

District overview of travel time to ART facilities: Mchinji

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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 Mchinji, September 2020.

Total PLHIV (all ages)	19,792 (16,559–23,495)
HIV prevalence, age 15–49 years	4.7% (3.9%–5.6%)
Total patients receiving ART	24,533
Average walking time to nearest ART (minutes)	58 (55–62)
Number PLHIV > 60 minutes walking time	8,089 (6,730–9,640)
Percentage PLHIV > 60 minutes walking time	41.9% (39.3%–44.7%)

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 Pitala: 152 (100–220)	TA Dambe: 2,599 (1,813–3,594)
15-49 Prevalence	TA Mduwa: 3.2% (2.4%–4.4%)	Mchinji Boma: 7.8% (5.3%–11.2%)
Average Walking Time	Mchinji Boma: 12 min (12–12 min)	STA Kapunula: 217 min (210–224 min)

Travel time to existing ART facilities

In Mchinji, there are 16 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 731. 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 Mchinji is 58 minutes (55-62 min).
- The shortest estimated average walking time to the closest ART facility is in Mchinji Boma (12 minutes (12-12 min)).
- The longest estimated average walking time to the closest ART facility is in STA Kapunula (217 minutes (210-224 min)).

An estimated 41.9% (39.3%–44.7%) of PLHIV reside more than 60 minutes walking time to their nearest ART facility, compared to 43.7% of the total population. This decreases to 17.2% (14.8%–20.1%) of PLHIV and 17.2% 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	393,442	62.4%	11,464 (9,625–13,471)	59.4% (56.9%–61.8%)
60	275,250	43.7%	8,089 (6,730–9,640)	41.9% (39.3%–44.7%)
90	108,618	17.2%	3,316 (2,586–4,200)	17.2% (14.8%–20.1%)
120	34,838	5.5%	1,170 (784–1,724)	6.0% (4.4%–8.5%)

Proposed facilities for new ART services

A list of 12 *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 Mlonyeni (1526 PLHIV (1059-2075) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **PITALA**, with 423 PLHIV (291-601) 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

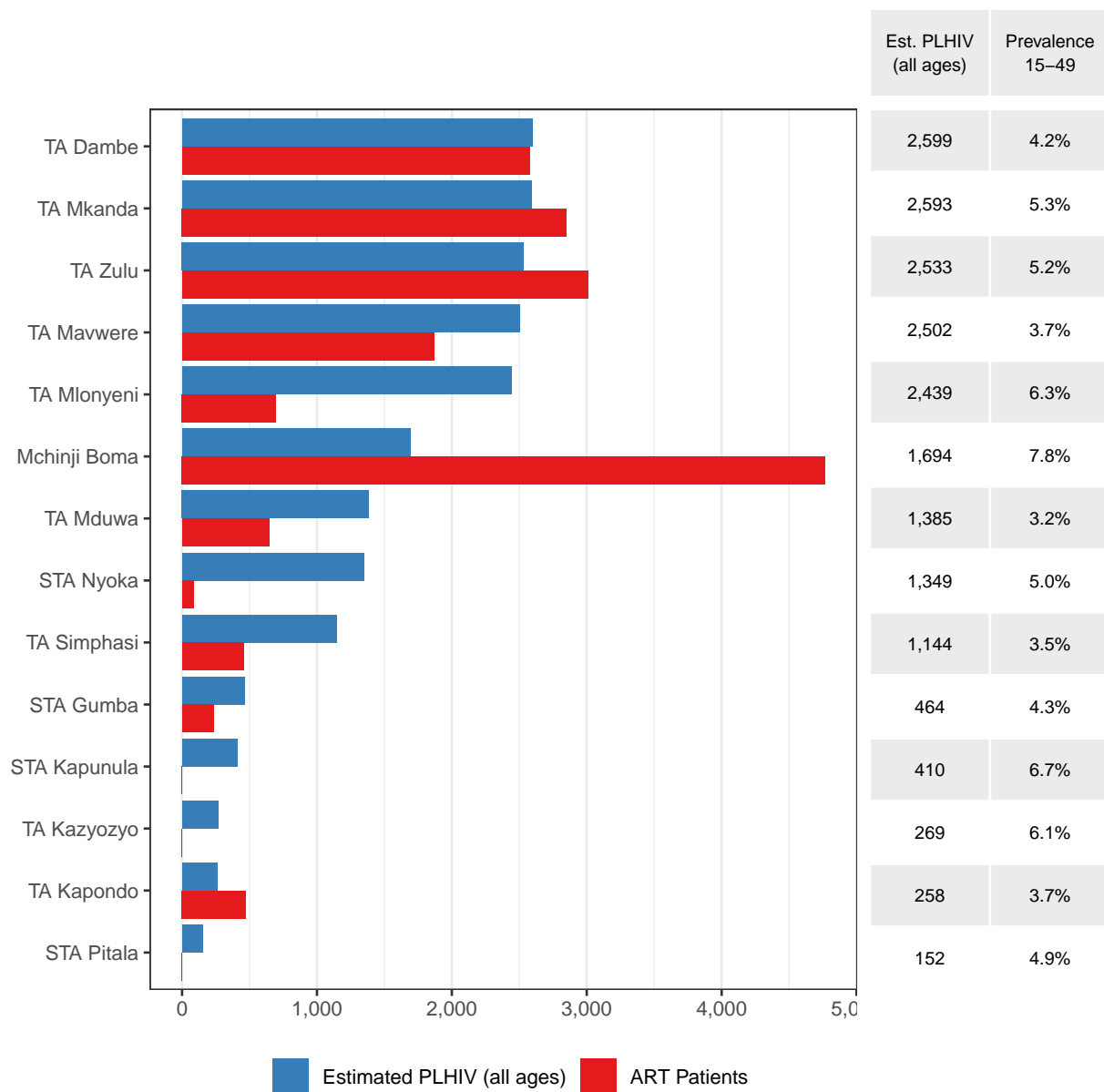


Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

HIV prevalence in ages 15-49

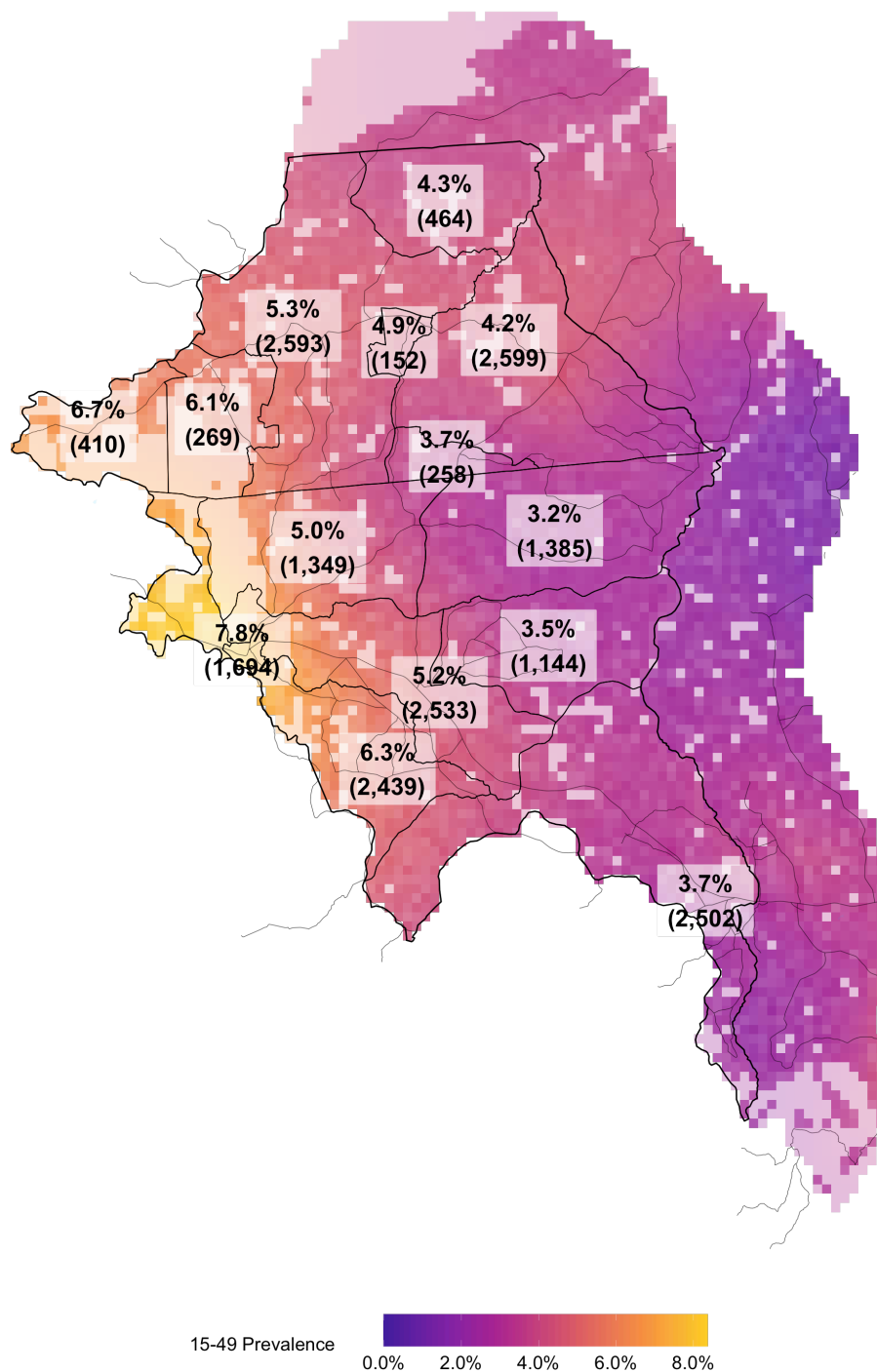


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

Estimated number of PLHIV at 1km square

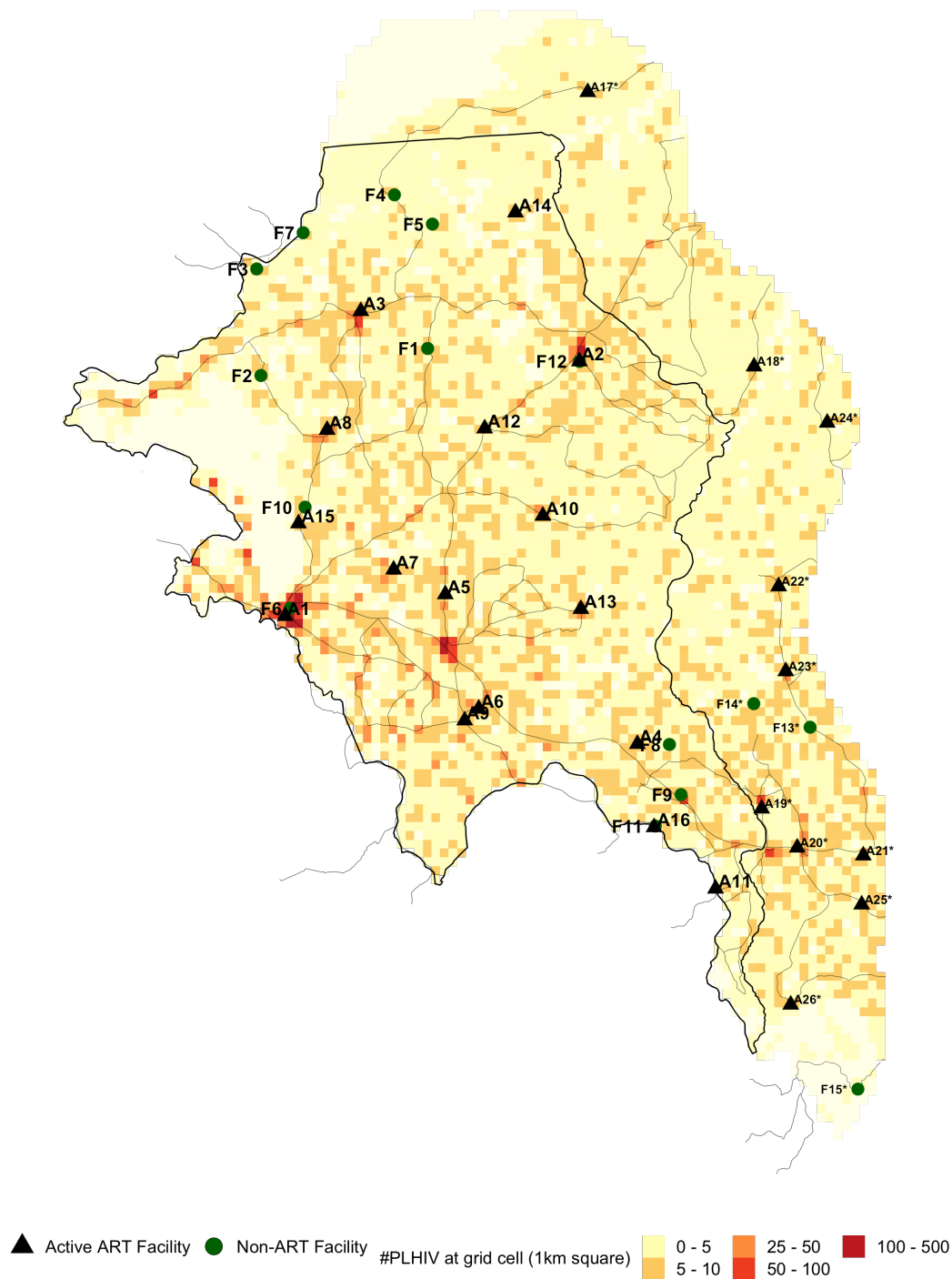


Figure 3: Estimated number of PLHIV on a 1km square.

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	Mchinji	Mchinji Boma	Mchinji District Hosp.	District hospital	Government	32.89	-13.80	4768
A2	Mchinji	TA Dambe	Kapiri Mission Hosp.	District hospital	CHAM	33.17	-13.56	2576
A3	Mchinji	TA Mkanda	Mkanda HC	Health centre	Government	32.96	-13.51	2085
A4	Mchinji	TA Mavwere	Nkhwazi HC	Health centre	Government	33.23	-13.92	1353
A5	Mchinji	TA Zulu	Kochilira HC	Health centre	Government	33.04	-13.78	1179
A6	Mchinji	TA Zulu	Guillime Mission Hosp.	Rural/Community	CHAM	33.08	-13.89	987
A7	Mchinji	TA Zulu	Ludzi St Josephs HC	Health centre	CHAM	32.99	-13.76	844
A8	Mchinji	TA Mkanda	Kaigwazanga HC	Health centre	Government	32.93	-13.63	766
A9	Mchinji	TA Mlonyeni	Tembwe HC	Health centre	Government	33.06	-13.90	696
A10	Mchinji	TA Mduwa	Mikundi HC	Health centre	Government	33.14	-13.71	646
A11	Mchinji	TA Mavwere	Kapanga HC	Health centre	Government	33.31	-14.06	487
A12	Mchinji	TA Kapondo	Chipumi HC	Health centre	Government	33.08	-13.63	474
A13	Mchinji	TA Simphasi	Chioshya HC	Health centre	Government	33.17	-13.80	454
A14	Mchinji	STA Gumba	Gumba HC	Health centre	Government	33.11	-13.42	234
A15	Mchinji	STA Nyoka	Home of Hope Clinic	Special	NGO	32.90	-13.72	85
A16	Mchinji	TA Mavwere	Namizana HC	Health centre	Government	33.25	-14.00	30
A17*	Kasungu	TA Kawamba	Kamboni HC	Health centre	Government	33.18	-13.31	296
A18*	Kasungu	TA Santhe	Mkhota Rural Growth HC	Health centre	Government	33.34	-13.57	158
A19*	Lilongwe	TA Kalolo	St Gabriel Mission Hosp.	District hospital	CHAM	33.35	-13.98	2724
A20*	Lilongwe	TA Kalolo	Chileka HC Lilongwe Static Art	Health centre	Government	33.39	-14.02	1101
A21*	Lilongwe	TA Kalolo	Nthondo HC Lilongwe	Health centre	Government	33.45	-14.03	838
A22*	Lilongwe	TA Khongoni	Khongoni HC	Health centre	Government	33.37	-13.77	754
A23*	Lilongwe	TA Khongoni	Chilobwe Majiga HC	Health centre	Government	33.37	-13.85	325
A24*	Lilongwe	TA Khongoni	Malembo HC Lilongwe	Health centre	Government	33.41	-13.62	308
A25*	Lilongwe	TA Kalolo	Ming'ongo HC	Health centre	Government	33.45	-14.08	204
A26*	Lilongwe	TA Kalolo	Mbang'ombe 1 HC	Health centre	Government	33.38	-14.17	161

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	Mchinji	STA Pitala	PITALA	Health Post	Government	33.03	-13.55	423	(291-601)
F2	Mchinji	TA Kazyozyo	Kazyozyo HC	Health Centre	Government	32.86	-13.58	287	(172-459)
F3	Mchinji	TA Mkanda	MWASE	Health Post	Government	32.86	-13.47	206	(109-356)
F4	Mchinji	STA Gumba	Chimwamkango HC	Health Centre	Government	32.99	-13.40	190	(107-314)
F5	Mchinji	STA Gumba	MALEWA	Health Post	Government	33.03	-13.43	179	(106-285)
F6	Mchinji	Mchinji Boma	BLM Mchinji	Special	NGO	32.89	-13.80	94	(65-133)
F7	Mchinji	TA Mkanda	KATUTULA	Health Post	Government	32.90	-13.44	141	(78-228)
F8	Mchinji	TA Mavwere	MTANGA	Health Post	Other	33.26	-13.92	97	(64-141)
F9	Mchinji	TA Mavwere	Waliranji	Health Centre	Government	33.27	-13.97	86	(59-120)
F10	Mchinji	STA Nyoka	NYOKA	Health Post	Government	32.91	-13.70	17	(12-24)
F11	Mchinji	TA Mavwere	Namizana Police Disp.	Dispensary	Other	33.25	-14.00	0	(0-0)

F12	Mchinji	TA Dambe	Our Lady of Mount Carmel Rural	Rural/Community	CHAM	33.17	-13.56	0	(0-0)
F13*	Lilongwe	TA Kalolo	Chiwe HC	Health Centre	CHAM	33.40	-13.91	387	(267-537)
F14*	Lilongwe	TA Kalolo	Lemwe HC	Health Centre	Government	33.34	-13.89	329	(215-470)
F15*	Lilongwe	TA Masumbankhunda	Dzalanyama/Kapomt	Health Centre	Government	33.44	-14.25	67	(37-112)

Travel Times to Closest ART Facilities

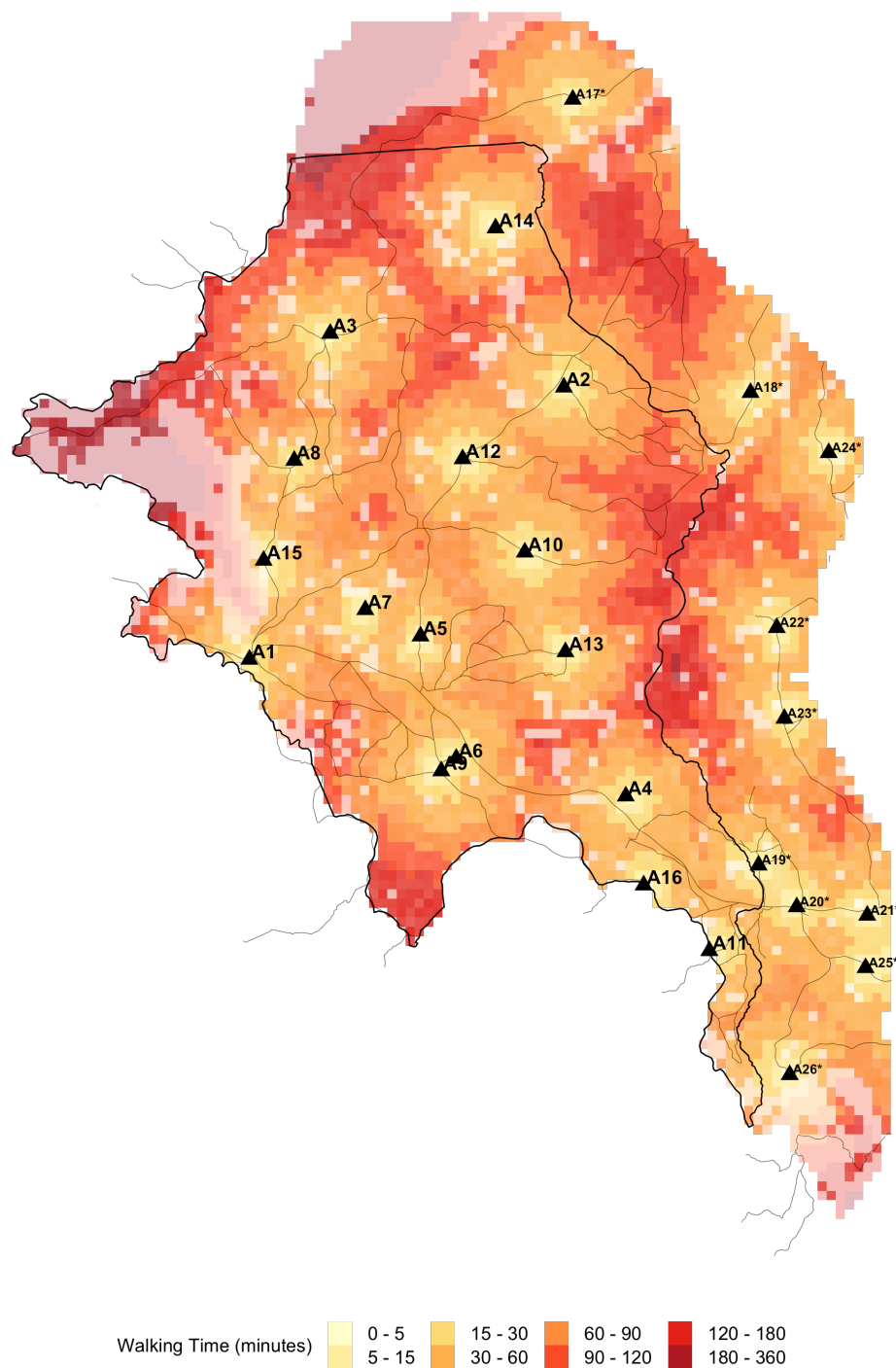


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.

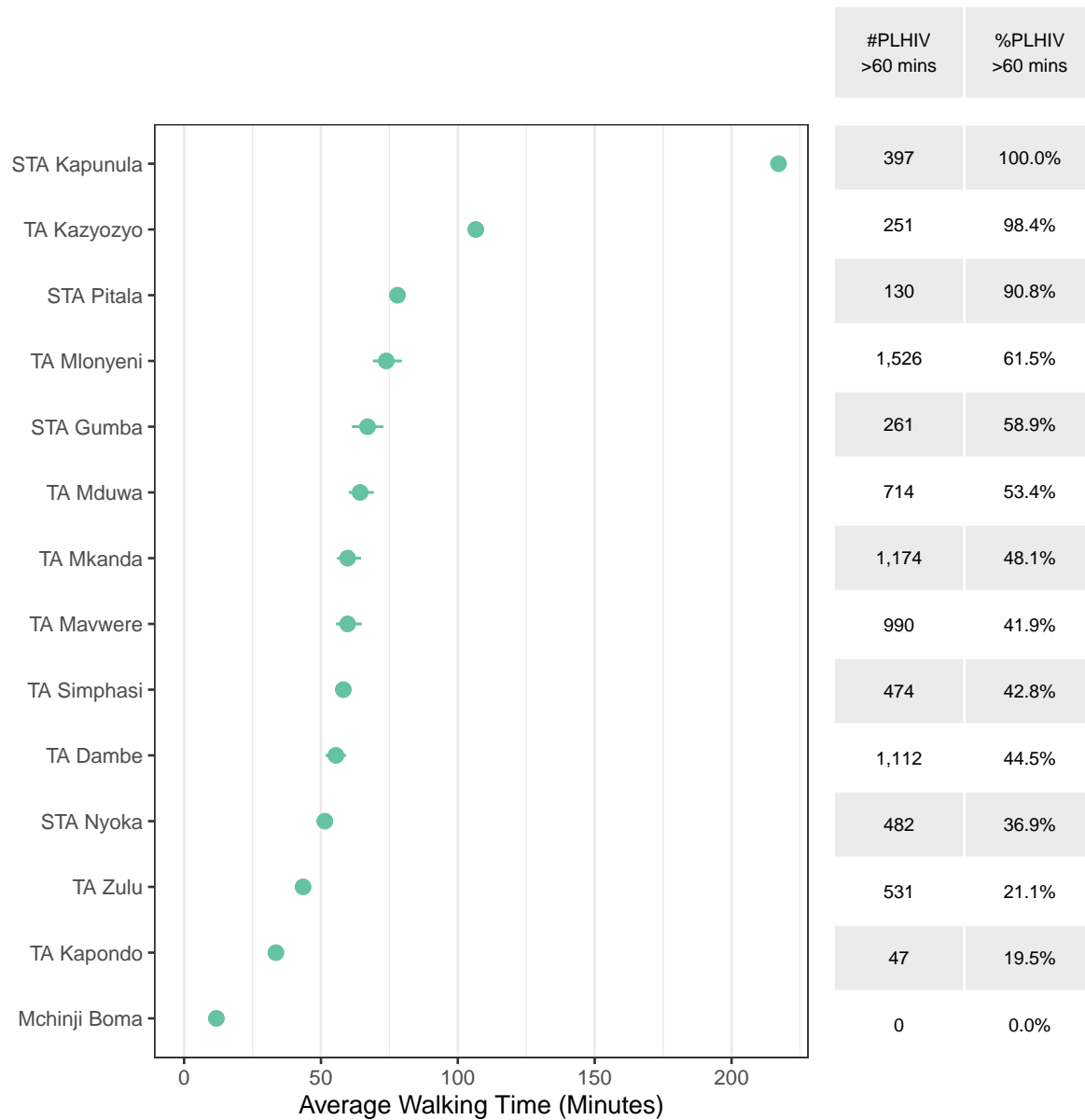


Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

Areas outside 60 minutes travel

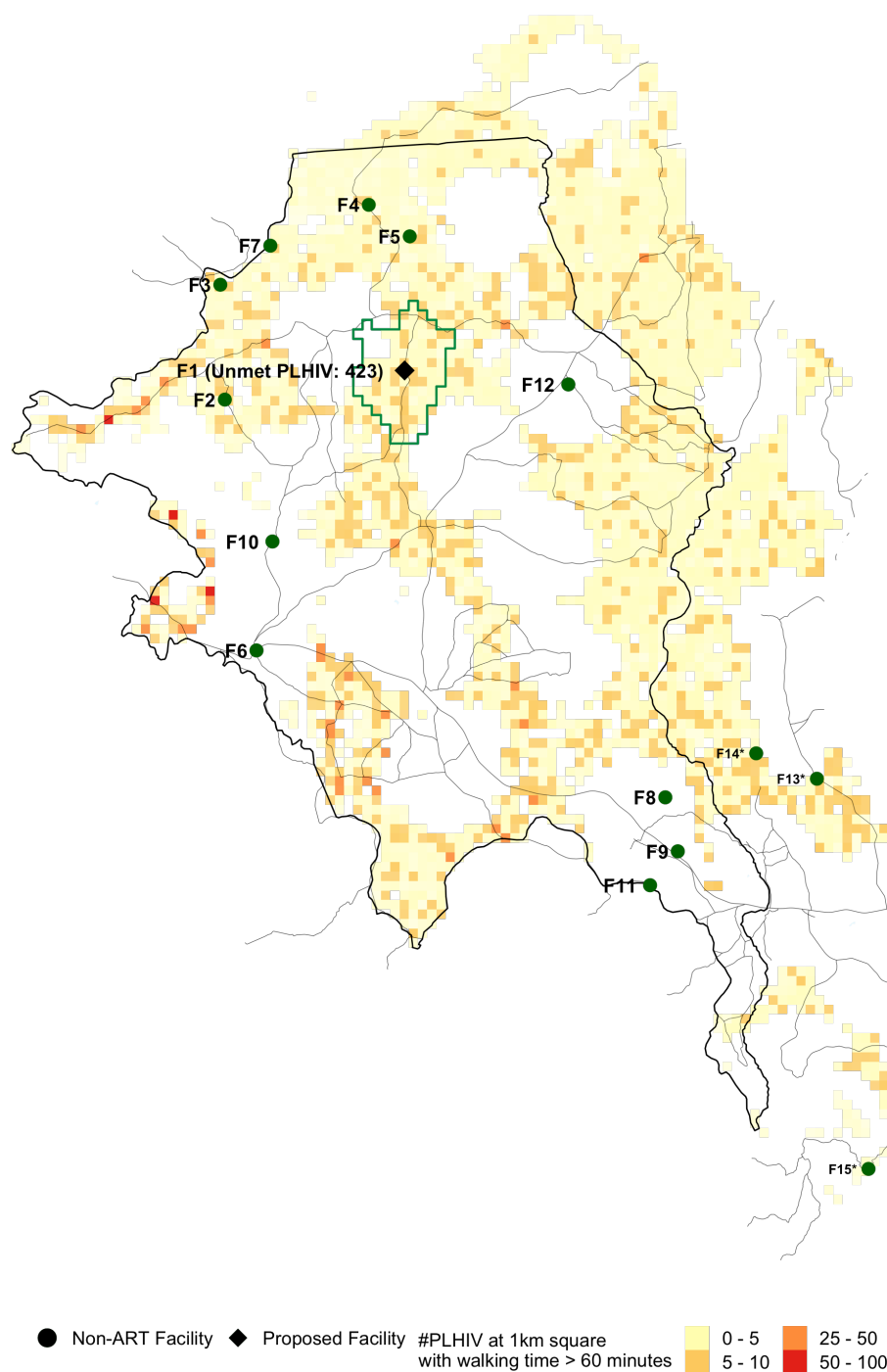


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

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.