Improving decision-making for DDD with GIS mapping and spatial modeling

Decentralized Drug Distribution (DDD) Learning Collaborative

November 19, 2020

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EpiC
Meeting Targets and Maintaining Epidemic Control

Session 7: Learning Collaborative Agenda (7-8:30 am EST)

- **Using GIS to support the implementation of DDD in South Africa**
  Mashudu Mashamba, USAID South Africa

- **Optimizing availability of antiretroviral therapy by mapping patients and pick-up points**
  Otoyo Toyo, Associate Director, Achieving Health Nigeria Initiative

- **Mapping of Fishing Community Landing Sites and Spatial Accessibility to Healthcare Facilities within the Kalangala District of Uganda**
  James Tobias, Sr. GIS Developer, Northrup Grumman
  Tonny Bogere, Public Health Informatician, Independent Contributor and former Public Health Information Systems Team Lead at CDC Uganda

- **Methods for modeling ART client locations for DDD using GIS**
  Caleb Parker: Senior Research Associate/GIS Analyst, FHI 360

- **Q&A**
  William Miller, Facilitator, Senior Technical Advisor for Key Populations, USAID/Washington, DC

Meeting Targets and Maintaining Epidemic Control (EpiC) Project

2020

DDD Learning Collaborative

About the Learning Collaborative

As several countries in sub-Saharan Africa are implement different decentralized drug distribution (DDD) models, this a community of practice will be an opportunity for knowledge exchange among stakeholders implementing DDD models – including representatives from national ministries, implementing partners, community-based organizations (CBOs), funders, and others. Join us for the first in a series of discussions on decentralizing ART

SPEAKERS

Mashudu Mashamba
USAID South Africa

Otoyo Toyo
Associate Director, Achieving Health Nigeria Initiative

Caleb Parker, MA
Senior Research Associate/ GIS Analyst, FHI 360

James Tobias
Sr. GIS Developer, Northrup Grumman

Tonny Bogere
Public Health Informatician, Independent Contributor

FACILITATOR

William Miller
Senior Technical Advisor, FHI 360

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Using GIS to support the implementation of DDD

Mashudu Mashamba
USAID South Africa
November 2020

How Are We Using GIS?

- Know where PLHIV are
  - Identify areas with the greatest HIV burden
    - Understand the demography/social context
  - Assess coverage of health care facilities
  - How far do people need to travel to access their medication
  - Where are the gaps
  - What about external Pick Up Points

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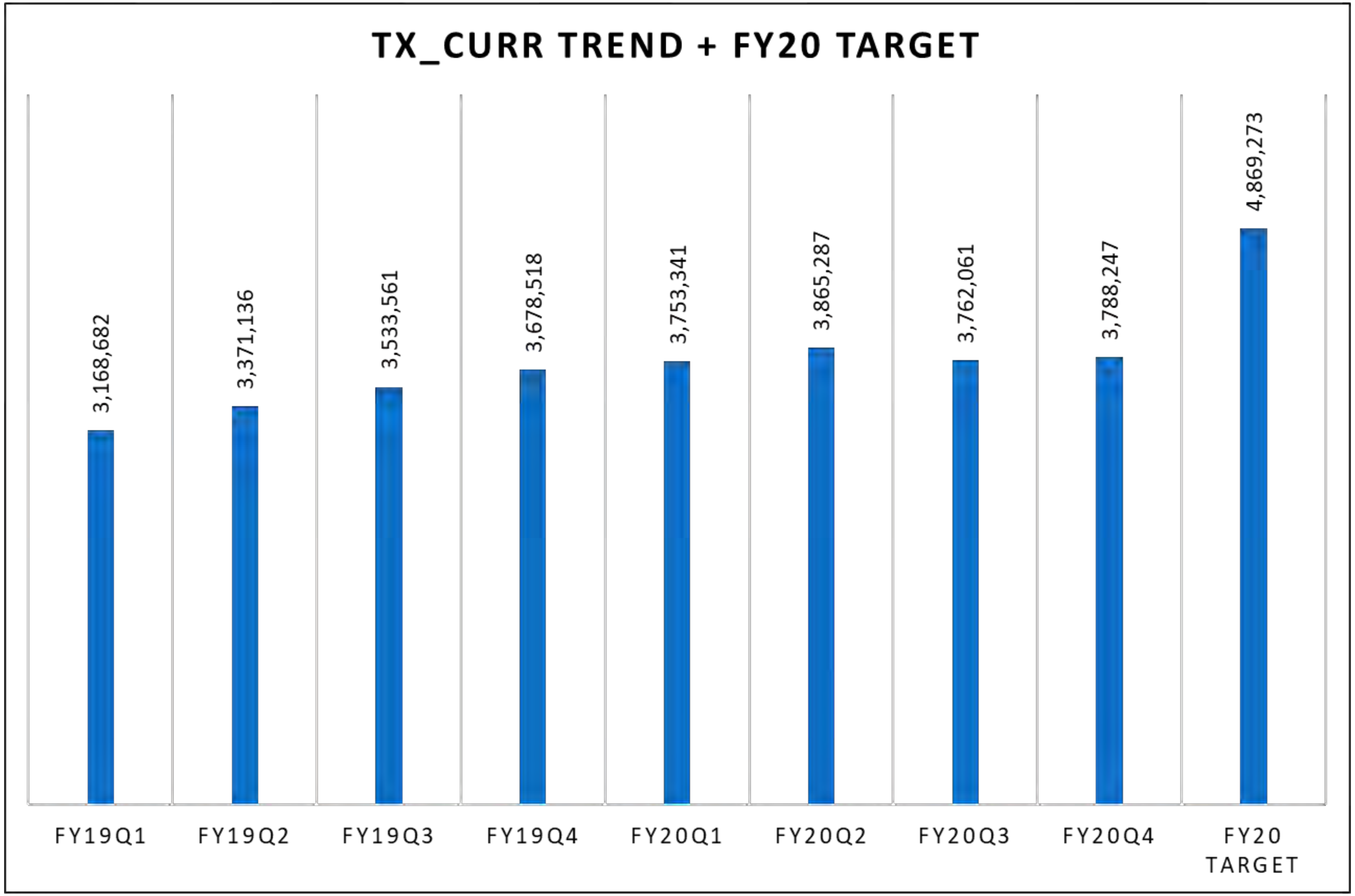
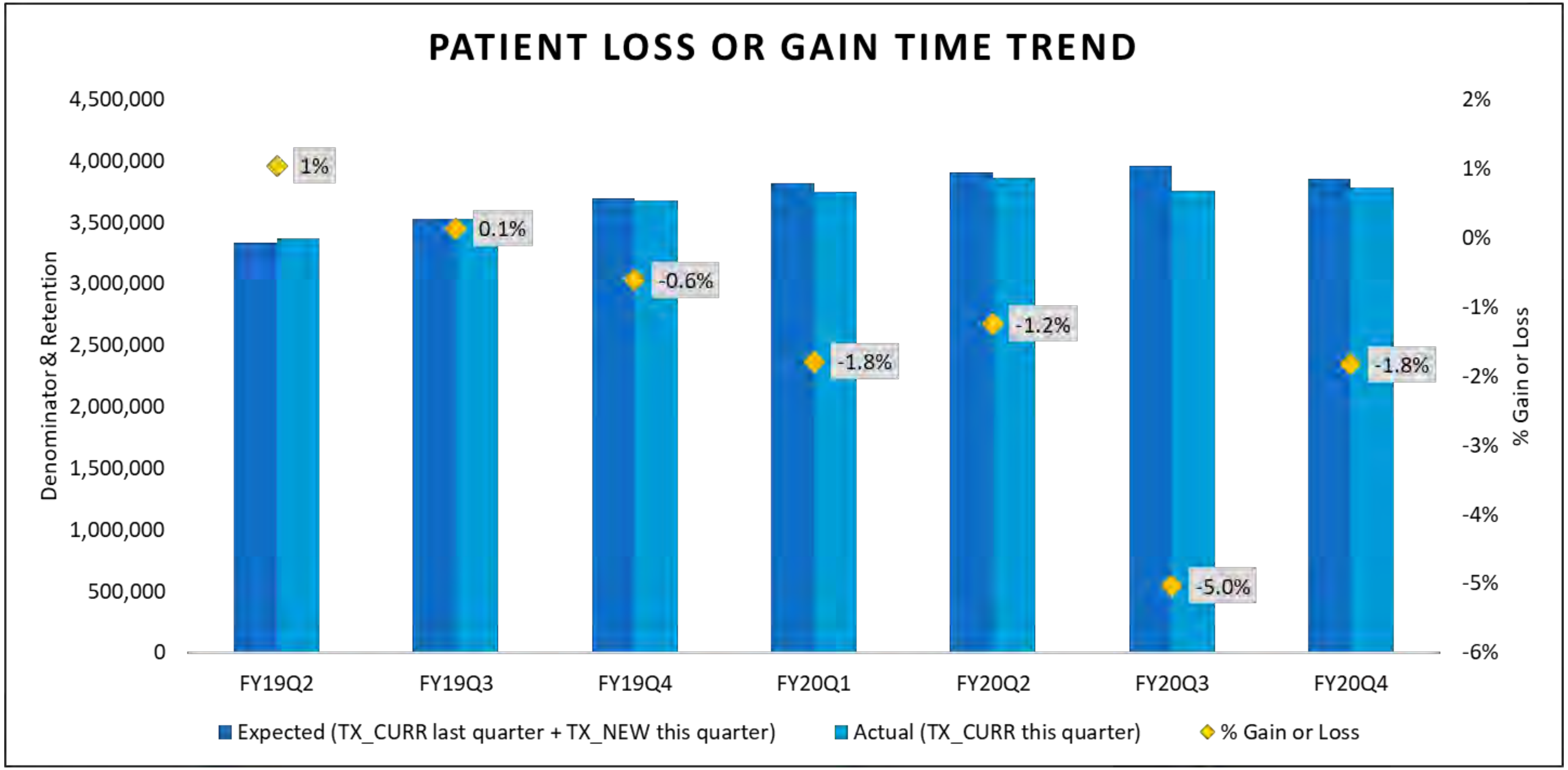
A Quick background on PEPFAR SA




PATIENT LOSS OR GAIN TIME TREND
Denominator & Retention
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
% Gain or Loss
2%
1%
0%
-1%
-2%
-3%
-4%
-5%
-6%
1%
0.1%
-0.6%
-1.8%
-1.2%
-5.0%
-1.8%
FY19Q2
FY19Q3
FY19Q4
FY20Q1
FY20Q2
FY20Q3
FY20Q4
Expected (TX_CURR last quarter + TX_NEW this quarter)
Actual (TX_CURR this quarter)
% Gain or Loss

Why South Africa is Implementing DDD?

- Congested health care facilities
  - Some high volume sites have >20,000 ART patients
- Long queues
- Travelling distance to the health facility
- Operating hours at the health facilities not catering for those who are working
- Patients being turned back if they come in after a certain time

Impact: Patients defaulting, resulting in high numbers of patient loss

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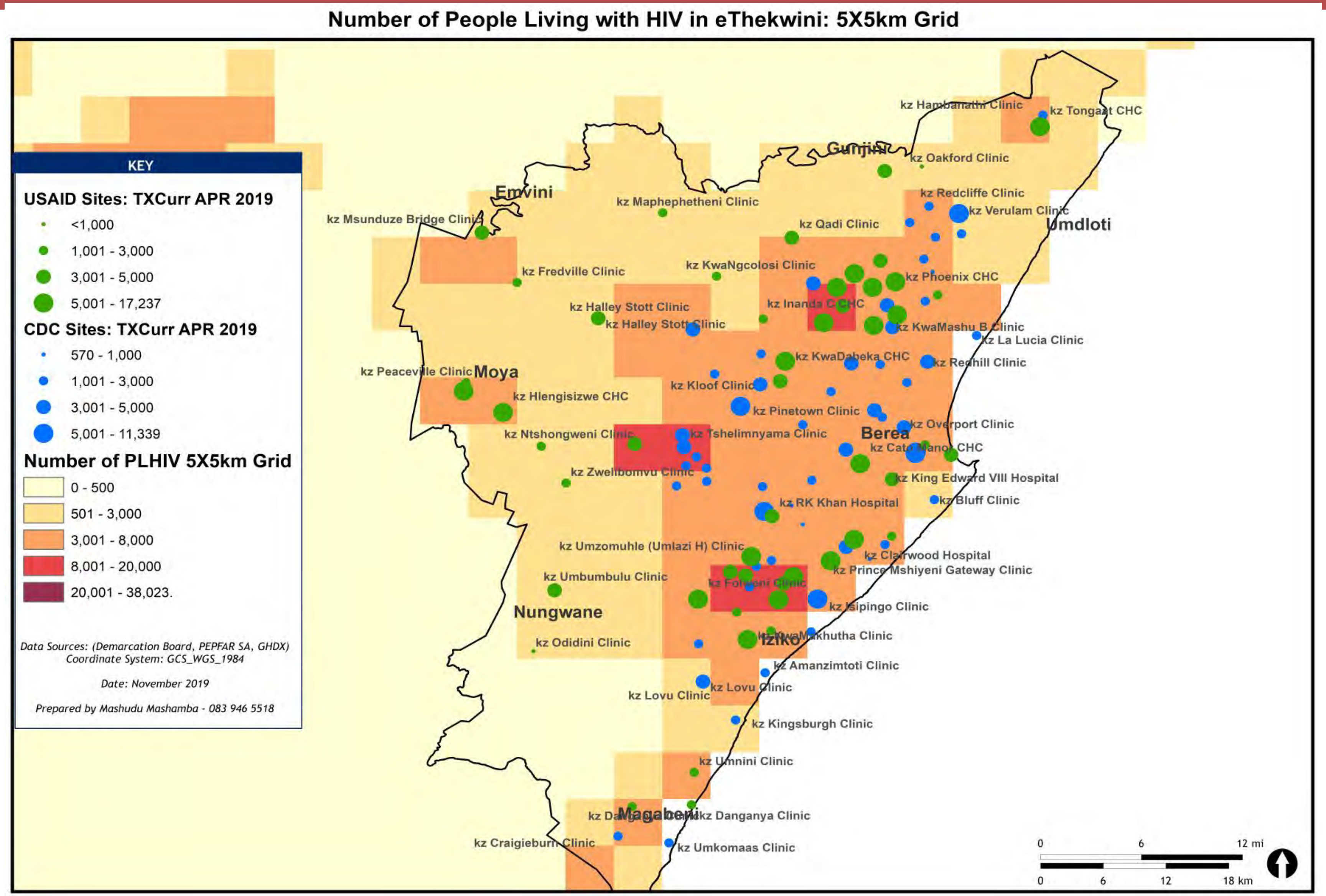
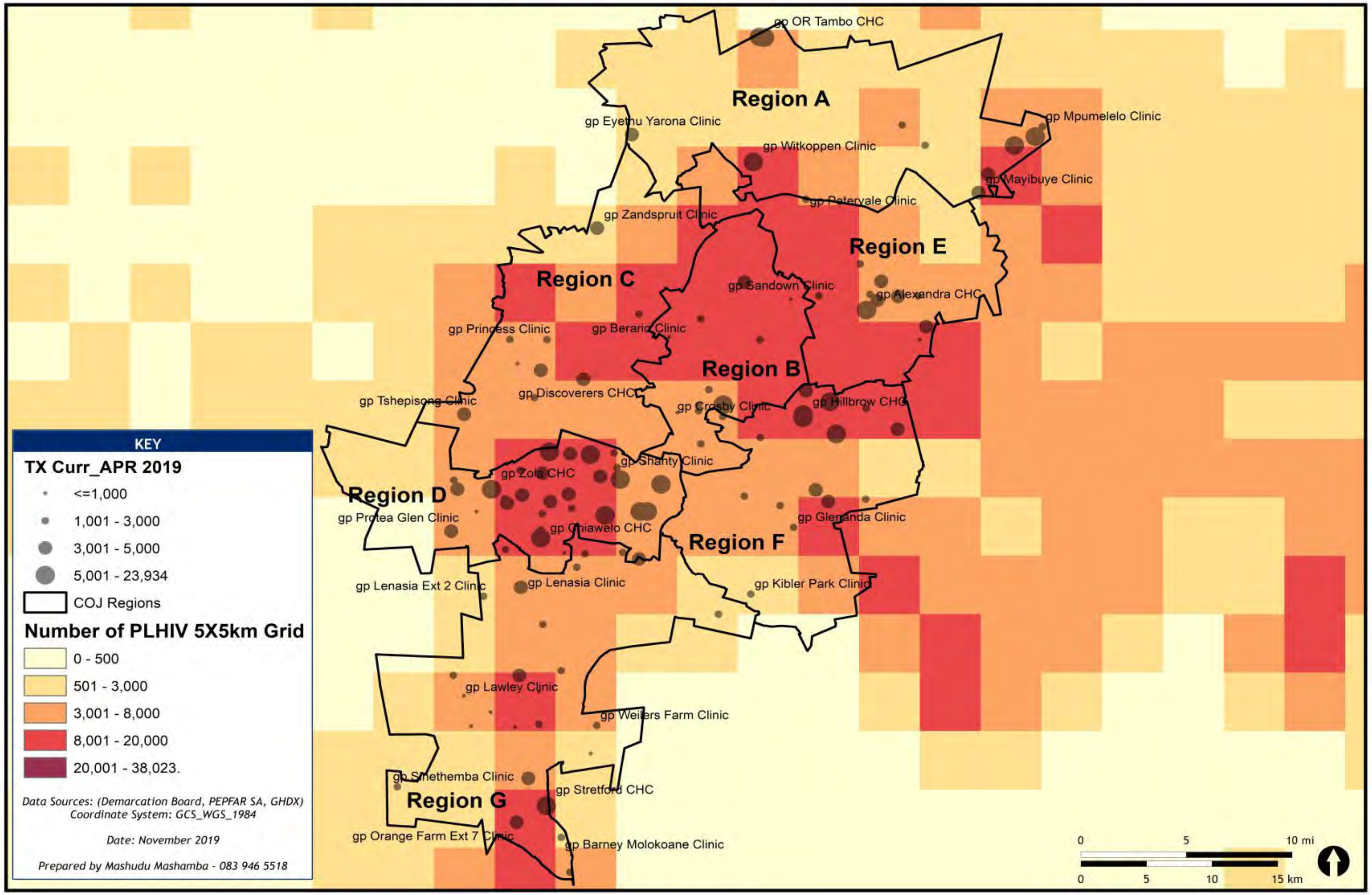
Know Where PLHIV Live - eThekwini



Know Where PLHIV Live – City of Johannesburg

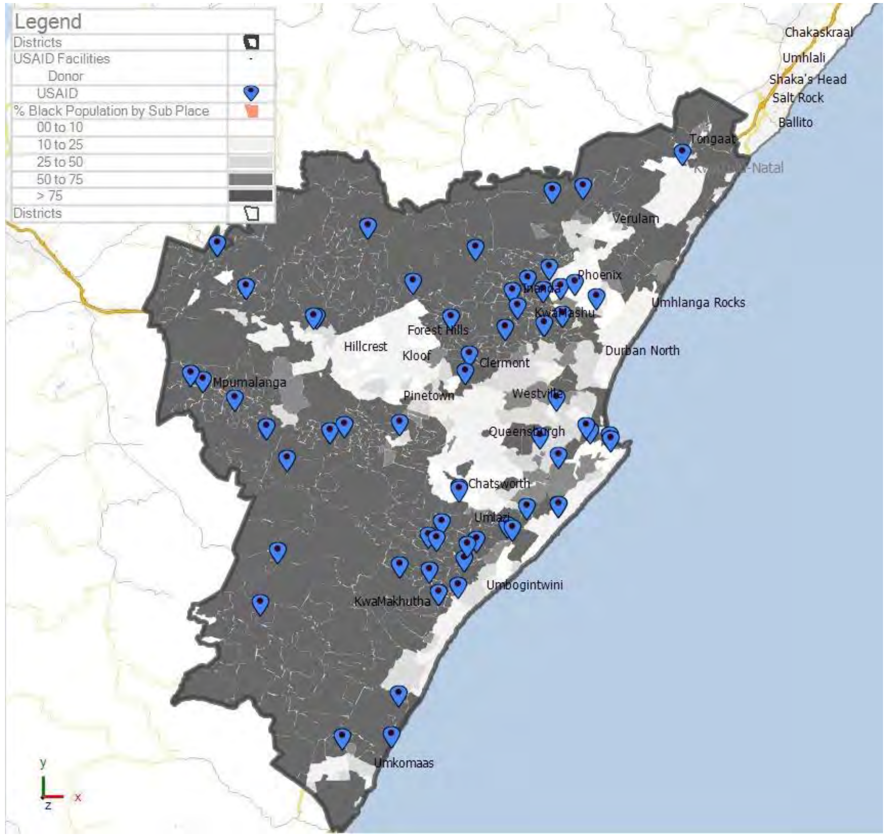
Number of People Living with HIV in City of Johannesburg: 5X5km Grid



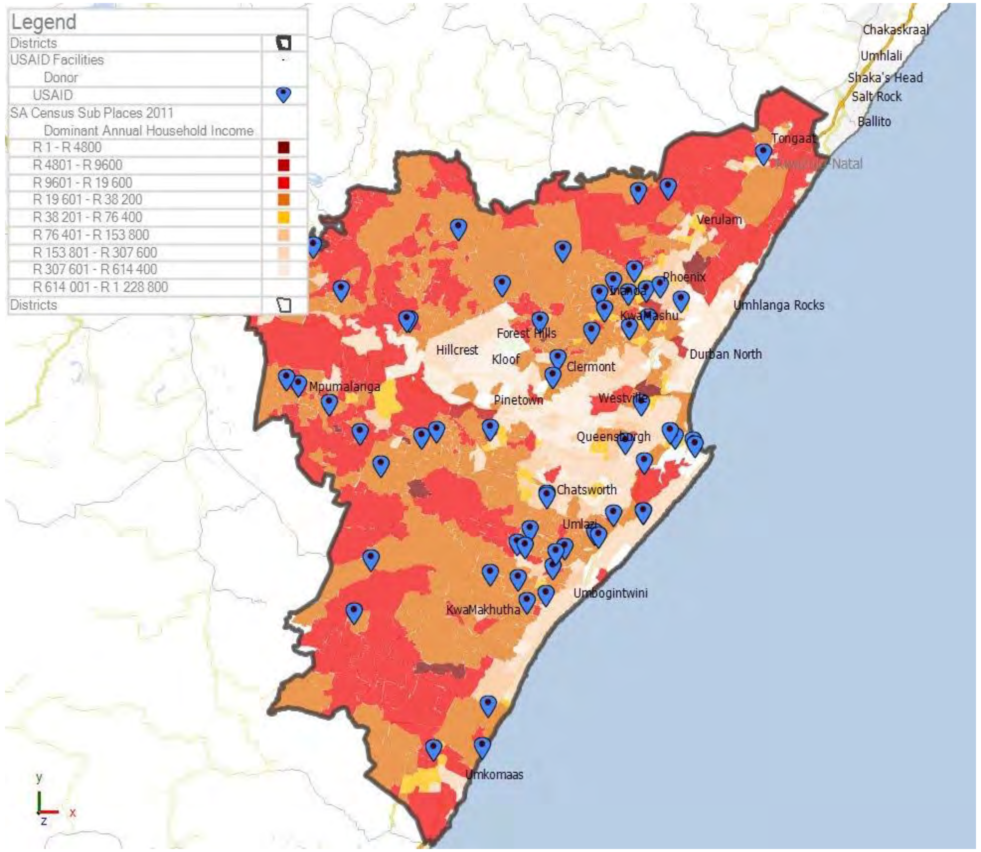
Understanding the Demography/Social Context in eThekwini

- Where do people live?
- Where do they work?
- How do they move around?
- Socio-economic status

Understanding the Demography/Social Context in eThekwini



MAP 1: USAID-Supported Facilities are Located in Predominantly Black Neighborhoods



MAP 2: USAID-supported Sites are Located in Some of the Lowest Income Neighborhoods in the Country

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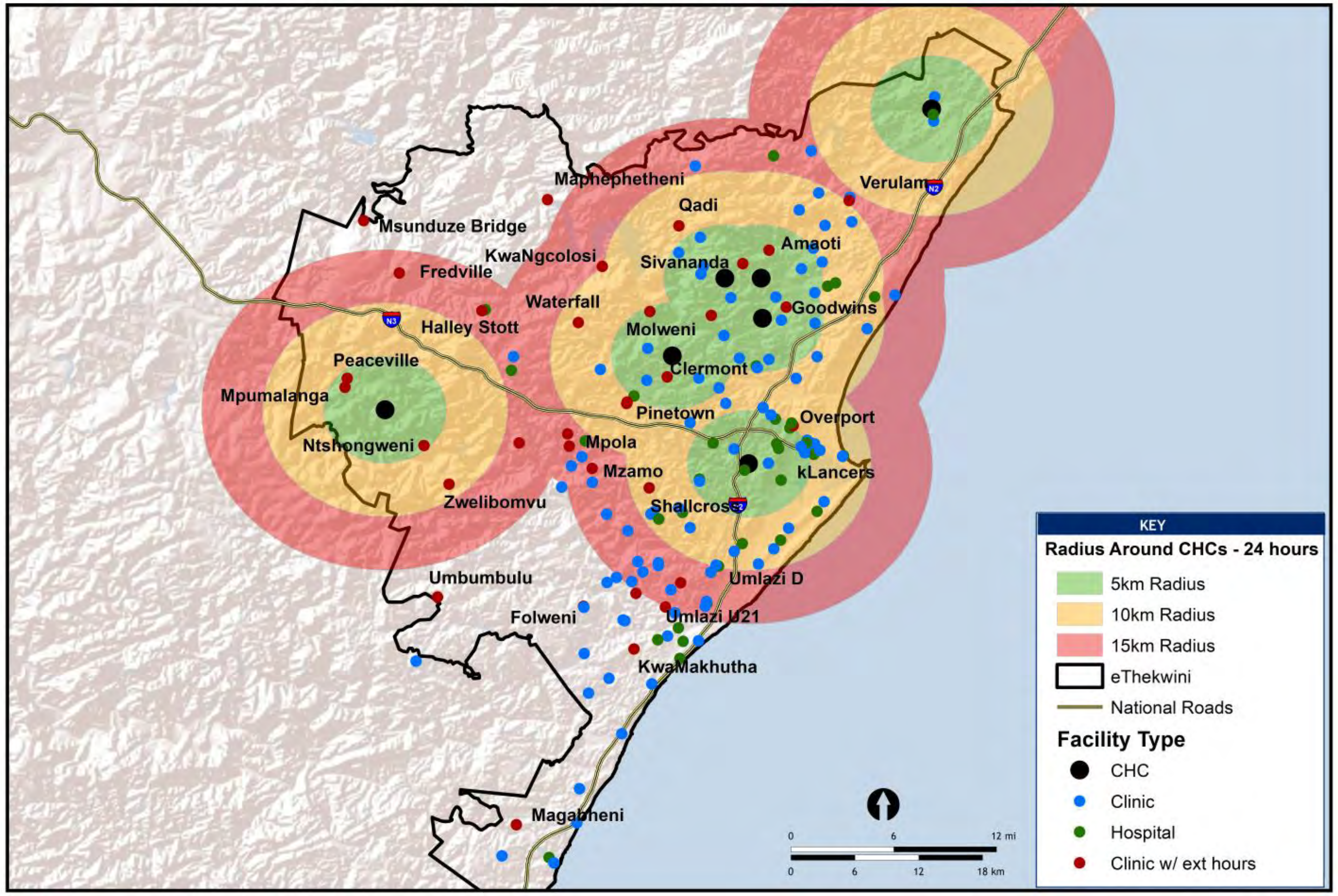
Distribution of Health Facilities

eThekwini Access to Health Care Facilities



Very few 24 hour facilities

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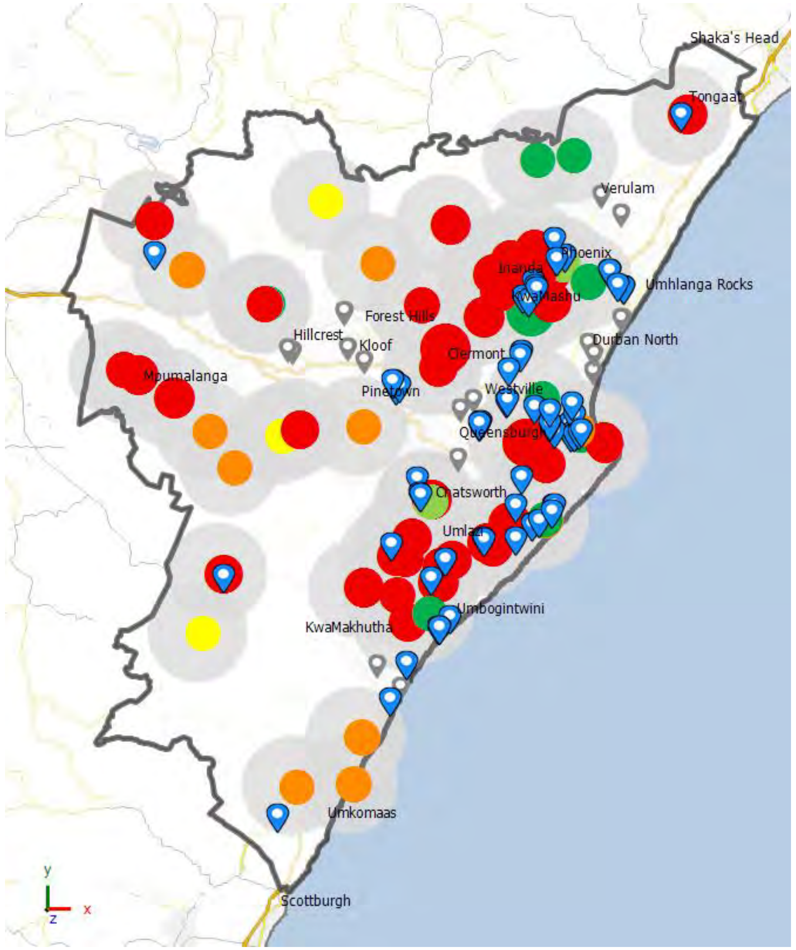
Looking at PuPs

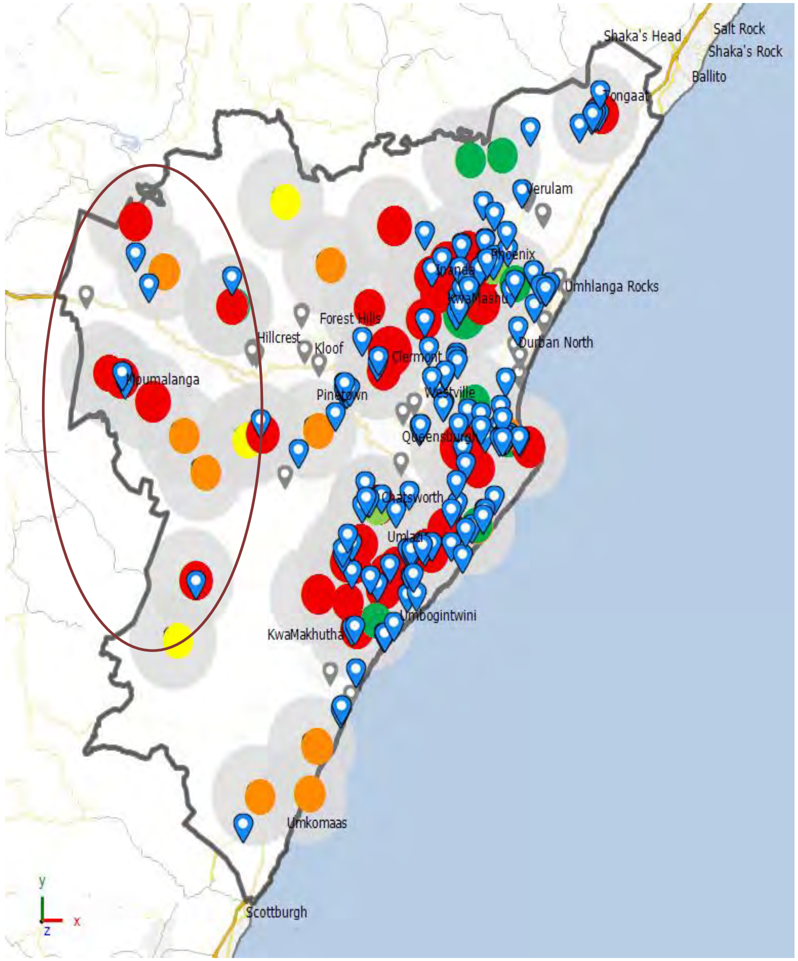
- Focus on PuPs intensified in 2019
- Health facilities given targets for decanted patients
    - 80% of stable patients should be decanted, some to PuPs
- Approval of PuPs done by the Ministry of Health
- PuPs need to be closer to the community they serve
    - Some in workplaces
- PuPs have flexible hours

Looking at PuPs in eThekwini

FY 2018
85 PuPs in eThekwini
66 PuPs in 5km radius of USAID sites



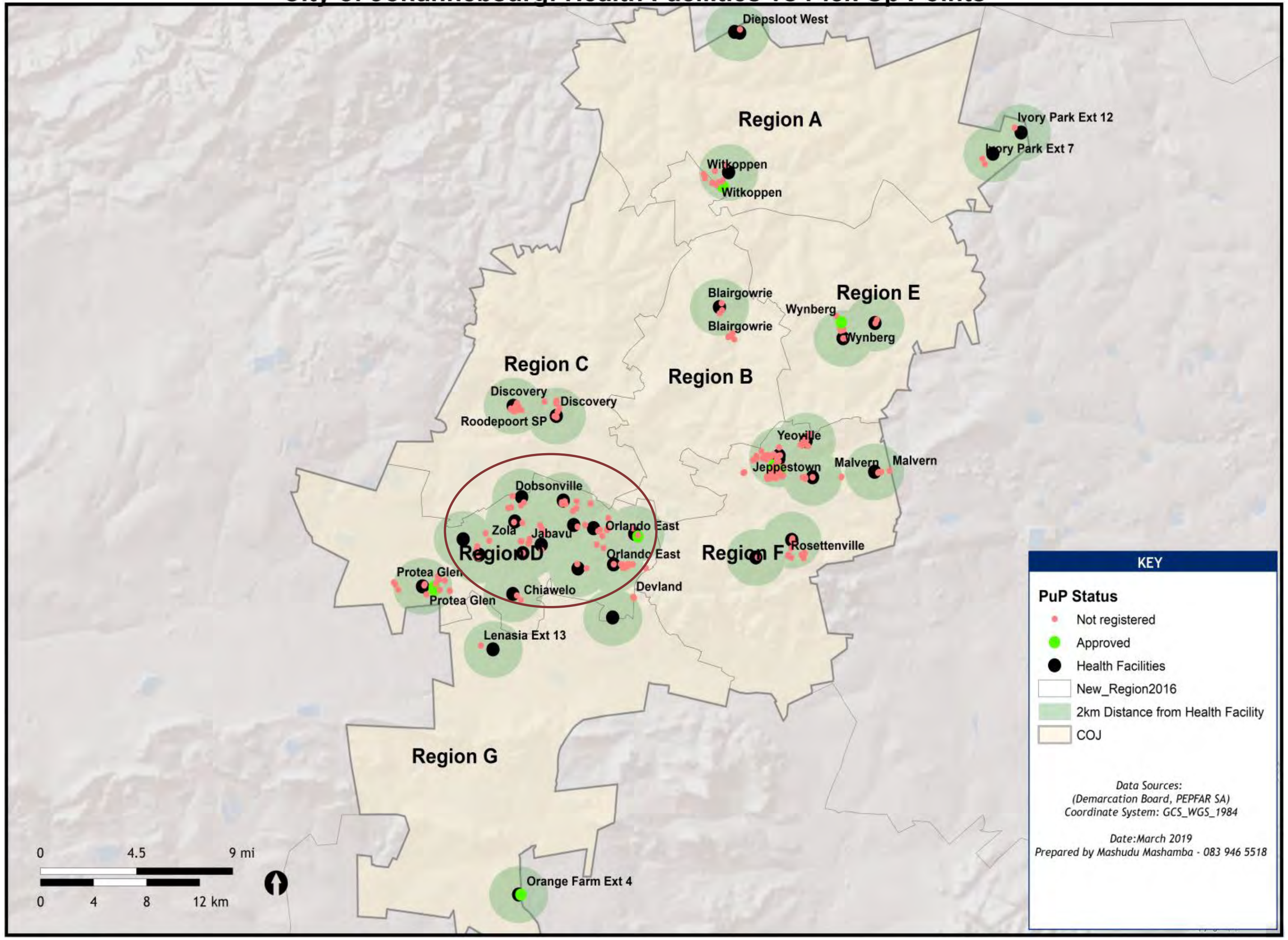
FY 2019
182 PuPs in eThekwini
154 PuPs in 5km radius of USAID sites



Legend	
Districts	
PuPs within 5km radius	
All PuPs	
USAID Facilities	
TROA (number)	
00 to 01	
01 to 500	
500 to 1 000	
1 000 to 2 000	
> 2 000	
5km Buffer	

Looking at PuPs in City of Johannesburg

City of Johannesburg: Health Facilities vs Pick Up Points



Which PuPs have been approved?

Next Steps

- Continue using GIS to inform program planning
- Map the current list of approved PuPs
  - Monitor progress
  - Identify gaps
  - Assess coverage of PuPs in relation to patient volume

Optimizing availability of antiretroviral therapy by

Mapping patients and pick-up points

Otoyo Toyo, Achieving Health Nigeria Initiative

Strengthening Integrated Delivery of HIV/AIDS Services

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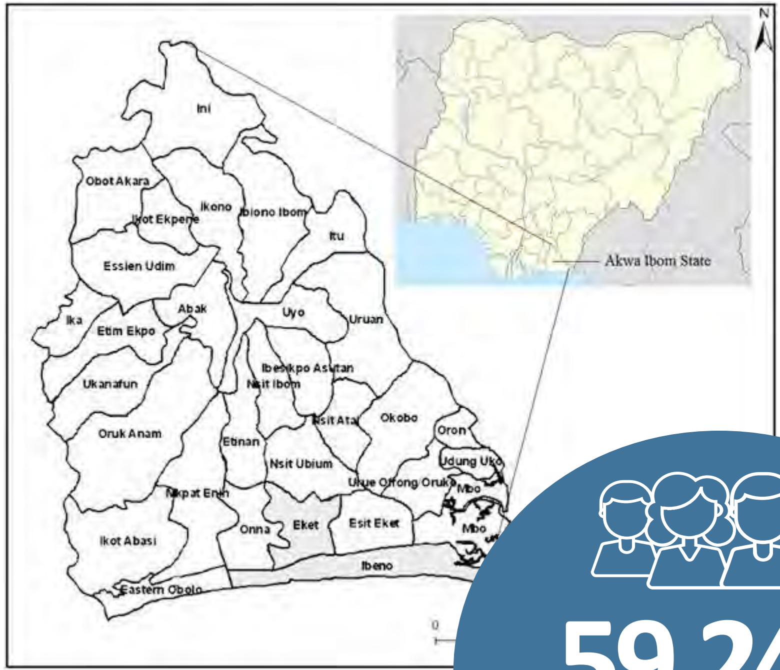
Funded by the President's Emergency Plan for AIDS Relief through U.S. Agency for International Development

Background

The Strengthening Integrated Delivery of HIV/AIDS Services (SIDHAS) project is funded by PEPFAR through USAID and is implementing the ART surge in Akwa Ibom State in Nigeria.



With HIV prevalence of 5.5%, Akwa Ibom State has a high HIV burden and high unmet need for services.

FY20 surge targets:

59,244 new clients enrolled into the ART program

91,159 PLHIV are retained on treatment

The ART surge has seen exponential growth:

4 TIMES

the TX_CURR about six QTRs ago

24,000+ to about **94,000+**

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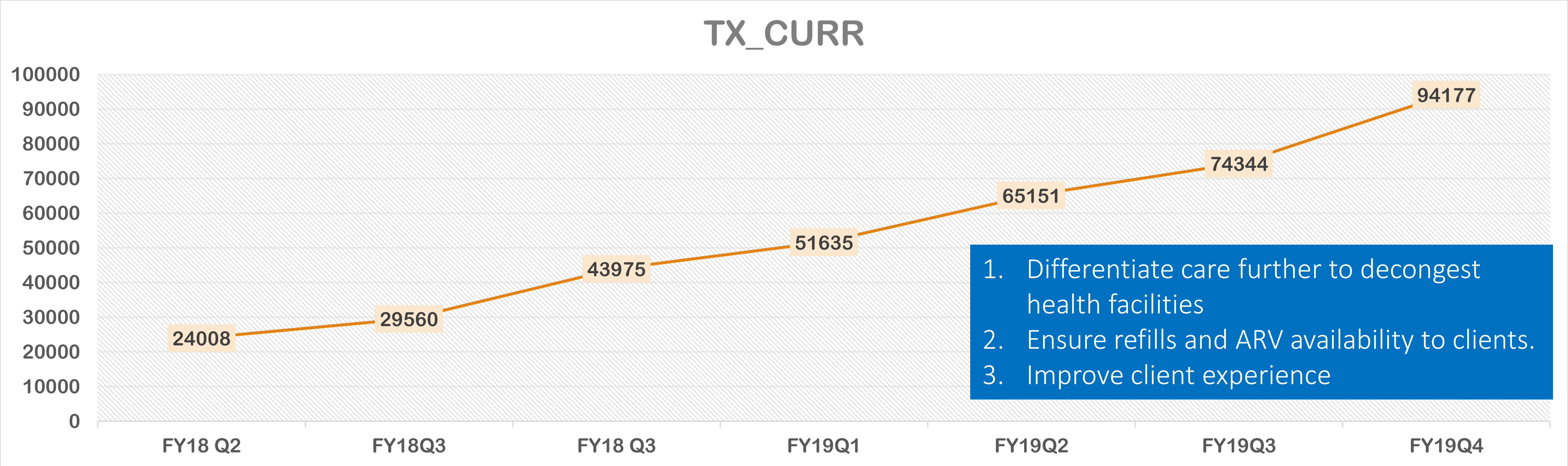

1. Differentiate care further to decongest health facilities
2. Ensure refills and ARV availability to clients.
3. Improve client experience

As we are successful in case finding and the TX_CURR rises, we reach a point where there are more clients than we can serve with current models

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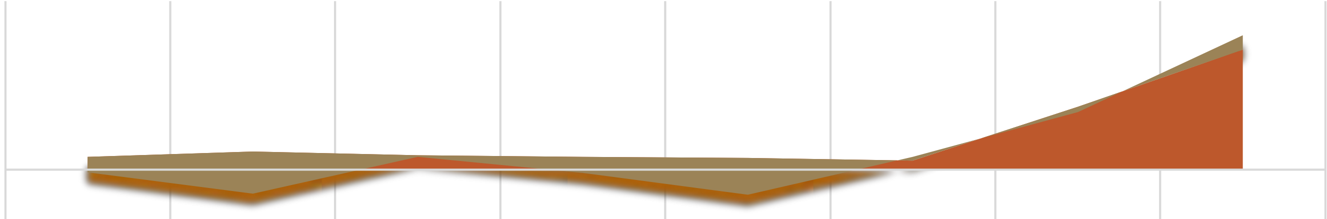
Background

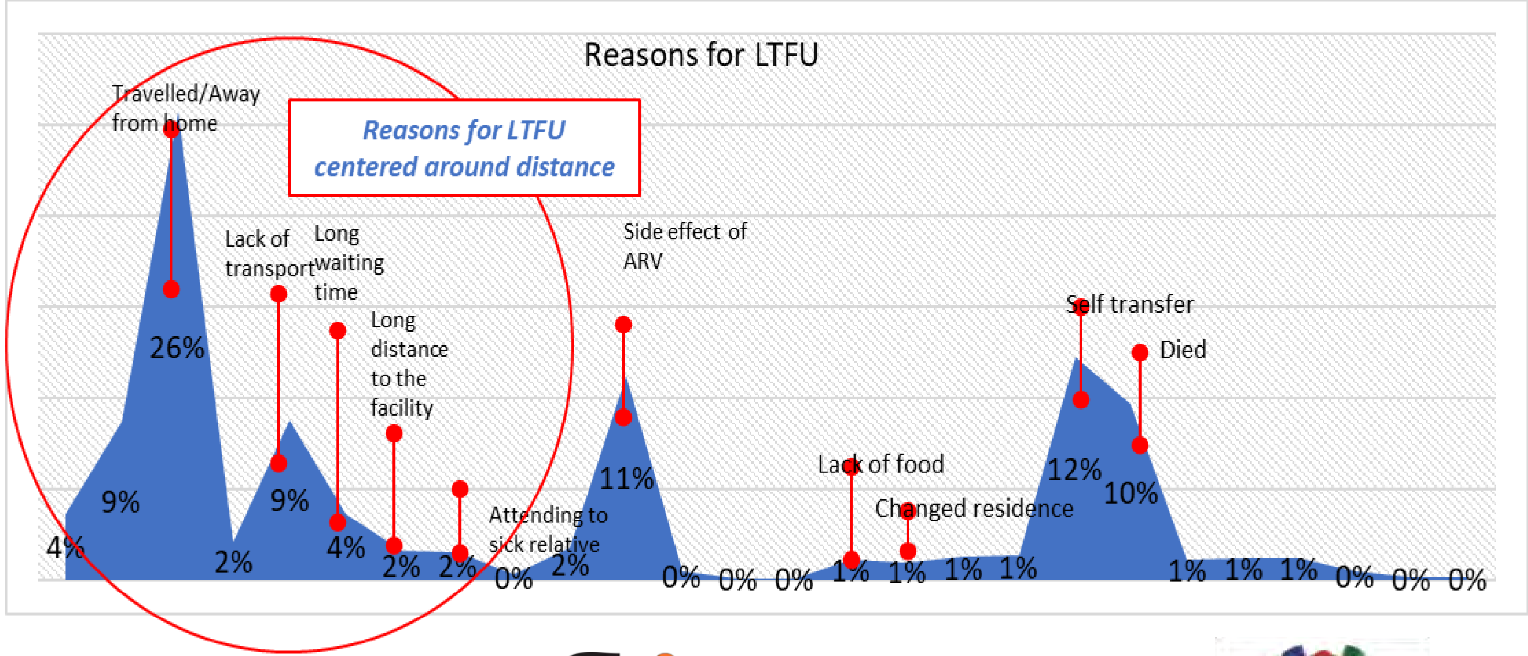
Access to certain hard to reach (HTR) areas has always been a challenge in Akwa Ibom.

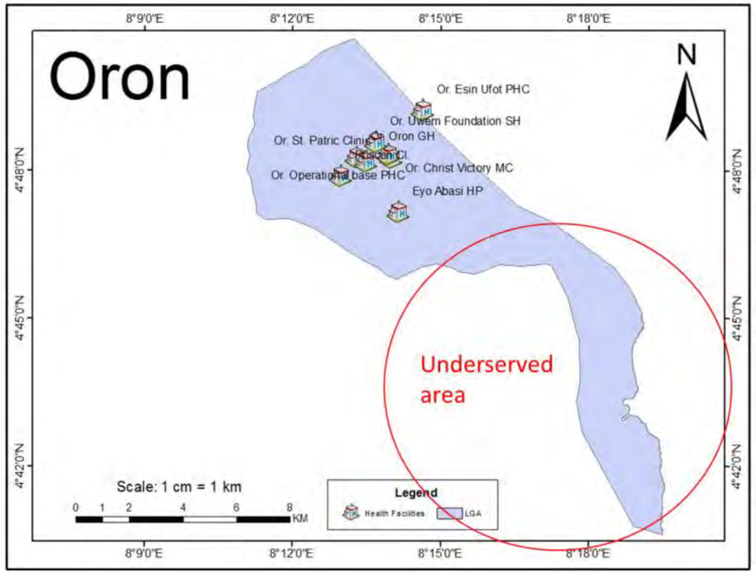
TX_NEW & LTFU TRENDS

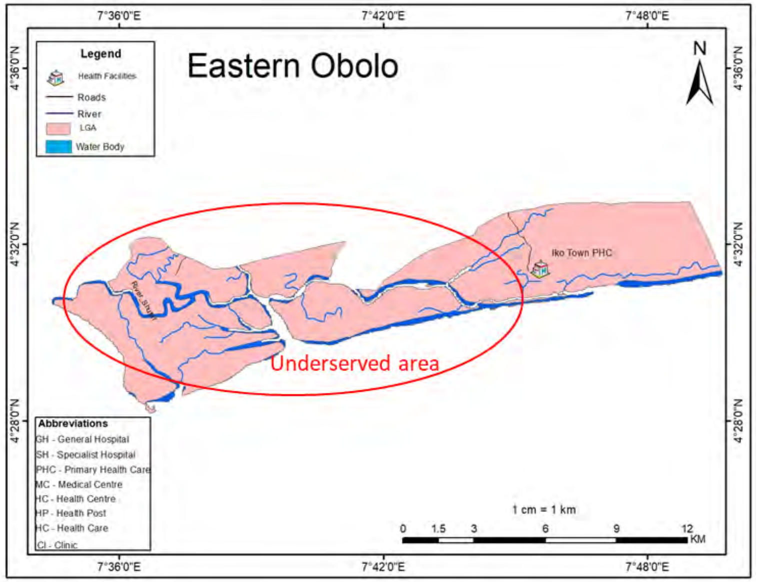


	FY18 Q1	FY18 Q2	FY18 Q3	FY18 Q4	FY19Q1	FY19 Q2	FY19 Q3	FY19 Q4
Program Growth	-139	-373	-10	-144	-329	32	-44	129
TX_NEW	112	159	125	112	104	80	558	1070

TX_NEW Program Growth





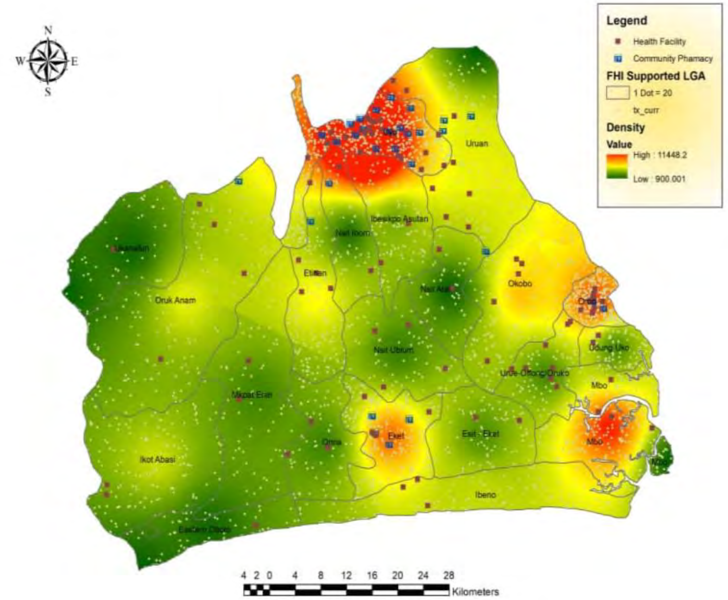


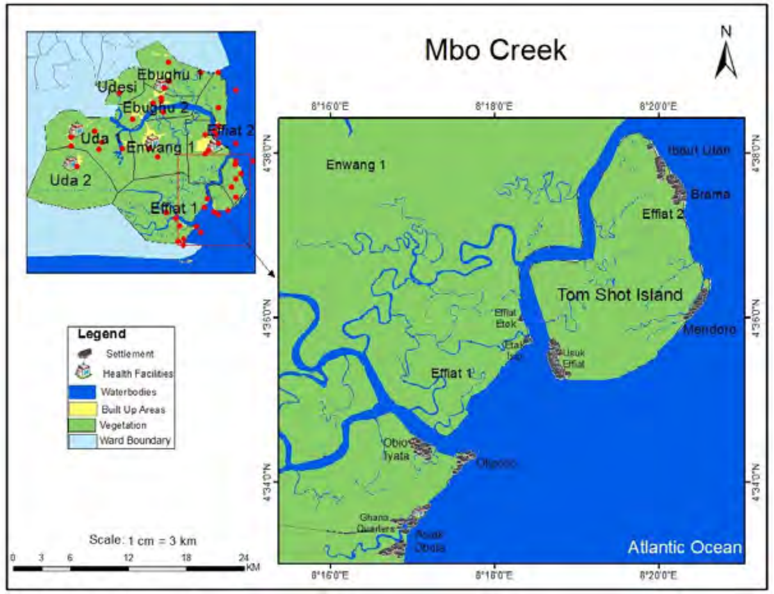
Rationale for mapping

Geospatial intelligence helps us see the magnitude of gaps in access to ARVs (from a bird's eye-view).

Identifies underserved populations and helps plan a client-centric course of action.

Allows us to spot disease patterns and structures to aid intervention.





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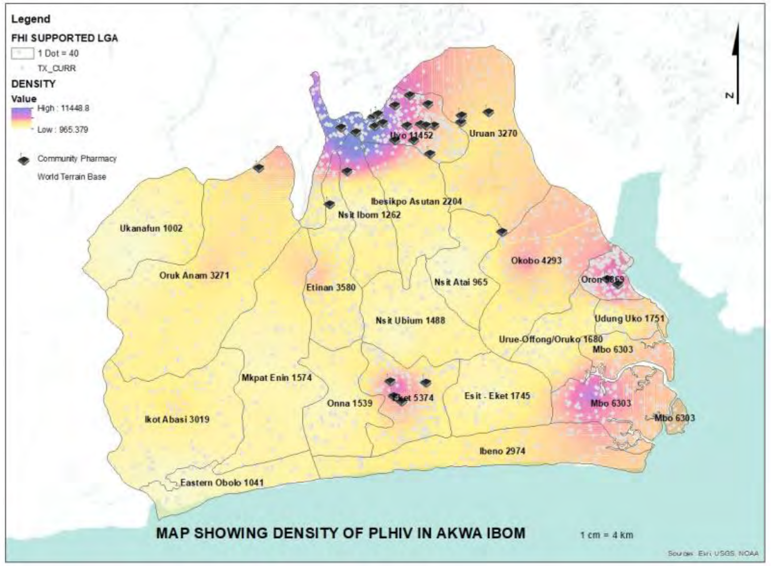
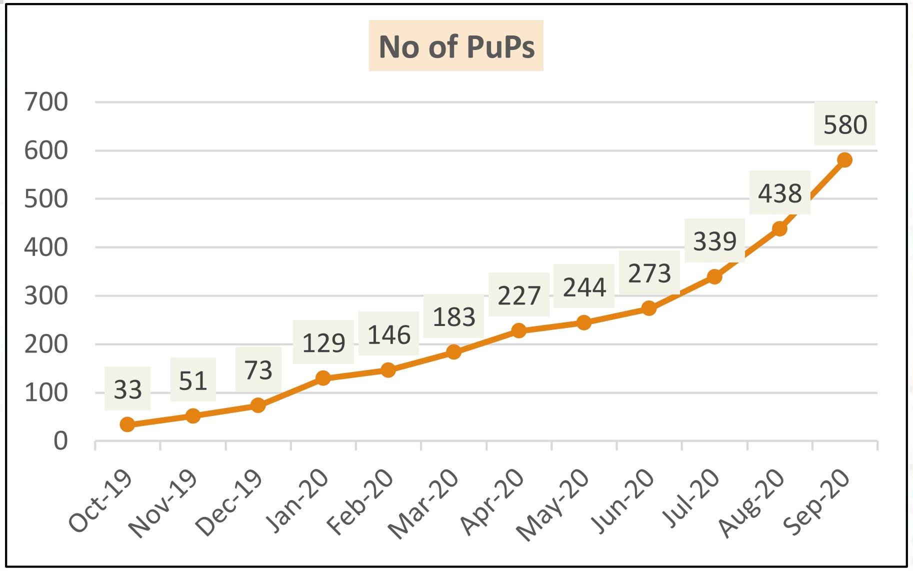
PLHIV density mapping, outcomes of the mapping, and benefits on the program

All supported health facilities, community pharmacies and Community ARV Refill Clubs (as pick-up points, or PuPs) in the 21 local government areas (LGAs) supported by FHI 360 were mapped and layered using the ArcMap software.

Distribution of PuPs **BEFORE** **Scale Up**

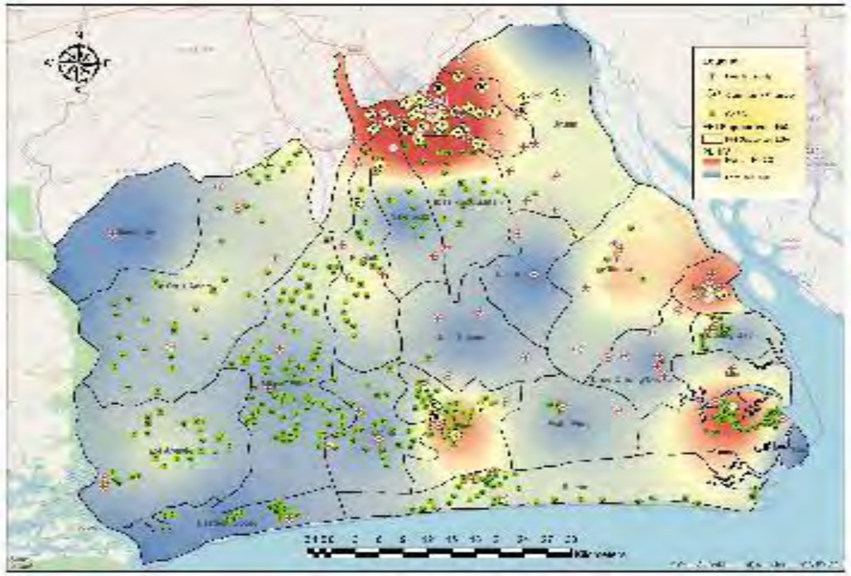


Urban LGAs had more options for drug refill, while the coastal LGAs with a dense population of PLHIV had fewer options.



Steady and progressive scale up of PuPs was done especially in coastal high-density areas to improve the options available to the clients

Distribution of PuPs **AFTER** **Scale Up**



- Internal IP led logistics system was developed to ensure steady supply of ARVs to all the PuPs
- Documentation of ARV pick-up is sent back to the facility

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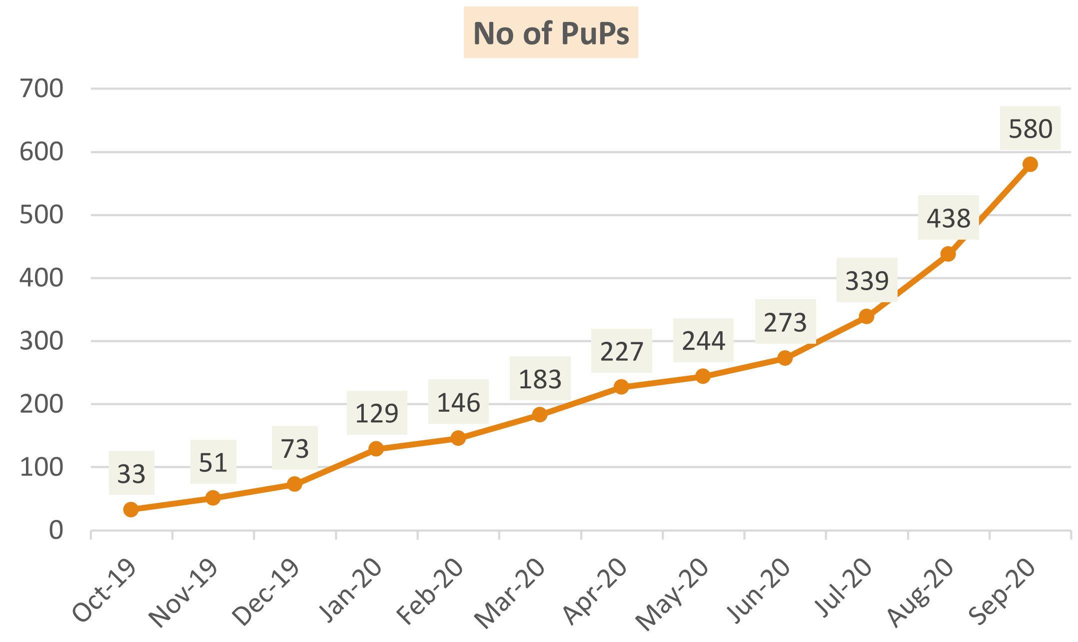
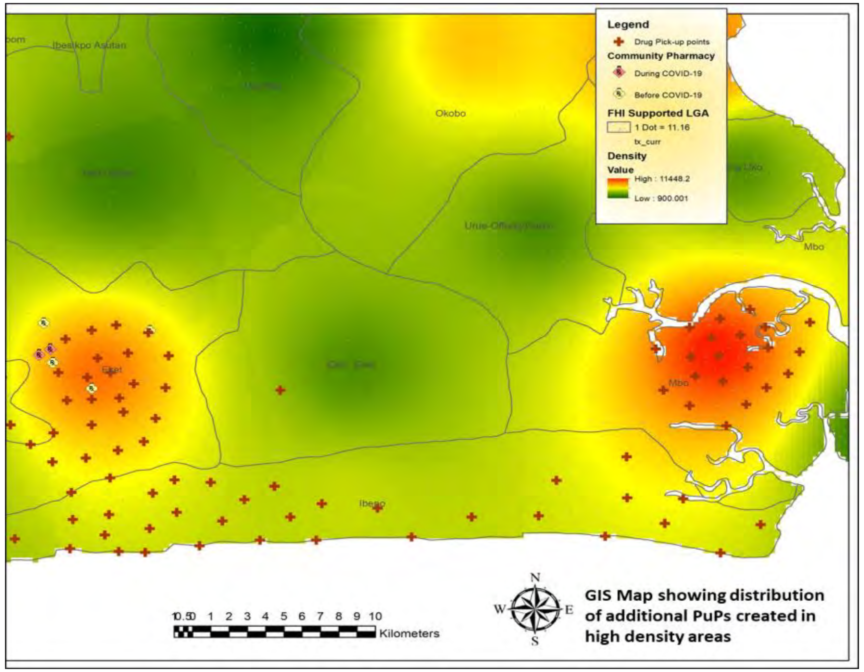
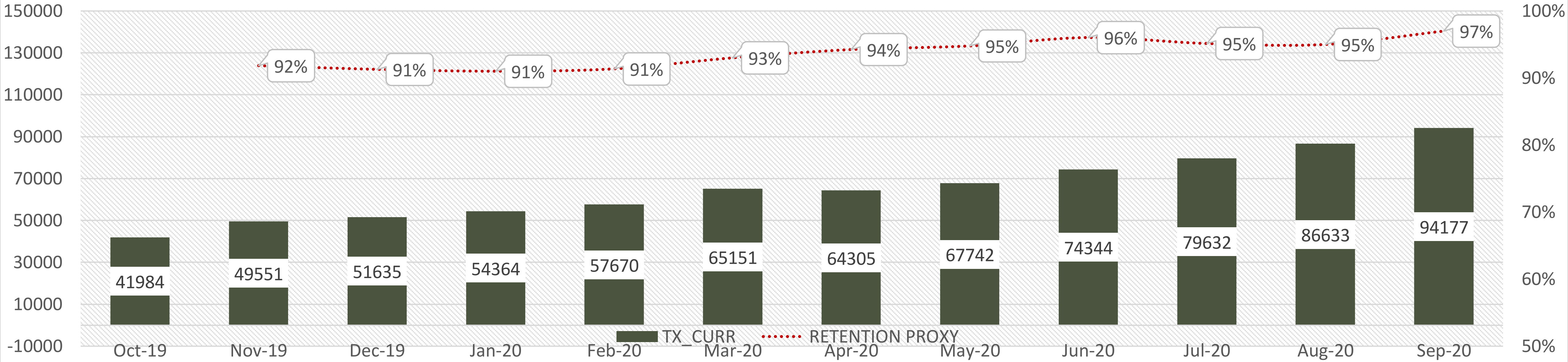


GIS map showing distribution of additional PuP- CPs and CP-led CARG groups created in high density areas

Chart showing scale of additional PuPs created in high density areas

Rate of refills amongst PLHIV due for refills





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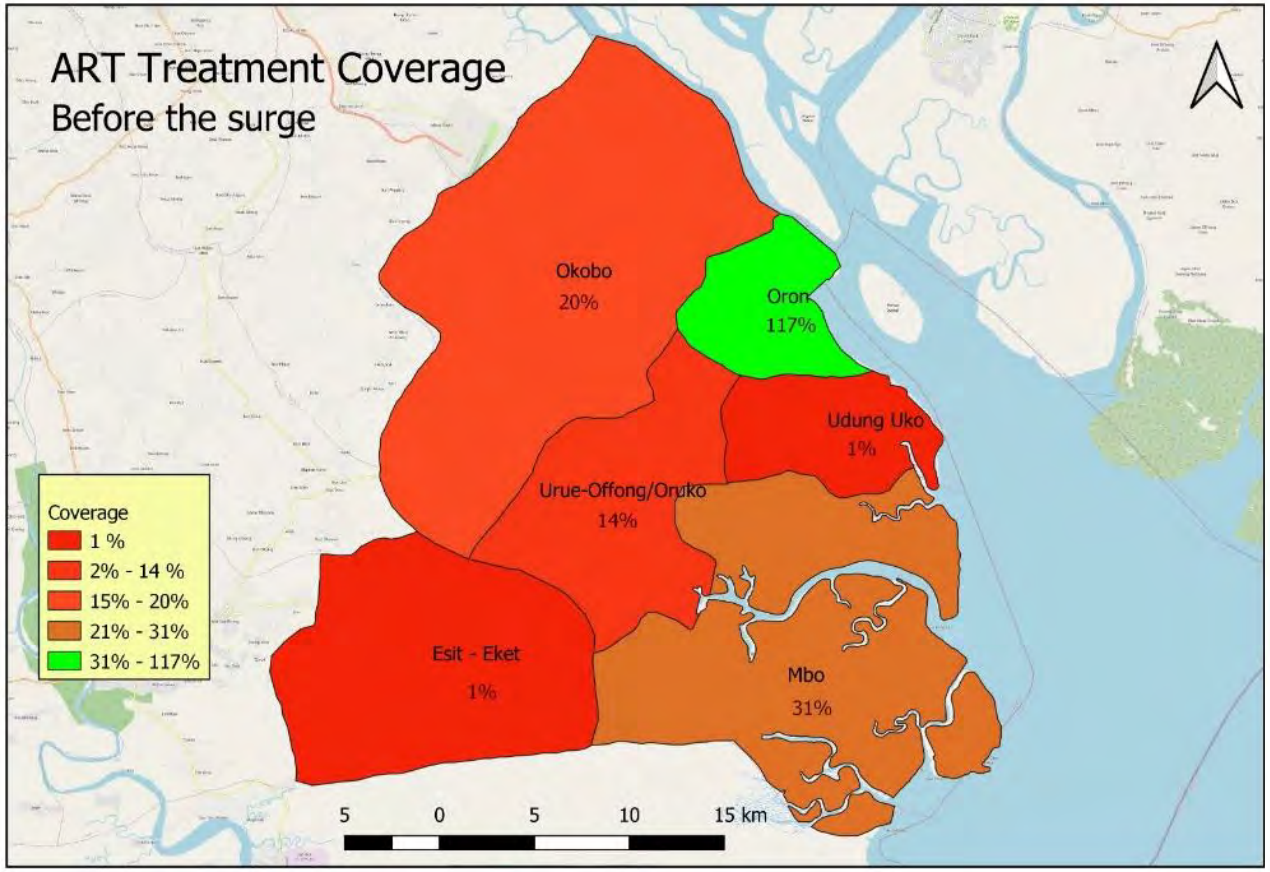
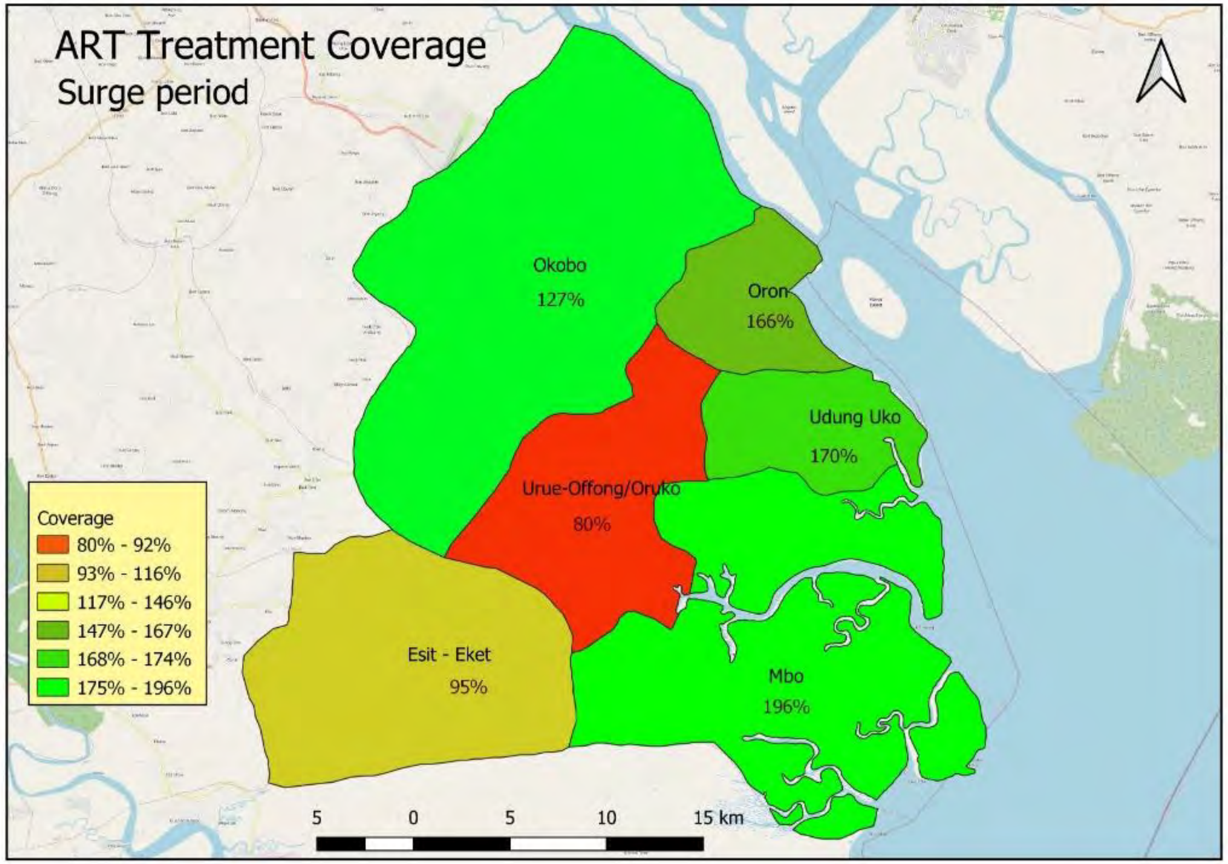
GIS Mapping and The Road to Epidemic Control





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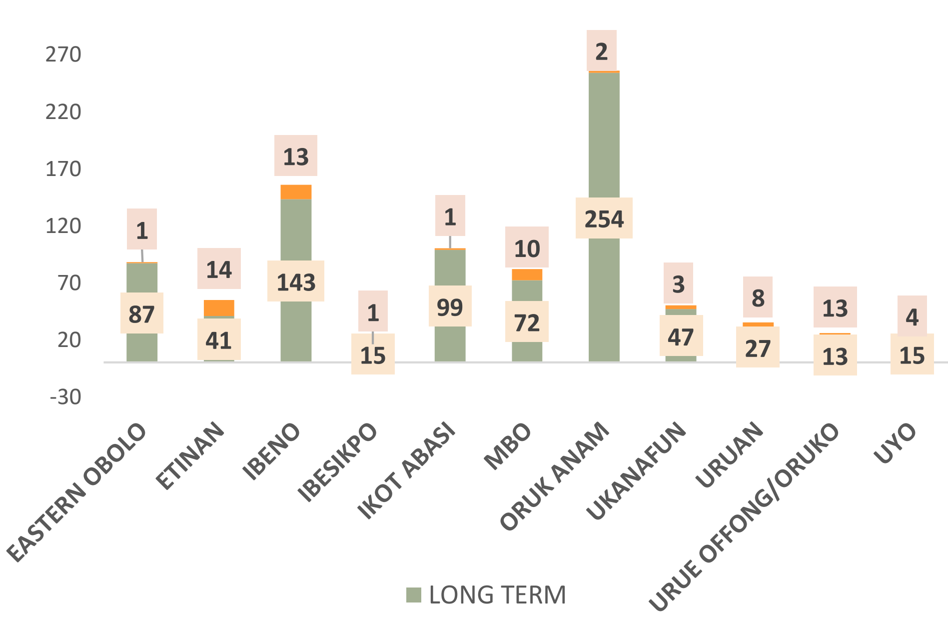
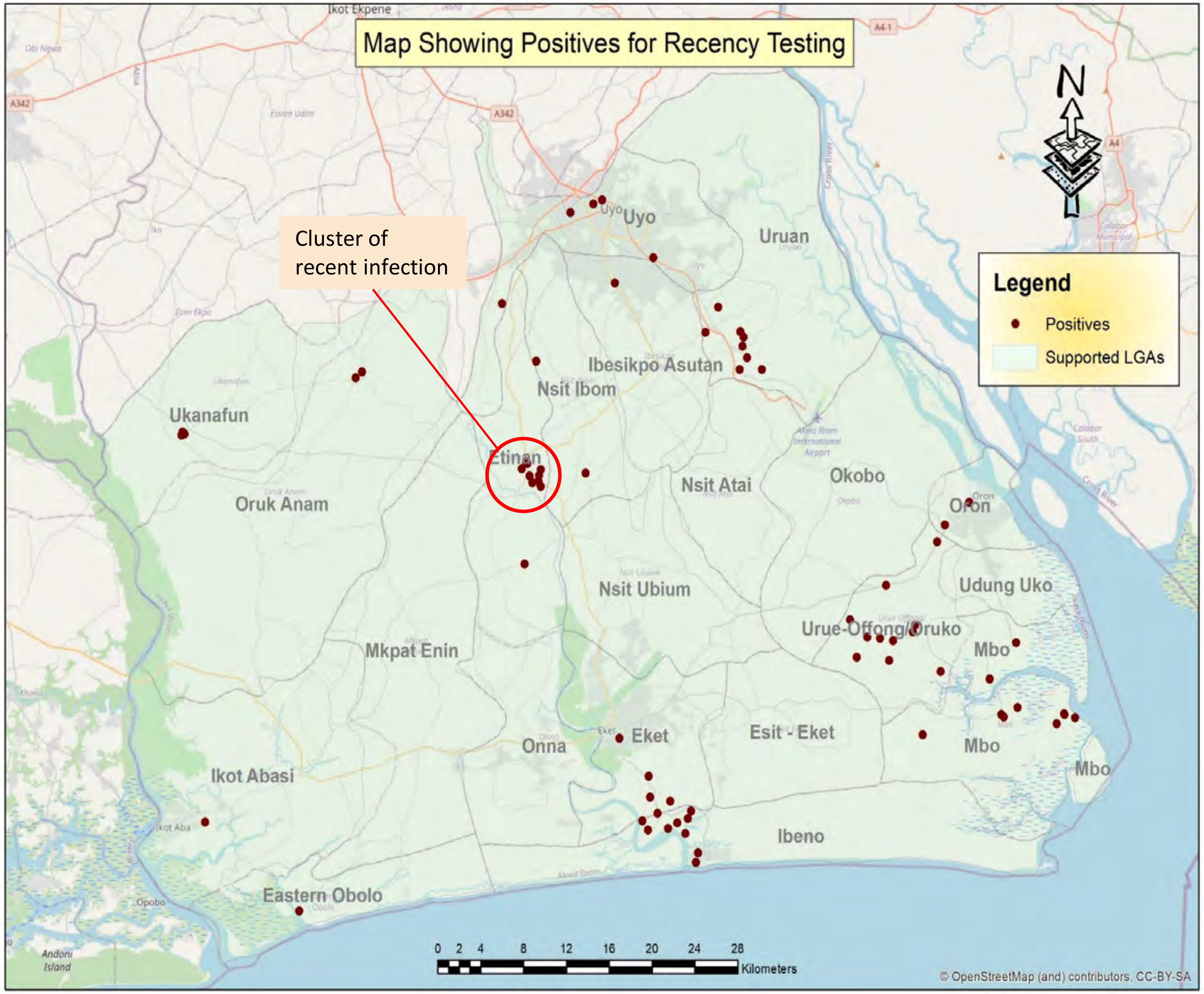
Other ways of using GIS mapping

GIS + Recency Testing

GIS mapping allows us to follow the trail of spread of the virus by mapping recent infections, we can identify areas where continuous spread is going on for intervention





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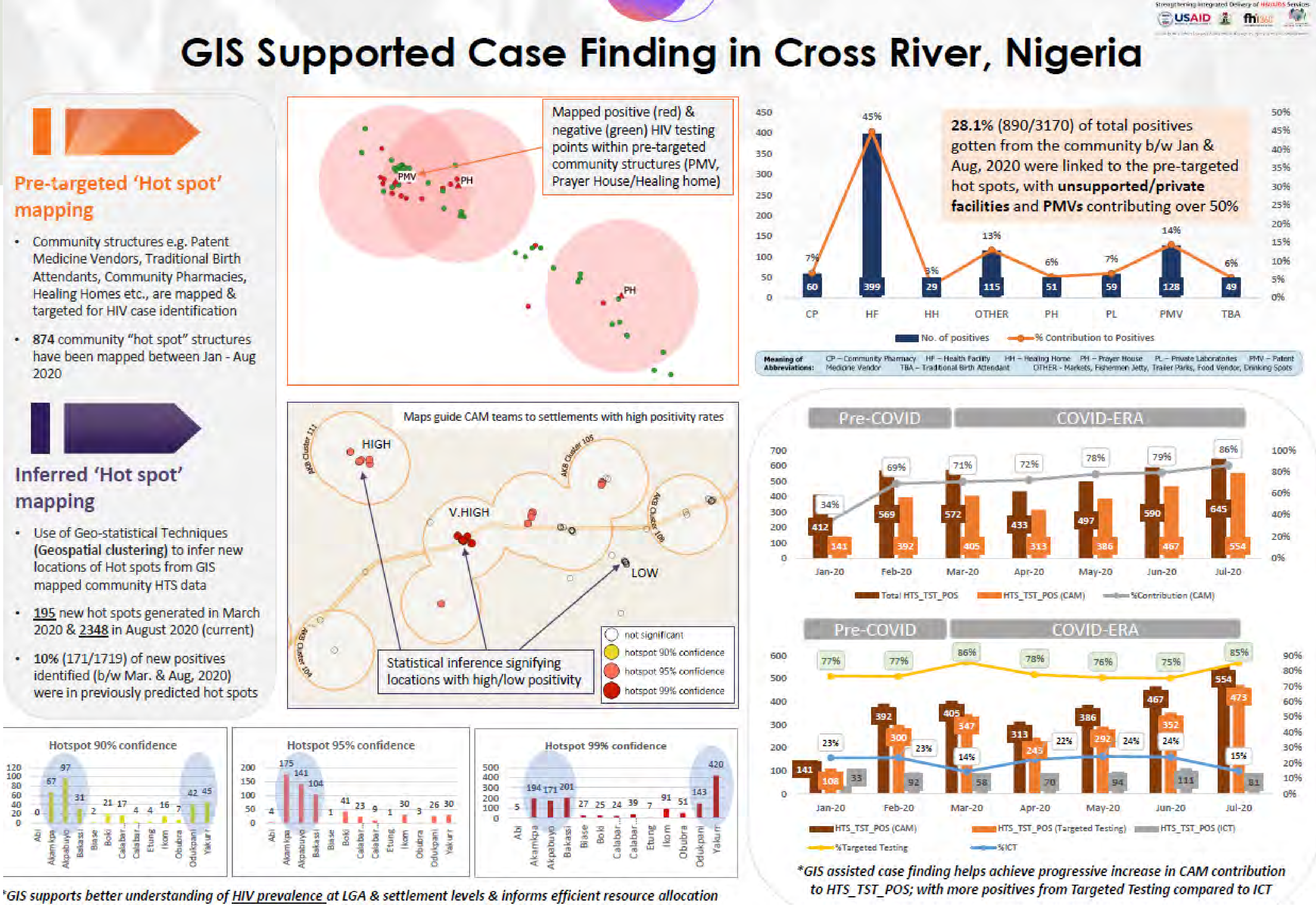
Other ways of using GIS mapping

GIS guided Case Finding

GIS supports better understanding of HIV Prevalence at LGA and settlement levels and informs efficient resource allocation

In CRS, it has been used for targeted testing with high yields comparable to ICT



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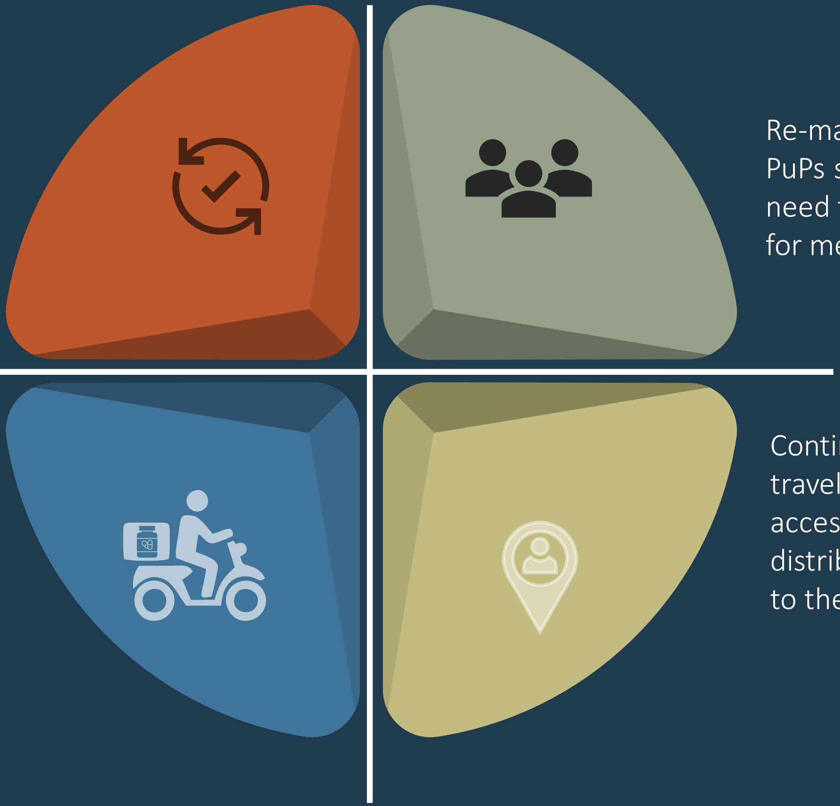
Looking Ahead

Continue to update geocode of client- level information

Re-map and overlay additional PuPs so that every client does not need to travel farther than 1 km for medications



Identify and expand PuPs to nonconventional settings—such as PLHIV support group leaders, experienced patent medicine vendors (PMVs), community gate keeper — where confidentiality is assured

Continuous remodeling of travel distance to ensure access and planned distribution of ARV as close to the client as possible

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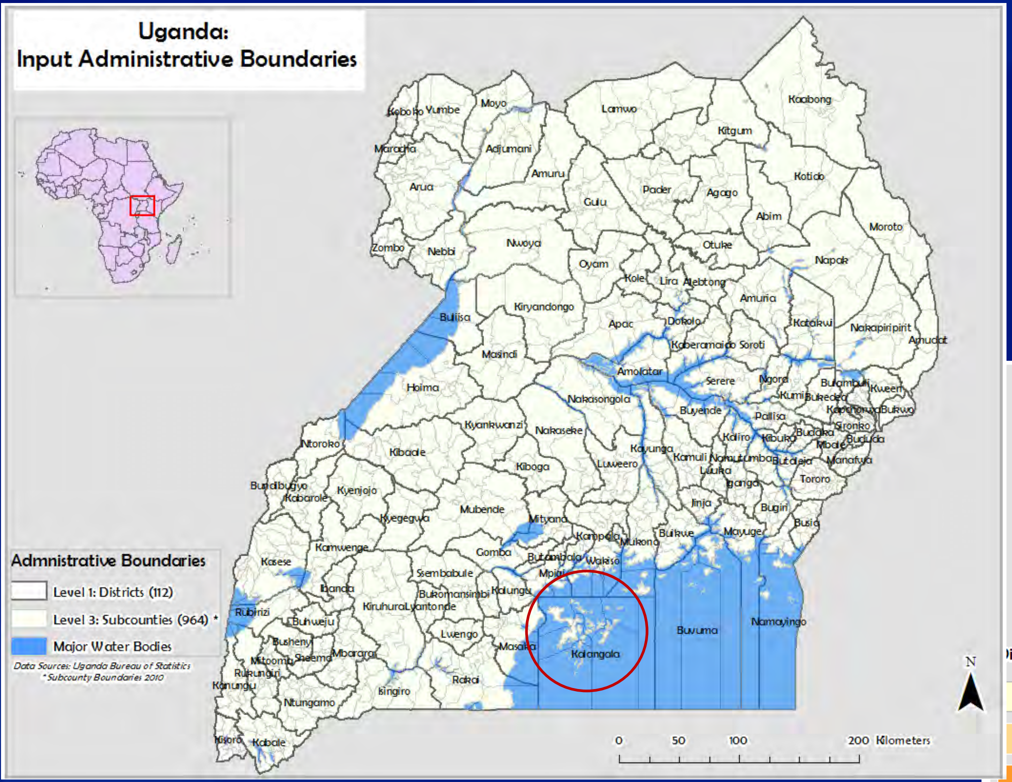
Mapping of Fishing Community Landing Sites and Spatial Accessibility to Healthcare Facilities within the Kalangala District of Uganda 2016

Kalangala District:

Tonny Bogere
James L. Tobias, Northrop Grumman, MS, GISP

HIV Burden In Uganda Fishing Communities

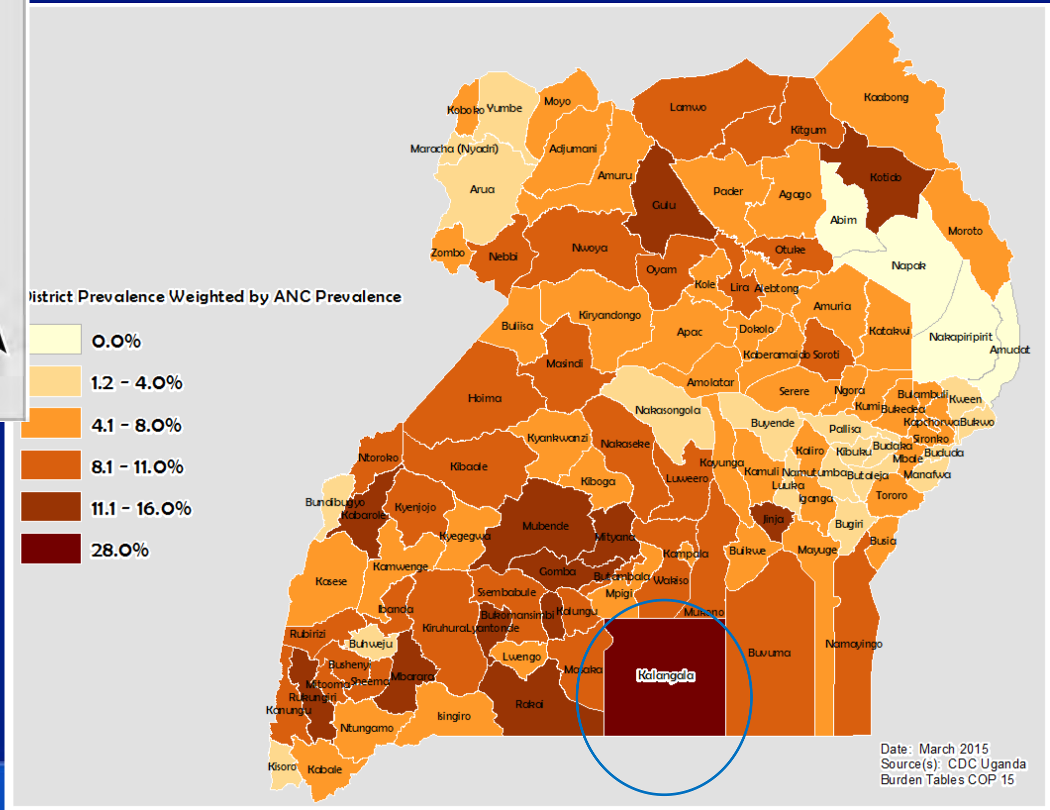


In Uganda, there are two districts that are surrounded by water

1- Kalangala District

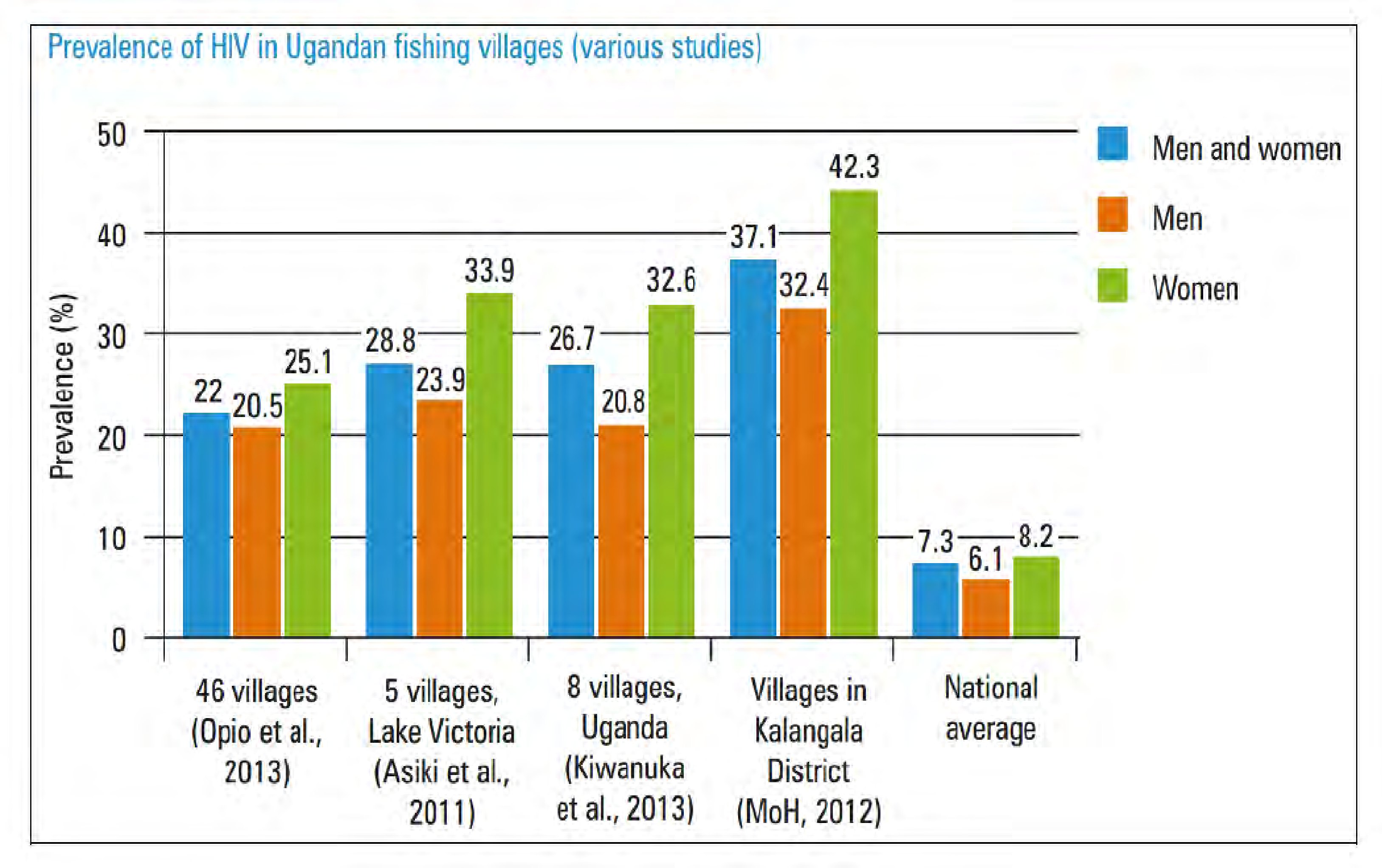
2- Buvuma District

Other districts with partial islands in Lake Victoria.



The population Dynamics with the fishing Communities are similar. Fluid Populations with other East African countries sharing the Lake Victoria (Kenya And Tanzania)

Epidemic at a glance- Fishing communities



Fishing Communities Dynamics - Uganda Context

- A fishing community is a group of people that substantially depends on or engages in harvesting fish to meet social and economic needs, and includes the owners of fishing vessels, operators, crew and fish processors (Lake Victoria Basin Commission, 2010). A fishing community has also been defined as a socioeconomic group of persons living together in a locality and deriving their livelihood directly or indirectly from fishing activities.
- Members of fishing communities include men and women who fish (boat crew), boat owners, fish processors, boat makers, local fishing gear makers or repairers, fishing equipment dealers and managers, as well as fishmongers and traders (Opio, Muyonga, & Mulumba, 2013).

HIV/AIDS KMCC

Strengthening Knowledge Management & Communications Capacity

http://kmcc.org.ug/

- The Uganda fishing community is very fluid, highly mobile and migratory and the social structures that constrain sexual behavior in more stable communities may not apply;
- Cash income, poverty, irregular working hours and being away from home mean that fishermen have disposable income and leisure time (when not fishing) – factors that favour the consumption of alcohol and use of prostitutes; the corollary of this is that low-income women are drawn to fishing landing sites precisely because of the opportunities to sell food, alcohol or sex;
- Alcohol and drugs are widely used in fishing communities in many parts of the world to help cope with danger and stress;
- Health services for fishing communities are limited due to both geographical remoteness and inaccessibility, as well as low health-seeking behaviour;
- Fishing is a high-risk occupation which contributes to a culture of risk denial or risk confrontation, and extends to displays of bravado and risk-taking in social and sexual arenas;
- Fishing communities are often socially marginalised and potentially seen to have a low status, which can cause exaggerated or 'oppositional' forms of masculinity in men;

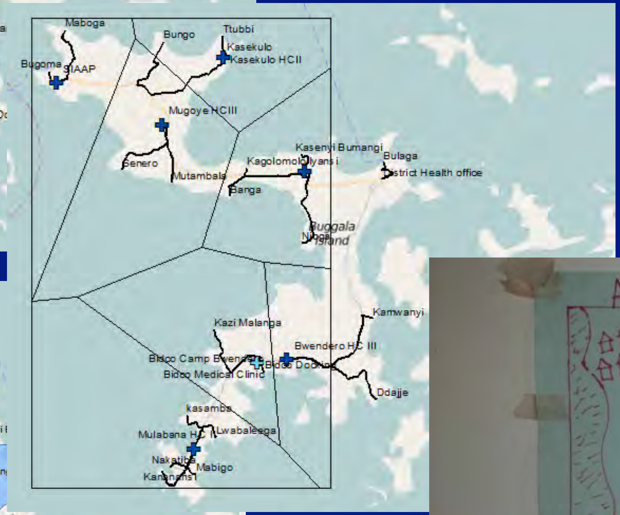
Behaviors:

- Transactional Sex
- Fish for Sex (Kenya fisherman) “Jaboya System”.....
- Women ownership of Boats (Uganda)
- Extra-martial Sex
- Boom-And-Bust
- Fatalism -- The Lake may kill me so I don’t worry as much about HIV.
- As many 5,000 fisherman per year lose their lives
  due to weather / lake conditions (alone).

Methods

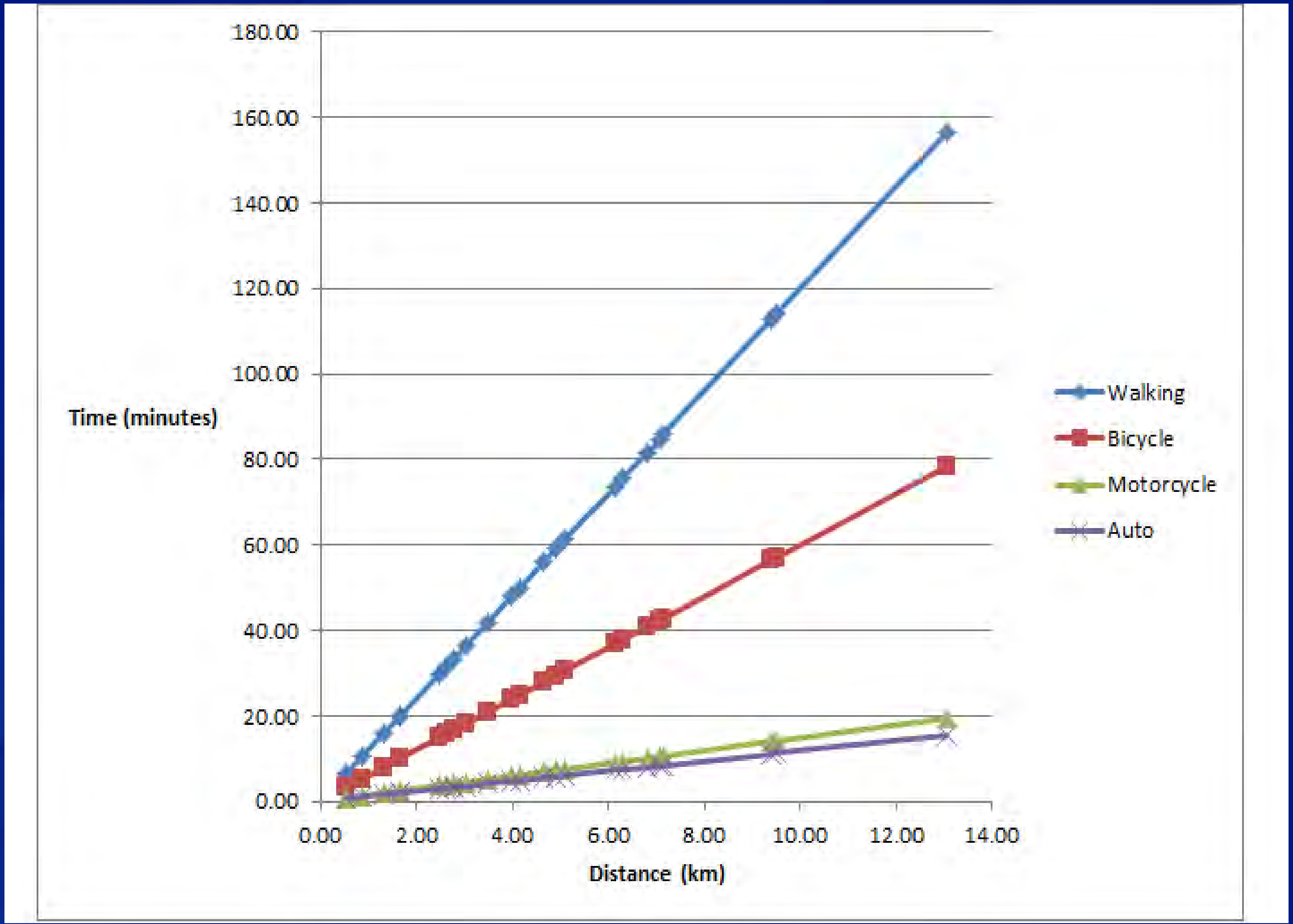
- Census Population data obtained for these landing sites via the district Population Officer
- HIV / ART data obtained for these landing sites via the district Biostatistician
- Garmin Etrex 20 GPS unit utilized to capture GPS coordinates of all landing sites and clinics covering ~-5 sites daily
- Digital photographs taken of landing sites, fishing camps, clinics, fishing boats, gear, processing posts
- Daily journal of notes maintained for the sampling of the Kalangala district
- Challenges documented , mitigated, and noted
- Aggregated all notes, photos, GPS coordinates and observations into a cloud GIS story map and story journal
- Tobler hiking algorithm
- Catchment Area estimations (buffers, Thiessen polygons, convex hulls)
- Path of Least Cost / Path of Least Resistance

Catchment Area Estimations:
Buffers, Thiessen Polygons, Convex Hulls, Sketch Maps



Time to reach nearest clinics by mode of transportation (walk, bike, boda boda, auto)

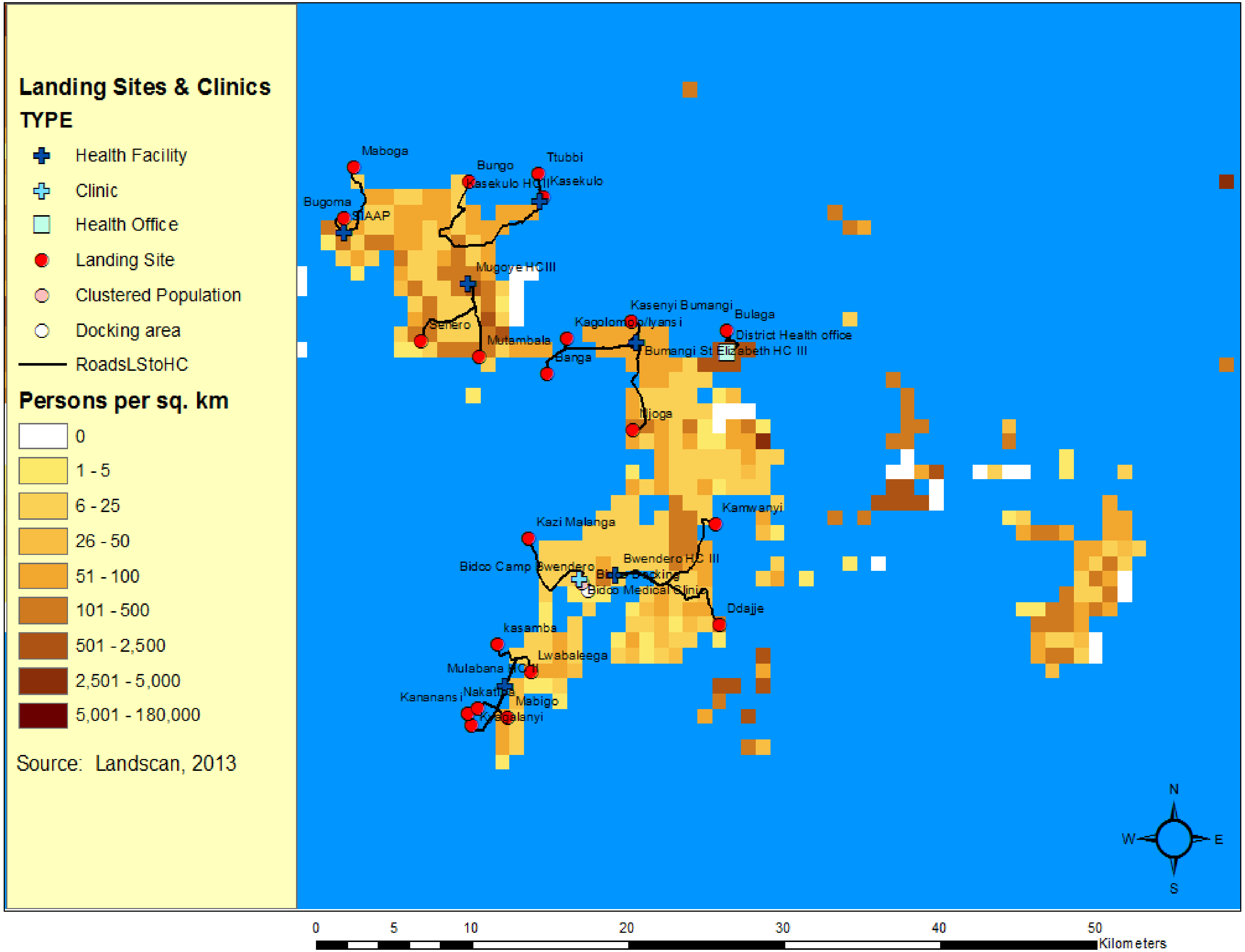
Est.travel speeds (walking: 5km/hr, bike: 10km/hr, motorcycle: 40km/hr, auto: 50km/hr)



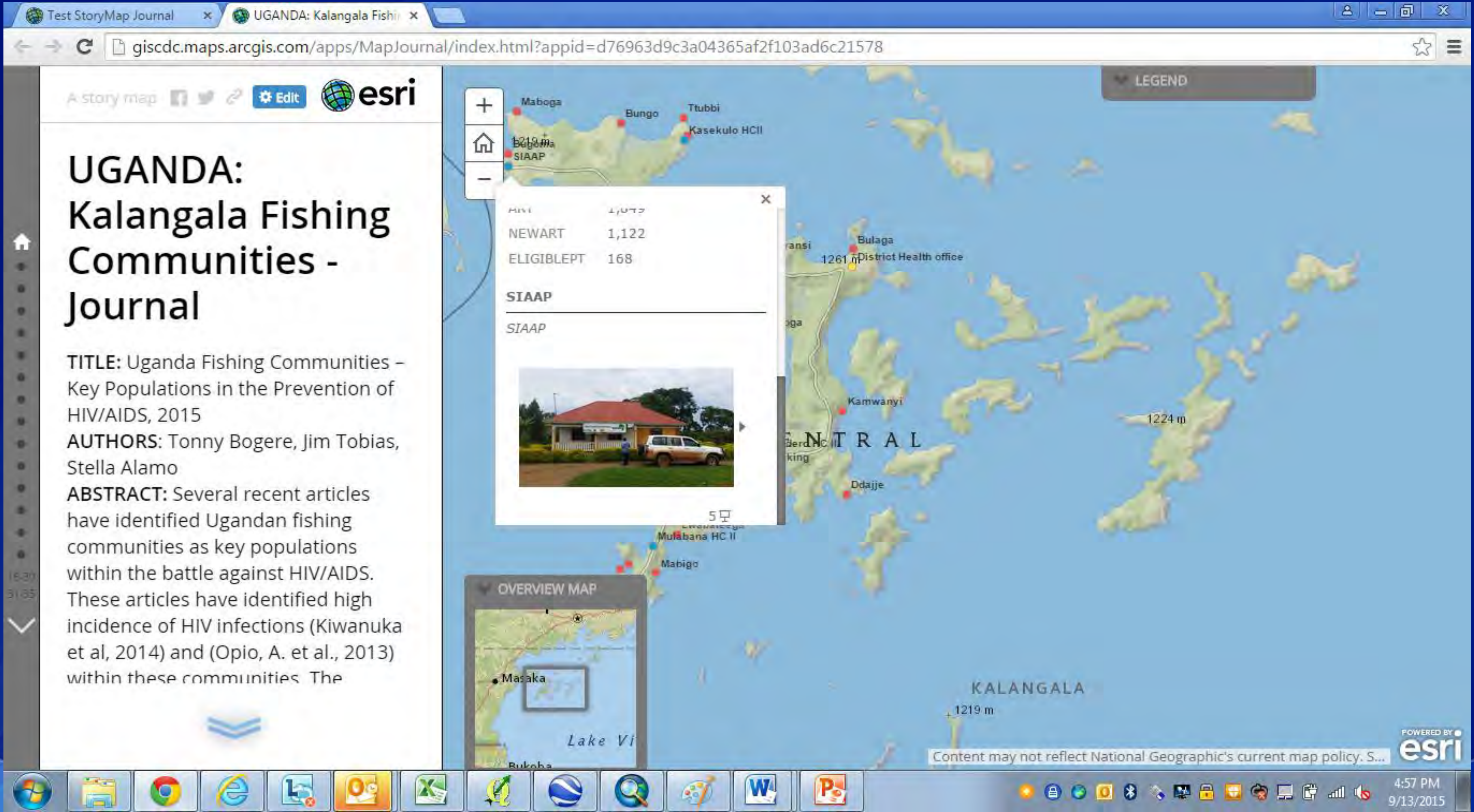
Spatial Accessibility

- Distance to facilities
- Time to reach facilities
- Elevation Change to reach facilities
- Cost to reach facilities
- Cost of fuel
- Time cost --- lost wages / hours of work
- Physical costs – some modes can injure or lead to additional lost time
- Catchment area representations:
- Buffers
- Thiessen Polygons
- Convex hulls
- Sketch Maps

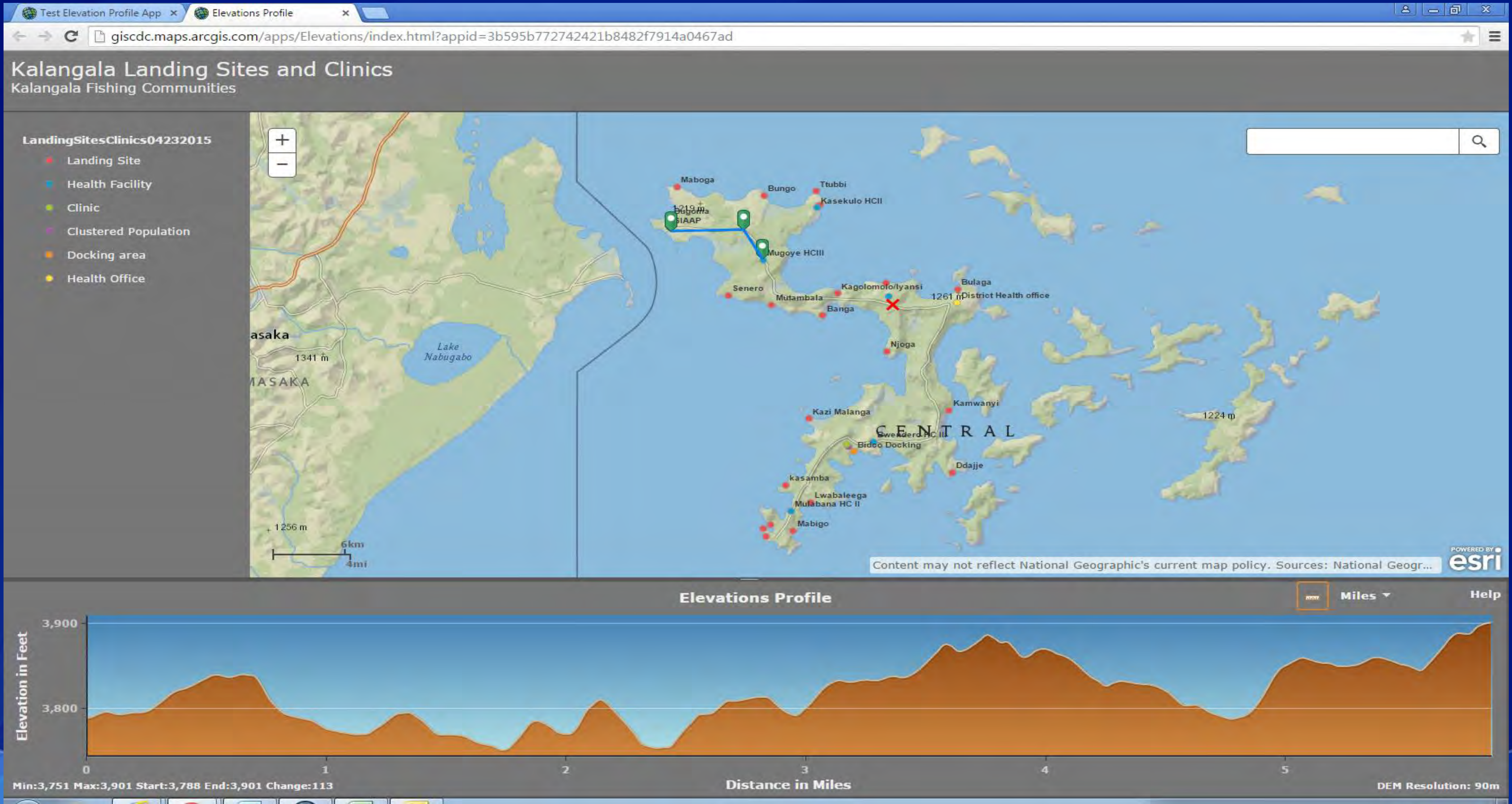
Kalanga District: Population Density with Landing Sites & HIV Clinics, 2013



Our StoryMap Journal- Kalangala Fishing Communities-Uganda



Elevation Profile App



Challenges & Limitations

Terrain / Road Conditions

Remote dispersed population

Landing sites located at water's edge of large island

Elevation change from sea level to 1000m

Difficult to obtain Kalangala district health data and Census data

Boat travel to clinics is not yet quantified / described and may change our spatial accessibility analyses substantially

Fisherman come from across Uganda to work in the Kalangala district.
The impact of HIV infection within Kalangala may contribute to new infections in many other Areas of Uganda.


"JABOYA"
"FISH FOR SEX"
TRANSACTIONAL SEX
CDC UGANDA


BUFUMIRA HC III - CATCHMENT AREA
KALANGALA CDC
9→ NAMASENKEKE
10→ KUSU
1→ KAAZI
2→ LWAMAYUBA

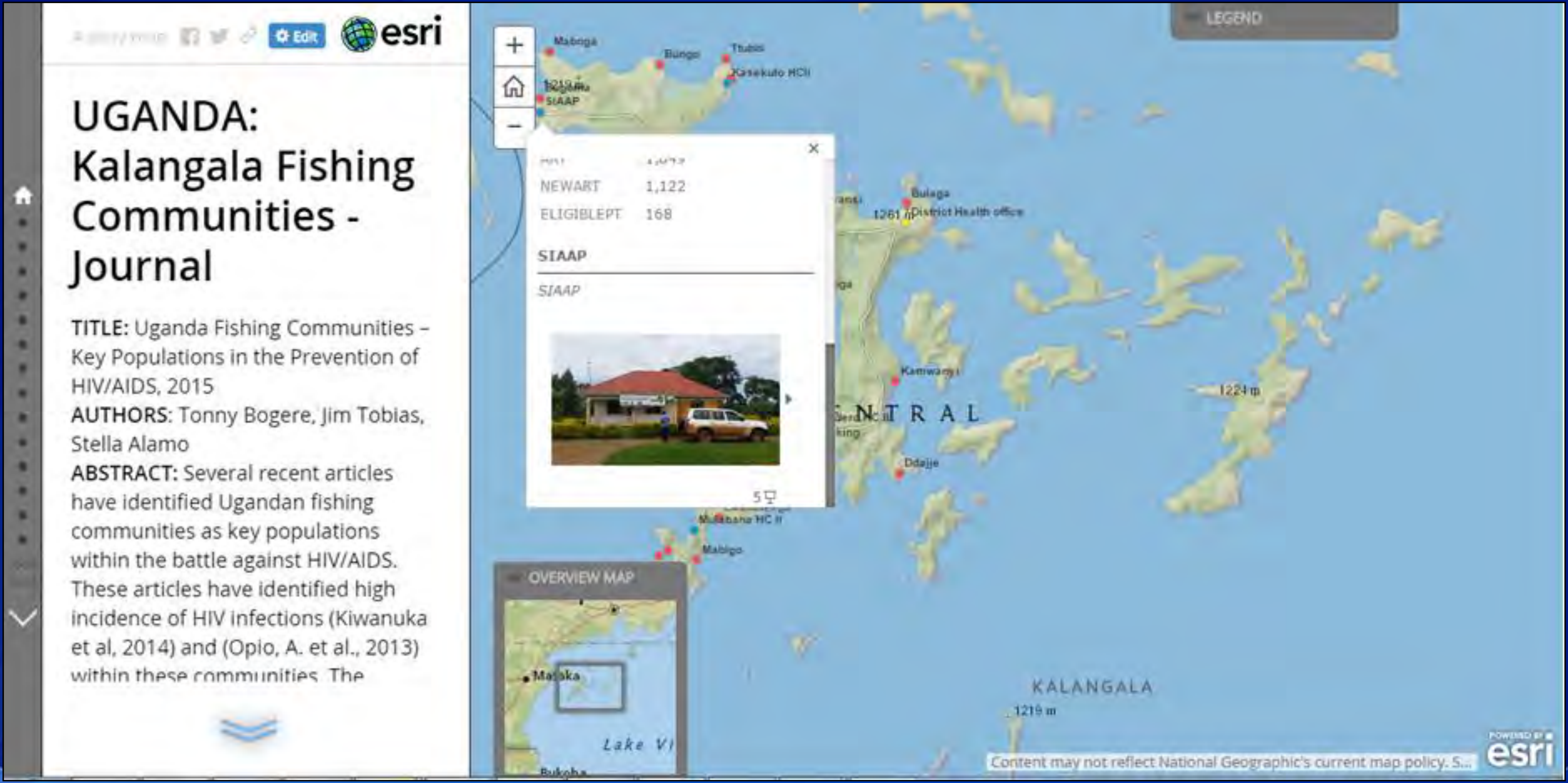

Republic of Uganda
Ministry of Health
BUFUMIRA HC III
Kyamuswa Health Sub-District
Open 24 hours:Monday-Sunday
KALANGALA CDC
Services offered
General Care
• Inpatient and General Outpatient Services
• Dental and Eye Care Services
• Mental Health Care Services
Reproductive Health
• Family Planning
• Antenatal Care, Delivery and Postnatal Care
HIV Prevention, Care and Treatment Services
• Safe Male Circumcision
• Palliative Care
Child Health and Immunization Services
Nutrition Services
Printed with support from USAID funded MSH-STRIDES for Family Health

3-hour ferry from Entebbe:

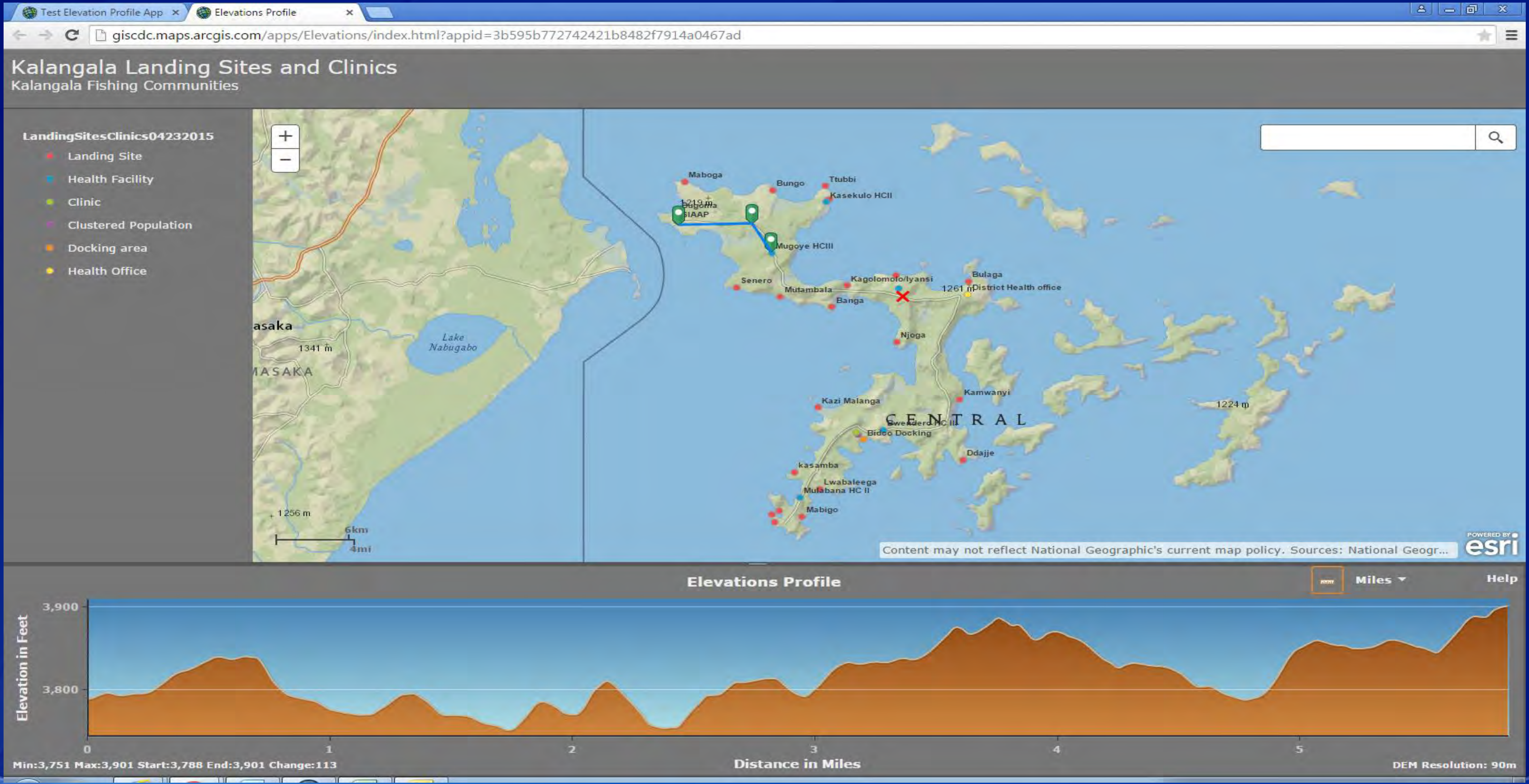
Phase 1 mapped via Vehicle:

Phase 2 mapped by small boat (3, 1-day loops)

StoryMap Journal- Kalangala Fishing Communities-Uganda



Uganda, Kalangala District: Elevation Profile App



Methods for modeling ART client locations for DDD using GIS

EPIC Learning Session #7

Caleb Parker

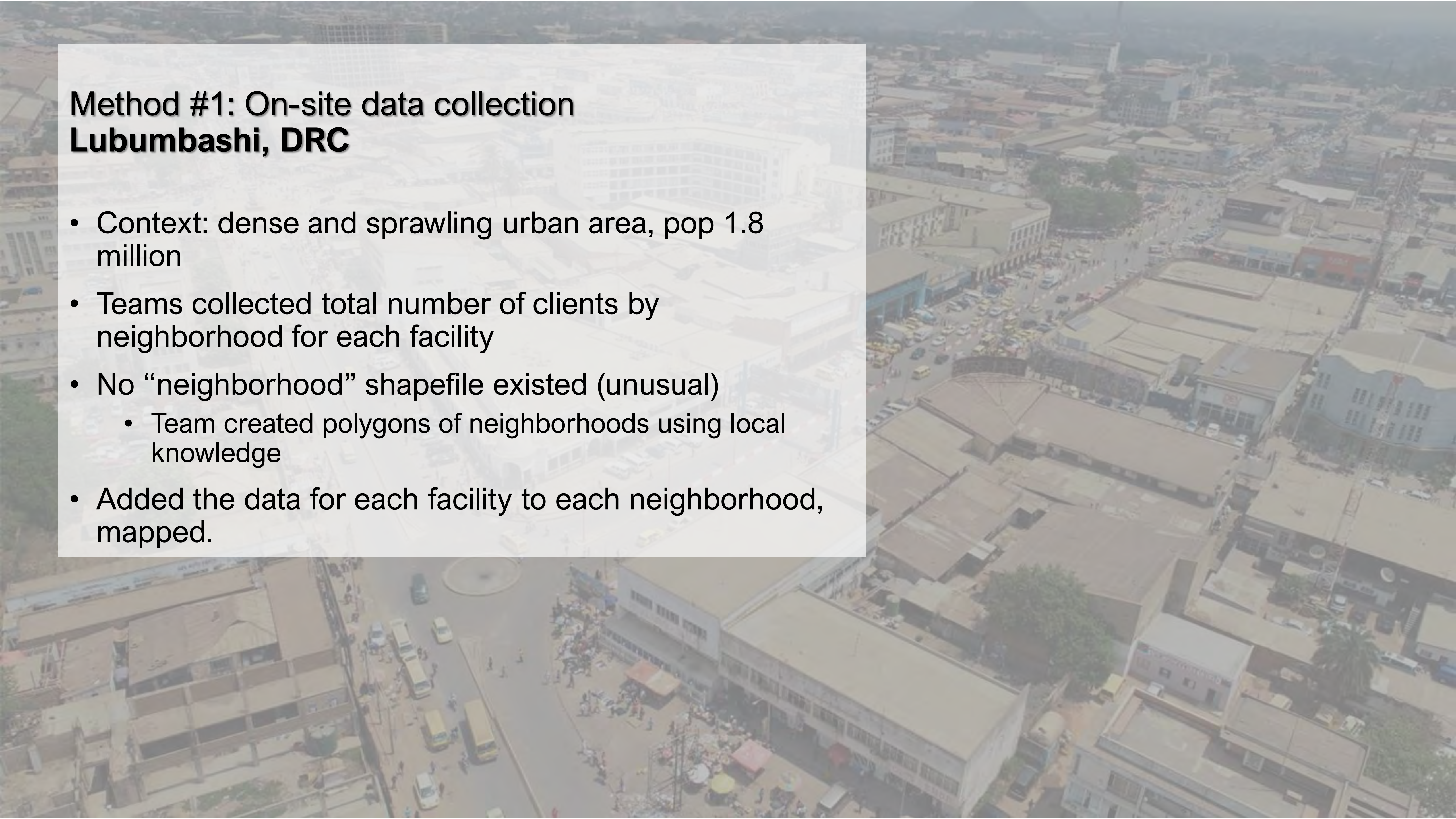
Senior Research Associate/GIS Analyst

Two Approaches using GIS

1. **On-site data collection, then mapping**
   Potentially better in denser, urban areas
   Requires onsite data collection, data cleaning
   Matching neighborhood names to spatial data OR creating it

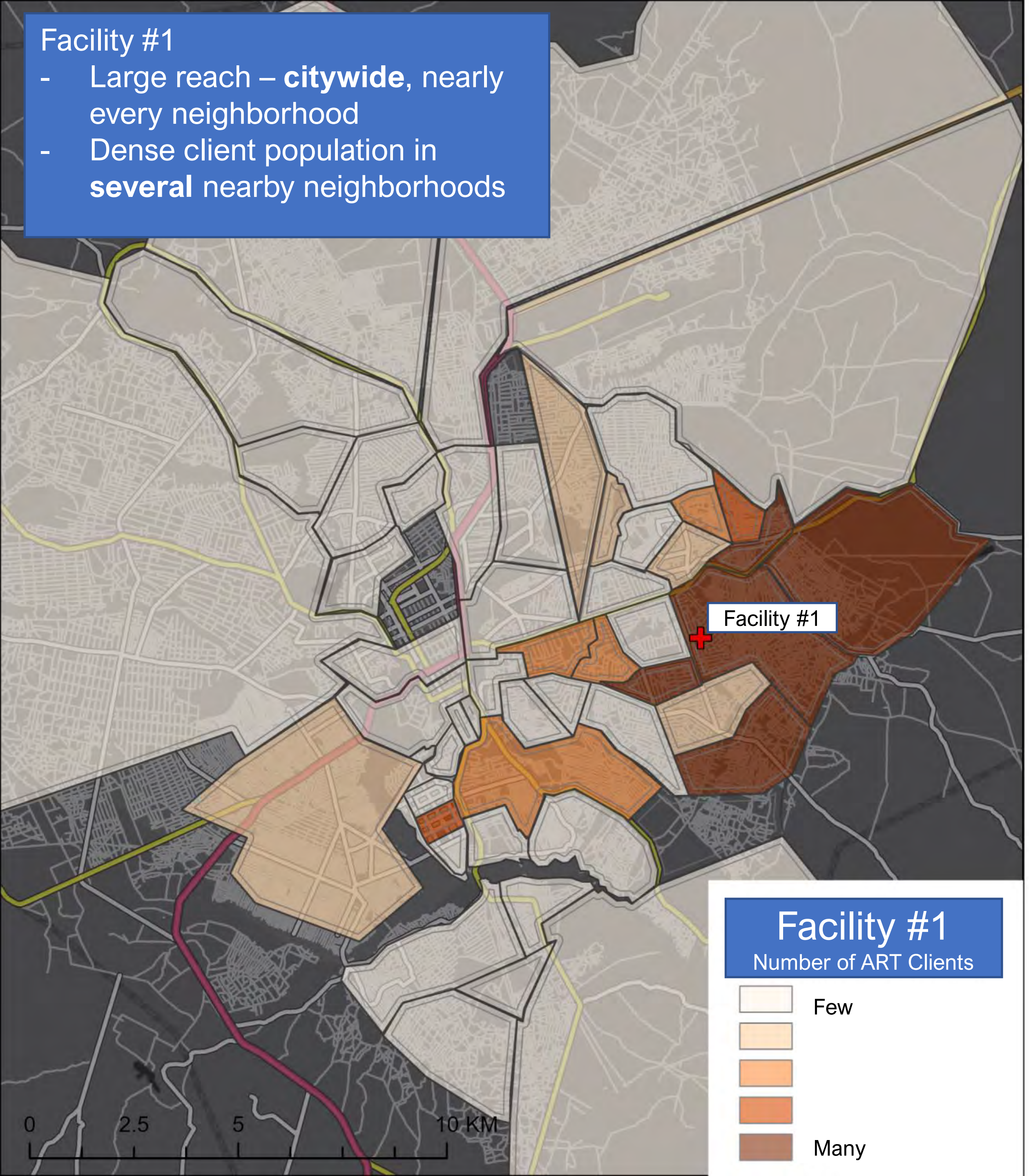
2. **Model catchment areas based on travel time; then health facility ART client totals disaggregated across catchment areas**
   Potentially better in rural areas
   Requires only gathering, cleaning GPS points and TX_CURR data
   Rigorous spatial methods that measure *travel time along roads/across terrain*

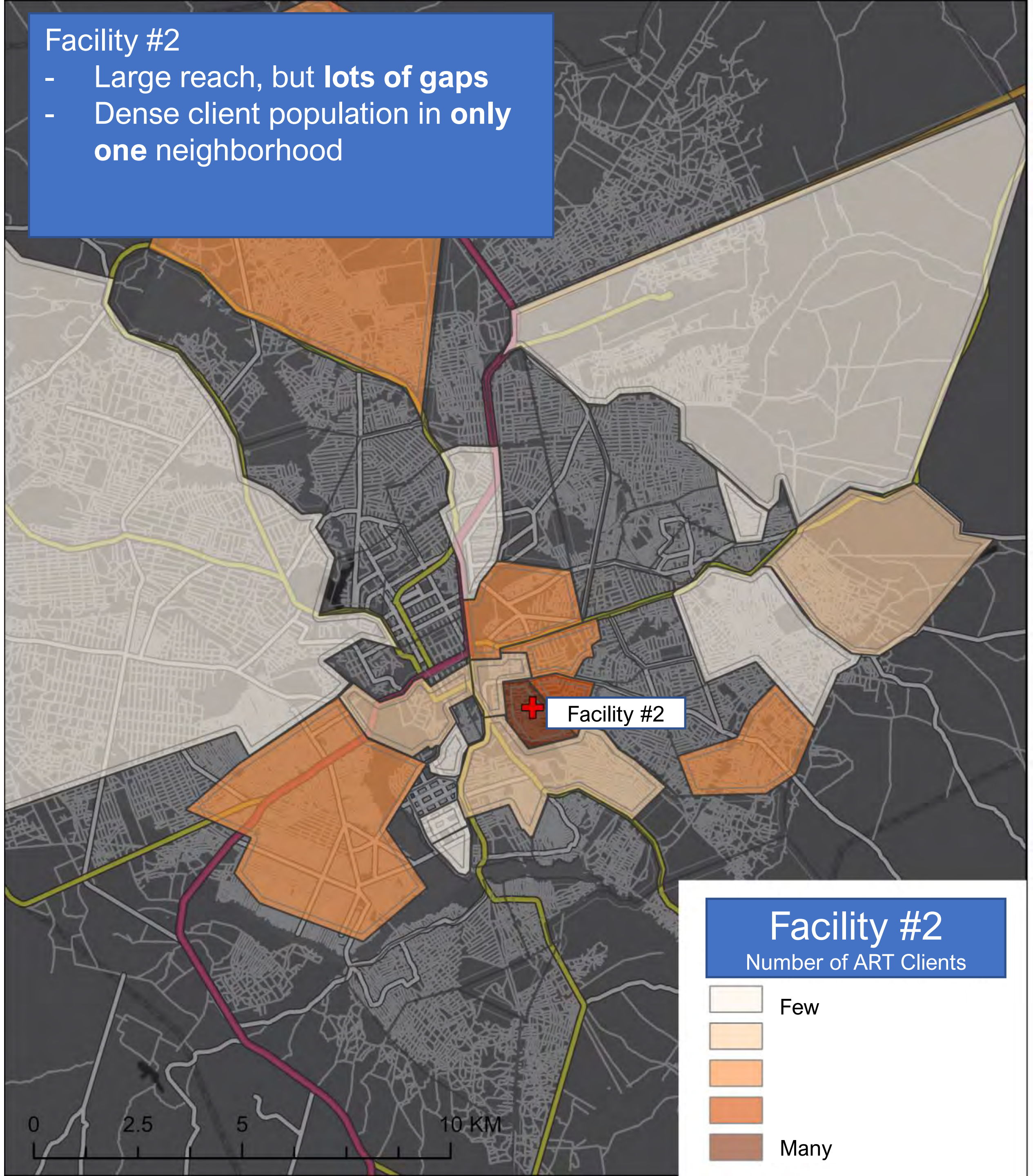
- Why is this important?
  Strategic placement of ART to improve access



Method #1: On-site data collection
Lubumbashi, DRC

- Context: dense and sprawling urban area, pop 1.8 million
- Teams collected total number of clients by neighborhood for each facility
- No “neighborhood” shapefile existed (unusual)
  - Team created polygons of neighborhoods using local knowledge
- Added the data for each facility to each neighborhood, mapped.


Facility #1
- Large reach – **citywide**, nearly every neighborhood
- Dense client population in **several** nearby neighborhoods
Facility #1
Facility #1
Number of ART Clients
Few
Many
0
2.5
5
10 KM


Facility #2
- Large reach, but **lots of gaps**
- Dense client population in **only one** neighborhood
Facility #2
Facility #2
Number of ART Clients
Few
Many
0
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10 KM

Facility #1

- Large reach – **citywide**, nearly every neighborhood
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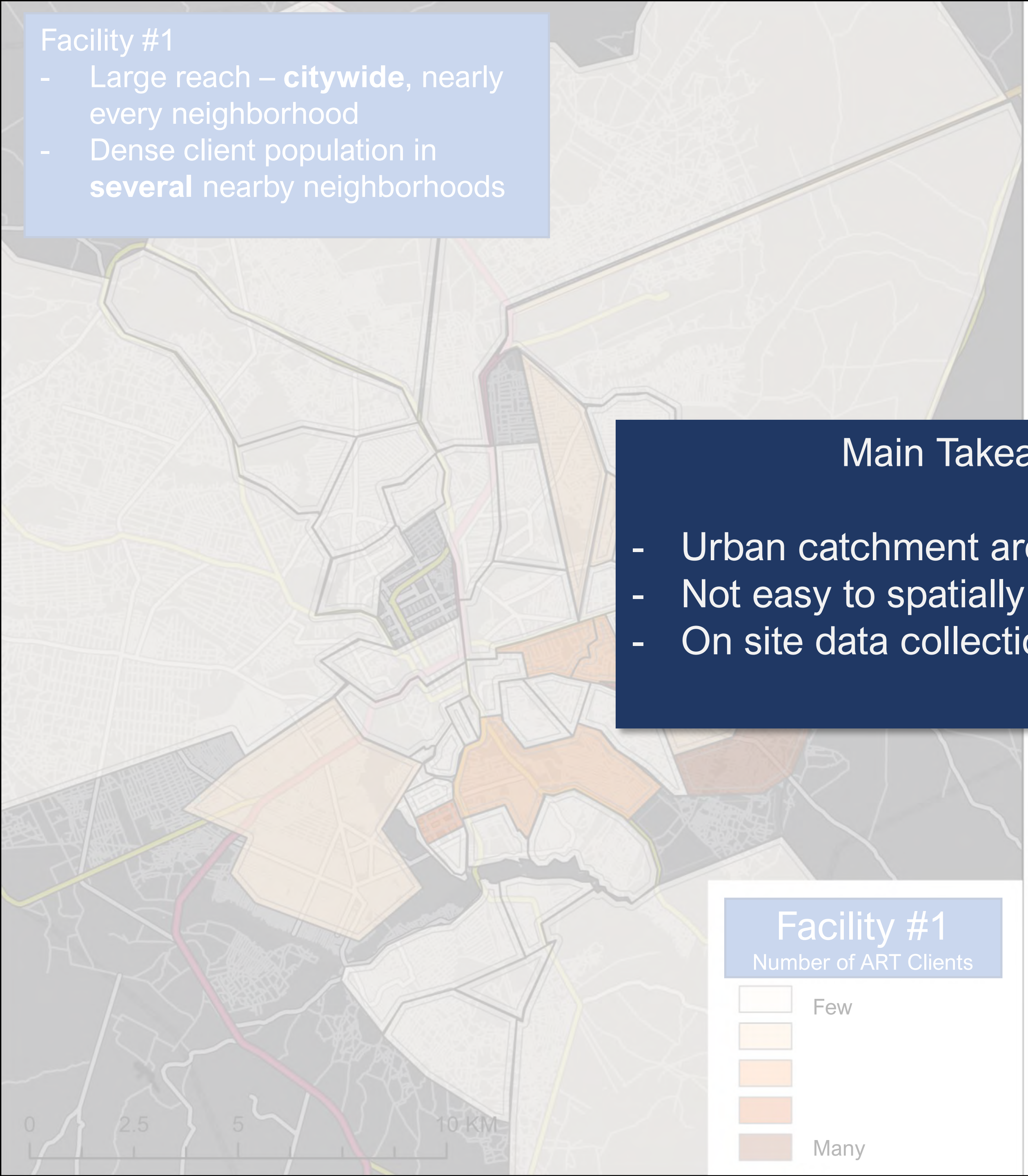
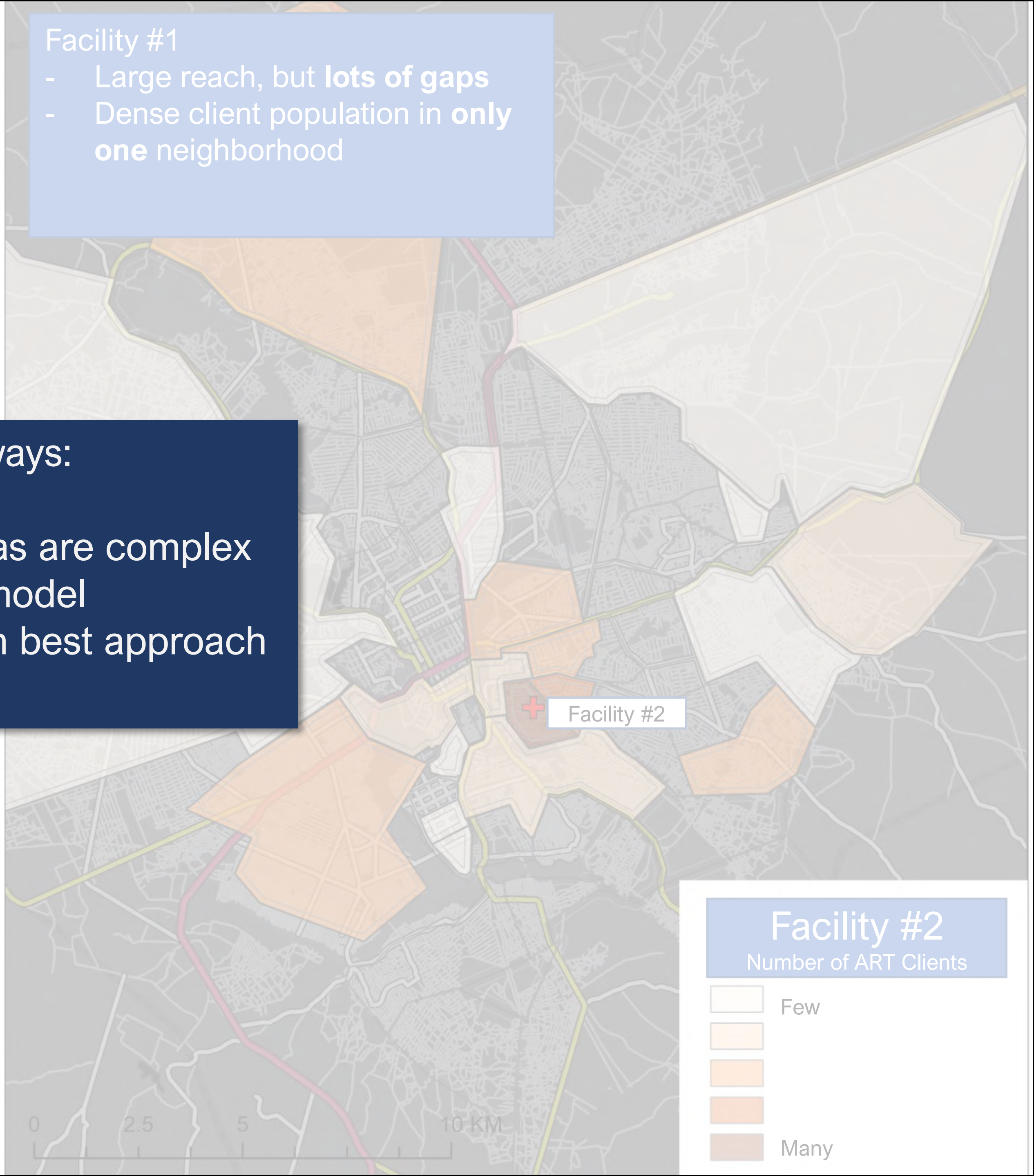


Facility #1

- Large reach, but **lots of gaps**
- Dense client population in **only one** neighborhood



Main Takeaways:

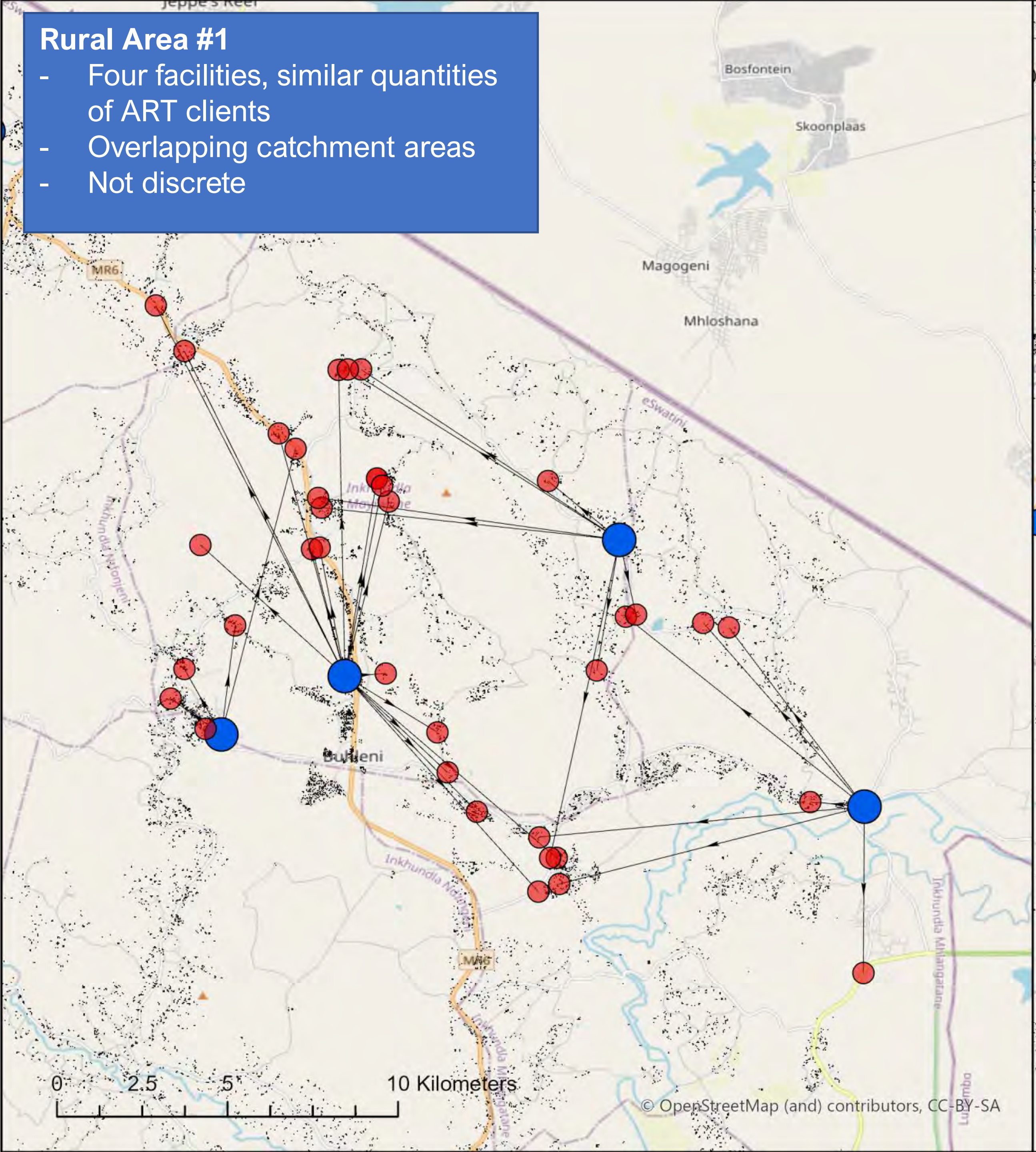
- Urban catchment areas are complex
- Not easy to spatially model
- On site data collection best approach

Example of "real" catchment areas
Rural Eswatini

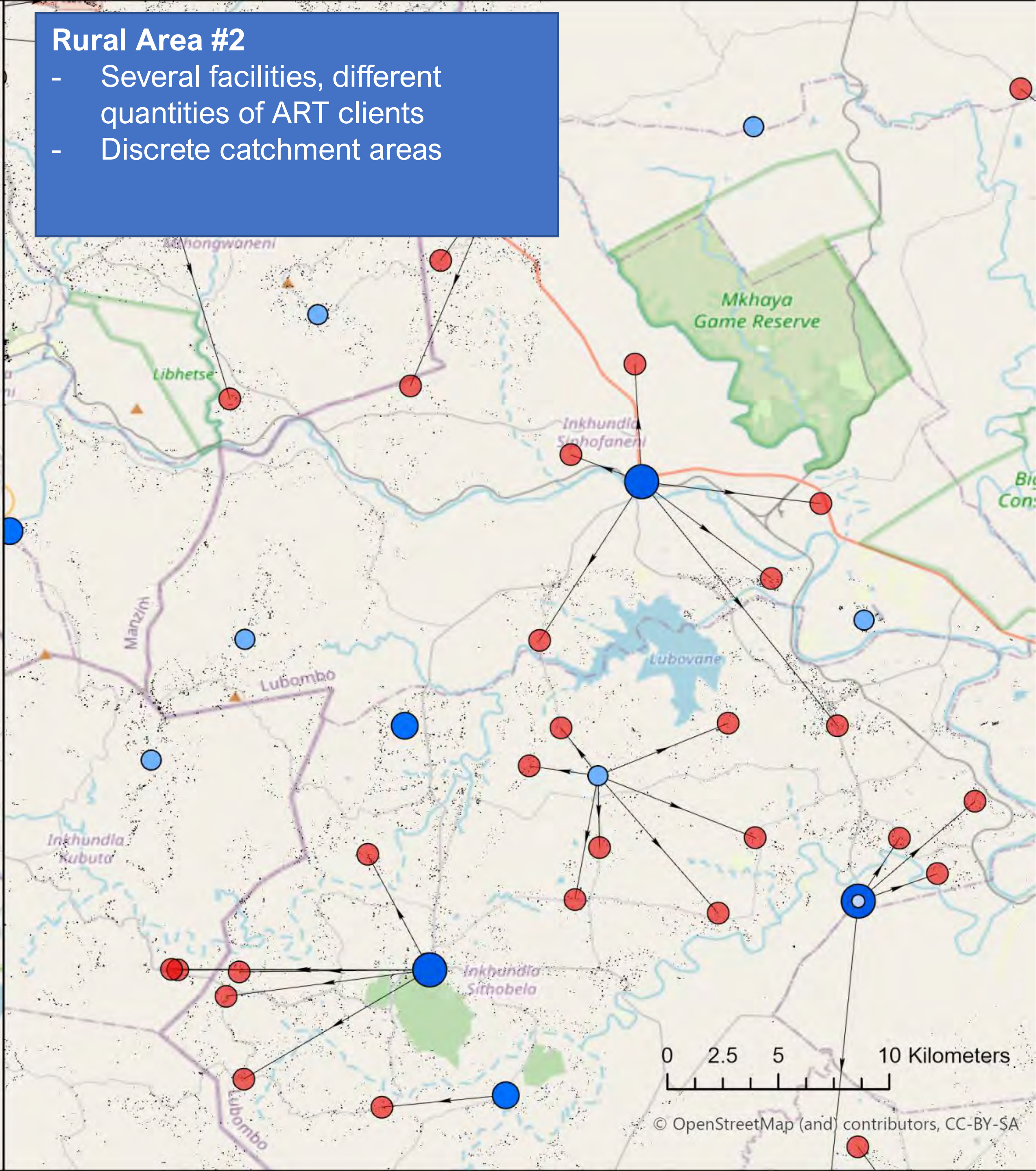
- Context: rural areas with high HIV burden
- Teams already identified community distribution points (CDPs) for DDD.
- Collected about half of the CDP's GPS points.
- Added the data for each facility to each neighborhood, mapped.

- Purpose for us is to show potentially what a catchment area might look like that can inform our modeling.

Rural Area #1
- Four facilities, similar quantities of ART clients
- Overlapping catchment areas
- Not discrete



Rural Area #2
- Several facilities, different quantities of ART clients
- Discrete catchment areas



Rural Area #1

- Four facilities, similar quantities of ART clients
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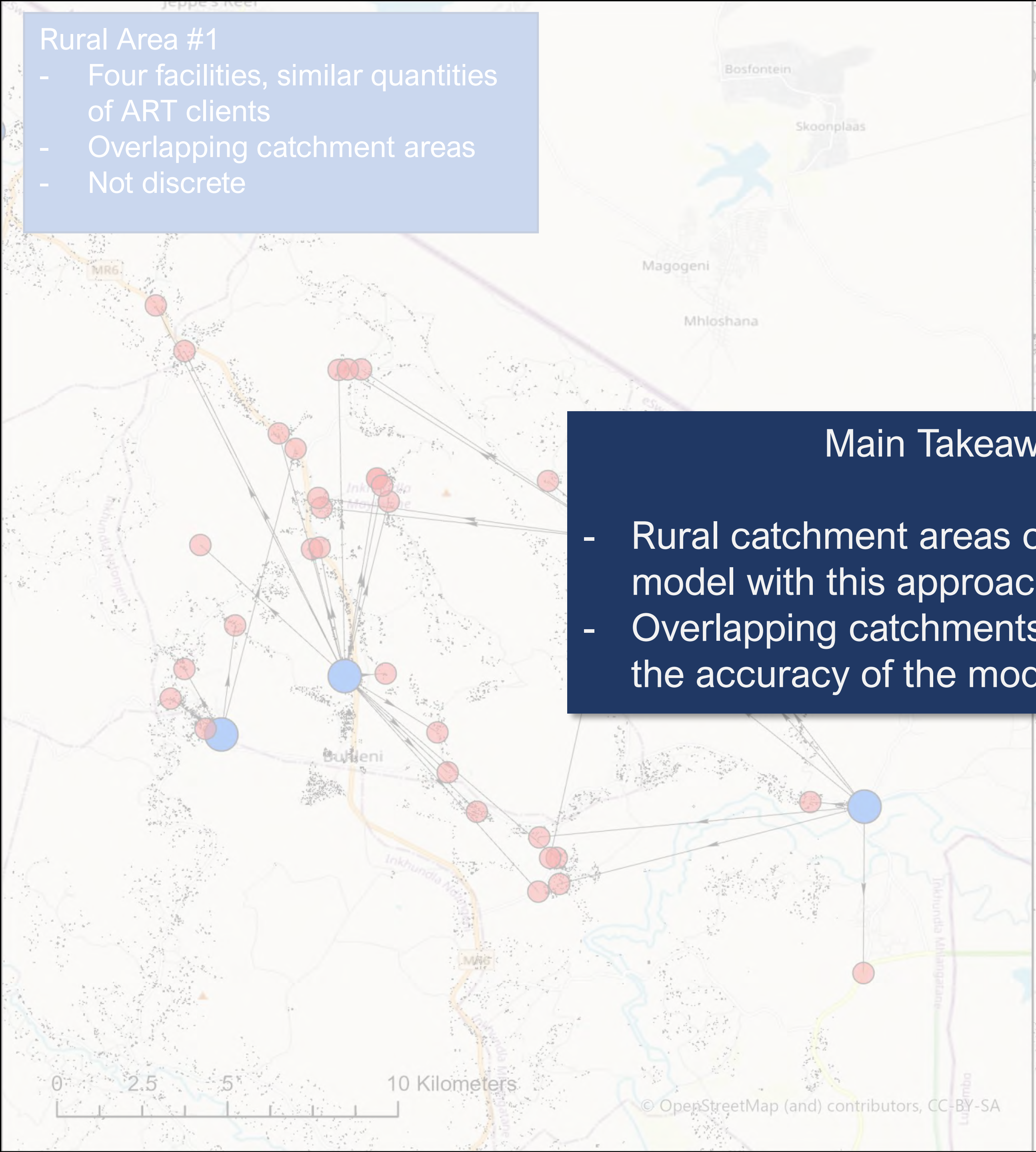
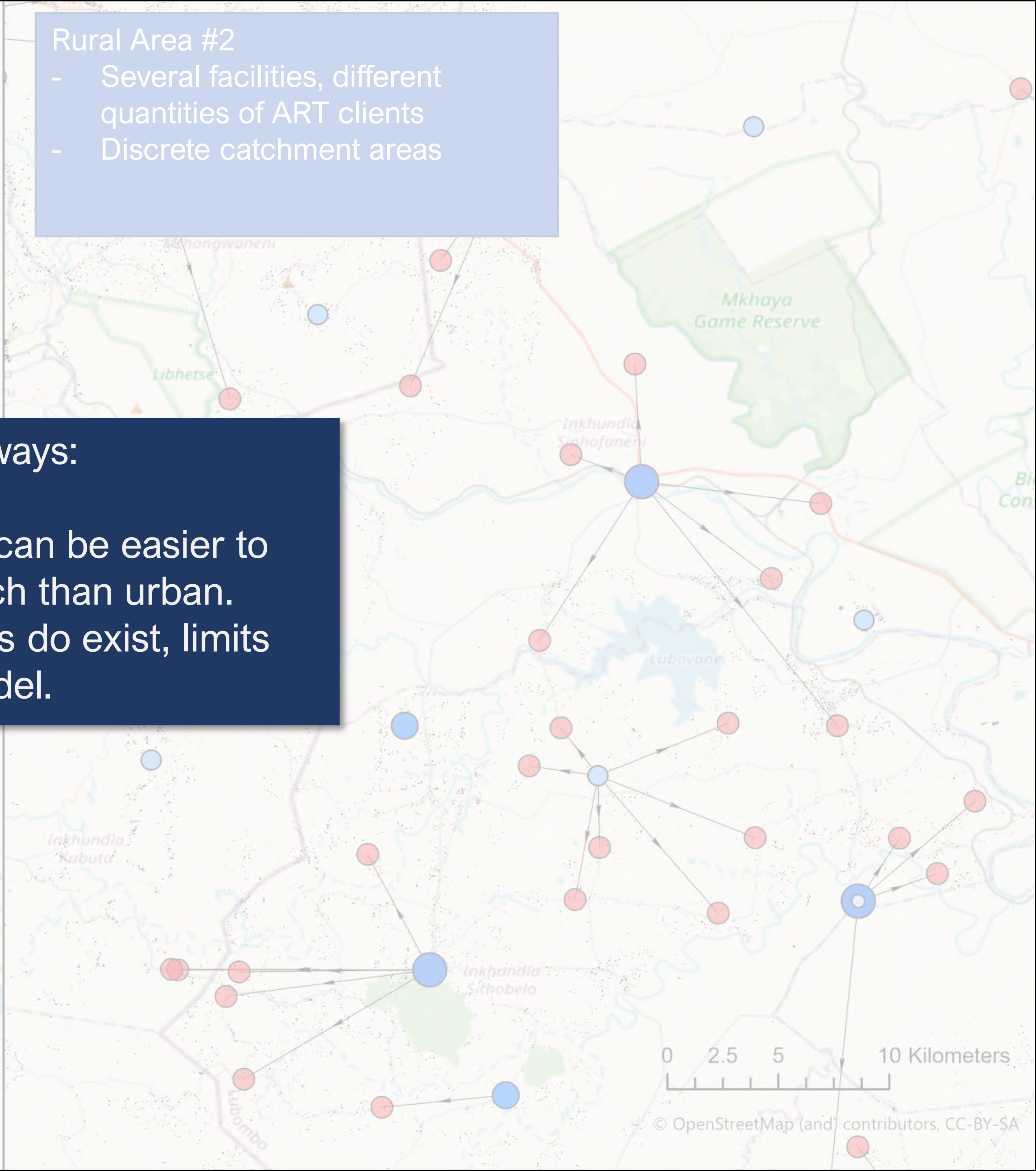


Rural Area #2

- Several facilities, different quantities of ART clients
- Discrete catchment areas

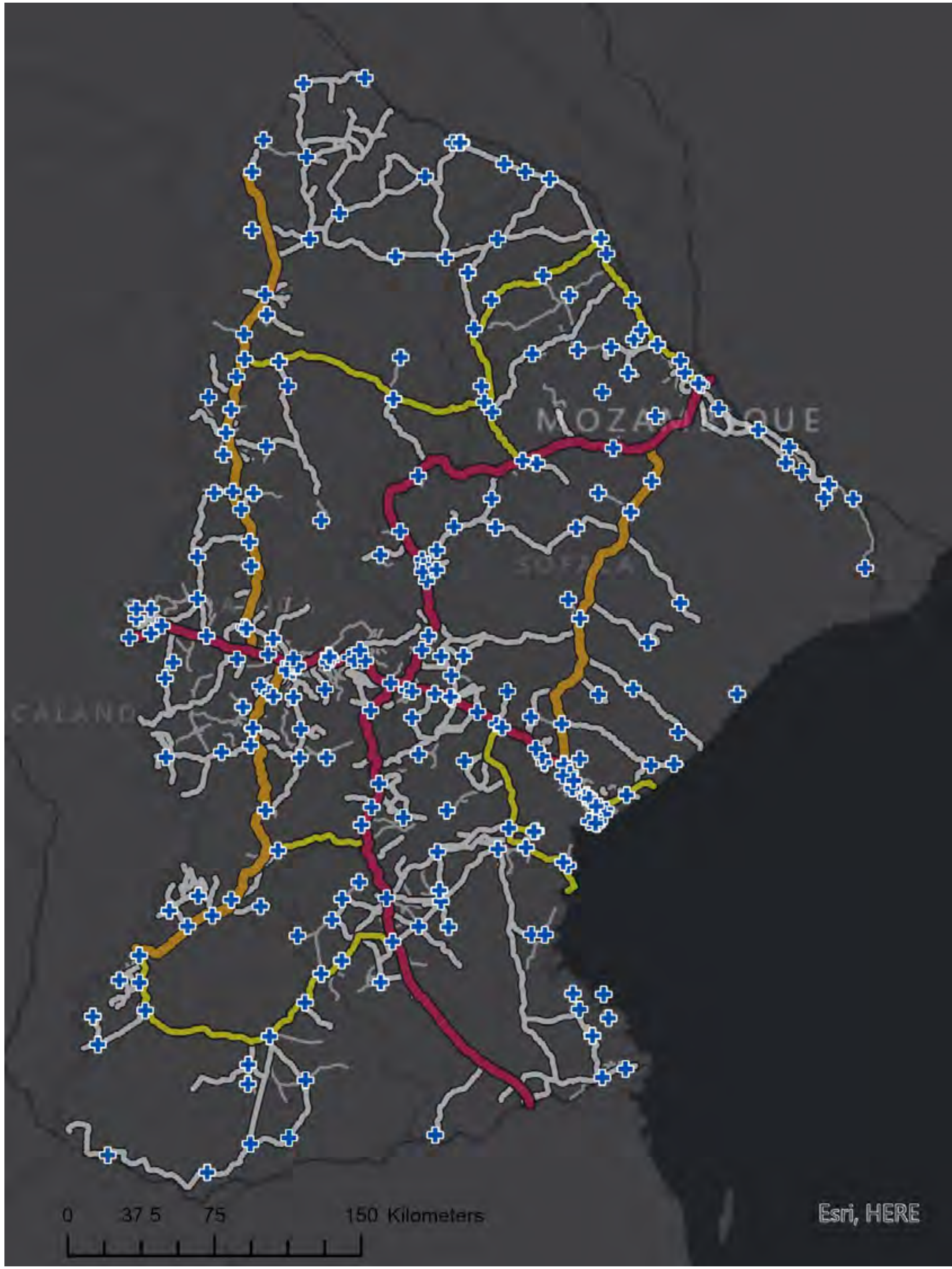


Main Takeaways:

- Rural catchment areas can be easier to model with this approach than urban.
- Overlapping catchments do exist, limits the accuracy of the model.

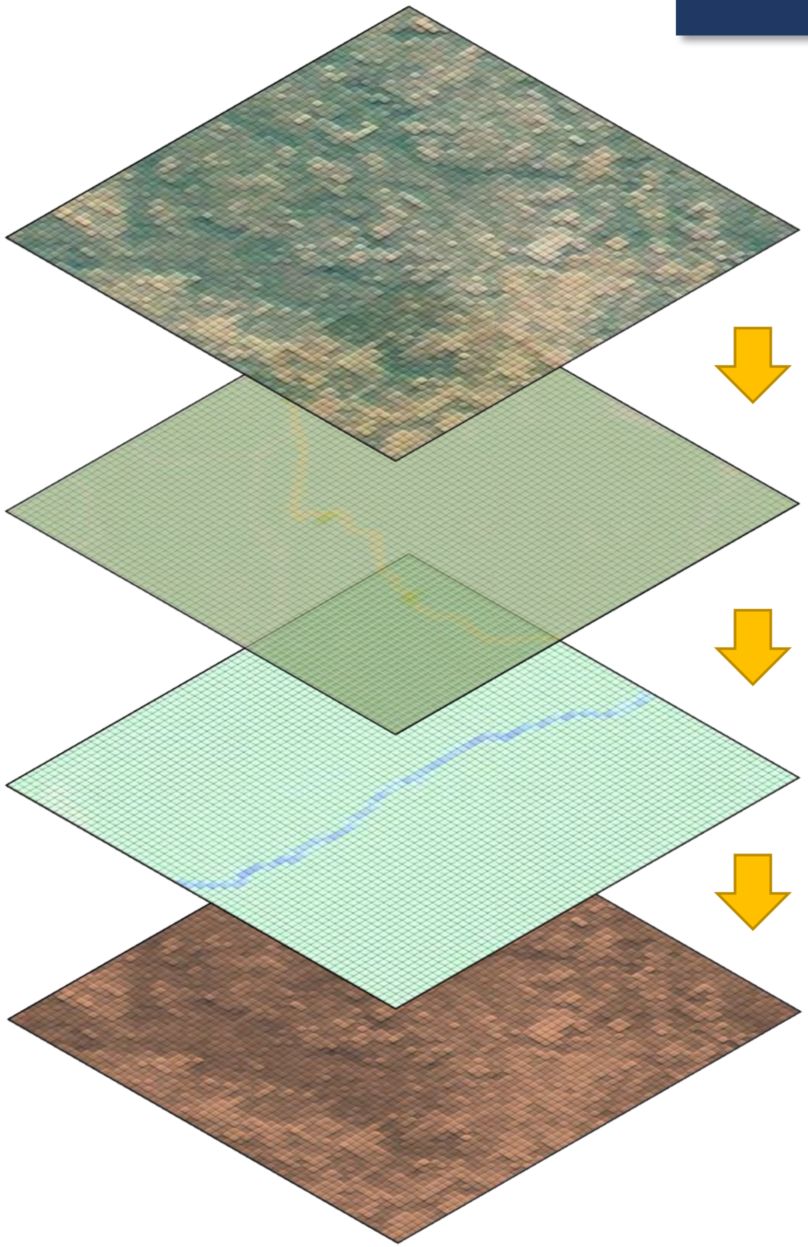
Method #2: Spatial modeling
Sofala and Manica Provinces, Mozambique

- Context: Two rural regions with major corridor connecting Zimbabwe with port of Beira
  - 4.2 million over 50,000 sq miles (130,000 km2)
- Acquired TX_CURR
- Gathered GPS coordinates of each facility; verified each site
  - Multiple online sources to verify each one
- Spatial modeling



Spatial Modeling

1: Create a Travel Time Raster



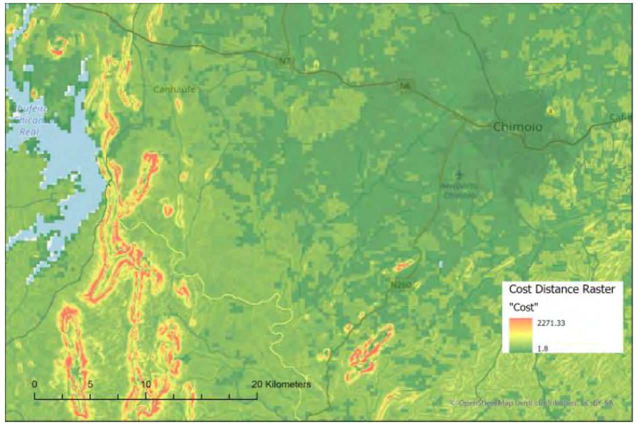
Land Type. Start with processed satellite imagery. Each "cell" gets one value for walking speeds

Roads. Replace any walking speeds with road speeds wherever roads are found.

Water Features. Remove any cells with rivers and lakes except at bridges and ferries

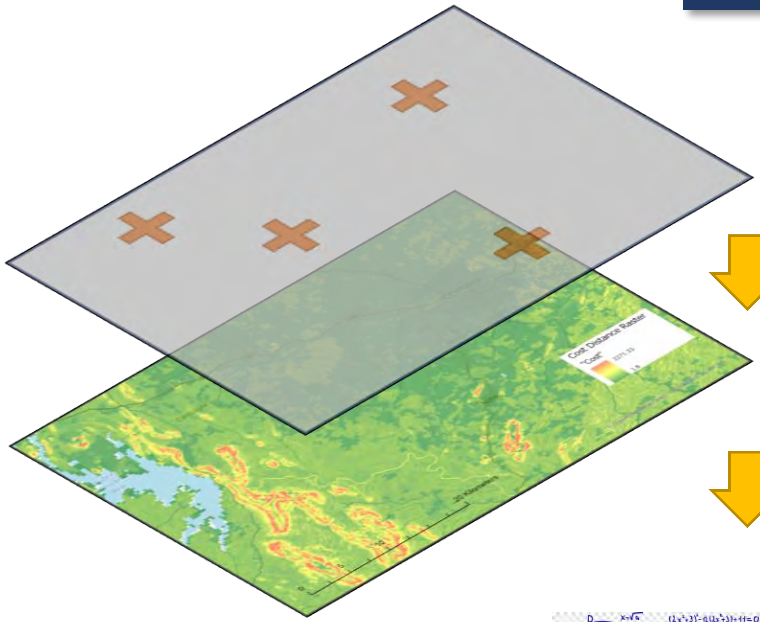
Slope. Adjust the walking and road speeds by changes in elevation.

Travel Time Raster. Final dataset to calculate travel across the surface of the provinces. From anywhere, to anywhere.



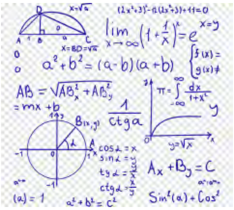
Spatial Modeling

2: Model Catchment Areas



Facilities. Facilities are placed with GPS coordinates onto the map.

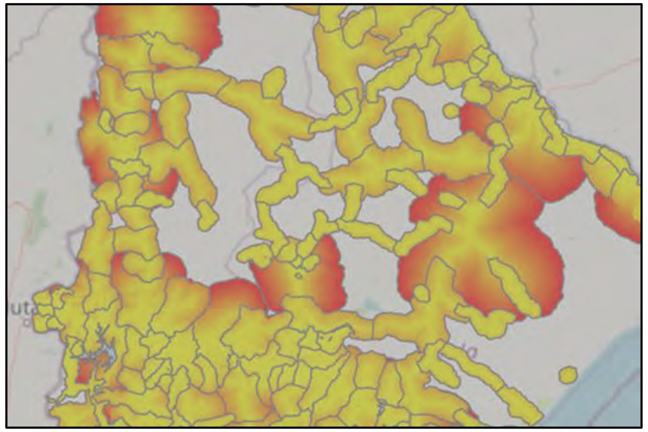
Travel Time Raster



Parameters and Assumptions

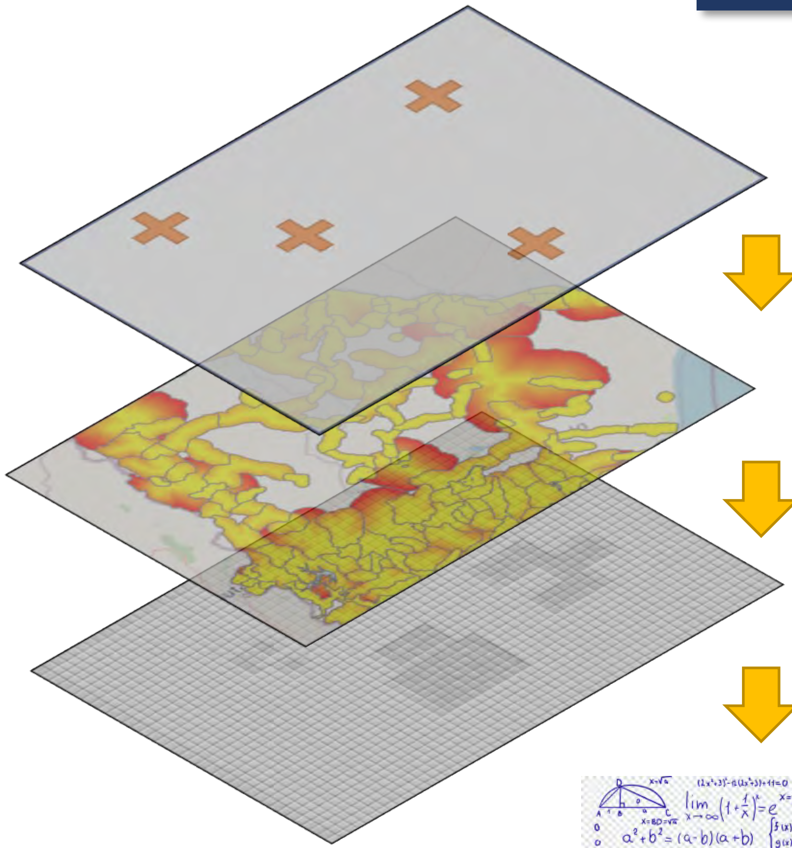
- People will walk/ride to their nearest facility.
- Facilities are given "travel time thresholds" based on their ART client volume.
    - 2, 4, 8, 12-hour thresholds
- Discrete boundaries, no overlap
- Waiting for a car or bus: +30 mins
- Waiting in queue at facility: +30 mins

Catchment Areas



Spatial Modeling

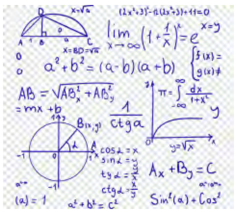
3: Disaggregate ART Clients



Facilities. Facilities are placed with GPS coordinates with TX_CURR.

Catchment Areas. Add the TX_CURR values to each catchment area

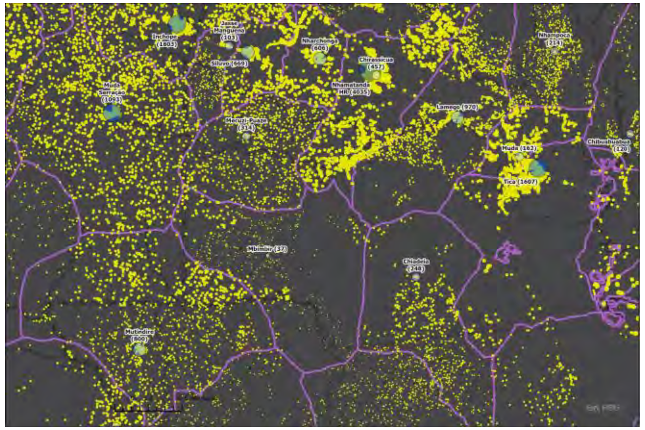
Population. Very small-scale data (30 meters)



Parameters and Assumptions

- ART clients in catchment area is divided by population in catchment area
- Each population “cell” is given an equal proportion of ART clients by catchment area

ART Client Locations. Detailed areas of ART clients. And we know how far they must travel to reach their facility.



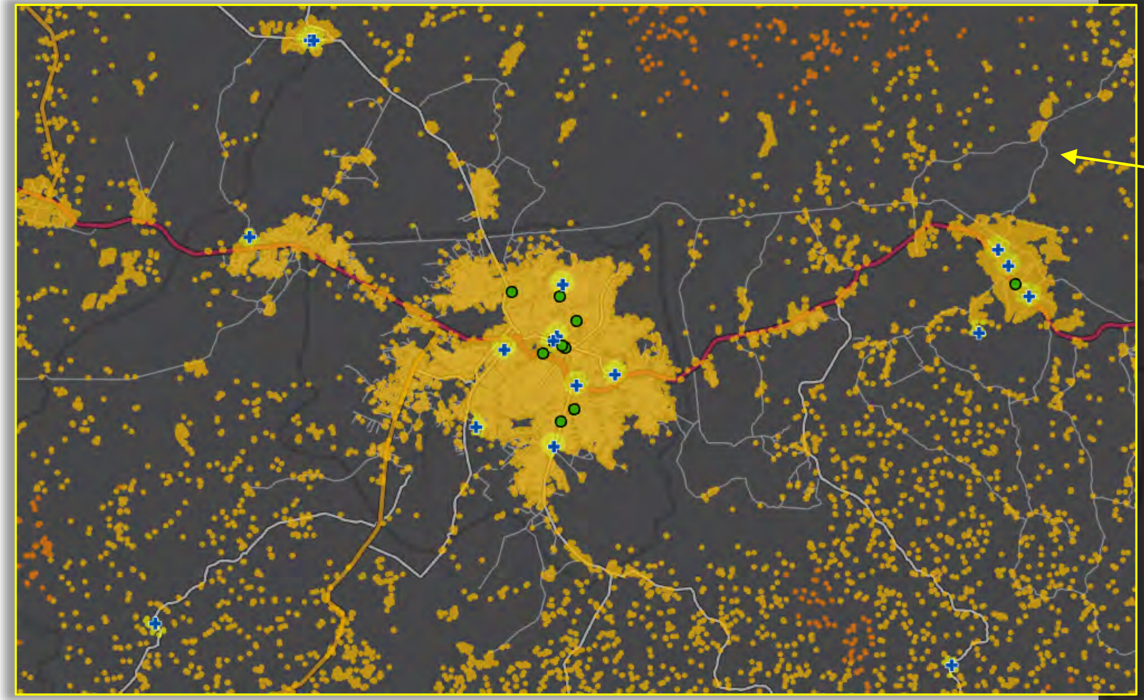
Spatial Modeling
RESULTS

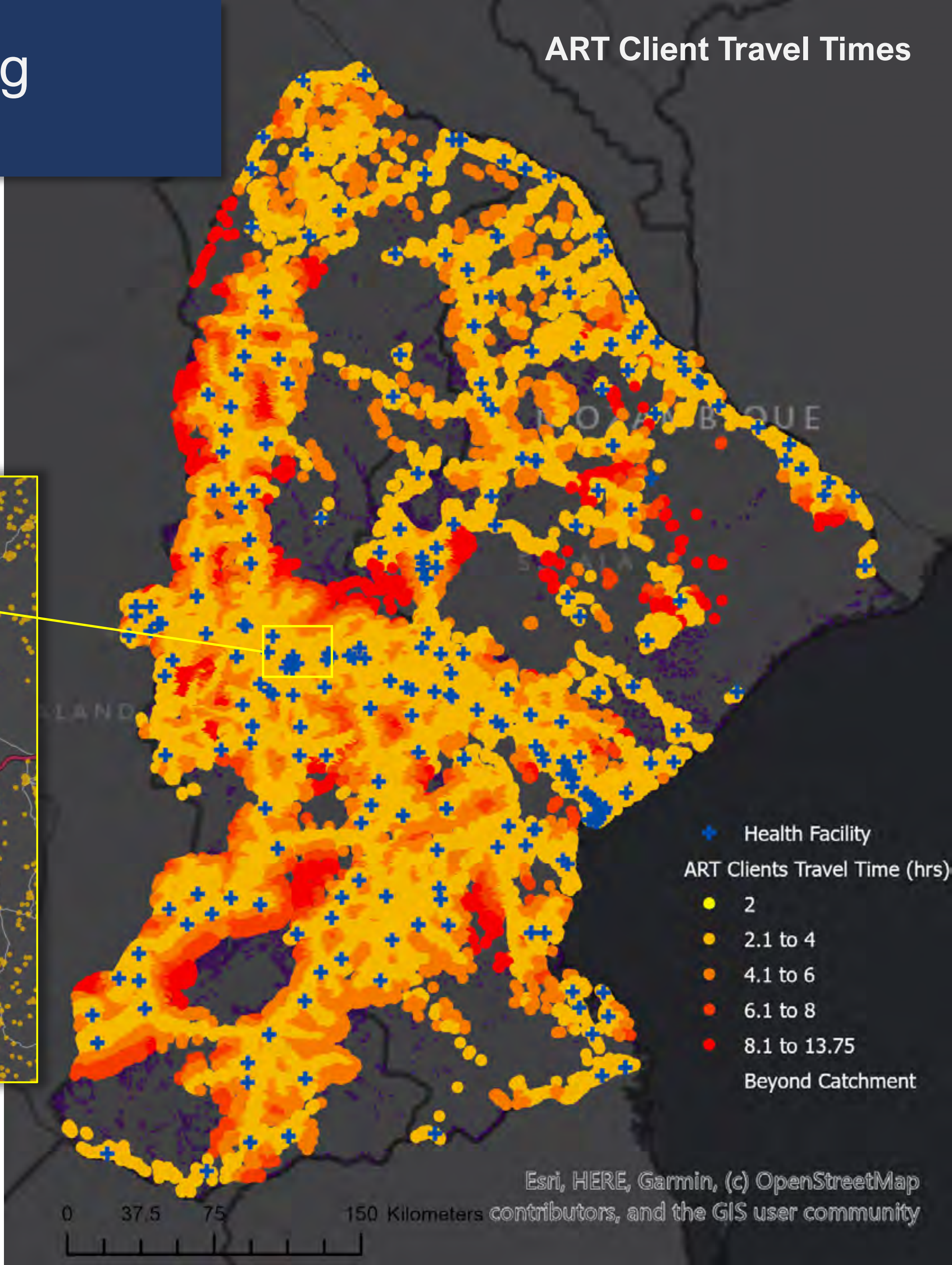
We can identify:

Long travel times. Where are clients that must travel for more than 4 hours?
Gaps in coverage. Where are populated places that are too far to reach services?
New DDD locations. Which pharmacies or other distribution points are located near ART clients?

Each point shows the travel time for each ART patient; and each point represents between 0.2 and 0.6 ART clients in this rural area.

Green dots are potential DDD pharmacies.





Spatial Modeling Limitations

1. We don’t know how well we do, but can experiment with this with Eswatini’s information in the future
2. We know there are issues that we can’t account for in the model:
    - ART clients are likely not evenly distributed with population
    - Stigma and convenience drives people to travel to different facilities not near their homes
    - People are not immobile, home-bound residents
    - People not always reside in one house
    - The assumption that boundaries are discrete, not overlapping

Despite limitations, these model advance our understanding, can support strategic placement of services

Upcoming Session

Estimating the cost and cost savings from decentralized distribution of antiretroviral therapy

Thursday, December 10, 2020

7:00 AM-8:30 AM EST | 13:00-14:30 CAT | 14:00-15:30 EAT

Register here