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## Producing mobility and population statistics from call detail records in low- and middle-income countries

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Conference of European Statistical Stakeholders

Flowminder Foundation
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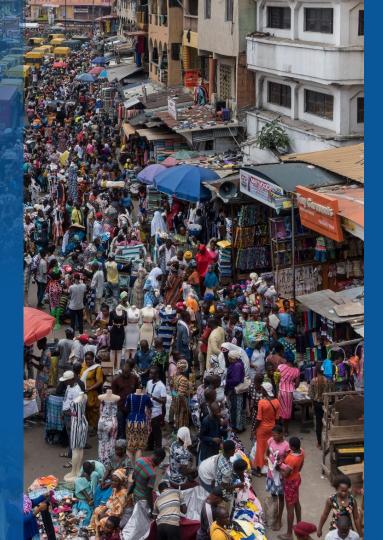Photo credit: ECHO, Susana Perez Diaz, Flickr

**Purpose**
Supporting humanitarian & development decision making

JIPS — informing solutions to internal displacement

GSMA

Hewlett Foundation

IDB — Inter-American Development Bank

Gavi — The Vaccine Alliance

dial — Digital Impact Alliance

IOM — UN MIGRATION

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Department of Foreign Affairs FDFA
State Secretariat STS-FDFA
Peace and Human Rights

**Our supporters**
Non-profit funded by key actors in humanitarian & development aid

**Our work**
Providing statistics and analyses in data-scarce contexts in LMICs

ARTICLES

Past and future spread of th
Aedes aegypti and Aedes alb

The New York Times

Le Monde

CrossMark

edictability of population displacement after th
rthquake

npg nature publishing group

Abstract

nat

Response to Disasters and Outbreaks
Movements with Mobile Pho
A Post-Earthquake Geospatial Stud

**Innovate**
Data science research
**Implement**
Data systems in LMICs
**Influence**
Data-driven decisions

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# Call Detail Records (CDRs) in low- and middle-income countries

# Call Detail Records (CDRs) | Subset example

| MSISDN | MSISDN_COUNTERPART | CELL_ID | EVENT_TYPE | TIMESTAMP |
|---|---|---|---|---|
| AA204V1542DCA00 | VEWV782AS945GJE | 451154211 | voice | 2016-10-10 15:35:25 |
| AA204V1542DCA00 | GNBE72BEA00HE51 | 451354312 | voice | 2016-10-10 20:03:45 |
| AA204 | 04EC | 451354312 | voice | 2016-10-10 21:21:56 |
| AA204V1 | 6220 | 451354312 | voice | 2016-10-10 21:59:32 |
| AA204V15 | 5GJE | 452616792 | voice | 2016-10-10 22:42:23 |
| B45QHV45CAEVA5 | ETG942BCVAEH36L | 476126941 | sms | 2016-10-10 08:13:21 |
| B45QHV45CAEVA5 | ETG942BCVAEH36L | 476126941 | sms | 2016-10-10 08:14:15 |
| B45QHV45CAEVA5 | ETG942BCVAEH36L | 476126941 | sms | 2016-10-10 08:14:59 |
| B45QHV45CAEVA5 | RBY25BA | sms | 2016-10-10 12:41:01 |
| B45QHV45CAEVA5 | RBY25BAC9 | sms | 2016-10-10 13:10:45 |
| B45QHV45CAEVA11 | EVG365BCA | sms | 2016-10-10 15:20:43 |
| B45QHV45CAEVA11 | PRA19HXME36P64B | 413579554 | voice | 2016-10-10 18:08:32 |
| B45QHV45CAEVA11 | RVC830RMC29EBB7 | 413579554 | voice | 2016-10-10 18:54:39 |
| B45QHV45CAEVA11 | DOB402VRM70GIBE | 413579554 | sms | 2016-10-10 20:53:32 |
| B45QHV45CAEVA11 | DOB402VRM70GIBE | 413579554 | sms | 2016-10-10 21:21:51 |
| CZW926NRV43WEP4 | EBI69BCA033KKK6 | 4862 511 | voice | 2016-10-10 09:01:10 |
| CZW926NRV43WEP4 | EBG663JJEB234PM | 492500 1 | | 2016-10-10 21:58:20 |
| CZW926NRV43WEP4 | TTBE206B67FDWUT | 42059423 | | 2016-10-10 12:01:29 |
| CZW926NRV43WEP4 | TTBE206B67FDWUT | 42059423 | voice | 2016-10-10 15:46:18 |
| DBT396BCW22YTVR | CRQB506BHCLR38Y | 455193201 | sms | 2016-10-10 16:28:28 |

**Anonymised caller ID (phone number)**

**Anonymised receiver ID (phone number)**

**Date and time of call**

**ID of network cell tower**

One row corresponds to one event.

A CDR dataset for one country will often have billions of events.

|       | Mon | Tue | Wed | Thur | Fri | Sat | Sun |
|-------|-----|-----|-----|------|-----|-----|-----|
| Person X | A | ? | ? | ? | A | ? | ? |

Phones are not necessarily used everyday.

The exact location of the phone is **different** from that of the cell tower.



······▶ Subscriber movements ● Network events ——▶ Observed trajectory

**Subscribers' location and mobility need to be approximated from mobile phone usage data (Call Detail Records, CDRs)**

Number of active cells

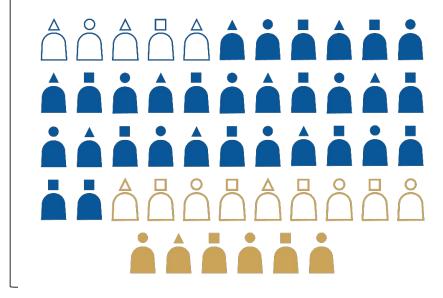Event of interest (earthquake, conflict)

Data loss

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# Mobility estimated from CDRs is different from the mobility of the general population



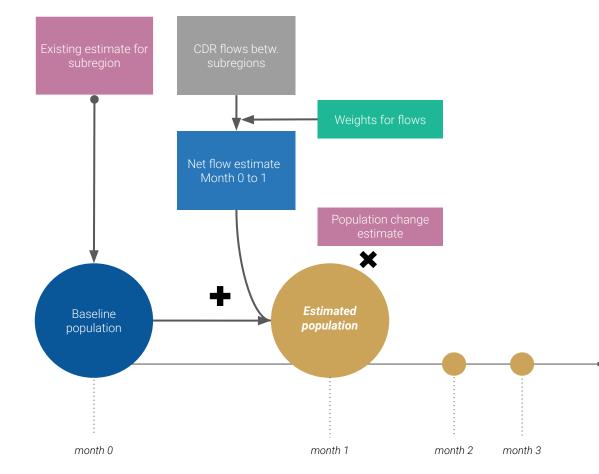National population

**Legend:**
- ○ No mobile subscription
- ● Subscribers to other mobile network operators (MNOs)
- ○ "Inactive" subscribers of participating MNO
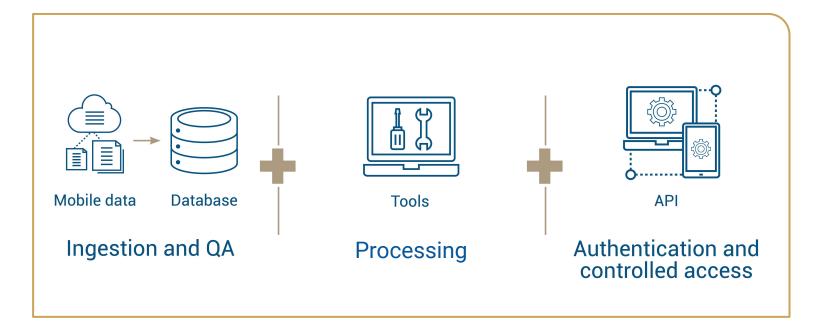- ● **"Active" subscribers of participating MNO**

**Flowminder collects primary survey data** on mobility, phone use and demographics, and has developed a weighting methodology: to **adjust for representation biases** in the CDRs and to **scale estimates to the general population**.

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# Method for monthly residents' estimates



Existing estimate for subregion

CDR flows betw. subregions

Weights for flows

Net flow estimate Month 0 to 1

Population change estimate

✖

Baseline population

➕

*Estimated population*

month 0      month 1      month 2      month 3

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# FlowKit components



Mobile data    Database

Ingestion and QA

Tools

Processing

API
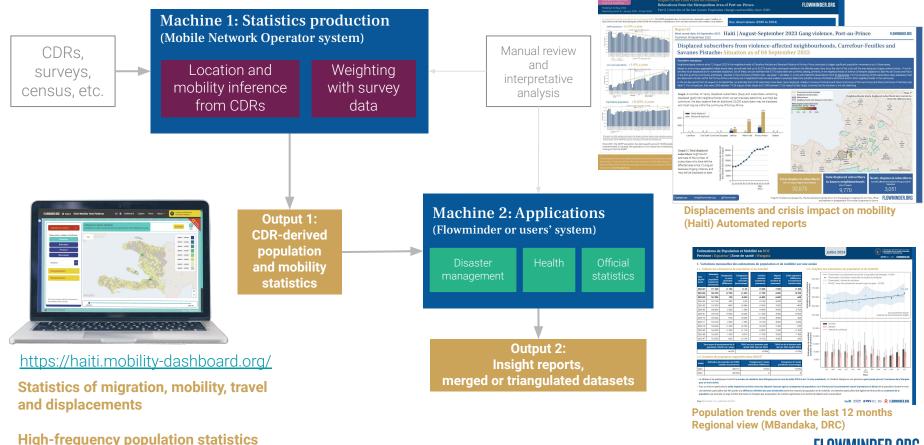
Authentication and controlled access

# From CDRs to population and mobility statistics, insights and applications

CDRs, surveys, census, etc.

## Machine 1: Statistics production
(Mobile Network Operator system)

Location and mobility inference from CDRs

Weighting with survey data

Manual review and interpretative analysis


Displacements and crisis impact on mobility (Haiti) Automated reports

Output 1:
CDR-derived population and mobility statistics

## Machine 2: Applications
(Flowminder or users' system)

Disaster management

Health

Official statistics

Output 2:
Insight reports, merged or triangulated datasets


Population trends over the last 12 months Regional view (MBandaka, DRC)

https://haiti.mobility-dashboard.org/

**Statistics of migration, mobility, travel and displacements**

**High-frequency population statistics (daily, weekly, monthly)**

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Working with CDRs

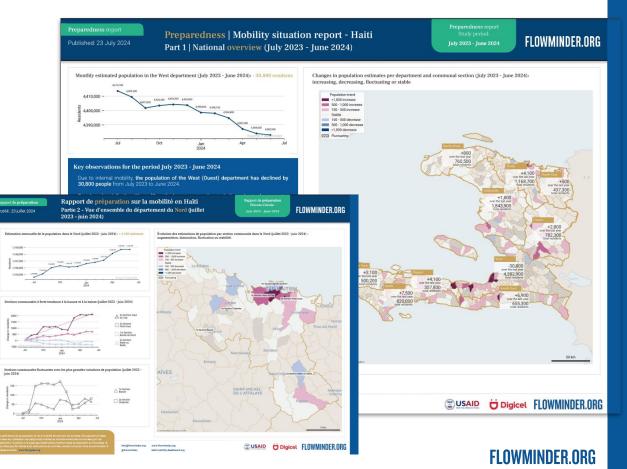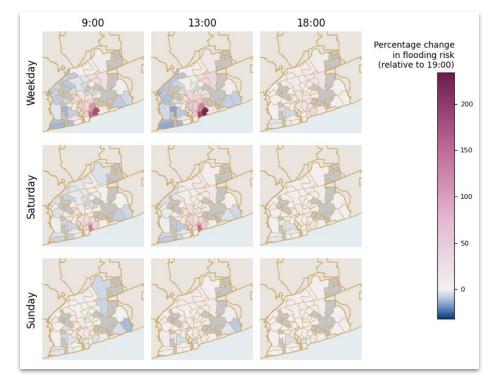# Reporting & dissemination; applications & use cases

# Disaster preparedness: humanitarian need assessment

- **Haiti**: Publication of preparedness reports on population trends

- UNFPA used FM estimates to cross-reference their latest Common Operational Dataset



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# Disaster preparedness: Risk mapping

- **Ghana**: Providing the National Disaster Management Organisation (NADMO) with dynamic flood risk maps
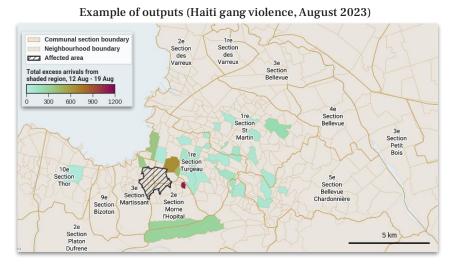


> **"Using mobility from GSS & Flowminder, we are able to get the estimated number of people on the ground at a particular time during the day, the week, or even the season of the year, to help us in preparedness and response planning.**

— Kelly Kekely Degboe, Head of ICT & EOC, Ghana's National Disaster Management Organization (NADMO)

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# Displacement statistics

- **Haiti**: Publication (and automation) of information reports on displacements following gang violence and natural hazards [reported interest and usage]
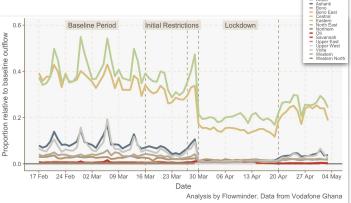
Example of outputs (Haiti gang violence, August 2023)



- **DRC**: To be used by GiveDirectly for Cash Transfer targeting [solution under testing]

> "This analysis gives us an indication of where to **prioritise our DTM field assessments and surveys** to deepen our understanding of the profiles and needs of displaced people and others on the move. [...] **We have therefore launched in-depth DTM assessments in this area** in order to obtain more information about the displacement situation there.
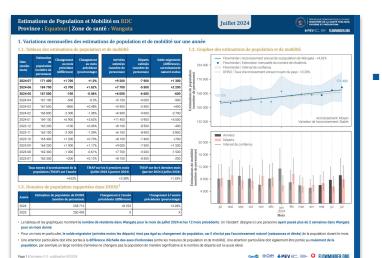
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— Yakin Mwanza, Data and Research Unit Coordinator at IOM-DTM, Data Management Unit - In response to Flowminder's Haiti gang violence displacement reports, August-October 2023 *(translated from French)*

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# Planning health interventions

- **Ghana**: Reports on the impact on mobility of Covid19 restrictions were used for decision making



Analysis by Flowminder. Data from Vodafone Ghana



- **DRC**: Information reports on analysis of population statistics for the Ministry of Health to review immunisation planning every month

> **"By looking at how the number of active users changed, we could see how effective lockdowns were in restricting people's movement. This was vital in telling us when to lift and when to renew measures.**

— Mahamudu Bawumia, *Vice-President of Ghana* in The Guardian

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# Data Sharing | Haiti Mobility Data Platform (haiti.mobility-dashboard.org)



**Concepts and definitions to support users' understanding of the data**

- Simplified definitions
- Detailed definitions & redirects to FlowGeek.org

**20+ indicators available under four main categories:**

- Residents (8)
- Relocation (4)
- Presence (7)
- Movement (4)

**Different resolutions**

- Temporal
- Spatial

**Controlled user access & account management**

- Controlled user access
- Thorough registration process
- Easy-to-use account management

**Possibility to choose preferred visualisation**

- Map
- Graph
- Chart

**Two download options**

- Download all
- Download selected

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# Achievements …

- Methodological solutions for the challenges posed by CDRs in LMICs
- Automated live data pipeline in three countries: CDRs → mobility and population estimates
- Use of estimates by development and humanitarian actors, government agencies

# … and next steps

- Triangulation with more data sources (survey, app data, imagery)
- Development of further use cases (disaster management, transport, health, official statistics)
- Higher-frequency and -resolution indicators
- Regular surveys for updating weights
- Porting system/pipeline to other countries
- Onboarding additional mobile network operators

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