

A multi-sensor remote sensing approach to predict cholera

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Goal of Research Project

- Development of a cholera prediction system using earth observations.
- *Synthesize and quantify role of hydrological, ecological, and climatic processes in triggering cholera outbreak at different spatial and temporal scales from satellites, and provide early warning to vulnerable population.*

Starting ARL: 2
Current ARL: 7



Overall timeline for research objective and activities at end user organization

Technical Strategy (WVU, UMD, URI)		ARL	Yr1	Yr2	Yr3
A1	Epidemic Cholera	3/4	C		
	Mixed-Model Cholera	3/4	C	C	
	Endemic Cholera	3/4	C		
A2	Estimate Hydroclimatological Cholera Risk	5		C	
A3	Cholera Index (hydroclimatology + societal)	6/7		C	C±
Decision making activities at the End User Organization, ICDDR, B*					
Organizational challenges identified and managed		4/5	C		
Potential to improve decision making activity		5		C	
Projected improvement in simulated environment and decision making activity		6/7		C	IP
Transition and Sustainability plan: Train-the-trainer workshops		5/6/ 7	C	C	IP

- Three new end-users have started to use our results
 - Met Office, UK
 - DfID, UK
 - UNICEF

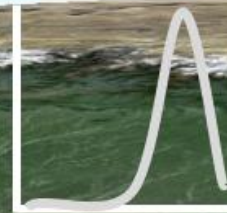


Summary of Cholera

Epidemic Cholera

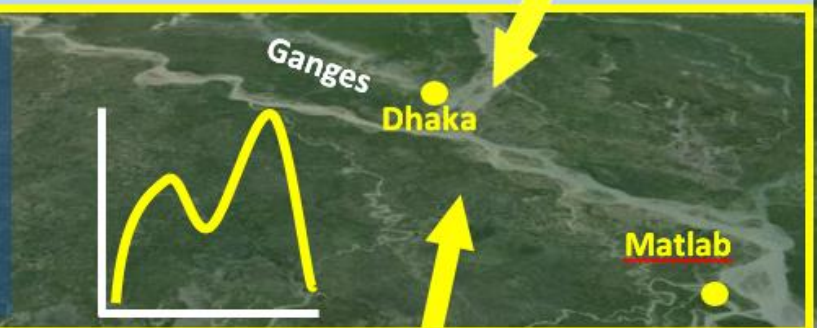
- Sporadic outbreak
- Usually occurs following floods or inundation of large landscapes
- Warm temperatures may increase growth of bacteria in aquatic bodies.

Typical cholera seasonality



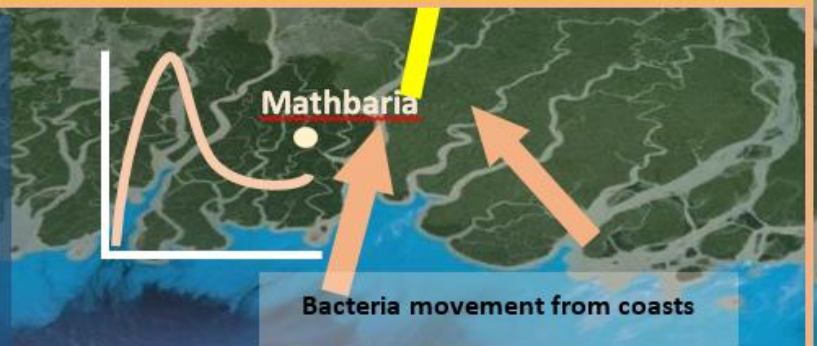
Mixed-mode Cholera

- Usually two seasonal peaks
- One peak related to seawater intrusion; Second peak associated with widespread inundation
- Specific to Bengal Delta region



Endemic Cholera

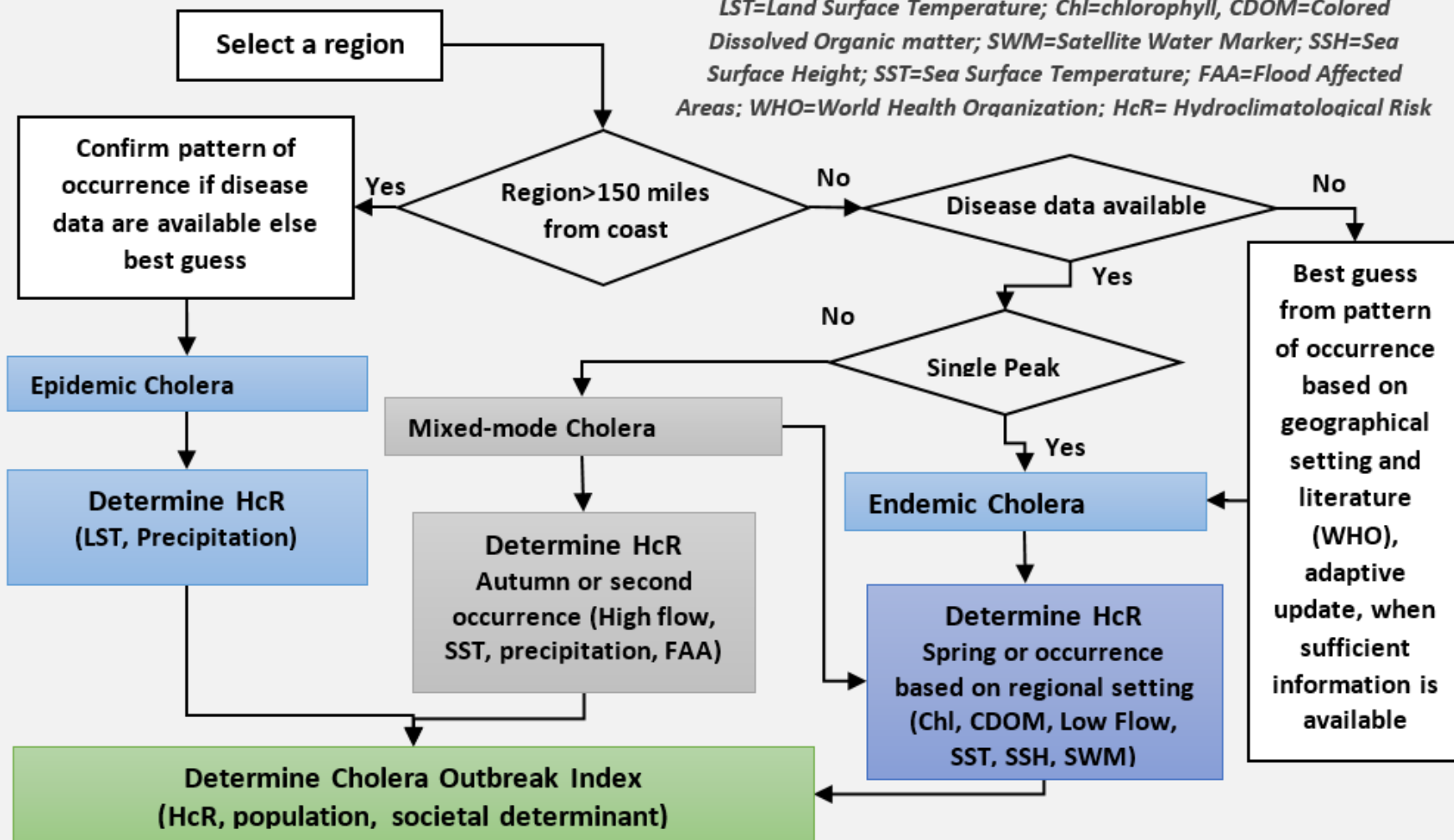
- Cholera persists throughout year in coastal regions
- Seawater Intrusion from coasts to inland
- Cholera outbreaks occur during low river flow season



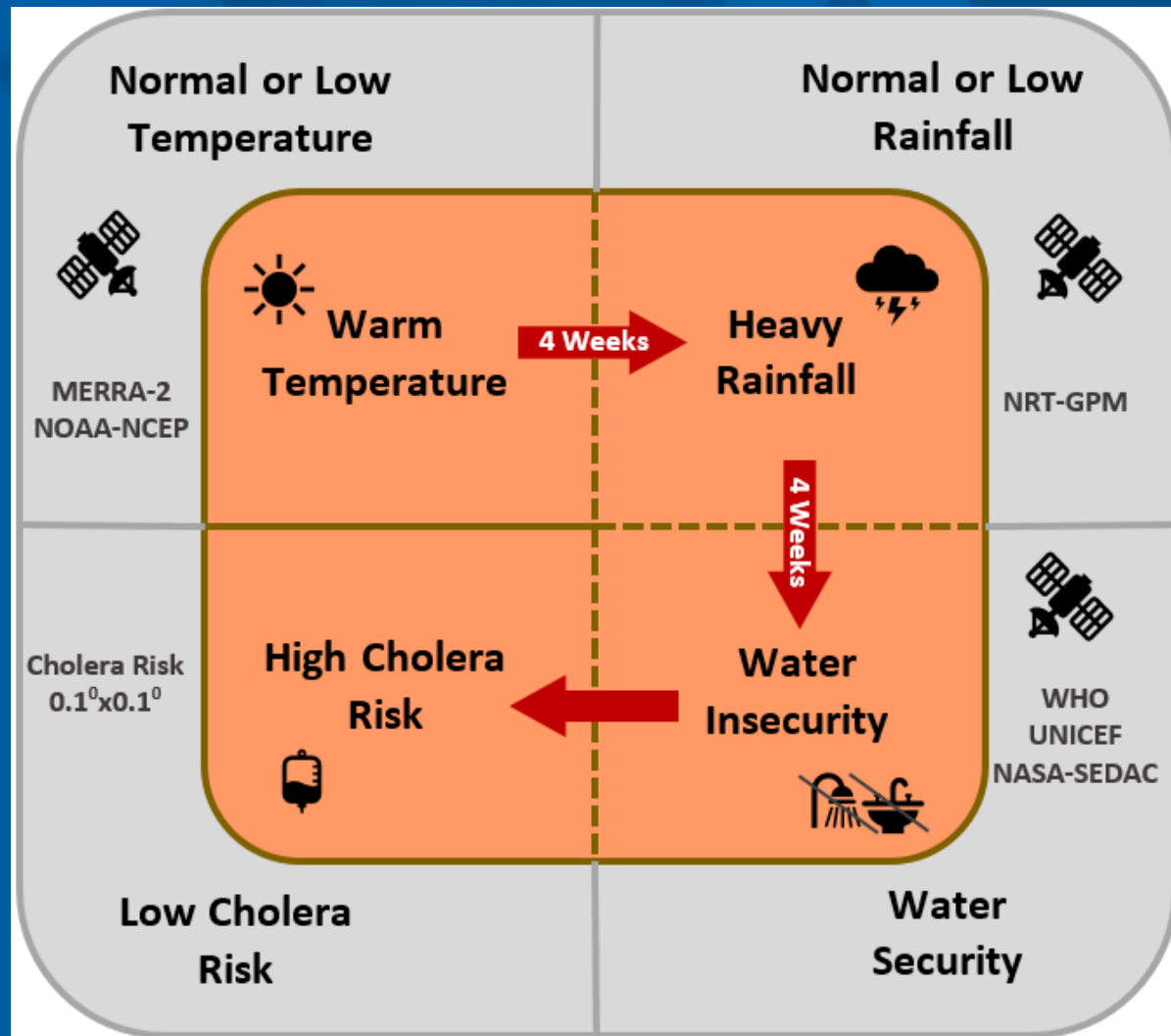
Background image: Bangladesh and Bay of Bengal



LST=Land Surface Temperature; Chl=chlorophyll, CDOM=Colored Dissolved Organic matter; SWM=Satellite Water Marker; SSH=Sea Surface Height; SST=Sea Surface Temperature; FAA=Flood Affected Areas; WHO=World Health Organization; HcR= Hydroclimatological Risk



Epidemic cholera model



Warm temperature= above climatological average temperature

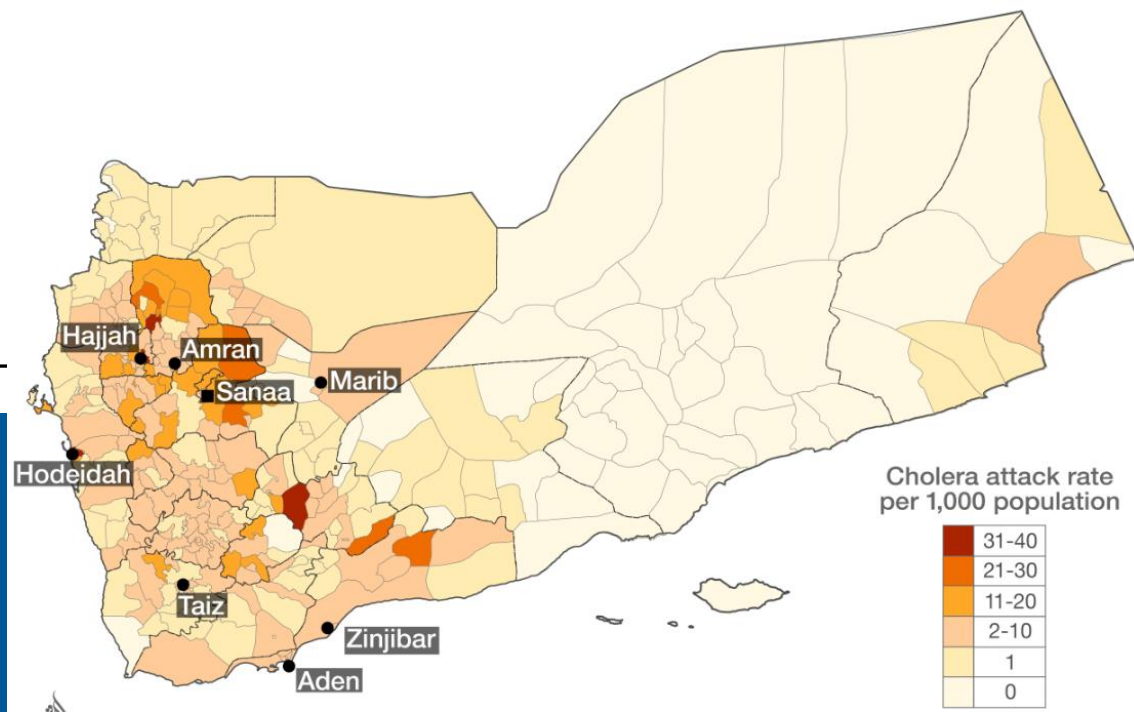
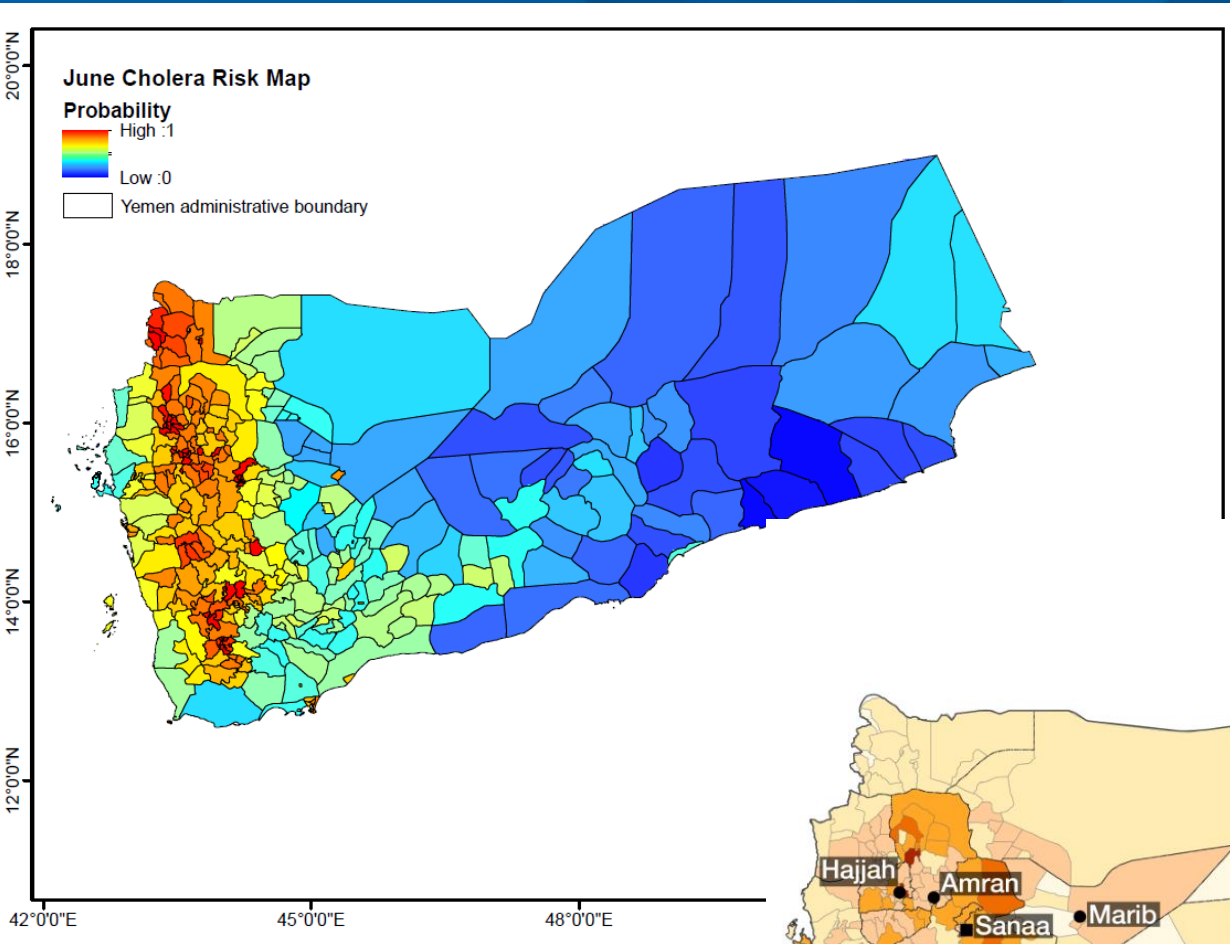
Heavy rainfall= above climatological average precipitation

Water insecurity=lack of access to water and sanitation access

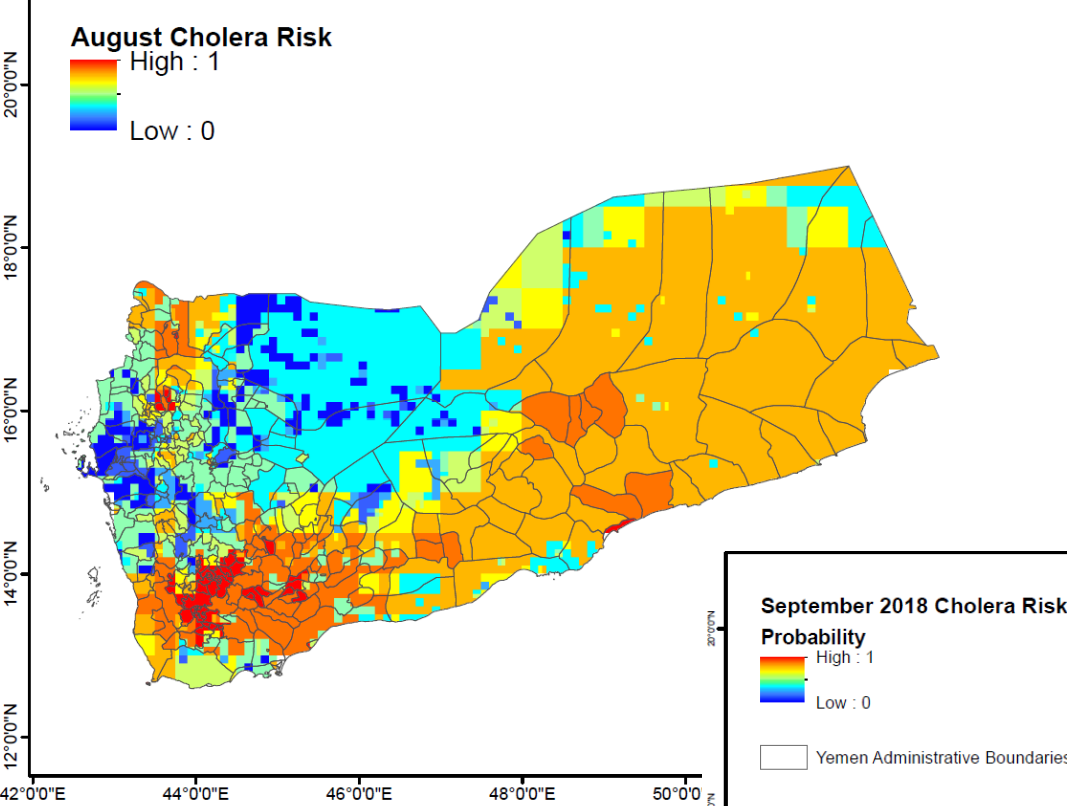
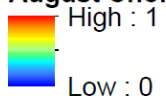
High cholera risk=probability of cholera greater than 50%



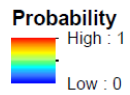
Epidemic cholera model



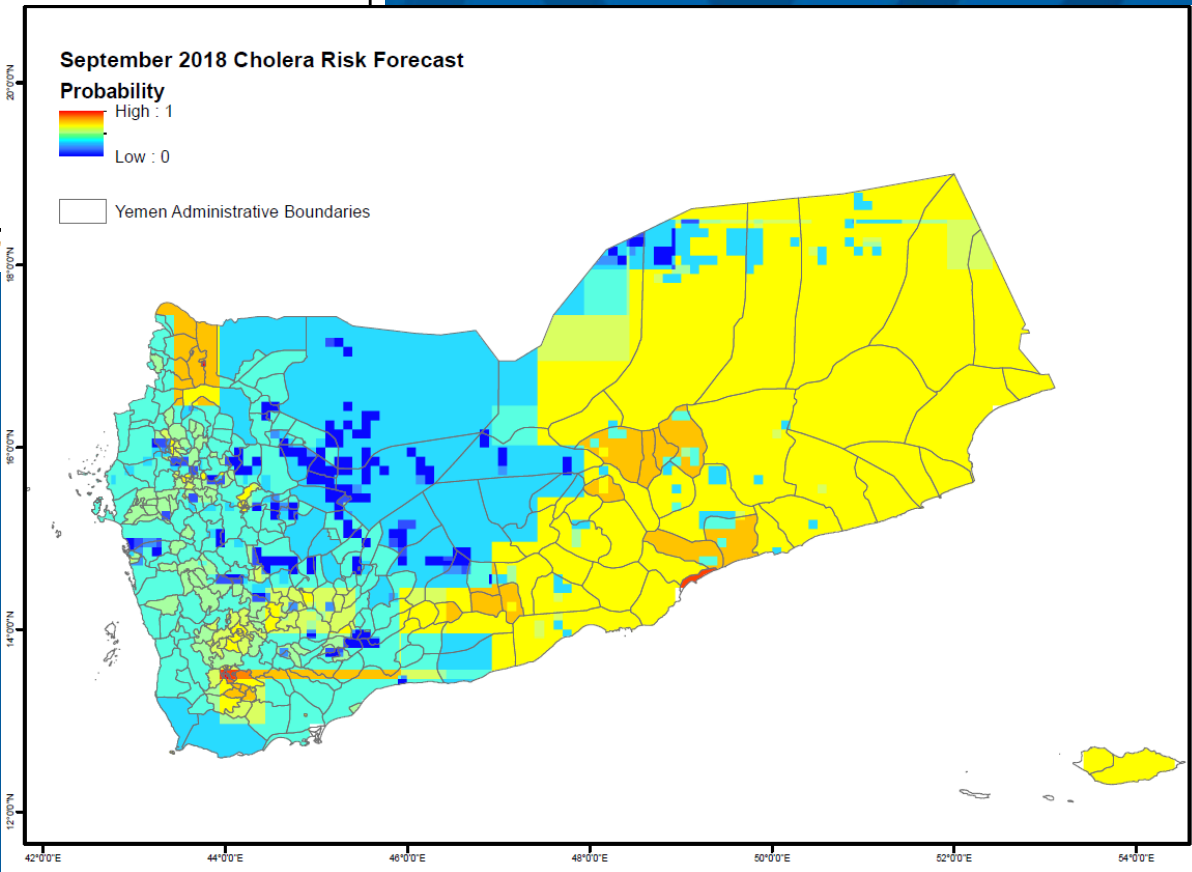
August Cholera Risk

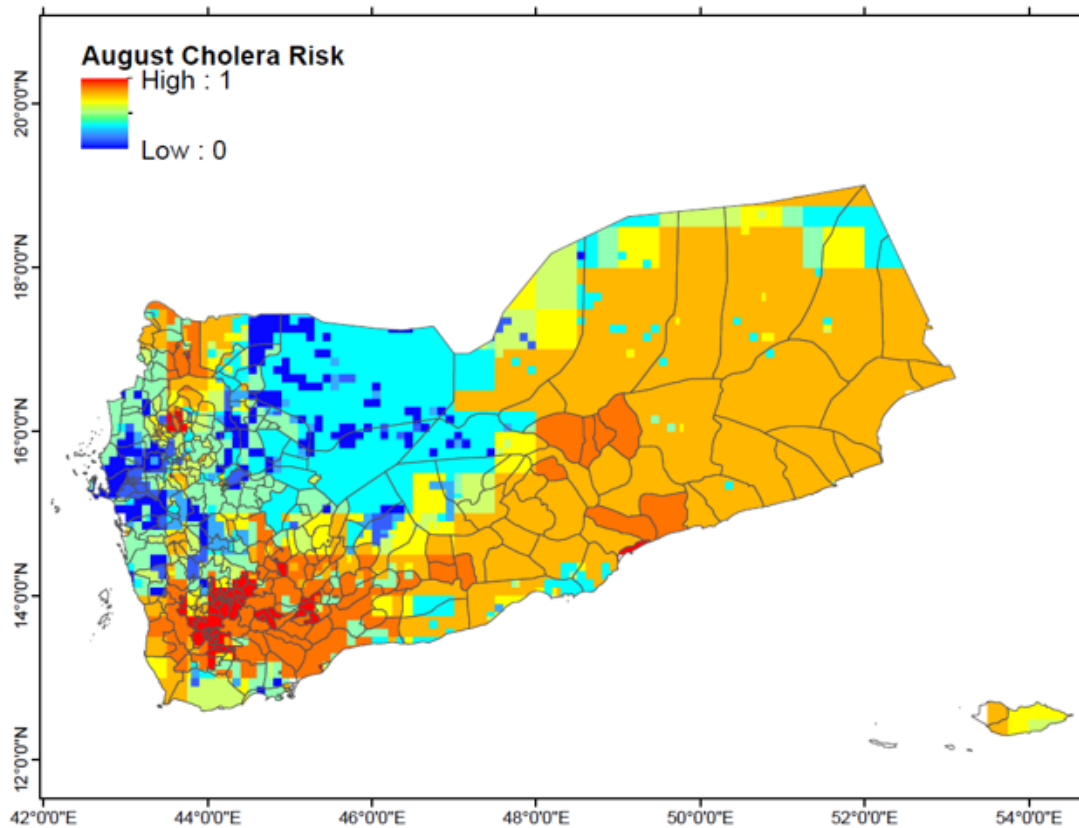


September 2018 Cholera Risk Forecast



Yemen Administrative Boundaries





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This research work is "in progress" and results should be interpreted carefully and cautiously. Work is made possible through a research grant from the NASA Applied Sciences Program.

For question, please contact

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How to interpret map?

0 represent no risk of cholera; 1 represent highest possible risk.

The map shows hydroclimatological risk of cholera. The value of 1 shows that there is a good potential that cholera bacteria may be present in the environment, assuming that there are water bodies in the vicinity of the area. If there are no water bodies, then the risk is not valid (e.g., the North-Eastern part of Yemen).

We know North-Eastern Yemen has low population, however during the month of July, it received low but anomalous rainfall with low warm temperatures. Overall, the risk of cholera triggering in region appears to be same when compared with July. But, if the population is exposed to contaminated surface waters, the chance of infection of cholera is high. Information on water insecurity is not fully incorporated into this map since such data are not available. Population density information was obtained from NASA SEDEC. We use NASA-GPM data to compute rainfall anomalies. While the data is highly accurate, yet it may have inherent limitations. This is a work in progress, therefore, confidence intervals are not computed.



ARL information

Starting ARL: 2/3

Current ARL: 7

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

Prototype application functionality tested & demonstrated in decision making activity

Target ARL: 7 but now expected to achieve 8.



Ongoing work

- **Integration of societal determinants into cholera prediction**
 - Data will be uploaded to common pool immediately after encoding will be complete (Dr Aziz will explain).
- **Analysis of economic value of prediction of cholera (Dr Aziz).**
- **Development of software architecture for automated risk assessment**
- **Train the trainer workshop.**



Real time application of models



The image shows a screenshot of a BBC News article. At the top, the BBC logo is on the left, and navigation links for 'Sign in', 'News', 'Sport', 'Weather', 'Shop', 'Earth', 'Travel', and 'More' are on the right. Below this is a red banner with the word 'NEWS' in white. Underneath the banner is another row of navigation links: 'Home', 'Video', 'World', 'US & Canada', 'UK', 'Business', 'Tech', 'Science', 'Stories', and 'Entertainment'. The main content area has a sub-header 'Health' underlined. The article title is 'Yemen cholera epidemic 'controlled' by computer predictions'. Below the title, it says 'By Pallab Ghosh, Science correspondent, BBC News'. There is a timestamp '27 August 2018' and a row of social media sharing icons (Facebook, Messenger, Twitter, Email, and a generic 'Share' icon). A tag 'Yemen crisis' is visible in a box. At the bottom of the article preview is a blurred photograph of a person's head and shoulders.

UNICEF video on using our algorithm

<https://www.dropbox.com/sh/x38lkwyuhrfp4u8/AABLmY986ED8AD8MfrIusEG6a?dl=0>

<https://www.youtube.com/watch?v=Snd6idHeGfg&feature=youtu.be>



Thank you

