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Dynamic Population Mapping: Applications to Public Health & Disaster Management

 **UN Big Data Regional Hub for Africa**

21 March 2024

Flowminder Foundation
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Data Scientist



Our services

What
we do



**Mobile Data
Partnerships**



**Population
Distribution &
Mobility
Analysis**

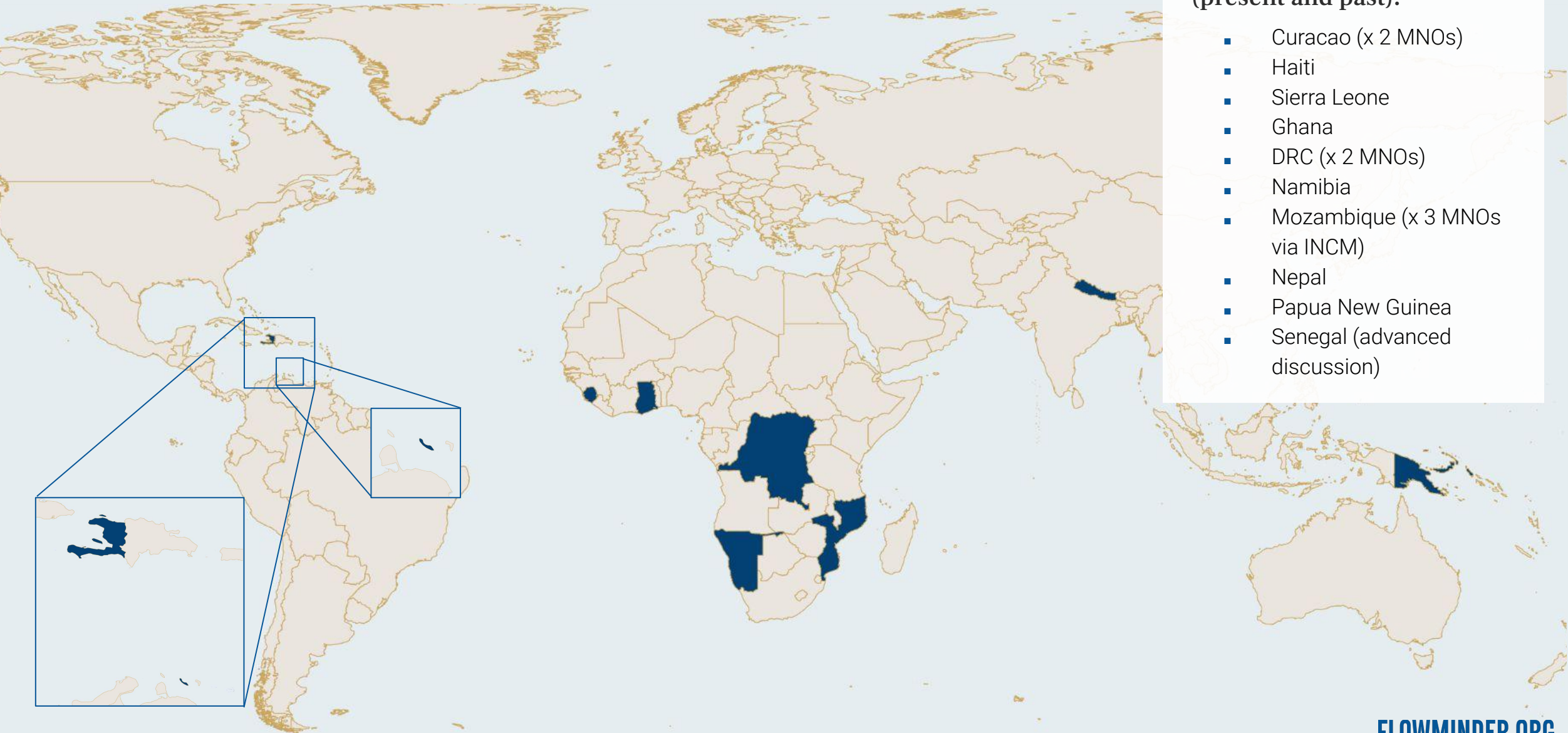


**Geospatial Data
Analysis & Site
Placement
Optimisation**



**Capacity
Strengthening**

Our mobile data collaborations to date



Countries where Flowminder has collaborated with MNOs (present and past):

- Curacao (x 2 MNOs)
- Haiti
- Sierra Leone
- Ghana
- DRC (x 2 MNOs)
- Namibia
- Mozambique (x 3 MNOs via INCM)
- Nepal
- Papua New Guinea
- Senegal (advanced discussion)



To enable **decision makers** to access
the **data** they need to **transform** the
lives of vulnerable people, at scale.



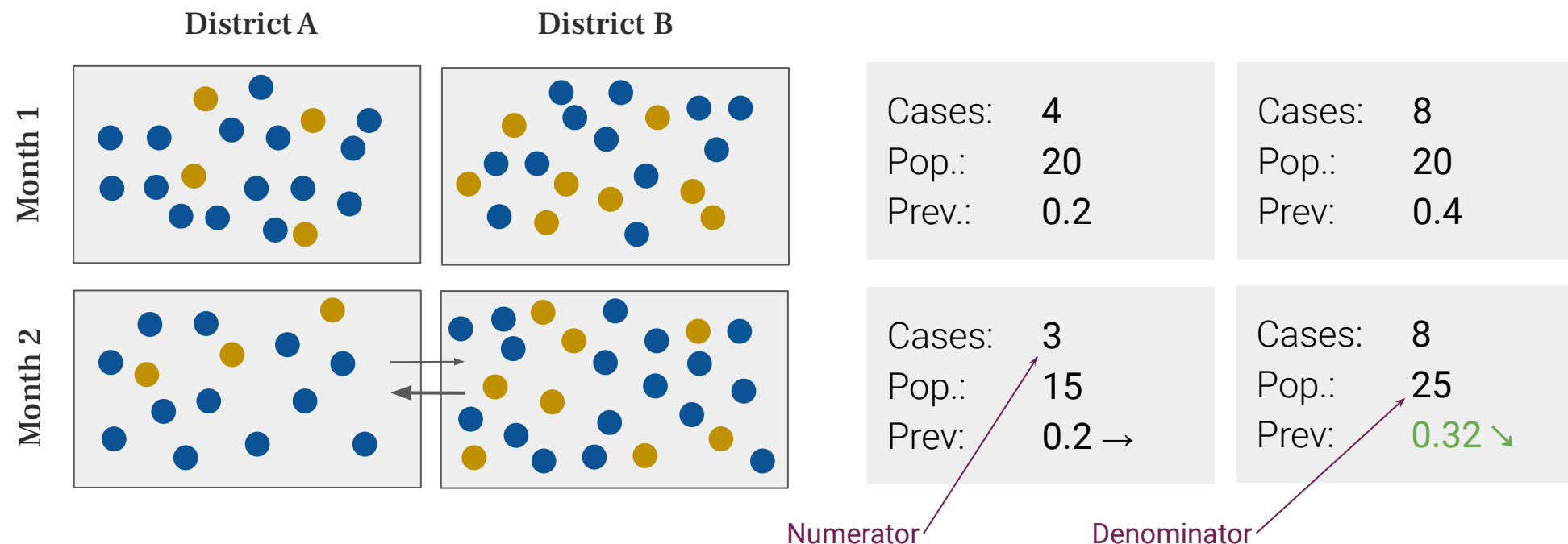
Applications of Dynamic Population Mapping



Applications

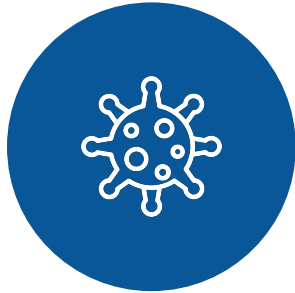
Public health

Mobility data can provide dynamic population density estimates for improved public health metrics



- Mobility data can provide **more frequent estimates of population**, based on detected temporary or permanent relocation of populations.
- Acts as a **“dynamic denominator”** for calculating per capita metrics and indicators

Applications of dynamic population estimates in for public health metrics



Infectious & non-infectious disease

- **Monitoring infectious disease**
 - Incidence
 - Prevalence
- **Estimating population at risk of an outbreak**



Vaccination

- **Monitoring vaccination rates**
 - Where might vaccination rate drop below a threshold?
- **Vaccination campaign planning**
 - How many doses are required in each district?



Infrastructure & resources

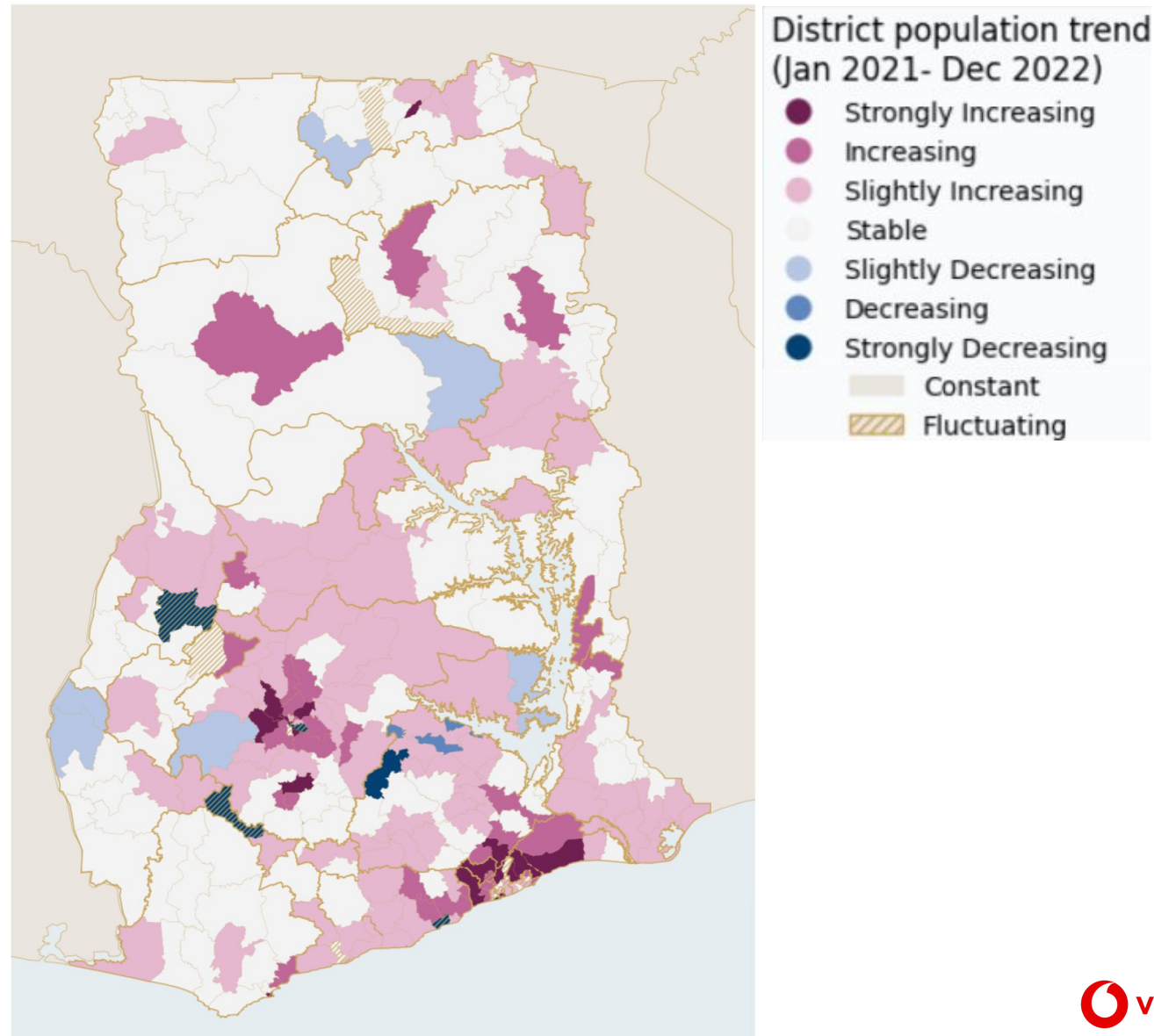
- **Planning new infrastructure**
- **Improving the distribution of resources**
 - Where has demand increased or decreased
 - Does demand fluctuate?

Collaborating with the health sector in Ghana to **identify the needs of decision-makers**

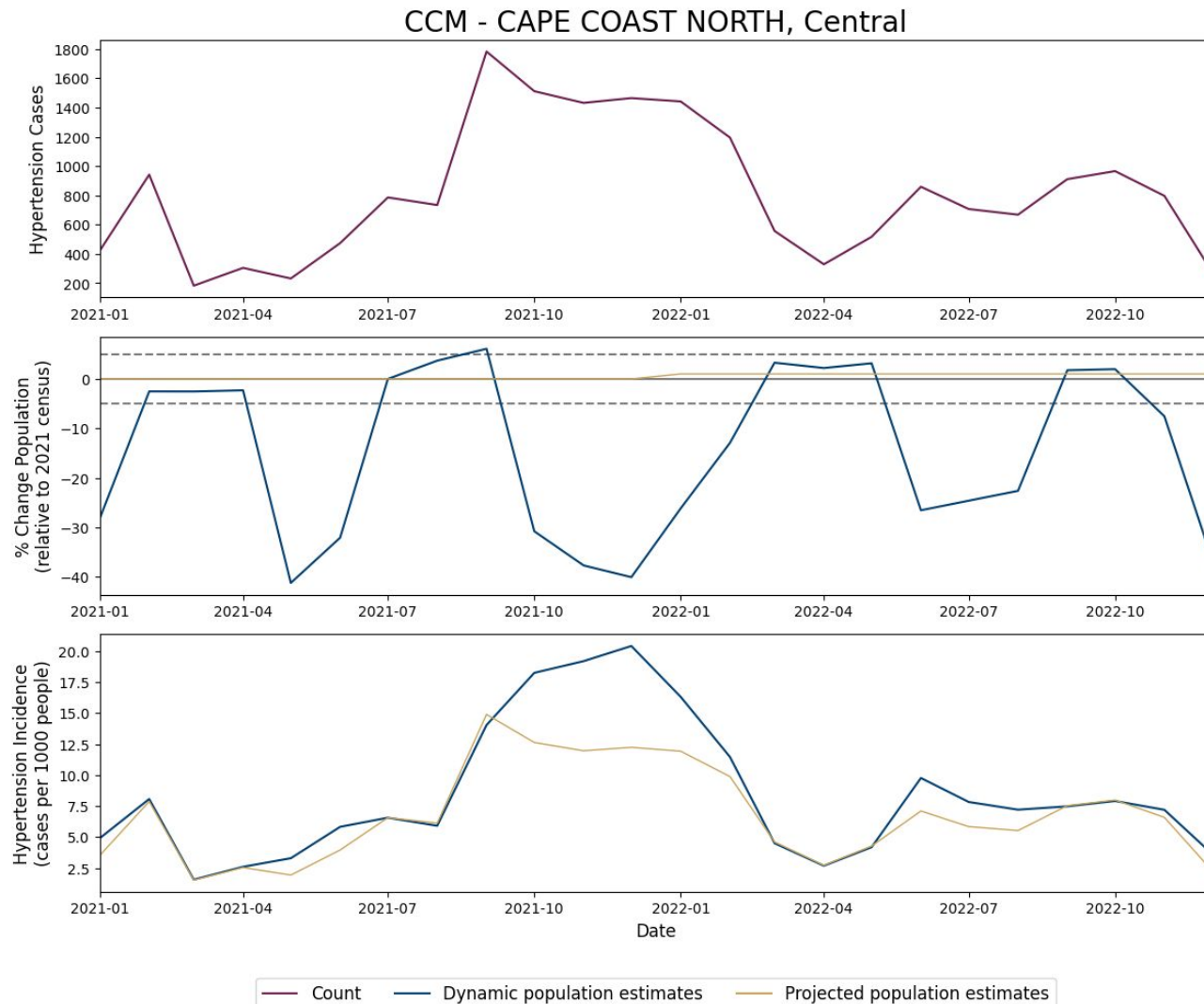
- In June 2023, GSS and Flowminder held a **two-day workshop on the use of mobility data for public health**
 - Attendees from Ghana Health Service (GHS), Ministry of Health and University of Ghana
 - Group discussions on key public health metrics and the impact of mobility data
- **Identified four priority health metrics**, covering different public health issues:
 - Tuberculosis incidence
 - Out-patient department attendance
 - Antenatal care coverage
 - Hypertension incidence



Dynamic Population Mapping | Ghana



Preliminary results: Tuberculosis incidence



Tuberculosis (TB) cases, 2021-2022

% change in the population, 2021-2022, based on CDR-derived dynamic population estimate (blue) and UN population projections (gold)

TB incidence 2021-2022 using CDR-derived dynamic population estimate (blue), compared to a UN population projections (gold)

Preliminary results: Tuberculosis incidence

OBUASI EAST, Ashanti



— Count — Dynamic population estimates — Projected population estimates

Outpatient Department (OPD) visits, 2021-2022

% change in the population, 2021-2022, based on CDR-derived dynamic population estimate (blue) and UN population projections (gold)

OPD attendance 2021-2022 using CDR-derived dynamic population estimate (blue), compared to a UN population projections (gold)

Dynamic Population Mapping | Mapping for Health

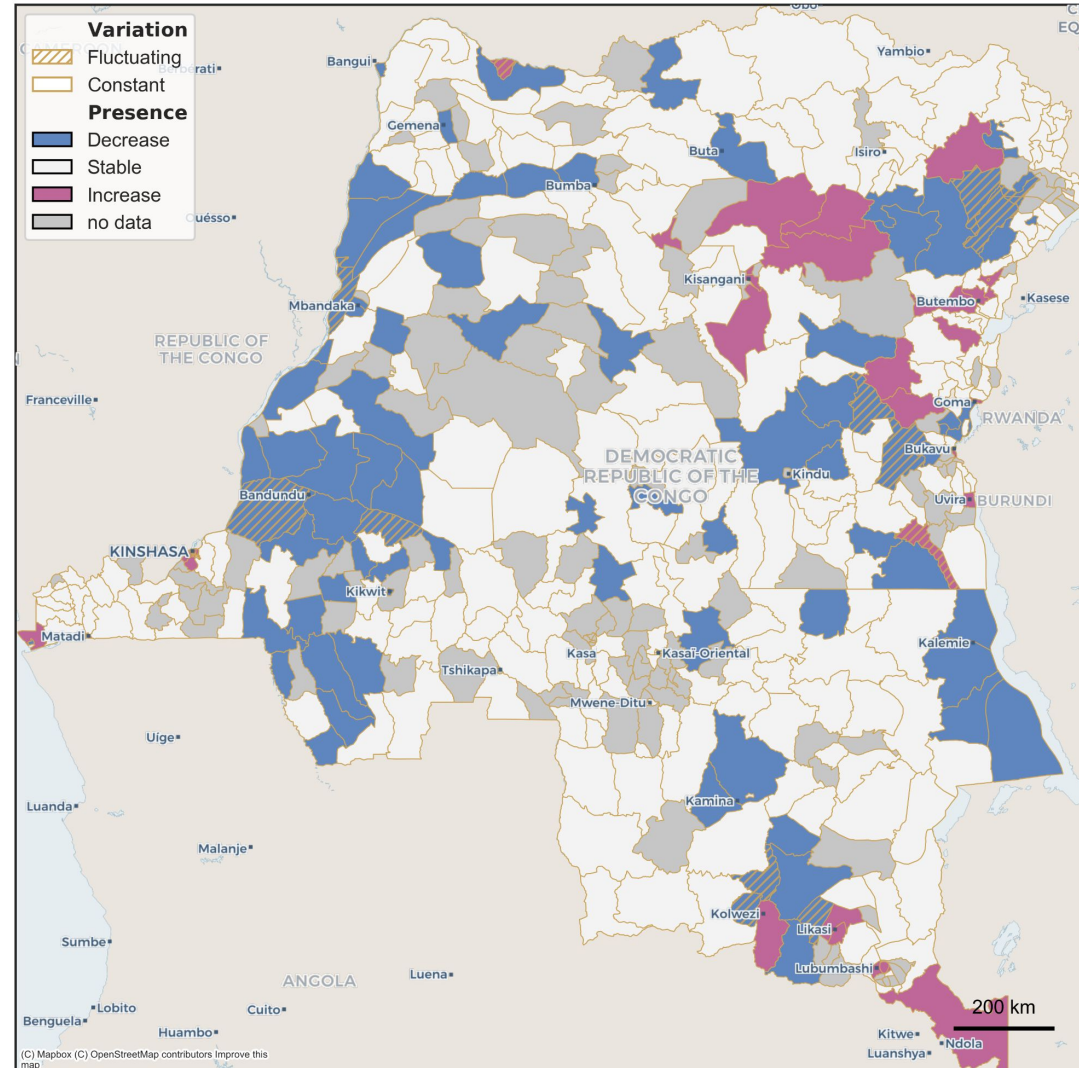


Children with zero doses, insufficient doses and/or ineffective doses (for example due to cold chain deficiencies) are most often located in the most rural or isolated areas, and areas where mobile populations are significant (instability due to insecurity, or informal settlements in urban areas).

Therefore a promising strategy to reach zero-dose and under-vaccinated children is:

1. **To identify areas with high mobility** (using mobile telephone data and field survey data to adjust the representation biases of mobile telephone data)
2. **To establish advanced and mobile vaccination sites in areas far from fixed vaccination centers** (the locations of these sites are proposed by our optimization algorithm to maximize population coverage with a minimum of resources)

Dynamic Population Mapping | Democratic Republic of the Congo



(C) Mapbox (C) OpenStreetMap contributors Improve this map

Mapping for Health | Vaccination

Microplanning

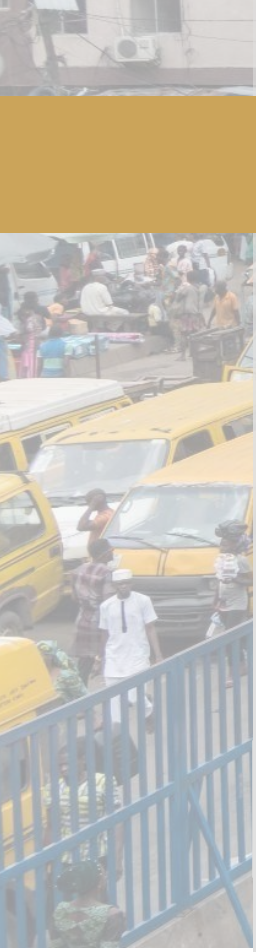
Use of mobility indicators to inform the implementation and planning of vaccination interventions:

1. **Contribution to effective targeting of communities on the move**
2. **Coordination between health zones at the regional level**, including on the **optimisation of the quantities of vaccines available locally** with consideration of the impact of population movements on population density
3. **Explanation of the discrepancies** between the quantities of vaccines distributed and the objectives of the annual plan.
4. **Planning of vaccination objectives by health zone** carried out at the central and regional levels on an annual basis may integrate changes in denominators observed over the long term (> 12 months) by health zone: local increase or decrease in population, or seasonal changes.



Applications

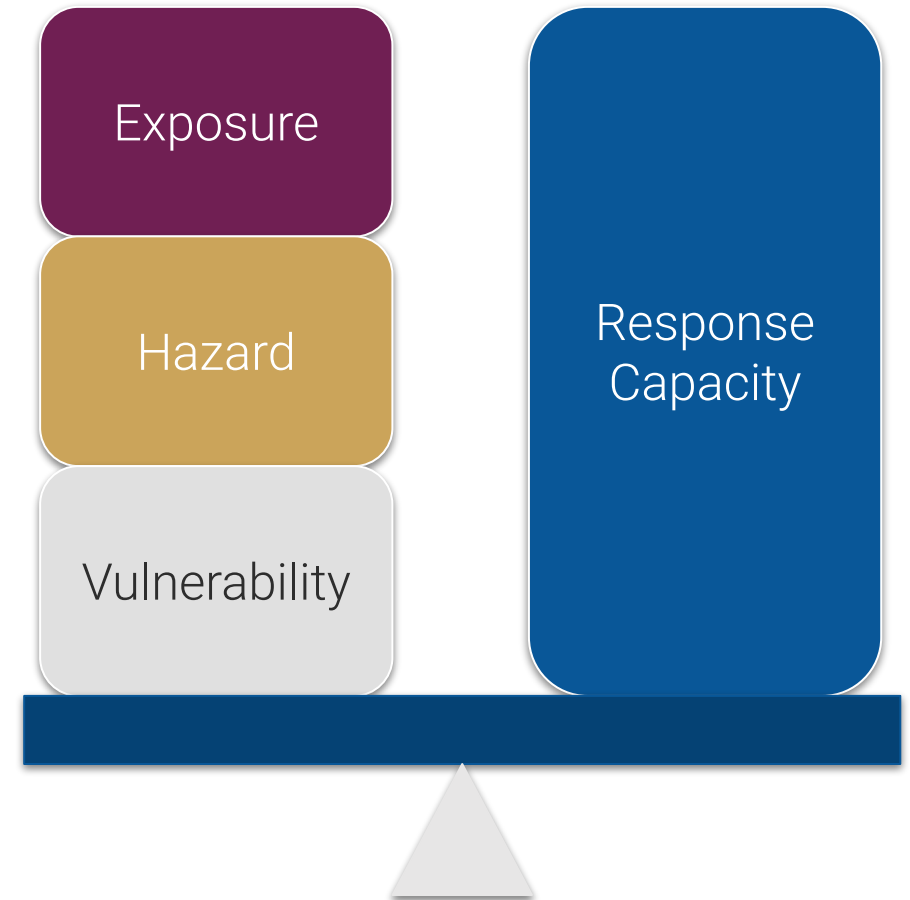
Dynamic risk mapping



Calculating risk hazard

Hazard risk analysis can include a range of **different factors**, including:

- The **probability of an area being impacted** by a given hazard
- The **number of people in an area** who would be exposed to a given hazard
- The **vulnerability of an area** to a given hazard, which may include dimensions such as:
 - *Socio-economic vulnerability*
 - *Presence of vulnerable groups*
- The **capacity for authorities and institutions to respond** to a given hazard



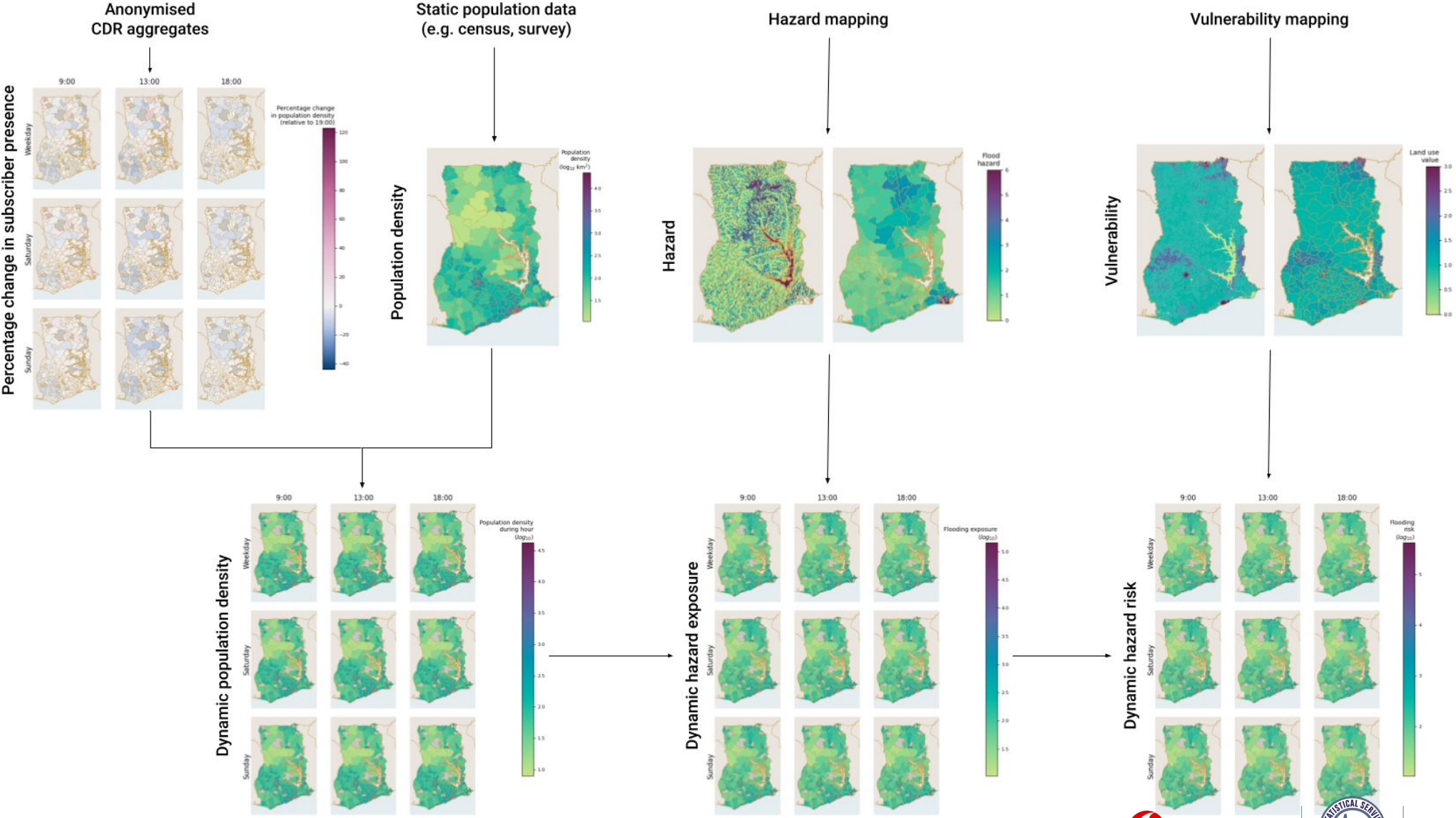
Hazard risk analysis for disaster preparedness in Ghana

- The **National Disaster Management Organisation** (NADMO) is responsible for the management of disasters and other emergencies in Ghana, including:
 - Flooding
 - Fires
 - Drought
 - Storm surges
- **Hazard risk analysis** is an essential part of disaster preparedness:
 - Support the development of suitable response plans for at risk areas
 - Optimise the placement of resources to facilitate emergency responses

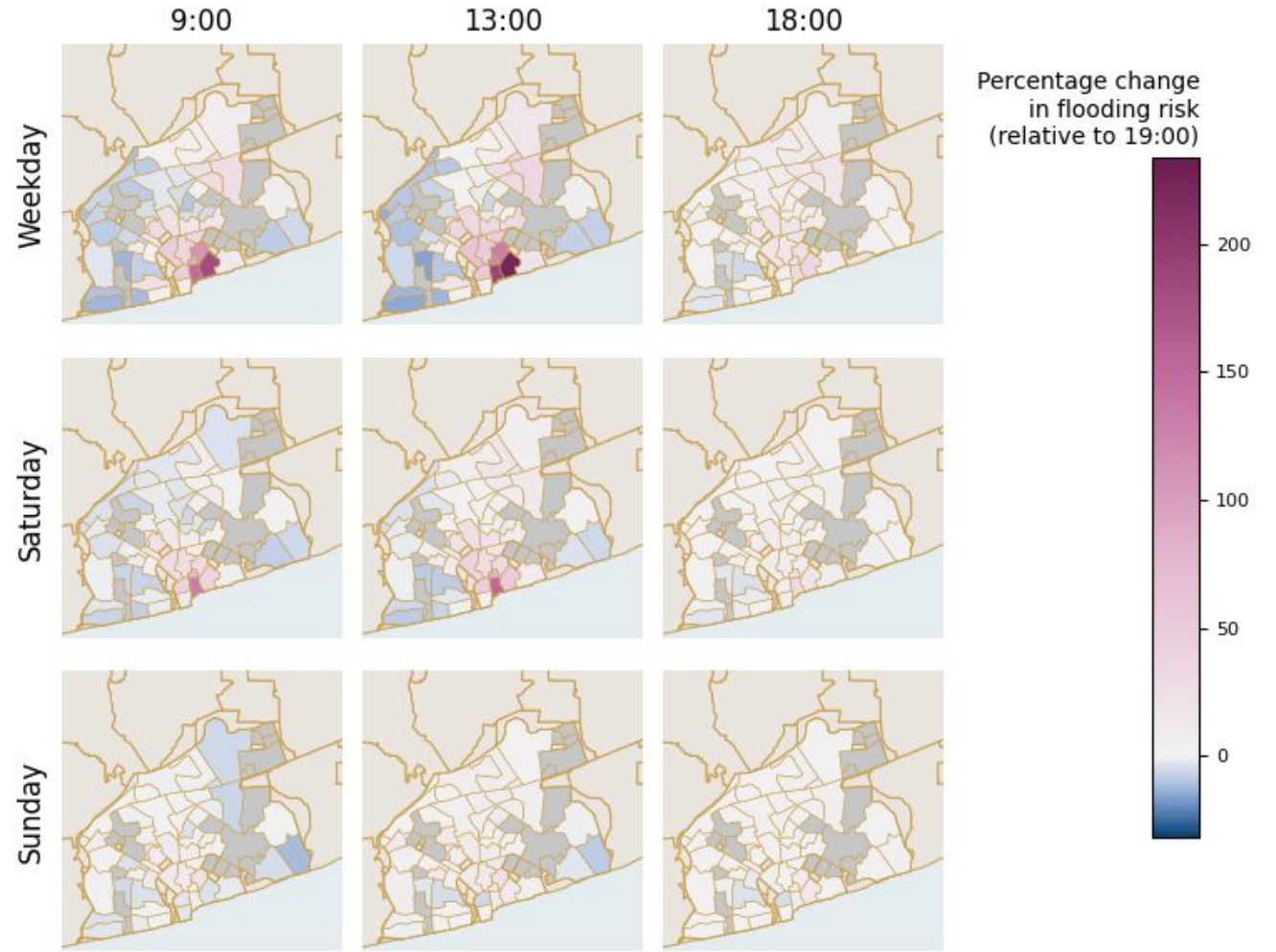
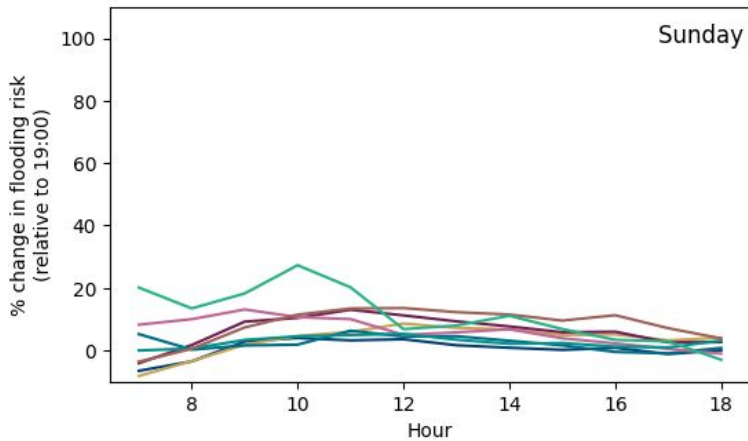
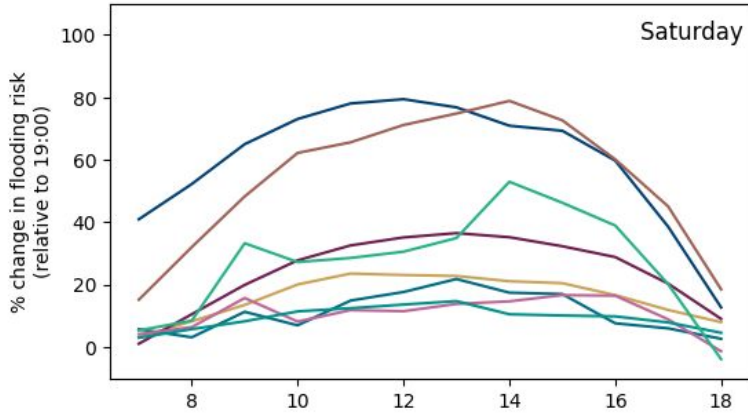
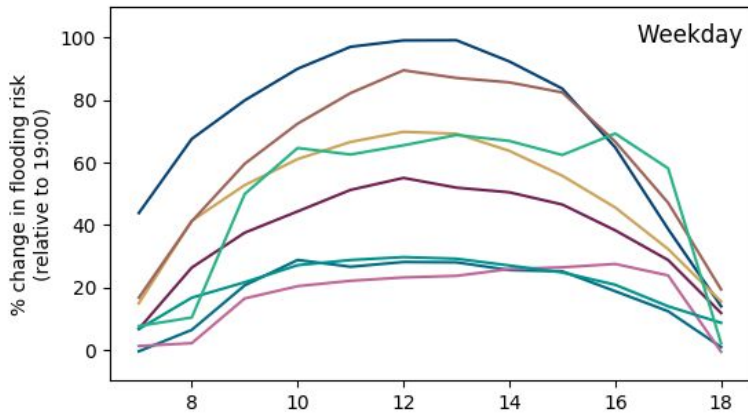


Flowminder & GSS' visit to NADMO

Calculating dynamic risk indicators



Dynamic flooding risk indicators





Thank you | Q&As

Any
questions?

Learning Hub

UN Global Platform Learning Management System

Supporting a series of e-learning courses on various statistical and Big Data topics

Available through the UN Global Platform LMS
(learning.officialstatistics.org)



BADAN PUSAT STATISTIK

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FlowGeek

- **FlowGeek is our open, online knowledge centre on CDR analytics**
 - created to **leverage the value** of CDR data and help **strengthen the community** of CDR data experts, enthusiasts and learners on the processing and analysis of such data.
- **Our content includes**
 - What are CDR data?
 - Applications of CDR data
 - Types of CDR indicators
 - Analyses and methodologies
 - Data governance and security



Each record contains the type of network event and the subscriber's identifier, as well as the time of the event and the cell site it was routed through.

The MNO stores these records in a database and may connect them with other information on the subscriber and their account, to inform their billing process. **These data can be analysed to better understand how people move within a country.**

Mobile phone metadata: CDRs

| MNO_ID | MNO_COUNTERPART | CELL_ID | REGION | EVENT_TYPE | TIMESTAMP |
|-----------------|-----------------|-----------|---------|------------|---------------------|
| AA204Y1542DCA00 | VENY782AD945G2E | 451154211 | north | voice | 2016-10-10 15:35:25 |
| AA204Y1542DCA01 | ORBE728A008E51 | 451354312 | north | voice | 2016-10-10 20:03:45 |
| AA204Y1542DCA02 | ETB47088A8158C | 451354312 | north | voice | 2016-10-10 21:21:56 |
| AA204Y1542DCA03 | | | north | voice | 2016-10-10 21:59:32 |
| AA204Y1542DCA04 | | | central | voice | 2016-10-10 22:42:23 |
| 845QW45CARVA5 | RY2Y28A0V28E350 | 476126941 | south | ana | 2016-10-10 08:13:21 |
| 845QW45CARVA6 | ET09428CVAR836L | 476126941 | south | ana | 2016-10-10 08:14:15 |
| 845QW45CARVA7 | ET09428CVAR836L | 476126941 | south | ana | 2016-10-10 08:14:59 |
| 845QW45CARVA8 | RY2Y28A0V28E350 | 476126941 | south | ana | 2016-10-10 12:41:01 |
| 845QW45CARVA9 | RY2Y28A0V28E350 | 476126941 | south | ana | 2016-10-10 13:10:45 |
| 845QW45CARVA10 | RY2Y28A0V28E350 | 476126941 | south | ana | 2016-10-10 15:20:43 |
| 845QW45CARVA11 | P8A13080821 | | south | voice | 2016-10-10 18:09:32 |
| 845QW45CARVA12 | RY2Y28A0V28E350 | 413579554 | south | voice | 2016-10-10 18:09:32 |
| 845QW45CARVA13 | DOB42V987T0G18E | 413579554 | south | ana | 2016-10-10 20:12:29 |
| 845QW45CARVA14 | DOB42V987T0G18E | 413579554 | south | ana | 2016-10-10 21:18:00 |
| CEW9268R438EP2 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 09:01:10 |
| CEW9268R438EP3 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP4 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP5 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP6 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP7 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP8 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP9 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP10 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP11 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP12 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP13 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP14 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
| CEW9268R438EP15 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |
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| CEW9268R438EP20 | ETB47088A8158C | 486201212 | central | voice | 2016-10-10 21:59:20 |

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