

Predictive assessment of transmission conditions of cholera in the environment and human population using earth observations

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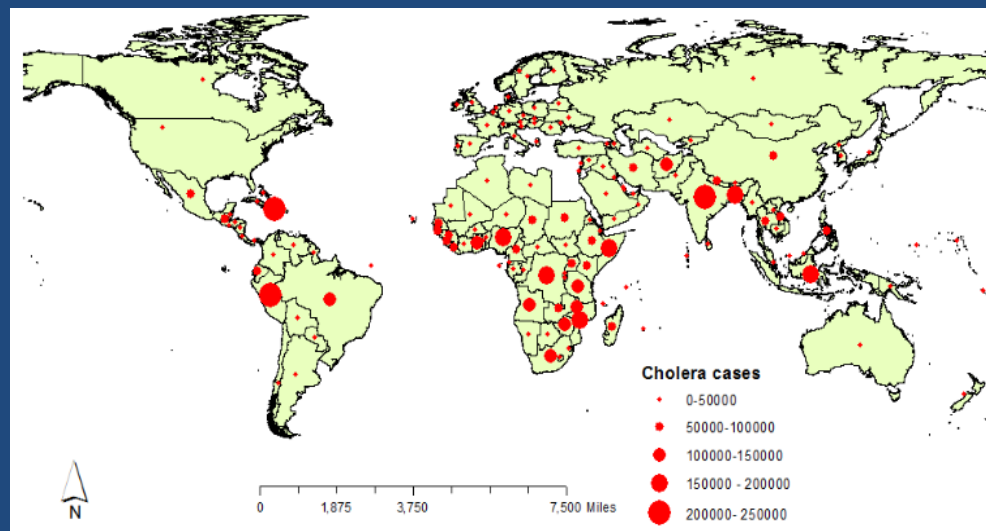
AfriGEOSS-GEO Secretariat
DfID, UK-Africa operations
UK Met Office
OCHA
UNICEF
WMO
WHO
Red Cross
State Department-Africa

Goal of Research Project

We thematically envision “Cholera Ready Nations” where satellite based prediction (of risk of trigger and likelihood of transmission of cholera in the human population) will provide sustainable and resilient readiness to prevent outbreak of disease, saving human lives and improving quality of life.

Objectives

- Systematically validate the epidemic and endemic cholera hypothesis for trigger component of cholera in Africa
- Develop, calibrate, and validate predictive model for transmission component of cholera.



Research Pathway

Relevant earth observations

EPIDEMIC CHOLERA

MODIS/VIIRS [LST, Land cover]
TRMM/GPM [Precipitation]
SRTM [DEM]

ENDEMIC CHOLERA

MODIS/VIIRS [Chlorophyll, SST,
Organic matter, Land Cover]
AVHRR [SST]
TRMM/GPM [Precipitation]
SRTM [DEM]
TOPEX/JASON [SSH]
Aquarius [Salinity]

SST: Sea Surface Temperature; SSH: Sea Surface Height; LST: Land Surface Temperature; MODIS: Moderate Resolution Imaging Spectroradiometer; TRMM: Tropical Rainfall Measuring Mission; GPM: Global Precipitation Mission; AVHRR: Advanced Very High Resolution Radiometer; DEM: Digital Elevation Model; SRTM: Shuttle Radar Topography Mission

Use of earth observations to advance science of cholera (Section 2.1)

Validation of trigger hypothesis for Epidemic mode of cholera (Task 1)

Validation of trigger hypothesis for Endemic mode of cholera (Task 2)

Cholera Transmission Model (CTM) (Task 3)

Anticipated Results (Section 3)

Risk maps showing probabilities of occurrence of inland cholera infection

Risk maps showing probabilities of occurrence of cholera infection along coasts

Ensemble scenarios on how cholera infection may spread in human population

Capacity building initiatives (Section 2.2)

- Communication plan with African partners identified by GEO Secretariat to identify core working group for cholera (Task 4)
- Determine feasibility of encourage use of earth observations and testing algorithms by partner foundations (Task 5)
- Workshop on African Cholera Initiative, social media and dissemination kit to advance Agenda 2030 plan (Task 6)

Knowledge transfer from previous project

Epidemic Cholera

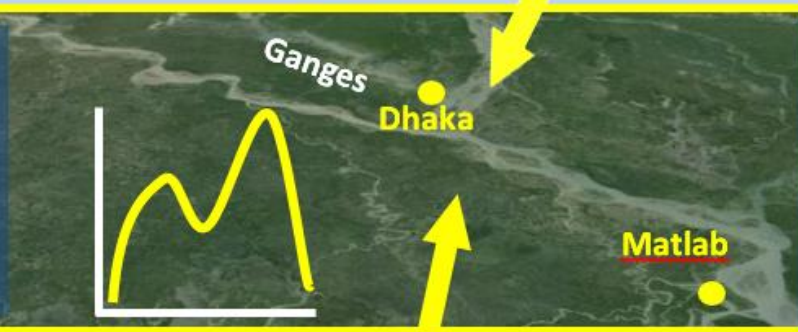
- Sporadic outbreak
- Usually occurs following floods or inundation of large landscapes
- Warm temperatures may increase growth of bacteria in aquatic bodies.

Typical cholera seasonality



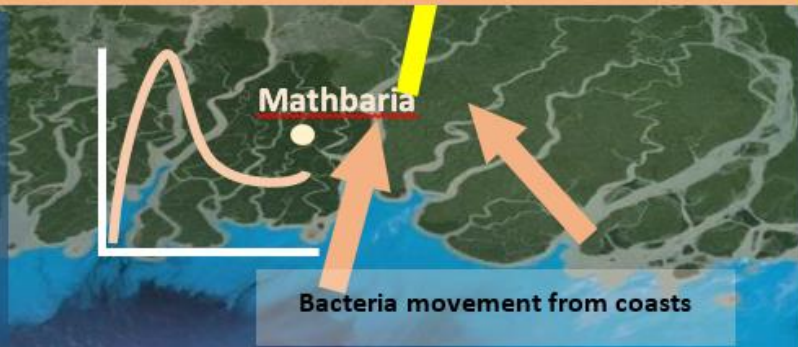
Mixed-mode Cholera

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



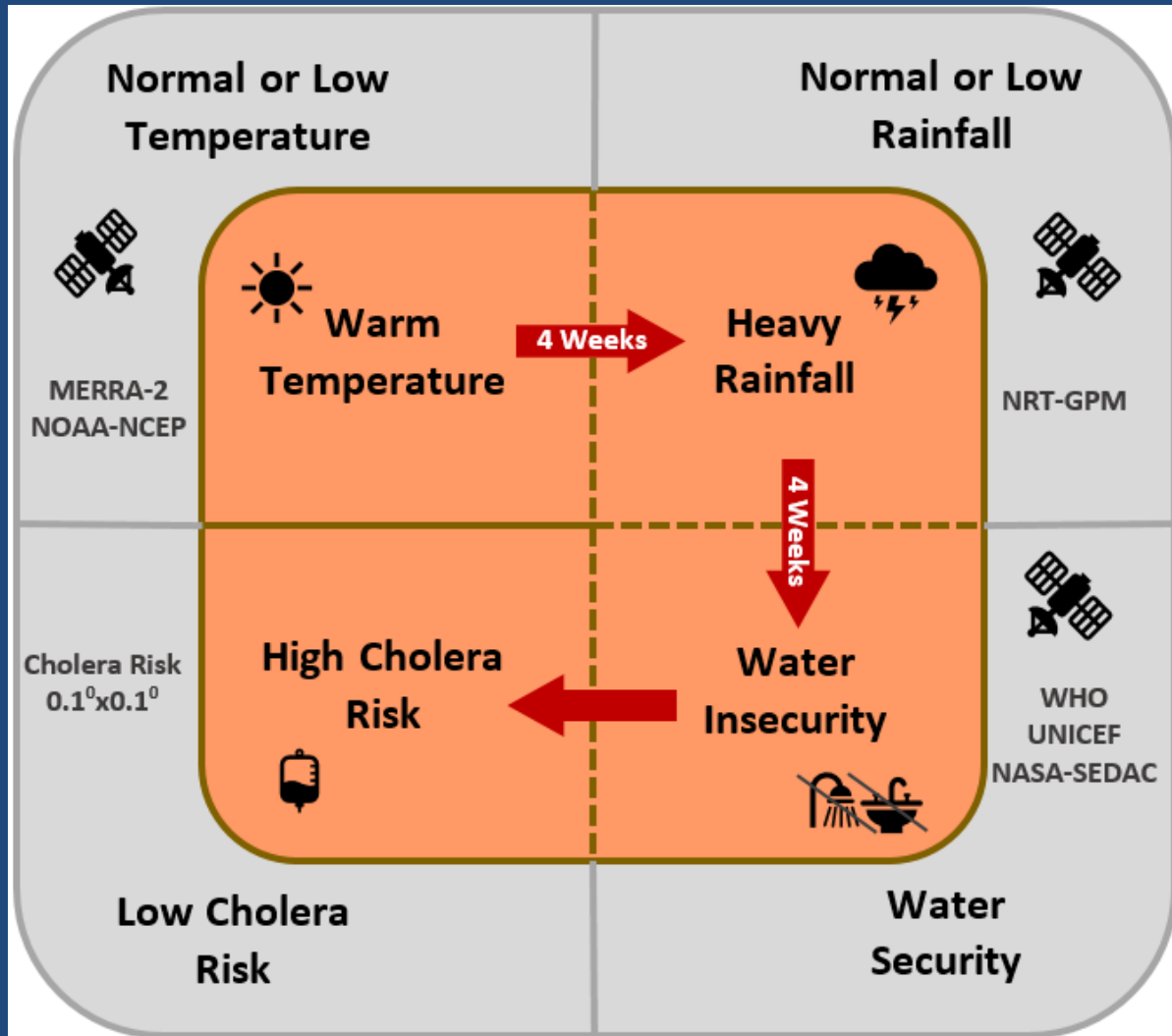
Endemic Cholera

- 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

Epidemic cholera model



Warm temperature= above climatological average temperature

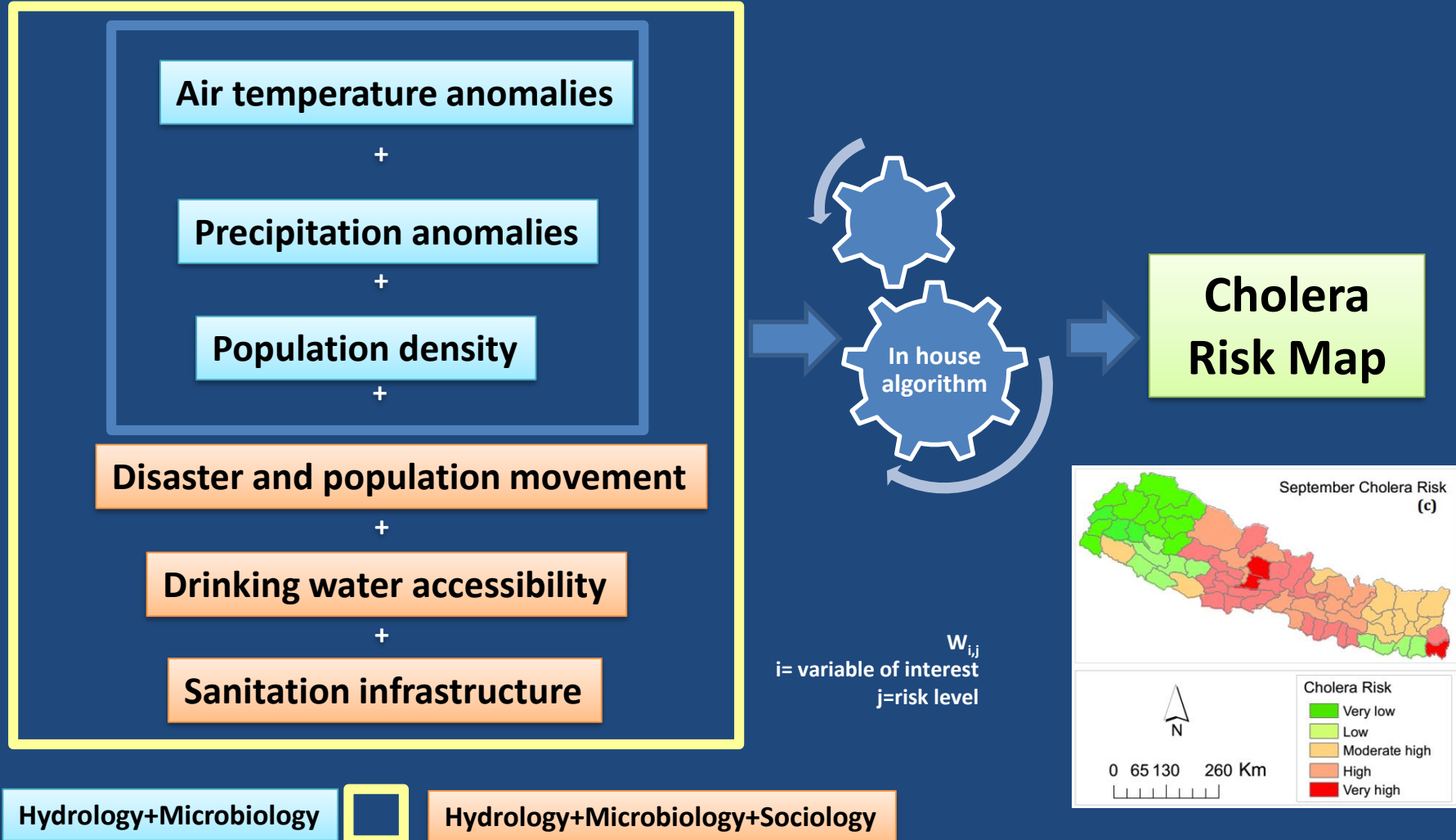
Heavy rainfall= above climatological average precipitation

Water insecurity=lack of access to water and sanitation access

High cholera risk=probability of cholera greater than 50%

Epidemic algorithm: Hydrology + Microbiology + Sociology

CHOLERA ALERT SYSTEM (CAS-version 4)

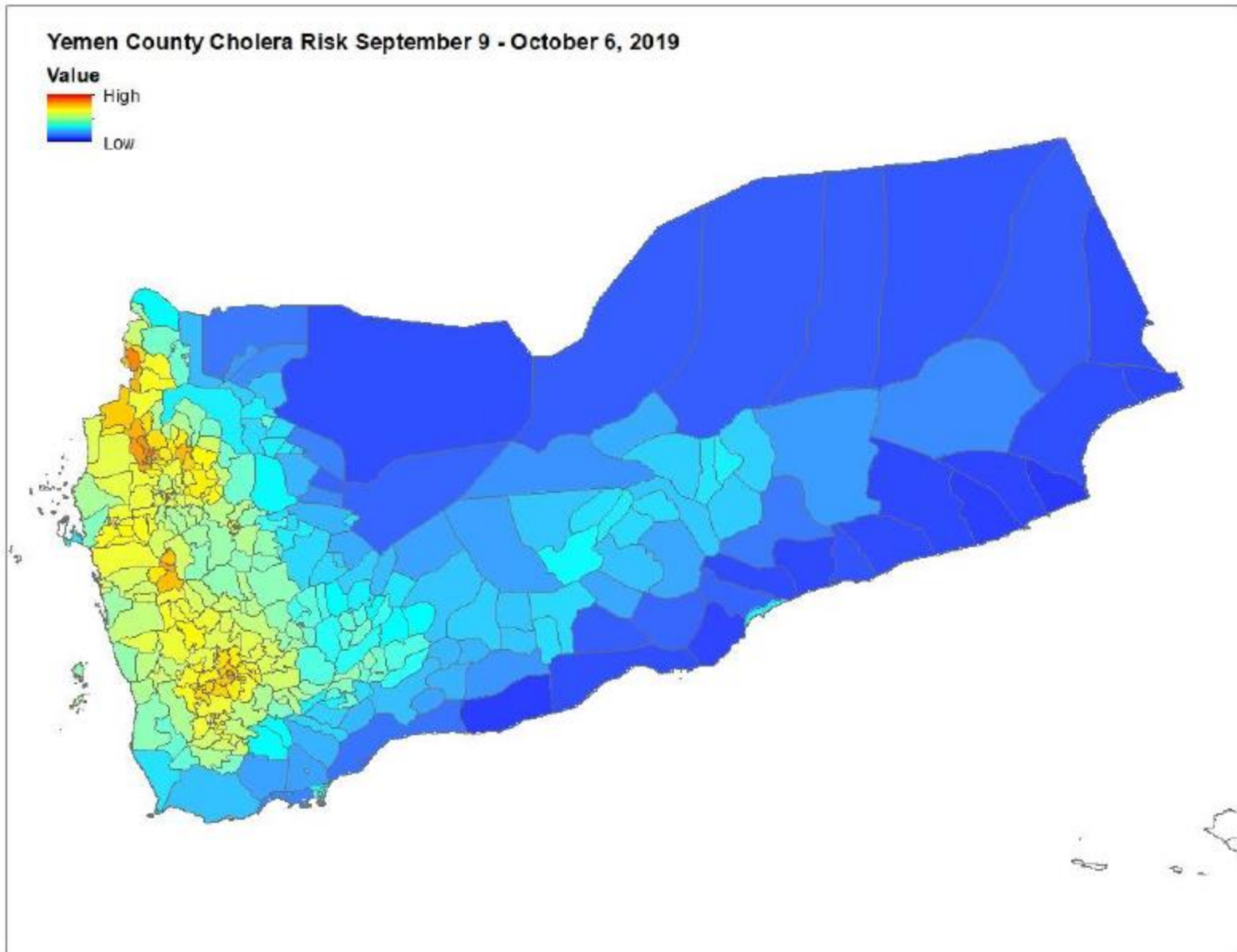


Hydrology+Microbiology



Hydrology+Microbiology+Sociology

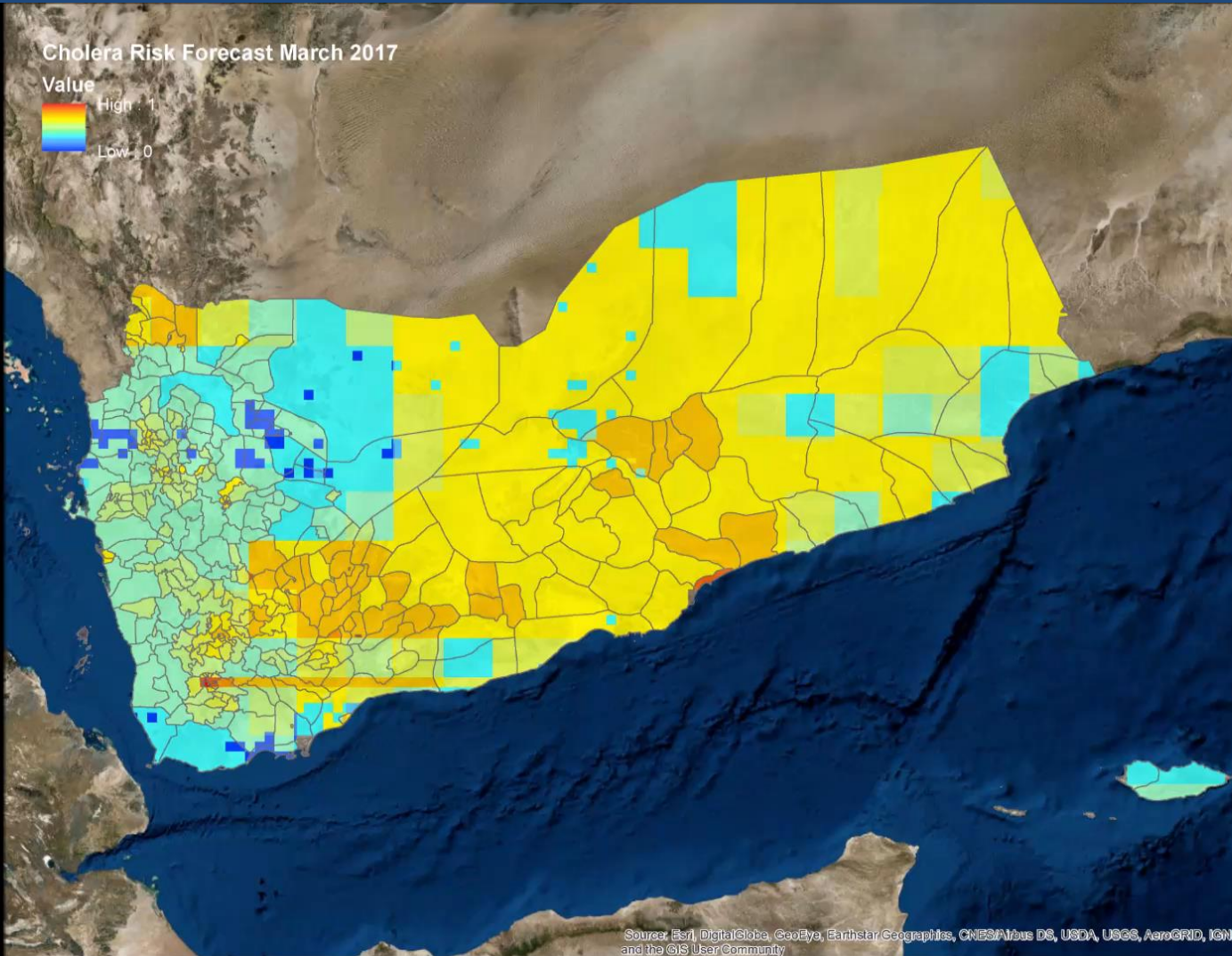
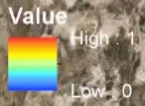
Cholera outlook for Yemen September 9 – October 6, 2019



OBJECTID	NAME	MEAN				
1	Al Buraiqeh	0.214002				
2	Al Mansura	0.510318				
3	Al Mualla	0.564102				
4	Ash Shaikh Outhman	0.528846				
5	Attawahi	0.485207				
6	Craiter	0.491124				
7	Dar Sad	0.506493				
8	Khur Maksar	0.483516				
9	Ahwar	0.2561				
10	Al Mahfad	0.334128				
11	Al Wade'a	0.305409				
12	Jayshan	0.251778				
13	Khanfir	0.27903				
14	Lawdar	0.375147				
15	Mudiyah	0.328232				
16	Rasad	0.567069				
17	Sarar	0.411538				
18	Sibah	0.467964				
19	Zingibar	0.416545				
20	Al A'rsh	0.462967				
21	Al Bayda City	0.615384				
22	Al Bayda	0.444793				

Action Reccomended
Action Reccomended
Action Reccomended
Action Reccomended

Cholera Risk Forecast March 2017



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



REPÚBLICA DE MOÇAMBIQUE

MINISTÉRIO DA SAÚDE

Gabinete de Comunicação e Relações Públicas

Comunicado de Imprensa

Assunto: Actualização dos Dados de Saúde face aos efeitos do Ciclone IDAI na Província de Sofala

No âmbito da actualização da informação sobre a situação sanitária na Província de Sofala face aos efeitos do ciclone IDAI, o Ministério da Saúde vem por meio desta tornar público a informação correspondente às 7H00 do dia 31 de Março às 7H00 do dia 01 de Abril de 2019.

Unidades Sanitárias da Cidade da Beira

Doença	Casos	Óbitos
Malária	63	0
Febre	165	0
Diarreia	182	0
Cólera	247	1

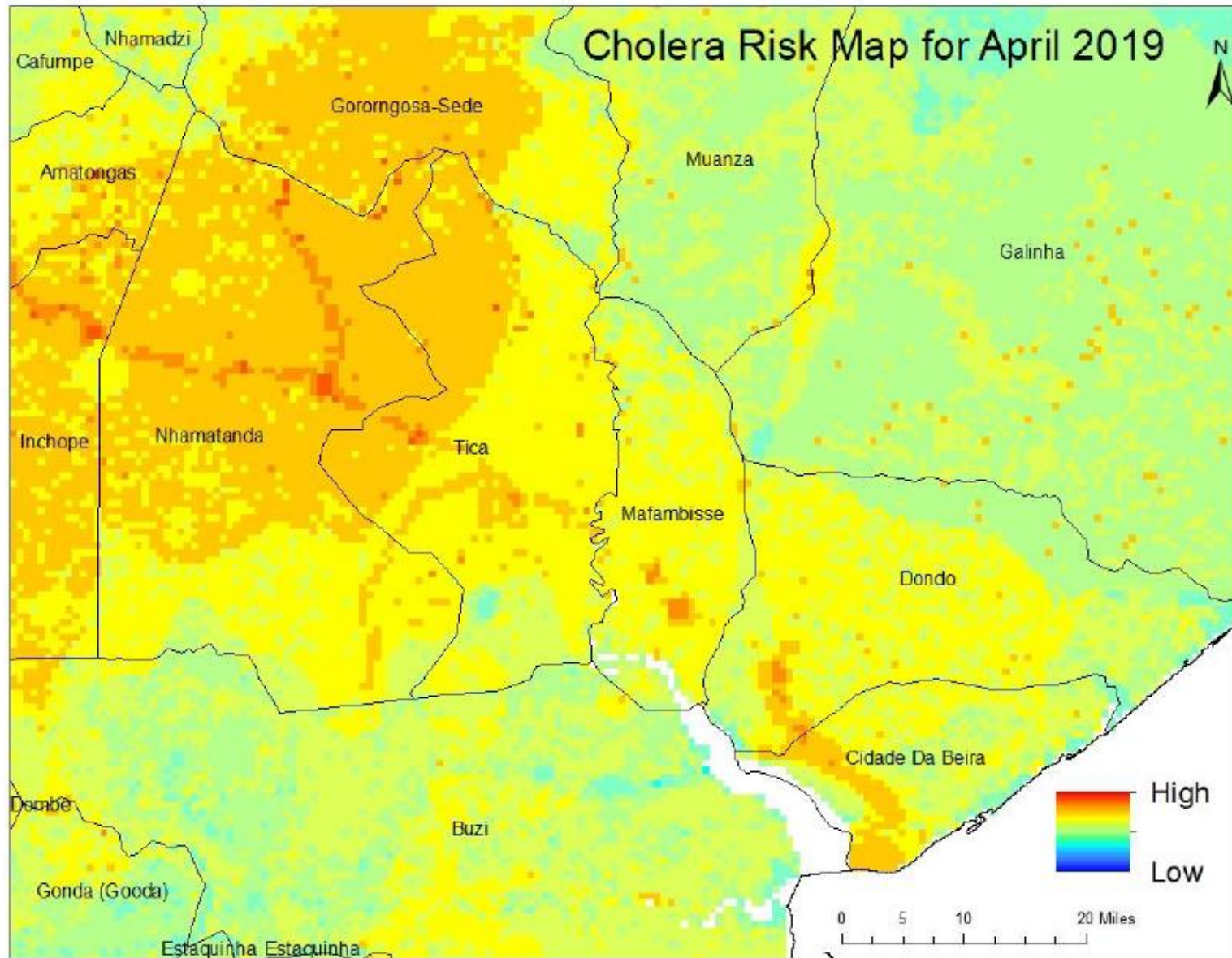
Antar,

April 2019

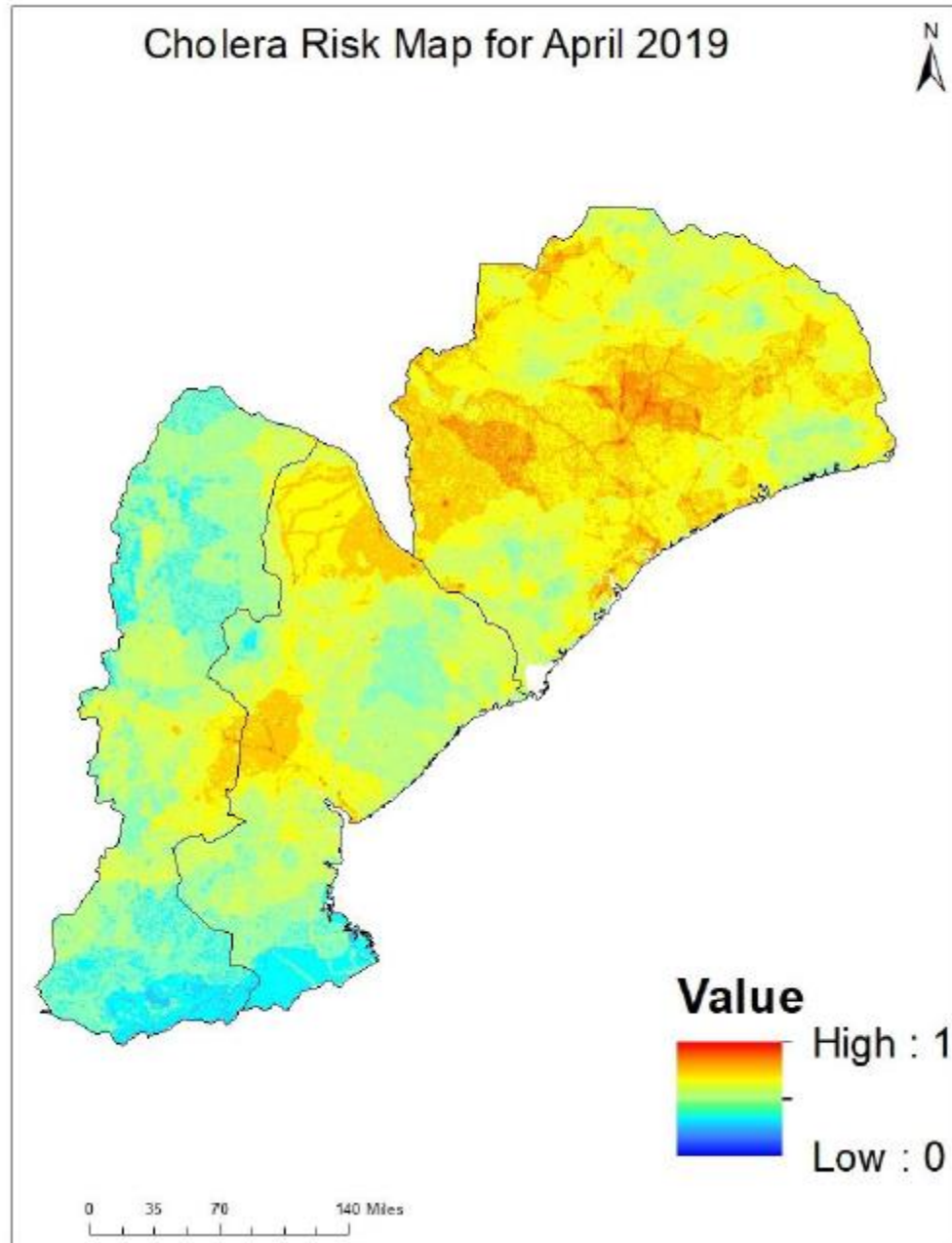
What are the possibilities/limitations of running your cholera risk model for Mozambique, given the current situation and increasing concerns re cholera risk?

Thanks,

Cholera outlook for three districts of Beira, Dondo and Nhamatanda, April 2019* (see note below)

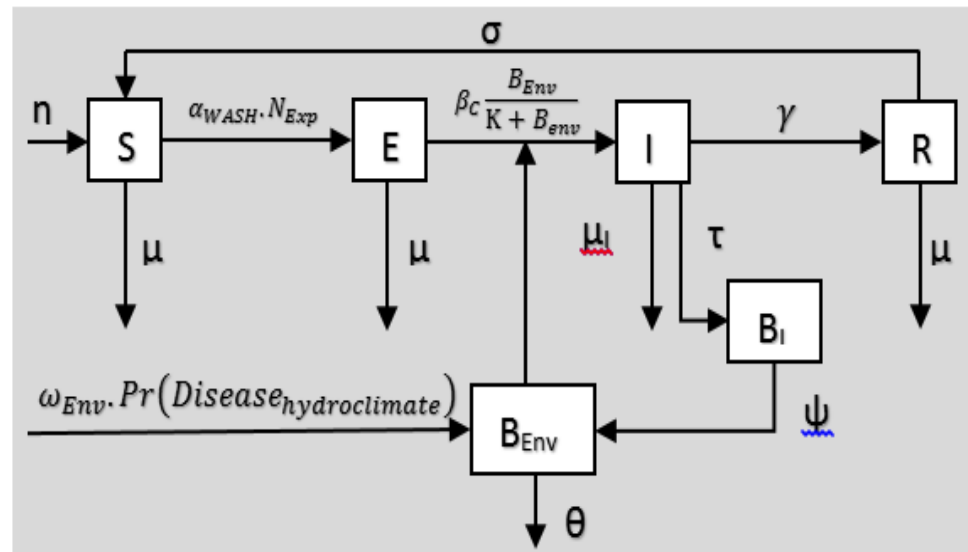


Cholera outlook for the provinces of Sofala, Zambezia and Manica, April 2019* (see note below)



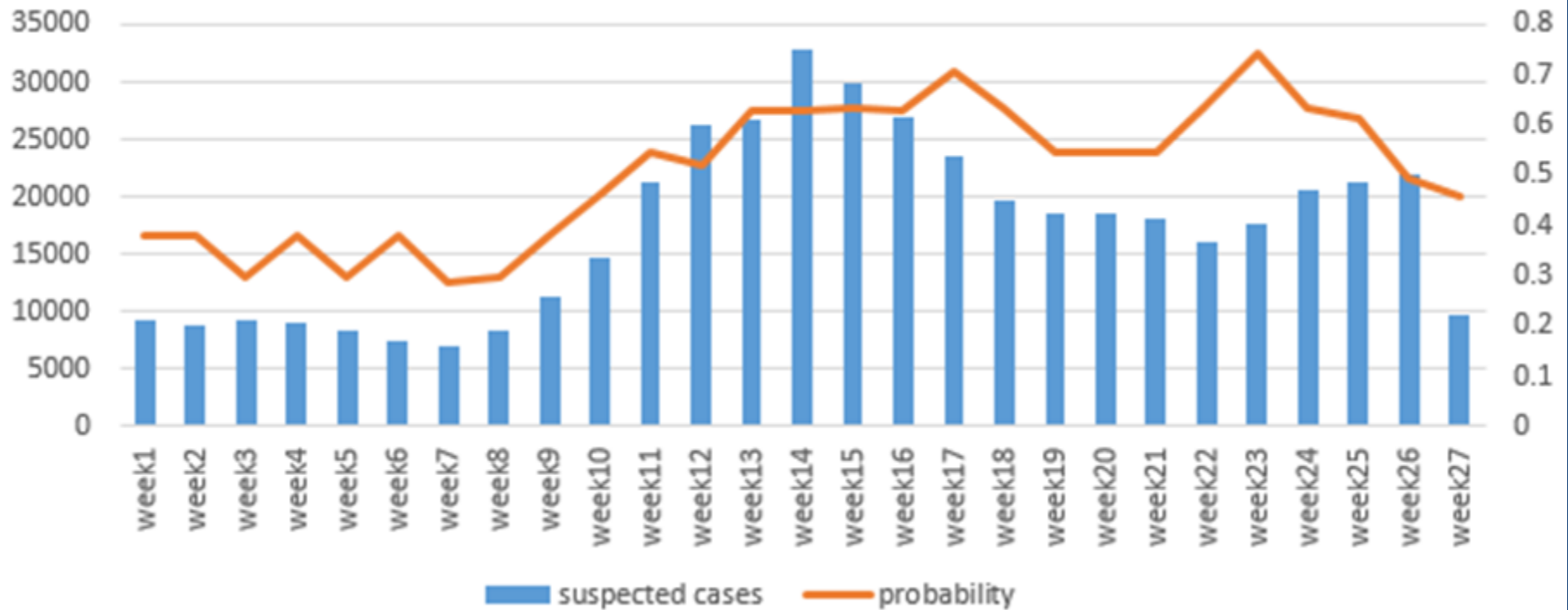
Mechanistic algorithms: Hydrology-Environment-Microbiology- Epidemiology: A new generation of mathematical models

$$\begin{aligned} \frac{dS}{dt} &= \eta(S + E + I + R) - [\sigma R + (\mu + \alpha)S] \\ \frac{dE}{dt} &= \alpha_{WASH} \cdot N_{Exp} \cdot S - \left(\mu + \beta_{fit} \cdot \frac{B_{Env}}{K + B_{env}} \right) E \\ \frac{dI}{dt} &= \beta_c \cdot \frac{B_{Env}}{K + B_{env}} E - (\mu_I + \tau + \gamma) I \\ \frac{dR}{dt} &= \gamma I - (\mu + \sigma) R \\ \frac{dB_I}{dt} &= \tau I - \psi B_I \\ \frac{dB_{Env}}{dt} &= \psi B_I + (\omega_{Env} \times Pr(Disease_{hydroclimate}) - \theta) B_{Env}; \quad Pr(Disease_{hydroclimate}) = \frac{e^{a+bx_n}}{1 + e^{a+bx_n}} \end{aligned}$$



Jutla et al., 2016: Plos-One

Trigger -> Transmission



ARL information

Starting ARL: 3

Current ARL: Approaching 5

Target ARL: 8

Overall timeline for research objective and activities at end user organization

Timeline of proposed activities and key milestones												
Activity	Year 1				Year 2				Year 3			
		Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Kick off meeting (Skype)	C											
Task 1: Epidemic cholera		C	C	IP	IP	IP						
Task 2: Endemic cholera				IP	IP	IP	X					
Task 3: CTM							X	X	X	X	X	
Task 4: Core group formation	C	C	X	X	X	X						
Task 5: Training/ dissemination plan with foundations					C	IP	X					
Task 6: Workshop								x ¹	x ¹	x ¹	x ¹	x ²
PI meeting	Third week of every month											
Veolia/Health Initiatives Foundation/Kirschbaum/Thiaw/ Jutla/Colwell meeting				C				X				X

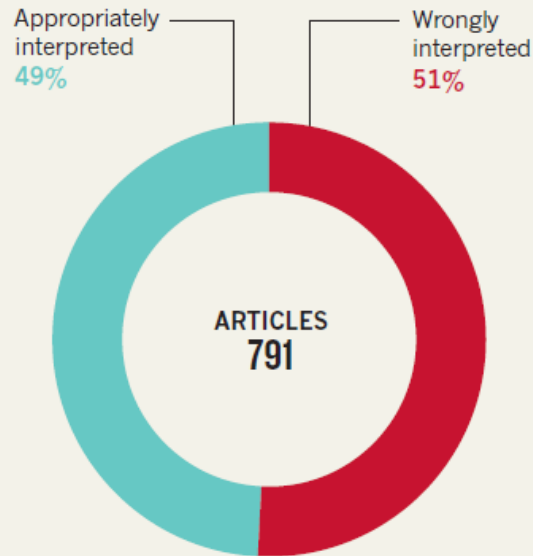
#initiate discussion with GEO Secretariat; x¹ : planning; x² : workshop at UMD or UF; Q1, Q2, Q3, Q4 represent quarter in a given year.

Retire statistical significance

Valentin Amrhein, Sander Greenland, Blake McShane and more than 800 signatories call for an end to hyped claims and the dismissal of possibly crucial effects.

WRONG INTERPRETATIONS

An analysis of 791 articles across 5 journals* found that around half mistakenly assume non-significance means no effect.



*Data taken from: P. Schatz *et al. Arch. Clin. Neuropsychol.* **20**, 1053–1059 (2005); F. Fidler *et al. Conserv. Biol.* **20**, 1539–1544 (2006); R. Hoekstra *et al. Psychon. Bull. Rev.* **13**, 1033–1037 (2006); F. Bernardi *et al. Eur. Sociol. Rev.* **33**, 1–15 (2017).

Thank you