

District overview of travel time to ART facilities: Mzimba South

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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 Mzimba South, September 2020.

Total PLHIV (all ages)	22,018 (18,936–25,604)
HIV prevalence, age 15–49 years	4.8% (4.1%–5.5%)
Total patients receiving ART	41,319
Average walking time to nearest ART (minutes)	62 (60–64)
Number PLHIV > 60 minutes walking time	11,178 (9,487–12,935)
Percentage PLHIV > 60 minutes walking time	50.0% (47.6%–52.6%)

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	STA Levi Jere: 913 (658–1,229)	TA Chindi: 4,839 (3,705–6,137)
15-49 Prevalence	TA Mabulabo: 3.2% (2.3%–4.3%)	Mzimba Boma: 7.8% (5.3%–11.4%)
Average Walking Time	Mzimba Boma: 12 min (12–13 min)	TA Khosolo Gwaza Jere: 77 min (73–81 min)

Travel time to existing ART facilities

In Mzimba South, there are 32 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 290. 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 Mzimba South is 62 minutes (60–64 min).
- The shortest estimated average walking time to the closest ART facility is in Mzimba Boma (12 minutes (12–13 min)).
- The longest estimated average walking time to the closest ART facility is in TA Khosolo Gwaza Jere (77 minutes (73–81 min)).

An estimated 50.0% (47.6%–52.6%) of PLHIV reside more than 60 minutes walking time to their nearest ART facility, compared to 54.4% of the total population. This decreases to 24.5% (22.6%–26.5%) of PLHIV and 26.9% 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	467,224	68.2%	14,164 (12,112–16,300)	63.4% (61.0%–65.7%)
60	372,720	54.4%	11,178 (9,487–12,935)	50.0% (47.6%–52.6%)
90	184,368	26.9%	5,475 (4,625–6,453)	24.5% (22.6%–26.5%)
120	54,914	8.0%	1,631 (1,321–1,980)	7.3% (6.4%–8.3%)

Proposed facilities for new ART services

A list of 8 *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 Chindi (3087 PLHIV (2382-3873) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **Lusangazi Disp.**, with 304 PLHIV (206-415) 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

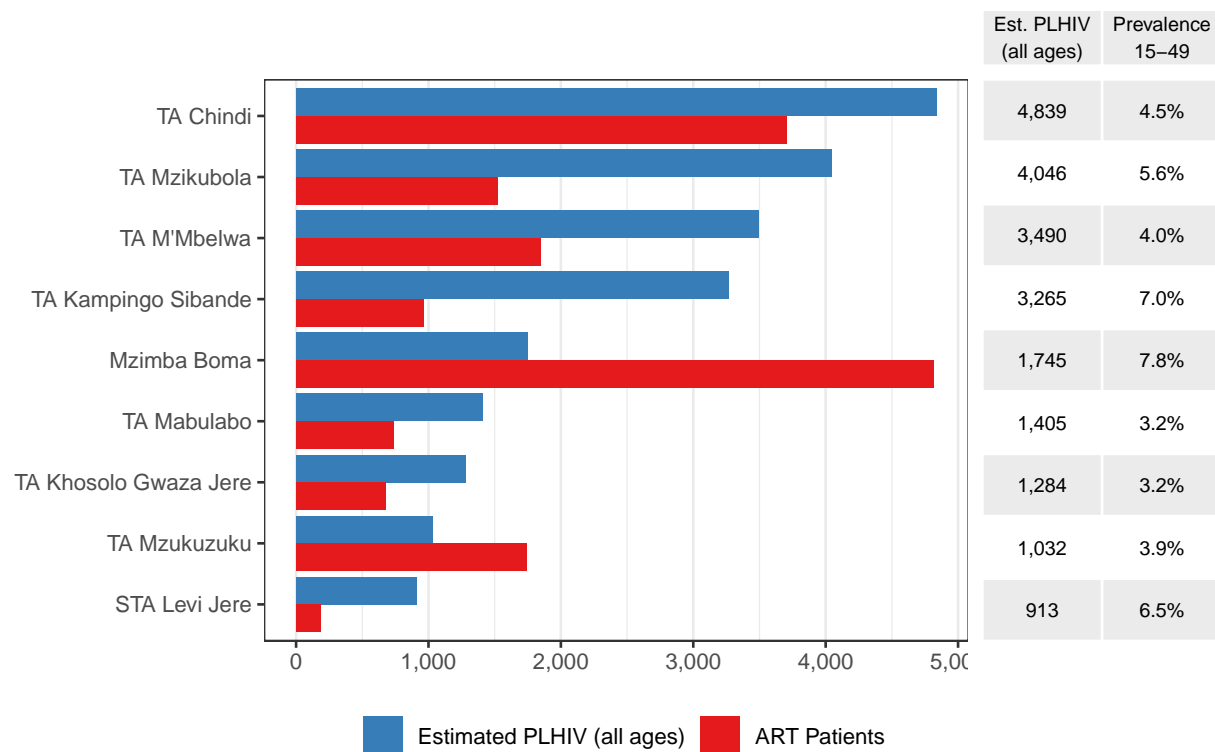


Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

HIV prevalence in ages 15-49

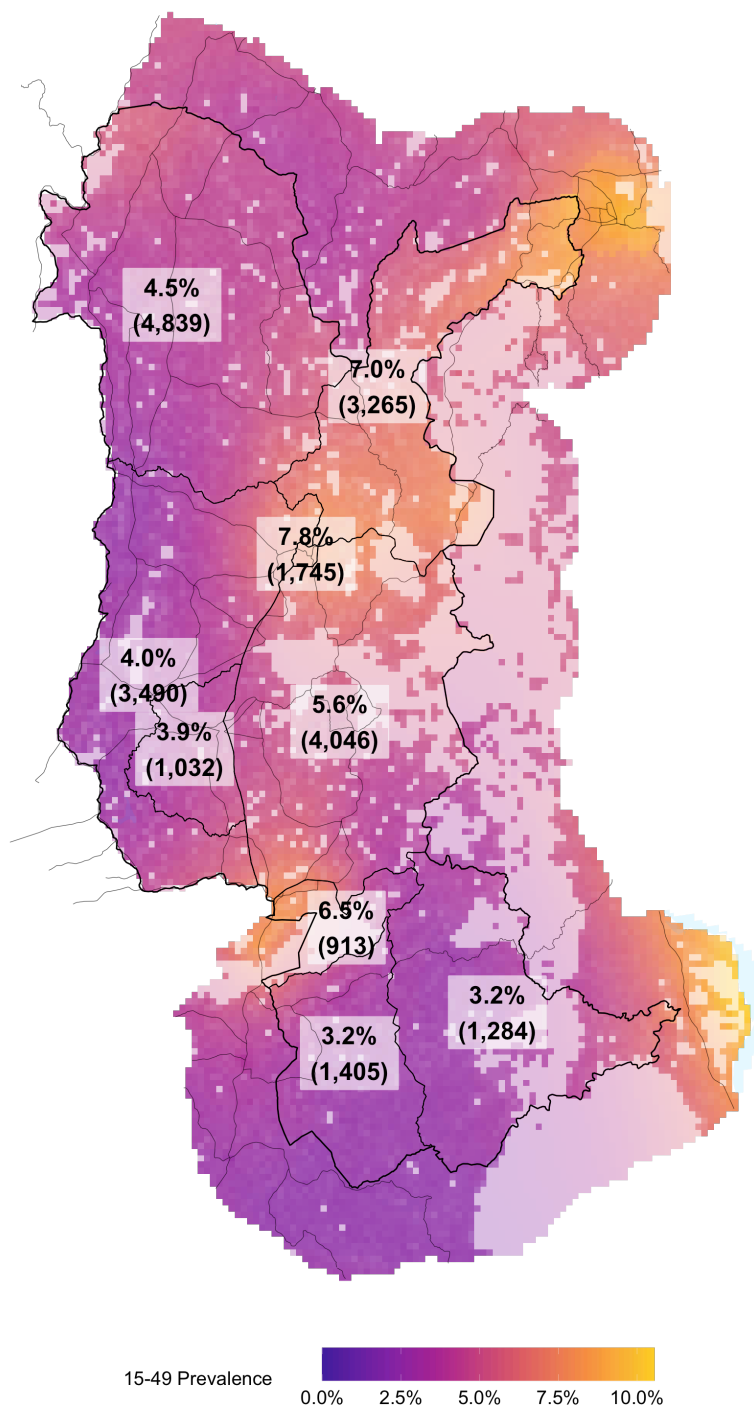


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

Estimated number of PLHIV at 1km square

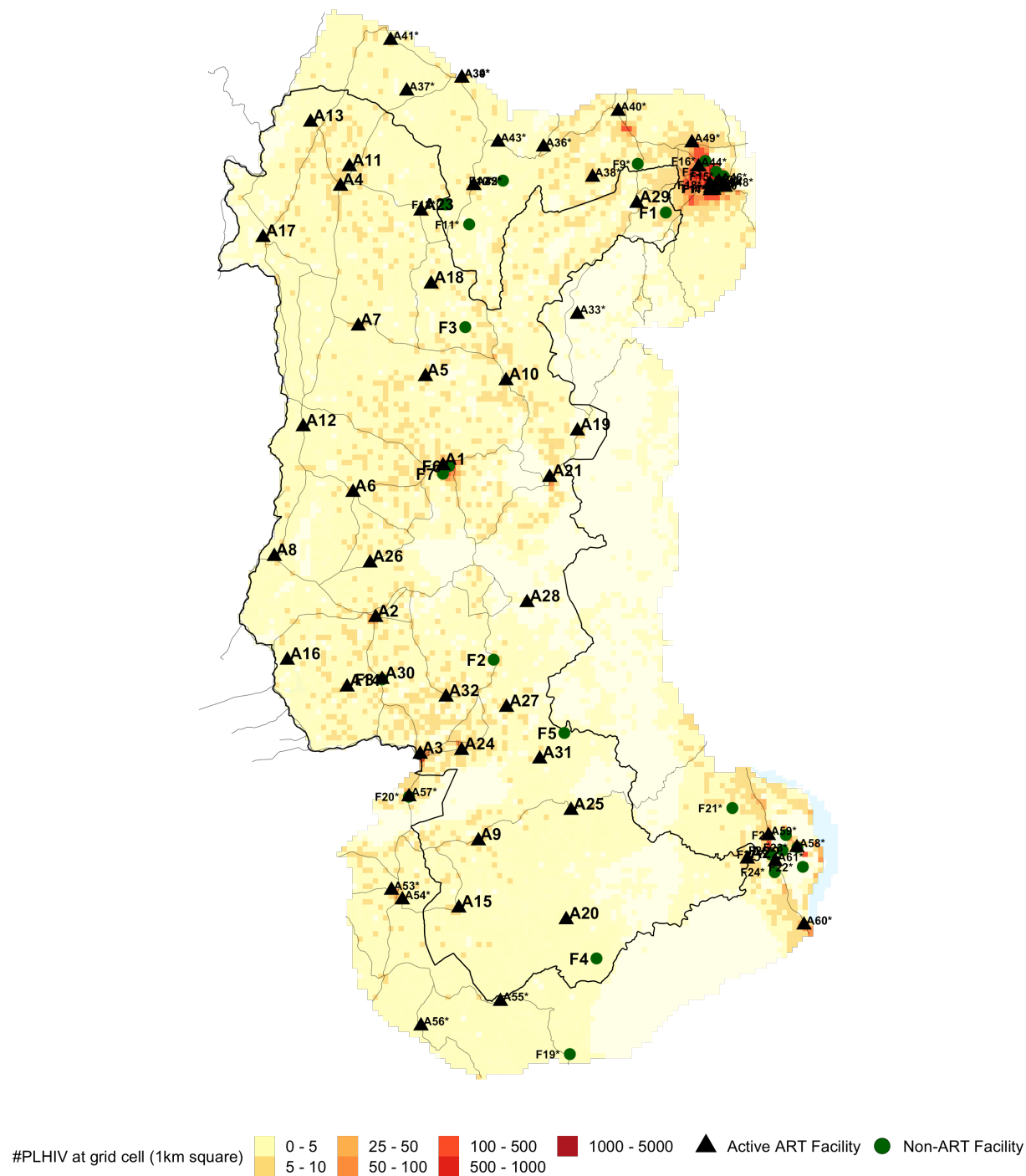


Figure 3: Estimated number of PLHIV on a 1km square.

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	Mzimba South	Mzimba Boma	Mzimba District Hosp.	District hospital	Government	33.58	-11.90	4818
A2	Mzimba South	TA Mzukuzuku	Embangweni Mission Hosp.	District hospital	CHAM	33.48	-12.14	1336
A3	Mzimba South	TA Mzikubola	Jenda HC	Health centre	Government	33.55	-12.35	1235
A4	Mzimba South	TA Chindi	Euthini Community Hosp.	Rural/Community	Government	33.42	-11.46	955
A5	Mzimba South	TA Chindi	Endindeni HC	Health centre	Government	33.56	-11.76	718
A6	Mzimba South	TA M'Mbelwa	Manyamula HC	Health centre	Government	33.44	-11.94	610
A7	Mzimba South	TA Chindi	Bulala HC	Health centre	Government	33.45	-11.68	554
A8	Mzimba South	TA M'Mbelwa	Edingeni HC	Health centre	Government	33.31	-12.04	456
A9	Mzimba South	TA Mbulabo	Luwelezi HC	Health centre	Government	33.64	-12.49	445
A10	Mzimba South	TA Kampingo Sibande	Lunjika HC	Health centre	CHAM	33.69	-11.76	399
A11	Mzimba South	TA Chindi	Mzambazi Community Hosp.	Rural/Community	CHAM	33.43	-11.43	389
A12	Mzimba South	TA M'Mbelwa	Kamteteka HC	Health centre	Government	33.36	-11.84	338
A13	Mzimba South	TA Chindi	Mbalachanda HC	Health centre	Government	33.37	-11.36	338
A14	Mzimba South	TA Mzukuzuku	Mabiri HC	Health centre	CHAM	33.43	-12.25	307
A15	Mzimba South	TA Mbulabo	Emfeni HC	Health centre	Government	33.61	-12.59	295
A16	Mzimba South	TA M'Mbelwa	Kalikumbi HC	Health centre	Government	33.33	-12.20	291
A17	Mzimba South	TA Chindi	Madede HC	Health centre	Government	33.29	-11.54	290
A18	Mzimba South	TA Chindi	Mzalangwe HC	Health centre	Government	33.57	-11.61	273
A19	Mzimba South	TA Kampingo Sibande	Chikangawa HC	Health centre	Other	33.80	-11.84	245
A20	Mzimba South	TA Khosolo Gwaza Jere	Mkoma HC	Health centre	Government	33.78	-12.61	238
A21	Mzimba South	TA Kampingo Sibande	Raiply Clinic	Health centre	Private	33.76	-11.92	216
A22	Mzimba South	TA Khosolo Gwaza Jere	Kabuwa HC	Health centre	Government	34.07	-12.52	214
A23	Mzimba South	TA Chindi	Mtende HC	Health centre	Government	33.55	-11.50	187
A24	Mzimba South	STA Levi Jere	Katimbira HC	Health centre	Government	33.61	-12.35	186
A25	Mzimba South	TA Khosolo Gwaza Jere	Khosolo HC	Health centre	Government	33.79	-12.44	152
A26	Mzimba South	TA M'Mbelwa	Mhalaunda HC	Health centre	Government	33.47	-12.05	151
A27	Mzimba South	TA Mzikubola	Hoho HC	Health centre	Government	33.69	-12.28	128
A28	Mzimba South	TA Mzikubola	Luwawa HC	Health centre	Government	33.72	-12.11	103
A29	Mzimba South	TA Kampingo Sibande	Matuli HC	Health centre	Government	33.90	-11.49	103
A30	Mzimba South	TA Mzukuzuku	Vibangala Disp.	Dispensary	Government	33.49	-12.23	98
A31	Mzimba South	TA Khosolo Gwaza Jere	Msese HC	Health centre	Government	33.74	-12.36	74
A32	Mzimba South	TA Mzikubola	Eehleni Disp.	Dispensary	Government	33.59	-12.26	57
A33*	Nkhatabay	TA Kabunduli	Nthungwa HC	Health centre	Government	33.80	-11.66	155
A34*	Mzimba North	TA Mpherembe	Mpherembe HC	Health centre	Government	33.61	-11.29	813
A35*	Mzimba North	TA Mtwalo	Kafukule HC	Health centre	Government	33.63	-11.46	528
A36*	Mzimba North	TA Mtwalo	Mtwalo HC	Health centre	Government	33.75	-11.40	286
A37*	Mzimba North	TA Mpherembe	Kabwafu HC	Health centre	Government	33.53	-11.31	266
A38*	Mzimba North	TA Mtwalo	Emsizini HC	Health centre	Private	33.82	-11.44	222
A39*	Mzimba North	TA Mpherembe	Manolo HC	Health centre	Government	33.61	-11.29	211
A40*	Mzimba North	TA Mtwalo	Kaweche HC	Health centre	Government	33.87	-11.34	199
A41*	Mzimba North	TA Mpherembe	Malidadi HC	Health centre	Government	33.50	-11.23	166
A42*	Mzimba North	TA Mtwalo	Njuyu HC	Health centre	Government	33.63	-11.46	145

A43*	Mzimba North	TA Mtwalo	Luvwere HC	Health centre	Government	33.67	-11.39	139
A44*	Mzuzu City	Luwinga Ward	Mzuzu Central Hosp.	Central hospital	Government	34.00	-11.43	5402
A45*	Mzuzu City	Masasa Ward	Mzuzu HC	Health centre	Government	34.01	-11.46	3877
A46*	Mzuzu City	Katawa Ward	St John's Mission Hosp.	District hospital	CHAM	34.03	-11.45	2781
A47*	Mzuzu City	Masasa Ward	MACRO Mzuzu	Special	NGO	34.01	-11.47	2729
A48*	Mzuzu City	Jombo - Kaning'ina Ward	Moyale Barracks HC	Special	Other	34.04	-11.46	672
A49*	Mzuzu City	Nkhorongo - Lupaso Ward	Nkhorongo HC	Health centre	CHAM	33.98	-11.39	425
A50*	Mzuzu City	Masasa Ward	Mzuzu Central Prison	Special	Other	34.02	-11.46	179
A51*	Mzuzu City	Masasa Ward	FPAM Clinic Mzuzu	Health centre	NGO	34.02	-11.46	125
A52*	Mzuzu City	Jombo - Kaning'ina Ward	St John of God Clinic	Special	CHAM	34.01	-11.46	84
A53*	Kasungu	TA Kaluluma	Nkhamenya Community Hosp.	District hospital	CHAM	33.50	-12.57	854
A54*	Kasungu	TA Kaluluma	Kaluluma Rural Hosp.	Rural/Community	Government	33.52	-12.58	593
A55*	Kasungu	TA Simlemba	Simulemba HC	Health centre	Government	33.68	-12.74	396
A56*	Kasungu	STA M'nyanja	Ofesi Disp.	Health centre	Government	33.55	-12.78	231
A57*	Kasungu	STA Chisikwa	Lodjwa HC	Health centre	Government	33.53	-12.42	140
A58*	Nkhotakota	TA Kanyenda	Dwangwa Matiki Clinic	Special	Private	34.15	-12.50	1636
A59*	Nkhotakota	TA Kanyenda	Nkhunga HC	Health centre	Government	34.11	-12.48	1066
A60*	Nkhotakota	TA Kanyenda	Liwaladzi HC	Health centre	CHAM	34.17	-12.62	489
A61*	Nkhotakota	TA Kanyenda	Dwangwa Cane Growers Association Clinic	Health centre	Private	34.12	-12.52	311

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	Mzimba South	TA Kampingo Sibande	Lusangazi Disp.	Dispensary	Government	33.94	-11.50	304	(206-415)
F2	Mzimba South	TA Mzikubola	LUVIRI	Health Post	Government	33.67	-12.20	231	(130-360)
F3	Mzimba South	TA Kampingo Sibande	MPHOFWA	Health Post	Government	33.62	-11.68	210	(137-304)
F4	Mzimba South	TA Khosolo Gwaza Jere	MGOZA	Health Post	Government	33.83	-12.67	116	(61-192)
F5	Mzimba South	TA Khosolo Gwaza Jere	LUPACHI	Health Post	Government	33.78	-12.32	48	(26-79)
F6	Mzimba South	Mzimba Boma	BLM Mzimba	Special	NGO	33.59	-11.90	29	(18-41)
F7	Mzimba South	Mzimba Boma	Mzimba Prison	Special	Other	33.58	-11.91	24	(16-34)
F8	Mzimba South	TA Mzukuzuku	Vibangalala HC	Health Centre	Government	33.49	-12.23	0	(0-0)
F9*	Mzimba North	TA Mtwalo	Ekwaiweni Disp.	Dispensary	Government	33.90	-11.42	206	(143-281)
F10*	Mzimba North	TA Mtwalo	KAPANGAMAWAWE	Health Post	Government	33.68	-11.45	90	(56-133)
F11*	Mzimba North	TA Mtwalo	GOWOKA	Health Post	Government	33.63	-11.52	81	(52-124)
F12*	Mzimba North	TA Mtwalo	ST ANNE'S	Health Post	Government	33.59	-11.49	42	(28-60)
F13*	Mzuzu City	Zolozolo East Ward	Zolozolo HP	Health Post	Government	34.02	-11.44	6	(4-8)
F14*	Mzuzu City	Masasa Ward	Escom, Mzuzu	Clinic	Government	34.02	-11.46	0	(0-0)
F15*	Mzuzu City	Katawa Ward	Mary Mount Clinic	Clinic	CHAM	34.04	-11.44	6	(4-8)
F16*	Mzuzu City	Luwinga Ward	Mzuzu Sobo Clinic	Clinic	Company	34.01	-11.42	0	(0-0)
F17*	Mzuzu City	Jombo - Kaning'ina Ward	Mzuzu Police Clinic	Special	Other	34.02	-11.46	0	(0-0)
F18*	Mzuzu City	Jombo - Kaning'ina Ward	BLM Mzuzu	Special	NGO	34.02	-11.46	0	(0-0)

F19*	Kasungu	TA Wimbe	Kapyanga HP	Health Post	Government	33.79	-12.82	169	(95-284)
F20*	Kasungu	STA Chisikwa	Livwezi HC	Health Centre	Government	33.53	-12.42	0	(0-0)
F21*	Nkhotakota	TA Kanyenda	Kawongozi HC	Health Centre	Government	34.05	-12.44	268	(176-384)
F22*	Nkhotakota	TA Kanyenda	Ukasi Clinic	Clinic	Company	34.16	-12.53	156	(107-220)
F23*	Nkhotakota	TA Kanyenda	Matiki HC	Health Centre	Private	34.15	-12.50	80	(52-117)
F24*	Nkhotakota	TA Kanyenda	Kasasa Clinic	Clinic	Company	34.12	-12.54	65	(43-94)
F25*	Nkhotakota	TA Kanyenda	Nyamvuu Clinic	Clinic	Company	34.14	-12.48	25	(17-35)
F26*	Nkhotakota	TA Kanyenda	Central 3 Clinic	Clinic	Company	34.13	-12.50	0	(0-0)
F27*	Nkhotakota	TA Kanyenda	BLM Dwangwa	Special	NGO	34.11	-12.51	0	(0-0)

Travel Times to Closest ART Facilities

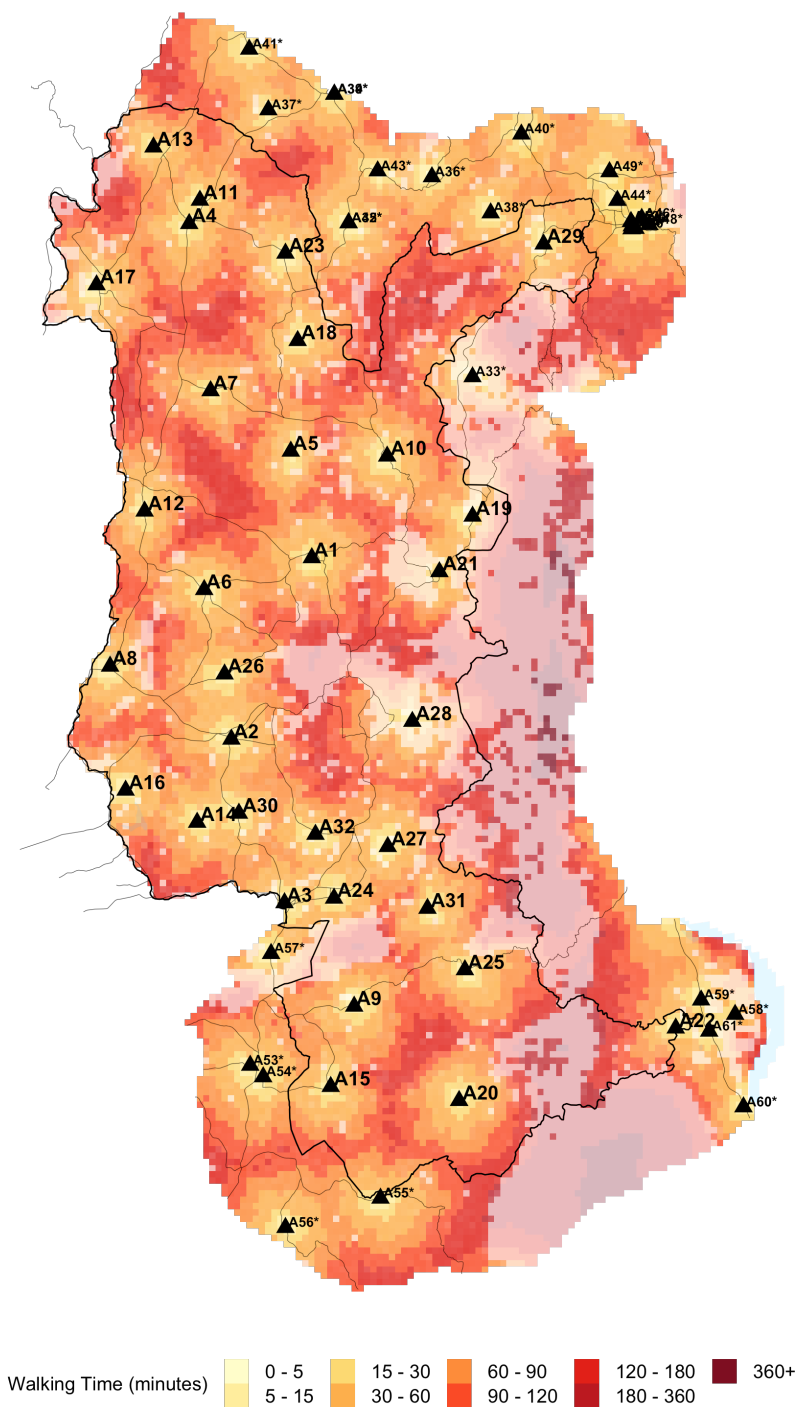


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.

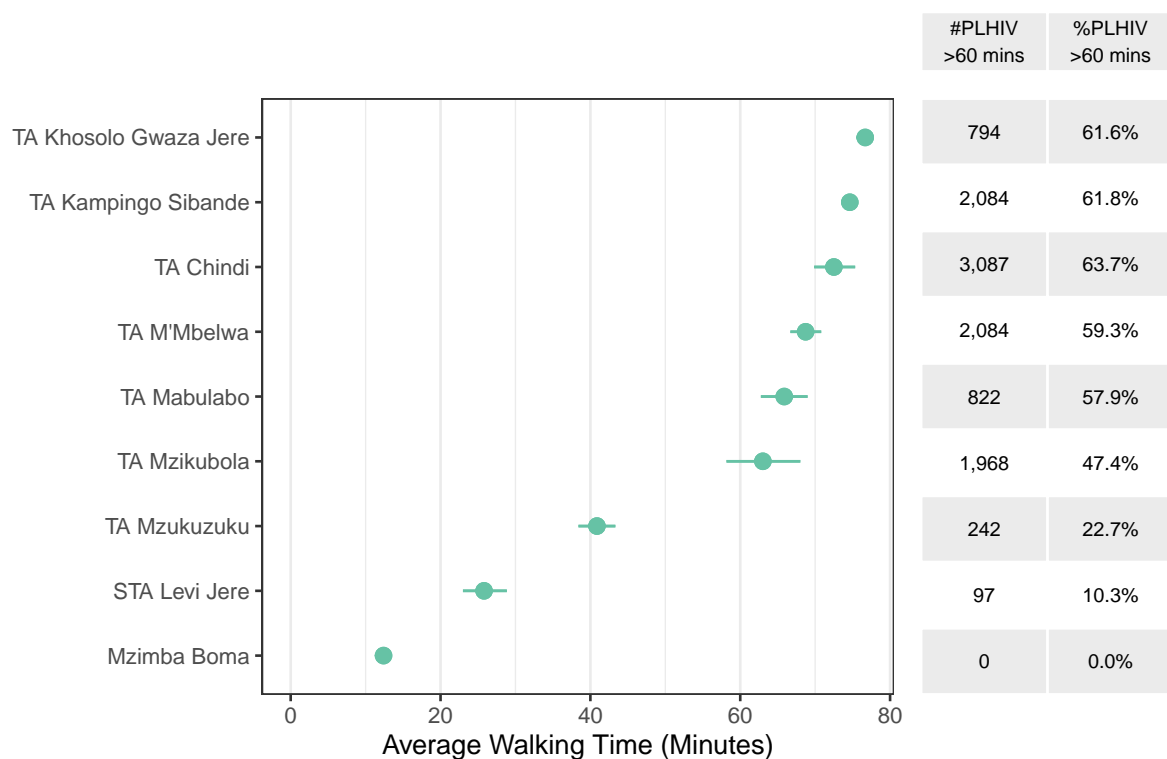


Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

Areas outside 60 minutes travel

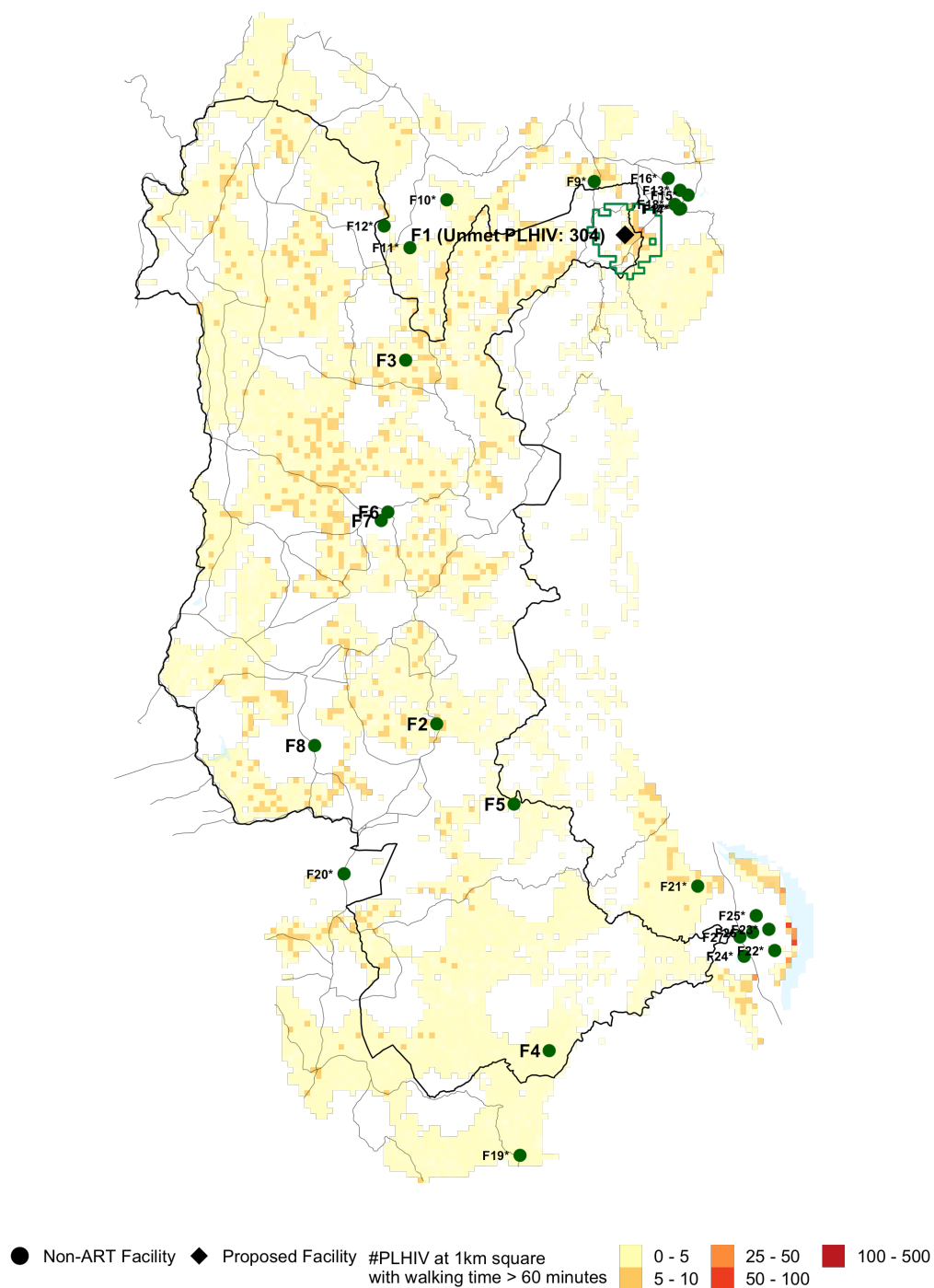


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

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 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.