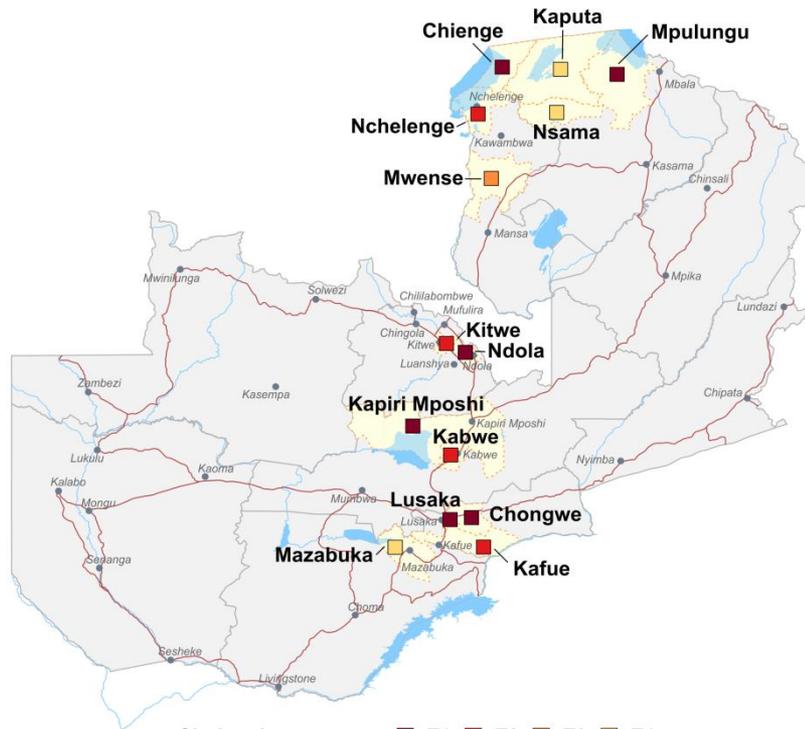


Options for Cholera Hotspot classification in Zambia

Epidemiological study of cholera hotspots and epidemiological basins in East and Southern Africa



Cholera hotspot type ■ T1 ■ T2 ■ T3 ■ T4

Study objectives

- To better understand the local dynamics of cholera at a national and regional level
 - Apply an approach combining field research, epidemiology and genetic analysis of clinical isolates of *Vibrio cholerae*
- To identify cholera hotspots as well as high-risk populations and practices for targeted emergency and prevention programs
- To establish effective strategies to combat cholera in Zambia and neighboring countries

Methods (1/2)

- Cholera case definition (Ministry of Health, WHO)

Suspected case:

- A patient of any age presenting with a rapid onset of acute watery or rice watery diarrhea (> 3 times in the last 24 hours)
 - with or without vomiting
 - with or without dehydration

Confirmed case:

- A suspected case in which *Vibrio cholerae* serogroups O1 or O139 has been isolated from stool samples (laboratory confirmation).

- 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.

- GIS shape files: 10 province and 94 districts (Ministry of Health 2016). Free vector map data from Natural Earth open source repository.

- Population data: population 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: from the Climate Hazards Group InfraRed Precipitation with Station (CHIRPS) dataset.

- 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 outbreak event to be considered
 - 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)

Cholera Hotspot definition

A geographically limited area (e.g. city, administrative level 2 or health district catchment area) where environmental, cultural and/or socioeconomic conditions facilitate the transmission of the disease and where cholera persists or re-appears regularly. Hotspots play a central role in the spread of the disease to other areas.

Source: Interim Guidance Document on Cholera Surveillance, Global Task Force on Cholera Control (GTFCC) Surveillance Working Group, June 2017.

http://www.who.int/cholera/task_force/GTFCC-Guidance-cholera-surveillance.pdf

Cholera Hotspot classification options

- Option 1

- Study period: 2008 – 2018 (week 22);
- Data considered: Weekly time series of cholera cases and deaths per district from 2008 to 2018;
- Epidemiological parameters considered: Number of cholera outbreaks, median duration of cholera outbreaks and median attack rate per week (per 10,000 inhab.).

- Option 2A

- Study period: 1999 – 2018 (week 22);
- Data considered:
 - Yearly number of cholera cases and deaths per district from 1999 to 2018 (missing data 2000, 2001 and 2004);
 - Weekly time series of cholera cases and deaths per district from 2008 to 2018.
- Epidemiological parameters considered: Number of cholera outbreaks, median duration of cholera outbreaks and median attack rate (per 10,000 inhab.).

- Option 2B

- Study period, data and epidemiological parameters considered identical to option 1;
- Sensitivity analysis on the epidemiological parameters thresholds.

Cholera Hotspot classification algorithm – Option 1

%ile: percentile

Is the area frequently affected ?

Yes

Recurrence

HIGH : ≥ 80 %ile (≥ 3 otk.)

MEDIUM : [40- 80] %ile (2 otk.)

LOW : < 40 %ile

Duration

Duration

LOW : < 40 %ile (< 6 weeks)

MEDIUM
to **HIGH** : ≥ 40 %ile (≥ 6 weeks)

LOW : < 40 %ile (< 6 weeks)

MEDIUM
to **HIGH** : ≥ 40 %ile (≥ 6 weeks)

Incidence

Incidence

LOW

MEDIUM

≥ 40 %ile (≥ 0.33)

Type 1
High priority

High outbreak recurrence and long duration delineating the key cholera foci

LOW

MEDIUM to **HIGH** :
 ≥ 40 %ile (≥ 0.33)

CFR ?

Type 4
Low priority

Moderate frequency, short duration, but high incidence describing intermittent zone of expansion of cholera outbreak

Type 2
Medium priority

Moderate frequency and long duration defining zones with substantial cholera burden and significant epidemiological character

Type 3
Medium priority

High frequency, but short outbreaks and high incidence Often surrounding cholera foci

Cholera Hotspot classification – Option 1

Hotspot Type	Frequency		Median duration		Median incidence	
	Percentile	No. of outbreaks	Percentile	No. of weeks	Percentile	No. cases per 10,000 population
Type 1	> or = 80	> or = 3	> or = 40	> or = 6	N/A	N/A
Type 2	40 - 80	2	> or = 40	> or = 6	N/A	N/A
Type 3	> or = 80	> or = 3	< 40	< 6	> 40	0.33
Type 4	40 - 80	2	< 40	< 6	> 40	0.33

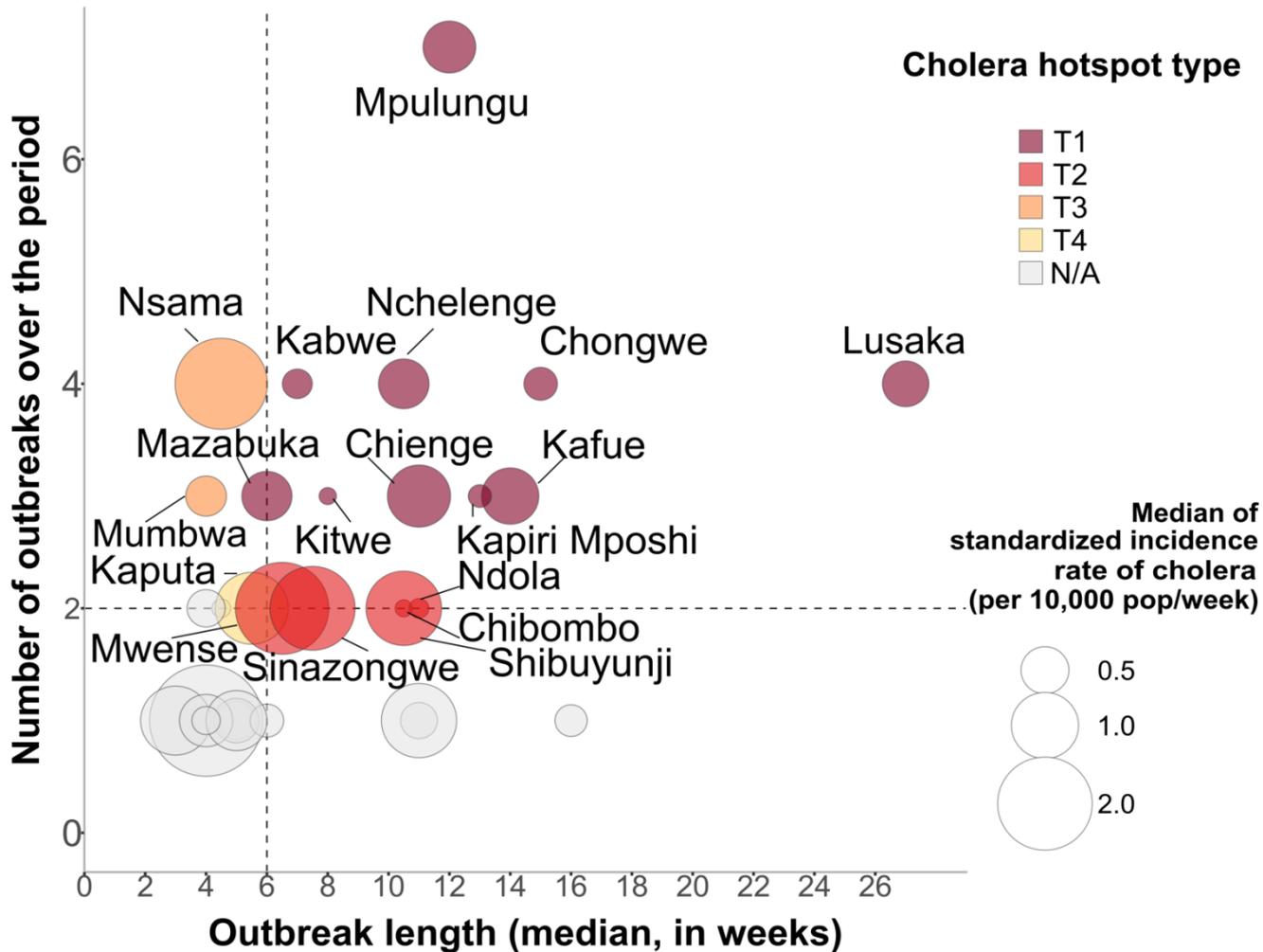
Type 1: Highest-priority area with cholera outbreaks of high frequency (≥ 3 otk.) and extended duration (≥ 6 weeks)

Type 2: High-priority area with cholera outbreaks of moderate frequency (2 otk.) and extended duration

Type 3: Medium-priority area with cholera outbreaks of high frequency and short duration (< 6 weeks)

Type 4: Low-priority area with cholera outbreaks of moderate frequency and short duration.

Cholera Hotspot classification – Option 1



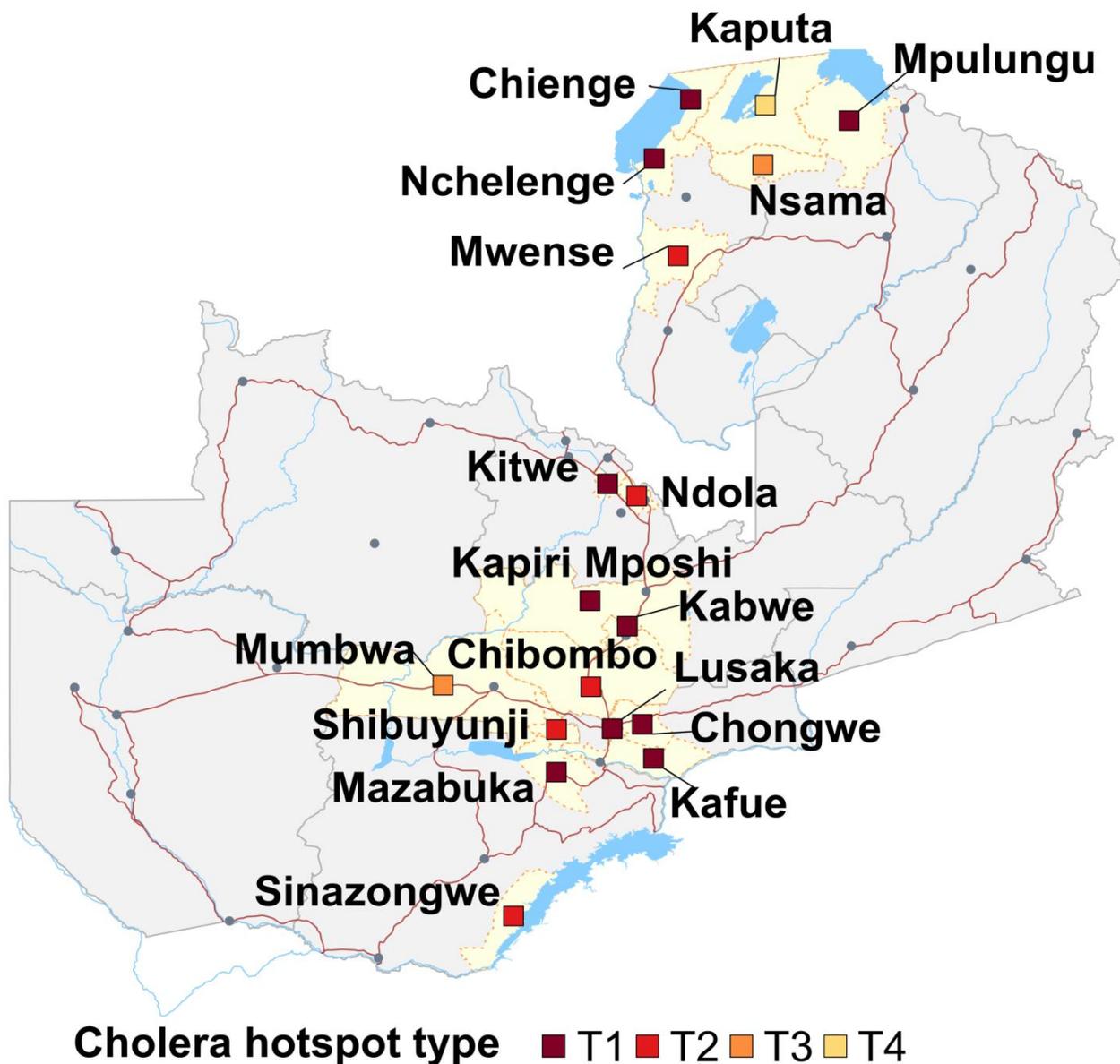
Type 1: Highest-priority area with cholera outbreaks of high frequency (≥ 3 otk. and extended duration (≥ 6 weeks));

Type 2: High-priority area with cholera outbreaks of moderate frequency (2 otk.) and extended duration

Type 3: Medium-priority area with cholera outbreaks of high frequency and short duration (< 6 weeks)

Type 4: Low-priority area with cholera outbreaks of moderate frequency and short duration.

Cholera Hotspot classification – Option 1



Key facts

- Hotspots located at the periphery of urban areas and around water bodies
- 18 hotspots (T1-T4) represent 96.5% of all cases
- 10 highest-priority hotspots (T1) represent 90% of all cases
- Lusaka represent 73% of all cases

Cholera Hotspot classification – Option 1

HOTSPOT TYPE	PROVINCE	DISTRICT	% of cases	Recurrence (No. of outbreaks)	Duration (No. of weeks)	Attack rate per week (median per 10,000 inhab.)
TYPE 1	CENTRAL	KABWE, KAPIRI MOSHI	1.5%	> or = 3	> or = 6	N/A
	COPPERBELT	KITWE	1.3%			
	LUAPULA	CHIENGE, NCHELENGE	4.7%			
	LUSAKA	CHONGWE, KAFUE, LUSAKA	76%			
	NORTHERN	MPULUNGU	5.6%			
	SOUTHERN	MAZABUKA	1.1%			
TYPE 2	CENTRAL	CHIBOMBO SHIBUYUNJI	0.9%	2	> or = 6	N/A
	COPPERBELT	NDOLA	0.6%			
	LUAPULA	MWENSE	1.6%			
	SOUTHERN	SINAZONGWE	1.2%			
TYPE 3	CENTRAL	MUMBWA	0.7	> or = 3	<6	0.33
	NORTHERN	NSAMA	0.9			
TYPE 4	NORTHERN	KAPUTA	0.4%	2	<6	0.33

Cholera Hotspot classification algorithm – Option 2A

%ile: percentile

Is the area frequently affected ?

Yes

Recurrence

HIGH : ≥ 80 %ile (≥ 5 otk.)

MEDIUM : [60- 80] %ile (3 - 4 otk.)

LOW : < 60 %ile

Duration

Duration

LOW : < 50 %ile (< 7 weeks)

MEDIUM
to **HIGH** : ≥ 50 %ile (≥ 7 weeks)

LOW : < 50 %ile (< 7 weeks)

MEDIUM
to **HIGH** : ≥ 50 %ile (≥ 7 weeks)

Incidence

Incidence

LOW

MEDIUM

≥ 40 %ile (≥ 2.94)

LOW

MEDIUM to **HIGH** :
 ≥ 40 %ile (≥ 2.94)

CFR ?

Type 1
High priority

High outbreak recurrence and long duration delineating the key cholera foci

Type 2
Medium priority

Moderate frequency and long duration defining zones with substantial cholera burden and significant epidemiological character

Type 3
Medium priority

High frequency, but short outbreaks and high incidence
Often surrounding cholera foci

Type 4
Low priority

Moderate frequency, short duration, but high incidence describing intermittent zone of expansion of cholera outbreak

Cholera Hotspot classification – Option 2A

Hotspot Type	Frequency		Median duration		Median incidence	
	Percentile	No. of outbreaks	Percentile	No. of weeks	Percentile	No. cases per 10,000 population
Type 1	> or = 80	> or = 5	> or = 50	> or = 7	N/A	N/A
Type 2	60 - 80	3 - 4	> or = 50	> or = 7	N/A	N/A
Type 3	> or = 80	> or = 5	< 50	< 7	> 40	2.94
Type 4	60 - 80	3 - 4	< 50	< 7	> 40	2.94

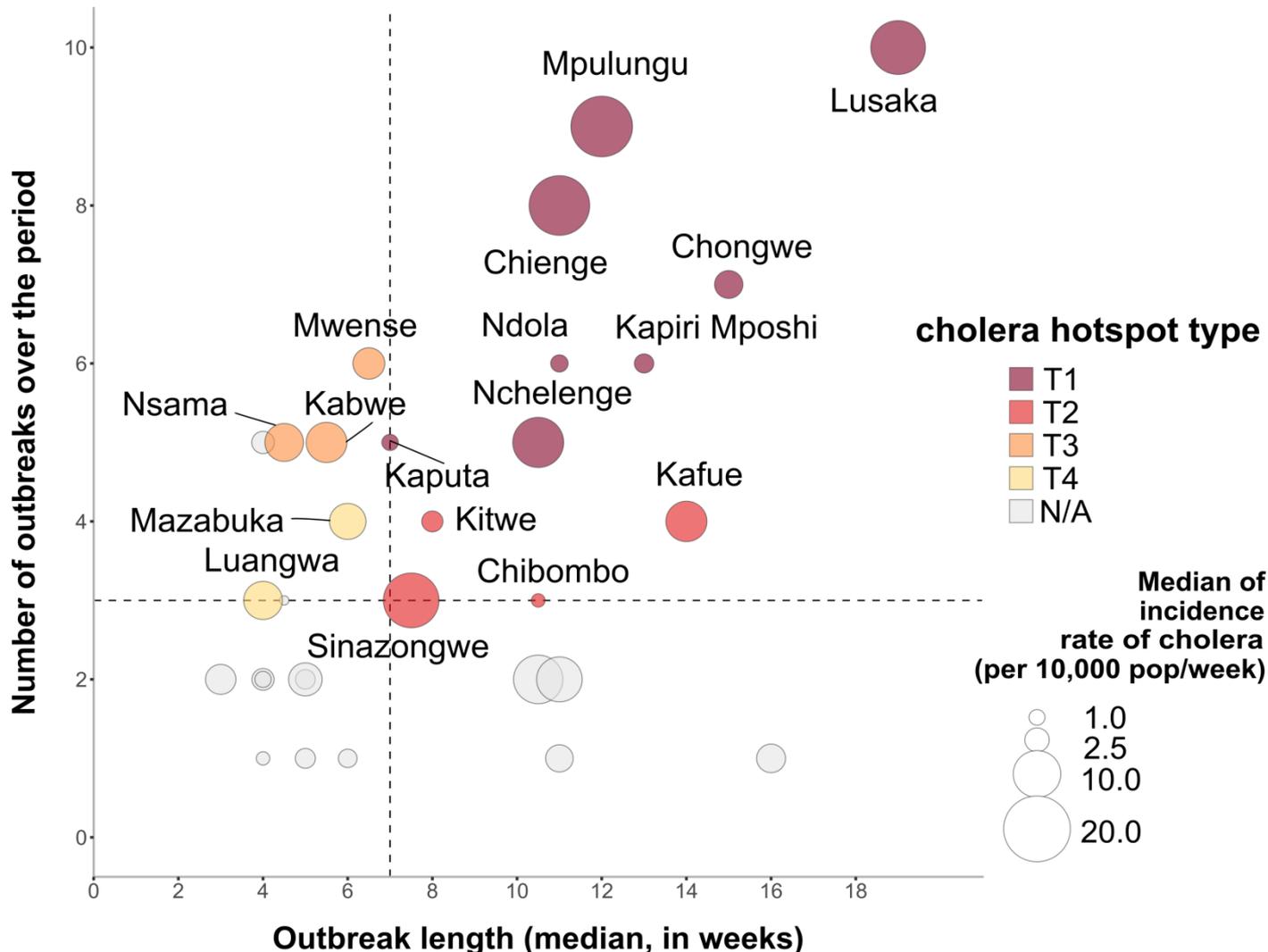
Type 1: Highest-priority area with cholera outbreaks of high frequency (≥ 5 otk.) and extended duration (≥ 7 weeks)

Type 2: High-priority area with cholera outbreaks of moderate frequency (between 3 and 4 otk.) and extended duration

Type 3: Medium-priority area with cholera outbreaks of high frequency and short duration (< 7 weeks)

Type 4: Low-priority area with cholera outbreaks of moderate frequency and short duration.

Cholera Hotspot classification – Option 2A



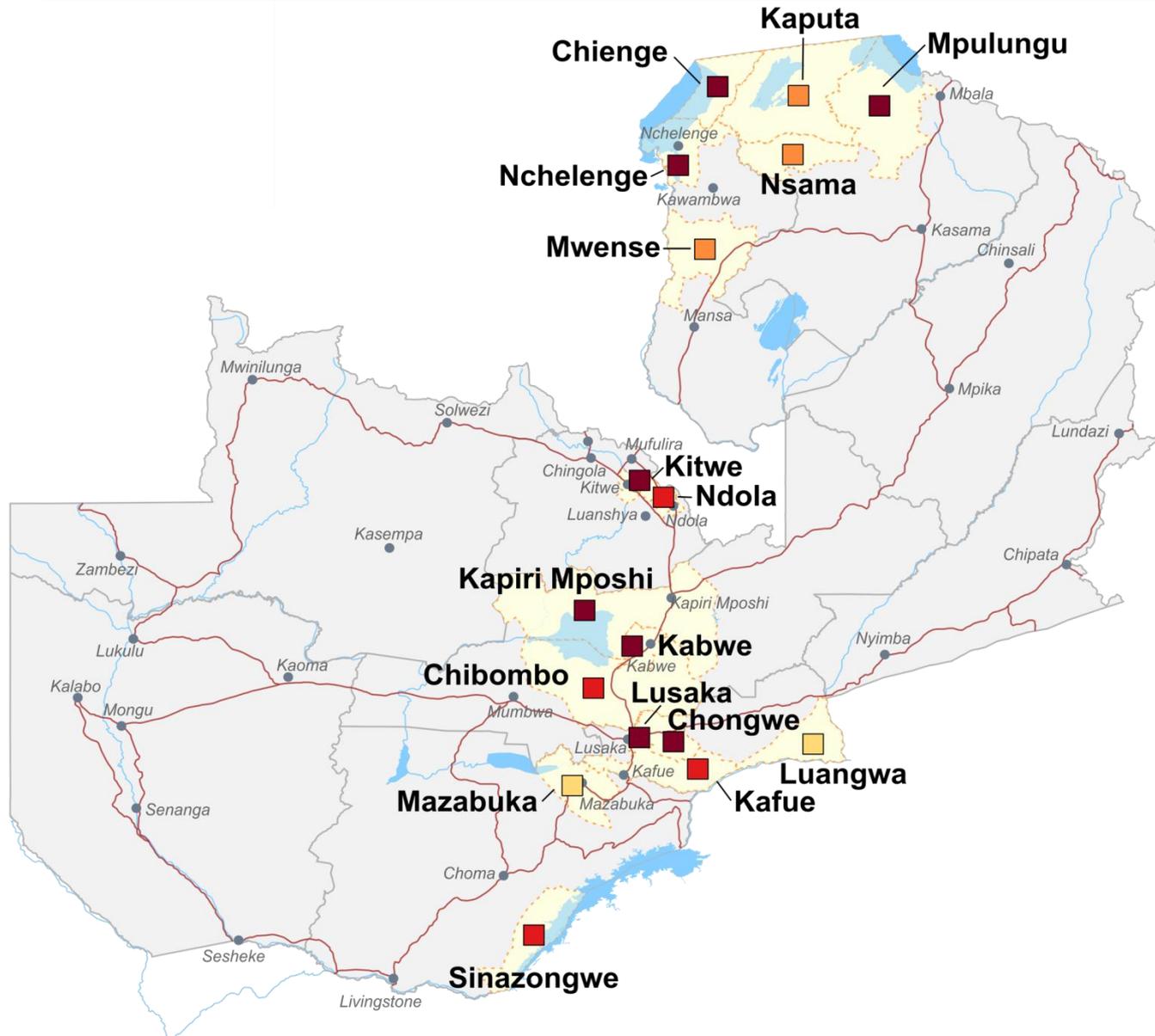
Type 1: Highest-priority area with cholera outbreaks of high frequency (≥ 5 otk. and extended duration (≥ 7 weeks));

Type 2: High-priority area with cholera outbreaks of moderate frequency (between 3 and 4 otk.) and extended duration

Type 3: Medium-priority area with cholera outbreaks of high frequency and short duration (< 7 weeks)

Type 4: Low-priority area with cholera outbreaks of moderate frequency and short duration.

Cholera Hotspot classification – Option 2A



Cholera hotspot type ■ T1 ■ T2 ■ T3 ■ T4

Key facts

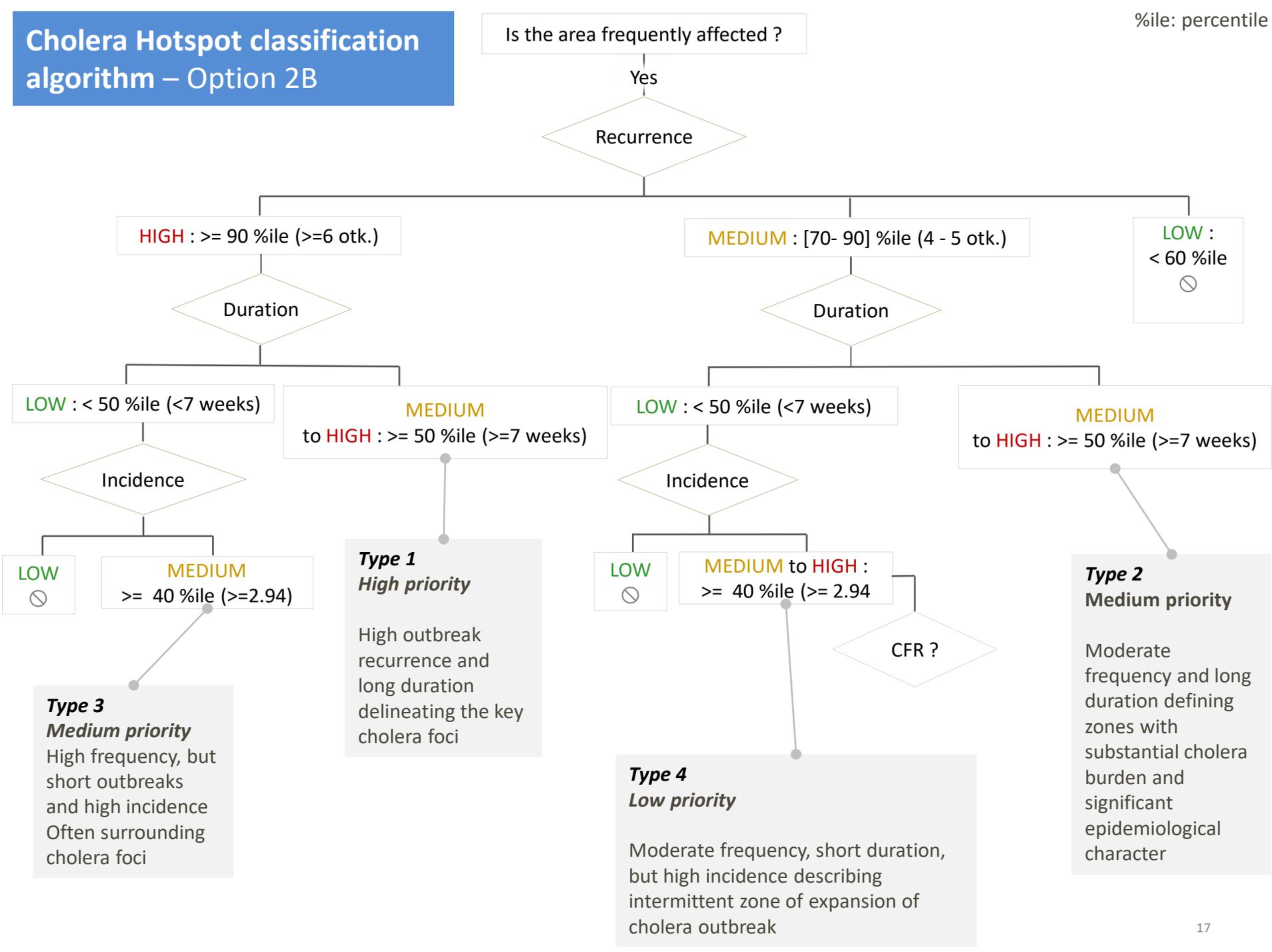
- Hotspots located at the periphery of urban areas and around water bodies
- 17 hotspots (T1-T4) represent 95% of all cases
- 8 highest-priority hotspots (T1) represent 88% of all cases
- Lusaka represent 72% of all cases

Cholera Hotspot classification – Option 2A

HOTSPOT TYPE	PROVINCE	DISTRICT	% of cases	Recurrence (No. of outbreaks)	Duration (No. of weeks)	Attack rate (median per 10,000 inhab.)
TYPE 1	CENTRAL	KAPIRI MOSHI, KABWE	2.1%	> or = 5	> or = 7	N/A
	COPPERBELT	NDOLA	4.7%			
	LUAPULA	CHIENGE, NCHELENGE	5.3%			
	LUSAKA	CHONGWE, LUSAKA	73.1%			
	NORTHERN	MPULUNGU	3.1%			
TYPE 2	CENTRAL	CHIBOMBO	0.3%	3 - 4	> or = 7	N/A
	COPPERBELT	KITWE	1%			
	LUSAKA	KAFUE	0.9%			
	SOUTHERN	SINAZONGWE	0.8%			
TYPE 3	LUAPULA	MWENSE	0.9	> or = 5	<7	2.94
	NORTHERN	KAPUTA, NSAMA	1.8			
TYPE 4	LUSAKA	LUANGWA	0.1%	3 - 4	<7	2.94
	SOUTHERN	MAZABUKA	0.9%			

Cholera Hotspot classification algorithm – Option 2B

%ile: percentile



Cholera Hotspot classification – Option 2B

Hotspot Type	Frequency		Median duration		Median incidence	
	Percentile	No. of outbreaks	Percentile	No. of weeks	Percentile	No. cases per 10,000 population
Type 1	> or = 90	> or = 6	> or = 50	> or = 7	N/A	N/A
Type 2	70 - 90	4 - 5	> or = 50	> or = 7	N/A	N/A
Type 3	> or = 80	> or = 6	< 50	< 7	> 40	2.94
Type 4	70 - 90	4 - 5	< 50	< 7	> 40	2.94

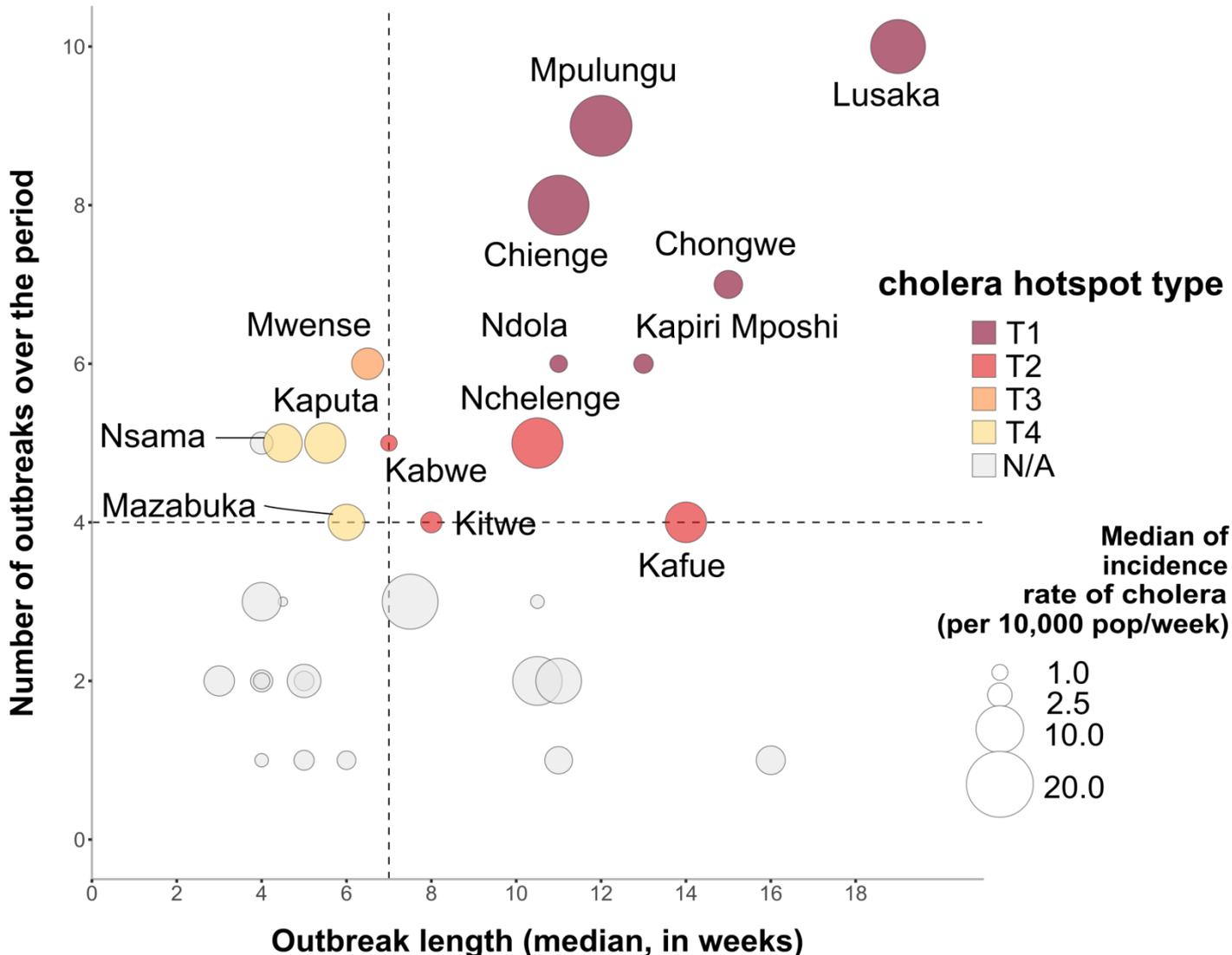
Type 1: Highest-priority area with cholera outbreaks of high frequency (≥ 6 otk.) and extended duration (≥ 7 weeks)

Type 2: High-priority area with cholera outbreaks of moderate frequency (between 4 and 5 otk.) and extended duration

Type 3: Medium-priority area with cholera outbreaks of high frequency and short duration (< 7 weeks)

Type 4: Low-priority area with cholera outbreaks of moderate frequency and short duration.

Cholera Hotspot classification – Option 2B



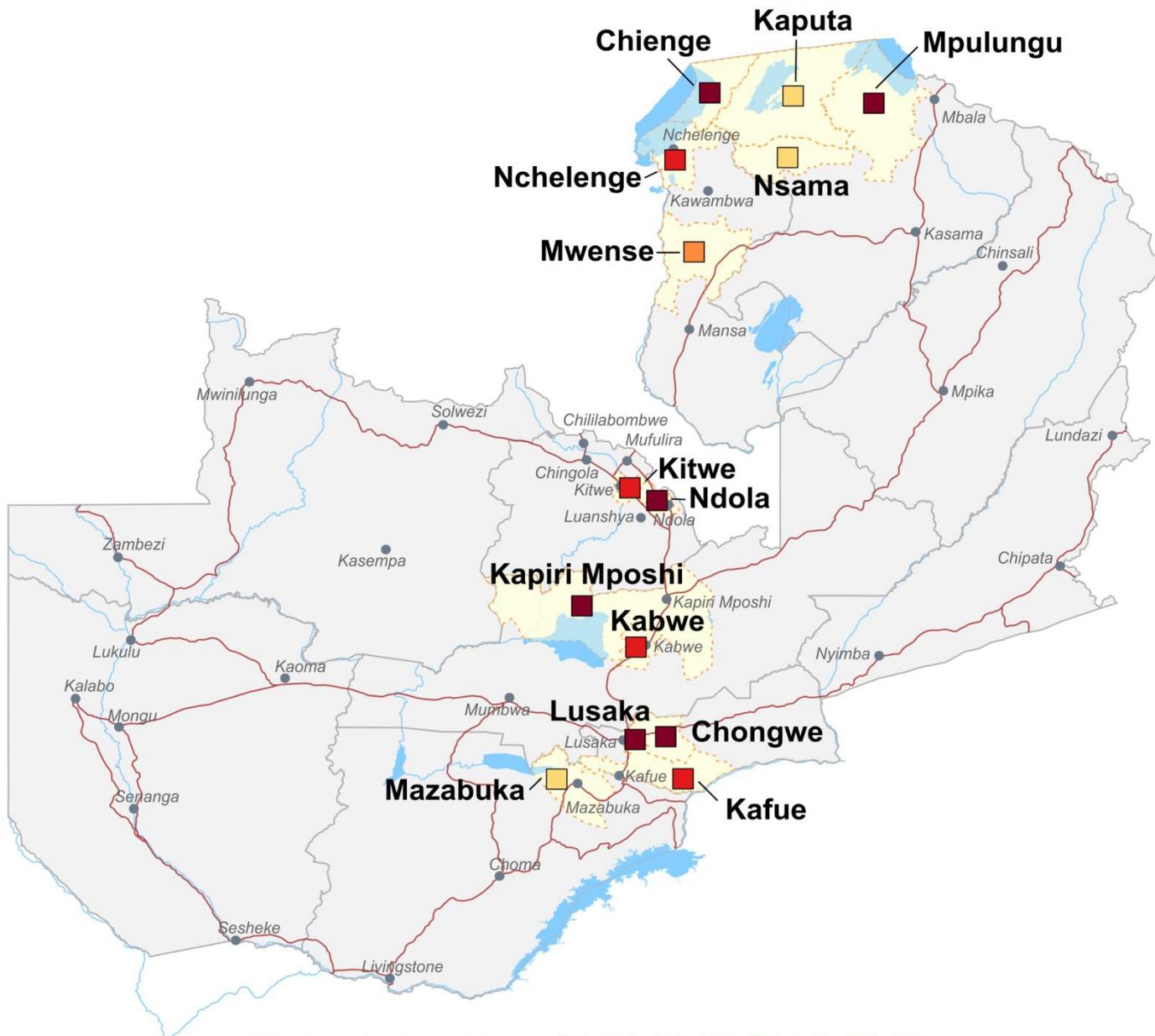
Type 1: Highest-priority area with cholera outbreaks of high frequency (≥ 6 otk. and extended duration (≥ 7 weeks));

Type 2: High-priority area with cholera outbreaks of moderate frequency (between 4 and 5 otk.) and extended duration

Type 3: Medium-priority area with cholera outbreaks of high frequency and short duration (< 7 weeks)

Type 4: Low-priority area with cholera outbreaks of moderate frequency and short duration.

Cholera Hotspot classification – Option 2B



Cholera hotspot type ■ T1 ■ T2 ■ T3 ■ T4

Key facts

- Hotspots located at the periphery of urban areas and around water bodies
- 14 hotspots (T1-T4) represent 94% of all cases – Sinazongwe discarded
- 6 highest-priority hotspots (T1) represent 86% of all cases
- Lusaka represent 72% of all cases

Cholera Hotspot classification – Option 2B

HOTSPOT TYPE	PROVINCE	DISTRICT	% of cases	Recurrence (No. of outbreaks)	Duration (No. of weeks)	Attack rate (median per 10,000 inhab.)
TYPE 1	CENTRAL	KAPIRI MOSHI	0.9%	> or = 6	> or = 7	N/A
	COPPERBELT	NDOLA	4.7%			
	LUAPULA	CHIENGE	3.8%			
	LUSAKA	CHONGWE, LUSAKA	73.1%			
	NORTHERN	MPULUNGU	3.1%			
TYPE 2	CENTRAL	KABWE	1.2%	4 - 5	> or = 7	N/A
	COPPERBELT	KITWE	1%			
	LUAPULA	NCHELENGE	1.5%			
	LUSAKA	KAFUE	0.9%			
TYPE 3	LUAPULA	MWENSE	0.9	> or = 6	<7	2.94
TYPE 4	NORTHERN	KAPUTA, NSAMA	1.8			
	SOUTHERN	MAZABUKA	0.4%	4 - 5	<7	2.94

Limitations

- More than 30% of the cholera data were missing for years 2000, 2001 and 2004. Those years were not considered for the analysis;
- Weekly number of cholera cases since 2008. Outbreak duration computed over 2008-2018;
- Disaggregated number of death per province and per district not available over the study period

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