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## **Internal Population Displacement in Haiti**

**Preliminary analyses of movement patterns of Digicel  
mobile phones: 1 December 2009 to 18 June 2010**

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## **Executive summary**

We analyzed data from the locations of all Digicel mobile phones in Haiti before and after the earthquake. This report is an update of our report on population movements describing the period up to 11 March. The update extends the analyses in the original report to 18 June.

### Port-au-Prince area:

The new analyzes show that there was a continuous and strong net inflow of mobile phones into the Port-au-Prince metropolitan area from the beginning of February until early May. From this time onwards, the net inflow gradually decreased but still remained positive at the end of the analysis period (18 June). On this date there was 6.6% less mobile phones within the Port-au-Prince metropolitan area than before the earthquake.

### Departments:

A parallel net outflow of phones took place from February in all departments outside Port-au-Prince but the net outflow slowed down after May. On 18 June all departments had a remaining net increase of phones compared with pre-earthquake levels.

### Movement of specific groups:

On 18 June, an estimated excess 250,000 thousand Port-au-Prince inhabitants were staying outside the city.

We also investigated if the resources allocated to the Port-au-Prince area had attracted significant numbers of newcomers into Port-au-Prince but could not find clear evidence for in-migration of above normal levels for people not living in Port-au-Prince before the earthquake.



## A. Introduction

Reports<sup>1</sup> described large population movements in Haiti following the Jan 2010 earthquake. The magnitude and trends of such population movements are important to efficient relief operations. In addition, such estimates provide essential information to design and interpret results of needs assessment surveys.

The Center for Disaster Medicine at Karolinska Institute in Sweden has in collaboration with Digicel Haiti analyzed data on movements of SIM cards from the Digicel Haiti mobile phone network in order to estimate migration patterns following the earthquake. The analyses cover the pre-earthquake period from 1 December, 2009 to 11 January 2010, as well as the post-earthquake period 12 January to June 18, 2010. This report extends the previous period of analyzes from 11 March to 18 June, 2010. In addition, data from 1 to 31 December has made it possible to more reliably define people's home. The analyses in this report supersedes earlier analyses.

Section one of this report shows the daily number of SIM cards within the Port-au-Prince metropolitan area during the 200 day-period. Section 2 shows the increase of SIM cards over time within each of the 10 departments of Haiti. Section three is more complicated and analyze the composition and movements of sub-groups of mobile phones and includes a population estimate of Port-au-Prince inhabitants in the 10 departments.

## B. Methods

We analyzed location data of all Digicel SIM cards (henceforward used interchangeably with the term "mobile phone" or "phone") between 1 December, 2009 to 18 June 2010. Location was registered at the first call of each phone, each day. To control for bias, we based the estimates on the subset 1.9 million SIM cards that had made at least one call during 1 December, 2009 to 11 January, 2010 (pre-earthquake period) and at least one call during 18 May to 18 June. Analyses do thus not included SIM cards registered after the earthquake, nor SIM cards that were destroyed or became non-active. The population estimates derive from estimates for the year 2009.<sup>2</sup>

The geographic locations of mobile phones refer to the locations of the cell phone towers to which the phones connected when calling. The data thus allows for locating a mobile phone to within an area of a few square kilometers. This means that no individual can be identified from the data. In addition, the analysis team has only have access to anonymized data.

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<sup>1</sup> OCHA. Haiti Earthquake - Population Movements out of Port-au-Prince - 17 February 2010. <http://www.reliefweb.int/rw/rwb.nsf/db900sid/AMMF-82SVUA?OpenDocument&query=population%20movement&emid=EQ-2010-000009-HTI>. Retrieved 11 May 2010.

OCHA. Haiti Earthquake - Population Movements out of Port-au-Prince - 8 February 2010. <http://www.reliefweb.int/rw/rwb.nsf/db900sid/MNIN-82GQYS?OpenDocument&query=population%20movement&emid=EQ-2010-000009-HTI>. Retrieved 11 May 2010.

<sup>2</sup> Population totale, population de 18 ans et plus menages et densités estimés en 2009. March 2009. Institut haïtien de statistique et d'informatique. [http://www.ihsi.ht/produit\\_demo\\_soc.htm](http://www.ihsi.ht/produit_demo_soc.htm). Retrieved 11 May, 2010.



Area definitions are based on the official Haitian administrative system, with the exception of the Port-au-Prince metropolitan area<sup>3</sup> (henceforward “Port-au-Prince”), which is defined in the appendix. When reference is made to the department “Ouest”, this area always excludes the Port-au-Prince area.

The movements of mobile phones is an exact measure and is clearly defined. However, not all people in Haiti have a mobile phone. Approximately half (an estimated 55%) of all 15-59 year-old persons in Port-au-Prince own a Digicel SIM card and use it for regular phone calls. Outside Port-au-Prince, this figure is lower.

The extent to which the mobile phone patterns can represent the movements of people without a mobile phone is not known at present. However, analyses of sub-groups of phones with different home regions, different frequency of calling and various pre-earthquake movement patterns can shed some light on this issue. Certainty can however not be achieved solely based on mobile phone data. In section 3, which is a bit more complicated, we discuss some of these issues further. In general, movement trends (shapes of the curves) are likely to be a better predictor of reality than point estimates of population numbers for specific days. For detailed information on these preliminary analyses, please contact the authors.

### **C. Caveats**

We believe that the estimates in this report are the best currently available on population displacement in Haiti. This is however the first time this method is used for estimating population displacement patterns and the estimates have not been validated by other studies. If people without a mobile phone have very different population movement patterns compared to people with a mobile phone, the biases in our estimates could be very large. We welcome decision makers to contact the scientific team for discussions on specific estimates.

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<sup>3</sup> See appendix for definition

## D. Results

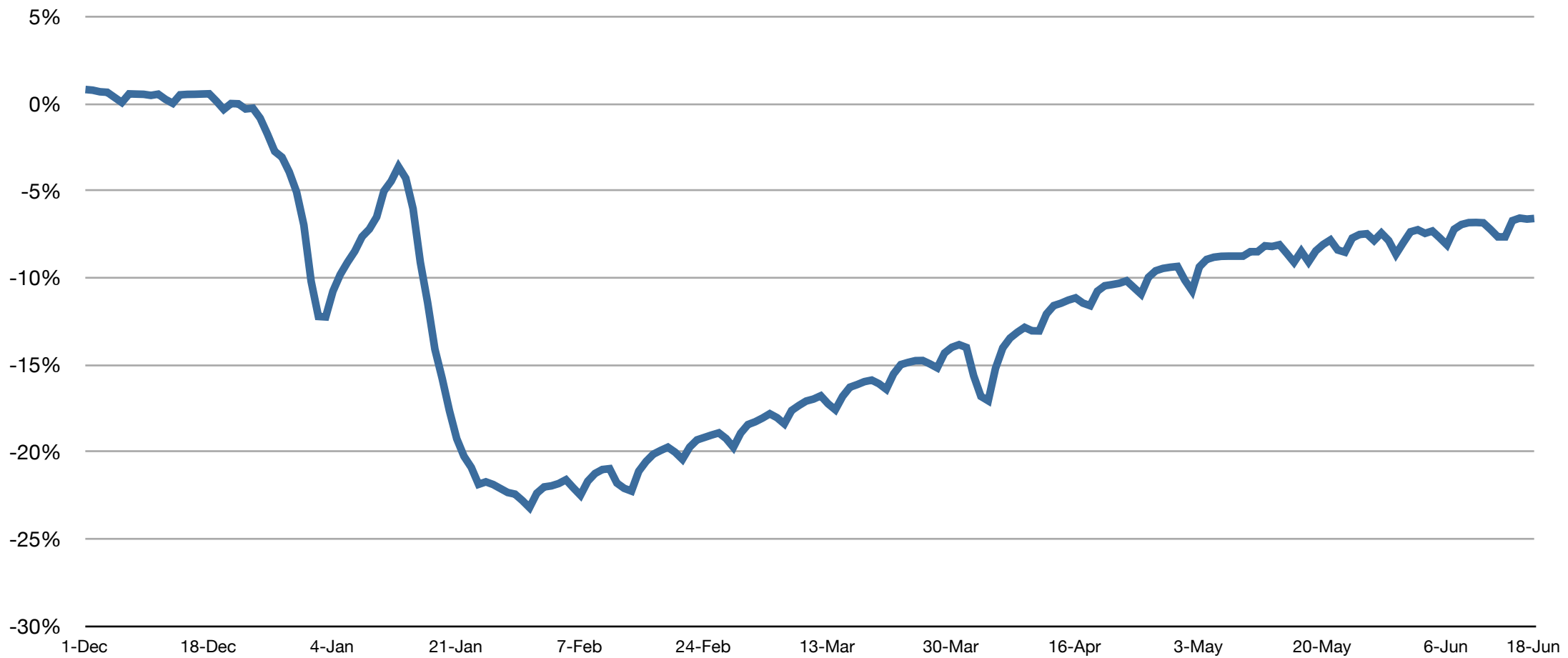
### 1. Mobile phones in Port-au-Prince

#### **The net inflow of mobile phones into the Port-au-Prince metropolitan area continued after March, but daily net inflows decreased from May and onwards**

Figure 1 below shows the relative changes in the number of mobile phones in Port-au-Prince between 1 December and 18 June. The vertical axis shows, for each day, the change in total number of mobile phones in percent compared to the number of phones present in Port-au-Prince on 21 December (845,000 phones). 21 December is chosen as a reference point since this was the most recent day before the earthquake at which population movements were stable and low. As an example on how to read the figure, there was on 31 January 23% less phones in Port-au-Prince than on 21 December.

Five phases of net mobile phone movement in and out of the Port-au-Prince metropolitan area can be seen:

- Phase 1** (1-20 Dec): Stable period. The net movement in and of Port-au-Prince was very small
- Phase 2** (21 Dec-11 Jan): A net out-migration from Port-au-Prince was followed by a similar net in-migration. This pattern was likely caused by people leaving Port-au-Prince to celebrate Christmas and New year. At the time of the earthquake (12 Jan), most, but not all of these persons, had returned to Port-au-Prince.
- Phase 3** (12-31 Jan): A large net out-migration followed the earthquake. On 31 January, the number of mobile phones in the city was 23% lower than on 21 December.
- Phase 4** (1 Feb-30 April): A stable and linear increase of the number of phones took place, primarily due to a return of the phones that left Port-au-Prince following the earthquake.
- Phase 5** (1 May-18 June): The net inflow of phones into Port-au-Prince metro area continued but the net daily inflow decreased (the curve flattens off). On 18 June there was 6.6% less phones in the Port-au-Prince metro area than on 21 December.



*Figure 1: The change in the number of mobile phones inside Port-au-Prince each day, compared to the number present in Port-au-Prince on 21 December, 2009. Observe that the changes are only due to migration, see method section. The decrease at the beginning of April is likely caused by Easter celebration.*



## **2. Mobile phones in the departments**

**There was a net in-migration of mobile phones into all departments after the earthquake. The net increase of phones was at its highest at the end of January. After March there was a strong movement back towards pre-earthquake levels in all departments.**

In this section we move away from Port-au-Prince and look at the situation in the 10 departments of Haiti. Figure 2 below shows for each day, the absolute change in the number of mobile phones in each department, compared to the number of phones present in each department on 21 December. As an example on how to read the figure, there was 43,576 more mobile phones in Sud department on 31 January compared with the number of phones in the department on 21 December.

The graph shows that the departments that received the largest numbers of mobile phones were Sud and Artibonite. A strong decline towards pre-earthquake levels is evident in most departments. The departments with the largest net changes, Sud and Artibonite, show the largest declines in absolute terms. On 18 June, the departments with the largest net increase in mobile phone numbers compared to 21 December were Sud, Centre and Nord-Ouest.



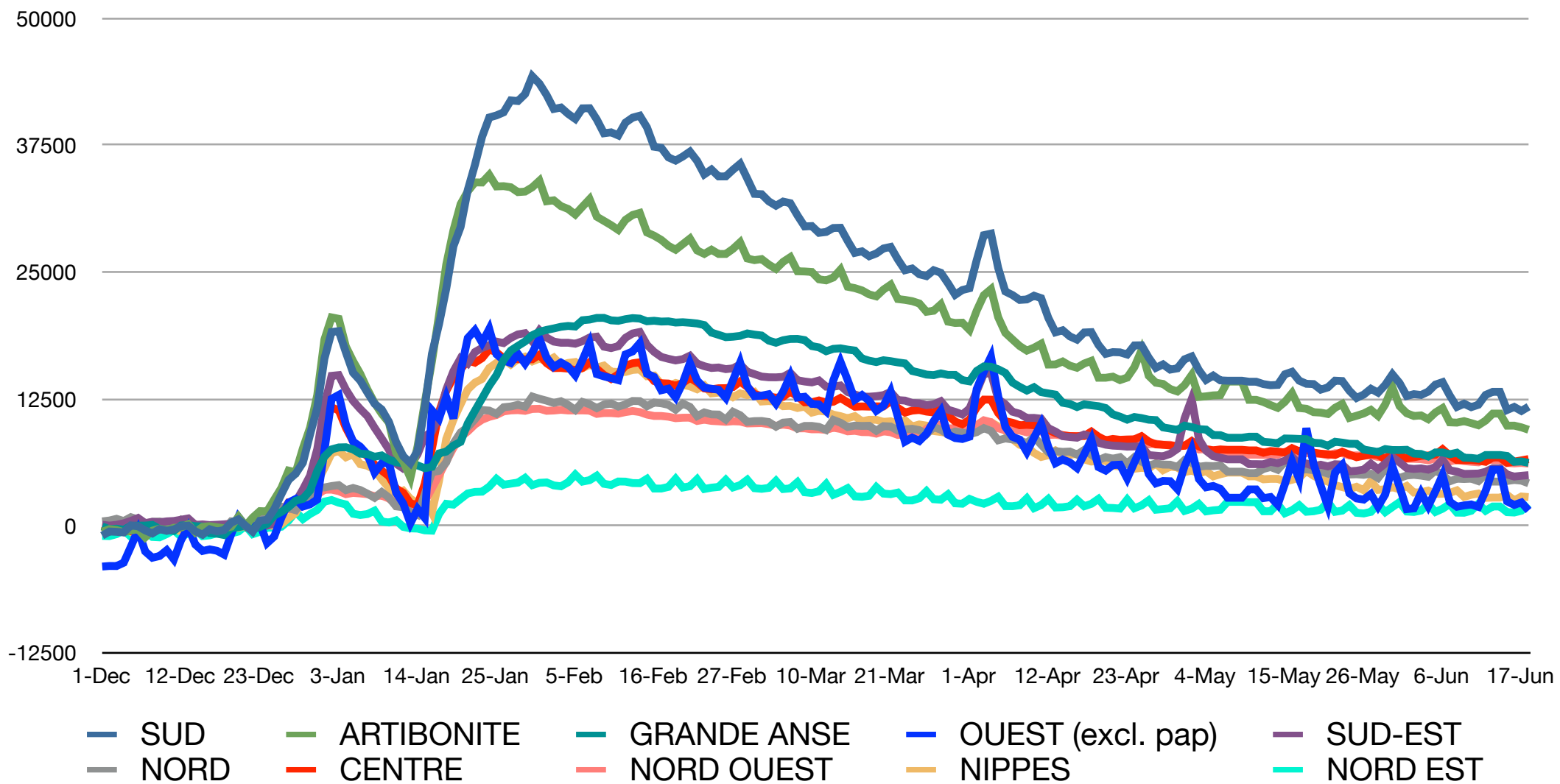


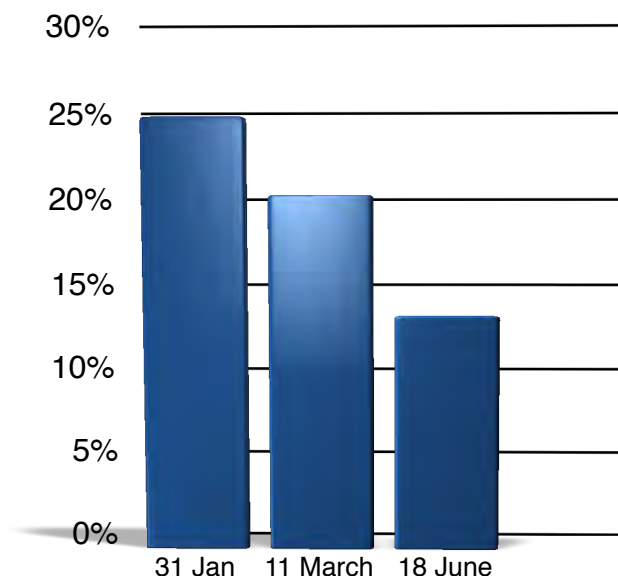
Figure 2: Absolute change in the number of mobile phones in each of the ten departments compared with the number present on 21 December.

### 3. Movement of sub-groups of mobile phones

Section 1 and 2 have described net changes in the number of phones within Port-au-Prince and the departments. Net movement is composed of in-flows and out-flows. In this section we describe some of these more complex movements in more detail.

***24% of the mobile phones in Port-au-Prince had moved out by 31 January. On 18 June the figure was down to 13%.***

Figure 3 below shows the proportion of all mobile phones in Port-au-Prince the day before the earthquake, that were located outside Port-au-Prince on 31 January, 11 March and 18 June.<sup>4</sup> Note that for any given time point there would be people in Port-au-Prince on temporary visits. This means that if all people who left Port-au-Prince after the earthquake would return to their homes, the proportion located outside Port-au-Prince (figure 3) should not be expected to reach zero.



***Figure 3: The proportion of the mobile phones present in Port-au-Prince before the earthquake that were outside Port-au-Prince on 31 January (24%), 11 March (20%) and 18 June (13%).***

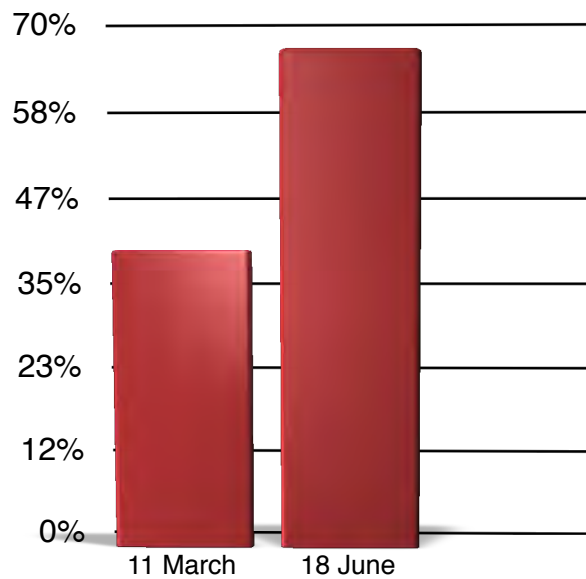
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<sup>4</sup> “Present in Port-au-Prince the day before the earthquake” is defined as having made the most recent phone call before the earthquake from within Port-au-Prince

***66% of mobile phones that had left Port-au-Prince on 31 January had returned by 18 June.***

The figures above show that large numbers of mobile phones left the city after the earthquake. On 31 January the number of mobile phones in Port-au-Prince was at its lowest point. We now look at the rate of return of those mobile phones that left the city.

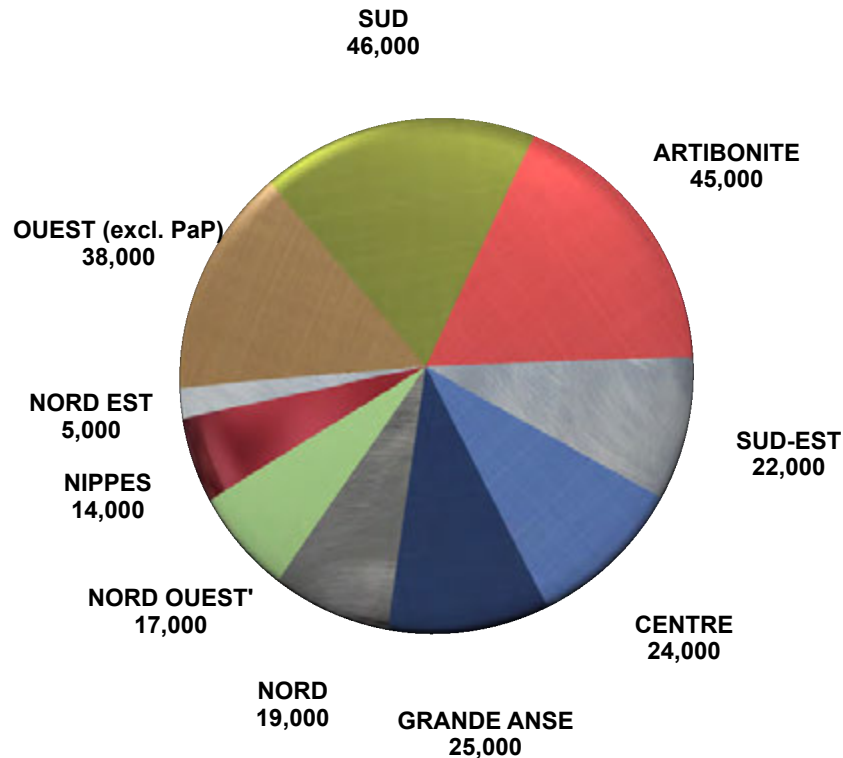
Figure 4 below shows the proportion of the mobile phones that had returned to Port-au-Prince on 11 March and 18 June (out of the phones that were present in Port-au-Prince the day before the earthquake and that also had left the city by 31 January). Again, note that we would not expect a 100% return rate even if all these persons had returned to their proper home, see above.



*Figure 4: Return rate into Port-au-Prince of mobile phones who were present in Port-au-Prince the day before the earthquake and had left by 31 January. 11 March: 40%; 18 March: 66%*

***On 18 June, an estimated excess 250,000 Port-au-Prince persons were staying in the 10 departments.***

The net increase of phones in the departments was largely caused by people who had moved out of Port-au-Prince. The estimated number of Port-au-Prince persons in each department (in excess of normal levels) on 18 June is shown in figure 5.<sup>5</sup>



***Figure 5: Estimated excess numbers of persons from Port-au-Prince who remained outside Port-au-Prince on 18 June.***

While there has been an outflow of people from Port-au-Prince there has also been an inflow into Port-au-Prince from the ten departments, reducing the total net change of the departments' populations (see figure 2).<sup>6</sup>

<sup>5</sup> A phone is defined as belonging to Port-au-Prince if it placed the majority of calls from Port-au-Prince during 1 to 21 December when population movements were low and stable. The population estimate assumes that the movements of the mobile phones are representative also for the non-mobile phone using population of Port-au-Prince.

<sup>6</sup> Note in figure 2 that for e.g. Ouest, the net change in the number of mobile phones within the department was very small comparing pre-earthquake figures with 18 June. This however masks the fact that both inflow into (figure 5) and outflow out of Ouest (not shown) were large. The areas of Port-au-Prince and Ouest (excl. Port-au-Prince) are very close which means that part of this phenomena might be due to misclassification of where these mobile phones really belong. It could however also be due to a sizable in-migration of some people into Port-au-Prince with a parallel and sizable outmigration from Port-au-Prince by others.



***At present, there is no clear evidence pointing towards higher than normal numbers of non-Port-au-Prince inhabitants moving into Port-au-Prince.***

As the majority of relief resources have been focused on the Port-au-Prince metropolitan area, we tried to see if there were indications that Port-au-Prince have attracted large numbers of new people from outside the city.

We found that 28,000 mobile phones (4,200 phones per month) that had not been in Port-au-Prince before the earthquake, had moved into Port-au-Prince by 18 June. The monthly number of Port-au-Prince inhabitants leaving the city during the last 3 months seems to be approximately on the same level, which potentially could mean that these movements are part of the normal migration pattern.

On the other hand departments outside of Port-au-Prince have less mobile phones per person. This could mean that inflow of non Port-au-Prince people into Port-au-Prince is presently somewhat higher, than the outflow of Port-au-Prince inhabitants out of Port-au-Prince. The issue can thus not be fully explored only based on cell phone data. Given the data available however, we do not find clear evidence that the inflow of non Port-au-Prince people into Port-au-Prince would be higher than normal.

## **E. Conclusions**

The method we have used is very promising for tracking population displacement after disasters, especially in areas with high mobile phone coverage. Further studies and in-depth analysis is however required and we hope to return with such data.

## **F. Scientific team**

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## **G. Additional acknowledgements**

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## H. Annex

### Definition of Port-au-Prince metropolitan area

The following communal sections are included in the Port-au-Prince metropolitan area.

Communal Sections	
17ème Procy	22ème Malanga
9ème Bizoton	3ème Bellevue
13ème Corail Thor	4ème Bellevue
16ème Taifer	7ème Bellevue Chardonnière
18ème Coupeau	1ère Montagne Noire
19ème Bouvier	3ème Etang du Jong
10ème Thor	4ème Bellevue la Montagne
2ème Varreux	1ère Varreux
21ème Berly	2ème Varreux
14ème Morne Chandelle	8ème Martissant
15ème Platon Dufréné	7ème Morne l'Hopital
11ème Rivière Froide	6ème Turgeau
20ème Laval	1ère Saint martin
1ère Petit Bois	2ème Varreux