

# District overview of travel time to ART facilities: Chikwawa

Kevin Lam, Jeffrey W. Eaton, Stone Mbiriya, Brown Chiwandira, Tiwonge Chimpanzule, Thokozi Kalua, Rose Nyirenda, Andreas Jahn. *Department of HIV and AIDS, Ministry of Health, Government of Malawi; MRC Centre for Global Infectious Disease Analysis, School of Public Health, Imperial College London*

Version: 05 March 2022; Correspondence to: Andreas Jahn ([ajahn@hivmw.org](mailto:ajahn@hivmw.org))

## 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 Chikwawa, September 2020.

Total PLHIV (all ages)	34,589 (29,679–40,099)
HIV prevalence, age 15–49 years	8.9% (7.6%–10.3%)
Total patients receiving ART	60,798
Average walking time to nearest ART (minutes)	59 (56–61)
Number PLHIV > 60 minutes walking time	14,579 (12,446–16,761)
Percentage PLHIV > 60 minutes walking time	43.2% (40.6%–45.7%)

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	Majete Game Reserve - Chikwawa: 10 (7–13)	TA Ngabu: 10,365 (8,224–12,713)
15-49 Prevalence	TA Chapananga: 4.7% (3.6%–6.2%)	TA Lundu: 11.3% (8.7%–14.5%)
Average Walking Time	Ngabu Urban: 10 min (9–10 min)	Lengwe National Park: 183 min (168–199 min)

## Travel time to existing ART facilities

In Chikwawa, there are 27 ART facilities that had at least 1 patient in September 2020. The median number of ART patients per facility was 746. 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 Chikwawa is 59 minutes (56-61 min).
- The shortest estimated average walking time to the closest ART facility is in Ngabu Urban (10 minutes (9-10 min)).
- The longest estimated average walking time to the closest ART facility is in Lengwe National Park (183 minutes (168-199 min)).

An estimated 43.2% (40.6%–45.7%) of PLHIV reside more than 60 minutes walking time to their nearest ART facility, compared to 46.6% of the total population. This decreases to 22.5% (20.3%–24.8%) of PLHIV and 25.2% 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	341,019	57.8%	18,243 (15,664–20,949)	54.0% (51.6%–56.4%)
60	275,144	46.6%	14,579 (12,446–16,761)	43.2% (40.6%–45.7%)
90	149,039	25.2%	7,604 (6,339–8,919)	22.5% (20.3%–24.8%)
120	66,028	11.2%	3,256 (2,662–3,891)	9.6% (8.4%–11.0%)

## Proposed facilities for new ART services

A list of 22 *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 Ngabu (4778 PLHIV (3825-5848) with walking time > 60 minutes).
- The facility that can reach the most PLHIV residing outside 60 minutes travel time is **Mitondo HP**, with 1118 PLHIV (770-1570) 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

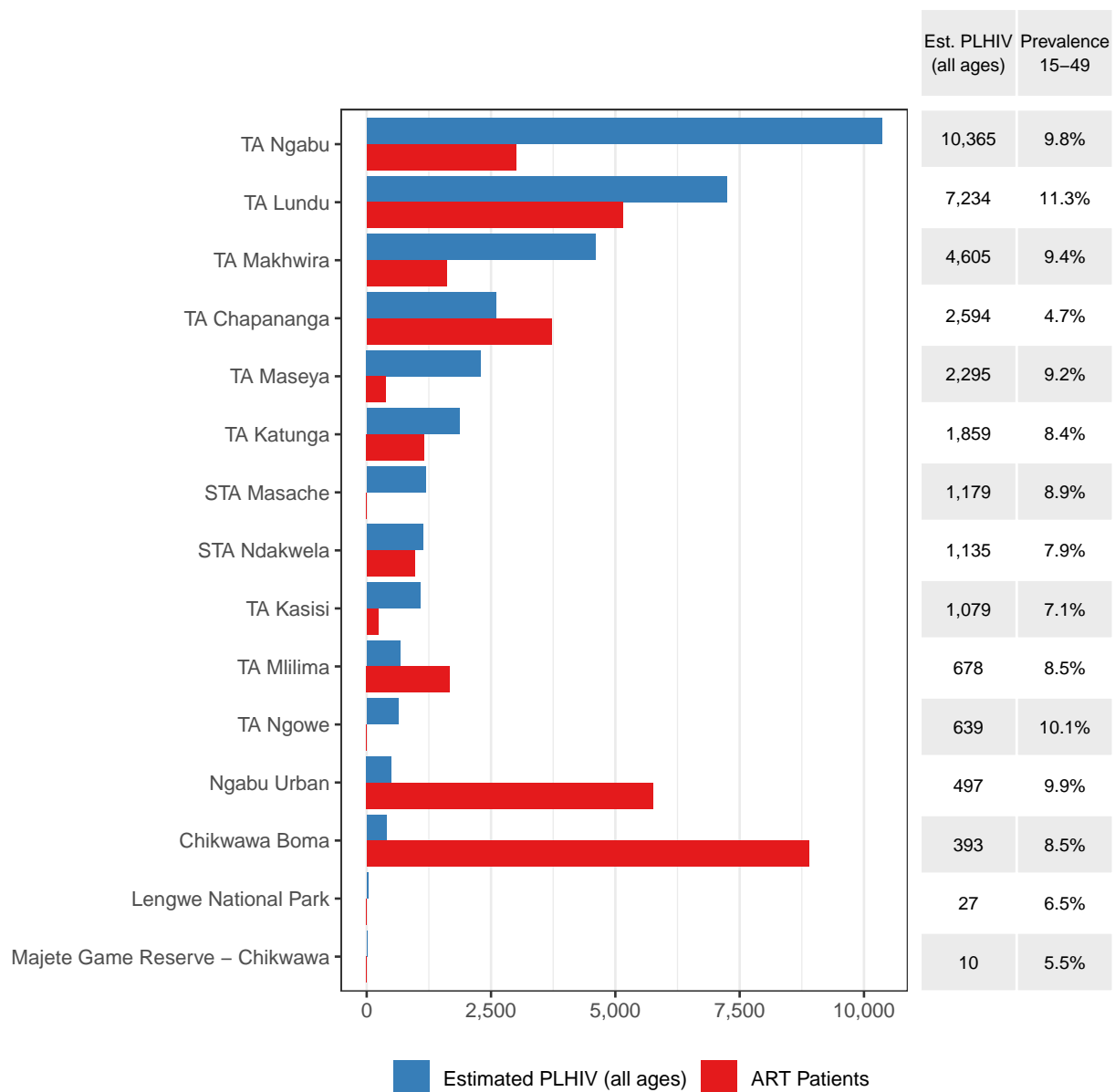


Figure 1: Number registered ART clients within each TA and estimated number of PLHIV within the TA. The right table indicates the estimated 15-49 HIV prevalence.

## HIV prevalence in ages 15-49

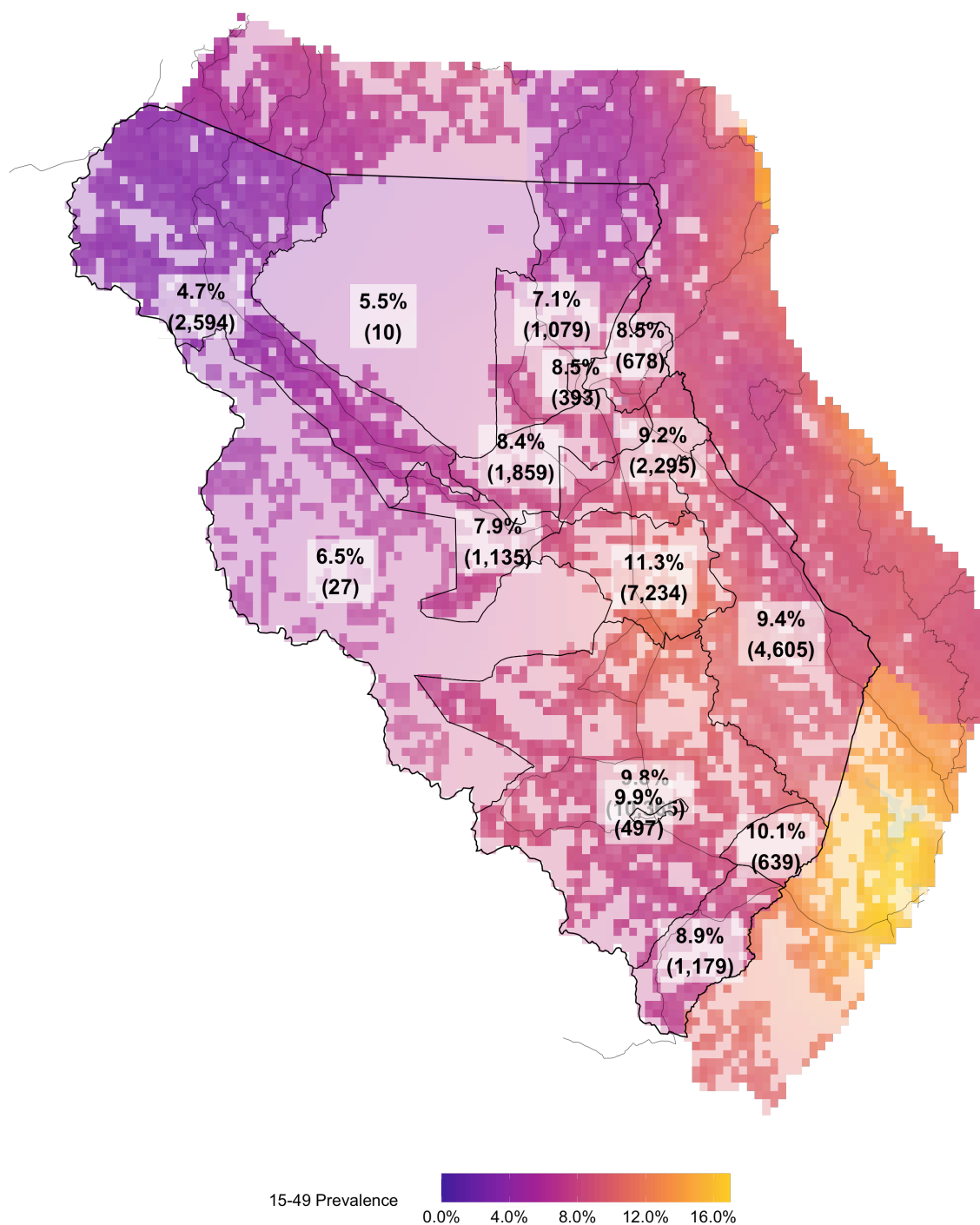


Figure 2: Estimated spatial HIV prevalence. Percentages correspond to TA level 15-49 HIV prevalence and numbers in brackets indicate the estimated number of PLHIV overall.

## Estimated number of PLHIV at 1km square

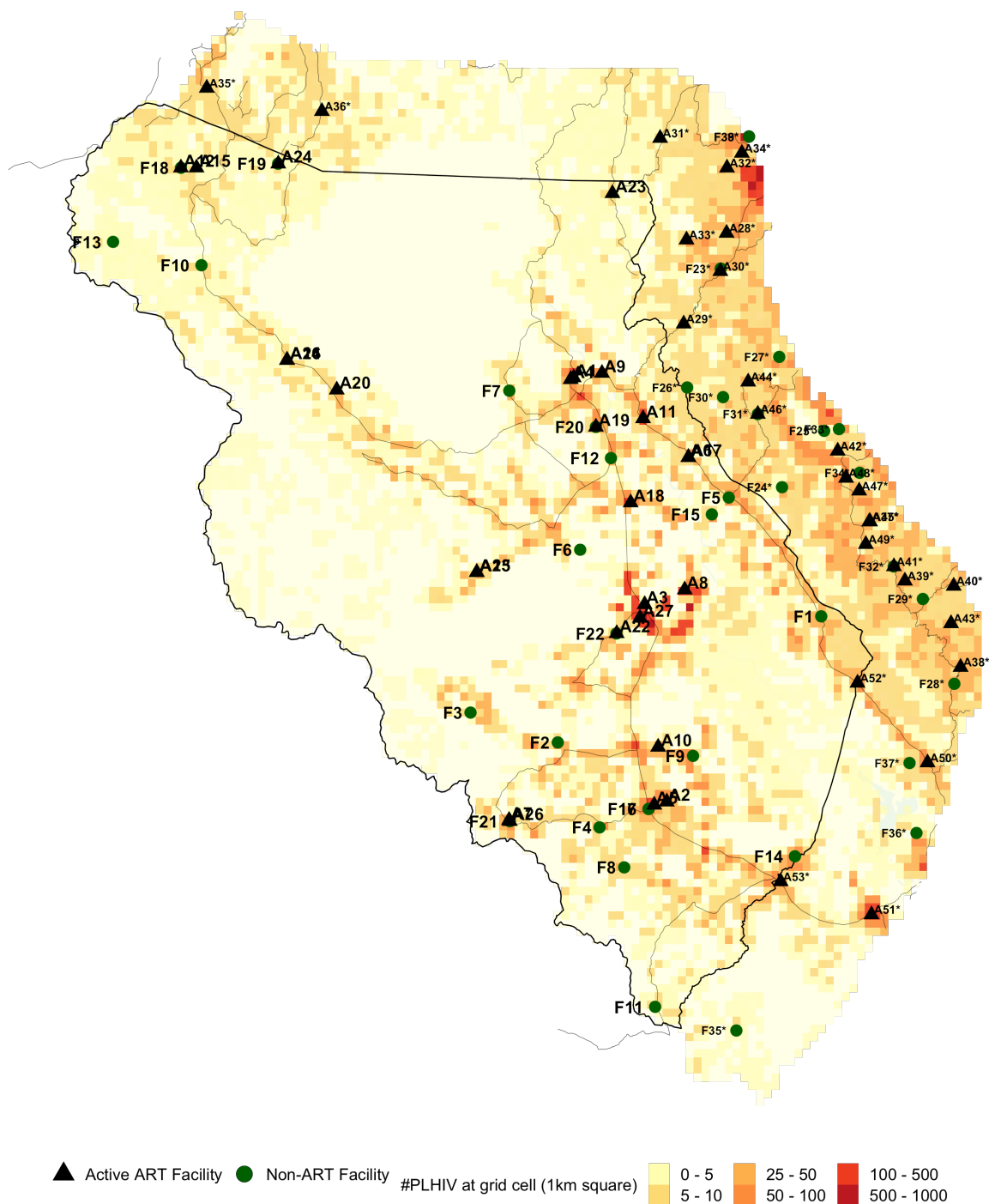


Figure 3: Estimated number of PLHIV on a 1km square.

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	Chikwawa	Chikwawa Boma	Chikwawa District Hosp.	District hospital	Government	34.79	-16.02	6504
A2	Chikwawa	Ngabu Urban	Ngabu Rural Hosp.	Rural/Community	Government	34.89	-16.46	4277
A3	Chikwawa	TA Lundu	St Montfort Hosp.	District hospital	CHAM	34.87	-16.26	4255
A4	Chikwawa	Chikwawa Boma	Makhwira HC	Health centre	Government	34.79	-16.03	2383
A5	Chikwawa	Ngabu Urban	Ngabu SDA HC	Health centre	CHAM	34.88	-16.46	1487
A6	Chikwawa	TA Makhwira	Mapelera HC	Health centre	Government	34.92	-16.11	1051
A7	Chikwawa	TA Ngabu	Dolo HC	Health centre	Government	34.72	-16.48	894
A8	Chikwawa	TA Lundu	Kalulu Health Centre, Chikwawa	Health centre	Private	34.91	-16.24	854
A9	Chikwawa	TA Mililima	Bereu HP	Health post	Government	34.82	-16.02	835
A10	Chikwawa	TA Ngabu	Sucoma Clinic Illovo	Health centre	Private	34.88	-16.40	831
A11	Chikwawa	TA Katunga	Mfera HC	Health centre	Government	34.87	-16.07	794
A12	Chikwawa	TA Chapananga	Gaga HC	Health centre	Government	34.37	-15.81	787
A13	Chikwawa	STA Ndakwela	Ndakwera HC	Health centre	Government	34.69	-16.22	768
A14	Chikwawa	TA Chapananga	Mkumaniza HC	Health centre	Government	34.49	-16.01	746
A15	Chikwawa	TA Chapananga	Chapananga HC	Health centre	Government	34.39	-15.81	699
A16	Chikwawa	TA Chapananga	Kakoma HC	Health centre	Government	34.49	-16.01	600
A17	Chikwawa	TA Makhwira	Mangulenje HC	Health centre	Private	34.92	-16.11	560
A18	Chikwawa	TA Maseya	Alumenda HC	Health centre	Private	34.85	-16.15	387
A19	Chikwawa	TA Katunga	Kasitu HC	Health centre	Government	34.82	-16.07	363
A20	Chikwawa	TA Chapananga	Minimini Disp.	Dispensary	Private	34.54	-16.04	359
A21	Chikwawa	TA Chapananga	Misomali HC	Health centre	CHAM	34.49	-16.01	324
A22	Chikwawa	TA Ngabu	Lengwe HC	Health centre	Private	34.84	-16.29	264
A23	Chikwawa	TA Kasisi	Chavala HC	Health centre	Government	34.83	-15.83	236
A24	Chikwawa	TA Chapananga	Chithumba HC	Health centre	Government	34.48	-15.80	202
A25	Chikwawa	STA Ndakwela	Mwanza Clinic Area 3	Health centre	Private	34.69	-16.22	197
A26	Chikwawa	TA Ngabu	Nkombedzi HC	Health centre	Private	34.72	-16.48	184
A27	Chikwawa	TA Lundu	Majete (Epicenter) HC	Health centre	Government	34.86	-16.27	38
A28*	Blantyre	TA Somba	Mpemba HC	Health centre	Government	34.96	-15.87	1910
A29*	Blantyre	TA Somba	Madziabango HC	Health centre	Government	34.91	-15.97	761
A30*	Blantyre	TA Somba	St Vincent HC	Health post	CHAM	34.95	-15.91	738
A31*	Blantyre	TA Kuntaja	Chimembe HC	Health centre	Government	34.89	-15.78	453
A32*	Blantyre	TA Kuntaja	Pensulo HC	Health centre	Government	34.96	-15.81	262
A33*	Blantyre	TA Somba	Mpingo Mat.	Health centre	Government	34.91	-15.88	104
A34*	Blantyre	TA Kuntaja	Sanjika Clinic	Dispensary	Government	34.97	-15.79	32
A35*	Mwanza	STA Govati	Thambani HC	Health centre	Government	34.40	-15.73	769
A36*	Mwanza	TA Kanduku	Tulonkhondo HC	Health centre	Government	34.52	-15.75	523
A37*	Thyolo	TA Kwethemule	Malamulo Mission Hosp.	District hospital	CHAM	35.11	-16.17	5006
A38*	Thyolo	TA Nsabwe	Thekerani HC	Rural/Community	Government	35.21	-16.32	2746
A39*	Thyolo	TA Changata	Changata HC	Health centre	Government	35.15	-16.23	1421
A40*	Thyolo	STA Mbawela	Zoa HC	Health centre	Government	35.20	-16.24	1219
A41*	Thyolo	TA Changata	St Martins Molere HC	Health centre	CHAM	35.14	-16.22	1011
A42*	Thyolo	TA Kwethemule	Mianga HC	Health centre	Private	35.08	-16.10	949
A43*	Thyolo	STA Mbawela	Mapanga Mat.	Special	CHAM	35.20	-16.28	875
A44*	Thyolo	TA Thomas	Thomasi HC	Health centre	CHAM	34.98	-16.03	821
A45*	Thyolo	TA Kwethemule	Chipho HC	Health centre	CHAM	35.11	-16.17	801
A46*	Thyolo	TA Mphuka	Didi HC	Health centre	Government	34.99	-16.06	569
A47*	Thyolo	TA Kwethemule	Sambankhanga HC	Health centre	Private	35.10	-16.14	298
A48*	Thyolo	TA Kwethemule	Hallena Oakley Ntambanyama HC	Health centre	CHAM	35.08	-16.13	241

A49*	Thyolo	TA Kwethemule	Makwasa Estate Clinic	Health centre	Private	35.11	-16.19	100
A50*	Nsanje	TA Mlolo	Trinity Mission Hosp.	District hospital	CHAM	35.17	-16.42	2798
A51*	Nsanje	TA Mbenje	Kalemba Community Hosp.	Health centre	CHAM	35.11	-16.58	2476
A52*	Nsanje	TA Mlolo	Masenjere HC	Health centre	Government	35.10	-16.34	1532
A53*	Nsanje	TA Mbenje	Sorgin HC	Health centre	Government	35.01	-16.54	1504

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	Chikwawa	TA Makhwira	Mitondo HP	Health Post	Government	35.06	-16.27	1118	(770-1570)
F2	Chikwawa	TA Ngabu	Chapwaila HC	Health Centre	Government	34.78	-16.40	782	(539-1087)
F3	Chikwawa	TA Ngabu	THERERE	Health Post	Government	34.68	-16.37	619	(368-929)
F4	Chikwawa	TA Ngabu	SAOPA	Health Post	Government	34.82	-16.49	568	(401-775)
F5	Chikwawa	TA Makhwira	Nkhate HP	Health Post	Government	34.96	-16.15	1050	(735-1413)
F6	Chikwawa	TA Lundu	SUCOMA Lengwe	Clinic	Company	34.80	-16.20	473	(320-679)
F7	Chikwawa	TA Kasisi	PENDE	Health Post	Government	34.72	-16.04	299	(202-434)
F8	Chikwawa	TA Ngabu	KHOKHWA	Health Post	Government	34.85	-16.53	322	(212-470)
F9	Chikwawa	TA Ngabu	NSOMO	Health Post	Government	34.92	-16.41	192	(137-264)
F10	Chikwawa	TA Chapananga	Kubalalika HP	Health Post	Government	34.39	-15.91	184	(113-275)
F11	Chikwawa	STA Masache	THENDO	Health Post	Government	34.88	-16.67	161	(80-291)
F12	Chikwawa	TA Maseya	HOPE VILLAGE	Dispensary	NGO	34.83	-16.11	119	(76-168)
F13	Chikwawa	TA Chapananga	GOLA	Dispensary	Government	34.30	-15.88	99	(49-170)
F14	Chikwawa	TA Ngowe	MWANAWANJOBVU	Health Post	Government	35.03	-16.52	59	(40-82)
F15	Chikwawa	TA Makhwira	MWANAYAYA	Health Post	Government	34.94	-16.16	289	(200-398)
F16	Chikwawa	Ngabu Urban	BLM Ngabu	Special	NGO	34.87	-16.47	44	(30-61)
F17	Chikwawa	Ngabu Urban	BLM Ngabu	Special	Private	34.87	-16.47	44	(30-61)
F18	Chikwawa	TA Chapananga	Changambika HC	Health Centre	Government	34.37	-15.81	0	(0-0)
F19	Chikwawa	TA Chapananga	Chithumba Disp.	Special	Government	34.48	-15.80	0	(0-0)
F20	Chikwawa	TA Katunga	Kasinthula Disp.	Dispensary	Government	34.82	-16.07	0	(0-0)
F21	Chikwawa	TA Ngabu	Nkumaniza HC	Health Centre	Government	34.72	-16.48	0	(0-0)
F22	Chikwawa	TA Ngabu	MAFALE	Dispensary	Government	34.84	-16.29	0	(0-0)
F23*	Blantyre	TA Somba	St Vincent HC	Health Centre	CHAM	34.95	-15.91	0	(0-0)
F24*	Thyolo	TA Mphuka	CHILENGO	Health Post	Government	35.02	-16.14	1073	(763-1406)
F25*	Thyolo	TA Mphuka	CHAWANI	Dispensary	Company	35.06	-16.08	337	(259-425)
F26*	Thyolo	TA Thomas	THABWANI	Health Post	Government	34.91	-16.03	276	(206-358)
F27*	Thyolo	TA Thomas	Chithebe HC	Health Centre	Government	35.01	-16.00	87	(64-117)
F28*	Thyolo	TA Nsabwe	Nsabwe HC	Dispensary	Government	35.20	-16.34	40	(31-51)
F29*	Thyolo	STA Mbawela	Mbalanguzi HC	Health Centre	CHAM	35.17	-16.25	15	(11-19)
F30*	Thyolo	TA Thomas	PUTENI	Health Post	Government	34.95	-16.04	85	(63-111)
F31*	Thyolo	TA Mphuka	Dzimhiri HP	Health Post	Government	34.99	-16.06	0	(0-0)
F32*	Thyolo	TA Changata	Molere HC	Special	Government	35.14	-16.22	0	(0-0)
F33*	Thyolo	TA Mphuka	Satemwa Clinic	Health Centre	Company	35.08	-16.08	144	(113-180)
F34*	Thyolo	TA Kwethemule	Kasembeleka	Dispensary	Company	35.10	-16.12	0	(0-0)
F35*	Nsanje	Mwabvi Game Reserve	Kanyimbi HP	Health Post	Government	34.97	-16.69	66	(30-125)
F36*	Nsanje	TA Mlolo	Mchacha HP	Health Post	Government	35.16	-16.49	37	(26-51)
F37*	Nsanje	TA Mlolo	Mlolo HP	Health Post	Government	35.15	-16.42	19	(14-24)
F38*	Blantyre City	Blantyre City Centre Ward	BLM Chilomoni	Special	NGO	34.98	-15.78	0	(0-0)
F39*	Blantyre City	Blantyre City Centre Ward	BLM Chilomoni	Special	Government	34.98	-15.78	0	(0-0)



## Travel Times to Closest ART Facilities

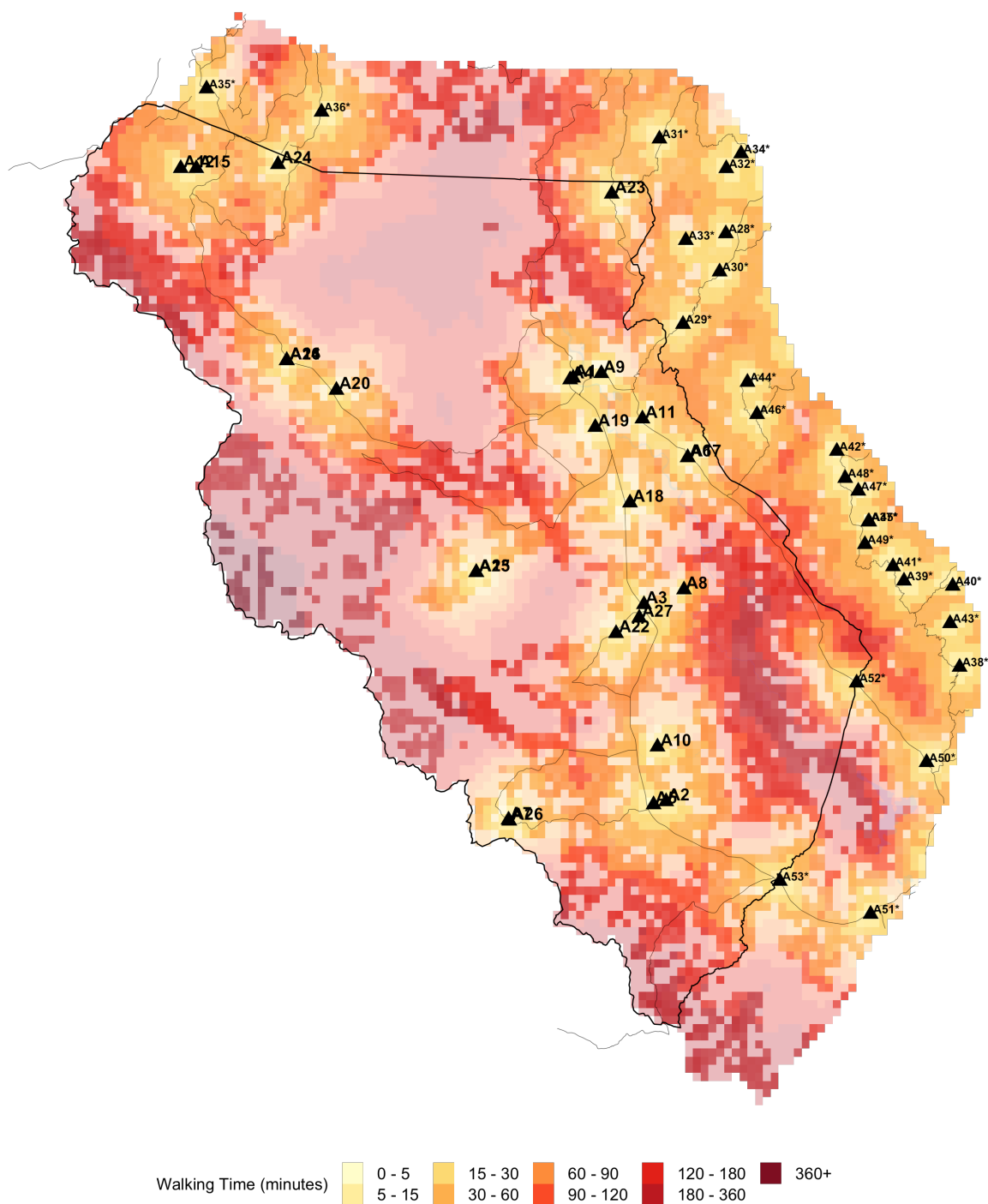


Figure 4: Estimated travel times to the closest ART facility. Travel times were calculated using data on road infrastructure, types of terrain and land elevation.

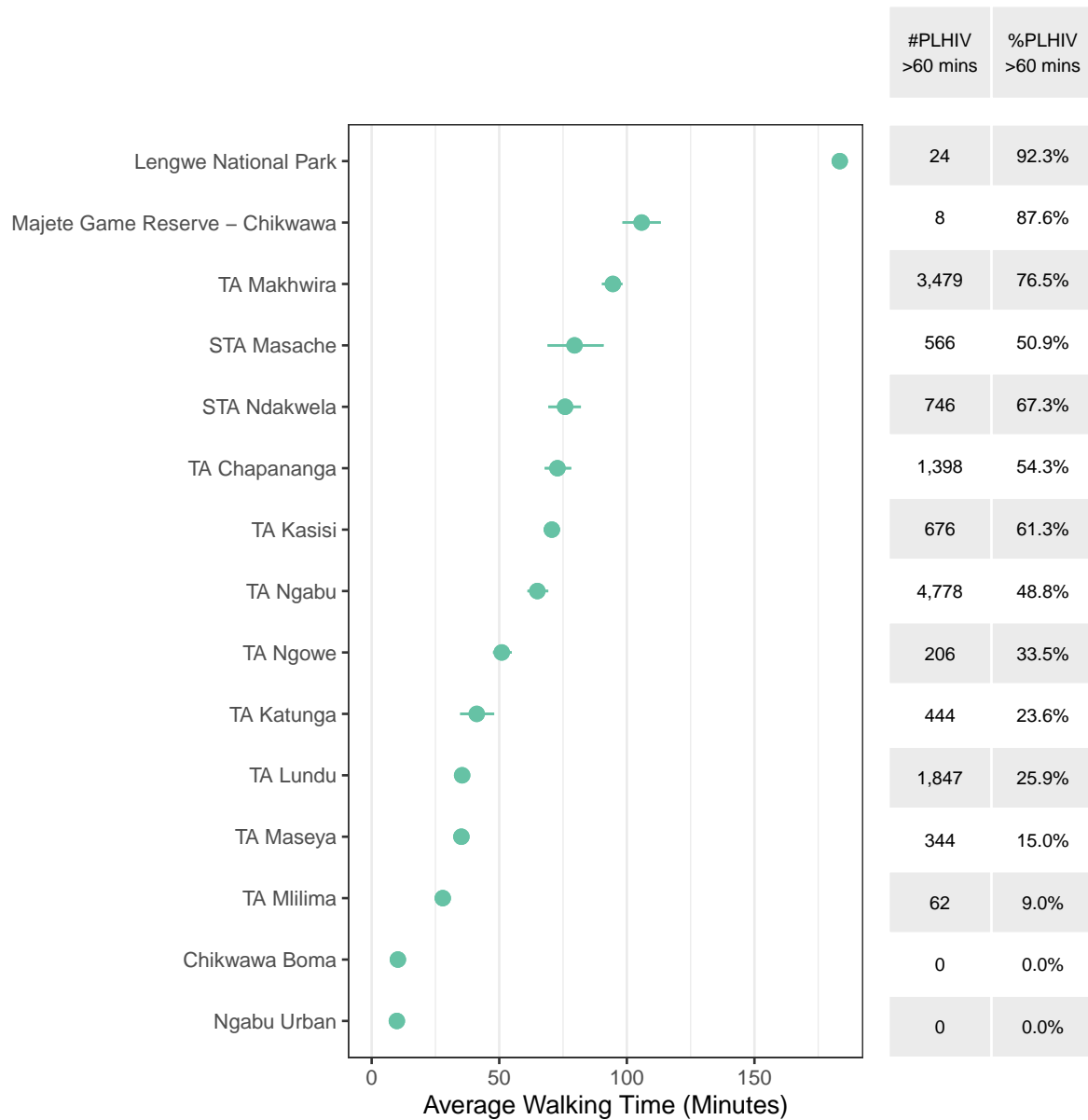


Figure 5: Estimated average walking time to the closest ART facility, weighted by the estimated number of PLHIV within the traditional authority. The right table indicates estimated number and proportion of PLHIV that need more than 60 minutes to travel to the closest ART facility, respectively.

## Areas outside 60 minutes travel

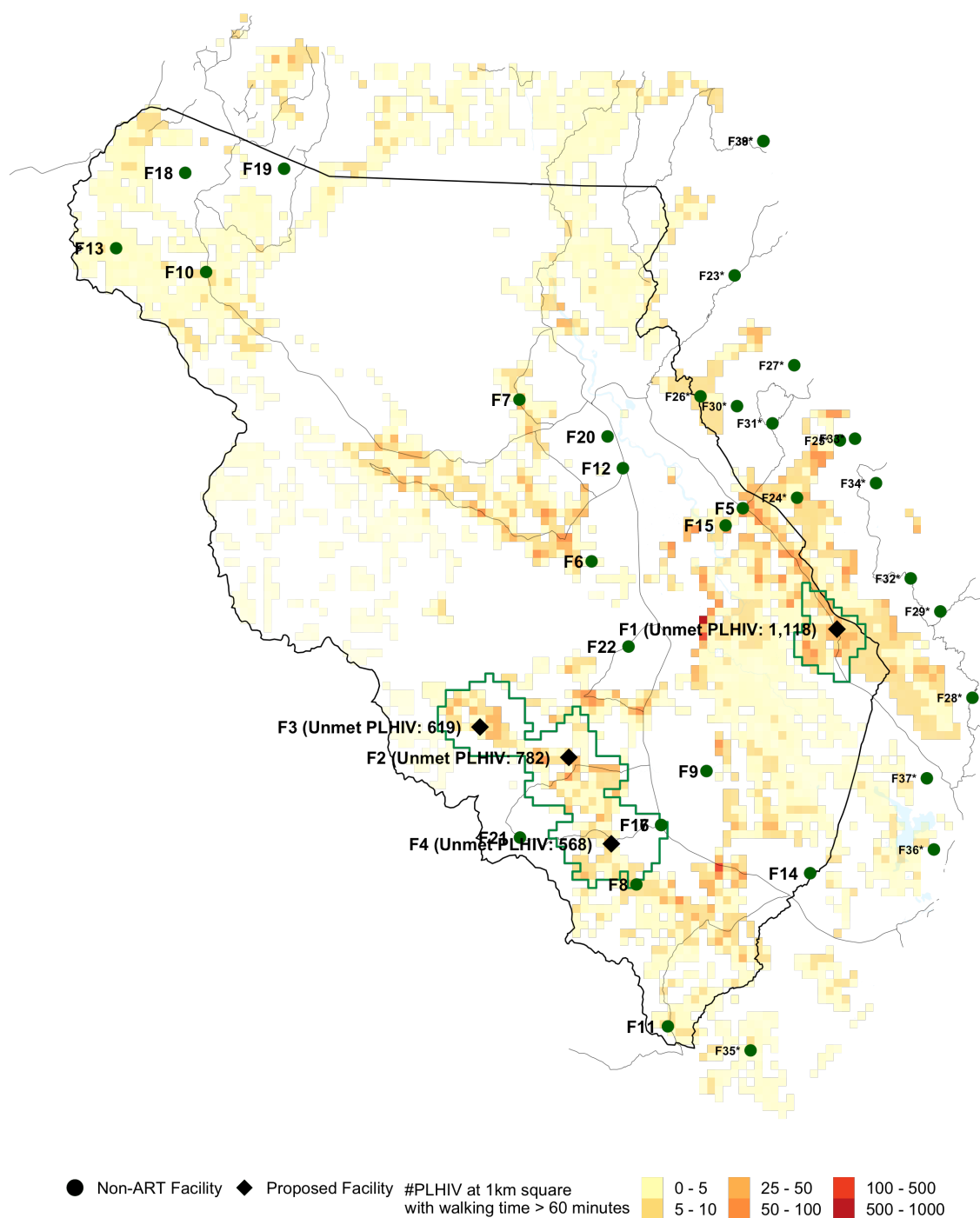


Figure 6: Proposed facility locations. Areas where the walking time to the closest ART facility is <60 minutes have been removed. Green lines indicate the 60-minutes catchment area of the proposed facility.

## 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.