District overview of travel time to ART facilities: Phalombe

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Objectives

- Map the estimated prevalence and number of people living with HIV (PLHIV) by approximately 1 km grid cells.
- Estimate the travel time to the nearest ART facility for PLHIV in Malawi.
- Identify optimal locations for additional facilities with ART service to reach PLHIV with long travel times to existing ART facilities (>60, 90, or 120 minutes).

Interactive results are available at: https://mrc-ide.github.io/mwi-hiv/ART_facilities/index.html.

HIV prevalence and PLHIV estimates

Figure 2 illustrates estimates for spatial HIV prevalence for adults aged 15-49 years. Figure 3 shows the estimated number of PLHIV (all ages), and the locations of health facilities with ART services (labelled with **A**) and without current ART services (labelled with **F**).

Table 1: Summary estimates for Phalombe, September 2020.

Total PLHIV (all ages)	36,552 (31,653–41,400)
HIV prevalence, age 15-49 years	12.6% (10.9%–14.3%)
Total patients receiving ART	54,859
Average walking time to nearest ART (minutes)	41 (39–43)
Number PLHIV > 60 minutes walking time	7,063 (5,782–8,559)
Percentage PLHIV > 60 minutes walking time	19.5% (17.3%–21.6%)

Table 2: Traditional authorities with the lowest and highest estimated number of PLHIV, 15-49 Prevalence, and average walking time, respectively.

	Lowest TA	Largest TA
PLHIV	Phalombe Boma: 679 (523–866)	TA Mkhumba: 8,845 (7,304–10,564)
15-49 Prevalence	TA Mkhumba: 12.0% (9.9%–14.4%)	Phalombe Boma: 13.6% (10.5%–17.4%)
Average Walking Time	Phalombe Boma: 11 min (11–11 min)	TA Chiwalo: 57 min (54–60 min)

Travel time to existing ART facilities

In Phalombe, there are 15 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 1957. The list of *active ART facilities* is in Table 4. Private not-for-profit facilities have been excluded from the analysis. Figure 4 shows the modelled travel times to the nearest active ART facility. The average walking time to the nearest facility for residents in each traditional authority are in (Figure 5).

- The estimated average walking time for PLHIV to the closest ART facility across Phalombe is 41 minutes (39-43 min).
- The shortest estimated average walking time to the closest ART facility is in Phalombe Boma (11 minutes (11-11 min)).
- The longest estimated average walking time to the closest ART facility is in TA Chiwalo (57 minutes (54-60 min)).

An estimated 19.5% (17.3%–21.6%) of PLHIV reside more than 60 minutes walking time to their nearest ART facility, compared to 19.9% of the total population. This decreases to 5.1% (4.0%–6.0%) of PLHIV and 5.1% of the total population residing more than 90 minutes walking time to their nearest ART facility. More details are provided in Table 3.

Table 3: Estimated PLHIV and population not reached at different thresholds

Threshold (minutes)	Population not reached	As % of total population	PLHIV not reached	As % of total estimated PLHIV
45	180,415	39.8%	14,087 (12,027–16,453)	39.0% (36.5%–41.2%)
60	90,054	19.9%	7,063 (5,782–8,559)	19.5% (17.3%–21.6%)
90	22,943	5.1%	1,828 (1,374–2,306)	5.1% (4.0%–6.0%)
120	7,090	1.6%	561 (418–718)	1.6% (1.2%–1.9%)

Proposed facilities for new ART services

A list of 6 *non-ART facilities* were considered to identify existing health facility locations for expanding ART services, listed in Table 5. Figure 6 shows the number of PLHIV in grid cells where the estimated travel time is longer than 60 minutes and candidate new ART facilities.

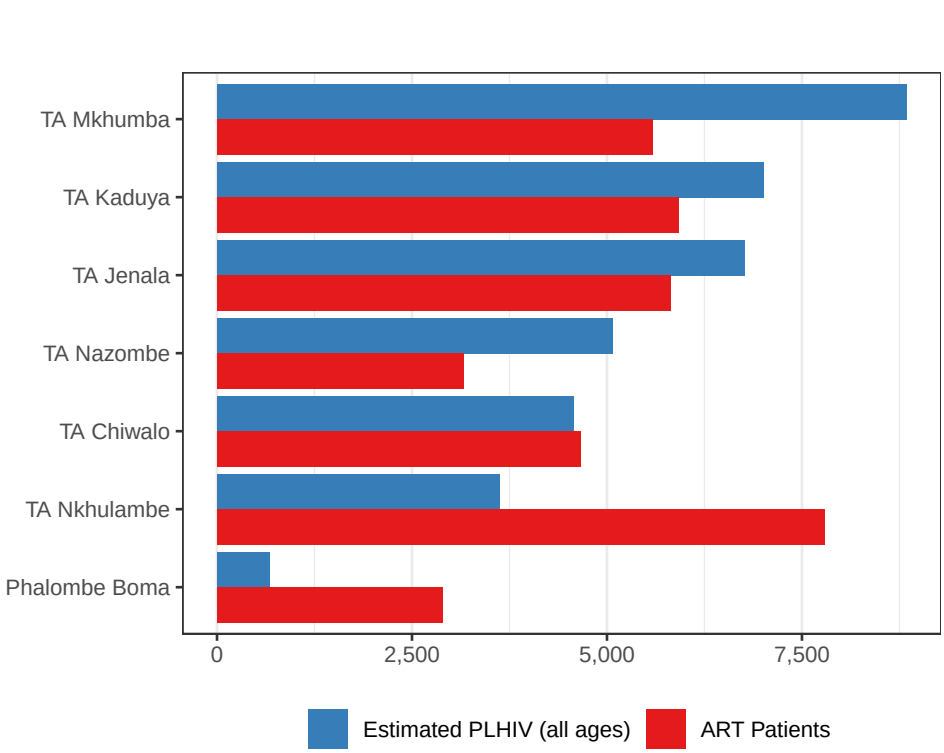
- The TA with the largest number of PLHIV residing more than 60 minutes from their closest ART facility is TA Chiwalo (2069 PLHIV (1492-2732) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **Waruma**, with 191 PLHIV (145-249) reached.

Limitations

There are several important limitations to this analysis:

- Travel time surfaces and catchments may not optimally reflect typical routine travel or movement patterns, for example for work or other activities.
- Results do not represent uncertainty in the 1km gridded maps of PLHIV arising from uncertainty about the gridded populations.
- There are discrepancies in the gridded HIV prevalence estimates from the Bayesian geostatistical model and the Naomi estimates for some districts which should be further reviewed, especially neighbouring urban and rural districts.
- Geographic locations of some health facilities are discrepant between multiple data sources and need to be confirmed.
- The physical infrastructure and suitability of candidate health facilities for supporting an ART service is unknown.
- Optimisation analysis for locations for new facilities has not considered overcrowding, wait times, or other barriers to access at existing facilities. It could be more optimal to expand services in some geographically dense locations to address barriers to access.

Summary figures and maps



Est. PLHIV (all ages)	Prevalence 15−49
8,845	12.0%
7,004	13.2%
6,762	12.1%
5,066	12.8%
4,576	12.7%
3,621	13.5%
679	13.6%

Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

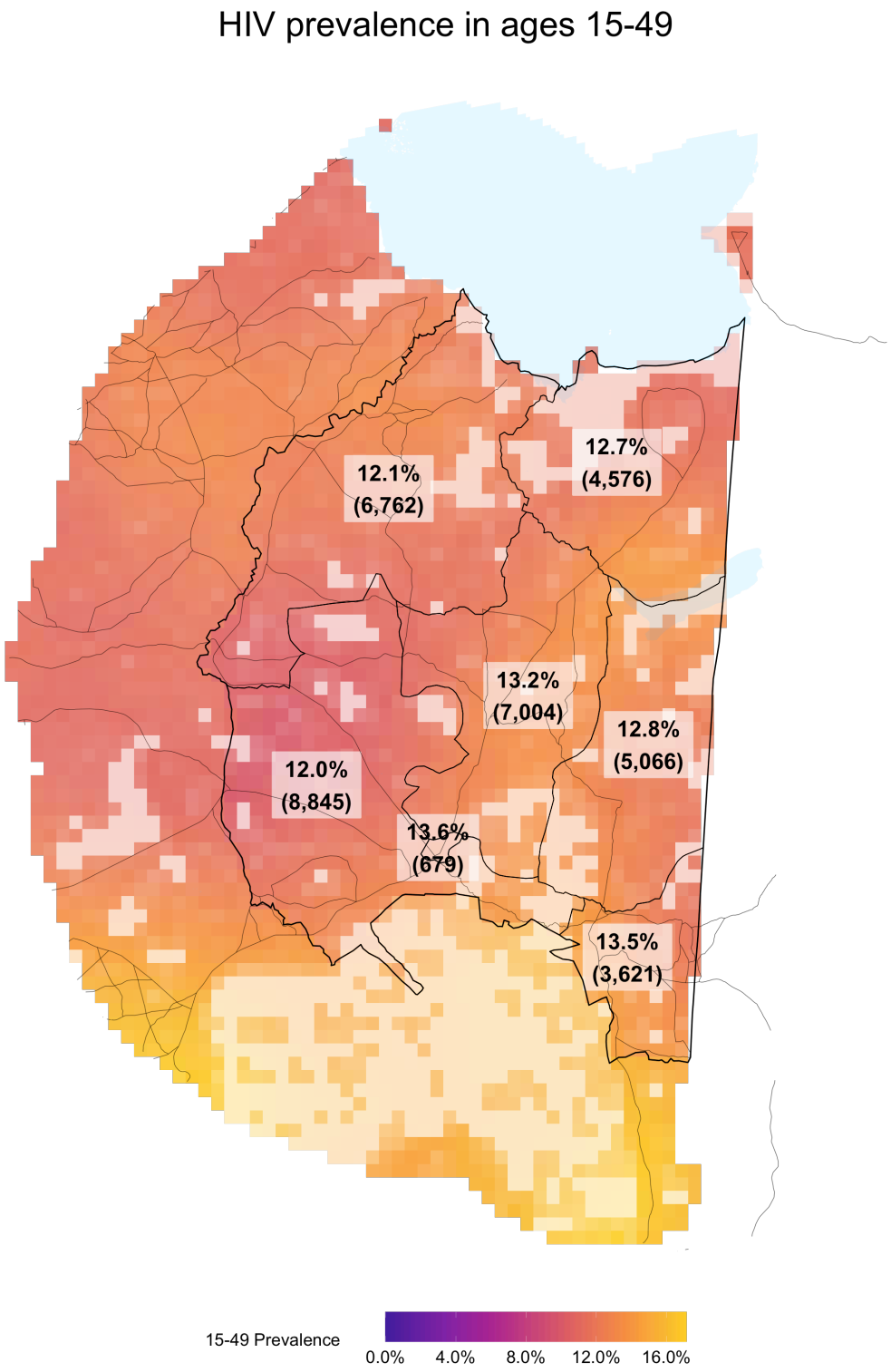


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

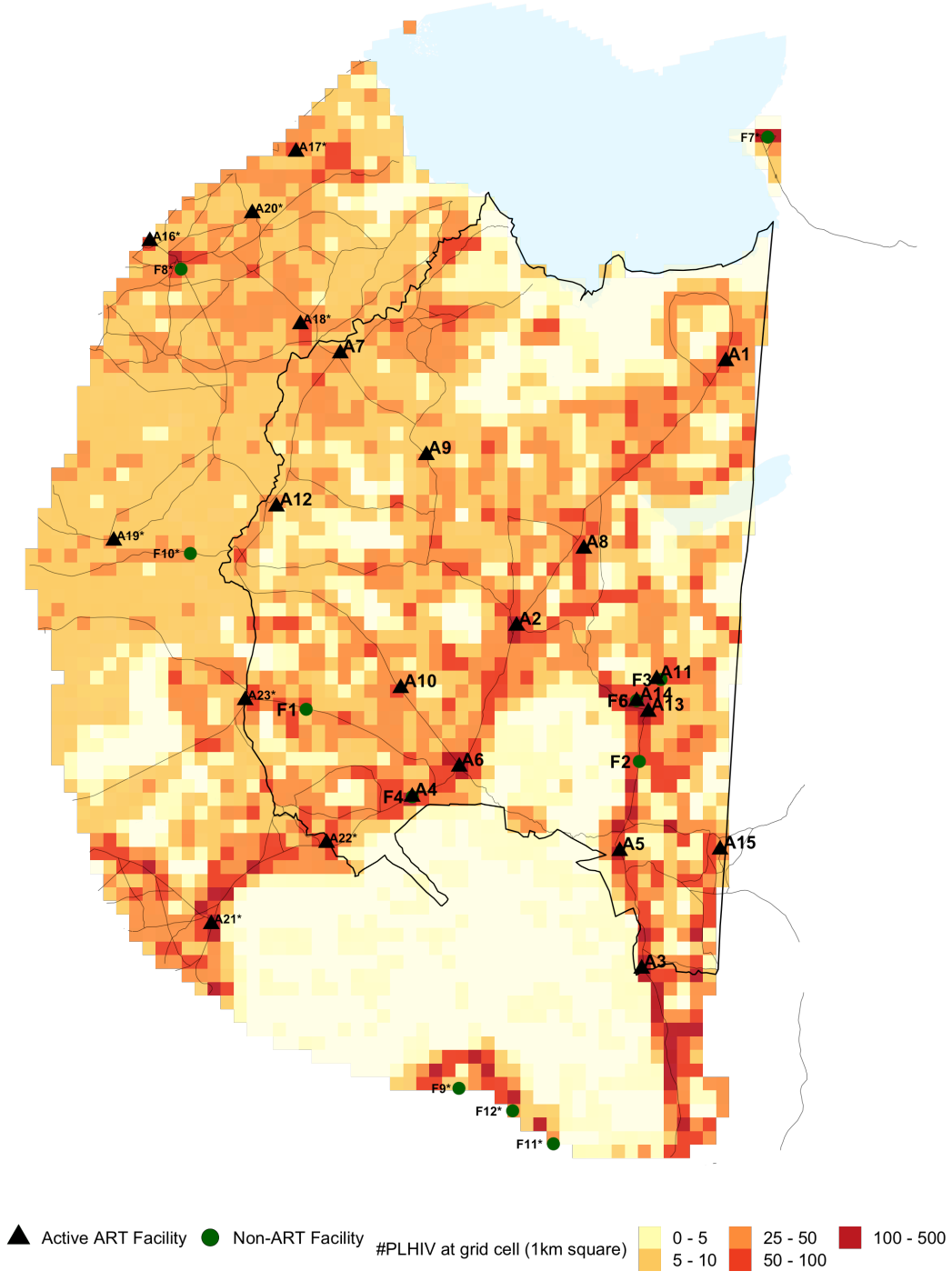


Figure 3: Estimated number of PLHIV on a 1km square.

Table 4: List of active ART facilities that had at least 1 registered ART patient in September 2020. The column ”ART” indicates how many ART patients are registered at the ART facility. Facilities outside the district boundaries that may be accessible to residents within the district are marked with ”*”.

ID	District	TA	Name	Type	Authority	Long.	Lat.	ART
A1	Phalombe	TA Chiwalo	Nambazo HC	Health centre	Government	35.82	-15.56	4655
A2	Phalombe	TA Kaduya	Migowi HC	Health centre	Government	35.69	-15.72	3960
A3	Phalombe	TA Nkhulambe	Sukasanje HC	Health centre	CHAM	35.77	-15.93	3838
A4	Phalombe	TA Mkhumba	Phalombe Mission Hospital Holy Family	District hospital	CHAM	35.62	-15.82	3784
A5	Phalombe	TA Nkhulambe	Nkhulambe HC	Health centre	Government	35.75	-15.86	3588
A6	Phalombe	Phalombe Boma	Phalombe HC	Health centre	Government	35.65	-15.81	2889
A7	Phalombe	TA Jenala	Chitekesa HC	Health centre	Government	35.57	-15.55	2828
A8	Phalombe	TA Kaduya	Kalinde HC	Health centre	Government	35.73	-15.67	1957
A9	Phalombe	TA Jenala	Nkhwayi HC	Health centre	Government	35.63	-15.61	1847
A10	Phalombe	TA Mkhumba	Mpasa HC	Health centre	Government	35.61	-15.76	1800
A11	Phalombe	TA Nazombe	Nazombe HC (Gogo Nazombe)	Health centre	Government	35.77	-15.75	1688
A12	Phalombe	TA Jenala	Mwanga HC	Health centre	CHAM	35.53	-15.65	1134
A13	Phalombe	TA Nazombe	Chiringa Mat.	Special	Government	35.77	-15.77	740
A14	Phalombe	TA Nazombe	Chiringa CHAM HC	Health centre	CHAM	35.76	-15.77	728
A15	Phalombe	TA Nkhulambe	Mulungu Alinafe Clinic	Health centre	NGO	35.82	-15.86	363
A16*	Zomba	TA Mwambo	Pirimiti HC	Health centre	CHAM	35.45	-15.48	4592
A17*	Zomba	TA Mwambo	Likangala HC	Health centre	Government	35.54	-15.43	3482
A18*	Zomba	TA Mwambo	Matiya HC	Health centre	CHAM	35.55	-15.53	2643
A19*	Zomba	STA Ngwelero	Ngwelero HC	Health centre	Government	35.43	-15.67	1508
A20*	Zomba	TA Mwambo	Chamba HC	Health centre	Government	35.52	-15.47	1287
A21*	Mulanje	TA Nkanda	Chambe HC	Health centre	Government	35.49	-15.90	2028
A22*	Mulanje	TA Nkanda	Kambenje HC	Health centre	Government	35.56	-15.85	1926
A23*	Mulanje	TA Nkanda	Mulomba HC	Health centre	Government	35.51	-15.77	1594

Table 5: List of non-ART facilities considered in the analysis. The column ”PLHIV” indicates the number of PLHIV that currently need more than 60 minutes to walk to the closest ART facility but less than 60 minutes to the listed health facility in the table. Facilities outside the district boundaries that may be accessible to residents within the district are marked with ”*”.

ID	District	TA	Name	Type	Authority	Long.	Lat.	PLHIV	95% CI
F1	Phalombe	TA Mkhumba	Waruma	Health Post	Government	35.55	-15.77	191	(145-249)
F2	Phalombe	TA Nazombe	Nambiti 2 HP	Health Centre	Government	35.76	-15.80	19	(14-24)
F3	Phalombe	TA Nazombe	Nambiti 1 HC	Health Centre	Government	35.78	-15.75	0	(0-0)
F4	Phalombe	TA Mkhumba	Holy Family Mission Hosp.	District hospital	CHAM	35.62	-15.82	0	(0-0)
F5	Phalombe	TA Nazombe	Chiringa HC	Health Centre	CHAM	35.76	-15.77	0	(0-0)
F6	Phalombe	TA Nazombe	Chiringa HC	Health Centre	Government	35.76	-15.77	0	(0-0)
F7*	Zomba	TA Mkumbira	LUNGAZI	Health Post	Government	35.85	-15.42	533	(245-968)
F8*	Zomba	TA Mwambo	HUNGER	Dispensary	CHAM	35.47	-15.50	466	(346-613)
F9*	Mulanje	STA Sunganinzeru	CHILINGWE	Dispensary	Company	35.65	-16.00	544	(395-720)
F10*	Mulanje	TA Juma	KAMWENDO	Health Post	Government	35.48	-15.67	408	(311-513)
F11*	Mulanje	TA Laston Njema	Chisambo Estate Clinic	Clinic	Company	35.71	-16.04	250	(193-321)
F12*	Mulanje	TA Laston Njema	Phwazi Estate Clinic	Clinic	Company	35.68	-16.02	159	(119-207)

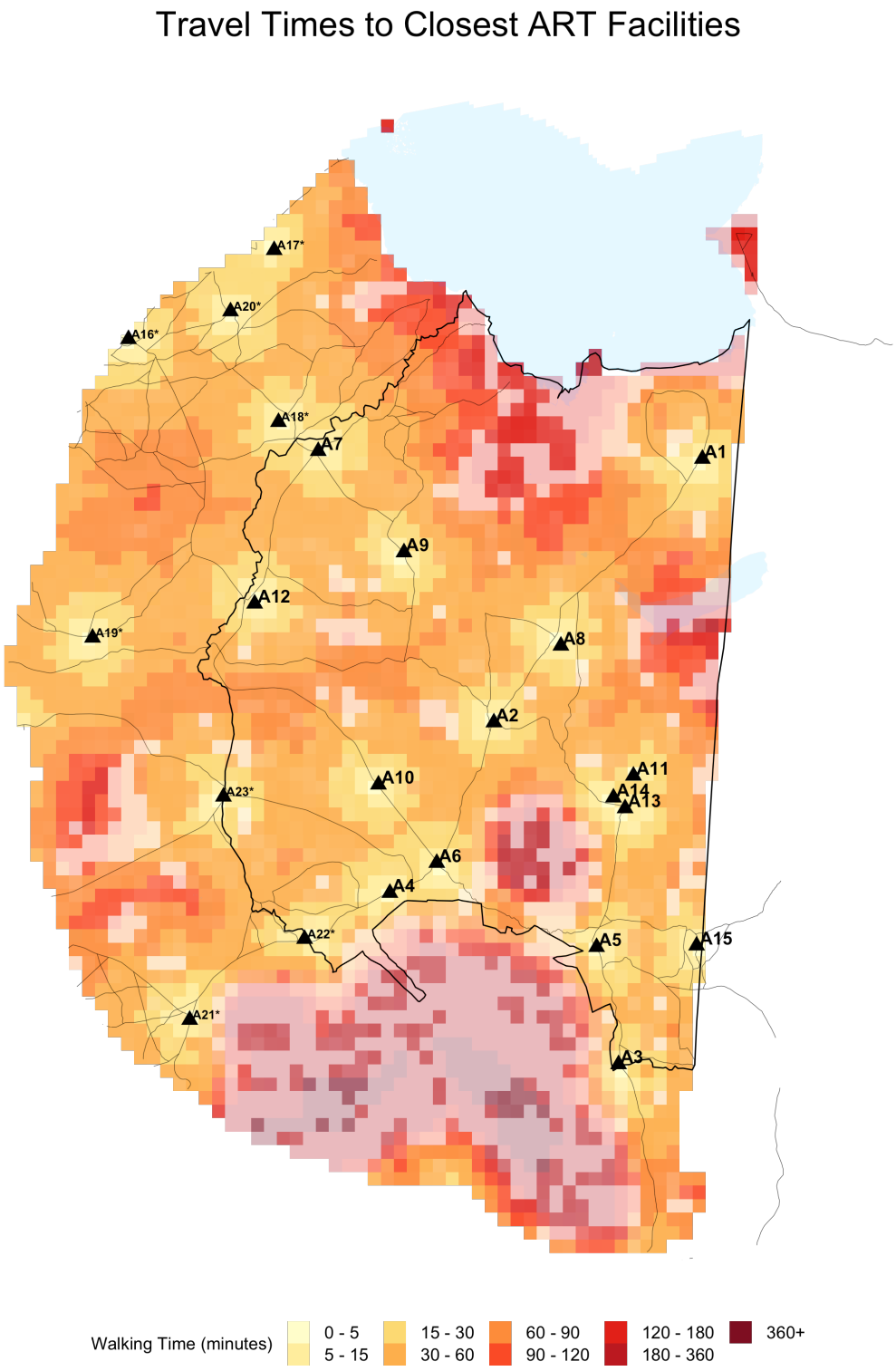
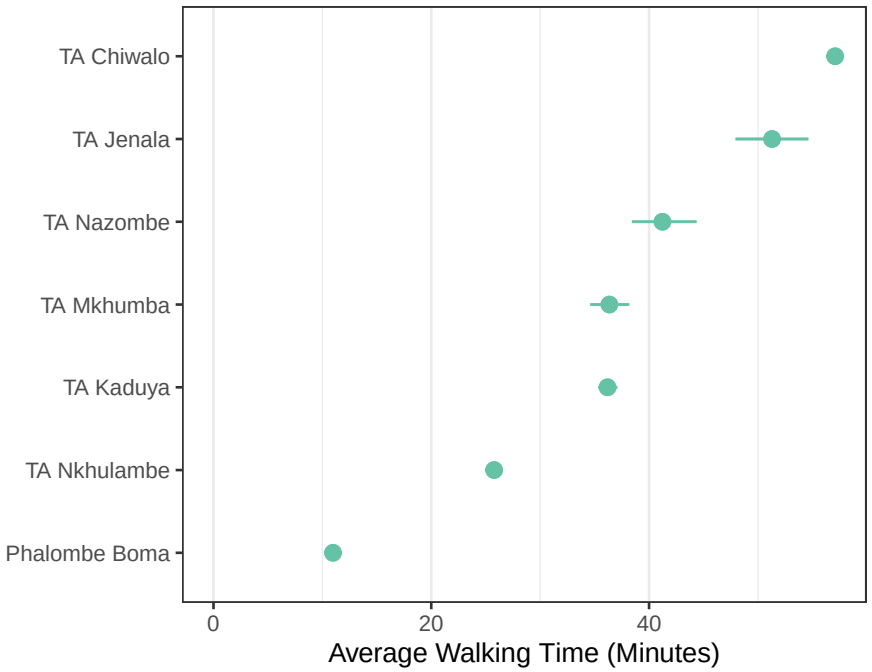


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.



#PLHIV >60 mins	%PLHIV >60 mins
2,069	45.2%
1,953	28.6%
1,059	20.7%
1,321	15.6%
537	7.8%
124	3.4%
0	0.0%

Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

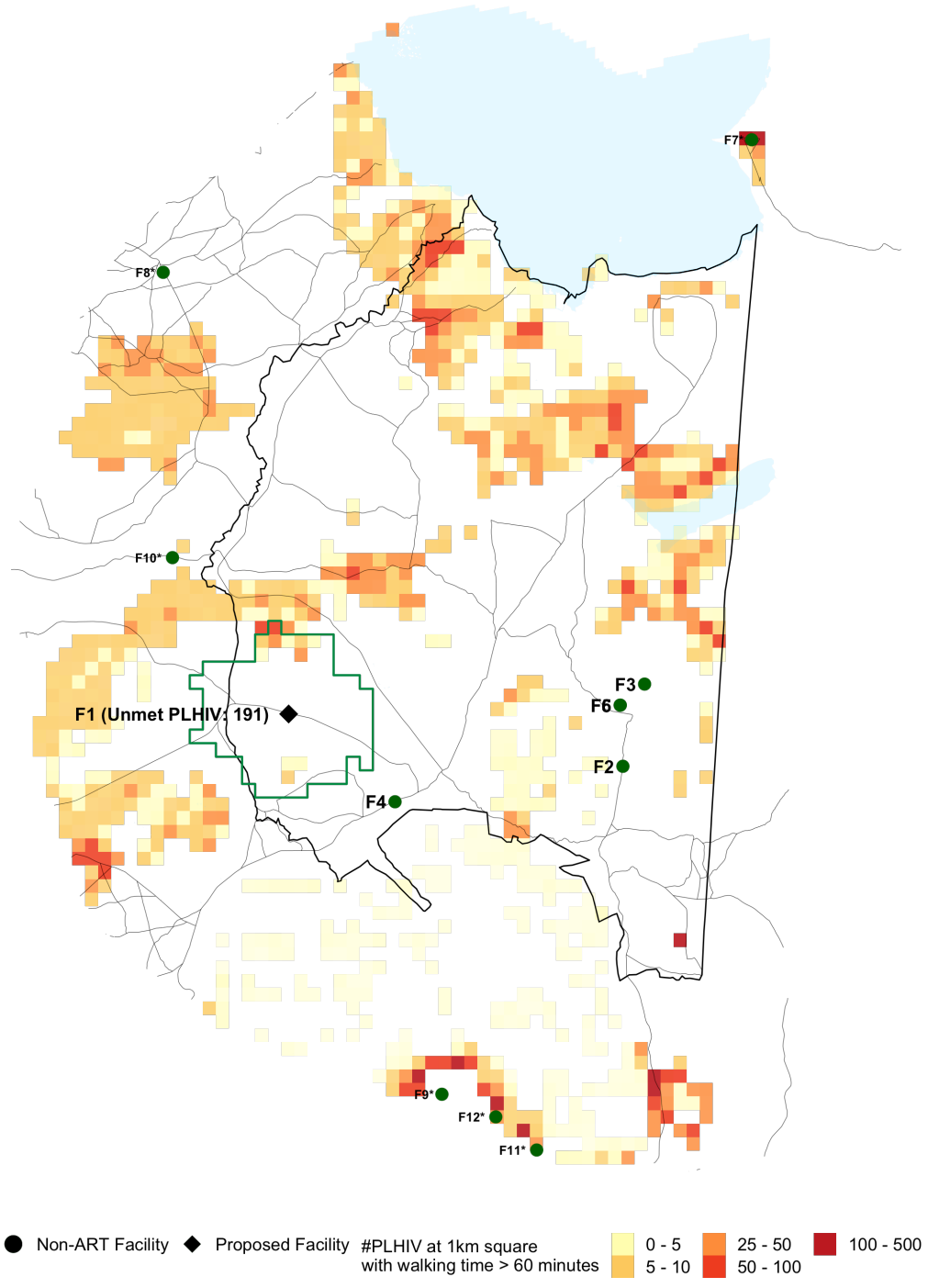


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

Appendix (Methods Summary)

The analysis involved several steps:

1. **Creating a map of spatial prevalence by approximately 1km grid cells.** We used cluster-level survey data from the 2015/16 MDHS and MPHIA household surveys and HIV prevalence amongst ANC clients from routine health facility data to obtain a gridded PLHIV prevalence map (1km grid cells).
2. **Calculate the estimated number of PLHIV in each 1km grid cell.**
   - Modelled estimates of total population by 1km grid cell were sourced from the WorldPop project (https://www.worldpop.org/geodata/summary?id=49698). Gridded populations are constrained to only grid cells containing built settlements based on satellite imagery.
   - Gridded populations were adjusted to match traditional authority (TA) population data from the 2018 household census, projected forward to 2020 based on district population projections.
   - Gridded HIV prevalence (step 1) was multiplied by population for estimates of the distribution of PLHIV by 1km grid cell.
   - The gridded PLHIV in each district were scaled to align to total PLHIV in each district from the from 2020 Naomi model estimates.
3. **Calculate walking travel time for PLHIV to existing ART services.** We used data on land cover terrain type (Global Land Cover 2000), roads (OpenStreetMap), elevation (GMTED2010), and water bodies (NASA Shuttle Radar Topography Mission) to model walking time from each grid cell to 757 public or not-for-profit health facilities providing ART services using the AccessMod software. Walking speed was assumed to be 6-7km/h on roads and 2-3 km/h on non-road surfaces.
4. **Analyse the number and locations of PLHIV residing greater than 60, 90, or 120 minutes walking time from existing ART facilities.** Grid cells were classified by the travel time to the nearest public or not-for-profit ART facility using the travel time model. Maps were filtered for PLHIV residing greater than 60, 90, or 120 minutes, thresholds of interest defined based on discussions with the Department of HIV and AIDS (DHA).
5. **Identify optimal locations to reach the most PLHIV who currently reside greater than 60 or 90 minutes from ART services.** An optimisation algorithm was implemented to systematically select the best facilities and locations where ART service delivery can be introduced to reach the most PLHIV residing outside travel time thresholds.

The list of 757 active facilities currently providing ART services was sourced from DHA-MIS database. Facilities that were private-for-profit were excluded from the analysis of travel time catchments. Health facilities which do not currently provide an ART service, which are candidate locations for expanding ART services, were sourced from facilities visited during the 2018/19 Service Availability and Readiness Assessment (SARA). Candidate facilities included existing health posts which are not staffed full time.