Estimating population mobility from mobile phone usage data

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Science & Innovation
Solid academic research. 50+ peer reviewed publications

Our team & work
38 staff to enable data driven decision support for LMICs

Backstory
2010 Haiti Earthquake & cholera epidemic

Our supporters
Non-profit funded by & supporting key actors

Some of our supporters:

JIPS
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The New York Times
Le Monde
Nature Publishing Group
Le Monde
The Wall Street Journal
FlowMinder.org
Flowminder MNO collaborations to date

Countries where Flowminder has collaboration 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
- Western African country (in discussion)
CDRs can provide near-real time estimates of population movements & changes in population density
Addressing potential sampling biases

Additional data on demographics, phone use and mobility from field and phone surveys can help to address biases and therefore to get the most out of CDR data.
Ensuring privacy and transparency

Key principles

- GDPR compliance throughout
- Transparency and peer review:
  - Detailed and open method descriptions
  - Open algorithms
  - Publications in peer-reviewed academic journals

CDR-derived insights should **never** permit the **identification** of individual subscribers.
A broad range of mobility indicators can be derived from CDRs

- Subscriber presence
- Home locations
- Crowdedness
- Population mixing
- Intra-regional travel
- Inter-regional travel
- Locations of interest
- Trajectories and mobility patterns

Other indicators: social connectivity, mobile phone usage and top-up expenses…
CDR data applications

Population dynamics:
The building blocks for applications
Mapping changes in population density

Day/Night cycle

Locations of phone users during the day
Mapping changes in population density

Day/Night cycle

Locations of phone users at night
Mapping changes in population density

Seasonal variation
Mapping monthly migration flows
Seasonal variation

Migration flows from March 2020 to February 2021 in the DRC
Mapping travel flows

**Routine** flows highlight the catchment areas of larger cities and towns, with Port-au-Prince catchment being the largest.
Analysing mobility disruption during a crisis

Mobility restrictions reduced the number of places visited during the day.

..but triggered a shift of population distribution from urban to rural areas (similar to changes occurring during the Christmas period)
Analysing change in mobility patterns post-crisis

Migration top percentile netflows in Haiti - Before, during and after COVID-related mobility restrictions in 2020

Post COVID-19 restrictions, people appear to relocate more often and at further distances, with dissimilar patterns to those observed at baseline.

Further work on COVID-19 recovery starting in Papua New Guinea, possible in other countries such as Haiti
Using mobile phone data as a proxy for employment or socio-economic status

Examples of metadata used for subscribers profiling

<table>
<thead>
<tr>
<th>Financial</th>
<th>Airtime purchases: Recharge amount per transaction, Spending speed, fraction of lowest/highest recharge amount, coefficient of variation recharge amount etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Revenue: Charge of outgoing/incoming SMS, MMS, voice, video, value added services, roaming, internet etc.</td>
</tr>
<tr>
<td></td>
<td>Handset: Manufacturer, brand, camera enabled, smart/feature/basic phone etc.</td>
</tr>
<tr>
<td>Mobility</td>
<td>Home district/tower, radius of gyration, entropy of places, number of places visited etc.</td>
</tr>
<tr>
<td>Social</td>
<td>Social Network: Interaction per contact, degree, entropy of contacts etc.</td>
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<tr>
<td></td>
<td>General phone usage: Out/In voice duration, SMS count, Internet volume/count, MMS count, video count/duration, value-added services duration/count etc.</td>
</tr>
</tbody>
</table>

Adapted from Sundsøy P. et al. (2017) Towards Real-Time Prediction of Unemployment and Profession. https://doi.org/10.1007/978-3-319-67256-4_2

Similar approaches to be used in Papua New Guinea and Ghana for wealth and poverty mapping