



Hyperlocal Targeting of Vaccine Hesitancy in Ethiopia

Prepared by Fraym for Johnson & Johnson Global Public Health

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Report Overview

Fraym produced hyperlocal visualizations of vaccine hesitancy using the World Health organization's "3Cs" framework, creating proxy profiles of the vaccine hesitant and how to reach them across Ethiopia.

- 1 Fraym used the World Health Organization's (WHO) "3Cs" of vaccine hesitancy—complacency, convenience, and confidence— to map each "C" across Ethiopia.
- 2 Fraym mapped complacency and convenience using the most recently available geo-tagged household survey (2016). Vaccine confidence was proxied using trust in government data at the state level.
- 3 In order to understand sub-groups of vaccine hesitant populations, Fraym developed five profiles that capture different reasons for not receiving the COVID-19 vaccine. Fraym then mapped these profiles to identify potentially high-risk communities and to estimate the number of adults at risk of not getting vaccinated.
- 4 Fraym developed use cases for each profile that illustrate how practitioners and on-the-ground implementers can utilize community-level data for targeting and outreach.
- 5 This mapping and associated analysis can help researchers, policymakers, and other global health stakeholders target their future activities and resource allocation.

Data and Methods

World Health Organization's "3Cs" of Vaccine Hesitancy

A person's decision to receive the vaccine can be influenced by one, two, or all three of the C's.

Complacency

Perceived risks of vaccine-preventable diseases are low, and vaccination is not deemed a necessary preventative action.

The higher an individual's complacency, the less likely it is that they will be vaccinated.



Convenience

Physical availability, affordability, and willingness-to-pay, geographical accessibility, ability to understand, and appeal of immunization services.



Confidence

Trust in the effectiveness and safety of vaccines, the system that delivers them, and the motivations of policymakers.



Source 1: 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/>

Fraym's Hyperlocal Mapping Methodology

Fraym uses machine learning software that weaves together household survey data with satellite imagery to create localized population information (1km²).

Survey Overview



This report leverages the 2016 Ethiopia Demographic and Health Survey.

Health facilities in sub-Saharan Africa were sourced from the World Health Organization.¹

Walking and driving time to health facilities were sourced from the Malaria Atlas Project.²

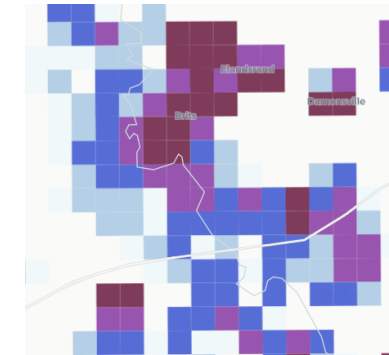
Machine Learning for Hyperlocal Mapping



The **localized maps** seen in this report were produced using the proprietary software FUSEfraym™.

This software uses artificial intelligence and machine learning (AI/ML) to weave together survey data with satellite imagery and geostatistical datasets.

Community-Level Data



Each **1km² pixel** represents the proportion or number of adults with behaviors related to vaccine hesitancy, complacency, or convenience.

Values in areas with no adult population are removed.

Note 1: This master list of health facilities was developed from a variety of government and non-government sources from 50 countries in sub-Saharan Africa, accessible here: <https://data.humdata.org/dataset/health-facilities-in-sub-saharan-africa>

Note 2: Least-cost distance compensates for travel costs, such as slope and terrain, accessible here: <https://malariaatlas.org/research-project/accessibility-to-healthcare/>

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

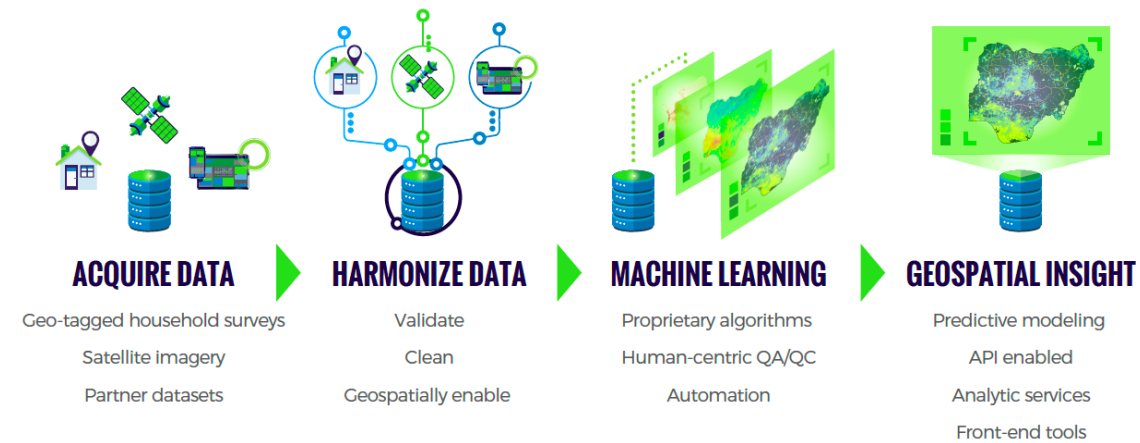
The primary ML model input is data from high-quality, geo-tagged household surveys. Key indications of a high-quality household survey include implementing organization(s), sample design, sample size, and response rates. After data collection, *post-hoc* sampling weights are created to account for any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

Indicators and Modeling

Mapping the “3Cs” of Vaccine Hesitancy

Fraym created hyper-local maps of vaccine complacency and convenience and a state-level view of confidence (proxied by trust in government).

- 1 Fraym used the 2016 Ethiopia Demographic and Health Survey to model vaccine complacency and convenience. To incorporate confidence, Fraym utilized state-level data from the 2021 Ethiopia Afrobarometer.
- 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.¹
- 3 Fraym created a confidence in government index using the 2021 Ethiopia Afrobarometer. The index averages trust in a range of public figures—including the Prime Minister, members of the House of Peoples’ Representatives, the local government, and traditional or religious leaders—through trust towards these figures and disapproval of their performance. The state-level data was normalized from zero to one. All individuals living in that state receive the same score.

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

Indicators for COVID-19 Vaccine Complacency

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

Indicator	Description
Interactions with the health system: 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, NGO health facility, or a private hospital/clinic for any births in the past 0-35 months.

Source: 2016 Ethiopia DHS

Note 1: Fraym removed female visits to health facilities or visits by fieldworkers from the vaccine complacency model due to lack of variation.

Indicators for COVID-19 Vaccine Convenience

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

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.
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.
Time burden: 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.
Financial burden: 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. ¹
Unemployment or agricultural employment	Individual is employed in the agriculture sector or is unemployed.

Source: 2016 Ethiopia 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.

Indicators for Confidence in Government

Fraym created a trust in government index using state-level Afrobarometer data.

Indicator	Description
Trust towards public figures	
Trust in public institutions	Individual trusts the Prime Minister, House of Peoples' Representatives, the local government, ruling party, opposition party, traditional leaders, or religious leaders "not at all" or "just a little".
Disapproval of public figures' performance	
Disapproval of performance	Individual "strongly disapproves" or "disapproves" of the way the Prime Minister, their member of the House of Peoples' Representatives, their elected local government leader, or traditional leaders have performed their jobs over the past 12 months.

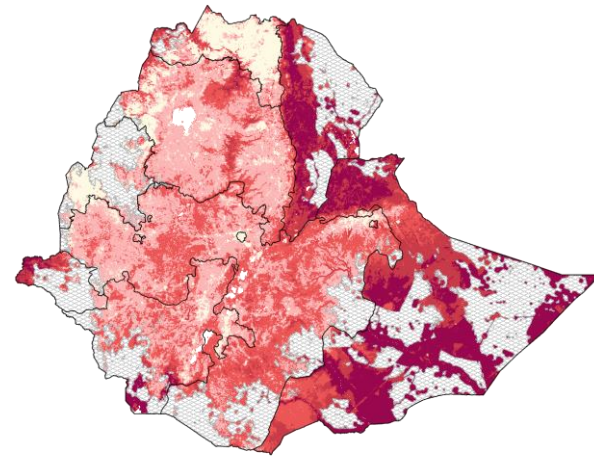
Source: 2021 Ethiopia Afrobarometer

Hyperlocal Mapping of Vaccine Hesitancy

Hyperlocal Mapping of the 3Cs

Fraym mapped each of the “3Cs” to understand how to target and reach the vaccine hesitant.

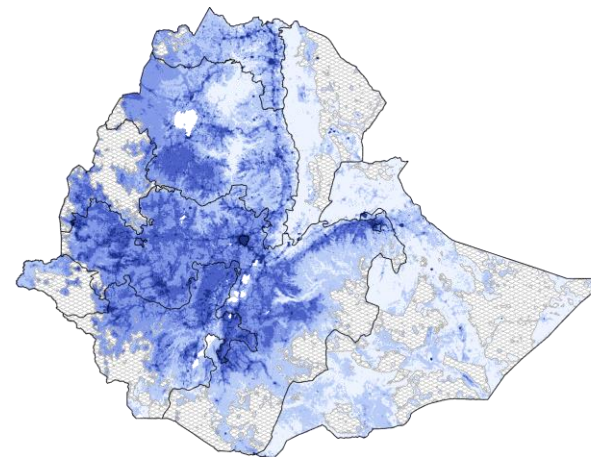
Complacency Index



Low High

Complacency is highest in eastern Ethiopia and the southwest of the country. The Somali, Afar, and Gambella regions have the highest concentrations of complacent adults.

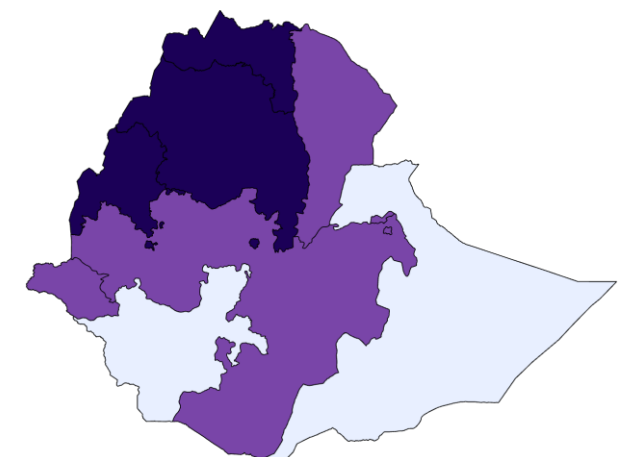
Convenience Index



Low High

Convenience is lowest in rural areas far from the country’s urban centers (including Addis Ababa, Dire Dawa, and Harari). Convenience is low in the Somali and Afar regions while it is much higher in the Oromia and Southern Nations regions.

Confidence Index



Low High

Region-level confidence (trust in government) is lowest in the Tigray, Amhara, and Benishangul-Gumuz regions. This might be tied to ethnic conflict, driven by distrust towards the national government.

Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer



Areas with no adult 15-49 population

Creating Profiles of Vaccine Hesitant Adults

Fraym developed five (5) profiles that capture different reasons for not receiving the COVID-19 vaccine. Fraym then mapped these profiles to identify potentially high-risk communities and to estimate the number of adults at risk of not getting vaccinated.

- 1 Confident Enthusiasts:** Previous high interactions with the health system and easy access to health services. These individuals would be the most likely to have rapid vaccine uptake.
- 2 Enthusiastic Pragmatists:** Previous high interactions with the health system and high trust in government, but significant challenges to vaccination due to accessibility, affordability or time burden constraints. These individuals would likely have delayed vaccine uptake.
- 3 Vaccine Ambivalents:** Despite moderate trust in government and no significant issues related to health service accessibility, these individuals have had low interactions with the health system. This could signal a low desire to prevent vaccine-preventable diseases that could lead to slow uptake among this group.
- 4 Vaccine Sceptics:** Previous interactions with the health system and some challenges related to accessibility, affordability, or time burden constraints. However, low trust in government among this group might create a disconnect with the health system that might lead to slow vaccine uptake.
- 5 COVID Cynics:** Least likely to receive the vaccine due to low previous interactions with the health system, moderate difficulties reaching health centers, and low trust in the government. Vaccine uptake may be unlikely among this group.

Profiles of Vaccine Hesitant Adults

Fraym created each profile based on their unique combination of the “3Cs”.

Profile	Confident Enthusiasts	Enthusiastic Pragmatists	Vaccine Ambivalents	Vaccine Sceptics	COVID Cynics
Confidence (Perceived safety and efficacy of the COVID-19 vaccine)	High	High	Moderate	Low	Low
Convenience (Perceived ease of getting vaccinated to COVID-19)	High	Low	Moderate	Moderate	Moderate
Complacency (Low perceived risk and severity of catching COVID-19)	Low	Low	High	Low	High
Profile Description	Perceive that the vaccine will be safe and effective, accessible and affordable, and are very concerned about COVID-19.	Trust the vaccine and are concerned about COVID-19, but they anticipate significant challenges to vaccination.	Not particularly distrustful or disconnected from the health system, but they are not concerned about COVID-19.	May have access to a vaccine and are concerned about COVID-19, but they do not trust the vaccines.	May have access to a vaccine, but they do not trust the vaccine nor are they concerned about COVID-19.
Estimated Speed of Uptake	Rapid	Delayed	Slow	Very Slow	Unlikely





Profile Summaries

Fraym produced replicated the Ipsos MORI vaccine segments using the World Health organization's "3Cs" framework, creating hyperlocal maps of each segment across Ethiopia.

- **Confident Enthusiasts:** Enthusiasts are more likely to be **Somali** and have **higher levels of education** than any of the other groups. Two in five enthusiasts have no education, compared to over half of the other groups. Enthusiasts also report higher rates of **television** viewership with nearly a third having watched television at least once a week.
- **Enthusiastic Pragmatists:** Pragmatists are less likely than the other groups to consume any type of media. **Fewer than one in ten listen to the radio** at least once a week, with an even lower share using television or newspapers regularly. Although similarly likely to have previous interaction with the health system, pragmatists are **much less educated** than enthusiasts and might be more **difficult to reach by traditional media campaigns**.
- **Vaccine Ambivalents:** Ambivalents are the **youngest group** with two thirds under the age of 35. Additionally, nearly 90 percent of ambivalents are from the **Oromo ethnic group**. This group would be most effectively reached by **radio**, although less than 20 percent listen to this media at least once a week.
- **Vaccine Sceptics:** This group has the **second highest primary school completion rate** after enthusiasts, with over a third having completed secondary school. Although this group has low levels of trust in government, **television** viewership is relatively high, with around one in five watching at least once a week.
- **COVID Cynics:** Although least likely to take the vaccine, this group is **relatively older** than the others with nearly three in five between ages 35 and 49. Additionally, antagonists are likely to be from the **Amhara ethnic group** and the **least educated** with around two thirds having no education at all.

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	
Age						
	15-34	62%	65%	67%	60%	43%
	35-49	38%	35%	33%	40%	57%
Ethnicity						
	Amhara	4%	2%	3%	64%	81%
	Oromo	3%	3%	89%	2%	3%
	Tigray	< 1%	< 1%	< 1%	29%	12%
	Afar	< 1%	< 1%	1%	< 1%	< 1%
	Somali	22%	10%	< 1%	< 1%	< 1%
Education						
	No education	41%	56%	59%	52%	67%
	Complete primary	15%	5%	5%	12%	6%
	Complete secondary	2%	< 1%	< 1%	1%	< 1%
	Higher education	1%	< 1%	< 1%	1%	< 1%
Media Consumption						
	Newspaper/Magazine	7%	1%	2%	3%	1%
	Television	29%	3%	4%	20%	8%
	Radio	20%	8%	16%	15%	10%

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

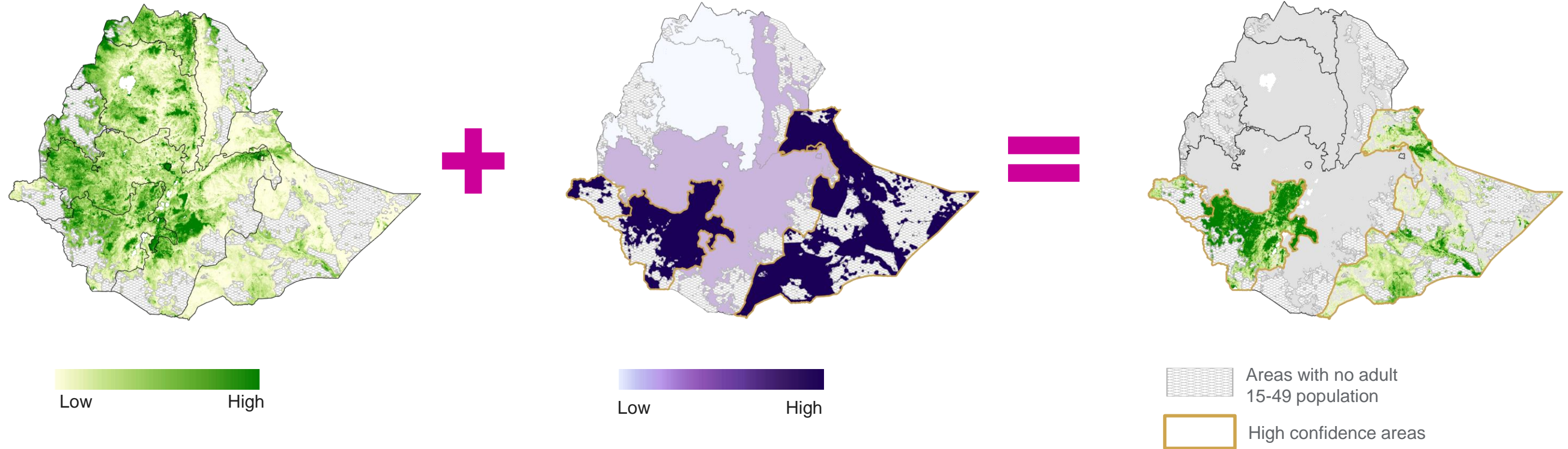
Confident Enthusiasts: Creating the Profile

Fraym mapped low complacency, high convenience adults living in high confidence areas.

Proportion of adults 15-49 who are low complacency, high convenience¹

High confidence areas on the state-level confidence index²

Proportion of adults 15-49 who are low complacency, high convenience and living in high-confidence areas



Note 1: Low complacency, high convenience adults are adults who are in the first tercile of the complacency index, and in the first tercile of the convenience index.

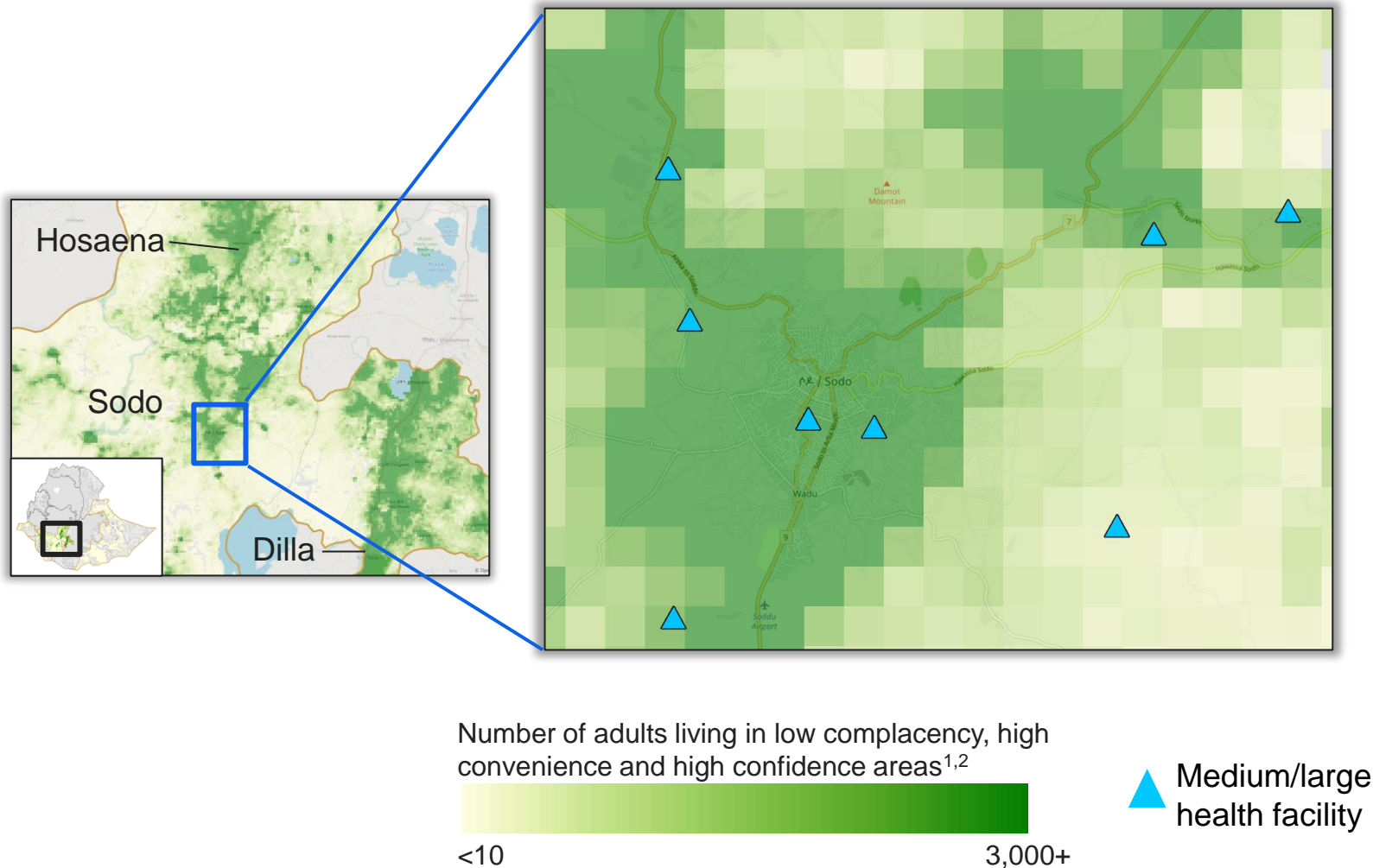
Note 2: High government confidence areas are those that fall into the first tercile of the region-level confidence index. Areas that are not high confidence were made transparent.

Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer, Fraym

Confident Enthusiasts: Hyperlocal View

Vaccine enthusiasts are convinced of the COVID threat and would likely be quick adopters.

Zoom into Sodo City in Southern Nations



10 million adults live in the Southern Nations region, of which **697,000 (7%)** are expected to be confident enthusiasts.

- Adults near cities such as **Sodo, Hosaena** and **Dilla** are generally expected to take the vaccine given their low complacency and high convenience scores.
- This population benefits from the presence of two **medium and large health facility** in the immediate vicinity and six on the outskirts of the city.
- Nearly 90 percent of enthusiasts have access to a **mobile phone**, making them potential mediums for a messaging campaign.

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

Note 2: Map shows the number of adults who are low complacency and high convenience and are living in high government confidence areas.

Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer, Fraym

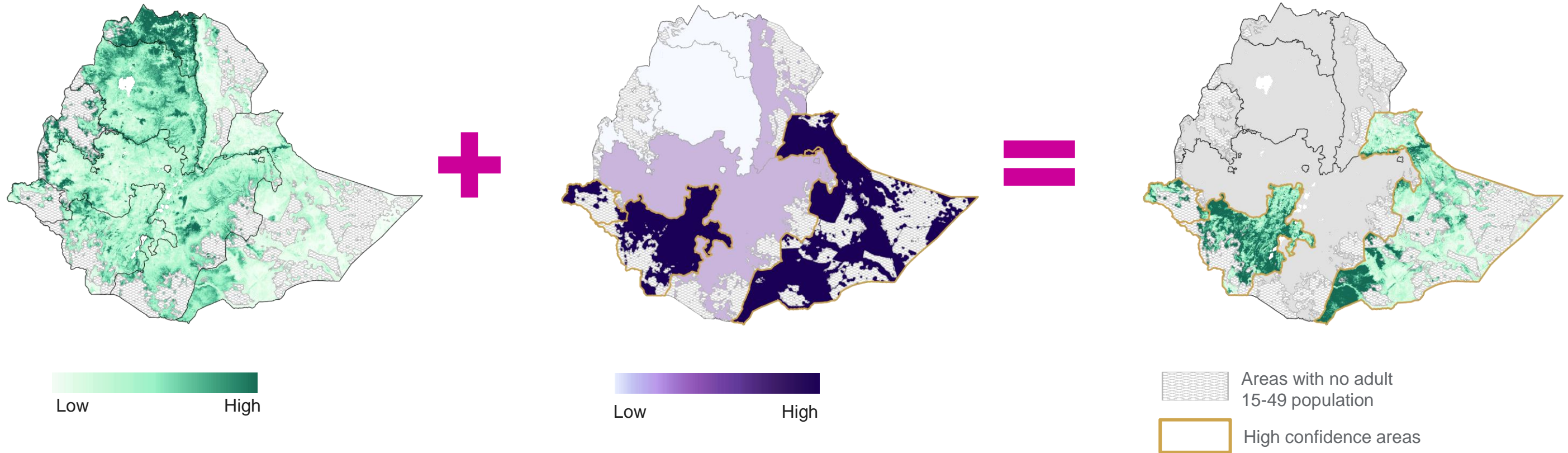
Enthusiastic Pragmatists: Creating the Profile

Fraym mapped low complacency, low convenience adults living in high confidence areas.

Proportion of adults 15-49 who are low complacency, low convenience¹

High confidence areas on the state-level confidence index²

Proportion of adults 15-49 who are low complacency, low convenience and living in high-confidence areas



Note 1: Low complacency, low convenience adults are adults who are in the first tercile of the complacency index, and in the third tercile of the convenience index.

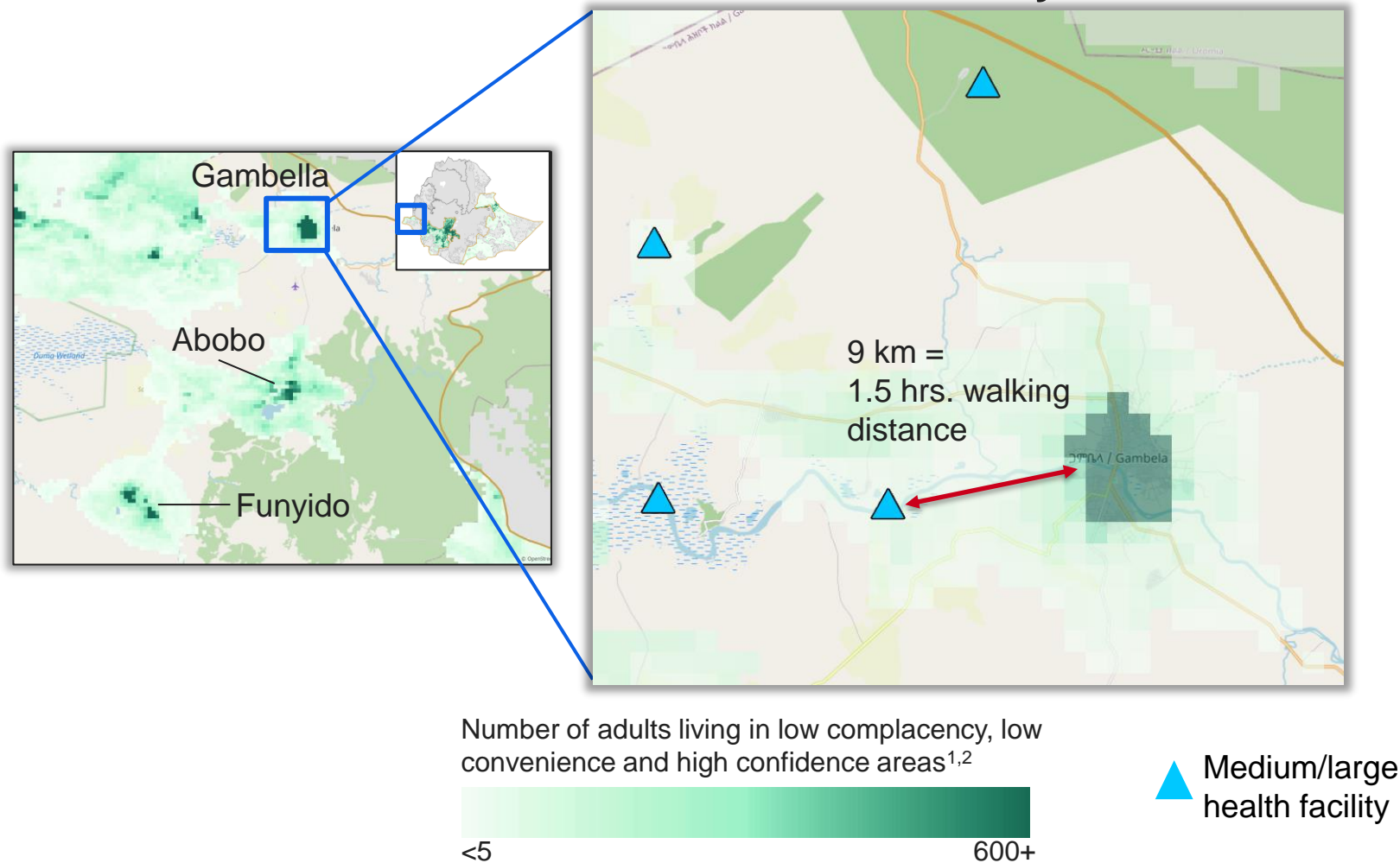
Note 2: High government confidence areas are those that fall into the first tercile of the state-level confidence index. Areas that are not high confidence were made transparent.

Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer, Fraym

Enthusiastic Pragmatists: Hyperlocal View

Enthusiastic pragmatists are convinced of the COVID threat but may have difficulty accessing a vaccine distribution site.

Zoom into Gambella City in Gambella



270,000 adults live in the Gambella region, of which **20,000 (7%)** are expected to be enthusiastic pragmatists.

- Adults near the largest cities such as **Gambella**, **Abobo** and **Funyido** are generally expected to take the vaccine but may be inconvenienced due to accessibility, time, or financial burdens.
- It would take over an hour and a half for a resident of Gambella to walk to the nearest health facility (9 km from city center).
- **Risk communication campaigns** should consider that enthusiastic pragmatists are the least likely group to access traditional media or own mobile phones. Creative outreach may be necessary to improve vaccination rates among these populations.

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

Note 2: Map shows the number of adults who are low complacency and low convenience, and are living in high government confidence areas.

Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer, Fraym

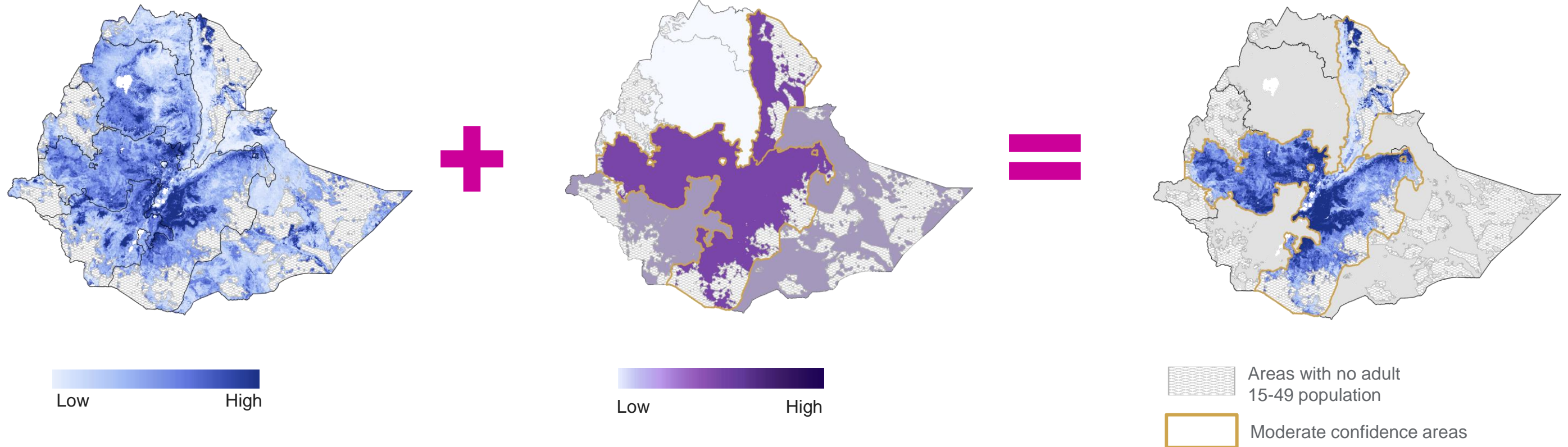
Vaccine Ambivalents

High complacency, moderate convenience adults living in moderate confidence areas.

Proportion of adults 15-49 who are high complacency, moderate convenience¹

Moderate confidence areas on the state-level confidence index²

Proportion of adults 15-49 who are high complacency, moderate convenience and living in moderate-confidence areas



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.

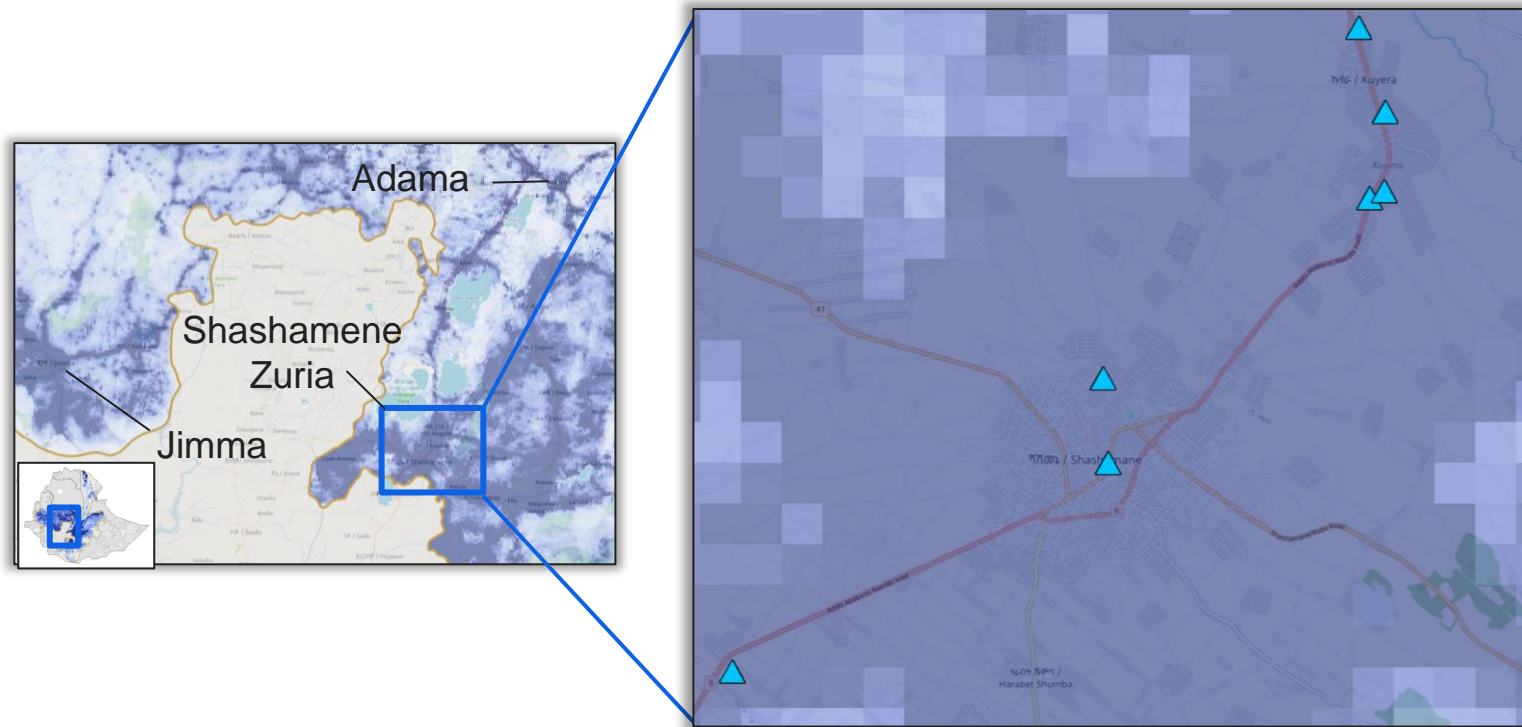
Note 2: Moderate government confidence areas are those that fall into the second tercile of the state-level confidence index. Areas that are not moderate confidence were made transparent.

Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer, Fraym

Vaccine Ambivalents: Hyperlocal View

Vaccine ambivalents still need to be convinced of the COVID threat and face some health access hurdles. Their situation may mean vaccine take-up may be slower.

Zoom into Shashamene Zuria in Oromia



Number of adults living in high complacency, moderate convenience and moderate confidence areas^{1,2}



<10

700+

▲ Medium/large health facility

18 million adults live in the Oromia region, of which **2.2 million (12%)** are expected to be vaccine ambivalents.

- Adults in urban areas such as **Adama, Shashamene Zuria, and Jimma** may require more convincing and outreach to take the vaccine due to their high complacency and moderate convenience scores.
- Risk communication campaigns for this group will be critical to explain the threat COVID-19 poses to them and their loved-ones. **Television** and **mobile phone** 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 and are living in moderate government confidence areas.

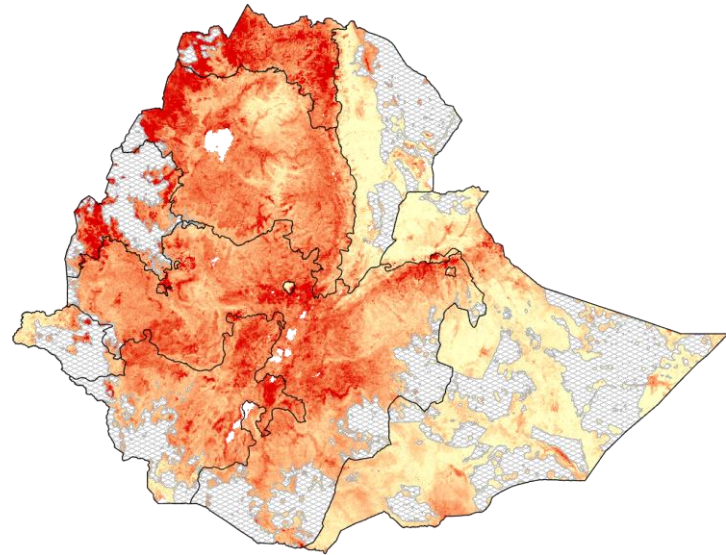
Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer, Fraym

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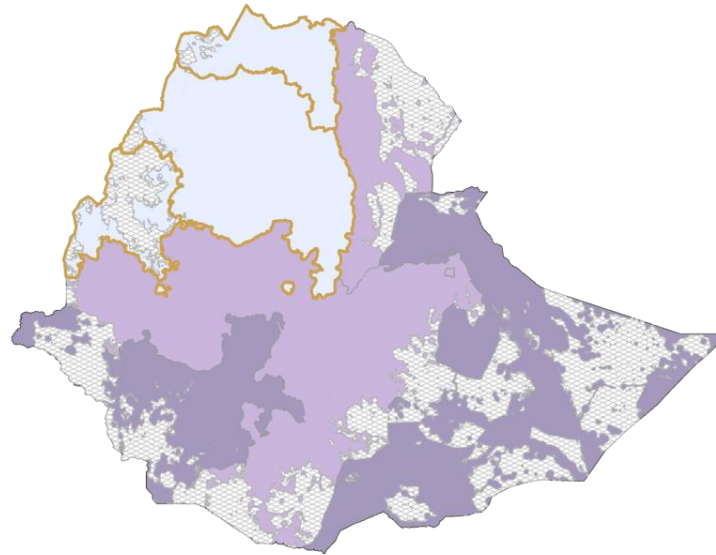
Vaccine Sceptics

Low complacency, moderate convenience adults living in low confidence areas.

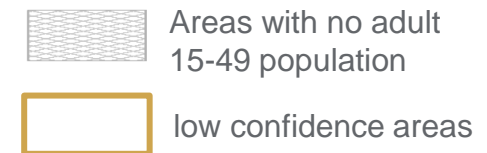
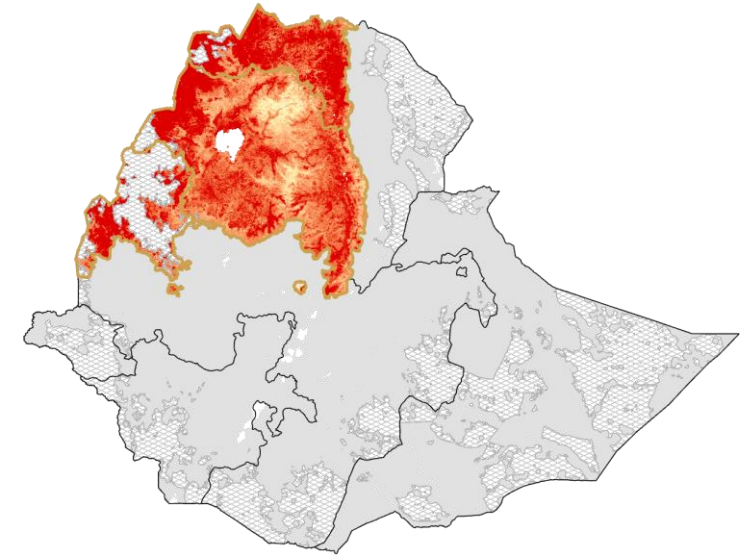
Proportion of adults 15-49 who are low complacency, moderate convenience¹



Low confidence areas on the state-level confidence index²



Proportion of adults 15-49 who are low complacency, moderate convenience and living in low-confidence areas



Note 1: 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.

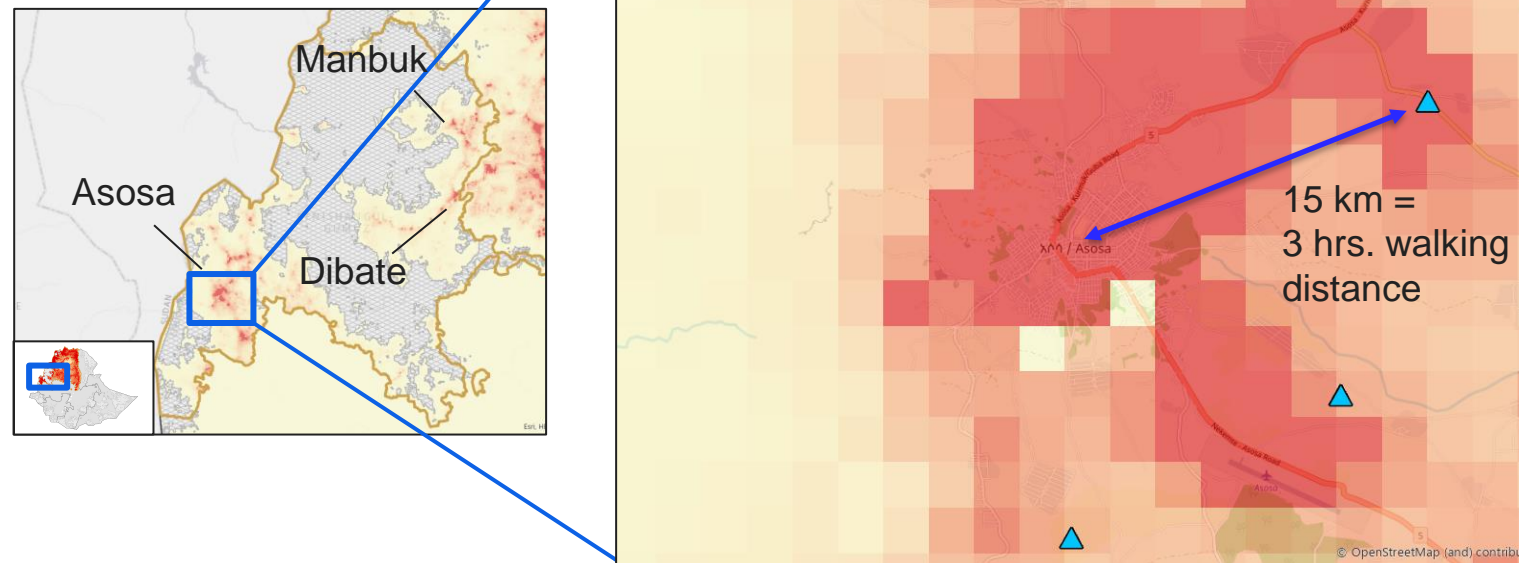
Note 2: low government confidence areas are those that fall into the first tercile of the state-level confidence index. Areas that are not low confidence were made transparent.

Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer, Fraym

Vaccine Sceptics: Hyperlocal View

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

Zoom into Asosa in Benshangul-Gumuz



Number of adults living in low complacency, moderate convenience and low confidence areas^{1,2}

<10 3,000+

▲ Medium/large health facility

536,000 adults live in Benshangul-Gumuz, of which **73,000 (14%)** are expected to be skeptics.

- Most vaccine sceptics live in cities such as **Asosa, Manbuk** and **Dibate**. This group may take the vaccine at a slower rate given their moderate convenience and low confidence.
- There are relatively few medium and large health facilities in these areas. Asosa could benefit from **pop-up clinics** providing services to this population closer to the town's center.
- Low confidence in the government poses a significant challenge but nearly 70% 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 and are living in low government confidence areas.

Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer, Fraym

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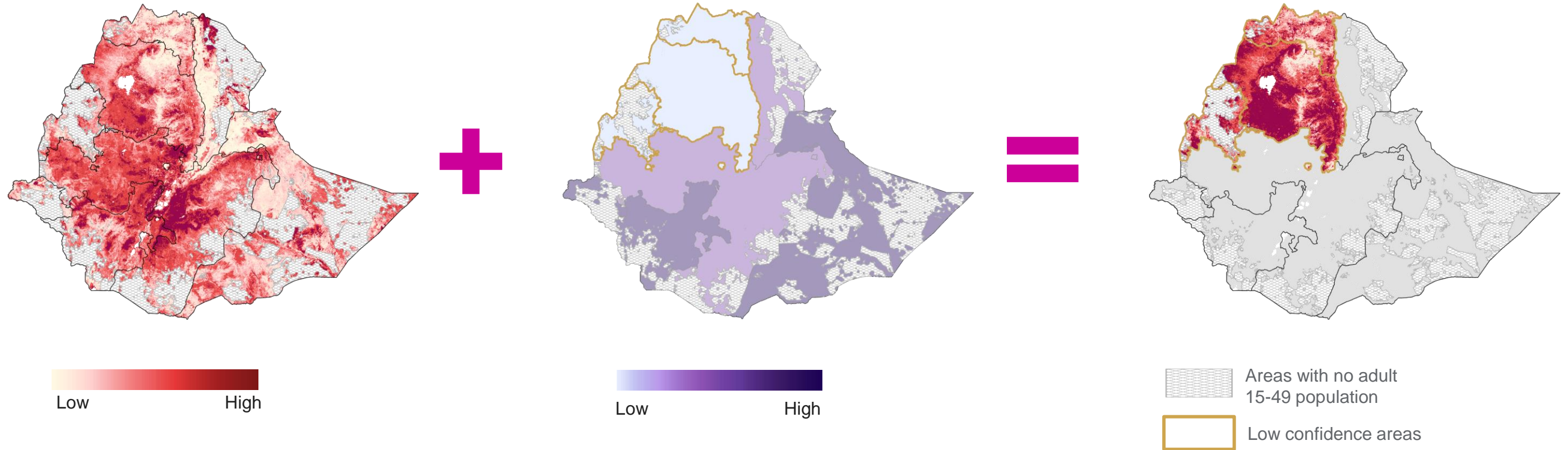
COVID Cynics: Creating the Profile

Fraym found high complacency, moderate convenience adults living in low confidence areas.

Proportion of adults 15-49 who are high complacency, moderate convenience¹

Low confidence areas on the state-level confidence index²

Proportion of adults 15-49 who are high complacency, moderate convenience and living in low-confidence areas

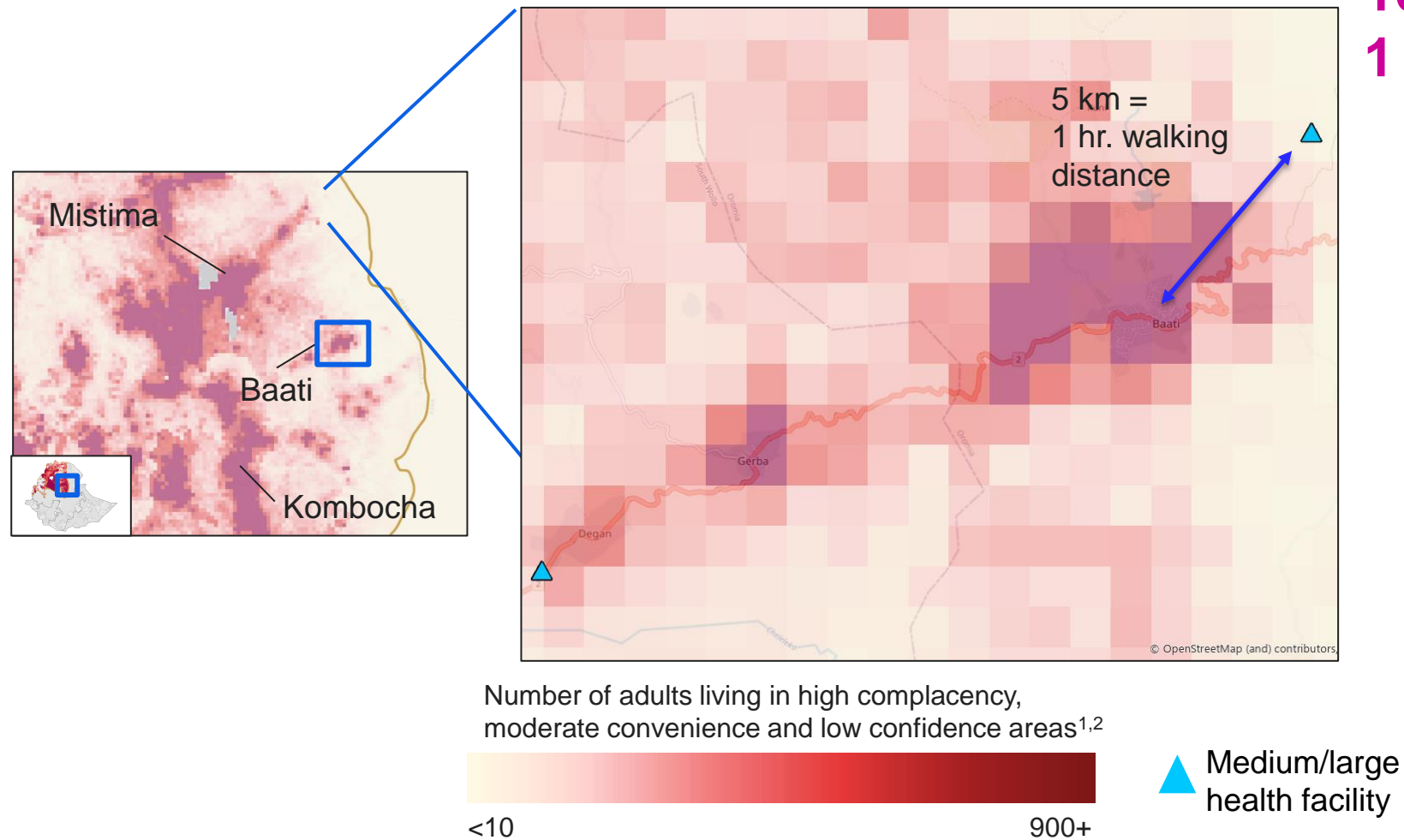


Note 1: High complacency, moderate convenience adults are adults who are in the third tercile of the complacency index, and in the second tercile of the convenience index.
Note 2: Low government confidence areas are those that fall into the third tercile of the state-level confidence index. Areas that are not low confidence were made transparent.
Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer, Fraym

COVID Cynics: Hyperlocal View

COVID Cynics have strong beliefs that predispose them against getting vaccinated.

Zoom into Baati in Amhara



10.8 million adults live in Amhara, of which **1 million (9%)** are expected to be cynics.

- Cynics are most prevalent in settlements across Amhara state, such as **Baati**, **Mistima** and **Kombolcha**. These adults will need to be convinced to get the Covid-19 vaccine.
- Health facilities in the area is limited and away from the core population centers. **A combination of pop-up clinics and messaging campaigns** may help drive vaccination rates.
- Less than one in ten cynics regularly consume media from TV, newspapers, or the radio, however around 3 in 5 have access to a **mobile phone**.

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, and are living in low government confidence areas.

Source: 2016 Ethiopia DHS, 2021 Ethiopia Afrobarometer, Fraym

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About Fraym

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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.



ACQUIRE DATA

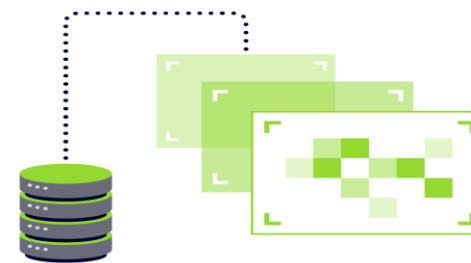
Geo-tagged household surveys
Satellite imagery
Partner datasets

Mobility data from network operators



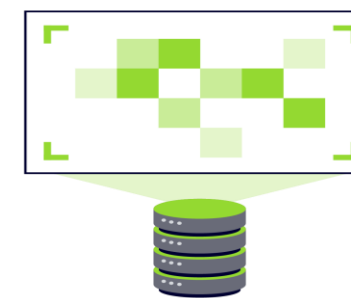
HARMONIZE DATA

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.

Ilse Paniagua || i.paniagua@fraym.io

Kenneth Davis || k.davis@fraym.io

Quinn Lewis || q.lewis@fraym.io

Johnson & Johnson