



Ghana Report

Prepared for Johnson & Johnson
Global Public Health

July 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.

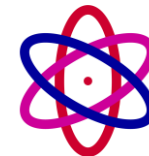
Outputs



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 km² level of granularity.

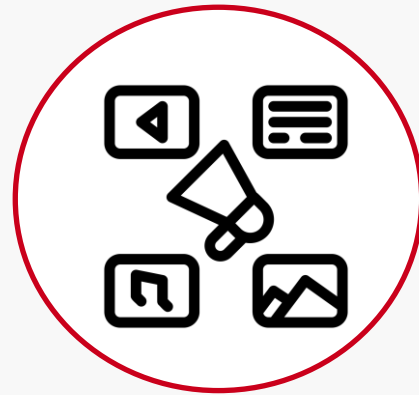


Complete datasets available regarding vaccine confidence, complacency, convenience, consumer segmentation, and media consumption patterns across the entire country, at a 1 km² level of granularity.

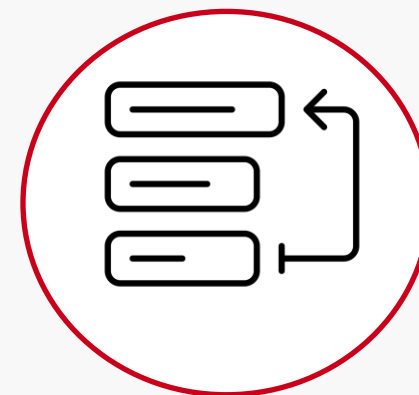
Potential Use Cases

This study provides critical insight into how **vaccine hesitancy may be increasing or decreasing** depending on the population segment and location. This will allow a more nuanced understanding of where, how, and potentially why RCCE interventions may be underperforming or having an outsized impact.

Adapting RCCE and SBC Messaging



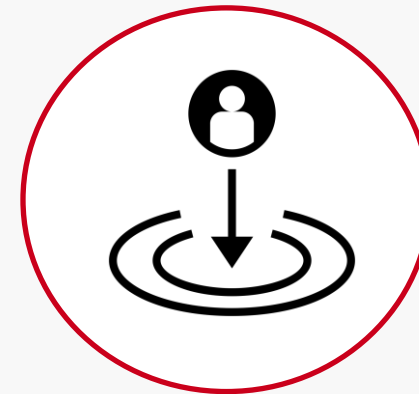
Prioritizing Resources and Interventions



Understanding the Drivers of Vaccination



Impact Measurement of Campaigns



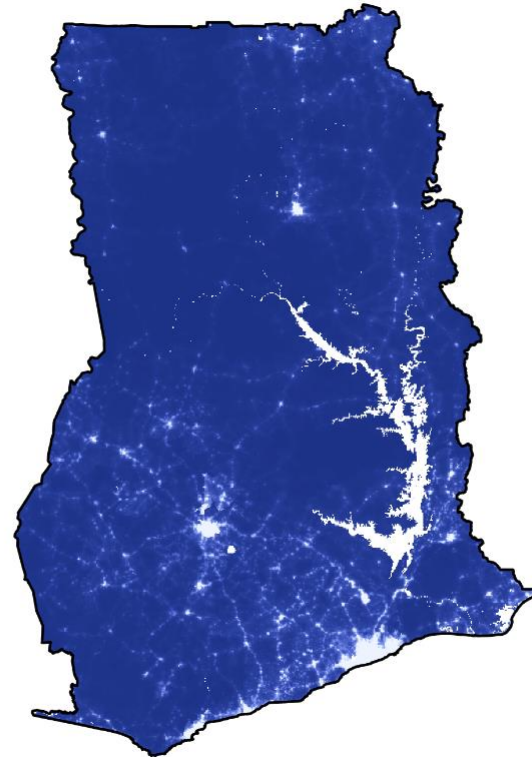
Q2 2022

METHODOLOGY

Ghana

Fraym conducted a georeferenced, **nationally representative** Computer Assisted Telephone Interview (CATI) survey in Q2 2022. The survey data was weighted to reflect the most recent population distribution from the 2021 Ghana Population and Housing Census across sex, age, and Region. Additionally, the survey was weighted to reflect urbanicity and socioeconomic status using the 2019 Ghana Malaria Indicator Survey.¹

Q2 2022



Data Collection: May 10 to June 29, 2022

Languages: English, Akan

Sample: 6,200+ adults (18+)

Sampling quotas:

State, age, sex, and urbanicity

Socioeconomic quotas based on asset ownership at the national level

Note 1: See Appendix for survey methodology notes for Q2 2022 survey.

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

- 1 3Cs Indices:** Fraym created indices for vaccine confidence, convenience, and complacency by combining a series of survey questions using multiple correspondence analysis (MCA).¹
- 2 Multivariate Regression:** Individuals were first classified into a segment based on the WHO 3Cs framework. Fraym then used multivariate regression methods to predict an individual's likelihood of belonging to each segment and classified individuals into the segment to with the highest predicted probability.²
- 3 Population Coverage:** All individuals were classified into a segment, reaching 100% of the adult population.

METHODOLOGY

Segment Distribution

The segments reach full adult population coverage. Furthermore, additional segments were created for only *Vaccinated* and *Unvaccinated* populations to capture differences between the two groups.

The largest segment among *All* and *Vaccinated* Adults are **Vaccine Ambivalents** whereas among *Unvaccinated* Adults, majority are **Covid Cynics**. The second largest segment for all populations are **Vaccine Sceptics**.

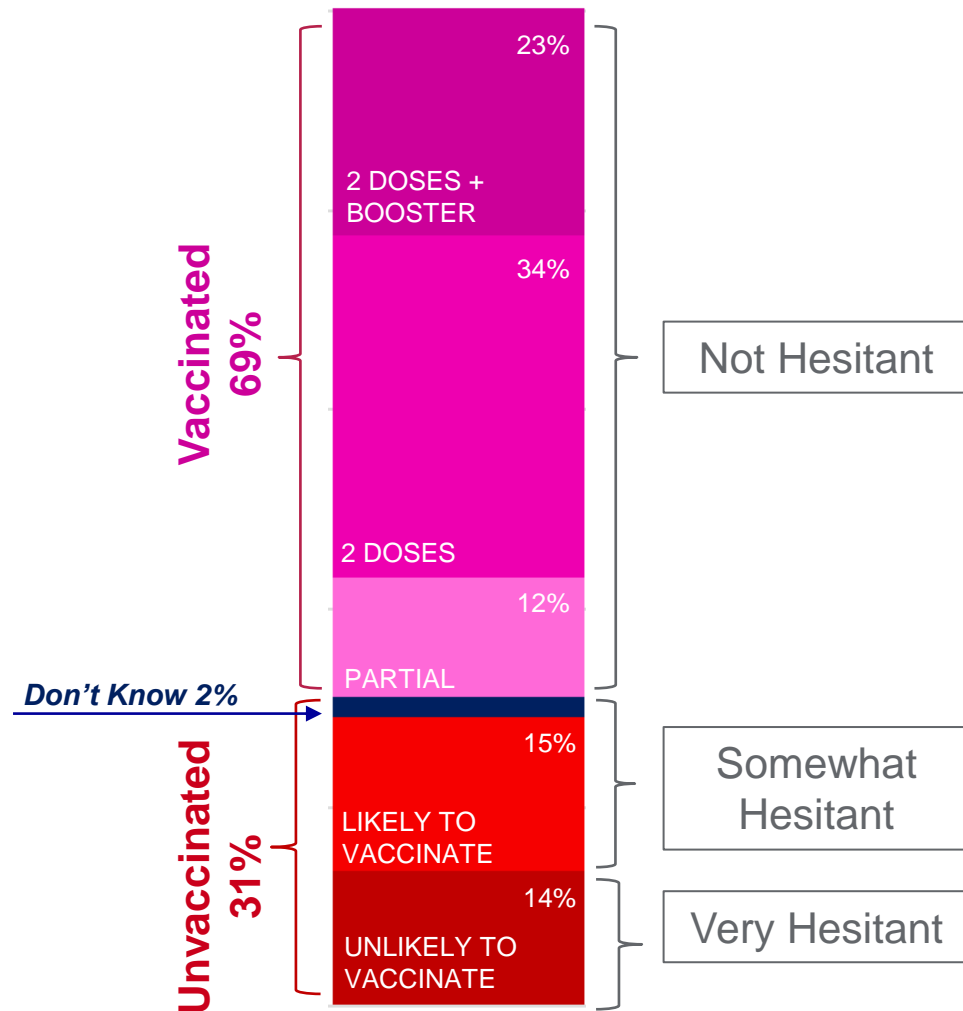
This indicates that efforts to increase awareness of the risk of infection and also vaccine safety and efficacy are still needed.

Segment Profile	Confident Enthusiasts	Enthusiastic Pragmatists	Vaccine Ambivalents	Vaccine Sceptics	COVID Cynics
Level of Confidence	High	High	Medium	Low	Low
Level of Convenience	High	Low	Medium	Medium	High
Level of Complacency	Low	Low	High	Low	High
All Adults	8%	13%	30%	26%	24%
Vaccinated Adults	9%	14%	37%	20%	20%
Unvaccinated Adults	5%	8%	18%	33%	36%

Note 1: Segments were originally classified based on indices created for each C. The indices were divided into “high” and “low groups”. Fraym then conducted multivariate regressions to predict the probability of belonging to each segment and used regression methods to create final categories.

NATIONAL OVERVIEW

Over half the unvaccinated population are *somewhat hesitant* and are more likely to be younger, less educated, and poorer.



Demographics	Not Hesitant	Somewhat Hesitant	Very Hesitant	All Adults
Gender				
Females	46%	52%	58%	49%
Male	54%	48%	42%	51%
Age				
18-34	49%	60%	55%	52%
Over 35	51%	40%	45%	48%
Highest Education Attained				
Primary	9%	9%	12%	9%
Secondary	33%	46%	33%	35%
Tertiary	55%	42%	52%	52%
Marital Status				
Single	40%	49%	48%	43%
Married	51%	42%	43%	48%
Annual Income				
Under GH¢ 500	15%	23%	17%	17%
Between GH¢ 500 - GH¢ 900	16%	19%	16%	16%
Between GH¢ 900 - GH¢ 1,200	17%	17%	13%	16%
Between GH¢ 1200 - GH¢ 1,500	14%	11%	16%	14%
Between GH¢ 1500 - GH¢ 2,500	15%	11%	16%	14%
More than GH¢ 2,500	8%	3%	9%	7%

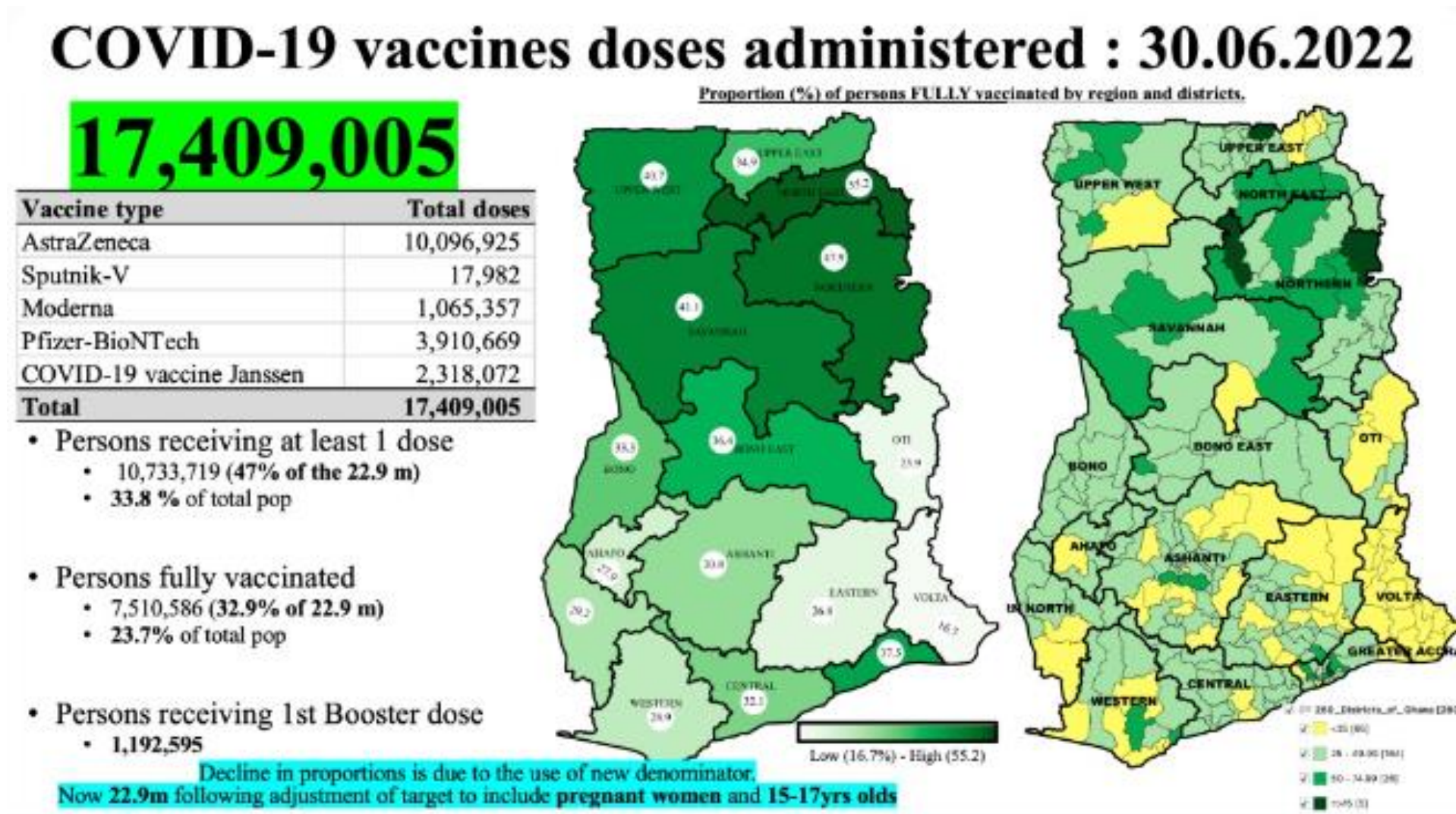
Note 1: Categories may not sum to 100 percent due to response options that are not shown.

Note 2: Statistically significant differences between groups and general population at the 90% level are marked with *, at the 95% level with **, and at the 99% level with ***.

Source: Fraym, Nationally Representative Survey, Ghana. June 2022

GHANA HEALTH SERVICE REPORTED FIGURES

As of June 30, 2022, Ghana government sources cite state that 17 million doses were administered, with more than 10 million receiving their full or partial dose.

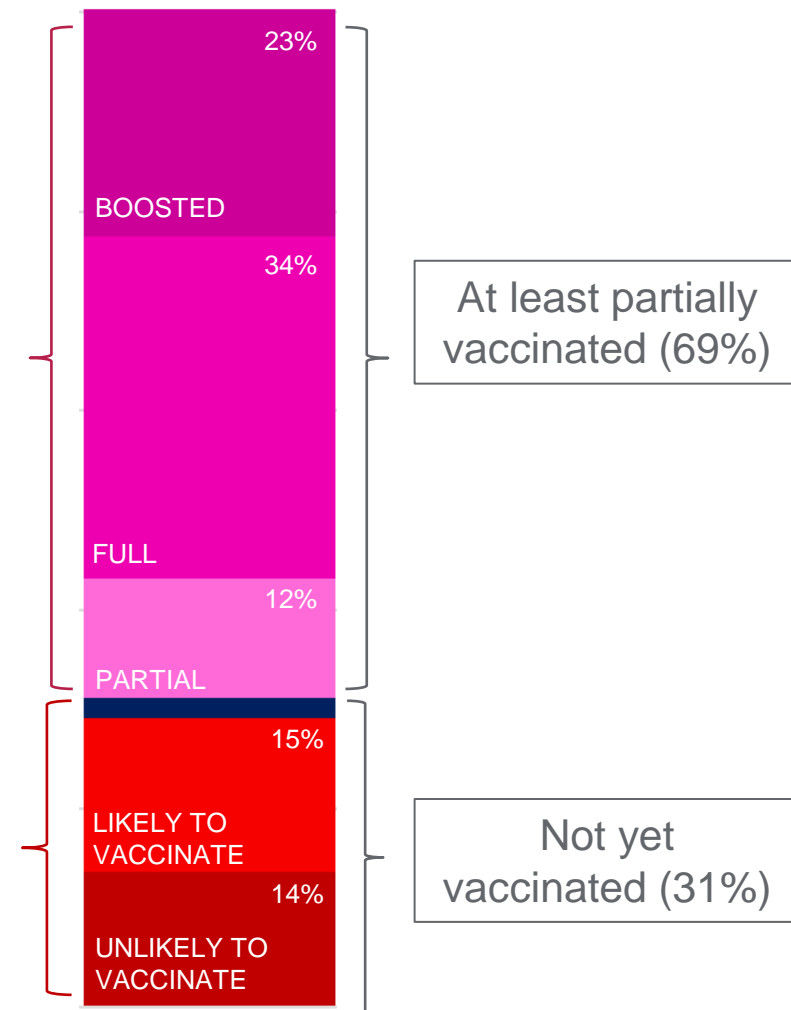


Note 1: The base population of the GHS statistics on vaccinations administered includes Ghanaian adults aged 15 years or older. The Fraym survey includes adults aged 18 years or older.
Source: Ghana Health Service [<https://www.ghs.gov.gh/covid19/>]

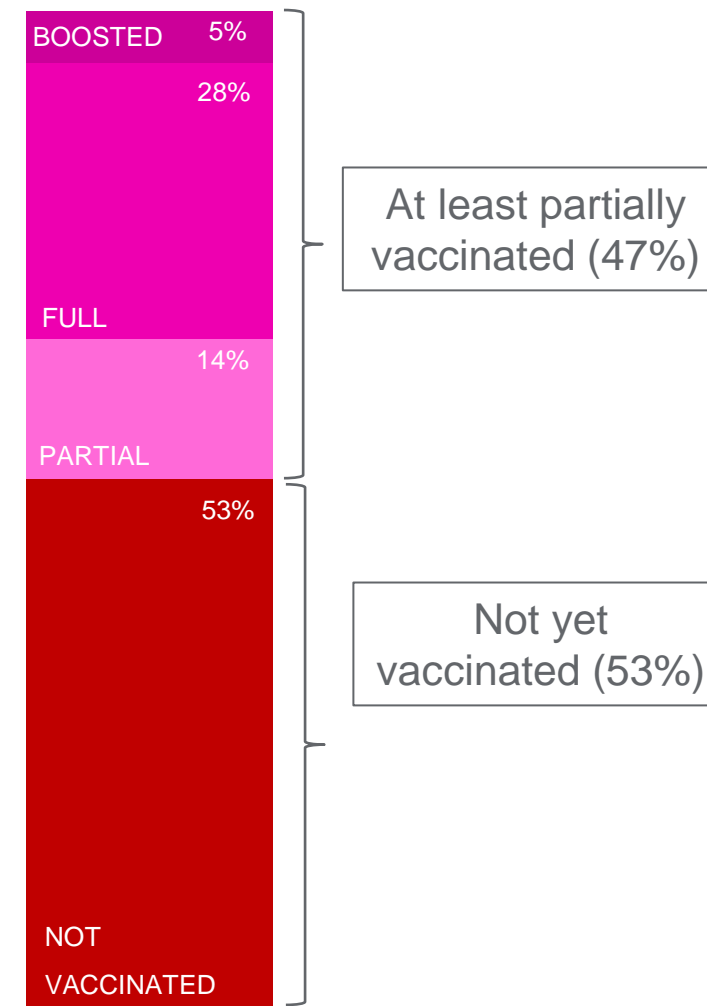
VACCINATION COMPARISONS

Fraym vaccination figures are higher than government sources, with roughly a 12 percentage point differences. This gap mainly stems from differences in booster figures. Fraym data has higher boosted adults in the sample compared to government data.

Fraym Data
Vaccination Rates



Government Data
Vaccination Rates

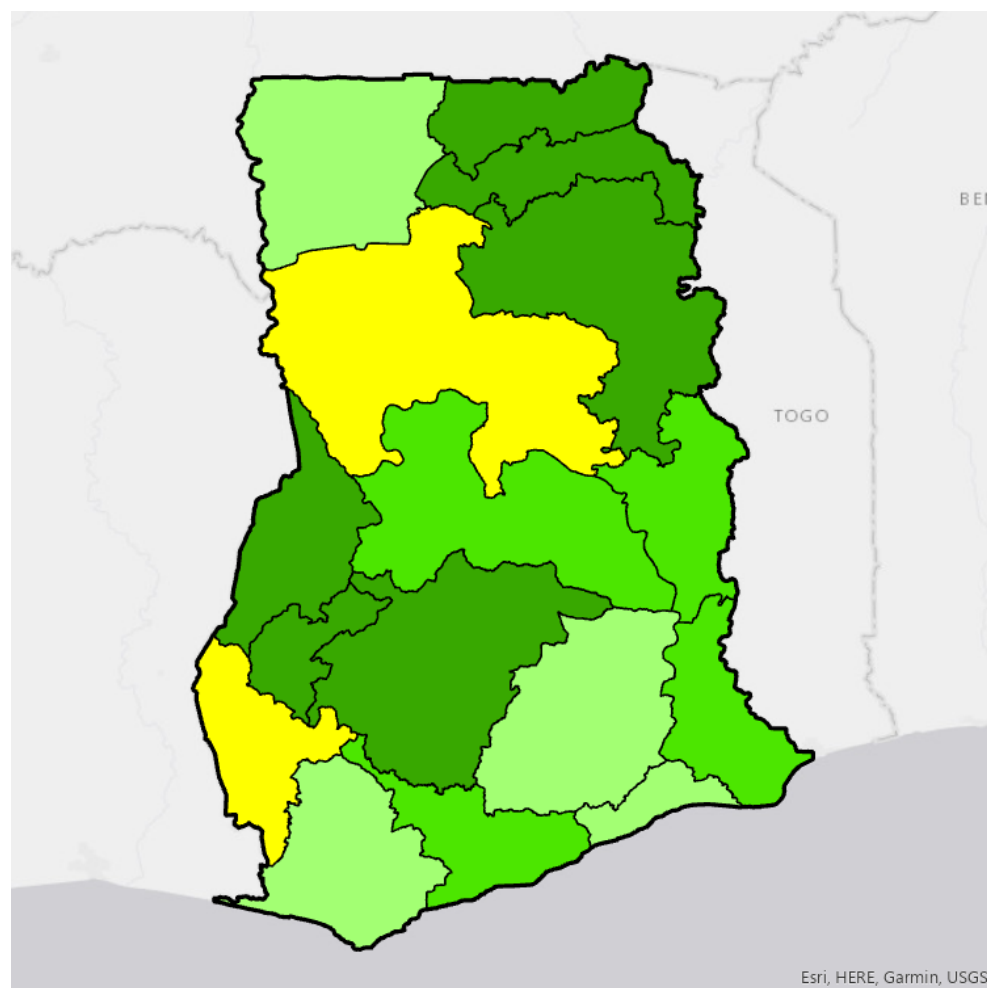
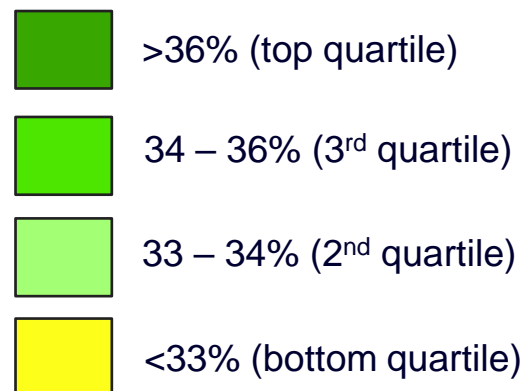


Note 1: Base population for Fraym data are adults age 18+. The government data includes adults age 15+.
Source: Fraym, Nationally Representative Survey, Ghana. June 2022

GHANA HEALTH SERVICE REPORTED FIGURES

For both Fraym and GHS data, the Northern and North East align the most in terms of having the highest vaccination rates. Vaccination rate distribution deviate for the Savannah region.

Fraym Data Full Vaccination Distribution by Region²



GHS Full Vaccination Distribution by Region



Note 1: The base population of the GHS statistics on vaccinations administered includes Ghanaian adults aged 15 years or older. The Fraym survey includes adults aged 18 years or older.

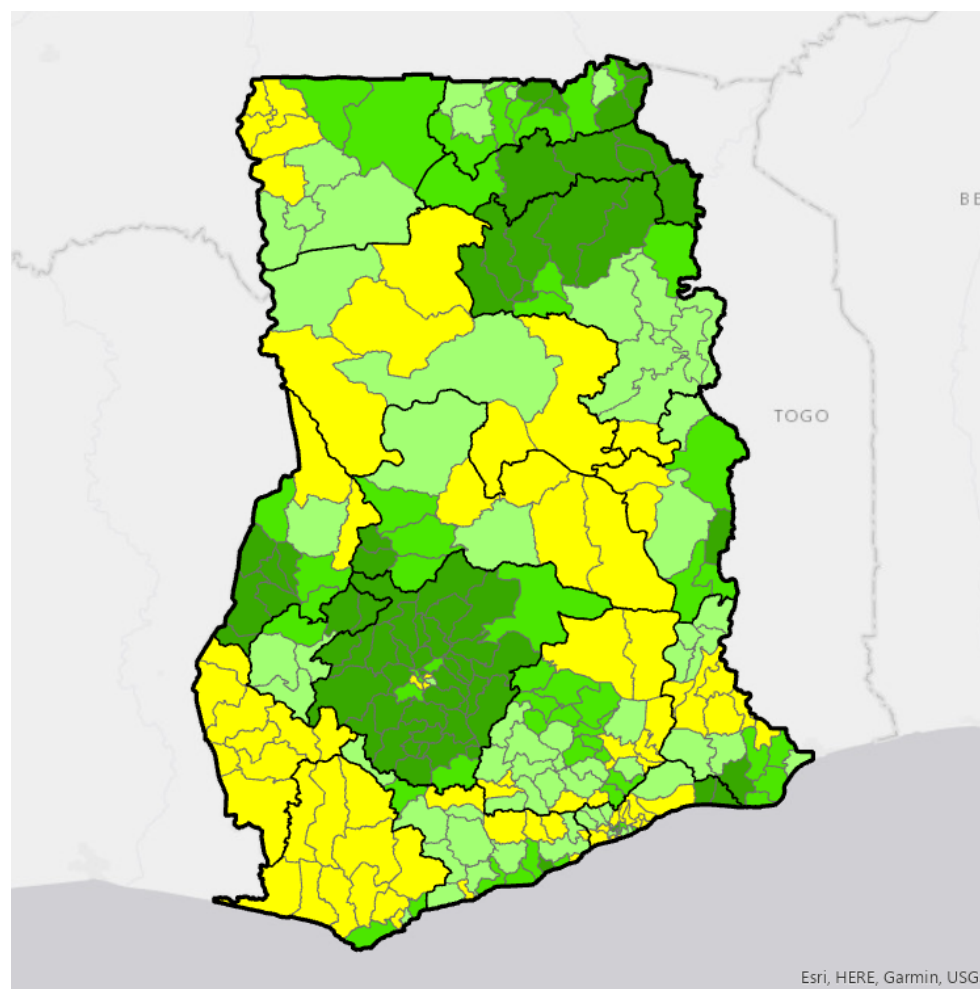
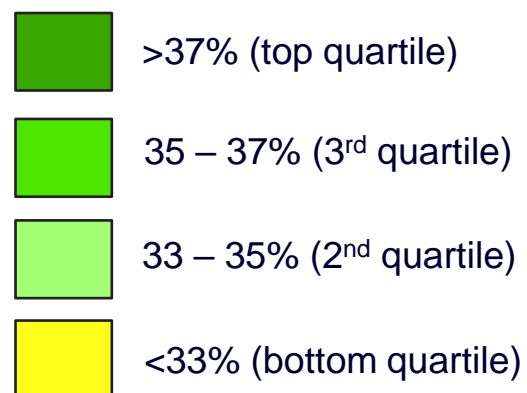
Note 2: Full vaccination rates from Fraym data have a narrower spread, ranging from 30 to 40 percent.

Source: Ghana Health Service [<https://www.ghs.gov.gh/covid19/>]

GHANA HEALTH SERVICE REPORTED FIGURES

Fraym data indicates higher full vaccination rates across the districts in Ashanti, but GHS have rates higher only around Kumasi. Both data show higher full vaccine rates in districts in North and North East.

Fraym Data Full Vaccination Distribution by District²



GHS Full Vaccination Distribution by District



Note 1: The base population of the GHS statistics on vaccinations administered includes Ghanaian adults aged 15 years or older. The Fraym survey includes adults aged 18 years or older.

Note 2: Full vaccination rates from Fraym data have a narrower spread, ranging from 24 to 45 percent.

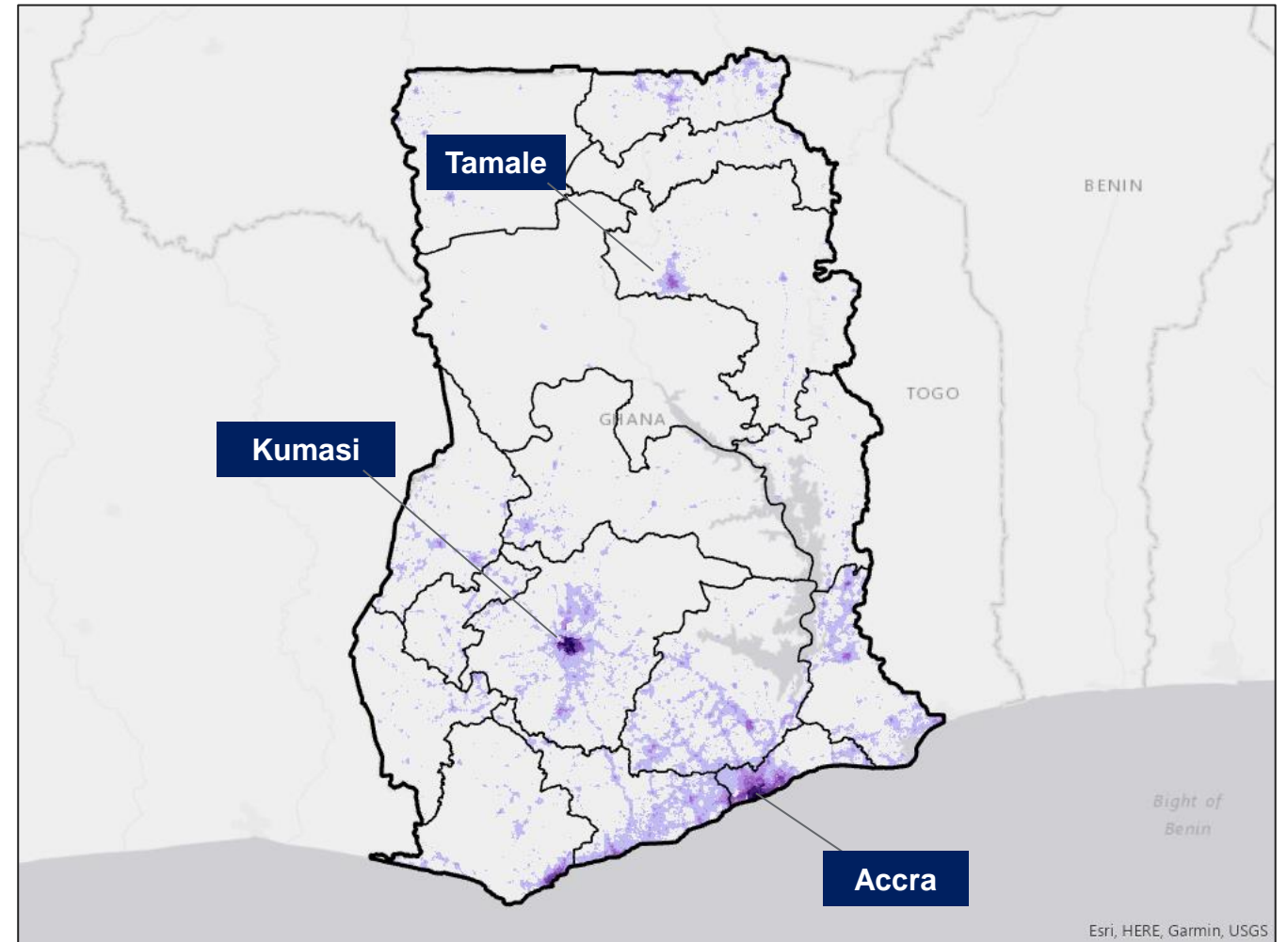
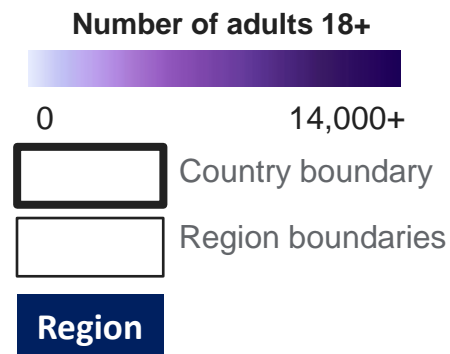
Source: Ghana Health Service [<https://www.ghs.gov.gh/covid19/>]

Ghana Adult 18+ Population

A large proportion of adults (18+) reside in and around urban centers such as Ashanti and Greater Accra.

The states of Ashanti and Greater Accra have the highest population of adults, with almost 4.1 million and 3.8 million residents, respectively.

These two regions have the largest urban centers in Ghana where most of the population is concentrated.



HYPERLOCAL MAPPING

Unlikely to Vaccinate¹

National Distribution

June 2022

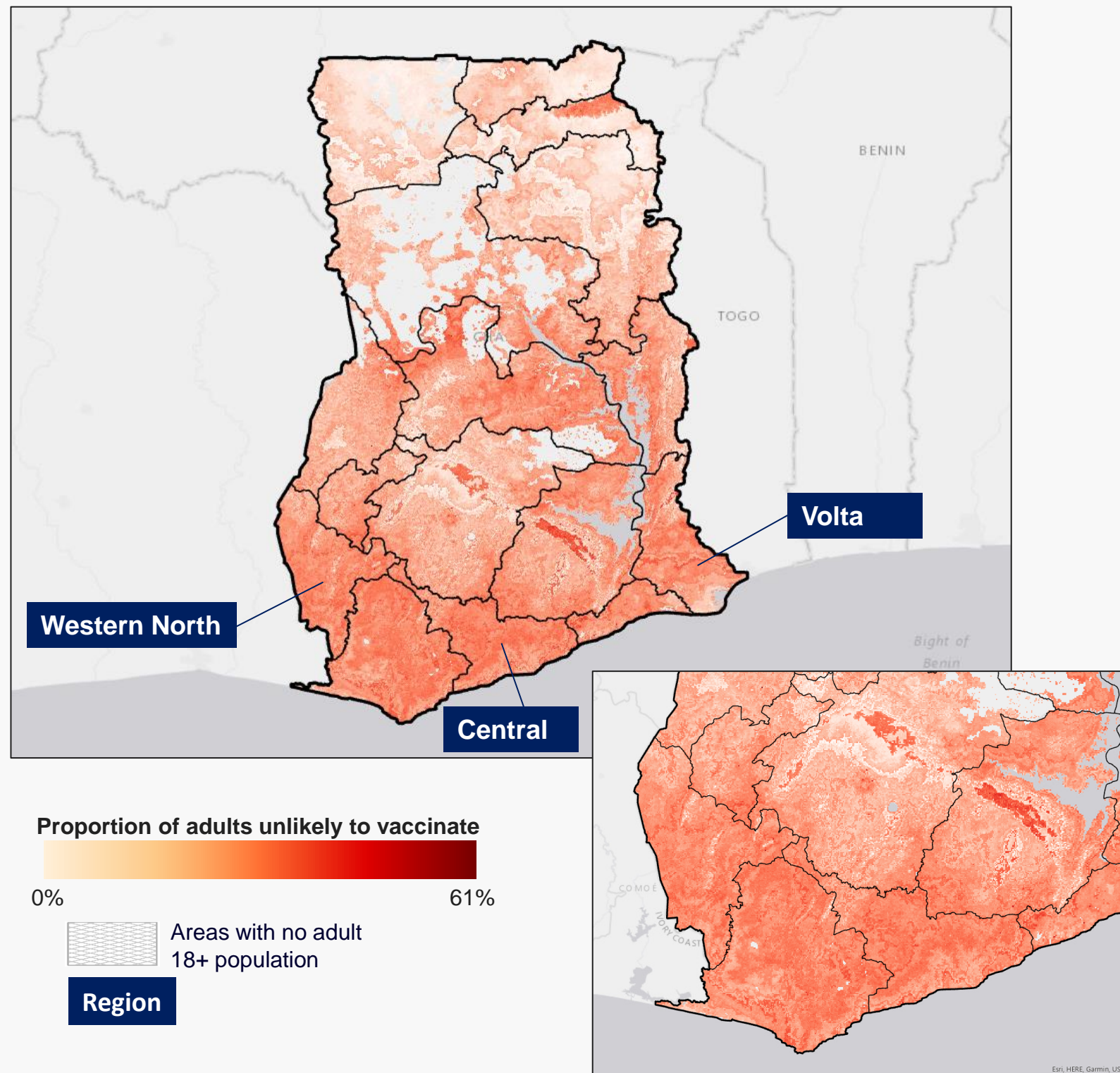
14%

14% of Ghanaian adults report being very hesitant about vaccination and are unlikely to do so¹.

The highest rates of vaccine unlikelihood are in the southern region of Ghana. The states of Western North (19%), Central (16%), and Volta (15%) have rates higher than the national average.

Note 1: Vaccine unlikelihood is defined as individuals reporting “very unlikely” to the question “How likely is it that you will get vaccinated?”

Source: Fraym, Nationally Representative Survey, Ghana. June 2022



HYPERLOCAL MAPPING: 3Cs

Vaccine Confidence

National Distribution

Jun 2022 (score)

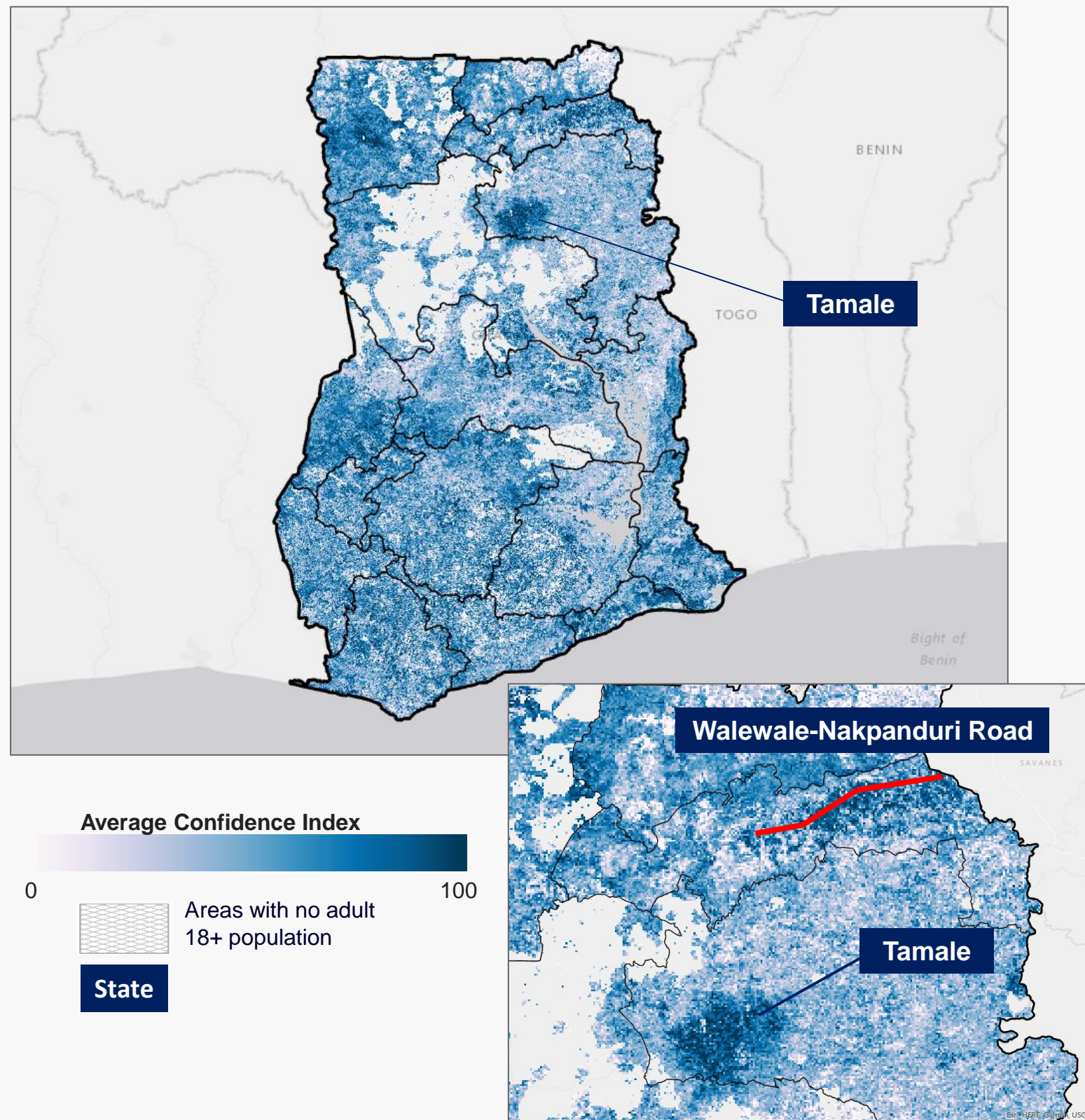
67

The average Confidence Index¹ in Ghana is 67 on a scale from 0 to 100. Confidence scores vary at a subregion level. Areas in and near Tamale have a confidence score ranging 70-90. The rest of the Northern region have confidence scores equal to or less than the average of 67.

Other high confidence hotspots are areas along the Walewale-Nakpanduri Road in the North East region.

Note 1: Vaccine Confidence Index ranges from 0-100. The lower the value, the lower is the level of trust in COVID-19 vaccine safety and efficacy.

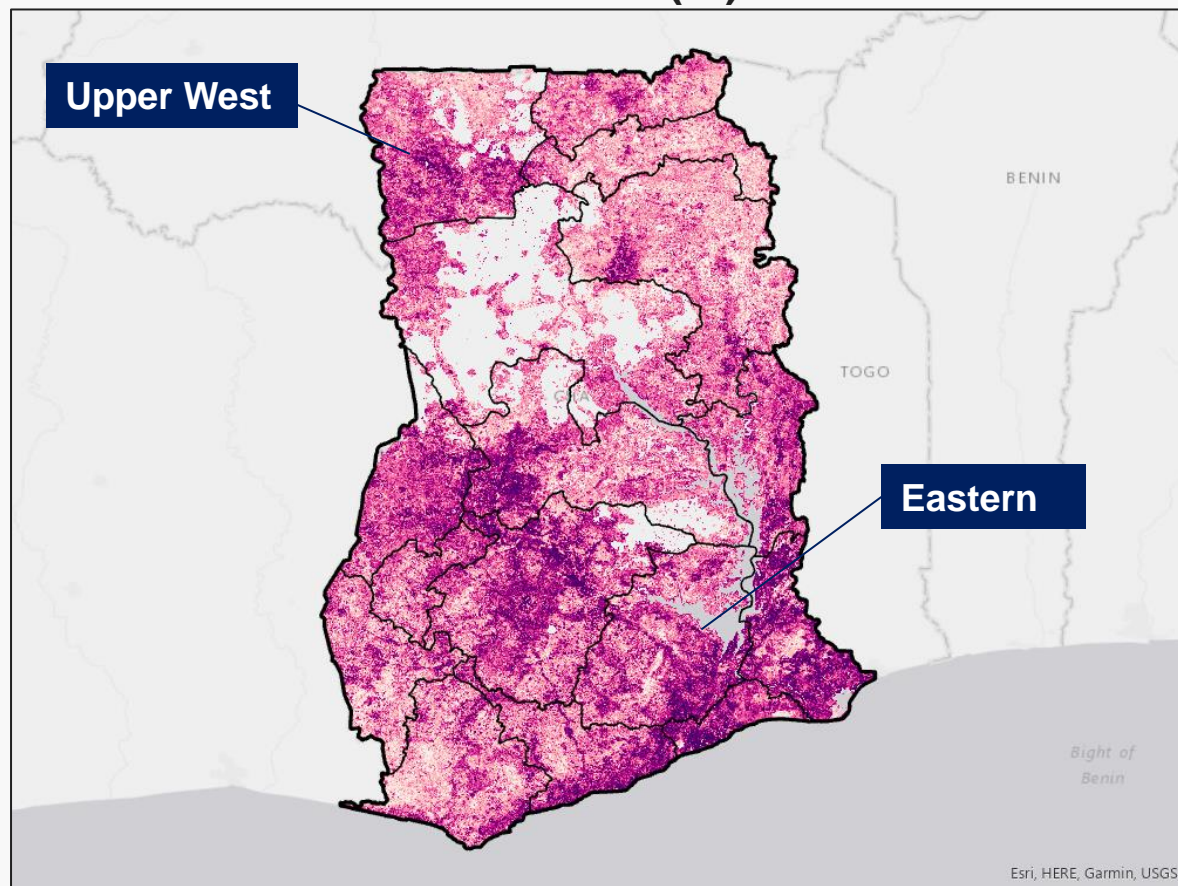
Source: Fraym, Nationally Representative Survey, Ghana. June 2022



Vaccine Ambivalents¹

The dashboard showcases segments for all adults, vaccinated adults, and unvaccinated adults. Concentrations of vaccine ambivalents populations vary between vaccinated and unvaccinated populations¹.

Vaccine Ambivalents (%): Vaccinated



National Distribution

June 2022 (Vaccinated)	June 2022 (Unvaccinated)
37%	18%

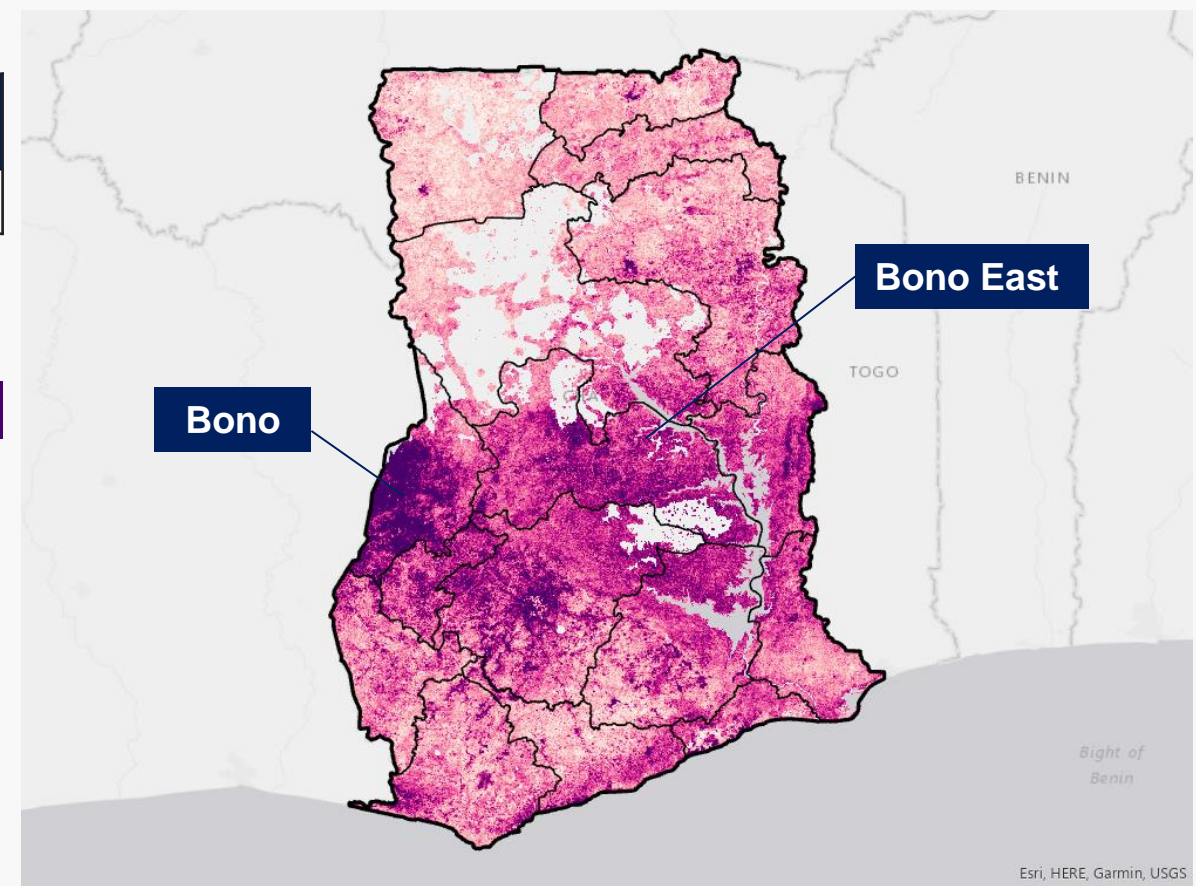
Proportion of Vaccine Ambivalents



Areas with no adult 18+ population

Region

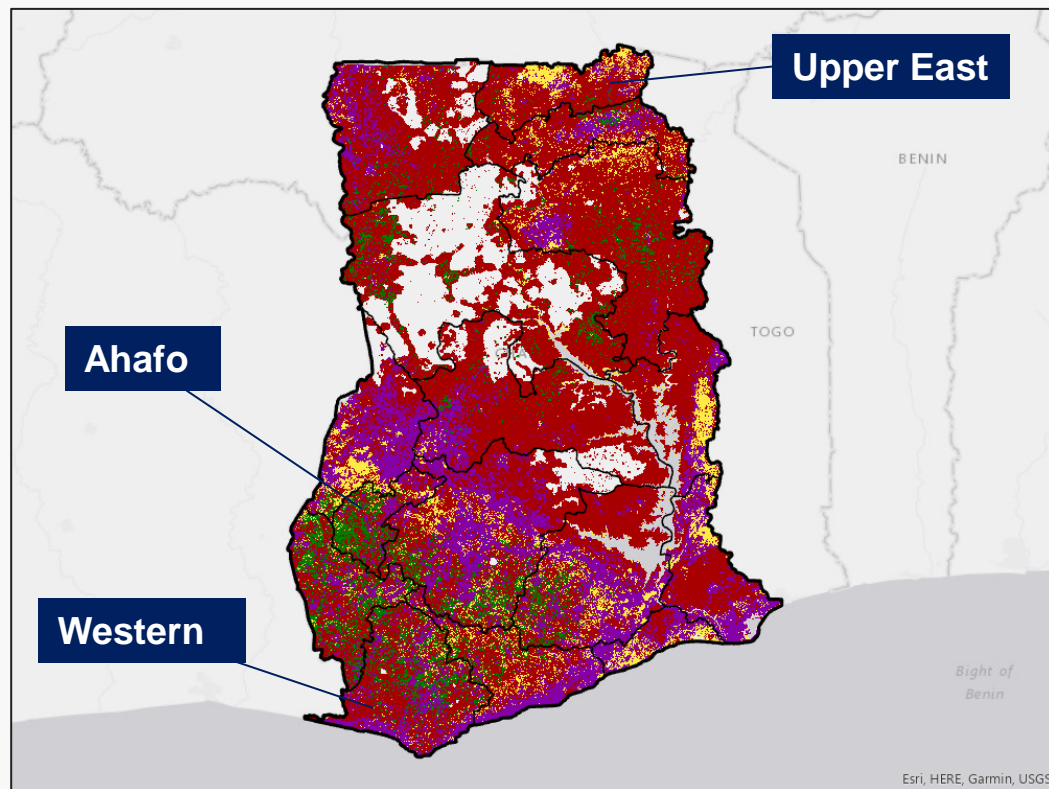
Vaccine Ambivalents (%): Unvaccinated



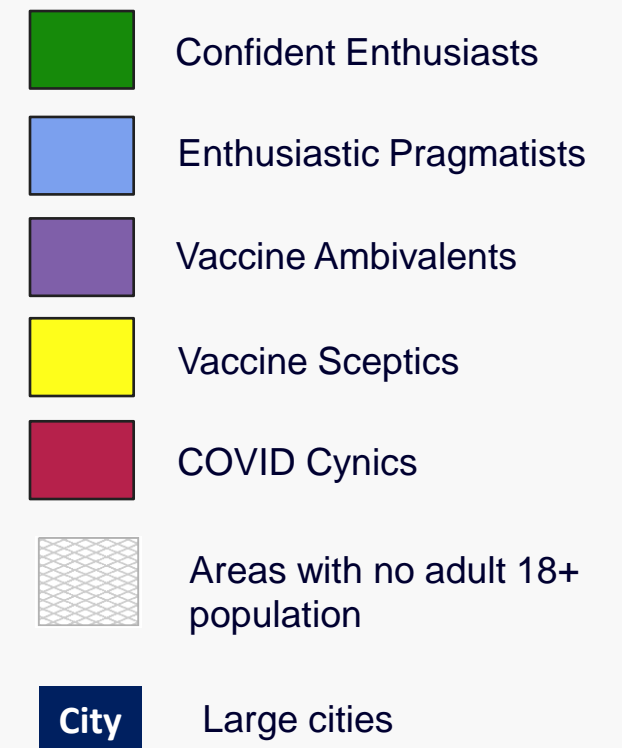
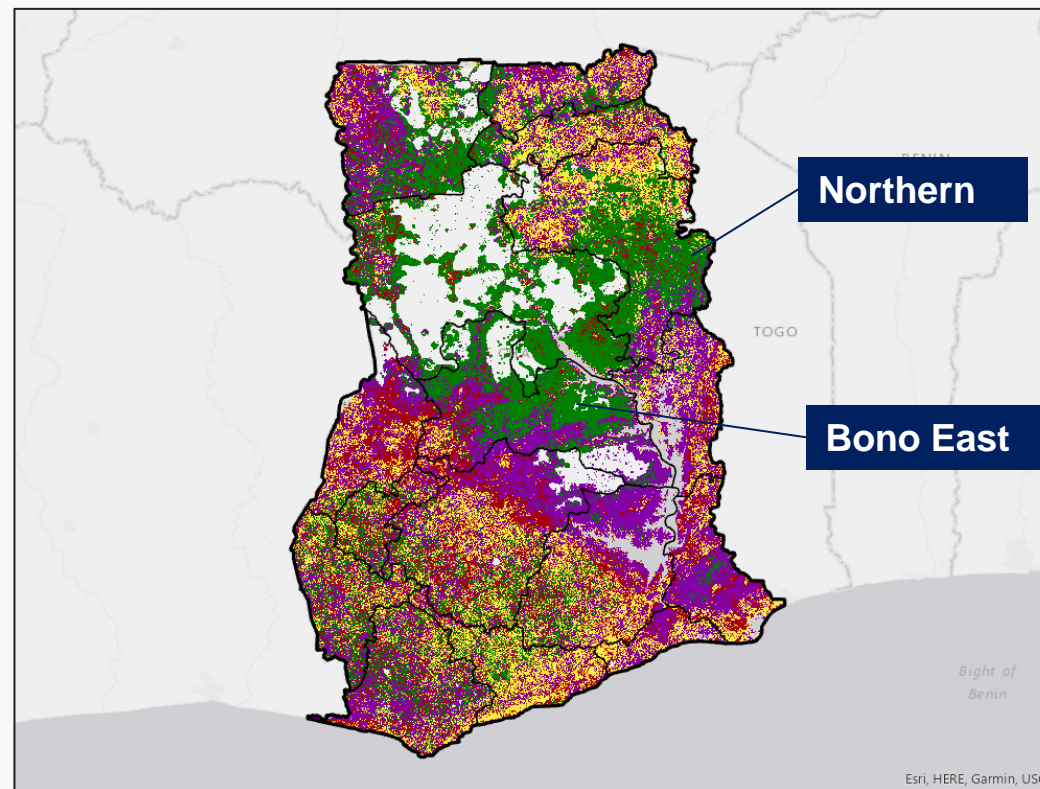
Most Common Segment¹

Vaccine Ambivalents are the most common profile in Ghana, but COVID Cynics are the most widespread. Confident enthusiasts are common in Northern and Bono East. Vaccine Sceptics are widespread in southern and northern regions.

Most Common Segment



2nd Most Common Segment



DRIVERS OF VACCINATION

Hesitancy and Drivers for Vaccination

The table on the right highlights correlations with the likelihood of getting a C19 vaccine if currently unvaccinated.

Convenience: Concern about the time to receive a vaccine was the only significant correlation. This indicates that time is perceived to be the largest burden among those likely to get vaccinated.

Complacency: The risk to personal social network increases likelihood of wanting to get vaccinated. This characteristic could inform information campaigns.

Confidence: Social network again plays a role in vaccination likelihood. Additionally, those who believe in the vaccine's safety and efficacy are more likely to be interested in getting the vaccine.

Based on these results, campaigns focused on risk to networks, such as friends and families, as well as vaccine safety and efficacy, will be effective at increasing vaccination rates. It may also help to emphasize associations with well known International Organizations active in the area and lead local targeting via Doctors and Community Health Workers.

Note 1: Statistically significant at the 95% confidence level.

Note 2: Reported "Likely" or "Very Likely" to question (*If unvaccinated*) *How likely is it that you will get vaccinated?*

Correlation Coefficient with Vaccination Plans ^{1,2}	
Convenience	
Concerned about having time to get the vaccine	0.32
Complacency	
Friends and family are at risk of COVID-19	0.17
Think that COVID-19 is not real	-0.12
Healthy so not worried about being hospitalized	-0.08
Confidence	
Would rather receive a vaccine produced in Africa	0.23
People they trust are getting vaccinated	0.22
COVID-19 vaccines are safe	0.21
COVID-19 vaccines are effective	0.19
The vaccine will be effective against new COVID strands	0.08
3C's Indices	
Low Confidence	-0.16
High Complacency	-0.11
Low Convenience	0.13
Trusted Source of Information about Vaccines	
International Agencies	0.21
Doctor	0.20
Community Health Workers	0.18
Government Agencies	0.18
Pharmaceutical Companies	0.13

DRIVERS OF VACCINATION

Drivers of Hesitancy

Confidence in vaccine safety and efficacy has the strongest relationship with vaccine hesitancy for those at both ends of the spectrum. For the Somewhat Hesitant, those who express more concerns about convenience of access and confidence in the vaccine are also more likely to report that they plan to take the vaccine.

Correlation Coefficient with Not Hesitant	
Confidence	
COVID-19 vaccines may not be safe	-0.19
COVID-19 vaccines may not be effective	-0.17
People I trust are not getting vaccinated	-0.14
I would rather take the risk of getting COVID-19	-0.11
Convenience	
I will not have time to get the COVID-19 vaccine	-0.14
I do not know where to get a COVID-19 vaccine	-0.13
There may be a financial cost associated	-0.11
The vaccine site will be difficult to travel to	-0.11
Indices	
Convenience Index	0.21
Confidence Index	0.36
Complacency Index	-0.09

Correlation Coefficient with Somewhat Hesitant	
Indices	
Convenience Index	-0.15
Confidence Index	-0.14
Complacency Index	-0.01

Correlation Coefficient with Very Hesitant	
Confidence	
COVID-19 vaccines may not be safe	0.12
People I trust are not getting vaccinated	0.12
COVID-19 vaccines may not be effective	0.11
Convenience	
I will not have time to get the COVID-19 vaccine	0.14
Indices	
Convenience Index	-0.06
Confidence Index	-0.23
Complacency Index	0.10

* Statistically significant at the 95% confidence level.

Source: Fraym, Nationally Representative Survey, Ghana, June 2022.

DRIVERS OF VACCINATION

Drivers of the 3Cs

While the 3Cs indices were constructed independently, there is evidence that an individual's perception of one C is related to others. For example, those who report high complacency are more likely to report both low convenience and low confidence.

Correlation Coefficient with Confidence Index	
Confidence	
COVID-19 vaccines may not be effective	-0.44
COVID-19 vaccines may not be safe	-0.43
The vaccine will not be effective against new COVID strands	-0.34
I would rather take the risk of getting COVID-19	-0.32
Convenience	
I do not know where to get a COVID-19 vaccine	-0.16
There will not be enough COVID-19 vaccines	-0.14
There may be a financial cost associated	-0.13
The vaccine site will be difficult to travel to	-0.13
Complacency	
I think that COVID-19 is not real	-0.18
Already had COVID-19 so not afraid I will spread it	-0.14
Indices	
Convenience Index	0.25
Complacency Index	-0.62

Correlation Coefficient with Convenience Index	
Convenience	
I do not know where to get a COVID-19 vaccine	-0.23
There will not be enough COVID-19 vaccines	-0.22
The vaccine site will be difficult to travel to	-0.22
There may be a financial cost associated	-0.21
Indices	
Confidence Index	0.23
Complacency Index	-0.39

Correlation Coefficient with Complacency Index	
Complacency	
Already had COVID-19 so not afraid I will spread it	0.23
I am healthy so I am not worried about being hospitalized	0.18
I think that COVID-19 is not real	0.17
COVID-19 is not spreading in my community	0.13
Indices	
Convenience Index	-0.11
Confidence Index	-0.16

Note: Correlations greater than 0.1 that are statistically significant at the 95% confidence level.

Source: Fraym, Nationally Representative Survey, Ghana, June 2022.

TARGETING

Regional distribution of Vaccine Hesitancy and 3Cs

Variation in vaccine hesitancy is evident across regions, and especially helpful to target areas with higher prevalence of the Somewhat Hesitant.

Region	Self-Reported Vaccination ¹ (%)	Vaccine Hesitancy (%)			3Cs (%)		
		All Adults	Not Hesitant	Somewhat Hesitant	Very Hesitant	Low Convenience	High Complacency
Ahafo	70%	70%	15%	15%	28%	30%	48%
Ashanti	75%	75%	17%	8%	41%	36%	41%
Bono	67%	67%	21%	12%	27%	33%	38%
Bono East	73%	73%	16%	11%	37%	29%	34%
Central	60%	60%	24%	16%	59%	30%	38%
Eastern	64%	64%	21%	14%	31%	30%	35%
Greater Accra	67%	67%	20%	13%	37%	29%	34%
North East	86%	86%	7%	7%	31%	22%	31%
Northern	67%	67%	22%	10%	54%	30%	37%
Oti	76%	76%	14%	10%	35%	32%	41%
Savannah	78%	78%	14%	9%	17%	25%	36%
Upper East	77%	77%	14%	8%	45%	30%	46%
Upper West	70%	70%	23%	7%	34%	34%	39%
Volta	65%	65%	21%	15%	35%	30%	41%
Western	72%	72%	16%	12%	48%	28%	42%
Western North	66%	66%	15%	19%	38%	32%	38%
National	69%	69%	19%	12%	40%	31%	38%

Statistically significant at the 95% confidence level.

Note 1: Two does and a booster, two doses, or partial vaccination

Source: Fraym, Nationally Representative Survey, Ghana, June 2022.

TARGETING

Segment Distribution by Region

There are **geographic differences** between the proportion of each segment when unvaccinated and vaccinated adult populations are modeled separately. These differences are beneficial in isolating areas for targeting that may have *low rates* of All Adult segment prevalence but *high rates* of Unvaccinated Adult segment prevalence. For example, whereas Enthusiastic Pragmatists All Adults are predominantly in the Central region (18%), Unvaccinated Adults are in Northern region (20%).

Region	Confident Enthusiast (%)			Enthusiastic Pragmatist (%)			Vaccine Ambivalent (%)			Vaccine Sceptic (%)			COVID Cynic (%)		
	All Adults	Vax Adults	No-Vax Adults	All Adults	Vax Adults	No-Vax Adults	All Adults	Vax Adults	No-Vax Adults	All Adults	Vax Adults	No-Vax Adults	All Adults	Vax Adults	No-Vax Adults
Ahafo	21%	26%	9%	5%	3%	9%	19%	24%	7%	23%	24%	18%	31%	22%	56%
Ashanti	6%	7%	4%	12%	14%	5%	31%	36%	23%	23%	17%	35%	28%	27%	32%
Bono	11%	16%	2%	12%	14%	7%	32%	36%	21%	21%	21%	15%	25%	14%	56%
Bono East	13%	14%	9%	16%	21%	4%	26%	32%	20%	22%	14%	29%	23%	19%	36%
Central	3%	3%	3%	18%	25%	4%	28%	35%	25%	30%	16%	41%	22%	20%	26%
Eastern	8%	10%	5%	13%	14%	11%	35%	45%	18%	26%	19%	33%	18%	12%	33%
Greater Accra	8%	8%	8%	12%	14%	9%	30%	40%	13%	29%	22%	37%	21%	17%	34%
North East	18%	17%	21%	13%	13%	10%	26%	28%	4%	19%	18%	30%	25%	23%	36%
Northern	4%	5%	3%	14%	12%	20%	27%	44%	10%	32%	25%	33%	23%	14%	34%
Oti	9%	10%	4%	9%	11%	4%	27%	36%	20%	29%	19%	38%	26%	24%	34%
Savannah	25%	32%	2%	4%	5%	0%	18%	27%	19%	23%	18%	24%	29%	18%	55%
Upper East	6%	7%	1%	12%	13%	9%	24%	28%	16%	30%	28%	30%	28%	24%	44%
Upper West	10%	13%	3%	10%	9%	12%	38%	42%	19%	21%	21%	25%	21%	15%	42%
Volta	7%	8%	6%	8%	8%	8%	30%	38%	17%	26%	22%	33%	28%	25%	35%
Western	3%	3%	3%	16%	19%	9%	29%	30%	16%	24%	24%	25%	29%	24%	48%
Western North	10%	9%	10%	8%	13%	0%	31%	40%	19%	27%	19%	31%	24%	18%	39%

TARGETING

Media Usage of All Adults across Segments

Viewing the most prevalent media sources by type, we see that rates of Social Media and TV viewership are highest across the segments.

Media	All Adults (%)	Confident Enthusiast (%)	Enthusiastic Pragmatist (%)	Vaccine Ambivalent (%)	Vaccine Sceptic (%)	COVID Cynic (%)
Social Media						
WhatsApp	60%	62%	64%	59%	62%	54%
Facebook	47%	51%	51%	47%	48%	41%
YouTube	22%	24%	22%	22%	24%	19%
Facebook Messenger	21%	22%	24%	22%	22%	17%
Instagram	20%	20%	21%	20%	21%	17%
TV						
TV3	51%	51%	54%	52%	50%	47%
Joy News	32%	33%	36%	33%	30%	30%
Adom TV	31%	33%	31%	32%	31%	28%
UTV United Television	29%	33%	31%	29%	30%	26%
Joy Prime	26%	28%	26%	29%	25%	23%
Radio						
Joy FM	20%	22%	20%	20%	19%	19%
Citi FM	17%	17%	17%	16%	18%	17%
Angel FM	15%	17%	17%	15%	14%	13%
Newspaper						
Daily Graphic	12%	12%	13%	12%	12%	11%
Daily Guide	9%	10%	9%	9%	9%	9%

Q2 2022 Indicator Definitions

Indicators for COVID-19 Vaccine Confidence

Indicators for COVID-19 vaccine confidence include attitudes about the safety and efficacy of the vaccine, as well as the vaccination status of people they trust.

Indicator	Description
Perceptions of vaccine safety	Individual believes COVID-19 vaccines are safe.
Perceptions of vaccine efficacy	Individual believes COVID-19 vaccines are effective.
Perceptions of social network vaccination	Individual believes people they trust are getting vaccinated.
Perceptions of vaccine's effectiveness against new strands	Individual believes COVID-19 vaccines will be effective against new strands.
Perceptions of relative risk	Individual would rather take the vaccine than take risk of getting COVID-19.
Preferences of vaccine produced in Africa	Individual does not prefer a vaccine produced in Africa than one produced elsewhere

High confidence = More likely to get vaccinated

Source: Fraym, Nationally Representative Survey, Ghana. June 2022

Indicators for COVID-19 Vaccine Convenience

Indicators for COVID-19 vaccine convenience include perceptions of accessibility, time burden, and financial burdens.

Indicator	Description
Accessibility: 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.
Scooter ownership	Individual lives in a household that owns a scooter
Concern about accessibility of travel to site	The COVID-19 vaccine site will not be difficult to travel to.
Time burden: Concerns about time, cost or vaccine site accessibility may deter vaccine uptake.	
Concern about vaccination time	Individual believes they will have time to get the COVID-19 vaccine.
Concern about vaccine availability	Individual believes there will be enough COVID-19 vaccines.
Financial burden: Lower financial resources may affect the ability to receive a vaccine, particularly if the vaccine is perceived as costly.	
Concern about financial cost associated with vaccine	Individual believes there will not be a financial cost associated with getting vaccinated.
Knowledge	
Knowledge of where to get vaccinated	Individual knows where to get a COVID-19 vaccine.

High convenience = More likely to get vaccinated

Source: Fraym, Nationally Representative Survey, Ghana. June 2022

Indicators for COVID-19 Vaccine Complacency

Indicators for COVID-19 vaccine convenience include attitudes about the safety and efficacy of the vaccine, as well as the vaccination status of people they trust.

Indicator	Description
Infection concerns and interactions with the health system: Individuals reporting low interactions with the health system might have a lower likelihood of getting vaccinated.	
Personal belief in COVID-19	Individual believes that COVID-19 is not real.
Perceived community risk of COVID-19	Individual believes that COVID-19 is not spreading in their community.
Perceived personal likelihood of serious illness from COVID-19	Individual believes that they are healthy and do not need to worry about being hospitalized
Perceived personal likelihood of spreading COVID-19	Individual believes that they already had COVID-19 and are not afraid they will spread it.
Perceived social network risk of COVID-19 infection	Individual believes that their friends and family are not at risk of COVID-19.

High complacency = *Less likely to get vaccinated*

Source: Fraym, Nationally Representative Survey, Ghana. June 2022

Methods

Vaccinated vs. Unvaccinated Adult Segments

Multivariate Regression Model

Fraym utilized a regression model to assign uncategorized individuals to their closest predicted segment.

Goal: Classify the uncategorized population of 80% to an Ipsos segment, in order to capture 100% of population using phase 3 data.

Approach: Multivariate regression (MV) models were constructed using the 3C indices as independent variables on all 5 Ipsos segments as dependent variables.

Methodology: The predicted probabilities of being in an Ipsos segment were individually calculated for all 5 Ipsos segments using the MV regression approach. We classified all respondents in our survey to a segment if their predicted probability was greater than the associated cut point prediction for that segment. This was repeated for each segment, then the final segment was chosen based on the maximum predicted probability across that respondents 5 predicted probabilities.

Model Fit: The All Adult model has an area under the ROC (AUC) curve of 0.90, where 1 signifies perfect identification of an Ipsos segment. Therefore, we find that this method shows significant predictive power for each segment.

Results: The appropriateness of the model was tested by comparing the results of using the 3C indices for predicting vs using all underlying phase 3 variable for predicting. The 3C indices performed better at predicting due to keeping a large sample size, having a higher AUC, and having prediction proportions more in line with our baseline prediction proportions by segment.

Area Under the ROC (AUC) Curve by Segment

An area under the ROC (AUC) curve of 0 signifies completely misidentifying a segment, an AUC of 0.5 signifies no ability to classify a segment (random chance), and an AUC of 1 means perfect identification of a segment. As the AUC of this model is well above 0.5, we find strong predictive performance from this model.

All Adults

Segment Profile	Confident Enthusiasts 1	Enthusiastic Pragmatists 2	Vaccine Ambivalents 3	Vaccine Sceptics 4	COVID Cynics 5	Average
AUC	0.96	0.96	0.81	0.91	0.86	0.90

Vaccinated Adults

Segment Profile	Confident Enthusiasts 1	Enthusiastic Pragmatists 2	Vaccine Ambivalents 3	Vaccine Sceptics 4	COVID Cynics 5	Average
AUC	0.96	0.96	0.80	0.93	0.88	0.91

Unvaccinated Adults

Segment Profile	Confident Enthusiasts 1	Enthusiastic Pragmatists 2	Vaccine Ambivalents 3	Vaccine Sceptics 4	COVID Cynics 5	Average
AUC	0.97	0.98	0.82	0.89	0.83	0.90

Survey Methodology

Study Methodology

Q2 2022

Sample Size: Fraym conducted a survey of 6,200+ Ghanaian respondents via a demographically and geographically-targeted Computer Assisted Telephone Interview (CATI) survey.

Dates: Data was collected between May 10 to June 29, 2022.

Sample Breakdown: The respondents identified the following gender identities: 3,215 females (52%), 2,998 males (48%). Ghana's 16 regions were represented as follows: Ahafo 126 (2%), Ashanti 1,076 (17%), Bono East 225 (4%), Bono 242 (4%), Central 595 (10%), Eastern 607 (10%), Greater Accra 1,266 (20%), North East 103 (2%), Northern 447 (7%), Oti 144 (2%), Savannah 100 (2%), Upper East 220 (4%), Upper West 122 (2%), Volta 332 (5%), Western North 170 (3%), and Western 438 (7%)

Socioeconomic status based on assets and housing materials as follows: low SES, 880 (14%), medium SES, 2,104 (34%), high, 3,229 (52%). SES status was incorporated into survey weights.

The average survey completion time was 15 minutes for respondents. The survey consisted of about 50 questions. Topics included demographics, childcare, attitudes about COVID-19, and media consumption.

Data Quality QA/QC

The survey vendor used for the sample adheres to industry best-practices. These include: (i) regularly testing/validating on a rolling basis to ensure participants and their responses are real/accurate; (ii) comparing answers from respondents to pre-collected information on the same respondents for consistency, such as same age, gender, socio-economic status, and geography; (iii) using automated natural language processing (NLP) on open-ended responses to detect non-sensical language etc.; (iv) check for straight lining (e.g. answering "C" for all questions); and (v) checking speed of completion rates, (e.g. flagging anyone who spends 1/3 or less of the median time to complete the questionnaire). Responses that fail any one of these tests were automatically removed from the data and possibly lead to the removal from the vendor's sample pool as well.

The data was designed to be nationally representative. Post-hoc weights were created to correct for these differences. An iterative proportional fitting process was used to simultaneously balance the distributions of the following parameters: gender, age, urban status, and the population in each of Ghana's 16 regions.

About Fraym

About Fraym

Fraym has built machine learning (ML) software that weaves together geo-tagged household survey data with satellite imagery to create localized population information (1 km²).

1

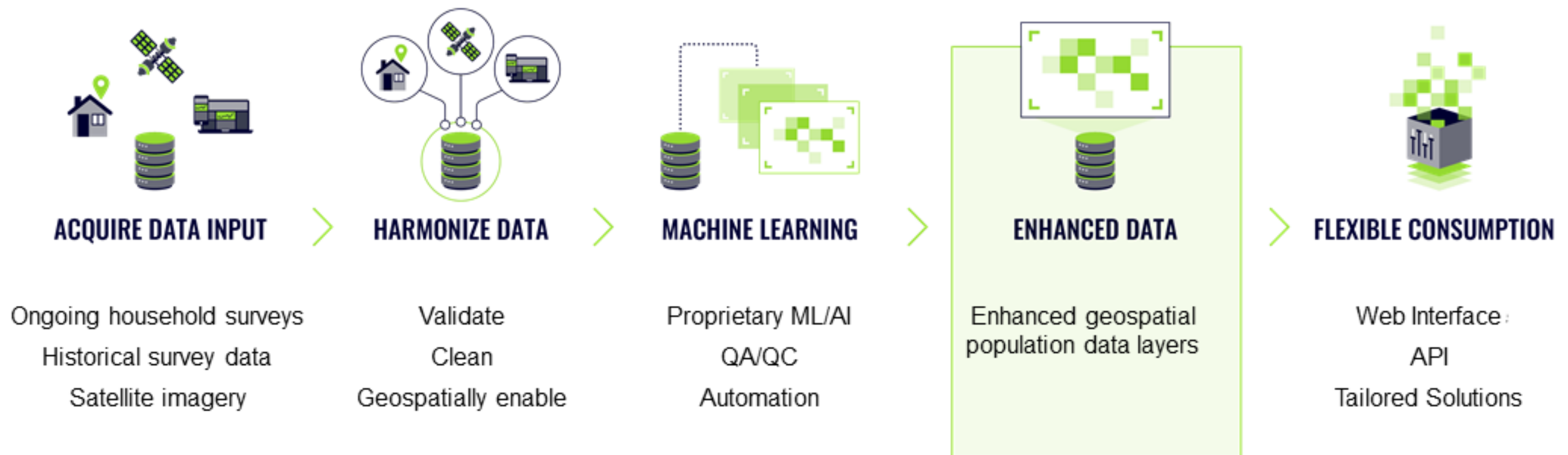
The primary ML model input is data from high-quality, geo-tagged household surveys. Key indications of a high-quality household survey include implementing organization(s), sample design, sample size, and response rates. After data collection, *post-hoc* sampling weights are created to account for any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

3

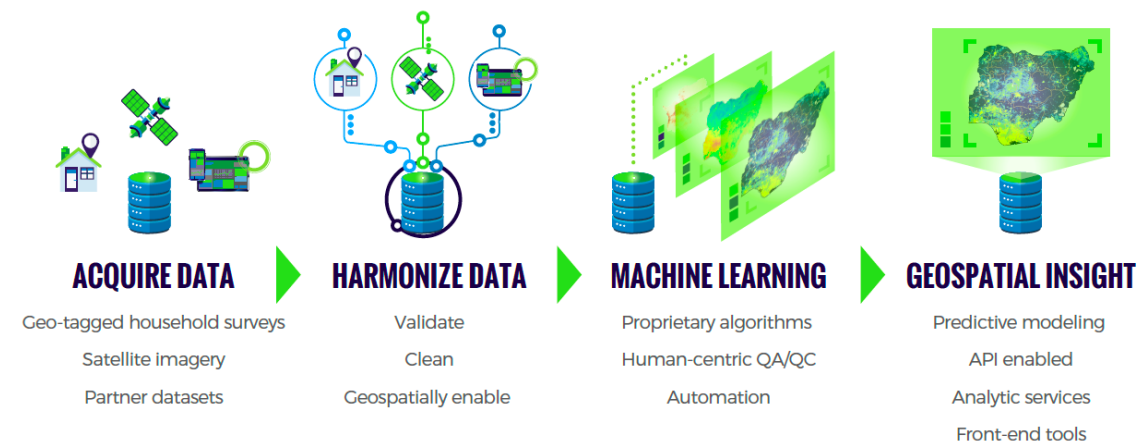
To create spatial layers from household survey data, Fraym leverages machine learning to predict an indicator of interest at a 1 square kilometer resolution. This methodology builds upon existing, tested methodologies for interpolation of spatial data. The resulting model is used to predict the survey 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.



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 km²).

- 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.
- 3 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.¹



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>

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