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
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

Can a universal real-time earth observations-based cholera prediction achievable?

Objective 1: Enhancement of predictive ability of cholera risk

Integration of Trigger Module on Global Scale (Task 1)

Validation of Transmission Module (Task 2)

Global Cholera Risk Model (Task 3)

Output 1
Maps showing risk of occurrence of cholera.

What are effective ways to communicate with end users with different data needs?

Objective 2: Communication Toolkit

Web Data Integration (Task 4)

Development of Communication App (Task 5)

Output 2
Data service automation for risk communication for cholera

What to do when there is a high, medium, or low risk of cholera?

Objective 3: Decision Making Toolkit

Development of a real-time Anticipatory Decision-Making Framework (Task 6)

Output 3
Flowgraphs on decisions

Figure 1: Research framework to develop Earth Observation based Global Cholera Prediction System (GCPS)
## Earth Observations, Models, and/or Technologies

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

Cholera Prediction
## Project Partners/Collaborators

List project Co-Investigators, collaborators, and other partners

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
<th>Affiliation</th>
<th>Organization Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO-I</td>
<td>Rita Colwell</td>
<td>U Maryland</td>
<td>University</td>
</tr>
</tbody>
</table>
| 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 |
Project End-users & Stakeholders

List organization names and organization types

<table>
<thead>
<tr>
<th>Organization Name</th>
<th>Organization Type</th>
<th>Decision Making Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN</td>
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<tr>
<td>FCDO</td>
<td>Commonwealth Office</td>
<td></td>
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<tr>
<td>Malawi Government</td>
<td>Ministry</td>
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</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Student</th>
<th>Lead</th>
<th>ARL</th>
<th>Yr1</th>
<th>Yr2</th>
<th>Yr3</th>
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<tr>
<td>Task 1: Trigger component</td>
<td>UF</td>
<td>UF</td>
<td>7 to 8</td>
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<tr>
<td>Task 2: Transmission component</td>
<td>UF</td>
<td>UF</td>
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<td>xx</td>
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<tr>
<td>Task 3: Global CRM</td>
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<tr>
<td>Task 4: Web Hub</td>
<td>UF, URI</td>
<td>UF</td>
<td>7 to 9</td>
<td>xx</td>
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<tr>
<td>Task 5: Cholera App</td>
<td>UF, URI</td>
<td>URI</td>
<td>7/8 to 9</td>
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<td>Task 6: ADM</td>
<td>UF/URI</td>
<td>UMD/UNOCHA/FCDO</td>
<td>8 to 9</td>
<td>xx</td>
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</tbody>
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### 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.
• We are providing real time support to USAID, FCDO and UNICEF for cholera risk in Malawi
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
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.
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.
The application will also allow the continuous retrieval and display of cholera risk value along a route or network to simulate cholera risk in a natural hazard or disaster.
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 choleraprediction_users@lists.ufl.edu
or
Scan

Key Contacts
Dr. Antar Jutla – ajutla@ufl.edu
Dr. Rita Colwell – rcolwell@umd.edu
Dr. Ali Akanda – akanda@uri.edu
Dr. Anwar Huq – huq@umd.edu
Text/WhatsApp at +1-352-575-0276
The Cholera Prediction Hub is a web-based tool that helps users in countries worldwide determine the potential risk of cholera.

**Features and Application**
- Indicates 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.

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

**Features and Application**
- Provides color-coded, publicly 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.
- Shows nearest pharmacies, safe water points, shops, hospitals, road networks.
- Allows users to customize map layers for visualization.
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


- 8 Conference/meeting presentations.
- 1 Patent