

Chapter 11 Strategies for Infrastructure Sectors in Antananarivo Agglomeration

11.1 Water Supply of Antananarivo Agglomeration

11.1.1 Background on Water Supply of Antananarivo Agglomeration

(1) Institutional Framework of Water Supply in Madagascar

Ministry of Water, Energy and Hydrocarbons (MEEH: *Ministère de l'Eau, de l'Energie et des Hydrocarbures*) is the ministry in charge of water supply in Madagascar. Within MEEH, Directorate of Management of Water Resources (DGRE: *Direction Gestion de Ressources Eau*) under General Directorate of Water Management, Sanitation and Hygiene (DGEAH: *Direction Générale de l'Eau, de l'Assinissement et de l'Hygiène*) is in charge of water supply.

JIRAMA is the national water and electricity company of Madagascar owned by the Malagasy government. Technical Directorate of Water in Antananarivo (DTOA: *Direction Technique Eau Antananarivo*) of JIRAMA exclusively concentrates on the operation of water supply in Antananarivo. Attached to DTOA there is the Coordinator of Non-Revenue Water (NRW) which is the responsible office for NRW. Its mandates focus on the improvement of the strategy for NRW reduction, and to undertake all activities on loss reduction. Other than DTOA, Director of Water Equipment (DEXO: *Direction Equipement Eau*) is in charge of equipment and projects and the Director of Strategic Planning (DPS: *Directeur de la Planification Stratégique*) is in charge of planning for both energy and power sectors.

(2) Present Situation of Water Supply in Antananarivo Agglomeration

1) Drinking Water Access Rate

In 2016, MEEH conducted a study on the water supply and sanitation infrastructure inventory for Regional Objective Budget Programme (BPOR: *Budget Programme par Objectif par Région*) covering the whole country. According to this study, the access rate to appropriate drinking water¹ in Madagascar was estimated to be 23%.

Table 11.1.1 shows the provisional results of the water supply infrastructure inventory for BPOR for the 38 communes of Antananarivo Agglomeration. The access rate to appropriate drinking water for the agglomeration was calculated to be 71.88%. CUA as well as the communes of Sabotsy Namehana, Atenhiroka and Ambohidrapeto had access rates higher than 80%. These communes with high access rate are located in the central part of the agglomeration and most of the people use water from JIRAMA's network. (See Figure 11.1.1)

¹ The following water sources were considered as appropriate water sources in Antananarivo Agglomeration:

- BP: Branchement Particulier (Private Connection)
- BF : Borne Fontaine Public et Sociale (Public and Social Connection (Water Kiosk))
- FPMH : Forage avec Pompe à Motricité Humaine (Deep Well with Human Powered Pump)
- PPMH : Puit avec Pompe à Motricité Humaine (Shallow Well with Human Powered Pump)

Table 11.1.1 Provisional Results of Water Supply Infrastructure Inventory for BPOR in Antananarivo Agglomeration

No.	Commune	Population*	BF		BP	FPMH		PPMH		Beneficiaries	Access Rate (%)
			F	NF		F	NF	F	NF		
1	1er Arrondissement	242,790	184	10	12,196	0	0	0	0	223,145	91.91
1	2e Arrondissement	134,689	136	1	10,627	0	0	0	0	117,148	86.98
1	3e Arrondissement	236,851	187	0	8,790	0	0	2	0	221,106	93.36
1	4e Arrondissement	313,277	209	8	7,454	0	0	0	0	280,236	89.46
1	5e Arrondissement	314,190	209	8	10,207	0	0	0	0	280,781	89.37
1	6e Arrondissement	87,199	151	5	1,067	0	1	0	0	76,753	88.03
	Sub-Total CUA	1,328,996	1,076	32	50,341	0	1	2	0	1,199,169	90.23
2	Ambatolampy	14,393	0	1	0	0	0	3	3	270	1.88
3	Ambohidratrimo	18,159	60	0	490	1	1	0	1	9,012	49.63
4	Ambohitrimanjaka	43,416	4	0	10	2	1	0	0	2,380	5.49
5	Ampangabe	16,064	0	0	0	0	0	0	0	0	0.00
6	Anosiala	39,758	25	20	317	0	0	10	9	11,580	29.13
7	Antehiroka	62,537	68	1	1,240	0	0	0	0	51,901	83.00
8	Ivato	53,502	71	2	2,865	0	0	0	0	37,234	69.60
9	Talatamaty	65,600	42	0	1,408	0	0	0	0	42,458	64.73
10	Alakamisy Fenoarivo	23,485	33	0	308	0	0	0	0	13,951	59.41
11	Ambavahaditokana	40,602	40	1	2,147	0	0	0	0	21,866	53.86
12	Ambohidrapeto	30,480	26	3	1,920	3	0	0	0	29,250	95.97
13	Ambohijanaka	29,532	47	3	238	2	0	2	1	9,396	31.82
14	Ampanefy	14,097	0	0	0	0	0	0	0	0	0.00
15	Ampitatafika	90,320	65	8	6,690	0	0	11	4	52,325	57.94
16	Andoharanofotsy	38,951	18	0	3,325	0	2	1	5	25,108	64.47
17	Andranonahoatra	49,442	20	0	1,333	0	0	4	1	13,594	27.50
18	Ankadimanga	1,566	0	0	0	0	0	0	0	0	0.00
19	Ankaraobato	4,912	0	0	0	0	0	0	0	0	0.00
20	Anosizato Andrefana	2,279	2	2	0	0	0	0	0	138	6.06
21	Bemasoandro	16,895	12	0	25	0	0	1	0	6,558	38.82
22	Bongatsara	28,294	20	0	504	0	0	92	0	16,017	56.61
23	Fenoarivo	25,840	49	4	1,760	0	0	1	0	17,461	67.58
24	Fiombonana	8,000	47	5	0	0	0	3	4	2,824	35.30
25	Itaosy	12,067	2	5	0	0	0	2	0	1,843	15.28
26	Soalandy	70,624	66	0	3,393	0	0	3	0	56,996	80.71
27	Soavina	4,985	5	0	3	0	0	0	0	380	7.63
28	Tanjombato	6,345	0	0	0	0	0	0	0	0	0.00
29	Tsiafahy	33,585	45	2	556	0	1	0	0	18,160	54.08
30	Alasora	30,802	98	5	290	0	0	3	2	19,682	63.90
31	Ambohimambola	15,937	18	8	45	0	0	0	0	5,625	35.30
32	Ambohimanga Rova	25,285	95	37	101	1	1	2	2	11,588	45.83
33	Ambohimangakely	64,474	41	1	185	0	0	0	0	10,121	15.70
34	Ankadikely Ilafy	41,404	55	3	840	2	0	0	0	15,544	37.55
35	Sabotsy Namehana	4,015	42	2	14	0	0	0	1	3,392	84.49
36	Manandriana	38,788	119	8	130	0	0	0	0	17,757	45.78
37	Anosy Avaratra	15,640	103	10	56	0	0	0	0	9,267	59.26
38	Ambatomirahavavy	16,998	180	25	19	0	0	0	0	12,353	72.68
Total		2,428,069	2,594	188	80,553	11	7	140	33	1,745,200	71.88

Note* : Figures are based on each fokontany's data

BF: Borne fontaine (Water Kiosk)

BP: Branchement Particulier (Private Connection)

FPMH : Forage avec Pompe à Motricité Humaine (Deep Well with Human powered Pump)

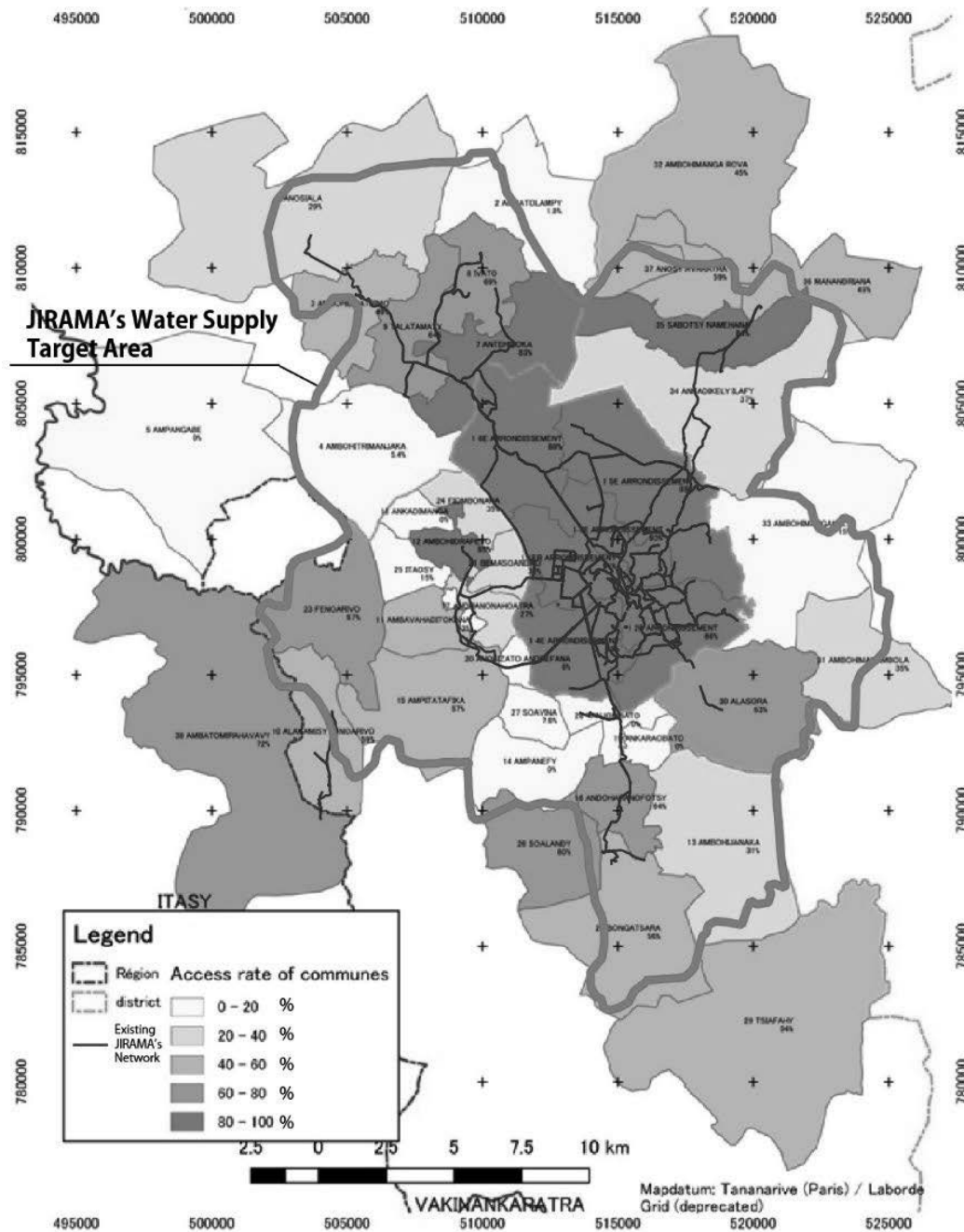
PPMH : Puit avec Pompe à Motricité Humaine (Shallow Well with Human powered Pump)

F : Functioning

NF : Not functioning

Source: MEEH, Water Supply Infrastructure Inventory for BPOR, 2016 (Draft)

JIRAMA's water supply network does not cover all areas of Antananarivo Agglomeration. Unserved communes outside of JIRAMA's network often have independent small water supply schemes mainly using gravity-fed water sources. Such independent water supply schemes are operated by NGOs, communes or fokontany. The number of BF (water kiosks) in Table 11.1.1 includes both of JIRAMA's network and independent systems.

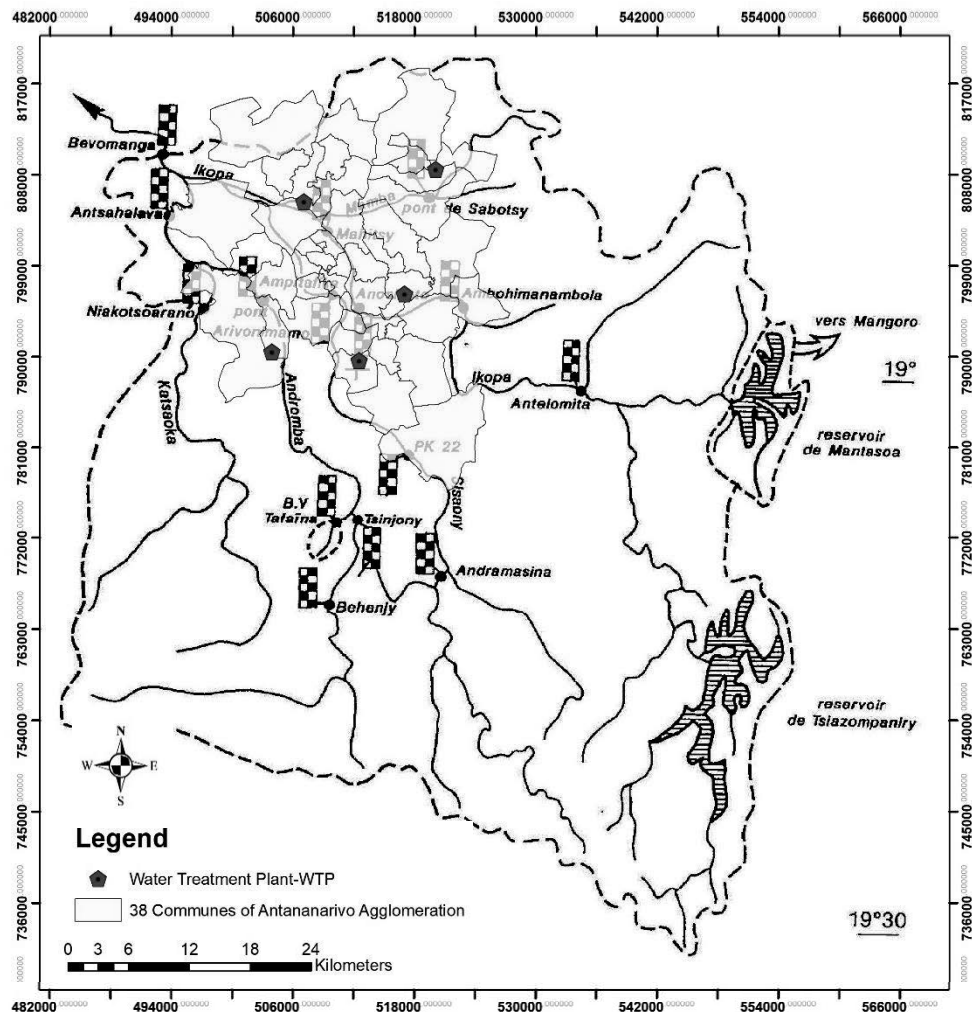


Source: JICA Study Team based on Provisional Results of Water Infrastructure Inventory for BPOR by MEEH and JIRAMA's data 2017

Figure 11.1.1 Access Rates to Drinking Water in Antananarivo Agglomeration

2) Water Resources for Antananarivo Agglomeration

The main source of water for Antananarivo Agglomeration is surface water from Mantsoa Dam and Tsiacompaniry Dam in the east and south east of Antananarivo (See Figure 11.1.2). Besides these two dams, surface water of rivers such as Mamba River and Andromba River which flows into Ikopa River are also used. Some communes such as Bongatsara, Anosiala and Ampitatafika use groundwater as part of their water resources as shown in Table 11.1.1. Subsoil water is also used in Rural Commune of Solandy.



Source: Fleuves et rivières de Madagascar, ORSTOM, 1993

Figure 11.1.2 Existing Dams and Hydrology of Ikopa Watershed

(3) Water Supply Facilities of Antananarivo Agglomeration

The water supply network of Antananarivo Agglomeration is composed of water treatment plants (WTPs) and other water infrastructures, such as pump stations, distribution reservoirs, primary conduits and booster pumps. Several distribution reservoirs and booster pumps are located in the agglomeration to regulate water pressure.

In recent years, annual net income of JIRAMA (including both energy and water sectors) have been negative. As a result, accumulated losses are increasing. Although JIRAMA is responsible for the investment of infrastructure under a concession contract with the government of Madagascar, it is difficult to invest for infrastructure extension or renewal given this financial situation.

1) Water Treatment Plants

Figure 11.1.3 shows the respective locations of WTPs in Antananarivo Agglomeration. There are six operating WTPs – Mandroseza I, Mandroseza II, Mandroseza II-bis, Sabotsy Namehana, Faralaza, Vontovorona and Ankadivoribe.

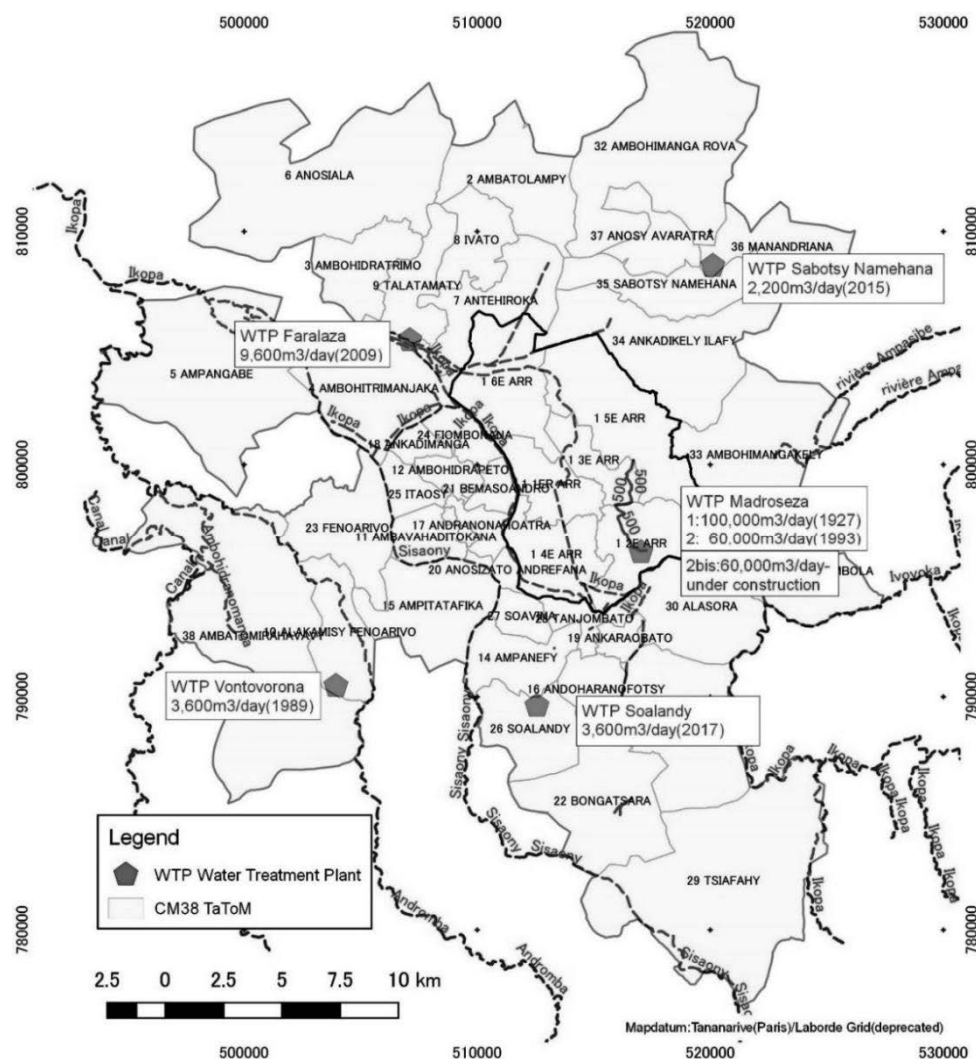
Since its establishment, Mandroseza I and II have produced almost 100% of urban water supply for Antananarivo. Mandroseza I and II WTPs also covers 90 % of the total water production in Antananarivo Agglomeration.

Mandroseza II-bis is a new WTP constructed adjacent to Mandroseza II. Planned capacity is 60,000 m³/day. However, only two out of six filters were completed in 2017 (equivalent to 20,000 m³/day)

capacity). The two completed filters started to operate in 2017 without increasing the water intake capacity from Mandroseza Lake (which is an artificial lake for taking water from Ikopa River). Therefore, II-bis has to contribute yet to the increase in production capacity.

In addition to Mandroseza II-bis, Ankadivoribe WTP was constructed in 2017 using subsoil water for Soalandy Commune. This commune was outside JIRAMA's target area, but is now covered by JIRAMA's network.

The capacity and characteristics of the WTPs in Antananarivo Agglomeration are summarised in Table 11.1.2.



Source: JICA Study Team based on JIRAMA's statistics data

Figure 11.1.3 JIRAMA's Water Treatment Plants in Antananarivo Agglomeration

Table 11.1.2 Operating Water Treatment Plants in Antananarivo Agglomeration

WTP	Daily Production (m³)	Hourly Rate (m³)	Operation Hour per Day (hr)	Year of Construction	Water Source	Filter Type
Mandroseza I	100,000	1,000	24	1927	Ikopa River (Pumping to artificial lake – Mandroseza Lake)	Bi-layer
Mandroseza II	60,000	1,000	24	1993	Ditto	Bi-layer
Sabotsy Namehana	2,200	100	24	2015	Mamba River (Pumping to sedimentation basin from dam and pumping station)	Bi-layer
Faralaza	9,600	400	20	2009	Ikopa River	
Vontovorona	3,600	150	24	1985	River	Mono-layer
Mandroseza II-bis	60,000	1,000	-	2017 (only two filters out of six)	Mandroseza Lake	'-
Ankadivoribe	3,600	150	-	2017	Subsoil Water	'-

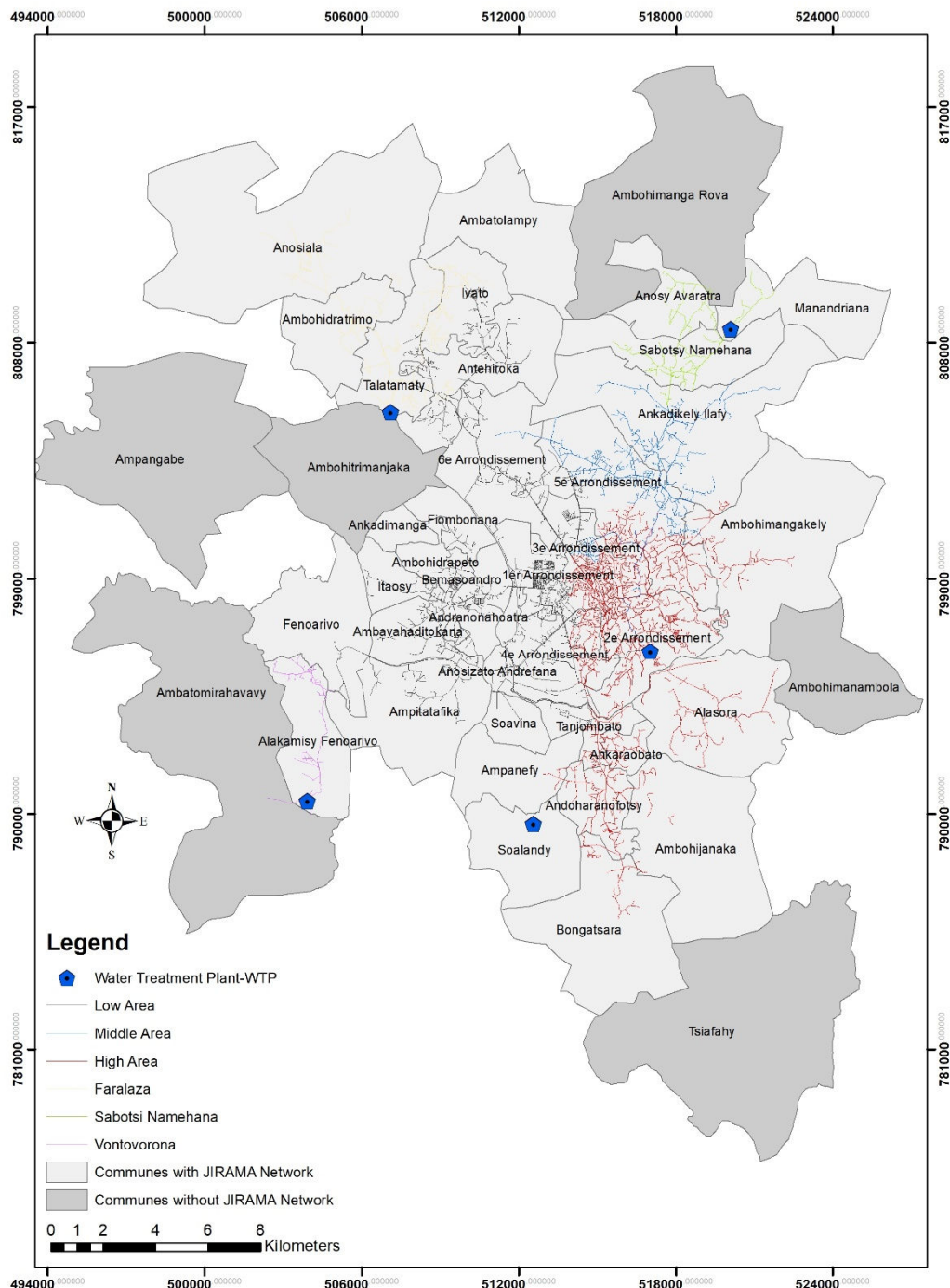
Source: JICA Study Team based on interview with JIRAMA in June 201

2) Water Supply Network and JIRAMA's Facilities

Figure 11.1.4 shows JIRAMA's water supply network in Antananarivo Agglomeration. JIRAMA's water supply network is divided into six areas, namely Low Area (Etage Bas), Middle Area (Etage Moyen), High Area (Etage Haut), Faralaza, Sabotsi Namehana and Vontovorona. Low Area, Middle Area and High Area are supplied by Mandroseza WTPs.

In the peripheral areas, only a small part of the communes is covered by JIRAMA's network. Furthermore, six communes, namely Ampangabe, Ambohitrimanjaka, Ambatomirahavavy, Ambohimanga Rova, Ambohimambola and Tsiafahy in the peripheral areas are not covered by JIRAMA's water supply network at all.

Table 11.1.3 shows detailed information of water supply network by distribution area.



Source: JIRAMA, 2017

Figure 11.1.4 JIRAMA's Water Supply Network in Antananarivo Agglomeration by Area (2017)

Table 11.1.3 JIRAMA's Water Supply Network by Distribution Area (2017)

No.	Distribution Area (Pipeline)	Pump Station	Water Tank	Booster	Total Length (km)	Area
1	Sabotsy Namehana (160-200PVC)	Ambatofotsy	Ambatofotsy	-	499	Manandriana - Ambatofotsy - Soaniadanana - Sab Nam - Ambohinorina-Namehana - Antsofinondry -Anosy Avaratra - Faravohitra - Lazaina - Ampangabe Ifaty
2	Vontovorona (200FTE)	Vontovorona	Vontovorona	-	99	Vontovorona - Alakamisy Fenoairivo
3	Faralaza (300, 200PVC)	Faralaza	Ambohidratrimo - Ivato	Mandriambéro	25	Faralaza - Tatalamaty - Amborompotsy - Mandriambéro - Ambohidratrimo-Andakana - Mandrosoa Ivato - Ivato Aéroport - BANI - Ivato Tanàna
4	Etage Bas (1000)	Mandroseza II	Fiadanana - Ambatondratrimo - Ambohidrapeto - Ambohidroa	Anosizato - Ambatondratrimo - Andraharo - Ambohimanandray - Ambodimita - Amboaroy	366	
5	Etage Haut (250)	Mandroseza I	Ambohimitsimbina	Rue Guillet	12	Ambanidia Volosarioka - Rue Guillet
6	Etage Haut (350, 450)	Mandroseza I	Fort Voyron - Bâche lavoloha - lavoloha I & II	Mahalavolona - lavoloha	137	Fenomanana Ambohimiandra - Mahazoarivo - Ambohivary Androndrabe - Androndrakely - Ambohitsoa - Manakambahiny - Ankaditoho Marohoho - Tsarafaritra - Anjahana - Tsimbazaza- Ouest Ambohijanahary - Ankadimbahoaka - Soanierana III I & III J - Mahamasina- Tanjombato - Ifarihy - Ankadilampotsy - Imerimanjaka - Dorodosy - Tongarivo Bevalala-Andoharanofotsy - lavoloha Bongatsara
7	Etage Haut (600)	Mandroseza I	Ambohimitsimbina - Andohalo - Ambohidenpona - Ambohipo - Campus - Faravohitra - Ambohibe - Ambohijatovo - Betongolo - Fort Duchesne - Ambohimahitsy - Ankatso	Rue Guillet - Antsahameva - Campus - Betongolo - Ambatomaro	241	Ambohimpotsy - Ambohimitsimbina - Manjakamiadana - Ambavahadimitafo - Andohalo-Ambohijatovo - Betongolo - Antaninarenina - Ampasamadinika - Tsaralalana - Analakely - Soarano - Behoririka - Tsiazotafy Ampandranana - Ankadivato -Besarety Andravoahandy - Anjanahary Manjakaray - Amboditsiry-Soavinandriana - Ambohitrakely - Ampahibe Ampasanimalo - Antanimora - Andohan'i Mandroseza - Ambohipo-Ankatso - Ampantokana - Andraisoro - Tsarahonenana - Ambohimahitsy - Ambohimagakely - Ambohibe
8	Etage Haut (450)	Mandroseza I	-	-	34	Alasora - Amboaroy - Ambodivondava - Miadana- Mendrikolovana - Mahitsy - Ampahibato
9	Etage Haut (350)	Mandroseza I	-	-	2	Cité Mandroseza
10	Etage Moyen (500)	Mandroseza I	Ampasapito - Ankadifotsy - Analamahitsy - Ambohimaiala	Nanisana - Analamahitsy - Ambohimaiala	150	Ankadifotsy - Nanisana ladiambola - Ankerana Ankadindramamy - Ambatobe Analamahitsy
11	Site Mandroseza				0.6	
	Total Length (m)				1115.48	

Source: JIRAMA's Statistics 2017

Total length of JIRAMA's network in 2017 was 1,115 km; in 2002, it was 837 km. This means 278 km of pipeline was newly constructed between 2002 and 2017. However, these new pipelines were mainly in CUA and most of the pipes have small diameters. The network progress in surrounding area remains insufficient.

There are two types of water supply networks, namely pressure network and gravity network. Minimum pressure which shall be ensured by JIRAMA is 1 bar.

The water supply network of Antananarivo suffered from insufficient pressures at many locations, due to leakage caused by aging pipes, insufficient diameters of pipelines, among others. Table 11.1.4 shows lengths of water pipelines by pipe type and diameter in Antananarivo Agglomeration.

Most of the aged water supply system consists of steel pipes. This is a major cause of water loss. JIRAMA considers that such steel pipes should be replaced by PVC pipes. However, JIRAMA's budget for the renewal of steel pipelines is limited. In addition, there could be several cases of land acquisition requirements for pipe renewal works that may pose some difficulties.

Table 11.1.4 Length of Water Pipelines by Pipe Type and Diametre in Antananarivo Agglomeration

Unit: m

Nominal Diametre (mm)	Pipe Type						Total
	Asbestos Cement	Steel	Grey Cast Iron	Ductile Cast Iron	Galvanized Steel	PVC	
40					5,037		5,037
50					4,765	70,788	75,553
60		46	2,817	236	89,127		92,226
63						226,485	226,485
75					24	114,757	114,781
80			38,678				38,678
90						69,433	69,433
100	1,341	1,382	82,580				85,303
110						25,503	25,503
125		971	539	9,995		23,057	34,562
140						6,899	6,899
150	1,935		58,994				60,929
160						16,701	16,701
200	779		70,801			28,730	100,310
250			79,441				79,441
300		671	20,689				21,360
350			18,571				18,571
400			14,790				14,790
450			1,480				1,480
500		1,273	12,957				14,230
600		2,717	2,066				4,783
700			3,173				3,173
800			1,612				1,612
1000			3,613				3,613
Total	4,055	7,060	412,801	10,231	98,953	582,353	1,115,453
Ratio	0.4%	0.6%	37.0%	0.9%	8.9%	52.2%	100.0%

Source: Statistics of JIRAMA 2017

There are 36 distribution reservoirs of JIRAMA in Antananarivo Agglomeration. Among these reservoirs 19 are in High Area, six are in Middle Area, and 11 are in Low Area. The total capacity is 45,000 m³. These distribution reservoirs work as storage reservoirs, which store the treated water to help in absorbing the hourly fluctuations in the normal water demand.

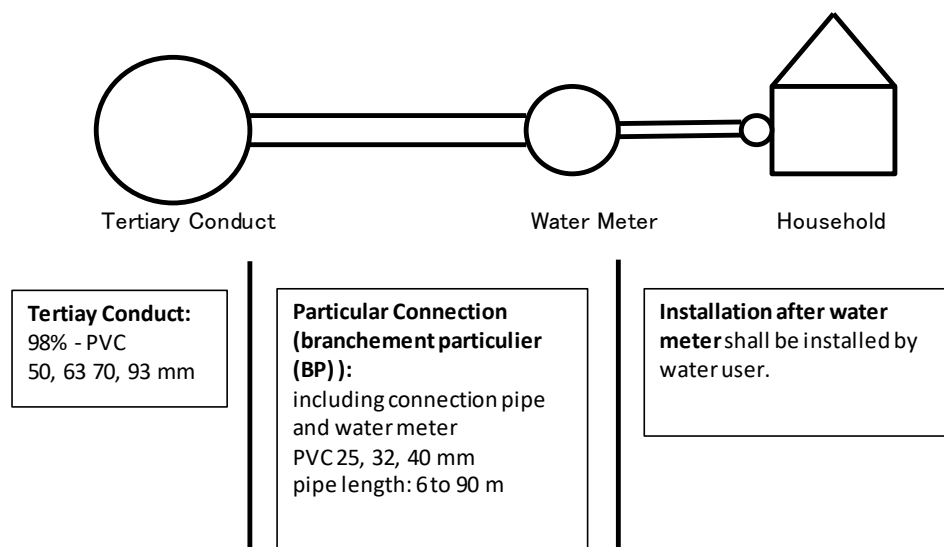
In 2000, JIRAMA had 11 pumping stations, excluding Mandroseza in Antananarivo Agglomeration. Between 2000 and 2017, nine additional pump stations were constructed and currently there are 20 pumping stations in Antananarivo Agglomeration, including transmission pumps for treated water and relay boosters. However, the construction of pump stations is not a principal measure to solve the deficiency of water pressure of the water supply network. The restructuring of water network and appurtenant facilities, including distribution reservoirs and boosters, based on appropriate demand estimation and hydraulic calculation, is necessary to achieve satisfactory improvement of the water supply situation in Antananarivo Agglomeration.

3) Water Supply Infrastructures

Figure 11.1.5 shows the concept diagram of private connections (BP: branchement particulier) of JIRAMA. Upon the acceptance of the request from the subscriber, JIRAMA will install a connection pipe between the water network and water metre. The pipes from the water meter to a household shall be installed by the subscriber. A private connection shall include connection pipe and water metre. These become property of the subscriber for five years from the time of installation, after that period these become property of JIRAMA. It is JIRAMA which is responsible for the maintenance of private connections after the installation.

Lack of budget for the purchase of materials to fulfil the needs of new private connections causes the delay of the installation works of new connections (only 20% to 25% of requests have been fulfilled). After the crisis of 2008, it became common for the clients to wait for two to three years before installation takes place.

In CUA, JIRAMA receives 300 to 350 requests for new connections each month. However, JIRAMA's plan is only for the installation of 250 connections per month (3,000 connections per year). Another problem concerning new connections in Antananarivo is the approval procedures by CUA. Each subscriber shall obtain the approval for a new connection from CUA (Direction des infrastructures). However, this process takes three to four months, and sometimes longer.



Source: JICA Study Team

Figure 11.1.5 Conceptual Diagram of Private Connection (BP)

As for BF (water kiosks), there are two types: public and private type. Public water kiosks are managed by communes, while private kiosks are managed by private water associations. Due to the difficulty in the management of public water kiosks by communes, JIRAMA promoted the transition of public water kiosks to private. Table 11.1.5 shows the change in the number of public and private water kiosks. The percentage of public water kiosks to total number was reduced from 79.4% in 2000 to 24.0% in 2016.

Table 11.1.5 Water Kiosks in Antananarivo Agglomeration (2000 and 2016)

Type of Kiosk Type	2000						2016					
	CUA		Surrounding Communes		Total		CUA		Surrounding Communes		Total	
	No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio
Public Water Kiosk	908	95.7%	63	23.0%	971	79.4%	179	12.5%	407	40.5%	586	24.0%
Private Water Kiosk	41	4.3%	211	77.0%	252	20.6%	1254	87.5%	599	59.5%	1853	76.0%
Total	949	100.0%	274	100.0%	1223	100.0%	1433	100.0%	1006	100.0%	2439	100.0%

Source: JIRAMA

(4) JIRAMA's Water Production and Consumption

1) Water Production

Table 11.1.6 shows the evolution of JIRAMA's water supply in Antananarivo Agglomeration.

Table 11.1.6 Water Supply in Antananarivo Agglomeration by JIRAMA (2010-2016)

Year	2010	2011	2012	2013	2014	2015	2016
Annual gross production of water (1,000 m ³ / year)	50,550	51,220	51,974	59,759	62,962	63,304	68,426
Daily average gross production of water (m ³ / day)	138,492	140,328	142,395	163,724	172,498	173,437	187,470
Annual net production of water (1,000 m ³ / year)	48,211	48,829	49,444	56,864	59,988	60,599	64,387
Daily average net production of water (m ³ / day)	132,086	133,779	135,463	155,793	164,351	166,025	176,403
Volume of water sold (1,000 m ³ / year)	31,687	31,779	31,751	31,439	33,185	33,738	33,800
Daily average volume of water sold (m ³ /day)	86,814	87,066	86,989	86,134	90,919	92,432	92,602
Number of subscribers	67,686	70,550	73,691	76,532	78,026	80,063	81,745
Revenue (million Ariary / year)	24,356	24,513	26,259	26,552	28,193	28,790	30,923
Revenue ratio	63%	62%	61%	53%	53%	53%	49%
Non-revenue ratio	37%	38%	39%	47%	47%	47%	51%
Average price of water (Ariary / m ³)	769	771	827	845	850	853	915

Source: Statistics of JIRAMA, 2017

2) Amount of Water Consumption

Table 11.1.7 shows the number of subscribers of JIRAMA in Antananarivo Agglomeration by category, as of December 2016. JIRAMA controls the water consumption and invoices using these categories which are given to each subscriber. It can be noted that majority (92.8%) of the subscribers belonged to BP category (private connection). Meanwhile, only 2.3% were classified as water kiosk subscribers. Other categories are not distinct, with less than 2% of the subscribers belonging to this category. This structure of subscriber categories is almost similar for CUA and surrounding communes.

Table 11.1.7 Number of JIRAMA's Subscribers in Antananarivo Agglomeration by Category (2016)

Code	Category*	CUA		Surrounding Communes		Total	
		No.	Ratio	No.	Ratio	No.	Ratio
03	JIRAMA agent (Active)	831	1.5%	380	1.4%	1,211	1.5%
04	JIRAMA agent (Retired)	597	1.1%	299	1.1%	896	1.1%
06	Internal consumption transfer	51	0.1%	11	0.0%	62	0.1%
50	Small private connection (BP)	49,993	92.4%	25,615	92.6%	75,608	92.5%
55	Gross private connection (BP)	146	0.3%	73	0.3%	219	0.3%
	Sub-Total BP	50,139	92.7%	25,688	92.9%	75,827	92.8%
52	Private water kiosk (BF)	1,254	2.3%	599	2.2%	1,853	2.3%
71	Public water kiosk (BF)	179	0.3%	407	1.5%	586	0.7%
	Sub-Total BF	1,433	2.6%	1,006	3.6%	2,439	3.0%
60	Small administration user	762	1.4%	248	0.9%	1,010	1.2%
65	Gross administration user	47	0.1%	11	0.0%	58	0.1%
70	Communal service	104	0.2%	13	0.0%	117	0.1%
72	Other Installation	113	0.2%	10	0.0%	123	0.2%
	Total	54,077	100.0%	27,666	100.0%	81,743	100.0%

Note*: Small private connection (BP): Not more than 1,000 m³ of consumption per month

Gross private connection (BP): More than 1,000 m³ of consumption per month

Private kiosk (BF): Water kiosk managed by user's associations

Public water kiosk (BF): Water kiosk managed by communes

Small administration user: Not more than 1,000m³ of consumption per month

Gross administration user: More than 1,000 m³ of consumption per month

Source: JIRAMA, 2016

Table 11.1.8 shows the daily average consumption of JIRAMA's subscribers in Antananarivo Agglomeration by category, as of December 2016. The first largest category was subscribers with private connection which occupied 72.4% of total daily average consumption. Second was water kiosk subscribers whose daily average consumption corresponded to 15.1% of total consumption. There was no significant difference in the structures of consumption of CUA and surrounding communes.

Table 11.1.8 Daily Average Consumption of JIRAMA's Subscribers in Antananarivo Agglomeration by Category (2016)

Code	Category	CUA		Surrounding Communes		Total	
		m ³ /day	Ratio	m ³ /day	Ratio	m ³ /day	Ratio
03	JIRAMA agent (Active)	679	1.0%	300	1.1%	979	1.0%
04	JIRAMA agent (Retired)	524	0.8%	252	0.9%	776	0.8%
06	Internal consumption transfer	384	0.6%	34	0.1%	418	0.4%
50	Small private connection (BP)	43,908	65.9%	19,879	74.4%	63,787	68.3%
55	Gross private connection (BP)	2,962	4.4%	877	3.3%	3,839	4.1%
	Sub-Total BP	46,870	70.3%	20,756	77.7%	67,626	72.4%
52	Private water kiosk (BF)	9,161	13.7%	1,893	7.1%	11,054	11.8%
71	Public water kiosk (BF)	1,513	2.3%	1,576	5.9%	3,089	3.3%
	Sub-Total BF	10,674	16.0%	3,469	13.0%	14,143	15.1%
60	Small administration user	4,294	6.4%	660	2.5%	4,954	5.3%
65	Gross administration user	2,315	3.5%	1,155	4.3%	3,470	3.7%
70	Communal service	685	1.0%	37	0.1%	722	0.8%
72	Other Installation	221	0.3%	45	0.2%	266	0.3%
	Total	66,646	100.0%	26,708	100.0%	93,354	100.0%

Source: JIRAMA, 2016

3) Non-Revenue Water

The ratio of non-revenue water to total production is approximately 45% in Antananarivo Agglomeration. Water losses are divided into the following two categories:

- Technical Loss including:
 - Failed counter
 - Problem on management (mistake with the statement, unbilled consumption, etc.)
 - Each network has its level of loss that is not visible.
 - Anomaly in counting
 - Water consumed by customers but not paid due to problem on checking
 - Problems with materials and with the process
- Commercial Loss including:
 - Unpaid bills
 - Customers already cancelled from the subscribers' list but remain active users
 - Bad counting, wrong bill
 - Illegal connection
 - Mistake with the statement
 - Refusal to pay
 - Problem of cost-recovery

Pressure regulation in the network is one of the counter-measures against technical losses. JIRAMA is measuring pressure at 100 points on network. In addition, JIRAMA has constructed a GIS database including the basic information and the conditions of pipelines, distribution reservoirs and booster pumps. By using this GIS database, JIRAMA is trying to improve the pressure control system of the network and extracting the problem sections of pipelines to be replaced immediately.

Due to losses caused by leakage, JIRAMA is now also conducting a sweeping operation within its service area, starting in February 2017 until 2020 (3 years). This systematic sweeping operation aims to visit all subscribers within 3 years. So far, approximately 600,000 m³ of losses have been recorded.

Many cases of unbilled water were recorded with 5,980 clients, including robbery cases and 162 cases of “ghost” clients (or those clients whose names were already cancelled in the subscribers’ list but remain active users in reality).

JIRAMA is supported by an international NGO, Water Supply for the Urban Poor (WSUP) in the procurement of equipment (such as leakage detectors) and in capacity development of technicians in charge of non-revenue water reduction.

JIRAMA also prepared a “Business Plan related to Reduction of Non-Revenue Water in Antananarivo (BUSINESS PLAN relatif à la reduction du non-revenue water, ville d’Antananarivo) in 2013 with a 5-year horizon, and which would supposedly commence in 2013 and run until 2017. The budget for this business plan is set at around 14 billion ariary, to be co-financed by WSUP with 27% and JIRAMA funding the remaining 73%. However, due to lack of funding the projects covered in the business plan have not been implemented yet. The objective of said business plan was to reduce the ratio of NRW of 45% in 2015 to 30% by 2017.

(5) Existing Plan and Project for Water Supply

1) JIRAMA’s Water Supply Master Plan for Antananarivo Agglomeration in 2003

JIRAMA formulated a water supply master plan for Antananarivo (Etude du schéma directeur du système d’adduction d’eau potable de la ville d’Antananarivo, also referred to as MP 2003) in 2003. This is the latest master plan for the water supply for CUA and its surrounding areas.

MP 2003 divided Antananarivo and its surrounding communes into “CUA” and nine areas of surrounding communes (“A” to “I”). The target areas of MP 2003 does not cover all of the 38 communes of TaToM.

MP 2003 projected the population of Antananarivo based on 1993 census data. As shown in Table 11.1.9, the projected population in 2020 (horizon of MP 2003) was 2.5 million, while the current population of Antananarivo Agglomeration already exceeds 2.9 million.

Table 11.1.9 Population Projection of Antananarivo Agglomeration by JIRAMA in MP 2003

Area	1993	2002	2010	2015	2020
CUA	710,236	845,060	959,483	1,028,554	1,091,766
Surrounding Communes	378,776	639,151	950,077	1,185,150	1,437,367
Total	1,089,012	1,484,211	1,909,560	2,213,704	2,529,133

Source: BCEOM (INFRAMAD), Etude du schéma directeur du système d’adduction d’eau potable de la ville d’Antananarivo, 2003, JIRAMA

MP 2003’s demand estimation for CUA and its surrounding areas until year 2020 is shown in Table 11.1.10. It can be noted that while MP 2003’s 2015 estimated water demand was 196,560 m³/day, the actual average water volume sold for the same year was only 92,432m³/day. Hence, there is a large gap between the estimated volume of water demand and actual volume of water supplied. This means JIRAMA was not able to fully implement MP 2003 as planned.

Table 11.1.10 Water Demand Estimation until 2020 for CUA and its Surrounding Communes in MP 2003

Area	Item	2002	2010	2015	2020
CUA	Demand (m ³ /day)	113,135	122,296	137,938	139,843
	Coverage Rate (%)	94.7	97.5	100	100
	of which private connection (%)	32.1	41.9	51.1	64.5
Surrounding Communes	Demand (m ³ /day)	27,365	74,264	137,636	163,323
	Coverage Rate (%)	25.8	63.8	100	100
	of which private connection (%)	13.7	28.4	38.4	49.6
Total	Demand (m ³ /day)	140,500	196,560	275,574	303,166
	Coverage Rate (%)	65	80.8	100	100
	of which private connection (%)	24.5	35.2	44.3	56

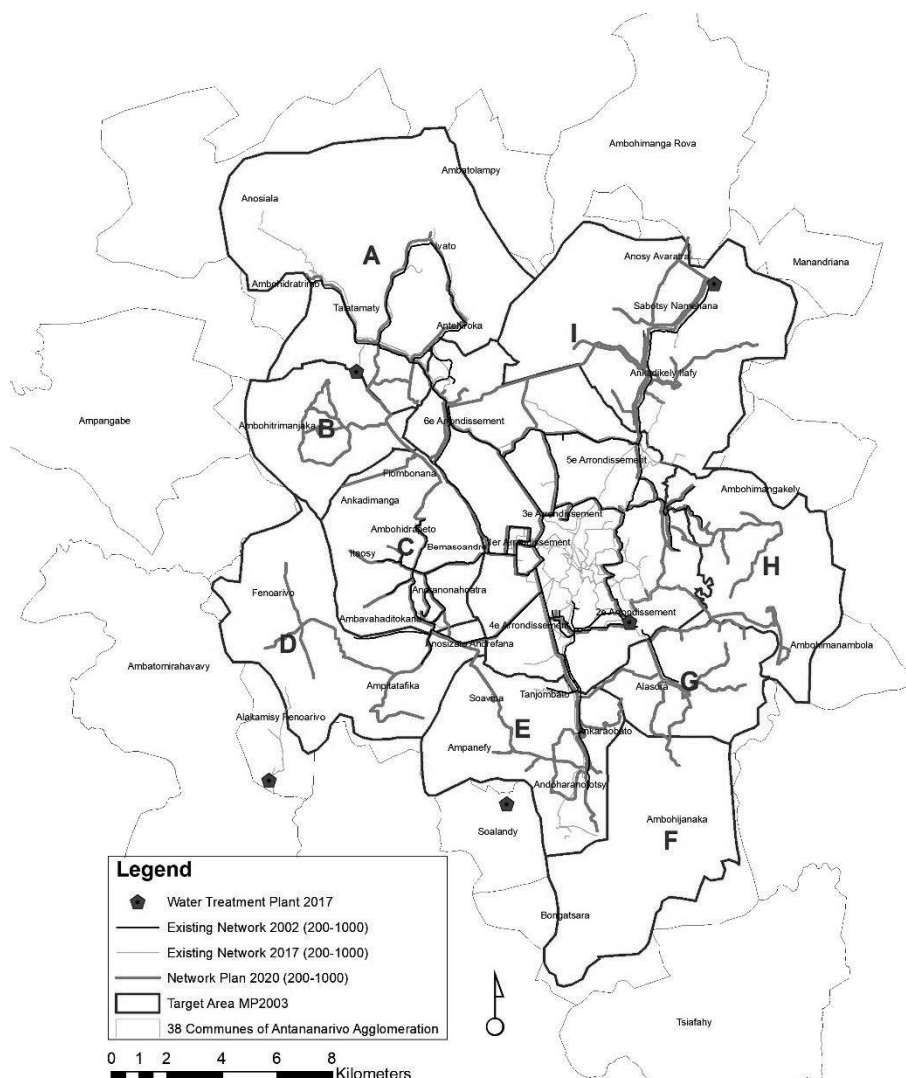
Source: BCEOM (INFRAMAD), Etude du schéma directeur du système d’adduction d’eau potable de la ville d’Antananarivo, 2003, JIRAMA

MP 2003 proposed to isolate water supply areas (i.e., right bank and left bank) of Ikopa River, the right bank (including CUA) shall be supplied by Mandrozeza WTPs, and by Laniera WTP to be constructed in the area between Mamba and Mambakely Rivers by 2020 with a capacity of 90,000 m³/ day. However, the construction has not started as of 2017.

Monthly drought flows were estimated to be 23.3 m³/s for 5 years, 20.5 m³/s for 10 years, 18.1 m³/s for 20 years, and 15.5 m³/s for 50 years. MP 2003 planned to increase water use of 2.8 m³/s to meet the demand in 2020, in addition to the current 1.7 m³/s water utilisation (4.5 m³/s = 388,800 m³/day in total).

On the other hand, the areas in the left bank of Ikopa River (the surrounding areas of “B”, “C”, “D”, “E”, “F” and “G”) was planned to be supplied by constructing six radial drainage wells with total discharge rate of 1.89 m³/s to be drilled in the alluvial plane along Ikopa and Sisaony Rivers. As of 2017, JIRAMA conducted the groundwater resources study² to develop groundwater resource for Soalandy Commune’s water supply, and the WTP in Soalandy Commune was constructed. However, its production is only 3,600 m³/h, and the entire groundwater capacity of the alluvial plain of Antananarivo remains to be clarified.

MP 2003 planned to extend the network by year 2020, as shown in Figure 11.1.6.



Source: JIRAMA's Water Supply Master Plan for Antananarivo, 2003

Figure 11.1.6 JIRAMA's Water Supply Network Extension Plan for 2020

² Projet de Renforcement de Production d'Eau dans la Zone Sud d'Antananarivo ; JIRAMA, July 2017

2) JIRAMA's New Water Supply Project (JIRAMA III)

JIRAMA is now implementing a new water supply project in Antananarivo Agglomeration, named "JIRAMA III." Provisional contents of JIRAMA III are as shown in Table 11.1.11. These contents were planned principally based on MP 2003. JIRAMA had agreement with European Investment Bank (EIB) and EU for the financing of this project in 2008. However, its implementation was suspended due to the political crisis until 2017 when the socio-economic study started.

The current schedule of JIRAMA III is as follows:

- May 2019: Preliminary design document will be prepared
- September 2019: Presentation to the Board of EU and EIB
- End of 2019: Signature of the loan and funding agreement
- End of 2020: Front end engineering document (FEED) will be prepared
- January 2021: Start of construction works (three to four years)

If all the provisional contents of JIRAMA III are realised, 150,000 m³/day of production capacity will be added to the water supply in Antananarivo Agglomeration. However, the contents may be reduced, depending on the results of the preliminary design. In addition, JIRAMA has concern on the capacity of water intake from Ikopa River and aquifers in alluvium plain, as the water resource study of the entire Ikopa basin has not been conducted since MP 2003.

Table 11.1.11 Provisional Contents of JIRAMA III

No.	Component	Contents
1	Doubling Mandrozeza 2 WTP	- Capacity 60,000 m ³ /day, intake from Mandrozeza Lake - Traditional treatment system: flocculation, decantation, bilayer filters - Raw water pump: Ikopa 4 x 1,100 m ³ /h, intake pump in the lake 4 x 1,100 m ³ /h - Transmission pump: 3 x 1,000 m ³ /h
2	Construction of Two WTP from Tana Plain (Groundwater)	- Capacity: 2 x 30,000 m ³ /day - Radiant drain wells in Ikopa alluvium plain - Iron removal plant and traditional filter system - Transmission pumps to existing reservoirs 3 x 500: 300 m ³ /h
3	Construction of a WTP at Laniera from Ikopa River	- Primary treatment module of 30,000 m ³ /day - Raw water pump (intake from the river): 2 x 1,500 m ³ /h - Transmission pumps: 4 x 700 m ³ /h - Reservoir: 4,000 m ³
4	Urgent Measures	- Replacement of existing pumps (5) - Installation of water meters (14,000 units) and flowmeters (60 units) - Replacement of broken connections (1,000 connections)
5	Replacement of Conduit (17 km)	- Replacement of conduits of galvanized steel: 17 km DN 50 to DN 200 by PVC
6	Construction of Primary Pipelines (22.2 km)	- 10.5 km of cast iron DN 400 to 600 - 3.8 km of cast iron DN 250 to 350 - 1.6 km of cast iron DN 300 - 3 km of cast iron DN 500 - 6.3 km of cast iron DN 600
7	Construction of Secondary Pipelines (354 km)	- West: 8 km of cast iron DN>200, 50 km of PVC DE<220, reservoir 2,500 m ³ - South: 13 km of cast iron DN>200, 41 km of PVC DE<220, reservoir 4,000 m ³ - North-East: 17 km of cast iron DN>200, 58 km of PVC DE<220, three reservoirs 2,700 m ³ , booster station at Mahalavolona 500m ³ , booster station at Mandriambero 135 m ³ /h
8	Remote Management System	- Enhancement and extension on 28 reservoirs and 20 booster stations in Mandrozeza WTP and in new WTP, and installation of central control system in Mandrozeza - Sectorisation of distribution network by the reinforcement of control/monitoring system of distribution network operation

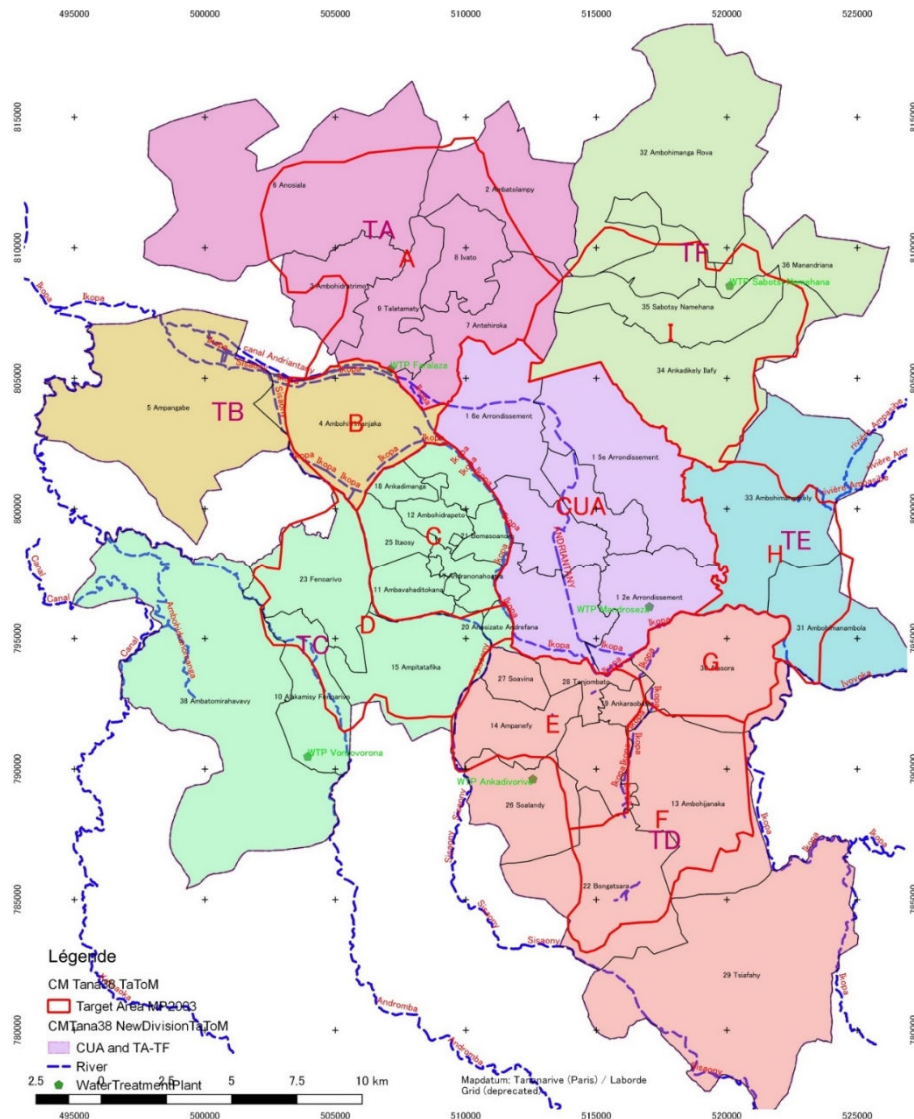
11.1.2 Future Demand Forecast for Water Supply of Antananarivo Agglomeration

(1) Expansion of Water Supply Areas

As described in 11.1.1, water supply areas of MP 2003 do not cover the entire areas of TaToM's target 38 communes. Hence, TaToM proposes a new division of water supply target areas of Antananarivo Agglomeration, as indicated in Figure 11.1.7. This new division was determined considering the following principal plan of MP 2003:

- Separation of water supply area into right bank and left bank of the Ikopa River
- Demand in right bank areas of the Ikopa River (CUA, "A", "I", "H" and "G") should be fulfilled by reinforcement from Mandrozeza WTPs and through new construction of Laniera WTP.
- Demand in left bank area of the Ikopa River ("B", "C", "D", "E", "F" and "G") shall be fulfilled by the development of groundwater with measure of construction of radial drainage wells in alluvial plain along the Ikopa River and the Sisaony River.

New target areas in Figure 11.1.7 are composed of CUA and six areas, namely: "TA", "TB", "TC", "TD", "TE" and "TF", each of which are comprised of areas in MP 2003 and peripheral communes not covered by MP 2003.



Source: JICA Study Team for TaToM

Figure 11.1.7 Expanded Water Supply Area Proposed by TaToM

(2) TaToM's Population Projection

Population of CUA and surrounding communes will be 1.8 million and 2.4 million, respectively, in 2033. Therefore, total population of Antananarivo Agglomeration will be 4.2 million in 2033. Table 11.1.12 shows population framework by commune until 2033.

Table 11.1.12 Population Framework for TaToM by Commune until 2033

Map No.	Commune	2018	2023	2028	2033	Target Area
1	1er Arrondissement	238,126	261,226	301,134	364,093	CUA
1	2e Arrondissement	192,215	216,293	232,724	238,945	CUA
1	3e Arrondissement	133,322	142,633	162,426	196,459	CUA
1	4e Arrondissement	255,847	289,276	312,129	320,733	CUA
1	5e Arrondissement	334,964	378,289	407,895	419,057	CUA
1	6e Arrondissement	120,733	138,756	170,582	223,812	CUA
	Total CUA	1,275,207	1,426,472	1,586,890	1,763,099	
3	Ambohidratrimo	22,176	29,086	37,398	47,749	TA
6	Anosiala	51,288	69,274	91,722	120,600	TA
9	Talatamaty	51,181	64,597	79,923	98,196	TA
7	Antehiroka	46,550	57,754	70,243	84,838	TA
8	Ivato	47,615	59,606	73,145	89,135	TA
2	Ambatolampy	25,798	34,713	45,788	59,974	TA
	Sub-Total TA	244,608	315,030	398,220	500,492	
4	Ambohitrimanjaka	36,970	43,828	50,933	58,777	TB
5	Ampangabe	17,152	21,328	25,998	31,468	TB
	Sub-Total TB	54,122	65,156	76,931	90,245	
15	Ampitatafika	62,937	74,920	87,427	101,310	TC
20	Anosizato Andrefana	26,498	29,544	32,293	35,050	TC
17	Andranonahoatra	57,139	64,621	71,643	78,873	TC
12	Ambohidrapeto	28,234	38,007	50,156	65,726	TC
21	Bemasoandro	51,573	54,494	56,444	58,058	TC
24	Fiombonana	12,084	14,467	16,979	19,787	TC
25	Itaosy	16,520	18,465	20,233	22,015	TC
11	Ambavahaditokana	39,257	50,577	63,877	80,113	TC
18	Ankadimanga	7,745	10,030	12,733	16,052	TC
23	Fenoarivo	31,650	34,700	37,294	39,803	TC
10	Alakamisy Fenoarivo	22,511	28,832	36,201	45,136	TC
38	Ambatomirahavavy	36,869	50,768	68,529	91,858	TC
	Sub-Total TC	393,016	469,427	553,808	653,781	
30	Alasora	58,316	76,180	97,555	124,056	TD
28	Tanjombato	43,406	45,836	47,447	48,774	TD
16	Andoharanofotsy	46,247	55,643	65,630	76,868	TD
19	Ankaraobato	42,433	46,365	49,662	52,823	TD
26	Soalandy	15,135	19,263	24,034	29,779	TD
14	Ampanefy	15,758	22,756	32,215	45,288	TD
27	Soavina	17,569	22,784	28,964	36,565	TD
13	Ambohijanaka	19,381	25,824	33,730	43,750	TD
22	Bongatsara	26,680	40,479	60,203	88,915	TD
29	Tsiafahy	20,114	22,902	25,562	28,333	TD
	Sub-Total TD	305,039	378,032	465,003	575,151	
31	Ambohimambola	15,815	19,010	22,400	26,212	TE
33	Ambohimangakely	111,718	152,209	203,287	269,614	TE
	Sub-Total TE	127,533	171,219	225,687	295,826	
37	Anosy Avaratra	16,881	22,679	29,867	39,058	TF
34	Ankadikely Ifafy	55,740	65,614	75,713	86,758	TF
35	Sabotsy Namehana	46,819	58,581	71,853	87,518	TF
36	Manandriana	9,149	12,024	15,491	19,817	TF
32	Ambohimanga Rova	30,130	38,413	48,007	59,579	TF
	Sub-Total TF	158,719	197,311	240,931	292,730	
	Total "TA" to "TF"	1,283,038	1,596,175	1,960,581	2,408,225	
	Grand-Total	2,558,245	3,022,647	3,547,471	4,171,324	

(3) Demand Projection

Water demand until 2033 is projected for each of new water supply areas proposed by TaToM. Table 11.1.13 shows the evolution of demand from 2018 to 2033. According to JIRAMA's statistics, water production capacity in the year 2018 was approximately 200 thousand m³/day. It means that deficit of water production is approximately 367 thousand m³/day and it will be 454

thousand m³/day in 2033, if the development of additional water production and water supply facilities will not be realized by this year.

Table 11.1.13 Commune-wise Population Projection until 2033 by TaToM

Year	2018	2023	2028	2033
Population	2,558,245	3,022,647	3,547,471	4,151,467
Demand (m ³ /d)	367,650	434,478	509,916	596,735

Table 11.1.14 shows the detailed calculation of the demand projection for 2033 by TaToM. The average daily production is calculated to be 597 thousand m³/day, in which revenue water is to be 478 thousand m³/day.

Table 11.1.14 TaToM's Water Supply Demand Projection for 2033

Item		Unit Consumption										TF				Sub-Total TA-TF				Total	
		CUA		TA		TB		TC		TD		TE		TF		Sub-Total TA-TF		Total			
		Value	Ratio	Value	Ratio	Value	Ratio	Value	Ratio	Value	Ratio	Value	Ratio	Value	Ratio	Value	Ratio	Value	Ratio	Value	Ratio
Population and Coverage Rate	Population (TaToM Estimation)	1,763,099		500,492		90,245		653,781		575,151		295,826		292,730		2,408,225		4,171,324			
	Served Population	1,763,099		500,492		90,245		653,781		575,151		295,826		292,730		2,408,225		4,171,324			
	Coverage Rate	100.0%		100.0%		100.0%		100.0%		100.0%		100.0%		100.0%		100.0%		100.0%			
	By BP	705,240	40.00%	200,197	40.00%	36,098	40.00%	261,512	40.00%	230,060	40.00%	118,330	40.00%	117,092	40.00%	963,290	40.00%	1,668,530	40.00%		
Subscribers	By BF	1,057,859	60.00%	300,295	60.00%	54,147	60.00%	392,269	60.00%	345,091	60.00%	177,496	60.00%	175,638	60.00%	1,444,935	60.00%	2,502,794	60.00%		
	Small private connection (BP)	82,565	38.40%	23,560	38.60%	4,248	38.60%	30,776	38.60%	27,074	38.6%	13,925	38.60%	82,565	38.6%	182,148	84.00%	264,712	83.5%		
	Water Kiosk (BF)	4,231	57.60%	1,210	58.00%	218	58.00%	1,580	58.00%	1,390	58.0%	715	58.00%	4,231	58.0%	9,344	4.30%	13,575	4.3%		
	Public Water Kiosk																				
Daily Average Consumption (m3/day)	Private Water Kiosk	4,231		1,210		218		1,580		1,390		715		4,231		9,344	4.30%	13,575	4.3%		
	Gross Private Connections (BP)	968	0.45%	244	0.40%	44	0.40%	319	0.40%	281	0.40%	144	0.40%	143	0.40%	1,175	0.90%	2,142	0.9%		
	Other Consumers	7,791	3.50%	1,896	3.00%	342	3.00%	2,476	3.00%	2,179	3.00%	1,121	3.00%	1,109	3.00%	9,122	6.50%	16,914	7.0%		
	Total Subscribers	99,787	100.00%	28,119	100.00%	5,070	100.0%	36,731	100.0%	32,313	100.0%	16,620	100.00%	99,787	100.0%	218,640	100.00%	318,426	100.0%		
Daily Production (m3/day)	Small private connection (BP)	69,734	46.3%	19,899	48.7%	3,588	48.72%	25,993	48.7%	22,867	48.7%	11,761	48.7%	69,734	67.6%	153,842	55.8%	223,576	52.5%		
	Water Kiosk (BF)	25,389	16.9%	7,257	17.8%	1,309	17.8%	9,480	17.8%	8,340	17.8%	4,289	17.8%	25,389	24.6%	56,063	20.3%	81,452	19.1%		
	Public Water Kiosk																				
	Private Water Kiosk	25,389	16.9%	7,257	17.8%	1,309	17.8%	9,480	17.8%	8,340	17.8%	4,289	17.8%	25,389	24.6%	56,063	20.3%	81,452	19.1%		
Daily Production (m3/day)	Gross Private Connections (BP)	24,189	16.1%	6,104	14.9%	1,101	14.9%	7,973	14.9%	7,014	14.9%	3,608	14.9%	3,570	3.5%	29,369	10.7%	53,557	12.6%		
	Other Consumers	31,166	20.7%	7,583	18.6%	1,367	18.6%	9,906	18.6%	8,714	18.6%	4,482	18.6%	4,435	4.3%	36,488	13.2%	67,654	15.9%		
	Total Sold (m3/day)	150,477	100.0%	40,842	100.0%	7,364	100.0%	53,352	100.0%	46,935	100.0%	24,141	100.0%	103,128	100.0%	275,762	100.0%	426,240	100.0%		
	Daily Maximum Production (m3/day)	210,668		57,179		10,310		74,692		65,709		33,797		144,379		386,067		596,735			
Daily Production (m3/day)	Daily Average Production (m3/day)	188,097		51,053		9,206		66,689		58,669		30,176		128,910		344,703		532,799			
	Revenue Ratio (%)	80.0		80.0		80.0		80.0		80.0		80.0		80.0		80.0		80.0			

Source: JICA Study Team

(4) Necessity of Water Production Capacity Reinforcement

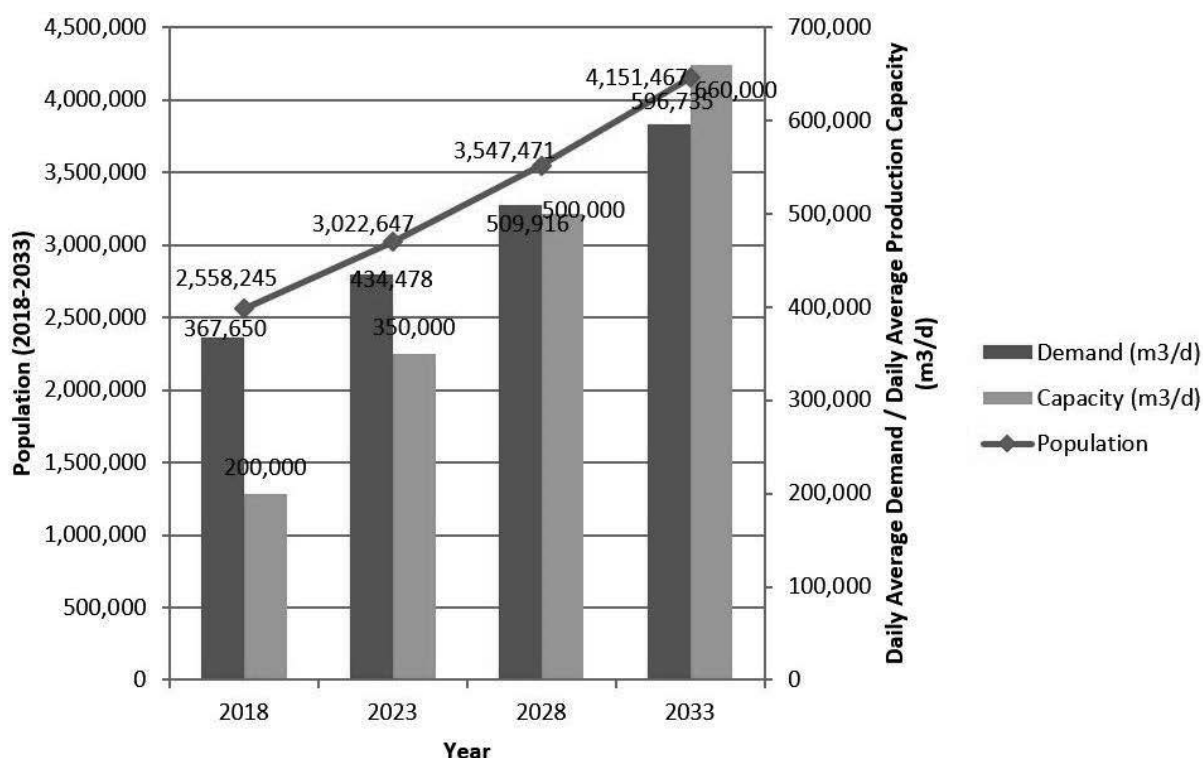
As described in the previous clause, currently there is a large gap between water demand and water production capacity of JIRAMA in Antananarivo Agglomeration. This gap will continuously increase according the rapid population increase. Therefore phased reinforcement of water production capacity is indispensable to catch up the increase water demand in 2033.

Table 11.1.15 shows an example of water production capacity reinforcement plan by 2033. According to JIRAMA's statistics, actual water production capacity in Antananarivo Agglomeration in 2018 was 200,000 m³/h. Therefore deficit between actual water production capacity and demand estimation in 2033 (654,761 m³/day) is approximately 440,000 m³/h. Under going JIRAMA III is planned to add 150,000 m³/h of production capacity. Therefore, other water facility construction projects to fulfil the gap shall be planned and implemented.

Table 11.1.15 Water Production Capacity Reinforcement Plan by 2033

Year	2018	2023	2028	2033
Population	2,558,245	3,022,647	3,547,471	4,151,467
Demand (m ³ /d)	367,650	434,478	509,916	596,735
Production Capacity (m ³ /d)	200,000	350,000	500,000	660,000
JIRAMA III (on going)		150,000		
Water Facility Construction Projects			150,000	
Water Supply Facility Construction Projects				160,000

Figure 11.1.8 shows evolution of population, water demand and water production capacity between 2018 and 2033, in case water production capacity reinforcement plan in Table 11.1.15 is implemented.

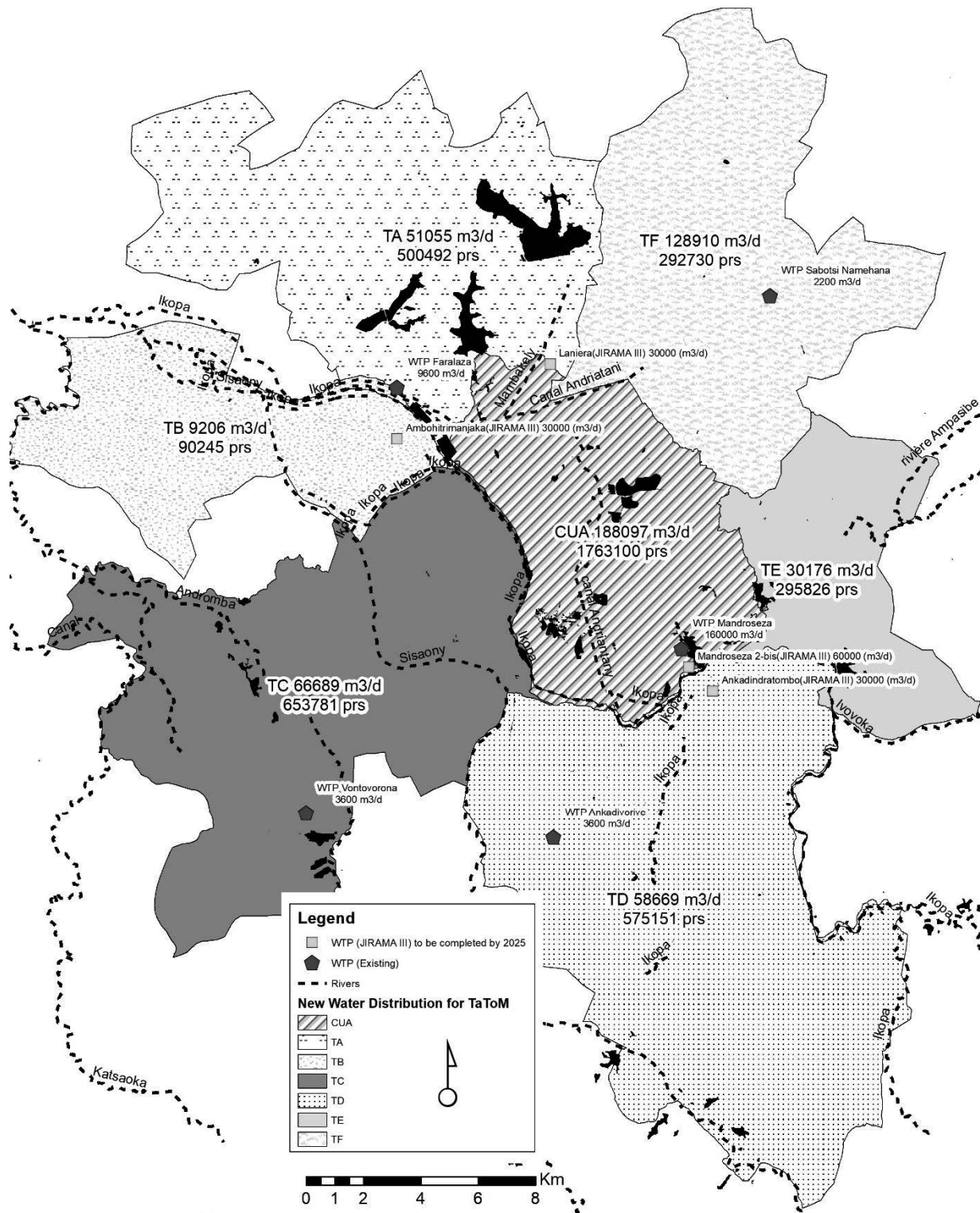


Source: Estimation by TaToM

Figure 11.1.8 Water Production Capacity Reinforcement Plan by 2033

Figure 11.1.9 shows area-wise water demand estimation in 2033. It shows locations of existing WTPs (Mandroseza, Sabotsy Namehana, Falaraza, Vontvorona and Ankadivoribe) and WTPs to be constructed by JIRAMA III (Laniera, Ambohitrimanjaka, Mandroseza 2-bis and

Ankadindratombo) with their production capacities. As described above, even with the realization of JIRAMA III (150,000 m³/day), the water production deficit will amount to 310,000 m³/day. Revision of water supply master plan in Antananarivo including water potential resources study and planning of water supply facility construction projects are very urgent issue.



Source: JICA Study Team

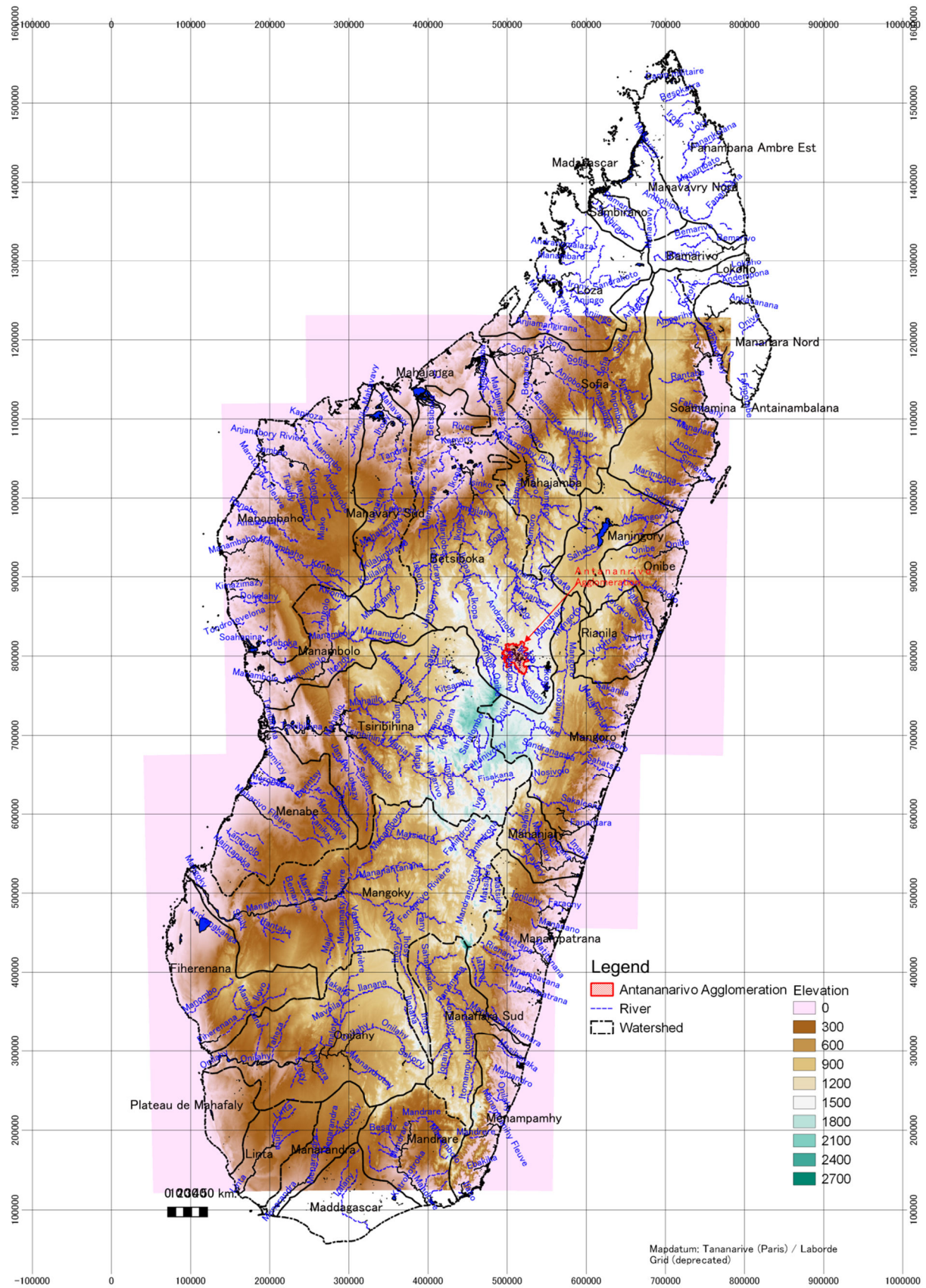
Figure 11.1.9 Provisional Demand Projection in the Horizon 2033

(5) Necessity of Development of Supplementary Water Sources from Other Watersheds

As described in the previous clause, increase of water production from current 200 thousand m³/day to 600,000 m³/day is necessary in order to fulfil the estimated demand in 2033. However, even the maximum use of Ikopa River and the groundwater in Tana plain will not reach to this target demand. Therefore, mobilization of supplementary water resources from rivers flowing in other watersheds neighbouring Ikopa sub-watershed.

Figure 11.1.10 shows the divisions of topography and watersheds in Madagascar. Antananrivo Agglomeration and Ikopa River including Mantasoa and Tsiazonpaniry dams are situated in the south end of Betsioka watershed. This area is almost the highest in Madagascar and there is no distinct river of which water flow is sufficient as to be supplementary water sources for the future demand of the Antananarivo Agglomeration.

Therefore, it is necessary to try to find such rivers in the neighbouring watersheds such as lower Betsiboka, Mangoro, Tsiribihina etc.



Source: Created from AW3D30 DSM (JAXA) and Proposition of Divisions of Watersheds Agencies (UNDP, 2008)

Figure 11.1.10 Topography and Watersheds in Madagascar

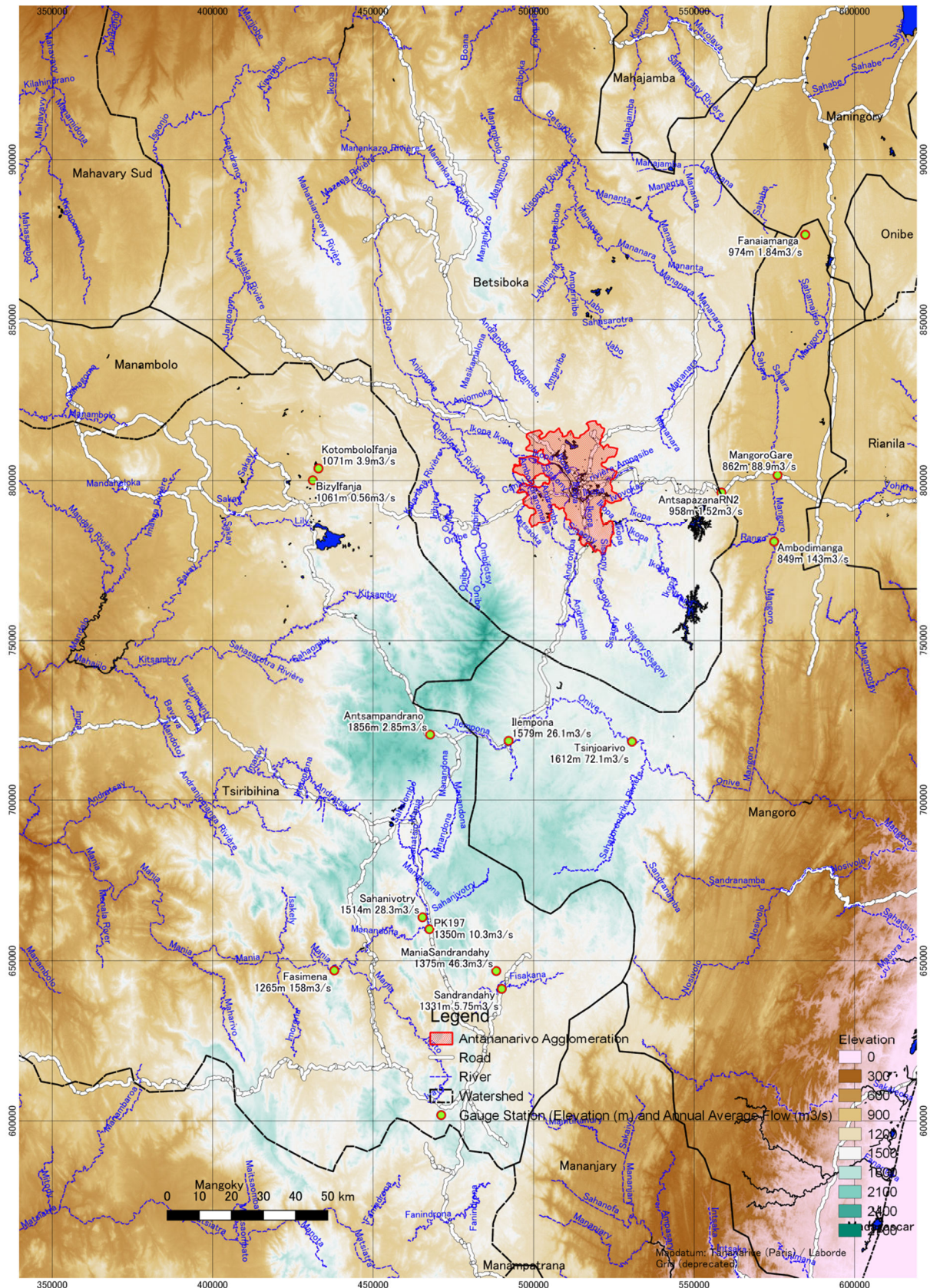
Figure 11.1.11 shows several data from Fleuve et Rivière de Madagascar of annual average flow of gauge station of rivers around Antananarivo Agglomeration. Several gauge stations which recorded more than 70 m³/s of annual average flow were identified as the following:

- A. The Mangoro River in Mangoro Watershed
 - 1) Mangoro Gare Station - 88.9 m³/day (Elevation 862 m, 100 km from Antananarivo)
 - 2) Ambodimanga Station – 143 m³/day (Elevation 849 m, 75 km from Antananarivo)
- B. The Onive River in Mangoro Watershed
 - 1) Tsinjoarivo Station - 72.1 m³/s (Elevation 1,612 m, 100 km from Antananarivo)
- C. The Mania River in Tsiribihina Watershed
 - 1) Fasimena Station – 158 m³/s (Elevation 1,265 m, 300 km from Antananarivo)

Among the above, A.1) and A.2) is situated in lower area than Mandrozeza (Elevation 1,285 m) by approximately 450 m. Therefore, it is difficult to pump up water from there to Antananarivo, even though water quantities and qualities are confirmed to be suitable for supplementary water sources.

In the respect of difference of elevation between candidate water sources and Antananarivo Agglomeration, B. 1) is suitable and C.1) is acceptable. They are situated in the high areas in the west of Mangoro watershed and in the east of Tsiribihina watershed. However, the river flow records of these rivers are very old and the water resources development capacity cannot be determined without detailed study with dense measurement of river flows and water quality, as well as the land conditions and socio-economic situation in the area where water production and conduct facilities will be constructed.

In addition, only few river data is available regarding rivers in the southern side of Ikopa sub-watershed in Betsiboka watershed. Possibilities of water resources development in such tributaries of Betsiboka River shall be grasped through the water resources development study, as well as rivers in Mangoro watershed and Tsiribihina watershed.



Source: Created from AW3D30 DSM (JAXA), Proposition of Divisions of Watersheds Agencies (UNDP, 2008) and Fleuves et rivières de Madagascar (ORSTOM, 1993)

Figure 11.1.11 Rivers around Antananarivo Agglomeration

11.1.3 Issues on Water Supply of Antananarivo Agglomeration

Issues on water supply of Antananarivo Agglomeration are summarised as follows:

(1) Water Supply Areas and Serviced Population

- JIRAMA's water supply area is limited to a part of the Antananarivo Agglomeration. It shall cover all the areas of TaToM's 38 target communes.
- There is a large gap between JIRAMA's population projection for its water supply area in Antananarivo Agglomeration in 2033 (3.0 million persons), and that of TaToM's provisional estimation (4.2 million persons). JIRAMA's water supply plan, as well as its target areas, shall be revised based on TaToM's estimates.

(2) Water Supply Coverage

- In 2015, access rate to urban water supply by JIRAMA's water supply area was only 44.0% , or 1.76 million of served population to 1.16 million of total population. Served population in 2033 based on JIRAMA's projection is 2.28 million, which is only 54.3% of the 4.2 million provisional population projection in 2033 by TaToM.
- There are two types of domestic water supply: small private connections (BP) and water kiosks (BF). In 2015, BP's served population was 0.61 million (52.7% to total); and for BF, it was 0.55 million (47.3% to total). BP and BF connections are insufficient to cover the population of Antananarivo Agglomeration in 2033, and numbers of both BP and BF shall be increased to fullfill the needs of water supply in the growing urban areas.
- Number of subscribers of gross private connections (i.e., subscribers with more than 1,000 m³/month of water consumption) was 216 (0.3% to total) in 2015 and their daily average consumption was 5.3 thousand m³/day (5.7% to total). Considering the rapid urbanisation of Antananarivo Agglomeration, increase in number of subscribers and daily consumption shall be considered for the horizon 2033.
- Number of subscribers with other types of consumption (i.e., small administration user, gross administration user, communal service, and other installations) in 2015 was 3,432 (4.3% to total), and their daily average consumption was 12.1 thousand m³/day (13.1% to total). Considering the future infrastructure development according to rapid urbanisation of Antananarivo Agglomeration, increase in the number of subscribers and daily consumption shall be considered for the horizon 2033. In addition, activities for the reduction of wasteuse of water and avoiding and/or minimising delays in payment by administrative organisations shall be promoted.

(3) Water Production and Water Resources

- There is a large gap between the 2033 projected daily average production by JIRAMA (0.21 million m³/day) and the projection by TaToM (0.65 million m³/day).
- JIRAMA's daily average production in Antananarivo Agglomeration in 2018 was 0.200 million m³/day, of which more than 95% was produced in Mandroseza station (I = 0.10 million m³/day; and II = 0.06 million m³/day). The other five production stations have small-scale operations (Sabotsy Namehana = 0.002 m³/day; Faralaza = 0.0096 m³/day; Vontovorona = 0.0036m³/day; and Ankardivoribe = 0.0036m³/day).
- JIRAMA is now implementing new water supply facility project named "JIRAMA III" which will increase water production capacity by 150,000 m³/day. Even if this planned production will be achieved, still it is insufficient considering the projected demand for 2033. Potential of

water surface water and groundwater sources so as to meet the demand in 2033 remains to be clarified.

- As it is difficult to fulfill the demand in 2033 only by water from the Ikopa River and groundwater in Tana plain in Ikopa sub-watershed, the water resource development capacity of rivers in neighbouring watersheds such as Mangoro, Tsiribihina and Betsiboka shall be studied in order to identify suitable supplementary water sources for Antananarivo Agglomeration.

(4) Water Supply Operation Management

- Existing pipelines of JIRAMA are aged, and non-revenue water ratio was as high as 51% in 2016.
- Due to aging pipes and under dimensioned facilities, pressure at the connection is below 0.1 MPa in many locations.
- Recently, annual net income of JIRAMA (including both energy and water sectors) have been negative every year and accumulated losses are increasing. An appropriate financial model for water supply operation by JIRAMA shall be introduced, and an increase of water tariff shall be considered to secure the budget for development of water supply facilities under the concession contract between Madagascar government and JIRAMA.

(5) Reinforcement and Construction of New Water Supply Facilities

- JIRAMA's water supply network covers only a part of Antananarivo Agglomeration.
- Water supply facilities, such as pipelines, reservoirs, and pump stations, are insufficient and under dimensioned. Master plan of facility renewal and new construction shall be updated to fulfill the demands in the horizon 2033.

11.1.4 Objectives of the Water Supply Sector of Antananarivo Agglomeration

The objectives of the water supply sector of Antananarivo Agglomeration are summarised as the follows:

(1) Water Supply Areas and Serviced Population

- Water supply areas shall be 38 target communes of TaToM. New area divisions proposed by TaToM is shown in Figure 11.1.7.
- Whole population shall be covered by JIRAMA's network by 2033. Provisional 2033 population projection by TaToM is 4.2 million persons.

(2) Water Supply Coverage

- Access rate to JIRAMA's water supply shall be 100% in 2033.
- Domestic water shall be supplied by means of small private connections (BP) and water kiosks (BF). The ratio and served population of each connection type in 2033 are as follows:
 - In CUA: BP – 0.89 million (40.0%), BF – 1.33 million (60.0%)
 - In Surrounding Communes: BP – 1.19 million (40.0%), BF – 1.78 million (60.0%)
- Daily average demand and ratio to total demand of gross private connections shall be 0.069 million m³/day (13.2%) in 2033.
- Daily average demand and ratio to total demand of other consumptions (i.e., small administration user, gross administration user, communal service, and other installations) shall be 0.085 million m³/day (16.2%) in 2033.

(3) Water Production and Water Resources

- Following the strategy of MP 2003, the water supply area shall be divided into right-bank areas (CUA, TA, TE, and TF) and left-bank areas (TB, TC, and TD) as shown in Figure 11.1.7.
- For right bank areas, the current intake and water production by Mandroseza, Faralaza, and Sabotsy Namehana stations are 180 thousand m³/day. It should be raised up to 453 thousand m³/day by 2033 by means of increasing the intake from the Ikopa River and construction of retention reservoir.
- For left bank areas, the current intake and water production by Vontovorona and Ankadivoribe stations is 7 thousand m³/day. It should be increased up to 201 thousand m³/day by 2033 by means of developing groundwater resources in the alluvial plain along the Ikopa River and the Sisaony River and also by supplementarily tapping surface water.

(4) Water Supply Operation Management

- Revenue ratio shall be increased to 65% in CUA and 80% in surrounding communes in 2033 by implementing measures against technical losses and commercial losses, and by replacement of pipelines.
- GIS-based hydraulic model shall be introduced for purposes of improving pressure management and asset management.
- Financial model for water supply operation shall be introduced to JIRAMA. The annual net income of water supply sector shall become positive by 2023.

(5) Reinforcement and New Construction of Water Supply Facilities

- Replacement and new construction plan for pipelines, reservoirs, pump stations, private connections, and water kiosks shall be formulated.

11.1.5 Strategies for Water Supply Sector of Antananarivo Agglomeration

(1) Water Supply Areas and Serviced Population

- As described in 11.1.2 (2), JIRAMA's water supply area shall be expanded to cover all 38 communes of Antananarivo Agglomeration.
- Population will be increased to be 4.2 million in the target year 2033. The water supply shall be reinforced in order to cover all this population. This means that water production shall be increased from 0.20 million m³/day in 2018 to 0.60 million m³/day in 2033.

(2) Water Supply Coverage

- Principal activities conducted to achieve increase in water supply coverage are promotion of replacing existing network and construction of new facilities where JIRAMA's networks currently do not exist and/or exist but insufficient. Difficulties arise, especially in CUA, where buildings are crowded and only small work space for pipeline rehabilitation is available. Proper hydraulic model shall be introduced to materialise appropriate dimensioning of networks which can ensure satisfactory water supply by 2033.
- Study on the distribution of water usage (e. g., domestic use, gross particular use, and other consumptions) shall be conducted based on TaToM's planned urban structure and population distribution in Antananarivo Agglomeration.

(3) Water Production and Water Resources

- New water resources and facilities development project financed by EIB and EU is now in the

study stage and the implementation will be started in 2021. Addition of 0.15 million m³/day of water production is expected by developing the water resources of the Ikopa River and groundwater in Tana Plain along the Ikopa River.

- Even though full of planned quantity of new water resources of JIRAMA III, there will be further gap between current production capacity (0.20 million m³/day in 2018) and estimation of increased water demand in the horizon 2033 (0.60 million m³/day).
- Probability of water shortage during the dry season such as the one JIRAMA and the population in Antananarivo Agglomeration experienced in 2017, will increase by the reinforcement of intake from the Ikopa River. Therefore, measures to ensure the stability of water intake as the followings shall be taken:
 - Water sources shall be decentralized. For example, JIRAMA III includes the development of groundwater source in Tana alluvium plain. The development of this groundwater sources shall be promoted in order to decrease the load of intake from the Ikopa River. However, water resources potential of groundwater sources, as well as surface water sources, shall be clearly grasped by conducting water resources study.
 - As another option of decentralization of water sources, aqueducting water source from rivers remote from Antananarivo, as supplementary resources to the Ikopa River. This option shall be planned based on the water resources development study in neighboring water sheds of Betsiboka, Mangoro, Tsiribihina and the pipeline design.
 - As a counter-measure against the future water shortage during the dry season, retention dam shall be constructed. JIRAMA is now planning to start the feasibility study for the new construction of a multi-purpose dam at Andavadaboara of Antananatsara commune on the Varahina River between Antelomita and Tsiazompaniry, of which retention volume is 53 million m³. Objective of this dam is to supplement the water shortage in Antananarivo during the dry season and failure of continuous operation of Antelomita hydroelectric station.

(4) Water Supply Operation Management

- Based on the current database of JIRAMA's existing facilities and operation statistics, a hydraulic model shall be developed which can simulate the actual water supply for the rehabilitation and renewal plan, and also the future water supply by 2033 for an appropriate dimensioning of the facilities to be renewed and/or constructed.
- Nonrevenue water reduction business plan of JIRAMA (2013) shall be updated. Activities for the reduction of nonrevenue water shall be planned to achieve the target value of revenue-ratio in 2033.
- A financial model shall be developed for JIRAMA to observe and analyse the cost structure and to balance the revenue and the water supply cost. At the same time, water tariff setting shall be re-examined.

(5) Reinforcement and Construction of New Water Supply Facilities

- Dimension of primary conduits which shall cover all the area of Antananarivo Agglomeration shall be designed based on the hydraulic model.
- Secondary and tertiary conduits shall be designed based on the population distribution of urban planning.
- New reservoirs shall be planned to equilibrate the fluctuation of water transmission and distribution. Total capacity of stock shall be increased to half of daily average demand.
- New relay pump stations shall be planned in each of distribution areas. Distance from the

production station and difference in elevation, especially in the peripheral areas of Antananarivo Agglomeration shall be considered for the hydraulic design.

11.1.6 Programmes and Projects for Water Supply of Antananarivo Agglomeration

(1) Action Plan of Water Supply of Antananarivo Agglomeration for Target Year 2033

In order to achieve objects of the water supply of Antananarivo Agglomeration for the target year 2033, at first water supply master plan of Antananarivo (MP2003) shall be revised with the consideration of expanded water areas and demand projection for 2033. After that, water supply facility renewal/construction and operation management shall be conducted according the revised master plan. Table 11.1.16 shows the provisional action plan for water supply Antananarivo Agglomeration until 2033.

Table 11.1.16 Provisional Action Plan of Water supply of Antananarivo Agglomeration until the Horizon 2033

Item	2019-2023	2024-2028	2029-2033
(1) Study and Implementation of JIRAMA III (under going)			
<ul style="list-style-type: none"> - Total production: 150,000 m³/day - Doubling Mandrozeza 2 WTP - Construction of two WTP from Tana plain (groundwater) - Construction of a WTP at Laniera from Ikopa river - Urgent measures (replacement of pumps, installation of water meters & flowmeters, replacement of broken connections) - Replacement of conduit (17 km) - Construction of primary pipelines (22.2 km) - Construction of secondary pipelines (354 km) 			
(2) Updating Water Supply Master Plan in the Antananarivo Agglomeration			
<ul style="list-style-type: none"> - Water resources potential study (surface water and groundwater in Ikopa sub-watershed) - Water resources potential study (surface water in Mangoro, Tsiribihina and Betsiboka watersheds) - Water resource development plan - Water demand estimation - Facility rehabilitation and construction plan (intake, aqueduct, treatment, transmission, stock, transmission, distribution, supply facilities) - Business operation plan - Environmental impact assessment 			
(3) Construction of New Retention Dam at Andavadoava			
Feasibility and Design Study			
Construction			
(4) New Water Supply Facility Construction Projects			
Phase-1: Total production 150,000 m ³ /day			
Design Study			
Construction			
Phase-2: Total production 150,000 m ³ /day			
Design Study			
Construction			
(5) Water Supply Coverage			
Installation of BP (Particular Connection)			
Installation of BF (Water Kiosk)			111,000 subscribers
			5,700 subscribers
(6) Water Supply Operation Management			
Updating of non-revenue water reduction plan			
Development of hydraulic model			
Development of financial model			
Asset management			
Non-revenue water reduction and renewal of pipelines			

(2) Priority Projects for the Water Supply of Antananarivo Agglomeration

Based on the actions listed in Table 11.1.16, priority projects for Antananarivo Agglomeration are selected as in Table 11.1.17. These priority projects will reinforce the water production capacity for Antananarivo Agglomeration, which is the most urgent issue to be tackled for water supply sector in Antananarivo Agglomeration.

Table 11.1.17 Priority Project for Water Supply in the Antananarivo Agglomeration

Project	Contents	Remarks
JIRAMA III Water Supply Facility Construction Project (on going)	<ol style="list-style-type: none"> 1) Doubling Mandrozeza 2 WTP (Production: 60,000m³/day) 2) Construction of Two WTP from the Ikopa River (Production: 2 x 30,000 m³/day, Intake from subsoil water of Tana Plain) 3) Construction of a WTP at Laniera from the Ikopa River (Production: 30,000 m³/day) 4) Urgent Measures: Replacement existing pumps and connections, Installation of water meters and flowmeters 5) Replacement of Conduit: 17 km 6) Construction of Primary Pipelines (22 km) and Secondary Pipelines (354 km) 7) Remote Management System 	This project is in the stage of the detailed design study which will determine the concrete contents of the project. Expected period of facility construction is for three to four years from 2021.
Water Supply Master Plan Formulation Project in Antananarivo Agglomeration	<ol style="list-style-type: none"> 1) Social / Water Demand Survey 2) Existing Facility Survey 3) Water Supply Operation Study 4) Water Use Survey (Potable, Irrigation and Industrial Water) 5) Water Resources Development Plan (Surface Water in Ikopa sub-watershed) 6) Water Resources Development Plan (Surface Water in Mangoro, Tsiribihina and Betsiboka watersheds) 7) Water Resources Development Plan (Groundwater) 8) Outline Design and Cost Estimation (New Facility Construction) 9) Outline Design and Cost Estimation (Rehabilitation of Existing Facility) 10) Construction Plan 11) Water Supply Operation Plan 12) Social Environment Assessment 	The objective of this project is to update the water supply master plan in order to fulfil the water demand in Antananarivo Agglomeration in 2033. Especially for grasp of the water resources development potential in order to select water source to be developed is a quite important issue for the water supply in Antananarivo Agglomeration.
Construction of New Retention Dam at Andavadaboara	Construction of a multi-purpose dam of which capacity is 53 million m ³ at Andavadaboara, which is located between Mandrozeza and Tsiazonpaliny. With this dam, the storage capacity against probable water shortage is expected to be reinforced.	Antananarivo Agglomeration experienced serious water shortage during the dry season in 2017. In order to reduce the water outage in such occasions in the future, this project is being planned by JIRAMA.
Construction of Water Aqueduct, Treatment and Transmission Facilities Using Water Source from the Onive River in Tsinjoarivo (Ambatolampy District)	<ol style="list-style-type: none"> 1) Construction of intake and aqueduct facilities which intake 310,000 m³/day of water at Tsinjoarivo in Ambatolampy District, and an aqueduct to the water treatment plant in Bongatasara Commune in Antananarivo Agglomeration with 86 km of 1,600 mm aqueduct pipeline, 2) Construction of water treatment plant in Bongatasara Commune with treatment capacity of 310,000 m³/day, and 3) Construction of transmission facilities to provide treated water to each of seven new water supply areas proposed by TaToM, including an initial transmission pump station at the water treatment plant, a loop transmission pipeline to deliver treated water to each of water supply areas and seven transmission pump stations for each of seven water supply areas. 	

Total average production of the above priority projects is 0.35 million m³/day, which covers 58 % of 0.60 million m³/day (production to be increased by the target year 2033). At the same time of the implementation of the priority projects, concrete plan of further water resource development,

extension of transmission and distribution network, reinforcement of stock facilities shall be formulated through the updating of the water supply master plan in order to commence as soon as possible the facilities construction to fulfil the future needs.

11.1.7 Profiles of Water Supply Priority Projects of Antananarivo Agglomeration

(1) JIRAMA III Water Supply Facility Construction Project (ongoing)

1) Rationale

JIRAMA formulated a drinking water supply system master plan of Antananarivo City in 2003³ (hereinafter referred to as “MP2003”). MP2003 proposed to reinforce the water supply facilities in order to fulfil the increasing water demand until 2020. The population of Antananarivo in 2020 was estimated to be 2.5 million, and 300 thousand m³/day of daily average water demand was calculated to cover the needs of this population. In order to fulfil this demand, MP2003 formulated the water supply facility construction and rehabilitation plan composed of 1) new water resources development by using the Ikopa River water and sub-soil water in Tana Plain, 2) extension and rehabilitation of water transmission and distribution network and 3) new construction and rehabilitation of electro-mechanical facilities.

JIRAMA had agreement with EIB and EU for the implementation of the facility construction plan of MP2003 in 2008. However, it was suspended due to the political crisis until 2017 when socio-economic study started.

2) Objective

To catch up with the delay in the implementation of MP2003 by reinforcing water production using the Ikopa River water and sub-soil water of Tana Plain, and through the extension and rehabilitation of water transmission and distribution network.

3) Project Description

The project is composed of the following 8 components:

- [A-E-01] Project for Doubling the Capacity of Mandrozeza 2 Water Treatment Plant
- [A-E-02] Project for Construction of Two Water Treatment Plants using Groundwater from Tana Plain
- [A-E-03] Project for Construction of Water Treatment Plant in Laniera
- Urgent Measures
- Replacement of Conduit (17 km)
- Construction of Primary Pipelines (22.2 km)
- Construction Secondary Pipelines (354 km)
- Remote Management System

4) Expected Benefits

Production capacity will be increased by 150,000 m³/day which will amount to a total water supply of 350,000 m³/day. This production can supply water to a population of approximately 2.8 million. Transmission and distribution network will be reinforced by extension and rehabilitation.

5) Executing Agency and Related Institutes

JIRAMA and the Ministry of Water

6) Estimated Project Cost

Euro 60 million

³ Etude du schéma directeur du système d'adduction d'eau potable de la ville d'Antananarivo, July 2003, JIRAMA, BCEOM, INFRAMAD

7) Implementation Schedule

- May 2019: Preliminary design document is prepared.
- September 2019: Presentation to the Board of EU and EIB
- End of 2019: Signing of the loan and funding agreement
- End of 2020: Front end engineering documents (FEED) will be prepared.
- January 2021: Start of construction works (for three to four years)

8) Necessary Actions for Implementation / Critical Factor

- Preliminary design is planned to be completed by May 2019 in order to finalise project contents.
- Coordination with related authorities such as communes in Antananarivo Agglomeration, MEEH, ANDEA, APIPA, etc.

9) Related Plans and Projects

- Community development plans
- River improvement projects
- Drainage projects

10) Social and Environmental Impacts

Normal mitigation measures should be designed (to be clarified through the ongoing study).

(2) [A-E-04] Water Supply Master Plan Formulation Project in Antananarivo Agglomeration

1) Rationale

As estimated by TaToM, the population in Antananarivo until 2033 will be 5.2 million with a corresponding water demand of 600 thousand m³/day. JIRAMA is currently implementing JIRAMA III project in order to reinforce its water supply. However, further development of water resources is necessary to meet the requirement in 2033. In addition, facility development and rehabilitation plan shall be formulated in order to fulfil the increasing demand caused by rapid urban expansion and population growth.

Therefore, a new water supply master plan shall be urgently formulated by updating JIRAMA's drinking water supply system master plan formulated in 2003 (hereinafter referred to as "MP2003").

After the preparation of MP2003, any comprehensive water resources study has not been conducted. Therefore, the water resources development potential of Ikopa River and sub-soil water in Tana Plain and potential of river water sources from other watersheds such as Mangoro, Betsiboka and Tsiribihina should be grasped through a water resources potential study in the course of the master plan formulation project.

2) Objective

To formulate a water supply master plan in Antananarivo Agglomeration in order to meet water demand until 2033

3) Project Description

The project shall be composed of the following:

- Water resources potential study (surface water and groundwater in Ikopa sub-watershed)
- Water resources potential study (surface water in Mangoro, Tsiribihina and Betsiboka watersheds)
- Water resource development plan
- Water demand estimation
- Facility rehabilitation and construction plan (intake, aqueduct, treatment, transmission, stock,

transmission, distribution, supply facilities)

- Business operation plan
- Environmental impact assessment

4) Expected Benefits

Contents of necessary projects such as 1) water resources development, 2) expansion and renovation of water transmission and distribution network, 3) construction and rehabilitation of electrical/mechanical facilities, etc. will be clearly determined during the commencement of the detailed studies for the implementation and budget securing.

5) Executing Agency and Related Institutes

JIRAMA and the MEEH

6) Estimated Project Cost

Euro 2.5 million

7) Implementation Schedule

Two Years

8) Necessary Actions for Implementation / Critical Factor

- JIRAMA shall start to secure the budget and prepare the TOR.
- Coordination with related authorities such as communes in Antananarivo Agglomeration, Ministry of Water, ANDEA, APIPA, etc.

9) Related Plans and Projects

- Community development plans
- River improvement projects
- Drainage projects

10) Social and Environmental Impacts

Not applicable

(3) [A-E-05] Project for Construction of New Retention Dam in Miadanandriana

1) Rationale

Water production in Antananarivo Agglomeration depends by more than 95% on Mandrozeza WTP that takes water from the Ikopa River. Due to this situation, water shortage in the Ikopa River during dry season directly affects the stability of water supply in Antananarivo Agglomeration, as the water supply problem experienced in the dry season of 2017.

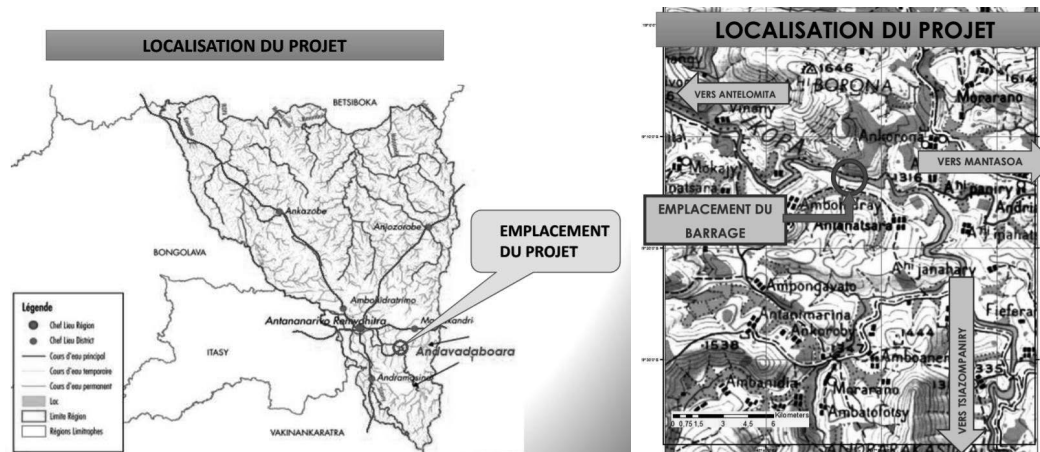
JIRAMA is now planning to formulate the retention dam between Mandrozeza and the source dams of Matasoa and Tsiazonpaniry. This is the urgent measure to compensate the probable water shortage during dry season in the future.

2) Objective

To compensate the water shortage of the Ikopa River during dry season by constructing a retention dam with a capacity of 53 million m³.

3) Project Description

- Location of the project: Rural Commune of Miadanandriana, Analamanga Region



Source: PROJET DE CONSTRUCTION D'UN BARRAGE DE RETENU SUR LA RIVIERE DE VARAHINA IKOPA SISE A ANDAVADABOARA COMMUNE RURALE D'ANTANANTSARA REGION ANALAMANGA

Figure 11.1.12 Location of New Retention Dam

- Capacity: 53 million m³
- Length: 235 m
- Height: 35 m

4) Expected Benefits

Production of 53 million m³ which is equivalent to water demand for 4 months in 2023.

5) Executing Agency and Related Institutes

JIRAMA and MEEH

6) Estimated Project Cost

Euro 38 million

7) Implementation Schedule

- 2019-2020 Feasibility and Design Study
- 2021-2028 Construction

8) Necessary Actions for Implementation / Critical Factor

- JIRAMA shall start to secure the budget and prepare the TOR for feasibility study.
- Coordination with related authorities such as communes in Antananarivo Agglomeration, MEEH, ANDEA, APIPA, etc.

9) Related Plans and Projects

- Community development plans
- River improvement projects
- Drainage projects

10) Social and Environmental Impacts

This project is a sensitive sector project, having characteristics that may cause adverse environmental impacts including resettlement and compensation.

(4) [A-E-06] Construction of Water Aqueduct, Treatment and Transmission Facilities Using Water Source from the Onive River in Tsinjoarivo (Ambatolampy District)

1) Rational

As of 2018, the estimated drinking water production in Antananarivo Agglomeration was 200,000 m³/day. This water production is being realised by the existing six water treatment plants of Madroseza (I & II), Sabotsy Namehana, Faralaza, Vontovotona and Ankadivorbe. In addition, a project for the construction of water supply facilities (named “JIRAMA III”) is being implemented by JIRAMA with support from EU Investment Bank and EU. With this project, the water production capacity in Antananarivo Agglomeration will be increased by 150,000 m³/day (making total production 350,000 m³/day).

However, TaToM estimated that the population of Antananarivo Agglomeration will increase to 4.2 million by 2033. In order to supply drinking water to this population, 600,000 m³/day of water production capacity will be necessary. This means that further development of water resources equivalent to 250,000 m³/day should be realised in addition to the six existing water treatment plants and four plants to be constructed by JIRAMA III.

It is considered that the intake volume of surface water from the Ikopa River and groundwater from Tana Plain have reached the maximum capacity to provide water resources. Therefore, the new water sources should be selected from the rivers in watersheds outside of Ikopa sub-watershed where Antananarivo Agglomeration is situated. Though there are no recent data on water flow measurement of rivers around Ikopa sub-basin, water intake from the Onive River at Tsinjoarivo in Ambatolampy District is considered to be a good candidate for a new water intake point for water supply in Antananarivo Agglomeration based on the hydrological data of Tsinjoarivo gauge station during the period between 1962 and 1980 (Fleuves et Rivières de Madagascar, ORSTOM, 1993).

In order to resolve the above-mentioned deficit on water supply in Antananarivo Agglomeration until 2033, JIRAMA is expected to conduct the water supply master plan study and to commence this project to bring water source from Tsinjoarivo to Antananarivo Agglomeration.

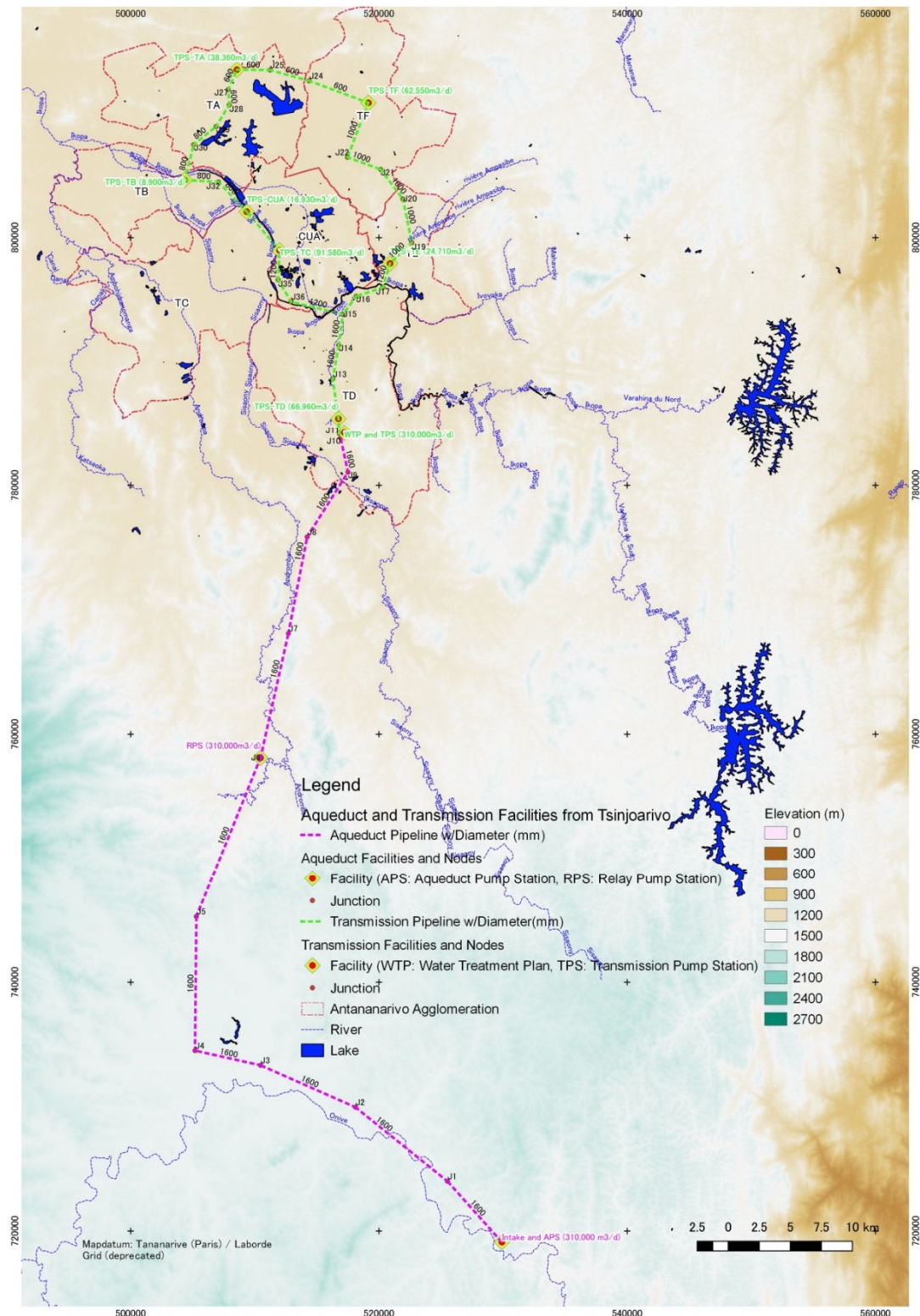
2) Objective

To mobilise new water sources from the Onive River in Tsinjoarivo in order to increase the capacity of water production and water supply for Antananarivo Agglomeration by 310,000 m³/day

3) Project Description

Figure 11.1.13 shows the layout of Aqueduct, Treatment and Transmission Facilities from Tsinjoarivo. Facilities of the Project to be constructed are composed of the following:

- Intake and aqueduct facilities which obtain 250,000 m³/day of water at Tsinjoarivo in Ambatolampy District, and an aqueduct to the water treatment plant in Bongatsara Commune in Antananarivo Agglomeration with 86 km of 1,600 mm aqueduct pipeline,
- Water treatment plant in Bongatsara Commune with treatment capacity of 250,000 m³/day, and
- Transmission facilities to provide treated water to each of seven new water supply areas proposed by TaToM (TA to TF and CUA), including an initial transmission pump station at the water treatment plant, a loop transmission pipeline to deliver treated water to each of water supply areas and seven transmission pump stations for each of seven water supply areas.



Source: JICA Study Team

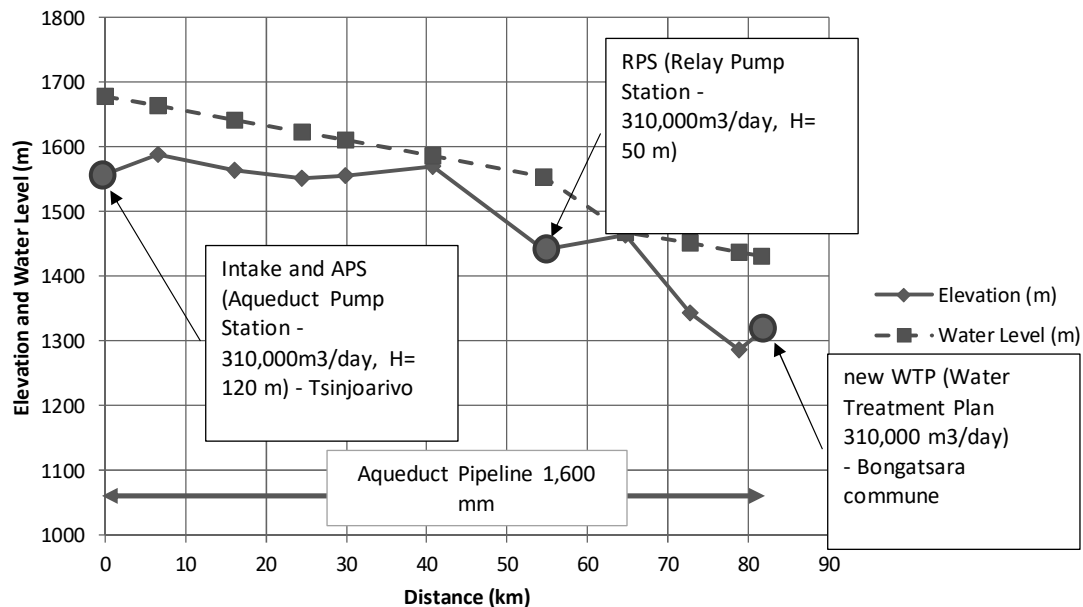
Figure 11.1.13 Layout of Aqueduct, Treatment and Transmission Facilities from the Onive River at Tsinjoarivo

a) Intake and Aqueduct Facilities

- Intake facilities from the Onive River at Tsinjoarivo in Ambatolampy District with an aqueduct pumping station of 2500,000 m³/day
- Aqueduct pipeline 1,600 mm x 81.6 km

- Relay pump station of 250,000 m³/day

Figure 11.1.14 shows the profile of aqueduct facilities and pipeline between the intake to the water treatment plant.



Source: JICA Study Team

Figure 11.1.14 Profile of Aqueduct Facilities between Onive River and Water Treatment Plant in Bongatsara

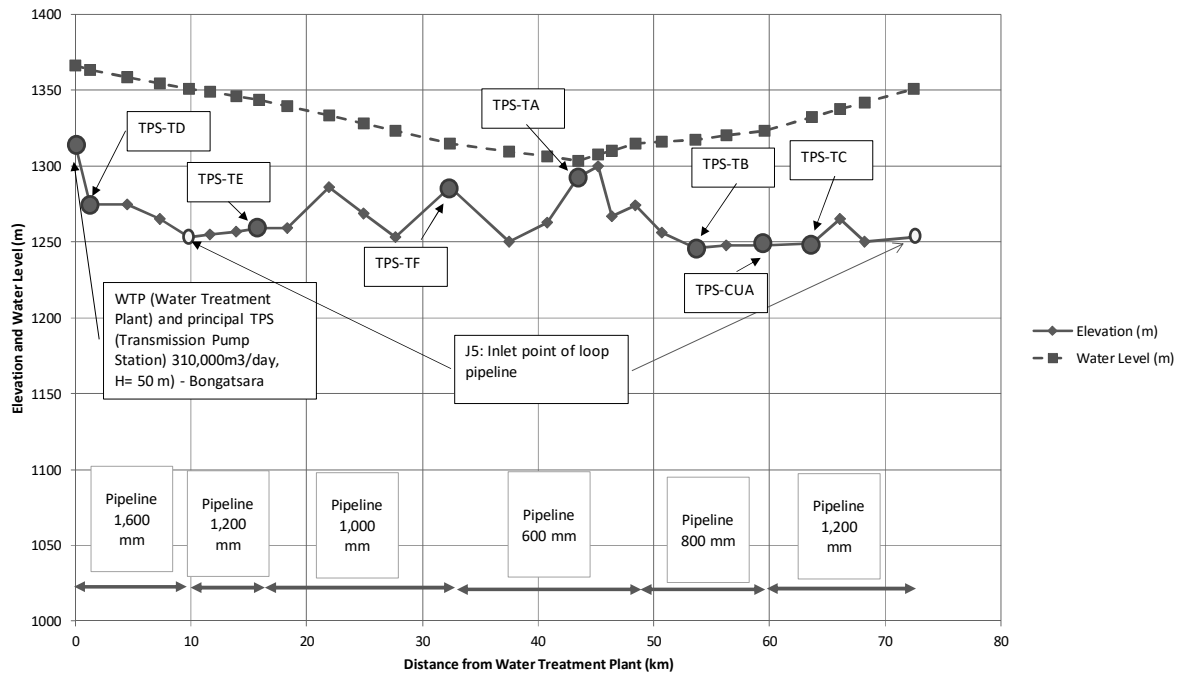
b) Water Treatment Plant

- Water treatment plant of 250,000 m³/day in Bongatsara Commune

c) Transmission Facility

- Principal transmission pump station (250,000 m³/day, H=50 m) from the water treatment plant in Bongatsara Commune
- Transmission pipeline (diameter 600 to 1600 mm) to bring treated water to each of water supply areas, 72.5 km
- Seven transmission pump stations to transmit water to each of the seven water supply areas.

Figure 11.1.15 shows the profile of transmission facilities and pipeline between water treatment plant and transmission pump stations.



Source: JICA Study Team

Figure 11.1.15 Profile of Transmission Facilities between Onive River and Water Treatment Plant in Bongatsara

4) Expected Benefits

By increasing 250,000 m³/day of water production capacity, it will be possible to fulfil the total estimated demand of 600,000 m³/day of Antananarivo Agglomeration in 2033.

5) Executing Agency and Related Institutes

JIRAMA and MEEH

6) Estimated Project Cost

Euro 470 million

7) Implementation Schedule

- 2019-2020 Feasibility and Design Study
- 2021-2023 Detailed Design Study
- 2024-2028 Intake, Aqueduct and Treatment Facility Construction
- 2029-3033 Transmission Facility Construction

8) Necessary Actions for Implementation / Critical Factor

- JIRAMA shall start to secure the budget and prepare the TOR for feasibility study.
- Coordination with related authorities, such as communes in Antananarivo Agglomeration, Ministry of Water, ANDEA, and APIPA

9) Related Plans and Projects

- Community development plans
- River improvement projects
- Drainage projects

10) Social and Environmental Impacts

This project is a sensitive sector project, having characteristics that may cause adverse environmental impacts including resettlement and compensation.

11.2 Sewer and Drainage System of Antananarivo Agglomeration

11.2.1 Background on Sewer and Drainage Systems of Antananarivo Agglomeration

(1) Hydrological Conditions and River System

The Analamanga Region is located in the Malagasy highland, on a crystalline platform with dense hydrographic network. A large part of the region belongs to the large basin of Betsiboka, which is one of the largest and longest rivers of Madagascar (531 km) after Mangoky River (911 km).

Antananarivo Agglomeration is located in the plains of Antananarivo crossed by three major rivers, namely, Ikopa River, Mamba River, and Sisaony River. To protect it from river flooding, a dike system with total length of 131 km was constructed along these rivers: Ikopa (right bank: 25 km, left bank 28 km), Sisaony (right bank: 22 km, left bank 26 km), and Mamba (right bank: 14 km, left bank 16 km).

The marshes and wetlands play an important role in flood control. However, due to rapid urbanisation, their landfilling tend to be accelerated.

(2) Present Situation of Sewerage and Drainage Systems in Antananarivo Agglomeration¹

The sanitation sector involves many actors from different fields: basic sanitation or management of excreta (family and community, emptying, depot, and treatment); garbage or solid waste management (collection, disposal, and treatment); drainage or wastewater, domestic, industrial, and rainwater management collection, transport, treatment, and discharge).

In this section, rainwater drainage and wastewater management are focussed on.

1) Wastewater

In CUA, a wastewater collection system with a total length of approximately 175 km exists, and only 10% of this system is a separated sewer system (i.e., separated collection of wastewater and surface run-off) situated in an area of 67 ha, comprising the administrative districts of Anosy and HJRA Hospital. The rest (90%) is a combined sewer system that collects rainwater as well as wastewater, and includes 5 pumping stations located in Ampefiloha, Ambodin'Isotry, the 67 Ha, Isotry, and Anatihazo serviced by separated sewer system. However, the combined sewer system is only servicing the 1st and 3rd arrondissements corresponding to 17% of CUA's population.

For the rest of CUA and peripheral communes, wastewater is managed locally with autonomous systems (sumps alone, septic tanks combined with sumps), by direct spreading on the ground, or by discharging into rainwater networks.

2) Storm Water

Though the management of rainwater that can cause heavy damage is an important issue in Antananarivo Agglomeration, the drainage system is not well developed and relies heavily on the existing road sanitation systems.

Hills area:

In almost all areas of CUA, the drainage system is equivalent to the combined sewage system collecting rainwater as well as household wastewater. Moreover, a significant proportion of the septic tanks are directly connected to a drainage network constituted of:

- Combined sewage system
- Gutters and drainage canals along roads (the total length is unknown)
- Natural ditches excavated by erosion (the management is sometimes conducted by residents or the fokontany)

¹ WSUP(2010), Développement des grandes lignes d'un plan stratégique d'assainissement à l'échelle de l'agglomération d'Antananarivo

Urban plain area:

The storm water of the urban plain is drained by a system that is managed by APIPA, which consists of main drainage canals and their respective buffer basins:

- Andriantany Canal (25 km)
- Lakes of Anosy (11 ha) and Masay (98 ha)
- C3 Canal (10 km)
- Basins of Anosibe (12 ha) and Andavamamba (4 ha)
- Ambodimita pumping station (3 pumps with a capacity of 3 m³/s each)

FIFTMA communes:

In peripheral communes, the drainage system consists only of gutters and ditches along existing roads, trails, and alleys. Since dwellings are located mainly in hilly areas and the density of residents is still relatively moderate, drainage is not yet perceived as a major component of sanitation.

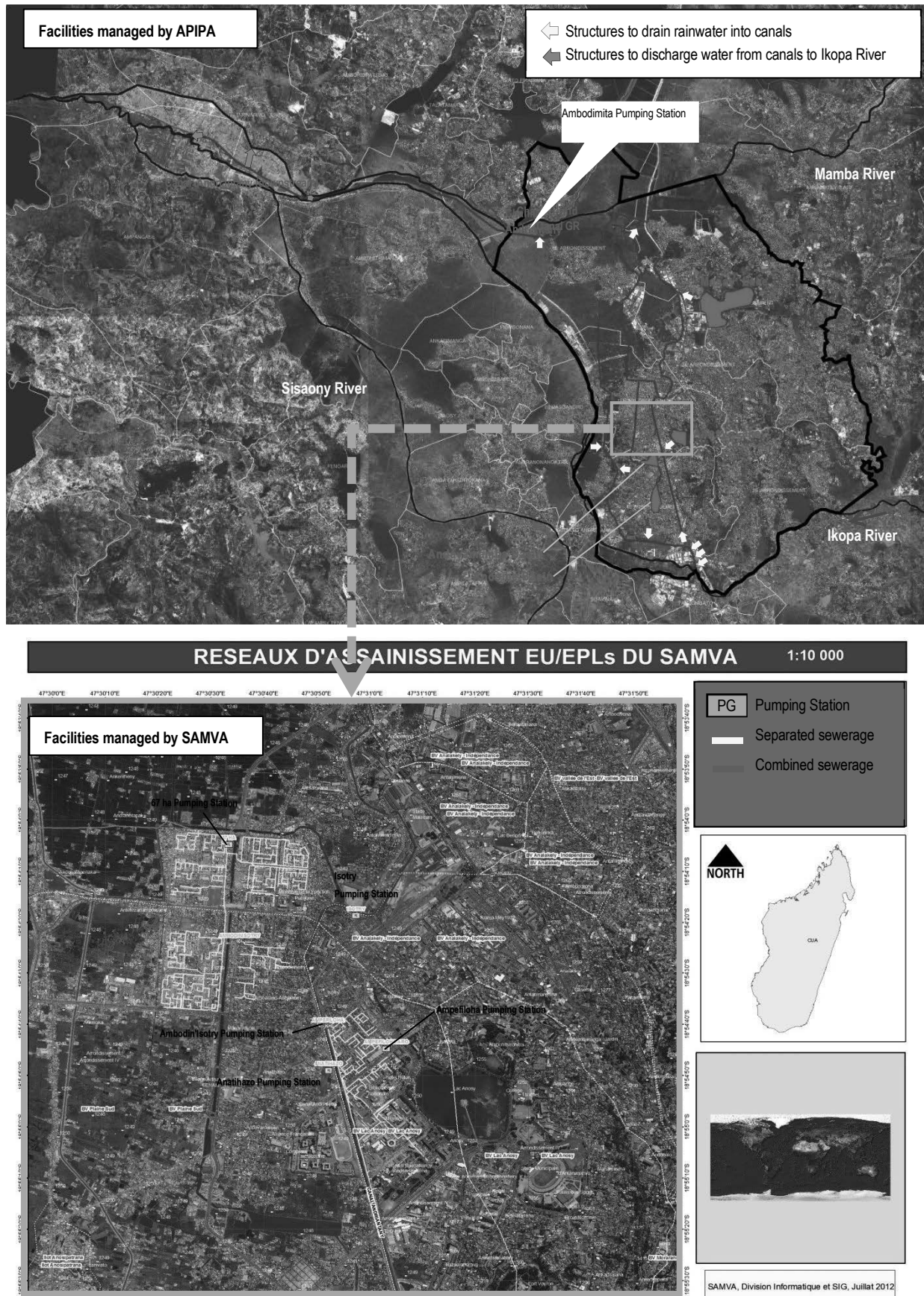
The following table summarizes the actual situation of the drainage and wastewater management systems in Antananarivo Agglomeration.

Table 11.2.1 Actual Situation of the Drainage and Wastewater Management Systems in Antananarivo Agglomeration

	Name of the Commune	Description of the Drainage and Wastewater Management System
1	CUA	<ul style="list-style-type: none"> ➤ 90% of the network is a combined sewerage system, the storm water and wastewater are treated separately only in a part of the city-centre. ➤ The system is 175 km long. ➤ Three entities (APIPA, SAMVA, and CUA) are responsible in the management of storm water and wastewater. ➤ Six pumping stations (one managed by APIPA and five by SAMVA) operate during floods. However, their capacities have decreased due to the lack of maintenance and deterioration of the assets.
2	Ambatolampy Tsimahafotsy	➤ 18 km long system (gutters) along provincial roads (RIP: <i>route d'intérêt provincial</i>)
3	Ambohidratrimo	➤ No information
4	Ambohitrimanjaka	➤ 5 km system (gutters) along asphalt road
5	Ampangabe	➤ 20 km along roads
6	Anosiala	➤ A study supported by Wateraid and EU is under preparation.
7	Antehiroka	➤ 4 km along the National Roads (RN: <i>Routes Nationales</i>) 4 and 52; and 6 km along RIP
8	Ivato	➤ Along roads
9	Talatamaty	<ul style="list-style-type: none"> ➤ The system is not adequate. ➤ 3 km along RN4. ➤ Regarding wastewater and excreta, consciousness-raising activities are conducted to equip each household with a sump hole (holding tank)
10	Alakamisy Fenoarivo	➤ Only along RN.
11	Ambavahaditokana	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater. ➤ Sump hole (holding tank) is required to obtain a construction permit.
12	Ambohidrapeto	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater. ➤ Sump hole (holding tank) is required to obtain a construction permit.
13	Ambohijanaka	➤ There is no collective network to collect wastewater.
14	Ampanefy	➤ Along roads.
15	Ampitatafika	<ul style="list-style-type: none"> ➤ Drainage gutters exist only along the inter-provincial road. ➤ The commune wants to construct sanitation canals.
16	Andoharanofosty	<ul style="list-style-type: none"> ➤ Gutters and canals to evacuate wastewater and storm water exist but in deteriorating condition. ➤ Infrastructure are lacking for the management of wastewater.
17	Andranonahoatra	<ul style="list-style-type: none"> ➤ A collective network connecting Andranonahoatra and Ambohidrapeto is existing but in poor condition. Some portions of this canal are filled by constructions. ➤ Sump hole (holding tank) is required to obtain construction permit.
18	Ankadimanga	<ul style="list-style-type: none"> ➤ A drainage canal from Bemasoandro and Avarabohitra to Sisaony at Fanindrona exists, but needs to be dredged. ➤ Additionally, due to the malfunction of gates (at the confluence of Sisaony River), storm water is discharged directly into rice paddies.
19	Ankaraobato	<ul style="list-style-type: none"> ➤ Gutters along communal roads exist but are in poor condition. ➤ Initially, gutters were constructed to drain storm water but these are also used for wastewater (i.e., no canal for wastewater).

	Name of the Commune	Description of the Drainage and Wastewater Management System
20	Anosizato Andrefana	<ul style="list-style-type: none"> ➤ A canal to discharge storm water into Sisaony and Ikopa exists from Ambodivona. However, this canal is also used for wastewater. ➤ Due to the diminution of the canal capacity at Beravina- Andranohoatra, flooding occurs in the western low area of the commune. ➤ Canals along main roads have to be rehabilitated.
21	Bemasoandro	<ul style="list-style-type: none"> ➤ A 4.7-km network is existing but in poor condition. ➤ Inundations occur almost every year due to the deterioration of the network.
22	Bongatsara	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater.
23	Fenoarivo	<ul style="list-style-type: none"> ➤ Along National Road
24	Fiombonana	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater. ➤ Sump hole (holding tank) is required to obtain construction permit.
25	Itaosy	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater. ➤ Sump hole (holding tank) is required to obtain construction permit.
26	Soalandy	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater. ➤ There are drainage canals along roads.
27	Soavina	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater. ➤ Since the gate is always open, reflux from Ikopa to Sisaony occurs and the fokontany along Sisaony gets flooded, like what happened in 2017 when flood depth reached 70 cm.
28	Tanjombato	<ul style="list-style-type: none"> ➤ The Ankady irrigation canal crossing through Tanjombato, Ampanefy, Soavina, Anosizato, and Ankarabato is also used to drain water. However, the evacuation of wastewater is still a problem. ➤ APIPA stopped the dredging of this canal three years ago.
29	Tsiafahy	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater.
30	Alasora	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater.
31	Ambohimambola	<ul style="list-style-type: none"> ➤ There are gutters along paved or asphalt roads.
32	Ambohimanga Rova	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater.
33	Ambohimangakely	<ul style="list-style-type: none"> ➤ Gutters along RN and RIP in the urban area exist.
34	Ankadikely Ilafy	<ul style="list-style-type: none"> ➤ No information
35	Anosy Avaratra	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater. ➤ Need to construct gutters along roads for drainage
36	Manandriana	<ul style="list-style-type: none"> ➤ There is no collective network to collect wastewater.
37	Sabotsy Namehana	<ul style="list-style-type: none"> ➤ Only two fokontany (Atsinanantsena and Andrefantsena) have collective systems to collect wastewater.
38	Ambatomirahavavy	<ul style="list-style-type: none"> ➤ There is no collective network. ➤ Gutters to drain water are along the National Road.

Source: JICA Study Team, from the results of commune surveys and meetings with APIPA, SAMVA, and CUA



Source: JICA Study Team by using data from APIPA and SAMVA

Figure 11.2.1 Drainage and Sewerage Systems in the Vicinity of CUA

(3) Actual Gaps

The actual general gaps are as follows:

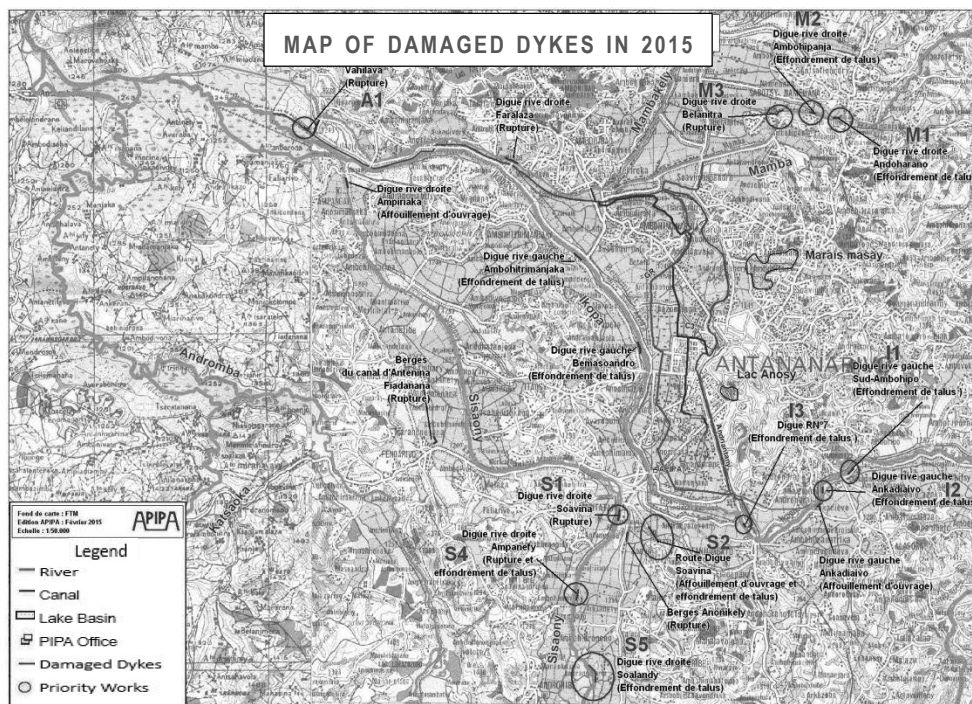
1) River System

Need to rehabilitate the dike system

As mentioned above, dikes were constructed to protect Antananarivo Agglomeration from overflowing of Ikopa River, Mamba River, and Sisaony River. However, most of these dikes were constructed after the floods of 1959 that severely affected CUA's urban area at that time. Consequently, the dike on the right bank of Ikopa River, aiming to protect CUA, is higher and wider than the dike on the left bank mainly for protecting agricultural lands.

The floods of January to February 2015, the worst since 1959, had caused severe damages to the dikes. According to APIPA², the most damaged portions due to levee breach were those on the right bank of Sisaony River in the commune of Soavina, and the one on the right bank of Mamba in the commune of Ankadikely Ilafy. The other damages were mainly the collapse of dike embankments and impacts to flood control facilities.

Although a series of high-priority rehabilitation works have been identified, all were not conducted yet due to the lack of budget.



Source: APIPA

Figure 11.2.2 Location of Dikes' Failures Caused by the Floods in January to February 2015

² APIPA (2015) : RAPPORT DES DEGATS SUR LES DIGUES EN 2015



Photo 1 Rehabilitated Dike (This dike was heightened after the 2015 floods.)



Photo 2 Dike that still need to be reinforced (Sisaony River)

Figure 11.2.3 System of Dikes in Antananarivo Agglomeration

Need to control sedimentation and activities disturbing Riverbed such as “brick” construction

The sedimentation of sand and mud is heightening riverbeds and reducing the discharge capacity of rivers. Aggravating the situation is the brick construction that extracts clay in river beds, reducing soil permeability (or the capacity to absorb water) and, consequently, causing the water level to rise. As a result, the actual level of protection against river floods has decreased and works to rehabilitate the original designed capacity are needed.



Photo 3 Fabrication of Bricks in Ikopa River

Figure 11.2.4 Activities Lowering River Capacity in Antananarivo Agglomeration

2) Urban Drainage System

Need to update plans and recalibrate wastewater and storm water drainage systems

The majority of the wastewater and storm water drainage systems were constructed during colonisation period in the 1950s to 1960s. However, due to the rapid urbanisation and population growth, the capacity of the existing sewerage system is not adequate to serve the entire agglomeration. According to SAMVA, the population to be served in CUA was originally estimated at 300,000; current population is now reaching 2,500,000.

Furthermore, due to the change in land use which has reduced the water retention potential of the soil, the risk of flooding has increased. Regarding CUA, sanitation plans were formulated in 1975 and 1993 in order to assess the actual situation, rehabilitate the drainage network, and update countermeasures. However, since the needed drastic measures were not implemented, and due to the deterioration and occupation of some canals, the actual drainage network is not fully working and the capacity is inadequate.

Low capacity of pumping stations

During the 2015 floods generated by Cyclone Chezda, low areas of the agglomeration were under water for one to two months. As shown in the following table, the pump capacity was originally low. Moreover, majority of SAMVA's assets are now out of service due to degradation of machinery accelerated by the inflow of sludge and solid waste.

Table 11.2.2 Capacity of the Pumping Stations

		Name	Original Capacity	Notes
1	APIPA	Ambodimita	3 m ³ /s x 3 pumps	
2	SAMVA	Ampefiloha	0.010 m ³ /s x 3 pumps (100 litres/s)	Only one is working
3	SAMVA	Isotry	0.033 m ³ /s x 2 pumps (333 litres/s)	Only one is working
4	SAMVA	67 ha	0.013 m ³ /s x 3 pumps (133 litres/s)	Only one is working
5	SAMVA	Ambodin'Isotry	0.012 m ³ /s x 2 pumps (12 litres/s)	Only one is working
6	SAMVA	Anatihazo	0.025 m ³ /s x 4 pumps (250 litres/s)	Only one is working

Source: APIPA, SAMVA

Decrease of the canal capacity caused by uncontrolled occupation and waste

According to the results of meetings with concerned organizations (Ministry of Water, APIPA, SAMVA, and CUA), the canal's capacity has decreased considerably due to the rapid growth of population, resulting to significant increase in waste generation, uncontrolled construction of habitation, and illegal connection of households to drainage pipes.



Photo 4 Accumulation of waste in the canal



Photo 5 Waste interfering with flow near structures



Photo 6 Gutter buried due to new construction

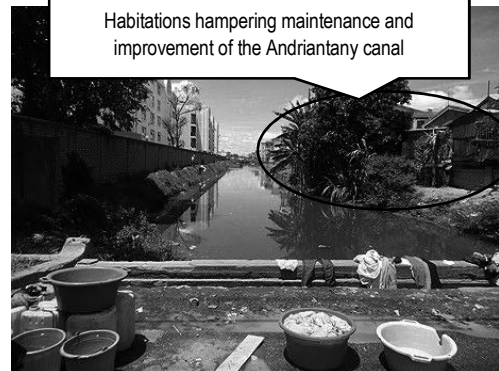


Photo 7 Habitation interfering with maintenance works

Figure 11.2.5 Uncontrolled Occupation and Waste Dumping in Drainage Canals of Antananarivo

Decrease in drainage canal's capacity due to insufficient maintenance

The existing drainage system (wastewater and storm water) was constructed during colonisation period when the urbanization was limited and population was 300,000, and so the recalibration of drainage infrastructure is needed to respond to the runoff changes and to serve the current

2,500,000 inhabitants. Further, due to the lack of maintenance, the capacity of existing assets is decreasing. According to SAMVA, 30% of the existing drainage canals cannot function as expected due to degradation, sedimentation, garbage accumulation, and vegetation growth.



Photo 8 Basin capacity decreased due to vegetation growth



Photo 9 Degradation of an existing canal

Figure 11.2.6 Degradation of Drainage Canals in Antananarivo

Three entities (communal government of CUA and two organizations attached to the Ministry of Water: APIPA and SAMVA) are mainly responsible to manage and maintain the waste water and storm water drainage systems in CUA. However, the limitation of human resources and budget makes it difficult to carry out the inspection and maintenance of the entire drainage system and the implementation of preventive measures before the rainy season.

Table 11.2.3 Resources and Gaps of the Entities Responsible for CUA's Drainage Systems

	Resources	Gaps
APIPA (responsible to manage and maintain rivers and main canals)	<p>Human resources:</p> <ul style="list-style-type: none"> ➤ 58 technical officers (civil engineers, geologists, hydrologists etc.) <p>Funding:</p> <ul style="list-style-type: none"> ➤ Contribution from the national government and communes to manage flood protection structures and equipment ➤ Royalties from landfilling (annual fee paid by landowners) ➤ Revenue resulting from intervention ➤ External aid fund 	<ul style="list-style-type: none"> ➤ The area of intervention of APIPA is covering 30 communes and almost all the dikes that it managed were constructed more than 100 years ago. <ul style="list-style-type: none"> ⇒ Due to the low human and budgetary resources, preventive measures such as rehabilitation of dikes and riverbed dredging are limited (Actually, communes are responsible to inspect dikes and sedimentation status and APIPA conducts maintenance and rehabilitation activities upon the requests of the communes).
SAMVA (Main canals of CUA)	<p>Human resources:</p> <ul style="list-style-type: none"> ➤ 120 officers in the service of sanitation (800 officers in total) ➤ 80 temporary staffs/ day are hired to dredge canals. <p>Funding:</p> <p>The main sources are:</p> <ul style="list-style-type: none"> ➤ Fees on water consumption (JIRAMA is supposed to allot 10% of the water consumption revenue to SAMVA) ➤ Charges on household waste ➤ Charges related to construction and emptying of individual sanitation facilities 	<ul style="list-style-type: none"> ➤ SAMVA and CUA are responsible to manage and maintain the wastewater and storm water drainage systems in CUA. <ul style="list-style-type: none"> ⇒ However, due to new constructions and illegal connections to drainage pipes and gutters, the entire picture of the drainage system is unknown. ⇒ Due to the population growth and insufficient waste management, open canals are filled with waste. Although SAMVA is conducting daily clearing works, the number of staffs is not adequate (According to SAMVA, 400 staffs / day are needed).
CUA (secondary and tertiary canals)	No information regarding the resources attributed to sanitation and drainage issues	

Source: JICA Study Team from the results of meetings with APIPA and SAMVA

11.2.2 Future Demand Forecast for Sewer and Drainage of Antananarivo Agglomeration

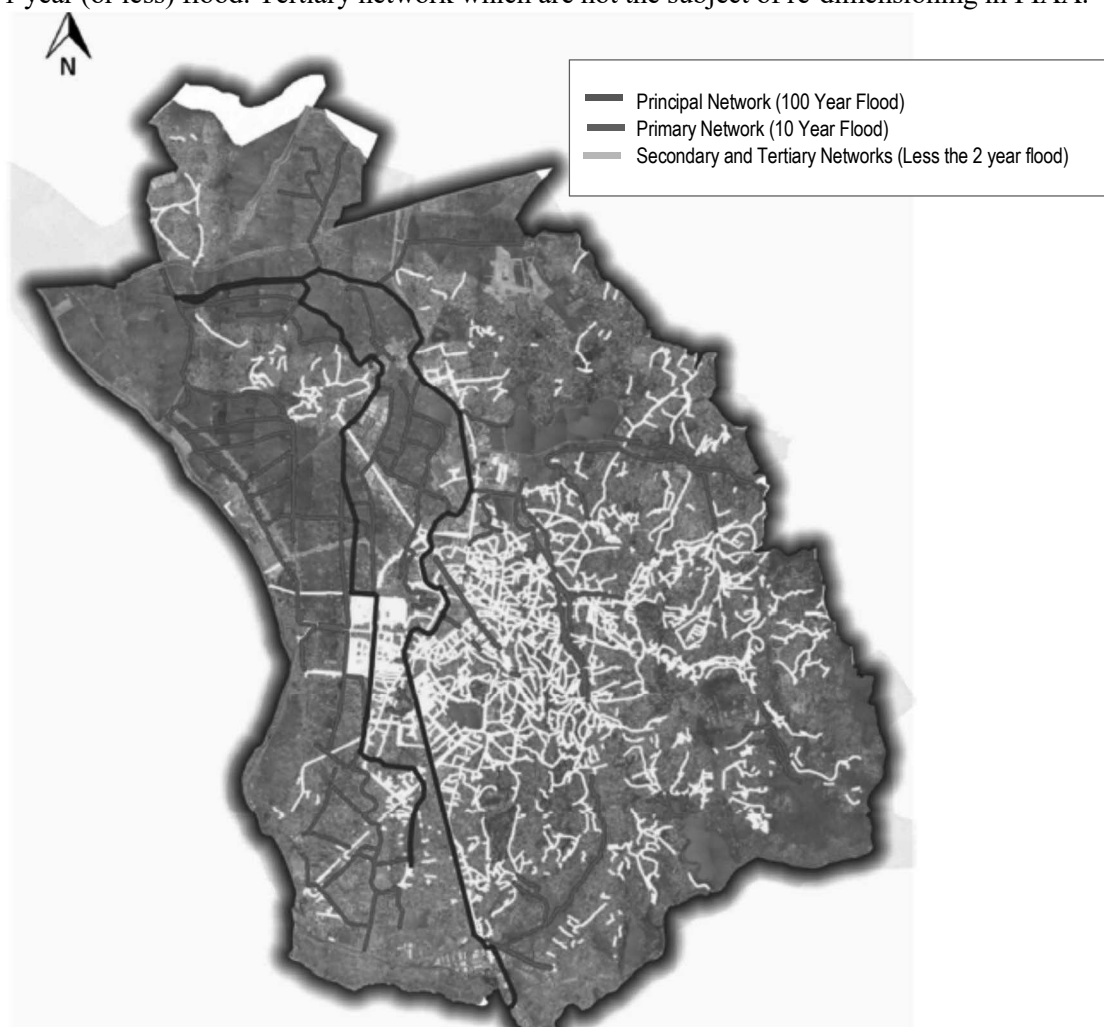
In this section, the future demand for rainwater and wastewater drainage systems are summarized.

(1) Management of Rainwater

As it will be explained in 11.2.4, the PUDi proposed by TaToM follows the vision, directions, measures proposed by the relevant studies, especially the “Integrated Sanitation Programme for Antananarivo” or PIAA.

The General Rule or Level of Protection of rainwater drainage infrastructures inside CUA targeted by PIAA are as followed.

- 100 year flood: Principal Network composed by the Andriantany and C3 Canals which overflow may affect a large population and cause deep impacts because of a long submersion duration and deep flood depth.
- 10 year flood: Primary network which overflow may cause important damage because of high velocity and deep flood depth
- 2 year flood: Secondary and tertiary network which overflow may cause temporary flooding with limited impacts.
- 1 year (or less) flood: Tertiary network which are not the subject of re-dimensioning in PIAA.



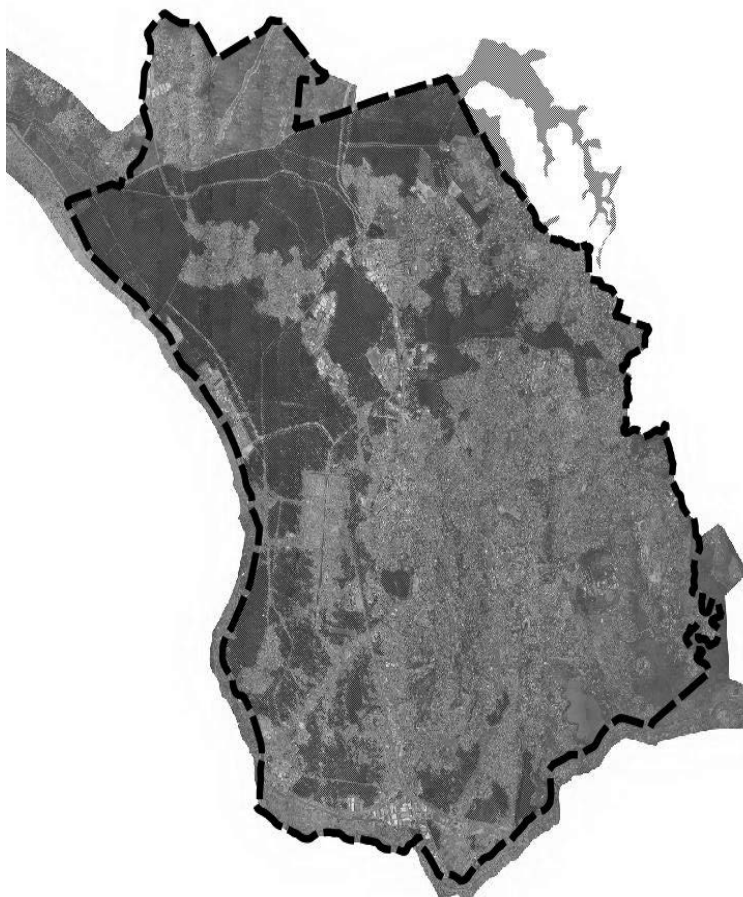
Source: BRL, PIAA, 2018

Figure 11.2.7 Location of the Drainage Canals in CUA

In addition, PIAA states that the preservation of wetland (buffer areas) enabling the storage of at least 15 million cubic meters is fundamental to avoid the occurrence of critical damage in CUA, and TaToM is proposing the preservation of wetlands and installation of storm water retention ponds to secure this volume.

With the implementation of PIAA including the preservation of 15 million cubic meters, it is expected that the management of rainwater in urbanized areas will be possible during 100 years-return period flood.

Note: The target of PIAA is “Rainwater Flooding” and the simulation results of flood with an intensity of 100 years-return period is not conducted yet.



Source: BRL, PIAA, 2018

Figure 11.2.8 Water Retarding Areas in the Event of 10-year Probability Rainfall in CUA

Regarding the surrounding Communes, there is not any Master Plan defining the level of protection against floods. However, the PIAA-extended Study for the “Formulation of Sanitation Master Plan covering the Great Antananarivo and the conduct of Flood Risk Assessment” which has started in the end of 2018 (TOR was approved in October 2018), is expected to 1) clarify the Sectoral Framework for Sanitation in the Great Antananarivo, 2) consider measure to improve flood management system, 3) improve the efficiency of drainage network, and 4) optimize benefits related to Sanitation. Therefore, the target level of protection for the entire Antananarivo Agglomeration will be set through this study.

(2) Management of Wastewater

According to PIAA, as of 2017, the management of waste water for more of 90% of the total households in CUA are done through non-collective system and only 2.4% households are connected to collective sanitation system. Regarding the Management of Wastewater, PIAA states three objectives that are:

- Limitation of Pollution caused by Anthropogenic Activities,
- Improvement of Sanitary Conditions through a functional system disconnected from rainwater but linked to the solid waste management system,
- Coordinated and Integrated implementation of urban projects.

To deal with the uncertainty regarding future population to serve, and capacity building of responsible organization to operate and maintain the new facilities that are not yet familiar in Madagascar, PIAA is proposing the adoption of “modular” approach allowing the gradual augmentation of the wastewater station capacity.

With the implementation of PIAA, 11% of the households will be connected to the collective network until 2037. On the other hand, the improvement of the overall non-collective system actually used by around 90% of the households will be enhanced until 2037.

11.2.3 Issues on Sewer and Drainage Systems of Antananarivo Agglomeration

In this section, the issues to consider in the PUDi are summarised.

(1) Urban Area of CUA

A population of over 750,000³ is estimated to be currently inhabiting the vulnerable areas exposed to rainwater flooding. With the construction of new roads, commercial/trade centres and other infrastructures enhancing socio-economic dynamism, the attractiveness of the agglomeration will increase and respond to population growth. Then it would be difficult to completely control and enable the landfilling of wetlands (or “buffer zones/ tampons”) which are playing a crucial role in absorbing rainwater.

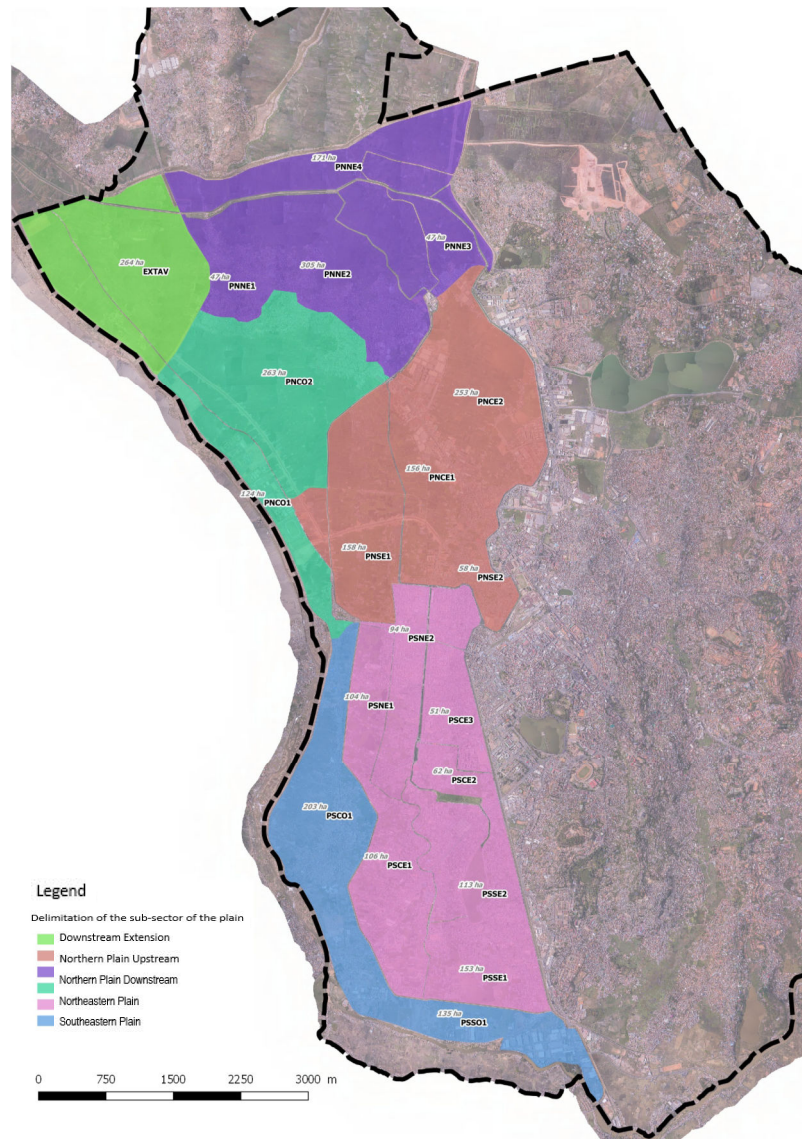
The discharge ratio of rainwater is expected to change due to increase in land coverage, hence the re-calibration and upgrade of the actual system will be needed in the existing highly populated area where the drainage capacity is already lacking.

On the other hand, the landfilling of wetlands in the lowland (polder) of CUA, which was lowly occupied and mainly used for agricultural purposes, has started and continuing⁴. Consequently, their retention capacity is dramatically decreasing. However, these areas (especially the South-West plain along the right side of Ikopa River) is not equipped with drainage system.

Similar problems also exist in wastewater drainage system because the actual facilities are not enough to respond to future demand caused by population growth.

³ Arcadis (2016), Analysis of flood management practices in Antananarivo

⁴ The cause of landfilling is not limited to informal occupation. Some new urban development projects are also projected to be implemented in the near future.



Source: BRL PIAA

Figure 11.2.9 Drainage Basins in the Polder

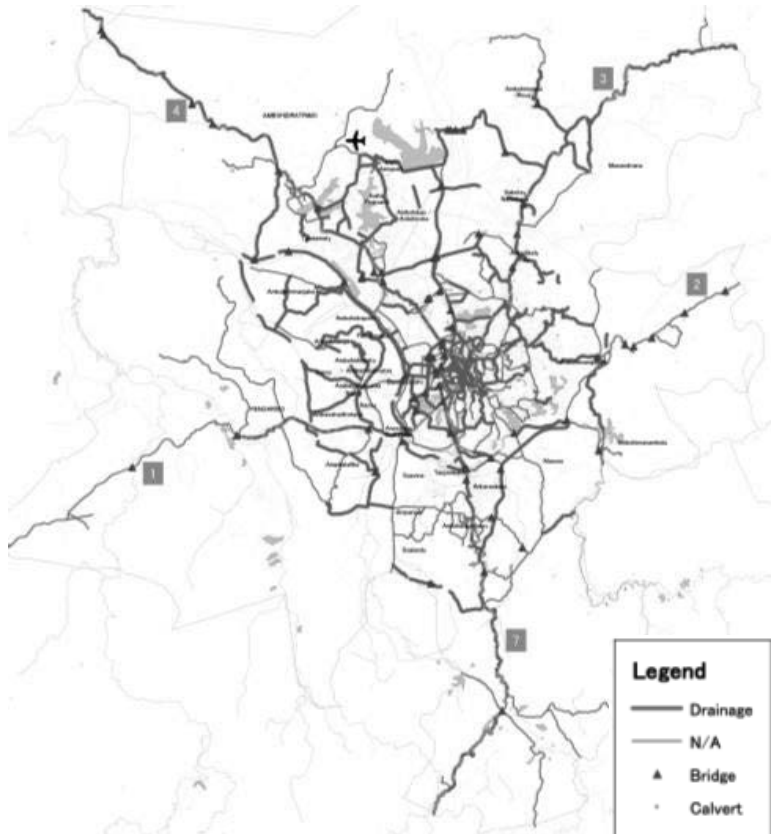
(2) Surrounding Communes

As summarized in Figure 11.2.10, the surrounding communes do not have any drainage system for both rainwater and wastewater.

Rainwater is mainly drained by the gutters along major or national roads. Regarding wastewater, there is no collective network to collect and manage it.

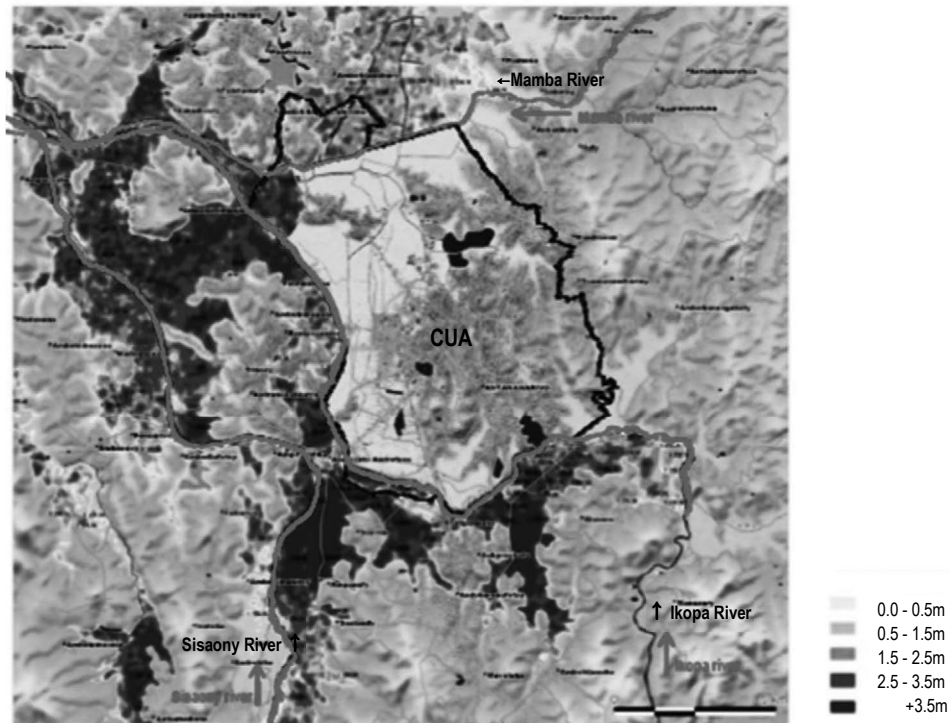
To enhance the dispersion of people as well as socio-economic centres near the “new poles”, the implementation of new drainage system will be needed.

Meanwhile, the surrounding communes are also exposed to river flooding (see Figure 11.2.11). However, as mentioned above, almost all of the dikes were built 50 years ago and were only reinforced until recently. Consequently, the actual level of protection against floods is lower than designed. Since the future land use zoning in surrounding Communes is referring to the actual possibility of disaster risks, the actual level of protection has at least to be maintained (e.g., maintenance of dikes), and then should be enhanced to achieve the original designed level of protection.



Source: JICA Study Team

Figure 11.2.10 Location of Gutters along Major Roads in Antananarivo Agglomeration



Source: Map provided by APIPA

Notes:

- 1) Dike protection level as of 2010
- 2) 50-Year rainfall

Figure 11.2.11 Areas Projected to be Inundated by the Over Flooding of Ikopa River and its Affluent Flooding (Return Period: 50 Years)

11.2.4 Objectives for Sewer and Drainage Systems of Antananarivo Agglomeration

The objectives for sewer and drainage systems of Antananarivo in the PUDi for Antananarivo Agglomeration will be aligned with the Vision 2036 of the GIEU (Integrated Urban Water Management of Greater Antananarivo) which was formulated in 2017 and is as follows:

"On the basis of an integrated approach, we will build, by 2036, the agglomeration of Antananarivo able to live in harmony with water by relying on a system of urban planning that will make the population and its environment resilient, healthy and responsive to environmental emergencies, including natural disasters".⁵

Based on this vision, the objectives related to rainwater and wastewater management is to be able to contribute to the sustainable and prosperous development of the agglomeration through the minimisation of human and socio-economic impacts caused by flooding.

11.2.5 Strategies for Sewer and Drainage Systems of Antananarivo Agglomeration

1) Maintain consistency with relevant studies

Important studies focusing on water resources and disaster risks are being conducted, and the strategies and future projects and programmes for Sewer and Drainage Systems of Antananarivo Agglomeration of PUDi should be in harmony with these studies.

Especially, there are three important studies to take into account. The first one is World Bank's "Support to the Development of a Strategic Planning for Integrated Urban Water Management of Greater Antananarivo" which aimed to support the strategic planning of GIEU (Integrated Urban Water Management) by adopting a participatory approach. The study was completed in 2017 with the formulation of strategic plans and action plans for rainwater, wastewater, and solid waste management.

The second one is AFD's "Integrated Sanitation Programme for Antananarivo" or PIAA which aims to 1) propose an institutional plan organizing the actors of the sanitation sector and assess the necessary financial means to the sustainable implementation of the proposed plan; 2) prepare the Integrated Sanitation Programme for Antananarivo that includes the main themes for rainwater, wastewater, and excreta, and integrating some aspects of crosscutting themes; 3) to prepare APS (Summary preliminary draft) / APD (Detailed preliminary draft) studies, lay down the bidding documents and ensure the supervision of a first phase of work to be started quickly; and to 4) to prepare APS/APD studies, lay down the bidding documents of the work of other phases. The study covering CUA is almost completed and the extended study covering the surrounding communes has started in the end of 2018.

The last one is the "Integrated Urban Development and Resilience Project" or PRODUIR (also by World Bank) aiming to improve the living conditions of the poorest in the precarious neighbourhoods of the Greater Antananarivo through the sustainable development of basic services, sanitation and resilience to natural hazards, and also to improve governance. PRODUIR also aims to prevent the development of new risks.

Especially the Strategies on Rainwater and Wastewater Drainage of TaToM will try to follow the ones proposed by PIAA that are as follows.

Rainwater Management:

- Phase I (2018-2022): Priority will be given to the: 1) Rehabilitation of the existing assets, especially the Principal Drainage Network, 2) Elimination of a certain number of black spots (neck points), 3) Initiation or establishment of tools and institutional, regulatory and organizational reforms to ensure the operation ability and sustainability of the Master Plan

⁵ In French: « Sur la base d'une approche intégrée, nous allons bâtir, à l'horizon 2036, une agglomération d'Antananarivo capable de vivre en harmonie avec l'eau en nous appuyant sur un système de planification urbaine qui rendra la population et son environnement à la fois résilients, sains et aptes à répondre efficacement aux urgences environnementales, notamment les catastrophes naturelles ».

prepared by PIAA,

- Phase II (2023-2027): The main directions will be the: 1) Continuation of the rehabilitation and reinforcement works on the Principal and Primary Drainage Networks, and 2) Increase the level of protection in correlation with the advancement of urban planning.
- Phase III (2028-2037): Priority will be given to the: 1) Rehabilitation of the existing secondary and tertiary networks, and 2) development of the resiliency in the areas exposed to flood risk

Wastewater Management

- Phase I & II (2018-2027): Upgrade of the existing infrastructures, implementation of standards to install non-collective sanitation facilities and construction of large scale infrastructure (faecal sludge and sewage treatment plant) in the North of CUA will be done.
- Phase III (2028-2037): During this Phase, the activities conducted before 2028 will be sustained and new collective network will be constructed to augment the population connected to the sanitation network and construction of large scale infrastructure (faecal sludge and sewage treatment plant) in the South of CUA will be done.

2) Optimize the capacities of existing assets and minimise the increase of flood risk

Recovery of existing assets and preservation of buffer zones in CUA

PIAA is giving a high priority to the rehabilitation and upgrade of existing infrastructures and to the capacity enhancement of agencies such as SAMVA and CUA, responsible to operate and maintain those facilities. Attention will first be addressed to the rehabilitation of the Principal Drainage Network (Canals Andriantany and C3) and implementation of small scale works to eliminate neck points such as the dredging of smaller canals. Then, new construction and upgrade of pumping stations are planned.

In addition to the measures proposed by PIAA, mitigation measures to minimize⁶ the negative impacts caused by the changes in land coverage (e. g., increase of the runoff coefficient) should be implemented. One of the measures would be the encouragement of permeable paving of the new major (arterial) roads to manage runoff, infiltration, and pollutant transport.

On the other hand, spaces to “temporarily” store rainwater in highly or newly urbanised area in the polder (in particular the drainage basin of Plaine Sud Est along Ikopa River and near Ankorondrano) will be developed to mitigate the negative effects of landfilling. In addition, standards and rules to develop areas which were originally used as “buffer zones” should be considered and come into force.

Implementation of countermeasures in newly developed areas to balance the increase of flood risk in existing urban areas

As shown in Figure 11.2.11, the over flooding of Ikopa and Sisaony Rivers is supposed to affect the Communes located on the left bank and upper stream (such as Ambihitrimanjaka, Fionbonana, Ankadimaka, Itaosy, Ambohidrapeto, Bemasoandro, Andranonahoatra, Anosizato Andrefana, Soavina Ampanefy and others). Actually, the main purpose of land in this rural communes is agriculture and some adaptation measures such as the conversion to “flood-tolerant agricultural varieties” and changes in harvest period are implemented.

Therefore the transformation of these agricultural land to residential, industrial or administrative will inevitably increase the flood risk in CUA which is already highly urbanized and populated. . So that, the ordered development of these areas will be required (eg.strict control of development

⁶ According to BRL in charge of the PIAA study, based on the reflections of the actual capacities of APIPA, SAMVA, CUA in charge to manage rainwater inside the polder of CUA and results of hydrological analysis, regarding the upgrade of pump station, the increase from 9 to 21 m³/s of the Ambodimita Pump Station; or the construction of a new 12 m³/s pump station is the most feasible and adequate alternative. However, additional to this pump capacity, a retention volume of at least 15 million cubic meters in the polder and an average of 60 000 to 150 000 m³ per km² of “upstream” catchment area will be needed (based on the consultation meeting held in February 2018).

or construction permission) and measures such as the installation of new retention ponds, construction of elevated roads or new drainage canals, enlargement of outlets in the newly developed areas will be fundamental to respond to the runoff increase.

Minimise the development of the confluent area of Ikopa and Mamba Rivers

Usually, such areas are lowland where water tends to stagnate due to effect of backwater. On the other hand, the preservation of those areas are fundamental to drain rainwater to the downstream (the development of the retention basins at the “exit” will increase the impacts of flooding in terms of water depth and flooding duration time of the upper drainage basins).

11.2.6 Programmes and Projects for Sewer and Drainage Systems of Antananarivo Agglomeration

As explained above, a wide variety of programmes and projects reflecting the actual capacities of each responsible agencies and legislative framework were proposed through past and on-going studies. The following programmes and projects for sewer and rainwater drainage systems of Antananarivo Agglomeration are composed of works proposed by relevant studies and newly proposed to implement PUDi.

(1) Implementation of the Programmes and Projects proposed by PIAA

1) 1-1 Implementation of the High-Priority Programmes Identified by PIAA (Short Term)

PIAA has identified a wide series of works to implement to deal with both rainwater flooding and river floods. Especially, 1) the rehabilitation of dikes on the right bank of Ikopa (around 4.5km) and Sisaony (125 m linear), and 2) the rehabilitation of Canal C3 are identified as High-Priority Projects to improve the overall drainage system. PIAA is also recommending the rehabilitation of the existing drainage structure to recover the initial designed capacity of each infrastructure and proposed the dredging/clearing of Canal C3, over a distance of 12 km, from Anosibe to Ambodimita station, including the retention lakes of Andavamamba and Anosibe and the Andriantany canal outlet. A technical feasibility study of these High-Priority Projects is actually ongoing and the works are planned to be implemented under the PRODUIR.

On the other hand, PIAA has identified around 70 works to conduct until 2022, including the rehabilitation, reinforcement of the overall existing network and construction of new linkage sections to optimize the function ability of the network.

2) 1-2 Construction of Large Scale Facilities (Mid to Long term)

As of December 2018, PIAA has identified a total of more than 700 works to improve rainwater drainage in CUA which are expected to be implemented until 2037.

In addition, the feasibility study and implementation of the following large-scale measures requiring the enhancement of technical, management and budgetary capacities of related agencies to operate and maintain those facilities are expected to be conducted.

- The installation of an additional pumping station of 12 m³/s capacity and / or the upgrade of the Ambodimita station from 9 to 21 m³ / s
- The leverage of the protection of Mamba River by the raising of dikes
- The dredging (lowering) of the riverbed of Ikopa River
- The development of a temporary storage area in the North-West Plain
- The raising of the banks of the evacuation canal of Mamba or creation of a new discharge canal to Ikopa

Additional projects covering the other communes and reflecting TaToM will be proposed through the on-going extended Study for the “Formulation of Sanitation Master Plan covering the Great Antananarivo and the conduct of Flood Risk Assessment”.

(2) Integration of drainage countermeasures into each individual development project

1) 2-1 Establishment of new frameworks and rules to develop new areas and promote the involvement of Private Sector in the Short Term (2019-2023)

Residential areas and administrative areas are planned to be newly developed in areas actually used as agricultural land or wetlands. Therefore, in the PUDi, parks and recreation areas enabling the temporary rainwater storage will be set in order to attenuate the effects due to landfilling. In the other hand, countermeasures to facilitate the infiltration of rainwater such as permeable paving and surface will be recommended for the construction of new towns and roads.

However, actually there is not any formal procedure to implement those countermeasures and the responsibility of each agency is not clear. Therefore, the identification of roles and responsibilities of each organization including Private Developers to oblige the implementation of adequate drainage countermeasures to construct new residential complex or industries and the establishment of strict rules to avoid unexpected development will have to be developed for the short term. In parallel, technical guidelines to construct and maintain countermeasures such as artificial flood control pond will have to be developed.

The following table shows examples of urban features that can be used as temporary storage.

Storage type	Description
Car parks	Used to temporarily store flows. Depth restricted due to potential hazard to vehicles, pedestrians and adjacent property.
Minor roads	Roads with speed limits up to 30 mph where depth of water can be controlled by design
Recreational areas	Hard surfaces used typically for basketball, five-a-side football, hockey, tennis courts
School playgrounds	Playgrounds can provide significant flood storage. Extra care should be taken to ensure safety of the children.
Playing fields	Set below the ground level of the surrounding area and may cover a wide area, offering significant flood volume
Parkland	Has a wide amenity use. Oftentimes may contain a watercourse. Care needed to keep floodwater separate and released in a controlled fashion to prevent downstream flooding.
Industrial areas	Low-value storage areas. Care should be taken in the selection as some areas could create significant surface water pollution.

Source: WB, GFDRL (2012), "Cities and Flooding A Guide to Integrated Urban Flood Risk Management for the 21st Century"

However, reflecting the actual capacities in term of budgetary, human resources, technical skills, the implementation of those countermeasures by Governmental Agencies will be difficult. Therefore, the promotion of Private Sector may present a solution to deal with issues such as funding and human resources in the Antananarivo Agglomeration.

2) 2-2 Construction of "compensatory" retention countermeasures integrated into individual development project in Mid to Long Term (2023-2033)

Based on the roles and functions of each stakeholder, directions and guidelines developed in Short Term, drainage countermeasures will be integrated into each development project.

3) 2-3 Promotion and Installation of Compensatory Water Retention Infrastructures in the Existing Urbanised Areas in the Short Term to mid Term (2019-2029)

Regarding CUA, unavoidable impacts will be caused by the changes in land coverage, so that spaces to temporary store rainwater in highly or newly urbanised area in the polder, in particular the drainage basin of Plaine Sud Est along Ikopa and near of Ankorondrano.

However, reflecting the actual low respect of rules and law regarding landfilling, such as the Decree No.2002-979 of August 28, 2002, stating that all landfilling planned in the Plain of Antananarivo are subject to the examination conducted by a Committee led by APIPA and obliging the construction royalties to APIPA, the protection of wetlands in existing urbanised areas will be

a challenge. Therefore the installation of water retention facilities in these areas where informal development is difficult to control will have to be implemented in priority.

(3) Planning and Implementation of Comprehensive Countermeasures Enabling the Improvement of Water Environment

1) 3-1 Establishment of New Frameworks and Rules in the Short Term (2019-2023)

For the short term, effective and feasible combination of countermeasures including institutional reforms to empower the compliance of environmental standards, capacity enhancement of “water police” agencies and public education programmes should be considered and planned.

In addition, the financial and organizational schemes enabling the implementation, operation and maintenance of infrastructures which will be installed in the mid term and long term will be considered and established in short term.

2) 3-2 Implementation of Countermeasures to Improve Water Environment in the Mid Term (2024-2029) to Long Term (2019-2033)

In addition to the structural countermeasures such as the construction of new faecal sludge and sewage treatment plants and upgrade of both collective and non-collective systems, non-structural countermeasures including the enhancement of water governance from the fokontany to national governments and including the introduction of private sector in term of funding, construction, operation and management of wastewater facilities will be conducted.

Table 11.2.4 Provisional Action Plan Sewer and Drainage Systems of Antananarivo Agglomeration

Item		2019-2023	2024-2028	2019-2033
1)	Implementation of the programmes and projects proposed by PIAA			
(1-1)	Implementation of the high-priority programmes identified by PIAA			
(1-2)	Construction of large scale facilities			
2)	Integration of drainage countermeasures into each individual development project			
(2-1)	Establishment of new frameworks and rules to develop new areas			
(2-2)	Construction of “compensatory” retention countermeasures integrated into individual development project			
(2-3)	Promotion and installation of compensatory water retention infrastructures in the existing urbanised areas			
3)	Planning and Implementation of comprehensive countermeasures enabling the improvement of Water Environment			
(3-1)	Establishment of new frameworks and rules			
(3-2)	Implementation of countermeasures to improve Water Environment			

Source: JICA Study Team

11.2.7 Profile of Priority Projects for Sewer and Drainage Systems of Antananarivo Agglomeration

The profile of priority projects to implement TaToM are as follows.

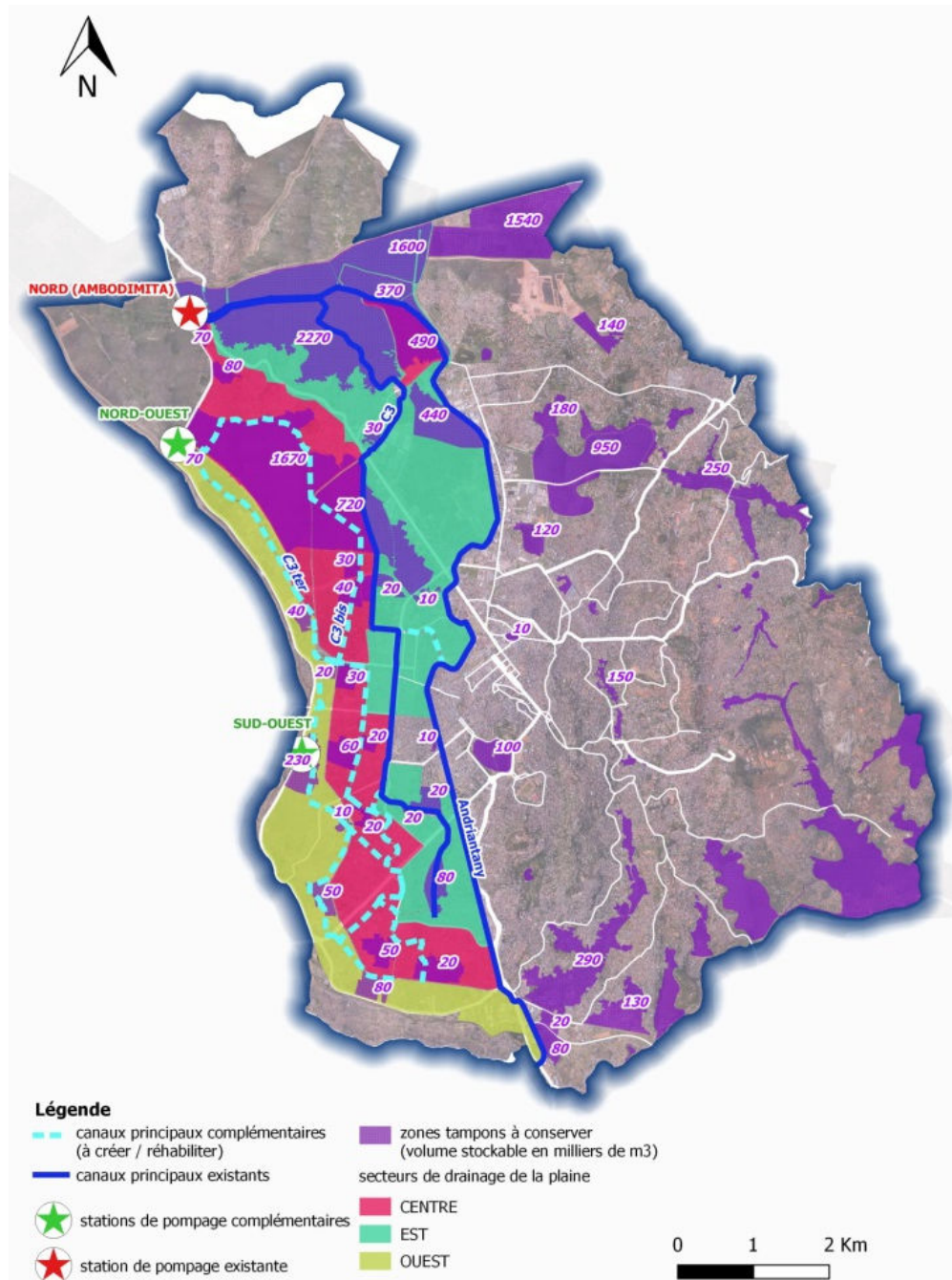
(1) Programme for Development of Retention Ponds and Waterfront Parks for Disaster Risk Reduction

1) Rational

- Rice fields and low lying lands around CUA have function as water retention zones to protect the plains of CUA from flooding in the event of heavy rain. However, even though the zoning

regulations of PUDi 2004 prohibit the urban use of plains, illegal landfilling continues to occur due to strong urbanisation pressure. As a consequence, the inundation risk inside CUA is increasing.

- PUDi 2019 for Antananarivo Agglomeration incorporates the study results of the PIAA Sanitation Master Plan for CUA. In the PIAA Sanitation Master Plan for CUA, inundation risk of most residential areas are targeted to be below 100 year rainfall. To reach this target, there is a need to sustain 15,000,000 m³ of water retention in total, inside CUA. Additionally, PIAA has provided a general guidance for the location and volume of water retention zones, with consideration towards the different catchment areas and drainage facilities (see Figure 11.2.12). The water retention specified in the revised PUDi (PUDi 2019) for Antananarivo Agglomeration are in line with the above targets and guidance.
- Retention ponds will be constructed in areas where the necessary water retention capacity is already close to the minimum requirement, or is under strong threat of further illegal landfilling. For example, large parts of the southern plains in the 4th Arrondissement in proximity to the commercial centre of CUA have been landfilled due to high urbanisation pressure. In order to firmly maintain the minimum required water retention capacity, it is necessary to secure the remaining wetlands with strong enforcement measures such as constructing retention ponds.
- CUA lacks in parks and recreation space for its citizens. The retention ponds will not only function as measures for disaster risk prevention, but also as recreational space for people to enjoy.



Source: PIAA Project, 2018

Figure 11.2.12 Location and Size of Retention Ponds Proposed by PIAA Project

2) Objectives

- To secure the water retention volume necessary for the “plaine nord amont” area, where landfilling for new urban development projects in Ankorondrano are planned, and to secure part of the water retention volume necessary for the whole of CUA.
- To increase the liveability and livelihood of the surrounding area, by creating new recreational space.

3) Project Description

The programme is composed of the following projects for development of retention ponds and waterfront parks:

Phase 1: 2019-2023

- Project for Development of Ankorondrano Lake (45 ha) and Waterfront Park (5 ha)
- Project for Development of Ankazomanga Atsimo Lake (49 ha) and Waterfront Park (2.5 ha)
- Project for Development of Andavamamba Anatihazo II Lake (10 ha) and Waterfront Park (0.3 ha)

Phase 2: 2024-2028

- Project for Development of South East Plain Retention Ponds (71 ha) and Waterfront Parks (7.5 ha)

Phase 3: 2029-2033

- Project for Development of South West Plain Retention Ponds (30 ha) and Waterfront Parks (10ha)

4) Expected Benefits

A retention pond with the capacity of 460,000 m³ will be constructed. This will ensure the minimum buffer storage recommended by the PIAA Sanitation Master Plan, in order to protect the southern plains of CUA from flooding in the event of 100 year rainfall.

5) Executing Agency and Related Institutes

- MAHTP
- APIPA
- CUA
- Private Sectors

6) Estimated Project Cost

- 5 million USD for Project for Development of Ankorondrano Lake and Waterfront Park
- 5 million USD for Project for Development of Ankazomanga Atsimo Lake and Waterfront Park
- 1 million USD for Project for Development of Andavamamba Anatihazo II Lake and Waterfront Park
- 8 million USD for Project for Development of South East Plain Retention Ponds and Waterfront Parks
- 4 million USD for Project for Development of South West Plain Retention Ponds and Waterfront Parks

7) Implementation Schedule

Phase 1: 2019-2023

- Project for Development of Ankorondrano Lake and Waterfront Park
- Project for Development of Ankazomanga Atsimo Lake and Waterfront Park
- Project for Development of Andavamamba Anatihazo II Lake and Waterfront Park

Phase 2: 2024-2028

- Project for Development of South East Plain Retention Ponds and Waterfront Parks

Phase 3: 2029-2033

- Project for Development of South West Plain Retention Ponds and Waterfront Parks

8) Necessary Actions for Implementation / Critical Factor

- Obtaining land for retention pond

9) Related Plans and Projects

- Ankorondrano PUDé
- PIAA Sanitation Master Plan

10) Social and Environmental Impacts

The projects have some adverse impact on water environment by construction retention ponds.

(2) Technical Assistance Project to Establish New Frameworks and Rules on Drainage Infrastructures to Develop New Areas

1) Rationale

As explained in 11.2.3, due to limited funds, technical capacities and human resources, almost all governmental agencies responsible of rainwater and wastewater management are facing challenges to adequately plan, implement, operate and maintain drainage infrastructures. Especially regarding rainwater drainage, informal and disordered development will increase the risk of flooding and consequently countermeasures to attenuate the impacts from flooding in both newly developed areas and existing urban areas should be implemented. One of the measures to adopt is the integration of drainage countermeasures attached to individual development projects such as development of residential complexes, construction of new arterial roads and others.

Regarding wastewater, the connection from new developed areas to existing collective network will require a considerable enlargement of the existing canals and construction of large-scale treatment plants (additional to those proposed by PIAA). However, the capacities of SAMVA and the communes are limited. Therefore, in a first time, the implementation of stand-alone non-collective wastewater treatment measures will have to be implemented in parallel with the development of new areas.

2) Objectives

The overall goal of this Project will be the creation of new frameworks and rules to respect for the development/landfilling of areas having retention potential. The objectives for each stage are as following:

[Stage 1: Establishment of new frameworks]

- To enhance the Technical Capacities of related agencies
- To consider the possibilities to involve Private Sector for the funding, planning, implementation, operation and maintenance of drainage facilities, such as the construction of artificial flood control pond in newly developed residential complexes and industrial areas
- To develop Technical Standards and institutional arrangements to promote the integration of drainage infrastructures into each development project

[Stage 2: Verification of the adequacy and feasibility of the new frameworks]

- To check the feasibility of the frameworks and rules established during the Stage 1 through the implementation of Pilot Projects

3) Project Description

This project will be a Technical Assistance involving CPGU which is responsible to develop Technical Standards, AGETIPA which is responsible to monitor design, prepare and implement important projects such as PIAA, MAHTP which is responsible to submit Construction Permission and other governmental agencies.

During the Stage 1, a platform involving related agencies will be installed to consider the possibility to promote PFI/PPP projects, create new technical standards to respect and consequently establish more effective and efficient drainage countermeasures to attenuate the impacts caused by new development projects.

During the Stage 2, the frameworks and rules developed during the Stage 1 will be verified through Pilot Projects (eg. pilot infrastructures). It is expected that the planning, design, and construction of pilot infrastructures will be included into development projects such as construction of residential complex, industrial areas and roads.

4) Expected Benefits

It is expected that drainage countermeasures will be integrated into all new development projects, and consequently that the increase of the impacts from floods will be attenuated.

5) Executing Agency and Related Institutes

- CPGU
- AGETIPA
- MAHTP , Urban Agencies from National Government to Communes
- Private Sector (Developers)

6) Estimated Project Cost

- N/A (Phase 1: USD 1 million, Phase 2: N/A)

7) Implementation Schedule

- Phase 1: 3 years (2020-2023)

8) Necessary Actions for Implementation / Critical Factor

Coordination and consensus building within related agencies will be needed.

9) Related Plans and Projects

- PUDi prepared by TaToM

10) Social and Environmental Impacts

Since the implementation of drainage "compensatory" countermeasures will be complementary to urban development projects, the social and environmental impacts of compensatory countermeasures are expected to be minor.

(3) Project to Set Up Priority and Install Compensatory Water Retention Infrastructures in Existing Urbanised Areas

1) Rationale

TaToM has identified 36 locations which have to be preserved as wetlands or developed into water retention ponds. As mentioned above, measures to prevent informal construction in some areas such as along Canal Andriantany in the City Centre will have to be implemented in priority.

2) Objectives

This Project will aim to:

[Stage 0 (during TaToM)]

- Identify priority infrastructures

[Stage 1]

- Feasibility Study
- Design, Construction of priority infrastructures

3) Project Description

As explained in the rationale, some locations are already subject of potential occupation which is not expected and will eliminate the water retention capacities of some buffer zones. Therefore, TaToM will identify the locations where emergency measures will be needed to avoid informal occupation, consider the possibilities to construct water retention infrastructures in short term.

The draft criteria to select priority infrastructures are as follows:

- Development Pressure / Possible landfilling of buffer zones
- Importance of the location to implement TaToM by reflecting Development Scenario
- Water retention capacity to secure per drainage basin
- Linkage with other Projects / Possibility to implement works at the same time

The type and scale of priority infrastructures will be confirmed by using the results of hydrologic and hydraulic analysis conducted by PIAA.

The detailed design will be conducted in parallel with land appropriation and infrastructure will be installed.

4) Expected Benefits

With the securement of water retention volume, the increase of the impacts caused by rainwater flooding are expected to be minimized.

5) Executing Agency and Related Institutes

- MAHTP

6) Estimated Project Cost

- To be determined

7) Implementation Schedule

2 years (1 year for the land Appropriation in parallel with the planning and design of the infrastructures, 1 year for the construction)

8) Necessary Actions for Implementation / Critical Factor

- The retention areas identified by TaToM are not already occupied.

9) Related Plans and Projects

- PIAA

10) Social and Environmental Impacts

- Relocation and land appropriation will be needed.

11.3 Power Supply of Antananarivo Agglomeration

11.3.1 Background on Power Supply of Antananarivo Agglomeration

(1) Power Demand and Supply Situation

The average annual growth of power production in Antananarivo Agglomeration was 5.2% over a period of 5 years (2012 to 2016). Gross power production of Antananarivo Regional Interconnection System (RIA)¹ accounts for about 70% of Madagascar's corresponding production. On the average, the annual growth of the peak demand from 2012 to 2016 was 4.8%. The power demand, supply, transmission, and distribution losses of the RIA over same period are shown in Table 11.3.1.

Transmission losses have been gradually increasing at a rate of 0.6%/annum. Possible reasons for the increase are deterioration of power facilities due to aging and overloading of the transmission and substation equipment, such as conductors and transformers.

The average transmission and distribution losses over the same period (2012-2016) was 33.4%. This value is significantly higher than those in the neighboring countries² (Mozambique: 15.3%, Tanzania: 19.7%, South Africa: 8.8%, Kenya: 17.5%, Zambia: 14.6%, and Zimbabwe: 18.1%). High distribution loss is attributed to deterioration of equipment due to aging, overloading the equipment due to lack of rehabilitation and/or replacement of the equipment responding to increase in the power demand, and commercial loss that includes power theft caused by illegal connections.

Table 11.3.1 Power Demand, Supply, and Losses of Antananarivo Regional Interconnection System

Items	Year				
	2012	2013	2014	2015	2016
A. Gross Power Production in Madagascar (GWh)	1,350.2	1,423.4	1,487.5	1,542.2	1,651.0
B. Gross Power Production of RIA (GWh)	941.4	988.5	1,038.7	1,077.4	1,153.5
C. Ratio of Gross Power Production of RIA to that of Madagascar (B / A x 100%) (%)	69.7	69.4	69.8	69.9	69.9
D. Energy delivered to transmission network (GWh)	928.9	977.3	1,030.6	1,071.6	1,149.3
E. Energy delivered to distribution networks (GWh)	888.4	925.1	968.0	1,004.3	1,070.5
F. Consumption (GWh)	633.7	652.3	672.3	704.1	768.8
G. Transmission Loss (GWh)	40.4	52.2	62.6	67.3	78.9
H. Transmission Loss (G / D x 100%) (%)	4.4	5.3	6.1	6.3	6.9
I. Distribution Loss (GWh)	254.7	272.8	295.8	300.2	301.7
J. Distribution Loss (I / E x 100%) (%)	28.7	29.5	30.6	29.9	28.2
K. Transmission & Distribution Loss (G + I) (GWh)	295.2	325.0	358.4	367.5	380.6
L. Transmission & Distribution Loss ((G + I) / D x 100) (%)	31.8	33.3	34.8	34.3	33.1
M. Peak Demand in Madagascar (MW)	285.7	305.7	320.6	328.3	342.5
N. Peak Demand Annual Growth Rate in Madagascar (%)	2.5	7.0	4.9	2.4	4.3
O. Peak Demand of RIA (MW)	188.1	201.7	211.5	217.3	225.2
P. Peak Demand Annual Growth Rate of RIA (%)	5.7	7.3	4.8	2.7	3.7

Sources: JIRAMA Annual Report 2015, Data by JIRAMA Strategic Planning Department, World Development Indicators (World Bank) in June 2017, and Annual Evolution of Productions, Sales and Number of Subscribers by ORE (www.ore.mg) in 2017

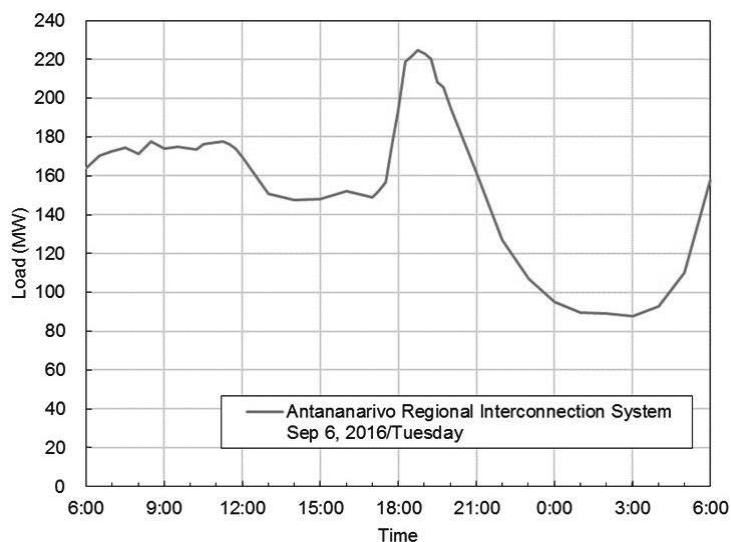
(2) Daily Load Curve

The daily load curve of the RIA on the day when the maximum system load was recorded on September 6, 2016, is shown in Figure 11.3.1. The daily peak of the system is from 5:30PM to 9:30PM. Primary cause of the steep increase in power demand in the evening is considered

¹ Antananarivo Regional Interconnection System consists of the power transmission network which supplies power to 23 cities and towns in Antananarivo Agglomeration, Antsirabe, and Moramanga.

² Source: <http://data.worldbank.org/indicator/EG.ELC.LOSS.ZS>

to be lighting needs.

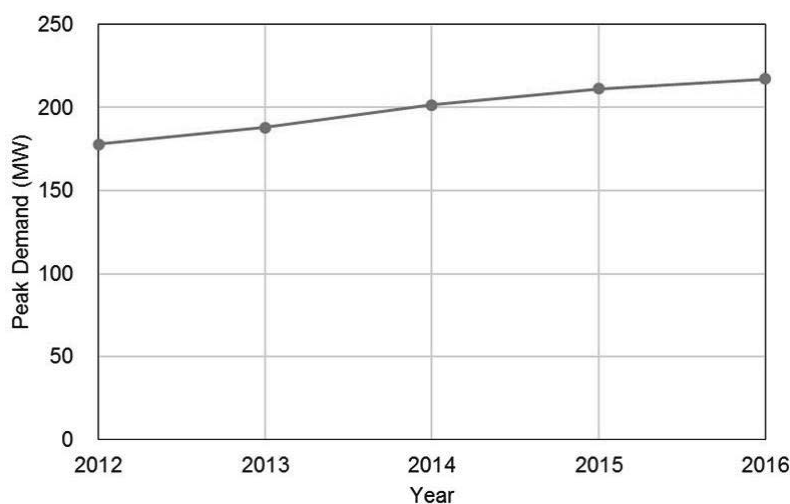


Source: JIRAMA's answers to questionnaire in July 2017 (Graph prepared by JICA Study Team)

Figure 11.3.1 Daily Load Curve of Antananarivo Regional Interconnection System

(3) Peak Demand

As shown in Figure 11.3.2, the peak demand of the RIA increased by 4.8% per annum over a period of 5 years, and that in 2016 it reached 225MW. The total available capacity of aggregation of the existing power plants was 212.8MW. This means that on the day when the maximum power demand was recorded, the power supply was not adequate to meet the demand, thus resulting in the implementation of load shedding for the lower priority customers in Antananarivo area.



Source: JIRAMA's Answers to Questionnaire in July 2017 (Graph prepared by JICA Study Team.)

Figure 11.3.2 Peak Demand for 5 Years (Antananarivo Regional Interconnection system)

(4) Access to Electricity

Furthermore, shows the access to electricity of Madagascar over a period of 5 years. "Urban" and "Rural" in the context of the discussion herein are defined in terms of the regional categorisations of the access to electricity. That is, *urban* refers to areas connected to the distribution network of JIRAMA, and the areas connected to the rural electrification project by ADER is referred to as rural.

Access to electricity in Madagascar, is calculated based on the following formula and

assumptions³:

Access to Electricity

$$= \frac{(\text{Number of subscribers of JIRAMA} + \text{Number of subscribers of private operators}) \times Q1 \times Q2}{\text{Total number of population}}$$

Q1: Average number of households served by a subscription (in rural area, Q1 = 1.3; in urban area, Q1 = 1.7; Throughout the country; Q1 = 1.5⁴)

Q2: Average household size (Rural Q2 = 4.90, Urban Q2 = 4.5, Throughout the country Q2 = 4.8⁵)

Table 11.3.2 Access to Electricity at the Country Level

Item	2012	2013	2014	2015	2016
Access to Electricity (% of Population)	15.35	15.25	15.02	15.02	N/A
Access to Electricity, Rural (% of Rural Population)	4.77	4.72	5.21	5.10	6.10
Access to Electricity, Urban (% of Urban Population)	57.87	57.59	55.38	56.66	N/A

Source: MEEH (Based on interview in September 2017)

The aggregation of the number of subscribers of JIRAMA in Antananarivo Agglomeration in 2017 was 211,897. Assuming the above coefficient (Q1=1.7 and Q2=4.5), approximately 1,621,000 persons (approximately 61.8% of the population⁶) were considered to have access to electricity in Antananarivo Agglomeration.

Furthermore, access to electricity in Antananarivo Agglomeration by commune was estimated based on the number of JIRAMA's individual customers in 2017 using the above-mentioned coefficients Q1 and Q2 for "Urban". In order to calculate the rate, the population of each commune in 2018 was estimated based on the preliminary result of the population census 2018. The result of the calculation is shown in Table 11.3.3⁷.

Besides the three communes (Ampangabe, Ambohimambola and Ambatomirahavavy) which are not connected to JIRAMA's network, communes such as Anosiala, Ampanefy, Bongatsara, Tsiafahy, Ambohimanga Rova, Anosy Avaratra and Manandriana, which are located further away from CUA have lower electricity access rates below 25%.

³ Source: MEEH "Mode de calcul du taux d'accès à Madagascar", October 2017

⁴ Data from the permanent household survey (EPM), INSTAT 2010

⁵ Data from the permanent household survey (EPM), INSTAT 2010

⁶ The population of Antananarivo Agglomeration in 2017 is 2,623,000, which is based on the estimation of JICA Study Team.

⁷ There was no available customer data for Communes of Ampangabe, Ambohimambola and Ambatomirahavavy.

Table 11.3.3 Access to Electricity of Communes in Antananarivo Agglomeration (2017)

Name of Commune	Name of District	Population	Number of Connection (JIRAMA)	Population with access to Electricity	Electricity Access Rate (%) (Estimate)
		Estimate			
Antananarivo	Antananarivo Renivohitra	1,275,207	127,012	971,642	76.2%
AMBATOLAMPY	Ambohidratrimo	25,798	954	7,298	28.3%
AMBOHIDRATRIMO	Ambohidratrimo	22,176	1,390	10,634	48.0%
AMBOHITRIMANJAKA	Ambohidratrimo	36,970	3,107	23,769	64.3%
AMPANGABE	Ambohidratrimo	17,152	#N/A	#N/A	#N/A
ANOSIALA	Ambohidratrimo	51,288	1,301	9,953	19.4%
ANTEHIROKA	Ambohidratrimo	46,550	5,143	39,344	84.5%
IVATO	Ambohidratrimo	47,615	4,783	36,590	76.8%
TALATAMATY	Ambohidratrimo	51,181	4,542	34,746	67.9%
ALAKAMISY FENOARIVO	Atsimondrano	22,511	1,518	11,613	51.6%
AMBAVAHADITOKANA	Atsimondrano	39,257	2,307	17,649	45.0%
AMBOHIDRAPETO	Atsimondrano	28,234	2,523	19,301	68.4%
AMBOHIJANAKA	Atsimondrano	19,381	1,098	8,400	43.3%
AMPANEFY	Atsimondrano	15,758	299	2,287	14.5%
AMPITATAFIKA	Atsimondrano	62,937	3,563	27,257	43.3%
ANDOHARANOFOTSY	Atsimondrano	46,247	5,799	44,362	95.9%
ANDRANONAHOTRA	Atsimondrano	57,139	4,172	31,916	55.9%
ANKADIMANGA	Atsimondrano	7,745	631	4,827	62.3%
ANKARAOBATO	Atsimondrano	42,433	2,956	22,613	53.3%
ANOSIZATO ANDREFANA	Atsimondrano	26,498	1,417	10,840	40.9%
BEMASOANDRO	Atsimondrano	51,573	2,970	22,721	44.1%
BONGATSARA	Atsimondrano	26,680	739	5,653	21.2%
FENOARIVO	Atsimondrano	31,650	1,335	10,213	32.3%
FIOMBONANA	Atsimondrano	12,084	557	4,261	35.3%
ITAOSY	Atsimondrano	16,520	2,350	17,978	108.8%
SOALANDY	Atsimondrano	15,135	569	4,353	28.8%
SOAVINA	Atsimondrano	17,569	692	5,294	30.1%
TANJOMBATO	Atsimondrano	43,406	3,562	27,249	62.8%
TSIAFAHY	Atsimondrano	20,114	332	2,540	12.6%
ALASORA	Avaradrano	58,316	4,989	38,166	65.4%
AMBOHIMANAMBOLA	Avaradrano	15,815	#N/A	#N/A	#N/A
AMBOHIMANGA ROVA	Avaradrano	30,130	829	6,342	21.0%
AMBOHIMANGAKELY	Avaradrano	111,718	5,401	41,318	37.0%
ANKADIKELY	Avaradrano	55,740	7,707	58,959	105.8%
ANOSY AVARATRA	Avaradrano	16,881	315	2,410	14.3%
MANANDRIANA	Avaradrano	9,149	136	1,040	11.4%
SABOTSY NAMEHANA	Avaradrano	46,819	4,899	37,477	80.0%
AMBATOMIRAHAVAVY	Arivonimamo	36,869	#N/A	#N/A	#N/A
Antananarivo Agglomeration		2,558,245	211,897	1,621,012	63.4%

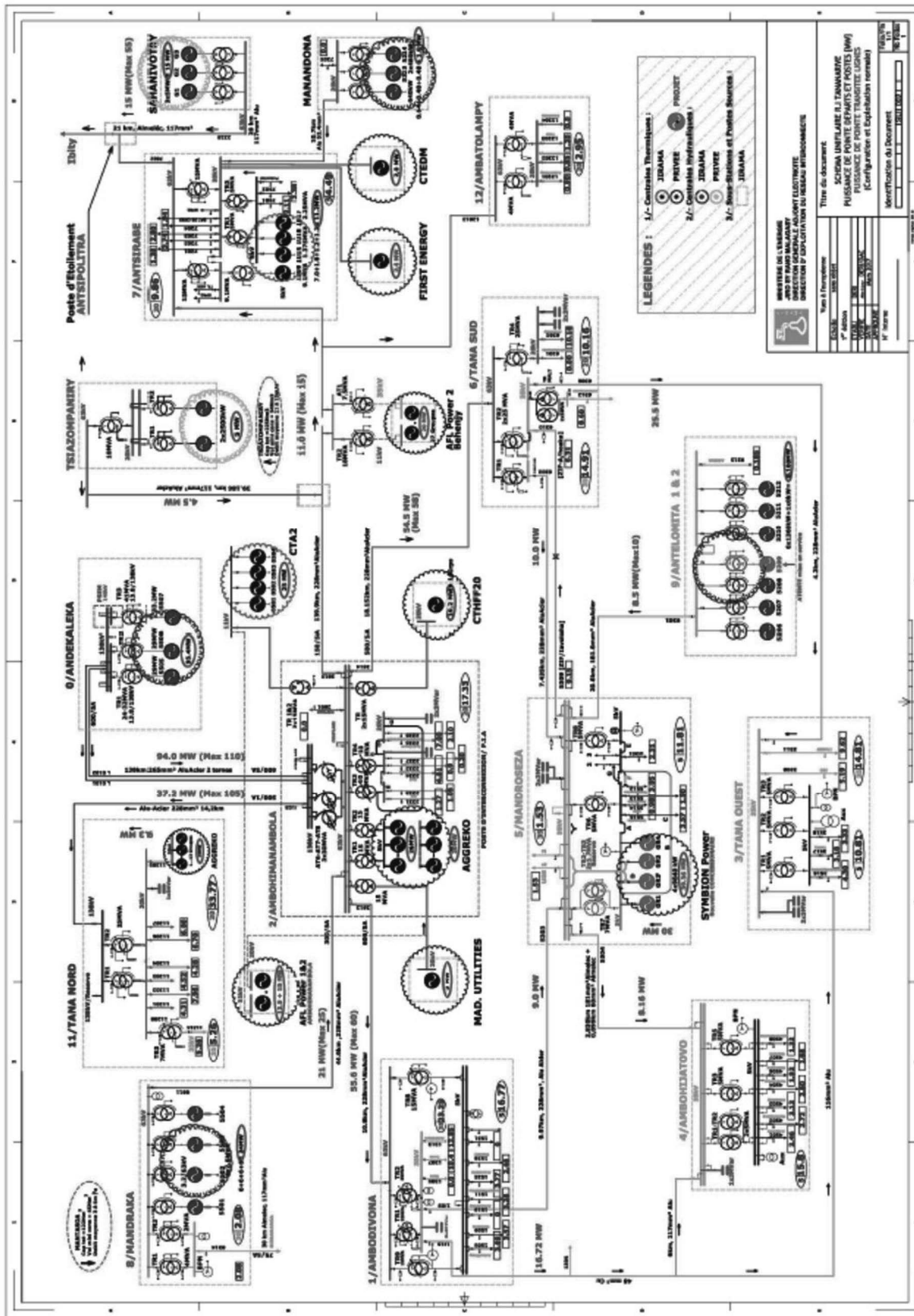
Source: JICA Study Team (Based on the assumption of coefficients provided by MEEH in October 2017)

(5) Existing Power System

There are three primary power systems in Madagascar: the RIA, which supplies power to Antananarivo Agglomeration, Antsirabe, and Moramanga (Figure 11.3.3); Toamasina Regional Interconnection system (RIT⁸) on the east coast; and Fianarantsoa Regional Interconnection system (RIF⁹) in the south. There is no interconnection among these three systems. At RIA, there are two hydropower stations located in Andekaleka and Mandraka (Figure 11.3.4), supplying power to Antananarivo Agglomeration. The evacuated power flows to Ambohimambola Substation in Antananarivo and then flows to Antsirabe. There are five private thermal power stations (AGGREKO, AFL Power, MAD. UTILITIES, CTA2, and CTHFF20) connected to Ambohimambola Substation through the 63kV network. For Mandroseza Substation, which is another hub of power supply in Antananarivo Agglomeration, one hydropower station (Antelomita) and one private thermal power station (SYMBION Power shown in Figure 11.3.5)

⁸ RIT: Réseau Interconnecté de Toamasina

⁹ RIF: Réseau Interconnecté de Fianarantsoa



Source: JIRAMA's Schematic Diagram of RIA, as of March 2017

Figure 11.3.3 Schematic Diagram of Antananarivo Regional Interconnection System



Figure 11.3.4 Mandraka Hydropower Station



Figure 11.3.5 SYMBION Power (Thermal Power Station)

(6) Existing Facilities for Power Supply

1) Power Plants

A list of the existing power plants of RIA, as of June 2017, is shown in Table 11.3.4. The total installed capacity was 391.64MW, of which 38.9% (152.44 MW) came from hydropower plants, while the remaining 61.1% (239.20MW) was generated by thermal power plants. In 2016, 62.4% of the annual power production of RIA was supplied by JIRAMA's properties, and the remaining 37.6% by private companies. JIRAMA's power plants comprised of 78.1% hydropower and 21.9% thermal power in terms of the installed capacity. On the other hand, power plants owned by private companies comprised of 10.2% hydropower and 89.8% thermal power.

Table 11.3.4 Existing Power Plants in Regional Interconnection System of Antananarivo Agglomeration

Name of Power Plant	Type of Operation	Owner of Property	Fuel Type	Installed Capacity (kW)	Available Capacity (kW)	Power Production in 2016 (kWh)	Power Production (%)	Note
1. JIRAMA								
(1) Hydropower Plants								
Andekaleka	JIRAMA	JIRAMA		95,000	63,000	618,885,902	53.6	31MW x 2 + 33MW x 1
Antelomita	JIRAMA	JIRAMA		8,840	8,200	30,295,300	2.6	1.36MW x 6
Manandona	JIRAMA	JIRAMA		1,600	800	4,370,765	0.4	0.48MW x 2 + 0.64MW x 1
Mandraka	JIRAMA	JIRAMA		24,000	6,000	63,233,720	5.5	6MW x 4
Hydropower Total				129,440	78,000	716,785,687	62.1	
(2) Thermal Power Plants								
Ambohimananambola 2	JIRAMA	SHERRITT	Fuel Oil	25,000	-	1,631,650	0.1	6.25MW x 4
Antsirabe	JIRAMA	JIRAMA	Diesel	11,200	3,100	2,851,631	0.2	1.2MW x 2 + 1.8MW x 1 + 7MW x 1
Thermal Power Total				36,200	3,100	4,483,281	0.4	
JIRAMA Total				165,640	81,100	721,268,968	62.4	
2. Private Companies								
(1) Hydropower Plants								
Sahanivotry	Purchase	HYDELEC		18,000	11,000	74,492,894	6.4	18MW x 1
Tsiazompaniry	Purchase	HFF		5,000	-	15,703,906	1.4	2.5MW x 2
Hydropower Total				23,000	11,000	90,196,800	7.8	
(2) Thermal Power Plants								
Ambohimananambola AFL POWER	Leasing	AFL POWER	Diesel	27,500	25,000			15MW x 1 + 12.5MW x 1
Ambohimananambola AGGREKO	Leasing	AGGREKO 2	Diesel	48,000	45,000	190,872,847	16.5	28MW x 1 + 20MW x 1
Ambohimananambola HFF	Leasing	HFF	Diesel	25,000	12,000			25MW x 1
Antsirabe	Leasing	EDM	Diesel	6,500	2,000			1.3MW x 5
Antsirabe	Leasing	Group e SM TP	Diesel	6,000	1,300	3,038,779	0.3	2MW x 3
Behenji/AFLPOWER	Leasing	AFL POWER	Diesel	40,000	15,000	120,673,100	10.4	40MW x 1
Tana Nord/AGGREKO	Leasing	AGGREKO	Diesel	10,000	-	935,799	0.1	10MW x 1
Mandrozeza	Purchase	SYMBION POWER	Fuel Oil	40,000	20,400	28,116,187	2.4	10MW x 4
Thermal Power Total				203,000	120,700	343,636,712	29.7	
Private Companies Total				226,000	131,700	433,833,512	37.6	
Grand Total				391,640	212,800	1,155,102,480	100.0	

Source: JIRAMA, July 2017

2) Transmission Lines

In JIRAMA's power system, nominal voltages of the transmission lines applied are 138kV, 63kV, and 35kV. Transmission line below 35kV is categorized as distribution voltage. Table 11.3.5 shows the list of existing transmission lines of RIA. Figure 11.3.6 shows both a 138kV (right) and a 63kV (left) transmission lines.

The following two 63kV transmission lines are overloaded; however, it is not possible to implement capacity enhancement projects of these lines since the operation of these lines cannot be interrupted due to lack of any alternative line to supply power to Tana Sud and Ambodivona Substations during the construction period:

- Ambohimananambola Substation – Tana Sud Substation (load flow: 60MW)
- Ambohimananambola Substation – Ambodivona Substation (load flow: 60MW)

The following two new 63kV transmission lines will be constructed as a part of the Electricity Sector Operations & Governance Improvement Project (ESOGIP or PAGOSE: *Projet d'Amélioration de la Gouvernance et des Operations dans le Secteur de l'Electricité*) financed by the World Bank in order to form a loop system, and thereby create an alternative source of power supply to the aforementioned two substations:

- Tana Nord Substation – Tana Sud Substation
- Tana Nord Substation – Ambodivona Substation

Table 11.3.5 Existing Transmission Lines of Antananarivo Regional Interconnection System

Voltage (kV)	From	To	Number of Circuits	Conductor Type	Conductor Size (mm ²)	Length (km)
138	Andekaleka HPP	Ambohimambola S/S ¹⁰	2	ACSR	265	138
138	Ambohimambola S/S	Tana Nord S/S	1	ACSR	228	14.2
6	Mandraka HPP	Ambohimambola S/S	1	ACSR	228	44.6
6	Ambohimambola S/S	Ambodivona S/S	1	ACSR	228	10.8
6	Ambohimambola S/S	Antsirabe S/S	1	ACSR	228	139.9
6	Ambohimambola S/S	Tana Sud S/S	1	ACSR	228	18.152
6 3	Tsiazompaniry HPP	Junction of Ambohimambola - Antsirabe line	1	ACSR	117	39.186
3	Ambodivona S/S	Mandroseza S/S	1	ACSR	228	9.97
3	Tana Sud S/S	Mandroseza S/S	2	ACSR	228	7.435
3 5	Mandroseza S/S	Ambohijatovo S/S	1	A.A.A.C	181	2.83
			1	A.A.A.C	60	0.899
3	Antelomita HPP	Mandroseza S/S	1	ACSR	181.6	20.6
3	Ambodivona S/S	Ambohijatovo S/S	1	N/A	N/A	N/A
3	Ambodivona S/S	Tana Ouest	1	N/A	N/A	N/A
3	Tana Sud S/S	Tana Ouest	1	ACSR	228	4.2

Source: JIRAMA, July 2017



Figure 11.3.6 Existing Transmission Lines (Right: 138kV, Left: 63kV)

The total lengths of 138kV and 63kV lines are 152.2km and 252.6km, respectively. The total length of 35kV transmission lines is 45.9km, excluding two lines: Ambodivona S/S - Ambohijatovo S/S and Ambodivona S/S - Tana Ouest S/S, the lengths of which are unknown.

3) Substations

Table 11.3.6 shows the list of existing substations of RIA. There are nine existing substations of RIA and the total capacity is 521.1MVA. Out of nine substations, seven substations (except Antsirabe and Ambatolampy) are located in Antananarivo Agglomeration which are the sources of power supply in the area. In Ambohimambola Substation, the largest substation of RIA (Figure 11.3.7), all three 138kV/63kV transformers (30MVA x 3units) are overloaded and will be replaced with two new 60MVA transformers as a part of PAGOSE project.

In Ambohimambola Substation, the two 63 kV / 20 kV transformers (10 MVA x 2 units) have reached already the maximum load of 18 MW (assuming the power factor as 0.9, the value is 100% of the rated capacity) even under the normal operation condition. But replacement of the transformers was not listed in the PAGOSE project from the viewpoint of a subproject proponent. Since the power demand for the 20kV distribution system connected to the secondary side is steadily increasing, considering the demand growth in the decade

¹⁰ S/S: Substation

ahead, it is necessary to add another transformer with larger capacity.

Also, considering that the future power demand in 2033 could become 3.8 times¹¹ of the 2016 figures, it is anticipated that many of the transformers in 138kV, 63kV, and 35kV substations would become overloaded. Therefore, it is necessary to replace the existing transformers with larger capacity or to construct new substations to accommodate the load increase.



Figure 11.3.7 Ambohimambola Substation (Left: 138kV and 63kV Yard, Right: Control Room)

Table 11.3.6 Existing Substations of Antananarivo Regional Interconnection System

No.	Name of Substation	Transformer No.	Primary Voltage (kV)	Secondary Voltage (kV)	Capacity (MVA)
1	Ambohimambola	AT6	138	63	30
		AT7	138	63	30
		AT8	138	63	30
		TR1	63	5	15
		TR2	63	5	15
		TR3	63	20	10
		TR4	63	20	10
		TR 1 & 2	63	11	2 x 15
		TR	63	20	2 x 15
2	Tana Nord	TR1	138	20	25
		TR2	138	20	25
		TR3	20	35	7
3	Ambodivona	TR1	63	35	25
		TR2	63	35	25
		TR8	63	5	15
		TR9	63	5	15
4	Tana Sud	TR1	63	35	25
		TR2	63	35	25
		TR4	63	20	25
5	Mandroseza	TR6	35	5	5
		TR7	35	5	7
		TR8	35	5	5
6	Ambohijatovo	TR1	35	5	5
		TR2	35	5	5
		TR3	35	5	5
		TR5	35	5	5
7	Tana Ouest	TR1	35	5	5
		TR2	35	5	5
		TR3	35	5	5
8	Antsirabe	1	63	20	15
		2	63	20	15
		TR1	5	20	5
		TR3	5	20	5
		3	5	20	9.1
9	Ambatolampy	1	63	20	4
		2	63	20	4
Total Capacity		521.1			

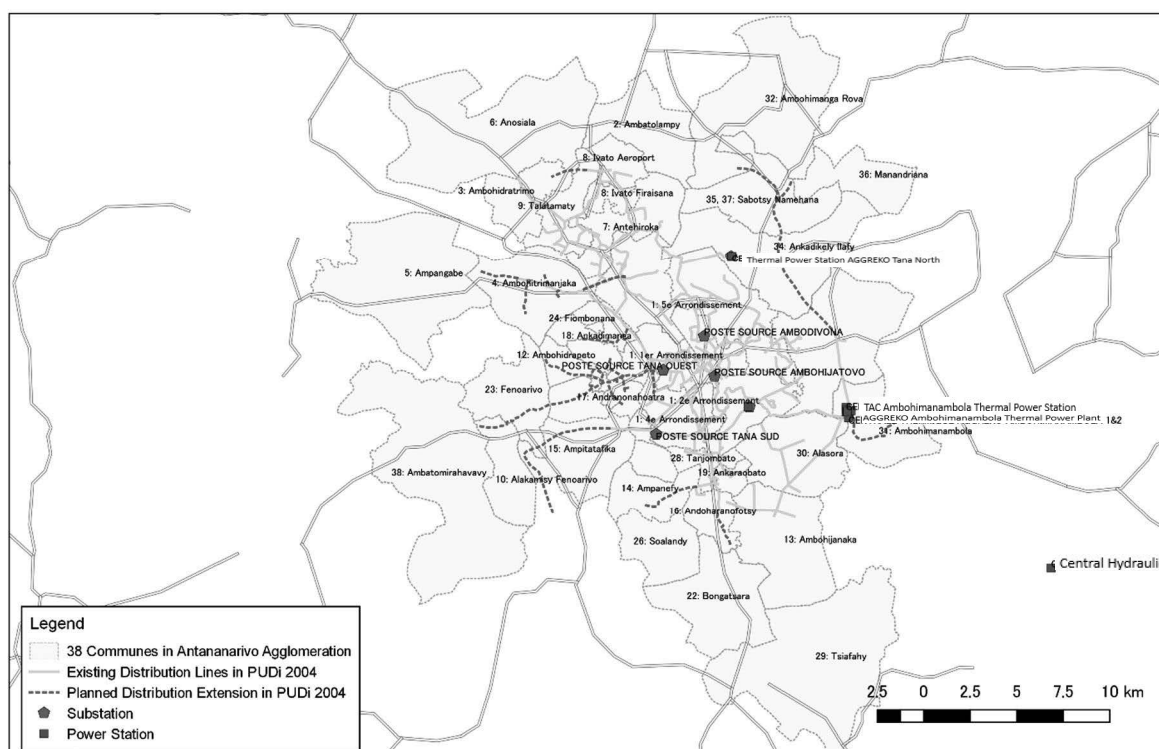
Source: JIRAMA, in July 2017

¹¹ In 2016, the peak demand was 225MW. The peak demand in 2033 is expected to reach 857MW ($857/225 = 3.8$).

4) Distribution Facilities

Distribution Facilities are divided into two categories, medium voltage (MV) and low voltage (LV). MV ranges from 500V to 50kV; and LV, below 500V. In Antananarivo Agglomeration, 35kV, 20kV, and 5kV are applied for the nominal voltages of the MV system and 380V and 220V for the LV system. As of July 2017, the total length of MV and LV distribution lines are 1,244.47km and 2,429.99km, respectively. The total number of MV and LV transformers is 2,470 units and the total capacity is 470.434MVA. The list of existing distribution lines and transformers are shown in Table 11.3.7 and Table 11.3.8, respectively. As of October 2017, development of geographical information data of the distribution system was under preparation, and the location map of the system was not yet available. Figure 11.3.8 shows the distribution system map based on drawings created for PUDi 2004.

Typical existing distribution line and substation are shown in Figure 11.3.9 and Figure 11.3.10, respectively.



Source: PUDi 2004

Figure 11.3.8 Power Supply Distribution System in Antananarivo Agglomeration



Figure 11.3.9 35kV Distribution Line

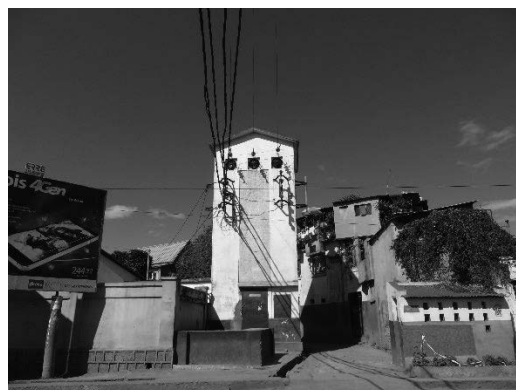


Figure 11.3.10 35kV/380V Substation

Table 11.3.7 Existing Distribution Lines of Antananarivo Regional Interconnection System

Operating Center	Voltage (kV)	Medium Voltage Line		Low Voltage Line			Total	
		Underground (km)	Overhead (km)	Overhead (Bare: km)	Overhead (Cable: km)	Underground (km)	Medium Voltage (km)	Low Voltage (km)
DTA								
Tana	5	24.24	114.28	374.87	472.42	7.72	138.52	855.01
Tana	20	4.49	70.00	13.64	390.08	-	74.49	403.72
G.Tana	20	1.18	638.51	16.28	394.38	46.16	639.69	456.81
Tana	35	7.19	384.58	152.38	561.65	0.42	391.77	714.45
Total		37.09	1,207.38	557.17	1,818.52	54.29	1,244.47	2,429.99

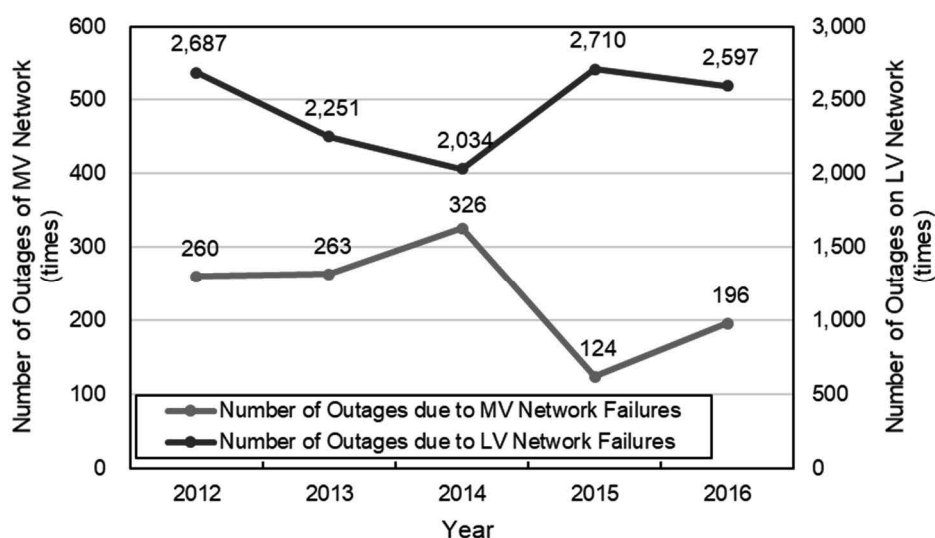
Source: JIRAMA, in July 2017

Table 11.3.8 Existing Distribution Transformers of Antananarivo Regional Interconnection System

Operating Center	Voltage (kV)	JIRAMA		Private		Mixed		Total	
		No.	Power (KVA)	No.	Power (KVA)	No.	Power (KVA)	No.	Power (kVA)
DTA									
Tana	5	238	53,485	416	61,529	21	3,405	675	118,419
Tana	20	127	30,420	180	35,640	6	1,600	313	67,660
G Tana	20	343	40,619	224	43,895	8	1,265	575	85,779
Tana	35	342	52,736	549	142,372	16	3,468	907	198,576
Total		1,050	177,260	1,369	283,436	51	9,738	2,470	470,434

Source: JIRAMA, in July 2017

JIRAMA does not own a geographic information management system for identifying the location of the distribution facilities such as distribution sections, poles, transformers, switches, etc. for individual distribution lines. For this reason, it has been difficult to formulate the facility refurbishment and/or reinforcement plans for overloading equipment, deteriorated equipment due to aging, and damaged equipment based on the power system analysis, periodical inspection and patrol records, and on the distribution system operating records. There are many overloaded MV and LV distribution lines and distribution transformers due to lack of capacity enhancement, taking into consideration power demand increase in Antananarivo Agglomeration. Figure 11.3.11 shows the record of outages due to failures of both MV and LV networks over a period of 5 years. Significant number of outages occurred to the secondary system of the RIA. This situation is one of the principal reasons of high distribution loss rate. Because of its deficit operation for years, JIRAMA has not been able to take drastic countermeasures on the considerable number of overloaded and deteriorated distribution facilities due to difficulty in financing refurbishment and replacement of the equipment.



Source: JICA Study Team based on information from JIRAMA in July 2017

Figure 11.3.11 Number of Outages Due to Network Failures of RIA

(7) Power System Operation

Currently, the power system of RIA is operated from the control center in Ambohimambola Substation. The control of the power output of each power station of RIA has been done by the operation command by telephone. Also, the power output values of each power station have been manually recorded by handwriting and input to the spreadsheet by the system operators. During hours with rapid load increase and decrease, these values are recorded every 15 minutes; and every hour in other time schedules. Since the system operation of RIA is expected to become more complicated and quick, an accurate system operation will be required after the expansion of the transmission system, including realisation of interconnection of other two isolated regional interconnection systems, namely, RIT and RIF. Also, it is considered necessary to modernise the control center for it to adopt the functions as the central load dispatching center.

11.3.2 Power Demand Forecast and Power Development Plan

(1) Power Demand Forecast

The power demand forecast and power development plan of RIA up to year 2033 is shown in Table 11.3.9. According to JIRAMA's estimate, the peak demand in 2033 is 488MW and the average annual growth rate of the demand is 4.6% per annum. This peak demand is the aggregation of the demand of Antananarivo Agglomeration and that of two other demand centers: Antsirabe and Moramanga. In the power development plan, 6 hydropower projects, three thermal power (Heavy Fuel Oil or HFO) projects, and 1 solar power project are planned to be implemented.

On the other hand, the peak demand in 2033, which is based on calculations using the GDP elasticity of power consumption, is 857MW. In general, the power consumption growth rate has a relationship with the GDP growth rate. The GDP elasticity of the power consumption of the RIA is shown in Table 11.3.10. Here, the annual GDP growth rate of Antananarivo Agglomeration is assumed to be equal to that of Madagascar. The average GDP Elasticity of the power consumption for the year between 2001 and 2014 is 1.0. Provided that both the annual load factor and transmission and distribution loss rate are the same throughout that period, the GDP elasticity of the power demand can also be assumed to be 1.0. Therefore, the same values as expected GDP annual growth rates are used for the future power demand forecast.

A demand-and-supply balance chart is shown in Figure 11.3.12. The dark grey line shows the power demand provided by JIRAMA and the light grey line shows the power demand with the annual growth rates set by the JICA Study Team. The following assumptions are made:

The annual growth rates of the Antananarivo Agglomeration are set at 6.9% (2016-2023), 8.6% (2024-2028), and 9.6% (2029-2033). Power supply during the dry season in 2016 is calculated assuming that the firm capacities of the existing hydropower plants decreased to 25%. Power supply during the wet season from 2017 to 2033 is the aggregation of available capacity in 2016 (213MW) and accumulated installed capacity of the new projects.

For the power supply during the dry season from 2017 to 2033, the installed capacities of relatively small hydropower stations (Andekaleka 4, Mahitsy, and Ranomafana) are reduced to 25% of the installed capacity, taking into consideration the available capacity of existing run-of-river type of hydropower stations.

For the power supply during the dry season from 2017 to 2033, the installed capacity of large scale (over 100MW) hydropower stations (Sahofica, Amtetazambato, and Mahavola) is reduced to 70% of the installed capacity, taking into consideration the ratio of wet and dry season outputs of the RIA in the previous study done in 2009¹².

¹² "Preliminary Study for Expansion of Manandona Hydroelectric Power Plant in Madagascar," Engineering and Consulting Firms

The installed capacity of a solar power station is neglected for both wet and dry seasons since the maximum output of the solar power station is achieved during daytime but the peak demand occurs in the evening, so it has no contribution during the peak hours¹³.

According to the chart, the power supply shortage will continue until 2020 during the dry season. From 2020 onward, however, the power supply capacity in both wet and dry seasons is considered enough to meet the future power demand of Antananarivo Agglomeration even considering the reserved margin. Nevertheless, there is still the possibility of delay in the implementation of each power development project considering the financial difficulty of JIRAMA. The power development plan would be updated once the Least-Cost Development Plan (PDMC: *Plan de Développement à Moindre Coût*), which is under preparation as a part of the PAGOSE project, becomes ready¹⁴.

Association Japan and Newjtec Inc., March 2009.

¹³ The condition may have to be changed if the power station has large storage batteries and has the ability to supply the stored power during peak hours.

¹⁴ As of December 2017, PDMC had not been completed and no detailed information were available.

Table 11.3.9 Power Demand Forecast and Power Development Plan of RIA

Name of Planned Power Plants	Type	Unit	Year																	
			2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
TAC Anbohimanantola	Thermal (HFO)	MW		48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
	Thermal (HFO)	MW		40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
	Thermal (HFO)	MW		60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	Solar	MW			20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Andekaleka 4	Hydro	MW			33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2	33.2
	Mahitsy	MW			18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
	Sahofika	MW					200	200	200	200	200	200	200	200	200	200	200	200	200	200
	Antezanibato	MW					180	180	180	180	180	180	180	180	180	180	180	180	180	180
Ranomafana	Hydro	MW						86	86	86	86	86	86	86	86	86	86	86	86	86
	Hydro	MW										500	500	500	500	500	500	500	500	500
	Power Demand by JIRAMA	MW	225	232	241	250	259	271	284	298	313	328	344	362	380	400	422	444	466	488
	Annual G.R. of Demand by JIRAMA's Forecast	%/year		3.2	3.7	3.8	3.8	3.8	4.6	4.7	4.9	5.0	4.8	4.9	5.1	5.2	5.3	5.4	5.2	5.0
Power Demand based on GDP G.R.	MW		241	257	275	294	314	336	359	369	390	423	460	499	542	594	651	714	782	857
	Annual G.R. of Demand equal to GDP G.R.	%/year		6.9	6.9	6.9	6.9	6.9	6.9	6.9	8.6	8.6	8.6	8.6	8.6	9.6	9.6	9.6	9.6	9.6
	Power Supply (Wet Season)	MW	213	361	361	412	792	878	878	878	878	1,378	1,378	1,378	1,378	1,378	1,378	1,378	1,378	1,378
	Power Supply (Dry Season)	MW	101	249	249	262	528	549	549	549	549	899	899	899	899	899	899	899	899	899
Power Surplus (+) /Shortage (-) (Wet Season)	MW		-12	120	104	137	498	564	542	519	488	955	918	879	836	784	727	664	596	521
	Power Surplus (+) /Shortage (-) (Dry Season)	MW	-124	8	-8	-13	234	235	213	190	159	476	439	400	357	305	248	185	117	42

Source: JICA Study Team

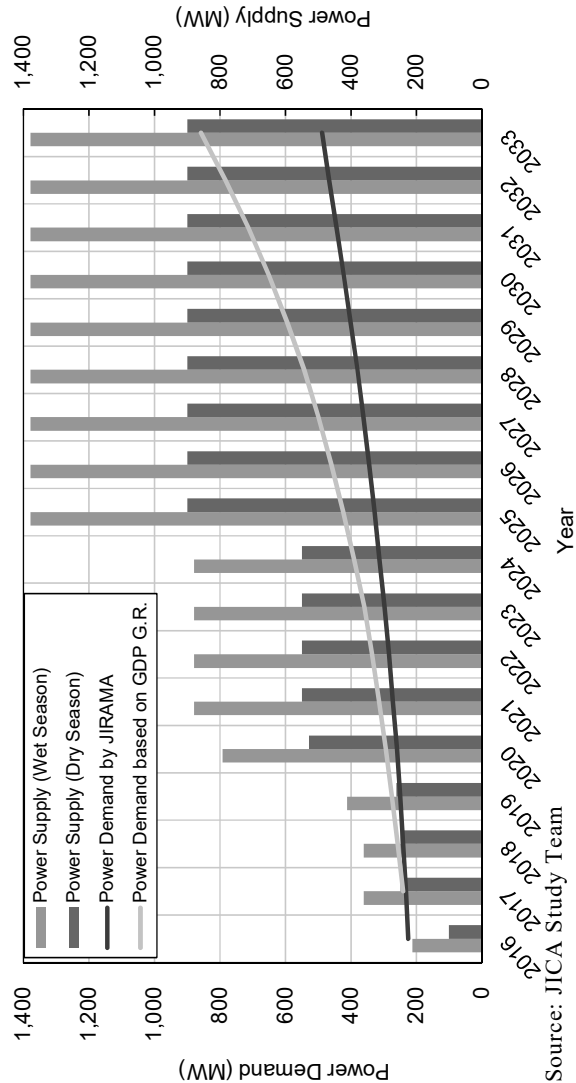


Figure 11.3.12 Power Demand and Supply Balance of RIA

Source: JICA Study Team

Table 11.3.10 GDP Elasticity of the Power Consumption of RIA

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Power Consumption of RIA (GWh)	452	399	467	531	538	554	563	619	550	586	602	633	652	618	705
Power Consumption Annual G.R. (%)	- 11.8	17.0	13.8	1.2	3.0	1.6	10.0	- 11.2	6.5	2.7	5.3	2.9	- 5.2	14.1	
GDP G.R.	6.0	- 12.7	9.8	5.3	4.6	5.0	6.2	7.1	- 4.0	0.3	1.5	3.0	2.3	3.3	
GDP Elasticity	- 2.0	- 1.3	1.4	0.2	0.7	0.3	1.6	- 1.6	- 1.6	10.2	3.6	1.0	- 2.3	4.2	
GDP Elasticity (Average of period 2001 to 2014)	1.0														

Source: JICA Study Team

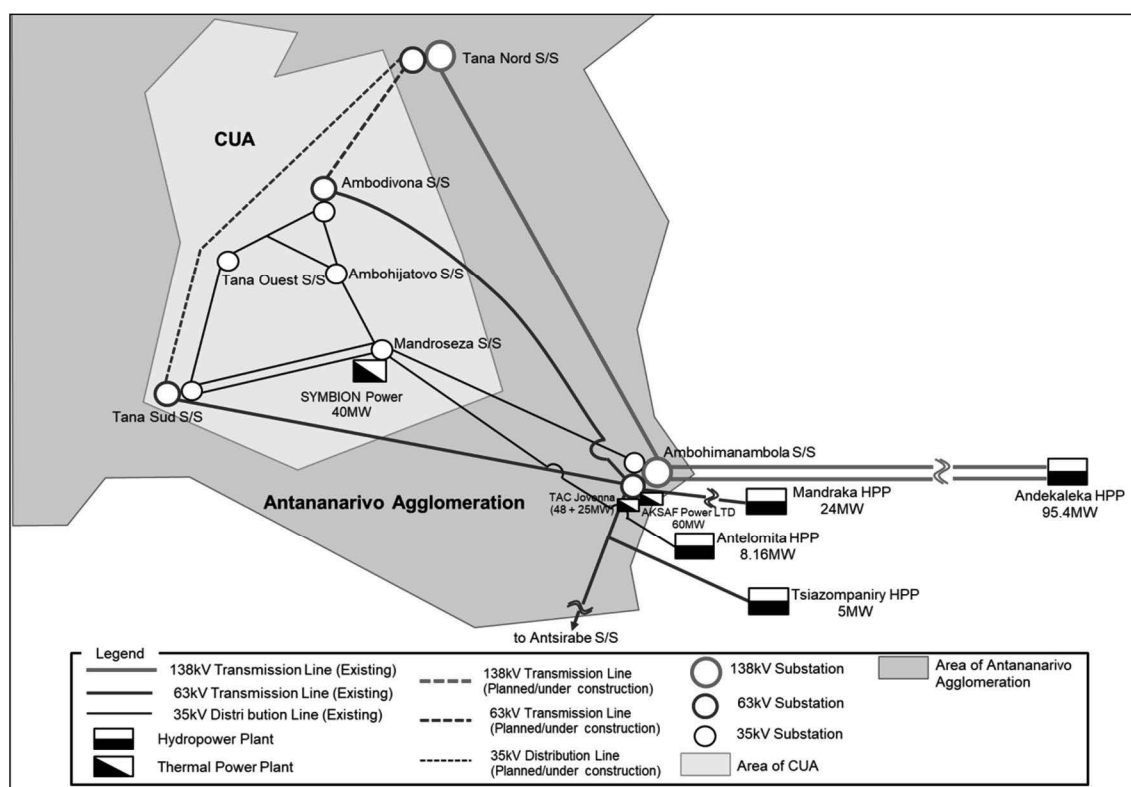
(2) Power System Development

In line with the power development, power system development is necessary to realise stable and reliable power supply to Antananarivo Agglomeration. The power system diagrams of both existing and future RIA are shown in Figure 11.3.13 and Figure 11.3.14, respectively. The diagram of the future power system was prepared based on the information provided by JIRAMA. However, the future system configuration is still conceptual and has not been determined by JIRAMA yet. The assumed locations¹⁵ (names of commune) of the new power stations and substations which are related to power supply for the Antananarivo Agglomeration are shown in Figure 11.3.11.

Table 11.3.11 Names and Locations of Planned Power Stations and Substations

Type of Facility	Name	District	Commune
Hydropower station	Mahavola	Ankazobe	Fiadanana or Kiangara
Hydropower station	Ranomafana	Ankazobe	Marondry or Antotohazo
Hydropower station	Mahitsy	Ambohidratrimo	Mahitsy
Substation	Tana Nord 2	Antananarivo Nord	Ankadikely Ilafy, Sabotsy Namehana, or Antehiroka
Substation	Tana Sud 2	Antananarivo Sud	Soavina, Ampanefy, or Ampitatafika

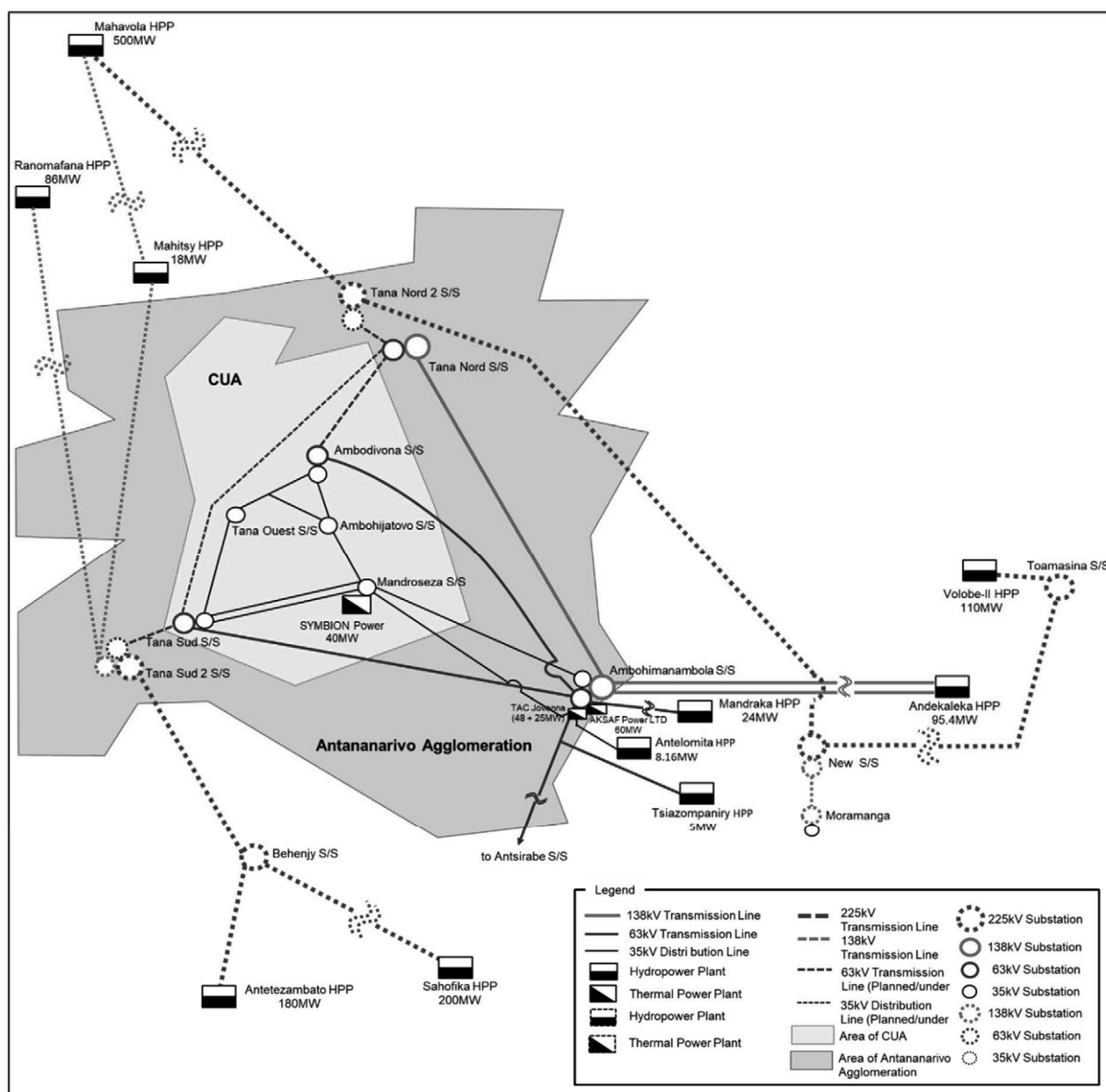
Source: JICA Study Team



Source: JICA Study Team

Figure 11.3.13 System Configuration of Existing RIA

¹⁵ The assumed locations were speculated by the JICA study team by matching the tentative names of the substations and the location of existing substations.



Source: JICA Study Team

Figure 11.3.14 System Configuration of Future RIA

(3) Overall Present Situation of Power Supply in Antananarivo Agglomeration

The present situation of Antananarivo Agglomeration's power supply is summarised as follows:

- With regards to power supply and demand balance, supply capacity is now satisfying demand due to the start of heavy oil-fired thermal power plant operation. However, considering the potential demand (the area where there is no electricity at present), it can be presumed that the actual demand for power supply is not satisfied.
- Several households share one electric metre.
- JIRAMA's network provides power supply to all communes. However, there is no existing data on the number of households with access to electricity in all communes. It should be noted also that there are still several fokontany which do not have access to electricity.
- In the existing power supply network, overload of the transmission lines and transformers of primary substations is a problem. Aging of the distribution network equipment is also a problem.

- Distribution loss (i. e., 33.4% in the last 5 years) is very high due to aging of equipment.
- The distribution network cannot be organised systematically since JIRAMA does not have its own geographical information of the existing equipment. And because of overlapping territory of each agent (service office), it is difficult to know the number of connected customers, making it difficult to determine the power demand by region
- The long-term power demand forecast currently in use is based on the outdated INSTAT census data published in 1993.

11.3.3 Issues on Power Supply of Antananarivo Agglomeration

Based on the analysis of the present situation, the following are the issues on power supply of Antananarivo Agglomeration:

- There are still a number of fokontany which do not have access to electricity even within CUA and its immediate surrounding area: JIRAMA's distribution network has been developed recently to cover almost all of the communes in Antananarivo Agglomeration. However, according to the commune survey done by Project TaToM, there are some fokontany outside CUA which still do not have access to electricity. The number of such fokontany is likely to be larger if the population density is low since it is difficult for JIRAMA to extend the distribution grid for such dispersed population.
- There are many households that share one watt-hour metre: As described in 11.3.1 (2), the average number of households served by a subscription is more than 1.0. This indicates that individual power connection per household has not been realised even in urban areas. Existence of such households getting power from an official customer of JIRAMA, and without official contract with JIRAMA, makes it difficult to determine the actual amount of power consumption per household.
- Factories in the suburbs do not benefit from stable power supply: The existing power transmission network of JIRAMA has been developed to supply power to meet the demand of CUA, the load centre of Antananarivo Agglomeration. However, overloaded or deteriorated power facilities due to lack of investments in upgrading, rehabilitation, and/or repair works have made it difficult for the factories in the suburbs to benefit from stable power supply.
- It is difficult to determine accurate power demand: For residential power usage, a common practice is that several households share a watt-hour metre. Additionally, the coverage area of each sales office overlaps. These comprised a difficult situation to determine the accurate power demand by region.
- There is no geospatial information of the existing facilities: Since JIRAMA had no geospatial information of its facilities until recently, it was difficult to formulate a power system analysis model based on the precise positional relation of each power facility and to formulate the network development plan based on it.

11.3.4 Objectives for Power Supply Development of Antananarivo Agglomeration

The objectives for the development of power supply in Antananarivo Agglomeration are summarized according to area.

- Improvement of the power supply service level within CUA (Supplying power to already

concentrated population with high service level and securing amenities as the central city of Madagascar 's metropolitan area), specifically as follows:

- Electricity access rate: 100%
- Individual watt-hour metre installation rate: 80%
- Increase in power consumption per capita
- Increase in industrial power supply
- Improvement of the power supply service level outside CUA (in order to promote appropriate urbanisation by enhancing power supply and providing a good living environment in addition to CUA plus 5 communes, to provide stable power and attract factories to suburbs) as follows:
 - Electricity access rate: 80%
 - Individual watt-hour metre installation rate: 60%
 - Increase in power consumption per capita
 - Increase in industrial power supply
- Improvement of the power supply service level in the periphery (about 15-km radius area) of Antananarivo Agglomeration as follows:
 - Increase of electricity access rate
 - Preparation of appropriate future power demand forecast and capital investment plan based on essential information, such as current accurate power demand and geographical space information of the existing power facilities
- Stable power to the industrial sector and boost industry promotion

11.3.5 Strategies for Power Supply Development in Antananarivo Agglomeration

In order to achieve the aforementioned objectives, the following strategies are recommended. The strategies for the power supply development in Antananarivo Agglomeration should be in line with the LCPDP which was supposed to be finalised in December 2017.

- To encourage the implementation of the power generation expansion plan promoted by the donors, such as World Bank and the private sector, and to focus on power distribution to residents, industry, and other consumers
- To enhance power distribution to urban centres in CUA of Antananarivo Agglomeration, which need to have higher urban functions in the future
- To support urbanisation outside CUA by developing new substations with larger capacity and distribution network in the suburbs outside CUA
- To enhance the power supply capacity outside of CUA, not only for satisfying the power demand outside of CUA, but also for supplying power also to CUA which needs a large and increasing volume of power and as an alternative supply source during the construction period of updating the power supply within CUA
- To ensure power supply to industries of which development is to be promoted outside of CUA

The ways to put the strategies into practice are as follows:

(1) Power Development

As mentioned in 11.3.2 (1), the total power generating capacity is expected to meet the peak demand of RIA from 2020, provided that all the planned power generation plants are constructed

on schedule. Hence, each of the power development project should be well managed to be implemented in a timely manner.

(2) Transmission System Expansion

The transmission system expansion should be implemented to meet the load increase of the primary system accompanied by increase in both inbound load flow from newly constructed power stations and load flow to substations. It constitutes construction of new transmission lines with higher voltage levels, construction of new substations with larger capacity transformers, and upgrading of existing transmission lines and substations. The specification of the facilities (such as applicable voltage, type and size of conductors, rated capacity of transformers, breaking capacity of the circuit breakers, and amount of reactive power compensation) should be determined based on the power system analysis.

(3) Distribution System Expansion

The distribution system expansion should be implemented to meet the load increase of the secondary system. It constitutes construction of new MV and LV distribution lines, construction of new transformer stations to step down from MV voltage to LV voltage. The distribution expansion plan should be formulated, taking the locations of the newly installed substations and future land use plan into account. The specification of the facilities (such as type and size of conductors, and rated capacity of transformers) should be determined based on the power system analysis.

(4) Replacement of Deteriorated Equipment

As mentioned in 11.3.3 (3), the existing distribution network had a number of deteriorated equipment due to aging and lack of investments in rehabilitation projects. Deteriorating equipment had become one of the causes of a significant number of outages and high distribution losses. In order to increase the reliability of the distribution network and reduction of distribution losses, dilapidated equipment should be replaced with new ones based on priority.

(5) Modernisation of Load Dispatching Centre

In order to enable quick and accurate system operation of the more complicated future power system, modernisation of the load dispatching centre is proposed. The modernisation includes state-of-the-art introduction of power system monitoring and control system.

11.3.6 Programmes and Projects for Power Supply Development in Antananarivo Agglomeration

(1) Transmission System Expansion

The following projects for the expansion of the transmission system are proposed for each year period:

From 2018 to 2023

1) Installation of New Transmission Lines

- 225kV transmission line (Sahofika Hydropower Station to Behenjy Substation)
- 225kV transmission line (Antetezambato Hydropower Station to Behenjy Substation)
- 225kV transmission line (Tana Sud 2 Substation to Behenjy Substation)
- 138kV transmission line (Ranomafana Hydropower Station to Tana Sud 2 Substation)
- 138kV transmission line (Mahitsy Hydropower Station to Tana Sud 2 Substation)
- 63kV transmission line (Tana Sud 2 Substation to Tana Sud Substation)

2) Installation of New Substations

- 225kV/63kV Behenjy Substation
- 225kV/138kV/63kV Tana Sud 2 Substation
- Tana Sud 2 Substation is expected to enhance the capacity of power supply to the communes in the southeast area of Antananarivo Agglomeration.

3) Reinforcement of Existing Transmission Lines

Capacity enhancement of existing 63kV and 35kV transmission system inside the loop system (Tana Nord – Tana Sud – Ambohimambola) by installation of additional circuits, upgrading the capacity of conductors, and/or application of bundled conductors

(Detailed study should be conducted to determine the target and scope of the projects.)

4) Reinforcement of Existing Substations

Capacity enhancement of existing substations by upgrading the capacity of transformers. (Detailed study should be conducted to determine the target and scope of the projects.)

From 2023 to 2028

5) Installation of New Transmission Lines

- 225kV transmission line (Mahavola Hydropower Station to Tana Nord 2 Substation)
- 225kV transmission line (Tana Nord 2 Substation to New Substation in Moramanga)
- 138kV transmission line (Mahavola Hydropower Station to Mahitsy Hydropower Station)
- 63kV transmission line (Tana Nord 2 Substation to Tana Nord Substation)

6) Installation of New Substations

- 225kV/63kV Tana Nord 2 Substation

Tana Nord 2 Substation is expected to enhance the capacity of power supply to the communes in both northeast and northwest areas of Antananarivo Agglomeration.

- 225kV/138kV New Substation in Moramanga

7) Reinforcement of Existing Transmission Lines

Capacity enhancement of existing 63kV and 35kV transmission system inside the loop system (Tana Nord – Tana Sud – Ambohimambola) by installation of additional circuits, upgrading the capacity of conductors, and/or application of bundled conductors

(Detailed study should be conducted to determine the target and scope of the projects.)

8) Reinforcement of Existing Substations

Capacity enhancement of existing substations by upgrading the capacity of transformers. (Detailed study should be conducted to determine the target and scope of the projects.)

From 2028 to 2033

9) Installation of New Transmission Lines and Substations

Detailed study should be conducted to determine the scope of the projects based on the LCPDP to be finalised.

(2) Expansion and Rehabilitation of the Distribution System

From 2018 to 2023

- Rehabilitation and/or upgrading of existing distribution networks by PAGOSE project¹⁶
- Replacement of 20/0.4kV overloaded transformers by new transformers with adequate capacities
- Installation of associated accessories and switchgear
- Construction of 20kV lines
- Installation of distribution substations with primary voltage 20kV
- Replacement of 5/0.4kV pole mounted transformers and insulators, accessories, and conductors of existing 5 kV lines to upgrade the infrastructure to operate in 20kV

The location of the components of PAGOSE project is shown in Figure 11.3.15.

The lists of the 35kV and 20kV distribution lines under JIRAMA projects are shown in Table 11.3.12 and Table 11.3.13, respectively. Also, the location of each distribution line project is shown in Figure 11.3.16. In the figure, blue solid lines pertain to 35kV distribution lines, and orange solid lines pertain to 20kV distribution lines. This figure also shows the future land use plan in 2033.

¹⁶ International Development Association Project Appraisal Document on a Proposed Project in the Amount of SDR 47.1 Million to the Republic of Madagascar for an Electricity Sector Operations and Governance Improvement Project, March 2016, World Bank

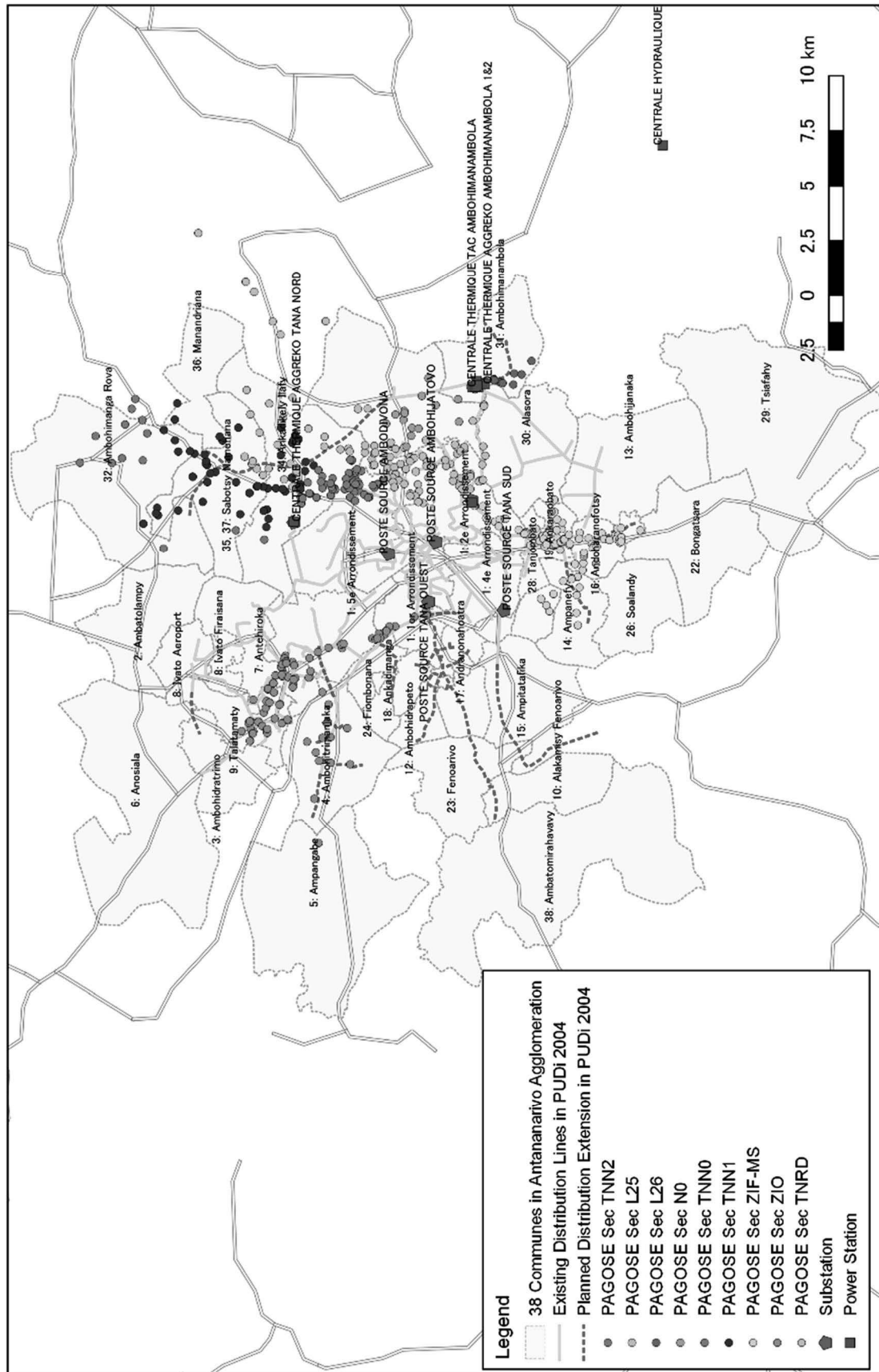


Table 11.3.12 List of 35kV Distribution Lines under JIRAMA Projects

No.	Name of Distribution Lines		Location	Name of Commune
1	CNP	1125 Anosimahavelona	CUA	4e Arrondissement
2	CNP near	1492 Andohatapenaka	CUA	4e Arrondissement
3	CNP	1658 Disconord	CUA	4e Arrondissement
4	CNP	1407 Ambatolampy Ambohibao	CUA	5e Arrondissement
5	CNP near	1123 Ambatolampy Antehiroka	CUA	6e Arrondissement
6	CNP	1376 Ambodimita	CUA	6e Arrondissement
7	CNP	1377 Anosisoa	CUA	6e Arrondissement
8	CNP	1650 Ambohimananina	CUA	6e Arrondissement
9	CNP near	1652 Ambodimita	CUA	6e Arrondissement
10	CNP	Ambohimananandray	CUA	6e Arrondissement
11	CNP	1030 Mandriamboro	Outside CUA	Ambohidratrimo
12	CNP	1040 Cité de cadre Ivato	Outside CUA	Ivato Aeroport
13	CNP	1081 Antanimenakely	Outside CUA	Andranonahoatra
14	CNP near	1105 Ambohibao Antehiroka	Outside CUA	Antehiroka
15	CNP	1106 Mahitsy Ambohitrimanjaka	Outside CUA	Ambohitrimanjaka
16	CNP near	1107 Ambohitrimanjaka	Outside CUA	Ambohitrimanjaka
17	CNP	1111 Antalamohatra	Outside CUA	Antehiroka
18	CNP near	1134 Marobiby	Outside CUA	Fiombonana
19	CNP	1136 Ambohimangidy	Outside CUA	Ampitatafika
20	CNP	1141 Loharanombato	Outside CUA	Ambavahaditokana
21	CNP	1150 Ankaraobato	Outside CUA	Ankaraobato
22	CNP	1155 Tongarivo	Outside CUA	Tanjombato
23	CNP near	1157b Andoharanofotsy	Outside CUA	Andoharanofotsy
24	CNP near	1201 Mandrosoa Ivato	Outside CUA	Ivato Firaiana
25	CNP	1209 Ambohimangidy	Outside CUA	Ampitatafika
26	CNP	1215 Ankaditany Vf	Outside CUA	Ampitatafika
27	CNP	1229 Ambohibao Flm	Outside CUA	Antehiroka
28	CNP near	1232 Ambatofilokana Itaosy	Outside CUA	Andranonahoatra
29	CNP	1281 Andoharanofotsy	Outside CUA	Andoharanofotsy
30	CNP	1136 Ambohimangidy	Outside CUA	Ampitatafika
31	CNP	1316 Antanetibe Itaosy	Outside CUA	Ambohidrapeto
32	CNP	1380 Antalamohatra	Outside CUA	Antehiroka
33		1434 Ambohimamory	Outside CUA	Andranonahoatra
34	CNP	1435 Beloha – Ambohitrimanjaka	Outside CUA	Ambohitrimanjaka
35	CNP near	1443 Antoby	Outside CUA	Ivato Aeroport
36	CNP	1448 Anelotsara Ambohitrimanjaka	Outside CUA	Ambohitrimanjaka
37	CNP	1449 Antsahamarina Ambohitrimanjaka	Outside CUA	Ambohitrimanjaka
38	CNP near	1461 Morondava Antehiroka	Outside CUA	Antehiroka
39	CNP	1474 Volotara	Outside CUA	Andoharanofotsy
40	CNP near	1483 Talatamaty	Outside CUA	Talatamaty
41	CNP	1484 Sakambahiny Itaosy	Outside CUA	Bemasoandro
42	CNP	1485 Chateau d'eau Ambohidrapeto	Outside CUA	Ambohidrapeto
43	CNP near	1513 Ambohimamory Itaosy	Outside CUA	Ambavahaditokana
44	CNP near	1547 Antanivony	Outside CUA	Bemasoandro
45	CNP	1568 Avaratsena	Outside CUA	Ambohidrapeto
46	CNP	1615 Ifarihy	Outside CUA	Ankaraobato
47	CNP	1693 Ambohinambo	Outside CUA	Talatamaty
48	CNP	1709 Antsahakely Itaosy	Outside CUA	Ambohidrapeto
49	CNP	1720 Mahalavolona	Outside CUA	Andoharanofotsy
50	P	1747 Ambavahaditokana Itaosy	Outside CUA	Ambavahaditokana
51	CNP	Ankadindravol	Outside CUA	Ivato Firaiana

Source: JIRAMA

Table 11.3.13 List of 20kV Distribution Lines under JIRAMA Projects

No.	Name of Distribution Lines			Location	Name of Commune
1	CNP	near Pole	20428 Andavamamba Anjezila	CUA	1e Arrondissement
2	CNP	near Pole	20455 Ambilanibe	CUA	1e Arrondissement
3	CNP	near Pole	20041 Androndra	CUA	2e Arrondissement
4	CNP	near Pole	20381 Avaratr' Ankatso	CUA	2e Arrondissement
5	CNP	near Pole	20021 Anosizato Est	CUA	4e Arrondissement
6	CNP	near Pole	20123 Tsena Namontana	CUA	4e Arrondissement
7	CNP	near Pole	21117 Anosizato Est	CUA	4e Arrondissement
8	CNP	near	2187 Ambohidahy Ankadindramamy	CUA	5e Arrondissement
9	CNP	near Pole	2294 Ampanotokana	CUA	5e Arrondissement
10	CNP	near Pole	20095 Androhibe	CUA	5e Arrondissement
11	CNP	near Pole	20100 Tsarahonenana	CUA	5e Arrondissement
12	CNP	near Pole	20143 Ambatolampikely Ambohibao	CUA	5e Arrondissement
13	CNP	near Pole	20181 Andraisoro	CUA	5e Arrondissement
14	CNP	near Pole	20305 Tsarahonenana	CUA	5e Arrondissement
15	CNP	near Pole	2030 Amboanjobe	Outside CUA	Bongatsara
16	CNP	near	2104 Mahitsy Ambohimambola	Outside CUA	Alasora
17	CNP	near Pole	2183 Morarano Mahalavolona	Outside CUA	Andoharanofotsy
18	CNP	near Pole	2206 Alakamisy Anosiala	Outside CUA	Anosiala
19	CNP	near Pole	2320 Ankandrina Soamanandrariny	Outside CUA	Ambohimangakely
20	CNP	near Pole	2324 Anosy Avaratra	Outside CUA	Anosy Avaratra
21	CNP	near Pole	2353 Ambohimangakely	Outside CUA	Ambohimangakely
22	CNP	near	2464 Alasora	Outside CUA	Alasora
23	CNP	near Pole	20036 Ankadindratombo	Outside CUA	Alasora
24	CNP		Tsimahandry	Outside CUA	Anosiala

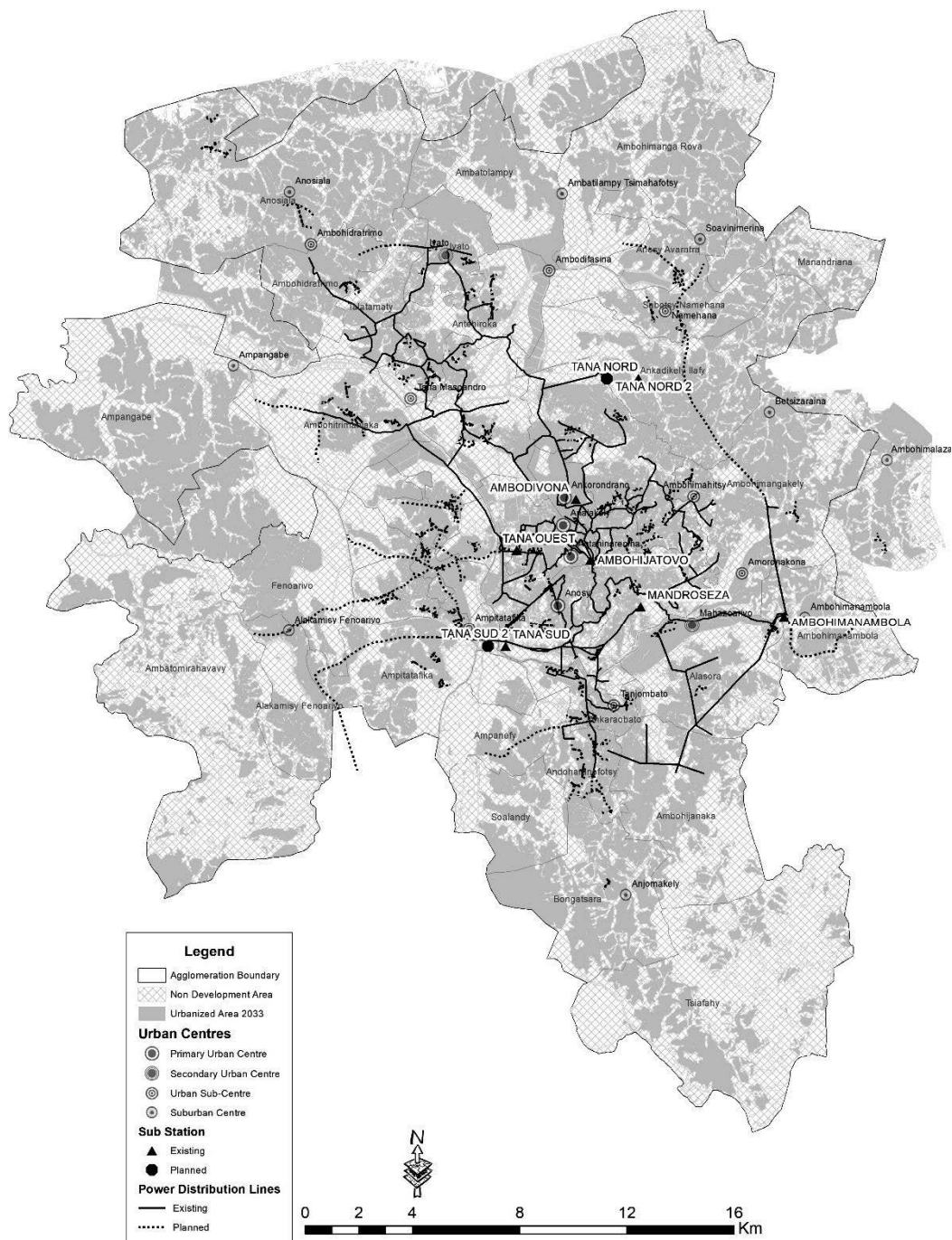
Source: JIRAMA

From 2023 to 2033

According to Figure 11.3.16, most of the parts of high- and mid-density residential areas are expected to be covered by either 35kV or 20kV distribution network; however, some of industry areas in northern and southern parts of the Antananarivo Agglomeration will not be covered without further development of either transmission or distribution network. The target and scope of the distribution system expansion projects should be determined based on the detailed study. It is necessary to develop both existing and future distribution system models for the analysis based on the precise and comprehensive inventory data. Grasp of the regional distribution of future demand and land use plan is essential to determine the location of the candidate transformer stations and the route of distribution lines.

(3) Modernisation of Load Dispatching Centre

Detailed study should be conducted to determine the scope of the projects.



Source: JICA Study Team

Figure 11.3.16 Location of Distribution Line Projects for Antananarivo Agglomeration 2033

11.3.7 Profiles of Priority Projects for Power Supply of Antananarivo Agglomeration

(1) Project for Installation of New Transmission Lines - Phase 1

1) Rational

Access to electricity of the people in Antananarivo Agglomeration is not at a satisfactory level. It is estimated that an average rate of access to the JIRAMA's distribution grid was about 63% for the people of Antananarivo Agglomeration in 2017 while that for Antananarivo was about 72%.

In 2016, the available capacity of power supply, combining of JIRAMA's and private

companies power stations, is 212.8 MW out of the installed capacity of 391.54 MW, which means that power supply capacity is a little bit short to meet the peak demand, 225.2 MW. The power planned to be developed by JIRAMA will be resolve the power shortage from 2020 onwards.

To widen the electricity service coverage area, it is required to expand transmission system and distribution system.

2) Objective

To expand transmission line to meet the load increased on the primary system caused by increase in both inbound load flow from new power stations and load flow to substations, to improve the access to electricity in Antananarivo Agglomeration.

3) Project Description

The following transmission lines should be developed.

- 225kV transmission line (Sahofika hydropower station to Behenjy Substation): 294km
- 225kV transmission line (Antetezambato hydropower station to Behenjy Substation): 111km
- 225kV transmission line (Tana Sud 2 Substation to Behenjy Substation): 34.8km
- 225kV transmission line (Tana Nord 2 Substation to New Substation in Moramanga): 90.3km
- 138kV transmission line (Ranomafana hydropower station to Tana Sud 2 Substation): 323km
- 138kV transmission line (Mahitsy hydropower station to Tana Sud 2 Substation): 32km
- 63kV transmission line (Tana Sud 2 Substation to Tana Sud Substation): 1km

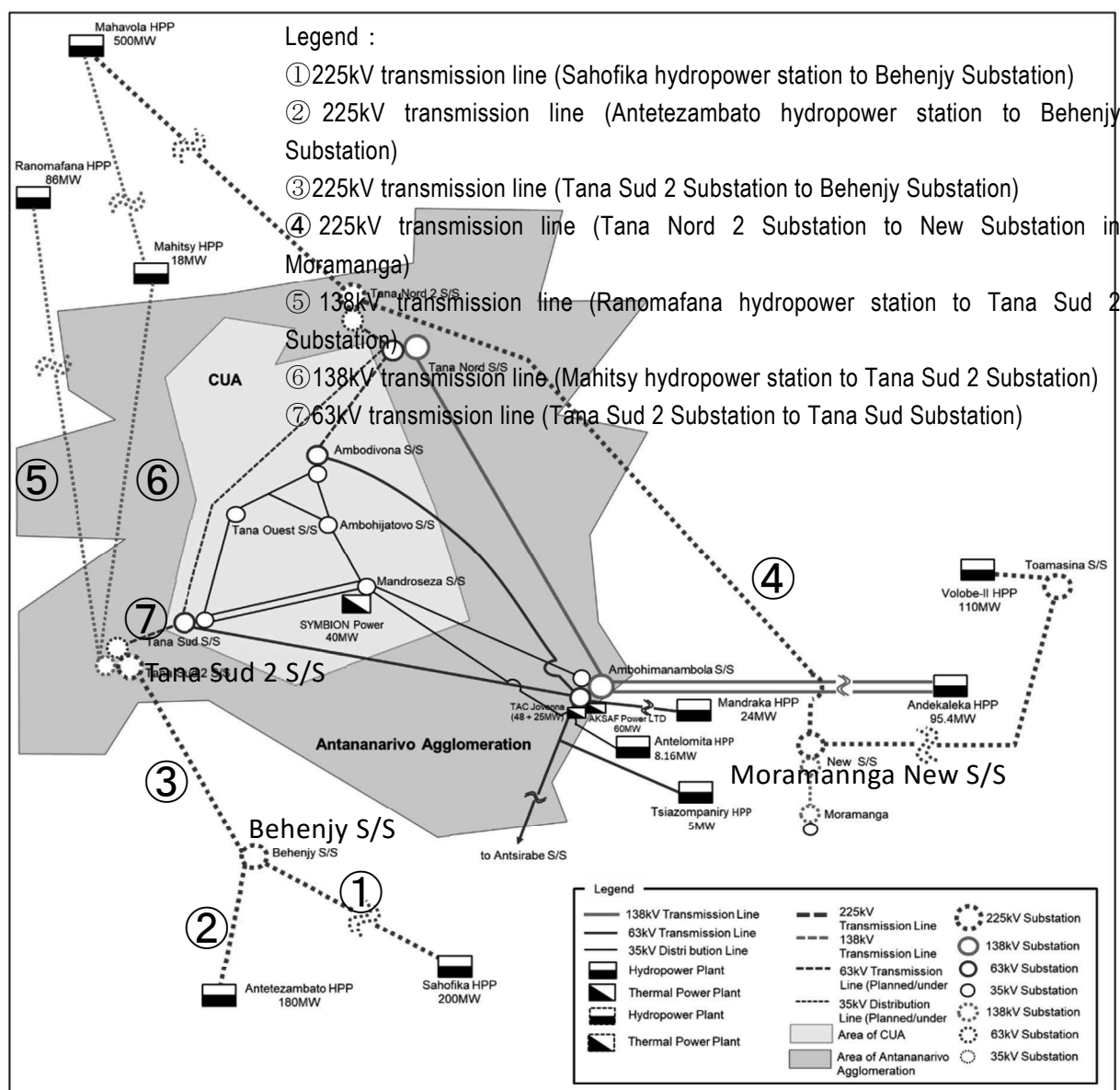


Figure 11.3.17 Location of Transmission Lines and Substations for Antananarivo Agglomeration Phase 1

4) Expected Benefits

- Population in 2023 will have access to electricity

5) Executing Agency and Related Institutes

- JIRAMA

6) Estimated Project Cost

- Approximately 445 million USD

7) Implementation Schedule

- Construction: 2019 - 2023

8) Necessary Actions for Implementation / Critical Factor

- Power system analysis
- Determination of the specification of the facilities, such as applicable voltage, type and

size of conductors, rated capacity of transformers, breaking capacity of the circuit breakers, and amount of reactive power compensation, based on the power system analysis.

- Land acquisition

9) Related Plans and Projects

- PAGOSE (Projet d'amélioration de la Gouvernance et des Opérations dans le secteur de l'Électricité)

10) Social and Environmental Impacts

N.A

(2) Project for Installation of New Substations - Phase 1

1) Rational

Access to electricity of the people in Antananarivo Agglomeration is not at a satisfactory level. It is estimated that an average rate of access to the JIRAMA's distribution grid was about 63% for the people of Antananarivo Agglomeration in 2017 while that for Antananarivo about 72%.

In 2016, the available capacity of power supply, combining of JIRAMA's and private companies power stations, is 212.8 MW out of the installed capacity of 391.54 MW, which means that power supply capacity is a little bit short to meet the peak demand, 225.2 MW. The power planned to be developed by JIRAMA will be resolve the power shortage from 2020 onwards.

To widen the electricity service coverage area, it is required to expand transmission system and distribution system.

2) Objectives

To expand the transmission system by developing new substations to connect the planned Hydro power plants (HPP) of Antenezambato HPP, Sahofika HPP, Ranomafana HPP, and Mahitsy HPP with the existing Tana Sud Substation.

3) Project Description

- 225kV/63kV Behenjy Substation
- 225kV/138kV/63kV Tana Sud 2 Substation
- Tana Sud 2 Substation is expected to enhance the capacity of power supply to the communes in the southeast area of Antananarivo Agglomeration.
- 225kV/138kV New Substation in Moramanga

4) Expected Benefits

- Population in 2023 will be access to electricity

5) Executing Agency and Related Institutes

- JIRAMA

6) Estimated Project Cost

N.A

7) Implementation Schedule

- Construction: 2019-2023

8) Necessary Actions for Implementation / Critical Factor

- Power system analysis
- Determination of the specification of the facilities, such as applicable voltage, type and size of conductors, rated capacity of transformers, breaking capacity of the circuit breakers, and amount of reactive power compensation, based on the power system analysis.
- Land acquisition

9) Related Plans and Projects

- PAGOSE (Projet d'amélioration de la Gouvernance et des Opérations dans le secteur de l'Électricité)

10) Social and Environmental Impacts

N.A

(3) Project for Installation of New Transmission Lines - Phase 2

1) Rational

Access to electricity of the people in Antananarivo Agglomeration is not at a satisfactory level. It is estimated that an average rate of access to the JIRAMA's distribution grid was about 63% for the people of Antananarivo Agglomeration in 2017 while that for Antananarivo about 73%.

In 2016, the available capacity of power supply, combining of JIRAMA's and private companies power stations, is 212.8 MW out of the installed capacity of 391.54 MW, which means that power supply capacity is a little bit short to meet the peak demand, 225.2 MW. The power demand for the year of 2033 forecasted by JIRAMA will reach 488 MW at an average growth rate of 4.6% per annum based on the past trend. On the other hand, the demand is forecasted to reach 857 MW, based on the elasticity of power consumption of RIA to the GDP growth by the TaToM Team. To meet such demand, the power are planned to be developed by JIRAMA thereby the power shortage will be resolved from 2020 onwards. In 2028, the power demand will be 380 MW (JIRAMA forecast) and 542 MW (forecast) by the TaToM team, with the power supply of 1,378 MW in wet season and 899 MW in dry season.

To widen the electricity service coverage area, it is required to expand transmission system and distribution system.

2) Objective

To expand the transmission system by developing new substations to connect the planned hydro power plants (HPP) of Mahavola HPP, Mahits HPP with the existing Tana Nord Substation through new substations of Tana Nord 2 and Moramanga Substation.

3) Project Description

- 225kV transmission line (Mahavola hydropower station to Tana Nord 2 Substation): 145km
- 138kV transmission line (Mahavola hydropower station to Mahitsy hydropower station): 118km
- 63kV transmission line (Tana Nord 2 Substation to Tana Nord Substation): 8km

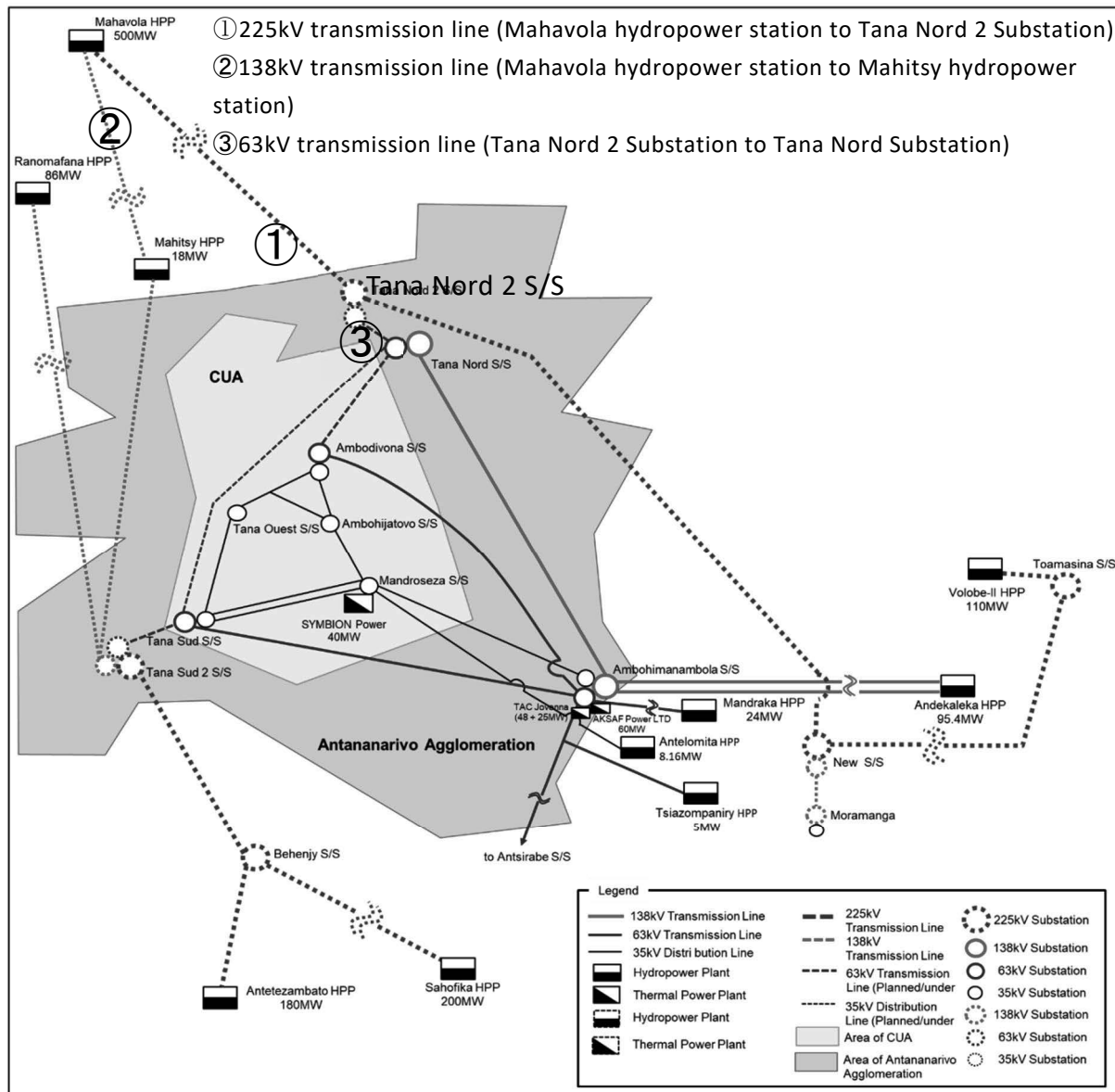


Figure 11.3.18 Location of Transmission Lines and Substations for Antananarivo Agglomeration Phase 2

4) Expected Benefits

- Population in 2028 will be access to electricity

5) Executing Agency and Related Institutes

- JIRAMA

6) Estimated Project Cost

- 145 million USD

7) Implementation Schedule

- 2024-2028

8) Necessary Actions for Implementation / Critical Factor

- Power system analysis
- Determination of the specification of the facilities, such as applicable voltage, type and

size of conductors, rated capacity of transformers, breaking capacity of the circuit breakers, and amount of reactive power compensation, based on the power system analysis.

- Land acquisition

9) Related Plans and Projects

- PAGOSE (Projet d'amélioration de la Gouvernance et des Opérations dans le secteur de l'Électricité)

10) Social and Environmental Impacts

N.A.

(4) Project for Installation of New Substations - Phase 2

1) Rational

Access to electricity of the people in Antananarivo Agglomeration is not at a satisfactory level. It is estimated that an average rate of access to the JIRAMA's distribution grid was about 48% for the people of Antananarivo Agglomeration in 2017 while that for Antananarivo about 58%.

In 2016, the available capacity of power supply, combining of JIRAMA's and private companies power stations, is 212.8 MW out of the installed capacity of 391.54 MW, which means that power supply capacity is a little bit short to meet the peak demand, 225.2 MW. The power demand for the year of 2033 forecasted by JIRAMA will reach 488 MW at an average growth rate of 4.6% per annum based on the past trend. On the other hand, the demand is forecasted to reach 857 MW, based on the elasticity of power consumption of RIA to the GDP growth by the TaToM Team. To meet such demand, the power are planned to be developed by JIRAMA thereby the power shortage will be resolved from 2020 onwards. In 2028, the power demand will be 380 MW (JIRAMA forecast) and 542 MW (forecast) by the TaToM team, with the power supply of 1,378 MW in wet season and 899 MW in dry season.

To widen such electricity service coverage area, it is required to expand transmission system and distribution system.

2) Objectives

To expand transmission line to meet the load increased on the primary system caused by increase in both inbound load flow from new power stations and load flow to substations, to improve the access to electricity in Antananarivo Agglomeration.

3) Project Description

225kV/63kV Tana Nord 2 Substation: Tana Nord 2 Substation is expected to enhance the capacity of power supply to the communes in both northeast and northwest areas of Antananarivo Agglomeration.

4) Expected Benefits

- Population in 2028 will be access to electricity

5) Executing Agency and Related Institutes

- JIRAMA

6) Estimated Project Cost

- To be estimated

7) Implementation Schedule

- 2024-2028

8) Necessary Actions for Implementation / Critical Factor

- Power system analysis
- Determination of the specification of the facilities, such as applicable voltage, type and size of conductors, rated capacity of transformers, breaking capacity of the circuit breakers, and amount of reactive power compensation, based on the power system analysis.
- Land acquisition

9) Related Plans and Projects

- PAGOSE (Projet d'amélioration de la Gouvernance et des Opérations dans le secteur de l'Électricité)

10) Social and Environmental Impacts

N.A.

11.4 Solid Waste Management in Antananarivo Agglomeration

11.4.1 Present Situation of Solid Waste Management in Antananarivo Agglomeration

(1) Present Situation on Solid Waste Management in CUA and Rural Communes in Antananarivo Agglomeration

Solid Waste Management (SWM) has become a serious problem in CUA due to the rapid rate of urbanisation, uncontrolled population, lack of resources, institutional weaknesses and lack of civic sense towards solid waste disposal. The average solid waste collection rates in CUA are currently only around 60%. This current waste collection rate in CUA is a result of the improvement of urban infrastructure of SWM being managed by public waste service body called Autonomous Maintenance Service of the City of Antananarivo (SAMVA: *Service Autonome de Maintenance de la Ville d'Antananarivo*) in the CUA area.

SAMVA, is a public waste service body established in 1995 under the direction of CUA and became attached to the Ministry of Water in 2009. Ministry of Water was changed to Ministry of Water, Sanitation and Hygiene (MEAH: *Ministère de l'Eau, de l'Assainissement et de l'Hygiène*) in early 2016, and again recently in 2019 to Ministry of Water, Energy and Hydrocarbons (MEEH: *Ministère de l'Energie, de l'Eau et des Hydrocarbures*). SAMVA is now attached to MEEH.

SAMVA is in charge of collection, transport and disposal of the solid waste in the final landfill site of Andralanitra which is located outside the CUA in the Rural Commune of Ambohimangakely. According to SAMVA, the total area of the final landfill is about 18 ha and the total waste amount that has been collected in the final landfill over the last 60 years running (1956-2017) is currently estimated at approximately 2.5 million tonnes in volume.

Pre-collection of household wastes is made by residents or sanitary worker for the Water and Sanitation System (RF2: *Rafitra fikojana rano sy fahadiovana*) of the fokontany (44 primary collection workers for 192 Fokontany in CUA in 2016) to a container (6m³ in capacity) fixed at collection points (295 points in 2016). At each collection point, the waste garbage collected in the container is handled by SAMVA's workers manually and loaded into a truck (25m³ in capacity) and transported to the final landfill of Andralanitra. Depending on season, there are 15 to 25 trucks making two to three trips each to the final landfill site every day. There is one bulldozer and one wheel loader at the final landfill. According to SAMVA, there are approximately 2,100m³ of waste coming in the landfill every day. In the AFD's feasibility study report (2007) and the WB's SWM report (2016), the waste composition tests show similar results; for instance, the AFD-2007 report shows that about 45% are organic materials, 33% are fine materials and 11% are plastic, paper and metal scrap, while the WB 2016-SWM report reveals that about 49% are organic materials, 25% fine materials and 19% plastic, paper and metal scrap. The source of the waste composition results above is based on data attained from SAMVA.

Besides CUA, current SWM of all 37 rural communes is found to be a simple collection/transportation system and open dumping system in the rural communes's inadequate budget. For instance, Ivato Rural Commune has outsourcing services providing a few rental vehicles for waste collection and disposal to open dump sites. In the case of Ambohimangakely Rural Commune, which has the existing landfill for the CUA, the commune disposes waste to the landfill site at Andranitra as contracted with SAMVA. As some other rural communes such as Ambohimanga Rova and Ambatomirahavavy are located remotely and less populated and more dispersed, they are supposed to employed self-disposal systems. There is room for illegal waste collectors and waste pickers to enter the open dumping sites.

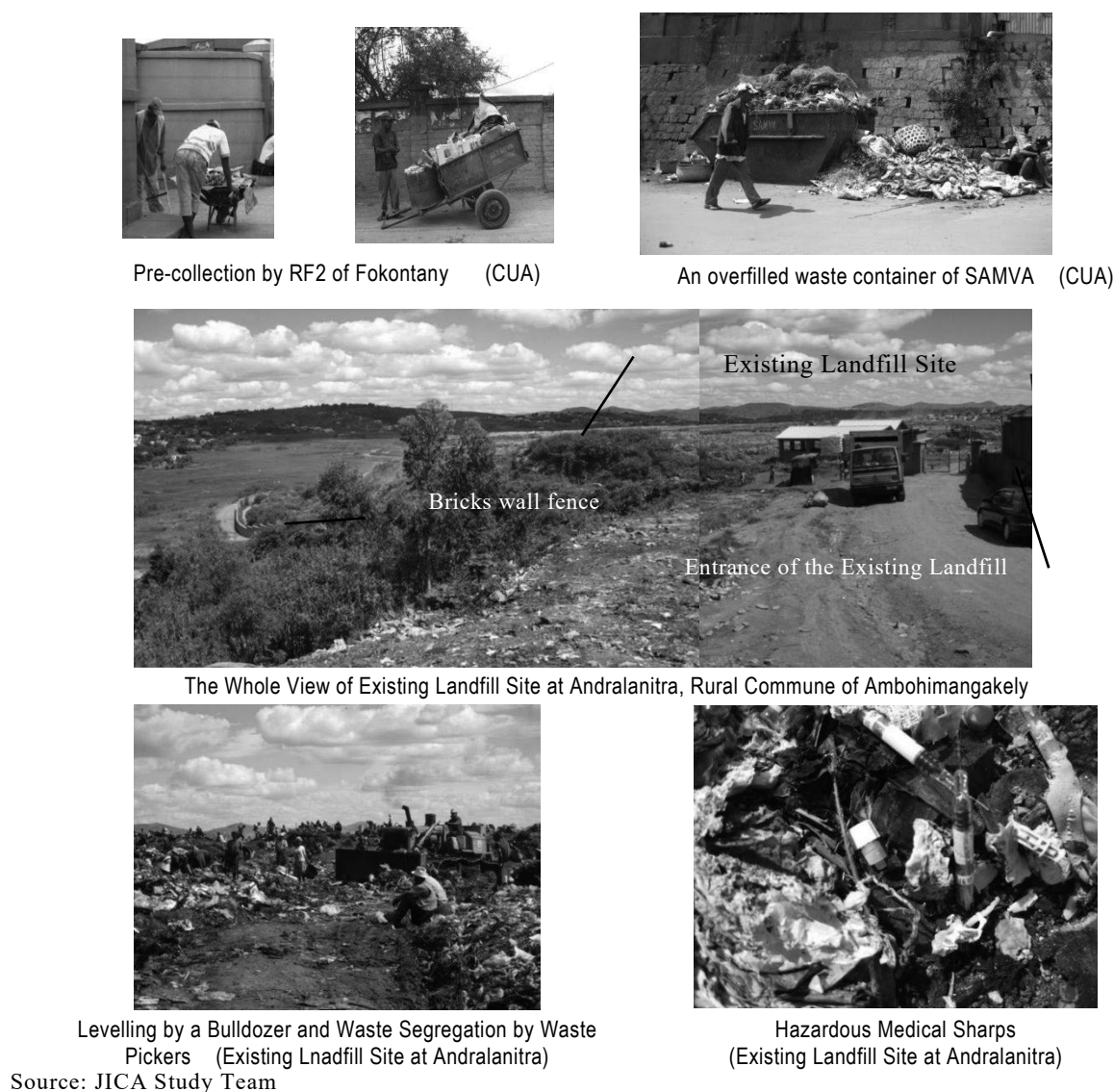


Figure 11.4.1 Present Situations of SWM in CUA and adjoining Rural Communes

(2) Disposal Sites

The most serious issue on the SWM in Antananarivo is that the final landfill site at Andralanitra for CUA, which is currently over capacity and can no longer be tolerated technically and environmentally. According to the AFD-2007 report on improving the collection and management of solid waste, it was noted that the landfill of Andralanitra was largely filled with waste and would have to be closed within a maximum of 5 years that is in 2012. Many environmental challenges on the SWM have been caused by the dumping over the years in the past which have serious consequences on public health and environmental hazards.

According to SAMVA, currently in the year 2017, the present height of the landfill has reached over 30m against the designed height of 15m as stated in the AFD's report. It is noted that the currently due to the accumulated waste, landfill faces a very high risk condition against landslide. In 2015, the slope of the south-western part of the landfill slope caused a large-scale landslide failure. Currently, the northeast slope and southwest slope of the landfill seem to be especially at a high risk of sliding. In recent years, several slope failures of landfill sites have been reported around the world, e.g. in March 2017 at least 48 people were killed in a landslide at a vast rubbish dump in Addis Ababa, Ethiopia, and also in February 2017 at least 50 people were killed in a landfill accident in China. Finding a new landfill site in the

rural communes and closing an existing landfill site at Andralanitra are matters demanding urgent actions by the stakeholders for solid waste management.

In 2007, a feasibility study regarding the following three potential landfill sites for CUA were studied by AFD:

- Avarabohitra site in Rural Commune (R.C.) Anosiala,
- Antsahamarofoza site in R.C. Ankadikely Ilafy, and
- Ambohipamonjy site in R.C. Ampitatafika.

However, no support was obtained from the related rural communes and residents, and the evaluation results of the three candidate sites are summarised in Table 11.4.1.

Table 11.4.1 Comparison of Potential Disposal Sites in 2007 AFD's Report for Antananarivo Agglomeration

Candidate Site	Avarabohitra site	Antsahamarofoza site	Ambohipamonjy site
Location	Anosiala Rural Commune	Manandriano Rural Commune	Ampitatafika Rural Commune
Basis of Selection	The site identified and prospected by the consultant in 2007-Feasibility Study report by AFD	The site selected in 2007-Feasibility Study Report by AFD through recommendation by SAMVA	The site identified by Etude SGI (1994) and selected in 2007 - Feasibility Study Report by AFD
Overview	8.5 km from RN4 Hilly land Area: about 10 ha Potential capacity: 1.8million m ³ Access is through a one-lane road, uneven, hard or impossible to pass during rainy season. The potential site is surrounded by steep hilly slopes in the valley basin. The valley is cultivated by surrounding villagers. No houses in the potential site.	7 km from the factory of SOMACOU along NR3 Hilly land Area: about 14 ha Potential capacity: 2.5 million m ³ Although the site is called Antsahamarofoza, it is not located in Antsahamarofoza Fokontany, but in Ambatolampy Fokontany of Manandriano RC. Houses exist in the potential site.	4.5 km from NR3 Hilly land Area: about 18 ha Potential capacity: 3.2 million m ³ Houses do not exist in the potential site. There is a provincial asphalt-paved road along the potential site.
Land Owner	Private	Private	Private
Correspondence from the Commune and Residents Regarding the AFD-Report	The commune mayor was appointed since 2015 and does not know anything about the AFD report. The commune's staff know the potential site though. The mayor has not seen the site either.	In Manandriano, there is strong opposition of the residents because there are existing residential areas at the site.	The candidate site that the AFD report proposed and the site that residents of Ampitatafika Commune and Fokontany does not want to be converted to a landfill site are different places. The main reasons why the commune mayor is against to the landfill site are the following: (1) For the 2007 AFD report, the commune had not been informed anything about the site. (2) The Mayor of the commune was not included in a trip to France. (3) AFD has not visited the concerned communes during the reporting preparation stage.
Evaluation of the 2007-AFD Report by the Rural Commune	The Mayor seems to avoid an evaluation at the moment. The communes prioritise having a dumpsite for themselves, rather than one for the group of communes.	Due to opposition of the residents, project implementation at this candidate site in the Manandriano RC cannot be realised.	Questions were raised towards the strong pressure put by the central government to the rural commune at the time.
Overall Response to Future Landfill Sites to JICA Study Team	An- independent system of solid waste treatment will be considered for the commune.	In Manandriano R.C, there is a candidate site for a sanitary landfill/treatment facility at the North-Zone within the commune. There is a need to improve the access road to the facility, among other concerns.	In September 2017, the mayor and the staff of the commune agreed that they will support the original candidate site and commit to reconsider it as a sanitary landfill/treatment facility for forming the rural commune group (Ampitatafika, Fenoarivo, Alakamisy Fenoarivo) in

			the West-Zone of the Antananarivo Agglomeration. The commune is seeking a donor who will support an engineering process for implementation of the sanitary landfill/ treatment facility.
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Note: RC in the above table means Rural Commune.

Source: JICA Study Team

On the other hand, some communes in Antananarivo Agglomeration such as Andohoranofotsy, Tsiafahy and Manandriana have shown interest in providing land for final landfill site to replace Andralanitra.

Although the present final landfill at Andralanitra has no truck-scale, the method of estimating the waste amount by visual inspection at the entrance gate of the landfill is conducted by SAMVA and the estimation is well-documented by SAMVA. A new final landfill should be sanitary and have a truck-scale system after the existing landfill is completely closed.

(3) Illegal Dumping

Uncollected waste is illegally piled on sidewalks, in open spaces, sewer lines, or even in canals, and rice fields and blockage of wastewater flow in the sewers is seen, causing additional problems for the local governments of urban and rural communes in Antananarivo. The laws and regulations related to solid waste management in Madagascar are limited and insufficient.

According to the said AFD 2007-report or a WB 2016-SWM report, there were waste piles stacked and dumped in open lots or on the banks of natural streams, rivers, paddy fields, and low-lying areas.



Source: JICA Study Team

Figure 11.4.2 **Illegal Dumping Site next to the River Bank of Ikopa and Waste Segregation by Waste Pickers**

The collected waste posed a serious health hazard and contaminated surface water sources. SAMVA together with CUA and Ministry of Water has responded to the major challenge of maintaining clean environmental sanitation status over the years. In the period of December 2015 to April 2016, SAMVA with CUA and the Ministry of Water presented a “Cleanliness Campaign” to the public. The following two photos shows the same location “Before” and “After” conditions.



"Before"

Photo taken before "Cleanliness Campaign "
(World Bank Group in 2014)



"After"

Photo taken after "Cleanliness Campaign "
(JICA TaToM Project in 2017)

"Cleanliness Campaign (Coup de Poking)" conducted between Dec.2015 to Apr. 2016
by SAMVA, CUA, Ministry of Water. (now, Ministry of Water, Energy and Hydrocarbons)

Figure 11.4.3 Photos of Current SWM Situation in CUA

(4) Solid Waste Management Service Implementor

In CUA, SAMVA is responsible to cover the waste collection and transportation service. In the rural communes, solid waste management is organized by the mayors of the communes in Antananarivo Agglomeration.

The number of collection vehicles and waste containers is insufficient for the collection of all wastes generated in the CUA. Waste discharged by the residents overflows around the container. In addition, some residents do not dispose the waste in to the container. As a result, the waste is scattered around the containers and it causes odour and deteriorates the environment in the city.

On the other hand, the open dumping method is employed in the other major urban areas of the adjoining rural communes outside CUA. In some rural communes, open dumping situations become more and more serious from the viewpoints of the environment and human hygiene. Rigid and integrated solid waste management in such rural communes are urgently required. As of 2017, among the five rural communes (Ivato, Ankadikely Ilafy, Ambohimangakely, Alasora, and Fenoarivo) recommended by SAMVA, and one of the surrounding 37 rural communes in the three districts (Atsimondrano, Avaradrano, Ambohindratrimo) none of them had a SWM system yet. The waste collection and disposal practices by most of the rural communes have been conducted since 1987 or 2002. The amount of waste discharged has increased and the waste situation has become worse. It is one of the pressing issues requiring concerted actions.

All unapproved disposal sites should be controlled under the responsibility of CUA or the adjoining rural communes in the three districts in conformity with the environmental sanitation policy.

(5) Present 3R (Reduce, Reuse, Recycle) Activities

In CUA, 3R (reduce, reuse, recycle) activities are hardly performed actively. However, there are noteworthy points concerning composting activities in the rural communes adjoining the CUA. One is the on-going landfill site at Andralanitra in the rural commune of Ambomangakely and the other is an existing waste open dumping site in the rural commune of Alasora. In the case of the landfill at Andralanitra, two one-story buildings for composting were constructed by AFD near the entrance of the final landfill site in December 2016. According to AFD, these facilities are to start waste segregation and composting.

In the case of the Alasora Commune, around 20 farmers have been employed for a new style composting yard near the waste open dumping site since December 2016. In a more than 30-year old and small scale waste dumping site, 16 rectangular holes (2 m wide x 10-15 m long

x 1 m deep) are dug and prepared. Segregated organic waste materials are cured in the holes for three months. This is the first composting preparation case in Antananarivo and good results are expected.

Certain private sector organisations such as MADA Compost has experience in composting, and related local governments/ NGOs. Also, good practice in composting using household waste is seen in an open dumping site in Alasora.



Source: JICA Study Team

Figure 11.4.4 Composting Site (private) near Final Open Dumping Site at Alasora Rural Commune

(6) Hazardous Risk Waste

Mixing of risk waste with non-risk waste is observed. It was observed at the final landfill site for the CUA that hazardous risk waste from smaller medical facilities is mixed with municipal waste, resulting in a major risk to sanitary workers and waste pickers. They are not aware of the hazardous nature of medical “e- risk” waste and they do not use any personal protective equipment at the time of sweeping.

The types of solid waste studied in the TaToM Project are limited to household waste, market waste, commercial waste, street sweeping waste and office waste. Therefore, the study on hospital waste and industrial waste is limited to only the policy suggestions and recommendations in this Master Plan.

(7) Laws and Regulations Related to 3R (Reduce, Reuse, Recycle) Activities on Solid Waste Management

There is no enforced legal system such as laws and regulations on SWM and 3R activities in Madagascar to support 3R activities. There is also no comprehensive law on SWM in Madagascar that is understandable to officials and residents.

It is also noted that there is no proper enforcement of laws, by-laws and regulations in Madagascar dealing with management of the waste discharged from industries. Mixing of industrial waste with municipal waste is seen at the illegal dumping sites along the bank of Ikopa River. Industrial data of the entire city is not available from any government or private sector. Only the list of industries that have membership with SAMVA is available. It is assumed that, to avoid tax payment, the private companies reject disclosure of any information such as types and sales of their production, number of employees, disposal of industrial waste, etc.

On the other hand, Hospital Waste Management Rules exists, but only address large scale hospitals and do not address small scale clinics nor regulate enforcement mechanisms for the implementation of rules and regulations, especially in terms of waste from private medical facilities.

(8) Lack of Finance

Insufficient financial independence in SWM services is observed. SAMVA is a 100% public service and is financed by revenue (tax) from household waste (ROM: *Redevance sur les Ordures Menageres*) and by subsidy from the government. SAMVA is not in a position to meet its financial needs from the internal financial sources. It falls back on subsidies from the Government of Madagascar. However, this dependence regarding the budget of SAMVA is not sustainable in the long term, and SAMVA needs to increase its financial resources to meet its statutory obligations.

(9) Lack of IEC (Information, Education and Communication)

There is a lack of awareness and coordination among the public and the departments including school education, SAMVA and the environment. To implement successful awareness raising campaigns or environmental education activity, much coordination among relevant bodies is necessary for Antananarivo Agglomeration.

Intensive hygiene and sanitation education to the public is necessary for the proper SWM in CUA and the rural communes, and in order to improve the current SWM system, SAMVA, CUA, the rural communes, related agencies, residents, NGOs, and private sector entities involved should all enhance their capabilities through the IEC (Information, Education and Communication) campaign.

(10) Workers in Risk for Social Considerations

Currently, waste pickers are working in severe condition of SWM services with dangerous environment and health risk. In a SWM plan, it is proposed that waste pickers are involved in the official process of SWM. They can be involved in the various programmes for sorting recyclable materials at the controlled area or in organic waste composting. Trying to get rid of waste pickers will result in failure based on experience in many developing countries. Waste pickers should be involved as a part of the SWM system. This system will benefit both Antananarivo Agglomeration and the waste pickers, including sanitary workers.

11.4.2 Future Forecast of Waste Amounts in Antananarivo Agglomeration

Based on the population projection of the Project TaToM, future waste generation amount in 2033 are estimated for the SWM plan in Antananarivo Agglomeration as shown in the table below. For the estimation, the per capita per day waste generation rates of 0.6 kg/capita/day for CUA, 0.5 kg/capita/day or 0.4 kg/capita/day for rural communes were used for 2018. For the estimation of future generation are assumed for the future waste amounts:

- Minimum increase rate of 1% per annum for waste generated
- Waste collection rate for commercial, institutional and other resources for urban area is set at 14% and for rural area at 12%

Table 11.4.2 Estimation of Projected Solid Waste Management Amount for Antananarivo Agglomeration in 2033

Description / Year		2018	2023	2028	2033
CUA	Waste collection amount from CUA (t/d)	569	868	1,258	1,771
	432	641	904	1,239	1,567
	136	227	353	531	671
Outside CUA	Waste collection amount from urban communes (t/d)	66	298	755	1,549
	52	226	558	1,115	1,385
	15	72	198	434	539
	Self-disposal (t/d)	425	368	230	0
Antananarivo Agglomeration	Total waste generation amount (t/d)	1,060	1,533	2,243	3,320
	Total waste collection amount (t/d)	635	1,165	2,013	3,320
	Share	60%	76%	90%	100%

Source: JICA Study Team

Notes: The following are adopted for the waste amount estimation in the above table based on the information obtained from SAMVA, Antananarivo.

- Adopted capita domestic waste generation rate in 2018 : 0.60 (kg/capita/day) for CUA, 0.50 for urbanized commune, 0.40 for rural commune, based on information from SAMVA and interviews from rural communes of Antananarivo Agglomeration..
- the amounts of waste collection rate for commercial, institutional, other sources are assumed to be at 14% for urban area in CUA and 12 % for urbanised rural Commune, based on the actual values of neighbouring development countries.
- Projected population between 2018 and 2033 for Antananarivo Agglomeration are estimated by TaToM JICA Study.

11.4.3 Issues on Solid Waste Management of Antananarivo Agglomeration

Based on the results of field surveys and reconnaissance, the issues of SWM in Antananarivo Agglomeration are identified below.

- Low level of waste collection service coverage
- Safety issues of the existing final disposal site, which reached its capacity six years ago and has continued to be used until now
- No determined plans for new final disposal sites
- Existence of a large number of illegal dumpsites
- Absence of formal intermediate treatment and 3R facilities
- Lack of human resource, SWM facilities and financial resource in the rural communes
- Lack of public awareness and IEC participation of residents
- Lack of laws and regulation related to SWM

11.4.4 Objectives for Solid Waste Management in Antananarivo Agglomeration

The objectives of SWM in the CUA and the surrounding rural communes are as follows:

- To improve the existing collection and disposal services, and expand the coverage area in SWM service area in order to maintain sanitation and cleanliness in the Study area. Specifically, the target is to have an average solid waste collection rate of 100% in the CUA and 100% as well in the surrounding rural communes in 2033
- To formulate the SWM development plan in the Urban Master Plan (PUDi) for the Antananarivo Agglomeration, for instance, the intermediate treatment and 3Rs promotion plan for the reduction of domestic waste generation, recovery of resources from waste, reuse, recycling, and intermediate treatment and resource circulation

- To obtain sustainable standard in quality and quantity in the treatment of household waste in the rural communes adjoining the CUA by developing several facilities and activities (Words of the President of the OPCI IKOPA, 2nd December 2015), for example, establishing several proposed sanitary landfill facilities in Antananarivo Agglomeration, with 3R activities and composting facilities

11.4.5 Strategies for Solid Waste Management of Antananarivo Agglomeration

To solve the issues, SWM plan of Antananarivo Agglomeration should be achieved for the long-term financial sustainability based on the following strategies:

- Reorganisation of SAMVA structure and organisation of SWM sector in Rural Commune of Antananarivo Agglomeration
- Establishment of optimum waste flow in Antananarivo Agglomeration
- Strategy of acquiring potential sanitary landfill sites in Antananarivo Agglomeration
- Establishment of Laws and Regulations related to SWM

Contents of the above strategies are summarized below.

(1) Reorganisation of SAMVA and Organisation of the SWM Sector of Rural Communes

SAMVA: Although SAMVA was an affiliated organisation of the Ministry of Water for SWM services in CUA, it was reorganised under the new ministry at the end of July 2017. The new ministry is the Ministry of Water, Energy and Hydrocarbon (MEEH), consisting of the Department of Water, Hygiene and Sanitation, and the Department of Energy and Hydrocarbons.

SAMVA is responsible for collecting and processing the solid waste in CUA, and its activities are the same as before the reorganisation of ministries and agencies in 2017. In addition, MEEH does not play the role of supervising SAMVA. According to SAMVA, there is also no change in SAMVA's staff salary because SAMVA maintains its self-budget (own budget) system.

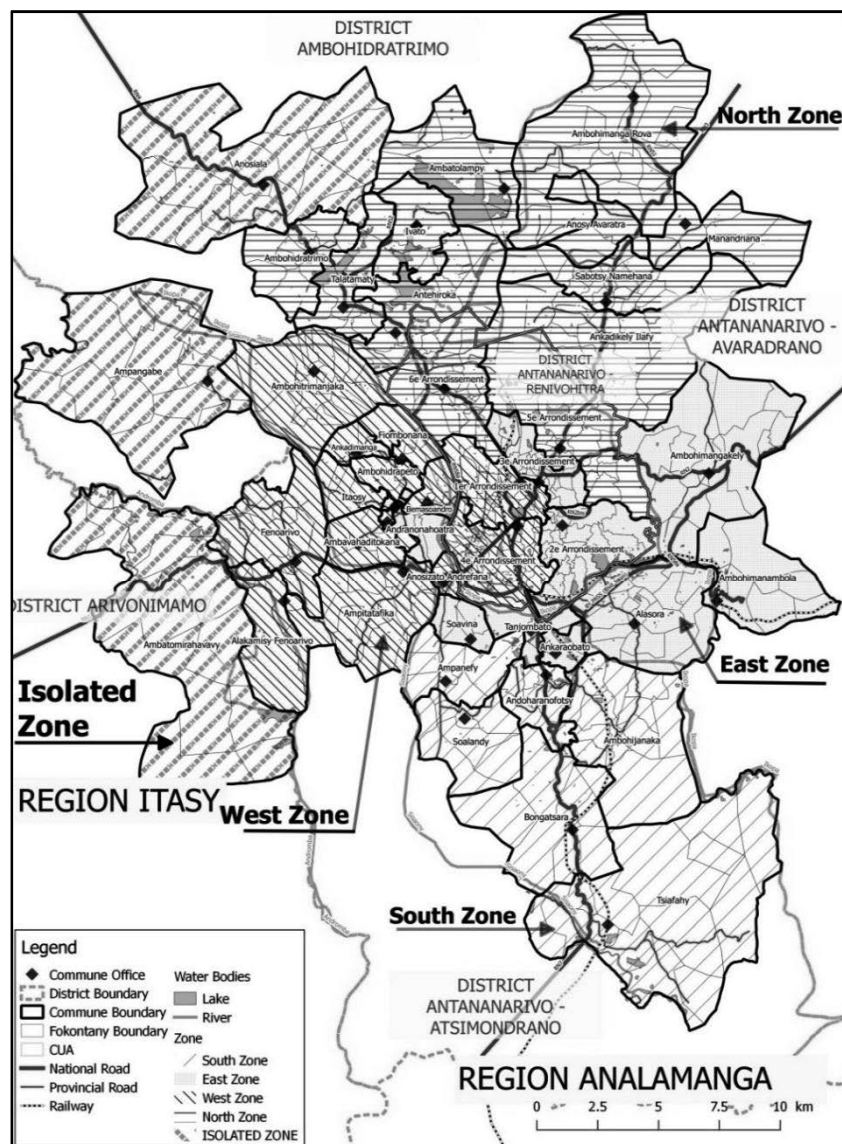
The Executive Board of SAMVA consists of 17 members, and the Mayor of CUA is the Chairman while there are four others from CUA who sit as members. Therefore, just like before the reorganisation, the relationship between CUA and SAMVA has not changed, and CUA can still comment on SAMVA through the Executive Committee in terms of the work of the waste collection and disposal system. CUA has no particular role or responsibility over SAMVA. According to SAMVA, however, it is noted that CUA is not responsible for the selection of potential disposal sites after the existing landfill site at Andralanitra is closed.

SWM Sector of Rural Communes: Presently, rural communes have a section related to SWM services but this has limited activities due to inadequate staffing and budget. For this reason, it is necessary to revitalise the SWM unit as an organisation responsible for SWM services in the future where population keeps on increasing. As the organisational structure of SAMVA can be a future model of SWM services for the neighbouring rural communes of CUA, the rural communes need to exchange opinions on SAMVA's organisation structure, roles, responsibilities, system, etc. in the future.

(2) Establishment of Optimum Waste Flow in Antananarivo Agglomeration

Optimum waste flow should be established for efficient operation of SWM services throughout Antananarivo Agglomeration. With the city population increasing, and the city area expanding at a rapid pace, Antananarivo Agglomeration needs a highly effective and efficient SWM operation system in the near future. In doing so, waste flow should be optimised by grouping several communes together, and establishing new waste disposal sites for each commune group.

Based on a series of discussions conducted in 2017 with the rural communes of the OPCI-Ikopa, it is recommended that the 38 communes of Antananarivo Agglomeration to be divided into four zones for an optimum waste flow trial, namely: East Zone, West Zone, North Zone and South Zone.



Source: JICA Study Team

Figure 11.4.5 Zoning of Rural Communes for Solid Waste Management in Antananarivo Agglomeration

(3) Strategy on Identifying Potential Sanitary Landfill Sites in Antananarivo Agglomeration

There are currently seven potential landfill plants tentatively agreed by the mayors of the respective potential sites and other mayors of rural communes, who may accept joining the groupings for SWM activity. The details by zone are shown in Table 11.4.3.

Figure 11.4.6 shows the location of proposed sanitary landfill plants within Antananarivo Agglomeration.

Table 11.4.3 Proposed Landfill Facility Zoning for SWM in Antananarivo Agglomeration

Zones	East Zone	West Zone		North Zone		South Zone
		West-1	West-2	North-1	North-2	
Wastes from Group Joining Rural Communes (R.C.)	3 R.C. (Alasora, Ambohimangakely, Ambohimambola)	11 R.C. (Ambohitrimanja, Fiombonana, Ankadimanga, Ambohitrampeto, Bemasoandra, Itaosy, Andranonahoatra, Ambavahadiokana, Anosizato, Ambohiratrimo)	3 R.C. (Ampitatafika, Fendarivo, Alakamisy, Fenoarivo, Amtomirahavavy)	6 R.C. (Anosiala, Ambatolampy, Ambohidratrimo, Ivato, Talamaty, Antehiroka, Anosiala, Ambatolampy)	5 R.C. (Ambohimanga Rova, Manandriana, Anosy Avaratra, Sabotsy Namehana, Ankadikely Ilafy, Ambohimanga Rova)	9 R.C. (Soavina, Tanjombato, Ankaraobato, Ampanefy, Andohanefolsy, Soalandy, Ambohij anaka, Bongatsara, Tsiafahy)
Wastes from Wards of the CUA (Arrondissement of CUA)	2nd Ward (50%) 3rd Ward 5th Ward (50%)	-	1st Ward 4th Ward	6th Ward	5th Ward (50%)	2nd Ward (50%)
Location of Proposed Landfill Facility	Ambohimambola R.C.	Ambavahaditokana R.C. & other potential landfills	Ampitatafika R.C.	Antehiroka R.C., & other potential landfills	Manandriana R.C., Ankadikely Ilafy R.C. & other potential landfills	Tsiafahy R.C. & Andohanefotsy R.C. potential landfills
Land for New Landfill Facility and Present Situation	Mayor of Ambohimambola accepted a land yard for new sanitary landfill plant. The site survey for a new landfill in R.C. Ambohimambola is required for further investigation of a large landfill site.	According to the mayor of Ambavahaditokana, there was a plan to conduct a F/S on SWM including a landfill development study by a consultant from Mauritius in November 2017. However, so far none of them has been. Other potential sanitary landfill sites are needed for proper SWM in West-1 Zone.	Based on the F/S report by AFD, Ampitatafika accepted to give a land of more than 10 ha for the construction of a new landfill facility for waste disposal from 3 rural communes. The land is presently paddy fields.	As of 2019, only 2ha land is to be served as a discharge site for R.C. Antehiroka only. Other potential sanitary landfill sites are needed for proper SWM in North Zone.	R.C. Manandriana plans to have about 24 ha of state-owned land as site for a new sanitary landfill. Other potential sanitary landfill sites are needed for proper SWM in North Zone.	R.C. Andohanefotsy agreed to accept a new sanitary land facility. R.C. Tsiafahy agreed to accept a new sanitary landfill facility. The site proposed by Tsiafahy is 5 ha owned by the state. The site survey for a new landfill in R.C. Tsiafahy is required for further investigation.
Expected Appurtenant Facilities	<ul style="list-style-type: none"> Composting yard RDF product Small-scale power electricity generation Recycling Biomass product, etc. 					
Related Improvement Works	<ul style="list-style-type: none"> Construction of access road going to the new landfill facility Composting facility with a small scaled pilot farm to test the quality of compost product RDF facility Power generation Cleaning/ greening of the plant complex 					
Advantages of construction of landfill facilities	<ul style="list-style-type: none"> Improving access roads to the landfill facility New income and job opportunities to be increased by related improvement works (refer to the above column) Better environment for the residents 					

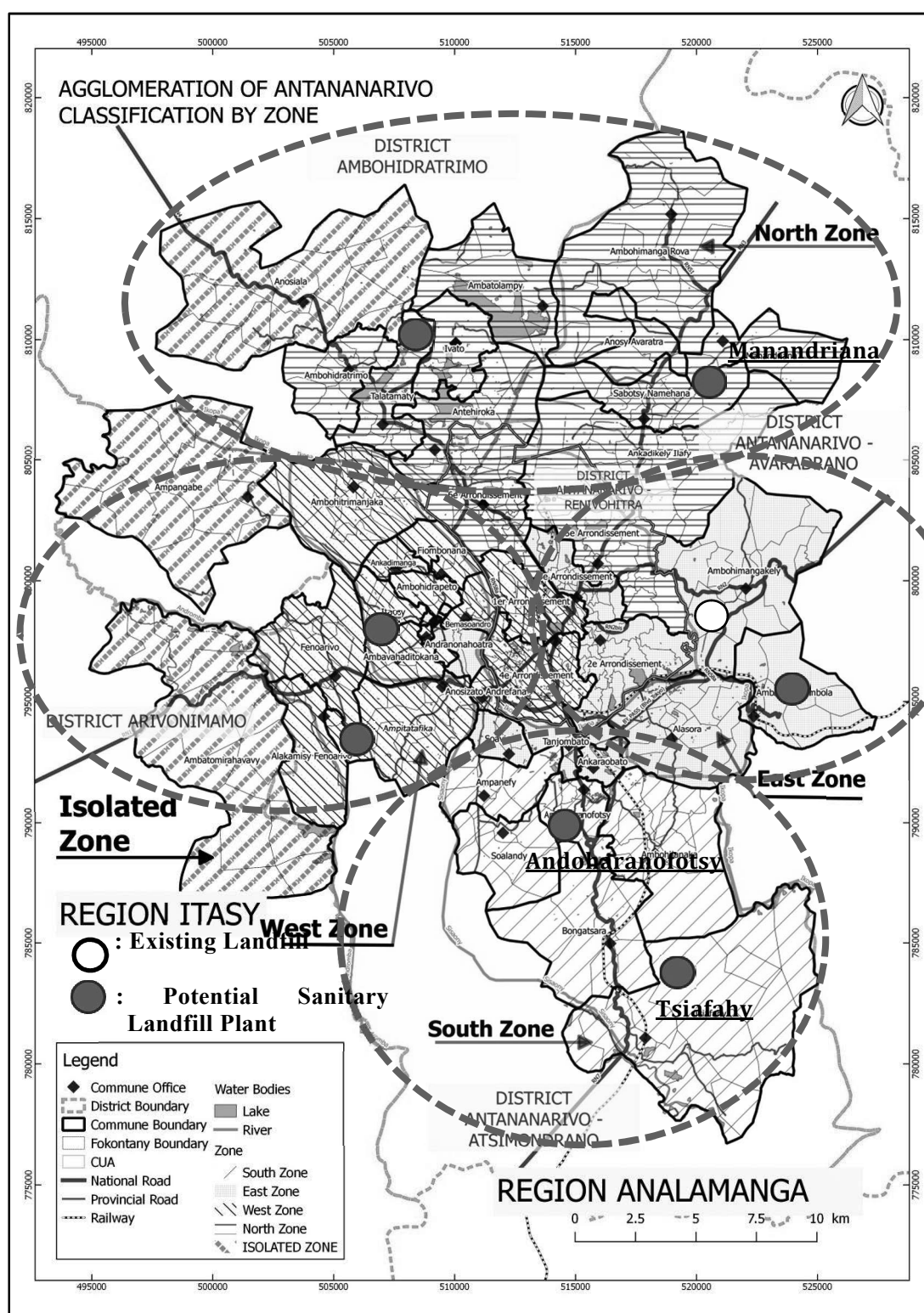
Notes: RDF * in the above table means "Reduce Derived Fuels" obtained from waste of plastics, papers, etc.

Source: JICA Study Team based on the information from the mayors of rural communes in Antananarivo Agglomeration.

As of July 2019, Manandriana Rural Commune, Andohanefotsy Rural Commune and Tsiafahy Rural Commune have agreed to accept a disposal site. However, it is still necessary for the east zone and west zone to identify a final disposal site.

Under such circumstances, it is essential that, construction work of the complete closure of the existing final disposal site (Andralanitra) and selection of potential sanitary landfill sites

in the surrounding communes should be implemented urgently, satisfactorily by local communes and residents.



Notes: 38 communes of Antananarivo Agglomeration can be classified into 4 zones of commune zones, namely, East zone, West zone, North zone and South zone as shown in the above figure, in term of the solid waste disposal flow in the 38 communes.

Source: JICA Study Team

Figure 11.4.6 Zoning of Rural Communes and CUA with Seven Potential Sites for Sanitary Landfill Facilities in Antananarivo Agglomeration (2033)

(4) Establishment of Laws and Regulations related to SWM

A comprehensive set of laws and regulations should be established and enforced for the future SWM activities in Madagascar. Currently, there is no set of functioning laws regulating the SWM system or 3R activities. As the urban population of Madagascar is growing at a rapid pace and will reach 16 million by 2033, it is crucial to establish a comprehensive set of laws and regulations for the SWM system of the cities.

Regulations are especially needed for 3R activities, industrial waste management and medical waste management, which currently have no legal framework at all. The growing population and economic activities will produce larger volumes of household waste, along with more hazardous waste that needs special treatment to be disposed without harming the environment. A legal framework is necessary to establish a system for 3R activities, which will help reduce the amount of waste disposed in dumping sites. There is also need for new regulations towards industrial and medical hazardous waste. If industries and hospitals in cities such as Antananarivo and Toamasina, which plan to have large economic and industrial development continue to deposit hazardous waste without special treatment, this will become a serious threat to the city's environment.

11.4.6 Programmes and Projects for Solid Waste Management of Antananarivo Agglomeration

The project components for SWM are formulated to tackle measures concerning the problems and issues defined in Subsection 11.4.3. These issues emphasised the implementation of four zoning areas as measures for the SWM plan implementation, especially for a proposed landfill facility in Antananarivo Agglomeration. First priority is given to the development of sanitary landfill facilities with intermediate treatment and 3R facilities in each zoning area. A responsible public-associated organisation in respective rural communes of the OPCI and CUA to formulate and implement the integrated SWM plan, including final disposal landfill facilities should carry out the feasibility study for landfill site selection and prepare a detailed design report, under the international donors. The evaluation factors for siting adopted in the report composed of the key items derived from the available provisions in Madagascar. These evaluation factors concern the area, location, environment, society and economy, and so forth.

The second priority is given to the rehabilitation and safe closure works of the existing disposal site at Andralanitra.

The SWM plan is formulated in 3 stages, short-term from 2019 to 2023, mid-term from 2024 to 2028, and long-term from 2029 to 2033 as shown in the list of projects below.

1) Short-term from 2019 to 2023

- Rehabilitation and safe closure works of the existing landfill site at Andralanitra in cooperation with AFD
- A feasibility study on six proposed sanitary landfill plants including intermediate treatment and 3R facilities
- Detailed design of six proposed sanitary landfill plants including intermediate treatment and 3R facilities
- Construction of 2 proposed sanitary landfill plants at Manandriana and Andoharanofotsy
- IEC for SWM for Antananarivo Agglomeration Phase 1

2) Mid-term from 2024 to 2028

- Safe closure works of the existing landfill site at Andralanitra in cooperation with AFD
- Construction of 4 proposed sanitary landfill plants with appurtenant facilities such as composting, etc.
- IEC for SWM for Antananarivo Agglomeration Phase 2

- Environmental monitoring of the sanitary landfill with appurtenant facility Phase 1

3) Long-term from 2029 to 2033

- IEC for SWM for Antananarivo Agglomeration Phase 3
- Environmental monitoring of the closed landfill site at Andralanitra in cooperation with AFD
- Environmental monitoring of the sanitary landfill with appurtenant facility Phase 2

The following four projects are selected as priority projects for solid waste management in Antananarivo Agglomeration:

- Project for Rehabilitation of Existing Landfill Site at Andralanitra
- Project for Development of Recycling Factory and Sanitary Final Disposal Site in Manandriana
- Project for Development of Recycling Factory and Sanitary Final Disposal Site in Andoharanofotsy
- Project for Formulation of Implementation Plan for Other Recycling Factories and Sanitary Final Disposal Sites

11.4.7 Profiles of Priority Projects for Solid Waste Management of Antananarivo Agglomeration

(1) Project for Development of Recycling Factory and Sanitary Final Disposal Site in Manandriana

1) Rational

The solid waste collection rates are not satisfactory at about 60% for CUA. The final landfill site of Andralanitra, located outside CUA in the rural commune of Ambohimangakely has also been overloaded and new landfill sites are strongly required to accommodate the increasing amount of waste in Antananarivo Agglomeration. A final disposal site at Manandriana is one of the proposed landfill sites. It is critical to take advantage of this available land to develop a sanitary landfill site at Manandriana.

2) Objectives

- To improve SWM in the north zone

3) Project Description

- To develop a sanitary landfill plant in Manandriana.

4) Expected Benefits

- Waste generated in the north zone will be appropriately collected and disposed

5) Executing Agency and Related Institutes

- SAMVA
- MEEH
- Rural Commune of Manandriana

6) Estimated Project Cost

- 7 million USD

7) Implementation Schedule

- F/S, D/D, and OM plan: 2019~2020
- Construction: 2021~2023

8) Necessary Actions for Implementation / Critical Factor

Stakeholder consultation to get understanding from the residents.

9) Related Plans and Projects

N.A.

10) Social and Environmental Impacts

- Land expropriation and resettlement if necessary

(2) Project for Development of Recycling Factory and Sanitary Final Disposal Site in Andoharanofotsy

1) Rational

The solid waste collection rates are not satisfactory at about 60% for CUA. The final landfill site of Andralanitra, located outside CUA in the rural commune of Ambohimangakely has also been overloaded and new landfill sites are strongly required to accommodate the increasing amount of waste in Antananarivo Agglomeration. A final disposal site at Andoharanofotsy is one of the proposed landfill sites. It is critical to take advantage of this available land to develop a sanitary landfill site at Andoharanofotsy.

2) Objectives

- To improve SWM in the south zone

3) Project Description

- To develop a sanitary landfill plant in Andoharanofotsy.

4) Expected Benefits

- Waste generated in the north zone will be appropriately collected and disposed

5) Executing Agency and Related Institutes

- SAMVA
- MEEH
- Rural Commune of Andoharanofotsy

6) Estimated Project Cost

- 7 million USD

7) Implementation Schedule

- F/S, D/D, and OM plan: 2019~2020
- Construction: 2021~2023

8) Necessary Actions for Implementation / Critical Factor

Stakeholder consultation to get understanding from the residents.

9) Related Plans and Projects

N.A.

10) Social and Environmental Impacts

- Land expropriation and resettlement if necessary

(3) Project for Formulation of Implementation Plan for Other Recycling Factories and Sanitary Final Disposal Sites

1) Rational

Solid waste management is a serious problem in CUA due to the increasing amount of solid waste caused by rapid increase in population and uncontrolled urbanization.

The collected solid waste is disposed at the final landfill site of Andralanitra, located outside CUA in the rural commune of Ambohimangakely. The landfill site has been operating since 1956 for more than sixth years, and about 2.5 million tons of waste has been disposed in a 18 ha of land. The landfill site should have been closed in 2012 when the landfill was fully occupied. It, however, has been used to dispose waste so that the waste is piled up to 30 meters high against the designed height of 15 meters, which reaches at the high risk level of landslide or slope failure.

In addition, some other problems as follows are observed. Uncollected waste is illegally piled on sidewalks, in open spaces, sewer lines, or even in canals, and rice fields and blockage of wastewater flow in the sewers is seen. 3R (reduce, reuse, recycle) activities are hardly performed actively in the CUA. Mixing of risk waste with non-risk waste is observed; it was observed at the final landfill site for the CUA that hazardous risk waste from smaller medical facilities is mixed with municipal waste, resulting in a major risk to sanitary workers and waste pickers.

As such, it is imperative to improve solid waste management in Antananarivo Agglomeration by developing appropriate waste collection and disposal system. And at the same time, it is required to restrain the increasing amount of waste by introduction of 3R (reduce, reuse, recycle) and environmental education.

2) Objectives

To improve the environmental sanitation condition in Antananarivo Agglomeration by providing proper solid waste management

3) Project Description

A feasibility study, detailed design, and formulation of operation, maintenance and monitoring plan of landfill plants including intermediate treatment and 3R facilities, in the West and East Zones.

4) Expected Benefits

The areas in west and east zones in Antananarivo Agglomeration will have solid waste collection.

The existing final disposal site which has risk of collapsing will be closed.

5) Executing Agency and Related Institutes

- SAMVA
- MEEH

6) Estimated Project Cost

- 3 million USD

7) Implementation Schedule

- 2019-2023

8) Necessary Actions for Implementation / Critical Factor

- Stakeholder consultation to get understanding from the residents.
- Formulation of programs for IEC for SWM

9) Related Plans and Projects

N.A

10) Social and Environmental Impacts

N.A.

11.5 Health Infrastructure in Antananarivo Agglomeration

11.5.1 Background on Health Infrastructure in Antananarivo Agglomeration

(1) Health Sector in Madagascar

1) Categories of Health Care Facilities

The health care facilities are categorized into the following categories:

- Basic Health Centre (CSB: *Centre de Sante de Base*)
 - CSB Level I (CSB I)
 - CSB Level II (CSB II)
- Reference Hospital
 - District Reference Hospital (CHRD: *Centre Hospitalier de Reference de District*)
 - Regional Reference Hospital (CHRR: *Centre Hospitalier de Reference Regional*)
- University Centre Hospital (CHU: *Centre Hospitalier Universitaire*)

2) Health Policy: Health Sector Development Plan 2015-2019

Despite the recent progress made in the health sector, some health problems still remain unresolved, including high maternal mortality rates and infant health, youth health issues such as early pregnancy and HIV/AIDs, communicable diseases, and lifestyle diseases. In order to address these health issues, the Health Sector Development Plan (PDSS: *Plan de Developpement du Secteur Sante*) 2015-2019 envisions that the vision of “In 2030, the entire Malagasy population is in good health in a healthy environment, having a better and productive life.” To realise this vision, six strategies are proposed, namely: 1) improving the provision of integrated quality care and services at all levels; 2) stimulating demand for better utilisation of health services at all levels; 3) strengthening the organisation and management of the health system; 4) improving the health of mothers and children; 5) strengthening the fight against diseases; and 6) promotion of healthy behaviours and health protection. The overall and specific objectives are formulated for each of the strategies and priority actions have been identified to solve urgent health problems.

There are two health sector issues concerned with planning of PUDI: development of health facilities and improvement of sanitary environment. As one of priority issues regarding primary health care service and referral health centres, PDSS identified as one of the causes less frequent use of health facilities due to insufficient geographic accessibility caused by poor distribution of the facilities, in addition to financial constraints, low quality of the services, lack of human resources and other factors. The objectives, priority interventions, outcome, and outputs identified in PDSS relevant to PUDI preparation are presented in Table11.5.1. However, PDSS does not include a detailed regional or district plan related to Antananarivo Agglomeration.

Table11.5.1 Objectives, Priority Interventions, Outcomes and Outputs in PDSS Related to Formulation of PUDI

3.3.3. Strengthening the organization and management of the health system					
Overall Objective	Specific Objective	Short and Medium-Term Priority Interventions 2015-2019	Outcome	Output	Target Indicators in 2019
3.3.3.4: Improve the availability and accessibility of the sanitary infrastructure, equipment and health inputs	3.3.3.4.1: Reduce the regional disparities by 50% in terms of sanitary coverage	<ul style="list-style-type: none"> - Preparation of legal texts governing the regulation of health coverage to ensure complementarity between the public system and the private system - Update of the health map - Improvement of CSB coverage meeting the standards - Improvement of CHRD coverage with surgery 	7: Availability and accessibility of health infrastructure, equipment, and health inputs are improved	7.1: Regional disparities in health coverage are reduced	<ul style="list-style-type: none"> - 100% of legal texts governing the regulation of health coverage applied - 347 CSBs built in areas without FS - 54 CHRDs without surgery converted into CHRD with surgery
	3.3.3.4.2: Specific objective Ensure upgrading	<ul style="list-style-type: none"> - Preparation of multi-year forecast plan of infrastructure and equipment - Establishment of coordination between the Infrastructure, Logistics and Heritage Department and the peripheral level 		7.2: Up to 70% of the sanitary infrastructure is brought up to standard	<ul style="list-style-type: none"> - 100% of Central and peripheral services applying the multi-year planning of infrastructure and equipment - 22 of Coordination Cells between the Infrastructure, Logistics and Heritage Department (SILOP: <i>Service des Infrastructures, de la Logistique et du</i>

	the standards of 70% of health infrastructure	concerning the establishment and maintenance of buildings Respect for equipment needs in relation to program allocations Improvement of existing infrastructures at all levels (maintenance, rehabilitation) Construction of new infrastructures Strengthening the technical platforms of health facilities Endowment of health facilities and public establishments in rolling stock (motorcycle, ambulance) Maintenance of sanitary equipment of health facilities			<i>Patrimoine</i>) and the peripheral level concerning the implementation and maintenance of buildings set up and functions - 50% of CSBs are rehabilitated according to standards and equipped with medical equipment compared to the number of CSBs in poor condition - 20% CHRD with surgery / CHRR / CHU are rehabilitated according to the standards and endowed with medical equipment in relation to CHRD shadow with surgery / CHRR / CHU in poor condition - 20% CHRD with surgery / CHRR / CHU are equipped with rolling stock (ambulance) - 75% of reference hospitals with equipment and equipment kits for maintenance of sanitary facilities
3.3.6. Promoting healthy behaviours and protecting health					
Overall Objective	Specific Objective	Short and Medium-Term Priority Interventions 2015-2019	Outcome	Output	Target Indicators in 2019
3.3.6.1: Insure a healthy and sustainable environment for better health of the population	3.3.6.1.2: Strengthen interventions in Water, Sanitation, and Hygiene (WASH)	- Promotion of the use of improved water source - Strengthening social mobilization at the community level for the promotion of sanitation and respect for the environment - Improved access to improved water sources at the community level and public health facilities - Improvement of access to latrines with handwashing facilities at health facilities and public primary schools - Scaling up the medical waste treatment system at the health facility level	16: The health of the population in a sustainable and healthy environment insured	16.2: WASH interventions are strengthened	- 53% population with access to improved drinking water sources - 96% of the population with access to latrines combined - Utilisation rate of water points 73% - 100% of the population sensitized on the three key message of WASH - 55% of CSBs with improved water source - Utilization rate of latrines 55% - 100% of CSBs with latrines with handwashing device - Open defecation rate 14% - 100% of CSBs with an incinerator - 100% of hospitals with an incinerator (CHRD, CHRR, CHU, ES)

Source: Health Sector Development Plan (PDSS) 2015-2019

(2) Health Facilities in Antananarivo Agglomeration

The numbers of health facilities in Antananarivo Agglomeration by categories in each district are summarized in Table11.5.2.

Table11.5.2 Overview of Health Care Facilities in Antananarivo Agglomeration

Region	DISTRICT	Communes	Population 2017	CSB		CHRD			CHRR	CHU
				CSB I	CSB II	CHRD I	CHRD II	Private		
Analamanga	Antananarivo Renivohitra	1	1,408,748	1	15	2	0	15	0	9
	Ambohidratrimo	8	233,652	1	9	0	1	6	1	2
	Atsimondrano	20	304,676	0	19	0	2	2		1
	Avaradrano	8	574,996	0	9	1	0	5	0	
Itasy	Arivonimamo*	1	13,086	1	1	0	1	-	0	0
	Total	38	2,535,158	3	53	2	1	28	1	12

Source: Regional Direction of Health, Ministry of Public Health 2017

In order to identify the issues on each category of health care facilities in Antananarivo Agglomeration, the current status of health care facilities including CSB, CHRD and CHU are evaluated in the following sections.

(3) Primary Health Care Facilities and Health Care Personnel

CBS I health facilities are the basic health facilities for first contacts located in fokontany, while CSB II health facilities are located in the headquarters of the communes, and are run by a doctor who holds a medical degree.

The current development status of CSBs is evaluated, compared with the development standard presented in Table11.5.3. In addition to the facilities, the availability of health care personnel is also examined in accordance with the WHO Standard. The current status of the CSBs and health care personnel are presented from Source: JICA Study Team based on the data from Ministry of Public Health

Figure11.5.1 to and in Table11.5.4.

Table 11.5.3 Development Standards for Health Care Facilities and Health Care Personnel

	CSB-I	CSB-II
Service Population	One per 4,000 persons at least	One per 8,000 persons at least
Location	One per fokontany	Capital of commune/ urban communes
Distance	The distance between two CSBs must be greater than 5 km	
Medical Staff	<ul style="list-style-type: none"> 2 paramedics (preferably: 1 male and 1 female) 	<ul style="list-style-type: none"> 1 doctor, or more if population is greater than 10 000 inhabitants. 2 paramedics including 1 nurse and 1 midwife (preferably: 1 male and 1 female)
Site Requirement	<ul style="list-style-type: none"> Dedicated area of at least 1,600 m² In a calm and healthy environment, away from a factory, bar, or place of sale of alcoholic beverages, preferably near a gendarmerie station, or school 	
Facilities	<ol style="list-style-type: none"> 1. Consultation room 2. Room SMI / PF / EPI 3. Delivery room 4. Place of birth 5. Wholesale and retail pharmacy 	<ol style="list-style-type: none"> 1. Consultation room 2. Treatment room 3. Room SMI/ PF/ EPI 4. Delivery Room 5. Hall of confinement 6. Wholesale and retail pharmacy 7. Waiting Room
Health Care Personnel*	One doctor for 10,000 persons One nurse per 5,000 persons One midwife per 5,000 persons	

Source: Standard for CSB Facilities: Service de Santé de Base, Ministry of Public Health. 2017. CSB Norms pre-validated.

*Standard for Health Personnel: WHO

1) Current Status of Basic Health Care Facilities in Antananarivo Agglomeration

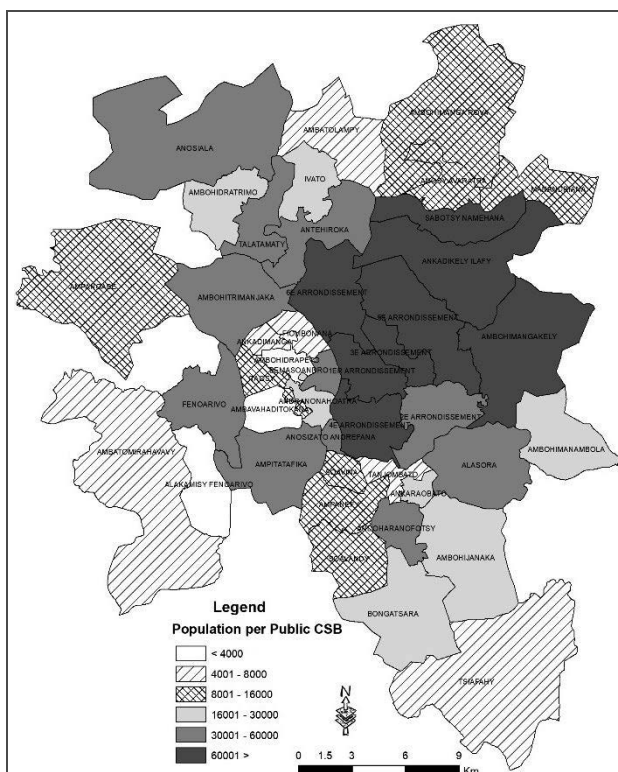
Significant lack of public CSB IIs is observed in CUA and some communes in Avaradrano District along National Road No. 3 (NR3). In 3rd, 4th and 5th Arrondissements of CUA, one public CSB II serves from 128,000 to 168,000 people, while in the communes of Ankadikely Ilafy and Ambohimangakely, and 1st and 6th Arrondissements, one CSB exists from 56,000 to 117,000 persons. The deficiency of public CSB IIs is found in 2nd Arrondissement, Tanjombato, the communes in Atsimondrano District along the NR1, and the communes in Ambohidratrimo District along the NR4 where one CSB provides health care for a population from 30,000 to more than 60,000. Compared to the standard of one public CSB II for 8,000 population, one CSB provides the service to 10 to 20 times larger population in some of arrondissements and communes where the most serious deficiency is found.

This huge gap in the provision of primary health care by the public sector is made up by the private provision. As shown in Figure 11.5.2, about 20 to 42 private CSBs are located in the Arrondissements, except 2nd and 6th in CUA, and there are more than 10 private CSBs in Ankadikely Ilafy and Sabotsy Namehana.

Combining the public and private CSBs, the deficiency of CSBs is identified rather in periphery communes in the west and south, such as Fenoarivo, Ampitatafika, Ambohijanaka and Bongatsara where one CSB offers health care for more than 18,000 population.

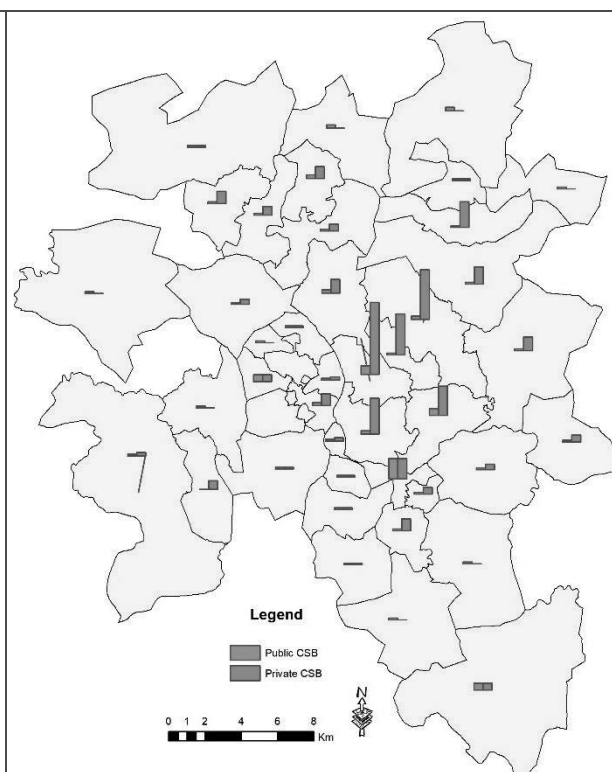
Thus, the acute deficiency on public primary health care provision is found in the most populous areas, such as some arrondissements and communes along the NR3; and therefore, affordable primary health care is necessary in these areas. On the other hand, primary health care provision is lacking in the periphery communes in the west and south where private provision is also not available.

There are three communes, namely, Alakamisy Fenoarivo, Ambavahaditokana and Ambohidrapeto which do not have any public CSB. However, five private CSBs are located in Alakamisy Fenoarivo, and a CHRD exists in Ambavahaditokana. The residents of Ambavahaditokana and Ambohidrapeto have relatively easy access to CSBs in the neighbouring communes.



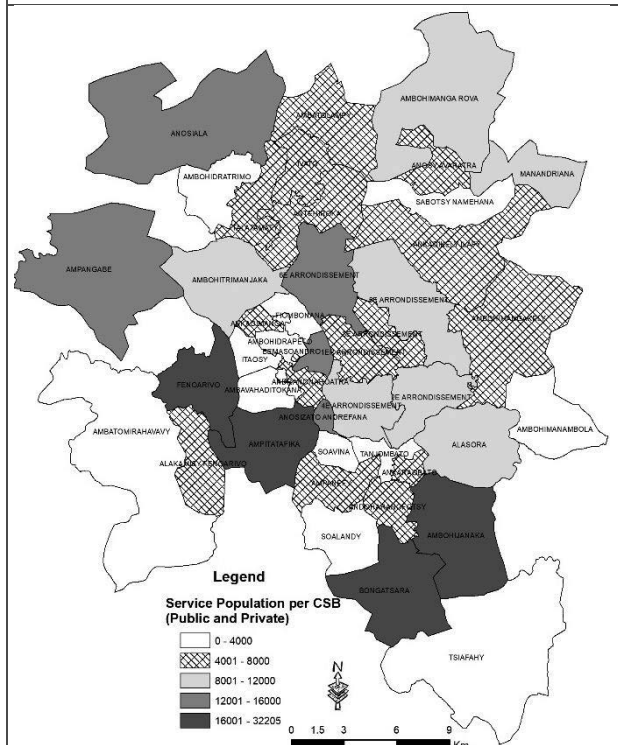
Source: JICA Study Team based on the data from Ministry of Public Health

Figure11.5.1 Population per Public CSB II in Antananarivo Agglomeration



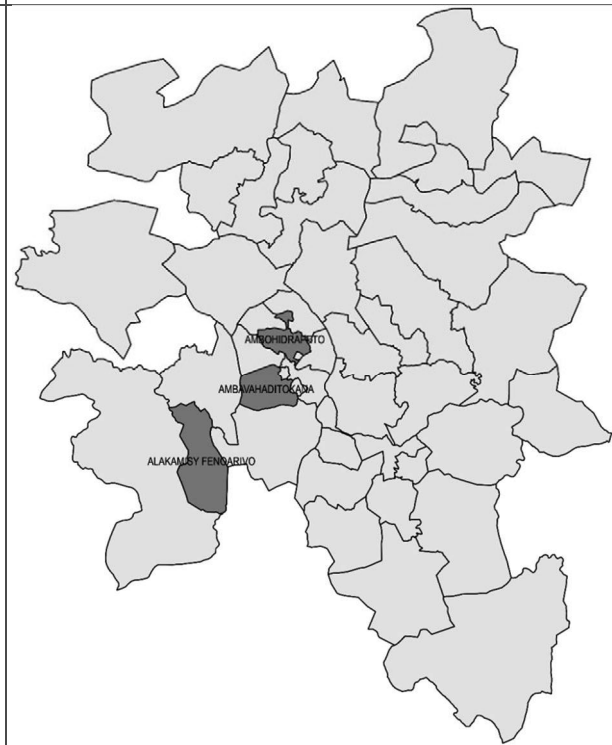
Source: JICA Study Team based on the data from Ministry of Public Health

Figure11.5.2 Distribution of Public and Private CSBs in Antananarivo Agglomeration



Source: JICA Study Team based on the data from Ministry of Public Health

Figure 11.5.3 Population per CSB II (All Types of CSB: Public and Private, CBS I and CSB II) in Antananarivo Agglomeration



Source: JICA Study Team based on the data from Ministry of Public Health

Figure11.5.4 Communes Without Public CSB in Antananarivo Agglomeration

Table11.5.4 Current Status of CSB by Commune in Antananarivo Agglomeration

No.	District	Commune/ Arrondissement	Population 2018	No. of Fokotany	Public CSB		Private CSB	CSB Total	Population per Public CSB II	Population per CSB
					CSB I	CSB II				
1	Antananarivo (CUA)	1er Arrondissement	238,126	44	1	4	42	47	59,531	5,067
2		2e Arrondissement	192,215	24	0	4	17	21	48,054	9,153
3		3e Arrondissement	133,322	34	0	1	24	25	133,322	5,333
4		4e Arrondissement	255,847	32	0	2	21	23	127,924	11,124
5		5e Arrondissement	334,964	27	0	2	29	31	167,482	10,805
6		6e Arrondissement	120,733	31	0	2	8	10	60,367	12,073
7	Ambohidratrimo	Ambatolampy	25,798	8	1	1	0	2	25,798	12,899
8		Ambohidratrimo	22,176	10	0	1	7	8	22,176	2,772
9		Ambohitrimanjaka	36,970	25	0	1	3	4	36,970	9,242
10		Ampangabe	17,152	12	0	1	0	1	17,152	17,152
11		Anosiala	51,288	17	0	1	1	2	51,288	25,644
12		Antehiroka	46,550	9	0	1	4	5	46,550	9,310
13		Ivato	47,615	13	0	2	7	9	23,808	5,291
14		Talatamaty	51,181	10	0	1	5	6	51,181	8,530
15	Avaradrano	Alasora	58,316	16	0	1	3	4	58,316	14,579
16		Ambohimambola	15,815	12	0	1	4	5	15,815	3,163
17		Ambohimanga Rova	30,130	22	0	2	0	2	15,065	15,065
18		Ambohimangakely	111,718	17	0	1	8	9	111,718	12,413
19		Ankadikely Ifafy	55,740	17	0	1	10	11	55,740	5,067
20		Anosy Avaratra	16,881	5	0	1	1	2	16,881	8,441
21		Manandriana	9,149	6	0	1	0	1	9,149	9,149
22		Sabotsy Namehana	46,819	17	0	1	15	16	46,819	2,926
23	Astimondrano	Alakamisy Fenoarivo	22,511	6	0	0	5	5	-	4,502
24		Ambavahaditokana	39,257	6	0	0		0	-	-
25		Ambohidrapeto	28,234	5	0	0		0	-	-
26		Ambohijanaka	19,381	12	0	1		1	19,381	19,381
27		Ampanefy	15,758	8	0	1	1	2	15,758	7,879
28		Ampitatafika	62,937	13	0	1	1	2	62,937	31,469
29		Andoharanofotsy	46,247	8	0	1	7	8	46,247	5,781
30		Andranahoatra	57,139	7	0	2	7	9	28,570	6,349
31		Ankadimanga	7,745	6	0	1		1	7,745	7,745
32		Ankaraobato	42,433	7	0	1	4	5	42,433	8,487
33		Anosizato Andrefana	26,498	7	0	1	2	3	26,498	8,833
34		Bemasoandro	51,573	6	0	1	2	3	51,573	17,191
35		Bongatsara	26,680	7	0	1		1	26,680	26,680
36		Fenoarivo	31,650	12	0	1		1	31,650	31,650
37		Fiombonana	12,084	5	0	1		1	12,084	12,084
38		Itaasy	16,520	11	0	1	3	4	16,520	4,130
39		Soalandy	15,135	8	0	1		1	15,135	15,135
40		Soavina	17,569	5	0	1		1	17,569	17,569
41		Tanjombato	43,406	5	0	1	11	12	43,406	3,617
42		Tsiafahy	20,114	15	0	2	2	4	10,057	5,029
43	Arivonimamo	Ambatomirahavavy	36,869	15	1	1	0	2	36,869	18,434
	Antanarivo Renivohitra (CUA)		1,275,207	192	1	15	141	157	85,014	8,122
	Ambohidratrimo		298,730	104	1	9	27	37	33,192	8,074
	Avaradrano		344,569	112	0	9	41	50	38,285	6,891
	Astimondrano *		639,739	174	1	20	45	66	31,987	9,693
	Antananarivo Agglomeration Total		2,558,245	582	3	53	254	310	48,269	8,252

Source: Regional Direction of Health, Ministry of Public Health 2017

* Astimondrano includes the data of Ambatomirahavavy Commune.

2) Personnel for Public Basic Health Care Provision in Antananarivo Agglomeration

According to Figure 11.5.5 that shows the availability of health care professionals by district, the lack of nurses and midwives is a more serious concern than the lack of doctors in most districts. In Atsimondrano and Ambohidratrimo, the standard for doctor (which is one doctor per 10,000 population) is almost satisfied. Nurses are significantly lacking in Atsimondrano, followed by CUA, while midwives are most needed in Avaradrano and CUA.

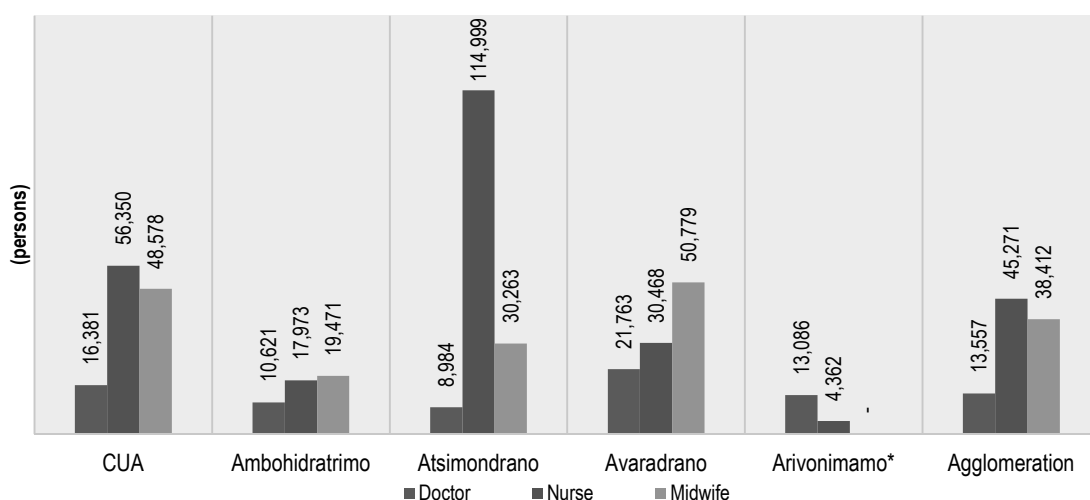
By commune as illustrated in Figure 11.5.6, doctors are most needed in 3rd, 5th and 4th Arrondissements, and Talatamaty and Antehiroka where one doctor services a population of more than 23,000 to 31,000, followed by the communes in the northwest and those along NR 3.

The lack of nurses is a more salient concern in CUA, especially in 5th Arrondissement, Sabotsy Namehana, 4th Arrondissement, 6th Arrondissement and Andranonahoatra, where one nurse at public CSB takes care of more than 40,000 (See Figure 11.5.7).

Similarly, 5th, 1st and 4th Arrondissements, and the communes in Atsimondrano in the west, such as Ampitatafika, Andranonahoatra and Bemasoandro are experiencing a significant lack of midwives. In these communes, one midwife serves more than 40,000 population (See Figure 11.5.8).

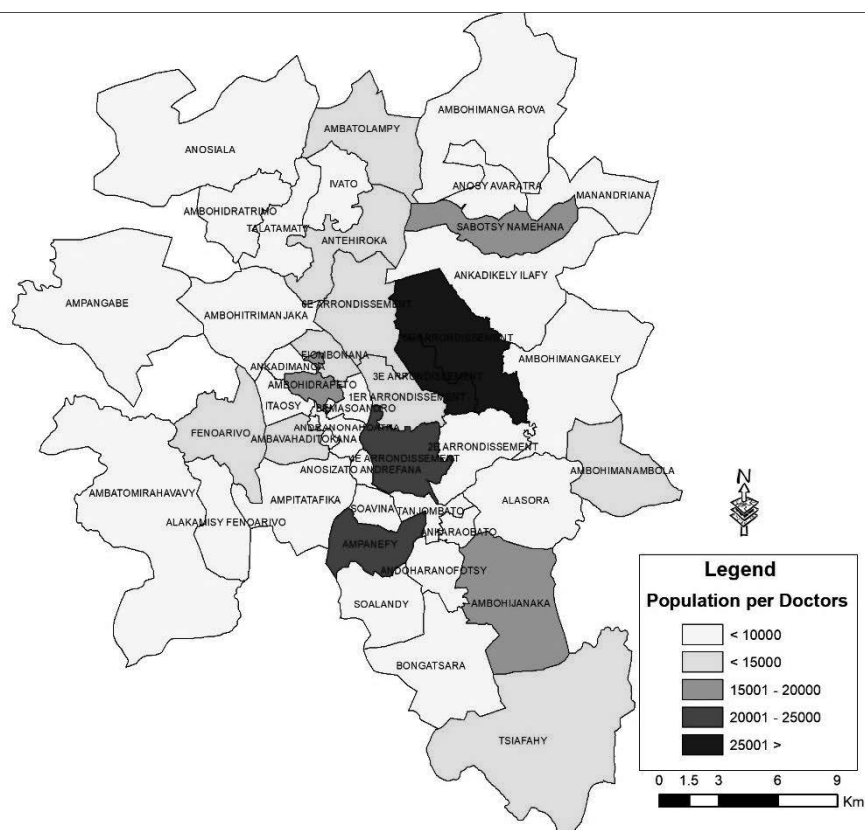
The significant deficiency in nurses and midwives can be observed in 5th Arrondissement. There is only one nurse and one midwife available per 167,000 and 112,000 population respectively.

Table 11.5.5 presents population per health professional by communes in Antananarivo Agglomeration.



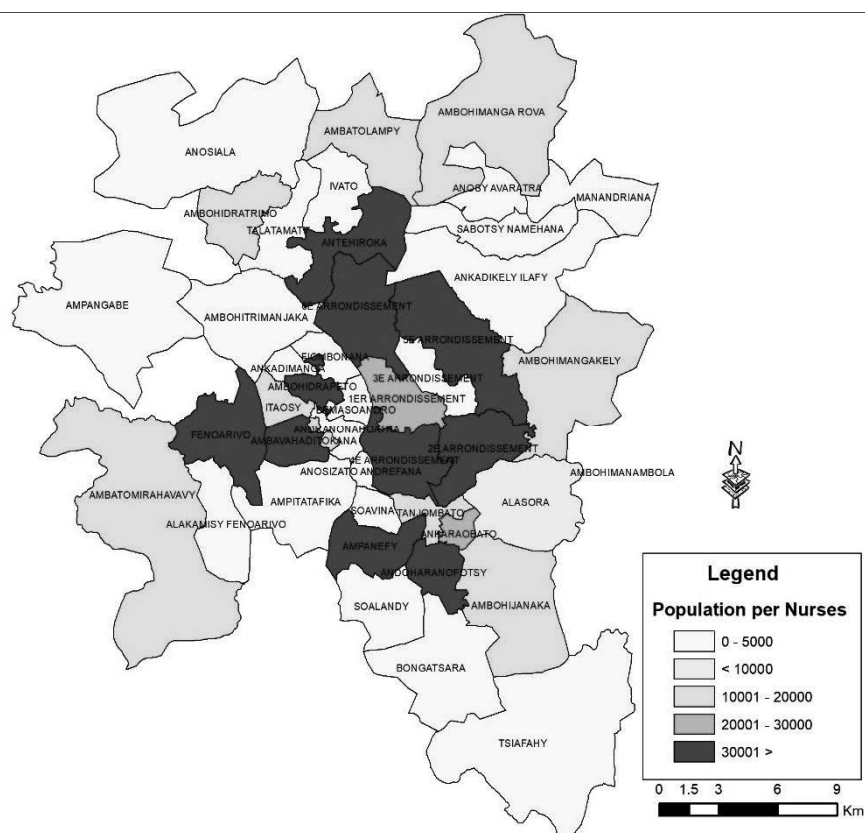
Source: Regional Direction of Health, Ministry of Public Health 2017

Figure 11.5.5 Population per Public CSB Health Professional in Antananarivo Agglomeration



Source: JICA Study Team, prepared based on the data from Ministry of Public Health 2017

Figure11.5.6 Population per Public CSB Doctor by Commune in Antananarivo Agglomeration



Source: JICA Study Team, prepared based on the data from Ministry of Public Health

Figure11.5.7 Population per Public CSB Nurse by Commune in Antananarivo Agglomeration

Table 11.5.5 Population per Health Professional by Commune in Antananarivo Agglomeration

No.	District	Commune/ Arrondissement	Population 2018	No. of Fokotany	No. of Health Professionals			Population per Health Professional		
					Doctor	Nurse	Midwife	Doctor	Nurse	Midwife
1	Antananarivo Renivohitra	1er Arrondissement	238,126	44	26	10	4	9,159	23,813	59,532
2		2e Arrondissement	192,215	24	24	6	8	8,009	32,036	24,027
3		3e Arrondissement	133,322	34	5	-	4	26,664	-	33,331
4		4e Arrondissement	255,847	32	10	4	5	25,585	63,962	51,169
5		5e Arrondissement	334,964	27	11	2	3	30,451	167,482	111,655
6		6e Arrondissement	120,733	31	10	3	5	12,073	40,244	24,147
7	Ambohidratrimo	Ambatolampy	25,798	8	-	-	-	-	-	-
8		Ambohidratrimo	22,176	10	3	2	2	7,392	11,088	11,088
9		Ambohitrimanjaka	36,970	25	3	2	-	12,323	18,485	-
10		Ampangabe	17,152	12	2	1	1	8,576	17,152	17,152
11		Anosiala	51,288	17	3	1	1	17,096	51,288	51,288
12		Antehiroka	46,550	9	2	1	1	23,275	46,550	46,550
13		Ivato	47,615	13	7	4	5	6,802	11,904	9,523
14		Talatamaty	51,181	10	2	2	2	25,591	25,591	25,591
15	Avaradrano	Alasora	58,316	16	3	-	3	19,439	-	19,439
16		Ambohimambola	15,815	12	4	1	-	3,954	15,815	-
17		Ambohimanga Rova	30,130	22	4	2	1	7,533	15,065	30,130
18		Ambohimangakely	111,718	17	-	-	2	-	-	55,859
19		Ankadikely Ilafy	55,740	17	3	2	-	18,580	27,870	-
20		Anosy Avaratra	16,881	5	-	4	-	-	4,220	-
21		Manandriana	9,149	6	-	-	-	-	-	-
22		Sabotsy Namehana	46,819	17	-	1	-	-	46,819	-
23	Astimondrano	Alakamisy Fenoarivo	22,511	6	-	-	-	-	-	-
24		Ambavahaditokana	39,257	6	-	-	-	-	-	-
25		Ambohidrapeto	28,234	5	-	-	-	-	-	-
26		Ambohijanaka	19,381	12	3	1	1	6,460	19,381	19,381
27		Ampanefy	15,758	8	3	-	1	5,253	-	15,758
28		Ampitafika	62,937	13	5	-	1	12,587	-	62,937
29		Andoharanofotsy	46,247	8	9	-	3	5,139	-	15,416
30		Andranonahoatra	57,139	7	3	1	1	19,046	57,139	57,139
31		Ankadimanga	7,745	6	3	-	1	2,582	-	7,745
32		Ankaraobato	42,433	7	5	-	1	8,487	-	42,433
33		Anosizato Andrefana	26,498	7	3	1	1	8,833	26,498	26,498
34		Bemasoandro	51,573	6	4	-	1	12,893	-	51,573
35		Bongatsara	26,680	7	4	1	1	6,670	26,680	26,680
36		Fenoarivo	31,650	12	4	-	1	7,913	-	31,650
37		Fiombonana	12,084	5	-	-	-	-	-	-
38		Itaasy	16,520	11	2	-	1	8,260	-	16,520
39		Soalandy	15,135	8	4	-	2	3,784	-	7,568
40		Soavina	17,569	5	4	-	-	4,392	-	-
41		Tanjombato	43,406	5	6	-	2	7,234	-	21,703
42		Tsiafahy	20,114	15	2	1	1	10,057	20,114	20,114
43	Arivonimamo	Ambatomirahavavy	36,869	15	1	3	-	36,869	12,290	-
	Antananarivo Renivohitra (CUA)		1,275,207	192	86	25	29	14,828	51,008	43,973
	Ambohidratrimo		298,730	104	22	13	12	13,579	22,979	24,894
	Avaradrano		344,569	112	14	10	6	24,612	34,457	57,428
	Astimondrano*		639,739	174	65	8	19	9,842	79,967	33,670
	Antananarivo Agglomeration		2,558,245	582	187	56	66	13,680	45,683	38,761

Source: Regio-I Direction of Health, Ministry of Public Health 2017

* Astimondrano includes the data of Ambatomirahavavy Commune.

3) Reference Hospitals

There are three types of regional or district reference hospitals as the next level of primary health care system in Madagascar.

- a. CHRR – Regional Reference Hospital at the regional level
- b. CHRD I/II - District Reference Hospital Level I or II at the district level
 - Level I - without a surgical unit
 - Level II - with a surgical unit

These hospitals, which are under the supervision of the Directorate of Regional and District Reference Hospitals, the Ministry of Public Health, are responsible for ensuring equity and improving the accessibility of the population, especially the poor, to quality care and services in public and private referral hospitals. Their mandates include supervision, development, monitoring, and service quality improvement of the reference hospitals, distribution of resources to the hospitals, and promotion of private-public partnerships at the hospital level.

In Antananarivo Agglomeration, there are four currently operational public CHRDs, including one CHRD I and three CHRDs under development. In addition, there are 50 private CHRDs in the agglomeration.

See Table 11.5.6 for public district reference hospitals and Table 11.5.7 for private district reference hospitals in Antananarivo Agglomeration.

Table 11.5.6 Public District Reference Hospitals in Antananarivo Agglomeration

No.	Type	District	Commune	Name	No. of Doctors	No. of Paramedics (Nurse and Midwife, etc.)	No. of Beds	Status
1	CHRD I	CUA	6th Arrondissement	Ambohidroa	3 - Doctor for public health 6 - General practitioner 1 - Dentist	3 - Midwife	NA	Operational
2	CHRD II	Avaradrano	Anosy Avaratra	Anosy Avaratra	2 - Surgeon 1 - Anaesthetist 7 - General practitioner 1 - Dentist	3 - Anaesthesiologists 1 - Radiologist 1 - Laboratory 1 - General Nurse 5 - Midwife	NA	Operational
3			Ambohimangakely	Ambohimangakely	NA	NA	No admission of patients	Being finalized. The new structure including an operating room, administrative building, etc. were constructed. Currently, the Ministry is regularizing the land change. The commune needs to connect water and electricity for this CHRD.
4		Atsimondrano	Itaosy	Itaosy	5 - Surgeon 1 - Anaesthetist 3 - Sonographers 8 - Other Doctor Specialist 9 - General Doctor 1 - Dentist	3 - Anaesthesiologist 1 - Radiologist 1 - Laboratory 3 - Physiotherapist 1 - other paramedical 7 - General nurse 7 - Midwife 1 - Sanitary aid	NA	Operational
5			Tanjombato	Tanjombato	NA	NA	NA	Operational
6			Bongatsara	Bongatsara	NA	NA	No admission of patients	Being finalized. The new structure including an operating room, administrative building, etc. were constructed. Currently, the Ministry is regularizing the land change. The commune needs to connect water and electricity for this CHRD.
7		Arivonimamo	Ambatomirahavavy	Ambatomirahavavy	Under Construction			In the design phase: The Ministry through the Infrastructure and Logistics Department (SILOP) is studying the areas needed for the construction of a CHRD and reviewing their building standards.

Table11.5.7 Private District Reference Hospitals in Antananarivo Agglomeration

No.	Location	Commune/ Arrondissement	Private Clinic and Hospital	No. of Beds	No. of Doctors	No. of Paramedics (Nurse and Midwives)
1	CUA	3 rd Arrondissement	Centre de Gynécologie obstétrique privé Marie Stopes Madagascar Avaradoha	16	14	25
2		3 rd Arrondissement	Clinique NOA Village des Jeux Ankorondrano	12	12	2
3		4 th Arrondissement	Care and Medical Assistance Hospital Anosibe	23	15	9
4		2 nd Arrondissement	Clinique Mpitsabo Mikambana MM 24	25	9	9
5		2 nd Arrondissement	Clinique Médico-Chirurgicale Ambatoroka Saint-Paul	25	3	5
6		3 rd Arrondissement	Clinique Manambina Village des Jeux Ankorondrano	6	7	7
7		5 th Arrondissement	Espace Médico-Chirurgical Ambodivona	7	22	9
8		1 st Arrondissement	Clinique Odonto-Stomatologique et Clinique Maxillo-Faciale Amboasariely	4	2	2
9		3 rd Arrondissement	Polyclinique Saint François d' Assise Ankadifotsy	120	25	46
10		6 th Arrondissement	Clinique Manpitsoa Ambatolampy Ambohimananina	33	2	3
11		4 th Arrondissement	Clinique Médico-Chirurgicale MIADANA Anosibe	10	3	3
12		5 th Arrondissement	Clinique Médico-Chirurgicale Appolon(Climca) Ampandrana	8	3	4
13		5 th Arrondissement	Clinique ALSA Ambatomainty	12	8	4
14		2 nd Arrondissement	Clinique Orbit Health Care Services Madagascar Ambatoroka	6	5	5
15		2 nd Arrondissement	Clinique AMADIA Faravohitra	20	15	2
16		5 th Arrondissement	Clinique Médico-Chirurgicale FIDY Ambatomainty	10	8	4
17		2 nd Arrondissement	Clinique de traitement des maladies rénales FUNHECE Faravohitra	4	3	3
18		5 th Arrondissement	Clinique Médico-Chirurgicale IMAHAO 3 A Analamahintsy	20	8	6
19		1 st Arrondissement	Clinique Médico-Chirurgicale MAHARAVO "CM2A" Analakely	6	7	6
20		3 rd Arrondissement	Clinique Méduco-Chirurgicale "MODERN MEDICAL MIHARY SOA Betongolo	10	7	6
21		1 st Arrondissement	Clinique d'urgence SANTEPRIM Ankaditapaka Behoririka	5	4	3
22		5 th Arrondissement	Centre médico-Chirurgical LANTOSOA	6	5	3
23		1 st Arrondissement	Clinique Reine Marie Antanimena	10	3	4
24		4 th Arrondissement	Clinique Médico-Chirurgicale FANANDRATANA Soanierana	14	7	3
25		4 th Arrondissement	Clinique Gynéco-Obstétrique LA JOIE Mahamasina	10	4	4
26		2 nd Arrondissement	Clinique Médico-chirurgicale "ANDRINDRA" Miandrarivo Ambanidia	5	3	4
27		5 th Arrondissement	Clinique DICOLO Analamahitsy	9	4	1
28		2 nd Arrondissement	Clinique Médico- Chirurgicale de Manakambahiny " CMCM"	8	4	3
29		3 rd Arrondissement	Clinique Sainte MARTHE	10	1	3
30		2 nd Arrondissement	Clinique de Chirurgie et Maternité "Saint-Thomas" Faravohitra	6	4	5
31		3 rd Arrondissement	Clinique TOKANTRANO SALAMA	6	2	2
32	Avaradrano	Ankadikely Ilafy	Polyclinique et Maternité Ilafy	28	29	3
33	CUA	5 th Arrondissement	Clinique Médico-Chirurgicale Adventiste Soamanandrany	10	NA	NA
34	Avaradrano	Ankadikely Ilafy	Clinique Médico-Chirurgicale OLIVA	25	3	2
35	CUA	5 th Arrondissement	Institut de la Vision Madagascar Mahazo	2	5	4
36	Avaradrano	Ambohimangakely	Clinique DOMINIQUE Ambohimangakely	12	4	1
37	Atsimondrano	Tanjombato	Clinique Médico-Chirurgicale Tanjombato	8	20	4
38		Andoharanofotsy	MALAZA Clinic Andoharanofotsy	20	2	3
39		Itaosy	Clinique FANANTENANA Andramahavola Itaosy	8	3	5
40		Andoharanofotsy	MALAZA Clinic annexe « MA-CLINIC annexe Andoharanofotsy	10	3	4
41		Itaosy	Clinique Médico-Chirurgicale KOLOINA		3	5
42		Ampitatafika	Clinique Médico-Chirurgicale SeFi	5	2	2
43		Itaosy	Clinique NATHAN	6	5	2
44		Ampitatafika	Clinique IVO KOLO AINA	6	4	2
45	Ambohitradrimo	Antehiroka	Hôpital FLM Ambohibao	50	18	9
46		Ivato	Clinique SANTE PLUS Ivato	6	5	6
47		Antehiroka	Clinique SOA NY AINA Antehiroka	6	2	4
48		Talatamaty	Clinique Angle Santé "CÂS" Talatamaty	8	3	2
49		Antehiroka	MEVA MEDICAL SERVICE	8	3	2
50		Antehiroka	Clinique MIAHY Amboaroy Antehiroka	6	1	3

Source : Service des Hôpitaux Privés (SHP)/DHRRD/MSP/2017

Most CHRDs, especially the private ones are located in CUA where 33 private CHRDs exist. Meanwhile, there are six private CHRDs in Ambohidratrimo, eight private CHRDs in Atsimondrano, and two private CHRDs in Avaradrano. Because one public CHRD is developed per district, there is no public CHRD in the Study Area of Ambohidratrimo District but the outside of the area, though some private clinics are located in the area. After three public CHRDs currently under development and the ones planned are completed, public CHRDs will be relatively equally distributed in the agglomeration and will be accessible from the most of communes. The distributions of public and private CHRDs are presented in Figure 11.5.9.

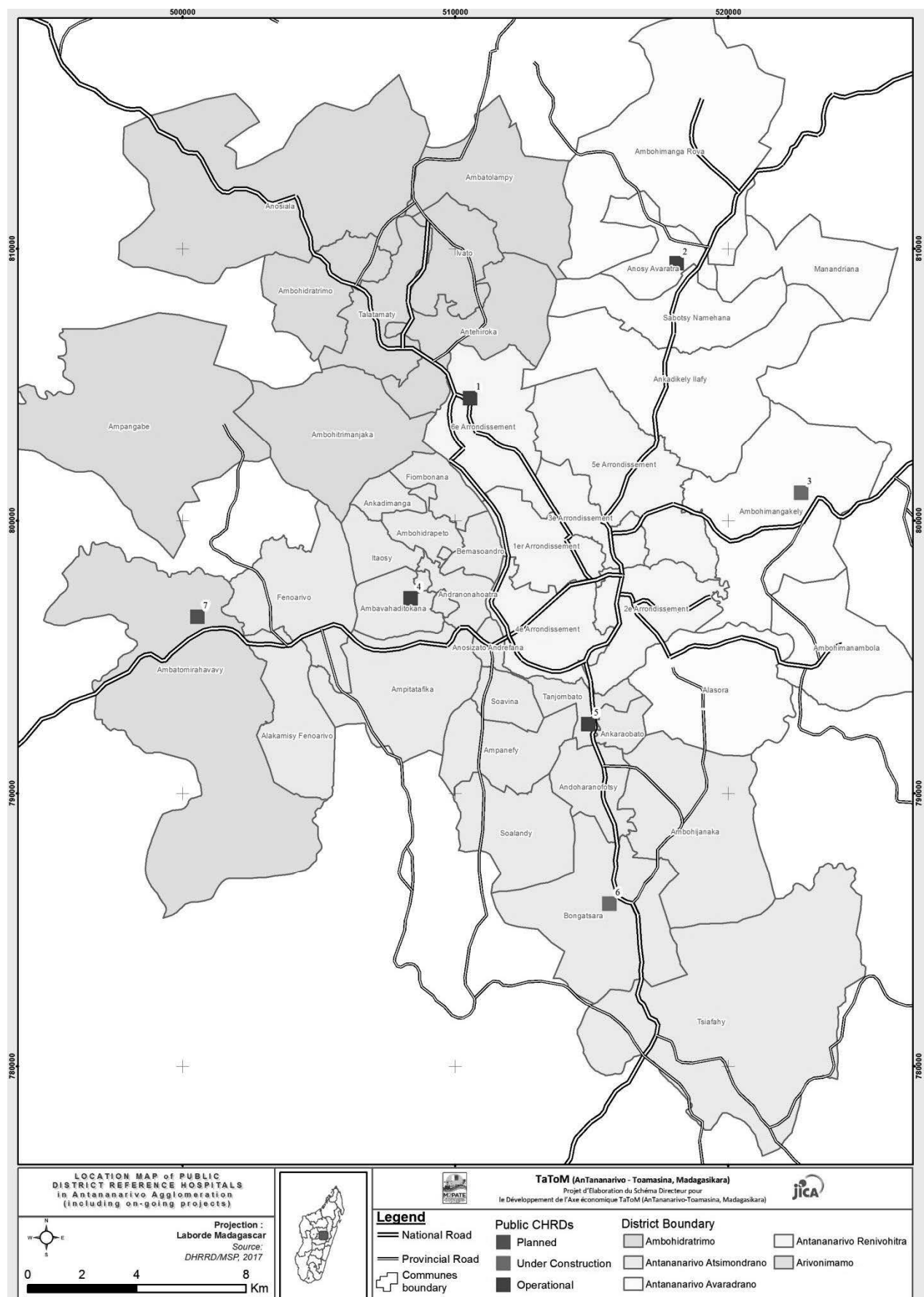


Figure 11.5.9 Location Map of Public District Reference Hospitals in Antananarivo Agglomeration



Figure 11.5.10 Location Map of Private District Reference Hospitals in Antananarivo Agglomeration

4) University Hospital Centres

University Hospital Centres (CHU) offer health care by experienced medical professional, students from universities of the Faculty of Medicine, and those from institutes of paramedics. At the same time, they are places of practical training and research for medical professionals, academics, and researchers. CHUs are under the supervision of the Directorate General of University Hospital Institutions (DGEHU) under the Ministry of Public Health.

There are 15 CHUs in the Antananarivo Agglomeration. Most of them are located in CUA, except four CHUs in Anosiala and Fenoarivo as shown in Table 11.5.8 and Figure 11.5.11.

The entire distribution of public and private CHRDs and CHUs is presented in Figure 11.5.12.

Table 11.5.8 University Hospital Centres in Antananarivo Agglomeration

No.	CHU Facility	Abbreviation	Location	Commune	No. of Beds
1	University Hospital Center of Care and Public Health Analakely	CHUSSPA	Analakely, Ex Institute of Hygiene	1st Arrondissement	0
2	Hospital Center Joseph and Raseta Befelatanana	CHUJRB	Befelatanana ambony, Mahamasina	4th Arrondissement	520
3	Hospital Center Mother - Child Befelatanana	CHUMEB	Maternity Befelatanana, Mahamasina	4th Arrondissement	NA
4	Hospital Center Gyneco -Obstetric Befelatanana	GOB CHU	Anosy	4th Arrondissement	160
5	Hospital Center Joseph Ravoahanagy Andrianavalona	CHUJRA	Anosy	4th Arrondissement	680
6	University Hospital Center 'Pavillon Sainte Fleur'		Anosy	4th Arrondissement	NA
7	Center Hospitalier Mother Child Tsaralalana	CHUMET	Tsaralalana in red cross face	1st Arrondissement	42
8	Center Hospitalier Universitaire Center of Apparatus of Madagascar	CHU CAM	Anosy	4th Arrondissement	0
9	Hospital Center University God Gives Rakotovao (Center of Stomatology and Maxillofacial Surgery)	JDR CHU	Anosy	4th Arrondissement	11
10	Universitaire Hospital Center Ambohimandra (Pediatrics Ambohimandra)	CHU AMBOHIMIANDRA	Ambohimandra	2nd Arrondissement	33
11	Hospital Center (Girard & Robic)	CHUGR	Soavinandriana (Girard and Robic)	3rd Arrondissement	NA
12	Hospital Center Andohatapenaka	CHU ANDOHATAPENAKA	Andohatapenaka	4th Arrondissement	100
13	Hospital Center Fenoarivo	CHUF	Fenoarivo	Fenoarivo	124
14	Anosiala Hospital Center	CHUANS	Anosiala	Anosiala	150
15	Anjanamasina Hospital Center	CHUAJ	Anosiala	Anosiala	110

Source: Directorate General of Hospito-Universities Institutions (DGEHU)

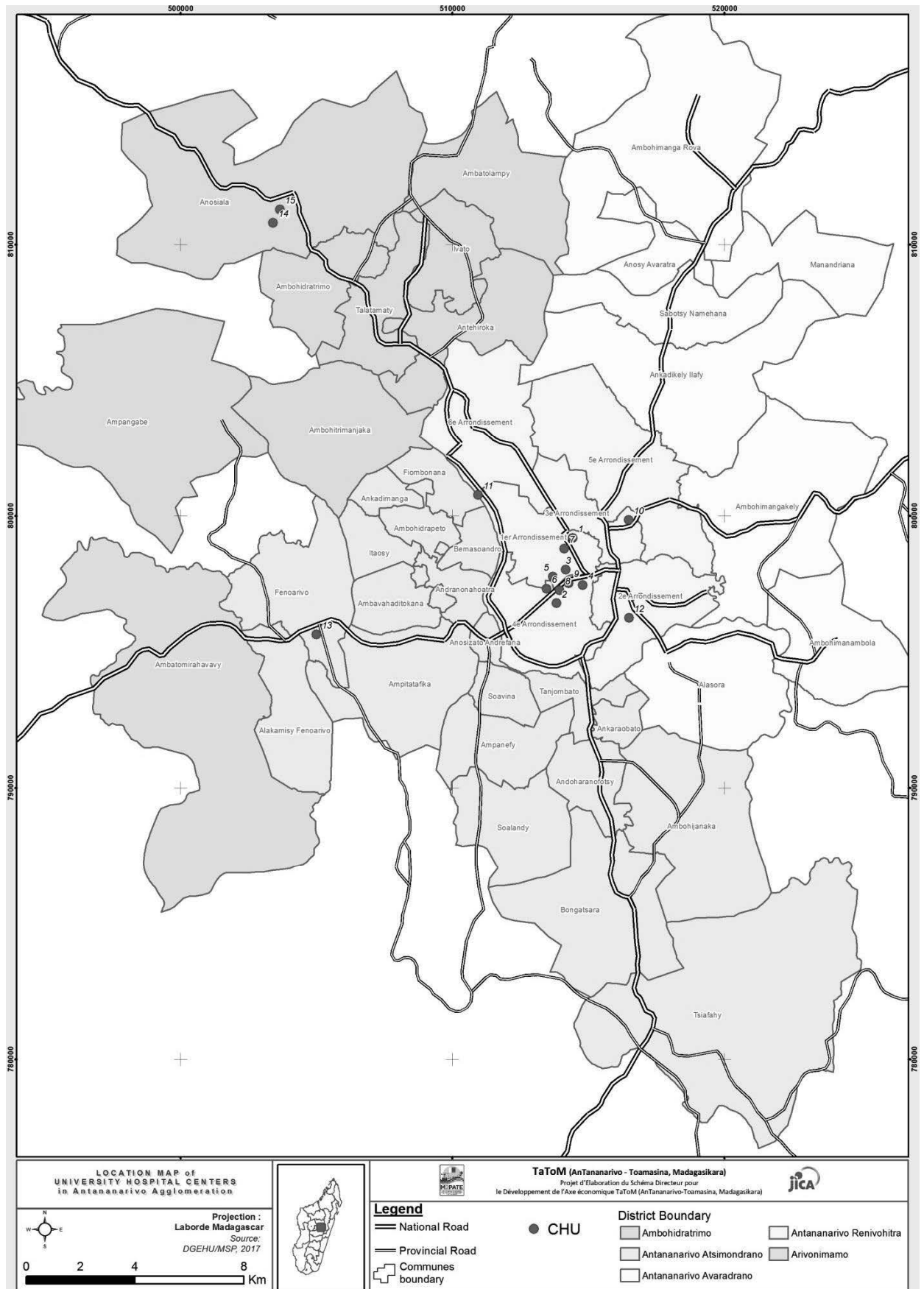


Figure 11.5.11 Location Map of University Hospital Centres in Antananarivo Agglomeration

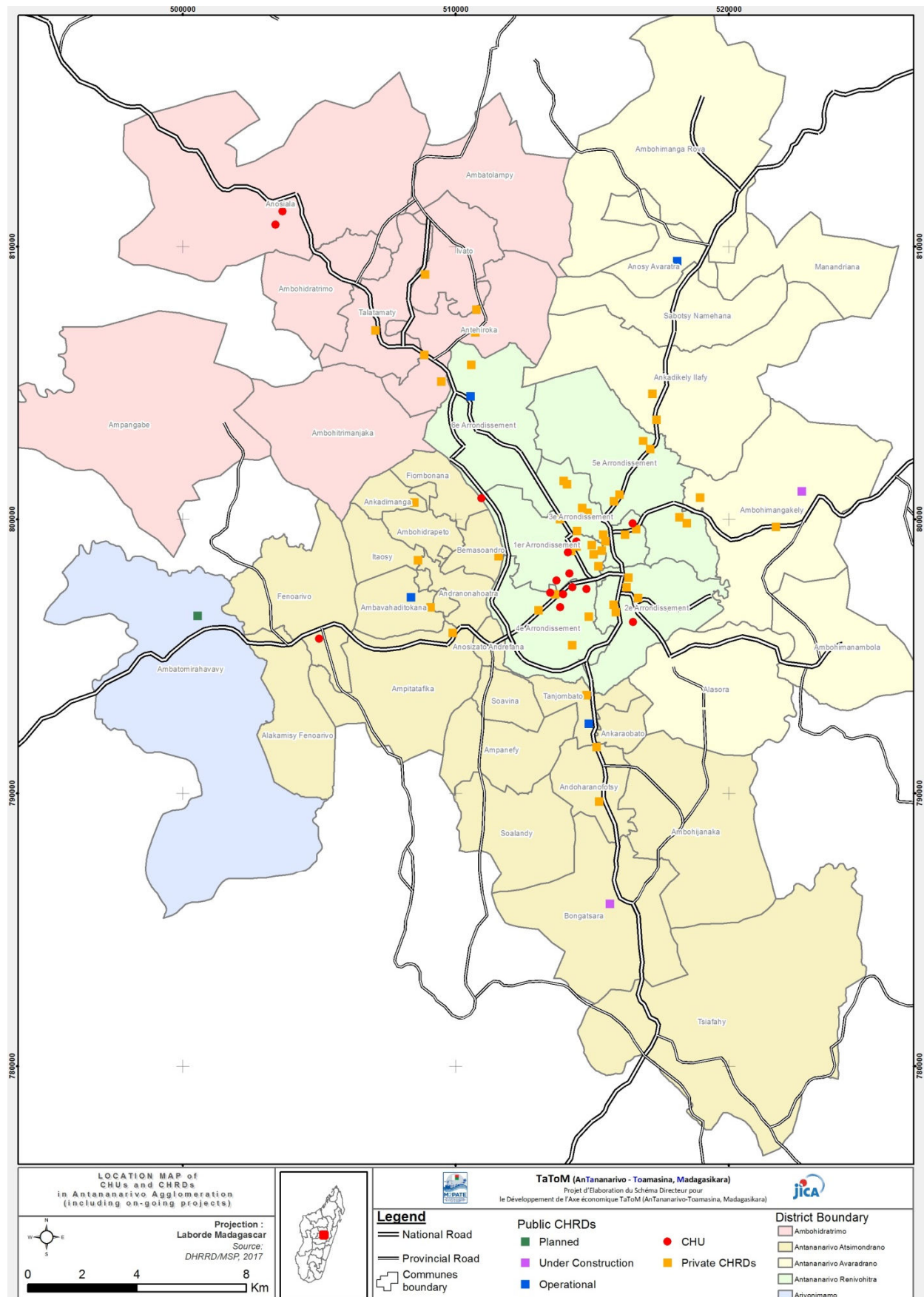


Figure 11.5.12 Location Map of District Reference Hospitals and University Hospital Centres in Antananarivo Agglomeration

11.5.2 Issues on Health Infrastructure in Antananarivo Agglomeration

From the analysis above, the issues related to health infrastructure to be addressed in the planning of PUDi are discussed in this section. A major problem identified is concerned with primary health care facilities such as CSBs. Because Antananarivo is the capital of Madagascar, CHRDs and CHUs are relatively accessible in the Study Area. There are still some issues with the hospitals to be addressed such as quality of health care provision, equipment and medical inputs, which are beyond the scope of this study. At first, the problems in primary health care provision are summarised by district before discussion on the issues of hospitals.

(1) Issues with Primary Health Care Provision

1) CUA

Public CSBs are significantly insufficient compared with the population and private CSBs fill in the gap in CUA. Even with the private CSBs, 6th Arrondissement does not meet the standard of CSBs and 2nd, 4th, and 5th Arrondissements are slightly below the standard. On the other hand, public and private CHRDs, and CHUs are concentrated in CUA. Thus, a major issue in CUA is the provision of affordable primary health care by public CSBs. Considering a large number of the poor population in CUA, it is important to increase the number of public CSBs in the populated areas for expansion of access to primary health care. In particular, additional public CSB(s) should be developed in 6th Arrondissement, and 4th and 5th Arrondissements, since the population growth is expected in the latter two arrondissements.

2) Ambohidratrimo

The facilities of public CSBs are not enough specifically in the communes of Antehiroka, Anosiala, and Ambohitrimanjaka. The deficiency of public CSBs in Anosiala is not compensated with the private CSBs, though two CHUs are located in the commune. Doctors, nurses, and midwives are lacking at public CSBs especially in Antehiroka and Anosiala. Though a lack of public CSBs are currently not less salient than CUA and the other districts, population growth is expected by the target year of 2033 since sub-centre development is planned near Ivato Airport and Ambohidratrimo. Hence, it is necessary to plan development of public CSBs in advance as part of the plan.

3) Avaradrano

Although three populous communes of Ankadikely Ilafy, Ambohimangakely, and Sabotsy Namehana along NR 3 and NR 2 are experiencing the most acute deficiency of public CSBs after CUA, the need for basic health care is fulfilled by the private provision. Public and private CHRDs are located and under development along the two NRs. Doctors and nurses are lacking in Ankadikely Ilafy especially, and nurse and midwives are insufficient in Sabotsy Namehana and Ambohimangakely respectively, compared with the standard. Thus, the continuous efforts to provide public CSBs are required in the three communes. Access issue to health facilities are also anticipated in remote communes such as Ampangabe.

4) Atsimondrano

The compelling need for public CSBs is found in the communes in Atsimondrano. Three communes, Alakamisy Fenoarivo, Ambavahaditokana, and Ambohidrapeto do not have any public CSBs in the communes, though the residents of the three communes are able to access to public CHRd, CHU, or private CBS within their commune or neighbouring communes. Because Atsimondrano District has recorded the highest population growth in the agglomeration and not many private CSBs have not been established yet, even with private clinics the service standard of CSB are not met in Fenoarivo, Ampitatafika, Ambohijanaka and Bongatsara. In addition, there is some concern with access to health care service in the communes without direct access to NRs, such as Soalandy and Ampanefy. District hospitals are located or under construction in the communes along the NRs. The number of doctors is relatively sufficient; however, nurses are not

enough in the suburban communes along NR7 and midwives are not enough in most of communes especially along NR 1.

In addition to the issues discussed above, it should be mentioned that poor populations simply do not have access to medical services, despite the provision of free health care at the public health centres and facilities and some financial support for medical related expenses.

(2) Issues with CHRDs and CHUs

Though the public CHRDs will be relatively evenly distributed across the agglomeration after the completion of the on-going and planned CHRDs, a number of issues with these hospitals are identified. The number and quality of health professionals are insufficient and need to be increased. Medical equipment and clinical devices are outdated or not available to provide advanced medical care. The capacity and quality of the facilities are still lacking and the hospitals with surgery are not evenly distributed. Thus, the quality of health service of the public hospitals is still less satisfactory and emergency care is also not available. As a result, the private hospitals and clinics are preferred by citizens, especially affluent patients. Yet, it is also reported that the private hospitals are not without problems in terms of the quality of human resources, equipment and medical care.

(3) Issues Concerned with Health Infrastructure to be Tackled

In short, the issues in health care facilities in Antananarivo Agglomeration are summarised as follows from the examination of the current situations above.

- Need for development of public CSBs in the communes without sufficient CSBs
- Need for planning of development of public CSBs in the suburban communes to be urbanized
- Need to provide the urban poor with access to primary health care especially in CUA and the adjacent communes
- Insufficient quality of medical services and advanced clinical care by CHRDs and CHU
- Lack of quality health care workforce of nurses, midwives, and doctors

Firstly, it is necessary to develop public CSBs in the communes with a significant gap in the provision of CSBs, taking account of the existing public and private CSBs. Because the three communes without public CSBs have relatively good access to CSBs in neighbouring communes or hospitals, a priority is given to the communes where both public and private CSB provision are not sufficient. Those communes include Fenoarivo, Ampitatafika, Ambohijanaka, Bongatsara, and Soalandy in Atsimondrano, and Anosiala and Ampangabe in Ambohidratrimo, among others.

The expansion of the population outside CUA by 2033 will increase the need for health care in the suburban communes. The current situation of the health care service provision - the private health care provision supplementing the deficiency of public provision of health care - is expected to continue in Antananarivo in future. However, there is a time lag until private health care service starts, since private clinics would be open only after urbanization occurred and sufficient people live in the area. It is important to plan a public health care facility together with the development of suburban areas since the beginning in order to prepare for the growth of the need for health service.

The access to primary health care should be expanded for the urban poor especially in CUA and the communes of Ankadikely Ilafy, Ambohimangakely, and Sabotsy Namehana. In these communes, significant deficiency of public primary health care provision is compensated by the private provision and there are a number of private clinics and hospitals; therefore, the action should target the poor population. Though the poverty data in CUA is not available, the poverty rate reaches 50% in Ambohimangakely for example.

In addition to the primary health care service, the quality of medical services at CHRDs and CHU should be upgraded to offer better medical care and advanced clinical treatment. Although the public CHRDs and CHUs are equally distributed in each of the district areas within the

Agglomeration, the medical care provided does not satisfy the needs of the residents. Because the Antananarivo Agglomeration is the national capital, there are more affluent families dwelling there who have the demand for advanced medical care and quality services. In fact, many patients choose to visit private clinics for treatment. By 2033, this preference of private clinics over public hospitals might be intensified, if the public hospitals would not be upgraded to provide the improved care. Thus, it is necessary to develop or improve the CHRDs and CHUs which could meet people's demand for better health services and can lead the medical services and set the industry standard of the quality of the health service in Madagascar. Moreover, regarding these hospitals, it is advisable to specify target indicators such as number of beds per population, because the current development standard for CHRDs is concerned with the quantity only, one CHDR per district without other indicators.

Regarding the health professionals, nurses and midwives are in short supply in the public primary health care sector and significant needs for these professionals exist throughout the Study Area, while a lack of doctors is less severe, being found in CUA and some near-by-communes. In addition to health care facilities, it is important to increase the number and quality of health care professionals by promoting training and education of the health care workers.

11.5.3 Objectives for Health Infrastructure Development in Antananarivo Agglomeration

From the analysis and discussion, the objectives for health infrastructure development in PUDi 2033 are proposed as follows:

Objective 1: To provide secure access to primary health care to the residents in Antananarivo Agglomeration

- To achieve the gross target of CSB development in all communes (8,000 persons per CSB)
- In CUA, to provide the urban poor with access to primary health care
- In outside CUA, to develop public CSBs together with suburban centre development, considering the location of CSBs, CHRDs, and other clinics and hospitals including the existing and the planned

Objective 2: To develop district reference hospitals (CHRDs) at urban sub-centres, which can provide quality medical treatment and emergency medical care

Objective 3: To develop an advanced medical centre in secondary urban centres for provision of advanced medical services

Objective 4: To improve the quality of health care by increasing health care professionals (especially nurses and midwives) working at public health centres and hospitals

11.5.4 Strategies for Health Infrastructure Development in Antananarivo Agglomeration

In order to achieve the objectives stated above, the strategies are identified as follows:

(1) Strategy 1: To Develop Basic Health Care Facilities (CSBs) for Improving Accessibility to Primary Health Care Services

Strategy 1 is divided into the following three sub-strategies:

- a) To develop public CSBs in the communes where the standard of 8,000 persons per CSB is not met, in accordance with the population growth
- b) To develop public and private CSBs by including development of a CSB in the development plan of sub-centre or new town with more than 8000 population

- c) To construct health posts in CUA for preventive and promotive health care services, especially in the area where population density is high, the deficiency of the public health care provision is the most serious, and the poor are concentrated, in coordination with development partners' initiatives to improve informal settlement areas

The first sub-strategy a) is concerned with the development of public CSBs in the communes where the standard is not met currently. The next sub-strategy aims to synchronize development of basic health care facilities and urban development in suburban areas. Sub-strategy c) tries to improve access to primary health care service in highly populated areas of CUA where public provision of primary health care service is significantly lacking.

(2) Strategy 2: To Develop a District Reference Hospital in each Urban Sub-Centre by including construction of a District Reference Hospital in the Urban Sub-Centre Development Plan

Strategy 2 aims to increase the number of district reference hospitals in suburban areas where the population is rapidly increasing, by constructing a district reference hospital in each urban sub-centre.

Strategy 2 suggests integration of district reference hospital development in urban sub-centre development plan and construction of CHRDs which offer quality health services including surgery and emergency medical care to the residents outside CUA.

(3) Strategy 3: To Develop Private Advanced Medical Centres in Primary and Secondary Urban Centres

Strategy 3 aims to provide high-level medical services in Antananarivo Agglomeration by attracting private investment in developing advanced medical centres in primary and secondary urban centres.

Strategy 3 is to develop private advanced medical centres in two secondary urban centres of Ivato and Mahazoarivo, as well as in Ankrondrano Primary Urban Centre. The medical centres will be equipped with state-of-art medical instruments and clinical devices necessary for advanced medical treatment, to meet increasing demands for the quality health care.

(4) Strategy 4: To Increase Health Care Professionals, and Assign them to Public CSBs and Hospitals

To increase the quantity and quality of health care personnel, especially nurses and midwives, nursing schools should be increased and training should be provided to the current paramedical staffs working for public CBSs and hospitals.

11.5.5 Programmes and Projects for Health Infrastructure of Antananarivo Agglomeration

The following programmes and projects are proposed, aiming to implement the strategies:

(1) Project for Development of District Reference Hospitals in Urban Sub-Centres

The objective of this project is to develop district reference hospitals (CHRDs) in urban sub-centres for the provision of quality health care including surgery and emergency medical care for the purpose of increasing the number of district reference hospitals in suburbanizing areas outside CUA and satisfying the people's demands for higher quality of medical services.

Current public CHRDs including under construction and planned ones are located in each of the districts outside CUA. However, the quality of health services, human resources, facility, and equipment do not necessarily meet the demand of the residents. The capacity of the hospitals and coverage of the medical treatment are insufficient to accommodate the needs derived from the population growth in suburban areas.

In this project, public CHRDs will be strategically developed in urban sub-centres by planning the CHRDs in PUDi and PUDé and by specifying the location for the CHRDs. The advanced medical equipment and clinical devices will be installed at the hospital with sufficient number of beds.

(2) Advanced Medical Centre Development Projects in Primary and Secondary Urban Centres

Antananarivo lacks a leading edge medical hospital which offers advanced clinical treatments for well-off citizens, and foreign tourists and visitors from developed countries. This project aims to develop advanced medical centres in two secondary urban centres, Ivato and Mahazoarivo, as well as in Ankondrano Primary Urban Centre.

The plan of a medical centre will be prepared as part of the development plan of the primary and secondary urban centres and its location will be shown in landuse plan of PUDé.

In the project, the government and private sectors will prepare land and develop basic infrastructure through the preparation and implementation of the PUDé. The private health operator will construct and operate the medical centre to generate sufficient revenue. As a result of the project, the patients and citizens who have to go abroad for special medical care will be able to receive necessary health services and treatment in these medical centres.

(3) CSB Development Project for Improvement of Primary Health Care Provision

This project aims to develop public CSBs in the communes where the standard of 8,000 persons per CSB is not met and in CUA, considering the current supply gap and future population growth. The project component will include activities of assessment of the current supply gap and needs in selected communes/ arrondissements, prioritization of the communes/ areas, project design, examination of project financing, social and economic analysis, etc. After the identification and prioritization of the projects in the communes and CUA, an investment plan will be prepared and the construction of CSBs will be started from the projects with higher priority.

(4) Development of Health Posts in Projects for Informal Settlement Improvement

Due to the concentration of the poor and deficiency of public CSBs in CUA, it is assumed that the urban poor in CUA are experiencing difficulty in access to primary health care service. This project intends to develop health posts in informal settlement areas where population density is high and hygiene condition is not very good, as part of the projects for informal settlement improvement. Health posts will provide and promote preventive care and maternal and infant health care, and raise awareness of hygiene and health by social and community workers, not medical staff. This type of the facilities can be placed in the existing public facilities such as fokontany office or community gathering places. This project can be implemented in collaboration with development partners' initiatives in improving informal settlement areas.

(5) CSB Development Project in Residential Areas of Suburban Centres and New Towns

This project is to plan development of public CSBs in advance as part of the development plan, and develop the CSBs in residential areas of suburban centres and new towns to be developed. By 2033, two-third of the population growth in Antananarivo Agglomeration is expected to occur outside CUA and therefore, development of suburban centres and new towns are planned to accommodate the growing population. The objective of the project is to develop public CSBs in these suburban centres and new towns, by incorporating their development plan in the PUDé, in accordance with the development standard and by constructing it as a necessary public facility along with roads and water supply.

(6) Programme for Human Resource Development in Health Sector

Human resource for the health sector should be improved in addition to the development of health facilities, for improvement of public health care services. Thus, this project will educate prospective health care workers, provide training to the existing paramedical staff such as nurses

and midwives who are working at the public CSBs and health care facilities, and expand the capacity of the nursing schools.

11.5.6 Profiles of Priority Projects for Health Infrastructure of Antananarivo Agglomeration

(1) Programme for Development of New District Hospitals in Suburban Areas of Antananarivo Agglomeration

1) Rational

Considering the rapid growth of population and the expected expansion of the urban areas outside CUA, it is essential to plan district hospitals (CHRDs) strategically together with the development plans of urban centres and roads. To accommodate the growing population, new towns are planned to be developed in suburban areas of Antananarivo Agglomeration and among them, the western area of CUA is expected to be transformed into a major new residential area by developing several large scale new towns. Ampangabe, which is currently a remote commune, lacking access to major arterial roads, with only one primary health centre, will become one of the largest new towns to be developed in the western area, while Ambodifasina Urban Sub-Centre will be also developed, taking advantage of the proximity to the airport. Though district hospitals (CHRDs) have been developed in each district along national roads and most of planned new towns will be located close to the existing or planned district hospitals, there is no existing or planned district hospital in Ambohidratrimo District, except University Hospitals. Therefore, development of new district hospitals in Ampangabe New Town and Ambodifasina Urban Sub-Centre are necessary to provide good access to health care service in the current and future residents of the New Town, Suburban Centre and surrounding areas, and also promote the development of the new residential areas.

2) Objectives

- To develop new district health centres in Ampangabe Suburban Centre and New Town and Ambodifasina Urban Sub-Centre for the provision of qualified health care service to the residents of the New Town, Suburban Centre, and their surrounding areas
- To promote development of new residential areas and their surrounding areas, by improving health care services together with development of infrastructure and other public facilities as part of the new town / urban sub-centre development projects

3) Project Description

The Programme is composed of the following projects:

- Phase 2 (2024-2028): Project for Development of New District Hospital in Ambodifasina Urban Sub-Centre
- Phase 3 (2029-2033): Project for Development of New District Hospital in Ampangabe Suburban Centre

In addition to the above projects, the following infrastructure provision is necessary:

- To develop access roads, water supply and other necessary infrastructure

4) Expected Benefits

The residents of Ampangabe Suburban Centre and New Town and Ambodifasina Urban Sub-Center, and their surrounding areas, where currently has difficulty to access to health care services will be able to receive improved and quality health care services provided by the new district hospitals. At the same time, the development of the suburban areas of the Agglomeration will be promoted to transform the mono-centric to a poly-centric spatial structure.

5) Executing Agency and Related Institutes

- Ministry of Public Health

- District of Ambohidratrimo
- MAHTP
- JIRAMA

6) Estimated Project Cost

- 18 million USD for Project for Development of New District Hospital in Ambodifasina Urban Sub-Centre
- 18 million USD for Project for Development of New District Hospital in Ampangabe New Town

7) Implementation Schedule

- Project for Development of New District Hospital in Ambodifasina Urban Sub-Centre is to be implemented in Phase 2 (2024-2028) of Project TaToM
- Project for Development of New District Hospital in Ampangabe New Town is to be implemented in Phase 3 (2029-2033) of Project TaToM.

Each project will be implemented in the following steps:

- Basic Design (6 months)
- Detailed Design (12 months)
- Construction (24 months)

8) Necessary Actions for Implementation / Critical Factor

- Land acquisition or land arrangement should be done in accordance with development of the new town and suburban centre.

9) Related Plans and Projects

- Project of Development of New Town Development for Housing Provision in Suburban Areas
- Project for Construction of Ambohidratrimo – Ampangabe Section of the Outer Ring Road (Western Part)
- Project for Promotion of Development of Ambodifasina Urban Sub-Centre
- Water and Power Supply Project

10) Social and Environmental Impacts

- The project is likely to have minimal or little adverse impact on the environment and society.

(2) Expansion of Existing District Hospitals in Namehana and Tanjombato Sub-Centres

1) Rational

Improvement of health care service is necessary in Antananarivo Agglomeration. The current health sector performance in Antananarivo is suffered due to lacks of human resources, facilities, equipment, despite the increasing demand for better health care services. As the national capital in particular, provision of advanced, high quality health service is indispensable to accommodate the needs of the current and future population of the Agglomeration as well as to attract multinational corporations and highly skilled and qualified human resources for economic development of Antananarivo and Madagascar. In order to improve the health care service provision in Antananarivo Agglomeration, the existing district hospitals should be upgraded and expanded, in addition to the construction of new district hospitals in urban sub-centres and new residential areas.

2) Objectives

- To upgrade and expand the health care service provided by the current district hospitals in Anosy Avaratra and Tanjumbato for the current and future population in the Districts of

Avaradrano and Atsimondrano

3) Project Description

- The Programme is composed of the following two projects:
- Project for Relocation and Expansion of the District Hospital in Namehana Urban Sub-Centre
 - To relocate the current district hospital from Anosy Avaratra and build a new district hospital with upgrading and expansion of the services in Namehana Urban Sub-Centre, as part of the urban sub-centre development project
 - The land for the relocated and expanded District Hospital will be developed by land filling in wetland in the newly developed area along the primary arterial road connecting Tsarasaotra Road and NR3
- Project for Expansion of the District Hospital in Tanjombato Urban Sub-Centre
 - To expand and upgrade the current district hospital in Tanjombato Urban Sub-Centre, as part of the urban sub-centre development project

4) Expected Benefits

The residents of the Districts of Avaradrano and Atsimondrano and surrounding areas will be able to access to improved health care services provided by the upgraded and expanded district hospitals.

5) Executing Agency and Related Institutes

- Ministry of Public Health
- Districts of Avaradrano and Atsimondrano,
- MAHTP
- JIRAMA

6) Estimated Project Cost

- 18 million USD for Project for Relocation and Expansion of the District Hospital in Namehana Urban Sub-Centre
- 14 million USD for Project for Expansion of the District Hospital in Tanjombato Urban Sub-Centre

7) Implementation Schedule

The projects of this programme are to be implemented in Phase 2 (2023-2028) of Project TaToM.

Each of the projects is to be implemented in the following steps:

- Basic Design (6 months)
- Detailed Design (12 months)
- Construction (24 months)

8) Necessary Actions for Implementation / Critical Factor

- Land acquisition or land arrangement should be done in coordination with the urban sub-centre development projects

9) Related Plans and Projects

- Project for Promotion of Development of Namehana Urban Sub-Centre
- Project for Promotion of Development of Tanjombato Urban Sub-Centre

10) Social and Environmental Impacts

- The project is likely to have minimal or little adverse impact on the environment and society.

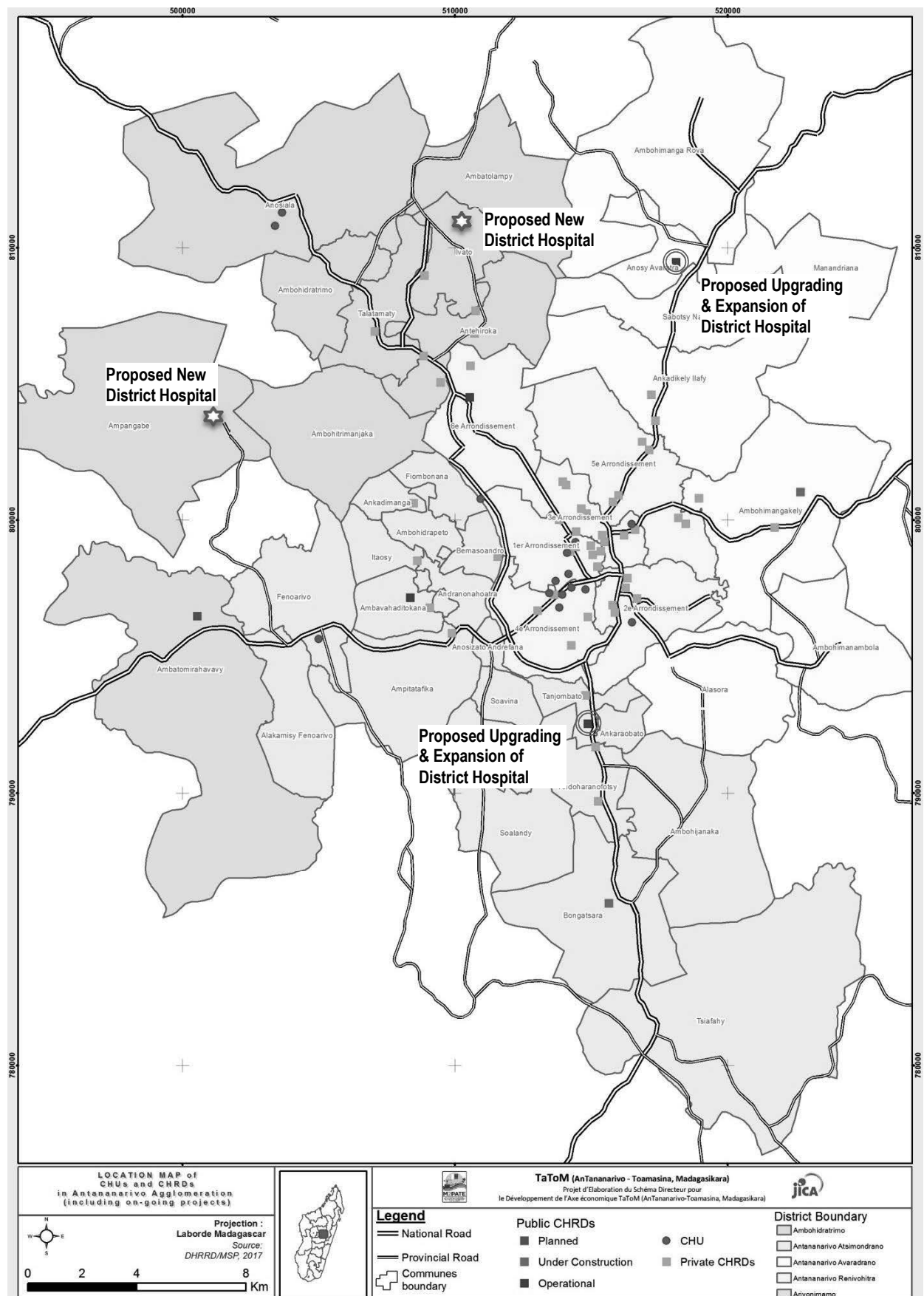


Figure 11.5.13 Location of Proposed Projects for Construction of New District Hospitals and Upgrading and Expansion of the Existing District Hospitals

11.6 Education Infrastructure in Antananarivo Agglomeration

11.6.1 Background on Education Infrastructure of Antananarivo Agglomeration

(1) The Performance of the Malagasy Education Sector

The performance of the Malagasy education sector significantly declined since the beginning of the 2000s. Though Madagascar was among the countries in the top tier in PASEC [the Conference of Ministers of Education of the States and Governments of the Francophonie (CONFEMEN) Education Systems Analysis Program] Survey 1997 – 2004, its standing moved to the lowest group, with the rank of 9th among 11 countries.¹ This decline of the education performance in Madagascar can be attributed to several factors, including rapid population growth, low quality of teaching staff, political and economic crises, poverty, malnutrition, etc.

According to the data from the Report of State of Madagascar Education System, the access and completion rates to primary, secondary, and high schools in Madagascar are slightly higher than the average rates of the countries at the similar economic development level with Madagascar as shown in Table 11.6.1. Nevertheless, the performance of reading and mathematics at the end of primary level education in Madagascar is lower among the Francophonie countries. The ratios of the Malagasy students who belong to level 3 and level 4 of the education achievement, which is above the “sufficient” threshold, account only for 17.2% for reading and 20.7% for mathematics, compared with 42.7% for reading and 41.0% for mathematics at the international average. Among 11 countries participated in PASEC 2014, only two countries (i.e., Niger and Chad) have lower score than Madagascar. (See Figure 11.6.1 and Table 11.6.2).

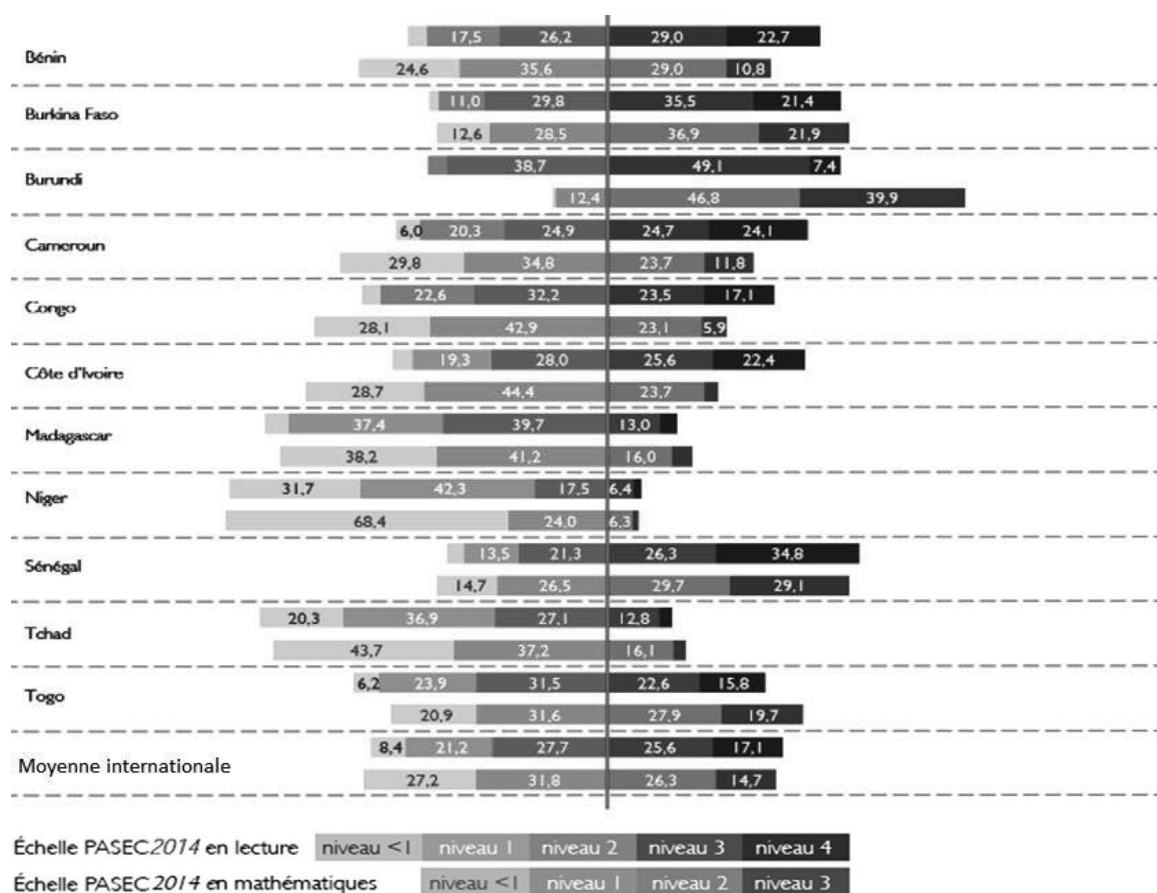
Within the country, according to comparison of the education performance by province in Figure 11.6.2, Antananarivo outperformed the other provinces while Toamasina’s rating is slightly lower than the national average.

Table 11.6.1 International Comparison of Access and Completion Rates of Primary, Secondary, and High Schools (Countries with a GDP / Capita Between 400 - 700 USD at Current Price 2013)

Countries	Access Rate to 1st Year of Primary School (%)	Completion Rate of Primary School (%)	Access Rate to 1st Year of Secondary School (%)	Completion Rate of Secondary School (%)	Access Rate to 1st Year of High School (%)	Completion Rate of High School (%)
Burkina Faso	88.3	54.9	35.4	19.9	8.7	6.5
Democratic Republic of Congo	136	71	51	43	39	30
Ethiopia	145.7	54.5	34.4	25.7	6.6	5.7
Gambia	108.7	72.4	65.3	64.7	39.1	30.3
Guinea	100	61.5	26.1	36.2	15.8	24.7
Mozambique	155.5	54.9	36.3	23.7	12.3	9.8
Niger	98.5	55.5	32.2	13.2	4.9	3.1
Rwanda	199.5	75	57.3	37.7	22	13
Togo	138.3	79	66	41.9	26.3	19.3
Uganda	143.8	55	36.4	27	11	9.9
Average for Countries	131.4	63.4	44	33.3	18.6	15.2
Madagascar	184.1	68.7	54.5	37.3	21.1	16.3

Source: Report of State of Madagascar Education System (RESEN). February 2016. Page 76

¹ PSE 2018-2022.



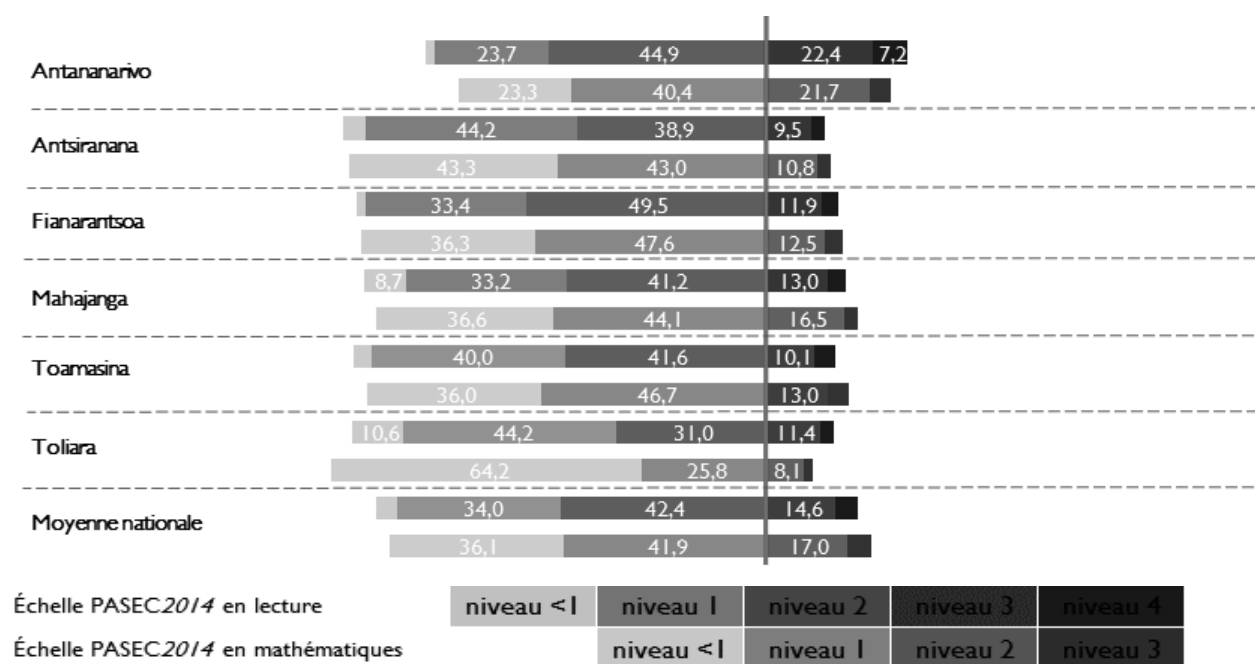
Source: CONFEMEN, PASEC, the Government of Madagascar, and the Ministry of National Education, Madagascar. PASEC2014 – Performances du système éducatif malgache: Compétences et facteurs de réussite au primaire. Mars 2017. Consulter le PowerPoint de présentation. (Data collection was conducted in 2015 in Madagascar, and in 2014 in other countries.)

Figure 11.6.1 Comparison of Education Achievements (Reading and Mathematics) at the End of Primary School among Francophonie Countries

Table 11.6.2 Comparison of Average Scores in Reading and Mathematics Between Madagascar and Other Francophonie Countries

	Countries with average score statistically higher than that of Madagascar	Country with average score statistically equal to that of Madagascar	Countries with average score statistically lower than that of Madagascar
Reading	Benin, Burkina Faso, Burundi, Cameroon, Congo, Côte d'Ivoire, Senegal, Togo	---	Niger, Chad
Mathematics	Benin, Burkina Faso, Burundi, Cameroon, Senegal, Togo	Côte d'Ivoire, Congo, Chad	Niger

Source: CONFEMEN, PASEC, the Government of Madagascar, and the Ministry of National Education, Madagascar. PASEC2014 – Performances du système éducatif malgache: Compétences et facteurs de réussite au primaire. Mars 2017. Consulter le PowerPoint de présentation. (Data collection was conducted in 2015 in Madagascar, and in 2014 in other countries.)



Source: CONFEMEN, PASEC, the Government of Madagascar, and the Ministry of National Education, Madagascar. PASEC2014 – Performances du système éducatif malgache: Compétences et facteurs de réussite au primaire. Mars 2017. Consulter le PowerPoint de présentation. (Data collection was conducted in 2015 in Madagascar, and in 2014 in other countries.)

Figure 11.6.2 Comparison of Educational Achievements at the End of Primary School by Province in 2015

(2) Educational Policy: Education Sector Plan 2018-2022

1) Strategies and Targets

The Education Sector Plan (PSE) 2018-2022 is the first consolidated educational sectoral plan for the three ministries in Madagascar, namely the Ministry of National Education (MEN), Ministry of Higher Educational Scientific Research (MESupReS), and Ministry of Employment, Technical Educational and Vocational Training (MEETFP). Facing declining educational performance in Madagascar, the plan was prepared with medium and long-term perspectives to achieve the objective of human capital development in the National Development Plan 2015-2019 (PND), which include i) to develop an effective education system in accordance with international needs and standards, ii) to promote technical and vocational education and / or vocational training, and iii) to provide university education that meets the standards and its quality assured.

For each Ministry in the education sector, PES provides for different but coherent strategic axes. The strategic axes of the three sectors are shown in Table 11.6.3. PSE sets the targets related to Sustainable Development Goal 4: “Ensure inclusive and quality education for all and promote lifelong learning,” some indicators of which are presented in Table 11.6.4.

Table 11.6.3 Strategic Axes of the Three Education Sectors of Madagascar

Sector	Strategic Axes
National Education	(1) Expand preschool education in controlled manner (2) Reform basic education 1 and 2 for a nine-year education. a) improved access, retention, and equity b) improvement of the quality of learning c) promotion of good governance and system management (3) Improve secondary education a) improvement of the moderate accessibility to secondary education to respond to the pressure due to the development of the fundamental and the requirement of equity; b) improvement of the quality for excellence c) improvement of the management and governance of the system (4) Improve the management and governance
Technical Education, Vocational Training and Skills Development	(1) Improve access to training for all, regardless of academic level or professional qualification (2) Improve the relevance and quality of training according to the requirements of potential jobs in the priority sectors (3) Establish partnership governance of the TVET / DC system for a better professional integration of the trainees
Higher Education and Scientific Research	(1) higher education with accessible and equitable quality (2) employability of trainees and graduates of higher education (3) adequacy of scientific research with training and development needs (4) Improvement of governance, management, and financing

Source: Education Sector Plan (PSE) 2018-2022

Table 11.6.4 Targets Related to SDG 4 Quality Education

Indicators		2014	2016	2018	2020	2022	2030*	2030**
4.1.4 Completion Rate (primary, lower secondary and upper secondary)	Primary	69%	68%	53%	60%	70%	105%	100%
	Lower Secondary	37%	36%	36%	40%	44%	88%	89%
	Upper Secondary	16%	19%	17%	17%	18%	42%	25%
4.6.23 Youth/adult literacy Rate	11-14 years	15%	33%	41%	43%	37%	0%	-
	15-45 years	26%	26%	28%	29%	31%	16%	-

Source: Education Sector Plan (PSE) 2018-2022

* Scenario that assumes external financing to achieve the SDG 4

** Scenario that assumes a constant external financing

2) Fundamental Education

One of the important policies proposed in PSE is the reform to change the current 5-year primary and 4-year secondary education into 9-year fundamental education consisting of three sub-cycles of 3-year education. In this reform, the new structure of 9-year fundamental education is a compulsory, free education cycle which allows all Madagascan children, especially those belonging to the most disadvantaged and vulnerable groups, to complete at least the two sub-cycles in good learning conditions and to access sub-cycle 3, leading them in pursuit of general or technical secondary education. The transition to the new system starts in 2020 and planned to be completed by 2023.

The school map prepared by CISCO will be used for the planning of the construction of 9-year fundamental schools, including construction of new schools and expansion of the existing schools, reconstruction, and rehabilitation of classrooms. The construction plan and priority will be finalized by MEN in accordance with its standards and criteria.

In order to reduce the construction cost of schools, PES proposes three approaches to building school infrastructure for the new system:

- Local community responsibility approach (A-RCL): 40% of school buildings will be developed by local community
- Delegated Project Management (A-MOD): 20% of school buildings will be constructed by executing agencies delegated by the Ministry
- Direct management: 40% of the schools will be directly constructed by the Ministry

The reform of basic education generates significant classroom needs. It is expected in 2022 that double-shift system in classrooms will reach 38%, and the average size of instructional groups will increase from 42 to 45. During the planning period of PSE, 619 and 4,230 new classrooms need to be built for the first and second sub-cycles, and for the third sub-cycle, respectively. According to

MEN, the rehabilitation and expansion of the existing schools are given priority, rather than constructing new schools accommodating students of all three cycles.

Table 11.6.5 Construction of Fundamental Schools

	2018	2019	2020	2021	2022	Total
Sub-Cycles 1&2	0	619	0	0	0	619
By Communities	0	217	0	0	0	217
By Government/ Technical & Financial Partner	0	403	0	0	0	403
Sub-Cycle 3	585	882	901	921	941	4230
In Primary Schools	585	882	901	921	941	4230
By Communities	0	221	225	230	235	911
By Government/ Technical & Financial Partner	585	662	676	691	706	3320
In Secondary Schools	0	0	0	0	0	0
Total	585	1 501	901	921	941	2763
By Communities	0	437	225	230	235	1127
By Government/ Technical & Financial Partner	585	1 064	676	691	706	2073

Source: Education Sector Plan (PSE) 2018-2022, Table 6.

3) General Secondary Education (High School)

The expected number of students and classroom needs by 2022 are presented in Table 11.6.11 and Table 11.6.12². It is predicted that the share of the students in private high schools will rise up to 60% by 2030.

Public high schools will be constructed by MEN. Disadvantaged areas meeting the standards of the school map will be prioritized. Classrooms will be built in connection with the identified needs for the creation of new high schools (30%) and for rehabilitation in the framework of the development of old high schools (70%).

Table 11.6.6 Number of Expected Students in General Secondary Education (High School)

	2017-18	2018-19	2019-20	2020-21	2021-22
Registered Students (thousands)	361	370	379	395	416
Students in Public High Schools	172	174	175	180	187
	47.6%	47.0%	46.2%	45.6%	45.0%
Students in Private High Schools	189	196	203	214	229
	52.4%	53.0%	53.6%	54.2%	55.0%

Source: Education Sector Plan (PSE) 2018-2022, Table 8.

Table 11.6.7 Classroom Needs in Public High School and New Construction Needs of Public High Schools

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	TOTAL
Classroom Needs	3,313	3,306	3,352	3,397	3,504	3,652	
Construction needs	0	0	0	40	148	179	368
New high schools (30%)	0	0	0	12	44	54	110
Old high schools (70%)	0	0	0	28	104	126	257

Source: PSE 2018 -2022, Table 9.

(3) Regulations for Private Schools

The establishment of private schools is regulated by the Decree of the Ministry of National Education No. 1032/2017 regarding private general education. Table 11.6.8 presents the standards for private school infrastructure based on the Decree.

² Planning assumption for classroom needs in high school: 1) The average size of a section: 50 students per section, 2) The weekly number of working hours per student: 37 hours per student, and 3) The average weekly use of a classroom : 36 hours per week. (PSE, 1.2.3.1.2)

Table 11.6.8 Standards for Private School Infrastructure Relevant to PUDi

<p>Article 7 C Infrastructure (Application for authorization to open a school)</p> <p>4. A plan of location in relation to the public road</p> <p>5. A title deed or an administrative certificate of legal status of the site of the school domain</p> <p>6. A technical report recording the infrastructure established by the School District School</p> <p>Article 8</p> <p>... each student needs to have 3 m³ of air to work in normal conditions ... the ceiling height must be no less than 2 m 50 cm.</p> <p>Article 9</p> <p>The minimum distance allowed between two private schools of the same level is fixed at 300 m and according to the school map. The establishment must be at least 300 m away from anything that may disrupt educational activities or affect in any way the morals and health of students, including drinking establishments.</p> <p>Article 10</p> <p>Any private school must have a space for student recreation and sanitary facilities inside the school.</p>

Source: Decree of the Ministry of National Education No. 1032/2017

(4) Problems on Educational Infrastructure in Antananarivo Agglomeration

In order to identify the issues on educational infrastructure in Antananarivo Agglomeration, the problems related to the current education infrastructure are examined in this section. Table 11.6.9 presents the overview of schools, student enrolment, and no. of students per classroom and per teacher by district. For the evaluation of the current educational environment, the standard of **50 students per classroom** is adopted for all levels of schools.³

A distinct characteristic of the education sector in the Study Area is that the majority of students attend private schools. 60% of primary school students and about 70% of secondary and high school students are enrolled in private schools. The comparison of the educational environment between public and private schools indicates the congestion of public schools at all levels for exceeding the standard of 50 students per classroom. The ratio of students per teacher is 55, which is also above the standard of 50 as shown in Table 11.6.9.

Therefore, this study focuses on planning and development of public schools for purposes of planning of PUDi. However, it is worth mentioning that some private schools are developed for children from the less privileged families, despite the assumption that private schools are for the students who are able to afford higher tuition fees.⁴

³ This standard is from the Ministry of National Education and used for primary school construction project of JICA.

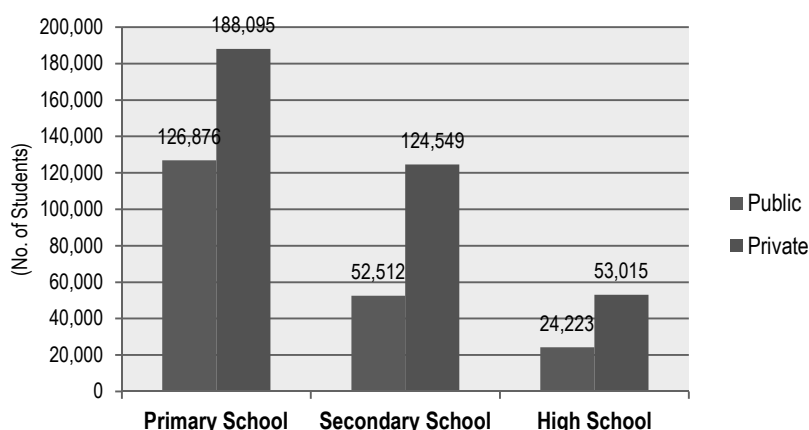
⁴ Interview with the Ministry of Public Education in March, 2018.

Table 11.6.9 Numbers of Schools and Students and No. of Students per Classroom and per Teacher by District in Antananarivo Agglomeration

District	Population 2015	Primary School			Primary School Students			Ratio of Public School Students	No. of Students per Classroom			No. of Students per Teacher		
		Public	Private	Total	Public	Private	Total		Public	Private	Total	Public	Private	Total
CUA	1,556,654	93	713	806	16,531	23,403	39,934	41%	76	29	38	52	28	34
Atsimondrano*	769,229	63	214	277	36,248	44,988	81,154	45%	47	26	32	-	-	-
Avaradrano	399,604	117	379	496	19,189	28,151	47,340	41%	59	25	34	48	26	33
Ambohidratrimo	365,167	80	243	323	54,908	91,553	146,461	37%	47	24	30	38	24	28
Grand Total	3,090,654	353	1,549	1,902	126,876	188,095	314,889	40%	61	27	35	55	31	37
District	Population 2015	Secondary School			Secondary School Students			Ratio of Public School Students	No. of Students per Classroom			No. of Students per Teacher		
		Public	Private	Total	Public	Private	Total		Public	Private	Total	Public	Private	Total
CUA	1,556,654	14	452	466	21,333	63,822	85,155	25%	74	35	40	32	18	20
Atsimondrano*	769,229	9	132	141	6,758	14,955	21,713	31%	72	27	33	-	-	-
Avaradrano	399,604	20	247	267	14,744	29,190	43,934	34%	64	28	35	31	17	20
Ambohidratrimo	365,167	13	139	152	9,677	16,582	26,259	37%	66	27	34	27	27	27
Grand Total	3,090,654	56	970	1,026	52,512	124,549	177,061	30%	69	31	37	35	21	24
District	Population 2015	High School			High School Students			Ratio of Public School Students	No. of Students per Classroom			No. of Students per Teacher		
		Public	Private	Total	Public	Private	Total		Public	Private	Total	Public	Private	Total
CUA	1,556,654	7	233	240	13,264	28,734	41,998	32%	52	33	37	22	15	16
Atsimondrano*	769,229	5	46	51	3,736	5,606	9,342	40%	55	29	35	-	-	-
Avaradrano	399,604	6	100	106	3,877	12,985	16,862	23%	62	33	37	23	18	19
Ambohidratrimo	365,167	7	58	65	3,346	6,287	9,633	35%	61	27	33	18	11	13
Grand Total	3,090,654	25	437	462	24,223	53,015	77,238	32%	55	32	36	25	17	19

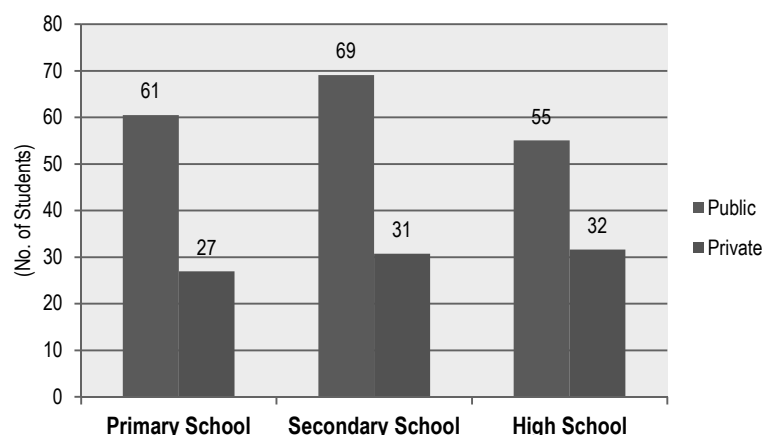
Source: CISCO CUA, Atsimondrano, Avaradrano 2014/2015, Ambohidratrimo 2016/2017. Population: INSTAT data adjusted by JICA Study Team

* Astimondrano District Data include the Commune of Ambatomirahavavy in Arivonimamo District.



Source: CISCO CUA, Atsimondrano, Avaradrano 2014/2015, Ambohidratrimo 2016/2017.

Figure 11.6.3 No. of Students in Public and Private Schools in Antananarivo Agglomeration

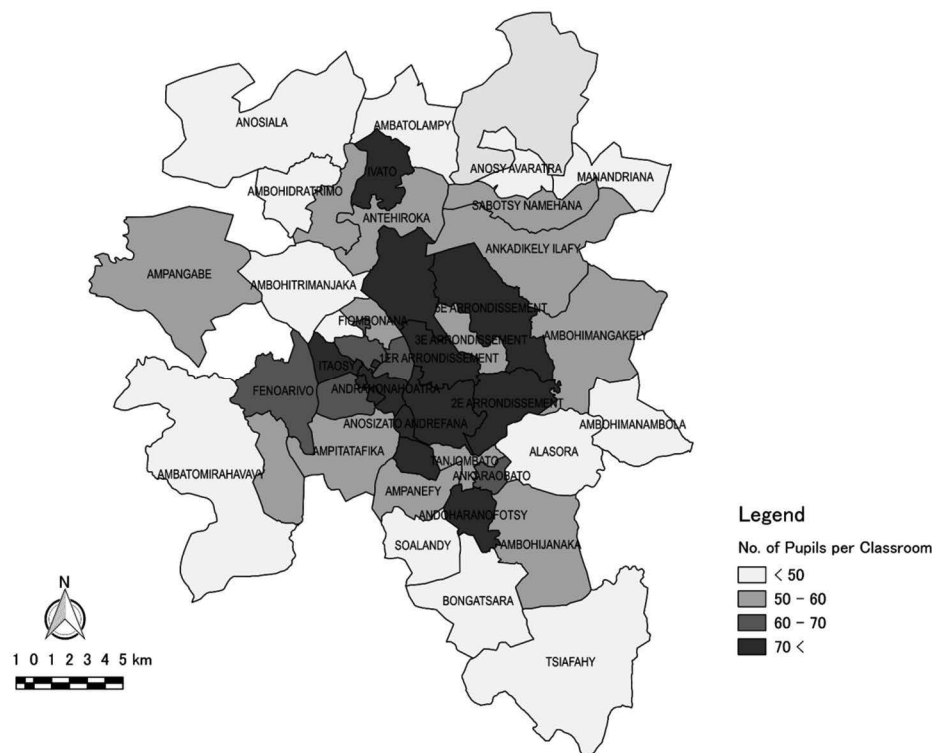


Source: CISCO CUA, Atsimondrano, Avaradrano 2014/2015, Ambohidratrimo 2016/2017.

Figure 11.6.4 No. of Students per Classroom of Public and Private Schools in Antananarivo Agglomeration

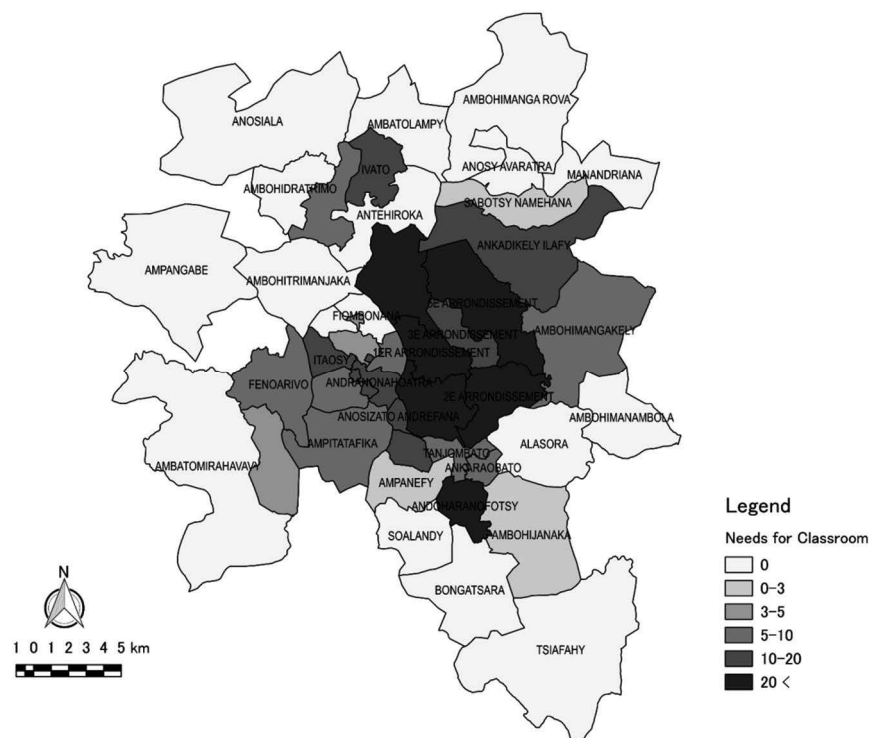
1) Public Primary Schools in Antananarivo Agglomeration

The current situations of public primary schools in the Study Area are presented in Figure 11.6.5, Figure 11.6.6, and Table 11.6.10. The average number of students per classroom in 26 out of 38 communes exceeds the standard of 50 students per classroom and in the case of 11 communes, the average class size is more than 70 students. The 11 communes include five Arrondissements in CUA, and Anosizato Andrefana, Soavina, Andranonahoatra, Ivato, Andoharanofotsy and Itaosy. To satisfy the standard, over 100 classrooms need to be added in 1st and 4th Arrondissements, and 45 to nearly 70 classrooms should be constructed in 5th, 6th, and 2nd Arrondissements. The communes with a need for more than 15 classrooms include Andoharanofotsy, Andranonahoatra, Ivato, and Anosizato Andrefana. Besides CUA, high needs for primary school classrooms are identified in the communes in Atsimondarano and in other communes adjacent to CUA.



Source: JICA Study Team, prepared based on data from CISCO CUA, Atsimondrano, Avaradrano 2014/2015, Ambohidratrimo 2016/2017

Figure 11.6.5 Primary School: No. of Pupils per Classroom by Commune in Antananarivo Agglomeration



Source: JICA Study Team, prepared based on data from CISCO CUA, Atsimondrano, Avaradrano 2014/2015, Ambohidratrimo 2016/2017.

Figure 11.6.6 Primary School: Needs for Classrooms in Antananarivo Agglomeration

Table 11.6.10 No. of Students per Classroom and Needs for Classroom in Public Primary Schools in Antananarivo Agglomeration

No.	Commune/ Arrondissement	District	Population	No. of Schools	No. of Students	Ratio of Public School Students (%)	No. of Students/ Classroom	Needs for Classrooms	No. of Students/ Teacher
1	1er Arrondissement	CUA	280,184	19	14,310	46%	79	104	53
2	2e Arrondissement	CUA	247,309	13	6,561	35%	75	44	51
3	3e Arrondissement	CUA	139,713	13	4,524	29%	58	12	45
4	4e Arrondissement	CUA	333,288	14	11,070	33%	94	103	57
5	5e Arrondissement	CUA	397,434	16	10,718	34%	73	67	50
6	6e Arrondissement	CUA	158,226	18	7,725	50%	70	45	48
7	Ambatolampy	Ambohidratrimo	17,479	5	905	37%	36	0	
8	Ambohidratrimo	Ambohidratrimo	28,283	4	1,141	38%	41	0	
9	Ambohitrimanjaka	Ambohidratrimo	48,041	14	2,876	53%	36	0	
10	Ampangabe	Ambohidratrimo	14,872	6	1,565	68%	50	0	
11	Anosiala	Ambohidratrimo	35,540	14	2,592	47%	40	0	
12	Antehiroka	Ambohidratrimo	86,662	6	2,551	36%	50	0	
13	Ivato	Ambohidratrimo	62,045	4	2,038	31%	85	17	
14	Talatamaty	Ambohidratrimo	72,245	10	2,863	37%	57	7	
15	Alakamisy Fenoarivo	Atsimondrano	23,195	5	1,807	61%	58	5	45
16	Ambatomirahavavy	Atsimondrano	15,808	13	2,006	64%	41	0	
17	Ambavahaditokana	Atsimondrano	45,333	4	1,448	37%	69	8	50
18	Ambohidrapeto	Atsimondrano	36,286	4	1,156	31%	61	4	41
19	Ambohijanaka	Atsimondrano	20,218	5	1,347	45%	52	1	42
20	Ampanefy	Atsimondrano	18,929	5	1,214	45%	53	1	42
21	Ampitatafika	Atsimondrano	76,851	8	2,456	38%	58	7	46
22	Andoharanofotsy	Atsimondrano	72,156	5	2,593	35%	84	21	51
23	Andranonahoatra	Atsimondrano	72,674	5	2,464	40%	85	20	50
24	Ankadimanga	Atsimondrano	11,884	3	843	54%	44	0	42
25	Ankaraobato	Atsimondrano	49,047	5	1,869	41%	69	10	46
26	Anosizato Andrefana	Atsimondrano	27,955	2	1,331	39%	111	15	61
27	Bemasoandro	Atsimondrano	70,676	7	2,259	35%	63	9	48
28	Bongatsara	Atsimondrano	26,123	6	1,311	50%	44	0	42
29	Fenoarivo	Atsimondrano	37,419	7	2,222	54%	65	10	42
30	Fiombonana	Atsimondrano	13,192	2	403	38%	50	0	31
31	Itaasy	Atsimondrano	23,077	3	1,649	56%	75	11	52
32	Soalandy	Atsimondrano	14,110	6	1,219	46%	45	0	37
33	Soavina	Atsimondrano	20,760	3	1,303	56%	93	12	52
34	Tanjombato	Atsimondrano	73,545	5	3,035	43%	58	9	53
35	Tsiafahy	Atsimondrano	19,991	14	2,313	74%	37	0	35
36	Alasora	Avaradrano	59,677	11	2,418	38%	45	0	37
37	Ambohimanambola	Avaradrano	19,455	6	1,068	37%	49	0	31
38	Ambohimanga Rova	Avaradrano	23,870	15	2,265	73%	31	0	31
39	Ambohimangakely	Avaradrano	95,327	14	3,722	28%	56	8	43
40	Ankadikely	Avaradrano	110,530	16	5,224	45%	57	13	45
41	Anosy Avaratra	Avaradrano	9,234	5	980	52%	38	0	35
42	Manandriana	Avaradrano	7,757	4	621	84%	35	0	30
43	Sabotsy Namehana	Avaradrano	73,755	9	2,891	40%	53	3	37

Source: CISCO CUA, Atsimondrano, Avaradrano 2014/2015, Ambohidratrimo 2016/2017. Population: INSTAT data adjusted by JICA Study Team

2) Public Secondary Schools in Antananarivo Agglomeration

The current situations of public secondary schools are presented in Figure 11.6.7, Figure 11.6.8, and Table 11.6.11. The deficiency of classrooms for public secondary schools is also very serious in the Study Area. In 34 out of 43 communes and arrondissements, the standard of the number of students per classroom is not met. In Anosizato Andrefana and Ivato, more than 90 students, or almost doubled number of students of the standard, are studying in a classroom, and more than 80 students are in a classroom in 5th and 3rd Arrondissements, Talatamaty, and Andoharanofotsy. In terms of the needs for the classrooms, 5th and 1st Arrondissements require additional classrooms of 45 and 28 respectively, followed by 4th, 3rd, and 2nd Arrondissements, each of which requires about 20 classrooms to satisfy the standard of 50 students per classroom. A need for about 15 classrooms is found in Ankadikely and Ambohimangakely in Avaradrano District. The two communes with the most congested study environment, Anosizato Andrefana and Ivato, and Ambohitrimanjaka require about 9 classrooms each. Moreover, there is no public secondary school in three communes of Ankadimanga, Fenoarivo, and Fiombonana.

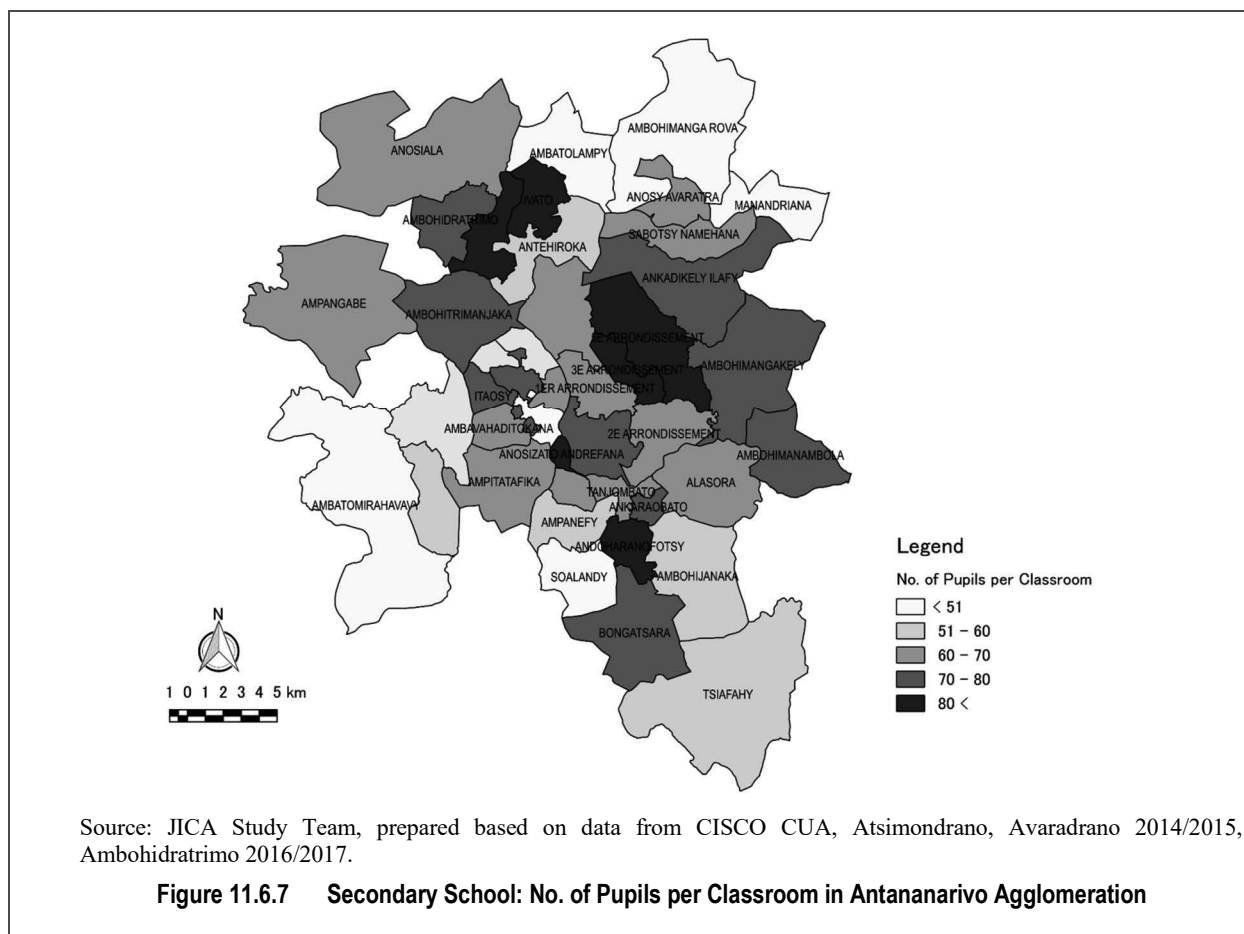
3) Public High School

The current situations of public high schools are presented in Figure 11.6.9, Figure 11.6.10 and Table 11.6.12. As shown in Figure 11.6.11, public high schools are not evenly distributed in Antananarivo Agglomeration. They are located in only half of the communes and arrondissements, and 55% of public high school students attend the schools in CUA. Not many high schools are located in communes in the south and west of the Agglomeration, while most of the communes along NR 3 and NR 2 have only one public high school in their jurisdiction.

The study environment of high schools in Andoharanofotsy, Alasora, 6th Arrondissement, and Sabotsy Namehana is very congested, having nearly 80 or more students in a classroom. Therefore, additional classrooms should be constructed in these communes. Due to the lack of public high school in the south, Andoharanofotsy needs the largest number of 13 classrooms to be constructed to satisfy the standard, followed by 6th Arrondissement and Sabotsy Namehana which require additional 9 and 8 classrooms, respectively. In 5th Arrondissement and Ivato, 5 and 4 classrooms should be added respectively.

4) Universities in Antananarivo Agglomeration

Being the capital of the country, Antananarivo hosts a number of universities and institutions of higher educations. As presented in Table 11.6.13 and Figure 11.6.12, most public universities, which are basically part of the University of Antananarivo, are located in CUA, except one which is in Alakamisy Fenoarivo. In CUA, 2nd Arrondissement hosts not only the main campus of the University but also some private universities, such as the Catholic University of Madagascar. The University of Antananarivo is the largest university in which about 30,000 students are currently enrolled.

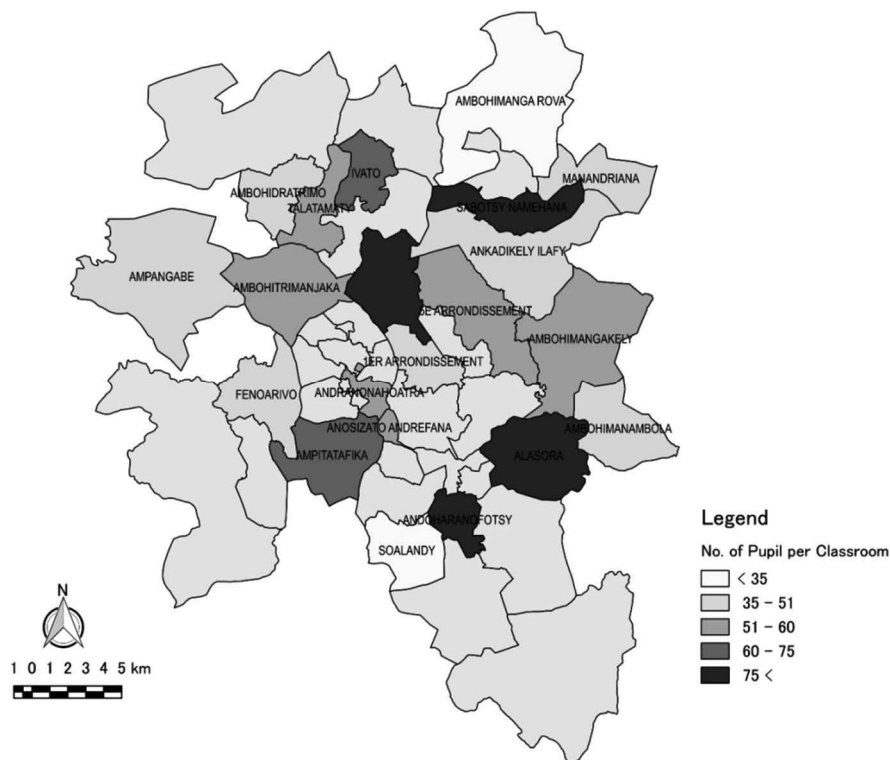


No.	Commune/ Arrondissement	District	Population	No. of Schools	No. of Students	Ratio of Public School Students (%)	No. of Students/ Classroom	Needs for Classrooms	No. of Students/ Teacher
1	1er Arrondissement	CUA	280,184	3	5,563	33%	67	28	34
2	2e Arrondissement	CUA	247,309	3	3,604	33%	66	17	29
3	3e Arrondissement	CUA	139,713	2	2,317	20%	83	18	30
4	4e Arrondissement	CUA	333,288	2	2,879	18%	78	20	31
5	5e Arrondissement	CUA	397,434	3	5,640	26%	84	45	36
6	6e Arrondissement	CUA	158,726	1	1,330	18%	67	6	27
7	Ambatolampy	Ambohidratrimo	17,479	1	243	17%	41	0	
8	Ambohidratrimo	Ambohidratrimo	28,283	1	1,102	57%	79	8	
9	Ambohitrimanjaka	Ambohidratrimo	48,041	1	1,392	46%	77	9	
10	Ampangabe	Ambohidratrimo	14,872	1	619	70%	69	3	
11	Anosiala	Ambohidratrimo	35,540	2	927	35%	66	4	
12	Antehiroka	Ambohidratrimo	86,662	1	790	21%	56	1	
13	Ivato	Ambohidratrimo	62,045	1	1,021	24%	93	9	
14	Talatamaty	Ambohidratrimo	72,245	1	664	17%	83	5	
15	Alakamisy Fenoarivo	Atsimndrano	23,195	1	1,511	62%	58	4	32
16	Ambatomirahavavy	Atsimndrano	15,808	2	666	67%	26	0	
17	Ambavahaditokana	Atsimndrano	45,333	1	459	28%	66	2	27
18	Ambohidrapeto	Atsimndrano	36,286	1	1,346	38%	75	8	27
19	Ambohijanaka	Atsimndrano	20,218	2	870	56%	58	2	24
20	Ampanefy	Atsimndrano	18,929	1	411	23%	51	0	26
21	Ampitatafika	Atsimndrano	76,851	1	1,042	29%	69	5	29

The Project on Master Plan Formulation for Economic Axis of TaToM (Antananarivo-Toamasina, Madagasikara)
Final Report: Strategies for Infrastructure Sectors in Antananarivo Agglomeration

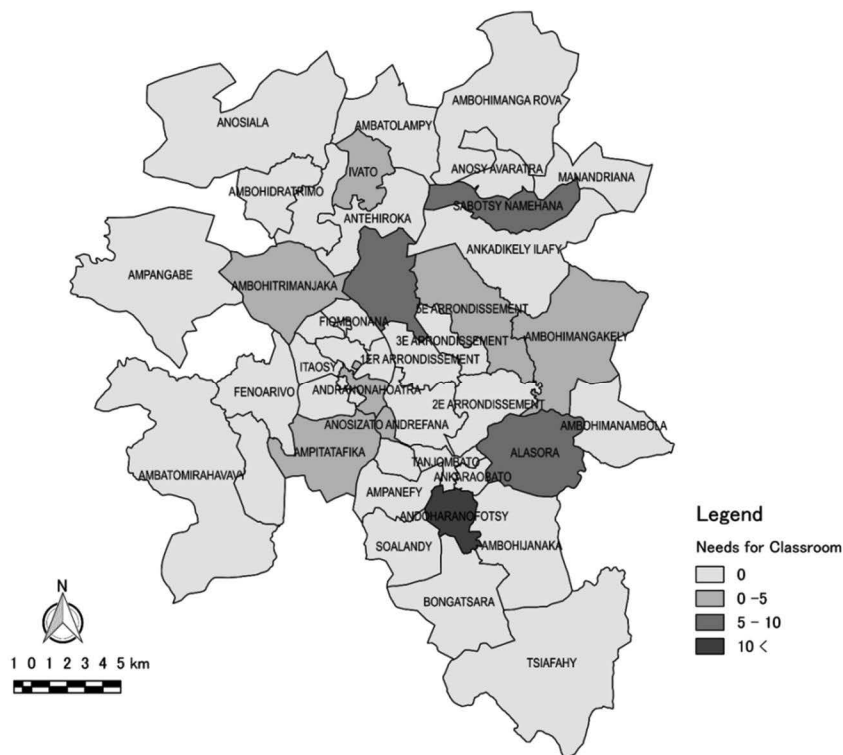
22	Andoharanofotsy	Atsimndrano	72,156	1	810	21%	81	6	25
23	Andranonahoatra	Atsimndrano	72,674	1	993	29%	50	0	34
24	Ankadimanga	Atsimndrano	11,884	0	0	0%		0	
25	Ankaraobato	Atsimndrano	49,047	1	507	19%	72	3	22
26	Anosizato Andrefana	Atsimndrano	27,955	1	880	48%	98	8	30
27	Bemasoandro	Atsimndrano	70,676	1	1,168	27%	61	4	29
28	Bongatsara	Atsimndrano	26,123	1	799	63%	73	4	35
29	Fenoarivo	Atsimndrano	37,419	0	0	0%		0	
30	Fiombonana	Atsimndrano	13,192	0	0	0%		0	
31	Itaosy	Atsimndrano	23,077	1	623	29%	78	4	28
32	Soalandy	Atsimndrano	14,110	1	327	29%	47	0	27
33	Soavina	Atsimndrano	20,760	1	486	52%	61	1	30
34	Tanjombato	Atsimndrano	73,545	1	1,189	33%	70	6	34
35	Tsiafahy	Atsimndrano	19,991	1	657	59%	60	2	41
36	Alasora	Avaradrano	59,677	1	1,155	33%	61	4	27
37	Ambohimambola	Avaradrano	19,455	1	729	50%	73	4	33
38	Ambohimanga Rova	Avaradrano	23,870	2	716	63%	48	0	22
39	Ambohimangakely	Avaradrano	95,327	2	2,285	30%	76	15	28
40	Ankadikely	Avaradrano	110,530	3	2,332	38%	78	16	30
41	Anosy Avaratra	Avaradrano	9,234	2	841	53%	60	2	24
42	Manandriana	Avaradrano	7,757	1	584	88%	49	0	28
43	Sabotsy Namehana	Avaradrano	73,755	1	1,035	25%	61	3	25

Source: CISCO CUA, Atsimondrano, Avaradrano 2014/2015, Ambohidratrimo 2016/2017. Population: INSTAT data adjusted by JICA Study Team



Source: JICA Study Team, prepared based on data from CISCO CUA, Atsimondrano, Avaradrano 2014/2015, Ambohidratrimo 2016/2017.

Figure 11.6.10 High School: No. of Pupils per Classroom in Antananarivo Agglomeration



Source: JICA Study Team, prepared based on data from CISCO CUA, Atsimondrano, Avaradrano 2014/2015, Ambohidratrimo 2016/2017.

Figure 11.6.11 High School: Needs for Classrooms in Antananarivo Agglomeration

Table 11.6.12 No. of Students per Classroom and Needs for Classrooms in Public High Schools in Antananarivo Agglomeration

No.	Commune/ Arrondissement	District	Population	No. of Schools	No. of Students	Ratio of Public School Students (%)	No. of Students/ Classroom	Needs for Classrooms	No. of Students/ Teacher
1	1er Arrondissement	CUA	280,184	4	9,460	63%	49	0	21
2	2e Arrondissement	CUA	247,309	0	0	0%		0	
3	3e Arrondissement	CUA	139,713	0	0	0%		0	
4	4e Arrondissement	CUA	333,288	0	0	0%		0	
5	5e Arrondissement	CUA	397,434	2	2,583	28%	56	5	22
6	6e Arrondissement	CUA	158,726	1	1,221	36%	81	9	24
7	Ambatolampy	Ambohidratrimo	17,479	0	0	0%		0	
8	Ambohidratrimo	Ambohidratrimo	28,283	1	1,212	81%	51	0	
9	Ambohitrimanjaka	Ambohidratrimo	48,041	1	774	51%	55	1	
10	Ampangabe	Ambohidratrimo	14,872	1	282	77%	47	0	
11	Anosiala	Ambohidratrimo	35,540	0	0	0%		0	
12	Antehiroka	Ambohidratrimo	86,662	0	0	0%		0	
13	Ivato	Ambohidratrimo	62,045	1	995	46%	66	4	
14	Talatamaty	Ambohidratrimo	72,245	1	473	23%	53	0	
15	Alakamisy Fenoarivo	Atsimndrano	23,195	0	0	0%		0	
16	Ambatomirahavavy	Atsimndrano	15,808	0	0	0%		0	
17	Ambavahaditokana	Atsimndrano	45,333	0	0	0%		0	
18	Ambohidrapeto	Atsimndrano	36,286	0	0	0%		0	
19	Ambohijanaka	Atsimndrano	20,218	0	0	0%		0	
20	Ampanefy	Atsimndrano	18,929	0	0	0%		0	
21	Ampitatafika	Atsimndrano	76,851	1	475	29%	68	2	20
22	Andoharanofotsy	Atsimndrano	72,156	1	1,512	57%	89	13	29
23	Andranonahoatra	Atsimndrano	72,674	1	833	37%	52	0	20
24	Ankadimanga	Atsimndrano	11,884	0	0	0%		0	
25	Ankaraobato	Atsimndrano	49,047	0	0	0%		0	
26	Anosizato Andrefana	Atsimndrano	27,955	1	463	84%	58	1	24
27	Bemasoandro	Atsimndrano	70,676	0	0	0%		0	
28	Bongatsara	Atsimndrano	26,123	0	0	0%		0	
29	Fenoarivo	Atsimndrano	37,419	1	516	44%	47	0	26
30	Fiombonana	Atsimndrano	13,192	0	0	0%		0	
31	Itaosy	Atsimndrano	23,077	0	0	0%		0	
32	Soalandy	Atsimndrano	14,110	1	78	47%	20	0	9
33	Soavina	Atsimndrano	20,760	0	0	0%		0	
34	Tanjombato	Atsimndrano	73,545	0	0	0%		0	
35	Tsiafahy	Atsimndrano	19,991	0	0	0%		0	
36	Alasora	Avaradrano	59,677	1	752	65%	84	6	25
37	Ambohimanambola	Avaradrano	19,455	1	404	62%	37	0	14
38	Ambohimanga Rova	Avaradrano	23,870	1	32	55%	32	0	4
39	Ambohimangakely	Avaradrano	95,327	1	591	25%	59	1	17
40	Ankadikely	Avaradrano	110,530	1	238	18%	48	0	16
41	Anosy Avaratra	Avaradrano	9,234	0	0	0%		0	
42	Manandriana	Avaradrano	7,757	1	168	100%	42	0	12
43	Sabotsy Namehana	Avaradrano	73,755	1	1,161	31%	77	8	20

Source: CISCO CUA, Atsimondrano, Avaradrano 2014/2015, Ambohidratrimo 2016/2017. Population: INSTAT data adjusted by JICA Study Team

Table 11.6.13 Major Universities Located in Antananarivo Agglomeration

No.	Name of Institution	No. of Students	No. of Staff	Total
Public Universities				
1	The University of Antananarivo	29,358	2,557	31,915
	• Faculty of Medicine	4,668	53	
	• Faculty of Arts and Humanities	4,283	124	
	• Faculty of Sciences	5,106	221	
	• Faculty of Law, Economics, Management and Sociology	10,900	50	
	• School of Agricultural Sciences	515	48	
	• Ecole Normale Supérieure	1,228	70	
	• Ecole Supérieure Polytechnique of Antananarivo	2,658	150	
	• The Institute of Civilization Museum of Art and Archaeology			
	• Others		1,841	
	• Geophysical Institute and Observatory of Antananarivo			
	• Institute of Global Health Charles Mérieux			
	• Institute of Energy Management			
	• Radioisotope Laboratory			
Private Universities				
2	Higher Institute of Communication, Business and Management (Private)	1 000		
3	Higher Institute of Technology in Antananarivo	1 300	140	1 440
4	National Institute of Public Health			
5	Catholic University of Madagascar	1 400		
6	INSCAE (National Institute of Science Accounting and Business Administration)			
7	IEP (Institute of Political Studies)			
8	IMGAM (Institute of Management, Arts and Crafts)			
9	ISPM (Polytechnic Institute of Madagascar)			
10	IFT (Technical Training Institute)			
11	ESSCA (Ecole Supérieure Sacré Coeur : Catholic Private Institute on Business and Management)			
12	UPRIM (Private University of Madagascar)			
13	ACEEM (Private Institute on Finance, Economics and Management)			
	Private Universities Total (Including the numbers not specified in cells above)	21,00	997	22,297

Source: Ministry of Higher Education



Figure 11.6.12 Location Map of Public Universities in Antananarivo Agglomeration

11.6.2 Issues on Education Infrastructure of Antananarivo Agglomeration

From the analysis above, issues on development for educational infrastructure that are concerned with the planning of PUDi are discussed in this section. The issues are important concerns related to the educational infrastructure to be addressed as part of physical planning and implementation of PUDi. Before the discussion of the issues, the current situation and problems are summarized by district.

The main issue concerned with the educational infrastructure in Antananarivo Agglomeration is the lack of classrooms, in other word that is how to meet the current and future demands for the schools (see Table11.6.14). The issues on current classroom needs are discussed in more detail by district and commune below.

Table11.6.14 Summary of Classroom Needs by District

District	No. of Students per Classroom			Needs of Classrooms		
	Primary	Secondary	High School	Primary	Secondary	High School
CUA	76	74	52	376	134	14
Ambohidratrimo	47	72	55	24	39	5
Atsimondrano	59	64	62	143	59	16
Avaradrano	47	66	61	24	44	15
Total	61	69	55	567	276	50

Source: JICA Study Team

(1) CUA

The deficiency of classrooms at all school levels is salient concern in CUA. Specifically, the classroom needs for primary schools is very high in 1st and 4th Arrondissements where more than 100 classrooms are required to be constructed. Basically, all arrondissements, except 3rd Arrondissement, have high demand for classrooms. For secondary schools, 5th Arrondissement needs 45 additional classrooms. High school classrooms are insufficient in 5th and 6th Arrondissements. Among the Arrondissements, it is in 5th Arrondissement where there is not sufficient educational infrastructure at all levels.

(2) Ambohidratrimo

In the District of Ambohidratrimo, classrooms at all school levels are lacking in Ivato. Ambohidratrimo and Ambohitrimanjaka need classrooms for secondary schools. It is assumed that high population growth near the airport is generating demands for classrooms. Because the communes in the western side of Ikopa River do not have good access to the eastern side, commuting to high schools in the communes in the District of Atsimondrano might need to be considered, though the school district of high schools is equal to the jurisdiction of district.

(3) Atsimondorano

The communes along NR1 and NR 7 lack sufficient classrooms for primary schools. Specifically, the deficiency of classrooms at all school levels is identified in the Communes of Andoharanofotsy and Anosizato Andrefana. For primary schools, Andranonahoatra has one of the highest needs of 20 classrooms; while for secondary schools, each commune of Ambohidrapeto, Tanjombato, and Ampitatafika needs more than five additional classrooms. In general, the communes in the western bank of Ikopa River have high demands for primary and secondary classrooms, reflecting the recent population growth. A significant need for classrooms of high school is found in the Commune of Andoharanofotsy along NR 7 in the south.

(4) Avaradrano

The two communes of Ankadikely Ilafy and Ambohimangakely have high demands for classrooms of primary and secondary schools. Located along NR 3 and NR 2, high population growth is anticipated in the two communes in the future as well. In terms of high school facility, a need for 6 to 8 classrooms is identified in Sabotsy Namehana and Alasora.

From the analysis above, the issues in terms of classroom deficiency in Antananarivo Agglomeration is summarized as follows:

- Significant needs for classrooms in almost all school levels in newly developed areas and subcentres along national roads (deficiency in all schools: 5th Arrondissement, Ivato, Andoharanofotsy, and Anosizato Andrefana; deficiency in primary and secondary schools: Ankadikely Ilafy and Ambohimangakely),
- High demand for primary school classrooms in CUA and in the communes in the western part of the agglomeration,
- The capacity of secondary schools is insufficient in communes outside CUA,
- Additional high school classrooms should be developed in the south and the west part, as well as in 5th and 6th Arrondissements of CUA.
- There are fokontany without any public primary school, and three communes have no public secondary school.

In planning of the education facilities in this study, two important factors should be considered in addition to the current needs for schools, namely, the future enrolment ratio and transition to 9-year fundamental education.

PSE sets the target to double the completion rates of the secondary and high schools by 2030, which means that the students of secondary and high schools will increase dramatically (see Table 11.6.15 and Table 11.6.16). Moreover, annual population growth rate of over 3% is expected to continue by 2033 in the agglomeration as shown in Table 11.6.17.

Furthermore, the 9-year fundamental education system consisting of 3 sets of 3-year sub-cycle is introduced to raise the enrolment ratios of primary, secondary, and high schools and the transition to the new system is planned to start from the academic year of 2020. Due to the lack of budget, however, construction of new schools to accommodate all students of 9 grades is not expected. Instead, the current school buildings are planned to be used continuously such that students will study for 6 years at the current primary schools to complete the first two sub-cycles, and then continue to study at the current secondary schools to finish the last 3-year cycle. Thus, the enrolment ratios of secondary and high schools are expected to increase for the time being and new schools for 9-year education would be constructed in the long term. A huge demand for all levels of school facilities is anticipated in the future, in addition to the current needs. However, the classroom needs estimated in PSE (i.e., 619 classrooms for primary and secondary schools) is too low compared to the current needs, since the primary and secondary classroom needs in Antananarivo Agglomeration alone reach 567 classrooms and 276 classrooms, respectively, which exceed the estimates of PSE.⁵

Table 11.6.15 Enrolment Ratios at Primary, Secondary, and High Schools in Antananarivo and National Average

Location		Primary School		Secondary School		High School	
		Net	Gross	Net	Gross	Net	Gross
Capital City		87.8%	121.4%	57.3%	81.9%	30.0%	62.2%
National Average	Cities (excluding Antananarivo)	84.4%	127.8%	54.8%	88.2%	28.2%	72.0%
	Rural	66.1%	105.7%	22.3%	37.5%	5.9%	13.6%
	Country	69.4%	108.4%	27.8%	45.5%	10.0%	23.4%

Source: INSTAT/ ENSOMD 2012-2013

⁵ See Table 11.6.5.

Table 11.6.16 Target Indicators by 2030 in PSE

	2015	2022	2030*	2030**
Primary Completion Rate	69%	70%	100%	100%
Effective Transition Rate from Primary to Secondary General	83%	88%	97%	93%
Secondary 1 st Cycle Completion Rate	38%	44%	89%	88%
Secondary 2 nd Cycle Completion Rate	18%	18%	25%	42%

Source: PSE 2018-2022

* Scenario that assumes external financing to achieve the SDG 4

** Scenario that assumes a constant external financing

Table 11.6.17 Population Framework by 2033 for Antananarivo Agglomeration

		1993*	2018	2023	2028	2033
CUA	Population	710,000	1,275,207	1,426,472	1,586,890	1,763,099
	Annual Growth Rate		2.37%	2.27%	2.15%	2.13%
Outside CUA	Population	406,000	1,283,038	1,596,175	1,960,581	2,388,368
	Annual Growth Rate		4.71%	4.46%	4.20%	4.03%
Antananarivo Agglomeration	Population	1,116,000	2,558,245	3,022,647	3,547,471	4,151,467
	Annual Growth Rate		3.37%	3.39%	3.25%	3.19%

Source: JICA Study Team

The important question is, therefore, how to increase the provision of educational facilities in order to meet the current and future demands for educational infrastructure. As discussed, because the significant deficiency of classrooms at all levels of schools is found in newly developed areas and centres of suburban areas, development of educational infrastructure should be incorporated in the development plans of suburban and residential areas since the beginning.

On the other hand, because only limited space is available in the urbanized area of CUA, it is necessary to use the land intensively by constructing high-rise school buildings. In addition, new urban development of landfilling, for example, should be mandated to examine the impacts of development on the need for educational facilities, if residential development is planned.

The future urban structure of Antananarivo Agglomeration is directed to de-concentrate the urban centre while developing suburban centres. Thus, it might be possible to encourage migration from the congested urban centres by strategically accelerating the provision of education facilities in the suburban areas as a priority.

In spite of the efforts to increase the capacity of public schools, however, it is less likely to build sufficient classrooms by MEN and the public sector to accommodate the current and future demands for schools in the Study Area. In fact, PSE predicts that the share of students enrolled in private high schools would expand. Considering that the ratios of students per classroom and teacher for the private schools are lower than the standard, that means private schools still have the capacity to accept more students. Thus, a realistic assumption is that the private sector will keep playing an important role in the provision of educational service in Antananarivo Agglomeration in future. Another option to address the lack of classrooms would be to encourage construction of schools by the private sector, including the community and NGOs, and also to improve the quality of private education.

11.6.3 Objectives for Education Infrastructure Development in Antananarivo Agglomeration

From the analysis and discussion on the current situations of educational infrastructure in Antananarivo Agglomeration, the objectives of the educational infrastructure development in PUDi 2033 are proposed as follows:

Objective 1: To expand the capacity of schools in CUA to meet the current and future demands for all levels of schools

- ✓ By increasing the capacity of public schools by developing new public schools in newly developed areas and expanding the existing public schools' capacity in the urbanized areas
- ✓ By expanding the capacity of private schools through proper guidance and regulations
- ✓ By creating and securing lands for new public schools

Objective 2: To plan and develop public primary and secondary (combined) schools, and high schools in newly developed urban sub-centres and suburban centres outside the CUA within Antananarivo Agglomeration

Objective 3: To develop primary and secondary schools outside the CUA together with suburban residential development

11.6.4 Strategies for Education Infrastructure of Antananarivo Agglomeration

In order to achieve the objectives and tackle the issues identified above, the following strategies are formulated in relation to urban development of Antananarivo Agglomeration:

(1) Strategy 1: To expand the capacity of public and private schools in CUA

In order to expand the capacity of public and private schools of primary, secondary, and high schools, four sub-strategies are identified. Strategy 1-1 and 1-4 aim to develop new public schools as part of urban development in land landfilling projects or redevelopment of the lands after relocation of some facilities. Strategy 1-2 intends to utilize the land of the existing schools more effectively. On the other hand, Strategy 1-3 tries to expand the supply of education service by the private sector.

Strategy 1-1: To construct large scale public primary and secondary schools and high schools in the area where landfilling is planned for urban development projects (The school buildings are to be developed as multifunctional facility, i.e., as community centre cum evacuation centre during disaster. School grounds are to be used as sports grounds for communities)

Strategy 1-2: To construct high-rise school buildings, including re-construction of school buildings, by using land of existing public schools intensively

Strategy 1-3: To improve the capacity and quality of private schools by establishing the regulations, improving the monitoring and evaluation, conducting training to instructors, and providing supports

Strategy 1-4: To develop public and private schools by encouraging relocation of factories, logistics facilities, and other large-scale public and private facilities, which are not always necessary within CUA, to suburban communes within the Antananarivo Agglomeration

(2) Strategy 2: To develop public primary and secondary (combined) schools, and high schools in newly developed urban sub-centres and suburban centres outside the CUA within Antananarivo Agglomeration

This strategy aims to specify locations and land for education facilities in the planned urban centres outside the CUA. The PUDi for Antananarivo Agglomeration recommends the development of new urban sub-centres and new suburban centres outside the CUA in order to induce residential development in these areas.

(3) Strategy 3: To develop new public primary and secondary schools in residential development sites in suburban areas outside the CUA, by obligating the formulation of PUDé for developing residential areas accommodating new public primary and secondary schools

When residential development, such as sub-division type of development, is planned in suburban areas, evaluation of the impact of the residential development on school needs should be obligated as part of the approval process of the development project, in order to predict the number of prospective students and assess future capital investment needs. Based on the capital investment plan, public primary and secondary schools should be constructed.

11.6.5 Programmes and Projects for Education Infrastructure of Antananarivo Agglomeration

The following programmes and projects are proposed, aiming to operationalize the strategies and achieve the objectives.

(1) Programme for Education Hub Development in Antananarivo Agglomeration

Despite current significant deficiency and increasing needs for school facilities, land is not available for such purposes in CUA and development of new schools has not been planned due to financial constraint. In particular, a high demand for high school classrooms is found in suburban communes and in the outskirts of CUA that are currently experiencing population growth and, thus, expecting student growth in the future as well. This project aims to develop education hubs, where a large-scale public primary and secondary school (9-year fundamental education school) and high school are located, in Antananarivo Agglomeration in the newly developed areas of CUA, and in urban sub-centres and suburban centres outside CUA.

The objectives of the programme, therefore, is to develop areas where high population growth is expected, and development of centres as education hubs are planned by constructing a large-scale public primary and secondary school (9-year fundamental education school) and a new high school. This project also intends to support the transition to the new education system and to accelerate the education reform by developing new model public schools that are able to set the development standards of school buildings and other planning requirements. By developing all levels of schools in several education hubs scattered across the Agglomeration, the project aims to contribute to the improvement of education quality and performance, which are indispensable for the economic growth of Madagascar.

The education hubs will include the following areas:

- Newly developed areas in CUA by landfilling
- Urban sub-centres outside CUA
- Suburban centres outside CUA
- Vacant lands after relocation of factories and other facilities in CUA

In accordance with the PUDi for Antananarivo Agglomeration, PUDés should be formulated for these areas for urban development and urban centre establishments so as to specify the location of schools. Lands for the education facilities should be secured by implementing regulatory measures, such as issuance of an ordinance or decree. The capacity of schools will be determined by estimating the current and future demands for high schools. The school buildings will be designed to have necessary disaster resilience and to function as multifunctional facility, i.e., community centre cum evacuation centre during times of disaster.

(2) Project for Constructing High-Rise Public School Buildings in CUA

This project aims to develop high-rise public school buildings for the capacity expansion of public schools in CUA, by effective and intensive use of lands of existing public schools. In this project, therefore, the existing deteriorated schools will be replaced by constructing new high-rise school buildings.

In the project, it is important to include the components of development of design standards for high-rise school buildings adjusted for the adoption of the new 9-year fundamental education system, and construction of high-rise public school buildings for high priority schools.

(3) Projects for Development of New Public Primary and Secondary Schools (9-year Fundamental Education) in Suburban Areas Outside CUA

This project aims to develop new public primary and secondary schools (9-year fundamental education) as part of residential development in suburban areas outside CUA. Because residential development is expected in suburban areas in the planning period, it is necessary to plan public primary and secondary schools in advance as part of the residential development plan and to develop schools in parallel with the implementation of residential development projects. When a developer proposes a residential development plan, a school development plan should be integrated in the plan and developed with the progress of the project. New schools can be developed ahead of residential development in order to promote development of certain suburban areas.

(4) Private School Improvement and Capacity Expansion Programme

The importance of the private sector in education cannot be ignored now and in the future, since the shortage of schools in Antananarivo Agglomeration cannot be resolved by the sole efforts of the public sector. However, private schools and education are not well regulated, and less qualified staffs are engaged in teaching in some private schools. An initiative to develop a legal framework for private education just started recently. Therefore, this project is proposed to enhance private education by establishing the appropriate legal framework on private schools, strengthening monitoring and management of private schools, improving the quality of education and study environment, and expanding the capacity of the private schools. To promote private school development, certain areas lacking sufficient schools can be specified as a special zone and land will be preferentially prepared in the areas where new residential development is planned.

11.6.6 Profiles of Priority Projects for Education Infrastructure of Antananarivo Agglomeration

(1) Programme for Development of Education Hubs in the Primary Urban Centre and Urban Sub-Centres of Antananarivo Agglomeration

1) Rational

Improvement of education is an urgent task for development of Antananarivo Agglomeration and Madagascar. The education sector performance in Madagascar has been deteriorating in last few decades, of which low quality education has become hindrance to economic and industrial development of the country.

In Antananarivo Agglomeration, relatively good quality and facilities of education services are available; however, there is no land available for expansion or development of schools in highly congested CUA urban centres, despite the impending needs for school capacity expansion. In order to meet the current needs for primary and secondary education or the newly introduced 9-year fundamental education and prepare for the growing demand for high school education, therefore, it is important to secure land for the 9-year fundamental education schools and high schools in advance in the locations where future population growth is expected.

Meanwhile, the currently undergoing education reform from primary and secondary education to the integrated 9-year fundamental education should be supported by developing appropriate school facilities corresponding to the modification of the school curriculum. This is because development of “model schools” for the new education system can contribute to acceleration of the education reform, by setting new development standards for school facilities and planning requirements.

In many cases, private schools are relatively of small scale in Madagascar. However, for establishing the Education Hubs, it is necessary to strategically mobilize private sectors, as well as public resources.

Therefore, it is necessary to develop all levels of schools in several education hubs scattered across the Agglomeration for the improvement of education quality and performance, which are indispensable for the economic growth of Madagascar.

2) Objectives

- To expand the classroom capacity of the 9-year fundamental education and high-school in Antananarivo Agglomeration, to meet the needs of the current and future students by developing “Education Hubs” consisting of large scale public model schools for the 9-year fundamental educations and high schools, strategically in the new urban centres (Ankorondrano Primary Urban Centre, Mahazoarivo Urban Sub-Centre, Namehana Urban Sub-Centre, and Tana Masoandro, Urban Sub-Centre) adjacent to the CUA where the already demand for school facilities is high and the large-scale and new urban centre development is planned with land-filling, and strategically by involving private sectors in establishment of Education Hubs
- To support the education sector reform introducing the 9-year fundamental education by specifying new school facility standards and developing “model schools
- To improve the education performance, especially of secondary and high school levels

3) Project Description

This programme is composed of the following four priority projects:

- Project of Development of Education Hub at Ankorondrano Primary Urban Centre
- Project of Development of Education Hub at Namehana Urban Sub-Centre
- Project of Development of Education Hub at Amoronakona Urban Sub-Centre
- Project of Development of Education Hub at Tana Masoandro Urban Sub-Centre

Each project of this programme has the following components:

- To develop an “Education Hub” consisting of large-scale public model schools for the 9-year fundamental education and 3-year high school (8 classes at each grade) in the new urban centre
- To develop new design standards for the school facilities including installing measures for necessary disaster resilience and multifunctional facility space for, i.e., community centre cum evacuation centre during times of disaster
- To develop access roads, water supply and other necessary infrastructure

4) Expected Benefits

By construction of the model schools and high schools, shortage of classrooms will be mitigated and better learning environment will be provided for the students of the 9-year fundamental education and high schools. As a result, enrolment and completion ratios of secondary levels and high school level education and education performance will be improved. Eventually this project will contribute to the improvement of human resources quality.

5) Executing Agency and Related Institutes

- Ministry of National Education and Technical and Vocational Education
- MAHTP
- JIRAMA

6) Estimated Project Cost

- 17 million USD for Project of Development of Education Hub at Ankorondrano Primary Urban Centre
- 17 million USD for Project of Development of Education Hub at Namehana Urban Sub-Centre
- 17 million USD for Project of Development of Education Hub at Amoronakona Urban Sub-Centre
- 17 million USD for Project of Development of Education Hub at Tana Masoandro Urban Sub-

Centre

7) Implementation Schedule

The projects of the programme are to be implemented in Phase 2 (2024-2028) of Project TaToM.

Each project will be done in the following steps:

- Basic Design (4 months)
- Detailed Design (12 months)
- Construction (24 months)

8) Necessary Actions for Implementation / Critical Factor

- Land acquisition or land arrangement in new development areas of the urban centres to be developed

9) Related Plans and Projects

- Project for Promotion of Development of Ankorondrano Primary Urban Centre
- Project for Promotion of Development of Amoronakona Urban Sub-Centre
- Project for Promotion of Development of Namehana Urban Sub-Centre
- Project for Promotion of Development of Tana Masoandro Urban Sub-Centre

10) Social and Environmental Impacts

- No serious environmental and social impact is expected by implementing this project.

(2) Programme for Development of Education Hubs in Suburban Areas of Antananarivo Agglomeration

1) Rational

As described in the section of the Rational for Project of “Urban Sub-Centre Education Hub Development Project,” improvement of the education sector is necessary in Antananarivo Agglomeration. The provision of education facilities, in particular of the secondary and high school levels needs a long-term perspective and continuous investments. While the aforementioned project aims for expansion of the capacity of the schools in urban sub-centres close to CUA to meet the current acute needs for the education facilities, it is also important to develop new education hubs in sub-urban centres at the fringe of the Agglomeration where urbanization of vast areas are expected. Considering the development of sub-urban centres and spatial distribution of the existing schools, locations of education hubs should be specified in advance as part of sub-urban centre development plans in order to narrow the gap between the needs and actual capacity of the schools, by formulating PUDés to secure the land.

In many cases, private schools are relatively of small scale in Madagascar. However, for establishing the Education Hubs, it is necessary to strategically mobilize private sectors, as well as public resources.

2) Objectives

- To expand the classroom capacity of the 9-year fundamental education and high-school in Antananarivo Agglomeration, to meet the needs of the current and future students by developing “Education Hubs” consisting of large scale public model schools for the 9-year fundamental educations and high schools, strategically in the new urban sub-centres (Fenoarivo and Anjomakely) in suburban areas where the future population growth is expected and strategically by involving private sectors for developing the Education Hubs
- To support the education sector reform introducing the 9-year fundamental education by developing “model schools

- To improve the education performance, especially of secondary and high school levels

3) Project Description

This programme is composed of the following four priority projects:

- Project of Development of Education Hub at Fenoarivo North New Town
- Project of Development of Education Hub at Anjomakely Suburban Centre

Each project of this programme has the following components:

- To develop “Education Hubs” consisting of large-scale public model schools for the 9-year fundamental educations and high schools (8 classes at each grade) in the new town and urban sub-centre
- To develop access roads, water supply and other necessary infrastructure

4) Expected Benefits

By construction of the model schools and high schools, shortage of classrooms will be mitigated and better learning environment will be provided for the students of the 9-year fundamental education and high schools. As a result, enrolment and completion ratios of secondary levels and high school level education and education performance will be improved. Eventually this project will contribute to the improvement of human resources quality.

5) Executing Agency and Related Institutes

- Ministry of National Education and Technical and Vocational Education
- MAHTP
- JIRAMA

6) Estimated Project Cost

- 17 million USD for Project of Development of Education Hub at Fenoarivo North New Town
- 17 million USD for Project of Development of Education Hub at Anjomakely Suburban Centre

7) Implementation Schedule

The projects of the programme are to be implemented in Phase 3 (2029-2033) of Project TaToM.

Each project will be done in the following steps:

- Basic Design (4 months)
- Detailed Design (12 months)
- Construction (24 months)

8) Necessary Actions for Implementation / Critical Factor

- Land acquisition or land arrangement in new development areas of the new town and urban centre to be developed

9) Related Plans and Projects

- Project for Promotion of Development of Alakamisy Fenoarivo Suburban Centre
- Project for Promotion of Development of Anjomakely Suburban Centre on NR7

10) Social and Environmental Impacts

- No serious environmental and social impact is expected by implementing this project.

Chapter 12 Spatial Development Strategies for Surrounding Areas of Antananarivo Agglomeration

12.1 Spatial Development Framework for Antananarivo Sub-Region

In this chapter, overall spatial development framework for Antananarivo Sub-Region and general spatial development strategies for Antananarivo Sub-Region outside Antananarivo Agglomeration will be discussed. Antananarivo Sub-Region covers the four districts of Analamanga Region, namely Ambohidratrimo, Atsimondrano, Antananarivo Renivohitra and Avaradrano (See Figure 12.1.1).

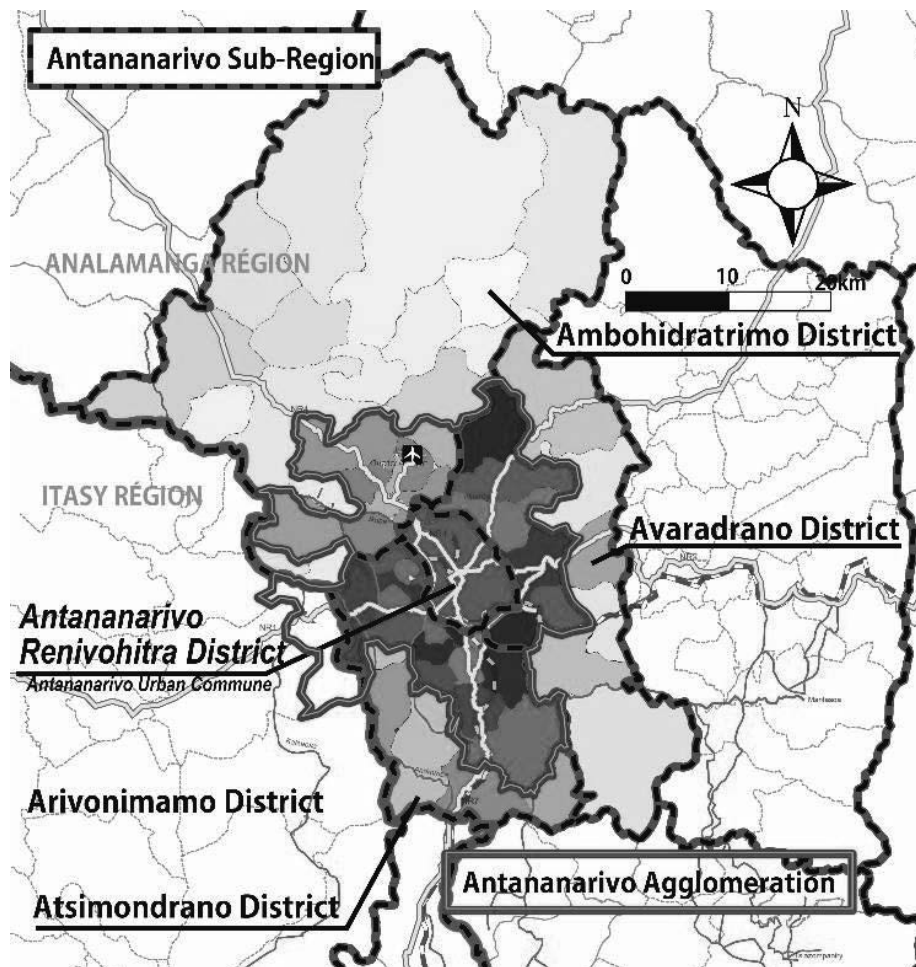


Figure 12.1.1 Antananarivo Sub-Region

12.2 Future Population Framework of Antananarivo Sub-Region

The population of the Antananarivo Sub-Region is estimated to be 2.81 million in 2018. The population of the sub-region is concentrated in Antananarivo Agglomeration with approximately 90% of the population in the Sub-Region living within this capital sphere.

The population outside Antananarivo Agglomeration, where the remaining 10% of the population inhabits, is expected to reach approximately 366 thousand in 2033.

Table 12.2.1 Future Population Framework of Antananarivo Sub-Region

		1993	2018	2023	2028	2033
Antananarivo Renivohitra	Population	710,236	1,275,207	1,426,472	1,586,890	1,763,099
	Annual Growth Rate		2.37%	2.27%	2.15%	2.13%
Antananarivo Avaradrano	Population	163,471	449,425	545,459	654,378	779,300
	Annual Growth Rate		4.13%	3.95%	3.71%	3.56%
Ambohidratrimo	Population	185,146	441,682	532,217	633,912	749,514
	Annual Growth Rate		3.54%	3.80%	3.56%	3.41%
Antananarivo Atsimondrano	Population	229,597	642,364	782,359	941,872	1,125,610
	Annual Growth Rate		4.20%	4.02%	3.78%	3.63%
Antananarivo Sub-Region	Population	1,288,450	2,808,678	3,286,507	3,817,052	4,417,523
	Annual Growth Rate		3.47%	3.47%	3.42%	3.27%
Antananarivo Agglomeration (not including Ambatomirahavavy)	Population	1,116,000	2,521,376	2,971,246	3,475,810	4,051,560
	Annual Growth Rate		3.31%	3.34%	3.19%	3.11%
Outside Antananarivo Agglomeration	Population	172,450	287,302	315,261	341,242	365,963
	Annual Growth Rate		2.06%	1.87%	1.60%	1.41%

Source: JICA Study Team

12.3 Strategies for Transport Sector in Antananarivo Sub-Region

12.3.1 Present Situation of Transport Sector in Antananarivo Sub-Region

Compared to other regions of the country, Analamanga Region is endowed with exceptional transport infrastructures with a very dense road network and a rail network composed of two main axes (TCE - MLA and Antananarivo-Antsirabe).

The sub-regions of Antananarivo are organized around five national roads that leave from the city centre to reach:

- Toamasina, provincial capital and the largest port of Madagascar (NR2);
- Mahajanga, provincial capital and 4th largest city of Madagascar (NR4);
- Toliara, provincial capital, passing through Fianarantsoa, provincial capital and Antsirabe, capital city of Vakinankaratra Region and 3rd largest city of Madagascar and industrial city (NR7)
- Tsiroanomandidy, capital city of Bongolava Region (NR1) and
- Anjozorobe, capital city of a District in Analamanga Region (NR3)

Communes locating between the national roads are served by 178 km of provincial roads and are connected by intercommunal roads.

Table 12.3.1 Paved Roads and Unpaved Roads in Antananarivo Sub-Region

Road	Location	Length	Paved portion	Non-paved portion
1.T	Anosizato (RN1) – Ambohijoky (RN7)	16	1	9
6.T	Ambohimanga (RN3) – Mahitsy (RN4)	12	2	10
7.T	Fenoarivo (RN1) – Ampagambe (District Ambohidratrimo)	14	1	13
8.T	RN7/PK22 - RN1/PK8	27	5	22
11.T	RN7/PK16+300 - ANKADITDRATOMBO (bypass)	15	4	11
15.T	RN2 - FIEFERANA TALATA VOLONONDY (RN3)	29	0	29
18.T	IVATO- RN3- LAZAINA-RP33T	11	0	11
21.T	ANKADINANDRIANA –TSIAFAHY (RN7)	20	0	20
24.T	ANKADIVORYBE - ANDOHARANOFOTSY (RN7)	7	0	7
25.T	AMBATOFOTSY - FIEFERANA	12	0	12
26.T	SABOTSY –ANTANAMBAO	10	3	7
153.T	ANDRANONAHOTRA –ANJAKAIVO	5	0	5

However, the networks in the region are more and more deteriorating and are considered inadequate to population growth. Indeed 75% of RIP and intercommunal roads are in poor condition, and sometimes not passable during the rainy seasons, making some hamlets and productive village inaccessible and isolated.

The transport network to Antananarivo Agglomeration from these communes outside Antananarivo Agglomeration is important for delivering fresh vegetables and other daily products to the capital. Therefore, road infrastructures play an important role in the development of sub-region, as these communes outside Antananarivo Agglomeration is rural. This will also help the residents in these communes to access to secondary and tertiary health and education facilities.

12.3.2 Issues on Transport Sector in Antananarivo Sub-Region

The main issue on transport sector in Antananarivo Sub-Region is the inadequate or poorly maintained transport infrastructure in some part of the sub-region. The increasing urban population of Antananarivo Agglomeration will continue to rely on the production of vegetables and dairy products from these neighbour rural communes. In order to improve the transport of goods to Antananarivo Agglomeration, connectivity from the agricultural production areas to the markets of the suburban centres in each districts is essential.

12.3.3 Objective for Transport Sector in Antananarivo Sub-Region

The objective for the development of transport sector is to improve mobility and connectivity between the rural communes in the sub-region outside Antananarivo Agglomeration and all the suburban centres to be developed in each district within Antananarivo Agglomeration.

12.3.4 Strategy for Transport Sector in Antananarivo Sub-Region

The strategy for the development of transport sector is to rehabilitate the RIP and intercommunal roads which connects to the national roads.

12.4 Strategies for Conservation Areas in Antananarivo Sub-Region

12.4.1 Background on Conservation Areas in Antananarivo Sub-Region

Analamanga Region is part of the great basin of Betsiboka and some small oriental basins. The large basin of Betsiboka is composed: on the one hand of Ikopa Basins which covers an area of 19,000 km² of which 9,268 km² is home to the three Districts (Avaradrano, Atsimondrano and Ambohidratrimo); and from the upper Betsiboka Basin, which covers an area of 8,064 km² of the eastern and northern boundary of Analamanga Region at the regional boundaries of Antananarivo.

It should be noted that the Betsiboka Basin drains a total area of 49,000 km² making it the 3rd largest basin of the island after Mangoky (55,750 km²) and Tsiribihina (49,800 km²). It belongs to the West and North-West Slopes following the natural division of the Malagasy hydrographic network.

Regarding hydrological point, the Analamanga Region belongs to the central uplands regime. It is crisscrossed by two large rivers that are Betsiboka and Ikopa.

The Analamanga Sub-Region is mainly drained by the Ikopa River, which has its source in Angavokely and receives inputs from other tributaries, particularly Sisaony, Andromba, Katsaoka, Manankazo, Ikotoratsy, Isandrano and Imamba.

These rivers and the catchment area of Ikopa play an important role not only for the drainage of the plain, and the irrigation of the agricultural perimeters in the sub-regions, but also for its protection against flooding.

However, watersheds are in a state of degradation due to bushfire and deforestation. The erosion of catchments causes siltation of rivers and lowland plains. In fact, the degradation of the Ikopa

watershed is likely to have a significant impact on the agricultural production of the sub-regions and on the protection of these sub-areas against flooding.

12.4.2 Issues on Conservation Areas in Antananarivo Sub-Region

Protecting watersheds, irrigated perimeters and watercourses are considered as an issue of economic development and improvement of standard of living in Antananarivo Sub-Regions.

Moreover, protection of the buffer area along these rivers is essential to prepare for disaster risk reduction.

12.4.3 Objective for Conservation Areas in Antananarivo Sub-Region

The objective for conservation areas in Antananarivo Sub-Region is to ensure sustainable water and soil management.

12.4.4 Strategies for Conservation Areas in Antananarivo Sub-Region

The strategy for conservation areas in Antananarivo Sub-Region is to implement the following watershed management programmes:

- Reforestation and soil conservation in the catchment area of Ikopa.
- Reinforcement of flood containment and flood transit on Ikopa
- Protection of the banks of the Ikopa River

Chapter 13 Action Plan for Integrated Urban Development in Antananarivo Agglomeration

13.1 Introduction

It is possible to achieve effective urban development when different types of actions are combined in a timely manner. For example, residential area development requires not only land development in accordance with land use regulations, but also provision of access roads and power supply and water supply. At the same time, in a wider view, drainage capacity needs to be rehabilitated for reducing inundation impact. Moreover, recycling factories and final disposal sites are also to be developed for solid waste management. That is, integrated development is essential for realizing a better urban agglomeration. Such integrated urban development is necessary not only at the local level, but also at the agglomeration level.

The PUDi is composed of the following components:

- Urban Development Strategies and Priority Projects,
- Land Use Policy and Land Use Zoning Regulations,
- Strategies for Development of Economic Sectors and Priority Projects,
- Strategies for Disaster Risk Reduction and Management and Priority Projects,
- Strategies for Road and Transport Development and Priority Projects, and
- Strategies for Development of Infrastructure Sectors and Priority Projects.

In order to implement the Revised PUDi for Antananarivo Agglomeration, an Action Plan is formulated by consisting of the following three sets of actions:

- Capacity Development for Communes in Utilization of Land Use Zoning Regulations in Antananarivo Agglomeration (See Section 6.6.1),
- Action Areas to Promote Integrated Urban Development in Antananarivo Agglomeration, and
- Priority Projects and High Priority Projects of Various Sectors in Antananarivo Agglomeration.

The first action is as described in Section 6.6.1. In this chapter, the remaining two actions are described.

13.2 Action Areas to Promote Integrated Urban Development in Antananarivo Agglomeration

13.2.1 Introduction

In order to promote integrated urban development described by the PUDi, it is necessary to take concerted actions at the local level, as well as at the agglomeration level.

In order to achieve the integrated urban development envisioned by the PUDi, the following different types of action areas are required:

- Action Areas for Development of Urban Centres and their Surrounding Areas

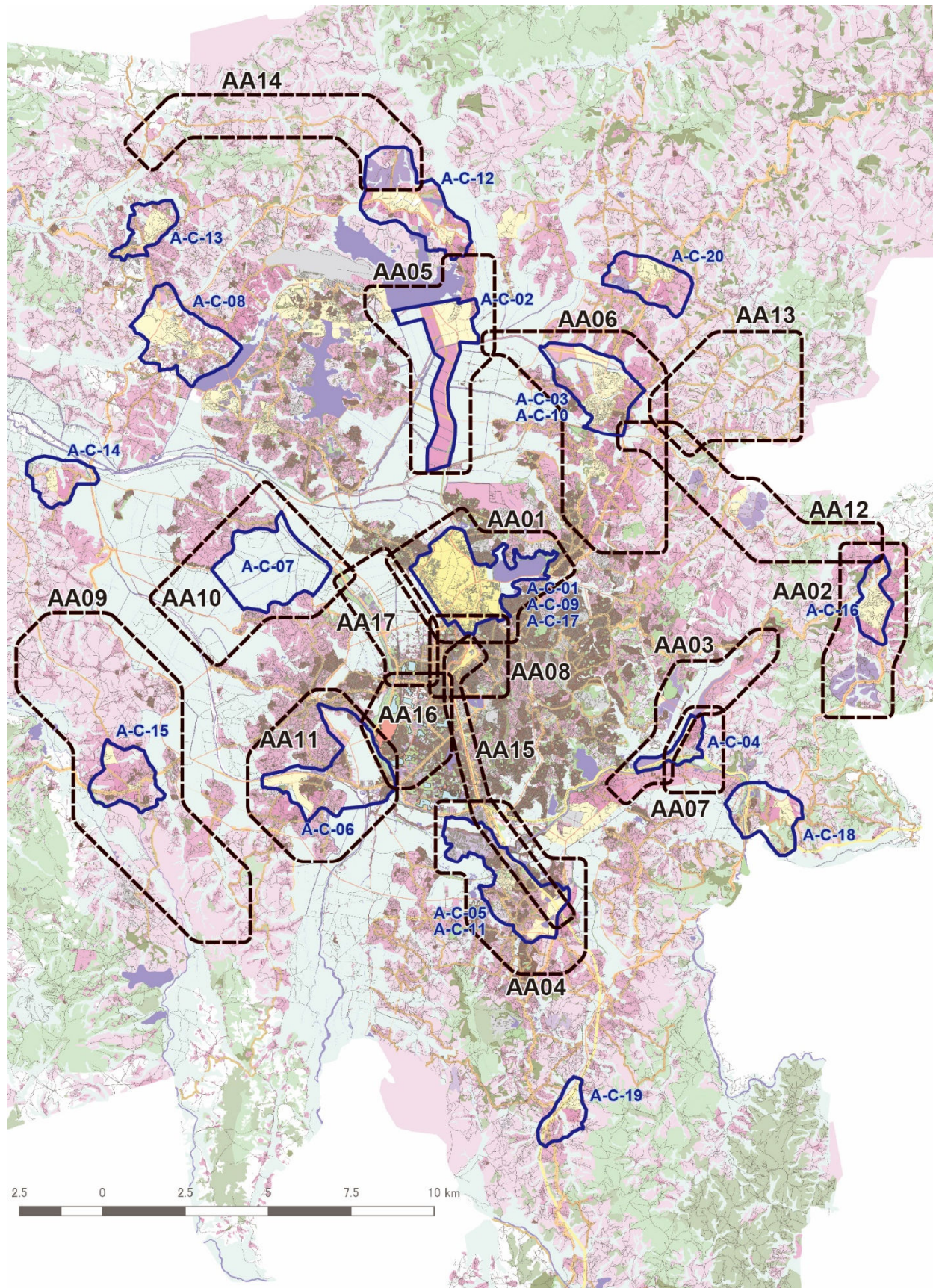
- Action Areas for Development of New Towns
- Action Areas for Development of Industrial Areas
- Action Areas for Transit-Oriented Development
- Action Areas for Securing of Water Retention Ponds

Therefore, a variety of priority action areas are designated, as shown in Table 13.2.1 and Figure 13.2.1. For each priority action area, actions are described for promoting integrated development.

Table 13.2.1 Priority Action Areas for Antananarivo Agglomeration

No.	Title of Action Area	Type of Action Areas
A-AA-01	Integrated Urban Development in the Ankondrano Primary Urban Centre and its Surrounding Areas	Urban Centre Water Retention Pond
A-AA-02	Development of Industrial and Logistics Areas in the South of Ambohimalaza near NR2	Industrial Area
A-AA-03	Establishment of Clean Light Industrial Zones along the Tokyo Boulevard	Industrial Area
A-AA-04	Development of Tanjombato Urban Sub-Centre and its Surrounding Areas	Urban Centre Transit-Oriented Development
A-AA-05	Development of Ambodifasina Urban Sub-Centre and its Surrounding Areas	Urban Centre
A-AA-06	Development of Namehana Urban Sub-Centre and its Surrounding Areas	Urban Centre
A-AA-07	Development of Amoronakona Urban Sub-Centre and its Surrounding Areas along Tokyo Boulevard	Urban Centre Industrial Area
A-AA-08	Reconstruction of Central Railway Station Area of Antananarivo	Urban Centre Transit-Oriented Development
A-AA-09	Development of Suburban Centre of Alakamisy Fenoarivo and New Towns in Surrounding of Alakamisy Fenoarivo	Urban Centre New Town
A-AA-10	Development of Tana-Masoandro Urban Sub-Centre	Urban Centre
A-AA-11	Development of Ampitatafika Sub-Centre and its Surrounding Areas	Urban Centre
A-AA-12	Development of Industrial Areas along North-East Section of Outer Ring Road	Industrial Area
A-AA-13	Development of Western New Towns in Suburban Areas	New Town
A-AA-14	Development of Ivato North Industrial Area along the Outer Ring Road	Industrial Area
A-AA-15	Development of TOD Corridor between Central Station and Tanjombato	Transit-Oriented Development
A-AA-16	Development Pole of Anosipatrana Digue together with Retention Ponds	Water Retention Pond
A-AA-17	Development and Management of Wetlands in Betsimitatatra Plain	Water Retention Pond

Source: JICA Study Team



Source: JICA Study Team

Figure 13.2.1 Location of Priority Action Areas for Integrated Development in Antananarivo Agglomeration

(1) Antananarivo Action Area No.01 [A-AA-01]: Integrated Urban Development in the Ankorondrano Primary Urban Centre and its Surrounding Areas

1) Objectives

- To upgrade the urban function of Antananarivo Agglomeration by providing lands for accommodating advanced business headquarter function and high-end shopping function
- To provide lands for mixed development consisting of commercial and residential areas
- To enable smooth east-west road connection within Antananarivo Agglomeration
- To enable smooth north-south road connection within Antananarivo Agglomeration

2) Major Components for Action Area

- Relocation of Oil Tanks and its Related Facilities of PL
- [A-R-03] Project for Construction of Primary Arterial Road between NR4 and Hydrocarbon Road within Ankorondrano Primary Urban Centre
- [A-R-04] Project for Construction of a Flyover at Ankorondrano Intersection of Hydrocarbon Road and Marais Masay Road
- [A-C-01] Project for Promotion of Development of Ankorondrano Primary Urban Centre Phase 1
 - Formulation of PUDé for Development of Ankorondrano Primary Urban Centre
 - Development of Private Residential Areas
 - Development of Private Commercial and Business Areas
- [A-G-01] Ankorondrano Lake and Waterfront Park Development Project
- Establishment of Education Hub
- Establishment of Advanced Medical Hospital

3) Schedule

- Phase 1 (2019-2023), Phase 2 (2024-2028) and Phase 3 (2029-2033) of Project TaToM

4) Main Executive Agencies

- A2P4R (Association of Landowners and Residents of the Perimeter surrounded by NR4, Hydrocarbon Road, Pape Road, Europe Boulevard and Marais Masay Lake)
- Ministry of Regional Development, Building, Housing and Public Works (MAHTP)

5) Related Agencies

- Ministry of National Education and Technical and Vocational Education
- Ministry of Public Health

(2) Antananarivo Action Area No.02 [A-AA-02]: Development of Industrial and Logistics Areas in the South of Ambohimalaza near NR2

1) Objective

- To provide lands for industrial and logistics use in the south of Ambohimalaza near NR2, by taking advantage of existing infrastructures

2) Major Components of Action Area

- Formulation of PUDé for Development of Industrial and Logistics Areas in the South of Ambohimalaza
- Construction of Access Road to an Industrial and Logistics Area to the south of Ambohimalaza

- Construction of an Access Road to the Industrial and Logistics Area in the south of Ambohimalaza
- Provision of Power Supply to the Industrial and Logistics Area to the south of Ambohimalaza
- Provision of Water Supply to the Industrial and Logistics Area in the south of Ambohimalaza

3) Schedule

- Phase 1

4) Main Executive Agencies

- Ministry of Industry, Trade and Handicrafts
- Ministry of Regional Development, Building, Housing and Public Works (MAHTP)

5) Related Agencies

- JIRAMA

(3) Antananarivo Action Area No.03 [A-AA-03]: Establishment of Clean Light Industrial Zones along the Tokyo Boulevard

1) Objectives

- To attract investment to industries in Antananarivo Agglomeration
- To utilize existing infrastructure, especially Tokyo Boulevard (urban arterial road), and land along the road

2) Major Components of Action Area

- Rezoning to Mixed Development Zones which allow Clean Light Industries along the Tokyo Boulevard
- Investment Promotion to Attract Clean Light Industries
- Construction of Access Roads to Mixed Development Zones
- Provision of Power Supply
- Provision of Water Supply

3) Schedule

- Phase 1 (2019-2023) of Project TaToM

4) Main Executive Agencies

- Ministry of Regional Development, Building, Housing and Public Works (MAHTP)
- Ministry of Industry, Trade and Handicrafts (MICA)

5) Related Agencies

- Economic Development Board of Madagascar (EDBM)

6) Related Plan

- PUDé for Area along Tokyo Boulevard (Plan d'Urbanisme de Détail des Territoires du Bypass et de la Bretelle)

(4) Antananarivo Action Area No.04 [A-AA-04]: Development of Tanjombato Urban Sub-Centre and its Surrounding Areas

1) Objectives

- To develop an urban sub-centre outside CUA
- To utilize Tokyo Boulevard (an existing major road) to provide good access to the urban sub-centre
- To utilize the existing railway for promote Transit-Oriented Development

2) Major Components of Action Area

- Re-zoning of PUDé of Tokyo Boulevard Area
- [A-C-05] Project for Promotion of Development of Tanjombato Urban Sub-Centre Phase 1
- [A-C-11] Project for Promotion of Development of Tanjombato Urban Sub-Centre Phase 2
- Construction of Local Roads to Connect Tanjombato with New Tanjombato Urban Sub-Centre along Tokyo Boulevard
- Rehabilitation of Urban Railway for Passenger Transport

3) Schedule

- Phase 1 (2019-2023) and Phase 2 (2024-2028) of Project TaToM

4) Main Executive Agencies

- MAHTP
- Government of Commune of Tanjombato

5) Related Agencies

Not Available

6) Related Plan

- PUDé for Area along Tokyo Boulevard (Plan d'Urbanisme de Détail des Territoires du Bypass et de la Bretonne)

(5) Antananarivo Action Area No.05 [A-AA-05]: Development of Ambodifasina Urban Sub-Centre and its Surrounding Areas

1) Objectives

- To distribute urban functions outside CUA for supporting urban residents and businesses
- To provide social housing units near Ivato Secondary Centre and Ambodifasina Urban Sub-Centre

2) Major Components of Action Area

- [A-C-02] Project for Promotion of Development of Ambodifasina Urban Sub-Centre
- [A-H-01] Project for Development of Social Housing Area in Ivato East
- [A-R-05] Project for Construction of Ambodifasina – Namehana Section of the Outer Ring Road between Tsarasaotra Road and NR3

3) Schedule

- Phase 1 (2019-2023) and Phase 2 (2024-2028) of Project TaToM

4) Main Executive Agencies

- MAHTP

5) Related Agencies

Not Available

(6) Antananarivo Action Area No.06 [A-AA-06]: Development of Namehana Urban Sub-Centre and its Surrounding Areas

1) Objectives

- To distribute urban functions outside CUA for supporting urban residents and businesses
- To increase the capacity of residential areas in the surrounding areas of Namehana Urban Sub-Centre

2) Major Components of Action Area

- Formulation of PUDé for this Action Area
- [A-C-03] Project for Promotion of Development of Namehana Urban Sub-Centre
- [A-C-10] Project for Promotion of Development of Namehana Urban Sub-Centre Phase 2
- [A-R-05] Project for Construction of Ambodifasina – Namehana Section of the Outer Ring Road between Tsarasaotra Road and NR3.
- [A-R-11] Project for Construction of Bypass Road of NR3 (between the Outer Ring Road and the Middle Ring Road)
- Construction of Local Roads in this Action Areas

3) Schedule

- Phase 1 (2019-2023) and Phase 2 (2024-2028) of Project TaToM

4) Main Executive Agencies

- MAHTP

5) Related Agencies

Not Available

(7) Antananarivo Action Area No.07 [A-AA-07]: Development of Amoronakona Urban Sub-Centre and its Surrounding Areas along Tokyo Boulevard

1) Objectives

- To distribute urban functions outside CUA for supporting urban residents and businesses
- To increase the capacity of residential areas in the surrounding areas of Amronakona Urban Sub-Centre
- To increase the industrial areas in the surrounding areas of Amoronakona Urban Sub-Centre

2) Major Components of Action Area

- Construction of Middle Ring Road between Amoronakona and Ankorondrano
- [A-I-01] Project for Rezoning to Mixed Development Areas which allow Clean Light Industries along the Tokyo Boulevard
- [A-C-04] Project for Promotion of Development of Amoronakona Urban Sub-Centre

3) Schedule

- Phase 1 (2019-2023) and Phase 2 (2024-2028) of Project TaToM

4) Main Executive Agencies

- MAHTP
- Ministry of Industry, Trade and Handicrafts

5) Related Agencies

Not Available

6) Related Plan

- PUDé for Area along Tokyo Boulevard (Plan d'Urbanisme de Détail des Territoires du Bypass et de la Bretelle)

(8) Antananarivo Action Area No.08 [A-AA-08]: Reconstruction of Central Railway Station Area of Antananarivo

1) Objectives

- To upgrade the urban function of Analakely
- To enhance the connectivity between urban rail and bus operation
- To enable north-south road connection and east-west road connection

2) Major Components of Action Area

- Relocation of Railway Repair Shop
- Construction of North-South Road
- Construction of East-West Road
- Reconstruction of Central Railway Station Building in combination with Bus Terminal
- Construction of Shopping Malls and Hotels in connection with the Central Railway Station

3) Schedule

- Phase 2 (2024-2028) and Phase 3 (2029-2033) of Project TaToM

4) Main Executive Agencies

- Ministry of Transport
- Ministry of Regional Development, Building, Housing and Public Works (MAHTP)
- Madarail

5) Related Agencies

Not Available

(9) Antananarivo Action Area No.09 [A-AA-09]: Development of Suburban Centre of Alakamisy Fenoarivo and New Towns in Surrounding of Alakamisy Fenoarivo

1) Objective

- To provide low-middle income populations with lands with basic infrastructure in suburban areas

2) Major Components of Action Area

- [A-H-02] Project for New Town Development for Housing Provision in Suburban Areas Phase 1 (Fenoarivo South)
- [A-H-03] Project of New Town Development for Housing Provision in Suburban Areas Phase 2 (Fenoarivo North New Town)
- Provision of Water Supply to Fenoarivo Areas
- Provision of Power Supply to Fenoarivo Areas
- [A-R-01] Project for Construction of 4-lane Road between Ankorondrano and Andranonahoatra (Northern Road Section between NR4 and NR1) (Part of the Middle Ring

Road including a Bridge crossing the Ikopa River)

3) Schedule

- Phase 1 (2019-2023) and Phase 2 (2024-2028) of Project TaToM

4) Main Executive Agencies

- MAHTP

5) Related Agencies

- JIRAMA

(10) Antananarivo Action Area No.10 [A-AA-10]: Development of Tana-Masoandro Urban Sub-Centre

1) Objective

- To distribute urban functions outside CUA for supporting urban residents and businesses

2) Major Components of Action Area

- [A-C-07] Project for Promotion of Development of Tana-Masoandro Urban Sub-Centre
- [A-R-08] Project for Construction of Primary Arterial Road between Tana-Masoandro and Antsavatsava
- [A-R-16] Project for Construction of Primary Arterial Road between Bypass Road of NR4 and Ampangabe Suburban Centre (through Tan-Masoandro)

3) Schedule

- Phase 1 (2019-2023) and Phase 2 (2024-2028) of Project TaToM

4) Main Executive Agencies

- MAHTP

5) Related Agencies

Not Available

(11) Antananarivo Action Area No.11 [A-AA-11]: Development of Ampitatafika Sub-Centre and its Surrounding Areas

1) Objective

- To distribute urban functions outside CUA for supporting urban residents and businesses

2) Major Components of Action Area

- [A-C-06] Project for Promotion of Development of Ampitatafika Urban Sub-Centre
- [A-R-02] Project for Construction of 4-lane Road between Ampitatafika and Antsavatsava (Southern Section between NR4 and NR1) (Part of the Middle Ring Road)

3) Schedule

- Phase 1 (2019-2023) of Project TaToM

4) Main Executive Agencies

- MAHTP

5) Related Agencies

Not Available

(12) Antananarivo Action Area No.12 [A-AA-12]: Development of Industrial Areas along North-East Section of Outer Ring Road

1) Objectives

- To provide lands for industrial use in the Commune of Ambohimangakely and Fieferana by taking advantage of the new Outer Ring Road
- To attract investment to industries in Antananarivo Agglomeration

2) Major Components of Action Area

- [A-R-06] Project for Construction of Soanierana-Sabotsy Namehana Section of the Outer Ring Road between NR3 and NR2
- [A-I-03] Project for Development of Industrial and Logistics Areas along Ambohimangakely - Sabotsy Namehana Section of the Outer Ring Road by Providing Access Roads, Water and Electricity

3) Schedule

- Phase 1 (2019-2023) of Project TaToM

4) Main Executive Agencies

- MATHP
- Ministry of Industry, Trade and Handicrafts

5) Related Agencies

- JIRAMA

(13) Antananarivo Action Area No.13 [A-AA-13]: Development of Western New Towns in Suburban Areas

1) Objectives

- To provide residential areas equipped with basic infrastructures in suburban areas
- To promote integrated urban development in western suburban areas

2) Major Components of Action Area

- Formulation of PUDé for New Town Development in Western Suburban Area
- Construction of Access Roads to Two New Towns
- New Town Development
 - [A-H-04] Project of New Town Development for Housing Provision in Suburban Areas Phase 2 (Namehana New Town)
 - [A-H-6] Project of Development of New Town Development for Housing Provision in Suburban Areas Phase 3 (Fieferana New Town)
- Outer Ring Road
 - [A-R-06] Project for Construction of Ambohimangakely - Namehana Section of the Outer Ring Road between NR3 and NR2
- Urban Sub-Centre
 - [A-C-03] Project for Promotion of Development of Namehana Urban Sub-Centre

3) Schedule

- Phase 2 (2024-2028) and Phase 3 (2029-2033) of Project TaToM

4) Main Executive Agencies

- MAHTP

5) Related Agencies

- JIRAMA

(14) Antananarivo Action Area No.14 [A-AA-14]: Development of Ivato North Industrial Area along the Outer Ring Road

1) Objectives

- To provide lands for industrial and logistics use in the Commune of Ambatolampy and Anosiala by taking advantage of the new Outer Ring Road
- To attract investment to industries in Antananarivo Agglomeration

2) Major Components of Action Area

- [A-R-12] Project for Construction of Anosiala - Ambatolampy Tsimahafotsy Section of the Outer Ring Road (Northern Part)
- [A-I-04] Project for Development of Industrial and Logistics Area along the Northern Part of the Outer Ring Road (between Anosiala and Ambatolampy Tsimahafotsy)

3) Schedule

- Phase 2 (2024-2028) and Phase 3 (2029-2033) of Project TaToM

4) Main Executive Agencies

- MATHP

5) Related Agencies

Not Available

(15) Antananarivo Action Area No.15 [A-AA-15]: Development of TOD Corridor between Central Station and Tanjombato

1) Objectives

- To construct a 6-lane urban arterial road accommodating Bus Rapid Transit in parallel with Urban Railway
- To promote middle-density residential development along the TOD corridor (part of TOD strategy)
- To promote commercial areas near stations of BRT or Urban Railway (part of TOD strategy)
- To create the environment for operation of Bus Rapid Transit

2) Major Components of Action Area

- [A-R-10] Project for Construction of Over Canal Road between Tanjombato and Ankorondrano
- Establishment of BRT System between Central Railway Station and Tanjombato
- Operation of Urban Railway between Tanjombato and Ankorondrano
- Enforcement of Land Use Zoning Regulations along the 6-lane Road in accordance with TOD strategy

3) Schedule

- Phase 1 (2019-2023): Land Acquisition for 6-lane Road
- Phase 2 (2024-2028): Construction of 6-lane Road and Preparation for the Operation of BRT
- Phase 3 (2029-2033): Operation of BRT

4) Main Executive Agencies

- MAHTP
- Ministry of Transport
- CUA

5) Related Agencies

- Private sectors

(16) Antananarivo Action Area No.16 [A-AA-16]: Development Pole of Anosipatrana Digue together with Retention Ponds

1) Objectives

- To promote residential and commercial development of wetlands by constructing retention ponds
- To conserve wetlands by constructing retention ponds
- To conserve wetlands by enforcing land use regulations

2) Major Components of Action Area

- Formulation of PUDé for Anosiparana Digue Development Pole
- [A-G-04] South East Plain Retention Ponds and Waterfront Parks Development Project
- [A-G-05] South West Plain Retention Ponds and Waterfront Parks Development Project
- Development of Residential Areas (By private developers)
- Development of Commercial Areas at the Junction between the Ilanivato - Ambohimamory Road and NR58a
- Construction of Ankasina - Ankadimbahoaka Road
- Extension of Ny Avon Ramanatoanina Road to the Ikopa River (Ilanivato - Ambohimamory Road)
- Construction of Bridge for Ikopa River
- The following PIAA projects are closely related to this Action Area:
- Rehabilitation of C3 bis
- Rehabilitation of C3 ter

3) Schedule

- Phase 1 (2019-2023) and Phase 2 (2024-2028) of Project TaToM

4) Main Executive Agencies

- MAHTP
- CUA
- APIPA

5) Related Agencies

Not Available

(17) Antananarivo Action Area No.17 [A-AA-17]: Development and Management of Wetlands in Betsimitatatra Plain

1) Objectives

- To conserving wetlands by constructing retention ponds
- To conserve wetlands by enforcing land use regulations
- To promote development of residential areas in accordance with the revised PUDi

2) Major Components of Action Area

- Formulation of PUDe for this Action Area
- [A-G-02] Ankazomanga Atsimo Lake and Waterfront Park Development Project
- The following two road development projects are closely related to this Action Area:
- [A-R-01] Project for Construction of 4-lane Road between Ankorondrano and Andranonahoatra (Northern Road Section between NR4 and NR1) (Part of the Middle Ring Road including a Bridge crossing the Ikopa River)
- [A-R-03] Project for Construction of Primary Arterial Road between NR4 and Hydrocarbon Road within Ankorondrano Primary Urban Centre

3) Schedule

- Phase 1 (2019-2023) and Phase 2 (2024-2028) of Project TaToM

4) Main Executive Agencies

- MAHTP
- CUA
- APIPA

5) Related Agencies

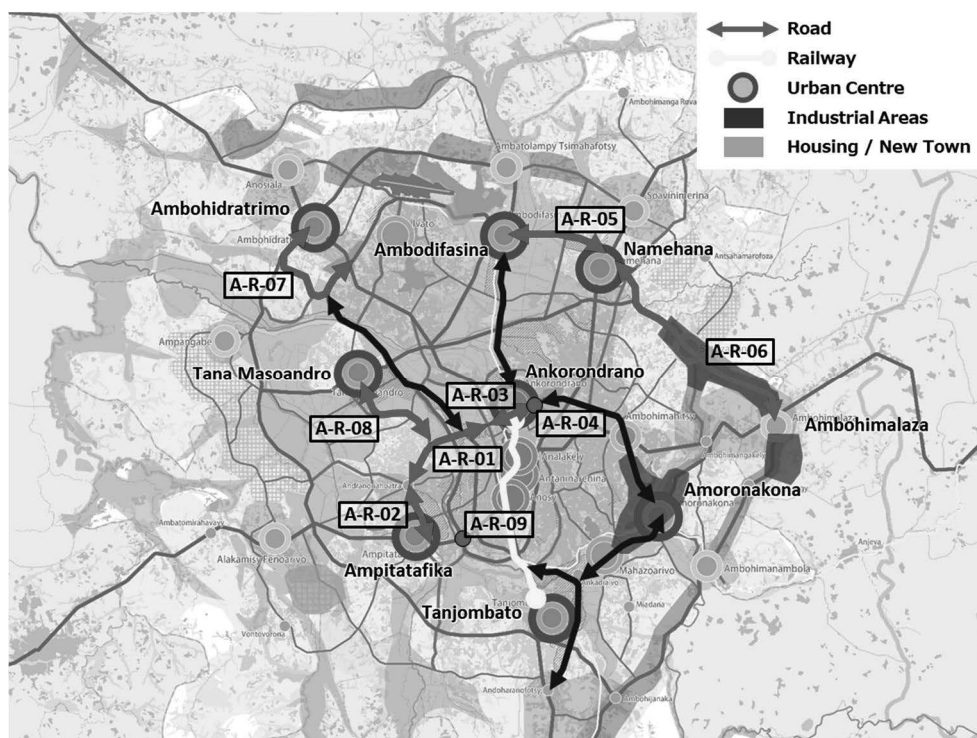
Not Available

13.3 Implementation of Priority Projects and High Priority Projects of Various Sectors in Antananarivo Agglomeration

13.3.1 Priority Projects and High Priority Projects for Phase 1 (2019-2023)

(1) Priority Projects of Constructing of Roads (Phase 1)

The priority projects of construction of roads for Phase 1 are shown in Figure 13.3.1 and listed in Table 13.3.1. Table 13.3.1 List of Priority Projects of Roads and Railway (Phase 1: 2019-2023)



Source: JICA Study Team

Figure 13.3.1 Location of Priority Projects of Constructing of Roads (Phase 1: 2019-2023)

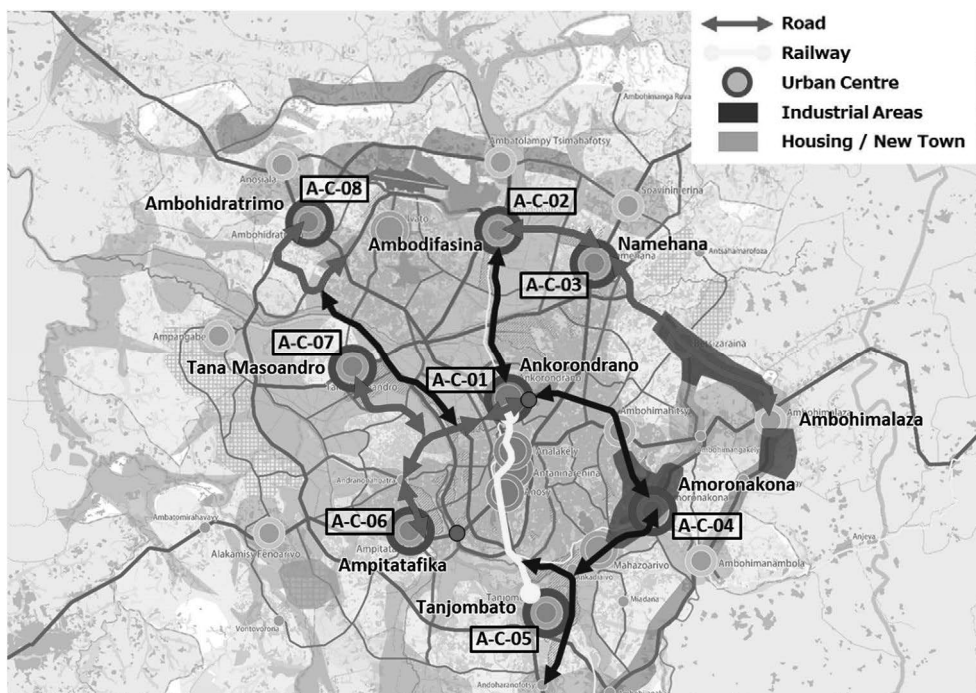
Table 13.3.1 List of Priority Projects of Roads and Railway (Phase 1: 2019-2023)

No	Priority	Ring Road Project Name	Cost (USD)	Organization in Charge
A-R-01	High	Project for Construction of 4-lane Road between Ankorondrano and Antsavatsava (Northern Road Section between NR4 and NR1) (Part of the Middle Ring Road including a Bridge crossing the Ikopa River)	60 mil.	MAHTP
A-R-02	High	Project for Construction of 4-lane Road between Ampitatafika and Antsavatsava (Southern Section between NR4 and NR1) (Part of the Middle Ring Road)	5 mil.	MAHTP
A-R-03	High	Project for Construction of Primary Arterial Road between NR4 and Tsarasaotra Road in Ankorondrano Primary Urban Centre	50 mil.	MAHTP
A-R-04	High	Project for Construction of a Flyover at Ankorondrano Intersection of Tsarasaotra Road and Marais Masay Road	40 mil.	MAHTP
A-R-05	High	Project for Construction of Ambodifasina - Sabotsy Namehana Section of the Outer Ring Road between Tsarasaotra Road and NR3.	10 mil.	MAHTP
A-R-06	High	Project for Construction of Soanierana-Sabotsy Namehana Section of the Outer Ring Road between NR3 and NR2	20 mil.	MAHTP
No	Priority	Radial Road Project Name	Cost (USD)	Organization in Charge
A-R-07	High	Project for Construction of Bypass Road of Ambohidratrimo Urban Sub-Centre	5 mil.	MAHTP
A-R-08	High	Project for Construction of Primary Arterial Road between Tana-Masoandro and Antsavatsava	10 mil.	MAHTP
A-R-09	High	Project for Construction of Flyover at Anosizato Intersection of NR4 and NR1	30 mil.	MAHTP
No	Priority	Railway and Cargo Transport Project Name	Cost (USD)	Organization in Charge
A-F-01	High	Project for Development of Multi-Modal Cargo Transport Terminal in Amoronakona for Antananarivo Agglomeration	50 mil.	MTTM, PPP
A-F-02		Project for Urban Passenger Railway Development between Ankorondrano - Tanjombato	100 mil.	MTTM

Source: JICA Study Team

(2) Priority Projects of Development of Urban Centres (Phase 1: 2019-2023)

The priority projects of development of urban centres for Phase 1 are shown in Figure 13.3.2 and listed in Table 13.3.2.



Source: JICA Study Team

Figure 13.3.2 Location of Priority Projects of Development of Urban Centres (Phase 1: 2019-2023)

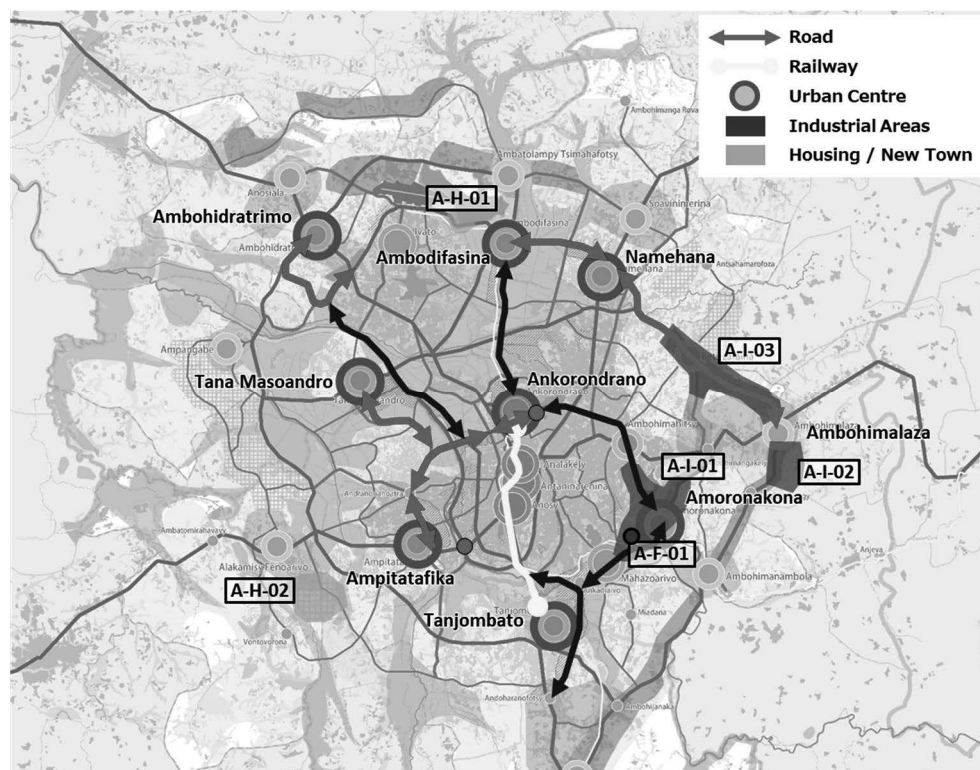
Table 13.3.2 List of Priority Projects of Development of Urban Centres (Phase 1: 2019-2023)

No	Priority	Urban Centre Project Name	Cost (USD)	Organization in Charge
A-C-01	High	Project for Promotion of Development of Ankorondrano Primary Urban Centre Phase 1	54 mil.	MAHTP, PPP
A-C-02	High	Project for Promotion of Development of Ambodifasina Urban Sub-Centre	86 mil.	MAHTP, PPP
A-C-03	High	Project for Promotion of Development of Namehana Urban Sub-Centre	35 mil.	MAHTP, PPP
A-C-04	High	Project for Promotion of Development of Amoronakona Urban Sub-Centre	38 mil.	MAHTP, PPP
A-C-05	High	Project for Promotion of Development of Tanjombato Urban Sub-Centre	30 mil.	MAHTP, PPP
A-C-06	High	Project for Promotion of Development of Ampitafika Urban Sub-Centre	57 mil.	MAHTP, PPP
A-C-07	High	Project for Promotion of Development of Tana-Masoandro Urban Sub-Centre	199 mil.	MAHTP, PPP
A-C-08	High	Project for Promotion of Development of Ambohidratrimo Urban Sub-Centre	16 mil.	MAHTP, PPP

Source: JICA Study Team

(3) Priority Projects of Development of Industrial Areas and Housing Areas (Phase 1: 2019-2023)

The priority projects of development of industrial areas and housing areas for Phase 1 are shown in Figure 13.3.3 and listed in Table 13.3.3



Source: JICA Study Team

Figure 13.3.3 Location of Development of Industrial Areas and Housing Areas (Phase 1: 2019-2023)

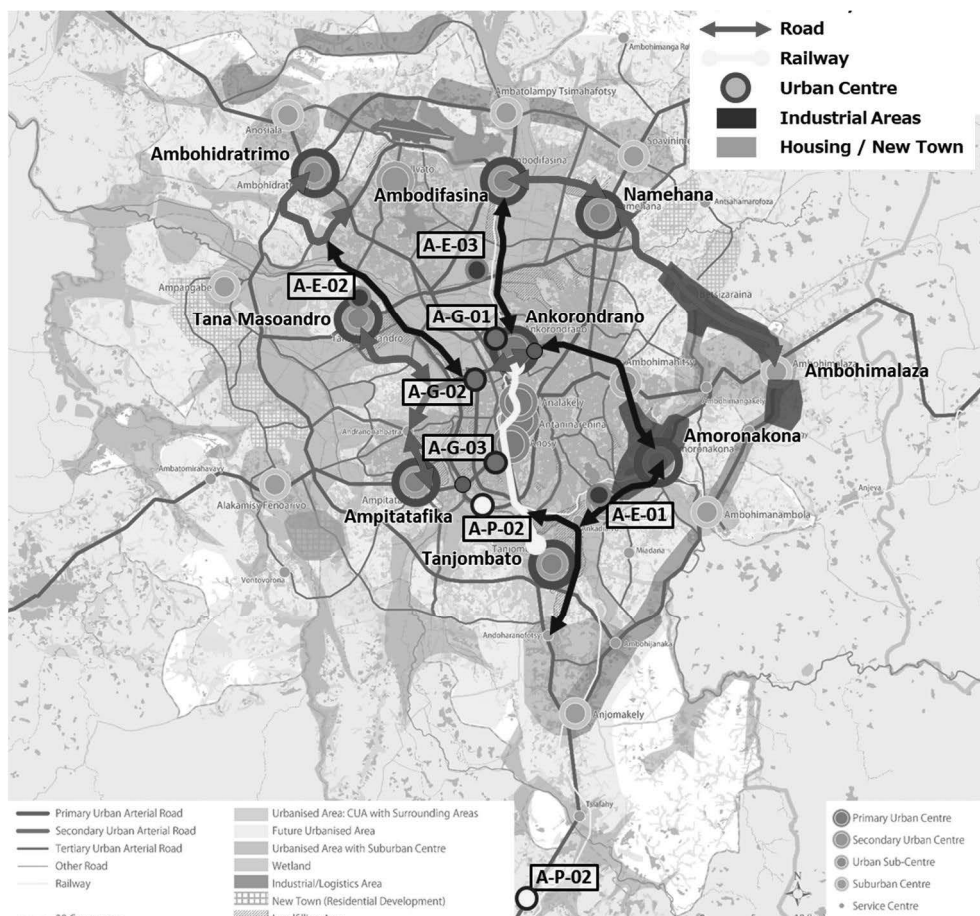
Table 13.3.3 List of Development of Industrial Areas and Housing Areas (Phase 1: 2019-2023)

No	Priority	Industrial Area Project Name	Cost (USD)	Organization in Charge
A-I-01	High	Project for Rezoning to Mixed Development Areas which allow Clean Light Industries along the Tokyo Boulevard	63 mil.	MAHTP, MICA, PPP
A-I-02	High	Project for Development of Industrial and Logistics Areas in the Southern Area of Ambohimalaza	84 mil.	MAHTP, MICA, PPP
A-I-03	High	Project for Development of Industrial and Logistics Areas along Ambohimalaza - Sabotsy Namehana Section of the Outer Ring Road by Providing Access Roads, Water and Electricity	70 mil.	MAHTP, MICA, PPP
No	Priority	Housing Area Project Name	Cost (USD)	Organization in Charge
A-H-01	High	Project for Development of Social Housing Area in Ivato East	-	MAHTP
A-H-02	High	Project for Development of Fenoarivo South New Town	42 mil.	MAHTP, PPP

Source: JICA Study Team

(4) Priority Projects of Water Supply, Power Supply, and Disaster Risk Management (Phase 1: 2019-2023)

The priority projects of water supply, power supply, and disaster risk management for Phase 1 are shown in Figure 13.3.4 and listed in Table 13.3.4.



Source: JICA Study Team

Figure 13.3.4 Location of Priority Projects of Water Supply, Power Supply, and Disaster Risk Management (Phase 1: 2019-2023)

Table 13.3.4 List of Priority Projects of Water Supply, Power Supply, and Drainage Improvement (Phase 1: 2019-2023)

No	Priority	Water Supply Project Name	Cost (USD)	Organization in Charge
A-E-01	High	Project for Doubling the Capacity of Mandroseza 2 Water Treatment Plant	68 mil.	JIRAMA
A-E-02	High	Project for Construction of Two Water Treatment Plants using Groundwater from Tana Plain		JIRAMA
A-E-03	High	Project for Construction of Water Treatment Plant in Laniera		JIRAMA
A-E-04	High	Project for Master Plan Formulation of Water Resources Development and Water Supply for Antananarivo Agglomeration	3 mil.	JIRAMA
A-E-05	High	Project for Construction of New Retention Dam in Miadanandriana	42 mil.	JIRAMA
No	Priority	Power Supply Project Name	Cost (USD)	Organization in Charge
A-P-01	High	Installation of New Transmission Lines <ul style="list-style-type: none"> • 225kV transmission line (Sahofika hydropower station to Behenjy Substation) • 225kV transmission line (Antetazambato hydropower station to Behenjy Substation) • 225kV transmission line (Tana Sud 2 Substation to Behenjy Substation) 	445 mil.	JIRAMA

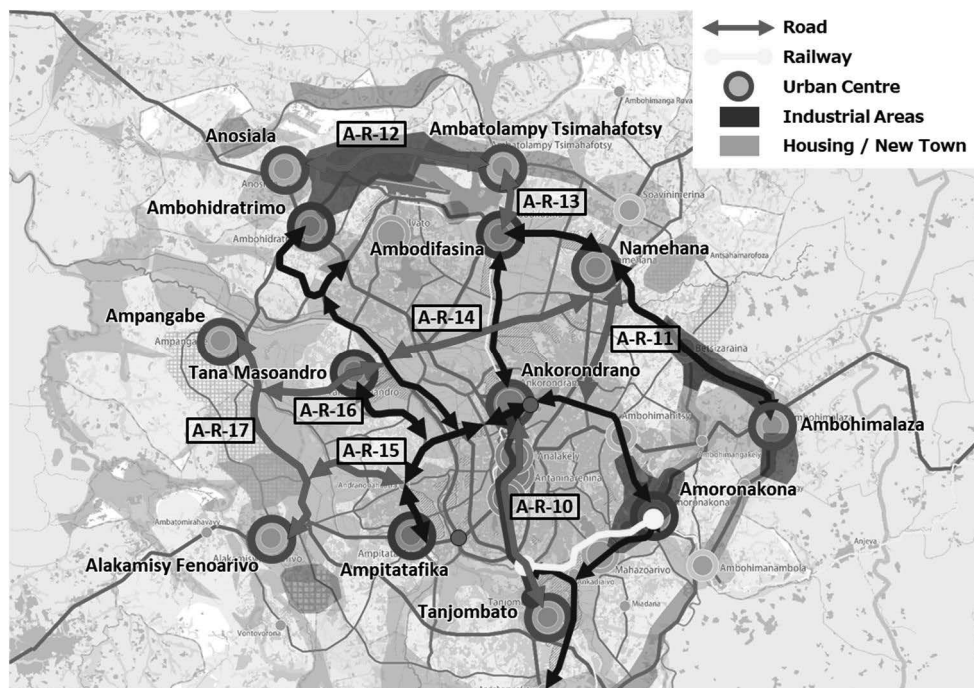
		<ul style="list-style-type: none"> • 225kV transmission line (Tana Nord 2 Substation to New Substation in Moramanga) • 138kV transmission line (Ranomafana hydropower station to Tana Sud 2 Substation) • 138kV transmission line (Mahitsy hydropower station to Tana Sud 2 Substation) • 63kV transmission line (Tana Sud 2 Substation to Tana Sud Substation) 		
A-P-02	High	Installation of New Substations <ul style="list-style-type: none"> • 225kV/63kV Behenja Substation • 225kV/138kV/63kV Tana Sud 2 Substation • 225kV/138kV New Substation in Moramanga 	-	JIRAMA
A-P-03	High	Reinforcement of Existing Transmission Lines	14 mil.	JIRAMA
A-P-04	High	Reinforcement of Existing Substations	-	JIRAMA
A-P-05	High	Project for Rehabilitation and Upgrade of Distribution Network including Establishment of New Distribution Control Centre for Expansion and Rehabilitation of the Power Distribution System	19 mil.	JIRAMA
No	Priority	Disaster Improvement Project Name	Cost (USD)	Organization in Charge
A-G-01	High	Project for Development of Ankorondrano Lake and Waterfront Park	5 mil.	MAHTP, APIPA, CUA
A-G-02	High	Project for Development of Ankazomanga Atsimo Lake and Waterfront Park	5 mil.	MAHTP, APIPA, CUA
A-G-03	High	Project for Development of Andavamamba Anatihazo II Lake and Waterfront Park	1 mil.	MAHTP, APIPA, CUA
No	Priority	Solid Waste Management Project Name	Cost (USD)	Organization in Charge
A-W-01	High	Project for Development of Recycling Factory and Sanitary Final Disposal Site in Manandriana	7 mil.	SAMVA, PPP
A-W-02	High	Project for Development of Recycling Factory and Sanitary Final Disposal Site in Andoharanofotsy	7 mil.	SAMVA, PPP
A-W-03	High	Project for Formulation of Implementation Plan for Other Recycling Factories and Sanitary Final Disposal Sites	3 mil.	SAMVA

Source: JICA Study Team

13.3.2 Priority Projects and High Priority Projects for Phase 2 (2024-2028)

(1) Priority Projects of Constructing of Roads (Phase 2: 2024-2028)

The priority projects of construction of roads for Phase 2 are shown in Figure 13.3.5 and listed in Table 13.3.5.



Source: JICA Study Team

Figure 13.3.5 Location of Priority Projects of Constructing of Roads (Phase 2: 2024-2028)

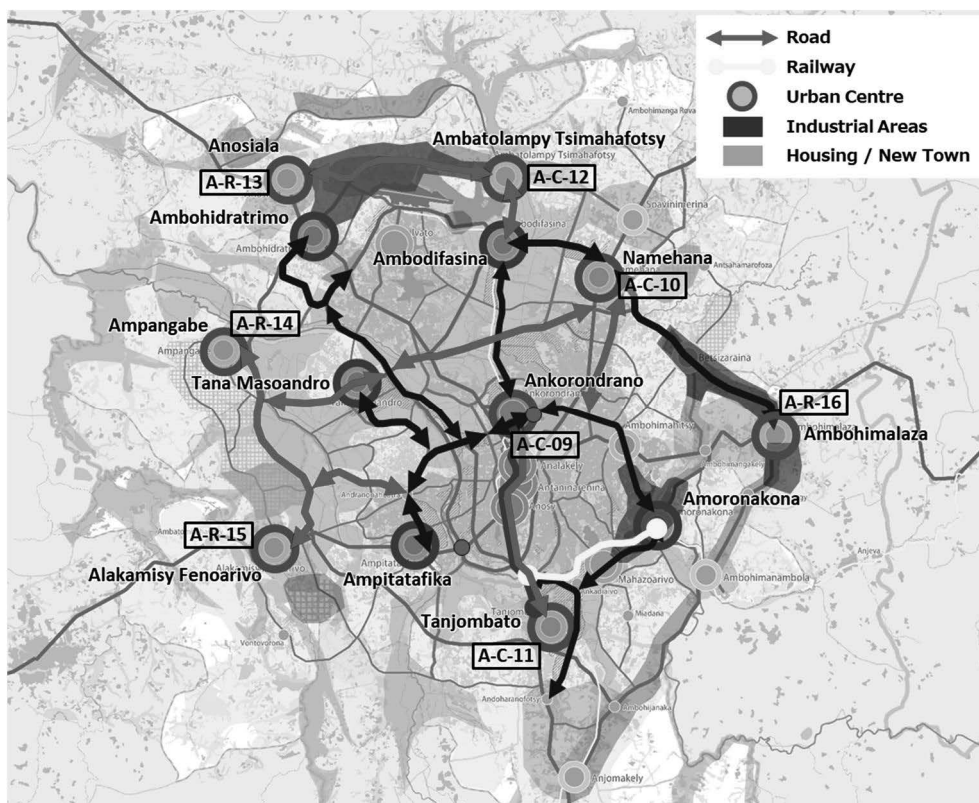
Table 13.3.5 List of Priority Projects of Roads (Phase 2: 2024-2028)

No.	Priority	Radial Road Project Name	Cost (USD)	Organization in Charge
A-R-10	High	Project for Construction of Over Canal Road between Tanjombato and Ankorondrano	150 mil.	MAHTP
A-R-11	High	Project for Construction of Bypass Road of NR3 (between the Outer Ring Road and the Middle Ring Road)	30 mil.	MAHTP
A-R-13	High	Project for Construction of Extension of Tsarasaotra Road between Ambodifasina Urban Sub-Centre and Ambatolampy Tsimahafotsy Suburban Centre	7 mil.	MAHTP
A-R-15	High	Project for Construction of Primary Arterial Road between Andranonahoatra and the Outer Ring Road	10 mil.	MAHTP
A-R-16	High	Project for Construction of Primary Arterial Road between Bypass Road of NR4 and Ampangabe Suburban Centre (through Tana-Masoandro)	80 mil.	MAHTP
No.	Priority	Ring Road Project Name	Cost (USD)	Organization in Charge
A-R-12	High	Project for Construction of Anosiala - Ambatolampy Tsimahafotsy Section of the Outer Ring Road (Northern Part)	15 mil.	MAHTP
A-R-14	High	Project for Construction of East-West Primary Arterial Road between NR3 and Bypass Road of NR4	25 mil.	MAHTP
A-R-17	High	Project for Construction of Alakamisy Fenoarivo - Ampangabe Section of the Outer Ring Road (Western Part)	20 mil.	MAHTP

Source: JICA Study Team

(2) Priority Projects of Development of Urban Centres (Phase 2: 2024-2028)

The priority projects of development of urban centres for Phase 2 are shown in Figure 13.3.6 and listed in Table 13.3.6.



Source: JICA Study Team

Figure 13.3.6 Location of Priority Projects of Development of Urban Centres (Phase 2: 2024-2028)

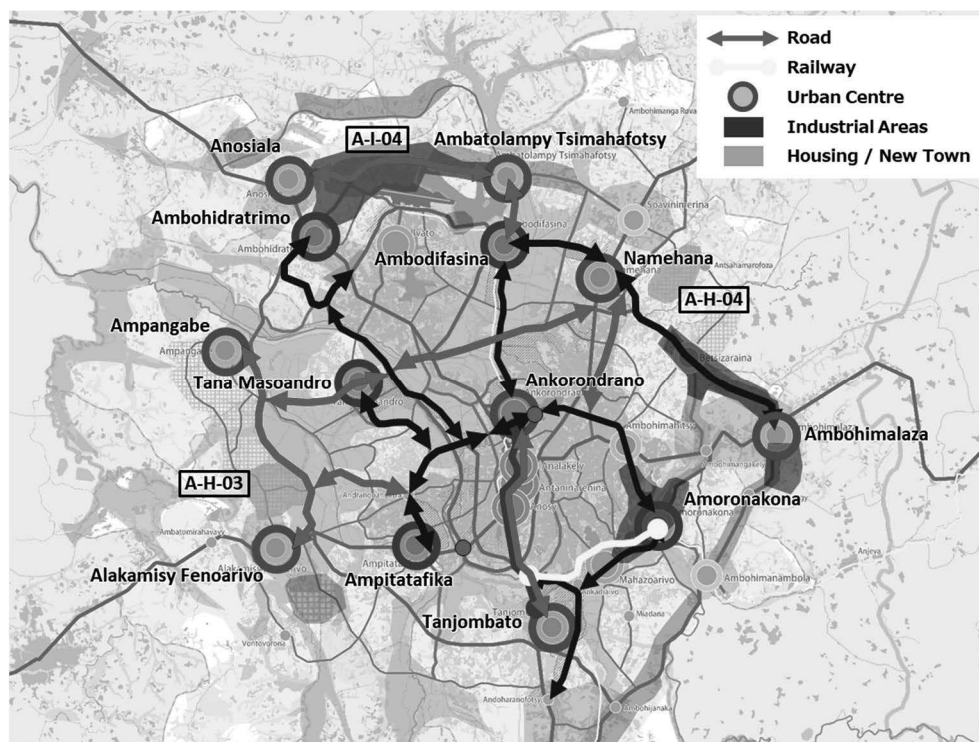
Table 13.3.6 List of Priority Projects of Development of Urban Centres (Phase 2: 2024-2028)

No.	Urban Centre Project Name	Cost (USD)	Organization in Charge
A-C-09	Project for Promotion of Development of Ankorondrano Primary Urban Centre Phase 2	43 mil.	MAHTP, PPP
A-C-10	Project for Promotion of Development of Namehana Urban Sub-Centre Phase 2	35 mil.	MAHTP, PPP
A-C-11	Project for Promotion of Development of Tanjombato Urban Sub-Centre Phase 2	30 mil.	MAHTP, PPP
A-C-12	Project for Promotion of Development of Ambatolampy Tsimahafotsy Suburban Centre	12 mil.	MAHTP, PPP
A-C-13	Project for Promotion of Development of Anosiala Suburban Centre	16 mil.	MAHTP, MICA, PPP
A-C-14	Project for Promotion of Development of Ampangabe Suburban Centre	13 mil.	MAHTP, MICA, PPP
A-C-15	Project for Promotion of Development of Alakamisy Fenoarivo Suburban Centre	16 mil.	MAHTP, MICA, PPP
A-C-16	Project for Promotion of Development of Ambohimalaza Suburban Centre	12 mil.	MAHTP, MICA, PPP

Source: JICA Study Team

(3) Priority Projects of Development of Industrial Areas and Housing Areas (Phase 2: 2024-2028)

The priority projects of development of industrial areas and housing areas for Phase 2 are shown in Figure 13.3.7 and listed in Table 13.3.7.



Source: JICA Study Team

Figure 13.3.7 Location of Development of Industrial Areas and Housing Areas (Phase 2: 2024-2028)

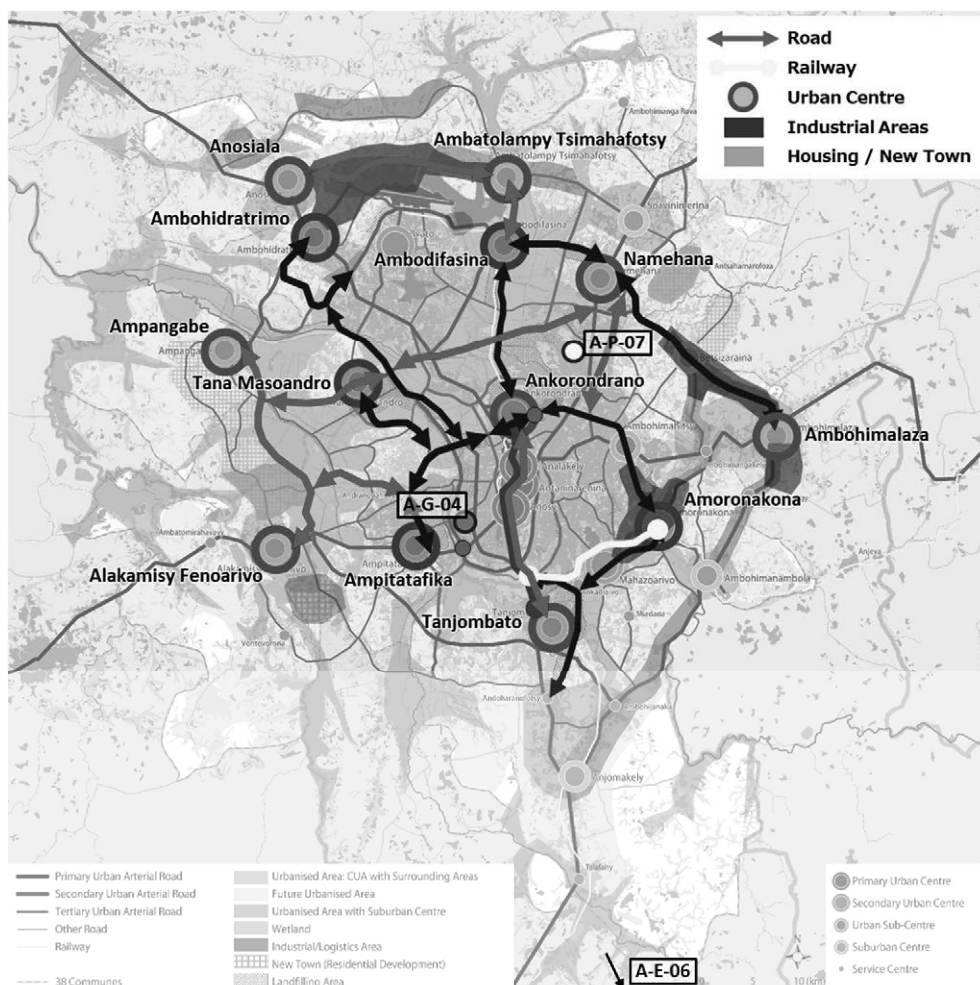
Table 13.3.7 List of Development of Industrial Areas and Housing Areas (Phase 2: 2024-2028)

No	Industrial Area Project Name	Cost (USD)	Organization in Charge
A-I-04	Project for Development of Industrial and Logistics Area along the Northern Part of the Outer Ring Road (between Anosiala and Ambatolampy Tsimahafotsy)	154 mil.	MAHTP, MICA, PPP
No	Housing Area Project Name	Cost (USD)	Organization in Charge
A-H-03	Project for Development of Fenoarivo North New Town	132 mil.	MAHTP, PPP
A-H-04	Project for Development of Namehana New Town	60 mil.	MAHTP, PPP

Source: JICA Study Team

(4) Priority Projects of Water Supply, Power Supply, and Drainage Improvement (Phase 2: 2024-2028)

The priority projects of water supply, power supply, and disaster risk management for Phase 2 are shown in Figure 13.3.8 and listed in Table 13.3.8.



Source: JICA Study Team

Figure 13.3.8 Location of Priority Projects of Water Supply, Power Supply, and Disaster Risk Management (Phase 2: 2024-2028)

Table 13.3.8 List of Priority Projects of Water Supply, Power Supply, and Drainage Improvement (Phase 2: 2024-2028)

No.	Water Supply Project Name	Cost (USD)	Organization in Charge
A-E-06	Project for Construction of Water Aqueduct, Treatment and Transmission Facilities using Water Source from the Onive River in Tsinjoarivo (Ambatolampy District)	520 mil.	JIRAMA
No.	Power Supply Project Name	Cost (USD)	Organization in Charge
A-P-06	Installation of New Transmission Lines <ul style="list-style-type: none"> 225kV transmission line (Mahavola hydropower station to Tana Nord 2 Substation) 138kV transmission line (Mahavola hydropower station to Mahitsy hydropower station) 63kV transmission line (Tana Nord 2 Substation to Tana Nord Substation) 	145 mil.	JIRAMA
A-P-07	Installation of New Substations <ul style="list-style-type: none"> 225kV/63kV Tana Nord 2 Substation 	-	JIRAMA
A-P-08	Reinforcement of Existing Transmission Lines	6 mil.	JIRAMA
A-P-09	Reinforcement of Existing Substations	-	JIRAMA
A-P-10	Expansion of the Power Distribution System	-	JIRAMA

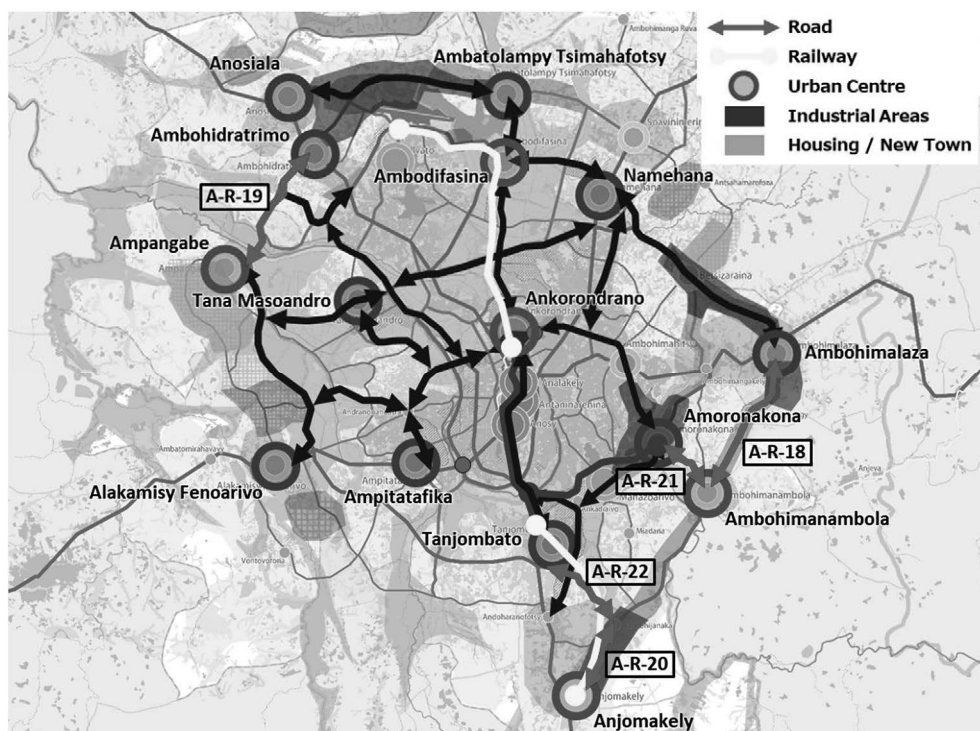
No.	Disaster Improvement Project Name	Cost (USD)	Organization in Charge
A-G-04	Project for Development of South East Plain Retention Ponds and Waterfront Parks	8 mil.	MAHTP, APIPA, CUA
No.	Health Infrastructure Project Name	Cost (USD)	Organization in Charge
A-S-01	Project for Development of New District Hospital in Ambodifasina Urban Sub-Centre	18 mil.	MINSAN, PPP
A-S-02	Project for Relocation and Expansion of the District Hospital in Namehana Urban Sub-Centre	18 mil.	MINSAN
A-S-03	Project for Expansion of the District Hospital in Tanjombato Urban Sub-Centre	14 mil.	MINSAN
No.	Education Infrastructure Project Name	Cost (USD)	Organization in Charge
A-D-01	Project of Development of Education Hub at Ankorondrano Primary Urban Centre	17 mil.	MENETP, PPP
A-D-02	Project of Development of Education Hub at Namehana Urban Sub-Centre	17 mil.	MENETP, PPP
A-D-03	Project of Development of Education Hub at Amoronakona Urban Sub-Centre	17 mil.	MENETP, PPP
A-D-04	Project of Development of Education Hub at Tana-Masoandro Urban Sub-Centre	17 mil.	MENETP, PPP
No.	Solid Waste Management Project Name	Cost (USD)	Organization in Charge
A-W-04	Project for Development of Additional Recycling Factories and Sanitary Final Disposal Sites	15 mil.	SAMVA, PPP

Source: JICA Study Team

13.3.3 Priority Projects and High Priority Projects for Phase 3 (2029-2033)

(1) Priority Projects of Constructing of Roads (Phase 3: 2029-2033)

The priority projects of construction of roads for Phase 3 are shown in Figure 13.3.9 and listed in Table 13.3.9.



Source: JICA Study Team

Figure 13.3.9 Location of Priority Projects of Constructing of Roads (Phase 3: 2029-2033)

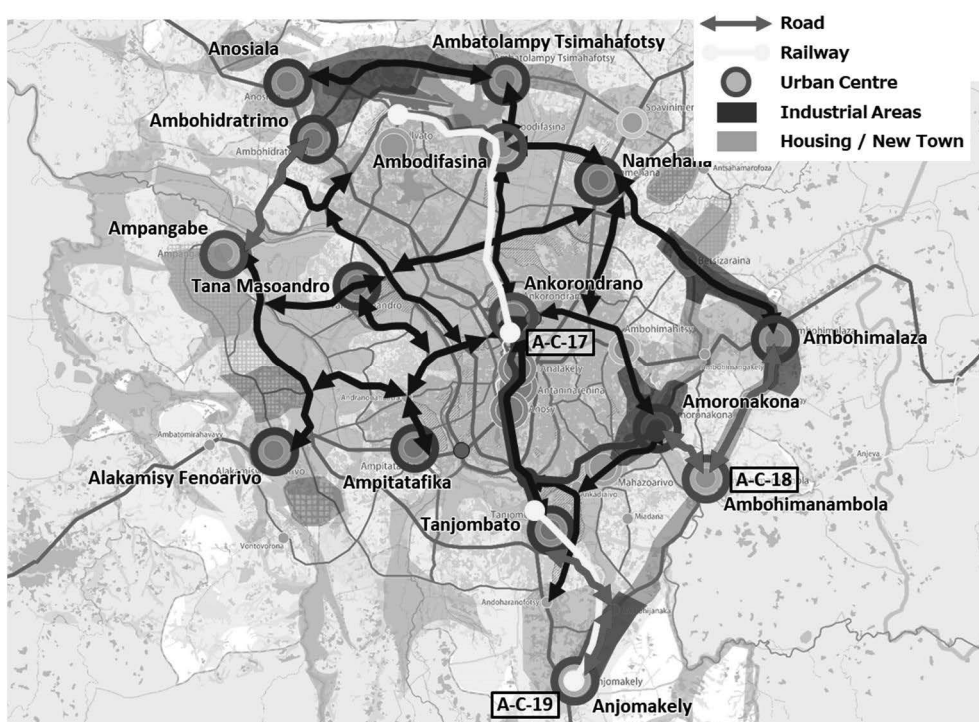
Table 13.3.9 List of Priority Projects of Constructing of Roads (Phase 3: 2029-2033)

No.	Ring Road Project Name	Organization in Charge
A-R-18	Project for Construction of Ambohimalaza - Ambohimambola Section of the Outer Ring Road (Eastern Part)	MAHTP
A-R-19	Project for Construction of Ambohidratrimo - Ampangabe Section of the Outer Ring Road (Western Part)	MAHTP
A-R-20	Project for Construction of Anjomakely - Ambohijanaka Section of the Outer Ring Road (Southern Part)	MAHTP
No.	Project Name: Radial Road	Organization in Charge
A-R-21	Project for Construction of Primary Arterial Road between Ambohimambola - Amoronakona	MAHTP
A-R-22	Project of Construction of Primary Arterial Road between Ambohijanaka - Andoharanofotsy	MAHTP

Source: JICA Study Team

(2) Priority Projects of Development of Urban Centres (Phase 3: 2029-2033)

The priority projects of development of urban centres for Phase 2 are shown in Figure 13.3.10 and listed in Table 13.3.10.



Source: JICA Study Team

Figure 13.3.10 Location of Priority Projects of Development of Urban Centres (Phase 3: 2029-2033)

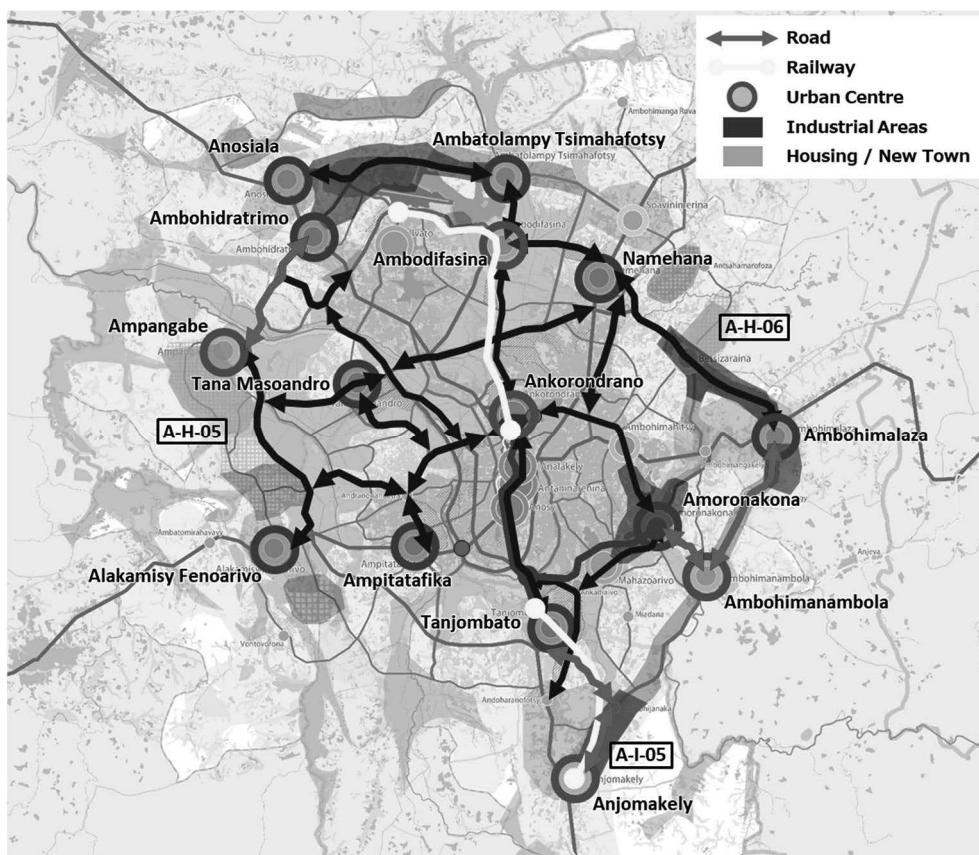
Table 13.3.10 List of Priority Projects of Development of Urban Centres (Phase 3: 2029-2033)

No.	Urban Centre Project Name	Organization in Charge
A-C-17	Project for Promotion of Development of Ankorondrano Primary Urban Centre Phase 3	MAHTP, PPP
A-C-18	Project for Promotion of Development of Ambohimambola Suburban Centre	MAHTP, MICA, PPP
A-C-19	Project for Promotion of Development of Anjomakely Suburban Centre on NR7	MAHTP, MICA, PPP

Source: JICA Study Team

(3) Priority Projects of Development of Industrial Areas and Housing Areas (Phase 3: 2029-2033)

The priority projects of development of industrial areas and housing areas for Phase 3 are shown in Figure 13.3.11 and listed in Table 13.3.11.



Source: JICA Study Team

Figure 13.3.11 Location of Development of Industrial Areas and Housing Areas (Phase 3: 2029-2033)

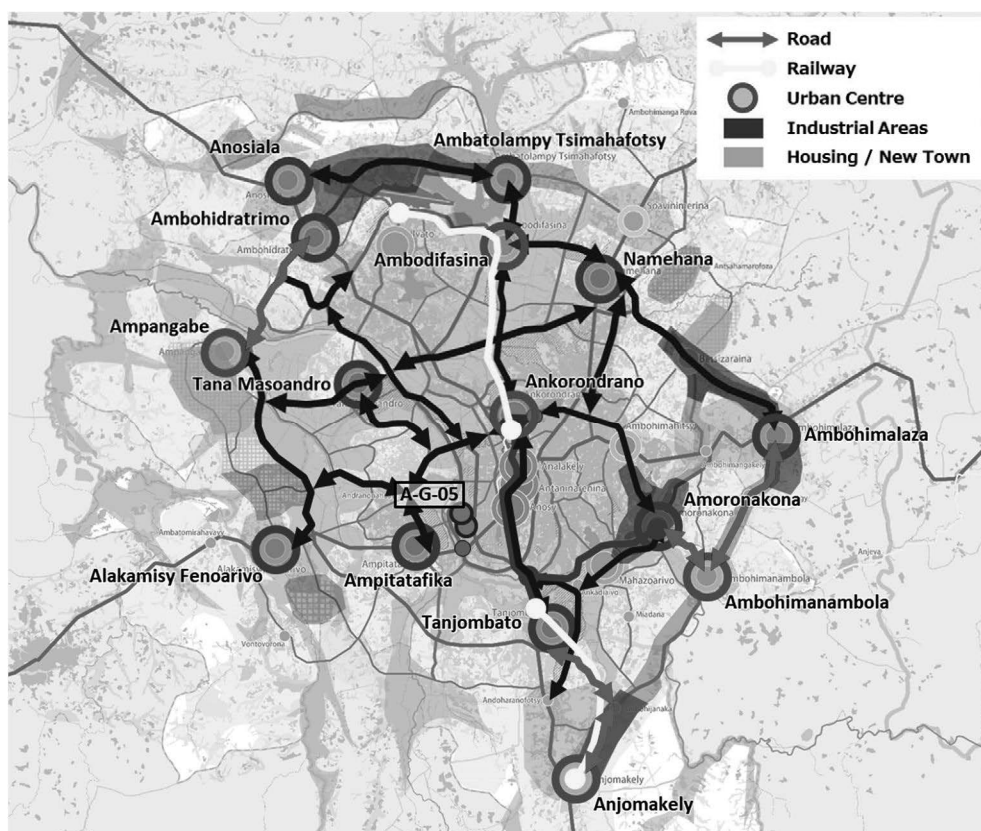
Table 13.3.11 List of Development of Industrial Areas and Housing Areas (Phase 3: 2029-2033)

No.	Industrial Area Project Name	Organization in Charge
A-I-05	Project of Development of Industrial and Logistics Area along Anjomakely - Ambohijanaka Section of the Outer Ring Road	MAHTP, MICA, PPP
No.	Housing Area Project Name	Organization in Charge
A-H-05	Project for Development of Ampangabe New Town	MAHTP, PPP
A-H-06	Project for Development of Fiefferana New Town	MAHTP, PPP

Source: JICA Study Team

(4) Priority Projects of Power Supply and Disaster Risk Management (Phase 3: 2029-2033)

The priority projects of power supply and disaster risk management for phase 3 are shown in Figure 13.3.12 and listed in Table 13.3.12.



Source: JICA Study Team

Figure 13.3.12 Location of Priority Projects of Power Supply and Disaster Risk Management (Phase 3: 2029-2033)

Table 13.3.12 List of Priority Projects of Power Supply and Drainage Improvement (Phase 3: 2029-2033)

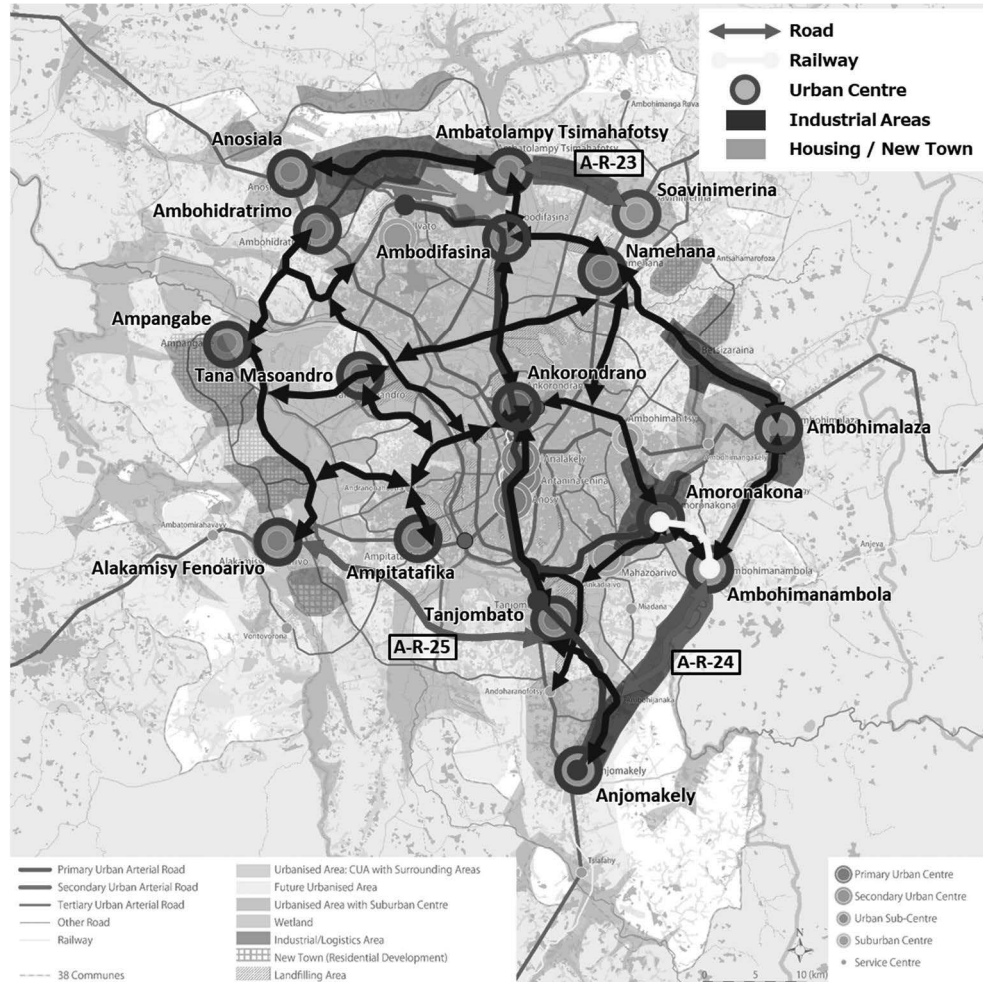
No.	Power Supply Project Name	Organization in Charge
A-P-11	Installation of New Transmission Lines	JIRAMA
A-P-12	Installation of New Substations	JIRAMA
A-P-13	Expansion of the Power Distribution System	JIRAMA
No.	Drainage Improvement Project Name	Organization in Charge
A-P-05	Project for Development of South West Plain Retention Ponds and Waterfront Parks	MAHTP, APIPA, CUA
No.	Health Infrastructure Project Name	Organization in Charge
A-S-04	Project for Development of New District Hospital in Ampangabe Suburban Centre	MINSAN
No.	Education Infrastructure Project Name	Organization in Charge
A-D-05	Project of Development of Education Hub at Fenoarivo North New Town	MENETP, PPP
A-D-06	Project of Development of Education Hub at Anjomakely Suburban Centre	MENETP, PPP

Source: JICA Study Team

13.3.4 Priority Projects and High Priority Projects for Phase 4 (2034-2038)

(1) Priority Projects of Constructing of Roads (Phase 4: 2034-2038)

The priority projects of construction of roads for Phase 4 are shown in Figure 13.3.13 and listed in Table 13.3.13.



Source: JICA Study Team

Figure 13.3.13 Location of Priority Projects of Constructing of Roads (Phase 4: 2034-2038)

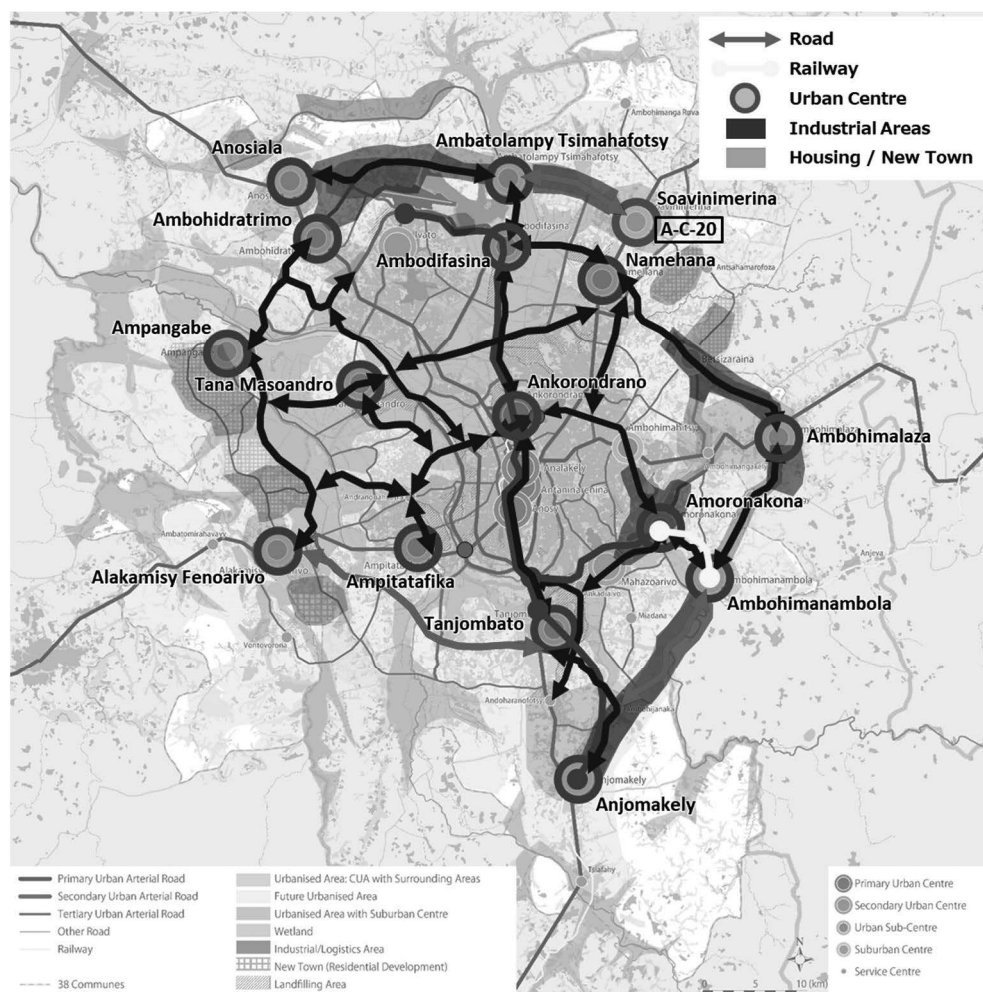
Table 13.3.13 List of Priority Projects of Constructing of Roads (Phase 4: 2034-2038)

No.	Ring Road Project Name	Organization in Charge
A-R-23	Project for Construction of Ambatolampy Tsimahafotsy-Anosy Avaratra Section of the Outer Ring Road (between Tsarasaotra Road and NR3)	MAHTP
A-R-24	Project for Construction of Ambohimambola-Ambohijanaka Section of the Outer Ring Road	MAHTP
A-R-25	Project for Construction of Alakamisy Fenoarivo-Andoharanofotsy Section of the Outer Ring Road (between NR1 and NR7)	MAHTP

Source: JICA Study Team

(2) Priority Projects of Development of Urban Centres (Phase 4: 2034-2038)

The priority projects of development of urban centres for Phase 4 are shown in Figure 13.3.14 and listed in Table 13.3.14.



Source: JICA Study Team

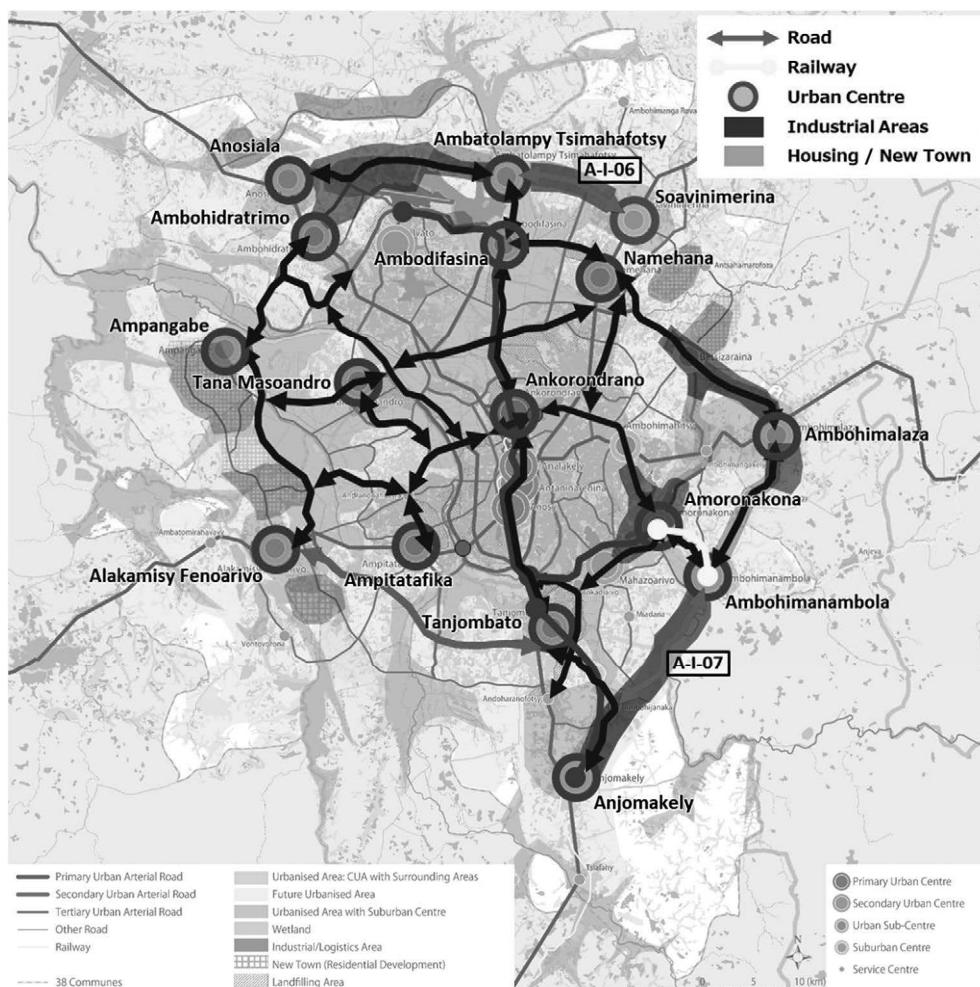
Figure 13.3.14 Location of Priority Projects of Development of Urban Centres (Phase 4: 2034-2038)

Table 13.3.14 List of Priority Projects of Development of Urban Centres (Phase 4: 2034-2038)

No.	Urban Centre Project Name	Organization in Charge
A-C-20	Project for Promotion of Development of Anosy Avaratra Suburban Centre	MAHTP, MICA, PPP

(3) Priority Projects of Development of Industrial Areas (Phase 4: 2034-2038)

The priority projects of development of industrial areas for Phase 4 are shown in Figure 13.3.15 and listed in Table 13.3.15.



Source: JICA Study Team

Figure 13.3.15 Location of Development of Industrial Areas (Phase 4: 2034-2038)

Table 13.3.15 List of Development of Industrial Areas (Phase 4: 2034-2038)

No.	Industrial Area Project Name	Organization in Charge
A-I-06	Project for Developing Industrial and Logistics Areas along Ambatolampy Tsimahafotsy - Anosy Avaratra Section of the Outer Ring Road by Providing Access Roads, Water and Electricity	MAHTP, MICA, PPP
A-I-07	Project for Development of Industrial and Logistics Areas along Ambohimambola - Ambohimankana Section of the Outer Ring Road by Providing Access Roads, Water and Electricity	MAHTP, MICA, PPP

Source: JICA Study Team