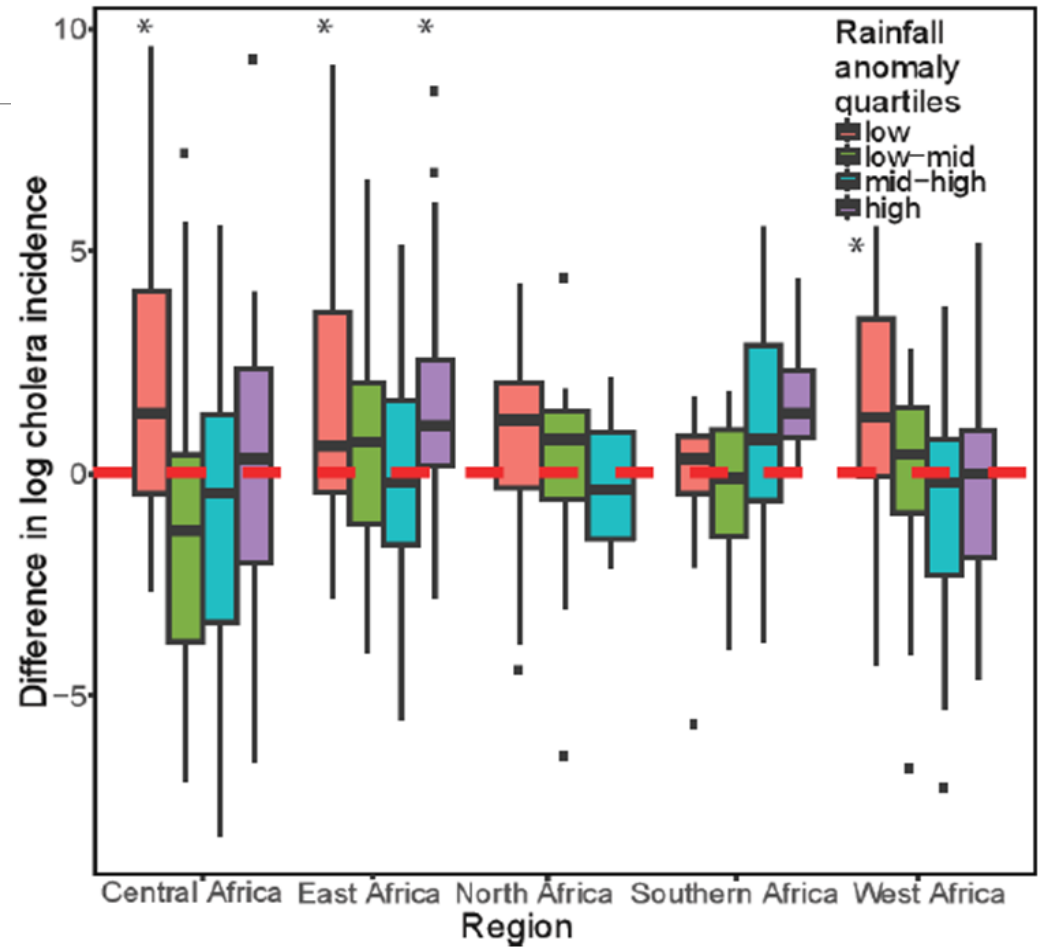
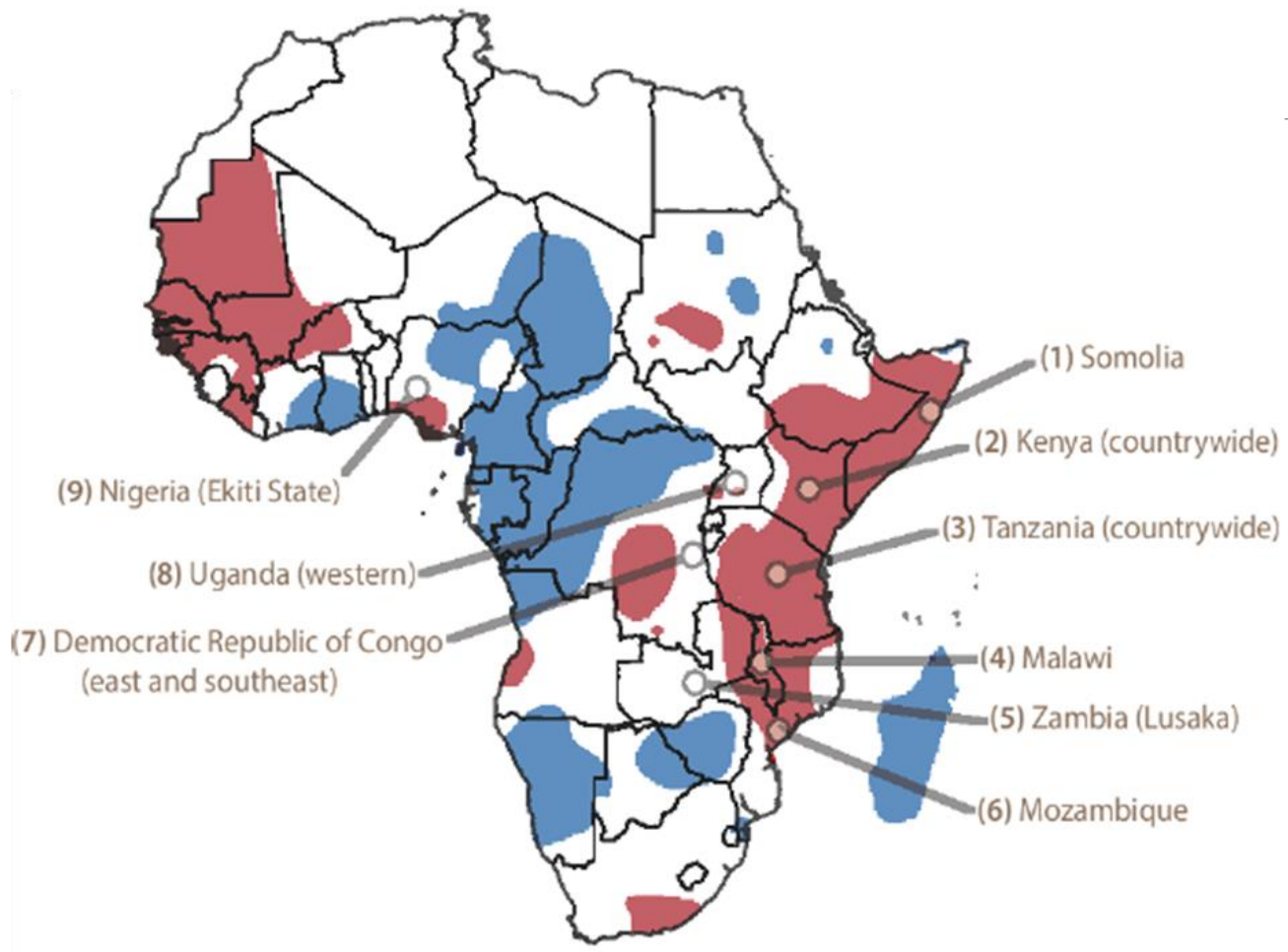




# The African Cholera Risk Early Warning System (ACREWS)

PI: BENJAMIN ZAITCHIK, JOHNS HOPKINS UNIVERSITY  
CO-I: JUSTIN LESSLER, JOHNS HOPKINS UNIVERSITY  
CO-I: ANDREW AZMAN, JOHNS HOPKINS UNIVERSITY  
CO-I: SEAN MOORE, NOTRE DAME UNIVERSITY  
COLLABORATOR: EMMA DIGGLE, SAVE THE CHILDREN



# Alarming spike in cholera as famine grips East Africa



The Disasters Emergency Committee says it is worried by the rapid increase in the number of waterborne diseases as famine begins to grip



22nd March 2017 by Paul Cardwell

0 Comments

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The Disasters Emergency Committee (DEC) has warned of an alarming surge in the transmission of waterborne diseases such as cholera across East Africa.

Prolonged drought, conflict and food and water shortages have left 16 million people on the brink of starvation and resulted in a spike in the number of cases of Acute Watery Diarrhoea (AWD) – a key symptom of cholera.

The DEC, which is made up of 13 of the UK's biggest aid charities, launched its East Africa Crisis Appeal last week and has since raised £26 million to fund work on the ground.

In Somalia alone, the UN recorded almost 12,700 cases of AWD and cholera in the first three months of 2017.

In South Sudan, the World Health Organisation has recorded 5,640 cases. One in five are children under five.

GLOBAL HEALTH

## *Cholera Is Spreading in Mozambique, and It's Far From the Only Health Threat*

About two million people are displaced, cholera has broken out, and malaria is expected. But doses of cholera vaccine have arrived, and the humanitarian crisis may yet be contained, aid agencies say.



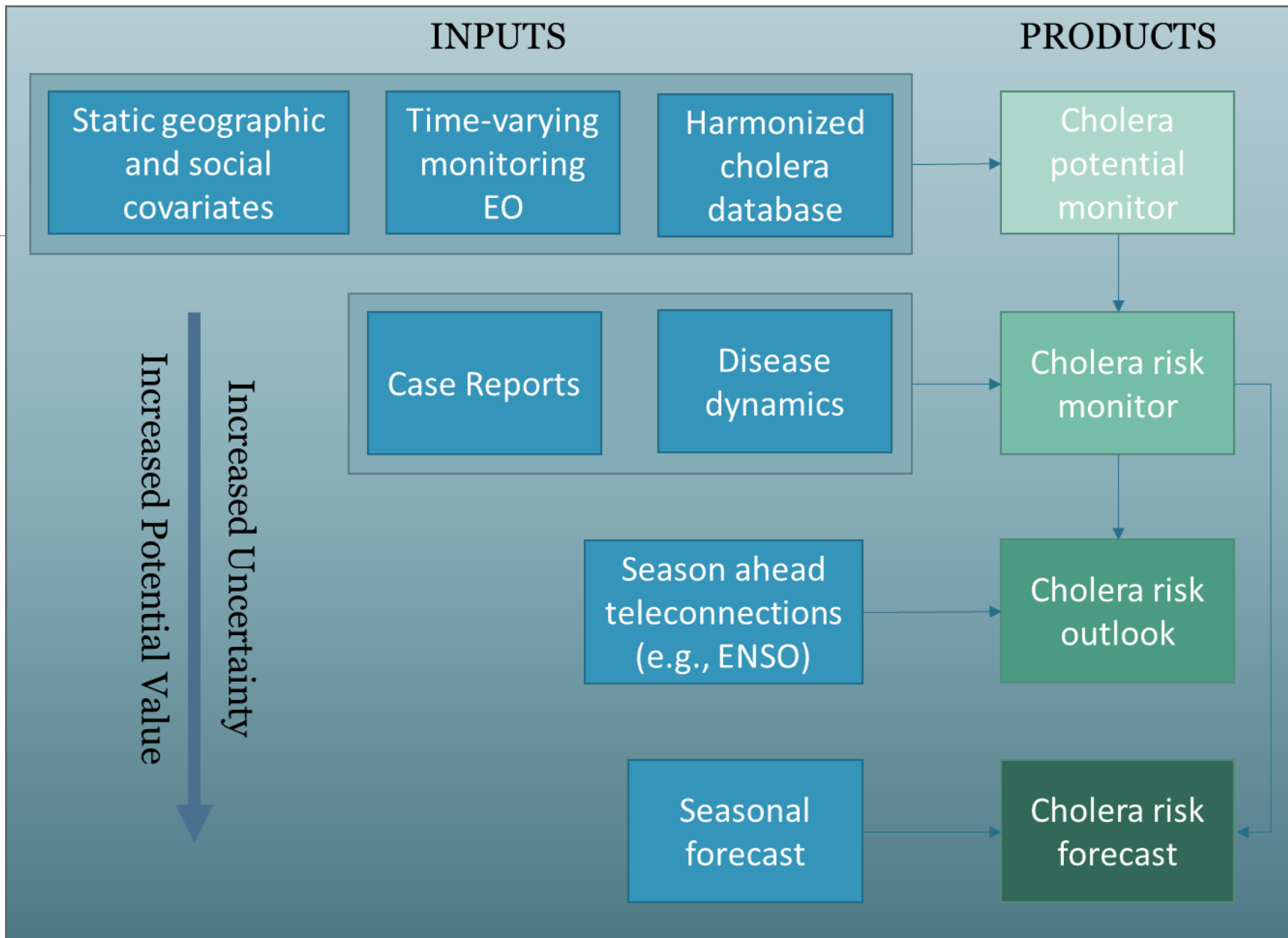
A doctor examined a girl with cholera on Saturday at a treatment center in Beira, Mozambique. Tsvangirayi Mukwazhi/Associated Press

# Project Goal

---

Develop and operationalize an **Earth Observation-informed African Cholera Risk Early Warning System (ACREWS)** to support rapid response interventions

End users: UN Taskforce on Cholera Control, Save the Children, MSF



# Objectives

---

1. Deliver a database of spatial and temporal variability in cholera burden across the continent.
2. Align our cholera database with a matching EO database of potential cholera predictors.
3. Collaboratively design a baseline system that generates weekly maps of environmental cholera potential based on historical correlations between ENSO, rainfall, and local cholera response.
4. Enhance the system to monitor actual cholera risk using EO-informed predictive models that account for the roles of population susceptibility, spatial correlation, and introduction probability
5. Apply two seasonal prediction techniques to extend the ACREWS time horizon: an ENSO analog-based cholera risk outlook and a dynamically-based cholera risk forecast.
6. Operationalize the system for decision support through partnership with the GTFCC.

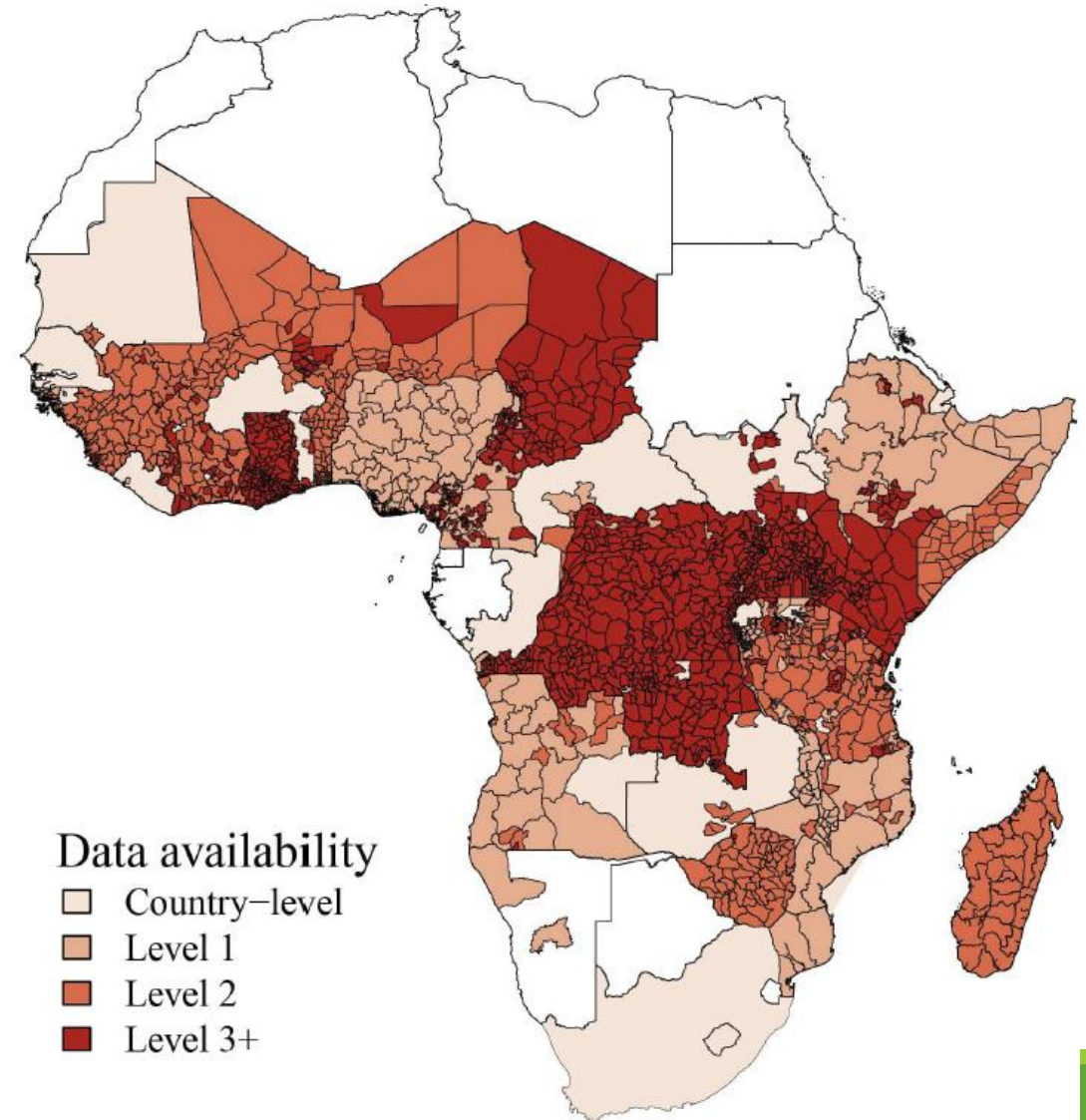
# Objectives

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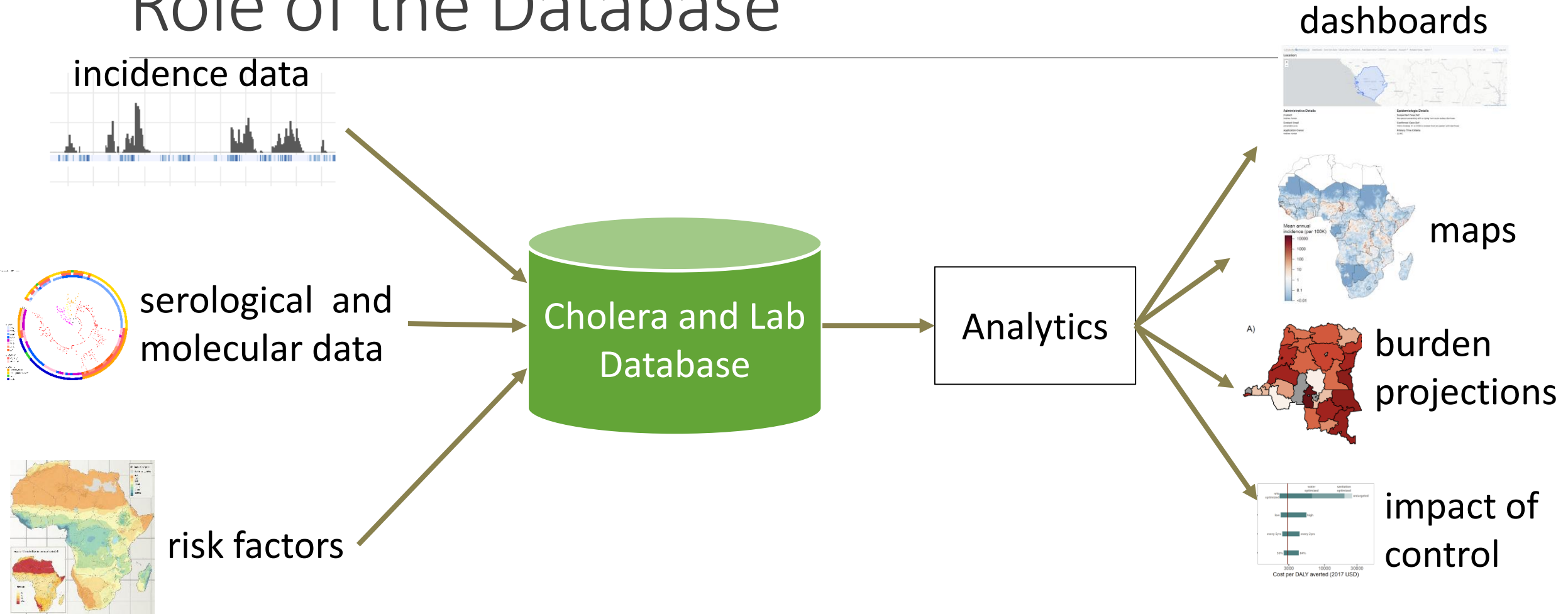
# 1. Database of spatial and temporal cholera variability

---

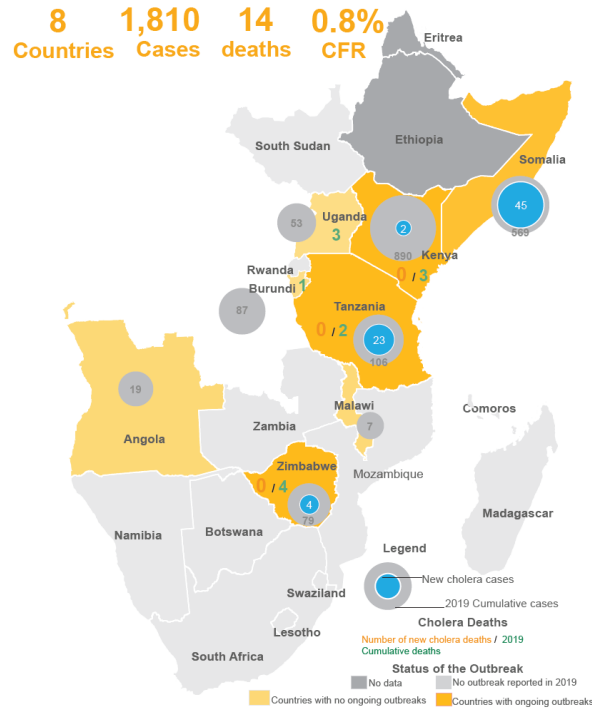




# Role of the Database



# Data come in many shapes and sizes



Published Date: 2019-05-09 12:55:05  
 Subject: PRO/EDR> Cholera, diarrhea & dysentery update (12): Africa, Asia  
 Archive Number: 20190509.6460944

CHOLERA, DIARRHEA AND DYSENTERY UPDATE (12): AFRICA, ASIA

A ProMED-mail post  
<http://www.promedmail.org>  
 ProMED-mail is a program of the International Society for Infectious Diseases  
<http://www.isid.org>

In this update:

- Africa
- [1] Cholera - Somalia: WHO
- [2] Cholera - Zimbabwe
- [3] Cholera - Mozambique (northern)
- [4] Cholera - Kenya (Mandera County)
- [5] Cholera - Kenya (Embu County)
- Asia
- [6] Cholera - Nepal (Kathmandu)

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Africa

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- [1] Cholera - Somalia: WHO

Date: Tue 7 May 2019

Source: WHO Emergencies preparedness, response, Disease Outbreak News (DONs) [edited]

<http://www.emro.who.int/pandemic-epidemic-diseases/cholera/outbreak-update-cholera-in-somalia-28-april-2019.html>

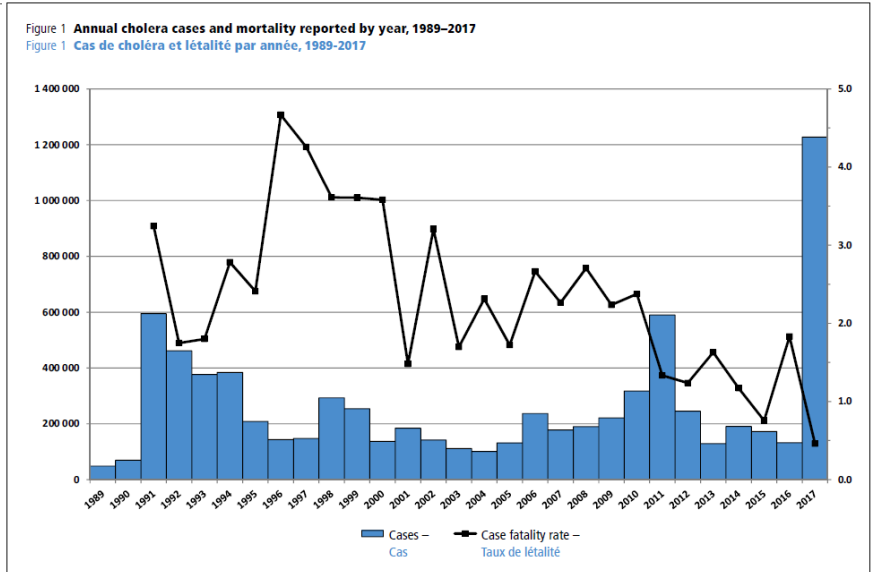
Outbreak update - Cholera in Somalia, 28 Apr 2019

The Ministry of Health (MoH) of Somalia has announced 36 new suspected cases of cholera, with no deaths, for epidemiological weeks 1 and 7 due to closure of the main cholera treatment center, from which data is collected the beginning of this outbreak in December 2017.

During the reporting period, cases occurred in 11 out of 17 districts in Banadir region, the worst affected district are Hodan (728) the cases (24) are children below 5 years of age.

WHO, MoH, and partners have contained the cholera outbreak in the districts of Jubaland, Hirshabelle, and South West states following (OCV) campaigns and other health interventions. However, active transmission is ongoing in 11 districts in Banadir -- Darkenly, D Bondere, Kahda, Kaaran, Waberi, and Warta nabada).

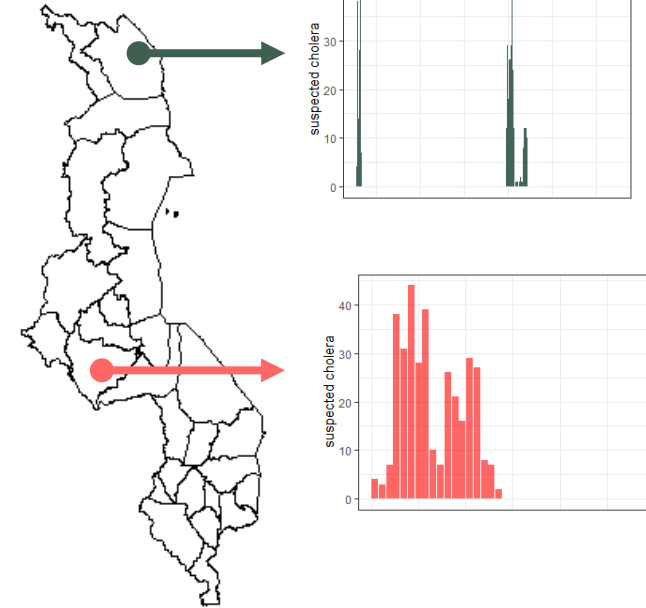
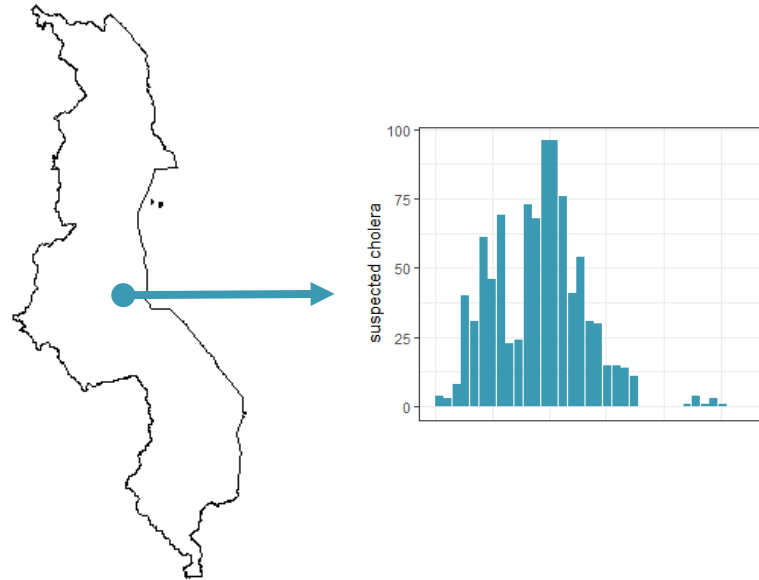
Region – Région	Country – Pays	Total no. of cases, including imported cases/deaths – Nombre total de cas (incluant cas importés et décès)	Imported cases – Cas importés	Deaths – Décès	Case fatality rate (%)* – Taux de létalité (%)*
Africa – Afrique	Angola	828		43	5.2
	Benin – Bénin	11		0	0.0
	Burundi	399		0	0.0
	Chad – Tchad	1 266		86	6.8
	Democratic Republic of the Congo – République Démocratique du Congo	56 190		1 190	2.2
	Kenya	4 288		82	1.9
	Malawi	344		5	1.4



	A	B	C	D	E
1	Country	Week 1		Week 2	
2		Cases	Deaths	Cases	Deaths
3	Mozambique	0	0	0	0
4	Kenya			115	2
5	Somalia	87	0	87	0

# Data are linked to locations and time periods

Locations

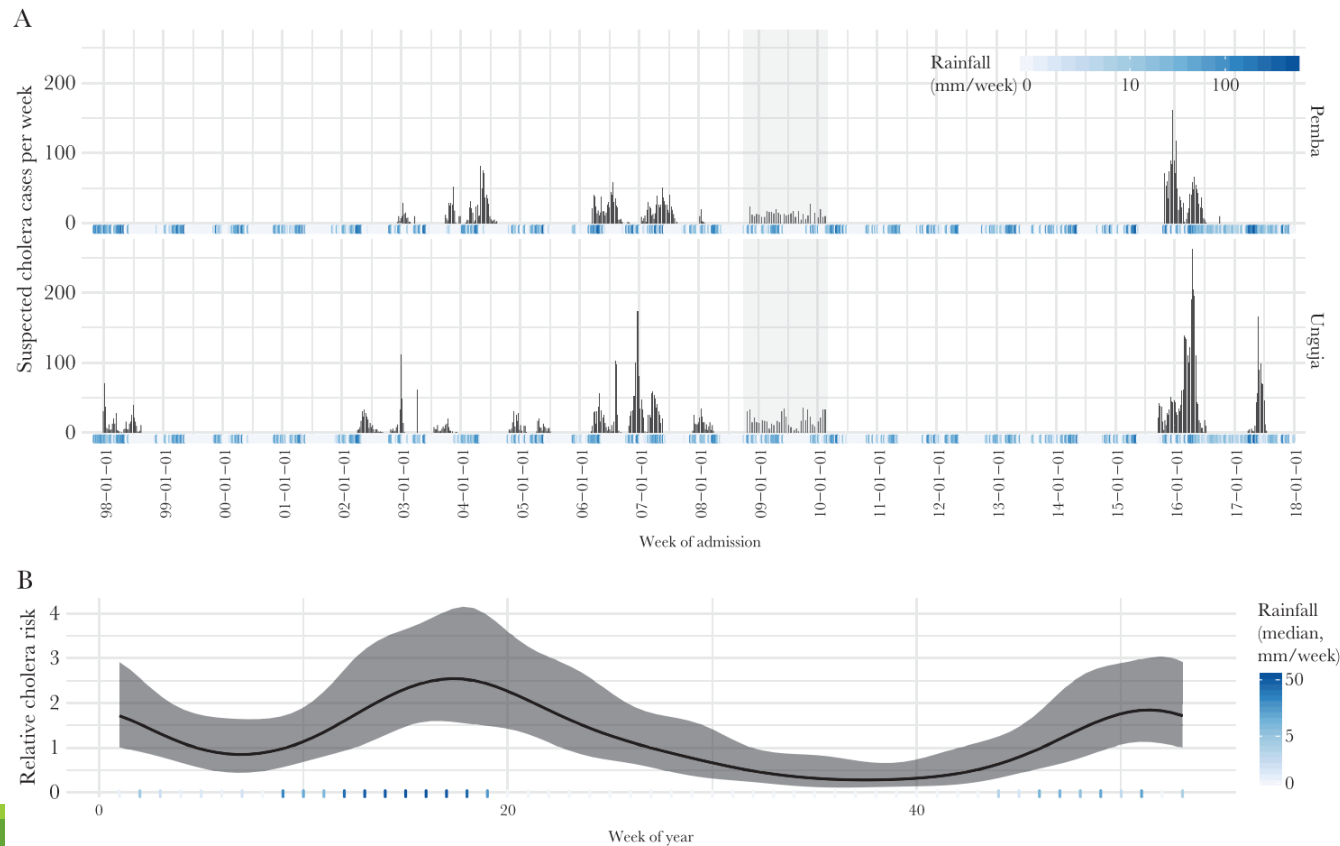


Time Periods

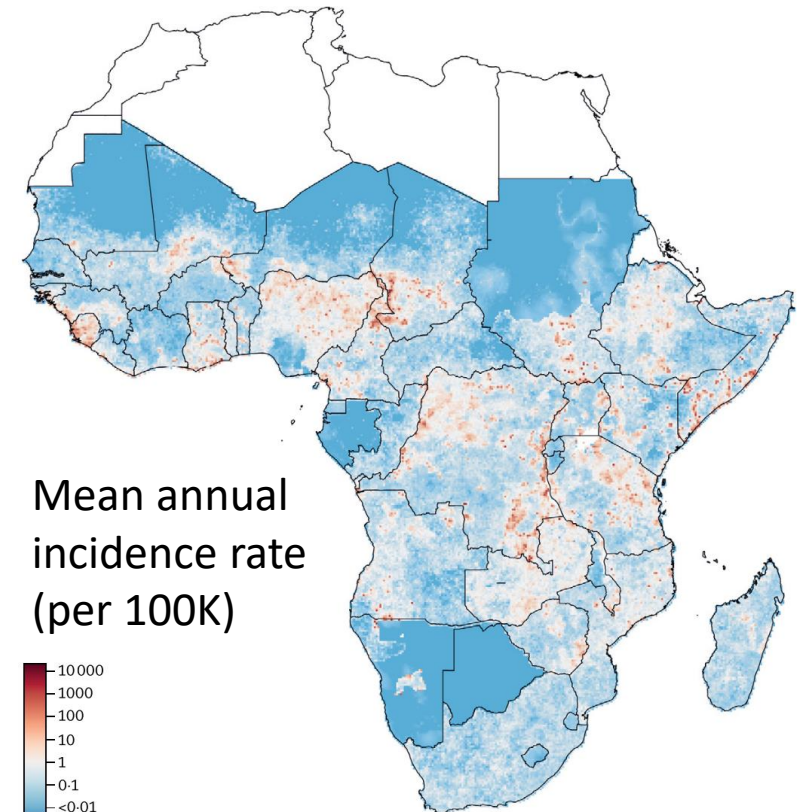


# Standardized descriptions of cholera epidemiology

## Temporal patterns



## Spatial patterns



A look at the  
current state of  
the database

View information  
about a single  
location

CHOLERA DYNAMICS Dashboard Overview Observation Add Observation Workspace Locations Account Release Admin Go to OC UID Log out  
Data Collections Collection Notes

## AFR::MWI.Malawi

[Edit Location](#) [Add Location Period](#)

**Name**  
Malawi

**Latitude**  
-13.5

**Longitude**  
34

**Observation Collections**

- 38
- 39
- 329
- 489
- 3017
- 3019
- 3020
- 3021
- 3024
- 3025
- 3026
- 3028**
- 3029
- 3030
- 3031
- 3032
- 3182
- 5100
- 5122
- 20350
- 20360


**Parent Location**  
[AFR](#)

**Child Locations**

- [AFR::MWI::MW-BA.Balaka](#)
- [AFR::MWI::MW-BL.Blantyre](#)
- [AFR::MWI::MW-CK.Chikwawa](#)
- [AFR::MWI::MW-CR.Chiradzulu](#)
- [AFR::MWI::MW-CT.Chitipa](#)
- [AFR::MWI::MW-DE.Dedza](#)
- [AFR::MWI::MW-DO.Dowa](#)
- [AFR::MWI::MW\\_KR](#)
- [AFR::MWI::MW-KR.Karonga](#)
- [AFR::MWI::MW-KS.Kasungu](#)
- [AFR::MWI::MW-LI.Lilongwe](#)
- [AFR::MWI::MW-LK.Likoma](#)
- [AFR::MWI::MW-MC.Mchinji](#)
- [AFR::MWI::MW-MG.Mangochi](#)
- [AFR::MWI::MW-MH.Machinga](#)
- [AFR::MWI::MW-MU.Mulanje](#)
- [AFR::MWI::MW-MW.Mwanza](#)
- [AFR::MWI::MW-MZ.Mzimba](#)
- [AFR::MWI::MW-NB.Nkhata Bay](#)
- [AFR::MWI::MW-NE.Neno](#)
- [AFR::MWI::MW-NI.Ntchisi](#)
- [AFR::MWI::MW-NK.Nkhotakota](#)
- [AFR::MWI::MW-NS.Nsanje](#)
- [AFR::MWI::MW-NU.Ntcheu](#)
- [AFR::MWI::MW-PH.Phalombe](#)
- [AFR::MWI::MW-RU.Rumphi](#)
- [AFR::MWI::MW-S](#)
- [AFR::MWI::MW-SA.Salima](#)
- [AFR::MWI::MW-TH.Thyolo](#)
- [AFR::MWI::MW-ZO.Zomba](#)
- [AFR::MWI::RefugeeCamps.Refugee Camps](#)

AFR::MWI::  [Add Location](#)

**Location Periods**  
6892 - 01/01/1800 - 12/31/2030



Leaflet | © OpenStreetMap © CartoDB


View information  
about a single source  
document

CHOLERA DYNAMICS Dashboard Overview Data Observation Collections Add Observation Collection Workspace Locations Account Release Notes Admin

Go to OC UID  Go Log out

Observation Collection 329 **Initial Data Entry Complete** [Edit Observation Collection](#) [Delete Observation Collection](#)

Location: AFR::MWI



**Administrative Details**

Contact  
Sean Moore

Contact Email  
smoore15@nd.edu

Application Owner  
Elizabeth Lee

Public?  
Yes

IRB Protocol  
Owner

Owner Email

MOU DSA Notes

Source  
WHO Annual Cholera Reports

Source URL  
<http://apps.who.int/globalatlas/dataQuery/default.asp>

Source Notes

Source Documents

Document Name	Created
<a href="#">mwi_who_gho_wer.zip</a>	04/10/2019 4:36 PM

**Notes**

Annual cases and deaths reported to WHO, excludes imported cases. Updated by Elizabeth Lee (elee154@jhu.edu). Added 2017 cases. Edited by Elizabeth Lee elee154@jhu.edu April 2019 2017 data comes from WER9338

**Observation Properties**

Start  
1973-01-01

End  
2017-12-31

Deaths  
3469

Suspected Cases  
143279

**Epidemiologic Details**

Suspected Case Def  
UNKNOWN

Confirmed Case Def

Primary Time Criteria  
CLINIC

Strains

Humanitarian Crisis?  
No

Reactive vaccination?  
Yes

Previous vaccination?  
Yes

View data from a single source document

CHOLERA DYNAMICS Dashboard Overview Data Observation Collections Add Observation Collection Workspace Locations Account Release Notes Admin Go to OC UID Go Log out

### Observation Fields

TL TR Primary Phantom deaths sCh

> Uploaded Observation Files

### Observations

Upload Observations Edit Observations Download Observations Delete All Observations

Location	TL	TR	Primary	Phantom	deaths	sCh
AFR::MWI.Malawi	2016-01-01	2016-12-31	✓		46	1792
AFR::MWI.Malawi	2015-01-01	2015-12-31	✓		11	693
AFR::MWI.Malawi	2012-01-01	2012-12-31	✓		2	187
AFR::MWI.Malawi	2011-01-01	2011-12-31	✓		4	120
AFR::MWI.Malawi	2010-01-01	2010-12-31	✓		17	1155
AFR::MWI.Malawi	2009-01-01	2009-12-31	✓		125	5751
AFR::MWI.Malawi	2008-01-01	2008-12-31	✓		26	831
AFR::MWI.Malawi	2007-01-01	2007-12-31	✓		5	475
AFR::MWI.Malawi	2006-01-01	2006-12-31	✓		55	4148
AFR::MWI.Malawi	2005-01-01	2005-12-31	✓		11	1105
AFR::MWI.Malawi	2004-01-01	2004-12-31	✓		4	675
AFR::MWI.Malawi	2003-01-01	2003-12-31	✓		34	2736
AFR::MWI.Malawi	2002-01-01	2002-12-31	✓		911	32618
AFR::MWI.Malawi	2001-01-01	2001-12-31	✓		42	2395
AFR::MWI.Malawi	2000-01-01	2000-12-31	✓		56	2391
AFR::MWI.Malawi	1999-01-01	1999-12-31	✓		648	26508
AFR::MWI.Malawi	1998-01-01	1998-12-31	✓		74	1745
AFR::MWI.Malawi	1997-01-01	1997-12-31	✓		15	130
AFR::MWI.Malawi	1996-01-01	1996-12-31	✓		0	1
AFR::MWI.Malawi	1995-01-01	1995-12-31	✓		0	1
AFR::MWI.Malawi	1994-01-01	1994-12-31	✓		11	107
AFR::MWI.Malawi	1993-01-01	1993-12-31	✓		524	25193
AFR::MWI.Malawi	1992-01-01	1992-12-31	✓		8	298
AFR::MWI.Malawi	1991-01-01	1991-12-31	✓		245	8088
AFR::MWI.Malawi	1990-01-01	1990-12-31	✓		481	13457

← Previous 1 2 Next →



View information  
about all data  
available for a specific  
location and time  
period

CHOLERA DYNAMICS Dashboard Overview Observation Data Collections Add Observation Collection Workspace Locations Account Release Notes Admin Go to OC UID Log out

## Observation Collections

Note: When multiple pages of results are present column sorting only affects the current page.

UID	Location	Observation Count	Observation Range	Created Date	Updated Date
329	AFR::MWI	34	1973-01-01 - 2017-12-31	01/25/2019	05/04/2019
3182	AFR::MWI	325	2000-11-01 - 2016-10-31	01/25/2019	02/22/2019
5100	AFR::MWI	1446	2015-02-01 - 2017-03-17	01/25/2019	02/22/2019
5122	AFR::MWI	1289	2000-11-01 - 2016-12-31	01/25/2019	04/08/2019
20350	AFR::MWI	997	2012-07-15 - 2018-07-07	02/05/2019	05/13/2019
20360	AFR::MWI	504	2017-11-20 - 2018-07-29	03/18/2019	05/08/2019

Displaying all 6 Observation collection

### Filters

WHO Region  
AFR

ISO-A1  
MWI

ISO-A2\_L1

Application Owner

Contact

Minimum # of observations

Maximum # of observations

Earliest observation  
01/01/2012

Latest observation

Sort Order

Status

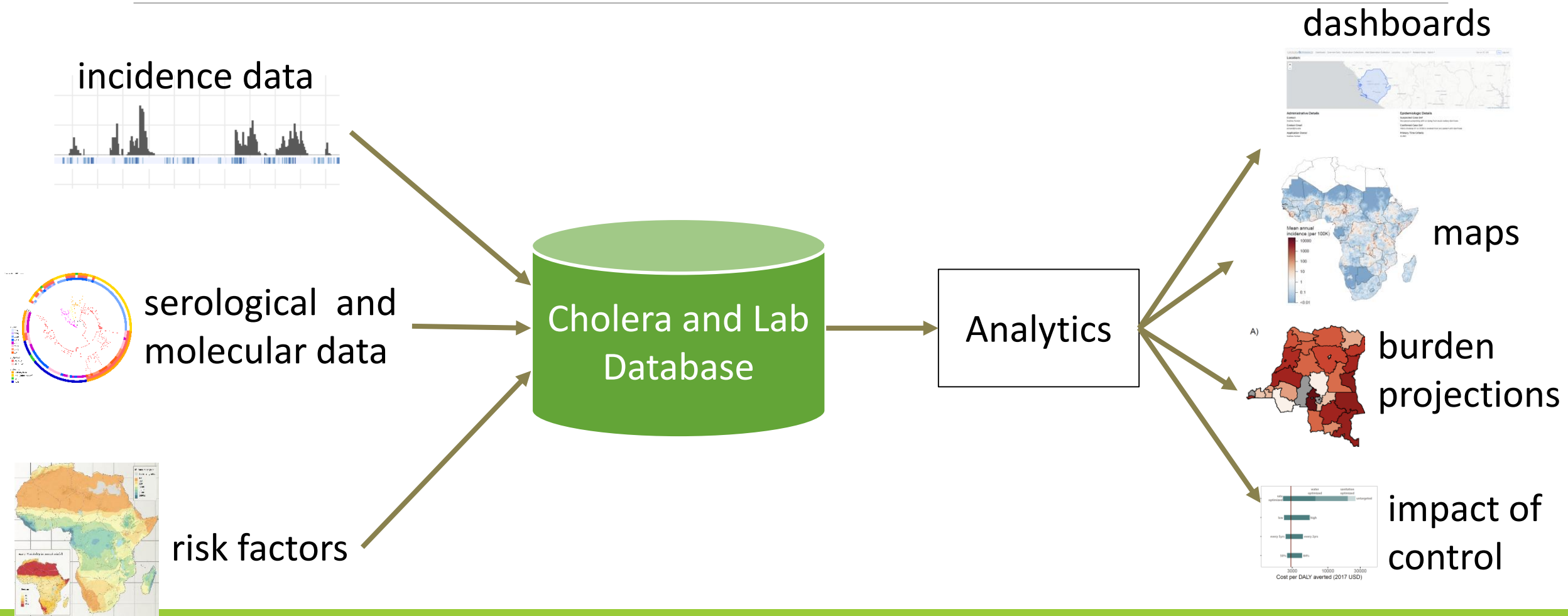
Options  
 Display Source  
 Display Contact

Update Clear Filters



Atlantic Ocean

# 2. Earth Observation database



## 2. Earth Observation database

---

Satellite-derived rainfall: **GPM/TRMM** and **CHIRPS**

Satellite-derived surface temperature and near-surface air temperature:  
**MODIS/VIIRS** and **CHIRTS**

Surface water extent and quality: **MODIS/VIIRS**; **Aquarius/SMAP** for salinity

Vegetation status: **MODIS/VIIRS**

Soil moisture and water flow from a **Land Data Assimilation System (LDAS)**

Subseasonal to Seasonal hydrological forecast: **NMME forecasts + LDAS**

## 2. Earth Observation database

---

Satellite-derived rainfall: **GPM/TRMM** and **CHIRPS**

Satellite-derived surface temperature and near-surface air temperature:  
**MODIS/VIIRS** and **CHIRTS**

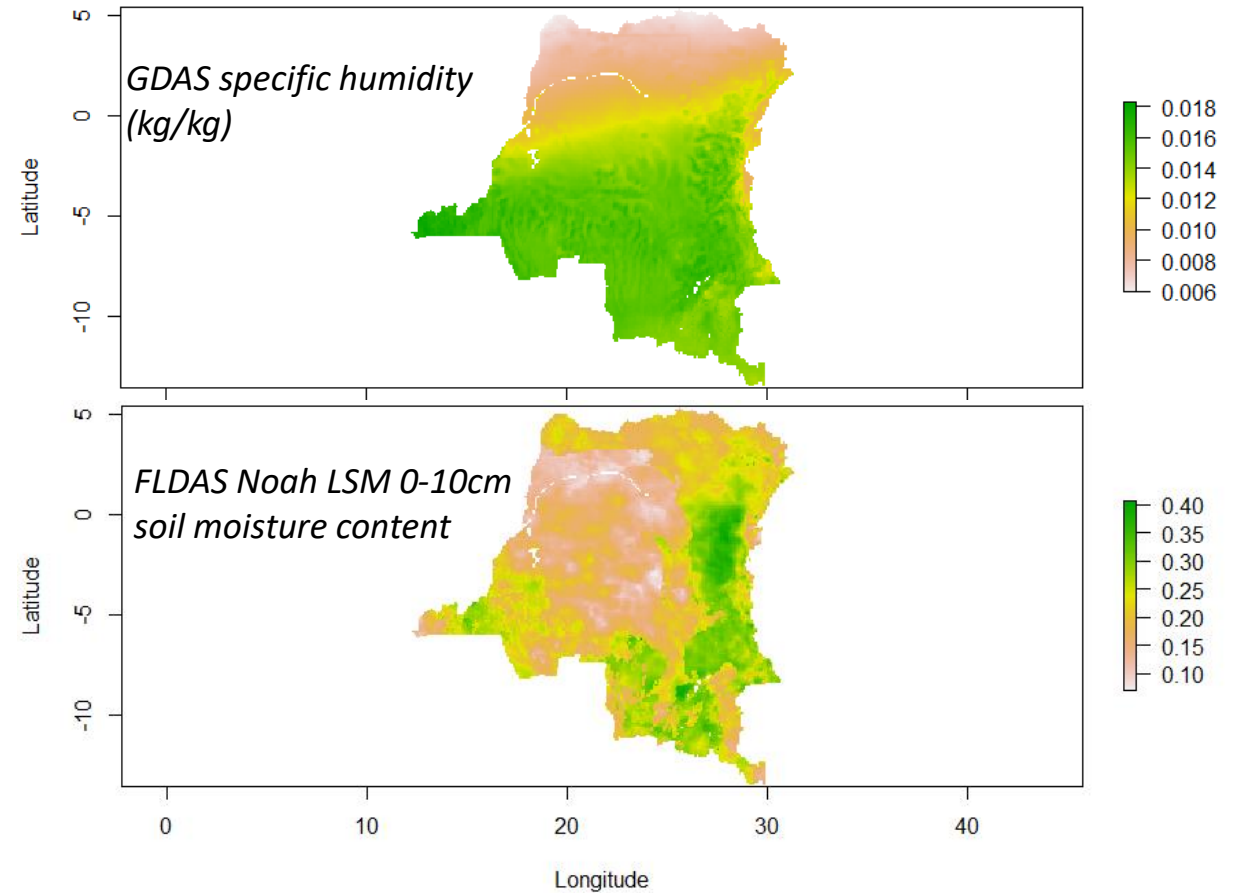
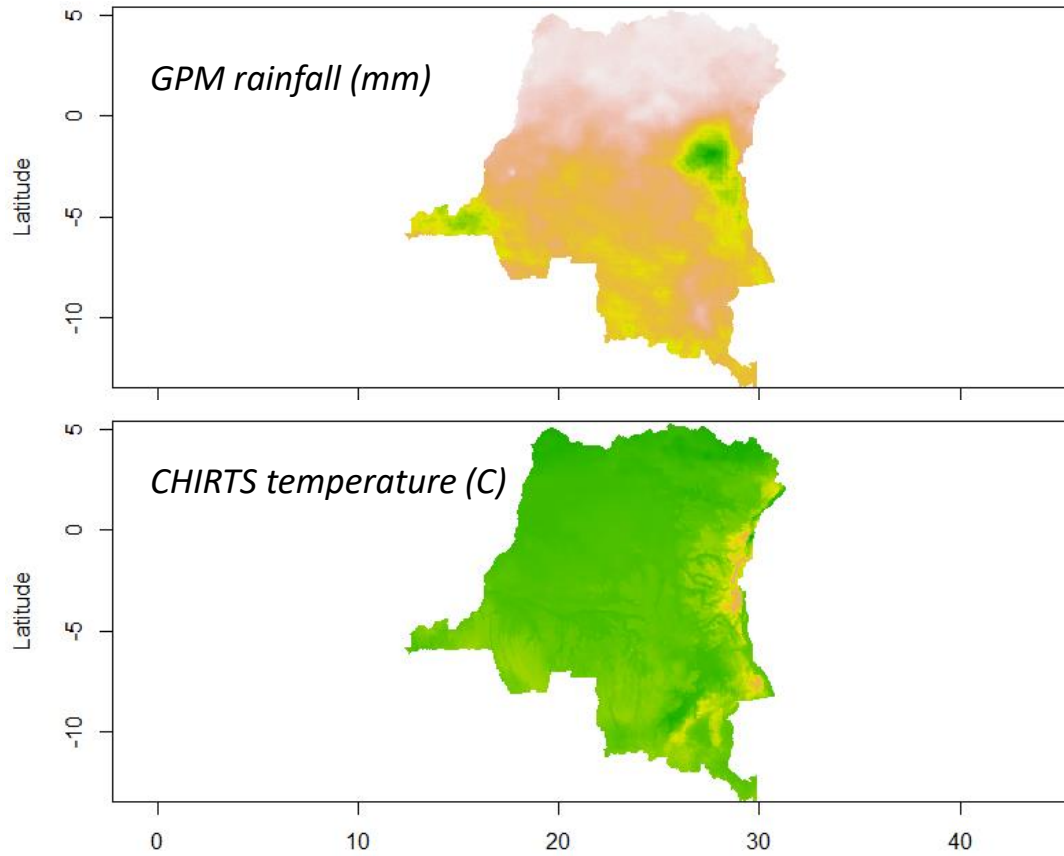
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Vegetation status: **MODIS/VIIRS**

Soil moisture and water flow from a **Land Data Assimilation System (LDAS)**

Subseasonal to Seasonal hydrological forecast: **NMME forecasts + LDAS**

# EO for the DRC



# 3. Weekly maps of environmental cholera potential

---

Based primarily on **established relationships** between environment and cholera risk.

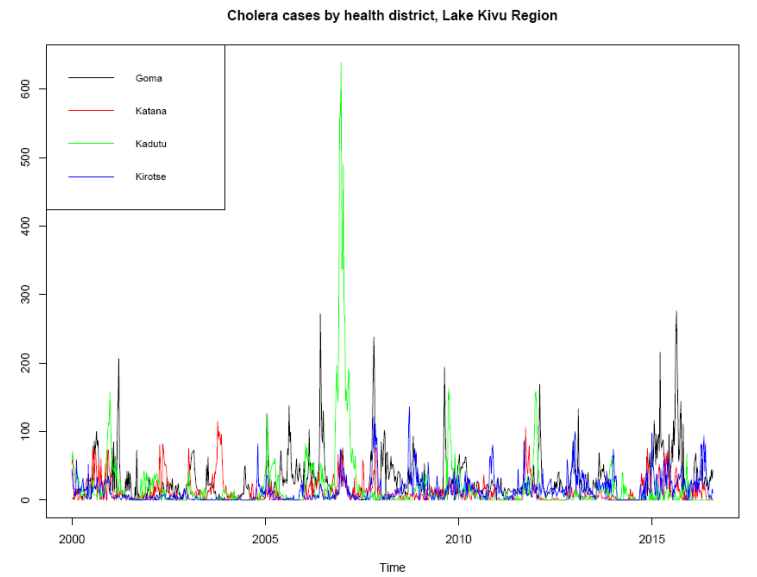
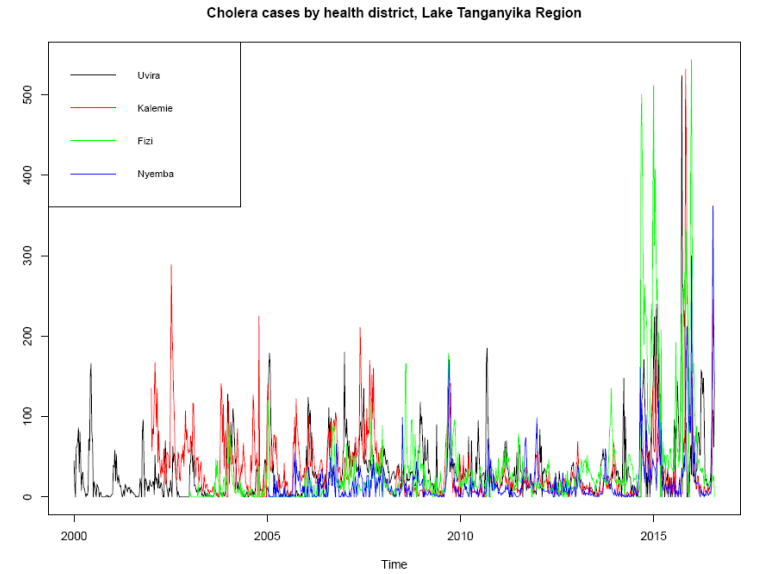
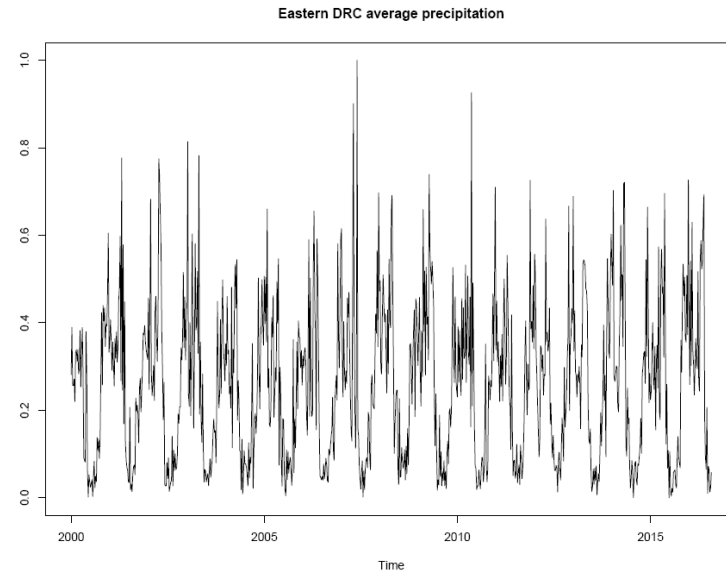
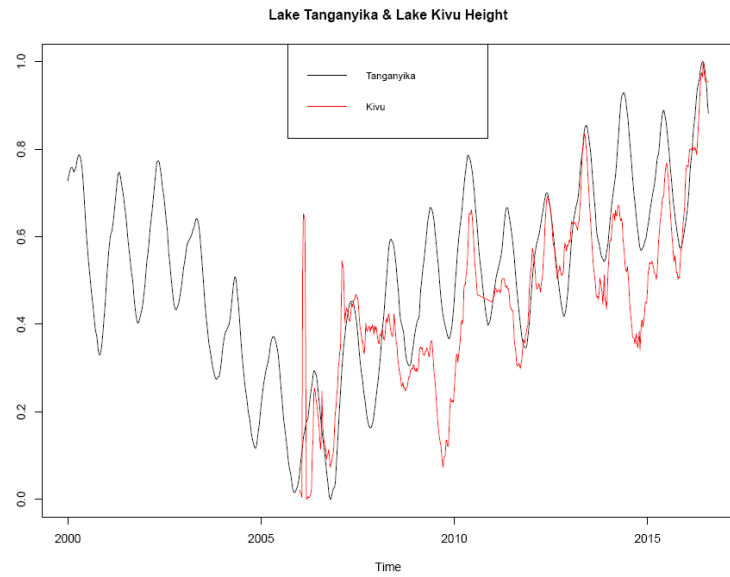
These relationships will **vary geographically and by season.**

Goal is a **20km gridded resolution monitoring product**, updated monthly or more frequently

# Exploratory Analysis: Eastern DRC

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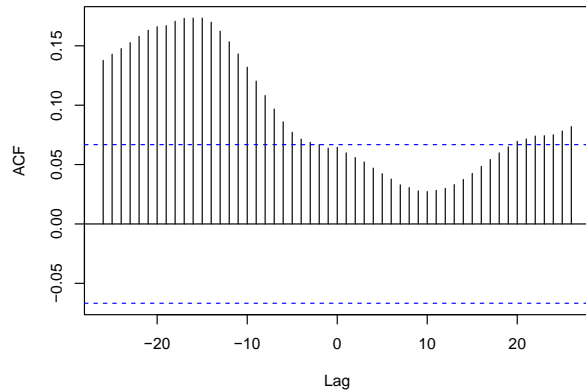


# Lake height correlations to cholera for high-incidence health districts in Eastern DRC.

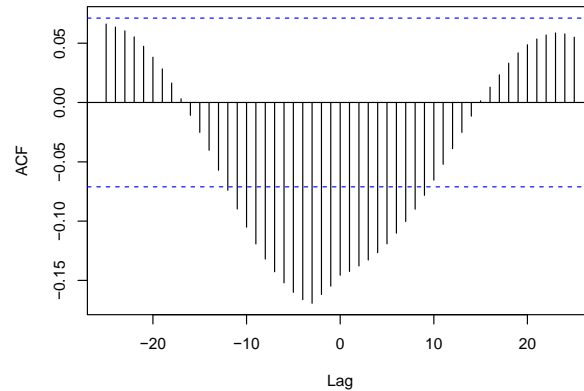
## LAKE TANGANYIKA HEALTH DISTRICTS

## LAKE KIVU HEALTH DISTRICTS

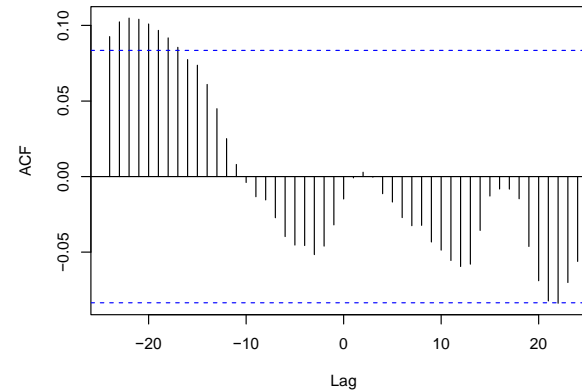
UviraCases & TanganyikaLakeHeight0016



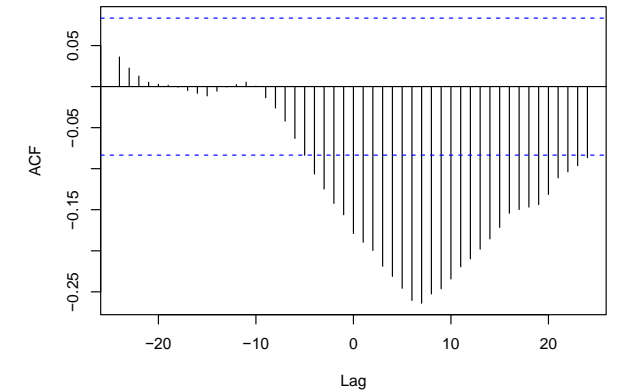
KalemieCases & TanganyikaLakeHeight0216



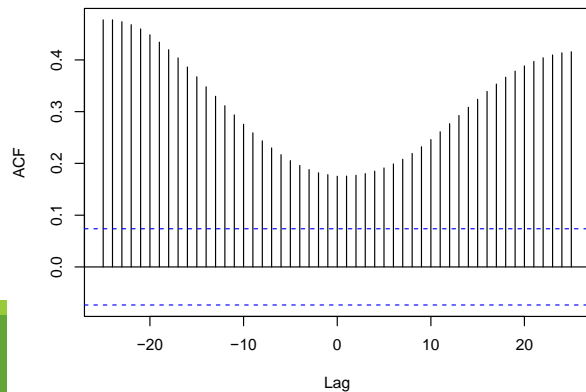
GomaCases0616 & KivuLakeHeight0616



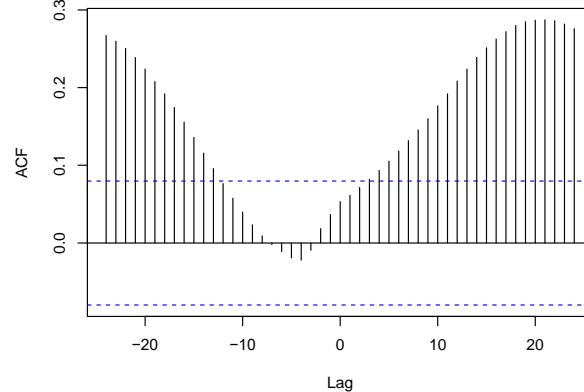
KatanaCases0616 & KivuLakeHeight0616



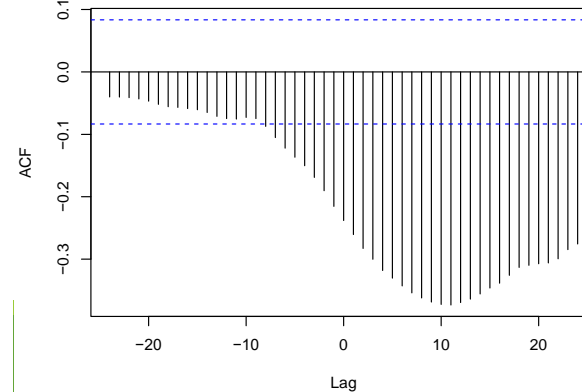
FiziCases & TanganyikaLakeHeight0316



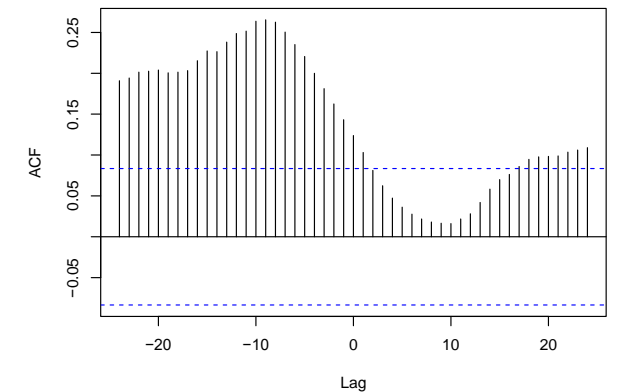
NyembaCases & TanganyikaLakeHeight0516



KadutuCases0616 & KivuLakeHeight0616



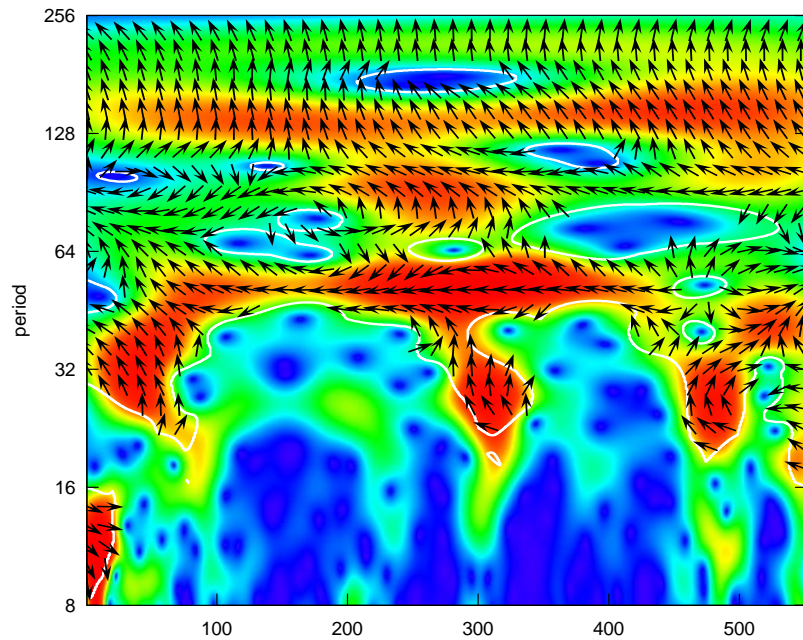
KirotseCases0616 & KivuLakeHeight0616



# Lake Kivu height data shows annual and biennial relationships to cholera incidence.

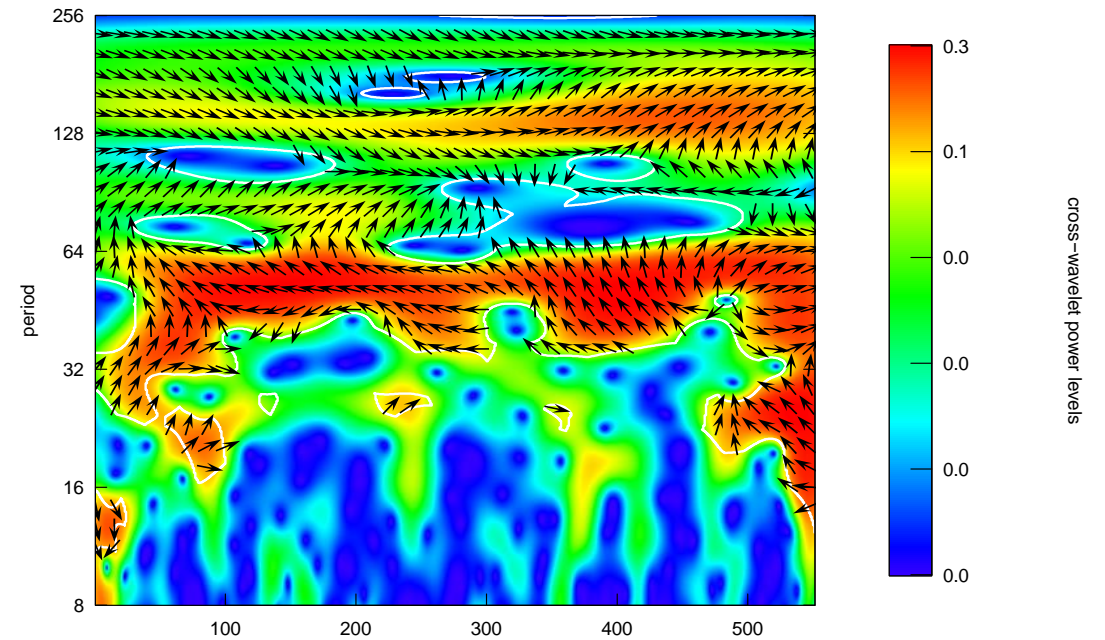
KALEMIE HEALTH DISTRICT  
TANGANYIKA PROVINCE

Katana Cases & Lake Kivu Height



KIROTSE HEALTH DISTRICT  
NORD-KIVU PROVINCE

Kiotse & Lake Kivu Height

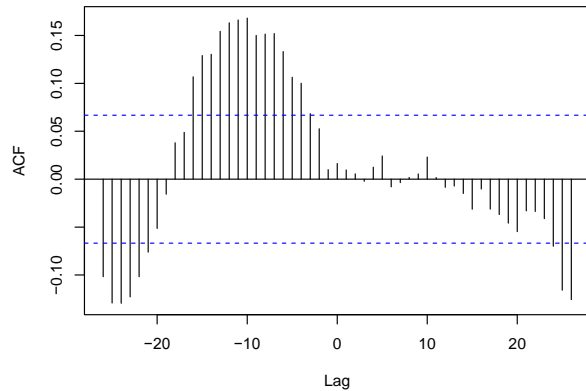


# Precipitation correlations to cholera for high-incidence health districts in Eastern DRC.

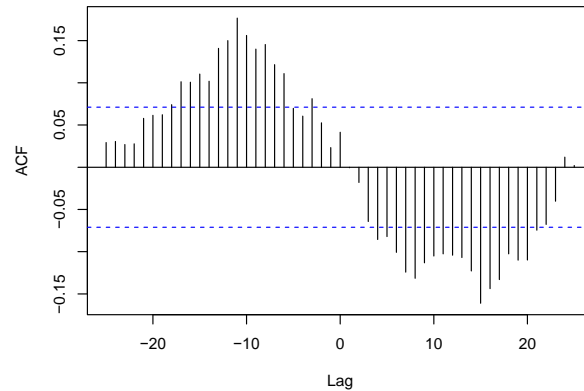
## LAKE TANGANYIKA HEALTH DISTRICTS

## LAKE KIVU HEALTH DISTRICTS

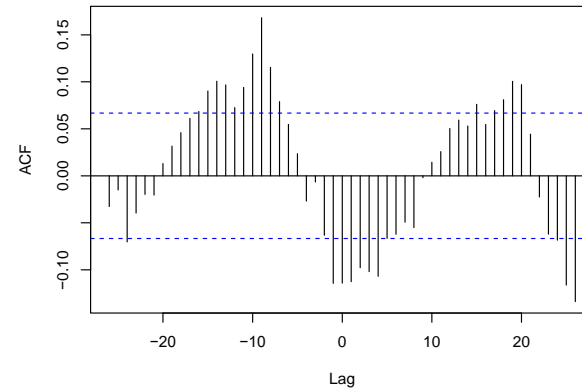
UviraCases & UviraPrecip0016



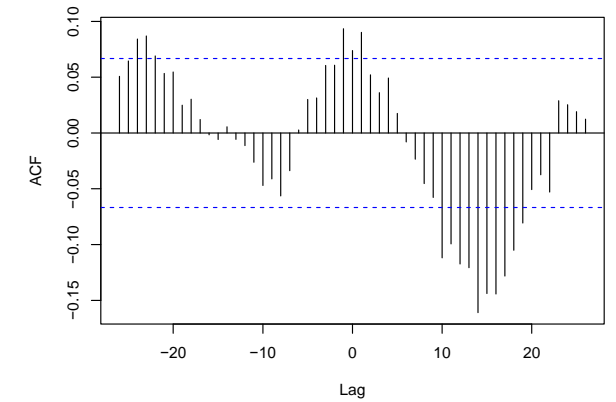
KalemieCases & KalemiePrecip0216



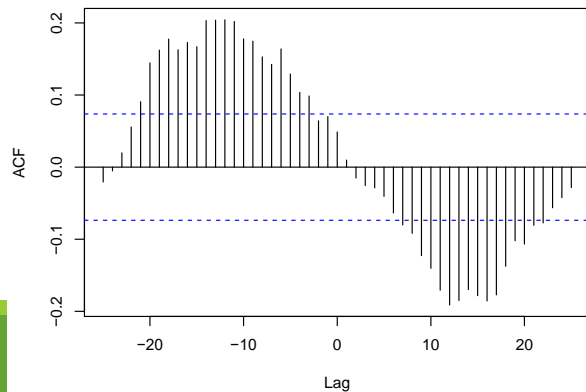
GomaCases & GomaPrecip0016



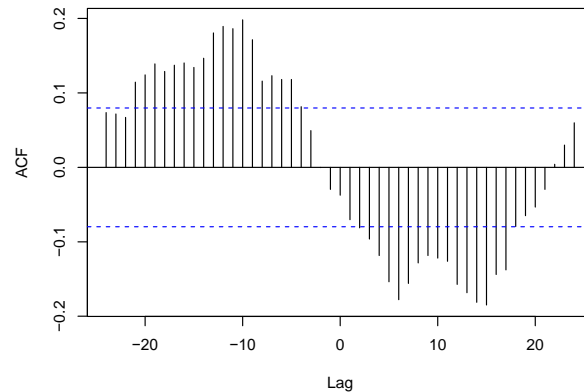
KatanaCases & KatanaPrecip0016



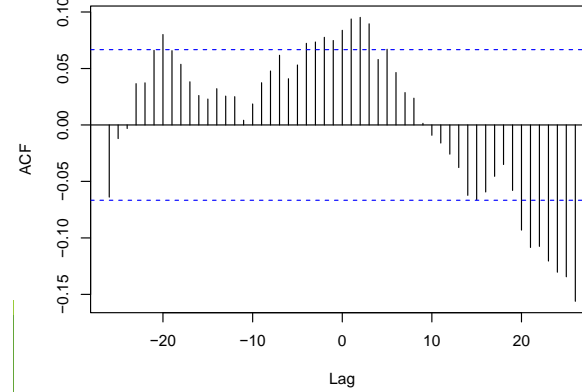
FiziCases & FiziPrecip0316



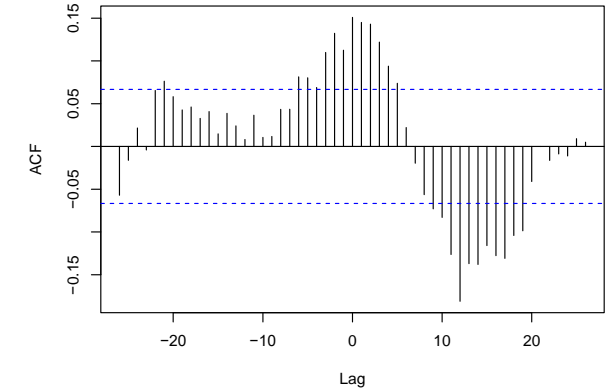
NyembaCases & NyembaPrecip0516



KadutuCases & KadutuPrecip0016

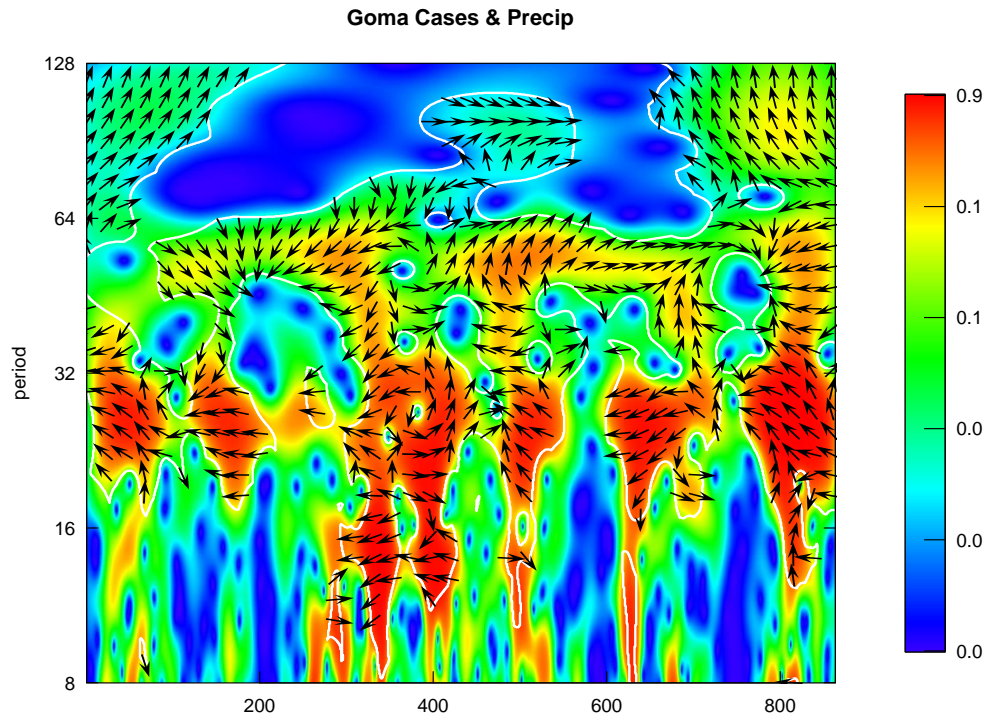


KiotseCases & KiotsePrecip0016

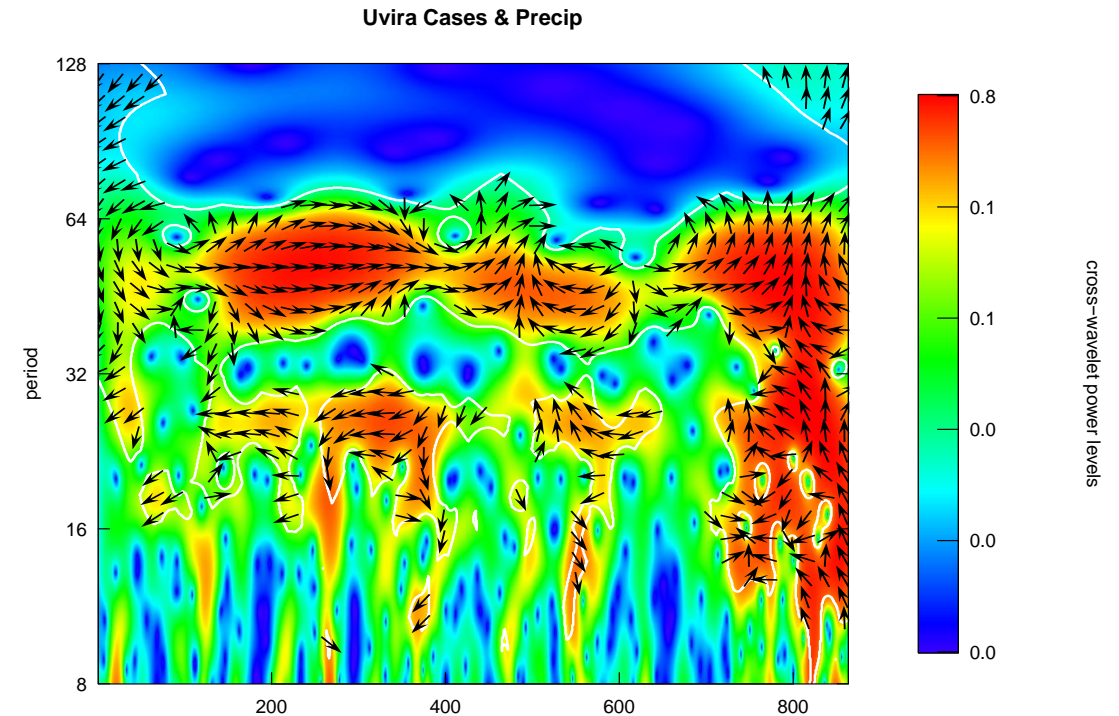


# Precipitation data shows annual and semi-annual/biennial relationships to cholera incidence in most lake-adjacent health districts.

GOMA HEALTH DISTRICT  
NORD-KIVU PROVINCE



UVIRA HEALTH DISTRICT  
SUD-KIVU PROVINCE



# Next Steps

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Project postdoc Javier Perez-Saez started this month!

Implement **cholera potential monitor for DRC**, then move on to other case studies

Begin cholera risk monitor development for DRC

## Risks:

How far can we go with the cholera and population data we have?

# ARL

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**Current:** ARL 3, almost 4

**Expectation:** ARL 6 this PY

**Goal:** ARL 8

Thank You

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