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Privacy-conscious data analytics to support the COVID-19 response in Haiti

Report 2, June 2020

Flowminder Foundation
James Harrison | Michael Harper | Jonathan Gray | Véronique Lefebvre

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Flowminder

Our Mission: Enabling decision makers to access the data they need to transform the lives of vulnerable people at scale

- Non-profit organisation
- Supporting mobile operators and governments to produce and use insights from mobile operator data to improve development and humanitarian decision-making
- Pioneered the analysis of mobile network data to support responses to infectious disease outbreaks and natural disasters
- Funded by Bill & Melinda Gates Foundation, DFID, DIAL, Hewlett Foundation, and others

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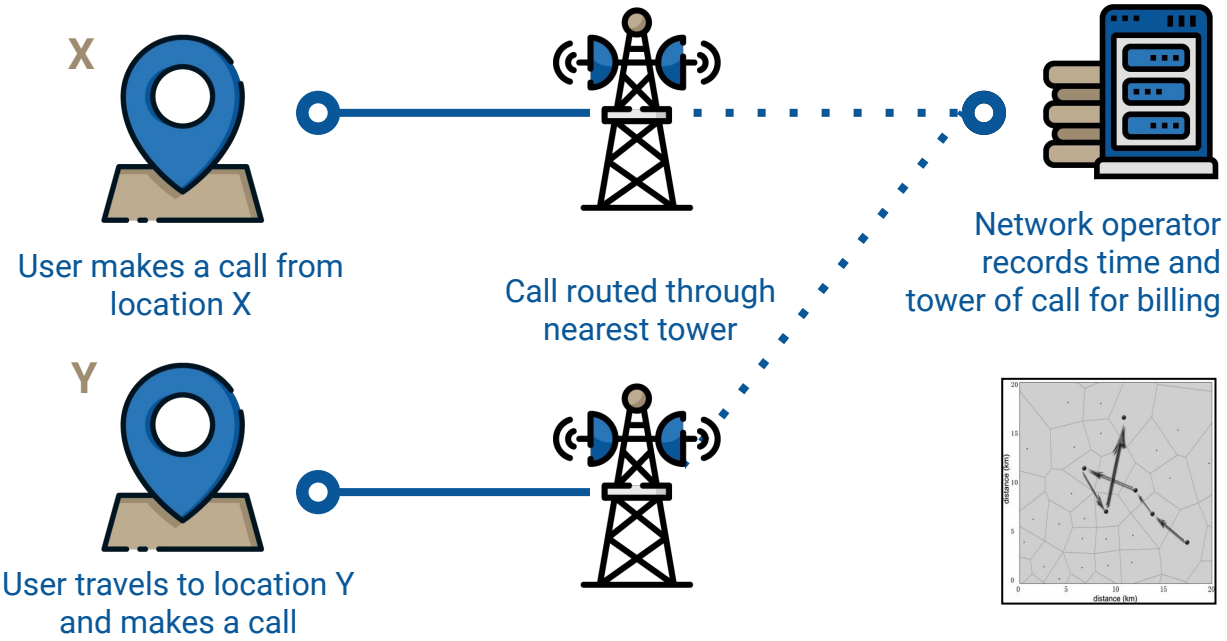
Call Detail Records (CDR)

- Base stations/towers with multiple cells
- Mobile Network Operators maintain a database of call detail records (CDR) for billing purposes
- Generated each time a mobile phone subscriber makes or receives a call, sends or receives a SMS, or uses mobile data



The New York Times

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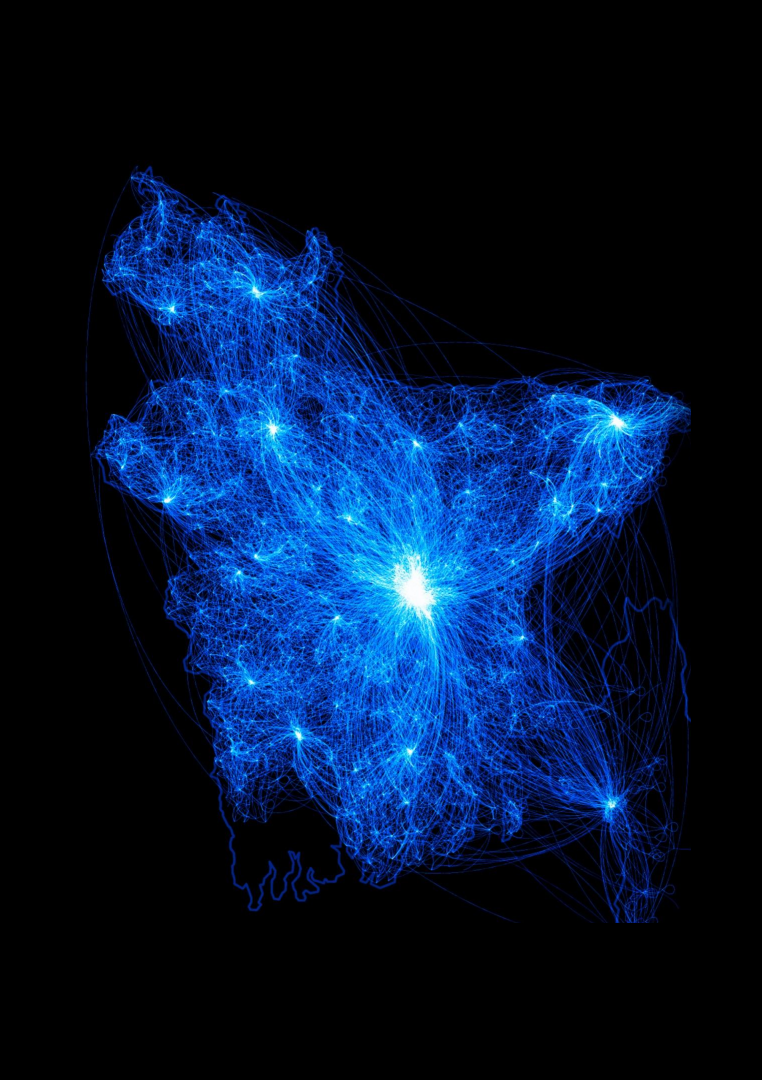

Benefits of using CDRs

- The data are automatically generated.
- The dataset contains billions of data points from millions of people – large geographic and time scales covered.
- There is a continuous stream of data – near real-time.

In the context of COVID-19

- Production of mobility indicators to monitor and plan interventions to respond to the outbreak

Supporting the COVID response in Haiti

Use cases for mobile phone usage data

Effectiveness of mobility restriction and social distancing measures

Monitoring the side effects of measures

Planning interventions and assess risk levels

Allocating health resources based on changes in population primary location

Input to other models and analyses (disease spread modelling)

Digicel Haiti provides access to its Call Detail Records to Flowminder for analysis.

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Supporting while ensuring no harm
Flowminder key principles:

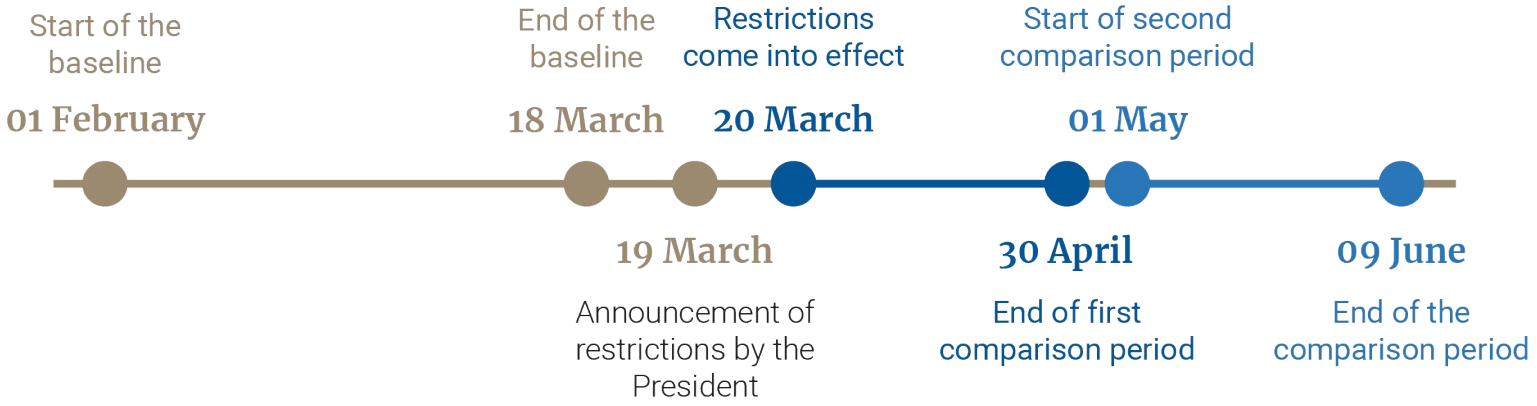
- Individual subscriber CDR data stay with the operator
- CDR-derived insights should never permit the identification of individual subscribers
- Provide methods and detailed description of results to avoid misunderstandings
- For COVID-19: Clarify both the effect of COVID-19 measures relating to the epidemic, and its harmful impact on the economy and livelihoods of vulnerable people

Report 2 | Study period:

The state of emergency and social distancing measures (closure of airports, borders, schools, universities, places of worship and factories, curfew and ban on gatherings) were announced on 19 March and came into effect on 20 March.

We chose to use CDRs from 01 February to compare mobility patterns before and after the start of the measures.

For this second report, we looked at changes in mobility in a first period from 20 March to 30 April, and then in a second period from 01 May and up to 09 June.



Baseline period used for analysis: 01 February - 18 March inclusive
Comparison periods used for analysis: 20 March - 30 April and 01 May - 09 June

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Photo credit: Bruno Le Bansais, Wikimedia

Report 2 | Key takeaways:

Reduction in countrywide mobility:

- Overall mobility on working days was reduced by 10% following the introduction of COVID-19 measures (20 March), and is equivalent to the mobility level observed on Sundays before the measures were implemented
- The number of phone users travelling between cities was reduced by 30%

Fewer phone users in city centres, but more in rural areas:

- City centres and town centres (commercial districts), busy roadside locations and border points all saw a sharp reduction in the number of visitors (~ -20%) following the introduction of COVID-19 measures
- On the contrary, villages, rural areas and residential areas surrounding cities and towns generally saw an increase in visitor numbers on average (+10%)

➜ Decreases in phone users presence in commercial districts and increases in residential areas, observed on daily basis, are likely to reflect a reduction in visits to workplaces

- Changes in phone user presence started immediately on the introduction of COVID-19 measures and persisted throughout our study period (up to June 9), with no relaxation overall

➜ COVID-19 measures appear to have a large and countrywide ongoing effect of reducing mobility, as well as a likely negative impact on the economy

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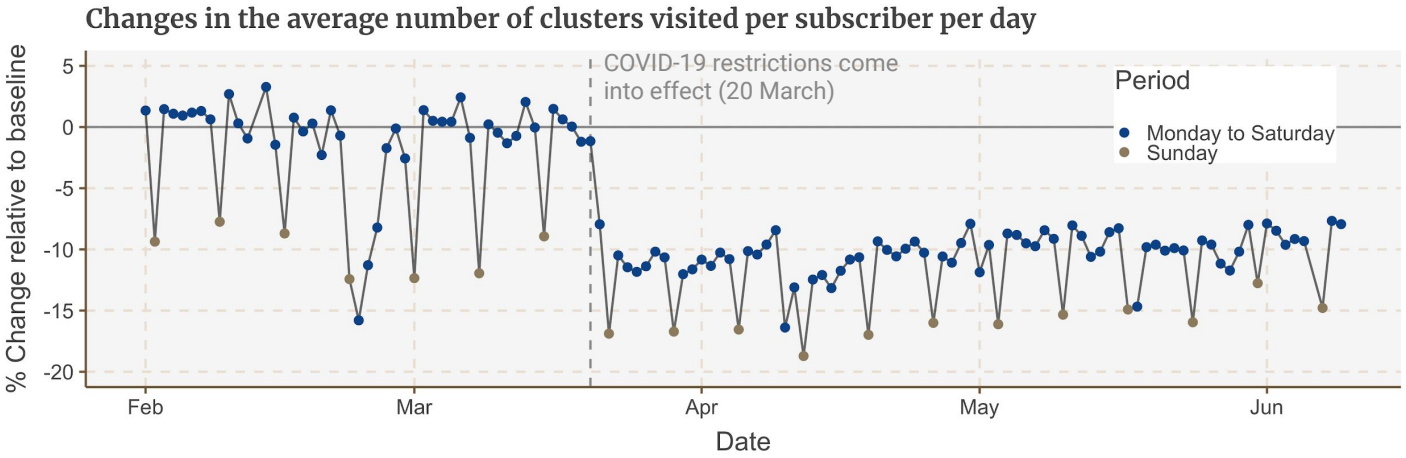
Report 2 | Contents:

Reduction in overall mobility



The graph shows the change in the average number of clusters of cell towers visited per active phone user in the country for each day.

Clusters cover areas of approximately 500 m radius in dense urban settings to 3 km radius in rural settings, we refer to these as 'localities'.

- Since COVID-19 restrictions started, the average number of localities visited per user on working days is stable, and significantly lower than its value before mobility restrictions (-10%), indicating that phone users on average have reduced their mobility.
- In comparison, mobility is similarly reduced on every Sunday by -8% to -12% (before the COVID-19 measures), and on non-working days or days when special events occur: Monday 24 to Wednesday 26 February (Mardi Gras carnival, canceled due to violence, -15% to -8%), Friday 10 to Sunday 12 April (Easter weekend, -15 to -17%), Friday 1st May (Fête du Travail, -12%), Monday 18 May (Fête du Drapeau, -15%).
- These events explain the departures from the stable Mon-Sat/Sundays pattern otherwise seen in the graph, and allow to put the disruption created by COVID-19 restrictions into perspective: Mobility on working days after the restrictions is similar to that of a Sunday before the restrictions.

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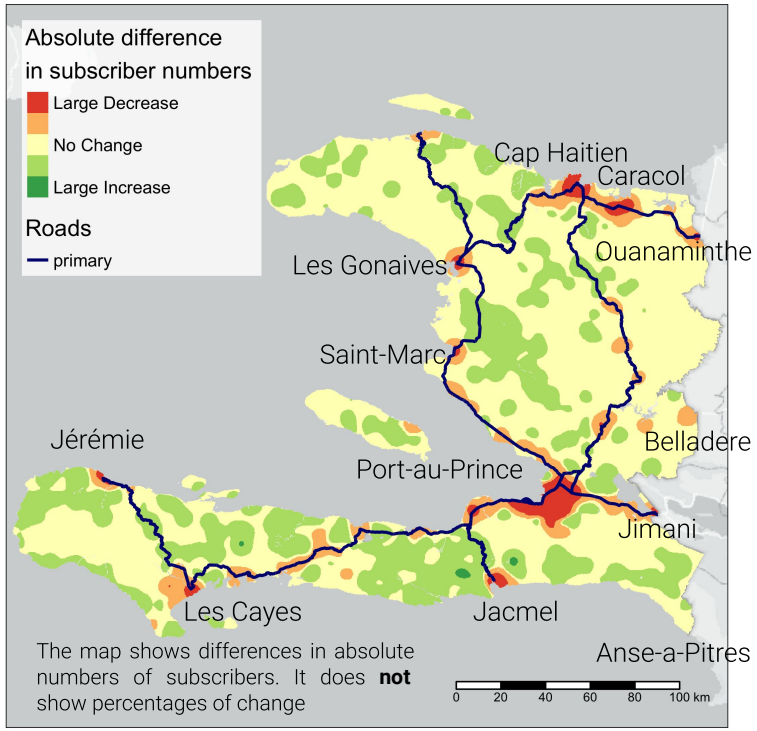
Changes in visitor numbers: period 1

From 20 March to 30 April

The map shows the difference in the median number of phone users active each day, between the baseline period and the first comparison period after COVID-19 restrictions (20 March to the end of April). Differences in presence of phone users are computed for each cluster of cell towers (termed 'locality'), and averaged within a 3km radius. Numbers of subscribers cannot be given so differences have been turned into discrete categories from 'large decrease' to 'large increase'.

Key observations:

- Large decreases in the number of phone users visiting cities and towns (corresponding to -20 to -40% decrease as a proportion of baseline subscriber presence), and Caracol Industrial Park (-50%)
- Decreases near border points and along the roads to the borders (for Ouanaminthe, Belladere and near Jimani, but no reduction is observed for Anse-a-Pitre), and reductions along most main roads
- Increases are seen in many rural localities throughout the country, with a small number of additional phone users active within each of these localities (corresponding to +20% on average), and larger increases in numbers in the rural areas surrounding Jacmel



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Changes in visitor numbers: period 2

From 01 May to 09 June

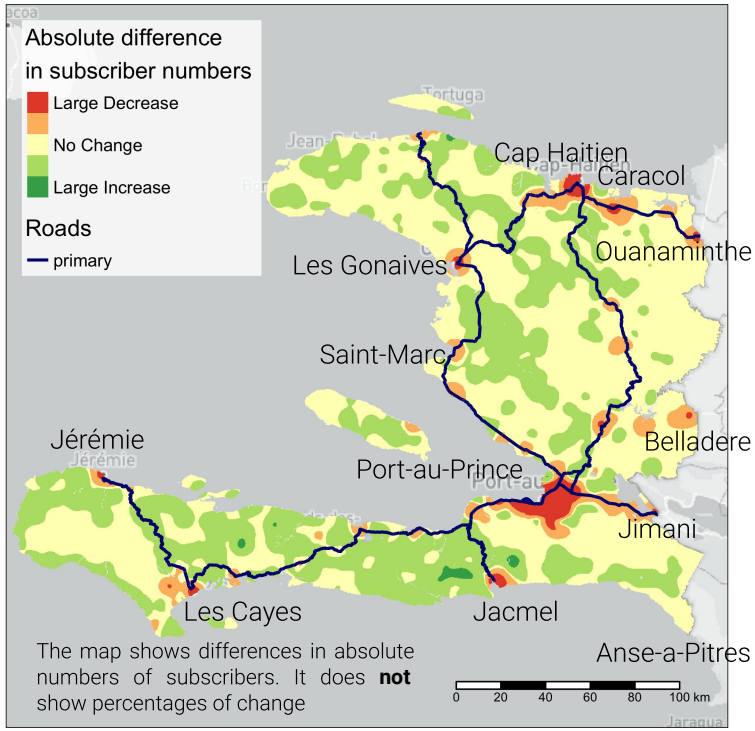
As on the previous slide, the map shows the difference in the median number of phone users active each day, but comparing the baseline period before COVID-19 restrictions (March 20) to the period from 01 May to 09 June.

Key differences compared to period 1:

- Reductions not as pronounced along some of the main roads (back to baseline level) and at Caracol Industrial Park (-20%, compared to -50% in April)
- Further reductions in visits to Belladere border, but similar subscriber presence for other borders
- Increases are observed in more villages and rural areas, especially around Jacmel (corresponding to +20% for most locations)

Overall the effect of COVID-19 restrictions on visitor numbers observed in period 1 persisted in period 2, and the two maps are very similar.

In the next slides, we grouped localities by the number of visitors during the baseline to further investigate the observation that restrictions have a differential impact in urban and in rural settings.



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Method: Grouping localities by urban setting

We grouped localities by the median number of phone users active each day during the baseline period. The number of active phone users visiting a locality reflects both the residents and the users who are only passing by. It is a good indicator of how busy a place is and generally of how 'urban' a place is.

We created 4 groups and labelled them as follows:

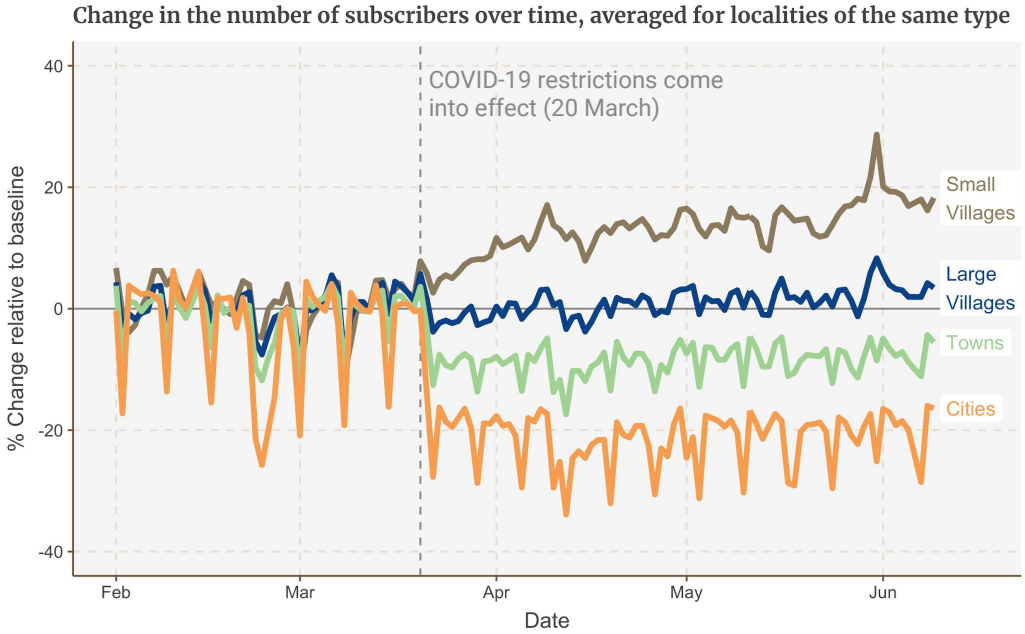
- 'Cities' : corresponding to the centre of Greater Port-au-Prince (part of Port-au-Prince, Delmas, Pétion-Ville, Cité Soleil, Tabarre and Carrefour), Cap Haitien and Les Cayes
- 'Towns' : corresponding to many towns such as Jacmel, Saint-Marc, Les Gonaives, Port-de-Paix, Jérémie, and to urban areas surrounding city centres
- 'Large villages' : corresponding to many settlements such as Hinche or Anse-a-Galets, especially those along the main roads, to suburbs surrounding towns and cities, and also to border points
- 'Small villages' : corresponding to smaller settlements (e.g. Dame-Marie or Anse-Rouge), especially those away from the main roads

We then computed the average change in phone users presence for localities within each of the 4 groups.

The graph on the next slide shows the number of subscribers active each day, expressed as a % of the median number of subscribers active during the baseline period, and then averaged for localities within each group.

Changes in visitor numbers per urban setting

Time series



➜ We observe a decrease in commercial districts, and an increase in more residential and more remote areas. These observations are likely to partly reflect a reduction in visits to workplaces with phone users staying more at home (as on Sundays before the restrictions), and possibly also relocations from urban to more rural areas, given the significant increase in phone users in some rural areas.

- The number of visits to urban areas sharply decreased following COVID-19 restrictions (20 March), with 20% fewer phone users on weekdays in the centres of cities on average (comparable to Sundays before the restriction), and decreases even more (-30%) on Sundays.
- At the same time (from 20 March), the number of active users started to progressively increase in small villages on average (up to 20%, with a peak for the last weekend of May), significantly more than on weekdays or Sundays before the restrictions.
- Localities with larger number of phone users on weekdays than Sundays are also the localities where the largest decreases post COVID-19 measures were observed (urban localities and some roadside localities).
- Note that the total number of users active each day in the country is stable throughout the study period (not shown), so it does not explain the observed changes.

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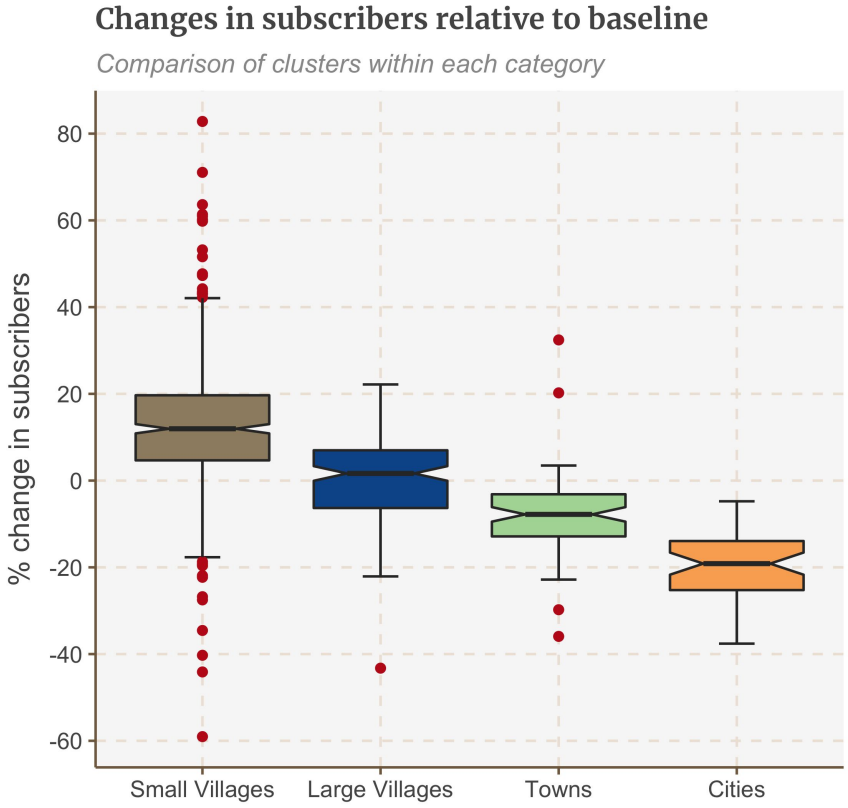
Changes in visitor numbers per urban setting

Distributions



The graph shows the distribution of the % change in the median number of phone users active per locality (visitors), grouped by urban setting. The change in visitor numbers was computed between the baseline period and the period from 20 March to 09 June.

This is to assess the variability of changes (increases or decreases in visitors) within each urban setting group:

- In small villages, COVID-19 restrictions brought an increase in active phone users on average (+10% compared to pre-restrictions numbers). Some villages have very large proportional increases or decreases (-60% to +80%), however these are small in absolute numbers of subscribers.
- The change in visitor numbers in large villages varied between -20% to +20%, averaging around no change overall.
- In all city centres the visitor numbers decreased following the measures, as well as in the majority of town centres, indicating a countrywide and consistent reduction of activity in commercial districts as a result of COVID-19 restrictions.

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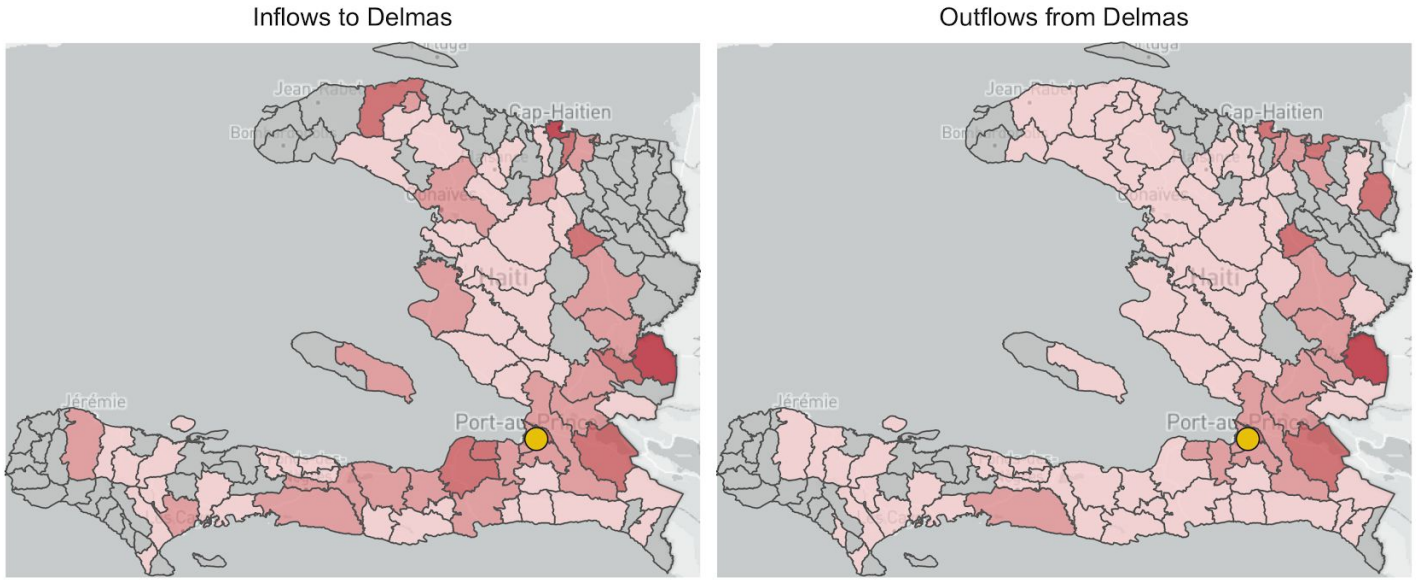
Changes in inter-city flows

Example: Flows to and from Delmas (Greater Port-au-Prince)



Visitor numbers and flows in/out of major cities decreased post COVID-19 measures. Delmas was chosen as example as it is one of the communes with the largest flows.

Maps show for each commune the % change in the median number of phone users travelling to Delmas (left) and arriving from Delmas (right), before and after COVID-19 restrictions. Note that we only count the flows occurring within a single 24-hour period.

Both inflows and outflows have decreased, especially from/to Cap Haitien and border points communes (-30%), from/to the Greater Port-au-Prince area, and along the main roads to Les Cayes, Saint-Marc and Cap Haitien. This suggests a large effect of border closing on mobility (see next slides), and a large effect of COVID-19 restrictions on inter-city travel.

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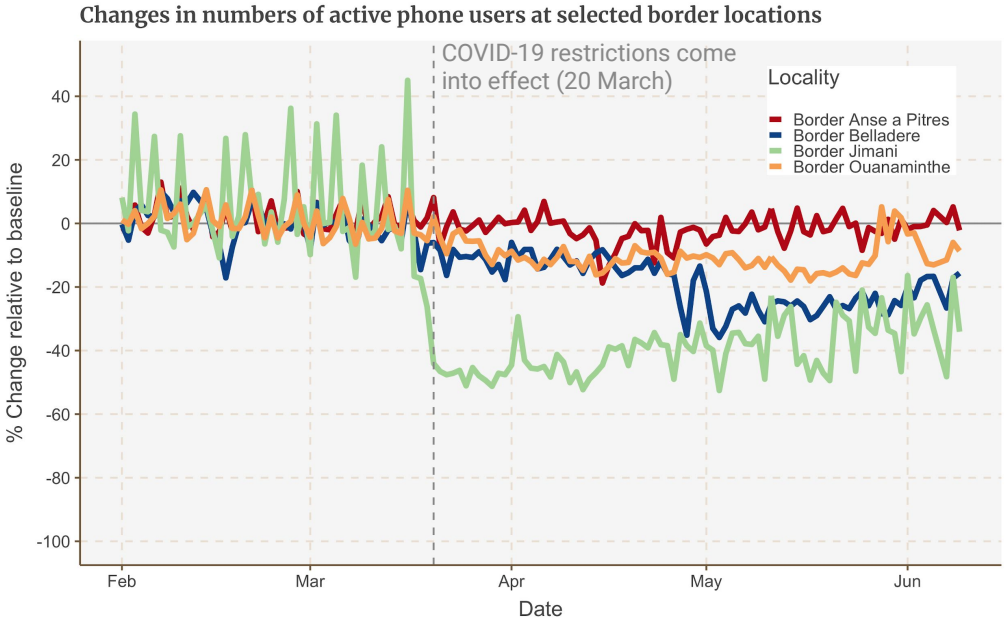
Changes in visitor numbers at border points

Time series

The graph shows the number of phone users active each day, expressed as a % of the median number of phone users active during the baseline period, for four border points. This is to evaluate the effect of border closure (20 March).

- No significant changes were observed in Anse-a-Pitres, which is a small town neighbouring a larger town in DR
- Near Jimani (no large settlement on Haiti side), we observed a 40% reduction in subscriber presence following the restrictions, however from May subscriber presence appears to slowly increase and resume a weekday / weekend pattern
- In Belladere (small mountain settlement), visitor numbers decreased following restrictions (-10%) and decreased further from May (-30%)
- In Ouanaminthe (small town), visitor numbers decreased by 10%, except for the last weekend of May when they are back to normal levels
- We also note that visitor numbers did not significantly increase prior to the border closure



➜ The change in visitor numbers in Ouanaminthe, Belladere and near Jimani are likely to reflect a reduction or absence of border crossing at these locations, the remaining visitors being residents. The absence of reduction in Anse-a-Pitres may indicate border crossing visits are not significant compared to the activity of the town, or that border crossing at this location did not decrease significantly.

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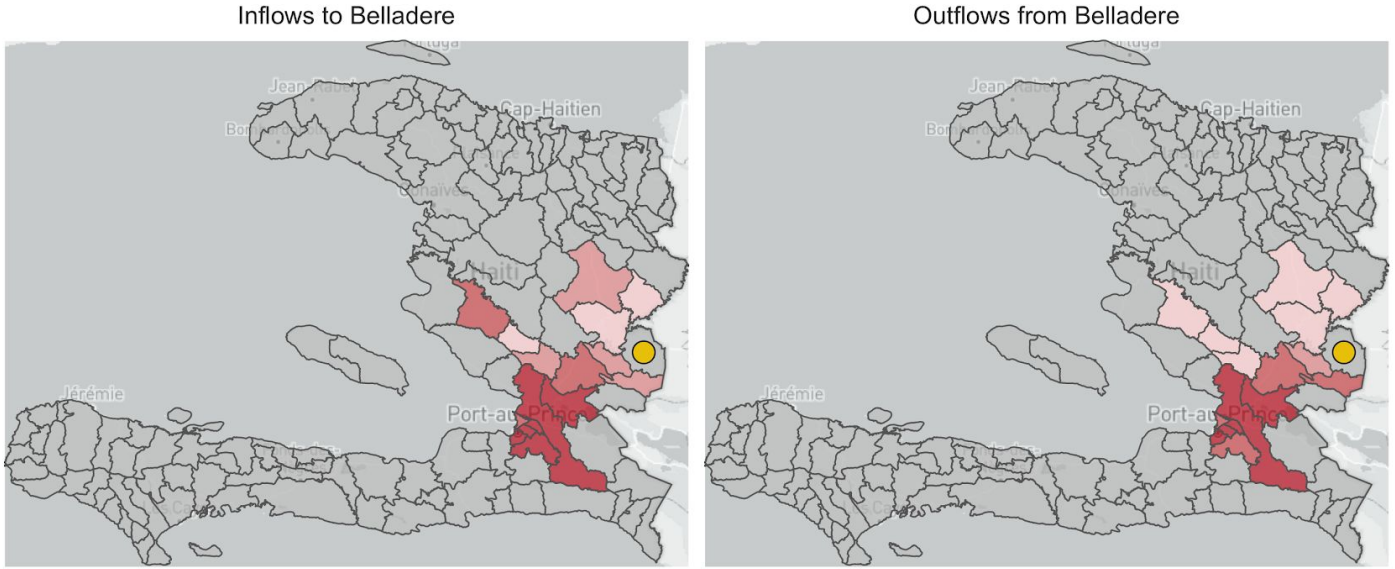
Changes in flows to/from border points

Example: Flows to and from Belladere border point



Visitor numbers generally decreased at border points post COVID-19 measures. Belladere was chosen as example to study flows, other border points can be shown in the next report.

Maps show for each commune the % change in the median number of subscribers travelling to Belladere (left) and arriving from Belladere (right), before and after COVID-19 restrictions. Note that we only count the flows occurring within a single 24-hour period and travels spanning multiple days (possibly to further locations) are not measured.

Flows between Belladere and Greater Port-au-Prince, and along the road in between, have decreased by over 30% in both directions, indicating a large effect of border closure in reducing travels.

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Report 2 | Concluding remarks:

- COVID-19 restrictions appear to have a large and persisting effect of reducing mobility in Haiti:
  - Lower mobility throughout the country (similar to a Sunday before the restrictions)
  - Fewer visitors to cities and towns (also similar to a Sunday before the restrictions)
  - Fewer travels along the main roads, in between cities and border points
  - Visible reduction in visitor numbers and travels can be observed at border points which are not small towns (Belladere and Jimani) - and no significant increase in visitor numbers was observed in border communes
- COVID-19 restrictions also lead to small increases in visitor numbers in more rural and residential areas throughout Haiti:
  - Increases in visitor numbers in residential and rural areas are likely to be partly due to people staying at home having stopped their commute to work, and partly to people relocating from urban to rural areas following the restrictions. To measure the extent of relocations we will compute the 'stay location' indicator for the next report.
- COVID-19 restrictions are likely to have a negative impact on the economy:
  - Large reduction of activity in commercial districts likely to affect businesses
  - Income loss for people whose income depends on presence at the workplace or in city and town centres
  - Large reduction in intercity travels and with the border likely to affect businesses

Next reports will include:

- Update on subscriber presence and overall mobility
- Indicators of movements such as average distance travelled and major flows through Haiti
  - to further assess the observed reduction in mobility
- Study of flows within cities and with surrounding areas
  - to further assess changes in commuting flows
- Study of changes in population distribution (changes in ‘stay’ location and day/night presence)
  - to investigate relocations versus reduction in commuting flows
- Study of population mixing and hotspots
- Analysis of changes in phone usage
  - to assess potential effect on mobility analysis (addition of a ‘caveats’ section)
- Further study of border points, using presence, population mixing and flow indicators
- Focus on areas of interest to the Haiti COVID taskforce

Next steps

Discussion with Haiti stakeholders to select the most useful analyses and indicators to produce

Standard reports at regular intervals to the Ministry of Health and IOM-DTM (pdf)

Flowminder coordination with Digicel and researchers in infectious disease modelling

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covid19@flowminder.org

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