

Johnson & Johnson



# Hyperlocal Targeting of Vaccine Hesitancy in Rwanda

Prepared by Fraym for Johnson & Johnson Global Public Health

February 2022

# Hyperlocal Support of Vaccine Uptake: Overview

We aim to bring local understanding of uptake barriers across SSA

## Goals



A **deeper understanding** of the 3C's occur locally and across entire countries to inform broad Risk Communication and Community Engagement (RCCE) efforts.



A **detailed mapping of J&J's consumer segments** and media consumption patterns across the country to close the gap between data and action.

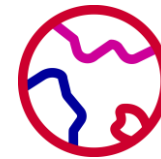


An **interactive tool to equip implementors with hyperlocal data** to overcome barriers to vaccine uptake faster.

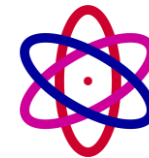
## Outputs



**Comprehensive reports** containing overviews and detailed assessments of hyperlocal patterns of vaccine confidence, convenience, complacency, consumer segmentation, and media consumption patterns across the entire country.



**DATAfraym® – an interactive web-based dashboard** – access, for custom data exploration, analysis, and exports, with mapping available at a 1 km<sup>2</sup> level of granularity.



**Complete datasets** available regarding vaccine confidence, complacency, convenience, consumer segmentation, and media consumption patterns across the entire country, at a 1 km<sup>2</sup> level of granularity.

# Paired with World Health Organization’s 3Cs Framework, Fraym has mapped J&J’s Consumer Segments to identify where vaccine uptake challenges are likely to occur



## The 3Cs

- Confidence:** High confidence = *More* likely to take a vaccine
- Convenience:** High convenience = *More* likely to take a vaccine
- Complacency:** High complacency = *Less* likely to take a vaccine

### Meet the segments: An introduction

	Segment 1 Confident enthusiasts	Segment 2 Vaccine sceptics	Segment 3 COVID cynics	Segment 4 Enthusiastic pragmatists	Segment 5 Vaccine ambivalents
Summary	Convinced of COVID threat and vaccine benefits. Would be quick adopters driven by social responsibility to protect their community.	Convinced of COVID threat, but scepticism around vaccine safety and efficacy inhibits perceived benefit and quick uptake.	Strongly hesitant of COVID threat and a COVID vaccine. Mistrust in the vaccine's purpose and advocates means they will be slow to vaccine adoption, if at all.	Convinced of COVID threat and merits of a vaccine, but inhibited by practical barriers. Cost-benefit analysis of the process could cause uptake delay.	Not convinced of the threat of COVID as a disease and lack motivation to seek a vaccine, but few barriers to uptake. Could be moved by social norms and strong messaging.
% of population	24%	25%	12%	19%	20%
Likelihood to take a COVID-19 vaccine	Very High	Moderately low	Very Low	High	Moderate
Speed of uptake	As soon as possible	Wait at least 6-12 months	Never	As soon as possible	Wait at least 6-12 months
Perceived ease of getting the vaccine	Very easy	Fairly easy	Fairly easy	Not easy/not at all easy	Fairly easy
COVID disease perceptions	High perceived risk and severity	High perceived risk and severity	Low perceived risk and severity	High perceived risk and severity	Low perceived risk and severity

## Consumer Segmentation

Different segments of people have different motivations and reasons to not get a COVID- 19 vaccine (barriers)

# Methodology

# Machine Learning for Hyperlocal Mapping

Fraym has built machine learning (ML) software that weaves together geo-tagged household survey data with satellite imagery to create localized population information (1 km<sup>2</sup>).

1

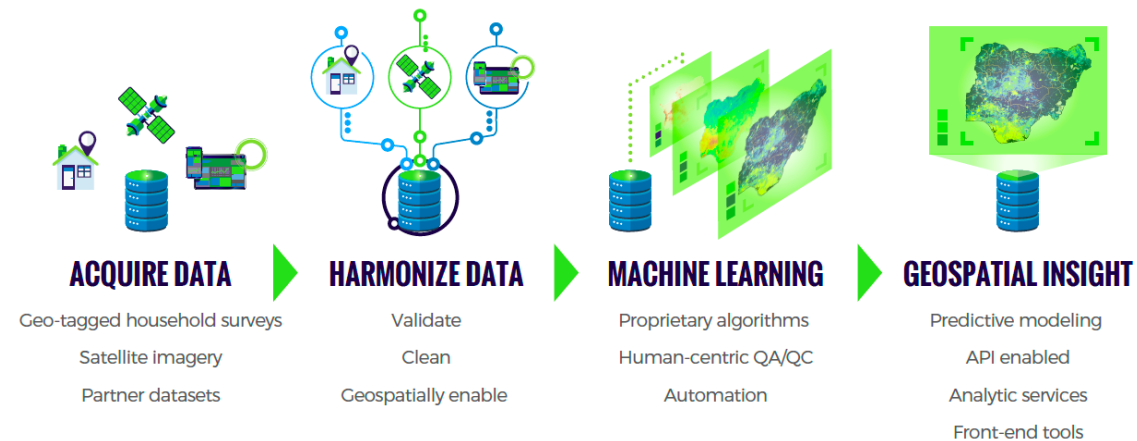
The primary ML model input is data from high-quality, geo-tagged household surveys. Key indications of a high-quality household survey include implementing organization(s), sample design, sample size, and response rates. After data collection, *post-hoc* sampling weights are created to account for any oversampling and ensure representativeness.

2

The second major data input is satellite imagery and related derived data products, including Earth observation (EO) data, gridded population information (e.g., human settlement mapping, etc.), proximity to physical locations (e.g., health clinics, ports, roads, etc.) and biophysical surfaces like soil characteristics. As with the survey data, Fraym data scientists ensure that the software only uses high-quality imagery and derivative inputs.

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To create spatial layers from household survey data, Fraym leverages machine learning to predict an indicator of interest at a 1 square kilometer resolution. This methodology builds upon existing, tested methodologies for interpolation of spatial data. The resulting model is used to predict the survey data for all non-enumerated areas. A similar approach was originally developed by academic researchers focused on health outcomes, which were expanded upon by USAID's Demographic and Health Surveys program since then by Fraym and others.<sup>1</sup>



**Note 1:** Gething, Peter, Andy Tatem, Tom Bird, and Clara R. Burgert-Brucker. 2015. Creating Spatial Interpolation Surfaces with DHS Data DHS Spatial Analysis Reports No. 11. Rockville, Maryland, USA: ICF International. Other notable, relevant work includes: Weiss DJ, Lucas TCD, Nguyen M, et al. Mapping the global prevalence, incidence, and mortality of *Plasmodium falciparum*, 2000–17: a spatial and temporal modelling study. Lancet 2019 and Tatem A, Gething P, Pezzulo C, Weiss D, and Bhatt S. 2014. Final Report: Development of High-Resolution Gridded Poverty Surfaces. University of Southampton. <https://www.worldpop.org/resources/docs/pdf/Poverty-mapping-report.pdf>

# 3Cs Model of Vaccine Hesitancy

Fraym used the *WHO Sage Working Group on Vaccine Hesitancy* backed 3Cs Model to analyze and segment vaccine hesitant populations.

## The 3Cs Model of Vaccine Hesitancy

- ① **Confidence:** Trust in the effectiveness and safety of vaccines, the system that delivers them, and the motivations of policymakers.
- ② **Convenience:** Physical availability, affordability, and willingness-to-pay, geographical accessibility, ability to understand, and appeal of immunization services.
- ③ **Complacency:** Level to which perceived risks of vaccine-preventable diseases are low and vaccination is not deemed a necessary preventative action.

Source 1: [https://www.who.int/immunization/sage/meetings/2014/october/1\\_Report\\_WORKING\\_GROUP\\_vaccine\\_hesitancy\\_final.pdf](https://www.who.int/immunization/sage/meetings/2014/october/1_Report_WORKING_GROUP_vaccine_hesitancy_final.pdf)

Source 2: <https://africacdc.org/download/covid-19-vaccine-perceptions-a-15-country-study/>

Source 3: <https://pubmed.ncbi.nlm.nih.gov/33684019/>

# Indicators for the “3Cs” Model<sup>1</sup>

## Vaccine Hesitancy

### Convenience

### Complacency

Accessibility

Perceived Time Burden

Perceived Financial Burden

Interactions with the Health System

Distance to Health Facility (Walking)

Distance to Health Facility (Driving)

Car or scooter ownership

Access to a Smart-phone or Tablet

Caregiving/domestic responsibilities

Time to fetch water

Bottom wealth quintile

Unemployment or agricultural employment

No previous childhood vaccination

Post-natal care

Family planning

Place of delivery

**Note 1:** Full indicator descriptions are available in the Appendix.

**Note 2:** The Rwanda report does not include an analysis of confidence because the Afrobarometer or similar public opinion dataset is not available in this country.

**Source:** Rwanda Demographic and Health Surveys, World Health Organization, Malaria Atlas Project “Global maps of travel time to health facilities”



# Profiles of Vaccine Hesitant Segments

Fraym created each profile based on their unique combination of the 3Cs. The replicated Ipsos segments are not exhaustive combinations of the “3Cs” and do not add to the total population of adults in Rwanda.

Segment Profile	Confident Enthusiasts	Enthusiastic Pragmatists	Vaccine Ambivalents	Vaccine Sceptics	COVID Cynics <sup>1</sup>
Segment Description	<i>Convinced of COVID threat and vaccine benefits. Would be quick adopters driven by social responsibility to protect their community.</i>	<i>Convinced of COVID threat and merits of a vaccine, but inhibited by practical barriers. Cost-benefit analysis of the process could cause uptake delay.</i>	<i>Not convinced of the threat of COVID as a disease and lack motivation to seek a vaccine, but few barriers to uptake. Could be moved by social norms and strong messaging.</i>	<i>Convinced of COVID threat, but scepticism around vaccine safety and efficacy inhibits perceived benefit and quick uptake.</i>	<i>Strongly hesitant of COVID threat and a COVID vaccine. Mistrust in the vaccine's purpose and advocates means they will be slow to vaccine adoption, if at all.</i>
Level of Confidence	High	High	Moderate	Low	Low
Level of Convenience	High	Low	Moderate	Moderate	Moderate
Level of Complacency	Low	Low	High	Low	High
Potential Speed of Vaccine Uptake	Rapid	Delayed	Slow	Very Slow	Least Likely

**Note 1:** The Rwanda report does not include an analysis of COVID cynics because without a source for confidence, Fraym is unable to differentiate the vaccine ambivalents and COVID cynics.



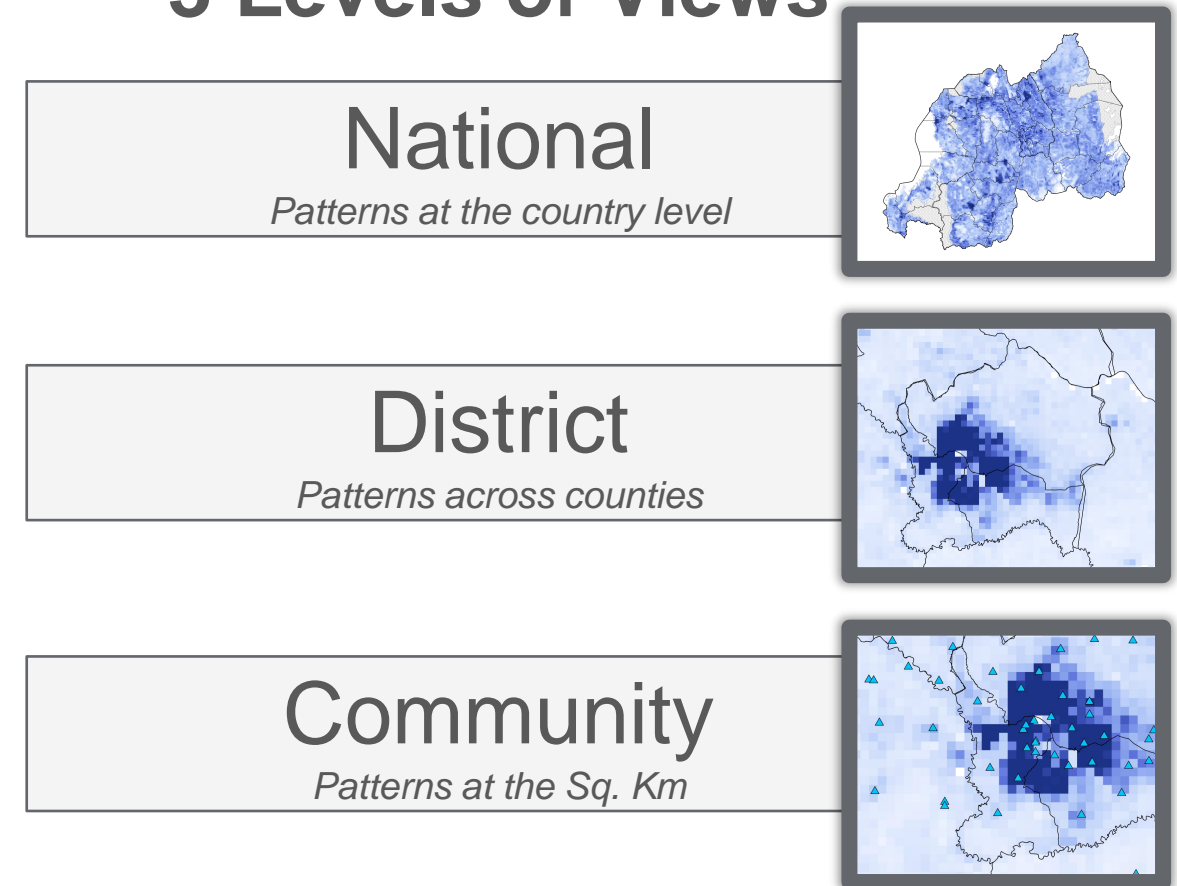
# How to use this analysis

Paired with WHO's 3Cs Framework, Fraym has mapped J&J's Consumer Segments to identify where vaccine uptake challenges are likely to occur.

## Potential Use-Cases:

- Concentrate communication campaigns and media spending in specific geographic areas
- Target specific messages to niche audiences in prioritized geographies
- Optimize vaccine distribution
- Service & Product Delivery Planning

## 3 Levels of Views



# Segment Mapping Use Cases

# Mapping the 3Cs of Vaccine Hesitancy





Fraym created hyper-local maps of vaccine complacency and convenience.

- 1 Fraym used the 2020 Rwanda Demographic and Health Survey to model vaccine complacency and convenience. Since the Afrobarometer is not available for Rwanda, confidence is not incorporated.
- 2 Vaccine complacency indicators were created based on limited interactions with the health system as a proxy for low perceived risk for diseases and preventative actions. Vaccine convenience indicators focus on accessibility, as well as time and financial burdens associated with getting vaccinated. Fraym utilized multiple correspondence analysis (MCA) to create complacency and convenience indices and normalized index values from zero to one.<sup>1</sup>
- 3 The Rwanda report does not include an analysis of confidence because the Afrobarometer or similar public opinion dataset is not available in this country.

**Note 1:** To learn more about MCA, please visit <https://www.sciencedirect.com/topics/computer-science/multiple-correspondence-analysis>.

# Demographics of Vaccine Segments

Fraym analyzed the demographic characteristics of each segment among adults aged 15-49.

	Confident Enthusiasts	Enthusiastic Pragmatists	Vaccine Ambivalents	Vaccine Sceptics	COVID Cynics <sup>2</sup>
<b>Age</b>					
 15-34	59%	54%	43%	54%	Not available
35-49	41%	46%	57%	46%	Not available
<b>Education</b>					
 No education	9%	18%	11%	10%	Not available
Complete primary	22%	18%	27%	24%	Not available
Complete secondary	8%	3%	4%	5%	Not available
Higher education	7%	1%	1%	2%	Not available
<b>Regular Media Consumption<sup>1</sup></b>					
 Newspaper/Magazine	13%	3%	7%	6%	Not available
Television	32%	8%	19%	20%	Not available
Radio	67%	53%	68%	64%	Not available
<b>Asset Ownership</b>					
 Mobile phone	87%	61%	85%	85%	Not available
Television	32%	7%	16%	19%	Not available
Radio	49%	35%	44%	45%	Not available

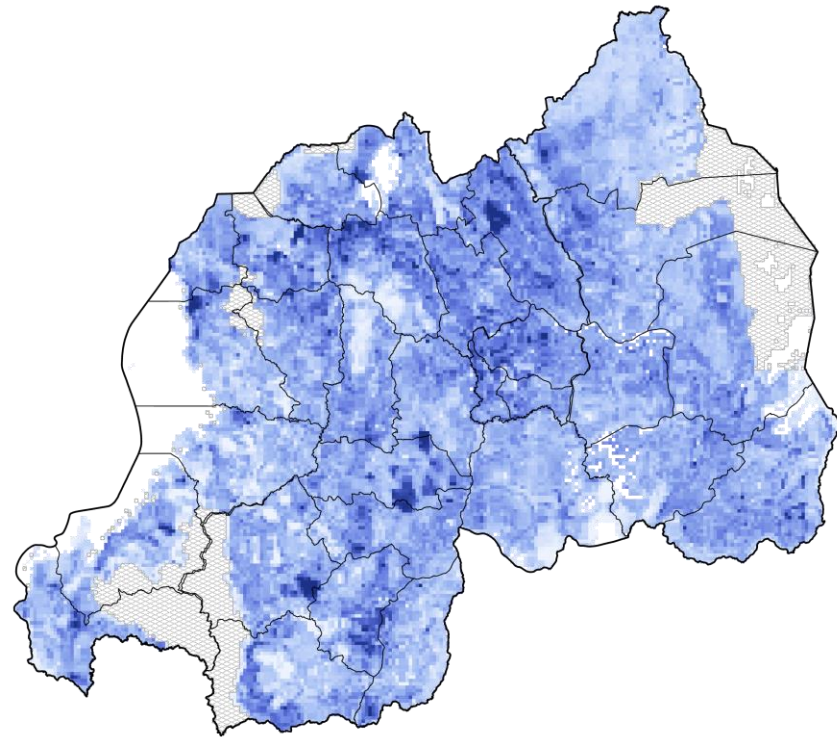
**Note 1:** Regular media consumption is defined as listening to the radio, watching television, or reading a newspaper or magazine at least once per week.

**Note 2:** COVID Cynic data is not available for Rwanda. Due to the lack of the Afrobarometer or similar confidence indicators, Vaccine Ambivalents cannot be differentiated from COVID Cynics in Rwanda.

**Note 3:** Categories do not add to 100% due to response options not shown.

# Identifying Vaccine Ambivalents and Vaccine Sceptics

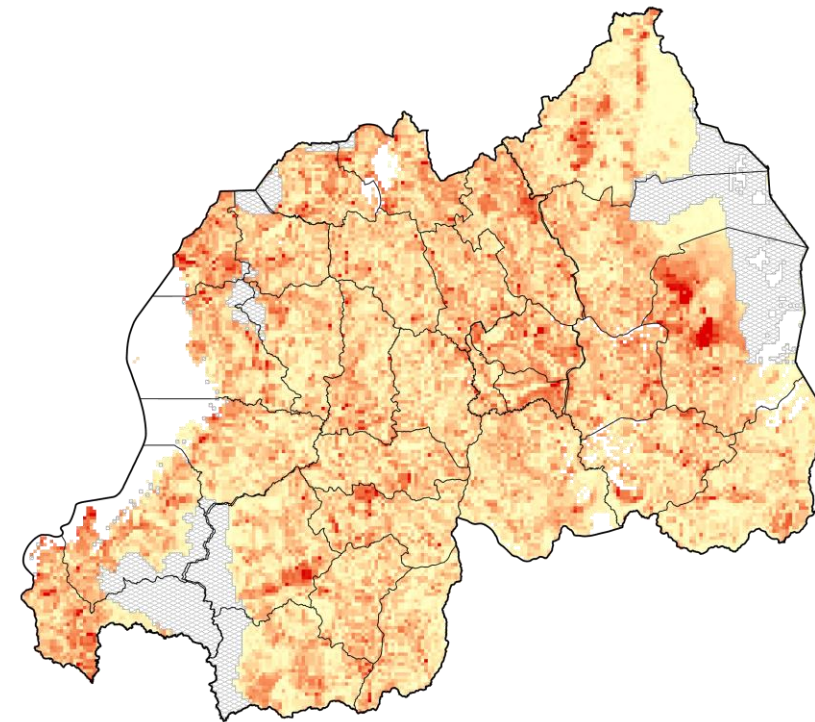
Proportion of adults 15-49 who are high complacency, moderate convenience<sup>1</sup>



Low High

Vaccine ambivalents (high complacency and moderate convenience) are not convinced of the threat of COVID as a disease and lack motivation to seek a vaccine, but face few barriers to uptake. This group could be moved by social norms and strong messaging.

Proportion of adults 15-49 who are low complacency, moderate convenience<sup>1</sup>



Low High

Vaccine sceptics are convinced of COVID threat, but have scepticism around vaccine safety and efficacy inhibits perceived benefit and quick uptake. Trust in the vaccine and the system that delivers it are key levers for this segment.

**Note 1:** High complacency adults are adults who are in the third tercile of the complacency index, and moderate convenience in the second tercile of the convenience index.

**Note 2:** Low complacency adults are adults who are in the first tercile of the complacency index, and moderate convenience in the second tercile of the convenience index.

Source: 2020 Rwanda DHS, Fraym



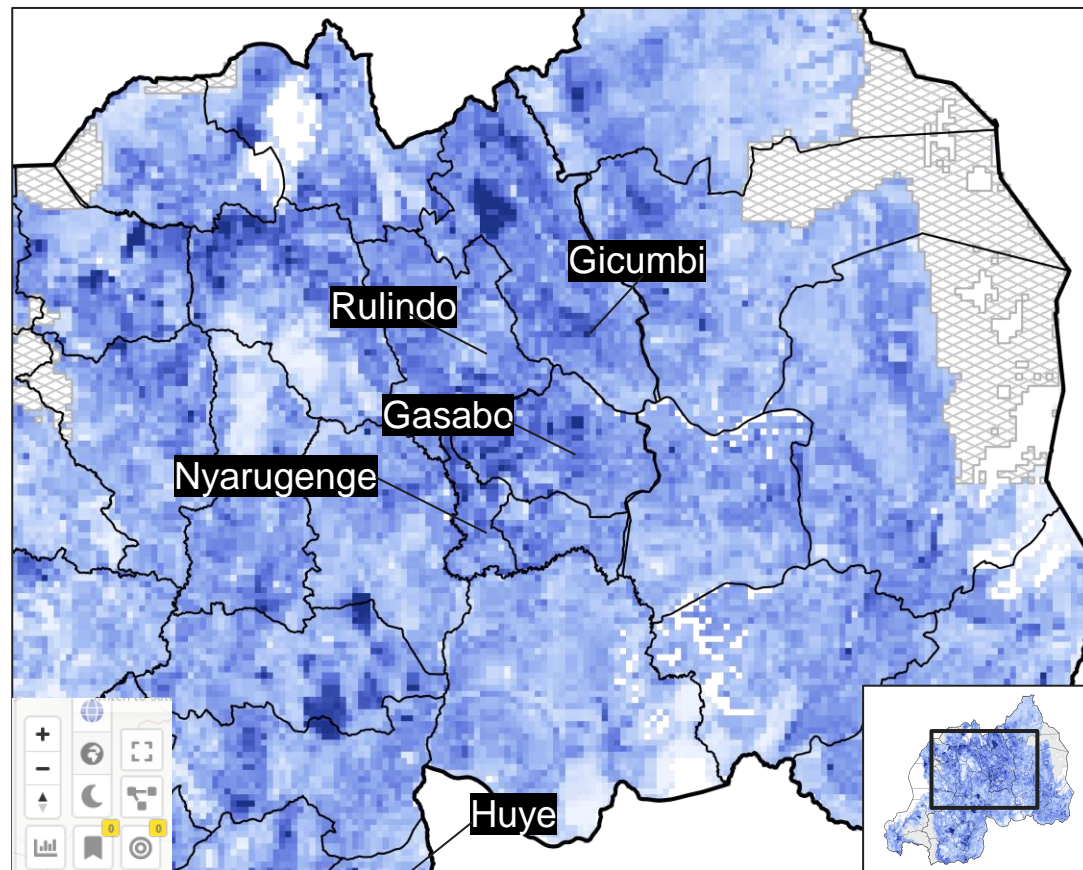
# Top Districts: Vaccine Ambivalents



Tip: Use the DATAfraym® “Top Locations” tool to view locations with the highest values for your chosen indicator.

Fraym calculated the percentage of vaccine ambivalents and aggregated them to the district level to identify the areas most in need *and* least likely to receive vaccines.<sup>1</sup>

Proportion of vaccine ambivalents



DATAfraym® allows users to target priority populations depending on specific programming needs. Fraym first identified the number of adults in a district, then found the proportion of high complacency adults. Of these high complacency adults, Fraym identified vaccine ambivalents who have moderate levels of convenience and confidence.

Rank (by % of vaccine ambivalents)	Province	District	Adult 15-49 population	High complacency (%)	Vaccine Ambivalents (%)	Vaccine Ambivalents (# of people)
1	Kigali	Nyarugenge	246,000	35%	13%	31,000
2	Northern	Gicumbi	222,000	41%	12%	27,000
3	Kigali	Gasabo	492,000	39%	12%	58,000
4	Northern	Rulindo	162,000	39%	11%	18,000
5	Southern	Huye	210,000	43%	11%	23,000

**Note 1:** The proportion of vaccine ambivalents was generated for every 1km<sup>2</sup> grid across Rwanda and then aggregated to the district level.

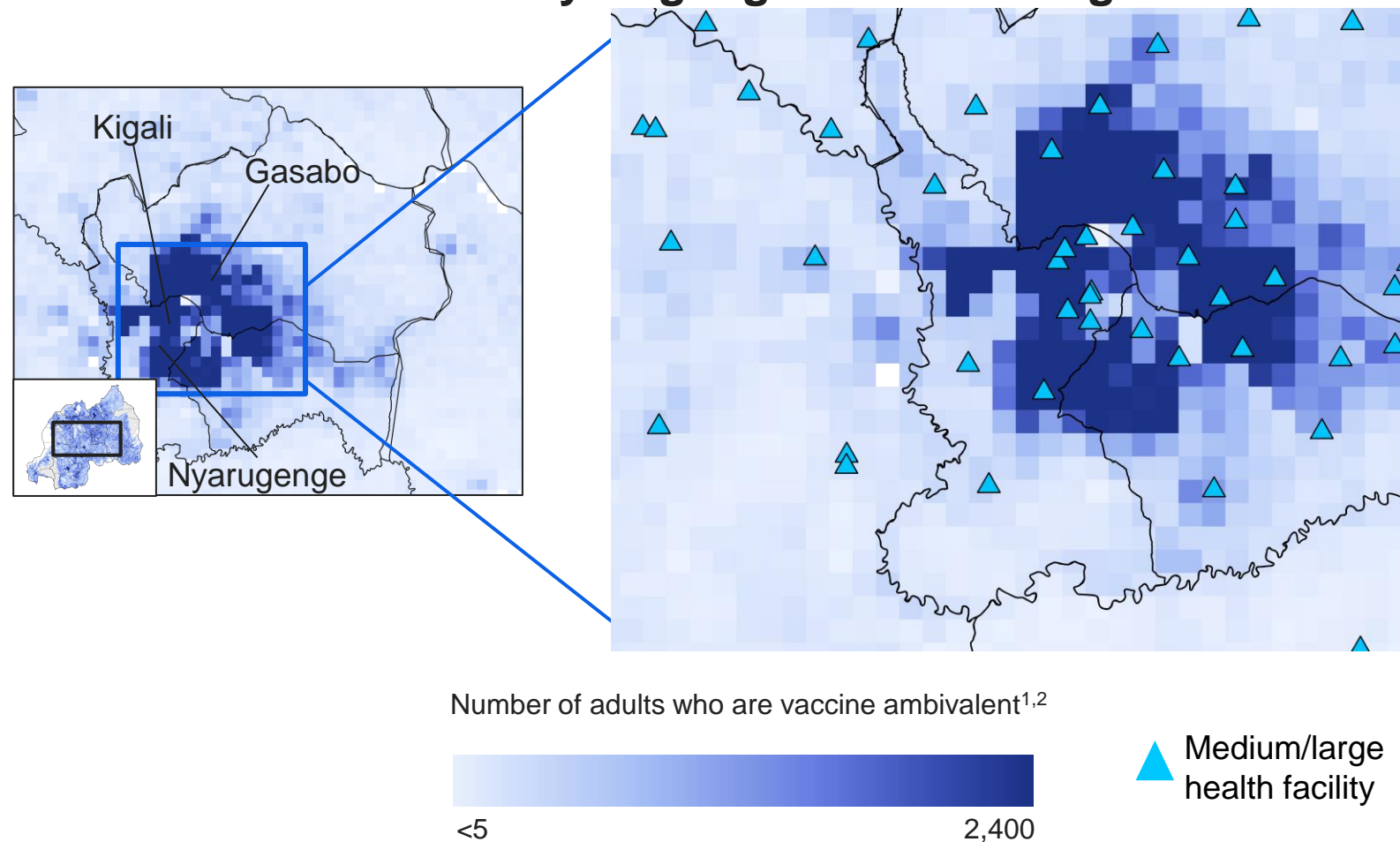
# Vaccine Ambivalents: Hyperlocal View

Communities with high numbers of vaccine ambivalent adults have access to several medium and large medium health centers. This signals that complacency, rather than access, is the main challenge for this group.

## Zoom into Nyarugenge District in Kigali Province

1 million adults live in the **Kigali** province, of which **115,000 (11%)** are expected to be vaccine ambivalents.

- Hotspots of vaccine ambivalent adults around Kigali can be found in the bordering urban district areas such as **Nyarugenge, Gasabo, and Nyanza**. This group may require more targeted outreach to take the vaccine.
- Risk communication campaigns for this group will be critical to explain the threat COVID-19 poses to them and their loved-ones. **Radio** (44% ownership) and **mobile phone** (85% ownership) campaigns will be most effective.



**Note 1:** Adults are defined as individuals aged 15-49.

**Note 2:** Map shows the number of adults who are high complacency and moderate convenience.

**Source:** 2020 Rwanda DHS, Fraym



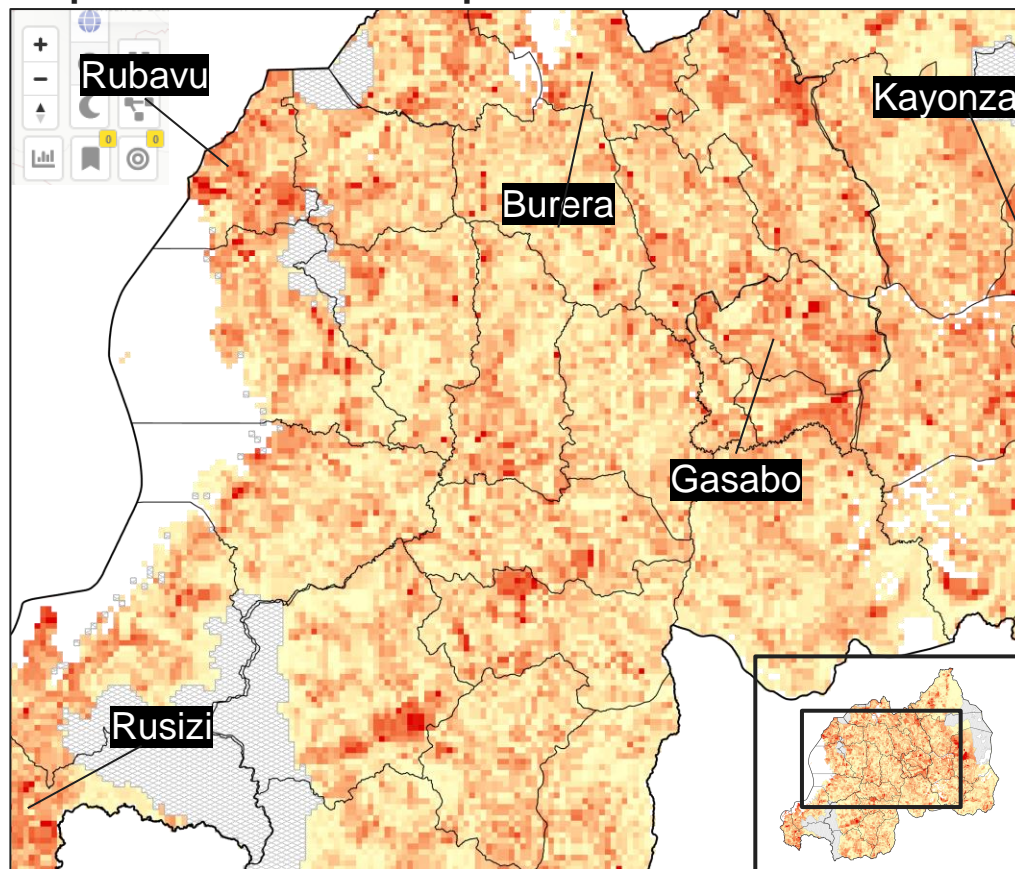
# Top Districts: Vaccine Sceptics



Tip: Use the DATAfraym® “Top Locations” tool to view locations with the highest values for your chosen indicator.

Fraym calculated the percentage of vaccine sceptics and aggregated them to the district level to identify the areas most in need *and* least likely to receive vaccines.<sup>1</sup>

Proportion of vaccine sceptics



DATAfraym® allows users to target priority populations depending on specific programming needs. Fraym first identified the number of adults in a district, then found the proportion of low complacency adults. Of these low complacency adults, Fraym identified vaccine sceptics who have moderate levels of convenience and low confidence.

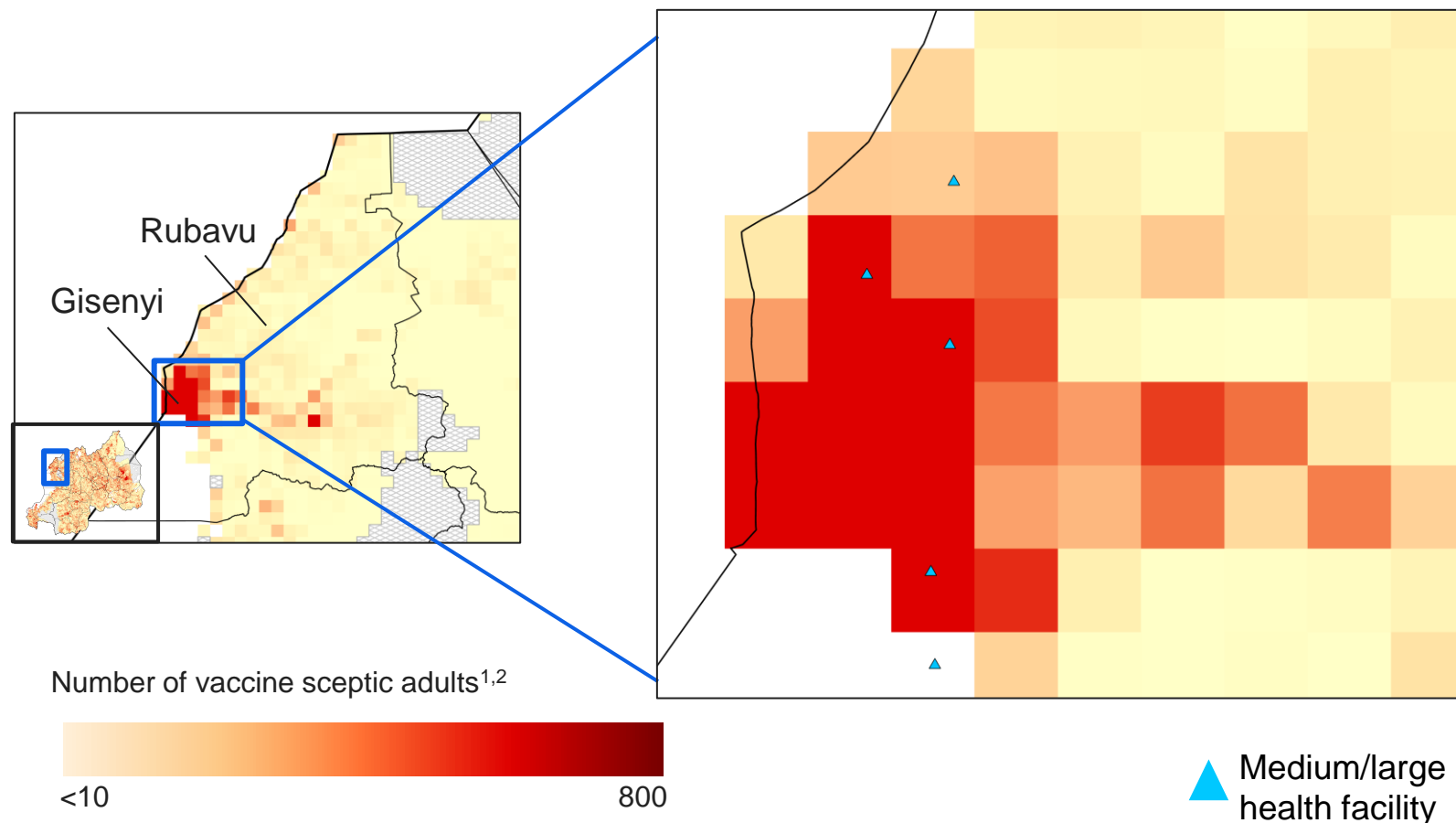
Rank (by % of vaccine sceptics)	Province	District	Adult 15-49 population	Low complacency (%)	Vaccine Sceptics (%)	Vaccine Sceptics (# of people)
1	Western	Rubavu	287,000	21%	6%	16,000
2	Western	Rusizi	258,000	18%	5%	12,000
3	Eastern	Kayonza	254,000	20%	4%	11,000
4	Northern	Burera	161,000	21%	4%	7,000
5	Kigali	Gasabo	492,000	18%	4%	21,000

**Note 1:** The proportion of vaccine sceptics was generated for every 1km<sup>2</sup> grid across Rwanda and then aggregated to the district level.

# Vaccine Sceptics: Hyperlocal View

Vaccine sceptics are convinced of the COVID threat, but low confidence in the government may make vaccine outreach more challenging.

## Zoom into Rubavu in Western Province



Nearly **300,000** adults live in Rubavu district, of which **16,000 (6%)** are expected to be vaccine sceptics.

- Most vaccine sceptics live in towns near the border with the DR Congo, such as **Gisenyi**. This group may take the vaccine at a slower rate given their moderate convenience and low confidence.
- There are already a few medium and large health facilities in these areas, but Rubavu could benefit from more **targeted outreach** to bridge the gap in confidence.
- Low confidence in the government poses a significant challenge but 85% have access to a **mobile phone** for possible media campaigns.

**Note 1:** Adults are defined as individuals aged 15-49.

**Note 2:** Map shows the number of adults who are low complacency and moderate convenience.

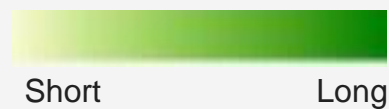
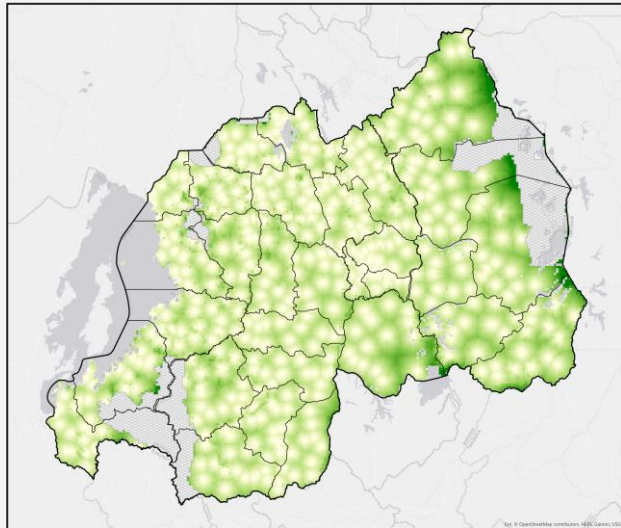
**Source:** 2020 Rwanda DHS, Fraym



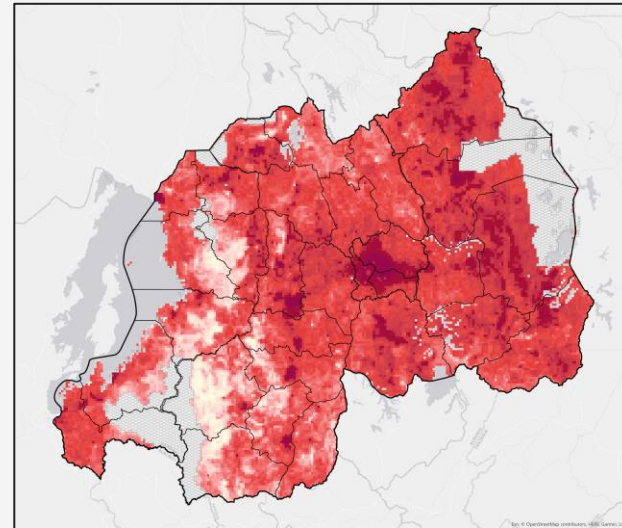
# Community-Level Context

Contextual information at the community level can help inform broad RCCE efforts. All of these data indicators are in the DATAfraym® dashboard with geographic precision at the 1km2, municipality, and department levels.

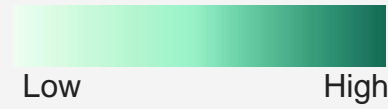
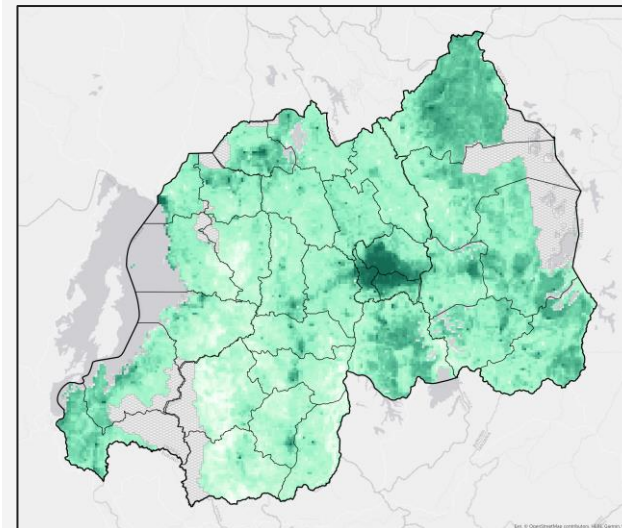
**Walking Distance to Health Facility (min)**



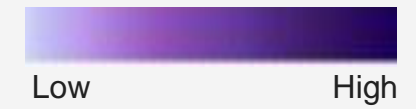
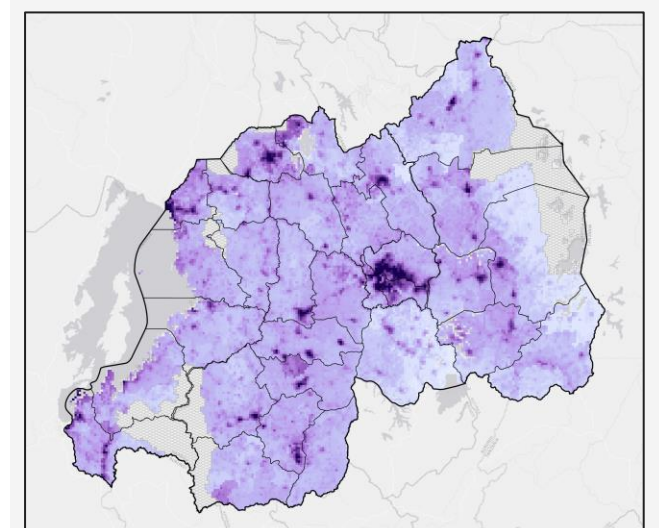
**Radio Listenership (%)**



**Mobile Phone (%)**



**Elderly Population 60+ (# of People)**



Source: 2020 Rwanda DHS, 2020 Malaria Atlas Project

# Data and Methods

# Indicators for COVID-19 Vaccine Complacency

Fraym modeled COVID-19 vaccine complacency based low interactions with the health system.

Indicator	Description
<b>Interactions with the health system:</b> Individuals living in households with limited preventative or birth-related services.	
No previous childhood vaccination	Individual lives in a household where at least one under 5 child has not been vaccinated for polio, diphtheria, pertussis (whooping cough), and tetanus (DPT), hepatitis B, or measles.
Post-natal care	Individual lives in a household where at least one woman received a postnatal check within 2 months of giving any births in the past 0-35 months.
Family planning	Individual lives in a household where at least woman has heard of family planning at a health facility in the past 12 months.
Place of delivery	Individual lives in a household where a woman has given birth at a government hospital, government health center, government health post, or a private hospital/clinic for any births in the past 0-35 months.

Source: 2020 Rwanda DHS.

# Indicators for COVID-19 Vaccine Convenience

Fraym modeled COVID-19 vaccine convenience with accessibility, time burden, and financial burden.

Indicator	Description
<b>Accessibility:</b> Geographic distance will determine how physically feasible it is to receive a vaccine. The type of health facility will determine service capacity as well as the quality of service that can be expected	
Distance to health facility (walking)	Walking time to nearest health facility using least cost distance. Travel time will determine how physically feasible it is to receive a vaccine.
Distance to health facility (driving)	Driving time to nearest health facility using least cost distance. Travel time will determine how physically feasible it is to receive a vaccine.
Car, truck, or scooter ownership	Individual lives in a household that owns a car, truck, or scooter.
Access to a mobile phone	Individual lives in a household that owns a mobile phone. If vaccine appointments are booked primarily using a smartphone or internet connection, lack of the necessary technology may make it more difficult book an appointment and receive a jab.
<b>Time burden:</b> Concerns about time, cost or vaccine site accessibility may deter vaccine uptake.	
Caregiving/domestic responsibilities	Individual lives in a household with a child under 5 or an adult over 60.
Time to fetch water	Individual lives in a household that must travel longer than 1 hour to fetch drinking water.
<b>Financial burden:</b> Lower financial resources may affect the ability to receive a vaccine, particularly if the vaccine is perceived as costly.	
Bottom wealth quintile	Individual lives in a household that is in the bottom of the DHS wealth quintile. <sup>1</sup>
Unemployment or agricultural employment	Individual is employed in the agriculture sector or is unemployed.

**Source:** 2020 Rwanda DHS, 2020 Malaria Atlas Project “Global maps of travel time to healthcare facilities”

**Note 1:** The wealth index is a composite measure of a household’s cumulative living standard from the DHS survey, calculated using information on household asset ownership, housing materials, and access to water and sanitation services. The first quintile is the poorest while the fifth quintile is the wealthiest.

# About Fraym



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## ACQUIRE DATA

Geo-tagged household surveys  
Satellite imagery  
Partner datasets  
Mobility data from network operators



## HARMONIZE DATA

Validate  
Clean  
Geospatially enable



## MACHINE LEARNING

Proprietary algorithms  
Human-centric QA/QC  
Automation



## GEOSPATIAL INSIGHT

Predictive modeling  
API enabled  
Analytic services  
Front-end tools

# Thank you.

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