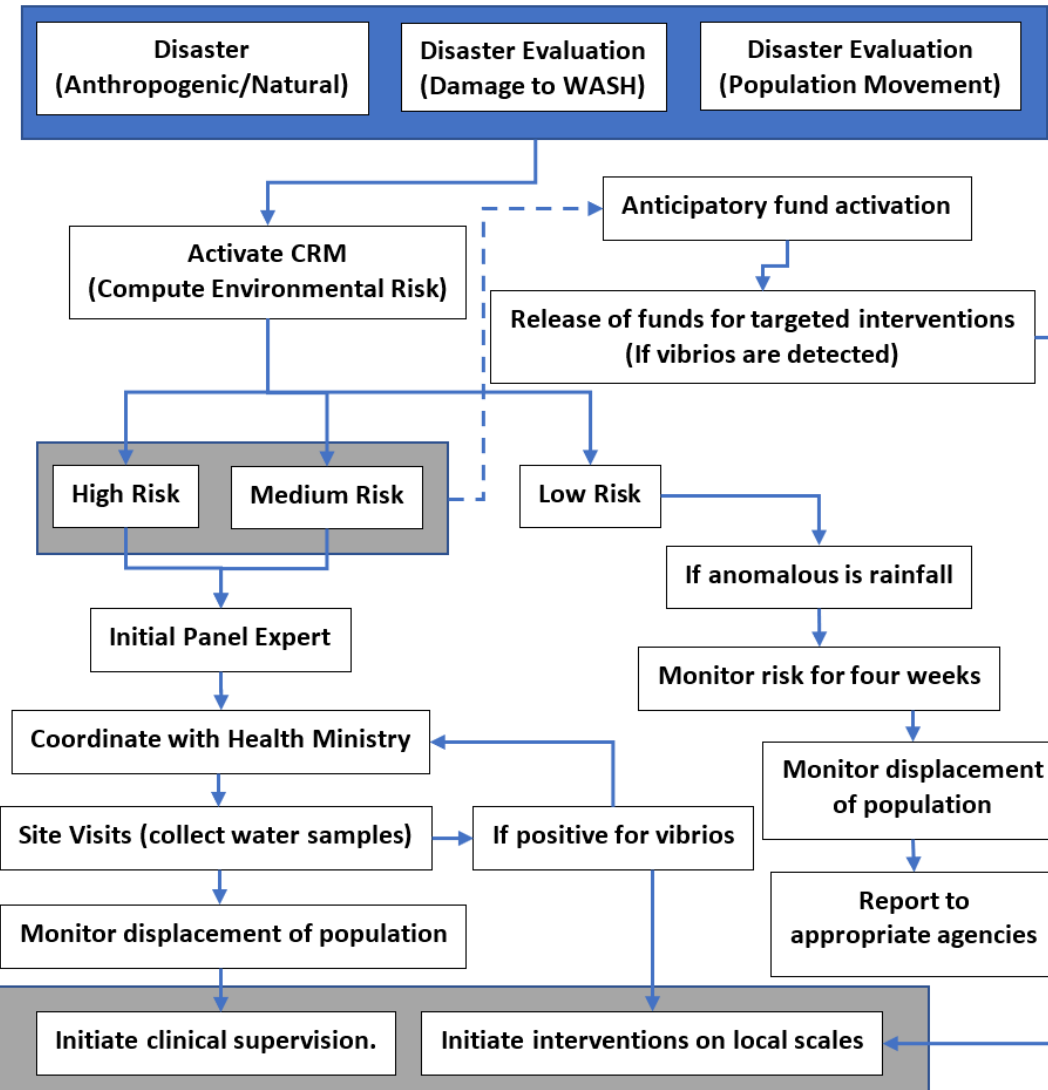
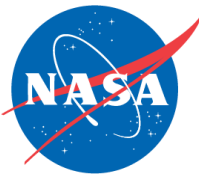


Figure 7: Preliminary flowgraph prototype of ADM being developed by UF/ UMD/URI/UNOCHA

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	

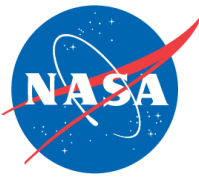


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Project Partners/Collaborators

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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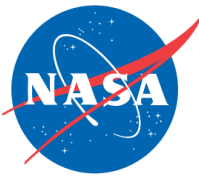
Project End-users & Stakeholders

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

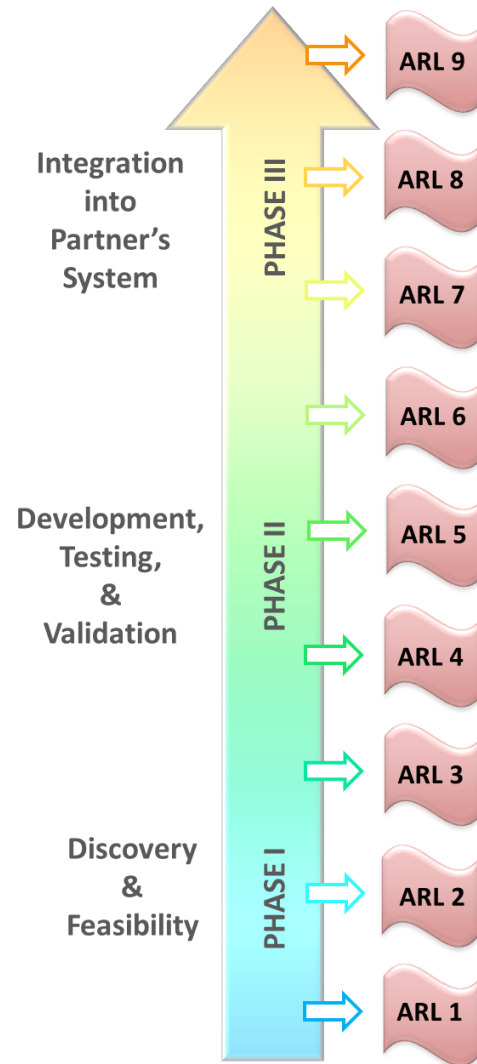
We send out the risk reports of cholera to our stakeholders on a weekly scale and based on their queries and interests we schedule virtual meetings. Cholera prediction dashboard and list have been created to keep the stakeholders and end-users updated with the progress and changes.



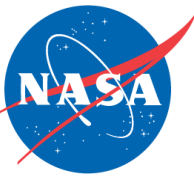
Schedule & Milestones

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
*Jutla to consult with UF Information Technology Services (budgeted); Yr: Year							

ARL Performance



- Start-of-Project ARL = 7 (*Jan 23*)
 - Cholera risk for Yemen were generated and distributing to intergovernmental organizations.
- Goal ARL = 9
- Current ARL = 7 (*Jan 2023*)
 - Started producing cholera risk for various countries (including Malawi) and distributing to intergovernmental organizations.



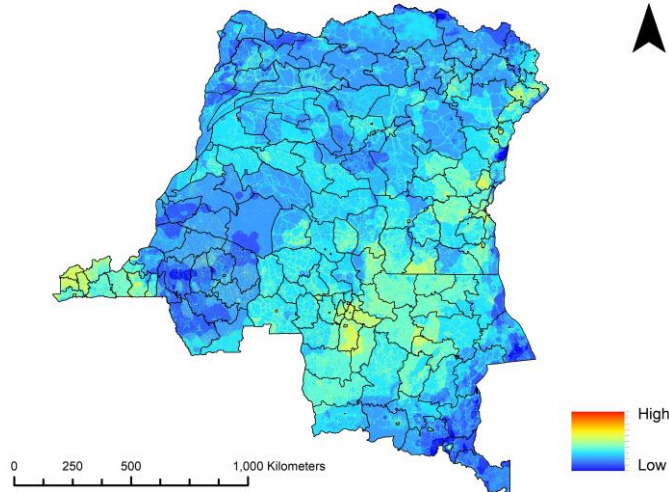
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Current ARL-Supporting Evidence

- ARL 6.5

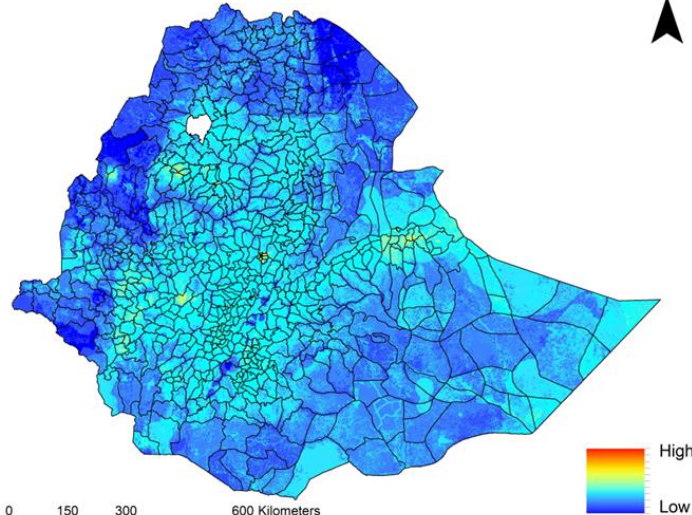
DRC

DRC County Cholera Risk December 5 - January 1



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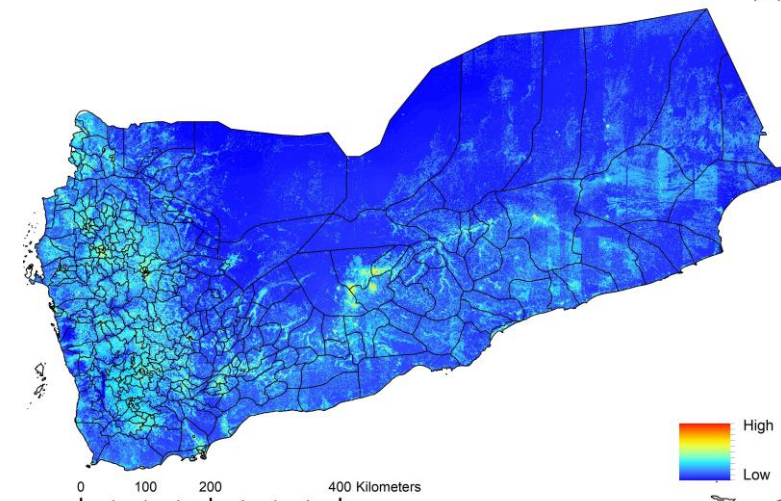
Ethiopia Cholera Risk December 12 - January 8



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Yemen

Yemen County Cholera Risk December 12 - January 8



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Prototype application system integrated into end-user's operational environment

Based on feedback, we have developed a dedicated spatial platform at UF with free access, that provides pixel and county level of risk scores for cholera cases for various regions of the world.

Prototype application functionality tested & demonstrated in decision making activity

The cholera trigger model is fully functional, and we have shown applicability for various regions

Cholera Prediction

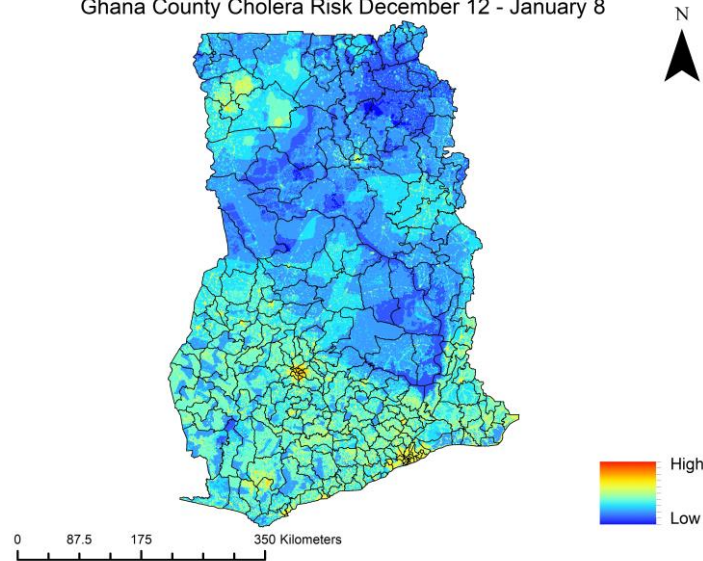


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Current ARL-Supporting Evidence

- ARL 7

Ghana County Cholera Risk December 12 - January 8

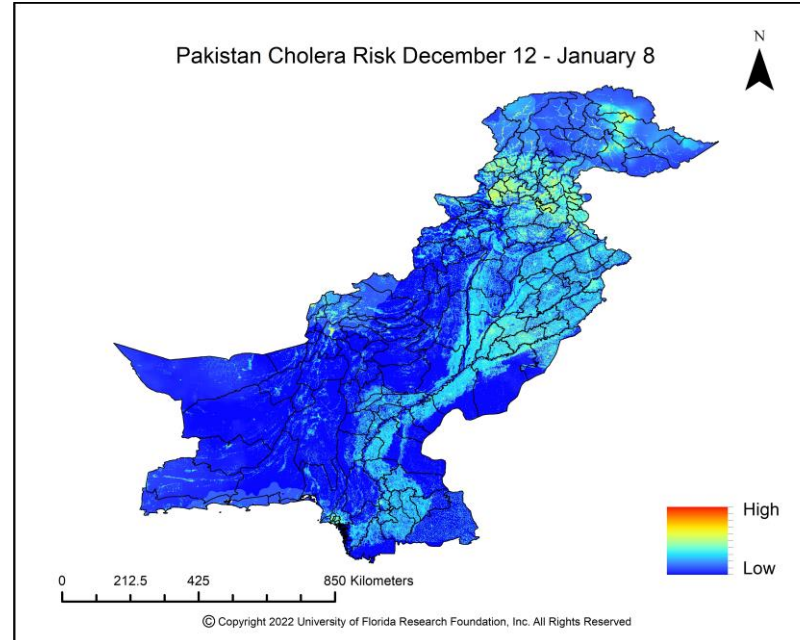


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Ghana

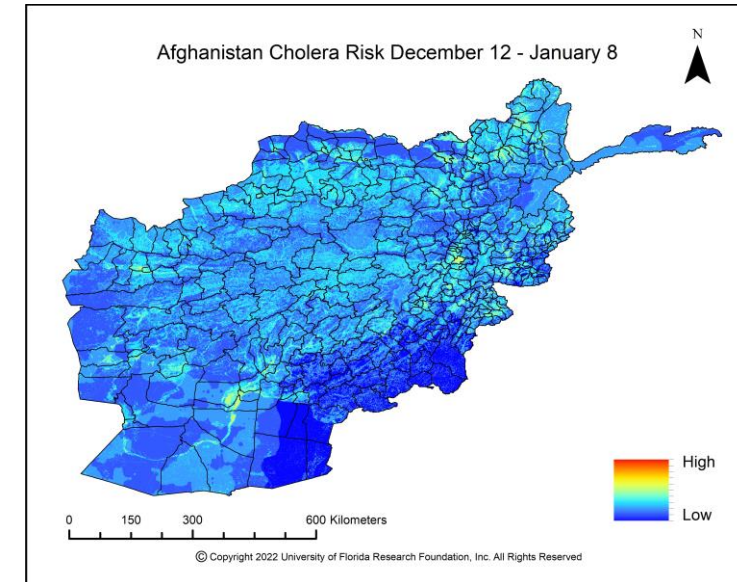
Pakistan

Pakistan Cholera Risk December 12 - January 8



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Afghanistan Cholera Risk December 12 - January 8



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Afghanistan

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

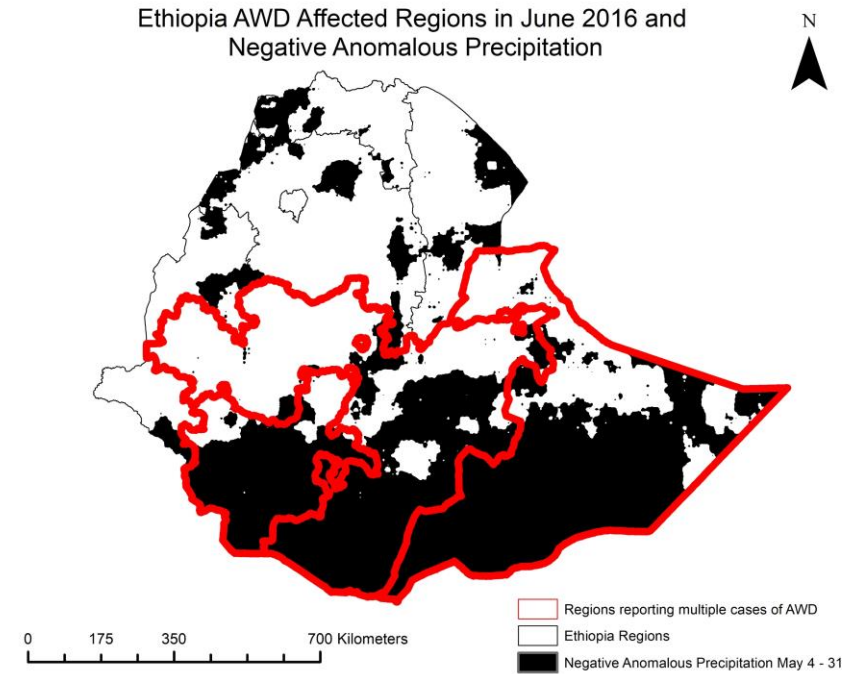
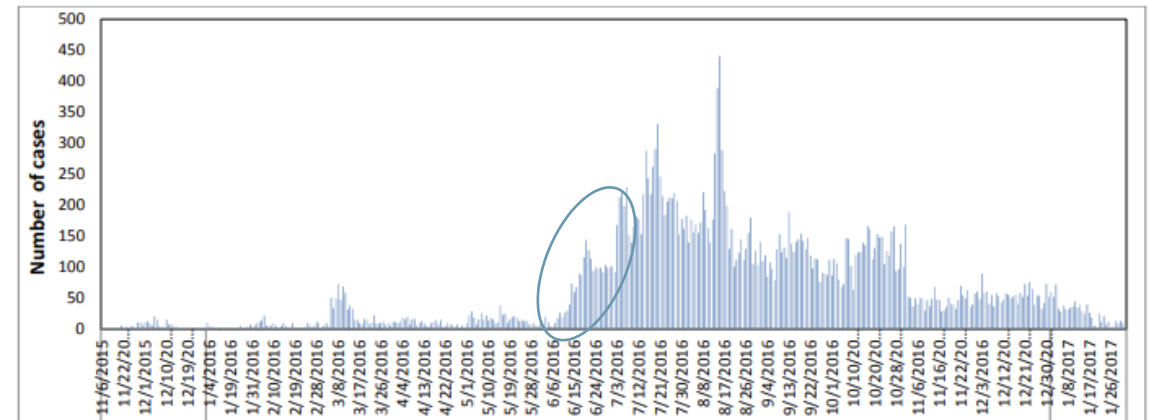
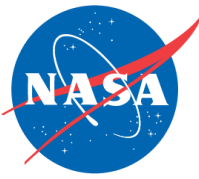


Figure 2: National Epi-curve of AWD Cases as of Week 5 February 2017
(Source: Health Cluster)



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



Challenges and Risks

Rank	Type *	Risk	Mitigation Action	Date first noted/Date resolved (if applicable)
1	B	Contracts execution delays	All subcontracts are executed	Nothing to report
2				
3				
4				
5				
...				

* Please designate risk type as: Technical (T), Budget (B), End-User/Stakeholder (ES), or Project Management (PM)

Accomplishments since Last Update

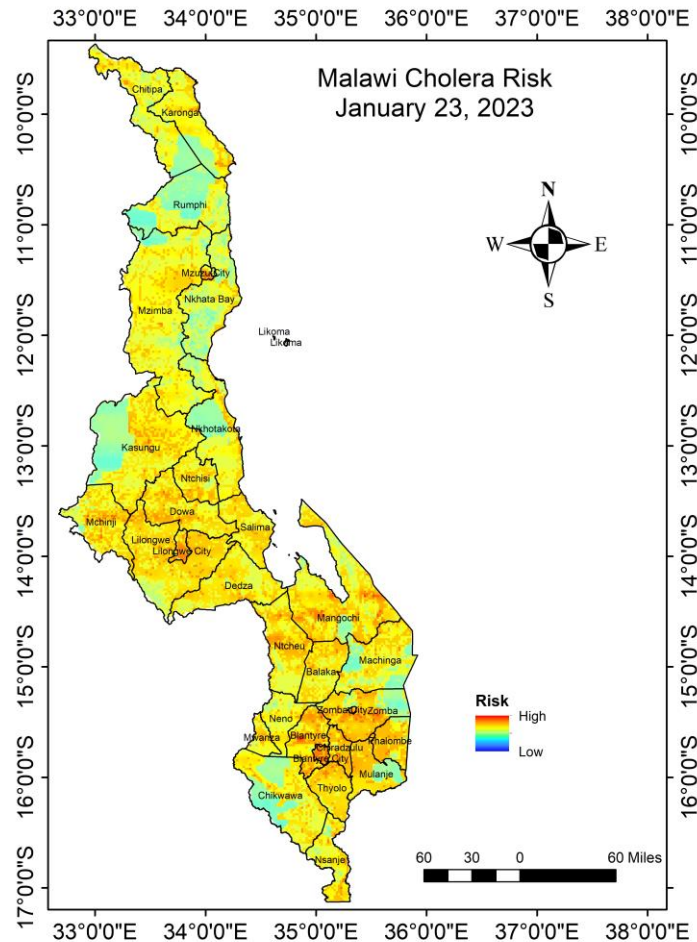


- In this year we have been able to increase the number of stakeholders and were able to add local ministries to the list. During 6th AfriGEO symposium in Ghana we were able to meet the representative of Malawi ministry who showed interest in our project and wanted to be end user.
- The study on effective utilization of cholera prediction system in Yemen has been accepted for publication in the Nature publications (details provide in the optional material section).

Highlight Image

- Since March 2022 Malawi has been continuously experiencing cholera cases, and our predictive system was able to capture the increase in risk. Figure below depict the high risk that the country experiences during late January and February 2023.

Malawi



Optional Materials

- Publications/presentations
- 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 (Accepted).
- 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
- Jutla, A., Usmani, M., Gonzalez, J., and Colwell, R. 2022: Towards a global framework for developing predictive intelligence water-borne infectious disease decision making system. AGU, Chicago, IL, USA. December 15.
- Jutla, A. 2022: Earth Observation Based Decision-making Framework for Enhancing Predictive Capabilities for Outbreak of Cholera in Africa. APHA, Boston, MA, USA. November 6.
- Usmani, M., Gangwar, M., Jamal, Y., Brumfield, K., Huq, A., Nguyen, T., Colwell, R., and Jutla, A. 2022: Human health as an indicator of water security: A climate change conundrum. FIH, San Juan, Puerto Rico, USA. June 24.