



GTFCC Lab Surveillance Meeting

Cholera hotspot mapping: Informing national cholera control plans and oral cholera vaccine deployment

Zambia's Experience

15 April 2019



Zambia: Country Profile

- Located in Sub-Saharan Africa; member of SADC
- Landlocked country surrounded by 8 neighbors: ***Angola, Botswana, Democratic Republic of Congo, Malawi, Mozambique, Namibia, Tanzania, Zimbabwe***
- Surface area: 752,614 km²
- Capital City: Lusaka
- 10 provinces
- 116 districts
- Population: ~16 million





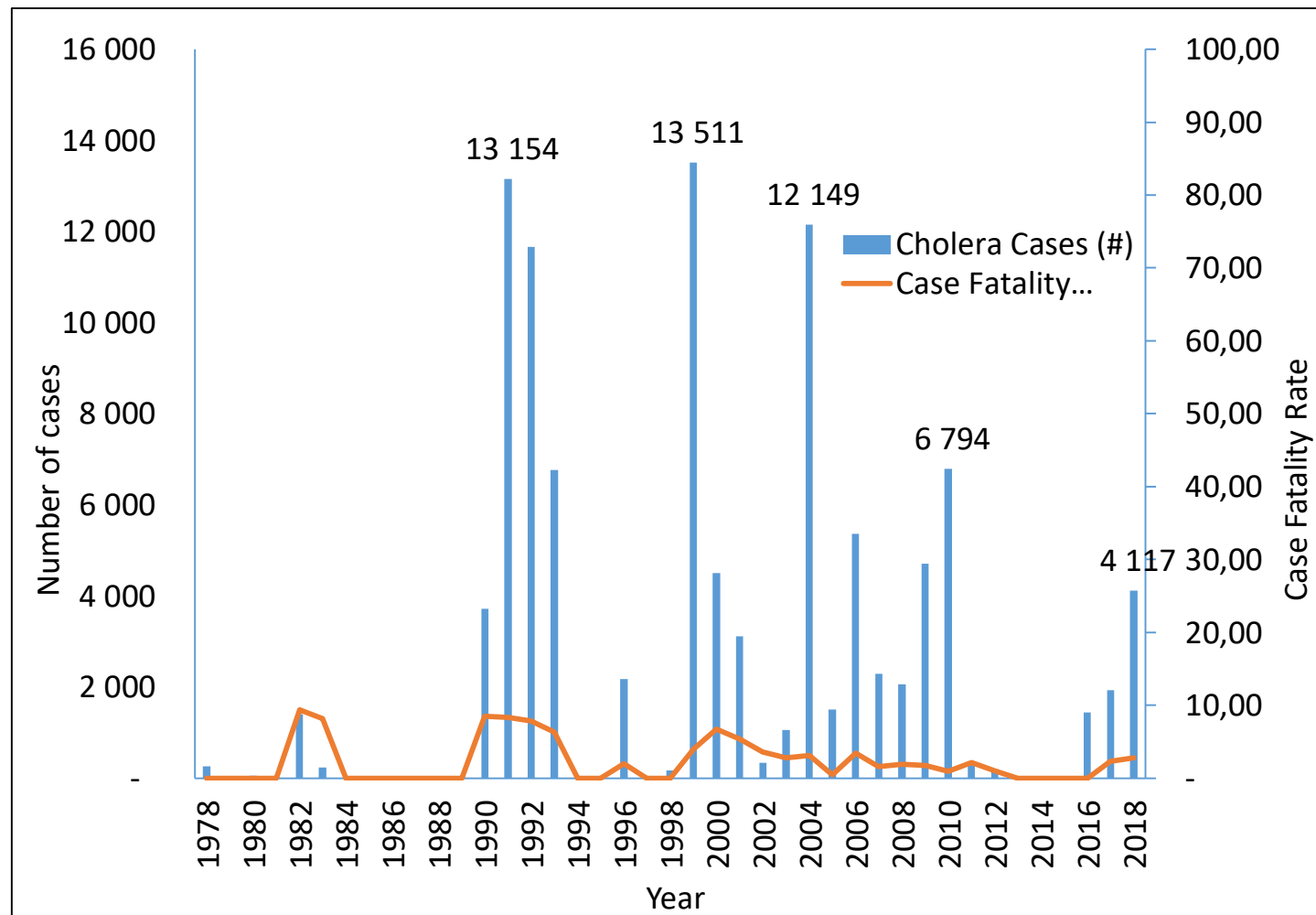
Outline

- The process of developing the Zambia cholera hotspot map
- Sources and quality of cholera epidemiologic data
- indicators used (including non-cholera disease burden data, such as WaSH indicators, population density, rainfall)
- Methodology applied, level of administrative area selected
 - partner collaborations employed
 - gaps and needs encountered



The process of developing the Zambia cholera hotspot mapping: Initiated in 2017

- Recognition of the significant burden of Cholera in Zambia since first outbreak in 1977
 - 29 outbreaks (1977- 2018)
 - Need to strategically intervene in hotspots
 - WASH intervention may take long
 - OCV needed in hotspots
- End Cholera strategy by 2025 in Zambia





Methods: Sources and quality of cholera epidemiologic data

- **Review of Cholera Epidemiology in Zambia**
 - The MoH collated historical cholera data
 - from 1970 to 2017 from DHIS2
 - Reviewed cholera mortality and morbidity reports
 - Reviewed suspected cholera case data recorded by district
 - which were available from 2008 to 2017 to identify the districts with highest and recent load
- **Expert review of cholera risk and ranking**
 - A meeting with Ministry of Health, World Health Organization and partners
 - 6-8 December 2017 in Lusaka



Identified risks and ranking: Indicators used

Identified risks:

- Recurrence of cholera outbreaks
- Poor WASH conditions
- Transit points/high population movements
- Presence of slum areas
- Prone to flooding
- Presence of displaced populations due to humanitarian crisis
- Presence of fishing camps

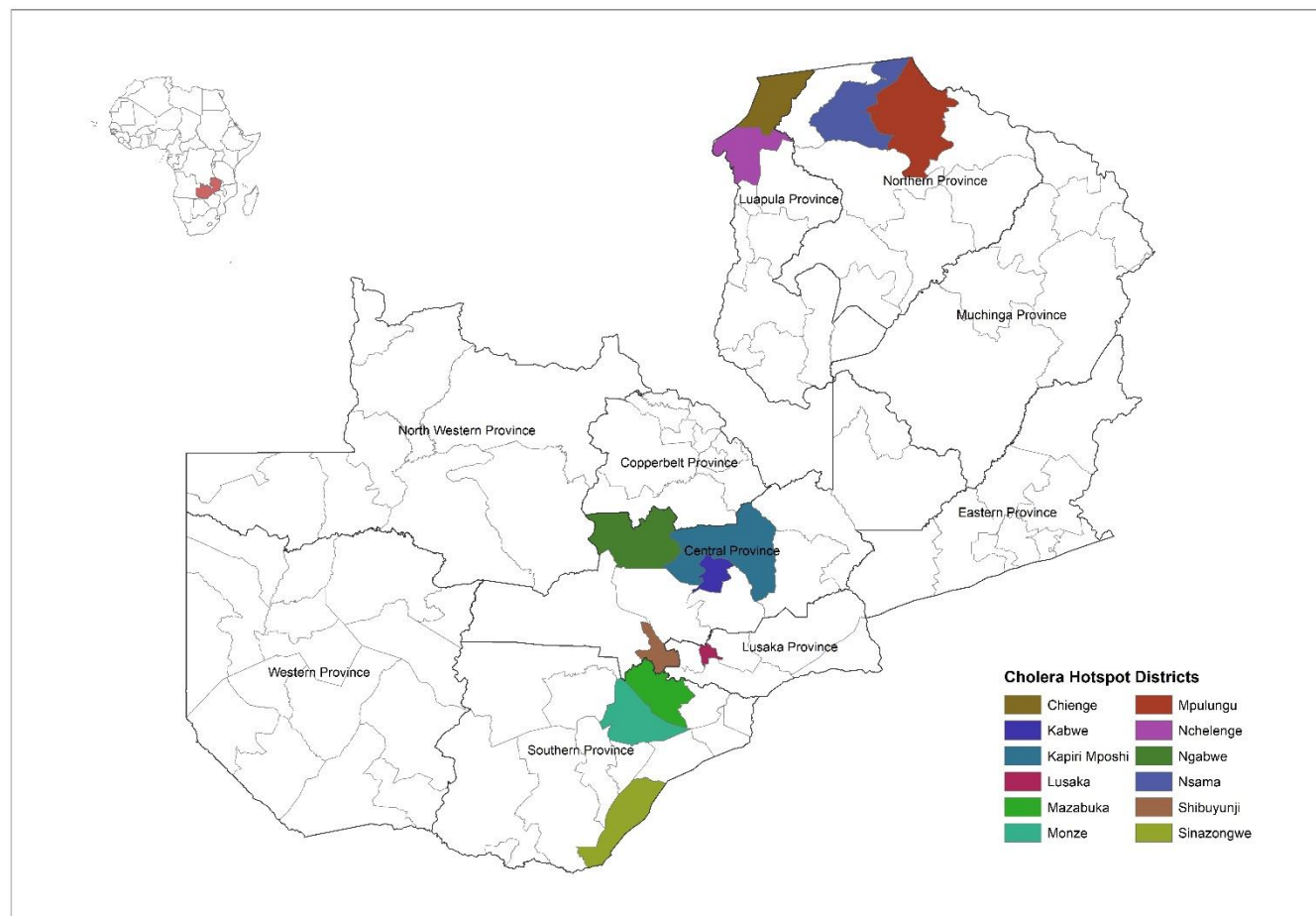
Ranking:

- 0 = not prioritized
- 1 = low priority
- 2 = medium priority
- 3 = high priority



Results: District prioritization

- A total of 37 of the 116 districts in Zambia identified as being at risk for cholera
- Results of ranking:
 - high priority- 12
 - medium priority- 11
 - low priority- 14





Partner collaborations: UNICEF Approach

Methods: Sources of data

- Cholera case definition and data: Ministry of Health
- Cholera cases and deaths (Ministry of Health, WHO)
 - Yearly number of cholera cases and deaths per district from 1999 to 2007 (missing data 2000, 2001 and 2004)
 - Weekly time series of cholera cases and deaths per district from 2008 to 2018 (week 22)
- GIS shape files: 10 provinces and 94 districts (Ministry of Health 2016). Free vector map data from Natural Earth open source repository.
- Population data: Population figures per district in 2018 from the Expanded Programme on Immunization (EPI). Population growth rate for the period 1999-2017 issued from the Population and Demographic Projections 2011 – 2035 report (Central Statistical Office).
- Rainfall data: Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) dataset.



Methods: Data Analysis Process

- Data cleaning and quality assessment, including missing data and outlier detection
- Smoothing and interpolation procedure
- Patterns of sporadic cases were removed (e.g., a single case or two to three cases without reported cases during the two weeks before and after)
- Two successive outbreaks separated by an inter-epidemic period equal to or greater than six weeks were considered as two separate events
- A minimum of ten cases for an event to be considered an outbreak
- Outbreak: extraction of the key epidemiological features per outbreak event (onset, peak, duration, incidence, case fatality rate, inter-epidemic period)
- Hotspot classification according to recurrence, duration and intensity of cholera outbreaks
- Interpretation of the results according to local contexts (literature and national expertise)



Partner collaborations: UNICEF Findings



Key findings

- Hotspots were located at the periphery of urban areas and around waterbodies
- Seventeen hotspots (T1-T4) represented 95% of all cases
- Eight highest-priority hotspots (T1) represented 88% of all cases
- Lusaka city represented 72% of all cases



Partner collaborations: CIDRZ Approach

- **Study design:** A retrospective study; covered all of Zambia
- **Cholera data source:** MoH data on confirmed and suspected cholera cases from 2008 through 2017
- **Population and socioeconomic data**
 - District level population proportions
 - from the 2010 Census (Central Statistical Office, 2010)
 - Socioeconomic data including the percentage of the population living below the poverty
 - from the CSO-Living Conditions Monitoring Survey of 2010



CIDRZ



Methods (cont)

Water, Sanitation and Hygiene (WASH) data

- Data on access to improved sanitation and clean water were obtained through the CSO-Zambia Demographic and Health Survey 2014.
- The data was presented based on percentages for urban and rural population.

Software Applications

- SatScan (<https://www.satscan.org/>) for identifying hotspots
- Geoda (<https://geodacenter.github.io/>) for spatial analysis,
- SAS 9.4 for analyzing the data using Zero Inflated Negative Binomial model
- ArcMap Desktop 10.6 (Esri Inc.) for thematic mapping of the hotspots.





Methods

Hotspots identification

Spatial scan test to identify spatiotemporal hotspots of cholera from 2008 to 2017 in Zambia.

A discrete Poisson-based space-time scan statistic was utilized to account for variations in cholera risk across both space (districts) and time (year) taking into account the 10-year study period.

Under the Poisson model, the likelihood function for a specific window is:

$$\lambda = \left(\frac{n}{\mu}\right)^n \left(\frac{N-n}{N-\mu}\right)^{N-n} I(n > \mu)$$

where, N is the number of cases in the study area, n is the number of cases within the window, μ is the expected number of cases within the window under the null hypothesis, and $I()$ is an indicator function

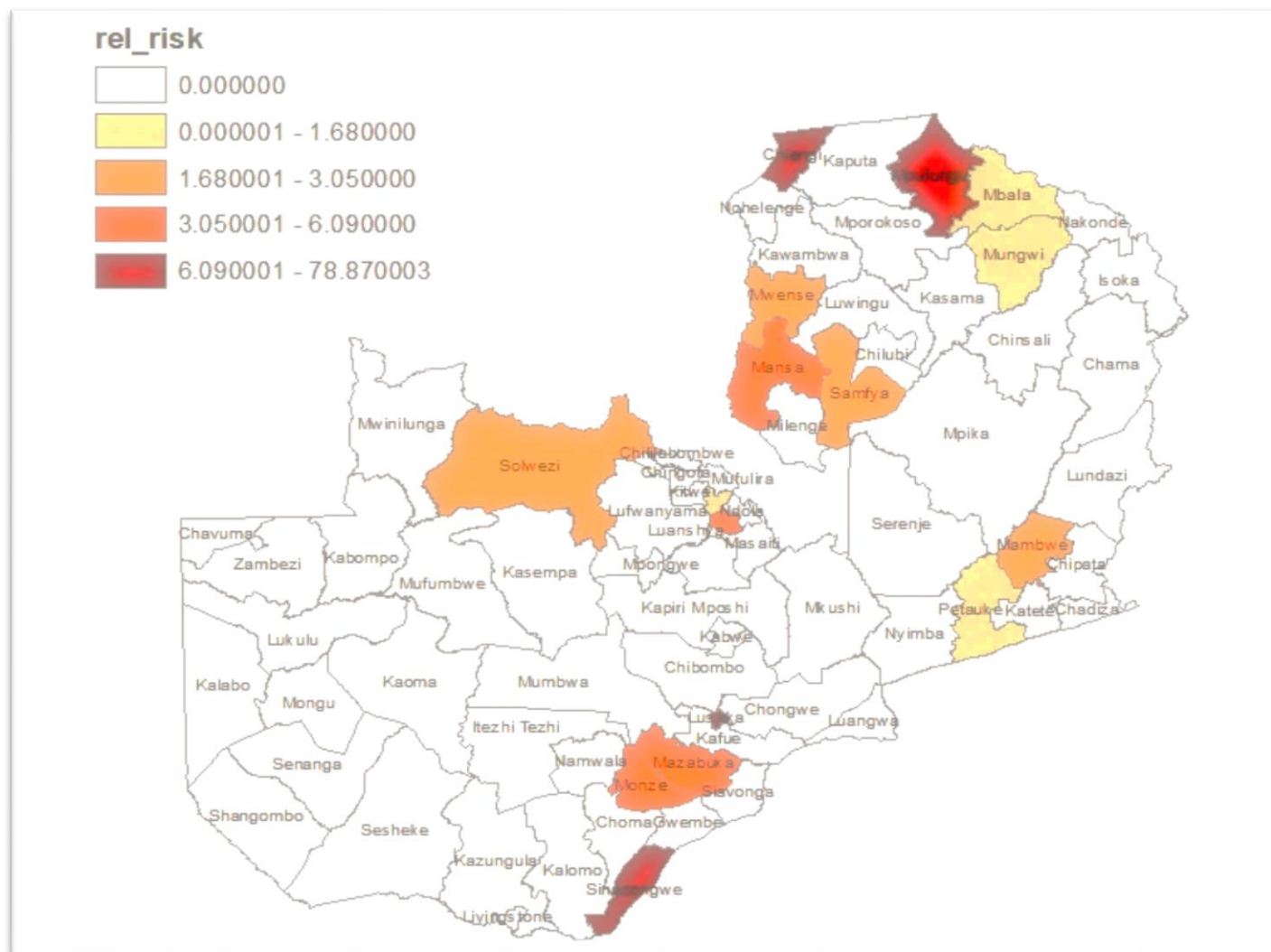


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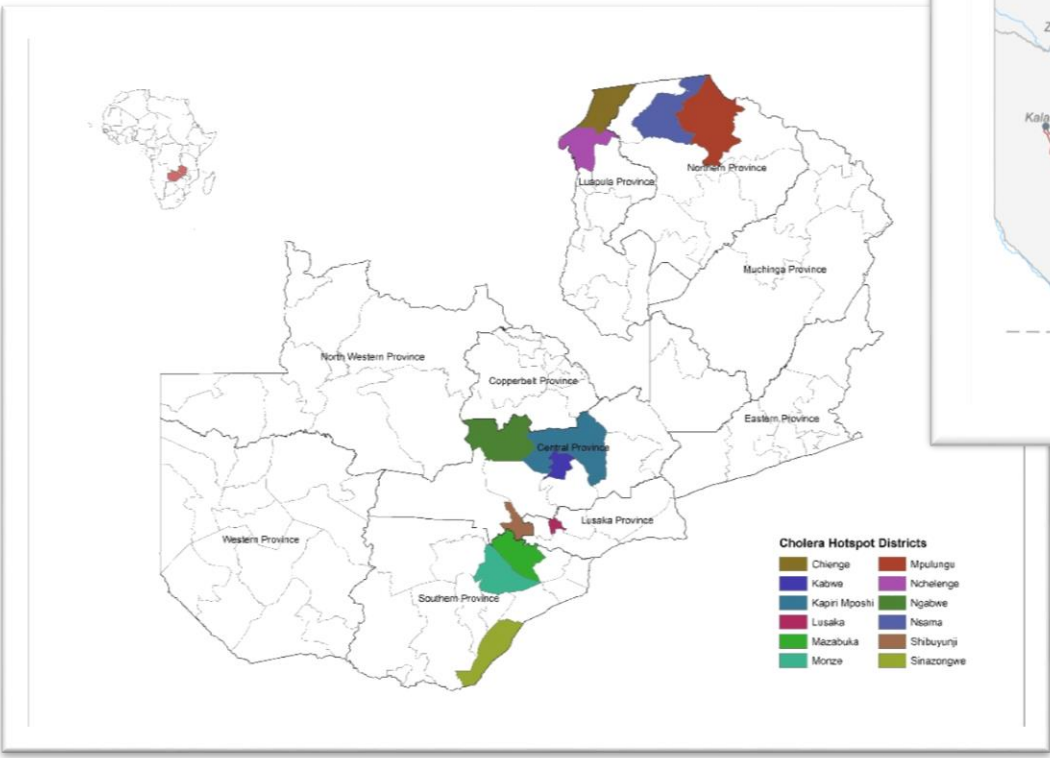
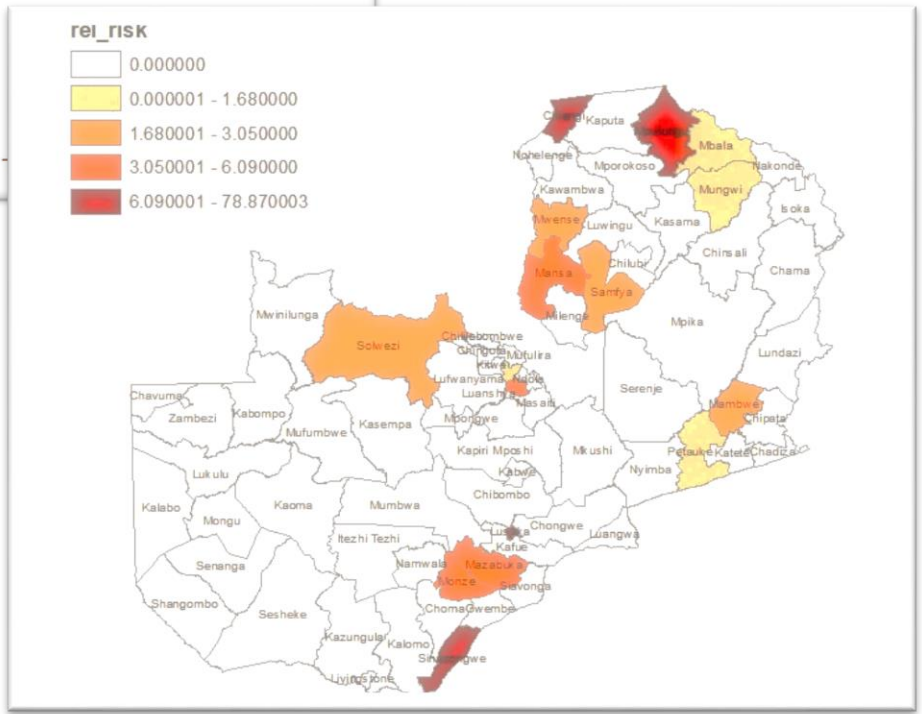
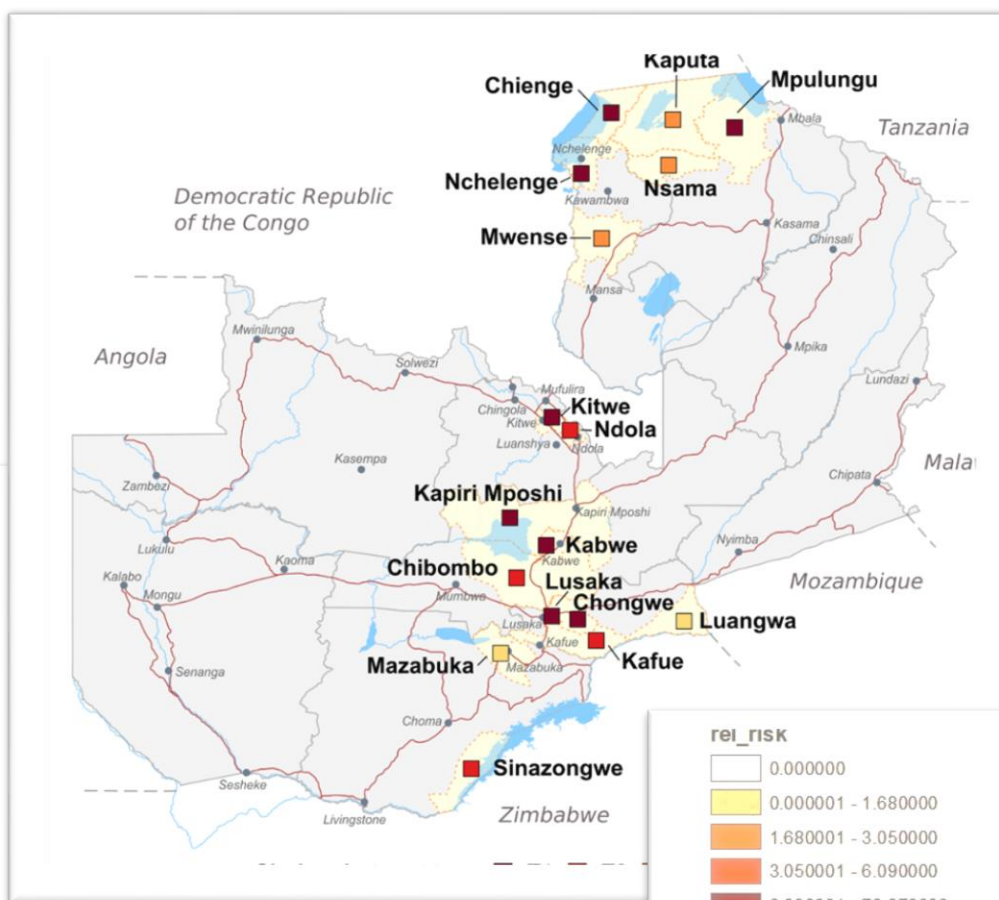


Results

Hotspot “high risk” districts for cholera

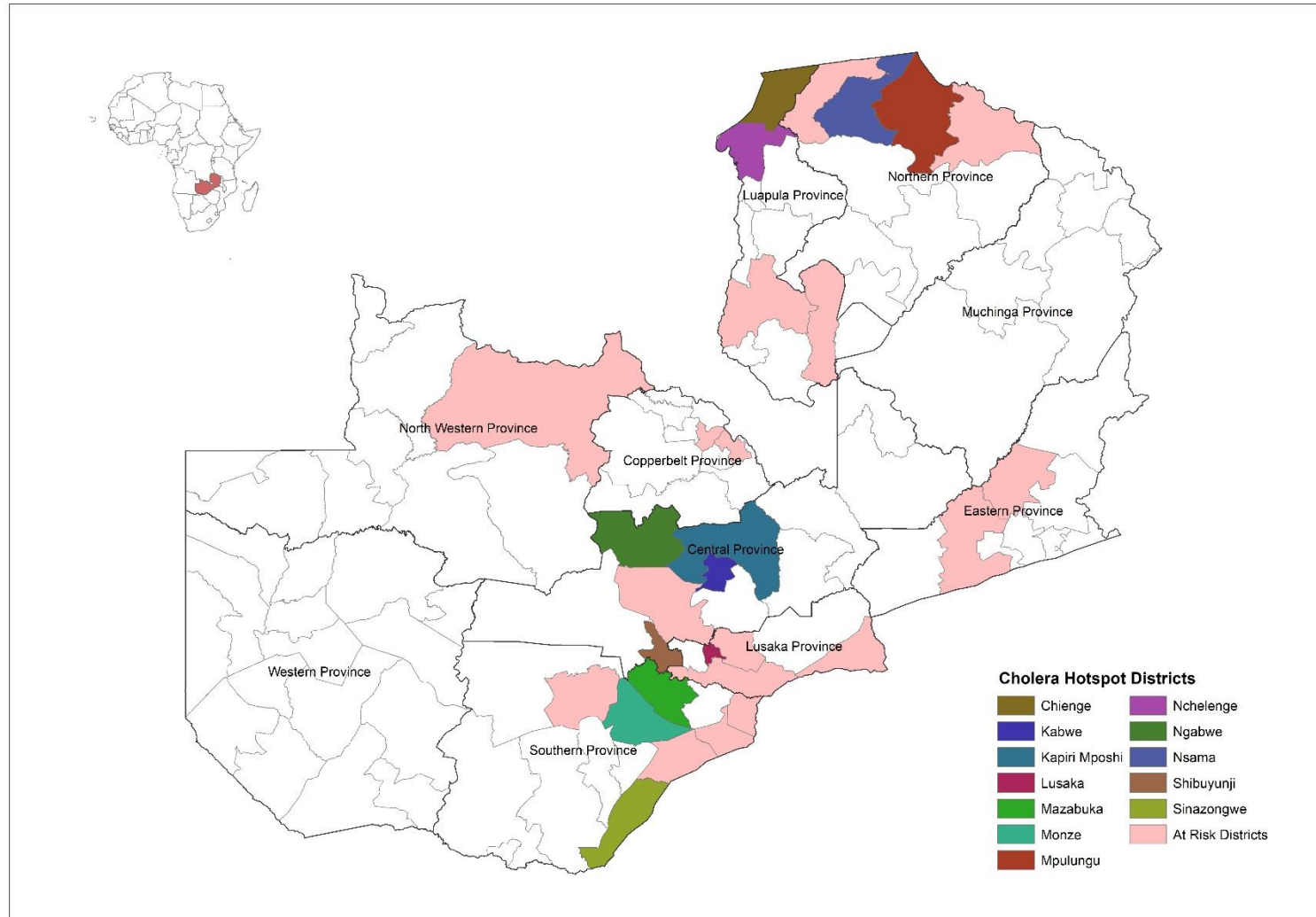


CIDRZ



Similar results from 3 approaches

Hot spots and at risk districts in Zambia



Discussion and Conclusion

- Cholera surveillance data can be used to map hot spots in at low cost
- Special attention to hot spots is key in the roadmap to cholera elimination
- OCV in hot spot will give time for WASH interventions to be improved