

District overview of travel time to ART facilities: Kasungu

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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 Kasungu, September 2020.

Total PLHIV (all ages)	23,284 (19,994–27,259)
HIV prevalence, age 15–49 years	3.9% (3.4%–4.6%)
Total patients receiving ART	27,802
Average walking time to nearest ART (minutes)	65 (62–67)
Number PLHIV > 60 minutes walking time	13,116 (11,239–15,290)
Percentage PLHIV > 60 minutes walking time	55.2% (52.7%–57.7%)

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	Kasungu National Park: 22 (14–31)	TA Wimbe: 3,045 (2,317–3,938)
15-49 Prevalence	TA Kapelula: 2.5% (1.6%–3.8%)	STA Chisikwa: 7.5% (5.1%–10.8%)
Average Walking Time	Kasungu Boma: 11 min (11–12 min)	STA Mangwazu: 138 min (136–140 min)

Travel time to existing ART facilities

In Kasungu, there are 31 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 331. 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 Kasungu is 65 minutes (62-67 min).
- The shortest estimated average walking time to the closest ART facility is in Kasungu Boma (11 minutes (11-12 min)).
- The longest estimated average walking time to the closest ART facility is in STA Mangwazu (138 minutes (136-140 min)).

An estimated 55.2% (52.7%–57.7%) of PLHIV reside more than 60 minutes walking time to their nearest ART facility, compared to 58.6% of the total population. This decreases to 28.0% (25.9%–30.0%) of PLHIV and 29.7% 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	621,245	70.1%	15,703 (13,496–18,204)	66.1% (63.5%–68.5%)
60	518,621	58.6%	13,116 (11,239–15,290)	55.2% (52.7%–57.7%)
90	263,317	29.7%	6,643 (5,609–7,863)	28.0% (25.9%–30.0%)
120	78,502	8.9%	2,017 (1,650–2,451)	8.5% (7.5%–9.5%)

Proposed facilities for new ART services

A list of 11 *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 Wimbe (1898 PLHIV (1441-2436) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **Kasungu Prison**, with 309 PLHIV (213-437) 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

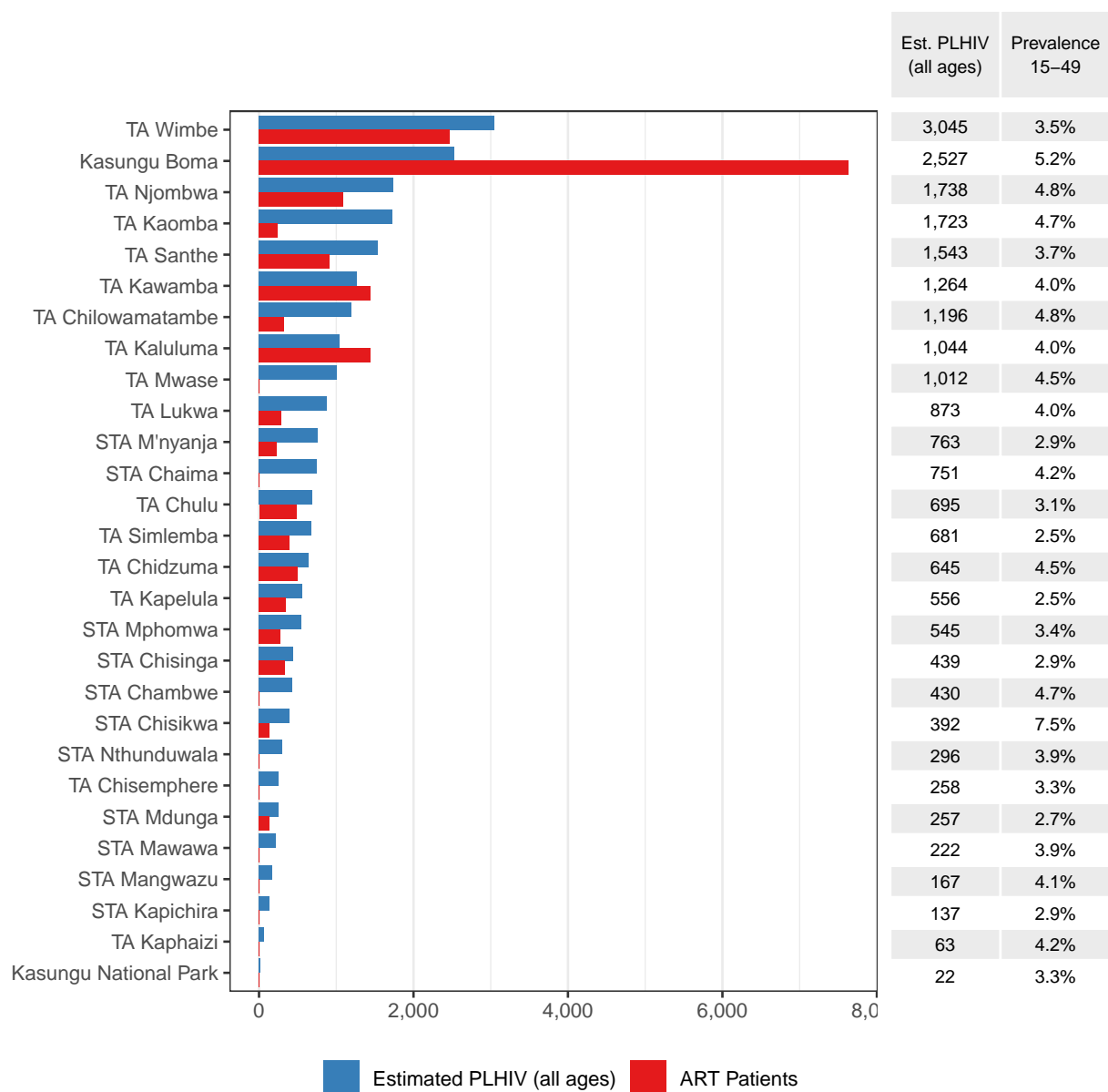


Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

HIV prevalence in ages 15-49

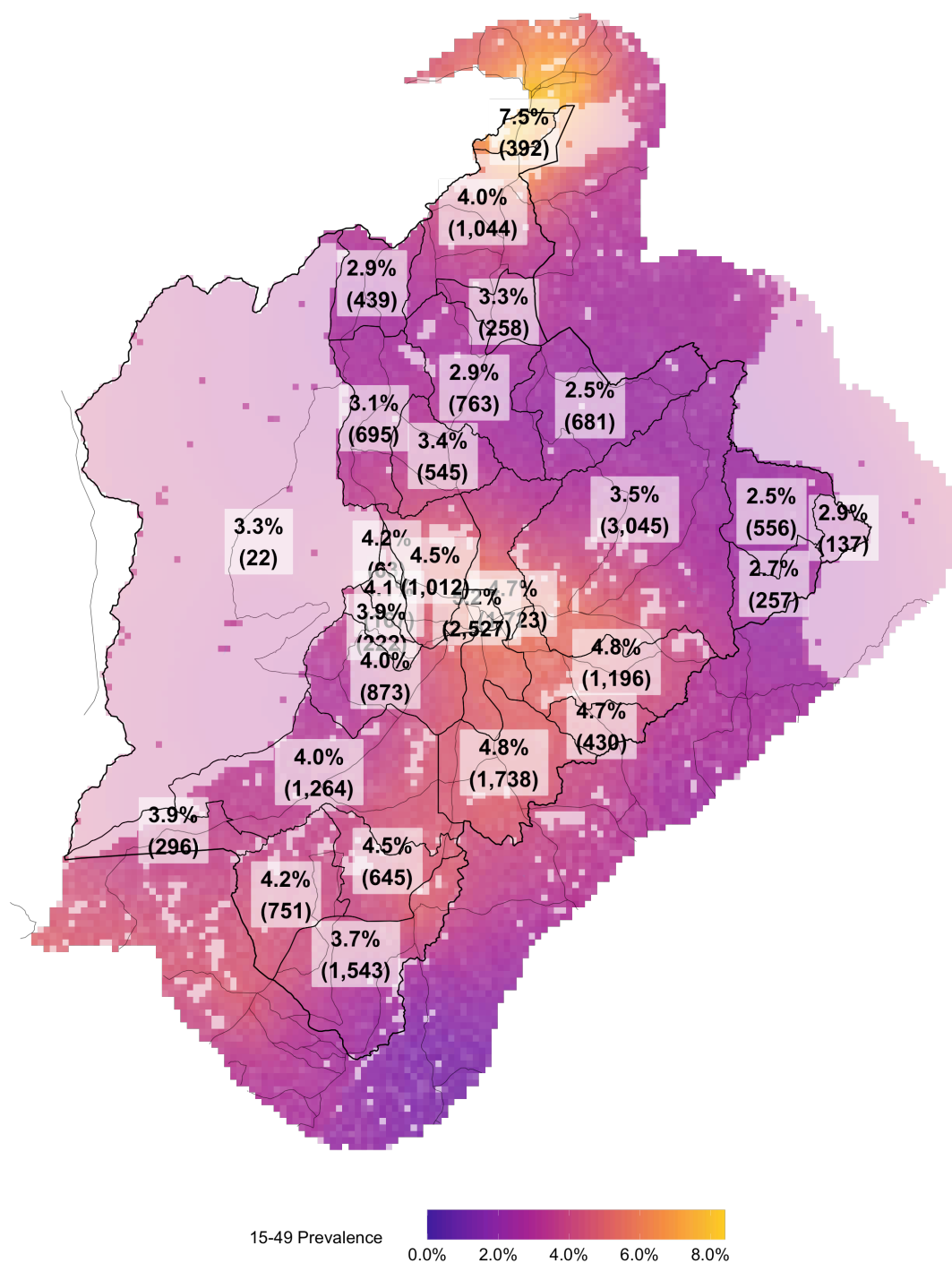


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

Estimated number of PLHIV at 1km square

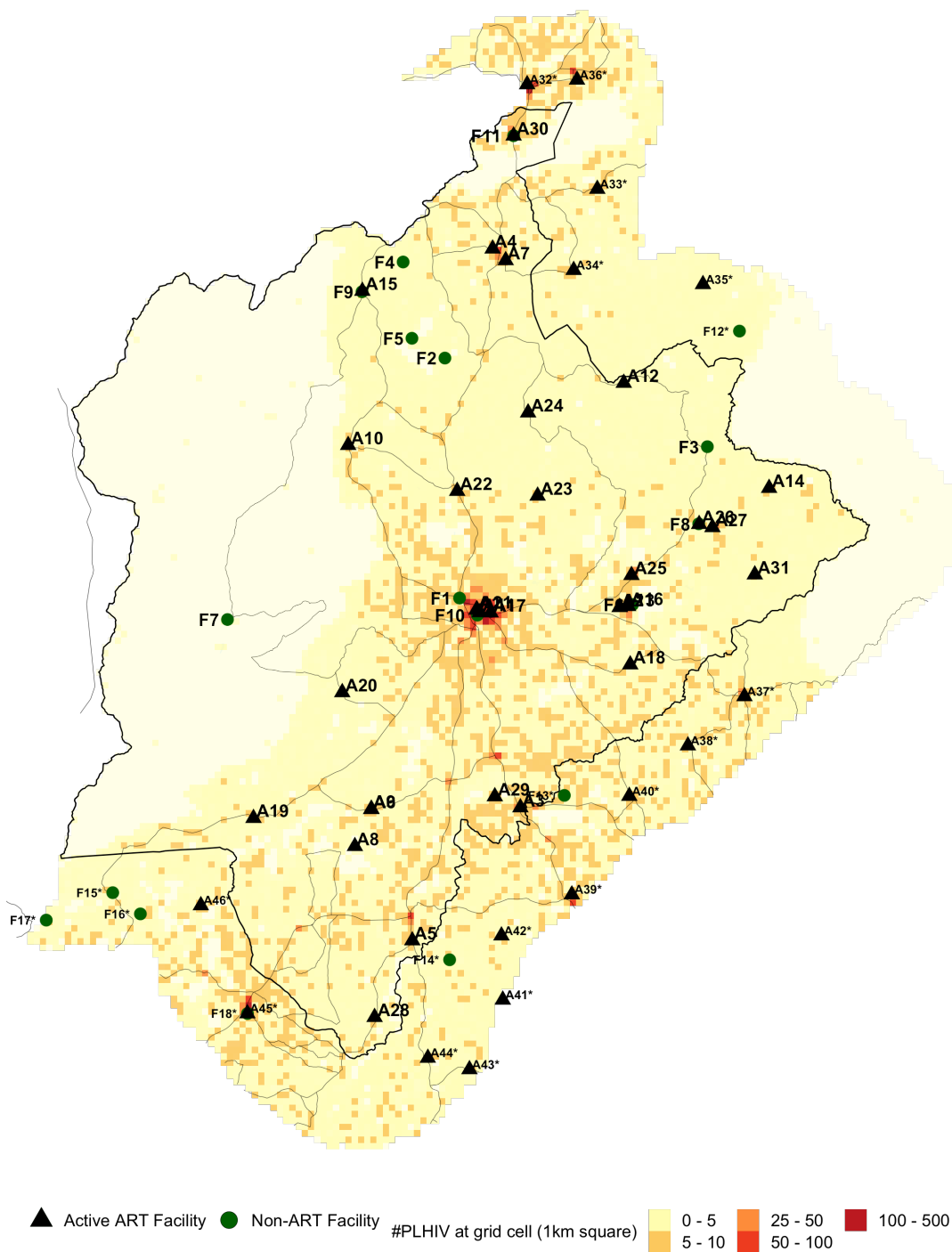


Figure 3: Estimated number of PLHIV on a 1km square.

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	Kasungu	Kasungu Boma	Kasungu District Hosp.	District hospital	Government	33.48	-13.04	6552
A2	Kasungu	TA Wimbe	St Andrews Clinic	Special	CHAM	33.67	-13.03	1176
A3	Kasungu	TA Njombwa	Bua Disp.	Dispensary	Government	33.54	-13.29	937
A4	Kasungu	TA Kaluluma	Nkhamenya Community Hosp.	District hospital	CHAM	33.50	-12.57	854
A5	Kasungu	TA Santhe	Santhe HC	Health centre	Government	33.39	-13.47	758
A6	Kasungu	TA Kawamba	Kawamba HC	Health centre	Government	33.34	-13.30	659
A7	Kasungu	TA Kaluluma	Kaluluma Rural Hosp.	Rural/Community	Government	33.52	-12.58	593
A8	Kasungu	TA Chidzuma	Khola HC	Health centre	CHAM	33.32	-13.34	505
A9	Kasungu	TA Kawamba	Kawinga HC	Health centre	Government	33.34	-13.30	487
A10	Kasungu	TA Chulu	Chulu HC	Health centre	Government	33.31	-12.82	483
A11	Kasungu	Kasungu Boma	FPAM Clinic Kasungu	Health centre	NGO	33.48	-13.04	474
A12	Kasungu	TA Simlemba	Simulemba HC	Health centre	Government	33.68	-12.74	396
A13	Kasungu	TA Wimbe	Mnyanja HC	Health centre	Government	33.67	-13.03	378
A14	Kasungu	TA Kapelula	Kapelula HC	Health centre	Government	33.87	-12.88	353
A15	Kasungu	STA Chisinga	Mpepa HC	Health centre	Government	33.33	-12.62	337
A16	Kasungu	TA Wimbe	Mtunthama HC	Health centre	Government	33.68	-13.03	331
A17	Kasungu	Kasungu Boma	Kasalika HC	Health centre	Government	33.50	-13.04	323
A18	Kasungu	TA Chitolowamatambe	Chamwabvi Disp.	Dispensary	Government	33.69	-13.11	323
A19	Kasungu	TA Kawamba	Kamboni HC	Health centre	Government	33.18	-13.31	296
A20	Kasungu	TA Lukwa	Linyangwa HC	Health centre	Government	33.30	-13.14	294
A21	Kasungu	Kasungu Boma	Katchale HC	Health centre	Government	33.48	-13.04	282
A22	Kasungu	STA Mphomwa	Dwangwa HC	Health centre	Government	33.45	-12.88	281
A23	Kasungu	TA Kaomba	Gogode Disp.	Health centre	Government	33.56	-12.89	239
A24	Kasungu	STA M'nyanja	Ofesi Disp.	Health centre	Government	33.55	-12.78	231
A25	Kasungu	TA Wimbe	Wimbe HC	Health centre	Government	33.69	-12.99	229
A26	Kasungu	TA Wimbe	St Augustine HC	Health centre	CHAM	33.78	-12.92	192
A27	Kasungu	TA Wimbe	St Faith Anglican Clinic	Health centre	CHAM	33.80	-12.93	169
A28	Kasungu	TA Santhe	Mkhota Rural Growth HC	Health centre	Government	33.34	-13.57	158
A29	Kasungu	TA Njombwa	Mziza HC	Health centre	Government	33.50	-13.28	158
A30	Kasungu	STA Chisikwa	Lodjwa HC	Health centre	Government	33.53	-12.42	140
A31	Kasungu	STA Mdunga	Mdunga HC	Health centre	Government	33.85	-12.99	132
A32*	Mzimba South	TA Mzikubola	Jenda HC	Health centre	Government	33.55	-12.35	1235
A33*	Mzimba South	TA Mabulabo	Luwelezi HC	Health centre	Government	33.64	-12.49	445
A34*	Mzimba South	TA Mabulabo	Emfeni HC	Health centre	Government	33.61	-12.59	295
A35*	Mzimba South	TA Khosolo Gwaza Jere	Mkoma HC	Health centre	Government	33.78	-12.61	238
A36*	Mzimba South	STA Levi Jere	Katimbira HC	Health centre	Government	33.61	-12.35	186
A37*	Ntchisi	TA Chilooko	Malomo HC	Health centre	Government	33.84	-13.15	890
A38*	Ntchisi	TA Chilooko	Malambo St Theresa HC	Health centre	CHAM	33.76	-13.21	123
A39*	Dowa	TA Chakhaza	Madisi Mission Hosp.	District hospital	CHAM	33.61	-13.41	1620
A40*	Dowa	TA Chakhaza	Bowe HC	Health centre	Government	33.68	-13.28	364
A41*	Dowa	TA Kayembe	Mbingwa HC	Health centre	Government	33.51	-13.54	235
A42*	Dowa	TA Chakhaza	Chizolowondo HC	Health centre	Government	33.51	-13.46	205
A43*	Dowa	TA Kayembe	Chisepo HC	Health centre	Government	33.47	-13.63	128
A44*	Lilongwe	TA Khongoni	Malembo HC Lilongwe	Health centre	Government	33.41	-13.62	308
A45*	Mchinji	TA Dambe	Kapiri Mission Hosp.	District hospital	CHAM	33.17	-13.56	2576

A46*	Mchinji	STA Gumba	Gumba HC	Health centre	Government	33.11	-13.42	234
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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	Kasungu	Kasungu Boma	Kasungu Prison	Clinic	Government	33.46	-13.02	309	(213-437)
F2	Kasungu	STA M'nyanja	MAFUPHIZI	Health Post	Government	33.44	-12.71	177	(101-289)
F3	Kasungu	TA Wimbe	Kapyanga HP	Health Post	Government	33.79	-12.82	169	(95-284)
F4	Kasungu	STA Chisinga	Newa / Mpasazi HC	Health Centre	Government	33.38	-12.58	168	(97-267)
F5	Kasungu	STA M'nyanja	Thupa HC	Health Centre	Government	33.39	-12.68	97	(53-165)
F6	Kasungu	TA Wimbe	Kamuzu Academy Clinic	Clinic	Company	33.69	-13.03	17	(12-24)
F7	Kasungu	Kasungu National Park	Lifupa Disp.	Dispensary	Government	33.15	-13.05	2	(1-5)
F8	Kasungu	TA Wimbe	Chamama HC	Health Centre	Government	33.78	-12.92	0	(0-0)
F9	Kasungu	STA Chisinga	Ntepa HC	Health Centre	Government	33.33	-12.62	0	(0-0)
F10	Kasungu	Kasungu Boma	BLM Kasungu	Special	NGO	33.48	-13.04	0	(0-0)
F11	Kasungu	STA Chisikwa	Livwezi HC	Health Centre	Government	33.53	-12.42	0	(0-0)
F12*	Mzimba South	TA Khosolo Gwaza Jere	MGOZA	Health Post	Government	33.83	-12.67	116	(61-192)
F13*	Dowa	TA Chakhaza	MTAMBALIKA	Health Post	Other	33.60	-13.28	252	(173-366)
F14*	Dowa	TA Kayembe	MONDWE	Health Post	Government	33.44	-13.49	185	(128-255)
F15*	Mchinji	STA Gumba	Chimwamkango HC	Health Centre	Government	32.99	-13.40	190	(107-314)
F16*	Mchinji	STA Gumba	MALEWA	Health Post	Government	33.03	-13.43	179	(106-285)
F17*	Mchinji	TA Mkanda	KATUTULA	Health Post	Government	32.90	-13.44	141	(78-228)
F18*	Mchinji	TA Dambe	Our Lady of Mount Carmel Rural	Rural/Community	CHAM	33.17	-13.56	0	(0-0)

Travel Times to Closest ART Facilities

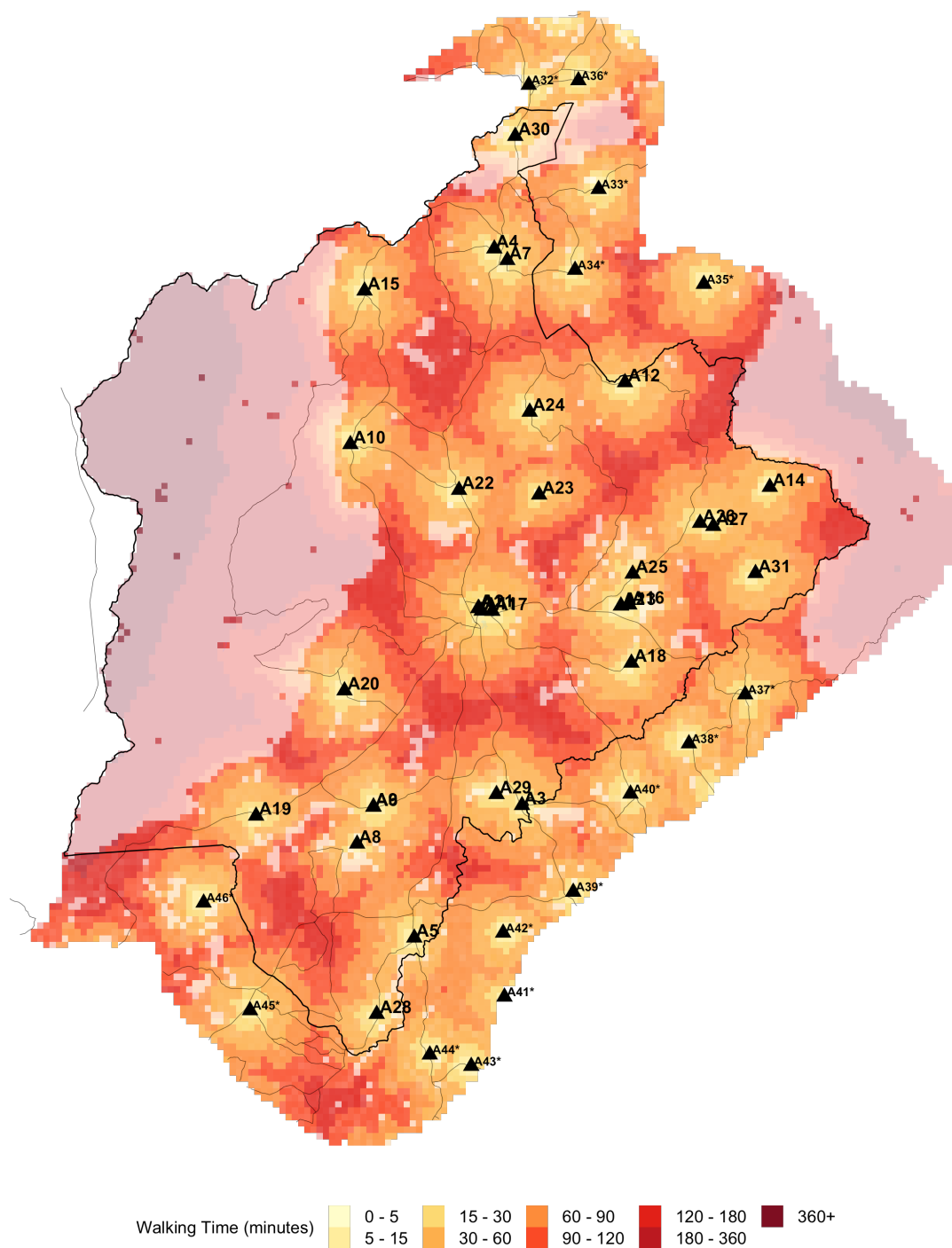


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.

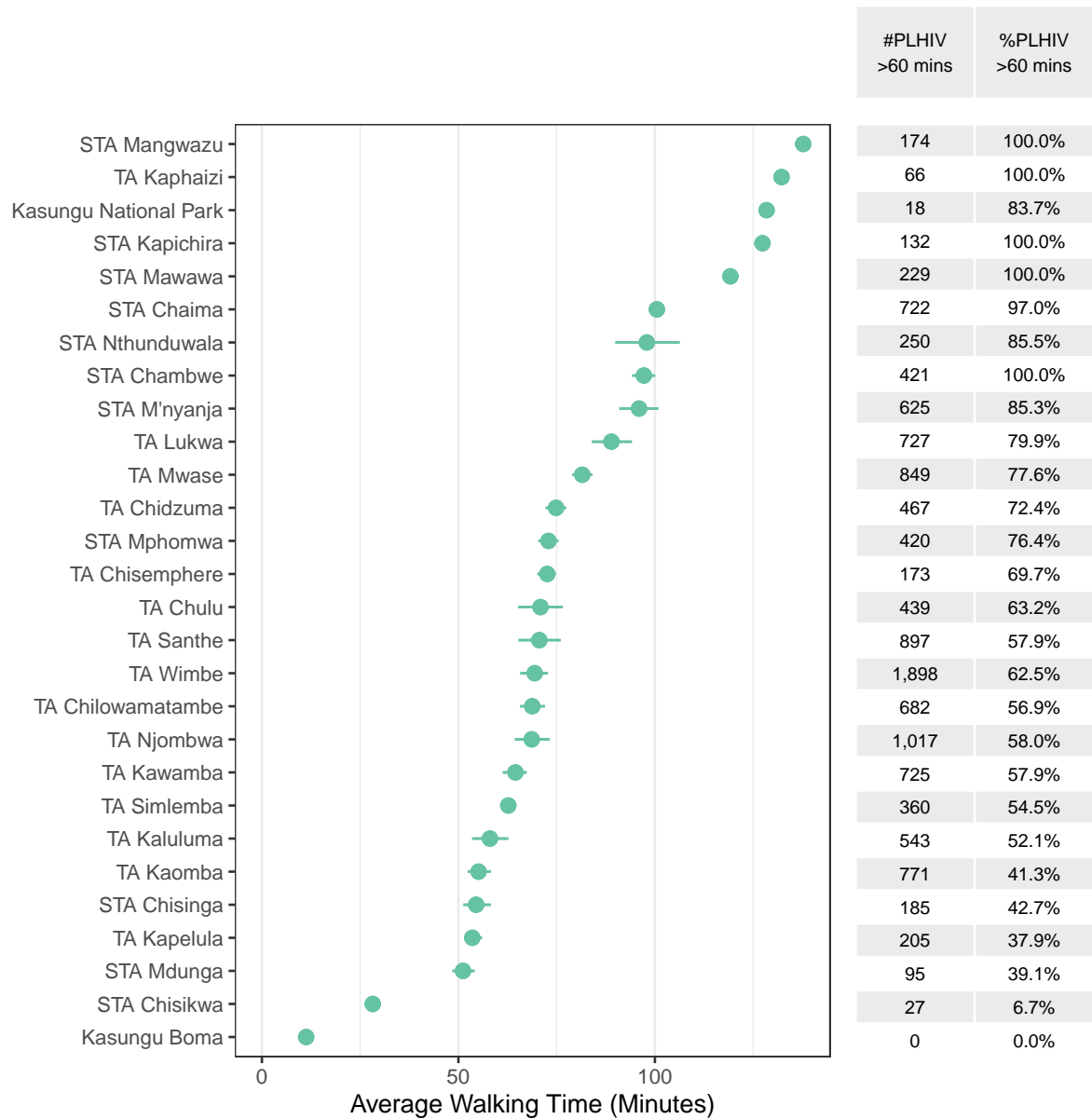


Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

Areas outside 60 minutes travel

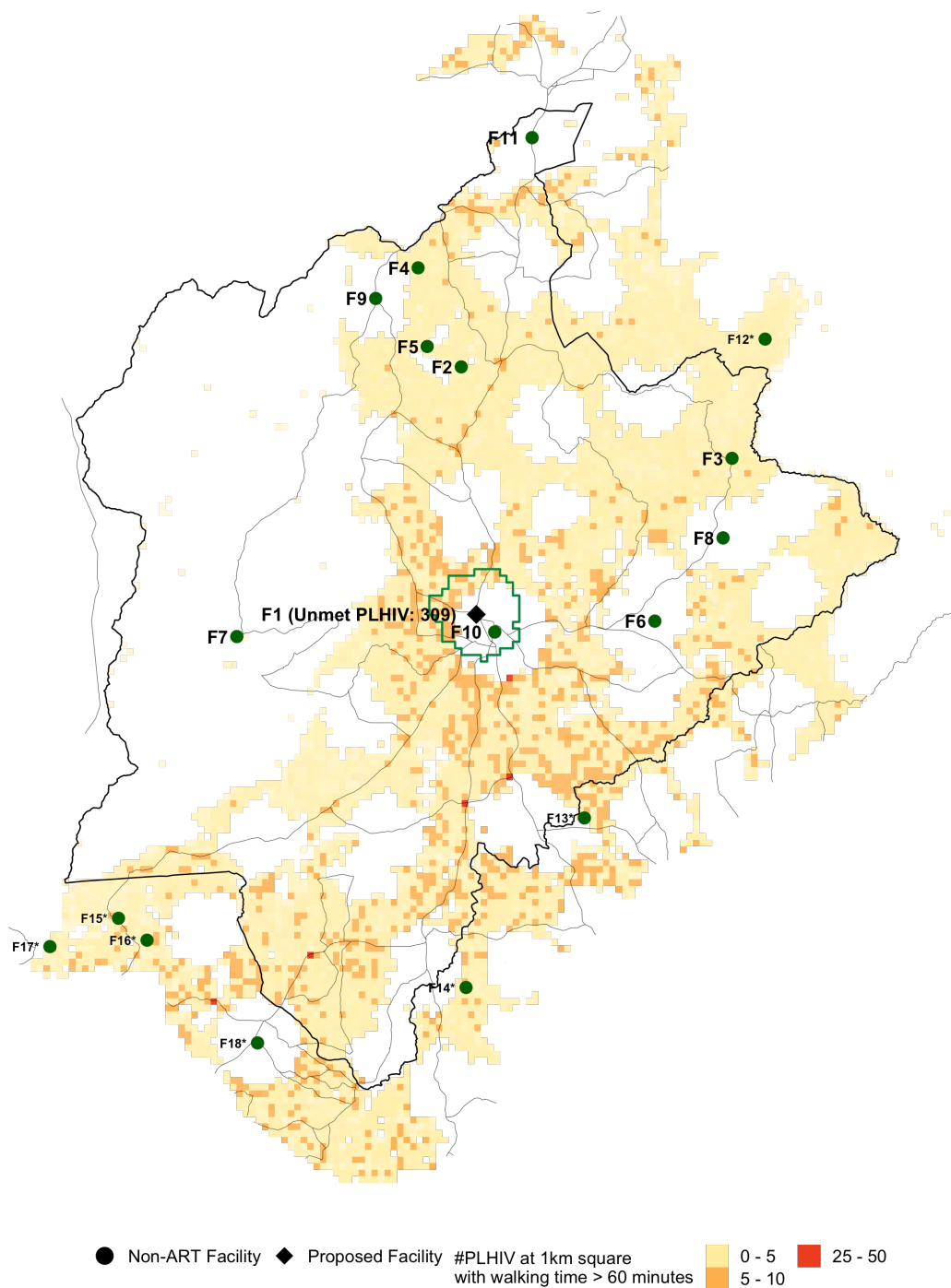


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

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.