Haiti: Hurricane Matthew

Estimated Population Movements as of 22 November 2016

Flowminder Foundation - Digicel Haiti - World Food Programme

Produced on 24 November 2016

FLOWMINDER.ORG

Our mission is to improve public health and welfare

We provide global public goods, working with partners to collect, aggregate, integrate and analyze anonymous mobile operator data, satellite and household survey data. We characterize and map vulnerable populations at risk in low- and middle-income countries.

All estimates and maps are available on the WorldPop Project website:
www.worldpop.org

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Cover photo: Cpl. Kimberly Aguirre. U.S. Marine Corps; www.dvidshub.net

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Background

Call detail records (CDRs) are registered by mobile operators for billing purposes. They include information on the cell tower used by subscribers when sending and receiving text messages and making calls. In de-identified formats, they can be used to estimate mobility patterns of a population. The CDR analysis described here was undertaken in compliance with the GSMA privacy guidelines developed in the context of the Ebola outbreak (GSMA, 2014).

Methodology

Population flow estimation

Haiti has an estimated population of 11 million people. Digicel is the largest operator, having approximately 4.7 million subscribers (85% market share).

We estimate population flows based on movements of de-identified Digicel subscribers who lived pre-hurricane in the affected Departments of Sud, Grande Anse and Nippes. We show estimated flows of people within and out of the affected departments. We show results for Communes and Communal Sections. Population movement estimates are calculated by combining de-identified data on SIM card movements with available population data.

We assume in these analyses that movements of mobile phone subscribers are representative of movements of the population in the three Departments. Mobile phone use is relatively lower in several groups including women, children, the elderly, and the poorest. If these groups have substantially different movement patterns than groups with high mobile phone use, results will be biased. In general the relative distributions of flows across the country are more reliable than absolute numbers given per area. Our previous research in Haiti (post-earthquake) and Kenya (stable conditions) show that overall estimates of mobility corresponded well to population-level data (Bengtsson et al., 2011; Wesolowski et al., 2013). However the estimates provided here should be interpreted with the above mentioned caveats in mind.

Specifically, we show estimated absolute and relative flows as well as flows above and below normal levels.

Absolute flows

Absolute flows are simply the estimated number of people who moved from one location to another. We define the home of each anonymous user before the hurricane (1 September 2016 to 28 September 2016) as the area from which the last call of the day was placed most frequently by the user. We define in the same way the present location of each user based on the period 16 November 2016 to 22 November 2016.

Relative flows

Using the definitions above, relative flows are defined as the estimated number of people who moved from one area to another divided by the total population of the area (IHSI, 2015). For relative flows into an area we divide the estimated number of people who arrived in the area by the population of that area. For relative flows out of an area we divide the estimated number of people who left the area by the population of that area.

Flows above normal

To put the observed population flows into perspective we provide a measure of the magnitude of flows by comparing the post-hurricane flows with pre-hurricane flows. We call these “flows above normal”. The estimates are rough and should only be used as an approximate measure.

Importantly, note that many people who have moved after the hurricane are likely to have done so due to the hurricane. The excess number of people who moved, compared to normal, should therefore not be interpreted necessarily as an estimate of the number of displaced people. We have in previous reports stated that absolute numbers of estimated moving people is likely to be a better measure of displacement than above normal movements in this context. This is situation is now gradually changing as normal mobility patterns return. We recommend that you contact Flowminder (contact information p. 6) for discussion on how to best interpret the results for specific areas.

The “above normal flow” is defined as the difference between the post-hurricane flow and the pre-hurricane flow. The pre-hurricane flow is determined as the time-averaged flow over the period from 2016-07-01 to 2016-09-28. For this calculation, the location of anonymous users is determined for a window of seven days, which is then compared to their locations in the previous four-week period. A time-series of flows is then generated, by moving the seven day window forwards by one day, from 2016-07-01 up to 2016-09-22. The post-hurricane flow is calculated by comparing the location of anonymised users in the period 2016-09-01 to 2016-09-28 with the period 2016-11-16 to 2016-11-22. Flows are scaled by census data population estimates (IHSI, 2015).

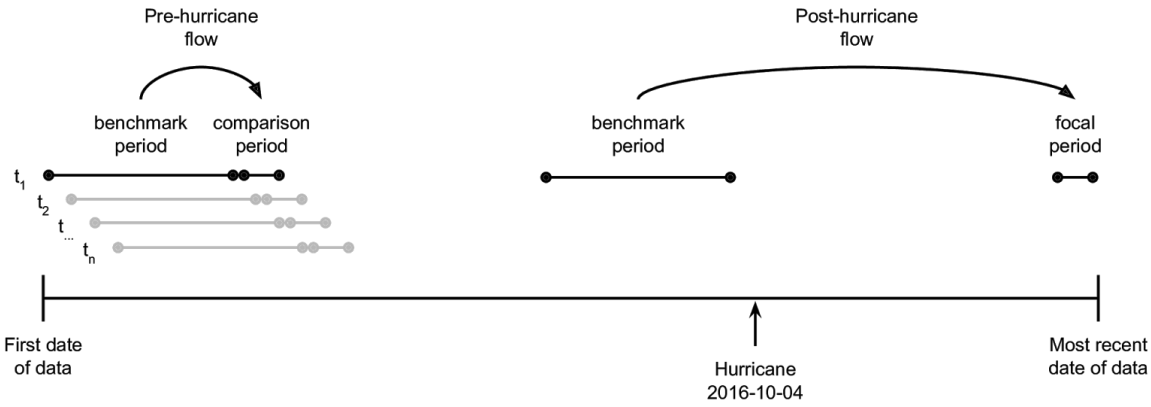

Figure 1. Definition of the time period and flows required to calculate flows above normal.
Pre-hurricane flows period: *2016-06-01 to 2016-09-28*
Post-hurricane flow benchmark period: *2016-09-01 to 2016-09-28*
Post-hurricane focal period: *2016-11-16 to 2016-11-22*

Supporting Datasets

Haiti Administrative Boundaries Level 0 - 3
UN OCHA Haiti, 5 October 2016
https://data.humdata.org/dataset/hti-polbndl-adm1-cnigs-zip

Haiti - Estimated population of 2015 (with p-codes)
UN OCHA Haiti, 13 October 2016
https://data.humdata.org/dataset/estimated-population-of-haiti-2015

Project Partners

Flowminder Foundation and WorldPop Project
www.flowminder.org www.worldpop.org

The Flowminder team pioneered the analysis of mobile network data to support responses to natural disasters and epidemics (Zanzibar 2009 malaria, Haiti 2010 earthquake and cholera outbreak). The WorldPop project is the leading open data repository for population densities and distributions, and is Flowminder's main dissemination platform.

Digicel www.digicelhaiti.com
Digicel Group is a leading global communications provider with operations in 33 markets in the Caribbean, Central America and Asia Pacific. Digicel is the largest operator in Haiti.

UN World Food Program www.wfp.org
WFP is the world's largest humanitarian agency, fighting hunger worldwide.

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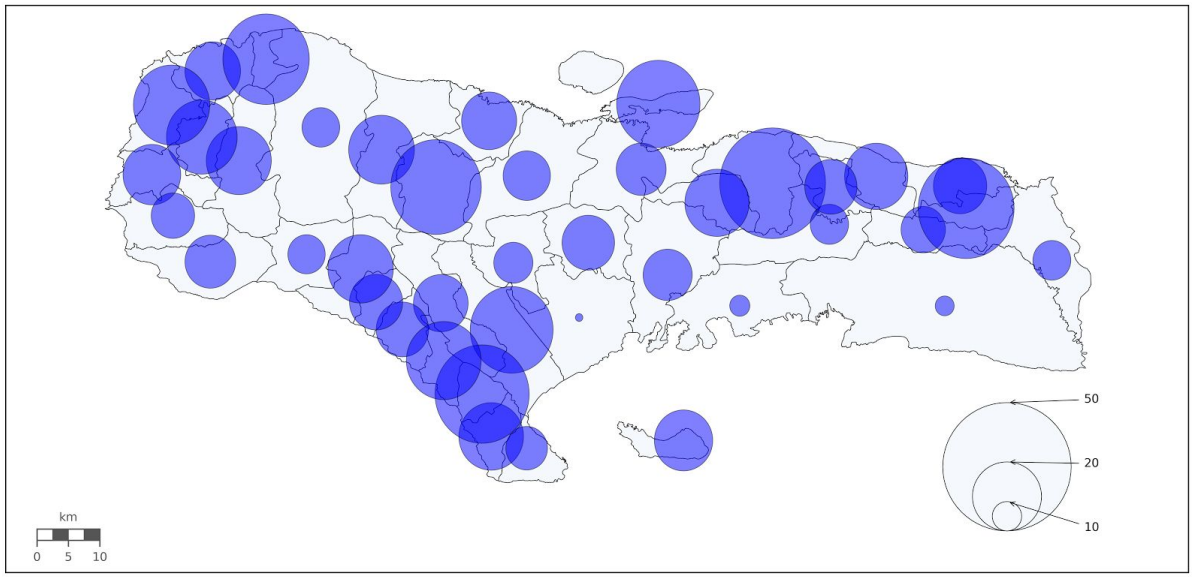
Results

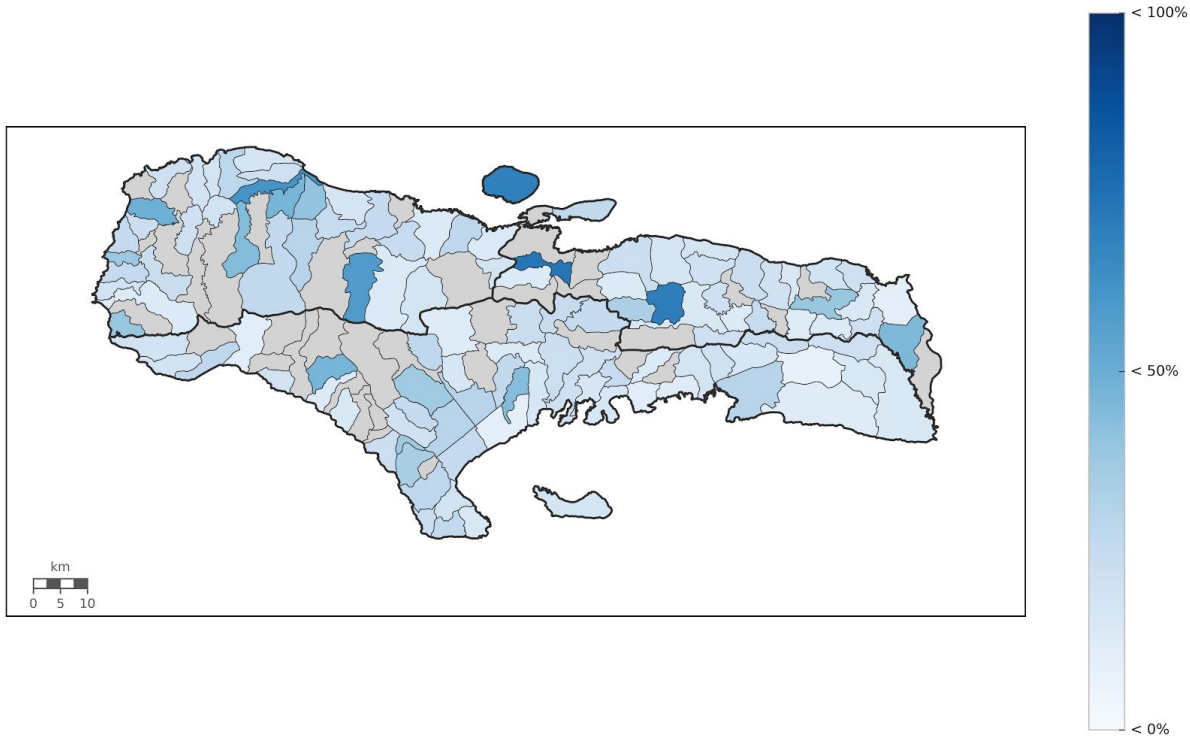
Population Outflows

Flows relative to the population



Map 1: Percentage of people who had left their Commune by the 22nd of November. The estimated number of people who left a Commune has been divided by the official 2015 population estimate for that Commune.

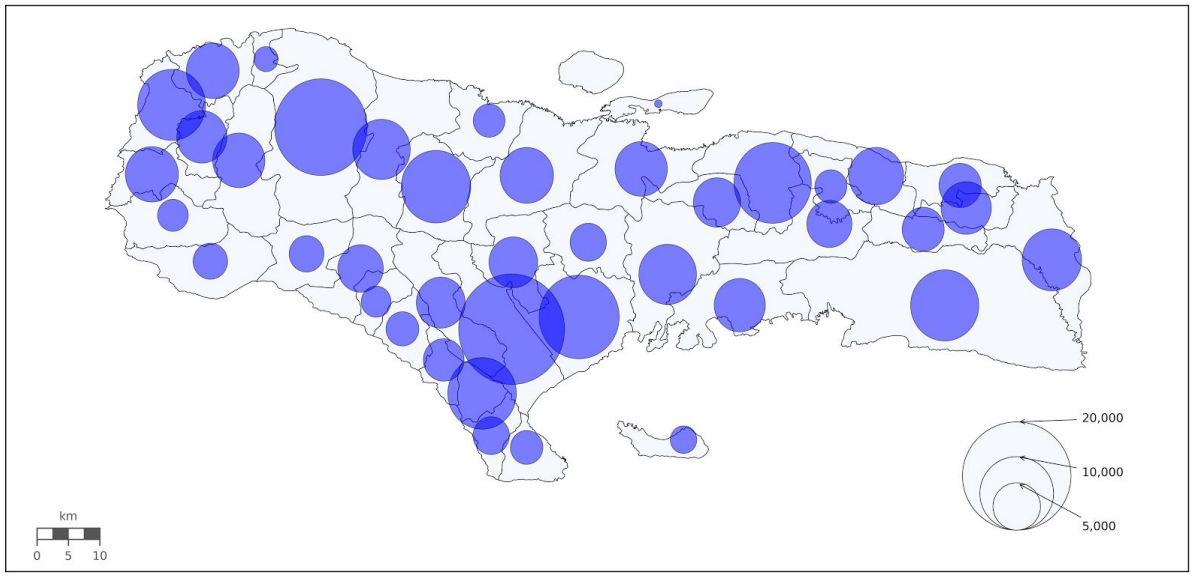
The analyses indicate that large proportions of the population have moved away from their home areas. The majority of Communes experienced more than a 15% loss of their populations, with the Communes of Petit Trou De Nippes, Paillant, and Arniquet experiencing the most people leaving. However, the **Southeast coast of the Department of Sud saw only a small proportion of people leaving.**



Map 2: Percentage of people who had left their Section Communale by the 22nd of November (same information as Map 1 but per Section Communale instead of per Commune). Grey areas indicate insufficient data.

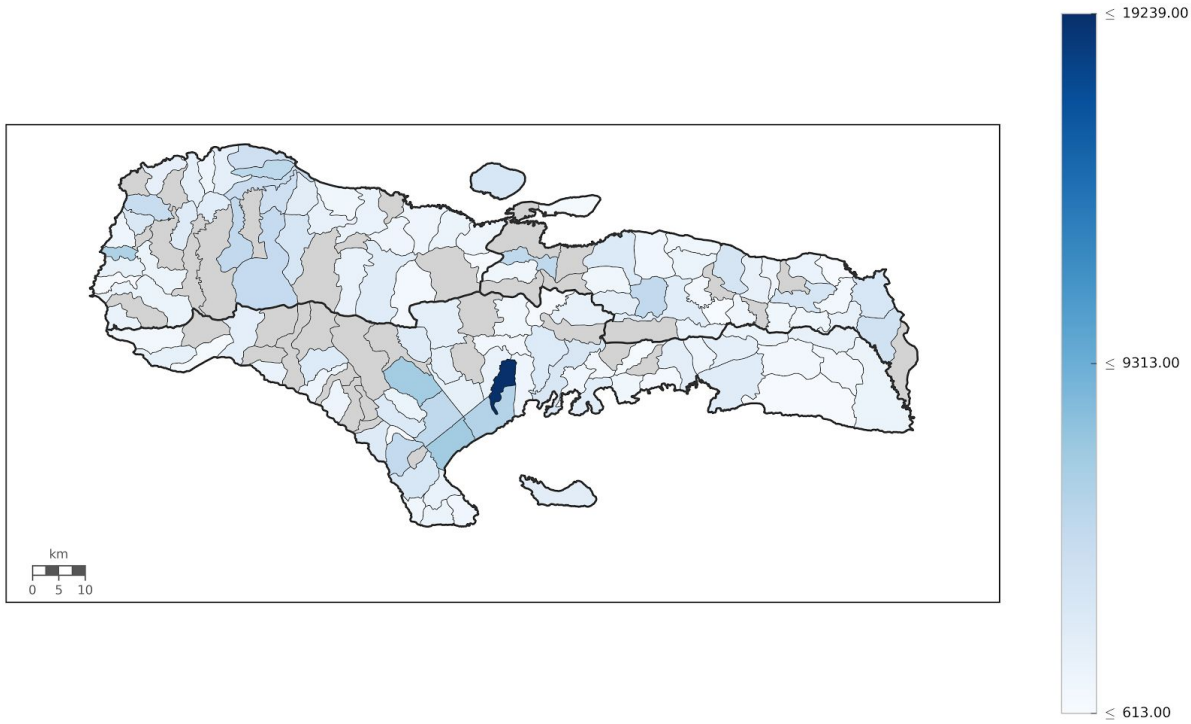
The majority of Section Communales experienced more than a 20% loss of their populations. The Section Communales of La Plaine, Lieve and Les Cayemites saw most people leaving.

Absolute flows



Map 3: Estimated number of people who left their Communes within the Departments of Sud, Grande Anse and Nippes.

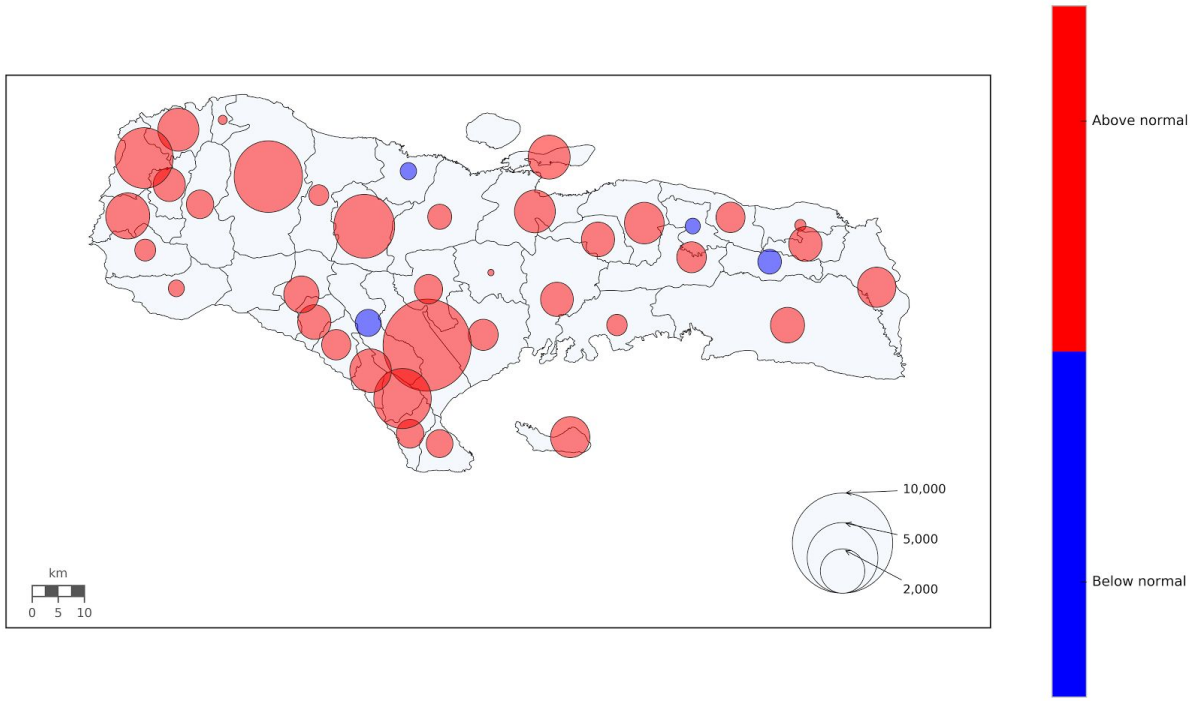
Most Communes saw between 2300 to 9500 people (mean ∓1 std) leaving their homes. The Communes of Torbeck, Jeremie and Les Cayes saw most people departing in absolute terms. The South West coast of the Department of Sud saw lower numbers of people leaving.



Map 4: Estimated number of people who left their Section Communales within the Departments of Sud, Grande Anse and Nippes. (same information as Map 3 but per Section Communale instead of per Commune).

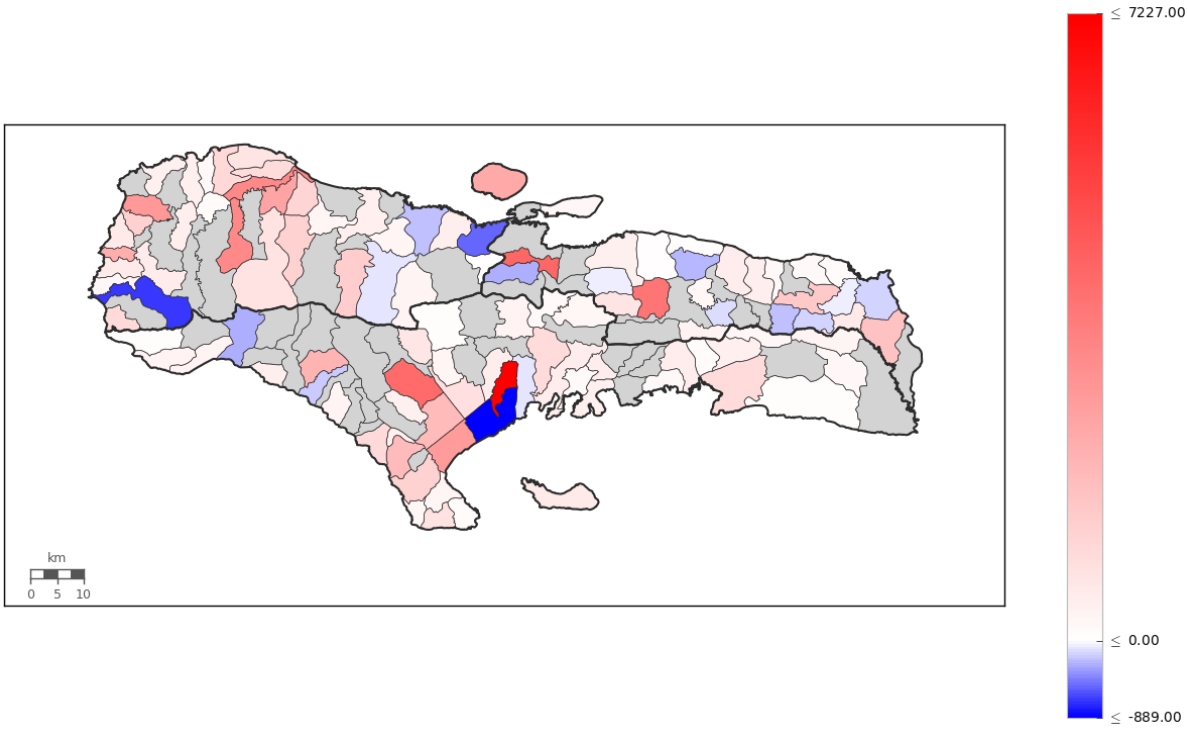
Most Section Communales experienced a drop in their population of between 400 and 5000 people (mean ∓1 std). The Section Communales of Laurent, Solon and Boury saw most people leaving in absolute terms.

Flows above normal



Map 5: Estimated number of people compared to normal, who left their Communes within the Departments of Sud, Grande Anse and Nippes.

The strong variation in flows above normal across the region indicates disruption to the normal patterns of population movement. Communes experiencing abnormally large outflows of people include Torbeck, Jeremie, Petit Trou De Nippes, and Dame-Marie. Flows above normal should not be interpreted as a direct measure of displacement (see methods).

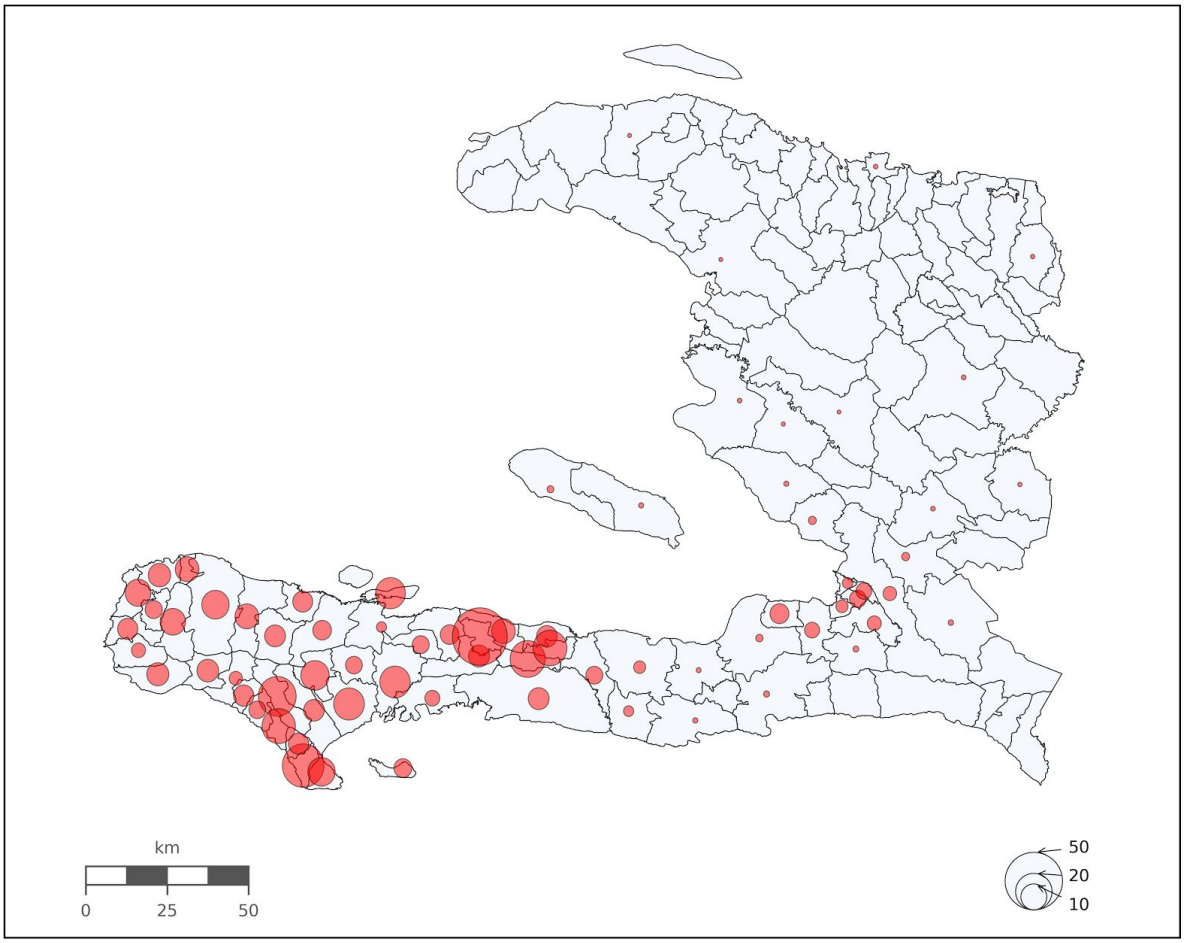


Map 6: Estimated number of people compared to normal, who left their Section Communales in the Departments of Sud, Grande Anse and Nippes (same information as Map 5 but per Section Communale instead of per Commune).

Similar to the Commune level, a large variation in flows above normal is seen at the Section Communale level. Section Communales experiencing abnormally large increases in outflows of people include Solon, La Plaine, Marfranc ou Grande Rivière and Laurent. Those experiencing abnormally large decreases in outflows of people include Cosse and Fond Tortue.

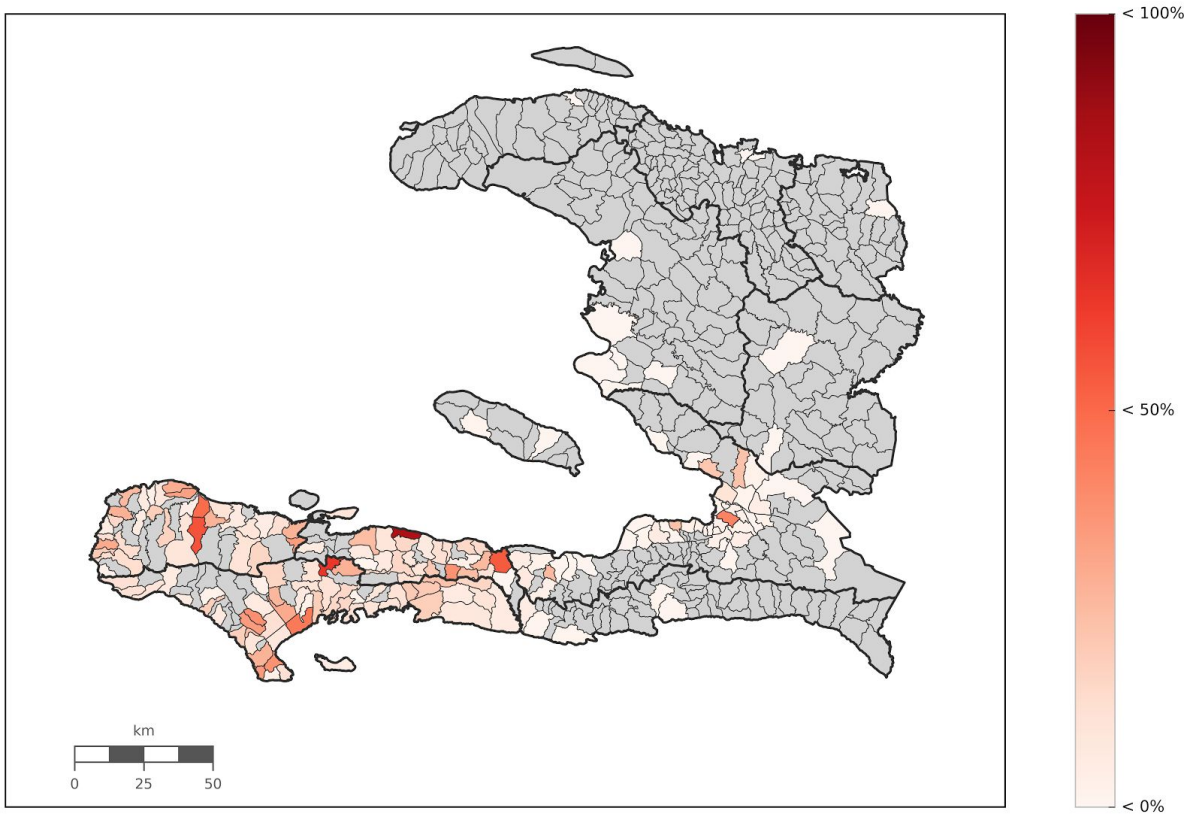
Population Inflows

Flows relative to the population



Map 7: Population increase (percent) per Commune due to inflow from affected Departments. Out of those who lived pre-hurricane in the Departments of Sud, Grande Anse and Nippes and who left their homes after the hurricane, the number of arriving phones per Commune is first determined. This number is subsequently divided by the total pre-hurricane population of the Commune.

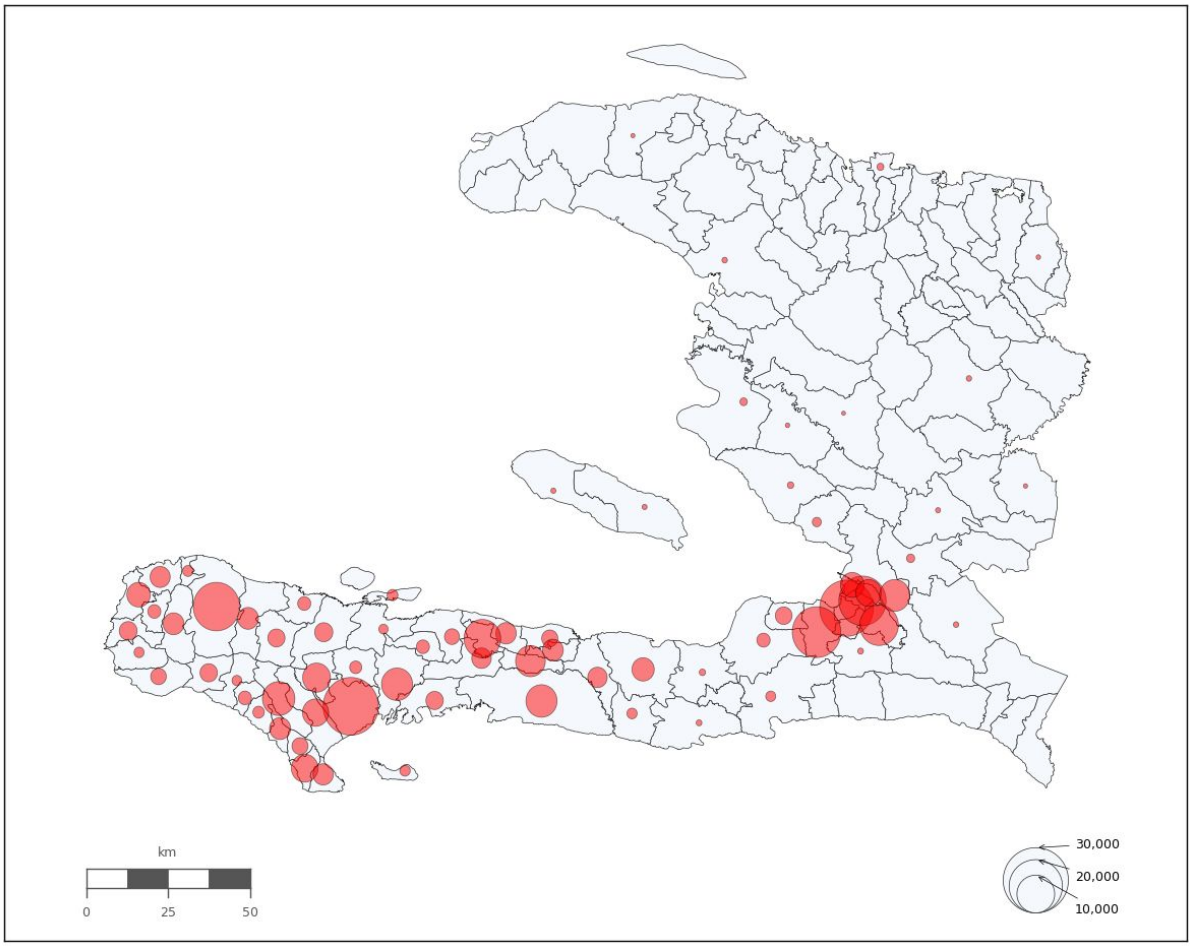
The movements of mobile subscribers indicate that some Communes have received large numbers of arrivals relative to their normal population. The Communes of Arnaud, Port-Salut and Chantal experienced the most people arriving relative to their normal populations.



Map 8: Population increase (percent) per Section Communale due to inflow from affected Departments (as Map 7 but on the level of Section Communale). Out of those who lived pre-hurricane in the Departments of Sud, Grande Anse and Nippes and who left their homes after the hurricane, the number of arriving phones per Section Communale is first determined. This number is subsequently divided by the total pre-hurricane population of the Section Communale.

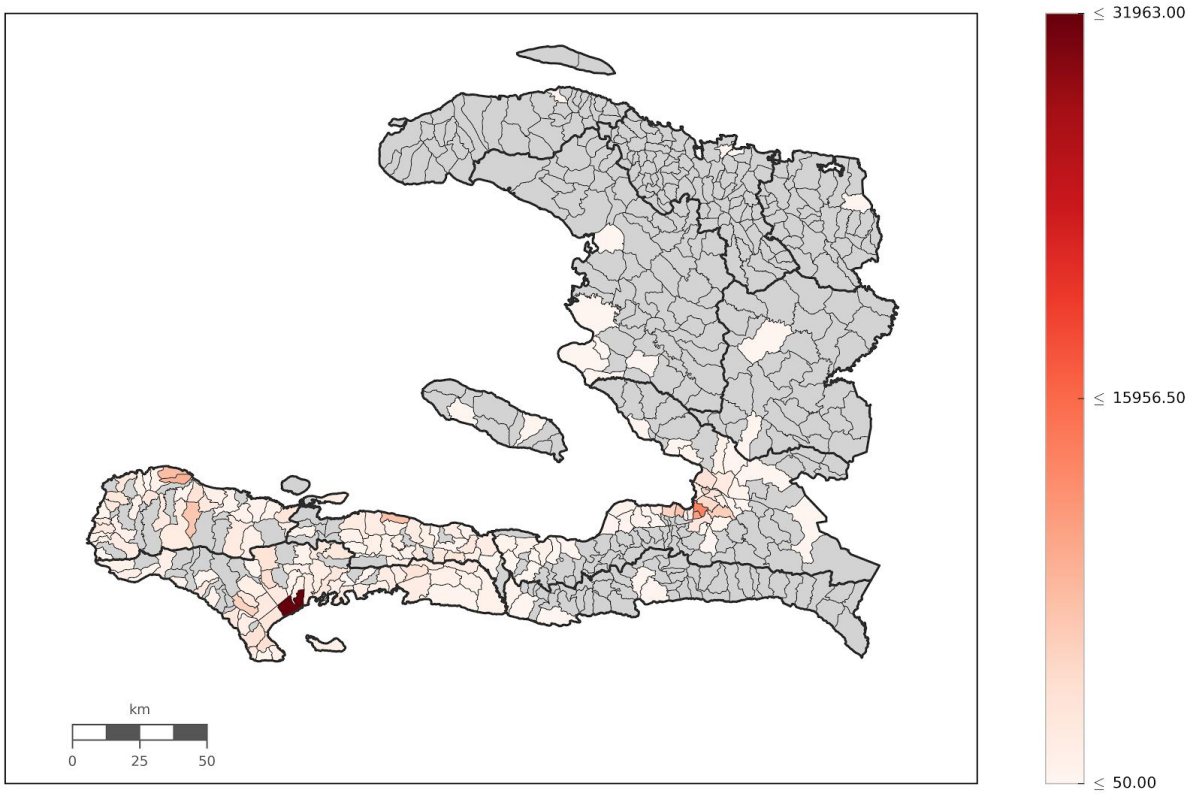
The Section Communales of Baconnois, Larogue and Haute Voldrogue experienced the most people arriving relative to their normal populations.

Absolute flows



Map 9: Estimated number of people who arrived into Communes from the Departments of Sud, Grande Anse and Nippes.

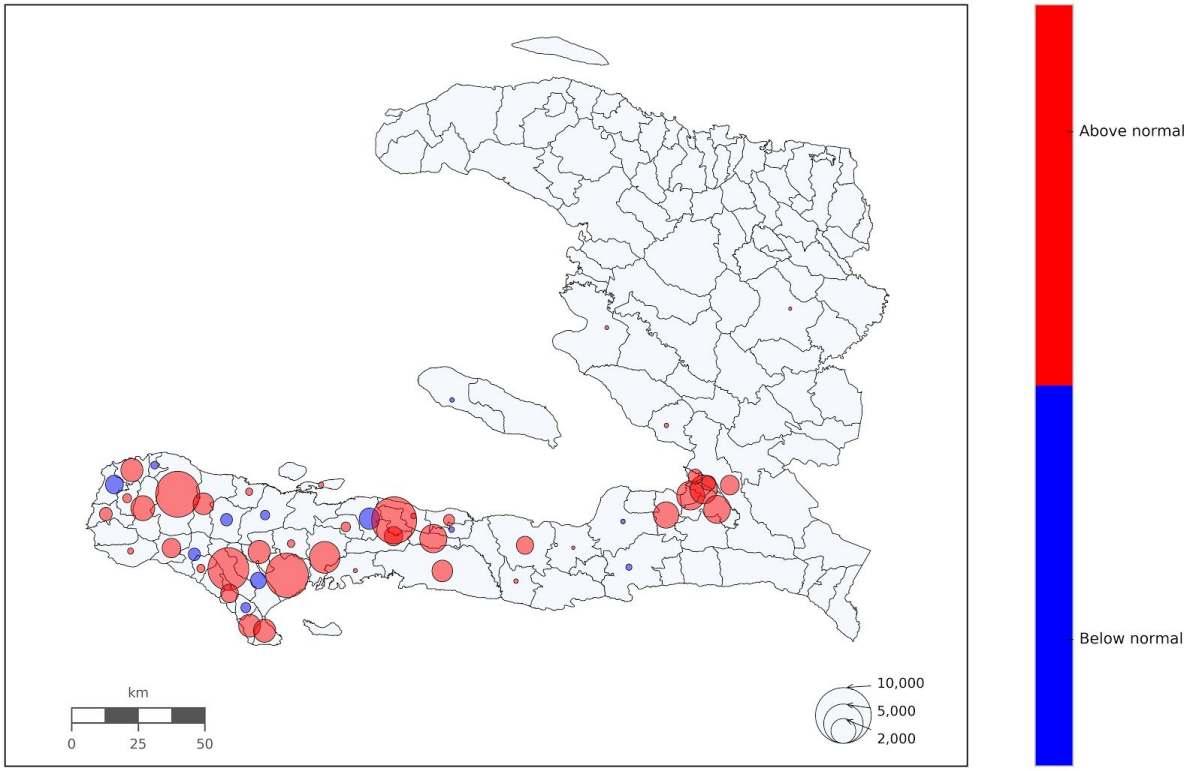
Large movements are seen towards urban areas, including the Port-au-Prince metropolitan area, Jeremie and Les Cayes. The movements towards Port-au-Prince may be important in relation to potential spread of cholera from the affected departments.



Map 10: Estimated number of people who arrived into Section Communales from the Departments of Sud, Grande Anse and Nippes (same information as Map 9 but per Section Communale instead of per Commune).

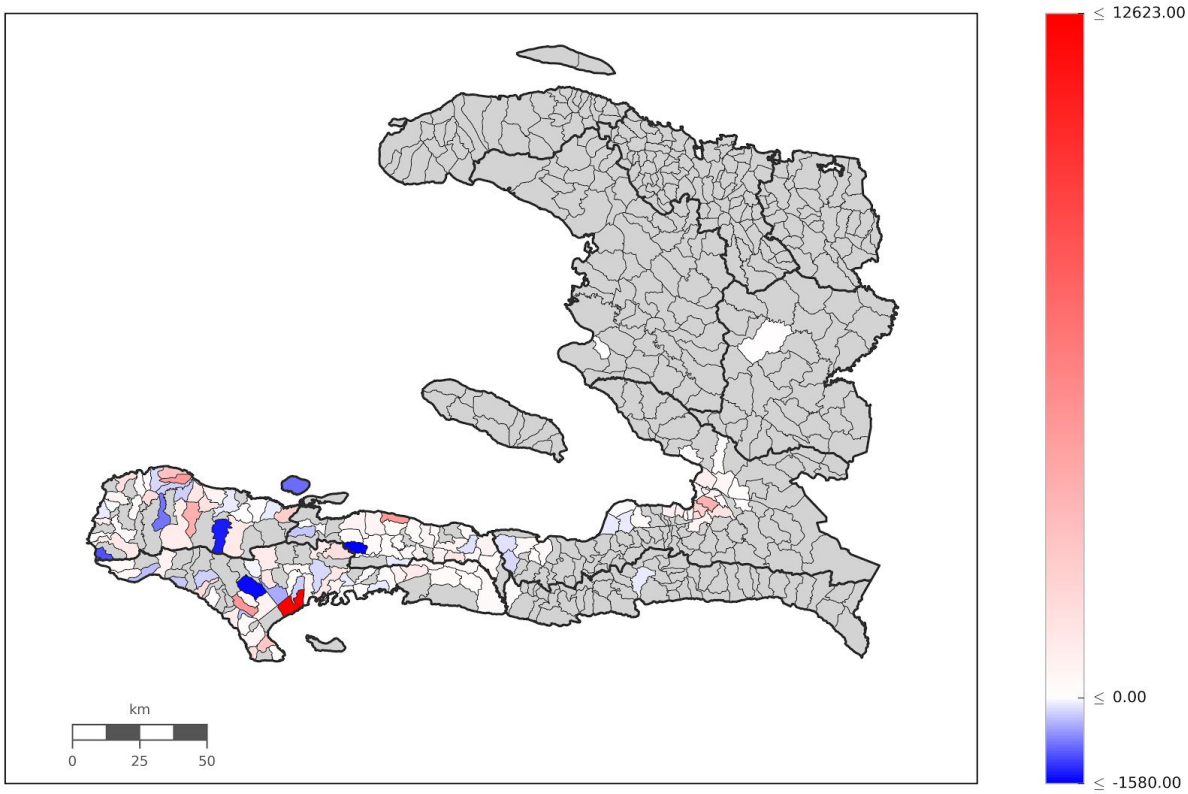
As seen at the Commune level, large movements are seen towards the urban centres.

Flows above normal



Map 11: Estimated number of people compared to normal, who arrived into Communes from the Departments of Sud, Grande Anse and Nippes.

The strong increase in flows above normal across the region indicates disruption to the normal patterns of population movement. Communes experiencing abnormally large increases in inflows of people include Chantal, Les Cayes and Arnaud, plus the Port-au-Prince metropolitan area.



Map 12: Estimated number of people compared to normal, who arrived into Section Communales from the Departments of Sud, Grande Anse and Nippes (same information as Map 11 but per Section Communale instead of per Commune)

Similar to the Commune level, a large variation in flows above normal is seen at the Section Communale level. Section Communales experiencing abnormally large increases in inflows of people include Bourdet, Veroniere, and Baconnois. Those experiencing abnormally large decreases in inflows of people include Lieve and Solon.

Population flows over time

Here we show how flows of people with pre-hurricane homes in the Departments of Sud, Grande Anse, and Nippes into and out of key areas have changed over time. The number of people in an area is the result of the balance of people moving out and people coming in. A large flow of people in and out of most areas are observed during normal times. The results below however show how movements of people (out of those with pre-hurricane home in the three Departments) out of and into urban areas spiked shortly after the hurricane and remain high in e.g. Jeremie, Les Cayes, and the Port-au-Prince metropolitan area.

Population Inflows

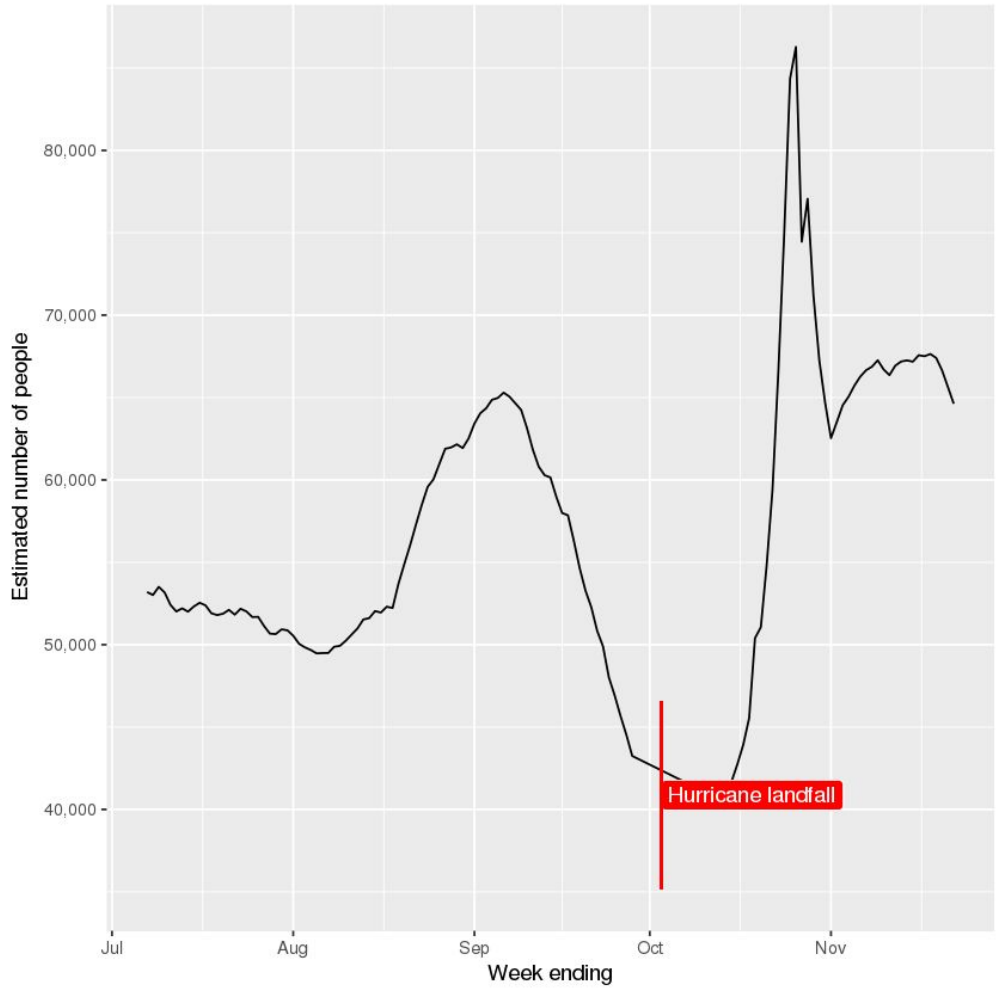


Figure 2. Estimated number of people per week arriving into the Port-au-Prince metropolitan area[1] from the Departments of Sud, Grande Anse, and Nippes.

[1] Defined as the Section Communales 1re Section Turgeau, 2e Section Morne l'Hôpital, 3e Section Martissant, 1re Section St Martin, 10e Section Thor, 11e Section Rivière Froide, 13e Section Corail Thor, 1re Section Morne Chandelle, 2e Section Platon Dufréné, 3e Section Taïfer, 4e Section Procy, 5e Section Coupeau, 7e Section Lavalle, 9e Section Bizoton, 1re Section Montagne Noire, 3e Section Etang du Jonc, 4e Section Bellevue la Montagne, 5e Section Bellevue Chardonnière, 1re Section des Varreux (Cité Soleil), 2e Section des Varreux (Cité Soleil), 3e Section Bellevue, 4e Section Bellevue, 1re Section des Varreux (Croix-des-Bouquets), 2e Section des Varreux (Croix-des-Bouquets) and 3e Section Petit Bois.

The Port-au-Prince metropolitan area has experienced a significant influx of people, which peaked during the last week of October, and has subsequently begun to tail off.

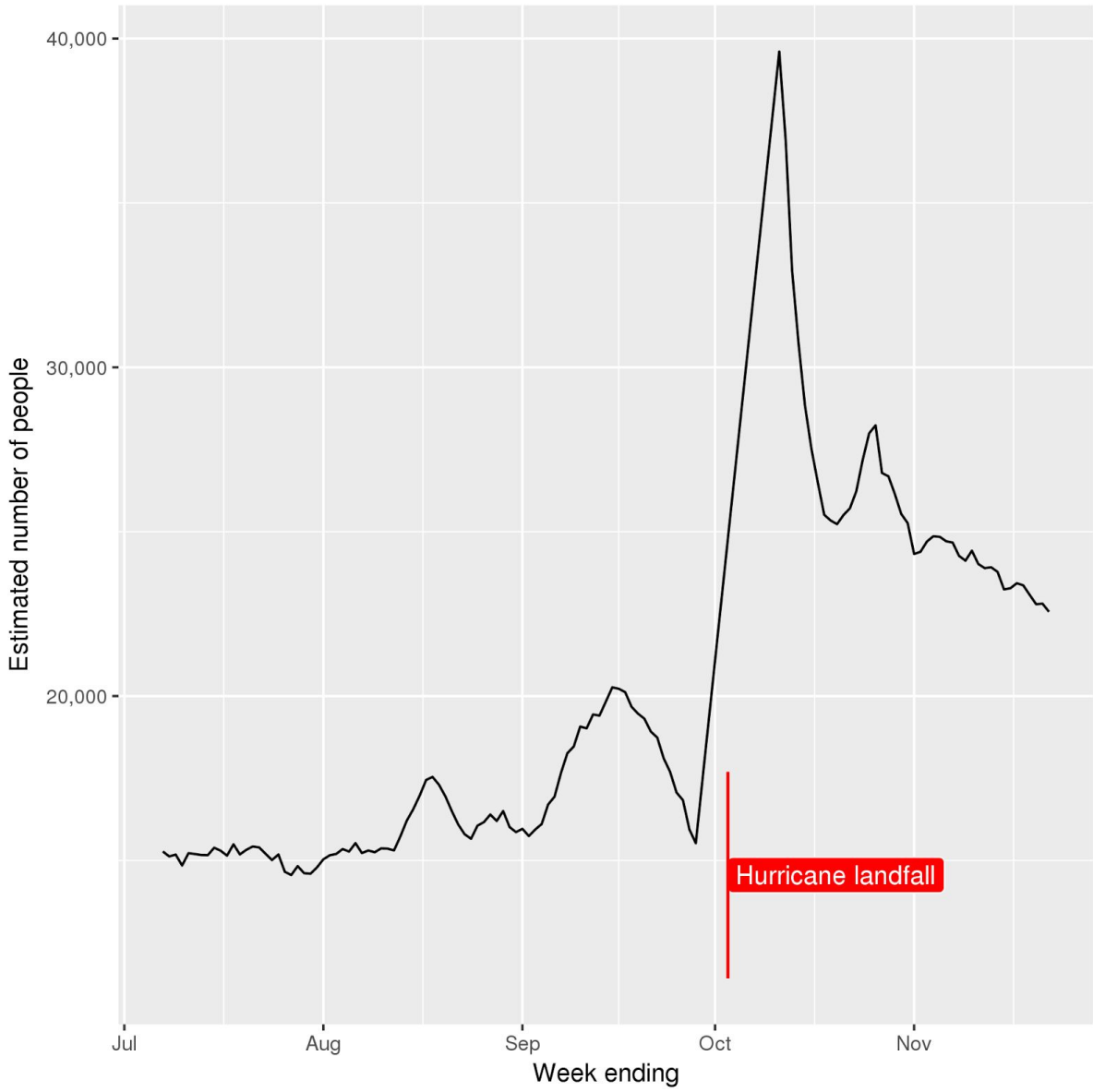


Figure 3. Estimated number of people per week arriving into the Commune of Les Cayes from the Departments of Sud, Grande Anse, and Nippes

Significant numbers of people arrived into Les Cayes, with inflow peaking shortly after the hurricane, and beginning to reduce moving into November.

Population Outflows

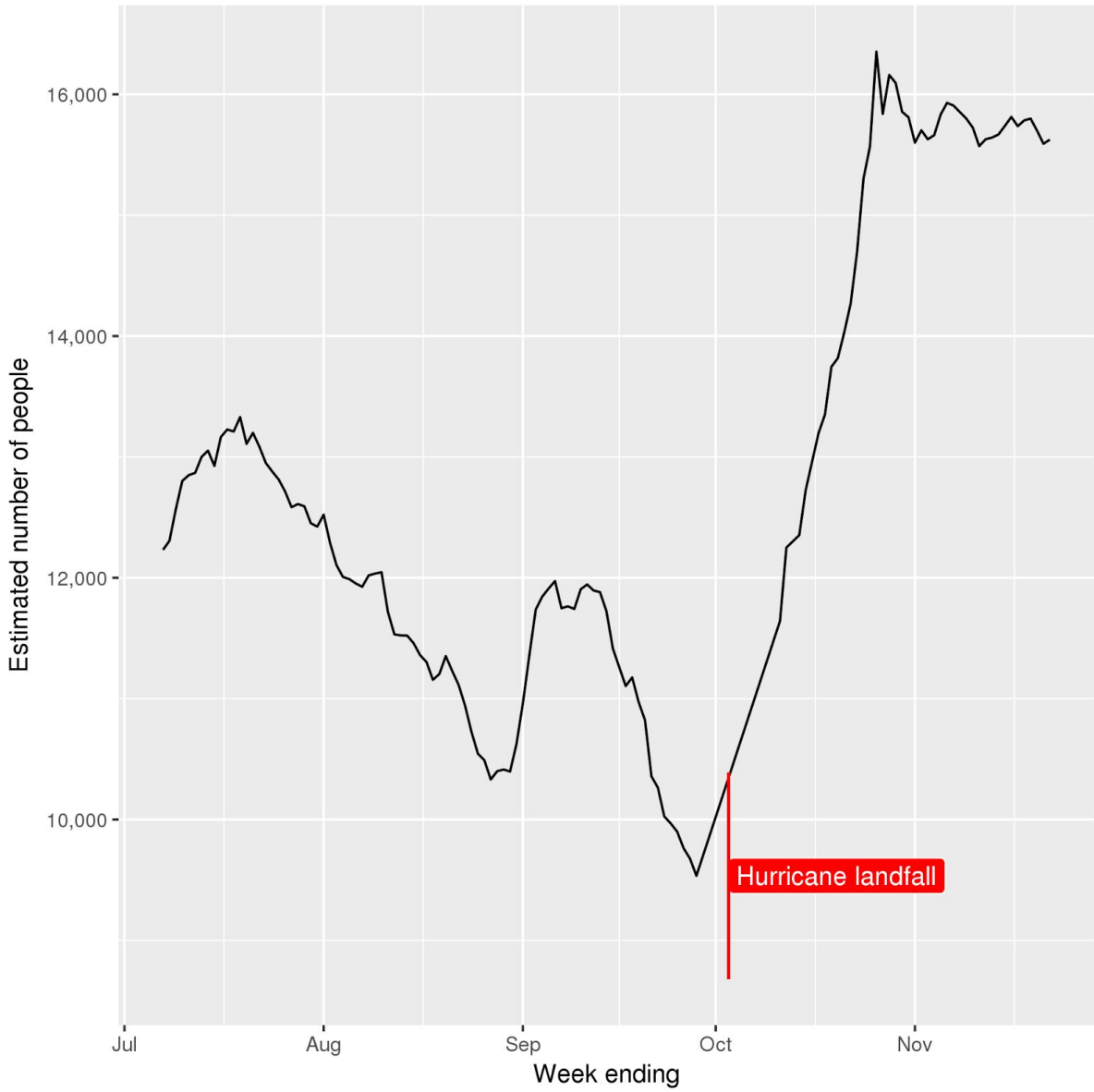


Figure 4. Estimated number of people leaving the Commune of Jérémie per week.

The number of people leaving Jérémie rose steadily throughout October, and has stabilised at a significantly higher level than normal in the last three weeks.

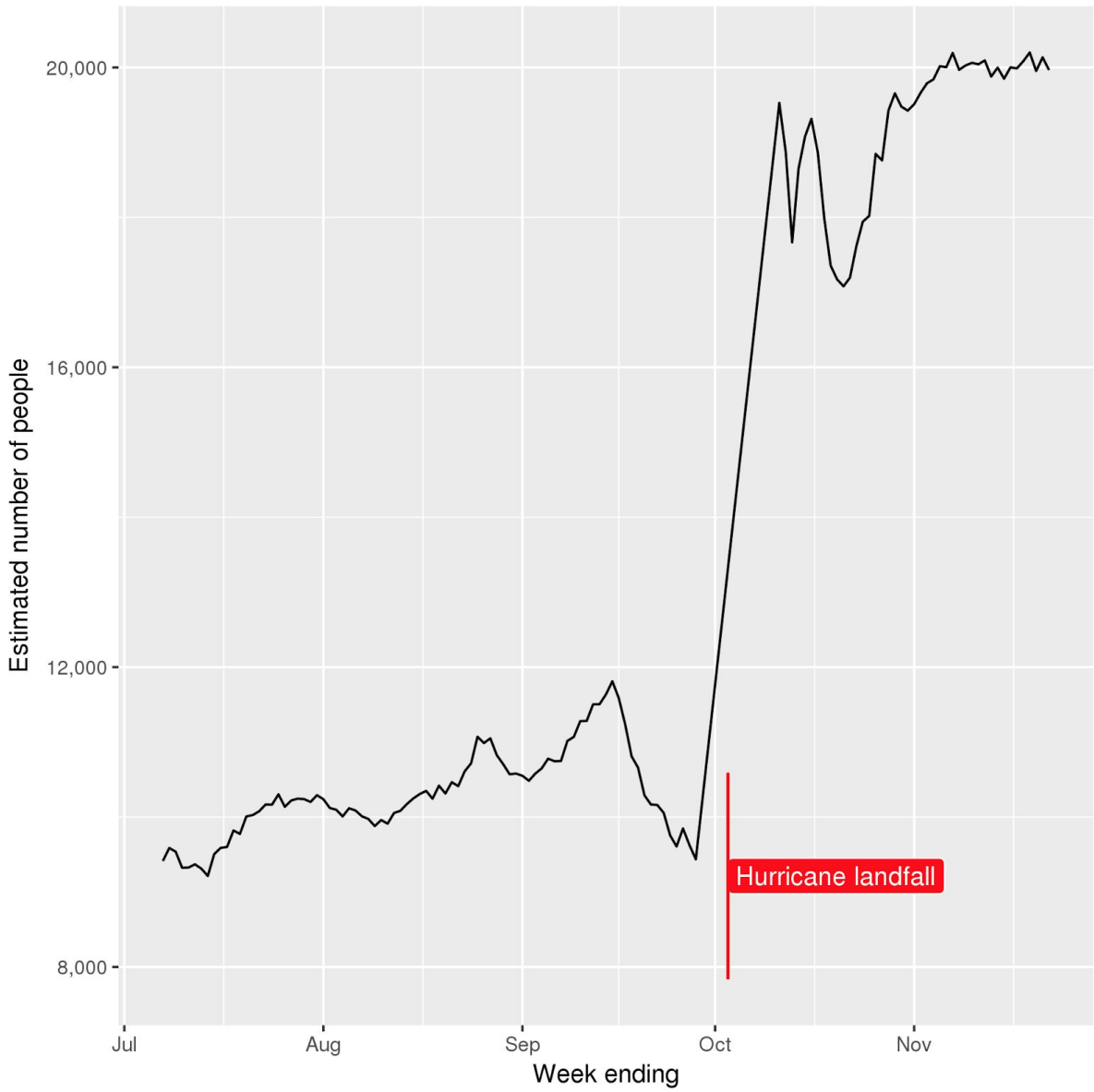


Figure 5. Estimated number of people leaving the Commune of Torbeck on a weekly basis.

The number of people leaving Torbeck increased sharply between the evacuation warning being given, and the first week after the hurricane. Departures remain high, and have stabilised at close to twice normal levels.