Case and population geo-location data for infectious disease outbreak investigation and surveillance

Emmanuel Robesyn, European Centre for Disease Prevention and Control

Access for public bodies to privately-held data. European Commission Workshop, Brussels, 26 June 2017

European Centre for Disease Prevention and Control

ECDC : An EU agency dedicated to the prevention and control of infectious diseases

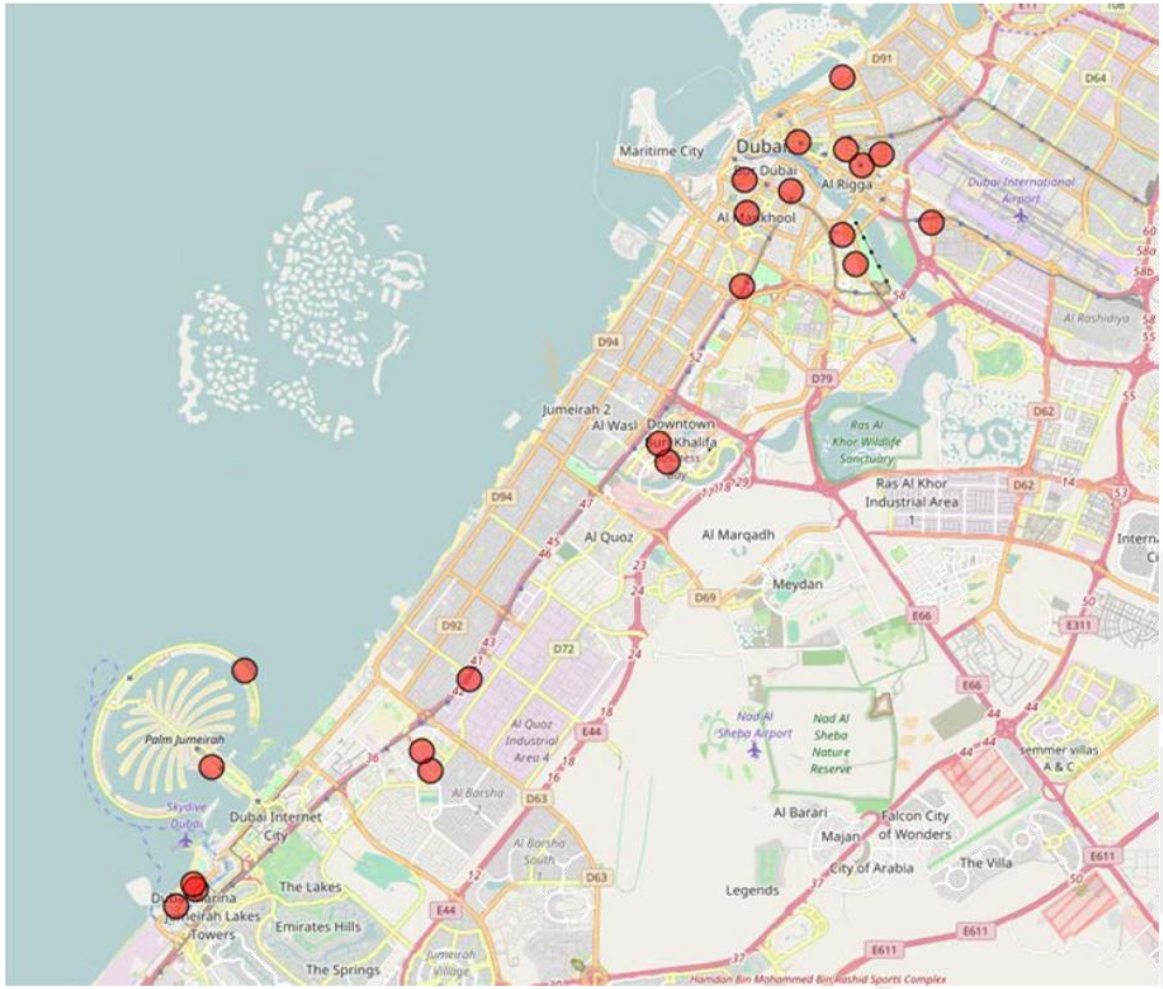
Identify, assess and communicate current and emerging health threats to human health from communicable diseases.

— ECDC Founding Regulation (851/2004), Article 3

- Case reports (aggregated or not)
- Outbreak event reports
- Population data
- Other (e.g. flights, vectors)

Legionnaires' disease, a motivating example for use of location data

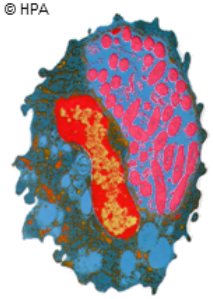
Figure 3. Accommodation sites in Dubai (N=22) where TALD cases* stayed, as of 21 December 2016



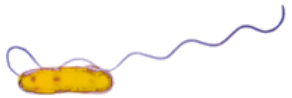
Welcome to the Legionnaires' disease outbreak investigation toolbox

Questionnaire:

Where have you been in 14 days before falling ill ?



Stain of Legionella pneumophila within a human lung macrophage



Individual Legionella pneumophila bacterium

REVIEW ARTICLES

The application of geographic information systems and spatial data during Legionnaires' disease outbreak responses

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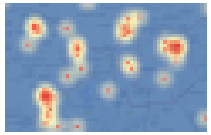
Case density map

- **Hotspot of case density suggest proximity of source**
- **Visualisation without disclosing case location data**

2. Select model

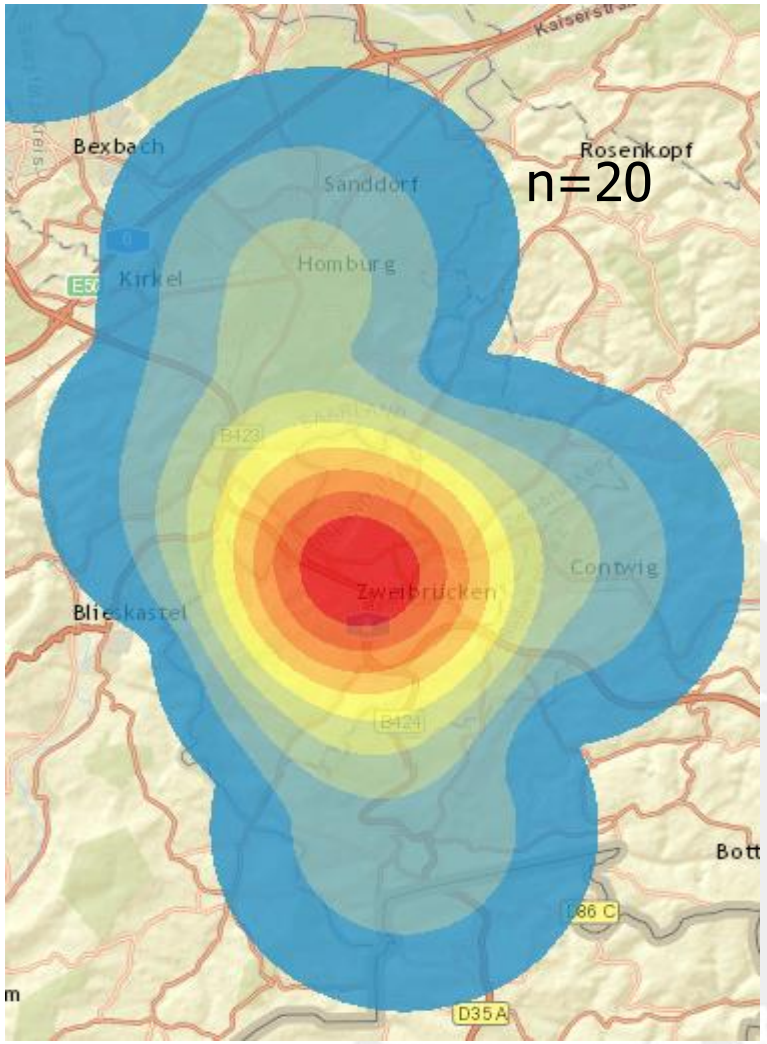
- Model 1: Case density ?
- Model 2: Disease risk ?
- Model 3: Buffer density ?
- Model 4: Buffer risk ?

Sample model result: 

1. Add data

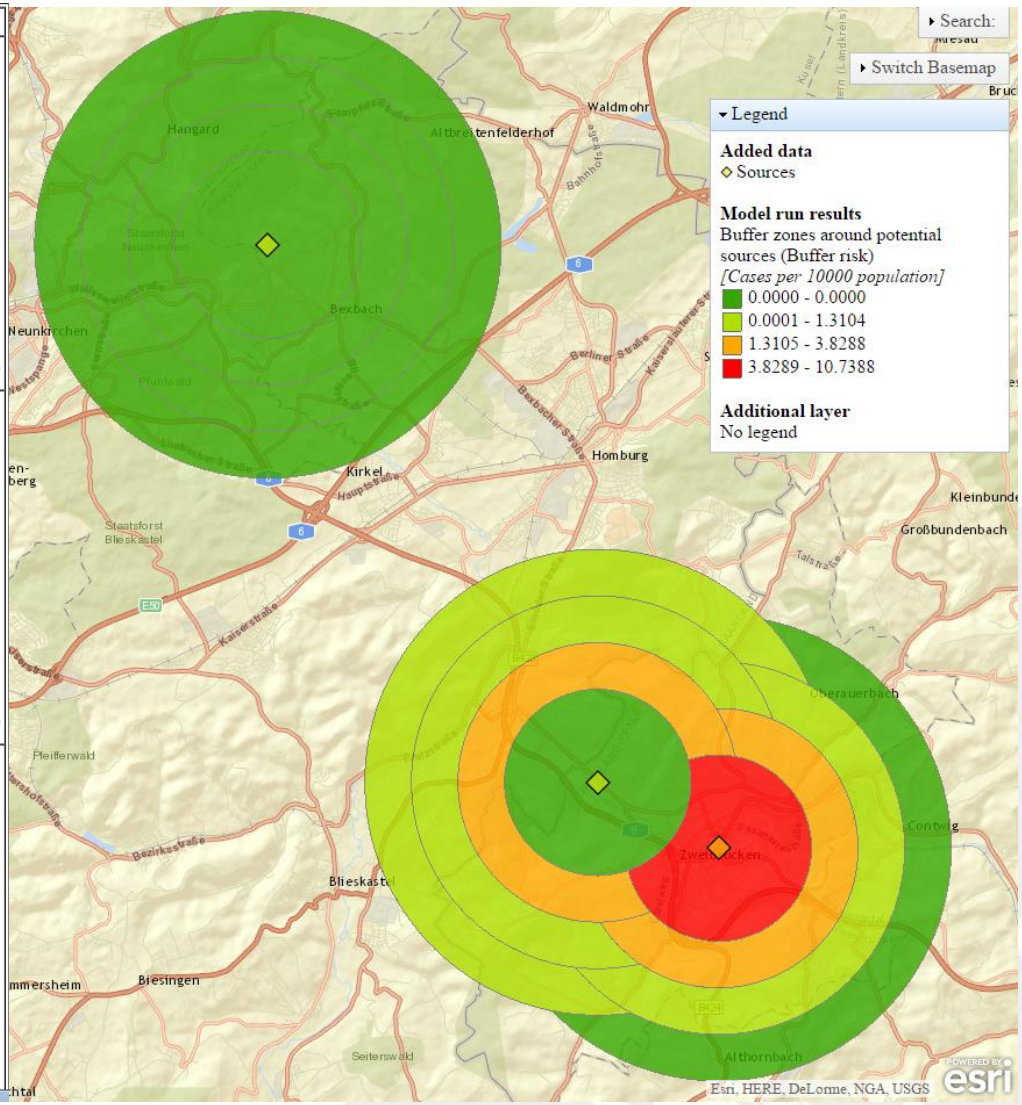
Cases: [0027] Import CSV Export CSV ?

Sources: [0009] Import CSV Export CSV ?



Case risk in rings around potential sources

ID	Name	Buffer, m	km²	Total pop.	Cases	Cases per 10000	Graph
2		4000	29.58	21628	0	0	
2		6000	36.99	24118	0	0	
2		8000	51.79	32834	0	0	
2		10000	66.58	46509	0	0	
3		4000	29.44	9312	10	10.739	
3		6000	36.82	13059	5	3.829	
3		8000	51.54	11338	1	0.882	
3		10000	66.27	12217	0	0	
4		4000	29.45	0	5	0	
4		6000	36.83	24025	7	2.914	
4		8000	51.57	22894	3	1.31	
4		10000	66.31	14102	1	0.709	



Use of several locations per person

- Assign weight to each location, proportional to time spent

  Example:
  - Case x, *residence location*, weight 0.5
  - Case x, *work place location*, weight 0.3
  - Case x, *hobby place location*, weight 0.2

Advantage of mobile phone location data

- More precise location, not limited to residence: usefulness dependent on tower coverage and spatial scale outbreak
- No recall bias
- Easier to collect
- Trajectory can still be verified and further detailed by case
- Includes time feature: can be related to most likely time of infection of each case

=> **mobile call data records for source detection**

- When multiple locations/movement data, risk calculation based on resident population not valid

=> **mobile call data records to estimate risk denominator**

Extending the use for other diseases

- Individual case location: source identification in outbreaks (environmentally linked infections)
  - Airborne from contaminated water (LD)
  - From infected animals (zoonosis e.g. Q fever, MERS, avian influenza)
  - Vector borne diseases (e.g. dengue, West-Nile, chikungunya, yellow fever)
- Population density (anonymous): population at risk
  - Outbreaks: attack rate, risk assessment, preventive action, transmission chain and characteristics
  - Surveillance: denominator real time (vs. static census data of resident population), more precise (e.g. commuting population, weekend vs. weekday, high vs. low season),
  - Mass gathering events (sports, religious, cultural, …)
  - Chemical/nuclear incident
- Population movement: migration (e.g. cholera Haiti*, ebola W-Africa**)

* Using Mobile Phone Data to Predict the Spatial Spread of Cholera, Bengtsson et al.

** Commentary: containing the ebola outbreak - the potential and challenge of mobile network data, Wesolowski et al.

Challenges

- Confidentiality – need for informed consent, data protection agreement
  - population (person identifiable data)
  - case (health data)
- Data storage and retrieval
  - Individual versus population density
  - Retrospective (how long back in time) versus prospective during outbreak (tracking to be turned on, on request of public health authorities)
  - Different mobile phone companies in outbreak area
- Accessibility: constraints for outbreak investigation purpose
  - timeliness (days - weeks)
  - established way to start tracking (if no default storage)
- Precision: constraints for outbreak investigation purpose
  - Legionnaires' disease outbreak - range 1 - 15 km
  - Vector borne or zoonosis - depending on range of vector, epizooty, …

=> NEED FOR FRAMEWORK TO FACILITATE USE

Thank you