

# District overview of travel time to ART facilities: Mulanje

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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](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 Mulanje, September 2020.

Total PLHIV (all ages)	72,784 (65,353–80,510)
HIV prevalence, age 15–49 years	15.3% (13.7%–16.9%)
Total patients receiving ART	129,591
Average walking time to nearest ART (minutes)	36 (35–37)
Number PLHIV > 60 minutes walking time	8,030 (7,049–9,104)
Percentage PLHIV > 60 minutes walking time	11.4% (10.6%–12.2%)

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	Mulanje Mountain Reserve: 32 (27–37)	TA Nkanda: 13,055 (10,749–15,631)
15-49 Prevalence	STA Tombondiya: 11.7% (9.0%–14.9%)	Mulanje Boma: 17.9% (14.2%–22.5%)
Average Walking Time	Mulanje Boma: 15 min (15–16 min)	Mulanje Mountain Reserve: 115 min (108–123 min)

## Travel time to existing ART facilities

In Mulanje, there are 25 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 1926. 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 Mulanje is 36 minutes (35-37 min).
- The shortest estimated average walking time to the closest ART facility is in Mulanje Boma (15 minutes (15-16 min)).
- The longest estimated average walking time to the closest ART facility is in Mulanje Mountain Reserve (115 minutes (108-123 min)).

An estimated 11.4% (10.6%–12.2%) of PLHIV reside more than 60 minutes walking time to their nearest ART facility, compared to 11.4% of the total population. This decreases to 1.0% (0.8%–1.1%) of PLHIV and 1.0% 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	236,376	33.0%	23,191 (20,606–25,819)	32.8% (31.5%–34.1%)
60	81,786	11.4%	8,030 (7,049–9,104)	11.4% (10.6%–12.2%)
90	7,214	1.0%	679 (577–797)	1.0% (0.8%–1.1%)
120	1,135	0.2%	101 (84–121)	0.1% (0.1%–0.2%)

## Proposed facilities for new ART services

A list of 26 *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 Nkanda (2879 PLHIV (2349-3471) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **DEMULA**, with 605 PLHIV (455-790) 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

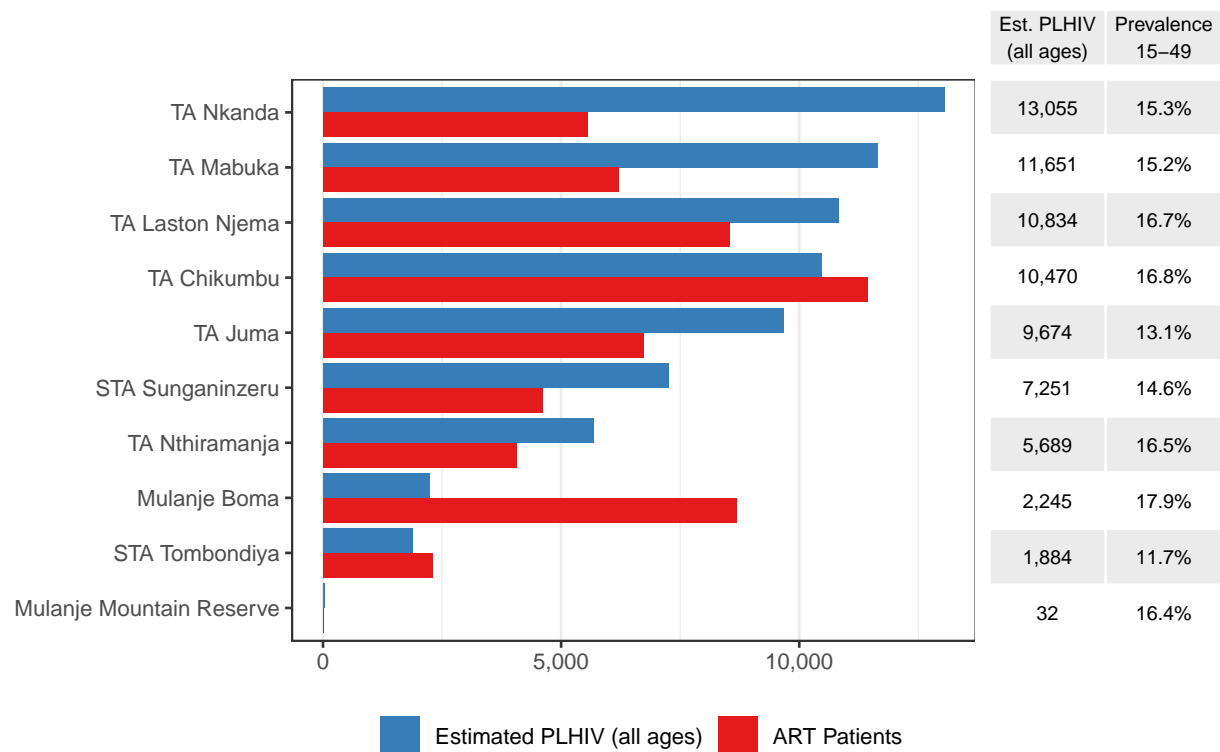


Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

## HIV prevalence in ages 15-49

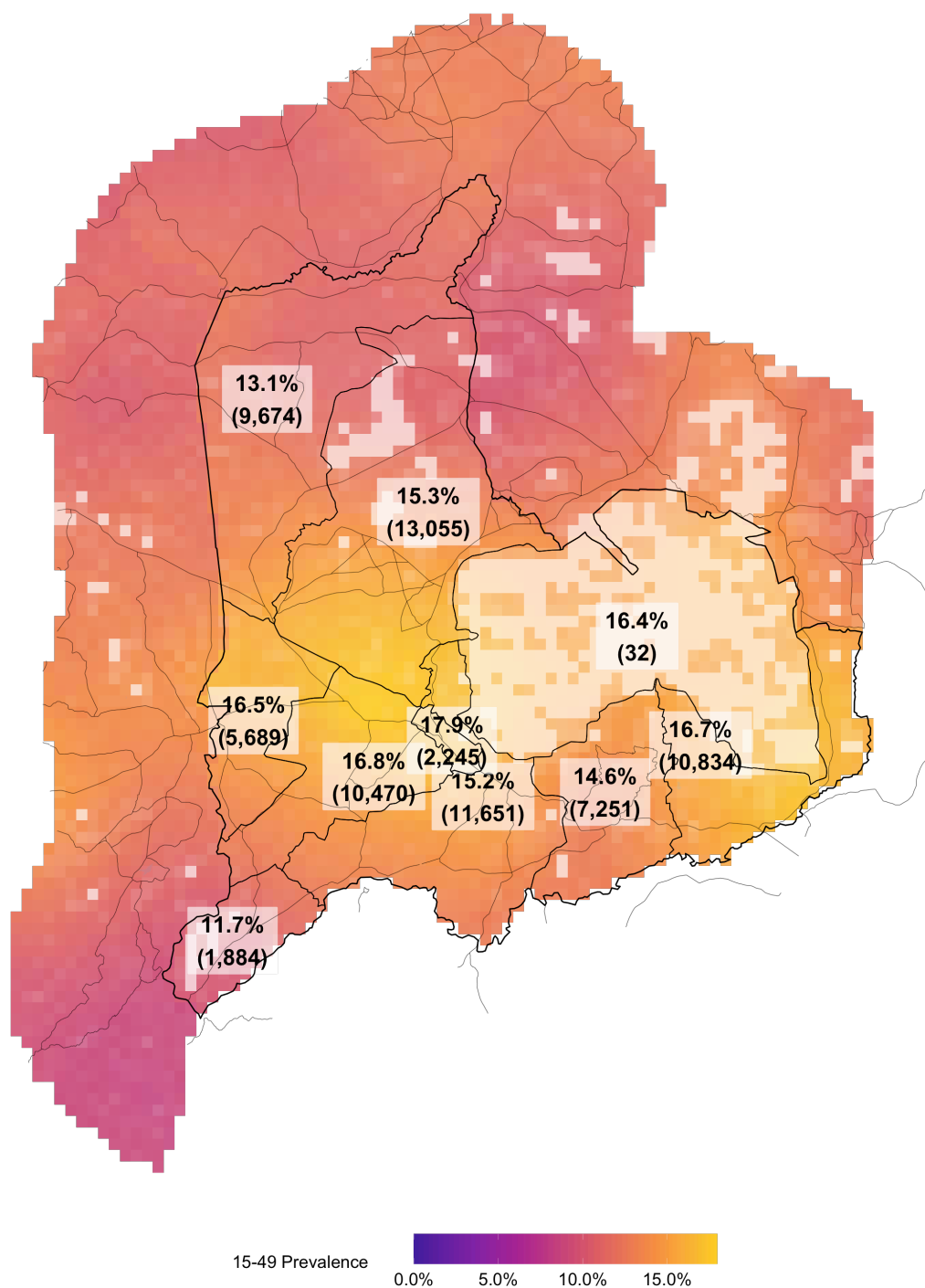


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

## Estimated number of PLHIV at 1km square

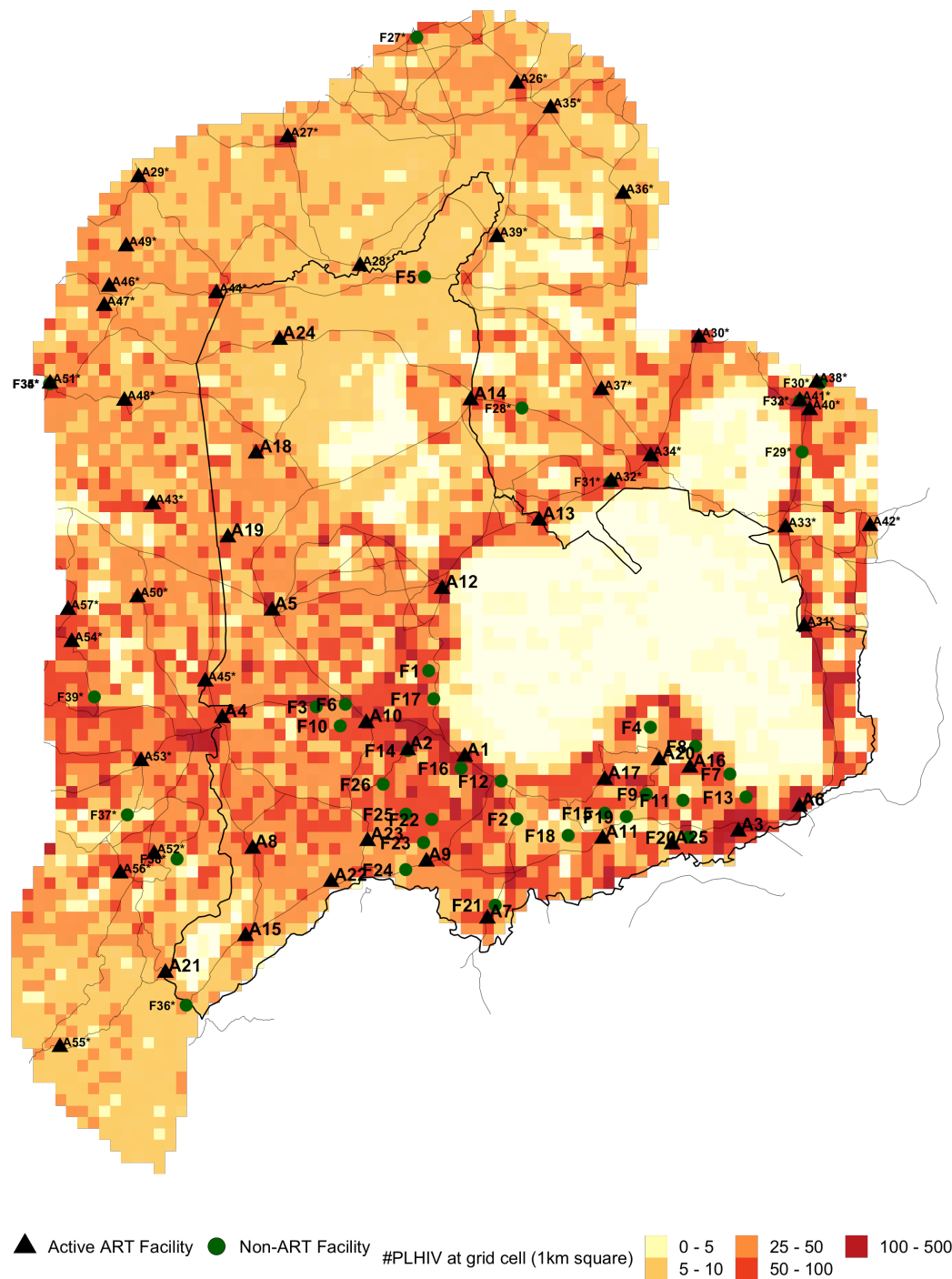


Figure 3: Estimated number of PLHIV on a 1km square.

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	Mulanje	Mulanje Boma	Mulanje District Hosp.	District hospital	Government	35.51	-16.03	8685
A2	Mulanje	TA Chikumbu	Mulanje Mission Hosp.	District hospital	CHAM	35.46	-16.02	6725
A3	Mulanje	TA Laston Njema	Namasalima HC Mulanje	Health centre	CHAM	35.72	-16.08	4381
A4	Mulanje	TA Nthiramanja	Chonde HC	Health centre	Government	35.32	-16.00	4064
A5	Mulanje	TA Juma	Thuchila HC	Health centre	Government	35.36	-15.92	3940
A6	Mulanje	TA Laston Njema	Muloza HC	Health centre	Government	35.76	-16.06	2673
A7	Mulanje	TA Mabuka	Mpala HC	Health centre	Government	35.52	-16.14	2591
A8	Mulanje	TA Chikumbu	Mbiza HC	Health centre	Government	35.35	-16.09	2476
A9	Mulanje	TA Mabuka	Milonde HC	Health centre	Government	35.48	-16.10	2384
A10	Mulanje	TA Chikumbu	Chisitu HC	Health centre	Government	35.43	-16.00	2229
A11	Mulanje	STA Sunganinzeru	Mimosa Disp.	Dispensary	Government	35.61	-16.09	2074
A12	Mulanje	TA Nkanda	Chambe HC	Health centre	Government	35.49	-15.90	2028
A13	Mulanje	TA Nkanda	Kambenje HC	Health centre	Government	35.56	-15.85	1926
A14	Mulanje	TA Nkanda	Mulomba HC	Health centre	Government	35.51	-15.77	1594
A15	Mulanje	STA Tombondiya	Chinyama HC	Health centre	Government	35.34	-16.16	1510
A16	Mulanje	TA Laston Njema	Naphimba HC	Health centre	Government	35.68	-16.03	1486
A17	Mulanje	STA Sunganinzeru	Bondo HC	Health centre	Government	35.61	-16.04	1176
A18	Mulanje	TA Juma	Namphungo HC	Health centre	Government	35.35	-15.80	1157
A19	Mulanje	TA Juma	Namulenga HC	Health centre	CHAM	35.33	-15.87	1155
A20	Mulanje	STA Sunganinzeru	Lujeri HC	Health centre	Private	35.66	-16.03	1090
A21	Mulanje	STA Tombondiya	Makapwa HC	Health centre	CHAM	35.28	-16.18	782
A22	Mulanje	TA Mabuka	Dzenje Mat.	Special	Government	35.41	-16.12	738
A23	Mulanje	TA Mabuka	Thembe HC	Dispensary	CHAM	35.43	-16.09	496
A24	Mulanje	TA Juma	Mkomaola HC	Health centre	Government	35.37	-15.72	478
A25	Mulanje	STA Sunganinzeru	Ruo Disp.	Dispensary	Private	35.67	-16.09	274
A26*	Zomba	TA Mwambo	Matiya HC	Health centre	CHAM	35.55	-15.53	2643
A27*	Zomba	TA Mbiza	Mayaka HC	Health centre	CHAM	35.37	-15.57	2134
A28*	Zomba	STA Ngweleru	Ngweleru HC	Health centre	Government	35.43	-15.67	1508
A29*	Zomba	STA Ntholowa	Nasawa HC	Health centre	Government	35.26	-15.60	1234
A30*	Phalombe	TA Kaduya	Migowi HC	Health centre	Government	35.69	-15.72	3960
A31*	Phalombe	TA Nkhulambe	Sukasanje HC	Health centre	CHAM	35.77	-15.93	3838
A32*	Phalombe	TA Mkhumba	Phalombe Mission Hospital Holy Family	District hospital	CHAM	35.62	-15.82	3784
A33*	Phalombe	TA Nkhulambe	Nkhulambe HC	Health centre	Government	35.75	-15.86	3588
A34*	Phalombe	Phalombe Boma	Phalombe HC	Health centre	Government	35.65	-15.81	2889
A35*	Phalombe	TA Jenala	Chitekesa HC	Health centre	Government	35.57	-15.55	2828
A36*	Phalombe	TA Jenala	Nkhwayi HC	Health centre	Government	35.63	-15.61	1847
A37*	Phalombe	TA Mkhumba	Mpsa HC	Health centre	Government	35.61	-15.76	1800
A38*	Phalombe	TA Nazombe	Nazombe HC (Gogo Nazombe)	Health centre	Government	35.77	-15.75	1688
A39*	Phalombe	TA Jenala	Mwanga HC	Health centre	CHAM	35.53	-15.65	1134
A40*	Phalombe	TA Nazombe	Chiringa Mat.	Special	Government	35.77	-15.77	740
A41*	Phalombe	TA Nazombe	Chiringa CHAM HC	Health centre	CHAM	35.76	-15.77	728
A42*	Phalombe	TA Nkhulambe	Mulungu Alinafe Clinic	Health centre	NGO	35.82	-15.86	363
A43*	Chiradzulu	STA Mpunga	Namitambo HC	Health centre	Government	35.27	-15.84	5334
A44*	Chiradzulu	STA Sandareki	Milepa HC	Health centre	Government	35.32	-15.69	3946
A45*	Chiradzulu	TA Nkalo	Nkalo HC	Health centre	Government	35.31	-15.97	3277
A46*	Chiradzulu	TA Kadewere	Chileka HC Blantyre	Health centre	Government	35.24	-15.68	2686
A47*	Chiradzulu	TA Kadewere	Ndunde HC	Health centre	Government	35.23	-15.70	2390
A48*	Chiradzulu	TA Kadewere	Thumbwe HC	Health centre	Government	35.25	-15.77	2338
A49*	Chiradzulu	STA Sandareki	Mauwa HC	Health centre	Government	35.25	-15.65	2323

A50*	Chiradzulu	TA Nkalo	Chimwawa HC	Health centre	Government	35.26	-15.91	481
A51*	Chiradzulu	STA Onga	PIM HC	Health centre	CHAM	35.19	-15.75	236
A52*	Thyolo	TA Kapichi	Khonjeni HC	Health centre	Government	35.27	-16.10	4188
A53*	Thyolo	TA Nanseta	Mangunda HC	Health centre	Government	35.26	-16.03	3225
A54*	Thyolo	TA Chimaliro	Chisoka HC	Health centre	Government	35.21	-15.94	1512
A55*	Thyolo	STA Mbawela	Zoa HC	Health centre	Government	35.20	-16.24	1219
A56*	Thyolo	TA Kapichi	Mitengo HC St Joseph	Health centre	CHAM	35.25	-16.11	970
A57*	Thyolo	TA Chimaliro	Chingazi HC	Health centre	CHAM	35.21	-15.92	648

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	Mulanje	TA Nkanda	DEMULA	Health Post	CHAM	35.48	-15.96	605	(455-790)
F2	Mulanje	TA Mabuka	Sayama Clinic	Clinic	Company	35.55	-16.07	578	(449-719)
F3	Mulanje	TA Chikumbu	KHAYA	Health Post	CHAM	35.39	-15.99	595	(461-752)
F4	Mulanje	STA Sunganinzeru	CHILINGWE	Dispensary	Company	35.65	-16.00	544	(395-720)
F5	Mulanje	TA Juma	KAMWENDO	Health Post	Government	35.48	-15.67	408	(311-513)
F6	Mulanje	TA Chikumbu	LUWANJE	Health Post	CHAM	35.42	-15.99	552	(438-677)
F7	Mulanje	TA Laston Njema	Chisambo Estate Clinic	Clinic	Company	35.71	-16.04	250	(193-321)
F8	Mulanje	TA Laston Njema	Phwazi Estate Clinic	Clinic	Company	35.68	-16.02	159	(119-207)
F9	Mulanje	STA Sunganinzeru	CHIKULI	Dispensary	Company	35.65	-16.05	76	(58-95)
F10	Mulanje	TA Chikumbu	MSITHE	Health Post	CHAM	35.41	-16.00	336	(261-424)
F11	Mulanje	TA Laston Njema	BLOOMFIELD	Dispensary	Company	35.67	-16.06	74	(56-93)
F12	Mulanje	TA Mabuka	Lauderdale Estate Clinic	Clinic	Company	35.54	-16.04	479	(371-599)
F13	Mulanje	TA Laston Njema	Limboli Estate Clinic	Clinic	Company	35.72	-16.06	130	(101-166)
F14	Mulanje	TA Chikumbu	BLM Mulanje	Special	NGO	35.46	-16.02	0	(0-0)
F15	Mulanje	STA Sunganinzeru	Eldorado Estate Clinic	Clinic	Company	35.61	-16.07	36	(27-45)
F16	Mulanje	Mulanje Boma	Esparanza Estate Clinic	Clinic	Company	35.50	-16.03	39	(30-50)
F17	Mulanje	TA Mabuka	Glenorchy Estate Clinic	Clinic	Company	35.48	-15.98	586	(438-767)
F18	Mulanje	STA Sunganinzeru	Likanga Estate Clinic	Clinic	Company	35.59	-16.08	162	(123-207)
F19	Mulanje	STA Sunganinzeru	Thornwood Estate Clinic	Clinic	Company	35.63	-16.07	36	(27-45)
F20	Mulanje	TA Laston Njema	NSUWADZI	Dispensary	Company	35.68	-16.08	36	(27-45)
F21	Mulanje	TA Mabuka	KHONGOLONI	Dispensary	Company	35.53	-16.13	95	(73-121)
F22	Mulanje	TA Mabuka	CHIBATHI	Health Post	CHAM	35.48	-16.07	0	(0-0)
F23	Mulanje	TA Mabuka	MISANJO	Health Post	CHAM	35.48	-16.09	0	(0-0)
F24	Mulanje	TA Mabuka	SALAMBA	Health Post	CHAM	35.46	-16.11	0	(0-0)
F25	Mulanje	TA Mabuka	EKHAMUNO	Health Post	CHAM	35.46	-16.07	0	(0-0)
F26	Mulanje	TA Chikumbu	NGOLOWERA	Health Post	CHAM	35.45	-16.05	0	(0-0)
F27*	Zomba	TA Mwambo	HUNGER	Dispensary	CHAM	35.47	-15.50	466	(346-613)
F28*	Phalombe	TA Mkhumba	Waruma	Health Post	Government	35.55	-15.77	191	(145-249)
F29*	Phalombe	TA Nazombe	Nambiti 2 HP	Health Centre	Government	35.76	-15.80	19	(14-24)
F30*	Phalombe	TA Nazombe	Nambiti 1 HC	Health Centre	Government	35.78	-15.75	0	(0-0)
F31*	Phalombe	TA Mkhumba	Holy Family Mission Hosp.	District hospital	CHAM	35.62	-15.82	0	(0-0)
F32*	Phalombe	TA Nazombe	Chiringa HC	Health Centre	CHAM	35.76	-15.77	0	(0-0)
F33*	Phalombe	TA Nazombe	Chiringa HC	Health Centre	Government	35.76	-15.77	0	(0-0)



F34*	Chiradzulu	STA Onga	Providence Industrial Mission HC	Health Centre	CHAM	35.19	-15.75	0	(0-0)
F35*	Chiradzulu	STA Onga	P.I.M HC	Special	Government	35.19	-15.75	0	(0-0)
F36*	Thyolo	STA Mbawela	SANDAMA	Health Post	Government	35.30	-16.21	127	(88-178)
F37*	Thyolo	TA Kapichi	Mafisi HC	Clinic	Company	35.25	-16.07	144	(110-183)
F38*	Thyolo	TA Kapichi	Kumadzi Disp.	Dispensary	Company	35.29	-16.10	29	(23-37)
F39*	Thyolo	TA Ngolongoliwa	SAMU	Health Post	Government	35.23	-15.98	0	(0-0)

## Travel Times to Closest ART Facilities

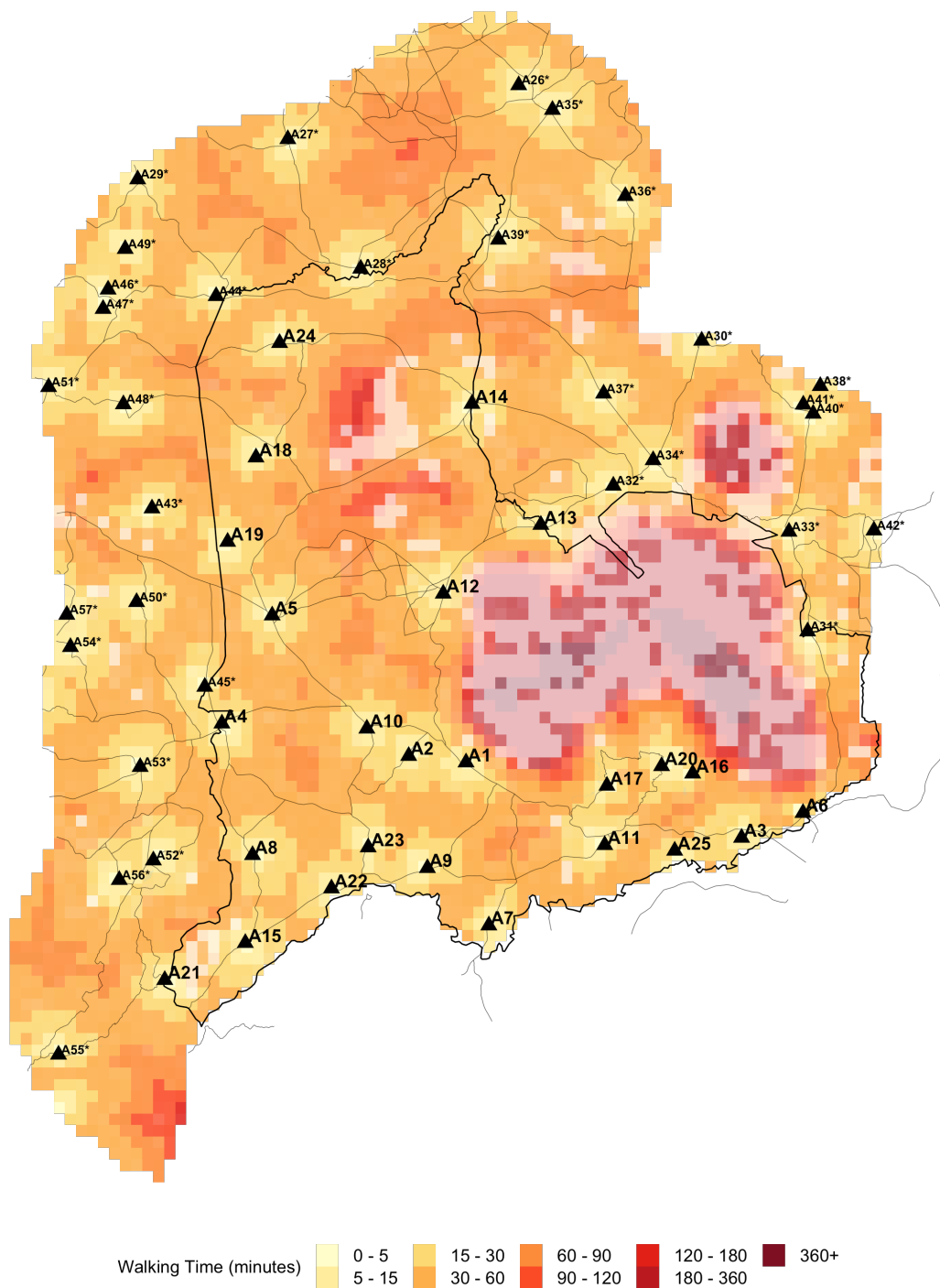


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.

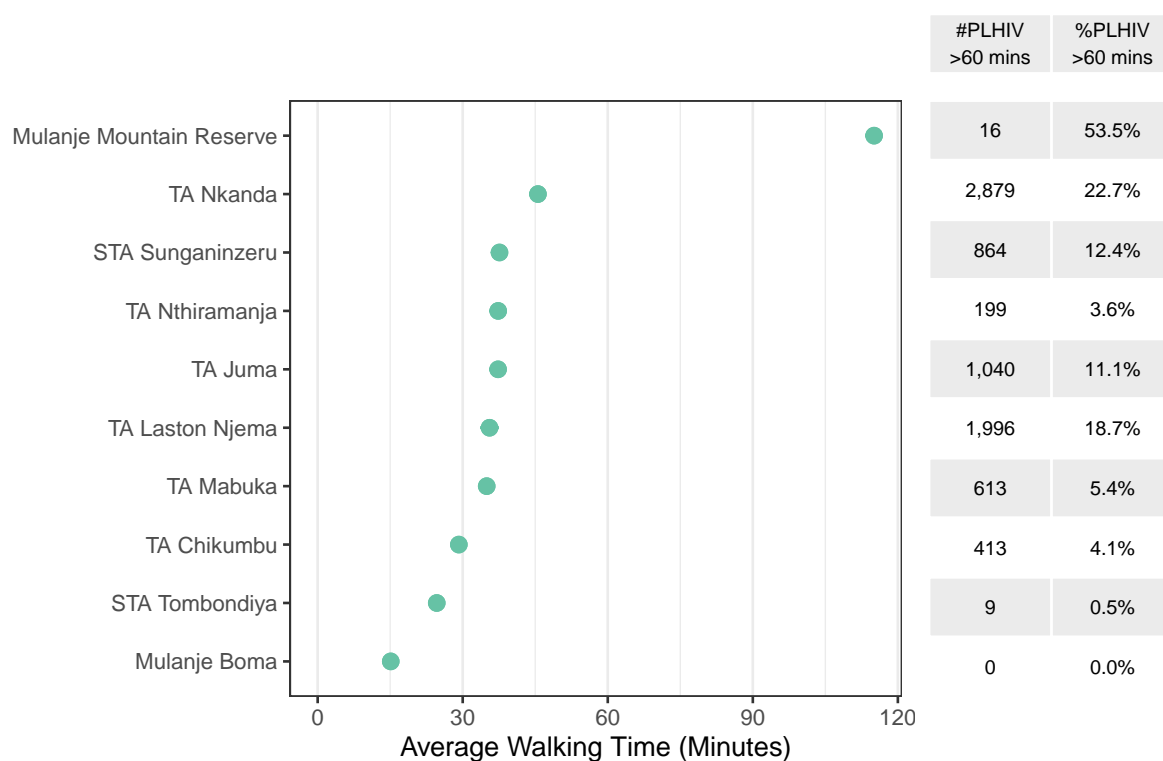


Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

## Areas outside 60 minutes travel

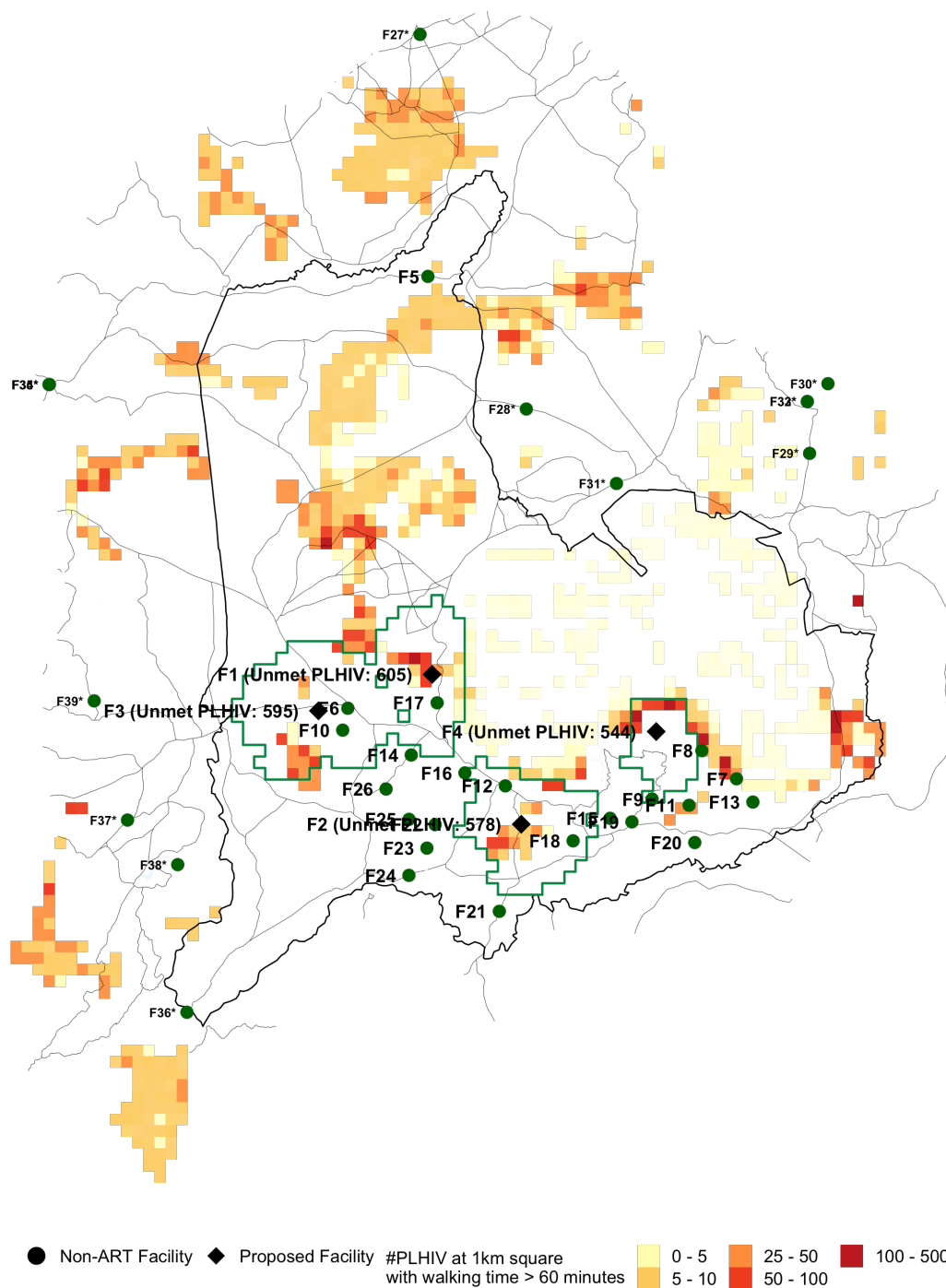


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

## 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.