



Oceans, Climate and Health: The Cholera Paradigm

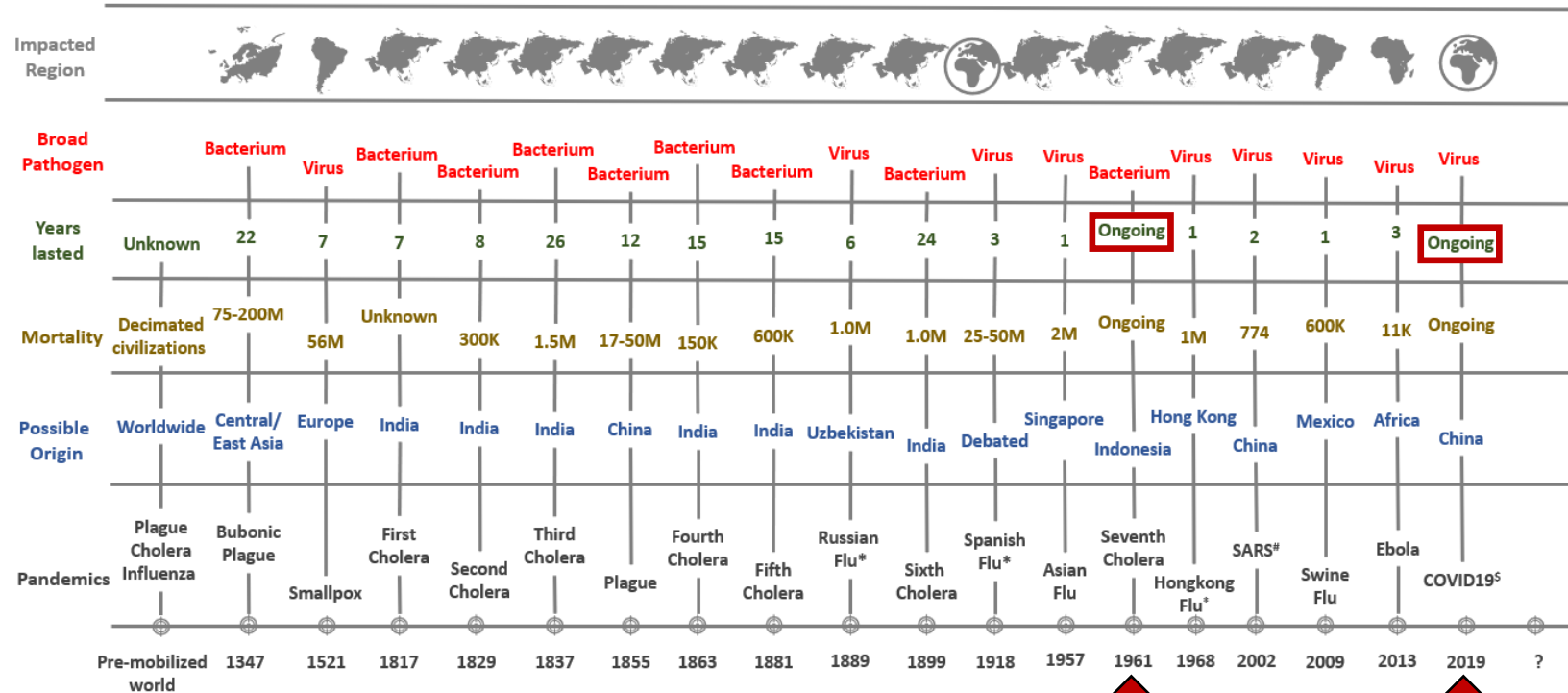
March 27, 2025

Global Vaccine and Immunization Research Forum 2025
Plenary 7: Rising to the challenges of climate change
Rio de Janeiro, Brazil

Rita R. Colwell, Ph.D., D.Sc.
Distinguished University Professor
University of Maryland College Park

blue: *V. vulnificus*
red: *V. cholerae*
purple: *V. fluvialis*
yellow: *V. alginolyticus*
green: *V. parahaemolyticus*

Pandemics of the modern world

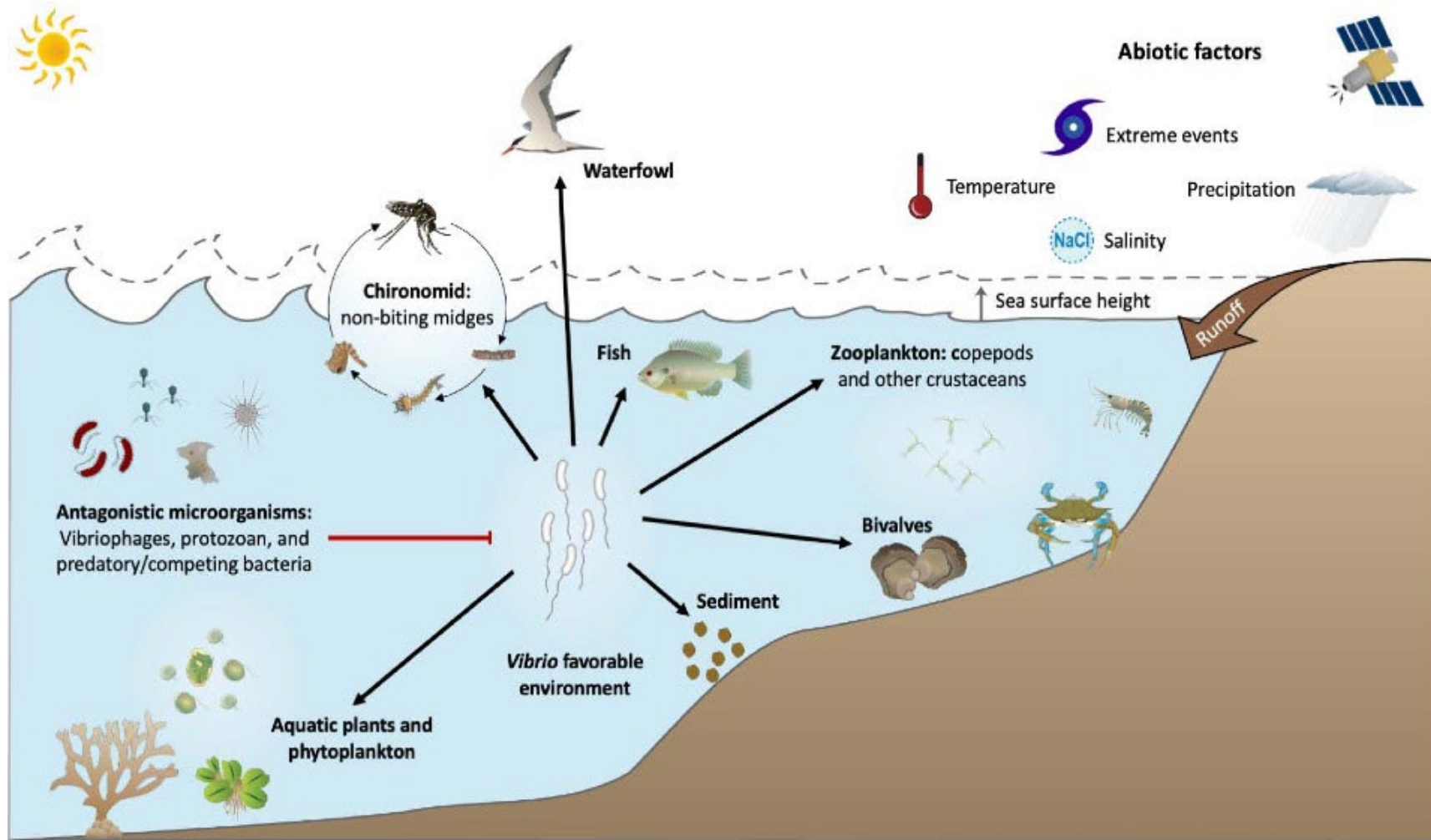


Data collected and summarized from
 Sherman, I. 2007 Twelve Disease that Changed Our World, American Society for Microbiology, USA
 Zimmerman, B.E. and Zimmerman, D.J 2003 Killer Germs, McGraw Hill, USA
 *Source of virus debated, hence used prevalent name of disease, #SARS-CoV-1, ^sSARS-CoV-2

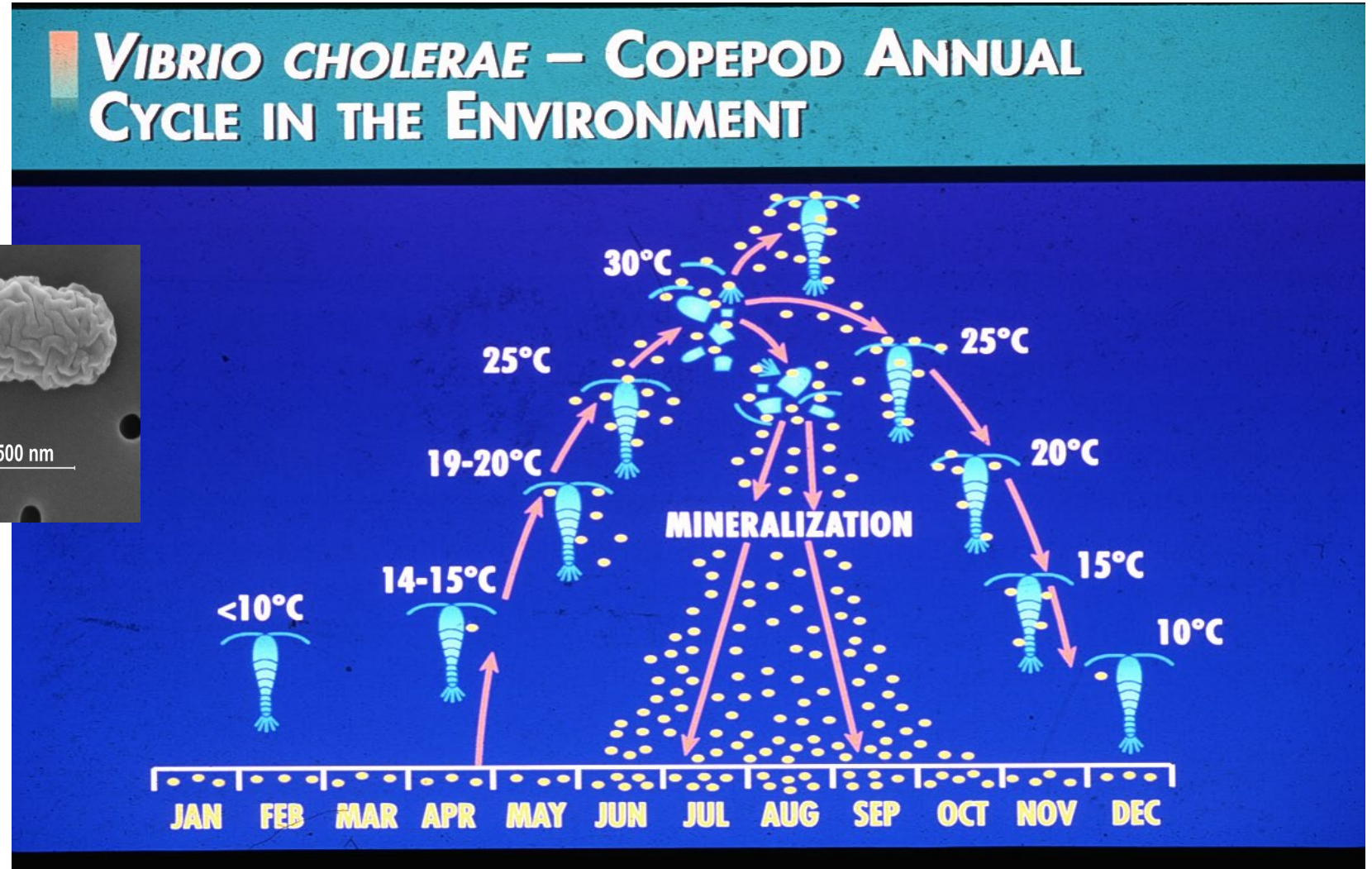
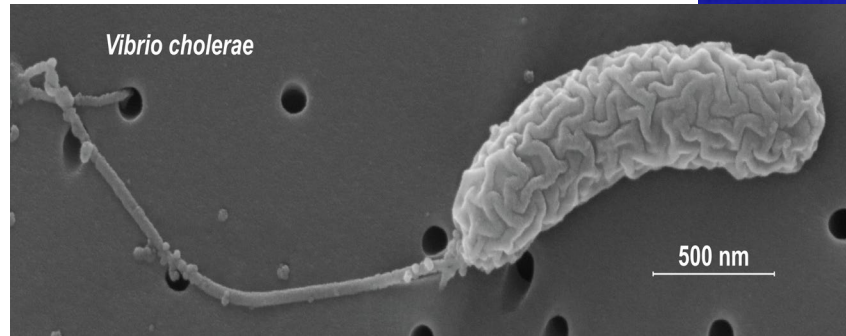
Cholera

COVID-19

Vibrios and their natural environment

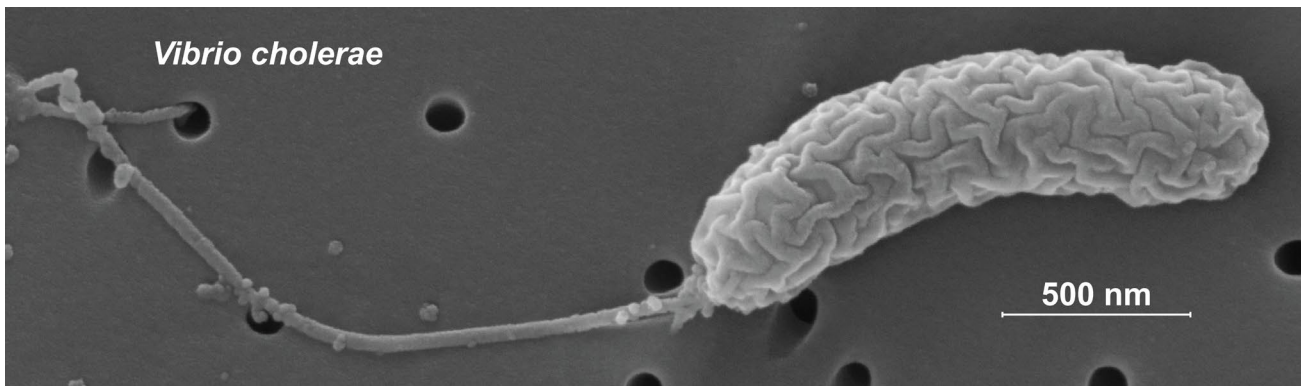


1965-1975 An early contribution of marine microbiology to human health: Determination of the *Vibrio cholerae* life cycle



Cholera

- Acute water-related diarrheal disease
- Reported in ~50 countries
 - Affects >10 million people
- ***V. cholerae* exists naturally**
 - New biotypes emerging
 - Will not be eradicated but can be controlled with **safe water**



Electron Microscopy: Lupari, H., Long, D., Pope, R., Brumfield, K., and Colwell, R.

Cholera

Common Symptoms



watery diarrhea



nausea/vomiting



dehydration

Severe Symptoms



low blood pressure



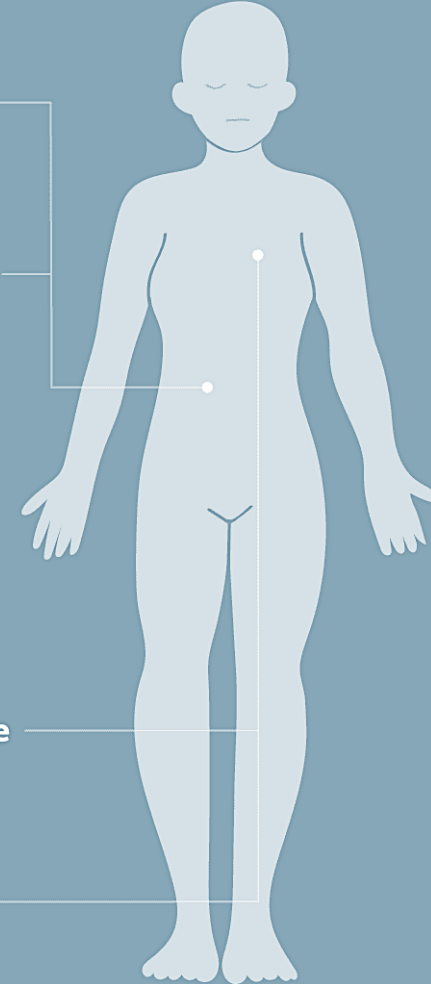
rapid heart rate



persistent
vomiting



muscle cramps



FIRST MODEL FOR TRANSMISSION OF *VIBRIO CHOLERAE* FROM THE ENVIRONMENT TO HUMANS (1975)

PHYSICAL & CHEMICAL CHARACTERISTICS OF WATER

- temperature
- sunlight
- rainfall
- pH
- dissolved oxygen
- salinity & nutrients



BIOLOGICAL CHARACTERISTICS

- algae bloom
- phytoplankton bloom



ZOOPLANKTON BLOOM (enters into non-culturable state)



FECAL SHEDDING
returns *V. cholerae*
to the water.



V. CHOLERAE
viable but non-culturable state in the water
column & attached to particulates. Commensal
or symbiotic relationships.

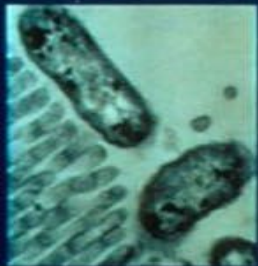


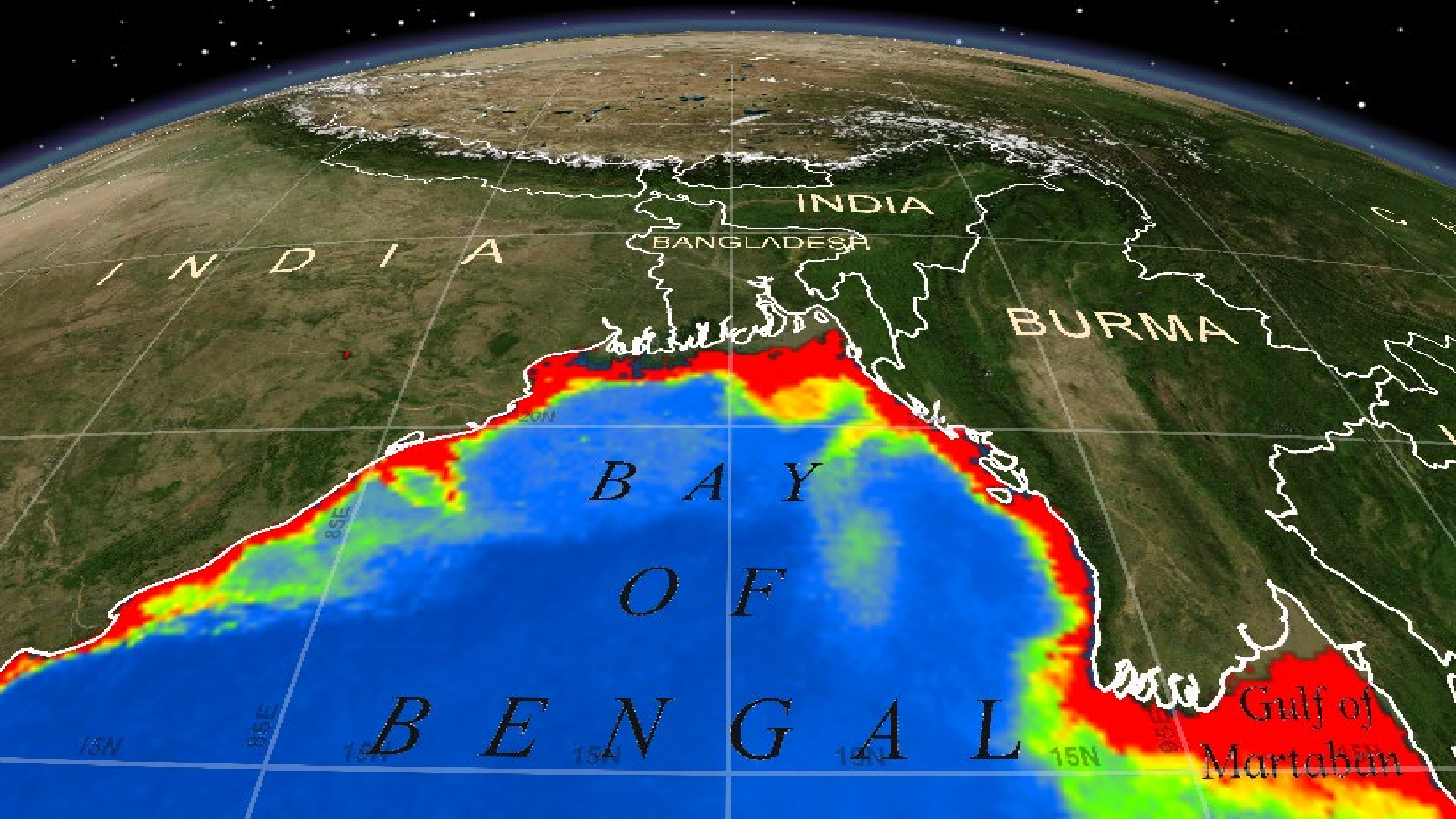
TRANSMISSION OF *V. CHOLERAE*
to humans via ingested water containing
colonized copepods or other vectors.





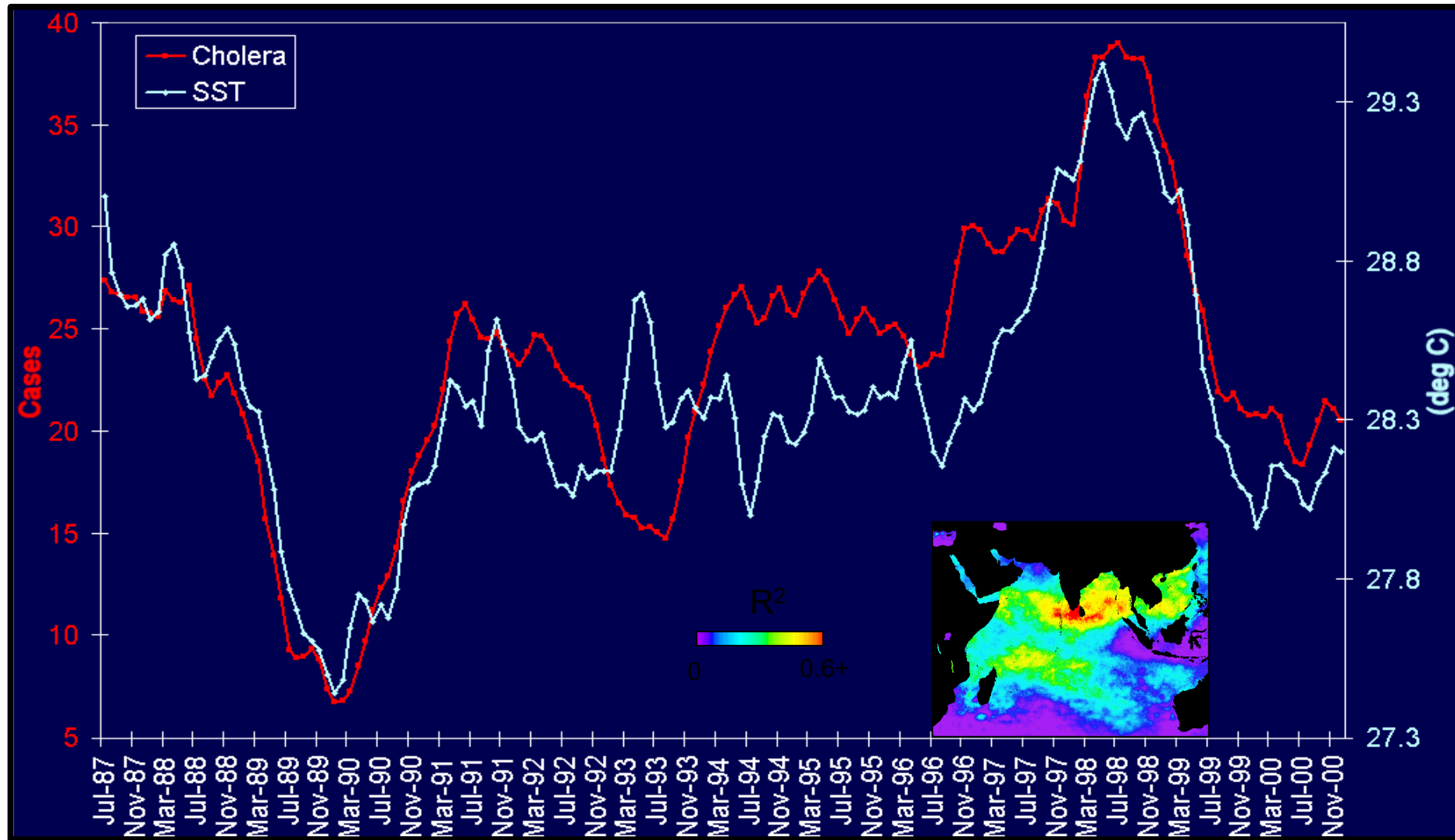
Vibrio cholerae



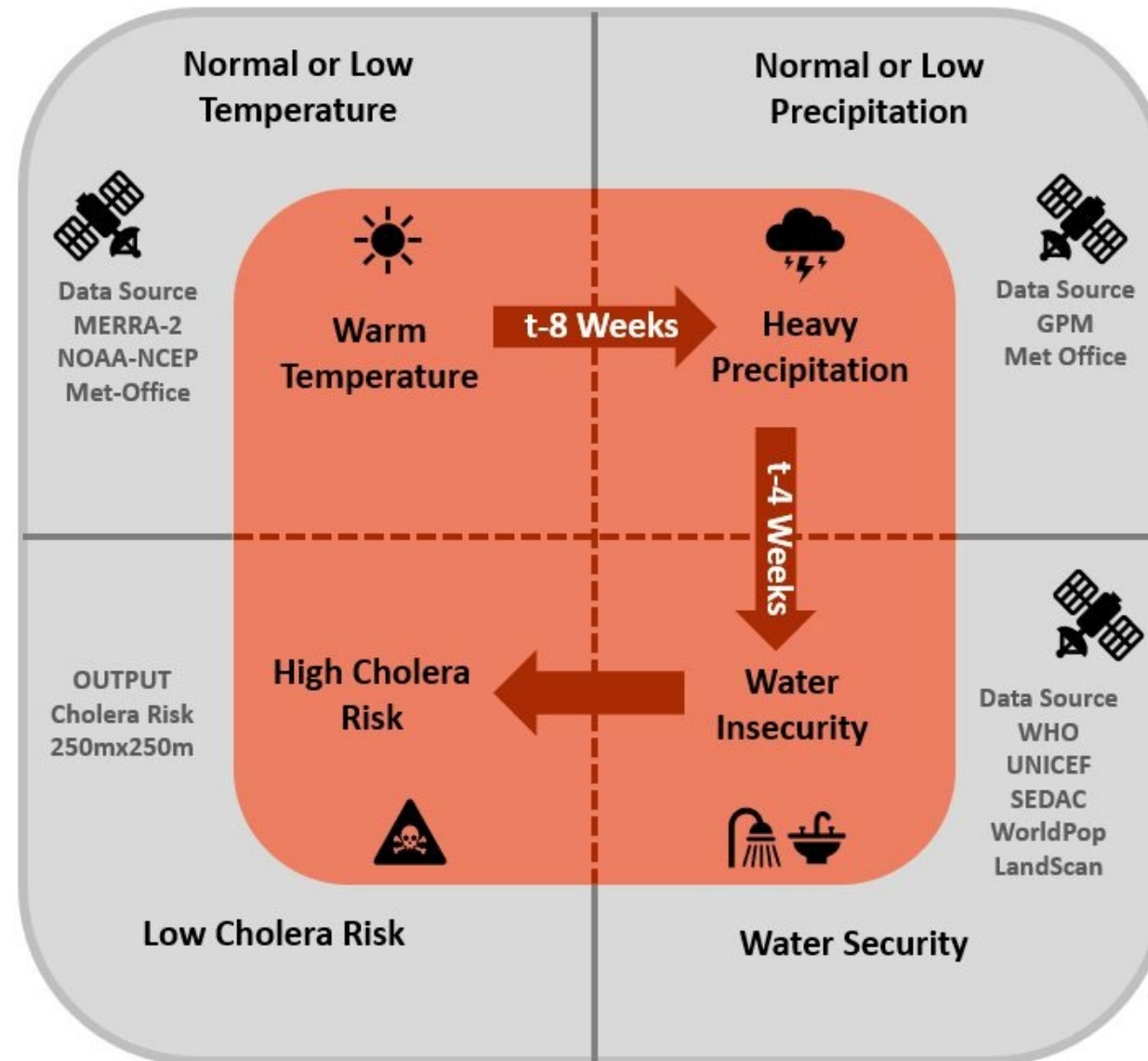


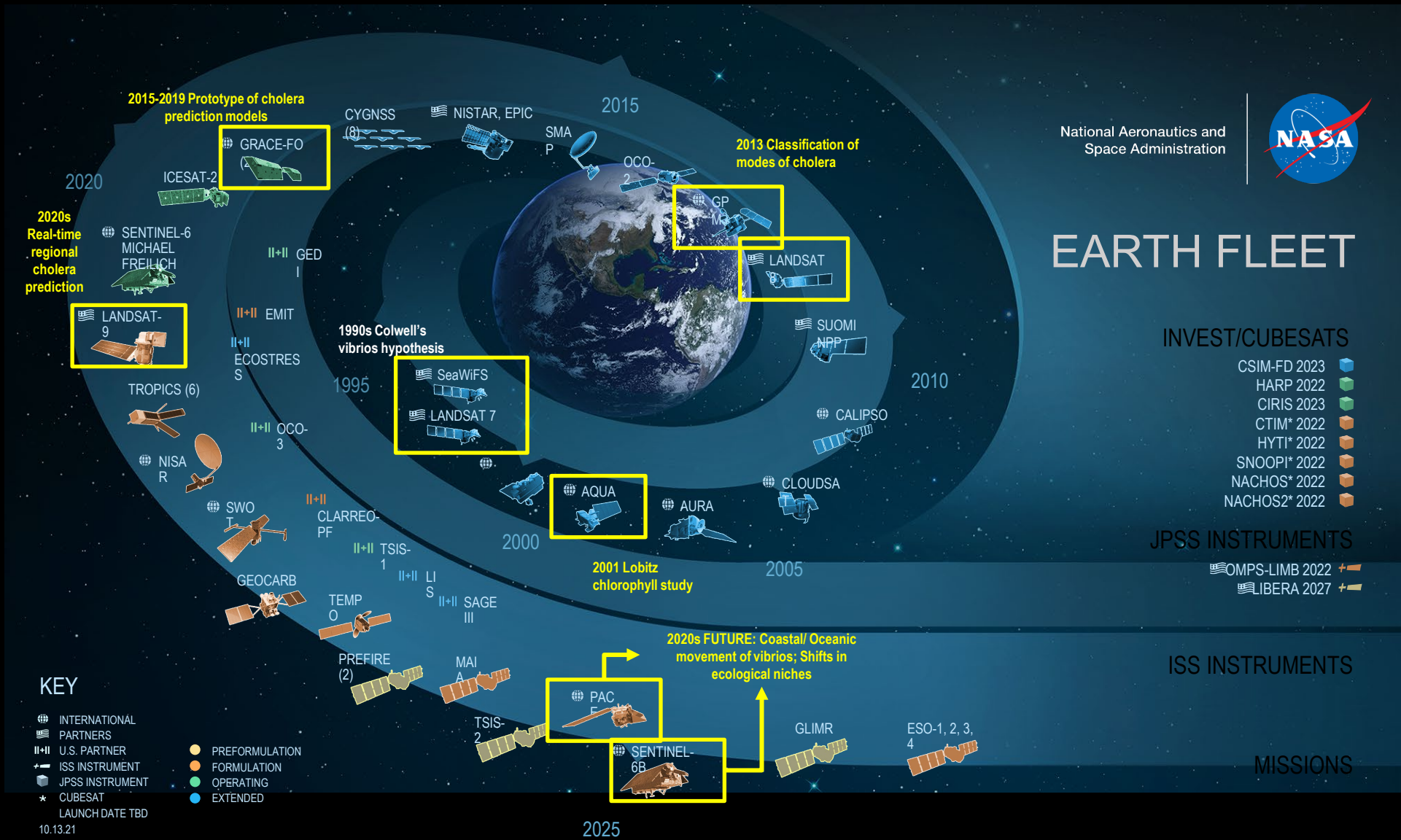
Cholera and SST in the Indian Ocean 1985 - 2000

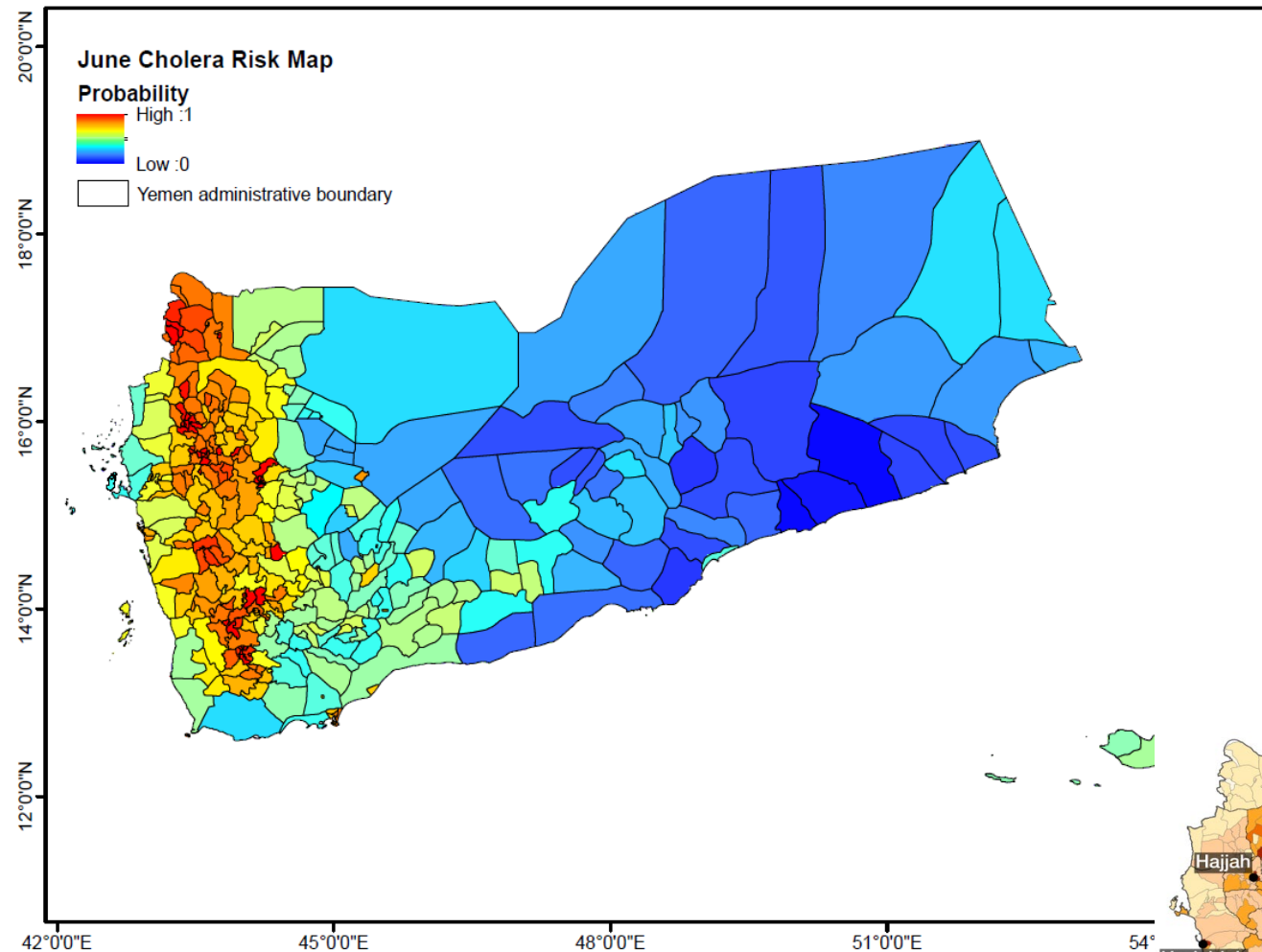
Six-month SST lead: $R^2 = 0.72$



Environment Sensitive Cholera Hypothesis



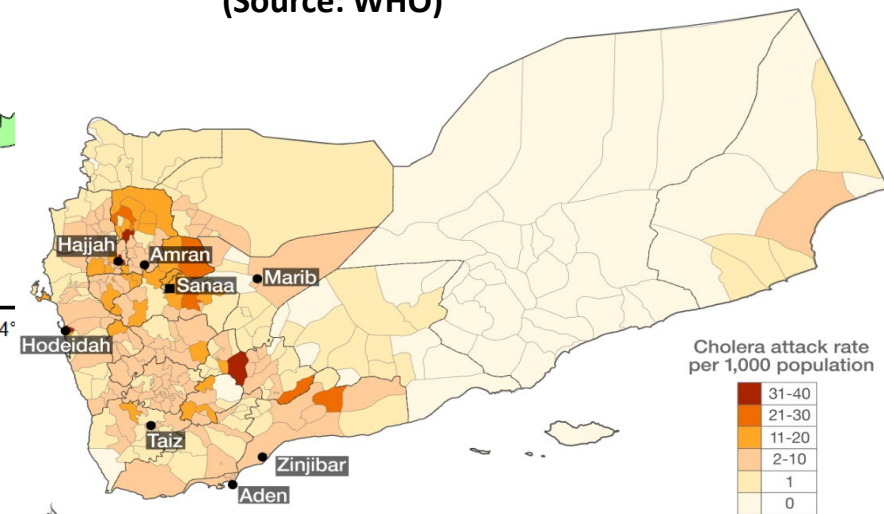




**Risk estimated on May 30th, 2017
for June 2017**

Real-time cholera prediction for Yemen

**Reported cholera cases for this month of June 2017
(Source: WHO)**



Current Operational Risk Prediction for Cholera

scientific reports

OPEN

Combating cholera by building predictive capabilities for pathogenic *Vibrio cholerae* in Yemen

Moiz Usmani¹, Kyle D. Brumfield^{2,3}, Bailey M. Magers¹, Juan Chaves-Gonzalez⁴, Helen Ticehurst⁵, Rosa Barciela⁵, Fergus McBean⁶, Rita R. Colwell^{2,3} & Antarpreet Jutla¹✉

Check for updates

GeoHealth

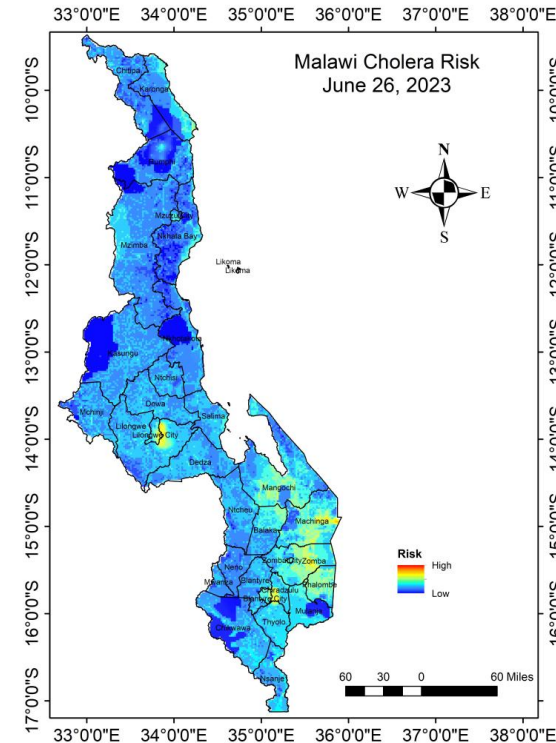
EDITORIAL

10.1029/2022GH000681

AGU
ADVANCING
EARTH AND
SPACE SCIENCE

Predictive Intelligence for Cholera in Ukraine?

Moiz Usmani¹ , Kyle D. Brumfield^{2,3} , Bailey M. Magers¹, Anwar Huq^{2,3}, Rosa Barciela⁴, Thanh H. Nguyen⁵ , Rita R. Colwell^{2,3} , and Antarpreet Jutla¹ 



Malawi



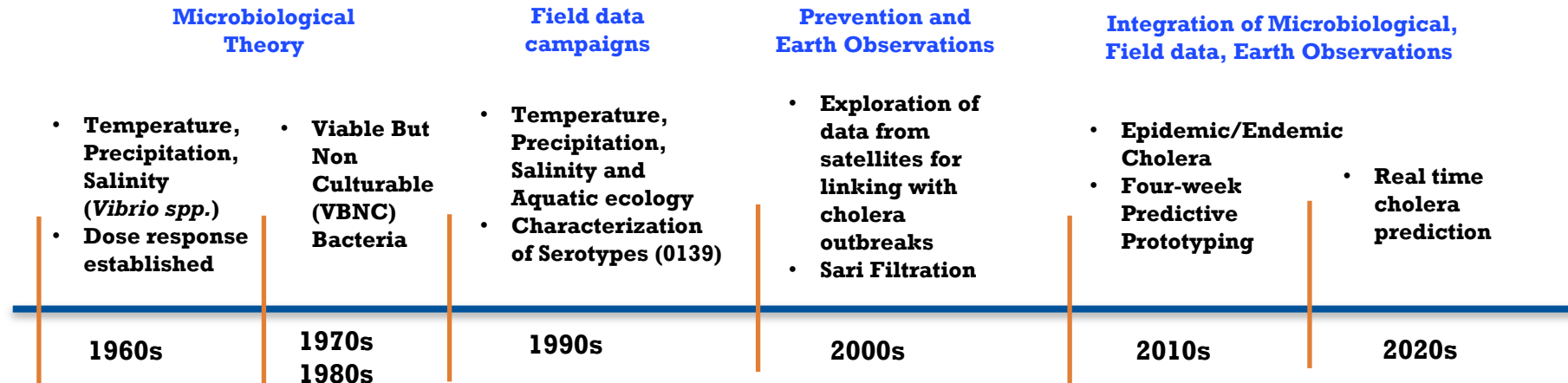
UNIVERSITY OF
MARYLAND

UF

Herbert Wertheim College of Engineering

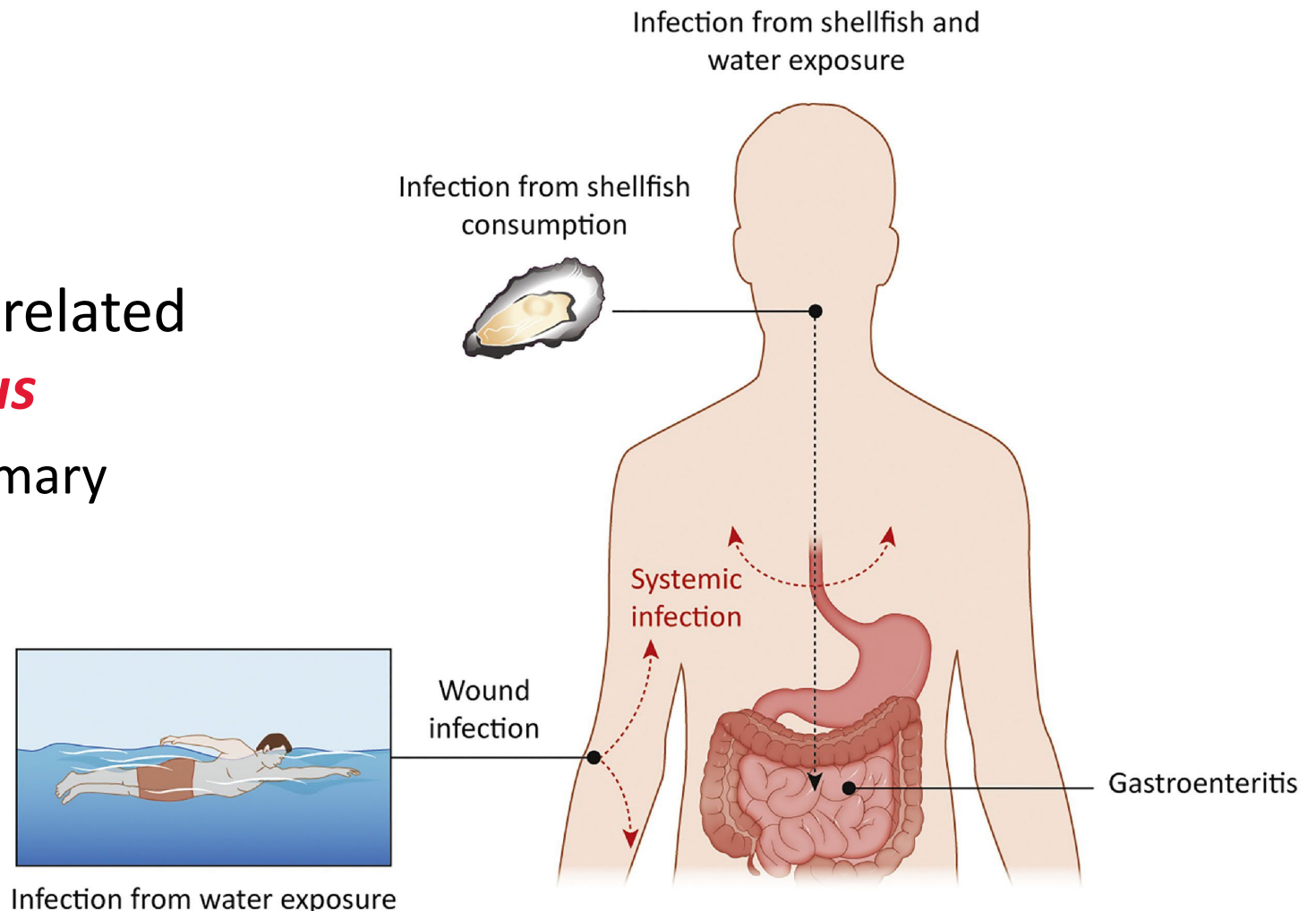
DEPARTMENT OF ENVIRONMENTAL ENGINEERING SCIENCES

Timeline of Cholera Prediction Model



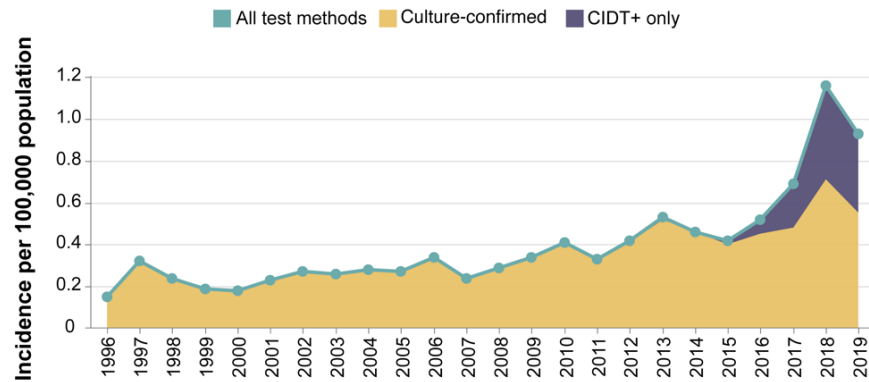
Non-cholera *Vibrio* spp. infections

- USA: 80,000 illnesses and hundreds of deaths p.a.
- 65% of cases are foodborne
 - *V. parahaemolyticus*
- 95% of waterborne/seafood related deaths caused by *V. vulnificus*
 - >50% case fatality rate for primary septicemia

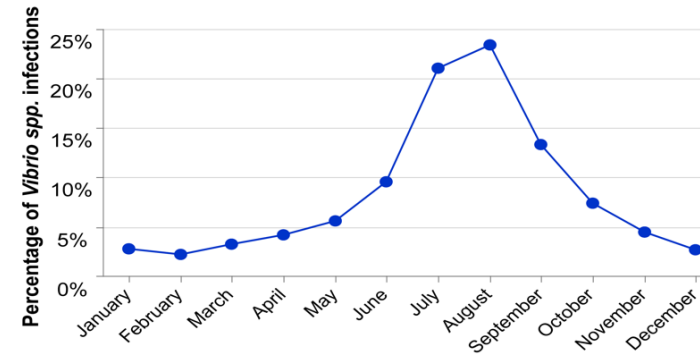


Vibrio spp. infections have increased in past decades

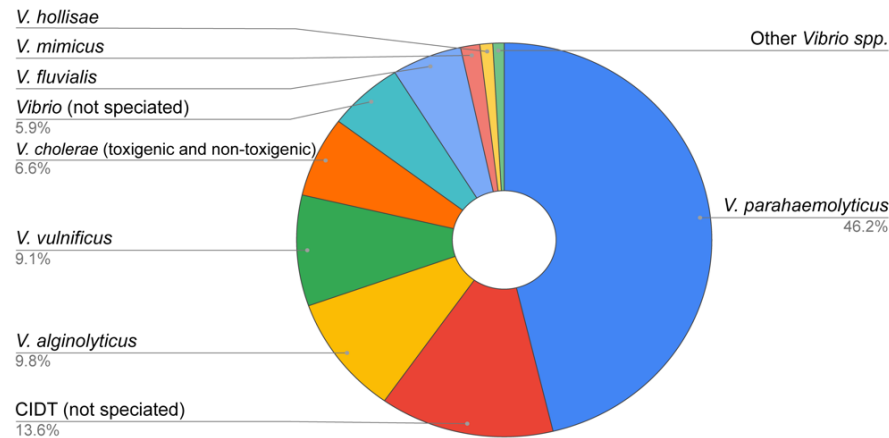
A) *Vibrio* spp. Infections; 1996-2019



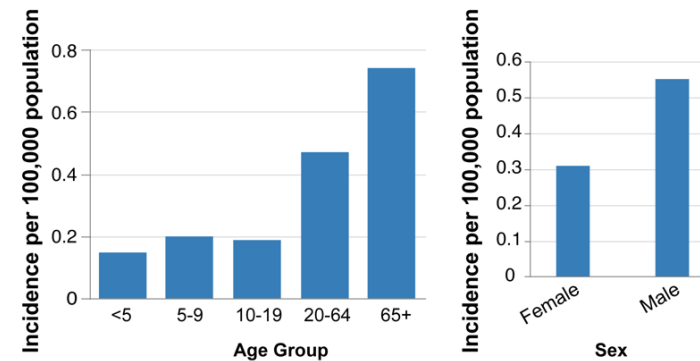
B)



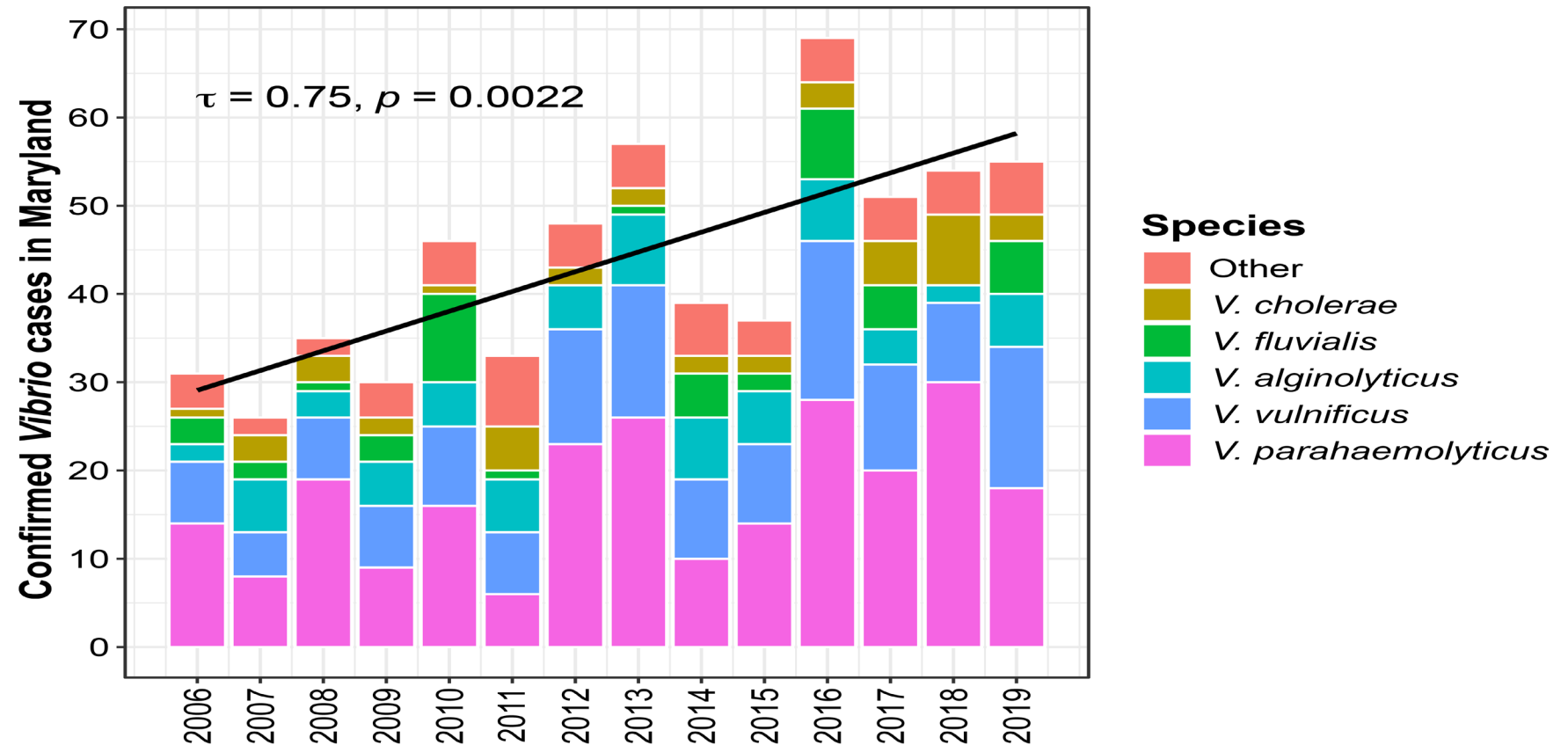
C)



D)

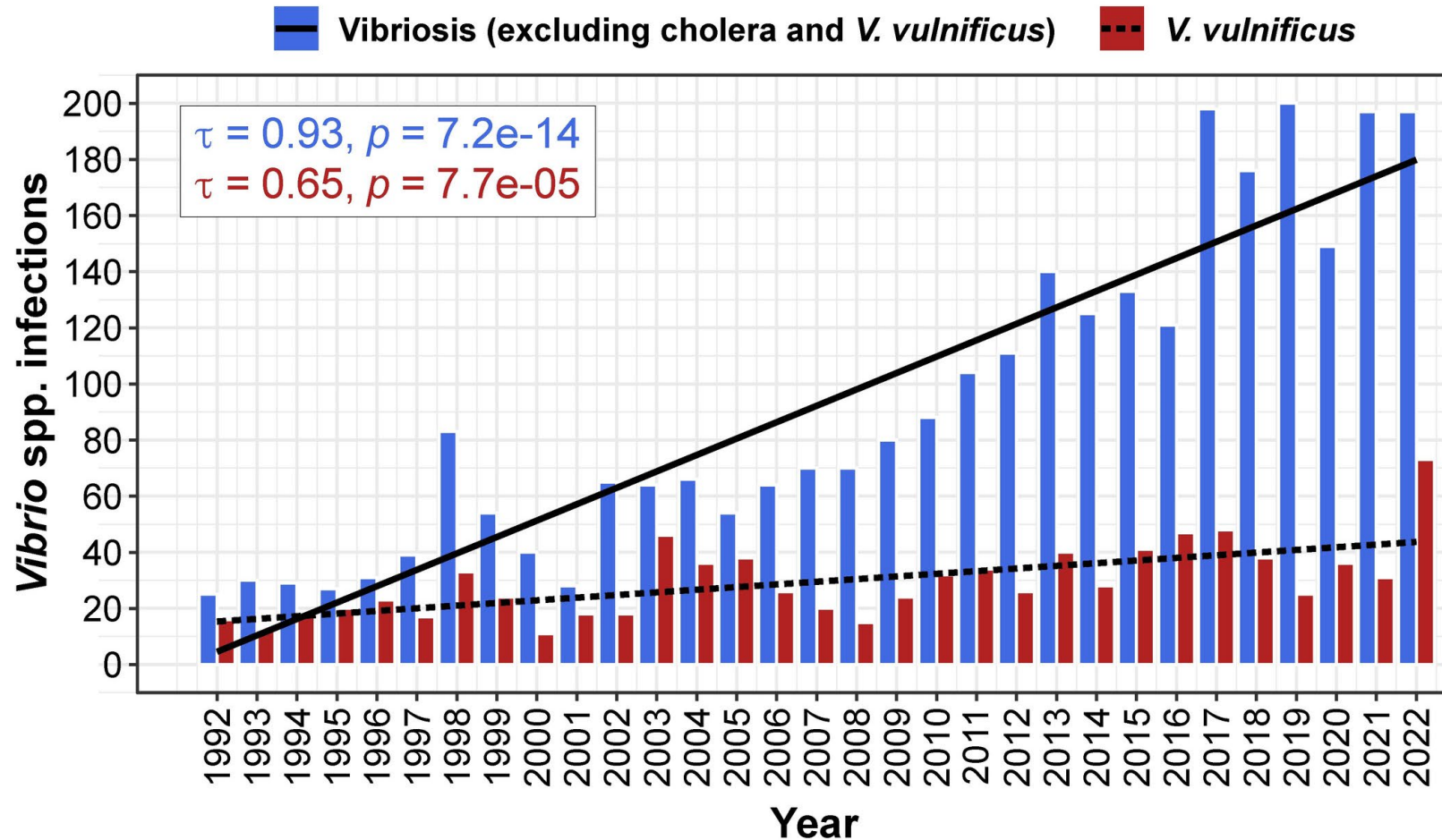


Long-term increase of vibriosis in Maryland

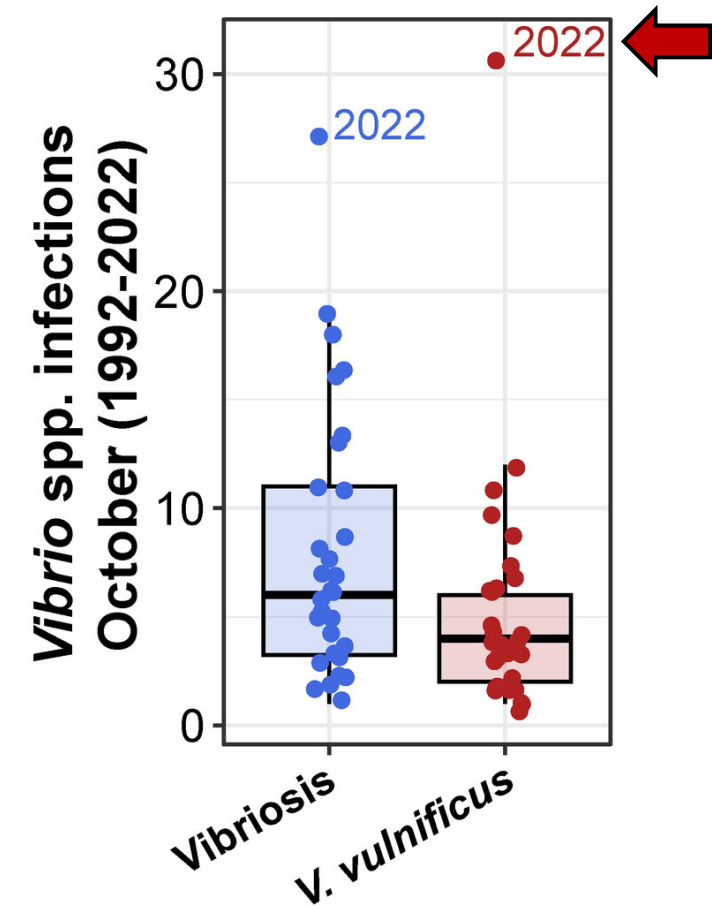


Morgado, M.E., Brumfield, K.D., Mitchell, C., Boyle, M.M., Colwell, R.R., Sapkota, A.R., Increased incidence of vibriosis in Maryland, U.S.A, 2006–2019. 2024. Environmental Research (2024), doi: <https://doi.org/10.1016/j.envres.117940>.

Increased vibriosis in FL



Brumfield et al., 2023. *mBio* 14 (6), e01476-23



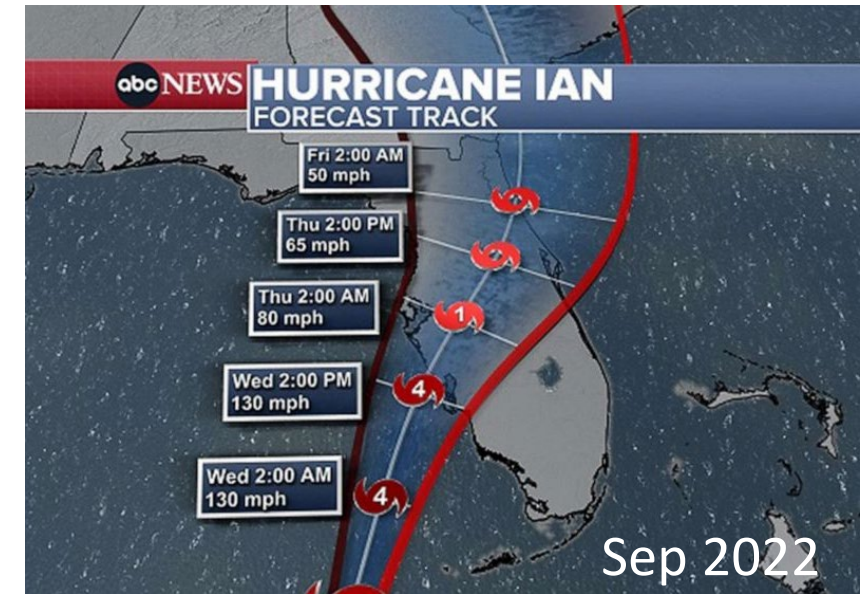
Public health implications of climate variability

Florida issues warning over flesh-eating bacteria in wake of Hurricane Ian

The New York Times
Hurricane Ian Is Blamed for Deadly Bacterial Infections in Florida

TIME

Flesh-Eating Bacteria Cases Are Rising in Florida After Hurricane Ian



FLESH-EATING BACTERIA IN FLORIDA

SO FAR THIS YEAR

65 CASES
OF VIBRIO VULNIFICUS

11 DEATHS
FROM VIBRIO VULNIFICUS

FLORIDA DEPARTMENT OF HEALTH; AS OF FRIDAY



FL Department of Health: October 2022

n p r

A rare but dangerous flesh-eating bacteria is infecting Florida residents

CNN

Dangerous flesh-eating bacterial infections increased in Florida after Hurricane Ian

Hurricane Milton Impacts



And when we thought we had enough --- Hurricane Milton happened

NATION

Vibrio vulnificus

Add Topic +

Flesh-eating bacteria cases rise to record level after hurricanes in Florida

The bacteria can infect a person with an open wound, such as a cut, and can cause the skin and soft tissue around the wound to quickly break down.

Liz Freeman, C. A. Bridges and Thao Nguyen USA TODAY NETWORK

Published 2:32 a.m. ET Oct. 22, 2024 | Updated 9:53 p.m. ET Oct. 22, 2024

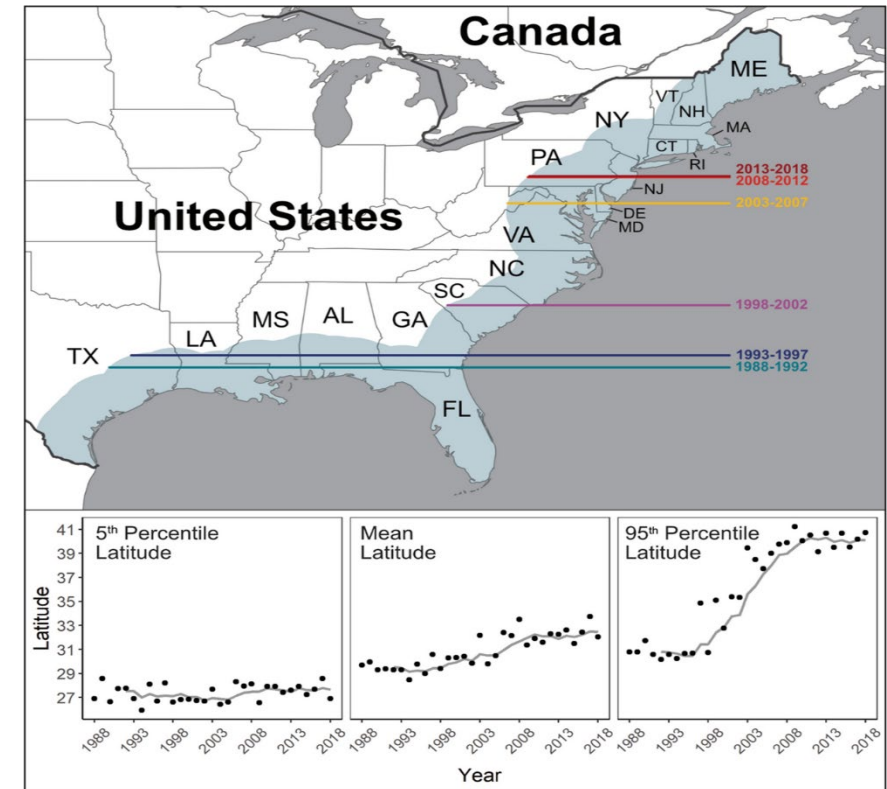


Climate warming and increasing *V. vulnificus* infections in North America

Eastern USA (1988-2018)

- Wound infections increased 8-fold
- Northern case limit shifted northwards ca. 50 km p.a.

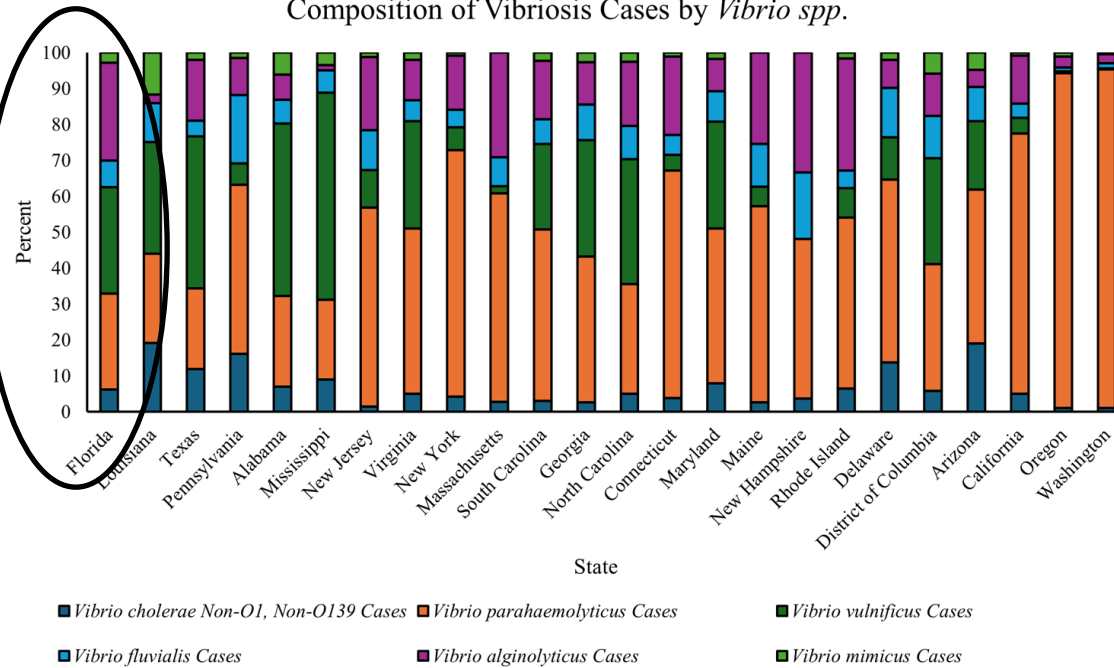
Source: Archer et al., 2023. *Sci Rep* **13**, 3893



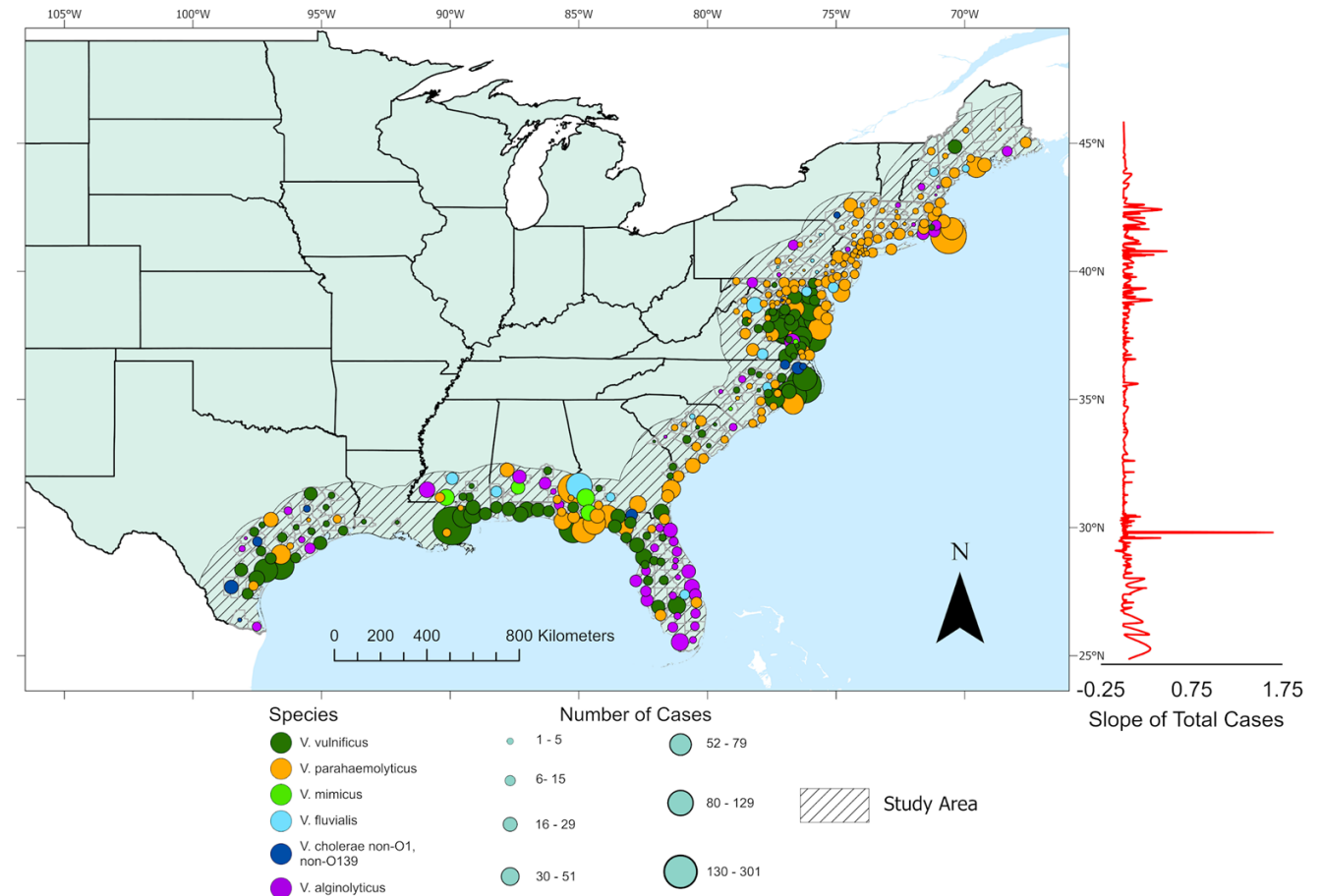
What Pathogenic *Vibrio* spp. Are in the USA?



Composition of Vibriosis Cases by *Vibrio* spp.

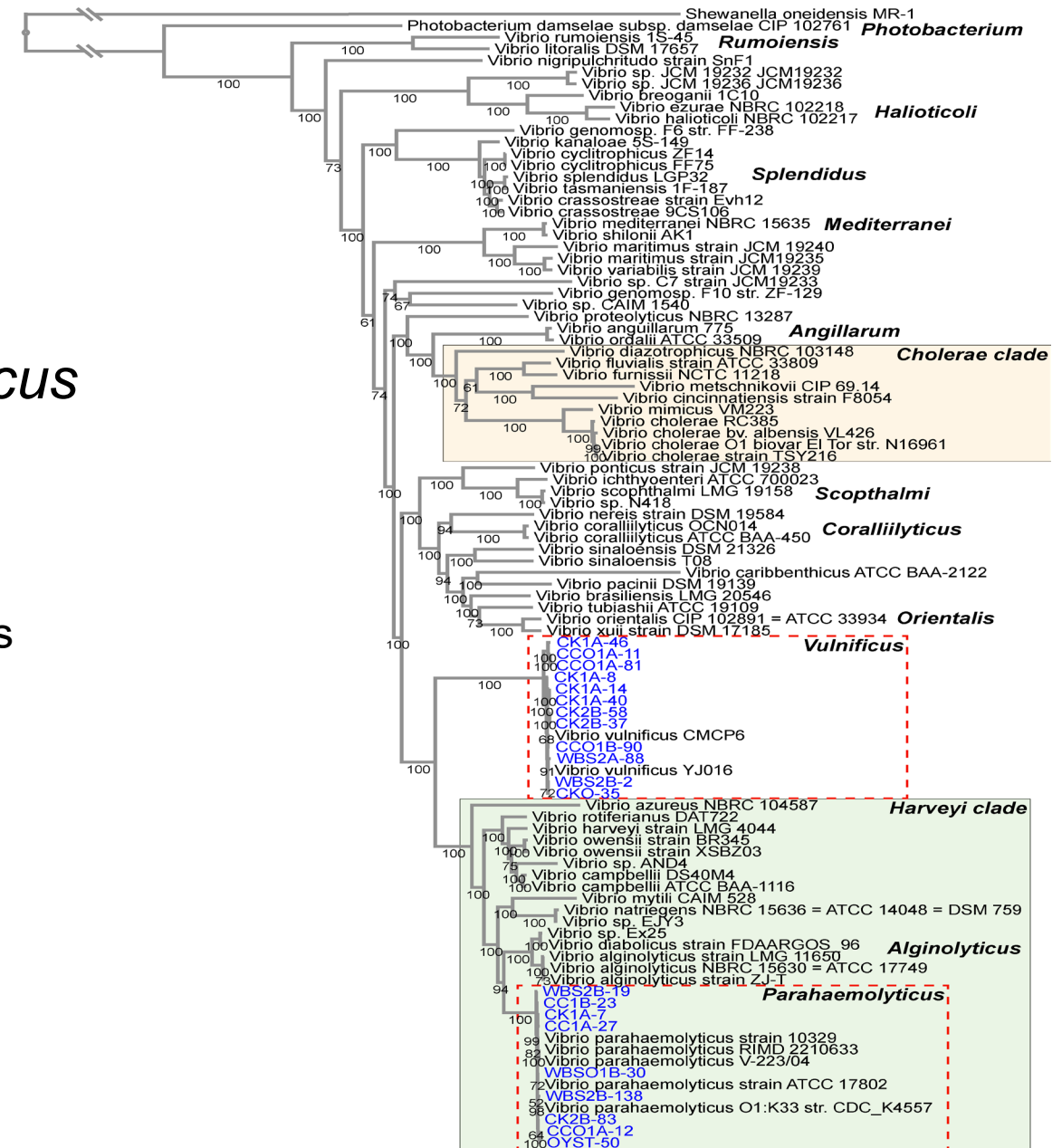


Dominant Species of Vibriosis Cases From 2010-2019

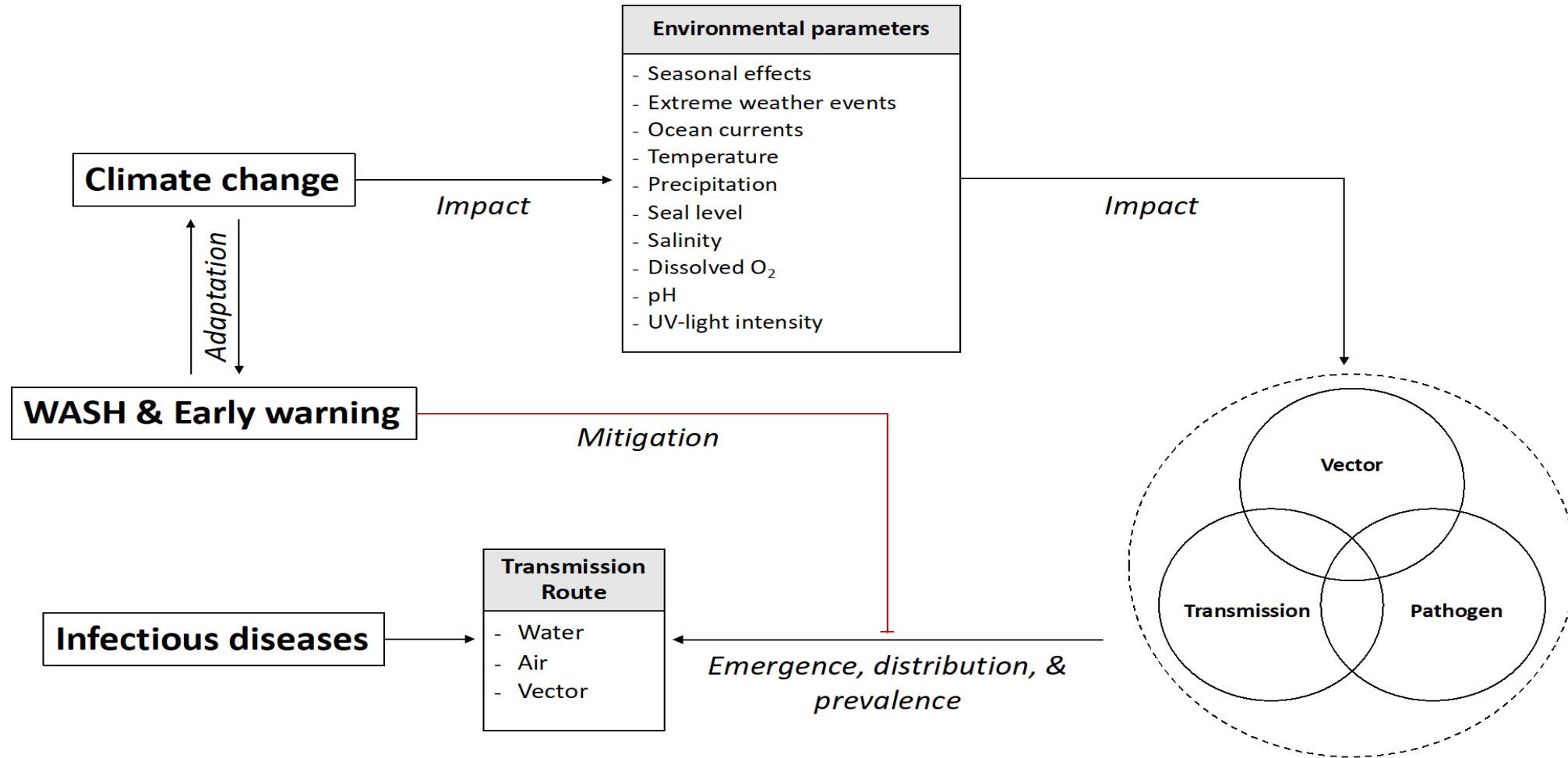


Phylogenomics of *Vibrio* spp.

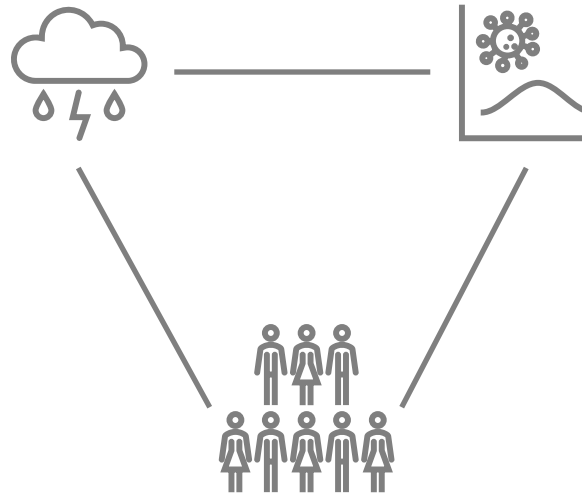
- Isolated *V. parahaemolyticus* and *V. vulnificus*
 - Also detected in water and oyster samples via PCR
- Whole genome sequencing
 - Strain level characterization: Multiple sequence types
 - Identified ARGs, VFs, and MGEs



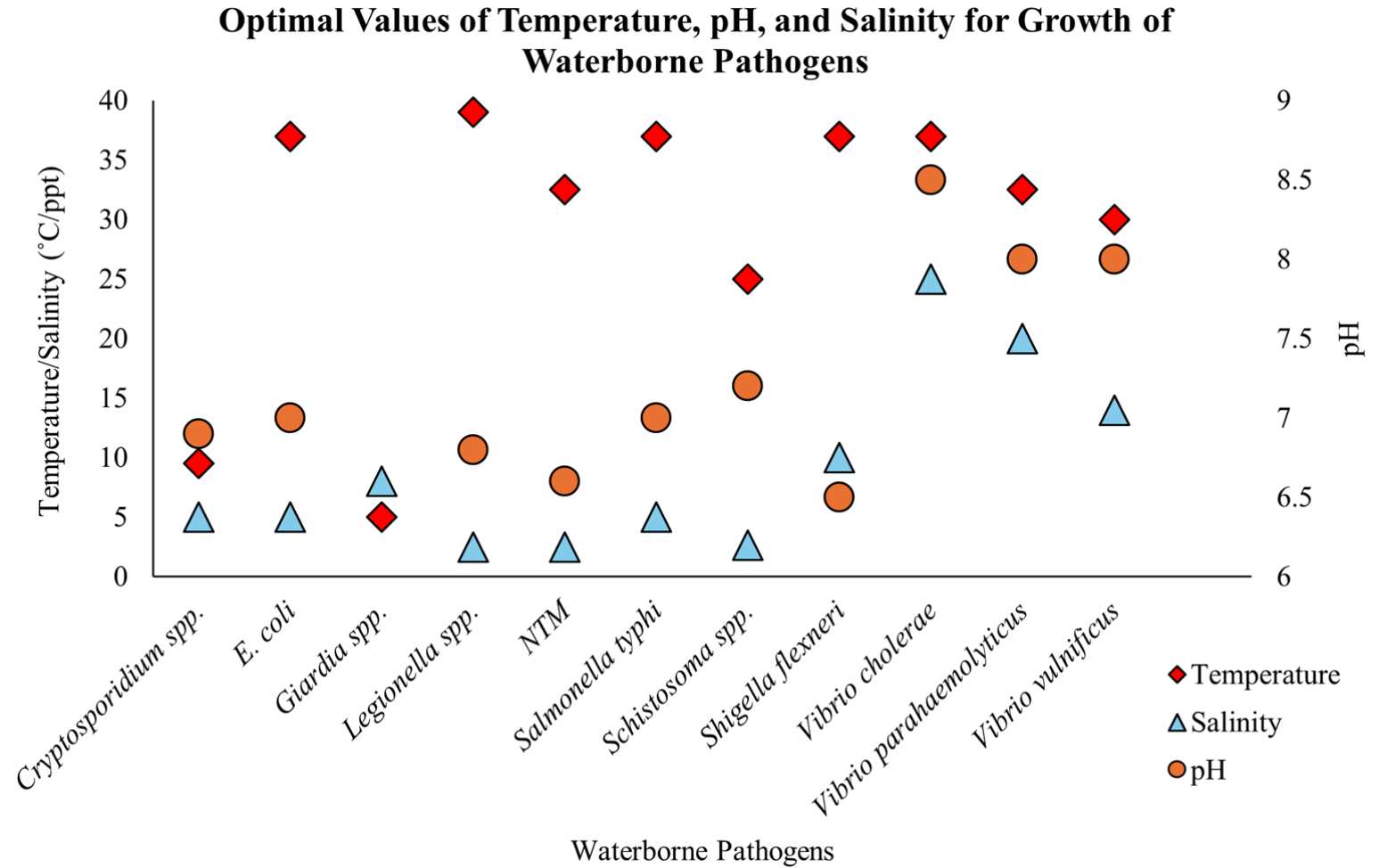
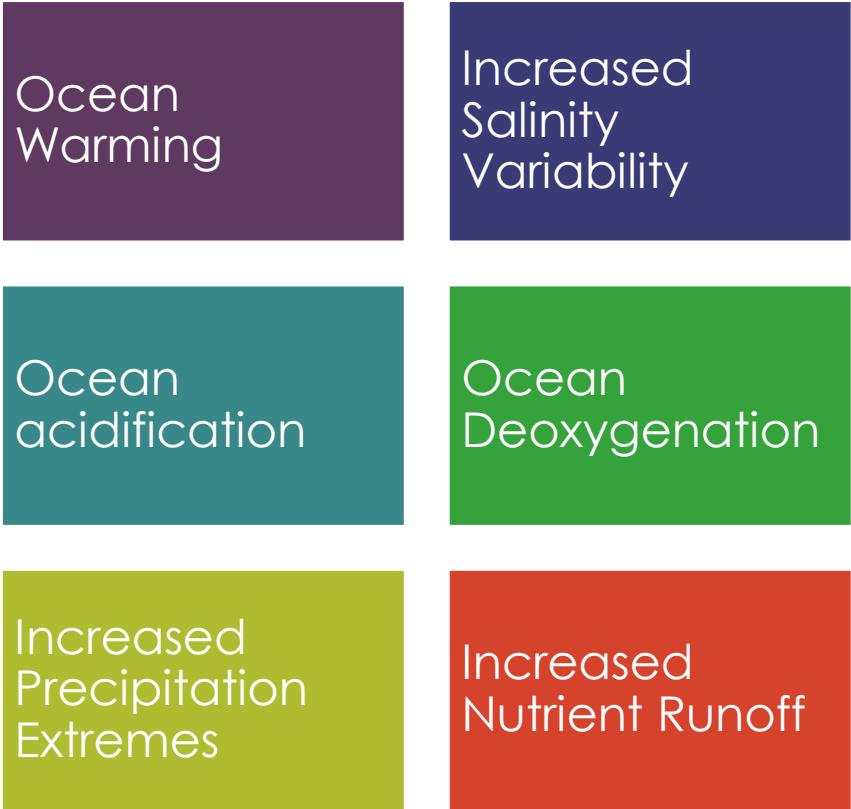
Lessons from *Vibrio* for other infectious diseases



Predictive Intelligence System for Water-borne Pathogens Using Earth Observations



Impacts of Environmental Variability on Waterborne Pathogens



Collaborators and Colleagues

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- Dr. Sirajul M. Islam
- Huda Khan
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University of Florida

- Antarpreet Jutla
- Moiz Usmani



<https://vibrio-prediction-ufl.hub.arcgis.com>



<https://covid-ufl.hub.arcgis.com>

