

Assignment 3:
Planning an infant vaccination campaign

Data Sources and Processing

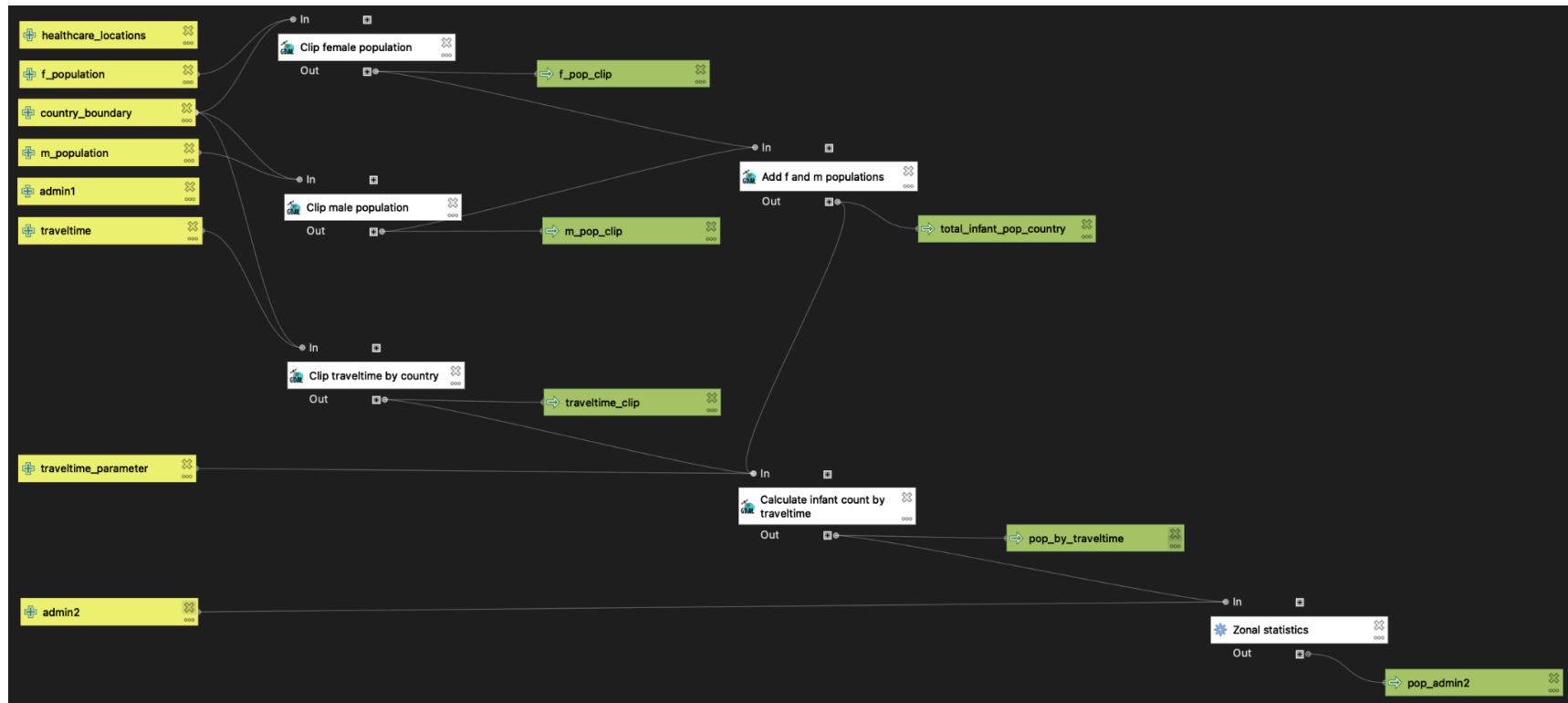
Data Compilation

Multiple geospatial datasets were integrated into this analysis to estimate the infant population (aged 0–1) residing more than 30 and 45 minutes away from healthcare facilities using motorized transport. Four publicly available datasets were accessed. First, healthcare facilities locations were obtained from Healthsites.io in a point dataset. This layer served as the destination data for calculating travel times. Second, global raster datasets from WorldPop provided population distributions disaggregated by age and sex. Two layers, representing male and female infants aged 0–1, were utilized to calculate the total infant population. Third, a travel time raster, including accessibility data estimating travel times to healthcare facilities via motorized transport, was sourced from Weiss et al. (2019). Fourth, administrative boundary data were obtained from the Database of Global Administrative Areas (GADM). These vector datasets provided boundaries for Admin 1 and Admin 2 levels, enabling subnational analysis and aggregation of results.

Analytical Workflow

The workflow was implemented in QGIS, utilizing core geoprocessing tools including raster calculator, clip tools, and zonal statistics. The processing model used to analyze these data comprised of several geoprocessing steps. The workflow began with clipping the global populations of infants between the ages of 0-1 year. The population rasters were clipped using the country boundary layer to restrict the analysis to the study area. This resulted in two new rasters, one for each sex, both representing the population distributions. Next, the clipped female and male layers were summed to produce the total infant population raster. The travel time raster was then clipped using the country boundary layer. A travel time threshold of 30- and 45-minutes was used to categorize areas based on healthcare accessibility. These parameters defined the population segments considered to have limited access. The travel time raster was used in conjunction with the total infant population raster to calculate the number of infants residing in areas with travel times exceeding the 30- and 45-minute thresholds. This calculation was performed using raster algebra. Finally, zonal statistics were applied to aggregate the infant population data into Admin 2 regions. This step provided the final estimates of infant populations requiring mobile vaccination over the travel time thresholds for each subnational unit.

Processing Model





Healthcare Inaccessibility of Madagascan Infants

Population of Infants <1 Year Old Living
30+ Minutes by Motorized Transport to
Nearest Healthcare Facility

Health Facility Locations
from healthsites.io

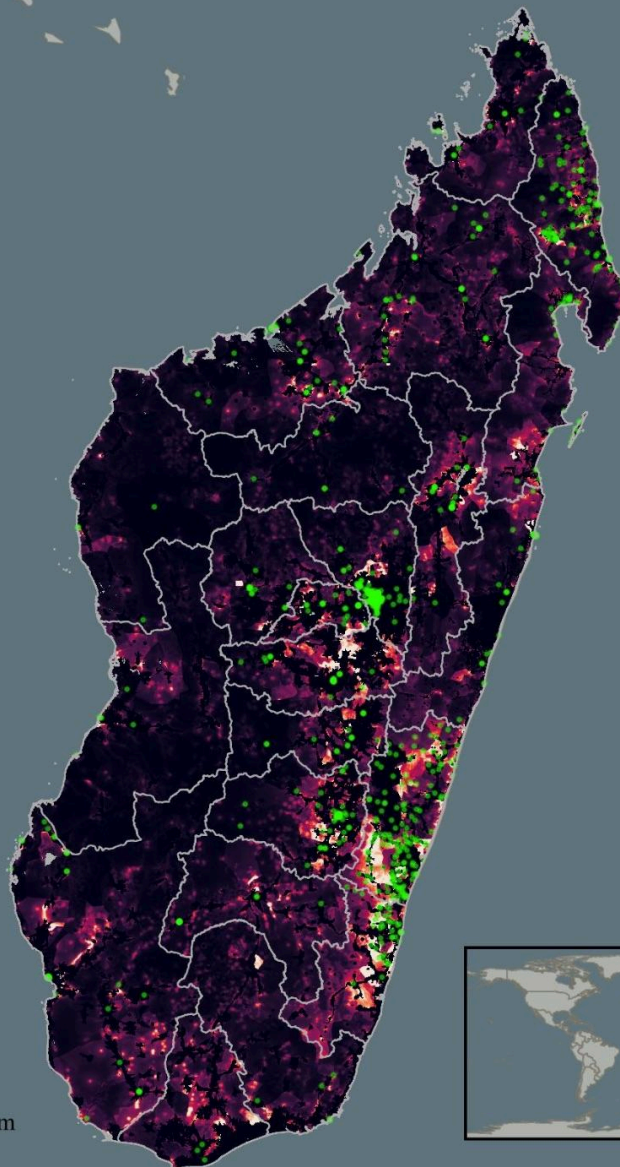
Infant Population Data
from WorldPop.org

Global Motorized Travel
Time to Healthcare from
Malaria Atlas Project
(Weiss et al., 2009)

Regional Administrative
Boundaries from
GADM.org

Date: November 2024

0 100 200 300 400 km



● Healthcare Facility

■ District Level
Boundaries

5+ infants present

0 infants present

Healthcare Inaccessibility of Madagascan Infants

Population of Infants <1 Year Old Living
45+ Minutes by Motorized Transport to
Nearest Healthcare Facility

Health Facility Locations
from healthsites.io

Infant Population Data
from WorldPop.org

Global Motorized Travel
Time to Healthcare from
Malaria Atlas Project
(Weiss et al., 2009)

Regional Administrative
Boundaries from
GADM.org

Date: November 2024

● Healthcare Facility

■ District Level
Boundaries

5+ infants present

0 infants present

0 100 200 300 400 km



Madagascan Infants (Aged 0–1) Living 30+ and 45+ Minutes from Healthcare Facilities by Motorized Transport and Requiring Mobile Vaccination.

Province (Admin 1 name)	District (Admin 2 name)	30+ minutes	45+ minutes
Antananarivo	Analamanga	9253	6758
Antananarivo	Bongolava	9880	7358
Antananarivo	Itasy	5960	3697
Antananarivo	Vakinankaratra	20835	13544
Antsiranana	Diana	10532	8207
Antsiranana	Sava	16529	13256
Fianarantsoa	Amoron'i Mania	9197	6761
Fianarantsoa	Atsimo-Atsinanana	31660	23345
Fianarantsoa	Haute Matsiatra	16618	12065
Fianarantsoa	Ihorombe	21273	17366
Fianarantsoa	Vatovavy Fitovinany	38685	29528
Mahajanga	Betsiboka	7743	6519
Mahajanga	Boeny	17471	12164
Mahajanga	Melaky	11180	9933
Mahajanga	Sofia	31063	24959
Toamasina	Alaotra-Mangoro	21726	17415
Toamasina	Analanjirifo	18419	15918
Toamasina	Atsinanana	16008	12806
Toliary	Androy	17712	10284
Toliary	Anosy	18011	14379
Toliary	Atsimo-Andrefana	43501	33638
Toliary	Menabe	16905	13573

Mozambican Infants (Aged 0–1) Living 30+ and 45+ Minutes from Healthcare Facilities by Motorized Transport and Requiring Mobile Vaccination.

Province (Admin 1 name)	District (Admin 2 name)	30+ minutes	45+ minutes
Cabo Delgado	Ancuabe	2230	1301
Cabo Delgado	Balama	2161	1338
Cabo Delgado	Chiúre	2931	2092
Cabo Delgado	Macomia	1853	1187
Cabo Delgado	Mecufi	218	71
Cabo Delgado	Meluco	480	359
Cabo Delgado	Mocimboa da Praia	1285	699
Cabo Delgado	Montepuez	3529	1844
Cabo Delgado	Mueda	2242	1707
Cabo Delgado	Muidumbe	714	489
Cabo Delgado	Namuno	4644	2646
Cabo Delgado	Nangade	1199	819
Cabo Delgado	Palma	616	392
Cabo Delgado	Pemba	709	374
Cabo Delgado	Quissanga	503	283
Gaza	Bilene	821	369
Gaza	Chibuto	1646	985
Gaza	Chicualacuala	1110	886
Gaza	Chigubo	1064	900
Gaza	Chókwè	691	286
Gaza	Guijá	1205	851
Gaza	Mabalane	798	603
Gaza	Mandlakazi	942	474
Gaza	Massangena	386	296
Gaza	Massingir	555	341
Gaza	Xai-Xai	1401	663

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Province (Admin 1 name)	District (Admin 2 name)	30+ minutes	45+ minutes
Inhambane	Funhalouro	1247	997
Inhambane	Govuro	650	416
Inhambane	Homoine	726	344
Inhambane	Inharrime	1412	866
Inhambane	Inhassoro	715	482
Inhambane	Jangamo	1053	446
Inhambane	Mabote	1142	834
Inhambane	Massinga	1302	717
Inhambane	Morrumbene	1006	524
Inhambane	Panda	1138	962
Inhambane	Vilanculos	1805	1172
Inhambane	Zavala	1653	821
Manica	Barue	4293	3198
Manica	Gondola	3555	2308
Manica	Guro	2378	1703
Manica	Machaze	3790	2973
Manica	Macossa	2309	1880
Manica	Manica	3080	1801
Manica	Mossurize	7214	4986
Manica	Sussundenga	3881	2640
Manica	Tambara	1517	1106
Maputo	Boane	61	14
Maputo	Magude	954	599
Maputo	Manhiça	274	86
Maputo	Marracuene	92	15
Maputo	Matutuíne	478	295
Maputo	Moamba	462	242
Maputo	Namaacha	300	176

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Province (Admin 1 name)	District (Admin 2 name)	30+ minutes	45+ minutes
Maputo City	Boane	0	0
Maputo City	Maputo	8	5
Nampula	Angoche	5020	2569
Nampula	Erati	3177	2501
Nampula	Lalaua	2693	1721
Nampula	Malema	3510	2536
Nampula	Meconta	2324	1351
Nampula	Mecuburi	4107	2571
Nampula	Memba	6694	4421
Nampula	Mogovolas	6375	3764
Nampula	Moma	6253	3415
Nampula	Monapo	4169	2450
Nampula	Mongincual	5693	3366
Nampula	Mossuril	1858	1142
Nampula	Muecate	2526	1620
Nampula	Murupula	3465	2231
Nampula	Nacala Velha	720	318
Nampula	Namapa	7196	5211
Nampula	Nampula	3687	1925
Nampula	Ribaue	3815	2147
Nassa	Cuamba	4626	2858
Nassa	Lago	2843	2059
Nassa	Lichinga	3657	2728
Nassa	Majune	1198	997
Nassa	Mandimba	1240	857
Nassa	Marrupa	1537	1091
Nassa	Maúa	2109	1687
Nassa	Mavago	1114	955
Nassa	Mecanheles	7640	3858
Nassa	Mecula	652	593
Nassa	Metarica	1159	994
Nassa	Muembe	1141	875
Nassa	N'gauma	2240	1374
Nassa	Nipepe	1080	895
Nassa	Sanga	1496	1137

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Province (Admin 1 name)	District (Admin 2 name)	30+ minutes	45+ minutes
Sofala	Buzi	657	171
Sofala	Caia	2076	1486
Sofala	Chemba	1935	1271
Sofala	Cheringoma	1766	1394
Sofala	Chibabava	3192	1924
Sofala	Dondo	154	4
Sofala	Gorongosa	2996	2067
Sofala	Machanga	1284	931
Sofala	Maringue	3238	2382
Sofala	Marromeu	4075	3087
Sofala	Muanza	1555	1143
Sofala	Nhamatanda	202	12
Tete	Angónia	2876	1028
Tete	Cahora Bassa	1975	1390
Tete	Changara	1568	709
Tete	Chifunde	4567	3099
Tete	Chiuta	4190	3244
Tete	Macanga	4809	2923
Tete	Magoé	4171	3536
Tete	Maravia	5811	5032
Tete	Moatize	7569	5614
Tete	Mutarara	11340	8240
Tete	Tsangano	1260	350
Tete	Zumbu	4393	3949
Zambezia	Alto Molocue	9022	6014
Zambezia	Chinde	1927	1298
Zambezia	Gile	5967	4074
Zambezia	Gurue	7993	5630
Zambezia	Ile	5836	3083
Zambezia	Inhassunge	904	538
Zambezia	Lugela	5207	4253
Zambezia	Maganja da Costa	7064	4530
Zambezia	Milange	10941	4955
Zambezia	Mocuba	4060	2124
Zambezia	Mopeia	4394	3335
Zambezia	Morrumbala	10621	6078
Zambezia	Namacurra	1779	848
Zambezia	Namarroi	3772	2551
Zambezia	Nicoadala	1991	1050
Zambezia	Pebane	6251	4692