Promotion of BAT / BEP to reduce releases of uPOPs from open burning of waste in Madagascar

INVENTORY, EVALUATION OF INFORMATION RELATING TO WASTE MANAGEMENT IN MUNICIPALITY OF:

ANTSIRABE

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Draft version

ABBREVIATIONS

CUA	:	Commune Urbaine d'Antsirabe / Municipality of Antsirabe
BEP	:	Best Environmental Practices
BAT	:	Best Available Technologies
ONE	:	Office National pour l'Environnement / National Office for Environment
NGO	:	Organisme Non Gouvernemental / Non-Governmental Organisation
RF2	:	Rafitra Fanadiovana Fako
uPOPs	:	Polluants Organiques Persistants non intentionnels / Unintentional Persistent Organic Pollutant
SADC	:	
SEPU	:	Service Embellissement et Propreté Urbaine / Infrastructure and Urban Sanitation Service
SIAU	:	Service Infrastructure et Assainissement Urbain/ Embellishment and Urban Cleanliness Service

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1 Context and justification

As part of the Stockholm Convention on Persistent Organic Pollutants ratified by Madagascar in August 2005, Parties are required to take the necessary measures to reduce or eliminate releases of POPs covered by the Convention, namely, among others:

- Measures to reduce or eliminate releases from intentional production and use;
- Measures to reduce or eliminate releases from unintentional production;
- Measures to reduce or eliminate releases from storages and wastes.

The regional project "Promoting BAT / BEP to reduce uPOP releases from open burning of waste in SADC participating African countries" has the overall objective of significantly and sustainably reducing the releases of uPOPs in the sector of open burning waste by improving guidance on best available techniques and best environmental practices for open burning processes of waste and biomass.

The specific objective of the project is to achieve a continuous reduction of uPOP releases in the open burning waste sector in participating African countries in the SADC region by introducing best available techniques and best environmental practices (BAT / BEP) on certain priority demonstration sites.

For Madagascar, two sites have been identified and selected for the establishment and implementation of waste management plans introducing these BAT / BEP. The first site is the Municipality of Antsirabe and the second site includes the municipalities of Ambohibao Antehiroka, Talatamaty and Ivato.

To do this, the consultant is asked to:

- Collect data, information on the feasibility of reducing open burning practices for waste in both sites: population served, characterization of waste, existing management system (collection, route, cost, ...)
- To propose a system of collection facilitating the recycling of the waste: advantages, constraints, possible costs...
- Evaluate the collected data / information in order to identify the relevant options for the implementation of the BAT / BEP to enable the realization of waste management plans in the sites;
- Compile the information obtained in a report;

In addition, a collection of waste management data at the level of textile free enterprises was entrusted to the consultant (type and volume of waste generated, method of processing, etc.)

2 Methodological approach

To carry out the various activities entrusted to the mandatory, the following approach is adopted:

- Development of sheets related to collection of information;
- Documentary study: monograph of Municipality,
- Field visit to gather the different information on the existing management systems:
    - Contact and interview with the different people involved in municipal waste management: Mayor, technical managers, chefs fokontany,
    - Contact of the entities that deal with the valorization of waste at local level: companies, associations, individuals ...
- Characterization of waste at the household level and landfills
    - Choice of Fokontany;
    - Household sampling; sorting and quantification of waste at the household sample level for a given period;
    - Sorting and quantification of the waste brought by the trucks to the landfills by applying the system of quarts (Sorting and weighing the QUART of the total capacity of the truck)
- Compilation and synthesis of all information collected;
- Proposal for a waste collection and management system for the sites;

3 The Municipality of Antsirabe

3.1 General information

The Municipality of Antsirabe is made up of 17 Fokontany with a total population of 150 708 inhabitants in 30 178 households. At the level of the AUC, on average, 30% of households are served by a collection system organized either by the Municipality itself through its technical service or individually at the household level itself. In the waste management system, the Municipality is currently working with the NGO EAST, which is working in 7 Fokontany through the establishment of a system of pre-collection at the household level and sorting at the level of garbage bins. In addition, the construction of a composting platform and a plastics recycling unit is underway as part of the project initiated by this NGO.

Table 3-1 Distribution of population and households by fokontany in the CUA

	Fokontany	Population	Households	Collection point	Households served by a collection system (%)	Households not served by a collection system (%)
1	Ambohimena Sud	12 243	2 485	2	33	67
2	Ambohimena Nord	8 082	1 616	3	33	67
3	Mahazoarivo Sud	12 974	2 595	1	33	67
4	Mahazoarivo Nord	24 616	4 923	1	33	67
5	Miaramasoandro	20 991	4 198	-	-	100
6	Mahafaly	11 739	2 348	-	-	100
7	Antsirabe Avaratra	11 001	2 200	3	67	33
8	Mahazina	6 109	1 222	-	-	100
9	Talata Andraikiba	6 395	1 279	1	33	67
10	Tsivahitrinikamo	7 771	1 554	1	67	33
11	Fitomilasy Bevokatra	4 203	841	1	33	67
12	Manodidina ny Gara	4 628	926	2	67	33
13	Tsarasaotra	3 608	722	2	67	33
14	Ambalavato Atsimo	4 017	803	-	-	100
15	Antsenakely	2 887	577	1	50	50
16	Androvakely	4 401	880	-	-	100

	Fokontany	Population	Households	Collection point	Households served by a collection system (%)	Households not served by a collection system (%)
17	Antanambao Est Ivohitra	5 043	1 009	-	-	100
	TOTAL	150 708	30 178	18	30	67,75

Source : Service Technique CUA- July 2018

In 2030, the population increase of the Municipality of Antsirabe is estimated at 25%, that is to say 362,552 inhabitants and a density of 3,000 Hab. /km ². With waste production estimated at 0.400 kg / day and per capita, the city's waste production should therefore reach about 53 000 tons. *(Source: State of play in solid waste management in the Antsirabe-Anjanoro Municipality Rakotomalala / Madacompost and Ghislain de Castries / Gevalor- April 2017)*

3.2 The different types of activities at CUA level

In the CUA, all activities could be found ranging from small shops, ironsmith, and supermarkets to industries (food, textiles ...). Agriculture still occupies a significant place in the activities identified at the CUA level.

The table below summarizes these different activities:

Table 3-2 Summary of activities at the CUA level

Activities			Number	Comments
Industry	Food		5	STAR, TIKO, SOCOLAIT, SEER, SOCOTA
	Textile		5	AQUARELLE, COTONA, COTTONLINE, ACCORD KNITS, ANTSIRABE KNITS WEAR
	Transformation (plastic…)			
	Others		2	SOBA, SACIMEM
Trading	Hyper market		2	JUMBO SCORE, SHOPRITE
Maket			10	3 Central Markets 6 neighborhood markets 1 markets of cattle
	Type		**Occupied area (ha)** *(données 2013)*	
Agriculture	Rice		2580	
	Corn		2000	
	Cassava		310	
	Vegetables		500	Potato, beans, cabbage, carrots, other vegetables
	Other		3000	Barley
			150	Fruits

Source: Service Technique CUA- Juillet 2018

3.3 Characterization of CUA waste

3.3.1 Waste at the household level

To make the typology and quantification of waste at the household level, six (6) Fokontany were chosen by considering the size, the number of the population, the diversity of activities at the household level, the socio-economic situation. Among these Fokontany are Mahazoarivo Avaratra, Mahazoarivo Atsimo, Avaratsena, Ambohimena Avaratra, Ambohimena Atsimo, Antsirabe Avaratra. Six (6) households per fokontany were taken as a sample. Garbage bags for sorting different types of waste were distributed and weighed daily and for two days.

Note that the limit of the study is the number of households sampled and the period because the amount generated depends on the season. Nevertheless, it allowed having a global idea of the quantity produced at the level of each household.

The results of household level waste characterization are presented in Annex 1. The average daily amount of waste generated per household is presented in Table 3.3. If this daily average is returned to all households at the CUA level to obtain an estimation of the annual amount of waste generated, the results are presented in Table 3.4.

Table 3-3 Average daily amount of waste generated per household and by Fokontany

FOKONTANY	MAHAZOARIVO AVARATRA	MAHAZOARIVO ATSIMO	AVARATSENA	AMBOHIMENA AVARATRA	AMBOHIMENA ATSIMO	ANTSIRABE AVARATRA	Average	%
	(g)	(g)	(g)	(g)	(g)	(g)	(g)	
TYPES								
Paper, Cardboard	46,83	146,5	170,4	46,8	26,3	19,25	76,03	6,44
Wood	10,50	55,2	31,4	10,5	0,0	107,5	35,84	3,04
Plastic	93,33	48,8	199,6	93,3	69,7	16,75	86,92	7,36
Glass, Ceramic	0,00	42,8	127,2	0,0	0,0	84,25	42,38	3,59
Food Waste / Green Waste	424,83	1635,3	1058,9	424,8	458,8	317,25	720,00	60,98
Metals	4,00	10,0	9,4	4,0	0,0	0	4,57	0,39
Textiles, Leather	0,00	144,3	0,8	0,0	10,5	2,25	26,31	2,23
Rubble	253,17	35,5	0	253,2	55,0	0	99,47	8,42
Particles	0,00	0,0	0	0,0	0,0	0	-	-
Other	166,17	0,0	182,1	166,2	0,0	20,75	89,20	7,55
	998,83	**2 118,50**	**1 779,80**	**998,83**	**620,33**	**568,00**	**1 180,72**	

Table 3-4 Estimated amount of waste generated annually at the household level

Types	Households			
	Average amount generated (kg / d)	Total amount generated (Kg / Household / d)	Average amount generated per year (T)	%
Paper, Cardboard	0,08	2 293,5	837,1	6,4
Wood	0,04	1 161,9	424,1	3,3
Plastic	0,09	2 622,5	957,2	7,3
Glass, Ceramic	0,04	1 276,5	465,9	3,6
Green Waste	0,72	21 728,2	7 930,8	60,9
Metals	0,00	120,7	44,1	0,3
Textiles, Leather	0,03	794,0	289,8	2,2
Rubble	0,10	3 008,7	1 098,2	8,4
Particles	0,00	-	-	-
Other	0,09	2 685,8	980,3	7,5
	1,18	35 691,8	**13 027,5**	

If we refer to the amount of waste generated per inhabitant with an average ratio of 0.4 kg / inhabitant / day (Source: inventory of solid waste management in the district of Antsirabe - Anjanoro Rakotomalala / Madacompost and Ghislain de Castries / Gevalor- April 2017), the quantity generated would be around 60 T / d, thus 21,000 T / year. It could therefore be said that the values obtained during the study are in a low average.

Note that the estimated amount of waste generated at the household level changes with the seasons and increases during the fruit season (rainy season) while the study was conducted during the dry and cold season.

3.3.2 Waste at the landfill

In order to determine the amount of waste collected and transported to the IVOHITRA landfill, the quart's system is used. It consists in taking the QUART of the truck body and proceeding to sort waste and weighing of each type.

The results of data collection at the IVOHITRA landfill are presented in the table below:

Table 3-5 Estimated amount of waste collected and transported at the landfill

LOCALISATION : IVOHITRA

DATE :	04/07/2018	05/07/2018		
ORIGIN:	Fokontany Ivory	Distrika-Pharmacie Vakinakaratra près ABE II		
TYPES	Quantity (Kg)	Quantity (Kg)	Average	%
Paper, Cardboard	10,5	30	20,25	6,54
Wood	5,5	3,5	4,5	1,45
Plastic	38,5	43,3	40,9	13,20
Glass, Ceramic	2,2	10	6,1	1,97
Green waste / Garden waste	101,9	51	76,45	24,67
Food Waste	66,5	169,5	118	38,08
Metals	0	0	0	-
Textiles	20	8,5	14,25	4,60
Leather	3,2	4	3,6	1,16
Rubble	30	4	17	5,49
Batteries	0,117	0	0,0585	0,02
Others (Baby diapers…)	11,5	6	8,75	2,82
	289,917	329,8	309,8585	

From these collected data, an estimation of the quantity collected and transported at the landfill level annually is presented in Tables 3.6 and 3.7.

Table 3-6 Estimated amount of waste collected and transported at the landfill

VOLUME OF WASTE	2	m3	Freq/d	QTTY (m3/d)	Freq/week	Quantity/year
WASTE WEIGHT	309,85	Kg				
DENSITY	154,925	Kg/m3				
QUANTITY COLLECTED (m3 / d)	8	m3	4	32	6	
	3	m3	3	9	6	
Total		m3		41	6	12 792
QUANTITY COLLECTED (T)						1 981,80

Table 3-7 Estimated quantity by type of waste collected and transported at the Ivohitra landfill

Types	**Discharge**			
	Quantity collected (Kg /d)	Total quantity collected (Kg / d)	Average amount collected per year (T)	%
Paper, Cardboard	20,3	415,1	129,5	6,5
Wood	4,5	92,3	28,8	1,5
Plastic	40,9	838,5	261,6	13,2
Glass, Ceramic	6,1	125,1	39,0	2,0
Green waste / Garden waste	76,5	1 567,2	489,0	24,7
Food Waste	118,0	2 419,0	754,7	38,1
Metals	-	-	-	-
Textiles	14,3	292,1	91,1	4,6
Leather	3,6	73,8	23,0	1,2
Rubble	17,0	348,5	108,7	5,5
Batteries	0,06	1,2	0,4	0,0

Types	Discharge			
	Quantity collected (Kg /d)	Total quantity collected (Kg / d)	Average amount collected per year	%
Others (Baby diapers…)	8,75	179,4	56,0	2,8
	309,9	6 352,1	**1 981,9**	

By comparing the amount of waste produced by households with the waste collected and transported at the level of the IVOHITRA landfill, we could say that the collection rate is around 15%. Note that these data do not include waste generated by industries and economic activities that have their own waste management system (collection, transportation and even private waste).

3.4 Resources allocated by the AUC for waste management

The budget allocated by the Municipality of Antsirabe for the purchase of fuel for the collection and transportation of waste at the IVOHITRA landfill amounts to 120 million Ariary per year, excluding staff salaries (Source: Technical Service of the CUA).

The material resources available to the AUC are shown in the table below:

Table 3-8 Summary of the rolling materials of the Municipality of Antsirabe and their respective capacity

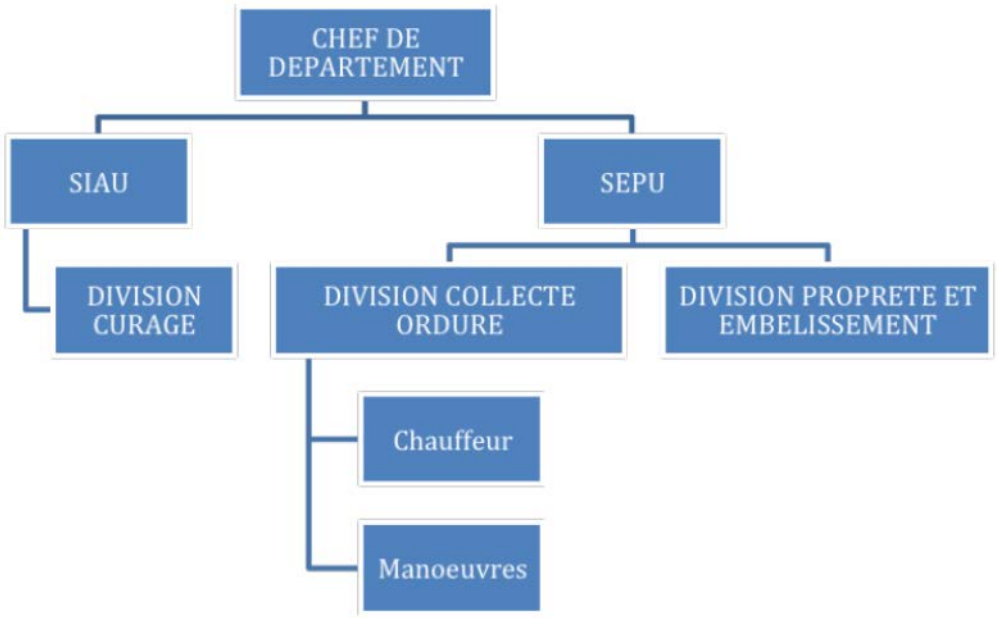
C.2. COLLECTION SYSTEM									
Type of contributor	:	Public	X	Private		Other			
Number of operators	:	CUA							
Type of contract	:								
Truck (a) / Tractor (b) / Others (c)		Number		Capacity		Travel / day			
		4	a	8	m3	4			
		1	b	3	m3	3			

Source: Technical service CUA - 2018

CUA dump truck dumping waste in Ivohitra

The Technical Department is in charge of waste management at the level of the Municipality of Antsirabe. This department has two services, the SIAU (Infrastructure and Urban Sanitation Service) and the SEPU (Embellishment and Urban Cleanliness Service) which deals with waste collection, street sweeping and garden maintenance. The Figure 3.1 shows the organization of the Department of Roads.

Figure 3-1 Organizational chart of the Department of waste management



Source: Highways - State of Solid Waste Management in the Municipality of Antsirabe - Anjanoro Rakotomalala / Madacompost and Ghislain de Castries / Gevalor- April 2017

3.5 The current system of waste collection at the CUA level

The CUA is mainly involved in the collection of household waste at collection points (Municipality bins, wild deposits) and does not deal with pre-collection at the household level. The town has bins whose dimensions and capacities are variable. Tables 3.9 and 3.10 summarize the data on garbage bins in the CUA. The frequency of evacuation of bins is very variable (daily, two to three times a week, once or twice a month) depending on their situation. Some of them are not emptied regularly and to reduce the volume of waste stored in these tanks the population burns them. This is the case of a bin in the fokontany of Ambohimena Avaratra.

The collection is carried out along the main axes of the urban centre and in the sites deemed "strategic" (high traffic areas, neighbourhoods near major highways, tourist sites). As mentioned in the previous paragraph, if we refer to the estimates of waste generated in households and those collected by the Municipality, the collection rate is around 15%.

Table 3-9 Information about CUA bins

Capacity of the bins	:	Variables between 6 m3 and 12 m3
Size of the bins	:	Variables average 2.5m x 4m x 1m
Other	:	Wild Bins (Wild Deposits)

Source: Technical Service CUA – July 2018

Garbage bin at the Fokontany Ambohimena Avaratra

Table 3-10 Recap of the bins by fokontany

Nom du *Fokontany*	Nombre de bacs	Capacité en m^3
3A	2	28
Ambohimena nord	4	48
Ambohimena sud	4	42
Amboronomby	1	12
Ampatana	3	36
Andafiatsimo star	1	12
Antsenakely	2	18
Antsirabe nord (avaratra)	5	72
Atsimotsena	2	18
Atsongo	1	10
Avaratsena	3	36
Bevokatra	1	12
Ivory	2	24
Mahazoarivo	2	14
Manodididna ny gara	4	32
Tsarasaotra	2	24
Tsivatrinikamo	2	24
Grand Total	**41**	**462**

Source: *Voirie 2017- State of play in solid waste management in the Municipality of Antsirabe-Anjanoro Rakotomalala / Madacompost and Ghislain de Castries / Gevalor- April 2017*

The NGO EAST has proposed to the CUA a waste recovery project by setting up a system composed of the following elements:

- pre-collection at the household level;
- Construction of collection bins;
- Sorting at the collection bins;
- Construction of a composting platform and recycling plastic in the IVOHITRA site.

Currently, it works at five Fokontany (Ivory, Atsimontsena, Ambalakisoa, Ampatana, 3A) and works with an association called FAMAFA for pre-collection, sorting at bins. To do this, it proposes a household participation of 500 Ar / month.

In summary, the main issues identified regarding waste collection are the following:

- Low collection rate which is around 15% while the objective of the Municipality is 60% resulting in most of the cases, the burning of waste in the bins;
- Insufficient of bins;
- Failure of transport equipment;

3.6 Valorisation and recycling of waste at the CUA level

Apart from a steel metal recycling unit in Ambohimena, there are no other recycling units at the CUA level. However, a study conducted by Madacompost in 2017 showed the existence of a local waste valorization sector, whether at the household level, in garbage bins or at the IVOHITRA landfill. Table 3.11 shows the data collected during this study.

Table 3-11 Valorization of waste sector at the CUA level

Localisation	Nombre collecteurs informels	Ordures collectées	Moyens de collecte	Moyen de transport	Prix de vente
Au niveau des ménages	NS	Bouteilles plastiques	Sac	A pied Charrette	50 à 200 Ariary la pièce
		Sachets plastiques			1000 Ariary le kg
		Métaux			150 à 2000 Ariary le kg
		Boite de conserve			150 Ariary la pièce
		Déchets putrescibles			10 000 à 11 000 Ariary la charrette
Dans les bacs de la CUA	Informels fixes Informels ambulants : 0 à 3 par bac selon l'emplacement	Bouteilles plastiques	Sac	A pied Charrette	30 – 100 Ariary la pièce
		Sachet plastiques			20 Ariary la pièce
		Métaux			200 Ariary le kilo
		Aluminium			1 000 Ariary le kilo
		Déchets putrescibles			10 000 à 15 000 Ariary la charrette
Dans la décharge (Ivohitra)	3 à 5 Trieurs/jour 10 à 15 charrettes/jour	Bouteilles plastiques	Fourche Soubique	A pied Charrette	30 Ariary
		Sachet plastiques			20 – 30 Ariary la pièce
		Métaux			250 Ariary le kilo
		Déchets putrescibles			Trieurs : 3000 à 3500ar Charrettes : 10000 à 15000ar
		Os			200 Ariary le kilo

Source: State of play in solid waste management in the Municipality of Antsirabe-Anjanoro Rakotomalala / Madacompost and Ghislain de Castries / Gevalor- April 2017

The estimation of waste that can be valorized from the waste generated by households is presented in the table below:

Table 3-1 Estimation of the amount of household waste that can be valorized

VALORISABLES	QUANTITY (T/year)
Paper	837
Wood	424
Plastic	957
Glass, ceramic	465
Green waste/Putrescible	7930
Metals	44
Textiles, leather	289

A survey of waste pickers in the IVOHITRA landfill provided information on the existence of a market for the waste sorted there. Aside from the ash collectors used as fertilizer, some trash diggers search for plastic debris, metals, bones and shoe laces that are purchased at 300 Ar, 500 Ar, 300 Ar and 200 Ar per kilogram, respectively.

3.7 The CUA dump site at IVOHITRA

3.7.1 General information

The CUA dumpsite is located at IVOHITRA about 3 km from the city centre on a Puzzolane quarry belonging to the Municipality. Since 2015, the CUA has used the site as a landfill site and has abandoned the Ambohipeno site due to the difficulty of access especially during the rainy seasons. This is an uncontrolled landfill as there are no control systems for discharges (leachate, gas ...) and the waste is not weighed.

The immediate environment of the site consists of:

- NE of the waste treatment platform (composting and recycling of plastics) built by the NGO EAST which works in partnership with the Municipality;
- In the NW of the site of SOS Children's Villages;
- SOUTH, of a wooded area;
- EAST, the road leading to the landfill and the composting site of the Municipality;
- In the west, the hill overlooking the dump;

Figure 3-2 Map showing the location of the Ivohitra landfill

Figure 3-3 Immediate environment of the Ivohitra landfill

3.7.2 Problems encountered (Issues)

The main points raised by neighbouring and JIRAMA (Water and Electric National Company) are the followings:

- Passage of the east side of the JIRAMA ducts from Lake Andraikiba to the water tank (water tower). Breakage of pipes due to risk of landslide. Existence of cases of rupture (recent case);
- Smoke generated by the burning of garbage by the trash diggers working on the site, carried by the wind to the premises of SOS Children's Village;
- Development of football field for the community with rubbish dumps seen by local residents, among other SOS Children's Village as an initiative of the Municipality to relocate the landfill at this location;
- Environmental permit not issued by ONE because of complaints from SOS Children's Village concerning the installation of waste treatment plant;

3.7.3 Actions of companies taken to solve problems (Actions undertaken)

Consultation of the parties involved in the issue: JIRAMA, CUA, Regional Prefect, Environment Directorate to see the solutions and the measures to be taken in relation to the issues. The solutions that have been proposed are:

- The Municipality decided to no longer use / exploit the eastern part adjacent to the water pipes of the JIRAMA
- Municipality and JIRAMA agreed to respect a footprint of 5m on each side of the JIRAMA's pipeline and to not use the East part of the Dumpsite (see official report in Appendix …)

Concerning the generation of smoke in dumpsite, the solution proposed by CUA is to stop waste burning by fencing the site and putting guards to prevent people from getting inside.

About the environmental permit for EAST project, ONE recommended that involved parties would do a round table to find a common and sustainable solution to address issues.

Above view of the Ivohitra landfill- Burning waste

Garbage diggers recovering recyclable waste (plastics, metals, bones, shoelaces) and ash from burning waste

View of the SOS Children's Village facility (NO side of the dump)

View of the platform for composting waste and plastic recycling (NE side of the landfill)

3.8 Proposal for a waste collection system

The main objectives of the project on the promotion of BEPs and BAT to reduce releases of uPOPs from open burning of waste are:

- Reduce waste to be sent to the landfill by valuing the waste that is generated at the household level;
- Put in place the BEP and BAT for waste treatment to avoid open burning

The direct consequence at the CUA level is the reduction of waste management costs as there will be a reduction in the cost of collection and transportation.

To do this, sorting at the source (at the household level) coupled with a waste recovery process will be proposed upstream of the management system. In addition, downstream of the management system, facilities to prevent burning at the disposal site will be considered.

In order to set up a new waste collection system, four (4) Fokontany were chosen. Among the selection criteria of Fokontany are:

- The number of the population;
- The lack of a pre-collection system;
- Non-membership of the EAST intervention area;
- The interest displayed by households in sorting (assessed during characterization of waste in households);
- The variety of socio-economic activities and the standard of living of households;
- Spatial distribution of fokontany;

The Fokontany chosen are: Antsirabe Avaratra, Mahazoarivo Atsimo, Avaratsena, Mahazoarivo Avaratra

3.8.1 Establishment of sorting at the source (at the household level)

Currently, household waste is mixed and brought to collection points (garbage bins, wild dumps) by themselves. The objective of the proposed activity is to get households to make a SORTING at the source of their waste to facilitate their valorisation.

Three (3) types of bins will be proposed to households:

- A bin for compostable waste: putrescible food waste and green waste
- A bin for other valuable / recyclable waste: plastics, glasses, metals, fabrics, leathers

- A bin for non-valuable

To do this, an awareness campaign and the household endowment of small bins for sorting are necessary.

3.8.2 Setting up a pre-collection system

To facilitate the valorisation of waste, a pre-collection system dealing with the recovery of sorted waste at the household level, their transfer to the collection points of the AUC, the sorting of waste for recovery / recycling with a participation per household which will be defined in general assembly will be put in place.

To do this, the experience of the NGO EAST with the FAMAFA association could be extended to other fokontany or the experiences of other municipalities (Antehiroka, Ivato or Talamaty) with the RF2 in the matter could be shared.

The organization and mode of operation of RF2 (Rafitra Fitantanana ny Fako) is summarized as follows:

- It is a structure set up at the level of the Fokontany from a Committee of inhabitants which is constituted by the general assembly of the population of Fokontany;
- RF2 is an association governed by legislation relating to Associations in Madagascar. It therefore functions as an association made up of its General Assembly, its Executive Board and its Board of Directors / Steering Committee;
- Its main resource is the household participation that will be defined in AG Fokontany. This participation varies from 500 Ar to 10 000A Ar according to the standard of living of the households;
- Its main responsibilities are the pre-collection of waste and the sanitation of the drainage channels at Fokontany (secondary roads).

For the implementation of RF2, the following activities are planned:

- Organization of a general assembly at the level of Fokontany for the constitution of the Committee of inhabitants in charge of hygiene and sanitation;
- Establishment of an association responsible for pre-collection of waste and sanitation (members of the Executive Board, CA / Steering Committee);
- Provision of small equipment and materials (wheelbarrows, shovels, brooms, bins / collection drums, PPE ...)
- Training of the members of the RF2: agents on sites, administrative agents ...
- Sensitization of the population on the attributions of RF2.

To this end, support from organizations such as ENDA OI could be envisaged.

3.8.3 Establishment of a waste sorting centre

For the valorisation of waste, a sorting centre will be set up at Fokontany level according to the availability of space. RF2 / FAMAFA will take care of the management of this centre:

- Manual sorting of valuable waste;
- Sale of waste and customer search;
- Maintenance of equipment.

Revenue from the sale of waste will be used to replenish the association's fund (RF2 / FAMAFA) to ensure its operation and the sustainability of these activities.

For the establishment of a sorting centre, the following activities need to be carried out:

- Land identification and acquisition;
- Construction / development of an office;
- Arrangement of a manual sorting platform;
- Training of agents responsible for sorting;
- Support of the association in search of outlets / customers;

3.8.4 Analysis of proposals

An analysis of the benefits and constraints associated with the proposed activities is presented in Table 3.13.

Tableau 3-2 Analysis of proposed activities

Activities	Advantages	Constraints
1- Establishment of Sorting at the source (at the household level)	o Easy recovery of waste o Uncontaminated waste because separated at the source o Reduction of waste sent to the landfill	o Reluctance of households to sort o Need to set up a motivation system o Availability of sorting bins. Support for the acquisition of bins
2- Setting up a pre-collection system	o Opportunity to employ people with limited resources in Fokontany (job creation) o More organized collection at the household level o Increase in the collection rate of the Municipality	o Consent to pay households. The recovery rate of RF2 is around 40% o This rate covers only the operation of the association without maintenance or renewal of equipment

Activities	Advantages	Constraints
	o Reduction of CUA costs for transportation of waste to the landfill	o Capacity of members to manage the association o Existence of the Household Garbage Tax (ROM) which is applied by the Municipality
3- Establishment of a reusable waste sorting centre	o Reduction of waste sent to the landfill o Reduction of CUA costs for transporting waste to the landfill o Source of additional money for RF2 / FAMAFA o Possibility of a return to the household level (motivation) o Market creation	o Capacity of the association to manage the centre o Sustainability of the Centre (no market) o Support for the installation and maintenance of materials / equipment o Land availability

Note that the implementation of this new pre-collection system at the Fokontany level identified will result in the reorganization of the current collection system at the level of the CUA: program, allocated resources...

3.9 Laying out at the IVOHITRA landfill

As mentioned in paragraph 3.7, in order to solve the various problems raised by the neighbourhood regarding the operation of the IVOHITRA landfill certain amenities and organization should be considered at the landfill level as:

- The fence of the site to limit the entries of the trash diggers who currently burn the waste to have ashes;
- The development of the composting platform of the Municipality for the treatment of green and fermentable waste;
- The recruitment of guards to secure the site;
- Respect for the 5m right-of-way on both sides of the JIRAMA water pipe;

To identify the main impacts of the operation of the landfill and the planned ancillary activities and to put in place the various mitigation measures, an impact study could be considered if necessary.

3.10 Information on textile industries in the CUA

As mentioned in Section 3.2 and Table 3.2 - Summary of activities at the AUC level, five (5) textile companies operate at the CUA level: AQUARELLE, COTONA, COTTON LINE, ACCORD KNITS, and ANTSIRABE KNITS WEAR.

Given that during the study these companies could not be approached, information on the composition of COTONA (Cotonnière d'Antsirabe) was presented in Table 3.14 for information purposes.

COTONA is one of the largest textile industries in Madagascar and it operates the entire cotton-growing sector until its transformation into fabric. COTTON LINE is one of COTONA's subsidiaries.

Tableau 3-3 Composition of COTONA waste

Type de déchets	Description	Utilisationactuelle	Quantité	Valorisation
Textiles	Chute issue de la production de tissus et de la confection	Chaudière / Récupérationemployés / Décharge	350kg/semaine	Bio-combustibles
Bourre de coton	Issus de la transformation du coton	Décharge (souventsouillé avec des graisses)	500 kg/semaine ;estimé à 25 t/an	Forte fuméeconstatée en combustion / Compostage (sous réserve de non contamination en métauxlourds)
Cartons	Cartons d'emballage	Chaudière / RécupérationDécharge	100kg/semaine	Bio-combustibles / Compostage
Plastiques	Emballage, principalement LDPE (à vérifier)	Décharge	1000 à 1500 kg/semainetous type confondu	Pavésplastiques (si LDPE)
Papiers	Bureau	Décharge / Combustion	5kg/an	Bio-combustibles / Compostage
Charbon	Imbrûlé du dispositif de combustion	Décharge / Combustion	150kg/jour	Bio-combustibles
Déchetsorganiques	Bio-déchetsprovenant des cantines	Décharge / récupération	3000-4000 repas par jour, soit entre 60 T et 100 T/an	Compostage
Boues	Provenant de la STEP	Décharge / Dépôtsauvage	Quantité 20m3/semaine	Co-compostage ?
Boues de vidange	Provenant de 12 fosses sceptiques	Enlevé par un prestataire. Décharge / Dépôtsauvage	Quantité 5m3/an	Co-compostage / Combustibles / Station de traitement
Fioul et huile de vidange	Provenant de machine	Récupérationemployé	Quantité 700 litres/mois	-

Source: Appendix of the state of play of solid waste management in the Municipality of Antsirabe-Anjanoro Rakotomalala / Madacompost and Ghislain de Castries / Gevalor- April 2017

4 Conclusion

This report on the inventory and assessment of waste management information in the Municipality of Antsirabe as part of the promotion of BEP / BAT to reduce emissions from uPOPs from open burning of waste is far from complete. However, it provides the necessary information to guide the parties concerned in making decisions about the activities to be undertaken to achieve the objectives they have set.

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- RAJAOMANANA Hery/ONE – Gestion et traitement des déchets ménagers dans les pays en voie de développement
- https:/www.pnae.mg/tbe/national

APPENDICES

Appendix 1: List of people contacted

LOCALITY	Surname and Names	Entity	Title/Responsability	Contact Information
ANTSIRABE	RAZANAKOLONA Paul	CU Antsirabe	Maire	034 66 424 66
		CU Antsirabe	Directeur de Cabinet	
	RAZAFIMANDIMBY Pierre Eugène Fidèle	CU Antsirabe	Directeur Technique	032 74 877 75 - 034 01 984 12 ing.fidele@gmail.com
	RATREMARIMANANA RAKOTOARISAONA Samoela	CU Antsirabe	Secrétaire Général	034 40 916 27- 033 12 121 14 Samoela.rakoto@yahoo.fr
	LEPETIT Jean-François	SOS Villages d'Enfants	Directeur National	32 05 007 19 dn@vsosmad.org www.vsosmad.org
	LAUTIER Jérémie	EAST	Représentant à Madagascar	032 11 402 54 East.madagascar@gmail.com
	RAZAFINJATO Norolalaina Fabienne	ENDA OI	Coordonatrice du Projet Assainissement	032 11 775 50 adqua@enda.mg

Appendix 2: Quantification Results of Waste at the Level of Some Households in 5 Fokontany

FOKONTANY : MAHAZOARIVO AVARATRA

MENAGE :	1	2	3	4	5	6
Nombre de personnes/ ménage	12	6	4	6	5	6
Adresse :	06F40	1118 F 185	27C80		1118H271	
Activité du ménage :	Gargotte	Gargotte : café-mofo	Epicerie		Vice-Pdt	Pdt

Date	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	Moyenne	%
	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)		
TYPES														
Papier, Carton	43	64	0	0	265	122	478	136	148	0	241	201	141,50	6,80
Bois	0	85	0	0	0	0	0	0	0	0	0	1875	163,33	7,85
Plastique	0	1	0	0	0	0	175	60	437	34	1117	111	161,25	7,75
Verre, Céramique	0	0	0	0	0	0	0	0	1358	0	0	0	113,17	5,44
Déch Alim/Déch verts	370	452	0	959	0	153	1048	2530	1230	2283	2204	0	935,75	44,99
Métaux	0	0	0	0	0	2	0	0	294	0	473	1032	150,08	7,22
Textiles, Cuir	0	0	0	0	0	9	0	0	49	0	106	0	13,67	0,66
Gravats	0	0	0	0	0	0	0	0	1243	154	499	0	158,00	7,60
Particules	0	0	0	0	0	0	0	0	0	0	2750	0	229,17	11,02
Autres									14				14,00	0,67
									Piles				2 079,92	

FOKONTANY : MAHAZOARIVO ATSIMO

MENAGE :	1	2	3
Nombre de personnes/ ménage		4	7
Adresse :	1116F81	1116F195	1116C400
Activité du ménage :	Mpivarotra provende	Epicerie	Mpivarotra

Date	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	Moyenne	%
	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)		
TYPES								
Papier, Carton	709	0	0	85	0	85	146,50	6,92
Bois	295	0	0	36	0	0	55,17	2,60
Plastique	109	0	0	100	0	84	48,83	2,31
Verre, Céramique	0	0	0	257	0	0	42,83	2,02
Déch Alim/Déch verts	4696	1100	0	1095	0	2921	1 635,33	77,19
Métaux	0	0	0	15	0	45	10,00	0,47
Textiles, Cuir	0	0	0	866	0	0	144,33	6,81
Gravats	0	0	0	213	0	0	35,50	1,68
Particules	0	0	0	0	0	0	-	-
Autres	0	0	0	0	0	0	-	-
							2 118,50	

FOKONTANY : AMBOHIMENA AVARATRA

MENAGE :	1	2	3
Nombre de personnes/ ménage		7	2
Adresse :	0708J515	0708J544	
Activité du ménage :			Pdt

Date	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	Moyenne	%
	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)		
TYPES								
Papier, Carton	3	0	268	10	0	0	46,83	4,69
Bois	0	0	5	58	0	0	10,50	1,05
Plastique	1	0	162	295	0	102	93,33	9,34
Verre, Céramique	0	0	0	0	0	0	-	-
Déch Alim/Déch verts	270	0	570	86	913	710	424,83	42,53
Métaux	0	0	24	0	0	0	4,00	0,40
Textiles, Cuir	0	0	0	0	0	0	-	-
Gravats	0	0	1519	0	0	0	253,17	25,35
Particules	0	0	0	0	0	0	-	-
Autres	0	0	81	916	0	0	166,17	16,64
			Os				998,83	

FOKONTANY : AMBOHIMENA ATSIMO

MENAGE :	1	2	3
Nombre de personnes/ ménage	6	5	4
Adresse :	0708G360	0708G360	0708G360
Activité du ménage :			

Date	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	Moyenne	%
	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)		
TYPES								
Papier, Carton	9	39	110	0	0	0	26,33	4,25
Bois	0	0	0	0	0	0	-	-
Plastique	38	2	378	0	0	0	69,67	11,23
Verre, Céramique	0	0	0	0	0	0	-	-
Déch Alim/Déch verts	15	197	602	707	619	613	458,83	73,97
Métaux	0	0	0	0	0	0	-	-
Textiles, Cuir	0	5	58	0	0	0	10,50	1,69
Gravats	0	0	0	0	0	330	55,00	8,87
Particules	0	0	0	0	0	0	-	-
Autres	0	0	0	0	0	0	-	-
							620,33	

FOKONTANY : AVARATSENA

MENAGE :	1	2	3	4	5	6
Nombre de personnes/ ménage		6	6	5	5	6
Adresse :	218145	218145		21A120	21C140	
Activité du ménage :	Epicerie	Mpivarotra mofo gasy	Epicerie	Gargotte	Gargotte	Pdt

Date	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	04/07/2018	05/07/2018	Moyenne	%
	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)	Qté(g)		
TYPES														
Papier, Carton	766	0	537	34	0	145	0	52	109	61			170,40	9,57
Bois	0	0	0	0	0	0	0	160	60	94			31,40	1,76
Plastique	208	0	42	14	542	498	148	16	178	350			199,60	11,21
Verre, Céramique	0	0	0	0	912	0	360	0	0	0			127,20	7,15
Déch Alim/Déch verts	0	0	2119	246	2300	1802	984	1953	709	476			1 058,90	59,50
Métaux	0	0	42	0	0	0	0	0	0	52			9,40	0,53
Textiles, Cuir	0	0	8	0	0	0	0	0	0	0			0,80	0,04
Gravats	0	0	0	0	0	0	0	0	0	0			-	-
Particules	0	0	0	0	0	0	0	0	0	0			-	-
Autres	0	0	0	0	328	0	1493	0	0	0			182,10	10,23
													1 779,80	

FOKONTANY : ANTSIRABE AVARATRA

MENAGE :	1	2
Nombre de personnes/ ménage	6	3
Adresse :	0906H170	0906H60
Activité du ménage :		Epicerie

Date	04/07/2018	05/07/2018	04/07/2018	05/07/2018	Moyenne	%
	Qté(g)	Qté(g)	Qté(g)	Qté(g)		
TYPES						
Papier, Carton	0	0	51	26	19,25	3,39
Bois	0	430	0	0	107,50	18,93
Plastique	0	0	5	62	16,75	2,95
Verre, Céramique	0	0	337	0	84,25	14,83
Déch Alim/Déch verts	338	0	931	0	317,25	55,85
Métaux	0	0	0	0	-	-
Textiles, Cuir	0	0	9	0	2,25	0,40
Gravats	0	0	0	0	-	-
Particules	0	0	0	0	-	-
Autres	0	0	67	16	20,75	3,65
					568,00	