Geospatial findings of XDR typhoid Outbreak in Pakistan- Story of spread in two cities

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Hyderabad

Outbreak investigation of XDR typhoid in Hyderabad, Pakistan I

- Largest outbreak of ceftriaxone-resistant *S* Typhi reported in Hyderabad in Nov 2016

- Clinical laboratory of Aga Khan University Hospital reported cases admitted at Aga Khan Maternal & Child Center Hyderabad with ceftriaxone resistant *S.* Typhi

- Outbreak investigation was initiated

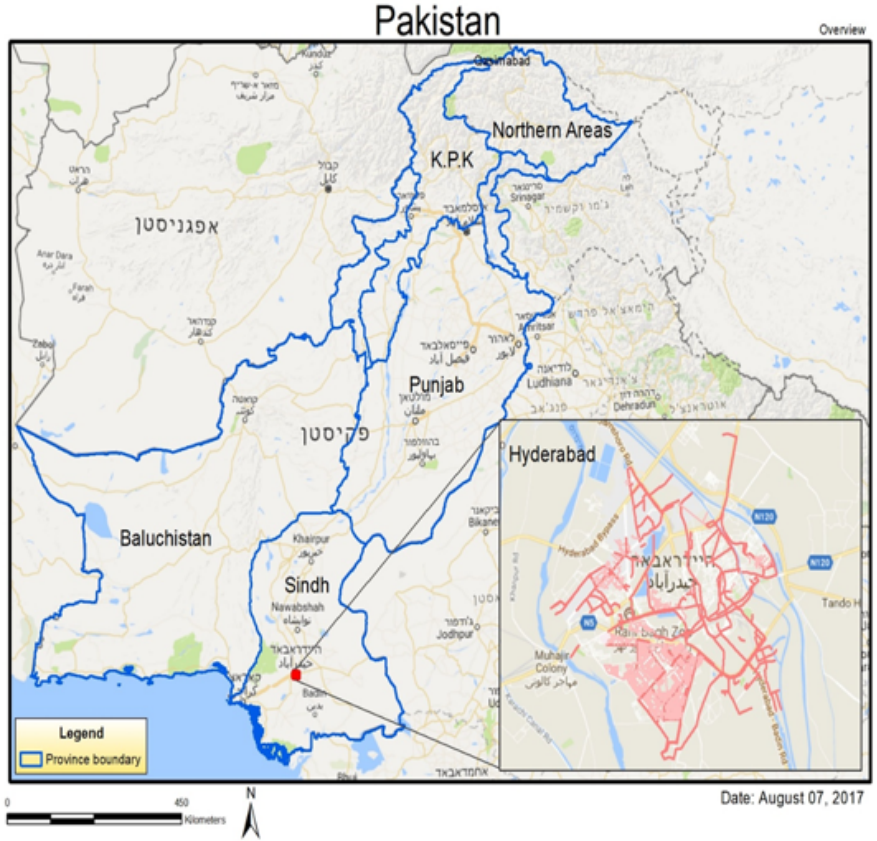
Outbreak investigation of XDR typhoid in Hyderabad, Pakistan II

- Few therapeutic options are available
  - Azithromycin and
  - Carbapenems
- These are expensive and have little accessibility

Geospatial Mapping I

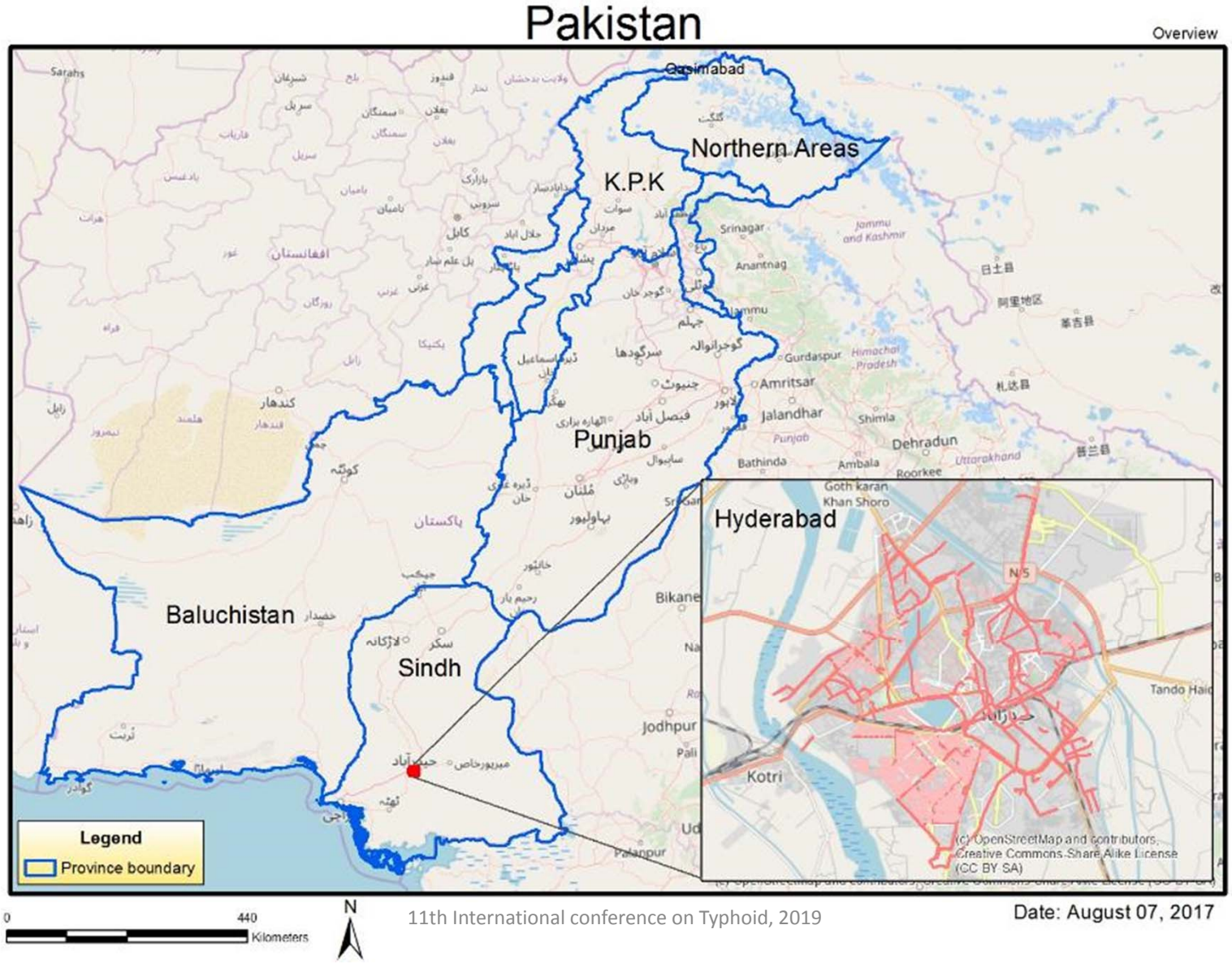
- Geospatial mapping of cases
  - Hyderabad city of Sindh (1.7 million)
    - Latifabad (0.67 million)
    - Qasimabad (0.3 million)

- Age distribution of cases
  - ≤ 5 yrs (≈60%)
  - 5-10 yrs (27%)
  - >10 yrs (13%)



Geospatial Mapping II

- Open street view map of Hyderabad was integrated in the Esri ArcGIS, version 10·5
- Important relevant landmarks, including paper-based map of the Hyderabad sewerage map was scanned and georeferenced in the Esri® ArcGIS software
- Coordinates were collected through the use of an in-house application form
- Color coding for both cases and controls and positive water samples


Pakistan
Overview
Northern Areas
K.P.K
Punjab
Baluchistan
Sindh
Hyderabad
Legend
Province boundary
0
440
Kilometers
N
Date: August 07, 2017
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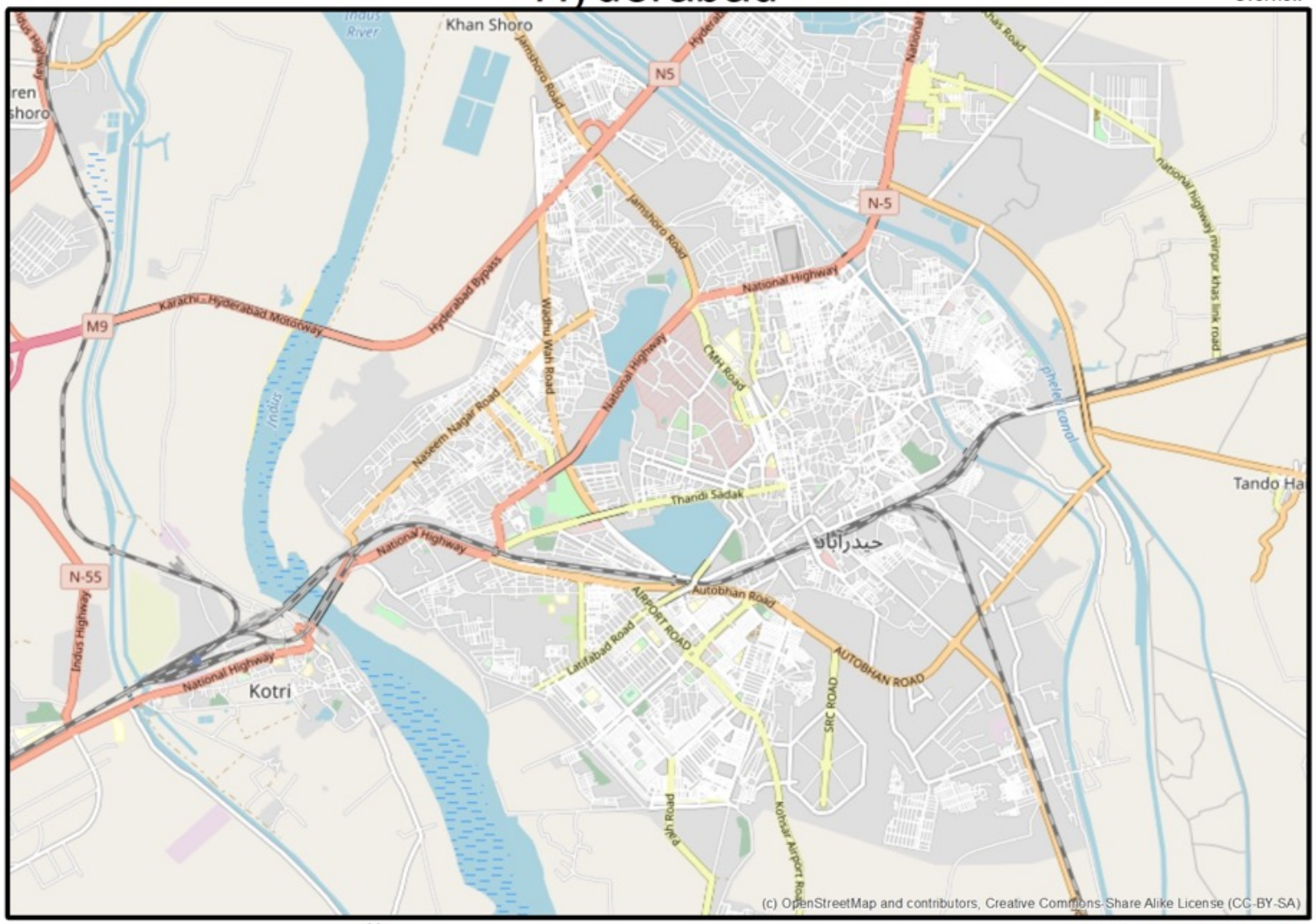
Hyderabad


Overview
Khan Shoro
Indus River
N5
N-5
M9
Karachi - Hyderabad Motorway
Hyderabad Bypass
Jamshoro Road
Wadhu Wah Road
National Highway
CMH Road
Naseem Nagar Road
Thandi Sadak
Tando Ha
حیدرآباد
N-55
Indus Highway
Autobhan Road
AIRPORT ROAD
Latifabad Road
AUTOBHAN ROAD
SRC ROAD
Kotri
Pakh Road
Kotsar Airport Road
national highway mirpur khas link road
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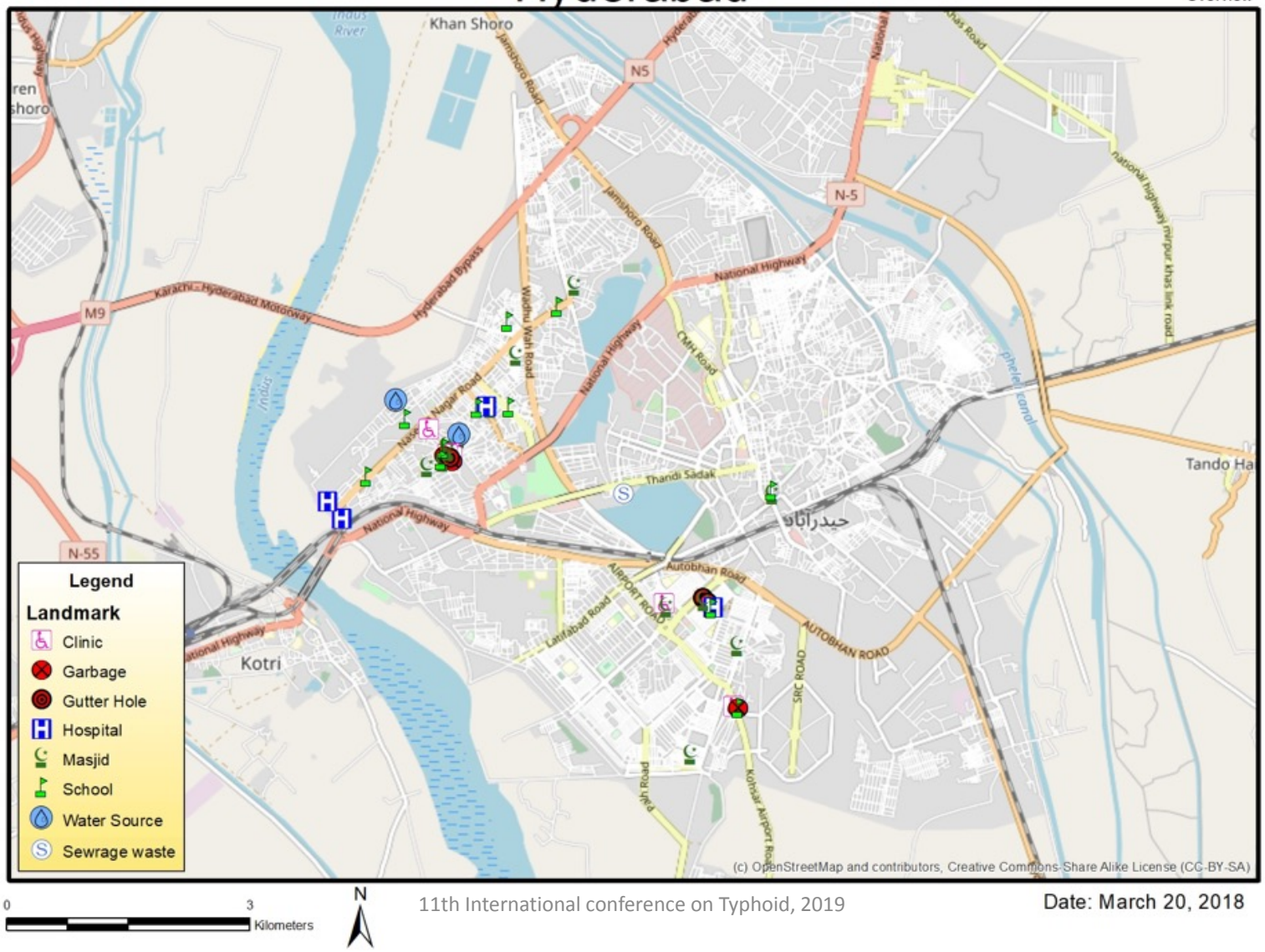
0
3
Kilometers
N
Date: March 20, 2018

Hyderabad


Overview
Khan Shoro
Indus River
N5
N-5
M9
Karachi - Hyderabad Motorway
Hyderabad Bypass
Jamshoro Road
National Highway
Wadhu Wah Road
CMH Road
Nagar Road
Thandi Sadak
N-55
Kotri
Autobhan Road
AIRPORT ROAD
AUTOBHAN ROAD
Latifabad Road
SRC ROAD
Kohsar Airport Road
Tando Ha
حیدرآباد
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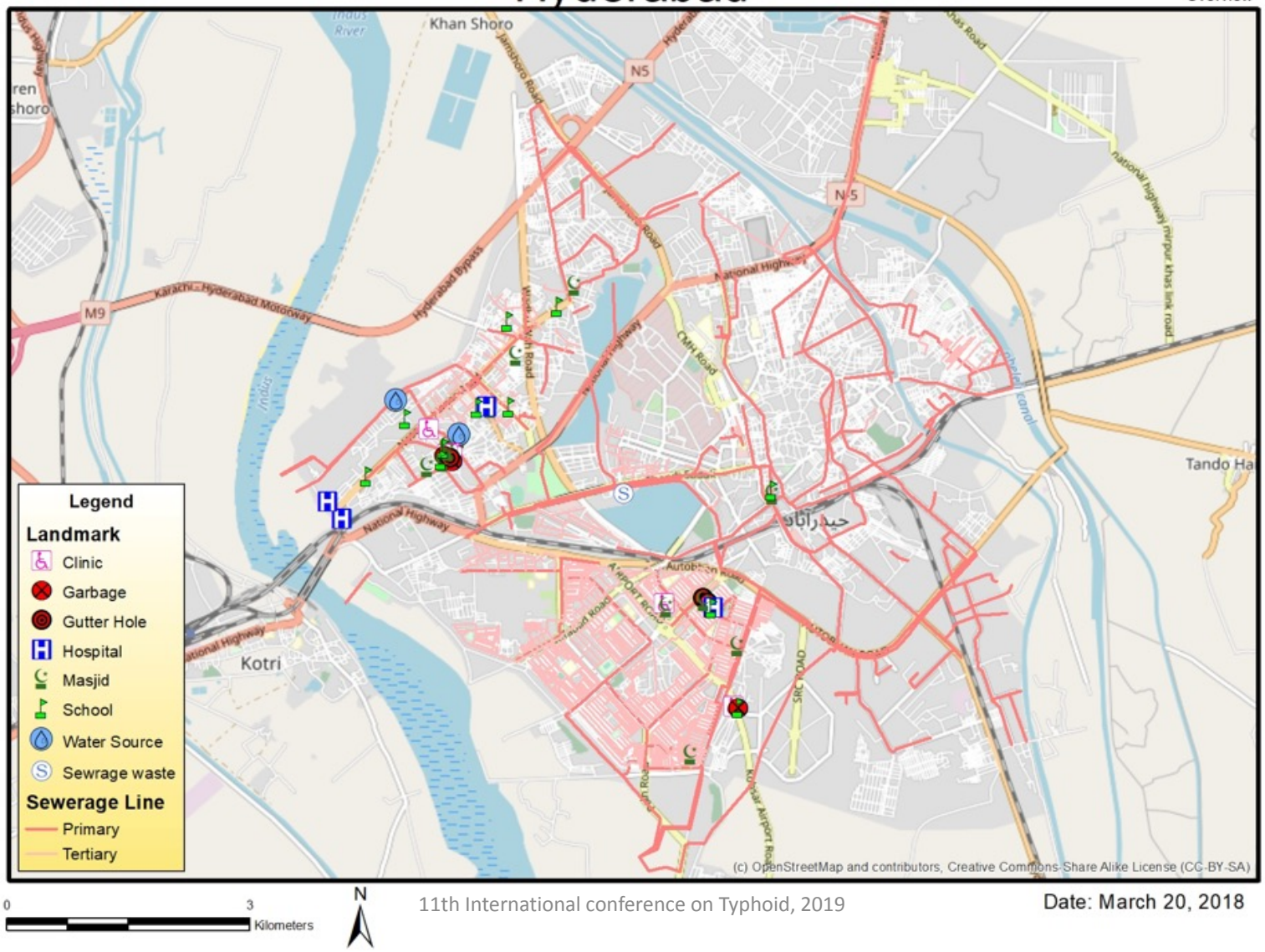
Legend
Landmark
Clinic
Garbage
Gutter Hole
Hospital
Masjid
School
Water Source
Sewrage waste
0
3
Kilometers
N
Date: March 20, 2018

Hyderabad


Overview
Khan Shoro
N5
M9
Karachi - Hyderabad Motorway
Hyderabad Bypass
National Highway
CMH Road
Kotri
Tando Ha
Legend
Landmark
Clinic
Garbage
Gutter Hole
Hospital
Masjid
School
Water Source
Sewrage waste
Sewerage Line
Primary
Tertiary
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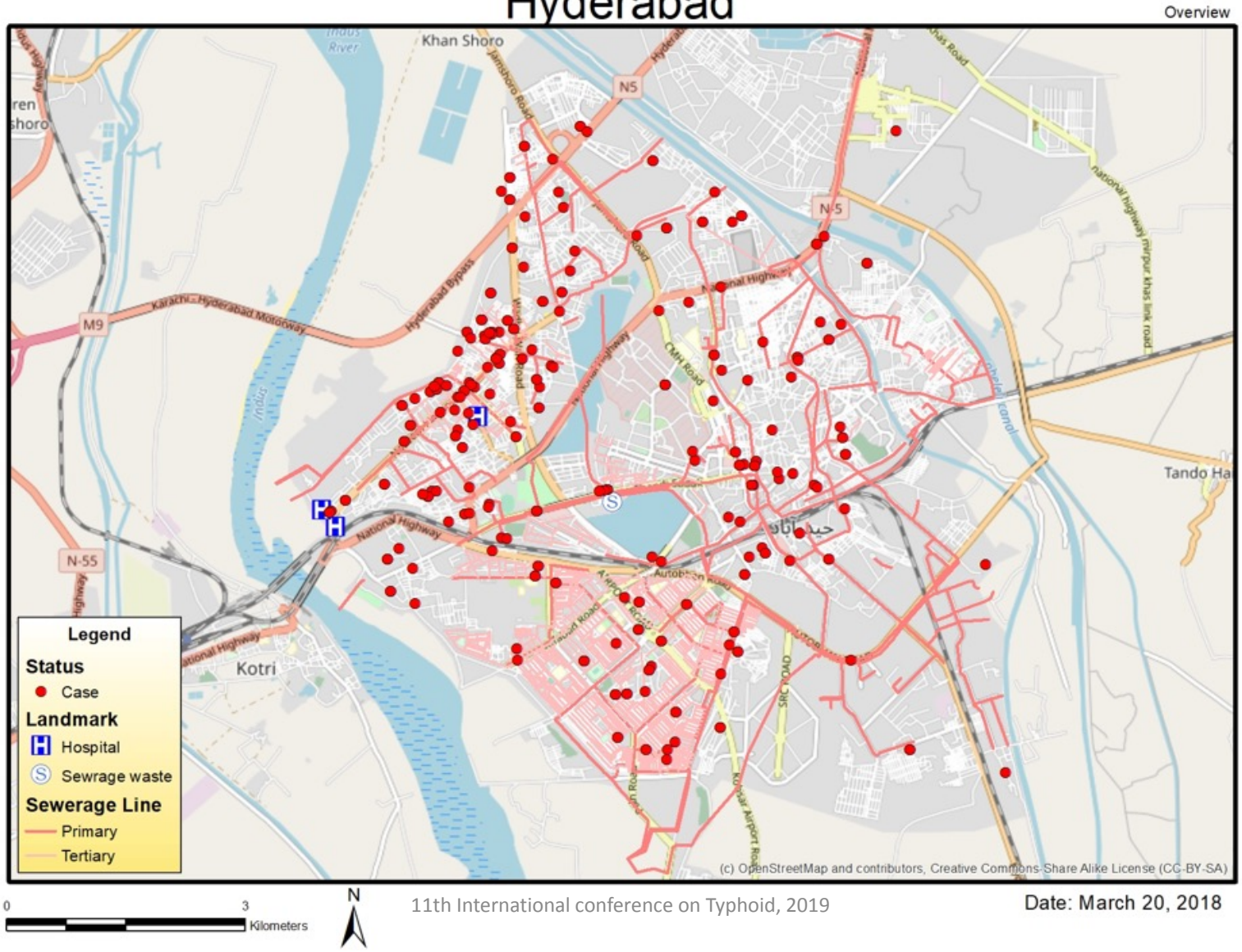
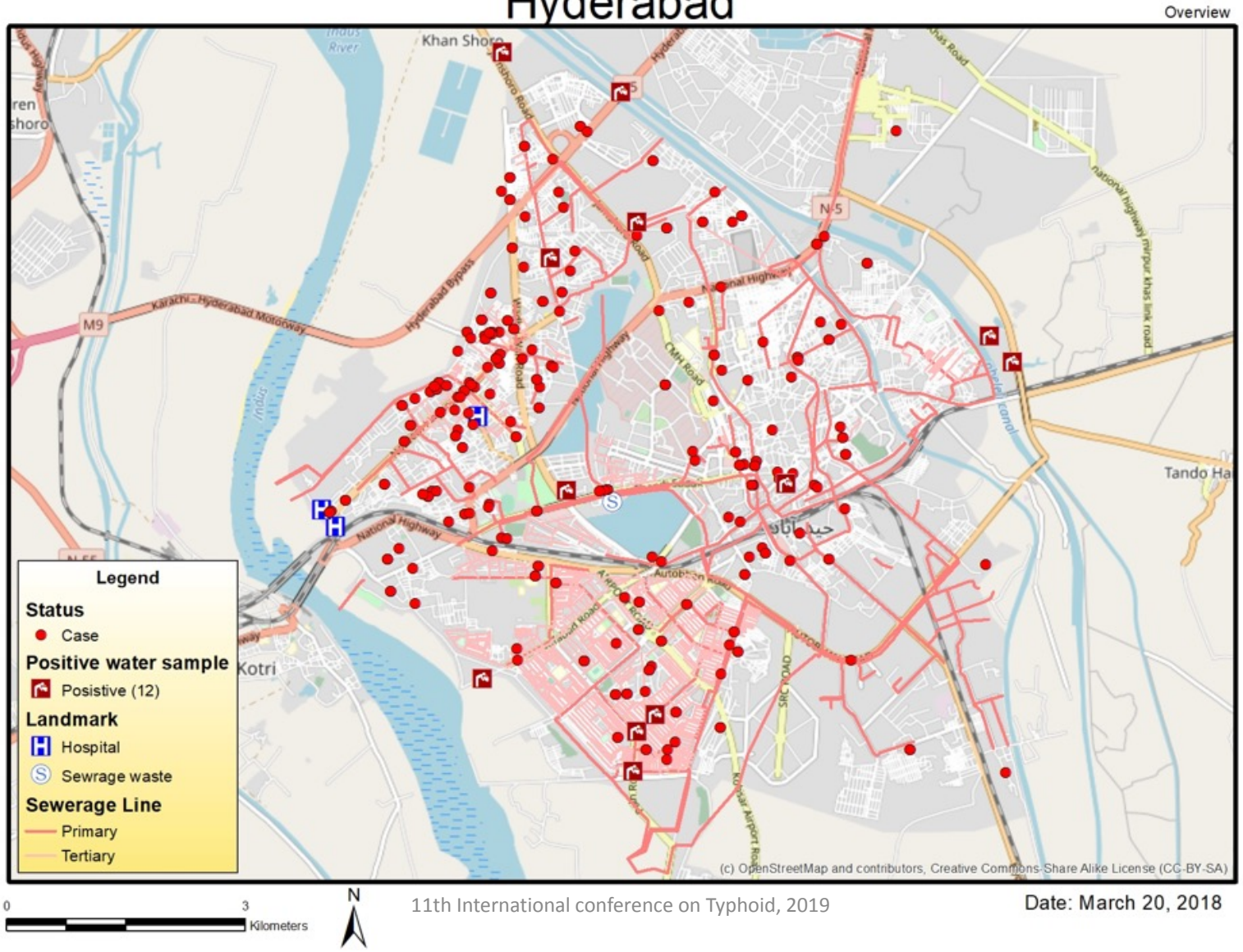
3
Kilometers
N
Date: March 20, 2018

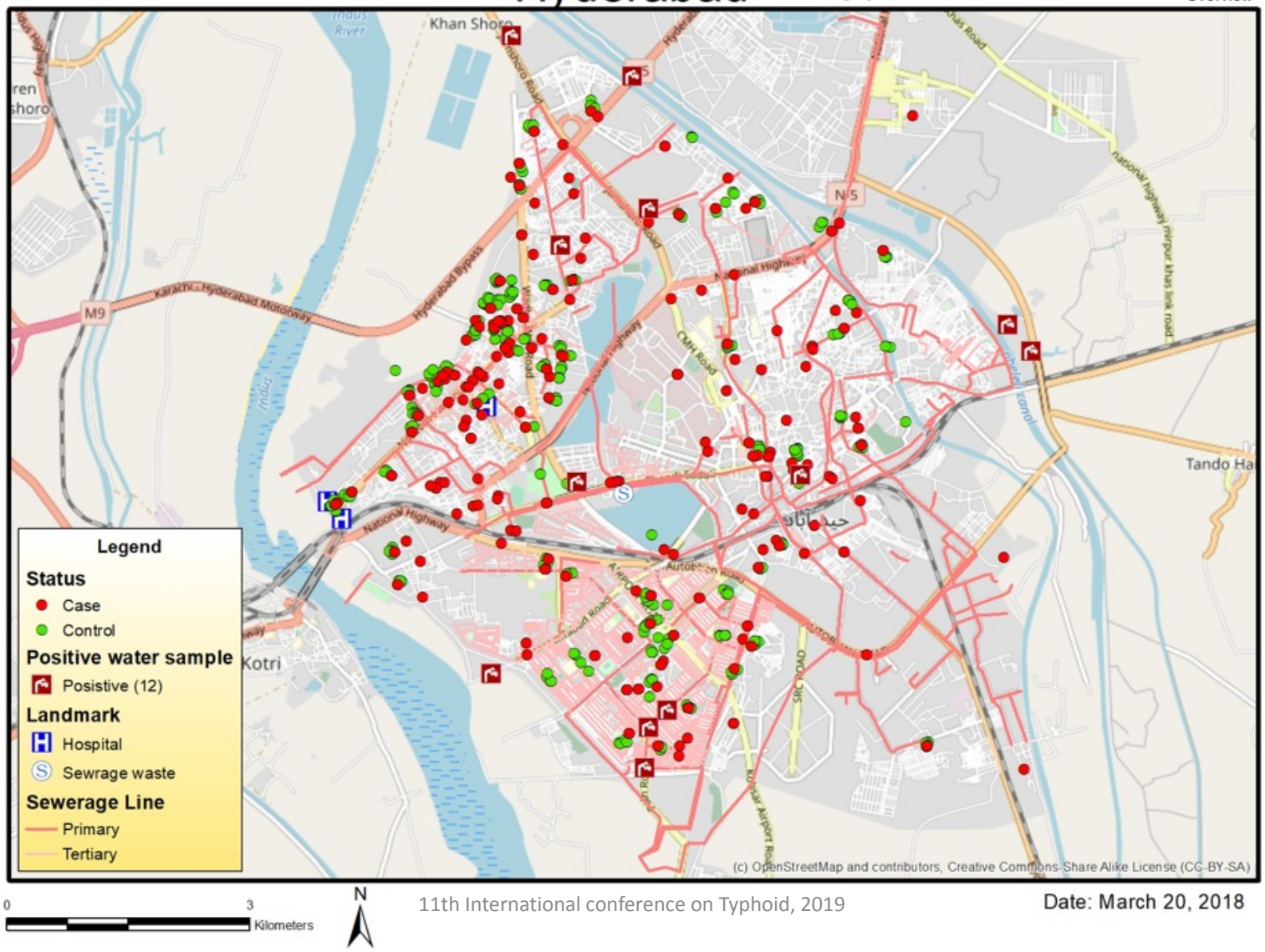
Hyderabad

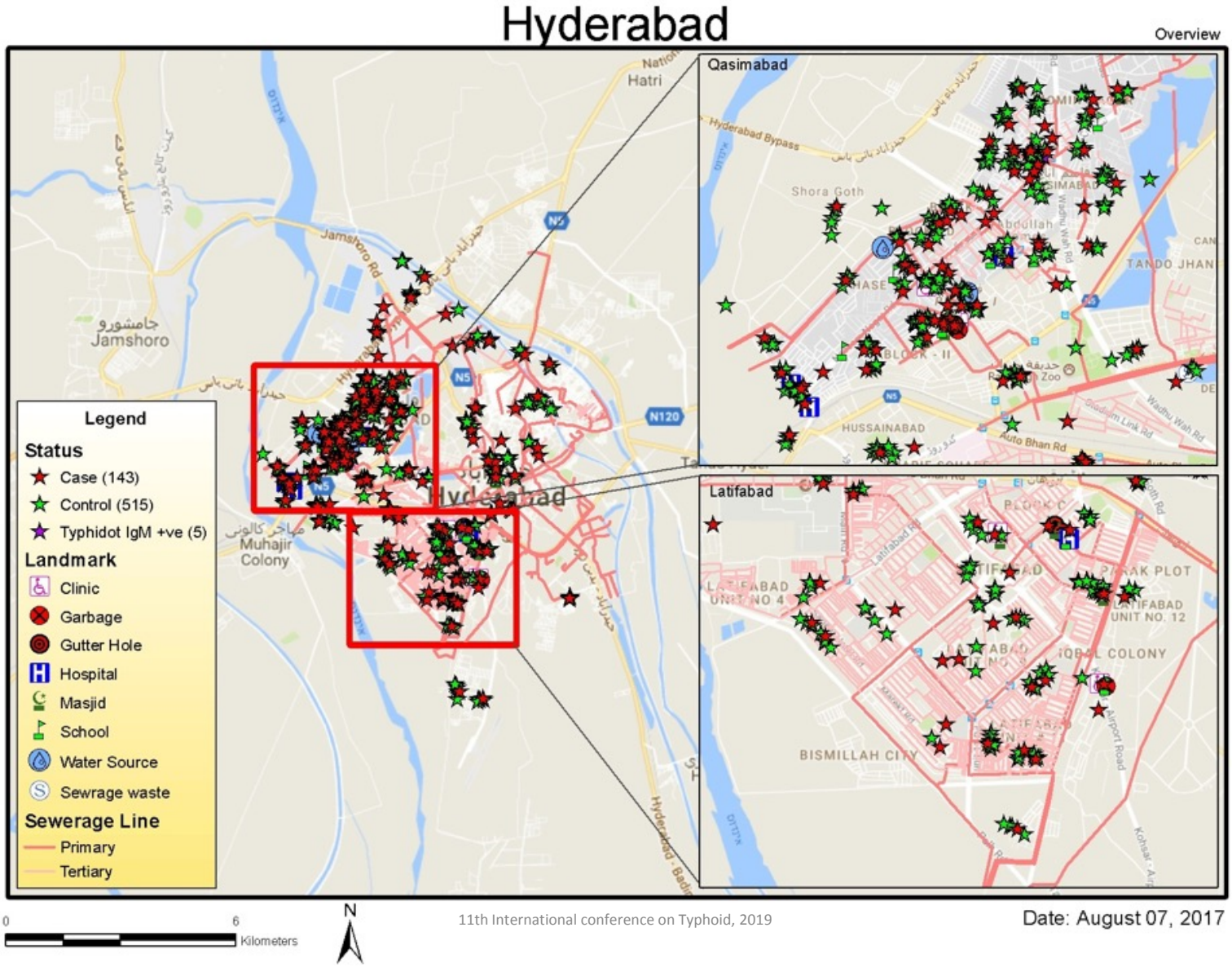

Overview
Khan Shoro
N5
N-5
M9
Karachi - Hyderabad Motorway
Hyderabad Bypass
National Highway
CMH Road
Tando Ha
N-55
Kotri
Legend
Status
Case
Landmark
Hospital
Sewrage waste
Sewerage Line
Primary
Tertiary
(c) OpenStreetMap and contributors, Creative Commons-Share Alike License (CC-BY-SA)
0
3
Kilometers
N
Date: March 20, 2018

Hyderabad


Overview
Khan Shoro
Indus River
N-5
M9
Karachi - Hyderabad Motorway
Hyderabad Bypass
National Highway
CMH Road
Tando Ha
Kotri
Legend
Status
Case
Positive water sample
Posistive (12)
Landmark
Hospital
Sewrage waste
Sewerage Line
Primary
Tertiary
(c) OpenStreetMap and contributors, Creative Commons-Share Alike License (CC-BY-SA)
0
3
Kilometers
N
Date: March 20, 2018

Hyderabad n=486

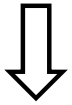



Hyderabad
Overview
Qasimabad
Latifabad
Legend
Status
Case (143)
Control (515)
Typhidot IgM +ve (5)
Landmark
Clinic
Garbage
Gutter Hole
Hospital
Masjid
School
Water Source
Sewrage waste
Sewerage Line
Primary
Tertiary
Jamshoro
Muhajir Colony
Hatri
Shora Goth
HUSSAINABAD
BLOCK - II
TANDO JHAN
LATIFABAD UNIT NO 4
LATIFABAD UNIT NO. 12
IQBAL COLONY
BISMILLAH CITY
Hyderabad Bypass
Jamshoro Rd
Auto Bhan Rd
N5
N120
0
6
Kilometers
N
Date: August 07, 2017

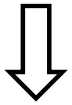
Karachi

Extracting Geospatial information from Lab Data I

List of culture positive XDR *S.typhi* is obtained from AKU diagnostic lab.



The list whether states the medical record (MR) number or the lab (L) number of patient



Different strategies are acquired to locate the coordinates.

Extracting Geospatial information from Lab Data I

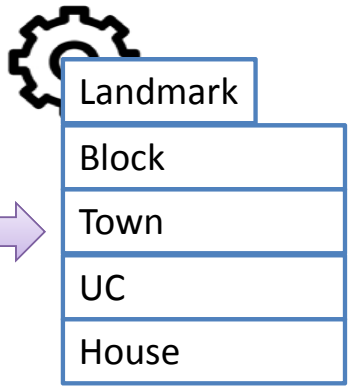
List of Typhoid cases

AKU records to get addresses

System Script Search the Coordinates from Google map against addresses

MR #

If address not found on Lab#



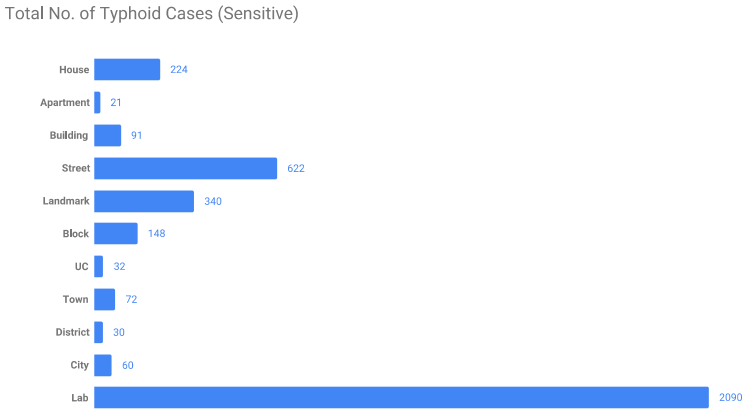
Lab collection point location is considered as the nearer block the house of patient

Extracting Geospatial information from Lab Data I

Tyhpoid Cases Statistics

Total No. of sensitive cases	3730

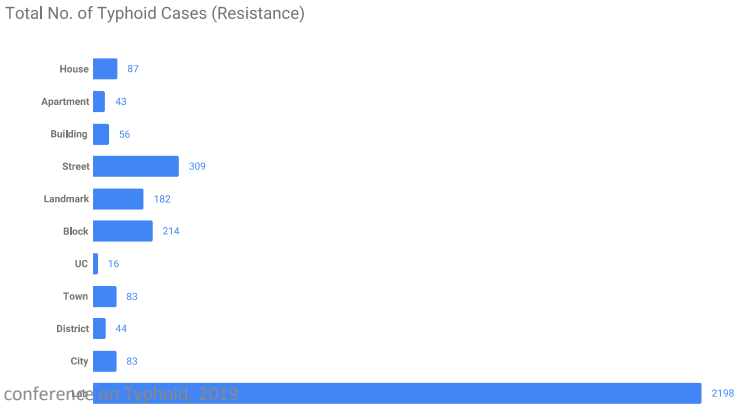
Address Sources	Total	%
House	224	6.01%
Apartment	21	0.56%
Building	91	2.44%
Street	622	16.68%
Landmark	340	9.12%
Block	148	3.97%
UC	32	0.86%
Town	72	1.93%
District	30	0.80%
City	60	1.61%
Lab	2090	56.03%



Tyhpoid Cases Statistics

Total No. of resistance cases	3315

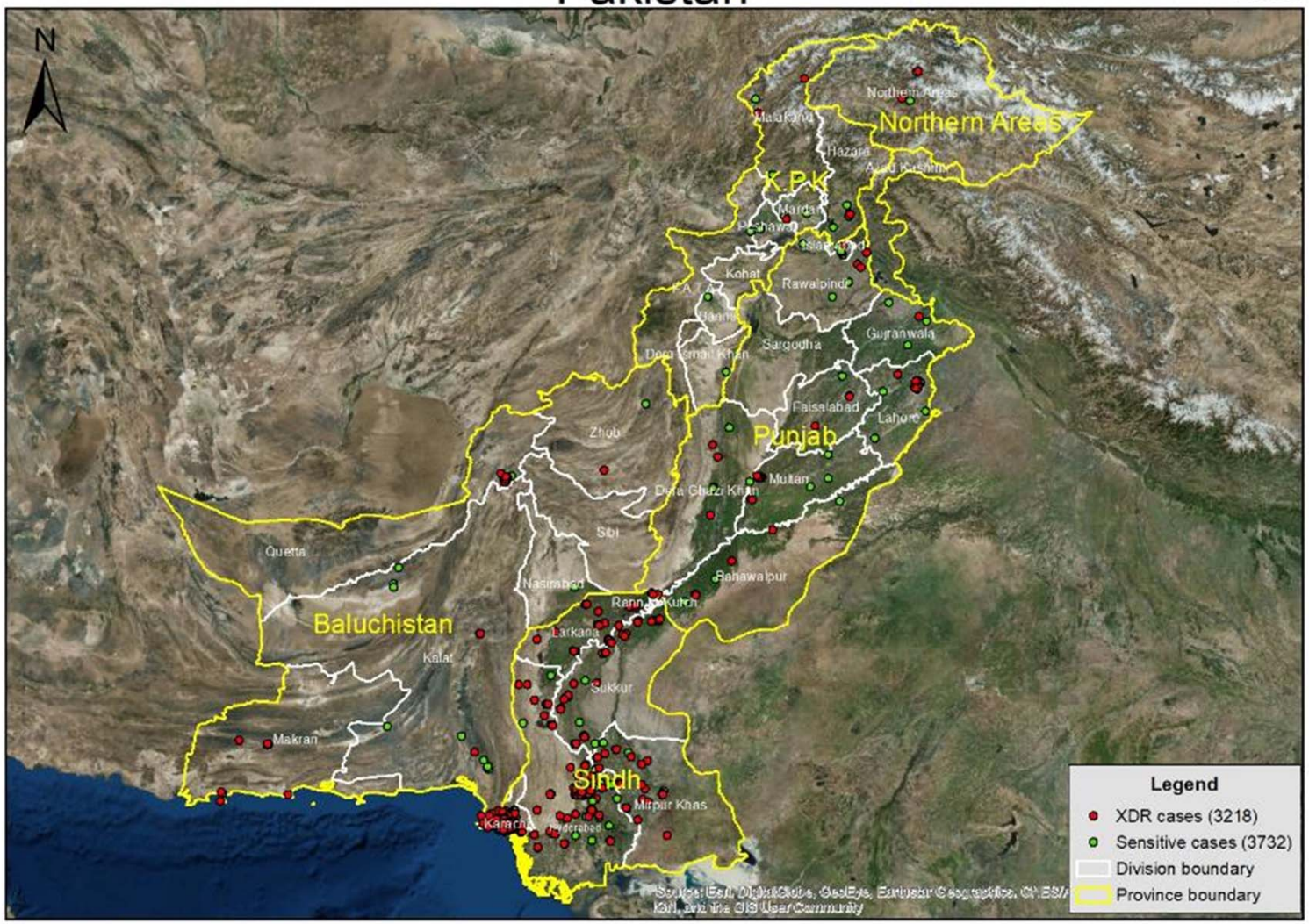
Address Sources	Total	%
House	87	2.62%
Apartment	43	1.30%
Building	56	1.69%
Street	309	9.32%
Landmark	182	5.49%
Block	214	6.46%
UC	16	0.48%
Town	83	2.50%
District	44	1.33%
City	83	2.50%
Lab	2198	66.30%



Karachi

Pakistan

Overview

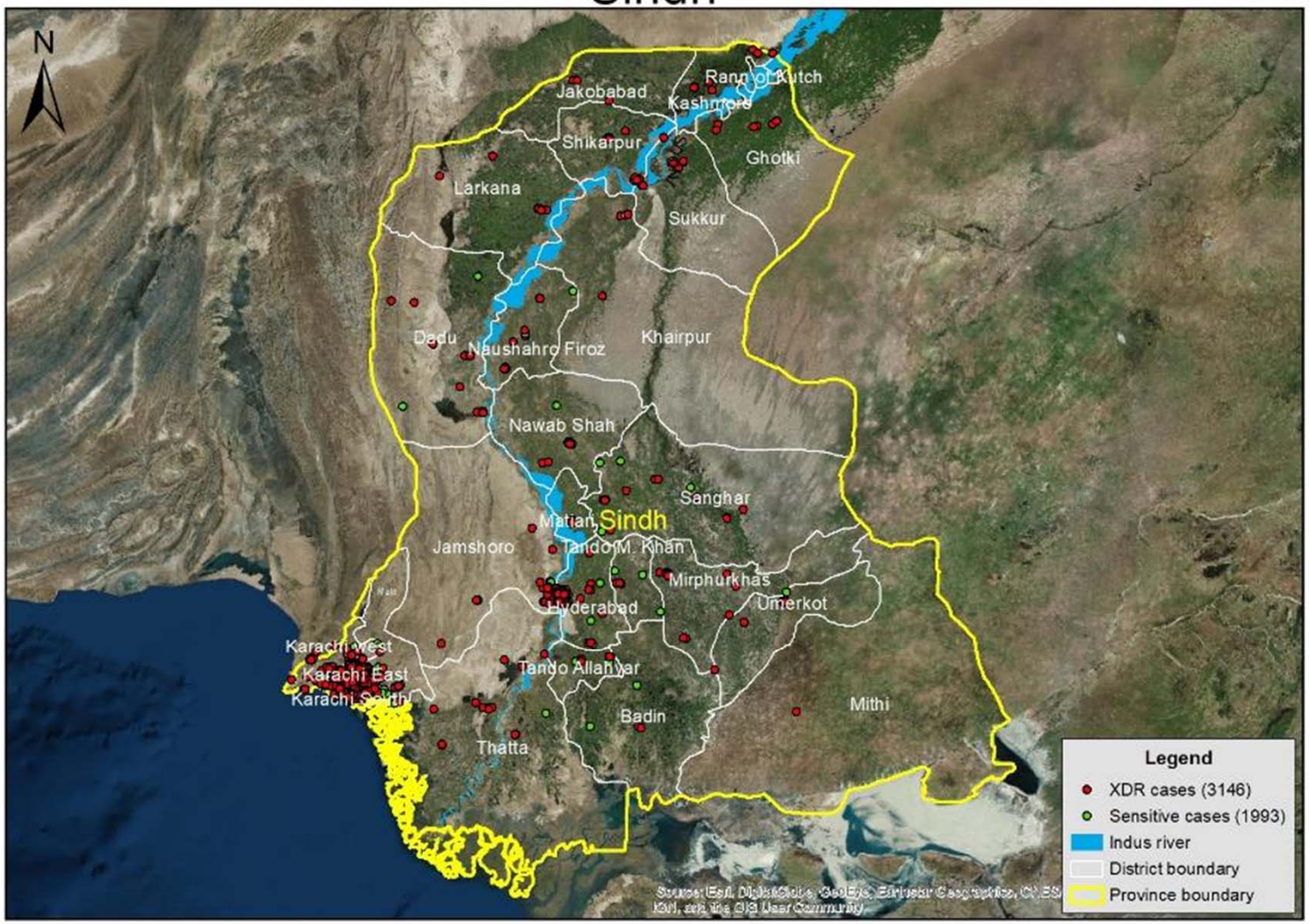


0 450 Kilometers

Date: March 20, 2019

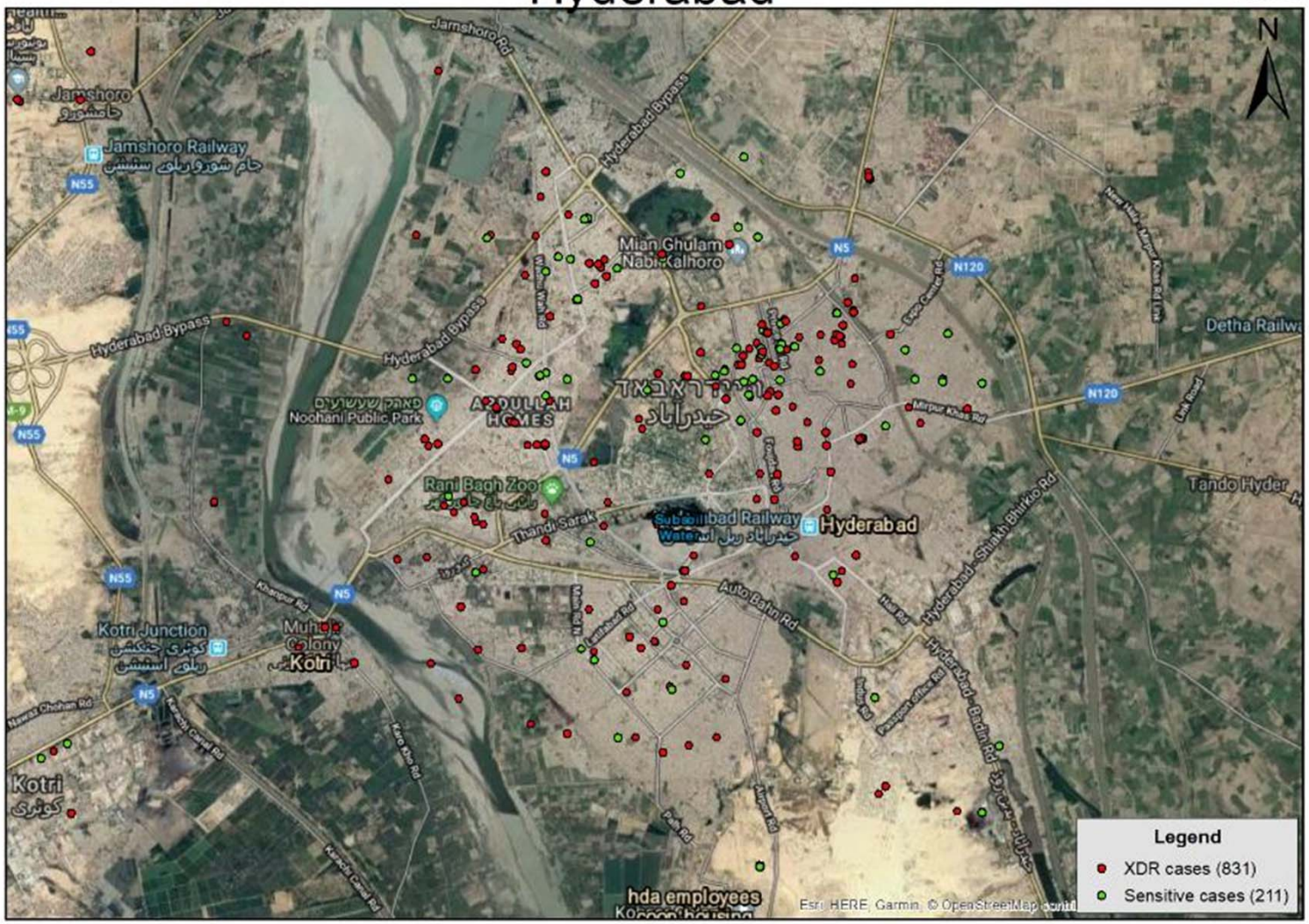
Sindh

Overview



Date: March 20, 2019

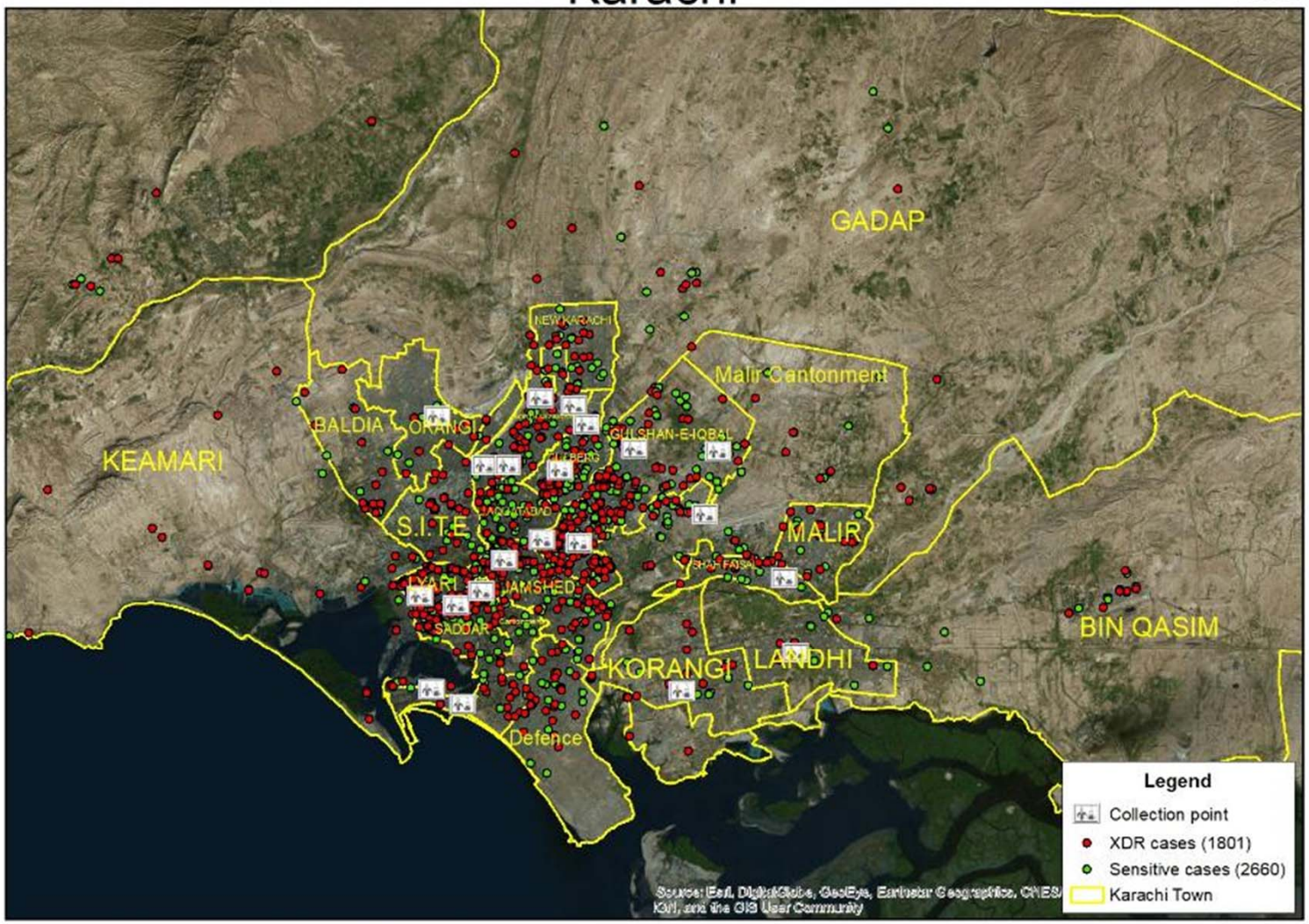
Hyderabad



Date: March 20, 2019

Karachi

Overview



0 13 Kilometers

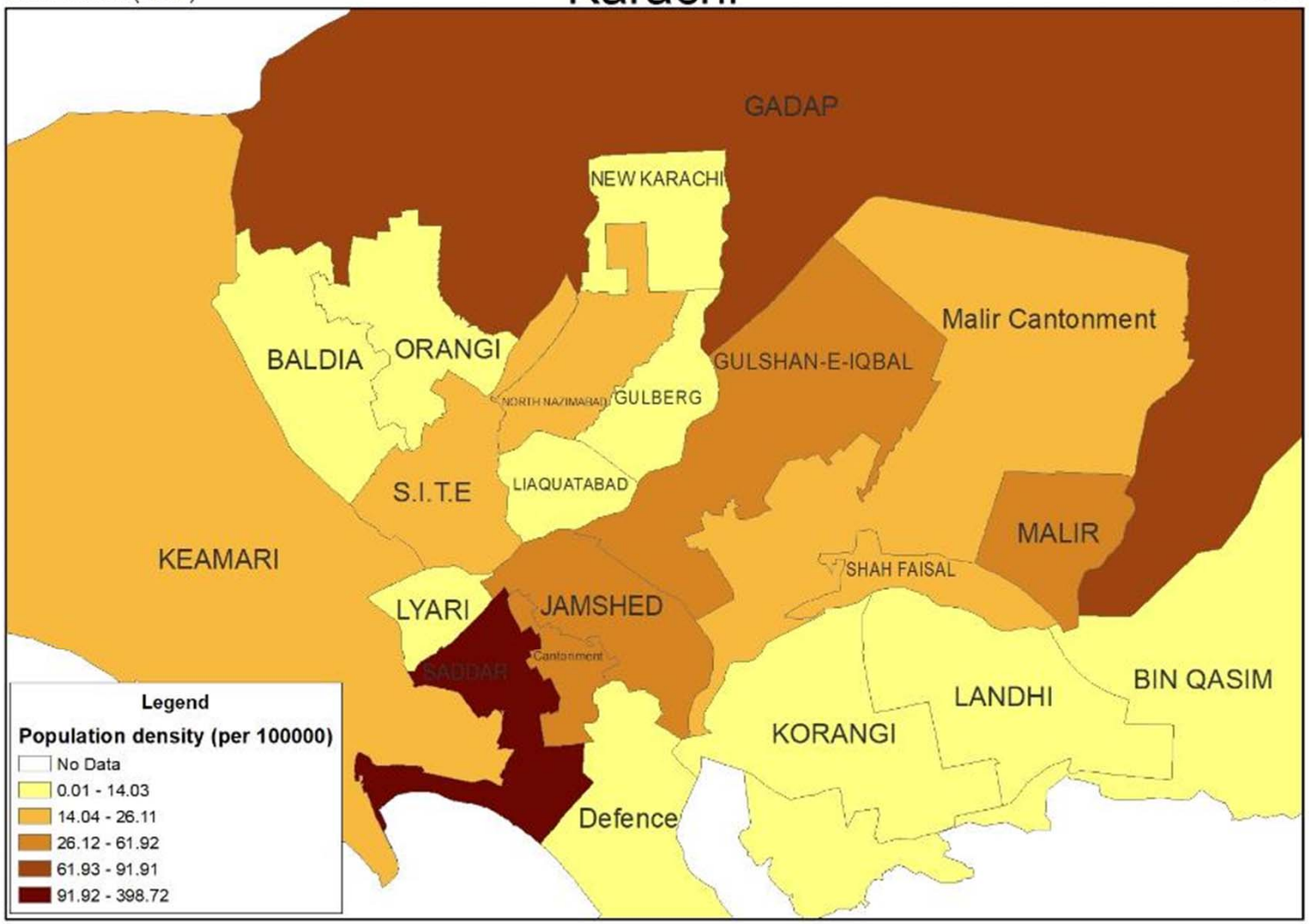
N

Date: March 20, 2019

XDR Cases (1801)

Karachi

Overview

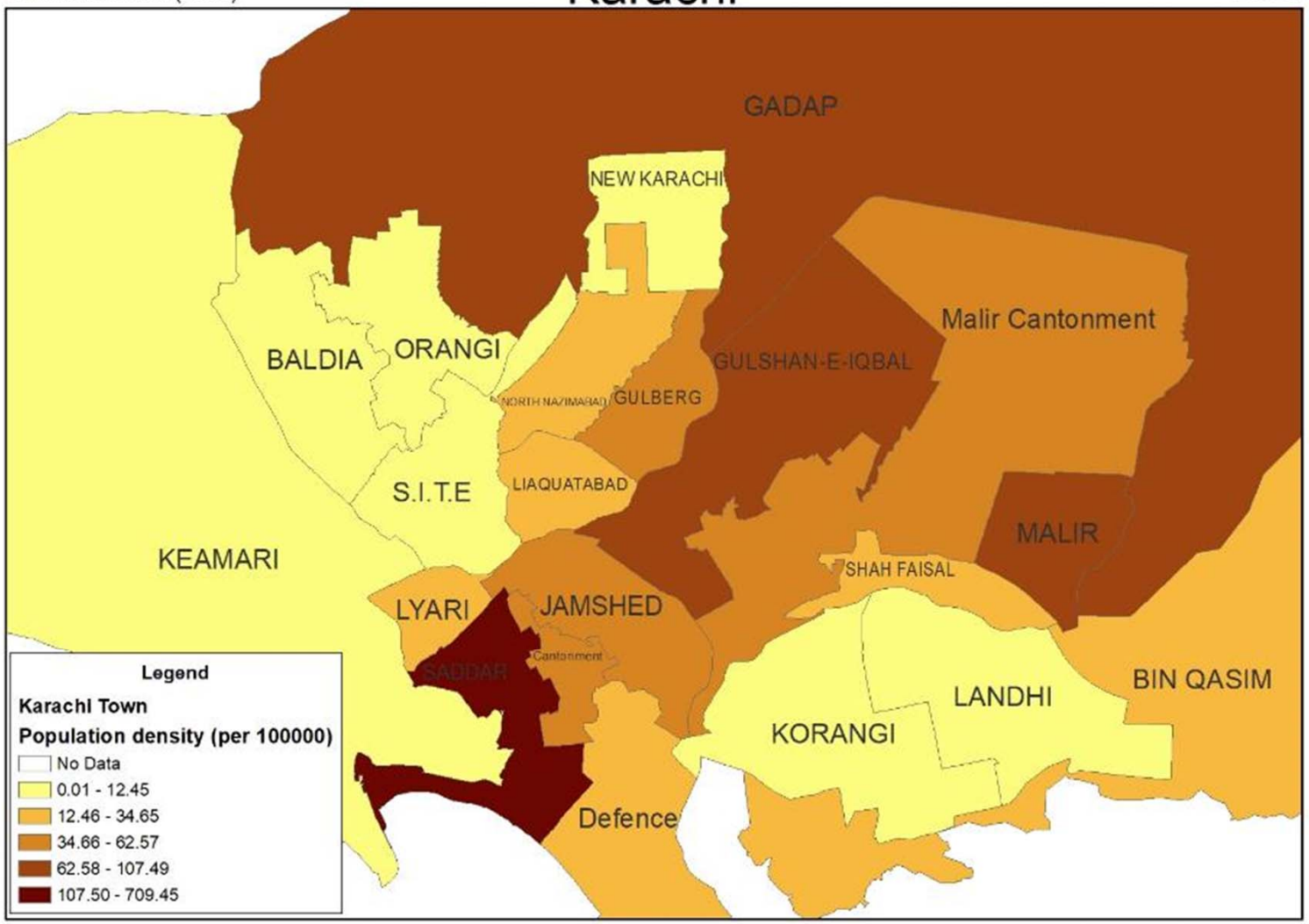


Date: March 20, 2019

Sensitive Cases (2660)

Karachi

Overview

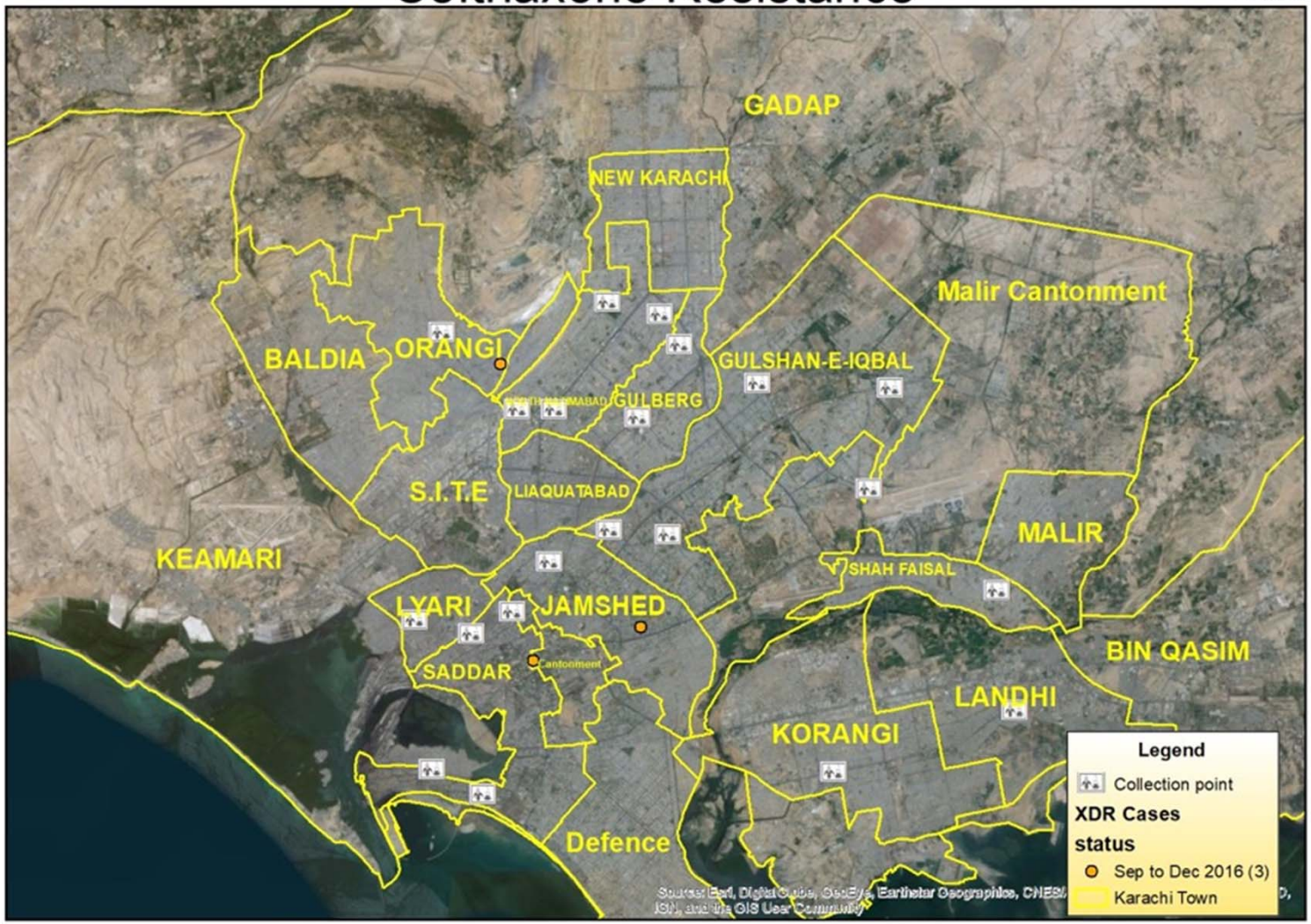


Date: March 20, 2019

XDR cases

Ceftriaxone Resistance

Overview



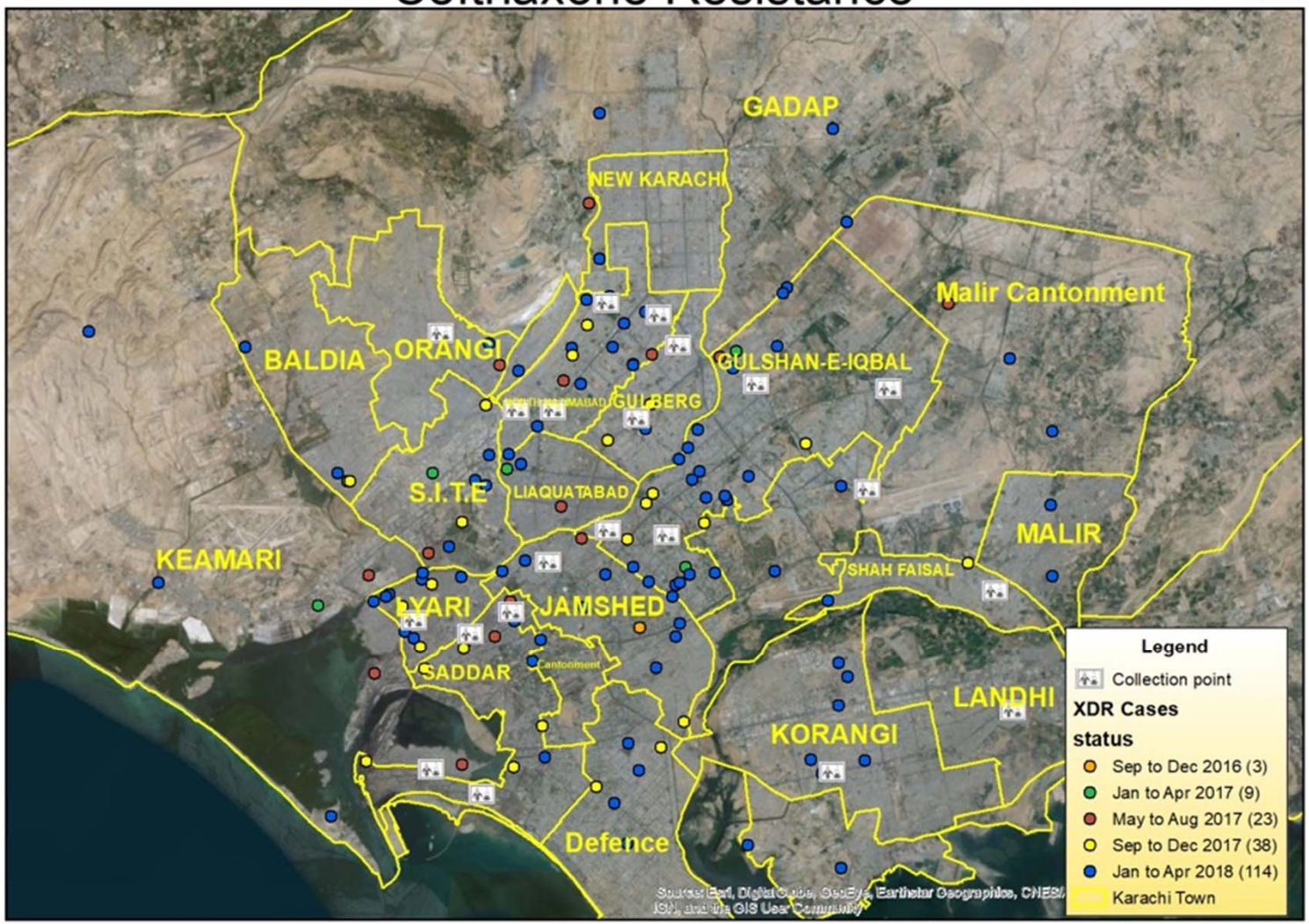
Date: November 11, 2018

Ceftriaxone Resistance

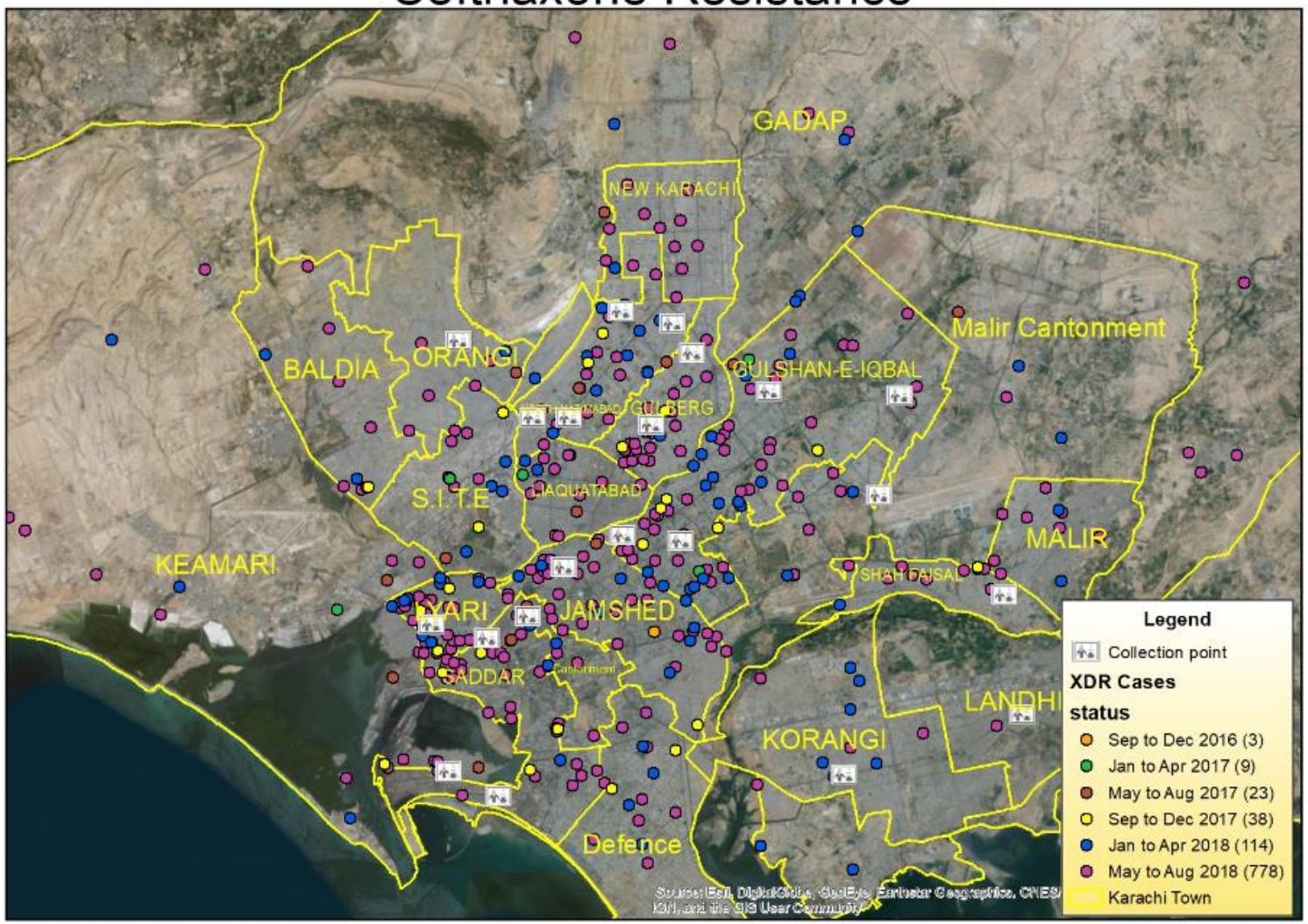
Ceftriaxone Resistance

Ceftriaxone Resistance

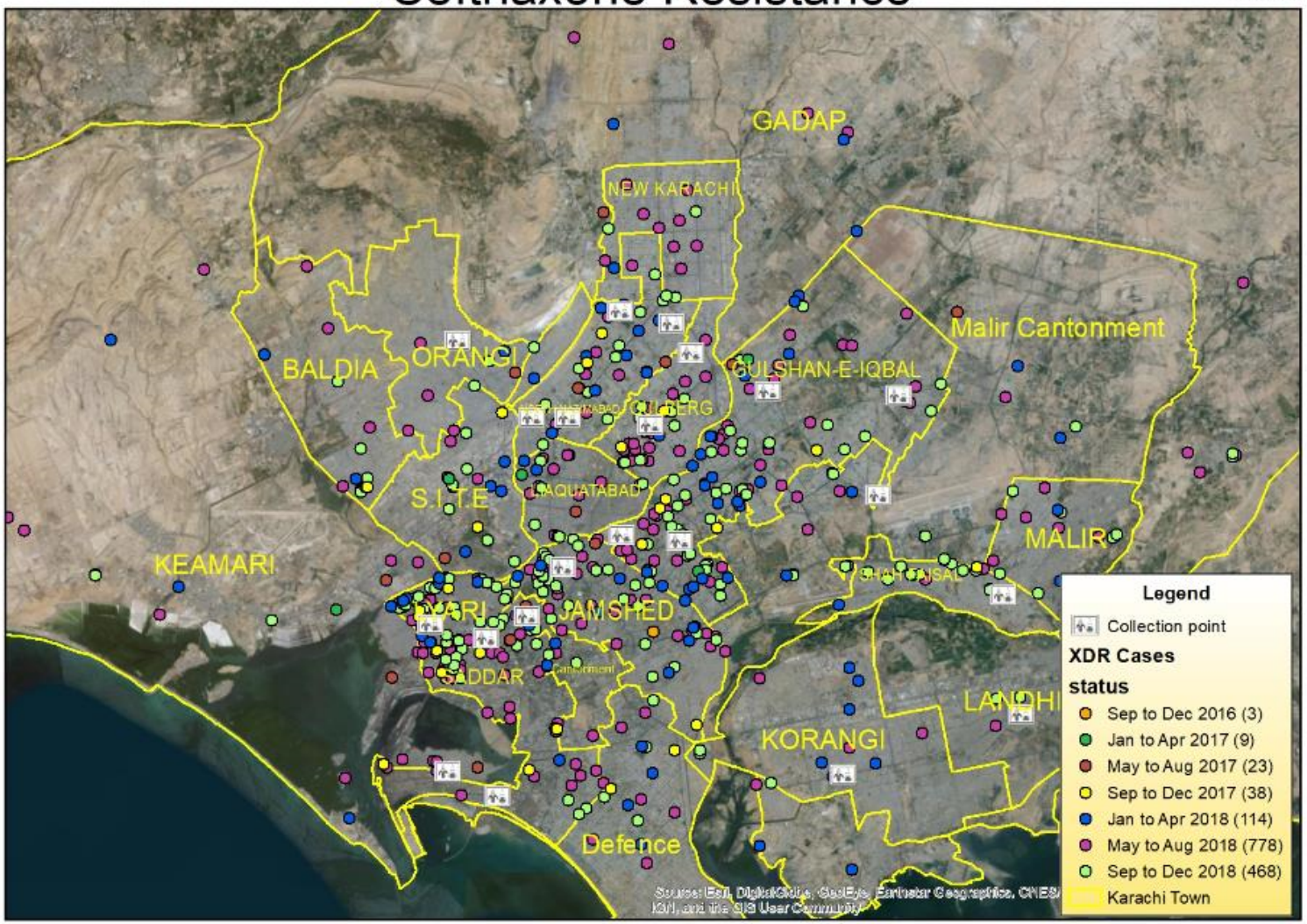
Ceftriaxone Resistance



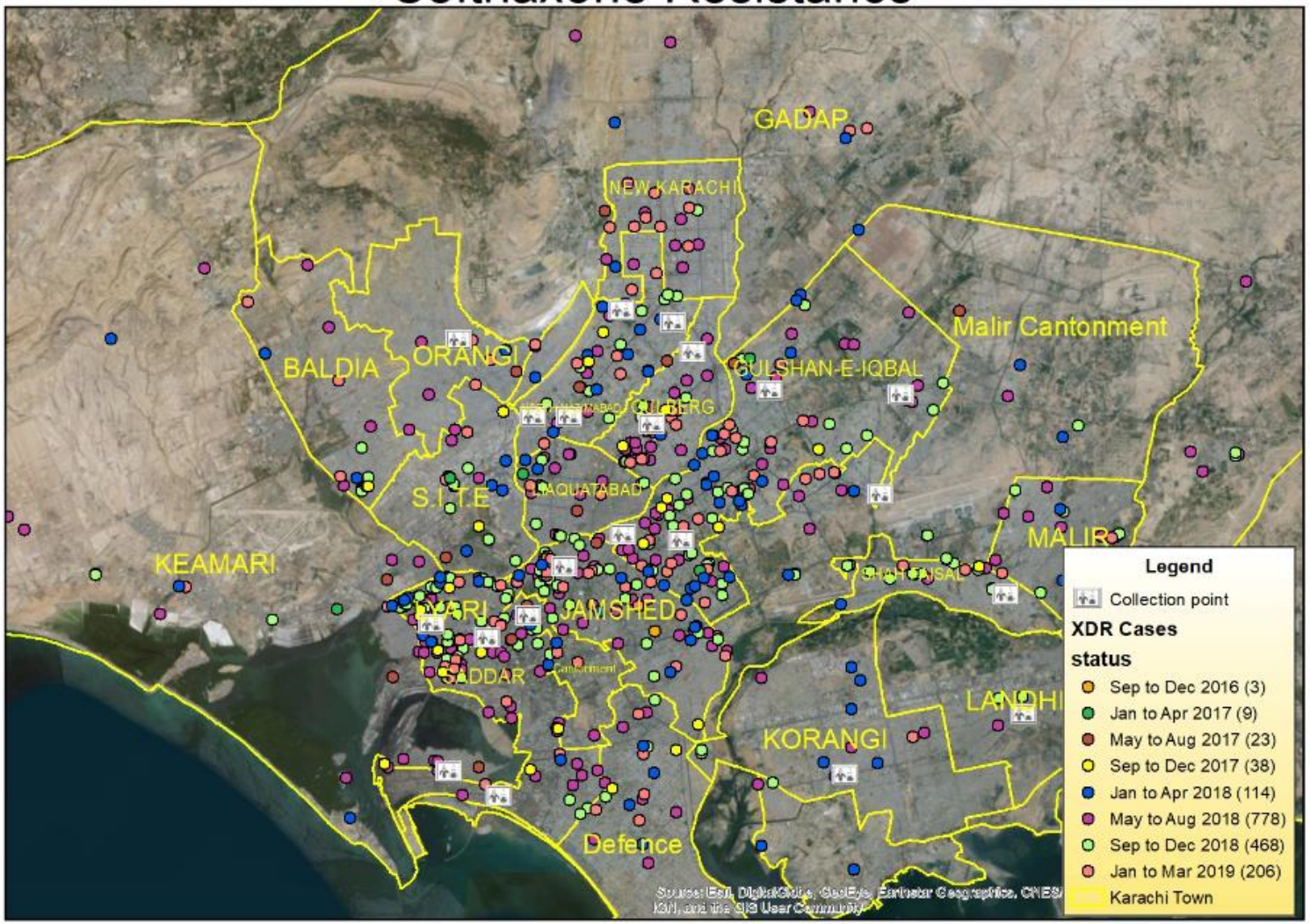
Ceftriaxone Resistance



Ceftriaxone Resistance



Ceftriaxone Resistance



Study Limitation

- The culture positive cases are only Aga University Hospital main and satellite labs
- In process of getting culture positive XDR cases location information from other major labs in Karachi, Sindh and Pakistan.
- In liaison with government of Sindh

Next step I

- **To generate Prediction models for spread of ceftriaxone-resistant Salmonella enterica serotype Typhi Outbreak in Pakistan using geospatial, genomic, environmental and sero-prevalence data**

  - Collect geospatial data through different techniques and examine changes in the spatial distribution of incidence over time
  - To conduct a sero prevalence study on a sub population
  - Utilize genomic and other epidemiological data to understand the mechanism of spread across major cities of Pakistan
  - To investigate the transmission dynamics of typhoid by collecting in-depth information about the water, sanitation and hygiene practices of the population at risk

Acknowledgements

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Seema Irfan
Afia Zafar
Heeramani Lohana
Sultan Karim

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Naveed Masood
Mudasir Rauf
DG Health; Dept of Health Sindh

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Dr Shafqat Ahmed

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Denise Garett (Sabin Vaccine Institute
Jason Andrews (Stanford)

Bill and Melina Gates Foundation