

District overview of travel time to ART facilities: Chiradzulu

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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 Chiradzulu, September 2020.

Total PLHIV (all ages)	31,154 (27,507–35,017)
HIV prevalence, age 15–49 years	12.1% (10.7%–13.6%)
Total patients receiving ART	166,244
Average walking time to nearest ART (minutes)	35 (34–35)
Number PLHIV > 60 minutes walking time	3,164 (2,761–3,644)
Percentage PLHIV > 60 minutes walking time	10.3% (9.4%–11.2%)

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	Chiradzulu Boma: 291 (229–363)	TA Likoswe: 6,514 (5,264–7,849)
15-49 Prevalence	TA Nchemba: 10.4% (8.2%–13.0%)	TA Nkalo: 13.6% (11.1%–16.4%)
Average Walking Time	Chiradzulu Boma: 6 min (6–6 min)	TA Nchemba: 45 min (44–45 min)

Travel time to existing ART facilities

In Chiradzulu, there are 15 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 2680. 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 Chiradzulu is 35 minutes (34–35 min).
- The shortest estimated average walking time to the closest ART facility is in Chiradzulu Boma (6 minutes (6–6 min)).
- The longest estimated average walking time to the closest ART facility is in TA Nchemba (45 minutes (44–45 min)).

An estimated 10.3% (9.4%–11.2%) of PLHIV reside more than 60 minutes walking time to their nearest ART facility, compared to 10.0% of the total population. This decreases to 0.3% (0.2%–0.3%) of PLHIV and 0.2% 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	104,742	28.3%	8,744 (7,720–9,806)	28.4% (27.2%–29.7%)
60	36,924	10.0%	3,164 (2,761–3,644)	10.3% (9.4%–11.2%)
90	889	0.2%	82 (66–103)	0.3% (0.2%–0.3%)
120	0	0.0%	0 (0–0)	0.0% (0.0%–0.0%)

Proposed facilities for new ART services

A list of 5 *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 Mpama (858 PLHIV (692-1060) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **NJULI**, with 1791 PLHIV (1451-2191) 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

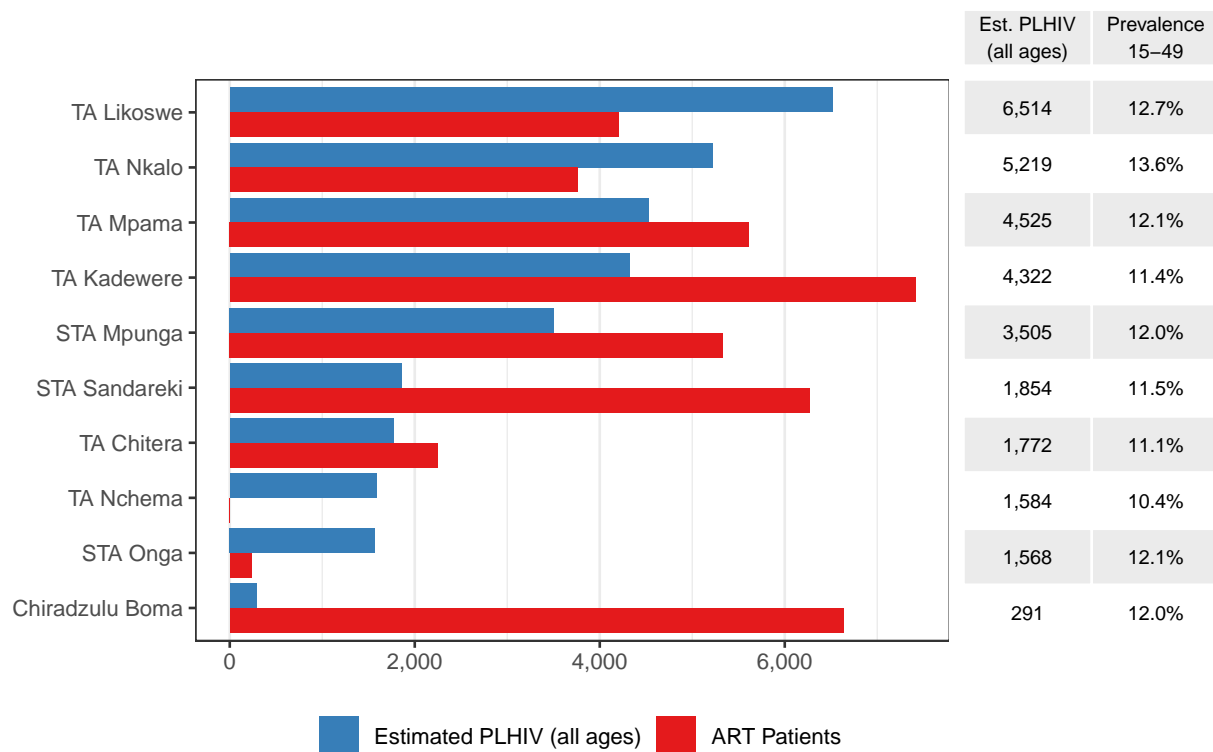


Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

HIV prevalence in ages 15-49

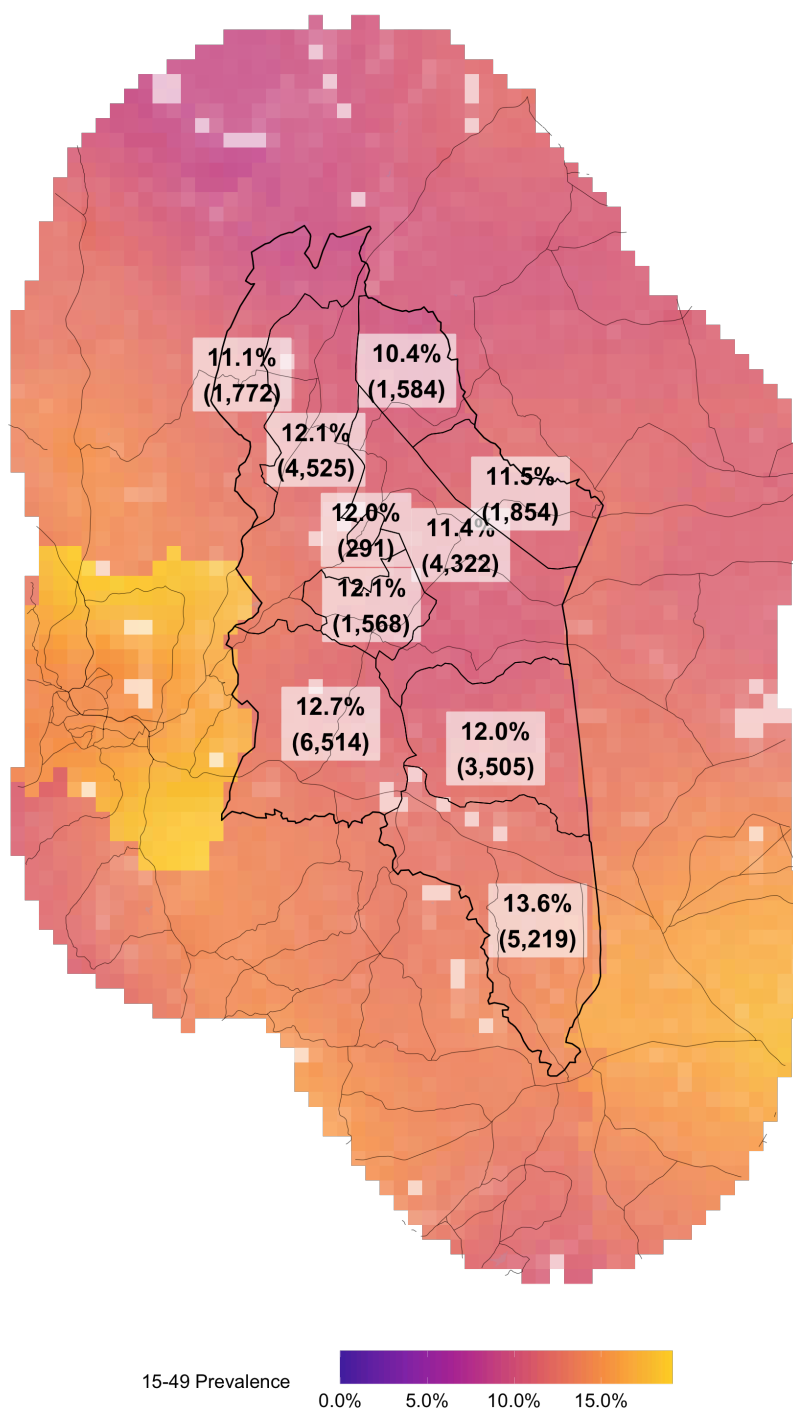


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

Estimated number of PLHIV at 1km square

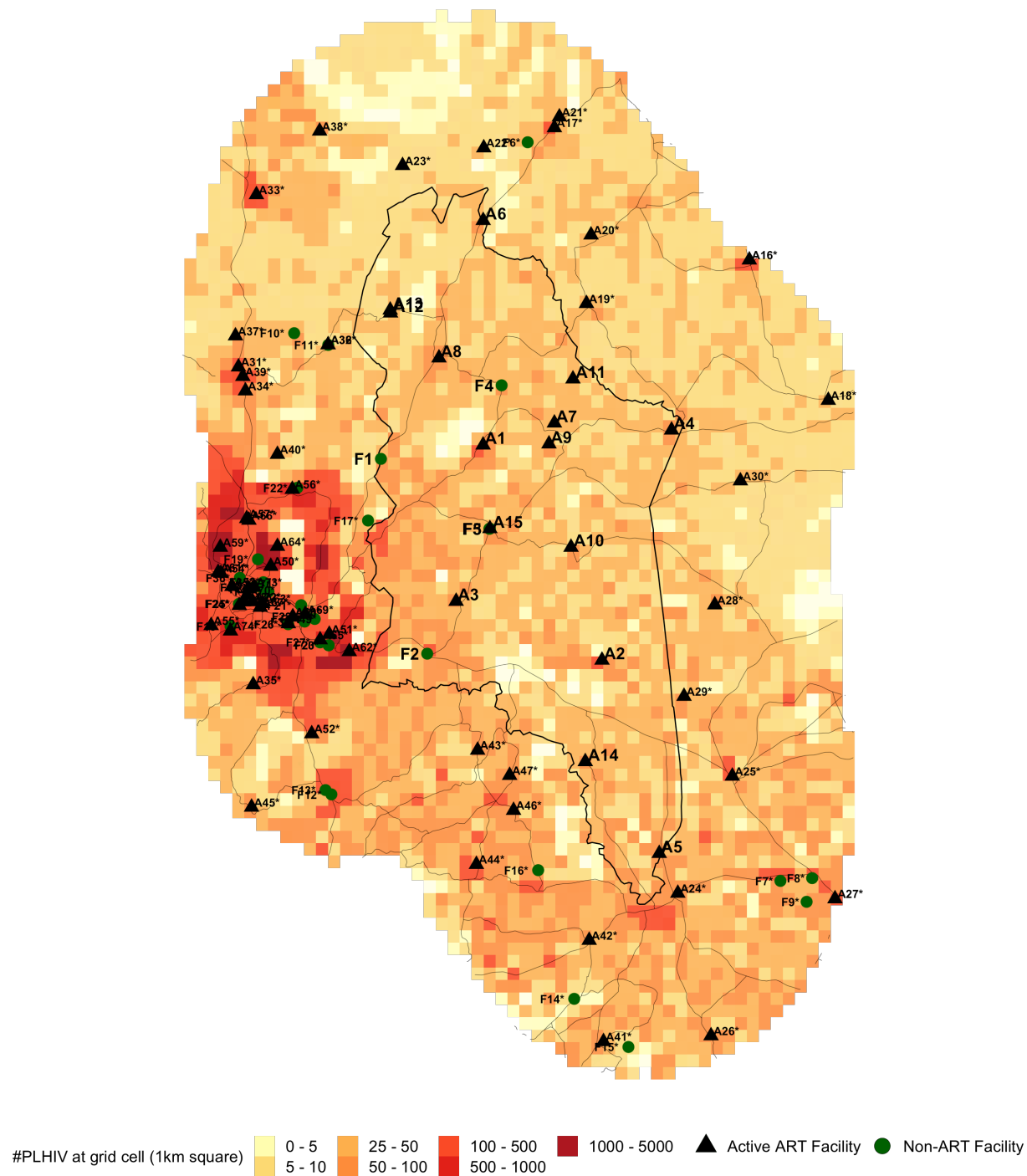


Figure 3: Estimated number of PLHIV on a 1km square.

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	Chiradzulu	Chiradzulu Boma	Chiradzulu District Hosp.	District hospital	Government	35.19	-15.70	6637
A2	Chiradzulu	STA Mpunga	Namitambo HC	Health centre	Government	35.27	-15.84	5334
A3	Chiradzulu	TA Likoswe	St Joseph Mission Hospital Nguludi	District hospital	CHAM	35.17	-15.80	4204
A4	Chiradzulu	STA Sandareki	Milepa HC	Health centre	Government	35.32	-15.69	3946
A5	Chiradzulu	TA Nkalo	Nkalo HC	Health centre	Government	35.31	-15.97	3277
A6	Chiradzulu	TA Mpama	Namadzi HC	Health centre	Government	35.19	-15.55	2934
A7	Chiradzulu	TA Kadewere	Chileka HC Blantyre	Health centre	Government	35.24	-15.68	2686
A8	Chiradzulu	TA Mpama	Mbulumbuzi HC	Health centre	Government	35.16	-15.64	2680
A9	Chiradzulu	TA Kadewere	Ndunde HC	Health centre	Government	35.23	-15.70	2390
A10	Chiradzulu	TA Kadewere	Thumbwe HC	Health centre	Government	35.25	-15.77	2338
A11	Chiradzulu	STA Sandareki	Mauwa HC	Health centre	Government	35.25	-15.65	2323
A12	Chiradzulu	TA Chitera	Chimvu HC	Health post	Government	35.12	-15.61	1169
A13	Chiradzulu	TA Chitera	Chitera HC	Health centre	Government	35.12	-15.61	1076
A14	Chiradzulu	TA Nkalo	Chimwawa HC	Health centre	Government	35.26	-15.91	481
A15	Chiradzulu	STA Onga	PIM HC	Health centre	CHAM	35.19	-15.75	236
A16*	Zomba	TA Mbiza	Mayaka HC	Health centre	CHAM	35.37	-15.57	2134
A17*	Zomba	TA Mlumbe	Thondwe HC	Health centre	Government	35.24	-15.48	1878
A18*	Zomba	STA Ngweleru	Ngweleru HC	Health centre	Government	35.43	-15.67	1508
A19*	Zomba	STA Ntholowa	Nasawa HC	Health centre	Government	35.26	-15.60	1234
A20*	Zomba	STA Ntholowa	Magomero HC	Health centre	CHAM	35.26	-15.56	1221
A21*	Zomba	TA Mlumbe	Namikango HC	Health centre	CHAM	35.24	-15.48	898
A22*	Zomba	TA Mlumbe	Mwandama HC	Health centre	Government	35.19	-15.50	484
A23*	Zomba	TA Mlumbe	Maera HC	Health centre	Government	35.13	-15.51	256
A24*	Mulanje	TA Nthiramanja	Chonde HC	Health centre	Government	35.32	-16.00	4064
A25*	Mulanje	TA Juma	Thuchila HC	Health centre	Government	35.36	-15.92	3940
A26*	Mulanje	TA Chikumbu	Mbiza HC	Health centre	Government	35.35	-16.09	2476
A27*	Mulanje	TA Chikumbu	Chisitu HC	Health centre	Government	35.43	-16.00	2229
A28*	Mulanje	TA Juma	Namphungo HC	Health centre	Government	35.35	-15.80	1157
A29*	Mulanje	TA Juma	Namulenga HC	Health centre	CHAM	35.33	-15.87	1155
A30*	Mulanje	TA Juma	Mkomaola HC	Health centre	Government	35.37	-15.72	478
A31*	Blantyre	TA Kapeni	Mlambe Mission Hosp.	District hospital	CHAM	35.02	-15.64	6690
A32*	Blantyre	TA Makata	Makhetha Clinic	Dispensary	Government	35.08	-15.63	1729
A33*	Blantyre	TA Lundu	Lirangwe HC	Health centre	Government	35.03	-15.53	1714
A34*	Blantyre	TA Kapeni	Kadidi HC	Health centre	Government	35.02	-15.66	1412
A35*	Blantyre	TA Somba	Soche Mat.	Special	Government	35.03	-15.86	789
A36*	Blantyre	TA Makata	Makata HC Lunzu	Health centre	Government	35.08	-15.63	760
A37*	Blantyre	TA Kapeni	Kapeni Dream Centre	Health centre	NGO	35.02	-15.62	483
A38*	Blantyre	TA Lundu	Namikoko HC	Dispensary	Government	35.07	-15.49	466
A39*	Blantyre	TA Kapeni	BLM Lunzu	Special	NGO	35.02	-15.65	446
A40*	Blantyre	TA Machinjiri	AMECCA Chilaweni HC	Health centre	Government	35.04	-15.70	170
A41*	Thyolo	TA Kapichi	Khonjeni HC	Health centre	Government	35.27	-16.10	4188
A42*	Thyolo	TA Nanseta	Mangunda HC	Health centre	Government	35.26	-16.03	3225
A43*	Thyolo	TA Chimaliro	Mikolongwe HC	Health centre	Government	35.18	-15.90	2393
A44*	Thyolo	TA Chimaliro	Chimaliro HC	Health centre	Government	35.18	-15.98	2386
A45*	Thyolo	TA Bvumbwe	Makungwa HC	Health centre	Government	35.03	-15.94	1811
A46*	Thyolo	TA Chimaliro	Chisoka HC	Health centre	Government	35.21	-15.94	1512
A47*	Thyolo	TA Chimaliro	Chingazi HC	Health centre	CHAM	35.21	-15.92	648
A48*	Blantyre City	Soche East Ward	Queen Elizabeth Central Hosp.	Central hospital	Government	35.02	-15.80	15053

A49*	Blantyre City	Limbe Central Ward	Limbe HC	Health centre	Government	35.05	-15.82	7758
A50*	Blantyre City	Ndirande Matope Ward	Ndirande HC	Health centre	Government	35.04	-15.78	6254
A51*	Blantyre City	Bangwe Mthandizi Ward	Bangwe HC	Health centre	Government	35.08	-15.82	6030
A52*	Blantyre City	Chigumula Ward	Bvumbwe Research HC	Health centre	Government	35.07	-15.89	5391
A53*	Blantyre City	Blantyre City Centre Ward	Blantyre Dream Project	Special	NGO	35.01	-15.79	4770
A54*	Blantyre City	Mbayani Ward	MACRO Blantyre	Special	NGO	35.01	-15.78	4435
A55*	Blantyre City	Blantyre South Ward	Zingwangwa HC	Health centre	Government	35.00	-15.82	3524
A56*	Blantyre City	South Lunzu Ward	South Lunzu HC	Health centre	Government	35.05	-15.73	2974
A57*	Blantyre City	Michiru Ward	Chirimba HC	Health centre	Government	35.02	-15.75	2236
A58*	Blantyre City	Soche East Ward	Gateway Clinic	Dispensary	Government	35.02	-15.80	1545
A59*	Blantyre City	Mbayani Ward	Mbayani HC	Health centre	Government	35.00	-15.77	1330
A60*	Blantyre City	Limbe Central Ward	MASM Medi Clinic Limbe	Special	Private	35.06	-15.81	1324
A61*	Blantyre City	Mbayani Ward	Blantyre Adventist Hosp.	District hospital	CHAM	35.00	-15.78	1228
A62*	Blantyre City	Namiyango Ward	Umunthu Foundation Clinic	Special	NGO	35.09	-15.84	953
A63*	Blantyre City	Soche East Ward	Blantyre City Assembly Clinic	Special	Government	35.03	-15.80	855
A64*	Blantyre City	Ndirande Makata Ward	Malabada HC	Health centre	CHAM	35.04	-15.76	635
A65*	Blantyre City	Bangwe Mthandizi Ward	Bangwe Madina HC	Health centre	CHAM	35.07	-15.83	593
A66*	Blantyre City	South Lunzu Ward	MACRO Chirimba	Special	NGO	35.02	-15.75	343
A67*	Blantyre City	Soche East Ward	Chichiri Prison Clinic	Health centre	Government	35.03	-15.81	337
A68*	Blantyre City	Limbe Central Ward	Kanjedza Police Clinic	Dispensary	Other	35.06	-15.81	259
A69*	Blantyre City	Limbe Central Ward	Soche Adventist HC	Health centre	CHAM	35.06	-15.81	225
A70*	Blantyre City	Namalimwe Ward	Pace Clinic	Special	Private	35.02	-15.80	211
A71*	Blantyre City	Namalimwe Ward	Chichiri ESCOM Clinic	Special	Private	35.02	-15.79	172
A72*	Blantyre City	Soche East Ward	Polytechnic Blantyre	Special	Other	35.03	-15.80	90
A73*	Blantyre City	Namalimwe Ward	Lafarge Cement Clinic	Special	Private	35.03	-15.79	74
A74*	Blantyre City	Soche West Ward	Nancholi Youth Organisation Clinic	Special	NGO	35.01	-15.82	

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	Chiradzulu	TA Mpama	NJULI	Health Post	Government	35.12	-15.71	1791	(1451-2191)
F2	Chiradzulu	TA Likoswe	Malavi Disp.	Dispensary	Government	35.15	-15.84	3	(2-4)
F3	Chiradzulu	STA Onga	Providence Industrial Mission HC	Health Centre	CHAM	35.19	-15.75	0	(0-0)
F4	Chiradzulu	TA Kadewere	Mwanje DAPP Clinic	Special	NGO	35.20	-15.66	0	(0-0)
F5	Chiradzulu	STA Onga	P.I.M HC	Special	Government	35.19	-15.75	0	(0-0)
F6*	Zomba	TA Mlumbe	Thondwe Pastoral Centre	Health Centre	CHAM	35.22	-15.49	0	(0-0)
F7*	Mulanje	TA Chikumbu	KHAYA	Health Post	CHAM	35.39	-15.99	595	(461-752)

F8*	Mulanje	TA Chikumbu	LUWANJE	Health Post	CHAM	35.42	-15.99	552	(438-677)
F9*	Mulanje	TA Chikumbu	MSITHE	Health Post	CHAM	35.41	-16.00	336	(261-424)
F10*	Blantyre	TA Kapeni	Aquid Lifeline Project	Clinic	NGO	35.06	-15.62	73	(53-96)
F11*	Blantyre	TA Makata	Makata Dispensary Ndirande	Health Centre	Government	35.08	-15.63	0	(0-0)
F12*	Thyolo	TA Bvumbwe	BLM Bvumbwe	Special	NGO	35.08	-15.93	1407	(1106-1747)
F13*	Thyolo	TA Bvumbwe	Bvumbwe HC	Health Centre	Government	35.08	-15.93	1320	(1036-1635)
F14*	Thyolo	TA Kapichi	Mafisi HC	Clinic	Company	35.25	-16.07	144	(110-183)
F15*	Thyolo	TA Kapichi	Kumadzi Disp.	Dispensary	Company	35.29	-16.10	29	(23-37)
F16*	Thyolo	TA Ngolongoliwa	SAMU	Health Post	Government	35.23	-15.98	0	(0-0)
F17*	Blantyre City	Mapanga Ward	Amitofo Care Centre	Clinic	NGO	35.11	-15.75	1852	(1483-2287)
F18*	Blantyre City	Soche West Ward	BLM Zingwangwa	Special	NGO	35.01	-15.82	0	(0-0)
F19*	Blantyre City	Ndirande Gamulani Ward	BLM Ndirande	Special	NGO	35.03	-15.77	0	(0-0)
F20*	Blantyre City	Bangwe Mthandizi Ward	BLM Midima	Special	NGO	35.08	-15.83	0	(0-0)
F21*	Blantyre City	Limbe Central Ward	Unilever South East Company Clinic	Special	Private	35.06	-15.80	0	(0-0)
F22*	Blantyre City	South Lunzu Ward	Sos Childrens Village Blantyre	Health Centre	NGO	35.06	-15.73	0	(0-0)
F23*	Blantyre City	Bangwe Mthandizi Ward	BLM Bangwe	Special	NGO	35.08	-15.83	0	(0-0)
F24*	Blantyre City	Soche East Ward	Beit trust Cure International	Other Hospital	CHAM	35.02	-15.80	0	(0-0)
F25*	Blantyre City	Soche East Ward	Kachere Rehabilitation Centre	Other Hospital	NGO	35.02	-15.80	0	(0-0)
F26*	Blantyre City	Limbe Central Ward	Limbe Home Based Care Centre	Clinic	NGO	35.05	-15.82	0	(0-0)
F27*	Blantyre City	Bangwe Mthandizi Ward	Madinah Social Services Clinic	Clinic	NGO	35.07	-15.83	0	(0-0)
F28*	Blantyre City	Bangwe Mthandizi Ward	Auction Holdings Clinic	Clinic	Company	35.06	-15.81	0	(0-0)
F29*	Blantyre City	Ndirande Matope Ward	Blantyre Water Board - Mudi	Clinic	Company	35.04	-15.80	0	(0-0)
F30*	Blantyre City	Namalinwe Ward	Carlsberg Brewery Malawi Ltd.	Clinic	Company	35.03	-15.79	0	(0-0)
F31*	Blantyre City	Bangwe Mthandizi Ward	Central East African Railways	Clinic	Company	35.06	-15.82	0	(0-0)
F32*	Blantyre City	Namalinwe Ward	David Whitehead	Clinic	Company	35.03	-15.79	0	(0-0)
F33*	Blantyre City	Namalinwe Ward	Henred Fruehauf Clinic	Clinic	Company	35.03	-15.79	0	(0-0)
F34*	Blantyre City	Bangwe Mthandizi Ward	Limbe Leaf Tobacco Clinic	Clinic	Company	35.07	-15.81	0	(0-0)
F35*	Blantyre City	Namalinwe Ward	Limb Portland	Clinic	Company	35.03	-15.79	0	(0-0)
F36*	Blantyre City	Namalinwe Ward	PVHO	Clinic	Government	35.02	-15.79	0	(0-0)

Travel Times to Closest ART Facilities

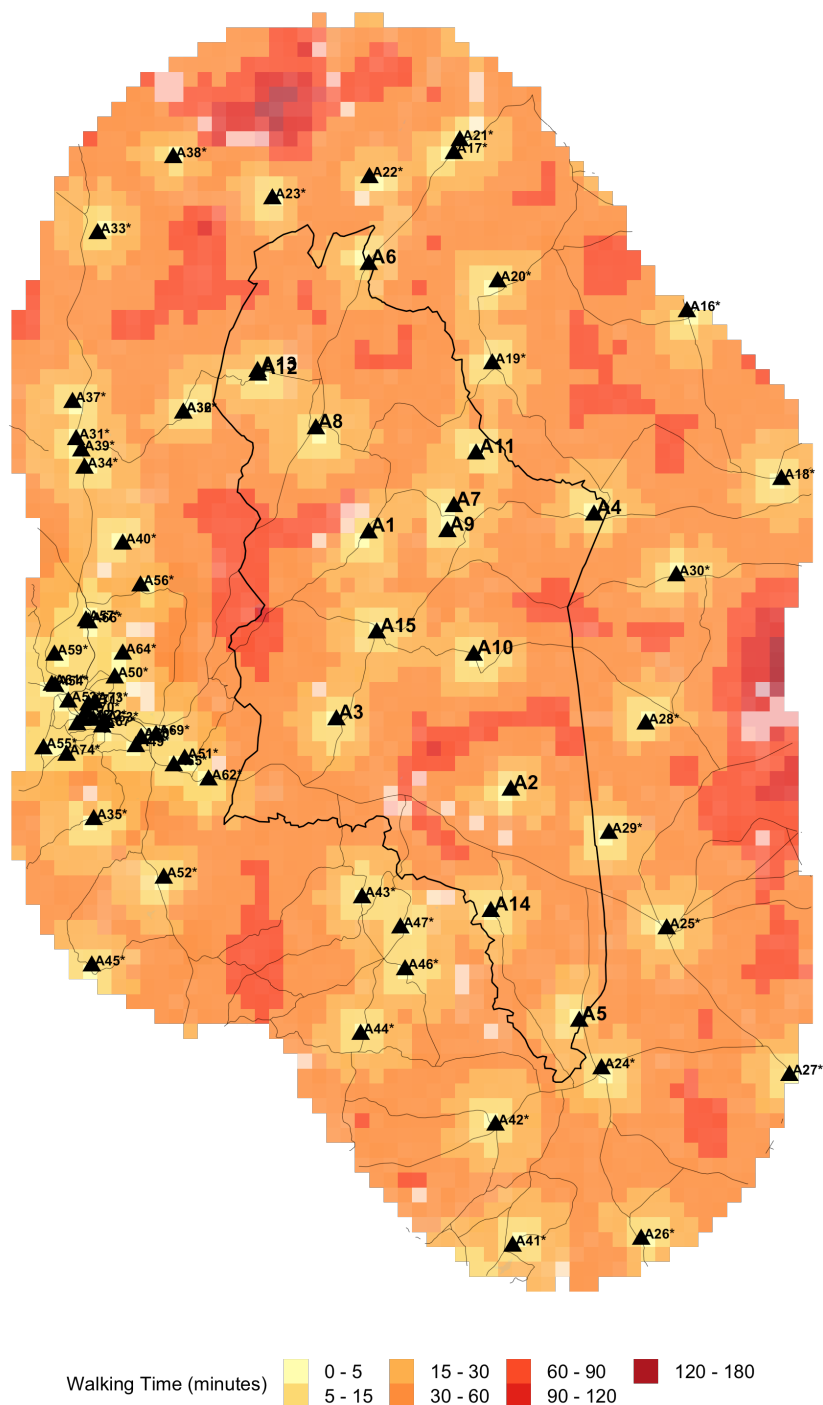


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.

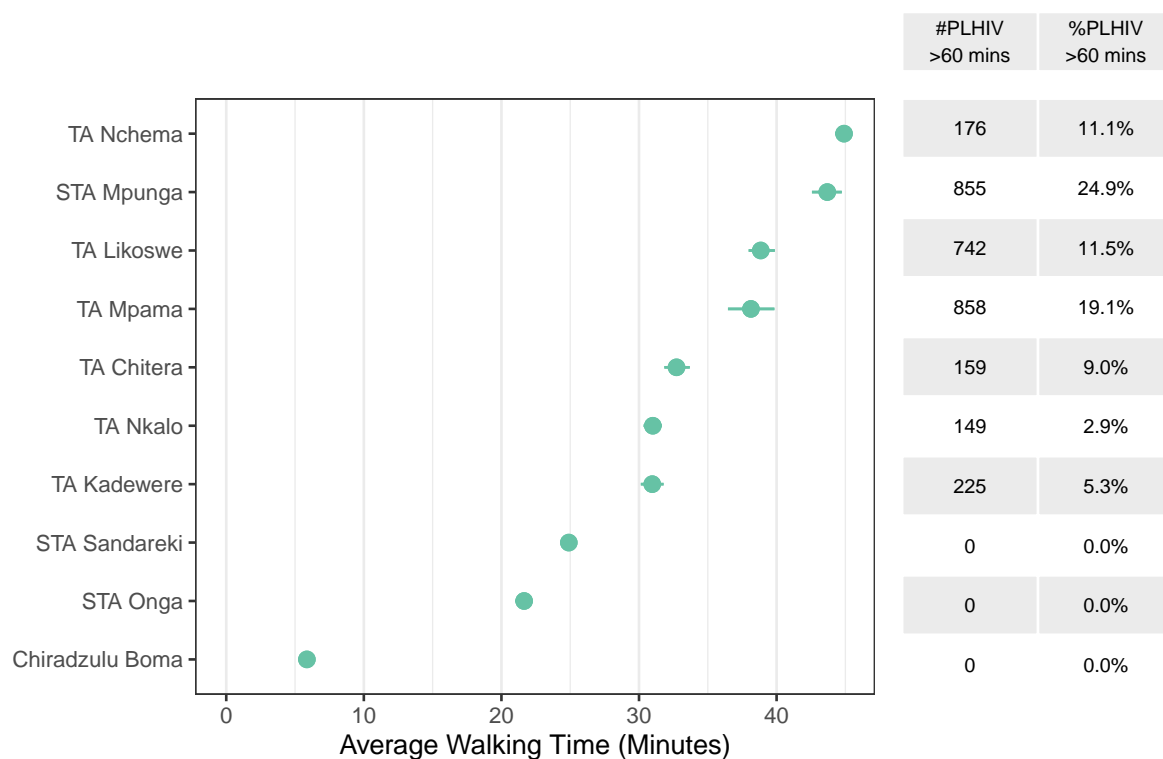


Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

Areas outside 60 minutes travel

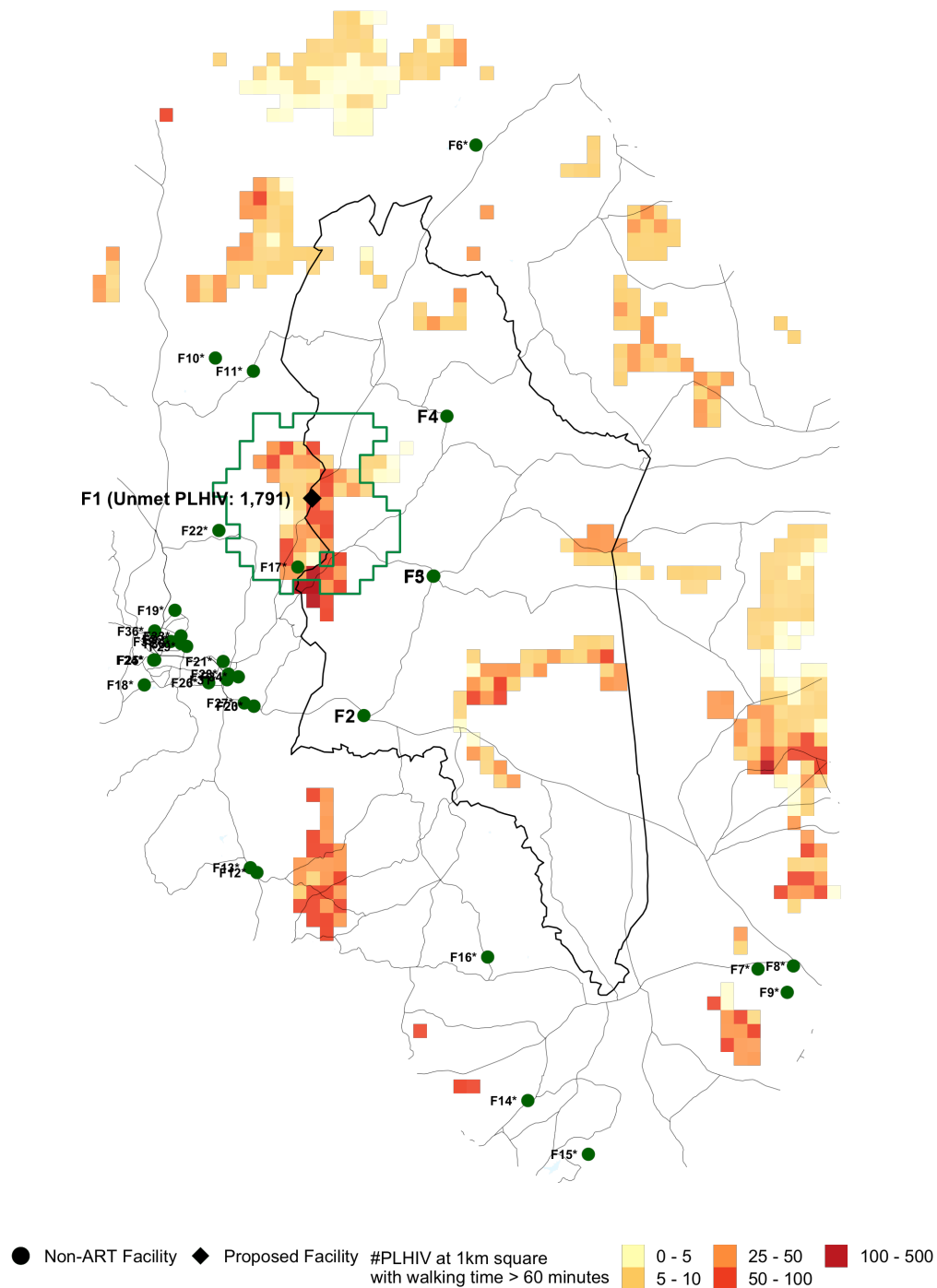


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

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.