Situation analysis and road ahead for solid waste management on Flores, Indonesia

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List of abbreviations, notation, definitions and currencies

SWM	Solid Waste Management
MSW	Municipal Solid Waste, comprising household waste, household-like waste and waste from the tourist sector
HHW	Household Waste
WtE	Waste to Energy
SDGs	Sustainable Development Goals
GHG	Green House Gas
RDF	Refuse Derived Fuel
IWP	Indonesian Waste Platform
CO_2	Carbon dioxide
CH_4	Methane
IFI	International Financial Institutions
KLHK	Kementerian Lingkungan Hidup dan Kehutanan / Ministry of Environment and Forestry (MOeF)
IDR	Indonesian Rupiahs
TPS	Tempat Penampungan Sementara / Waste transfer station
TPA	Tempat Pemrosesan Akhir / Final disposal site or landfill
TPS3R	Tempat Pengolahan Sampah Reduce, Reuse, Recycle / Waste recycling site

This report uses the following definitions for disposal sites:

Dumpsite	Open dumpsite without formalization in permits, with no management or surveillance and without measures to prevent emissions and dangers to the environment
Controlled dumpsite	Open dumpsite, formalized and with some surveillance but without any protective measures
Controlled Landfill	Controlled and formalized site with fences and some basic protective measures such as a bottom liner
Sanitary landfill	Well managed formal disposal site with all needed measures to prevent emissions and dangers such as, fencing, weighing bridge, access and site roads, bottom liners, extraction and treatment systems for leachate and landfill gas, cell-wise operations, daily coverage, aftercare.
Incineration facility	Formalized facility to burn waste in order to reduce its volume and weight
WtE plant	Incineration facility with additional measures to recuperate energy and to clean off-gases

Financial information is given in Indonesian rupiahs.

All financials are in Indonesian Rupiahs or IDR. One Euro is 17.040 IDR and 1,094 USD.

For notation of numbers, commas are used for decimals and dots for thousands.

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0. Summary

A study was conducted on assessing the solid waste management situation in Flores, Indonesia. Information was gathered by analyzing available documents, sending out questionnaires, meeting representatives of public authorities and other stakeholders such as the recycling sector and the tourist sector and through field visits to regencies, urban and rural areas and some islands, dumpsites and the recycling sector.

The study indicated that Flores produces around 350.000 tons per year. Approximately 56% of this quantity can be qualified as unmanaged. The percentage of reuse/recycling is at 42%, mainly due to direct reuse of a large part of the organic waste as animal feed in the households or its direct vicinity. Only 16% of the population has access to waste collection and service levels are low.

There seems to be a lack of alignment between citizens and their respective regencies, which has led to a situation where essential services are either unavailable or inadequate, and people are reluctant to pay for them. The general budget from the regencies is insufficient to provide the yearly money needed for spendings on these services.

The analysis proposes a roadmap for the development of a shared system of waste management infrastructure and services, which would require the full cooperation of all 8 regencies and the province of East Nusa Tenggara. A sustainable and affordable backbone of collection, transfer, landfills and recycling is proposed, in an organization setup of 3 regions. Investments for such a backbone would need 1,8 billion IDR in investments and gap financing. In order cover these spendings, a system of full cost coverage through dedicated waste management fees is proposed. Eventually, an average household would have to pay 470.000 IDR per year but, in case Flores is able to find a source for granting the investments, this retribution would go down to around 210.000 IDR. Overall, these retributions are affordable.

The roadmap described in this report could be implemented within 5 years.

1. Introduction

Solid waste management (SWM) is a crucial aspect of public services because it directly affects the health and well-being of citizens, resource recovery and environmental quality. Nevertheless, the original purpose of SWM, which is to remove waste away from urban dwellings, is still a problem in many developing countries. Globally, waste and plastic pollution on land and in the sea are receiving a lot of attention as a growing environmental problem that requires global action. Litter is now found in all oceans and seas of the world, even in very remote uninhabited areas, due to its transboundary nature. Continued growth in the amount of poorly managed solid waste and slow degradation are leading to a gradual increase in the amount of litter in rivers, on land and in the marine environment. Indonesia is amongst the largest contributors in the world of mismanaged plastic waste to the marine environment. The Indonesian Institute of Science estimated emissions of plastics in 2018 at 0.27-0.59 million tons. A recent study found that 105 rivers in Indonesia were among the 1656 rivers contributing to 80% of global river plastic emissions to the ocean. Moreover, the (poor) quality of waste management is an important topic due to its close relation with climate change. Estimates show that 15-25% of all GHG emissions is related to CO_2 and CH_4 emissions come from improper waste management. The Sustainable Development Goal 15, reflects this stating "The terrestrial environment continues to be the primary sink for waste, while rural communities face complex waste management challenges that if left unmanaged can significantly impact ecosystems and dependent livelihoods." Globally, some 2.7 billion people do not have their waste collected of which 2 billion in rural areas and 700,000 in urban areas. This amounts to 540 million tons of MSW, or around 27 per cent of the global total, not being collected.

The Indonesian Waste Platform requested for support to improve the waste management situation on the island of Flores in Indonesia. Labuan Bajo on Flores is one of Indonesia's five super priority tourist destinations to be developed at a large scale. This adds to the already existing need to improve the waste management. There is a clear need to abate the current problematic waste situation and, in doing so, to pave the way for future circular economy initiatives on the island. The shortfalls in services represent an opportunity for improvement, investment and economic growth leading to more and better jobs. As part of the effort to boost this development, an assessment is needed to evaluate the potential of getting systems for SWM in place.

The Dutch program PIB (Partners for International Business Waste and Circular Economy Indonesia – Netherlands) is a collaboration of Dutch companies who joined forces in engaging with the Indonesian market for the waste management sector. One of the activities of this PIB is knowledge to knowledge (K2K) and it aims to contribute to capacity-building in Indonesia thereby supporting the connection of PIB partners with local stakeholders to share knowledge and experience. Rijkswaterstaat, an Agency of the Dutch Ministry of Infrastructure and Water Management, and the PIB, in coordination with the Netherlands Embassy in Jakarta, agreed to fill in the request of IWP by assigning the Open Universiteit of the Netherlands (OU) the making of a situation analysis. For this purpose, the OU partnered with BreAd B.V. from the Netherlands.

The work for this Situation analysis was mainly done on Flores in the period from 9-20 September. In order to ensure knowledge transfer, an on-the-job training was performed in which five persons joined the project team during the entire period. Moreover, capacity building workshops for more than 150 regional and local government representatives and other relevant stakeholders were organized to give them more insight into waste management in remote and rural regions and how to act upon it. The workshops also ensured receiving valuable local knowledge and insights from these stakeholders.

This report gives the results of the situation analysis. It is divided into the following 7 chapters:
- Chapter 2 gives a general description of the island Flores
- Chapter 3 provides the scope and methodology used for this situation analysis
- Chapter 4 comprises all the results of the data gathering
- Chapter 5 gives the analysis based on these data
- Chapter 6 then continues with elaborating a possible way forward
- Chapter 7 summarizes the conclusions of the report

The authors wish to thank IWP for organizing the meetings and events during the team's visit to Flores in September 2024.

2. A blend of natural beauty and cultural diversity

Flores Island is one of the main islands in East Nusa Tenggara, Indonesia (Fig.1). Geographically, Flores Island is located in the central part of the Nusa Tenggara Archipelago. The island has an East-West orientation stretching over a distance of nearly 400 kilometers. From North to South, it measures in between 10 and 60 kilometers. In total it covers an area of approximately 14,300 square kilometers. The varied topography ranges from coastal lowlands to high mountains.

FIGURE 1. MAP OF FLORES

The island has a unique blend of stunning natural beauty and rich cultural diversity. It offers a wide range of natural attractions with extraordinary wildlife, beautiful mountains and hills, lush rural landscapes and exotic beaches. The best-known highlights of Flores are:
- The active volcanos of Mount Kelimutu, Egon, Inerie and several others.
- Three-colored Kelimutu Lake, with its mysterious color changes, is one of the natural wonders of the world.
- The beautiful beaches of Pink Beach Komodo, Koka Beach, and Wairterang Beach.
- Komodo National Park, being home to the Komodo dragon, the world's largest lizard, and many other species of flora and fauna.

The Western part of the island, around Labuan Bajo, has been assigned to be one of the five new top priority destinations of Indonesia. A touristic masterplan is in place to guide this development (Fig.2).

FIGURE 2. MAP OF FLORES' TOURISTIC MASTERPLAN

Additionally, Flores is known for its friendly people who still adhere to various tribal cultural traditions and the significant influence of religion in their lives. The people of Flores come from various ethnic groups, such as Manggarai, Ende, and Flores Timur. Each tribe has its unique language, customs, and culture. This cultural diversity is a treasure in itself for Flores. The majority of the population is Catholic, but there are also adherents

of Islam, Protestantism, and Hinduism. Agriculture, fishery and tourism are the main livelihoods of the people. The island enjoys good air- and water-connections to the other Indonesian islands. The population is currently estimated at 2.164.000 and is growing at around 1,6% per year. The island is administratively divided into 8 regencies and the largest cities are Maumere, Ruteng and Ende.

Despite its enormous potential, Flores faces several challenges, such as inadequate infrastructure, threatened ecosystems and poor public services such as waste management. This holds especially for the rural areas and the more remote inhabited islands that belong to Flores.

3. Scope, analysis-framework and data

3.1 Geographical scope

The geographical scope of this situation analysis is on Flores as a whole. It includes:
- All 8 regencies.
- Both the urban and rural areas.
- All smaller inhabited islands.

3.2 Waste scope

The waste types covered in this report are
- Waste from households.
- Household-like waste from public cleaning services including harbor activities.
- Household-like waste from the public, social and commercial facilities (shops, industries, hotels, restaurants, offices, schools, government offices and hospitals).

The analysis will not include agricultural waste, process waste from industries, construction and demolition waste and hazardous waste from hospitals and industries. This last restriction does not mean that these categories have no relation to the subject of this analysis. A future masterplan or policy may very well rule that the public waste management infrastructure should also enable the treatment of these wastes. For example, it could be the case that hazardous hospital waste could best be treated at the future sanitary landfills of Flores.

3.3 Analysis framework

Sustainable development goals

Solid waste management can be considered as an important instrument when working on meeting the Sustainable Development Goals. Figure 3 shows which of the SDGs will be promoted when working on proper waste management services.
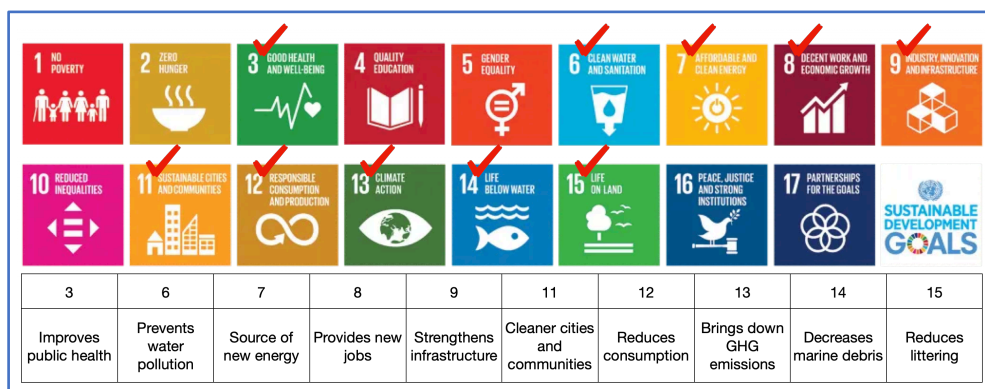

3	6	7	8	9	11	12	13	14	15
Improves public health	Prevents water pollution	Source of new energy	Provides new jobs	Strengthens infrastructure	Cleaner cities and communities	Reduces consumption	Brings down GHG emissions	Decreases marine debris	Reduces littering

FIGURE 3. PROMOTING SDG'S THROUGH SWM

The most obvious influence is of course on health/wellbeing, clean water and sanitation and sustainable cities and communities. But investing in the improvement of SWM infrastructure and services will also have strong positive effects on Flores' contribution to combating global warming, the economy (tourism), employment (more and better jobs) and sustainable production. It is this role of waste management that provides Flores with an important entry point to achieve tangible progress on the SDG's. The analysis described in this report aims at operationalizing waste management as an instrument for reaching SDG goals.

Development phases of waste management

A country's development level may reflect itself in the quality of the provided solid waste management services and available infrastructure. Figure 4 illustrates the evolution countries and cities, almost inevitably, go through. The growth of population, urbanization, and wealth creates the need to get the waste out of the cities through city cleaning and collection. In this first phase the problem and its solutions are local and the emphasis on protecting citizens' health through actions of the local government. The second phase asks for proper treatment facilities to deal with the collected waste. The focus shifts to protecting the environment by public and private actions that need the regional scale. After some time, mere disposal is not accepted and this increases the need and market for recycling in order to prevent wasting resources. Developments are often guided by the national government and implemented by the private sector. After years of professionalizing, recycling is no longer a separate and national branch of industry. It becomes an integral part of the sustainability strategies of all mainstream industries.

It's not possible for an island like Flores, or Indonesia, to leapfrog from the initial stages of waste management, directly to a circular economy. Albeit important to prevent and recycle waste, societies cannot "prevent-and-recycle" their way out of poor waste conditions and bypass the need for sanitary landfills. Landfills are an integral part of waste management, even in societies that claim to be in the circular phase.
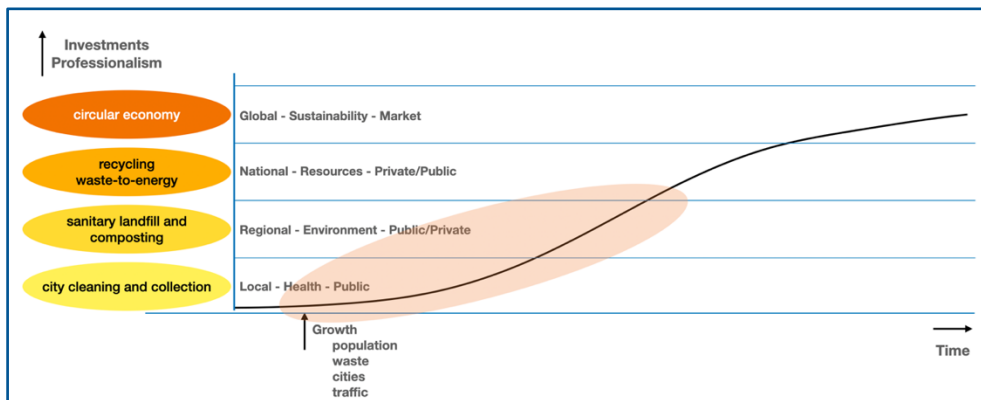

FIGURE 4. THE HISTORICAL DEVELOPMENT OF WASTE MANAGEMENT

In general, Indonesia and Flores, can be considered to be somewhere in the orange indicated area of this sigmoid curve below.

Multiple sustainabilities

The development described above, shows the successive growth towards environmental sustainability. But this is not the whole story on sustainability. There are a number of other dimensions playing an important role in achieving overall sustainability. They are schematically presented in Figure 5.

FIGURE 5. A SUSTAINABLE SWM PYRAMID

This pyramid adds a usable hierarchy to the factors that jointly construct the framework that makes environmental sustainability viable and feasible. They can be described as follows:

- Legal sustainability – At the bottom there are needed laws and regulations that need to be implemented and enforced. An operational planning and control cycle is practiced, at least at the national level.
- Organizational sustainability – Ideally, services and infrastructure are aligned with the needed economy of scale. Political and operational responsibilities are clearly defined, separated and attributed. All stakeholders are able to play their roles.
- Financial sustainability - An SWM-fee system is implemented and it ensures full cost coverage. Cashflows are earmarked for SWM in order to prevent interference with other priorities. Fees reflect the polluter-pays-principle.
- Social and economic sustainability - All citizens enjoy at least basic SWM services at an affordable cost. Ongoing awareness campaigns promote their participation. The fee-system takes affordability into account by using an appropriate differentiation scheme. The private sector steps in where needed and possible.
- Technical sustainability - Infrastructure, services and maintenance reflect the state-of-art. Clear manuals and instructions are implemented and assessed on a regular basis. Professionalism is achieved through continuous capacity building. Data collection is an integral part of the core activities.
- Environment sustainability - City cleaning and collection should show 100% coverage. Good quality disposal facilities are in place. Their use is limited to the minimum through the implementation and promotion of recycling activities. Contributions to global warming and littering are minimized.
- Resource sustainability - A maximum reduction of the need for primary raw materials and energy is achieved through dedicated design of products and services and circular business models.

The lower five in Figure 5 of these sustainabilities will serve as a "ruler" to assess the present situation with regard to solid waste management in Flores.

3.4 Data gathering

In order to obtain the input needed for this analysis data were gathered by literature search, consultation of available statistical data, questionnaires, stakeholder interviews, site visits, a workshop and a meeting with representatives of KLHK.

Literature

An internet search, using Google Scholar, was performed in order to gather specific data connected to the solid waste management situation in Flores using search terms such as "waste", "waste management", "recycling", "producer responsibility", "marine litter", "litter", "dumpsites", "landfill", "collection", "tourist", "population", "economy", "statistics", in combination with "Flores" and "Indonesia'. Only a few publications, that could be used for this analysis, were found in this search. They appear as numbered footnotes in this report.

Statistical data

Statistical data on Indonesia are made available through a number of reports by the Badan Pusat Statistik, the National Institute of Statistics (For example for the province East Nusa Tenggara[1]).

Meetings and visits

During a period of two weeks (from 9-20 September) a number of events, stakeholder-meetings and field-visits took place. The meetings were in four regencies (Labuan Bajo, Ende, Maumere and Mbay) and with their departmental representatives, with representatives of more than 10 sub-districts and villages and with representatives of the recycling and tourist sector. Some in-depth conversations with high level representatives were held during the field work and by kind invitations.
The analysis took advantage of the contacts with more than 150 participants during a series of 3 training events in Labuan Bajo, Maumere and Mbay. These events lead to insights on the general interest in SWM but also provided input on (the latest developments in) rules and regulations. During the two weeks some 20 field visits

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[1] Nusa Tenggara Timur Province in figures, 2024, volume 40

to areas in the cities and villages took place, along with visits to beaches, dumpsites and waste treatment sites. The two-week period was wrapped up by doing a hybrid workshop in Labuan Bajo, with more than 20 participants, on first findings. An overview of all events and visits can be found in annex 1.

Questionnaires and phone calls

The project team prepared for IWP a questionnaire, to be used to interview around 400 households, restaurants and hotels across Flores. Also, plans were made to gather data on budgets, revenues, equipment and workers related to SWM from all regencies. Neither of these actions were successful, partly due to the fact that public authorities are reluctant to provide data without being formally asked and/or required to do so. To fill in this gap, the project team engaged with the Indonesia Judicial Research Society (IJRS) who performed additional internet-search and questionnaires that were distributed to the KLHK, the province and the regencies.

Expert inputs and other data

The work on this assessment was strongly improved through the input of all project team members. The core members had expertise on solid waste management, spatial analysis, marine debris, environmental sciences, pollution, cultural expects, financial aspects, governance and stakeholders' involvement, both at the Indonesian and on the global level. Inputs by others were cross-checked with the team experiences. When necessary, expert estimates were made by the team and a final check was done through a meeting with experts of KLHK. GPS and remote sensing maps and data were gathered through:
- Flores administrative boundaries: https://export.hotosm.org
- Roads on Flores: https://export.hotosm.org
- Remote sensing data on nightlight: VIIRS Nighttime Day/Night Band Composites Version 1 from Google Earth Engine https://earthengine.google.com/
- Remote sensing data on topography: Copernicus DEM GLO-30: Global 30m Digital Elevation from Google Earth Engine https://earthengine.google.com/

4. Results

This chapter provides the results from the data gathering. It starts with general characteristics of the Regencies (4.1) and will then focus on waste generation and composition (4.2). The next paragraph (4.3) deals with the environmental sustainability of the SWM situation in the regencies. Paragraphs 4.4 - 4.8 subsequently cover the other sustainabilities mentioned in the analysis framework of paragraph 3.3 (Fig.5).

4.1 Regency characteristics

The 8 regencies and their capitals are given in Table 1, along with their most important administrative, physical and demographic characteristics.

TABLE 1. CHARACTERISATION OF REGENCIES

Name of Regency (from east to west)	Capital	Districts	Villages	Inhabited islands	Area	Population (2024 estimate)	Population growth	Urbanization (2024 estimate[2])	Household size (2019)
		(#)	(#)	(#)	(km2)	(#)	(%/year)	(%)	(#/household)
East Flores Regency	Larantuka	19	250	2	1.813	292.520	1,47	26	4,6
Sikka Regency	Maumere	21	160	8	1.732	340.330	1,49	24	4,7
Ende Regency	Ende	21	278	1	2.085	281.370	1,03	44	4,8
Nagekeo Regency	Mbay	7	113	0	1.417	168.360	1,41	4	5,4
Ngada Regency	Bajawa	12	151	0	1.621	174.090	1,4	16	5,1
East Manggarai Regency	Borong	12	177	0	2.391	296.170	1,94	3	4,9
Manggarai Regency	Ruteng	12	223	1	1.344	334.460	1,8	33	4,9
West Manggarai Regency	Labuan Bajo	12	169	8	3.141	276.280	2,02	9	4,7
Total or average		116	1521	20	15.545	2.163.580	1,59	21	4,8

The summary shows that 21% of Flores' population lives in the urban areas. An average household has 4,8 members. The largest urban areas are listed in Table 2. It shows that Maumere, Ruteng and Ende are the main cities on Flores.

TABLE 2. LARGEST CITIES OF FLORES

City	Population (2023 estimate)	City	Population (2023 estimate)	City	Population (2023 estimate)
	(#)		(#)		(#)
Larantuka	41.500	Bajawa	41.500	Ende	88.921
Maumere	91.550	Ruteng	91.550	Labuan Bajo	6.987

Overall, Flores is sparsely populated with only 150 inhabitants per km². Figure 6 illustrates this by showing the remote sensing results of light intensities on the island. The red areas are very low in population density; the more populated urban areas can easily be distinguished.

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[2] Recent data on urbanization are not available. The most recent percentages are for 2010 as given by the website www.citypopulation.de/en/indonesia/admin/. We used a year-on-year growth of 2% on these percentages (average for Indonesia), except for Nagekeo and East Manggarai. Based data for Mbay and Borong we assumed 4% and 3% respectively at this moment.
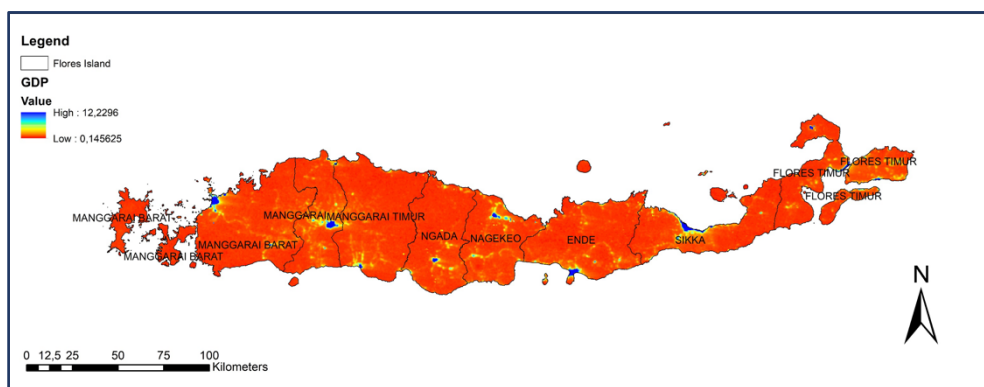
FIGURE 6. MAP WITH LIGHT INTENSITIES FROM REMOTE SENSING; PROXY FOR POPULATION DENSITY

Figure 7 provides a map with a summary of the smaller inhabited islands. In total, these 20 smaller islands are home to almost 220.000 inhabitants being around 10% of Flores' population.
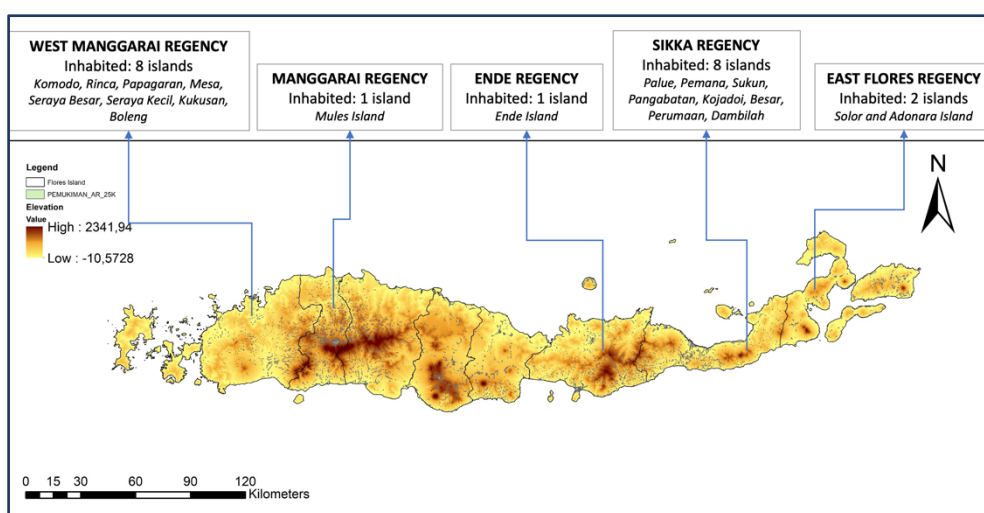

**FIGURE 7. TOPOGRAPHIC MAP WITH SMALL INHABITED ISLANDS PER REGENCY**

Table 3 gives additional data on the regencies, especially on economics and physical infrastructure

TABLE 3. ADDITIONAL CHARACTERISTICS OF REGENCIES

Name of City or Regency (from east to west)	Average family income	Population below the poverty line	Average number of visitors	Average stay of visitors	Road length total (2023)	Road length paved
	(IDR/year)	(%)	(#/year)	(days /visit)	(km)	(km)
East Flores Regency	43.020.092	11,77	21.688		993	150
Sikka Regency	42.432.542	12,56	39.525		1.057	90
Ende Regency	58.355.218	22,86	12.848		1.102	145
Nagekeo Regency	57.603.093	12,33	7.967		724	70
Ngada Regency	54.275.636	12,06	29.066	2	1.312	157
East Manggarai Regency	40.460.848	25,06	3.101		1.476	90
Manggarai Regency	50.498.023	19,69	15.649		1.746	98
West Manggarai Regency	52.545.361	16,82	355.836		1.461	134
Total or average	48.884.767	17,09	485.680	2	9.871	934

The minimum wage for all of Flores' regencies is uniformly set at IDR 2.186.826 per month and the average net formal salary is IDR 2.287.094 per month[3]. 71% of the population is 15 years or older, and of this group, 52% are reported as workers. Combining these data leads to the average family incomes listed in Table 3. The interviews indicated that average salaries do not fully reflect a person's income and responses to statistical inquiries tend to be underestimated while income from barter is not included. As a result, the average family income could be well around 50 million IDR per year. The poverty line for the regencies is around 6.000.000 IDR per year. An average of 17% of the population lives below that line.

Although Labuan Bajo is one of the new top priority destinations, the tourism sector is still relatively small. The number of visitors is at a low level and the number of nights per stay is only 2. It brings the number of visitor-days to no more than 1 million per year at this moment, with most of them coming to Labuan Bajo and the Komodo islands. Still, tourism is expected to grow strongly, with rising numbers of visitors and nights per visitor. Flores' regencies are connected by a basic linear system of 934 km of paved, one- or two-lane roads. Due to the width and quality of these roads, road transport is very time-consuming. Figure 8 provides a schematic map of the system of main roads with inter-city distances and time needed for a truck to drive from city to city. A truck starting at Labuan Bajo, will take around 23 hours to travel over 750 km in order to reach Larantuka. More importantly, a more significant problem may lie in reaching the rural villages as they are only accessible from the main roads through a network of around 1.000 km of sand and gravel roads.
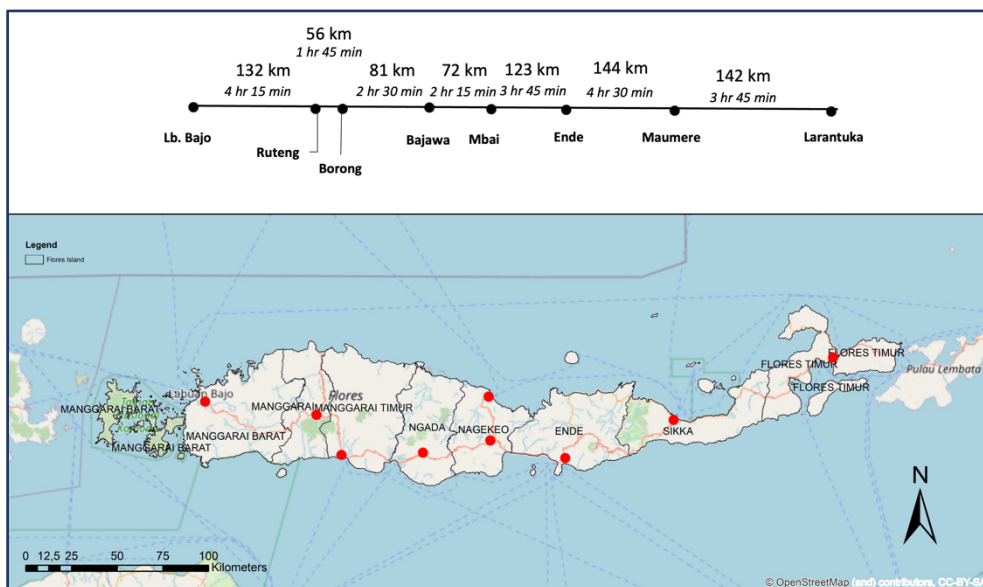
FIGURE 8. SCHEMATIC REPRESENTATION OF FLORES MAIN ROAD SYSTEM USED TO GET INSIGHT IN ACCESSABILITY AND CONNECTION TIMES

4.2 Waste quantities and qualities

When analyzing quantities, a clear distinction has to be made between generated waste, waste available for collection and actually collected waste. For households these can be defined as follows (Fig. 9):
- Generated waste is all waste that is generated in a household, so including all waste that is directly reused or recycled within the household. Mostly, this parameter is expressed in kg per capita per day.
- Waste available for collection is defined as all generated waste, minus the waste that is directly reused or recycled within the household. So, if the organic waste of a household is reused as food for the animals of a household or its neighbors, this part of the waste is no longer available for collection.
- Collected waste is the waste that is actually collected through public or private services.

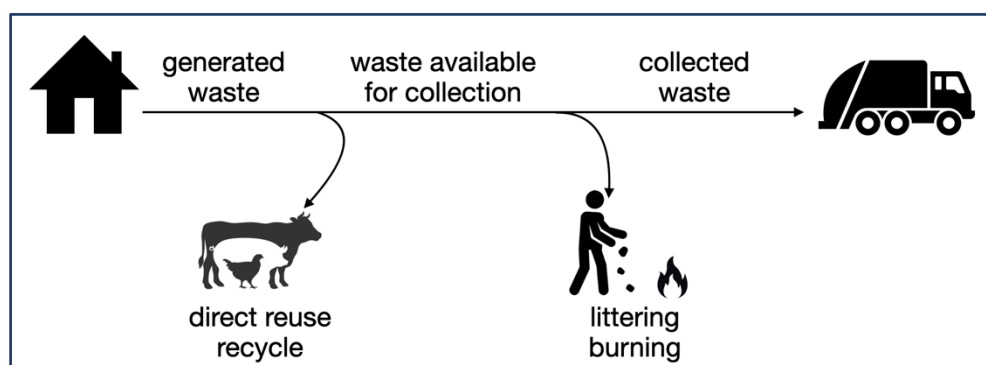[3] Nusa Tenggara Timur Province in figures, 2024, volume 40

FIGURE 9. GRAPH WITH GENERATED WASTE, WASTE AVAILABLE FOR COLLECTION AND COLLECTED WASTE

Hard data on *generated waste* is not available for Flores. Two reports were found for Labuan Bajo. One study mentions that data on waste generation are absent[4]. The second states that citizens in Labuan Bajo produce 0,29 kg/capita.day, but it is not clear how this is defined and measured [5]. A study on Larantuka in 2018 mentions the production of 96 m³ of waste per day by 30% of the urban population, being 38.029 inhabitants at that time [6]. It could mean that generation in Larantuka would be almost 1 kg/capita/day which sounds rather high. But, also here, definitions and methods are unclear. Some regencies use a calculation method provided by the National government to estimate their waste generation[7] but the numbers used in this method are from 1995 and therefore not usable.

In order to obtain a more usable indication, estimates need to be made. This is done by using results from other countries as compiled by the World Bank along with the insights urbanization gathered during this assessment. In general, it can be stated that the per capita production of household waste (HHW) is highly dependent on wealth (GDP) and on living in either urban or rural areas. Based on analyses of the World Bank[8], per capita HHW generation on Flores is differentiated between urban and rural areas by using 0,69 kg/capita.day and 0,34 kg/capita.day respectively. Using these assumptions leads to an estimate of total waste generation in the 8 Regencies of around 330.000 tons of HHW per year, as shown in column 5 in table 4. It turns out that 65% of this waste is produced in the rural areas and on the small islands.

TABLE 4. WASTE GENERATION

Name of City or Regency (from east to west)	Total population	Urban HHW generation	Rural HHW generation	Total HHW generation	Household like waste from shops, restaurants, offices, hospitals etc.	Waste from tourist sector	Total waste generated
	(#)	(tons/year)	(tons/year)	(tons/year)	(tons/year)	(tons/year)	(tons/year)
East Flores Regency	292.520	19.413	27.036	46.450	2.322	87	48.859
Sikka Regency	340.330	20.328	32.583	52.910	2.646	158	55.714
Ende Regency	281.370	30.811	19.946	50.757	2.538	51	53.346
Nagekeo Regency	168.360	1.694	20.294	21.987	1.099	32	23.119
Ngada Regency	174.090	6.932	18.398	25.330	1.266	116	26.713
East Manggarai Regency	296.170	2.234	36.071	38.306	1.915	12	40.234
Manggarai Regency	334.460	27.746	28.142	55.888	2.794	63	58.745
West Manggarai Regency	276.280	6.417	31.486	37.903	1.895	1.423	41.222
Total or average	2.163.580	115.576	213.955	329.531	16.477	1.943	347.950

Because of the scope of this assessment, the household-like waste from shops, restaurants, offices, hospitals and municipal cleaning services needs to be added. Based on international experiences within the team, and checked by the calculation method of the Indonesian government[9], 5% can be added to the volumes of HHW

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[4] Filling the gap: opportunities to maximize efficacy of waste management systems in Labuan Bajo, Indonesia, Ocean conservancy/UNEP, February 2019
[5] The impact of waste management on tourism sustainability in Labuan Bajo, West Manggarai Regency, Leha et al., Advances in Economics, Business and Management Research, Vol. 169, 2020
[6] Studi Sampah dan analisa partispasi masyarakat di kota Larantuka kabupaten Flores Timur, Hayuanandra et al., Ecotrophic 12 (2), 2018
[7] Standar Nasional Indonesia 19-3983-1995, Spesifikasi timbulan sampah untuk kota kecil dan kota sedang di Indonesia.
[8] More growth, Less garbage, World Bank report 2021
[9] Standar Nasional Indonesia 19-3983-1995, Spesifikasi timbulan sampah untuk kota kecil dan kota sedang di Indonesia.

(See column 6 of Table 4). And finally, the waste from the tourist sector has to be included. For this, the assessment assumes that every tourist-day leads to 2 kilograms of waste (column 7 of Table 4). In total, Flores is estimated to produce a little less than 350.000 tons of household waste, household-like waste and tourist waste per year.

Also, few data are available with regard to the composition of the waste. The graph in Figure 10 shows a global average and regional breakdown of waste compositions around the world[10]. For South-East Asia, an average organic content of around 60% is found. Using this graph as an assumption would then also lead to a best estimate for plastics (13%), metals (3%) and paper (17%). One literature source[11] gives 34% as their estimate of organics in the waste of Labuan Bajo. Another gives more than 60% for Larantuka[12]. The basis of these last estimates is not clear.
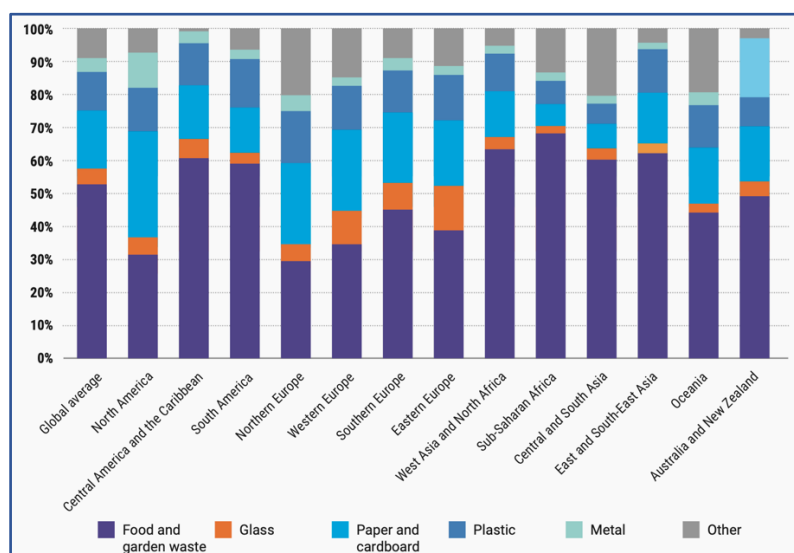
FIGURE 10. AVERAGE WASTE COMPOSITION AROUND THE GLOBE

The views of experts and the observations during the visits lead to the conclusion that most families in Flores use a large percentage of the organic waste to feed their own animals or those of others. This also holds for a part of the urban households. Based on all these considerations, this assessment assumes that generated waste on Flores holds 55% of organic waste, 25% of recyclables (paper, cardboard, plastics, glass, metals) and 5% of sand/stones/floor sweepings. It is also estimated that urban inhabitants directly reuse 50% of their household organics as animal feed and that their rural neighbors directly reuse 90% of this waste.

TABLE 5. WASTE AVAILABLE FOR COLLECTION

Name of City or Regency (from east to west)	Waste generation (tons/year)	Organic contents (tons/year)	Recyclable contents (tons/year)	Sand, stones and sweepings (tons/year)	Waste available for collection (tons/year)
East Flores Regency	48.859	26.872	12.215	2.443	30.137
Sikka Regency	55.714	30.643	13.929	2.786	33.995
Ende Regency	53.346	29.340	13.336	2.667	35.000
Nagekeo Regency	23.119	12.715	5.780	1.156	12.607
Ngada Regency	26.713	14.692	6.678	1.336	15.699
East Manggarai Regency	40.234	22.129	10.058	2.012	21.764
Manggarai Regency	58.745	32.310	14.686	2.937	37.184
West Manggarai Regency	41.222	22.672	10.305	2.061	23.871
Total or average	347.950	191.373	86.988	17.398	210.259

[10] Beyond an age of waste, turning rubbish into a resource, UNEP/ISWA Global waste management outlook 2024
[11] The impact of waste management on tourism sustainability in Labuan Bajo, West Manggarai Regency, Leha et al., Advances in Economics, Business and Management Research, Vol. 169, 2020
[12] Studi Sampah dan analisa partispasi masyarakat di kota Larantuka kabupaten Flores Timur, Hayuanandra et al., Ecotrophic 12 (2), 2018

Subtracting the volume of organic waste that is directly reused in the households, would lead to the conclusion that a total of around 210.000 tons of waste is available for collection. It's important to mention that direct reuse of organic waste may change drastically in the future. As soon as there are good waste collection services in place, direct reuse in the households will decrease and organics will "return" to the waste that's available for collection.

The waste available for collection contains around 87.000 tons of recyclables, 53.000 tons of residual organics that are not directly reused and 17.000 tons of sand/stones/sweepings. Such a composition would still provide the regencies with a good potential input for recycling facilities. If used to the maximum, it could lead to a situation that no more than 80.000 tons per year would have to be landfilled. This would lead to a situation in which 75% of all generated waste will be diverted from the landfills, leading to the reuse of resources and to a longer lifespan for these facilities.

4.3 Environmental sustainability

Cleanliness

4 regencies and sub-towns were visited during the course of this situation analyses. It revealed a degree of cleanliness varying extensively between regencies and between rural and urban areas. In general, the main streets of the cities show a modest cleanliness. Street cleaning appears not to be a daily job. Littering is especially visible around public gathering places such as markets and near ambulant sellers of street-food. Along the main roads between the cities, the littering is sometimes extensive, taking the shape of small dumpsites. Near the cities, the beaches are mostly clean with some visible waste. Further away, the situation is very divers. Sometimes, as in the case of two small villages on the island of Pemana, clean and littered beaches seem to be close to each other and it appears to be a deliberate choice, depending on whether or not a coastal village has a shared interest in clean living circumstances or not. High amounts of waste were for example seen in the coastal village Wuring close to Maumere.

Sometimes waste on beaches can be very substantial. For some communities the beach appears to be the dumpsite of choice or even a way to construct new land by filling it up with plastics and other debris. Often, it is not clear whether the waste comes from dumping by the communities close to the shore or is washed upon the shores from sources further away, as seen in other parts of Indonesia and depending on current and wind conditions.

Two reports on marine litter on Flores were found. In 2022 the Ministry of Environment and Forestry (KLHK) conducted a study in 15 provinces, including a survey in the Labuan Bajo area at Gorontalo and Mangiatan beach. The study was performed according to UNEP guidelines and it concluded that the beaches of Flores were the most polluted, mainly due to the amount of plastic. The second survey was also reported in 2022 and is about the activities of IWP on Komodo, Mesah and Papagaran Islands [13]. The NGO was able to collect some 230.000 kilos of waste during their 2020-2021 campaigns on the three islands.
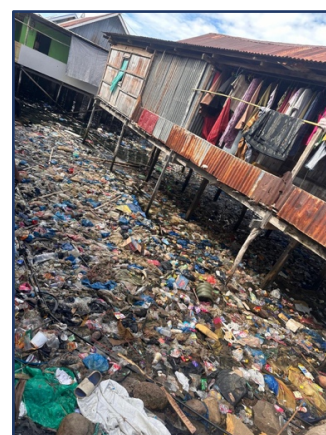
PHOTOS 1. WASTE LITTERING ON BEACHES, DUMPSITES AND VILLAGES

[13] Komodo report, Indonesian Waste Platform, 2021

Burning of waste seems to be quite general, both in the urban as in the rural areas. There are no specific data for Flores on this subject. One report, for Indonesia as a whole, estimated that some 75% of all uncollected waste is burned by the households[14]. This also seems to be the case on Flores and mostly also since no waste collection is in place.

Service coverage for city cleaning and collection

There is almost no data available regarding the coverage of waste collection services and the amount of *collected waste*. One source provides some data[15] but most of it is outdated and/or unclear on the way these data are established. A register of the Indonesian statistics authority[16] gives some insight by providing the method of waste disposal per subdistrict (Table 6). The overview shows that in 2021, burning or burying the waste was used in 90% of all subdistricts. Only 5% of the subdistricts used some kind of collection of the waste.

TABLE 6. DISPOSAL TYPES FOR THE SUBDISTRICTS IN THE 8 REGENCIES IN 2021

Name of City or Regency (from east to west)	Villages with container collection	Villages where waste is burned or buried	Villages where waste is thrown in river/ocean	Villages where waste is thrown in drainages or other	Total number of villages
	(#)	(#)	(#)	(#)	(#)
East Flores Regency	15	212	6	17	250
Sikka Regency	11	132	2	15	160
Ende Regency	15	247	2	14	278
Nagekeo Regency	0	113	0	0	113
Ngada Regency	9	141	0	1	151
East Manggarai Regency	1	160	0	16	177
Manggarai Regency	21	197	0	5	223
West Manggarai Regency	3	165	1	0	169
Total or average	75	1367	11	68	1521

Registers of weighed collected waste are missing and, in fact, the only weighbridge is on the landfill (TPA) of Labuan Bajo. The town reports that in 2023, 6.718 tons of waste were collected. For four other regencies, estimates were received from the Ministry KLHK[17]. These data are shown in columns 3 and 4 of Table 7. In addition, estimates were made based on the coverage of waste collection in the 3 regencies visited during this assessment and for 2 regencies for which data are available through literature[18] [19]. In combination with the above-mentioned estimates on waste generation, it is possible to make best indications on the percentage of the population serviced with waste collection and the percentage of the waste actually collected. The regency-representatives indicated that, in case they collect waste, they also do so at shops, institutions, hotels and similar sources. This waste is therefore included in the Estimates. The results are shown in columns 5-9 of Table 7.

According to the team's estimate, currently the regencies are servicing around 70% of the urban population. With some exceptions, the rural population is not serviced at all. Exceptions occur when the local public officer and the population take the initiative for collection themselves, as in the example of the small island village of Pemana. There seems to be a discrepancy between the team's estimates and the existing official data for the regencies Sikka, Nagekeo and Ngada. Apparently, these regencies have reported higher collection coverages but the basis of their estimates are unclear.

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[14] Building robust governance and securing sufficient funding to achieve Indonesia's waste management targets, Systemiq, 2021
[15] Standar Nasional Indonesia 19-3983-1995, Spesifikasi timbulan sampah untuk kota kecil dan kota sedang di Indonesia.
[16] https://ntt.bps.go.id/en/statistics-table/2/NjcxlzI=/type-of-garbage-disposal-unit.html
[17] Data from KLHK provided on October 10th, through the Indonesian Judicial Research Society, IJRS
[18] The impact of waste management on tourism sustainability in Labuan Bajo, West Manggarai Regency, Leha et al., Advances in Economics, Business and Management Research, Vol. 169, 2020
[19] Studi Sampah dan analisa partispasi masyarakat di kota Larantuka kabupaten Flores Timur, Hayuanandra et al., Ecotrophic 12 (2), 2018

Name of City or Regency (from east to west)	Waste available for collection (tons/year)	Reported waste collection (ton/day)	Reported waste collection (%)	Serviced urban population (%)	Serviced rural population (%)	Serviced population in total (%)	Generated waste that is collected (%)	Available waste that is collected (%)
East Flores Regency	30.137	8640	28%	30%	0%	8%	9%	15%
Sikka Regency	33.995	14490	43%	100%	2%	25%	29%	47%
Ende Regency	35.000	n.a.	-	100%	0%	44%	44%	67%
Nagekeo Regency	12.607	3380	27%	100%	0%	4%	6%	10%
Ngada Regency	15.699	7850	50%	50%	0%	8%	10%	17%
East Manggarai Regency	21.764	n.a.	-	50%	0%	2%	2%	4%
Manggarai Regency	37.184	n.a.	-	50%	0%	16%	18%	28%
West Manggarai Regency	23.871	6720	28%	100%	0%	9%	16%	27%[20]
Total or average	210.259			72%	0%	16%	19%	31%

Only 16% of the total population has access to regular waste collection. This may well align with the 5% of the subdistricts, mentioned above, in case the urban subdistricts have larger populations. In total, only 66.000 tons of municipal solid waste per year are actually collected. This volume represents 19% of all waste and 31% of all waste that is available for collection.

Waste treatment

Every Regency has its dumpsites. The only exemption is Labuan Bajo. The town has a location of 1 hectare with a landfill and a waste incinerator. The situation on and around the other dumpsites is not sustainable. Most of them can be characterized as open and uncontrolled. There are no fences, the waste is not compacted nor covered and there are no measures taken to prevent leachate entering the soil or methane being emitted into the air. Mostly, a limited number of scavengers are working on or near the dumpsites. All visited dumpsites were burning. This is done on purpose by the regencies in order to reduce volume. Some villages use the beaches as their dumpsites. As most of the dumpsites are very small and already in use, there is virtually no option for environmental optimization. One could consider to place fences and to add compaction and daily coverage to the operations but that would only sparsely improve the situation. These dumps simply do not provide the economy of scale for any environmental measure, whatsoever. The lack of proper treatment facilities is also felt for hazardous hospital waste. There are small incinerations for this waste but there is no budget for maintenance and fuel. As a result, every individual hospital has to find its own solution.
The waste treatment system is described in more detail in section 4.8 on Technical Sustainability

Recycling

The value chain of informal and formal collectors, traders, upgraders and recyclers can be sketched as follows. Informal collectors are mostly active inside the urban areas and on the dumpsites. They sell their goods (paper, plastics, metals, glass bottles) to a limited number of traders. Traders buy the goods and do some sorting and preparation for (optimal) transport. Then they hire a sea container to bring it to recyclers, mostly on Java. Upgraders treat the waste by, for example, washing, selection, crushing, chipping and baling, after which the goods are send to recyclers.
There are two traders/upgraders active on Flores. The largest one being UD Sumber Plastik has two branches; one in Maumere and one in Labuan Bajo. These traders are the main channels for shipping all separately collected recyclables to the recyclers. Based on the meetings with the largest trader, an estimate can be made of the recycling volumes on Flores, as done in Table 8. Extrapolating these data would indicate that, currently, Flores' recycling volumes are at an annual 4-5.000 tons.

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[20] This percentage can be combined with the amount of waste available for collection. It would lead to an estimate of 5.500 tons of waste being collected on a yearly basis. This is in the same order of magnitude as the 6.718 tons per year reported by Labuan Bajo.

TABLE 8. RECYCLING VOLUMES ON FLORES

Traded recyclables	Paper/Cardboard (tons/month)	Plastics (#)	Metals (%)	Glass (%)
Maumere	25	40	150	0
Labuan Bajo	5	10	10	15
Others (assumed)	20	20	50	0
Total	**50**	**70**	**210**	**15**

The public authorities are also supposed to play a role in recycling through a network of TPS3R's and waste banks. The assessment found that on Flores the public TPS3R's and waste banks are no longer active (see section 4.8).

Mass balance

When aggregating the data presented above, a first indicative mass balance can be drawn up for the generation, treatment and destination of waste in the eight Regencies of Flores. This mass balance is shown in Figure 11.
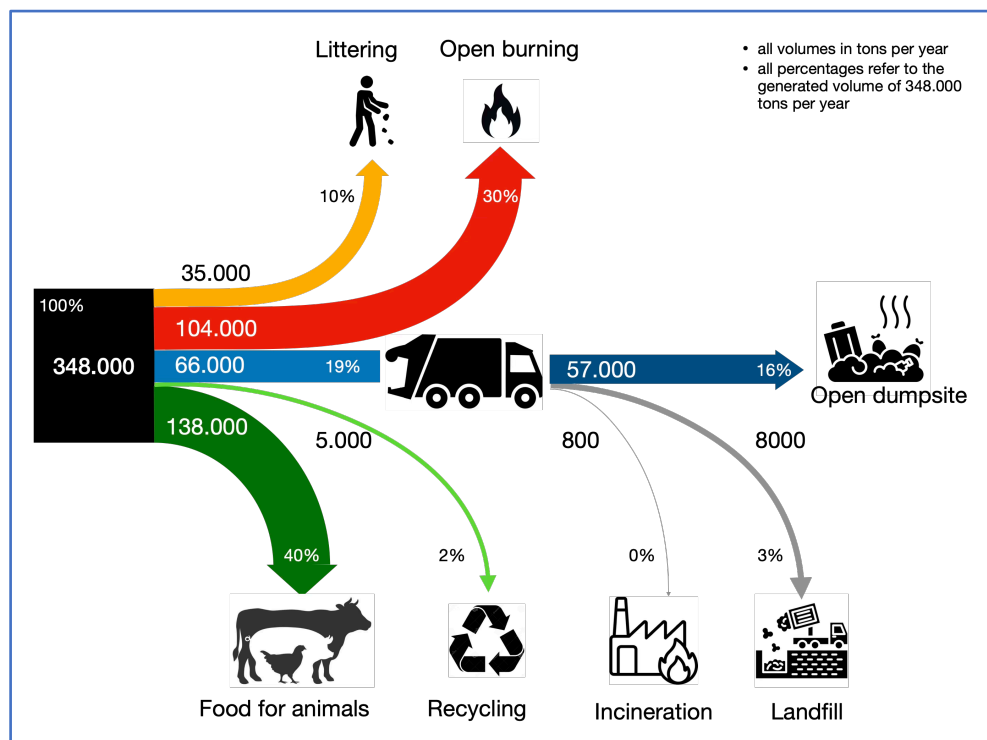
FIGURE 11. MASS BALANCE WASTE ON FLORES. BASED ON THE DATA, CALCULATIONS AND ESTIMATES IN CHAPTER 4

The graph shows that Flores generates around 350.000 tons of waste per year. Of this volume only 19% is formally collected. The total percentage of unmanaged waste (littered, burned and dumped) is 56%. The remarkable high percentage of using organic waste as animal feed leads to an overall recycling percentage of 41%. A total of 3% can be categorized as being treated through managed disposal.

4.4 Legal sustainability

Indonesia has 7 administrative levels, as presented in Figure 12. There are no formal cities on Flores. Flores as such does not have a distinctive administrative level or authority somewhere in between the provincial level of Nusa Tenggara Timur and the 8 regencies. It means that any Flores-wide plan, regulation or cooperation can only exist with the consent of the 8 regencies and also only with the consent of the Province East Nusa Tenggara.
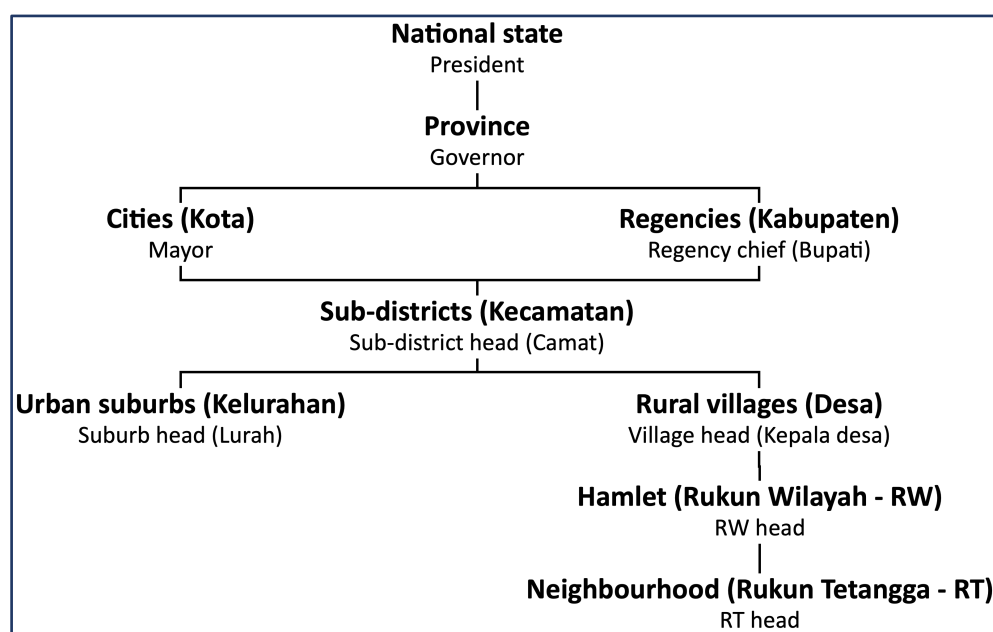
FIGURE 12. ADMINISTRATIVE LEVELS OF INDONESIA

Laws and regulations

The government of Indonesia is committed to advancing the country's waste management system. This is an integral part of a mission to reach zero emissions by 2050 from the waste sector in order to address climate change. The mission is part of the Long Term Strategy Low Carbon and Climate Resilience 2050 (LTS-LCCR 2050 and the Enhanced Nationally Determined Contribution (ENDC) documents. For reaching the target, Indonesia launched the Zero Waste Zero Emission 2050 document as an effort to translate the emission reduction target into a measurable operational plan. It comprises:
- Sanitary landfills with methane gas capture facilities
- No new landfill construction by 2030 (optimization of existing landfills, landfill mining)
- Zero open burning in 2031
- Optimization of waste management facilities, such as Waste to Energy, Refuse Derived Fuel (RDF), Solid Recovered Fuel (SRF), biodigesters, and other organic waste management. Thus, by 2040, the landfill will only receive residues.
- Strengthen waste segregation activities at the source and utilize waste materials as waste resources as part of circular economy (for example on plastic waste [22]).

All these targets will affect Flores, but the second point is of special importance. It puts a pressure on the island's regencies and on the province to move fast forward with initiating the needed landfill capacity on the island and to come to a sustainable waste management system for the coming 10 to 20 years.

Waste management in Indonesia is ruled under various regulations at national and regional levels. Waste Management Law No 18/2008 is the umbrella for the national waste management policy and practice. Main parts of the SWM infrastructure (such as new landfills) are provided by the national government to local

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[21] Legal framework of waste management in Indonesia, Hasianna Purba et al., 1st Int. Conf. ICOLGIS 2019
[22] National plastic waste reduction strategic actions for Indonesia, KLHK-UNEP-IETC-IGES, June 2020

government through the Ministry of Public Works and Housing[23]. Regencies are required to operate a full waste collection and handling system on their territory. They will also be in charge of the waste retribution fee. The provinces are in charge of initiating and operating any needed treatment facilities, such as recycling facilities and sanitary landfills, that serve multiple regencies. The following are the relevant regulations related to waste management:

National law
- Law No. 18/2008 on Solid Waste Management, as a basic law for current national waste management policy and practice in Indonesia

Government Regulation
- Government Regulation No. 81/2021 on Management of Household and Household-like waste

Presidential Regulation
- Presidential Regulation No. 97/2017 on National Policy and Management Strategy of Household Waste and Household like waste. Through this regulation, the government aims to reach the goal of 30% waste reduction and 70% of waste handling by 2025.
- Presidential Regulation No. 35/2018 on Acceleration of Development of Waste to Energy Installation Using Environmental-sound Technology
- Presidential Regulation No. 83/2018 on Handling marine debris, where the government targets 70% marine debris reduction by 2025 (the action plan will be updated)

Ministerial Regulation
- Ministry of Public Works Regulation No.3/2013 on Implementation of Solid Waste Infrastructure and Facilities
- Ministry of Environment and Forestry Regulation No. P.59/2016 on Leachate quality standard for business/activity at the landfill
- Ministry of Environment and Forestry Regulation No. P76/2019 on the Implementation of Adipura as an instrument of supervision and guidance of districts/cities in Indonesia. This in accordance to the data of Regional Solid Waste Management Strategy submitted through National Waste Management Information System (SIPSN)
- Ministry of Environment and Forestry Regulation No. P.10/2018 which require city/regency government to develop Regional Strategic Policy on Household Waste and Waste Similar to Household Waste
- Ministry of Environment and Forestry Regulation No.75/2019 on Roadmap to Waste Reduction by Producers
- Ministry of Home Affairs Regulation No. 7/2021 on retribution systems and rates to be implemented by the regencies
- Ministry of Environment and Forestry Regulation No. 14 /2021 on Waste Management at waste bank
- Ministry of Environment and Forestry Regulation No. P.26/2020 on handling of bottom ash and fly ash (FABA) from thermal processing of waste
- Ministry of Environment and Forestry Regulation No. 6/2022 require the local government to submit waste management data periodically (2 times a year).

Regional/local Regulations
- Governor of East Nusa Tenggara Regulation No. 55/2018 on Regional Strategic Policy on Household Waste and Waste Similar to Household Waste (Jakstrada) which outlines the regional government target to reduce and handle household waste within 5 years period and in a similar waste as described at the National level (30% reduction and 70% handling
- Local government regulation of West Manggarai Regency No 18 of 2017 on Waste Retribution Fee

Through the Ministry of Environment Regulation No. P.10/2018, the national government provides guidelines for preparing the Jakstrada document, being the regional strategy on waste management. It has to include how to collect relevant data, how to set the target, who will monitor the progress, etc. The results of Jakstrada implementation will be reported annually to the Ministry of Environment and Forestry and informed the Ministry of Home Affairs, the Ministry of Planning and Development and the Governor for the regency/city of Jakstrada. By 2023, 36 provinces (out of 38) and 480 regencies/cities (out of 514) already have their own Jakstrada. Based on the emphasis that is put on abating climate change, new Jakstradas will have to focus more on reducing the emissions of greenhouse gases.

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[23] Producer responsibility in Indonesia, What to know, what stakeholders think, and what could happen next, Sistemiq, December 2021

The importance of reducing GHG emissions is also reflected in the 5 targets listed at the beginning of this paragraph: sanitary landfills capture their landfill gas, open burning must be abolished, recycling must focus on organic waste and sanitary landfills should only accept residues of recycling.

As is the case for many public services, also waste management is regarded as a decentralized responsibility of the provinces and regencies. In line with this, the regencies of Flores are free to decide for a cooperation on services and infrastructure for waste management. Nevertheless, the province of East Nusa Tenggara will play an important role in any route forward. This role is primarily on initiating and operating treatment facilities that serve multiple regencies, but also on acquiring national funding for SWM-related investments.

As mentioned above, the determination of waste retribution fees is under the authority of the local government. The national government, through the Ministry of Home Affairs has issued Regulation No. 7 of 2021 and it provides guidelines for the local government to calculate the retribution tariff in waste management. In general, tariffs should cover all costs and should be guided by the volume of waste produced per category of producers. But, in case these data are not available yet, the regencies can use the electricity tariff classes from PLN (Electricity state-owned company) for establishing the tariffs per household. The regulation does not give a deadline for implementing these guidelines.

Currently, there is no regulation that explicitly mentions Extended Producer Responsibility as an instrument to incentivize the industry and shift part of the financial burden to the producers. However, the above-mentioned Regulation no. 75 by the Ministry of Environment and Forestry contains a Roadmap to Waste Reduction by Producer (2020 - 2029). It is regarded as the basis for EPR regulations in Indonesia. By 2029 the producers are obliged to achieve a 30% reduction of waste from sales and packaging[24]. This will also affect waste generation and recycling on Flores but the effects are not yet clear at this moment.

Law enforcement on waste management in Indonesia appears to be rather weak. While there are many regulations in place, there is a lack of clear directives on how and where any misconduct a should be handled. Surprisingly, law enforcement appeared to be a rather generally felt concern amongst the participants in the meetings and events for this situation analysis. Singapore appears to be one of the good and well-known examples in the region.

4.5 Organizational sustainability

Scale

Waste management comprises many activities and all of them have their own specific economy of scale. City cleaning and collection need some investments in equipment but, all the same, these services mainly operate on operational expenses related to labor, maintenance and fuel. In general, the Regencies have the needed local network and knowledge, and they have the scale, to implement efficient operations. As such there isn't a clear need to cooperate amongst the regencies on waste collection. Nevertheless, there can be important advantages to cooperate anyway. These advantages may come from optimizing waste collection by sharing equipment and having collection routes that cross the borders of regencies.

When considering to leave the current path of using dumpsites and making a choice for sanitary landfilling and recycling, the individual Regencies do not have the needed scale and so they have no choice but to cooperate (together with the province, see under 4.4). Landfills and recycling facilities need high investments and knowledgeable staff whereas operational expenses are relatively low. Efficient operation of a sanitary landfill would require a serviced population of 500.000 inhabitants or more. Looking at the low generation rates on Flores, that scale may already be too small. Cooperation of the Regencies on this topic is therefore needed and beneficial for all parties. All regency-representatives, that took part in the events of this assessment, showed a clear willingness for such a cooperation. Flores has shown a similar cooperation in the past, when drawing up a masterplan for tourism on the island.

Centralizing landfill and recycling facilities as described, will need the use of simple and cheap transfer stations (for example on the present dumpsites). Such transfer stations serve to disconnect collection and transport. Small collection trucks empty their contents on a concrete slab where a crane takes it over and loads it into a large capacity truck to haul it to the landfill. And in the future, such transfer stations may also play an important role in guiding waste to larger recycling facilities. Flores will need a network of such transfer stations (TPS), to be

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[24] Extended producer responsibility guideline on plastic products and packaging for industries in Indonesia, WWF-Indonesia Plastic Smart Cities, 2022

located at strategic points across the island. In order to enable this network to play its important role in optimizing logistics and reducing costs, it has to be in the hands of the combined cooperation of regencies.

Governance

The current waste management services in the Regencies display a uniformity. Every Regency has its waste management department, with equipment and operations that show a similar approach through operating waste banks, TPSs, TPAs and TPS3Rs.

It can be observed that, in the present situation, political and operational responsibilities are still very much intertwined. This may become a problem when building up modern SWM services and facilities as described above. Investments need stability, technical and logistical operations need businesslike decision structures and undisturbed services need steady cashflows. It would be good to face these needs and to consider a governance structure on Flores with separation of political and operational responsibilities.

The last observation with regard to governance is on finance. As said, undisturbed services need undisturbed and sufficient cashflows. At this moment SWM finances on Flores are mainly subsidized from the general budget and are therefore subject to ever changing political priorities and processes. Section 4.6 will elaborate the financials into more detail.

Similar conclusions on governance were recently drawn in a broad Indonesian study by Systemiq[25].

Stakeholders

For any current or future actor with an interest in SWM on Flores, it is important to analyze the relevant stakeholders regarding their interests and stakes, along with their power and roles. The chart in Fig. 13 provides a simple qualitative summary off these aspects for the most important stakeholders at this moment.
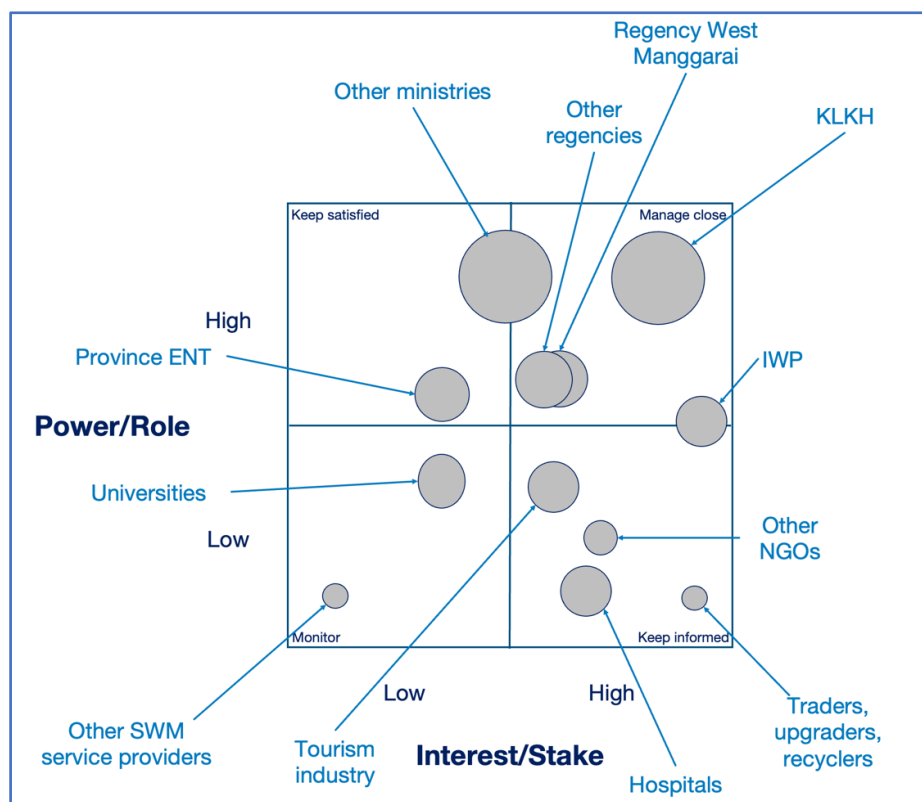
FIGURE 13. OVERVIEW OF STAKEHOLDERS. X-AXIS REFLECTS EXTENT IN WHICH AN ORGANISATION HAS ACTIVE INTEREST IN SWM ON FLORES. THIS INTEREST IS LARGER WHEN THIS ORGANISATION HAS SWM AS ITS ONLY INTEREST AND WHEN THE ORGANISATION HAS A FORMAL, RESPONSIBILITY IN SWM. Y-AXIS REFLECTS THE EXTENT IN WHICH AN ORGANISATION HAS THE BUDGET, NETWORK, INSTRUMENTS, LEGAL POSITION ETC. TO ACT ON SWM. THE SIZE OF THE SPHERES IS A QUALITATIVE MEASURE FOR THE GENERAL STRENGTH, SIZE AND FINANCIAL POWER OF THE ORGANIZATION.

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25 Building robust governance and securing sufficient funding to achieve Indonesia's waste management targets, Systemiq/Norvegian Embassy, 2021

The analysis reflects the obvious strong role and interest of all public stakeholders by placing them in the upper right and left quadrants. From the viewpoint of the future actor, all stakeholders in the upper-right quadrant should be managed close, meaning that these stakeholders are decisive for any progress.

Important waste producers and recyclers can be found in the lower-right corner of the quadrant meaning that they must be kept informed on all relevant developments. The lower-left quadrant shows that, currently, there is none or little interest from private service providers to play a role in SWM on Flores. NGOs, such as IWP, can be characterized as important stakeholders because of their networks of relations on Flores.

4.6 Financial sustainability

Costs, revenues and cost coverage

Data on public budgets and revenues for waste management are not readily available on Flores. Table 9, provides the little information that could be retrieved for two regencies.

TABLE 9. CURRENT PUBLIC CASHFLOWS FOR SWM ON FLORES

Name of City or Regency (from east to west)	Total population	Population serviced with collection	Waste collected	Yearly costs of SWM	Yearly revenues for SWM	Cost coverage	Costs per inhabitant serviced	Costs per ton collected
	(#)	(%)	(tons/year)	(IDR/year)	(IDR/year)	(%)	(IDR/inh.yr)	(IDR/ton collected)
Ende Regency	281.370	44%	26.831	1,7 billion	20 million	1%	14.000	60.000
West Manggarai Regency	276.280	9%	5.555	11,8 billion	2 billion	20%	500.000	2 million

The summary shows large differences between the two regencies. In Ende, waste collection is restricted to the urban areas of the town Ende. The regency reported that the entire urban area is covered. Dividing the yearly costs by this urban population leads to unrealistically low costs per citizen, even when considering that Ende only operates waste collection and then brings the waste to its local dumpsite.

The figures for West Manggarai are in fact figures for the town of Labuan Bajo. Costs there are calculated at 500.000 IDR per serviced inhabitant per year and they are rather high. For a well-equipped, good-quality system of waste services on Flores, we would expect costs to be around 100.000 IDR (see section 6.5). The high costs may be related to the waste coming from tourists and boats visiting Labuan Bajo. On average, the town hosts around 2.000 guests on a daily basis, and these tourists produce at least 3 times more waste per day than the inhabitants of the town. In addition, there is waste coming from the boats that moor in the harbor of the town. The collection of all that waste is comprised in the budget of 11,8 billion IDR per year. If this sum is divided by only the number of inhabitants, the costs per inhabitant may indeed be high.

In such cases, it may be better to look at the costs per ton of waste that is collected and treated. But even then, the costs per ton are rather high. The overall costs are 2 million IDR per ton where we would expect that costs for a good system would not need to be higher than 1 million IDR (section 6.5). Most probably, these high costs can be attributed to the very small scale of the landfill and incineration plant.

The World Bank reports[26] that, on average, upper-middle-income countries like Indonesia spend 5-150 USD/ton on a combination of collection and sanitary landfilling (Table 10). Translated to the Flores situation this would mean costs between 300.000 and 1.000.000 IDR per household per year. So also in an international perspective, SWM costs and fees are extremely low in Ende (and high in the exceptional case of West Manggarai).

The very low costs and cost coverage must be looked at as a serious weakness in the current system. This holds especially in combination with the earlier mentioned overlap between political and operational responsibilities. In situations where political interest in solid waste management is fluctuating, budgets will fluctuate as well and this will obstruct any improvement in the quality of SWM services and infrastructure. Governance systems should guarantee autonomous cashflows, that cover all costs and that provide earmarked money that cannot be spent on other purposes. Such separation of responsibilities and ringfenced cashflows are also highly appreciated by banks and (international) institutions providing financing for SWM investments.

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[26] What a waste 2.0, World Bank report, 2018

TABLE 10. COST DATA FROM WORLD BANK

US$/tonne	Low-income countries	Lower-middle-income countries	Upper-middle-income countries	High-income countries
Collection and transfer	20–50	30–75	50–100	90–200
Controlled landfill to sanitary landfill	10–20	15–40	20–65	40–100
Open dumping	2–8	3–10	—	—
Recycling	0–25	5–30	5–50	30–80
Composting	5–30	10–40	20–75	35–90

Source: World Bank Solid Waste Community of Practice and Climate and Clean Air Coalition.
Note: — = not available.

Fees and fee collection

The interviews showed that most regencies have a system in place for collecting waste management retributions from households, institutions and commercial entities. It was also reported that a number of regencies have introduced a system of establishing differentiated fees according to the capacity of the power connection of the houses and buildings. Nevertheless, cost coverage is still zero or very low in most regencies on Flores. Also here, West Manggarai is a positive exception.

Waste retributions are ruled by the Ministry of Home Affairs in its regulation 7/2021. This regulation also guides the linkage of these retributions to the level of electricity supply as done by the Indonesian power company PT Perusahaan Listrik Negara. The regulation gives five categories, going from households with low-capacity connections to households with high-capacity connections. The regencies are free to adjust the system to the conditions in their territories.

Polluter pays principle

In the international SWM community, there is no discussion on the fairness of the polluter-pays principle. This means that every citizen, shop, company etc. should be charged a fee that's able to cover all costs related to its collection and treatment. With collected fees covering no more than zero or just a few percent of the actual costs it can be concluded that the Regencies still have a long way to go.

Financing waste management

Most regencies in Indonesia use their general local budget (APBD) for covering the expenses of waste management. One report[27] shows budgets for SWM in five cities in the range of 0,3%-0,7% of the APBD. Coverage of these costs through waste management retributions show larger variations:7%- 48%.
The APBD money is primarily used for covering the operational expenses. In addition, a number of regencies have received and used financial support from the state budget (APBN) for covering investments in SWM-assets. There are different sources within the state budget used for this purpose: the Specific Allocation Fund, the Co-administered Fund, the Special Autonomy Fund, the Local Incentive Fund and the Vertical Fund from the Ministry of Public Work and Housing.
There are a number of other ways to fund waste management investments, outside the APBD and ABPN. They are listed below:

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[27] Study of solid waste management financing in Indonesia, Widita Vidyaningrum, Embassy of Denmark, 2020

- Grants and technical assistance through development partners such as KfW, UN ESCAP (funding digestion projects for organic waste in Malang and Jambi City), USAid and others.
- Special financing through PT Sarana Multi Infrastruktur, a non-bank financial institution under the Ministry of Finance using bonds and blended financing platform SDG Indonesia One
- IFIs like the Asian Development Bank and the World Bank[28] could provide concessional loans and technical assistance but mostly these are for large scale, complex programs of investments.
- Venture capital and Impact investors can provide private funding.
- Philanthropic funding, such as Minderoo Foundation's Sea the Future initiative on incentivizing waste collection and recycling
- Funding from large (international) corporates and other commercial investors and banks such as Morgan Stanley who committed to funding initiatives on reducing plastic waste.

All Indonesian public authorities have to report their external loans and grants to the Ministry of National Development Planning (Bappenas).

Pricing of recyclables

Recycling activities tend to be highly dependent on market prices and these prices tend to be very volatile. When selling prices for traders drop, buying prices are also decreased in order to maintain a margin. Falling prices are mostly a reason for (informal) collectors to reduce or even fully stop their activities. This makes the recycling sector very unstable.

Prices for recyclables are very volatile. Traders provided some insight in current prices for buying and selling of their goods, as shown below. Other data were gathered through online research (for example [29]).

TABLE 11. BUYING AND SELLING PRICES OF RECYCLED GOODS.

	Buying price (IDR/kg)	Selling price (IDR/kg)
Paper/cardboard	1.500	1.000-2.000
PET plastics	1.200	2.500
PE plastics	1.200	2.000
Iron	?	5.000
Aluminum	?	8.000
Glass	?	?

The data enable to calculate that, with a yearly throughput of 5.000 tons, the current market in Flores reaches a yearly turnover of 15 billion IDR.

4.7 Social sustainability

Affordability

According to statistical data, per capita GDP (current prices) on Flores is currently at IDR 18 million per year. With an average of 4,6 persons per household this would lead to an average GDP per family in Flores being IDR 80 million. A worker with a minimum income earns around IDR 25 million per year. The World Bank and the United Nations use a benchmark of 1% of a per family GDP that, when spent on waste management, can be regarded as "affordable".

If we use this benchmark, we may conclude that, at this moment, SWM fees could be at a little below 1 million IDR per family per year. If instead, we would relate the 1% benchmark to a real income of a family that has only one minimum income, SWM fees could be as high as 250.000 IDR per year. It is clear that in the current situation, most regencies are very well below that level.

The interviews lead to the observation that regencies need more revenues in order to be able to improve their services. But at the same time the regencies conclude that citizens are not willing to pay a higher SWM fee because of the lack of service quality. This looks like a deadlock situation in which local government first has to work on regaining trust and appreciation before it will be able to raise taxes.

Employment

Two regencies (Nagekeo and West Manggarai) reported an overall workforce of 191 employees. When extrapolated to entire Flores it would lead to a total workforce of around 500, employed in waste management activities.

In addition, the observations showed that every dumpsite, but also the landfill in Labuan Bajo, has waste-pickers active in searching for plastics, paper and metals. The recycling company in Maumere reported to employ 8 employees formally on its premises and to work with at least 40 informal waste-pickers for its supplies. When assuming a total of 50-70 informal workers per regency, the estimate could be that currently, the informal workforce on Flores could be around 500.

The total of formal and informal workers would then be around 1000 for all of Flores.

Awareness

"Awareness" is a generic term covering, in this report, a notion of importance with regard to living in clean and healthy circumstances and everyone's shared responsibility in achieving this. It's not hard to conclude that awareness is still at a low level on Flores. Although the finger is mostly pointing at the citizens in general, it must also be emphasized that this awareness is still not internalized within the public organizations themselves and not reflected, as shown above, in the governance structure and financial emphasis.

IWP and its relations across the island have so far played a role in raising awareness on waste management and related subjects.

4.8 Technical sustainability

Services, equipment and workers

From 2 regencies, information was received on the number of trucks that are used in waste collection. The same regencies also supplied numbers of workers employed. Nagekeo reported a total of 30 employees. West Manggarai employs 161 workers in the combined waste activities. Of this workforce, 60 are employed in street cleaning, 47 in waste collection and the rest is working on the treatment facilities or involved in greenery services. For 4 other regencies, data could be retrieved from a summarizing website with more historical data [30] and through data provided by KHLK[31]. Based on these inputs, truck- and worker-efficiencies can be calculated as shown in Table 12. The results show large and unexplainable differences. When compared to international experiences, most efficiencies of both the trucks and the workers, are very low. It is most probably caused by the type and quality of the trucks that are used. But another factor that may play a role is the insufficiency of budgets. The departments are often limited in their operations because of the inability to buy sufficient fuel for the trucks.

These observations were confirmed during the meetings with the regencies. They revealed that many regencies are not able to deploy their trucks every day of the week, because of lack of money for fuel and wages. This leads to a decrease in the number of collection rounds per week, to restrictions on the number of households that can be serviced and to an overall reduction of service quality. This was also supported by an observation in Labuan Bajo. One of the sites of the waste management departments was used for the storage of at least 20, rather new, tricycles that were meant to be used for waste collection. Most of the vehicles were not in use, or even never used, because of the inability to buy fuel for them.

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[30] https://perkim.id/profil-pkp/profil-kabupaten-kota/profil-perumahan-kawasan-permukiman-kabupaten-manggarai-timur/
[31] Data from KLHK provided on October 10th, through the Indonesian Judicial Research Society, IJRS

TABLE 12. COLLECTION EFFICIENCIES ON FLORES.

collection of waste	# trucks	truck productivity		# workers	worker productivity		#workers per #trucks
		serviced population per truck	tons collected per truck per day		serviced population per worker	tons collected per worker per day	
East Flores Regency	5	4680	900	n.a.	-	-	-
Sikka Regency	7	12150	2280	n.a.	-	-	-
Nagekeo Regency	3	960	1100	30	220	370	4,2
Ngada Regency	3	4660	890	n.a.	-	-	-
East Manggarai Regency	3	1970	290	37	160	25	12,3
West Manggarai Regency	17	1462	333	47	529	120	2,7

Infrastructure

In Indonesia, mostly the subdistricts are responsible for collecting waste and bringing it to a transfer station (TPS) or to a combined transfer/recycling site (TPS3R). The regencies are than responsible for bringing the waste from the TPS to a landfill (TPA) or a large processing facility (TPST). This system is struggling in all of Indonesia[32] and also on Flores. One example is the decreasing number of transfer sites reported for Flores for the period 2018-2021, as shown in Table 13. It shows that in only 3 years the number of subdistricts with transfer sites has gone down with 40%. The number of subdistricts with small recycling sites has gone down with 39% in that same period. Maybe this downward trend can be attributed to Coved but that's unsure. It fits in the trend that was communicated to the team that currently, there are no longer any public waste banks active on Flores.

TABLE 13 NUMBER OF TRANSFER SITES (TPS) AND TRANSFER SITES WITH RECYCLING (TPS3R)

Name of City or Regency (from east to west)	Number of subdistricts with TPS in 2018	Number of subdistricts with TPS in 2021	Number of subdistricts with TPS3R in 2018	Number of subdistricts with TPS3R in 2021
	(#)	(#)	(#)	(#)
East Flores Regency	35	28	18	10
Sikka Regency	14	13	0	6
Ende Regency	25	8	23	8
Nagekeo Regency	9	8	10	8
Ngada Regency	26	10	8	3
East Manggarai Regency	18	3	10	3
Manggarai Regency	15	11	3	8
West Manggarai Regency	18	12	16	8
Total or average	160	93	88	54

As mentioned before, every regency uses open and uncontrolled dumpsite(s). Table 14 comprises some data on the number of these sites. The only exemption is West Manggarai. The regency has a location near Labuan Bajo of 1 hectare with a landfill and a waste incinerator. Both were constructed in 2022. The landfill is very small with a usable surface of only 0,5 hectares. It is provided with a High-Density Polyethylene (HDPE) bottom liner and there are 3 treatment basins for the leachate, although it was unclear whether they are actually used. Daily coverage of the waste with a soil layer is not executed. There is no gas extraction. Some 10 waste-pickers are working on the landfill on a regular basis.

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[32] Building robust governance and securing sufficient funding to achieve Indonesia's waste management targets, Systemiq/Norvegian Embassy, 2021

TABLE 14. NUMBER OF DUMPSITES AND LANDFILLS

Name of City or Regency (from east to west)	Number of TPA (#)
East Flores Regency	1 dumpsite
Nagekeo Regency	1 dumpsite
Ngada Regency	1 dumpsite
East Manggarai Regency	1 dumpsite
Manggarai Regency	1 dumpsite
West Manggarai Regency	1 controlled landfill

The incinerator near Labuan Bajo comprises a hall with two installations. Their combined capacity is designed at 20 tons per day, which is remarkably small. The concept is that of moving grids. The waste is introduced at one side of the oven and is transported to the other, lower, side by a moving floor. Apparently, there are two stages. The first stage is the burning of the waste at the grid which is enhanced by a blower. The second stage is the after-burning of the gases, enhanced by a second blower and the injection of diesel. The off-gases are fed to a cyclone and a wet-scrubber and then led to the exhaust stack. The effectivity of the processes could not be assessed. When visiting, the incinerators were not operational. The process is said to run at 800 °C which is too low to prevent dioxin emissions. It was mentioned that in reality the temperature is even lower because of the lack of diesel to fire the process. The process needs 100 liters of diesel per day for the generator, 40 liters for starting up the incineration and 40 liters per hour for the afterburner. Due to lack of budget, the installation is reported to treat only 2 tons per day. The investment in the incinerator was almost 50 billion IDR. Such an investment, assuming to run at its designed capacity of 20 tons/day and given the consumption of diesel, would lead to an average cost-price of well over 2 million IDR per ton (>130 USD per ton). It clearly shows the lack of economy of scale for such installations, not even considering the probable problematic air emissions it produces.

PHOTOS 2. LANDFILL AND INCINERATOR IN LABUAN BAJO.

The team was told that, during Covid, some hospitals were supplied with incinerators for their hazardous waste. After Covid, the financial support to run these incinerators stopped and the hospitals did not proceed operations on their own expenses. As a result, hospitals are looking for other ways to treat that waste.

Data availability

The availability of data is extremely low. There is no routine in gathering and assessing quantities and using them to improve services.

Professionalism

All stakeholders showed a clear interest in SWM and its development through improved professionalism. Regency representatives seem to be well aware of their important role but also mentioned their limitations caused by lack of budget. Due to this, their focus is still strictly on running daily routines and not on improving performance.

5. Analysis

The observations provided in chapter 4 can be summarized in a simple score card with red, orange and green giving a qualitative indication for a weak/poor, moderate/average or good score respectively. Table 15 comprises the scores in the first three columns. Column 4 gives the scores that can be achieved within 5 years.

TABLE 15. SCORECARD FOR WASTE MANAGEMENT ON FLORES

Sustainabilities	Items	Current score	Achievable in 5 years
Environmental	cleanliness	🔴	🟠
	service coverage	🔴	🟠
	dumpsites/landfills	🔴	🟢
	recycling percentage	🔴	🟠
Technical	infrastructure and services	🔴	🟠
	equipment	🔴	🟢
	data-basis	🔴	🟢
	professionalism	🔴	🟢
Social	affordability of fees	🟢	🟢
	employment	🟠	🟢
	awareness and participation	🔴	🟠
Financial	fee collection system	🟠	🟢
	fee differentiation	🟠	🟢
	polluter pays	🔴	🟢
	cost coverage	🔴	🟠
	financing for SWM	🟢	🟢
Organisational	right scale	🔴	🟢
	responsibilities, governance	🔴	🟢
	stakeholder involvement	🟠	🟢
Legal	laws and regulations	🟢	🟢
	planning and control	🟢	🟢
	law enforcement	🔴	🟢

The scorecard shows that at this moment the overall situation must be assessed as grave, especially because:

- No more than 16% of the population is serviced with city cleaning and waste collection.
- Around 56% of all waste, being 195.000 tons of waste per year, is left uncollected and unmanaged and is littered, buried, burned or dumped.
- The situation at the dumpsites is in no way sustainable.

- Recycling is at a good level but this is mainly due to direct re-use of organics in the households, a practice that is going to decrease when Flores economically develops
- There's a substantial risk with regard to the continuity and quality of existing services because of the very low level or even absence of incoming revenues from waste management fees.

The upside may be that there is a good potential for improvement, as is shown in column 4. This positive prospect is rooted in:
- the availability of a rather well-developed legal system that is dedicated for guiding waste management all over Indonesia
- the availability of several possibilities to finance investments in SWM
- the willingness amongst the Flores' regencies to cooperate
- the potential that lies in improving the efficiency of the existing workforce and truck fleet,
- the availability of systems for SWM fee collection and fee differentiation and
- the fact that low levels of SWM fees provide room for increasing cashflows.

6. The way forward

6.1 Priorities and strategy

When designing a way forward, the first question is about priorities. Resources are not unlimited and improvements in waste management need important societal and institutional changes. It takes time and there is no way to reach circularity without going through a long period in which there will still be larger volumes of waste that cannot be prevented or recycled; not at the households and not in large scale recycling facilities. At the same time, a number of priorities seem to compete. Public health, cleanliness of streets and beaches, the prevention of plastics and GHG emissions and the reduced use of resources are not always pointing in the same direction. Or, to be more precise, they cannot all be met at the same time.

Looking at the policy of the Indonesian government, the first priority must be on reducing GHG emissions. This can only be achieved by reducing the amount of unmanaged waste as quickly as possible. And in turn, this can only be done through full collection-coverage, replacing open dumpsites by sanitary landfills and enforcing a full ban on open burning. Such a strategy would also directly benefit the priorities on health, cleanliness and marine littering. All of this also supports Flores' endeavors to stay an attractive tourist destination and an example for other parts of Indonesia.

This priority does not exclude any priority on prevention and recycling. On the contrary, it will lead to a professional infrastructure with strong cashflows that will, in itself, be the strongest possible incentive for more prevention and recycling. Gate-fees for waste entering the system will rise and this will push municipalities and other producers to seek for recycling alternatives. And if this is not enough, landfill bans can be introduced in order to steer waste towards recycling facilities. In fact, any strategy that includes landfills should also include policies and investments aiming at using that capacity as limited as possible.

Overlooking the above, the conclusion must be that there are no thinkable systems for prevention and recycling that can replace the priority given above.

6.2 Waste projections

When elaborating this strategy, there is a clear need to know the volume of waste that can be expected in the years to come. Figure 14 provides a projection until 2040 of the waste available for collection within the urban and rural areas on Flores and a projection of the waste from the tourism sector (including the top priority destination Labuan Bajo) and other businesses. It is based on the following assumptions:

- The situation in 2023, as calculated in paragraph 4.3 can be used as a starting point.
- The population will grow with a year-on-year rate of 1,59%.
- GDP per capita will grow with a year-on-year rate of 3,71%.
- Urbanization will grow at annual steps of 1%.
- An average tourist produces 2 kg per capita per day. The number of tourists is growing year-on-year at 10% and the average number of nights per tourist will grow from the current 2 towards around 5 in 2040.
- Waste from other businesses is estimated at 5% of all household waste. This percentage will grow at 2%/yr reaching 7% in 2040.
- Direct reuse of organics in rural and urban households is expected to decrease with annual steps of 2%.
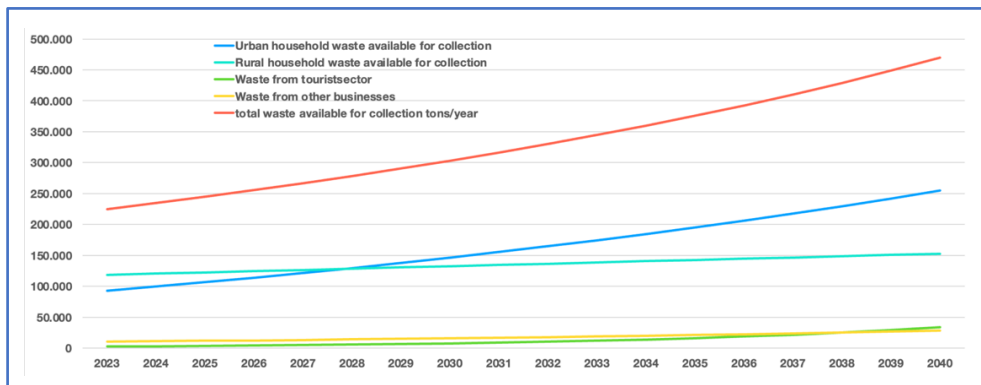
FIGURE 14. WASTE PROJECTIONS UNTIL 2040 FOR FLORES

This projection shows that the total waste volume for collection (red line) will double from 225.000 tons/yr in 2023 towards 460.000 tons/yr in 2040. This growth is mainly due to the growth in urban household waste (blue line). Rural household waste (light blue line) will show little growth. Currently, the volume of waste from tourism (green line) almost plays no role, but it will grow steadily towards 35.000 tons/yr in 2040.

6.3 A possible framework

Based on the analysis in this report, Flores is faced with the question how to tackle the following challenges:
- Population density and waste generation are low. It may weaken the needed basis for sustainably financing the investments, especially regarding sanitary landfills.
- The long-stretched shape of the island and the weak road infrastructure add problems to the logistic system that has to bring the waste to the treatment facilities.
- The finer network of rural roads that is needed to reach most of the rural inhabitants, is problematic as it consists of low quality, narrow, sand and gravel roads.
- The fact that 10% of Flores' population lives on smaller islands calls for a dedicated approach.
- Tourism is expected to boom and the waste it generates will put an extra pressure on the system.
- The population is reluctant to pay money for (poor) waste management.
- Household incomes are rather low when compared to the rest of Indonesia.

Looking at the low density and waste generation rates on Flores, a sanitary landfill can only be financially feasible when serving a population of at least 500.000 inhabitants. When also considering the shape of the island and the road distances, Flores could best choose for a waste management system that divides the island into three regions with only one sanitary landfill in each region (Figure 15).

A sanitary landfill must be used as little as possible. Often, locations are hard to find and extending the lifetime of a landfill becomes a priority in itself. The Indonesian government has issued that, by 2040, landfills should only be used for real residues; waste that can't be recycled. This can be achieved through investments in recycling facilities that remove and recycle the organic fraction, plastics, paper/cardboard, metals and glass. The landfill sites can be used for this purpose as they already have a number of services and installations (fences, weigh-bridges, water treatment etc.) in place to receive and handle waste. In this set up, landfills become the ecoparks of the future.
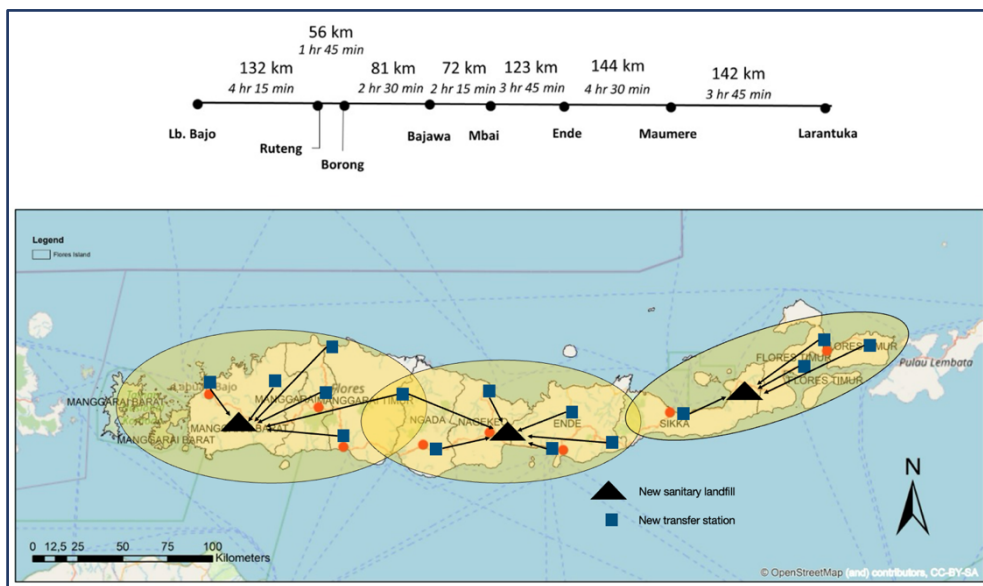
**FIGURE 15. POSSIBLE WASTE MANAGEMENT REGIONS ON FLORES**

The logistic challenge can only be overcome through a network of transfer stations (TPS). They enable the regencies to disconnect collection from transport. The collection trucks can deliver their waste at the nearest station and then return to their collection routes. Larger bulk-trucks then pick up the waste at the transfer stations and bring it to the landfills and to other treatment facilities. The transfer sites could be located on the existing dumpsites and construction could include cleaning up of these sites.

To collect the waste in the thinly populated rural areas, it could be advisable to use street containers (Figure 16).

FIGURE 16. STREETCONTAINER AND COLLECTION TRUCK

These 1,1 m^3 steel or plastic containers are placed at the side of the road on fixed locations. The number and location of the containers should enable households to bring their waste at any time they prefer and within a walking distance of preferably no longer than 200 meters. That last constraint could be a problem in the Flores' situation. Figure 17, shows the remote sensing map used in paragraph 4.1, but now with the road infrastructure plotted in, including a zone of 200 meters on both sides of the roads. Based on this map it can be concluded that only 60% of the populated areas lie within this bandwidth. It also shows that even in the urban areas, not all households are within this reach. Additional calculations show that increasing the bandwidth to 500 meters would reach more than 90% of the populated areas. At this stage, it is not exactly possible to translate "populated area" to "population". Nevertheless, the analysis shows that between 10% and 30% of the population would have to walk in between 200 and 500 meters to reach the nearest waste container.
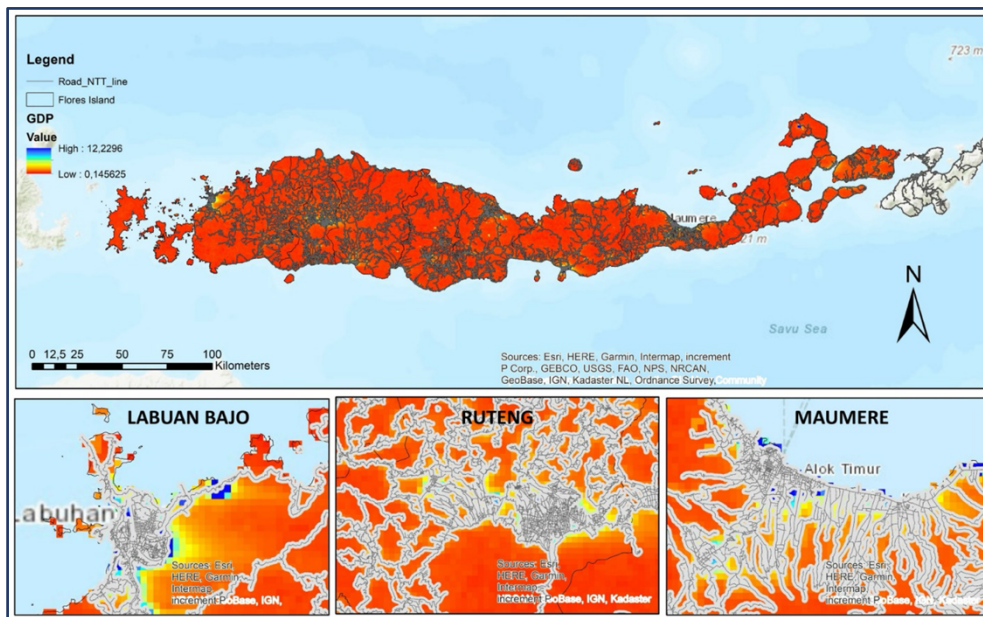
FIGURE 17. ROAD INFRASTRUCTURE WITH 200 METER ZONE ON BOTH SIDES OF THE ROADS.

To empty the containers, small, sturdy, 4-wheel-drive collection trucks should be used (Figure 16). The usability of these trucks on the rural roads was confirmed during our interviews. But it was also clear that most of these trucks could do no more than 1 route per day. In the urban areas, larger trucks can be used and they should be able to do 2 or 3 routes per day.

Collecting the waste on the smaller islands could call for community-based initiatives. Every island has its specific social and natural challenges and there will probably not be a one-size-fits-all approach. The uniform part could start after collection by providing containers at the harbors. Emptying these containers and transporting the contents to the main island has to be designed in more detail.

Waste from the tourism-sector will grow but volumes will not surpass 10% of regular household waste on Flores. This volume can be absorbed in the regular system for household waste.

6.4 Governance

The framework described above, would need a strong cooperation between the 8 regencies on Flores. In its minimum variant this cooperation could be limited to a shared infrastructure of transfer stations and landfills. This could be done in a dedicated company, publicly owned and managed by the province and all 8 regencies. The company would bring together all knowledge and experience needed for this infrastructure and, based on this, it should be in charge of the investments and operations. All costs of the transfer stations and landfills can be uniformly spread over the regencies by using a flat tariff per ton of waste delivered at any one of the sites. In such a situation, the exact location of the landfills would not be relevant to the regencies; they can do their own street cleaning and waste collection and deliver their waste at the nearest transfer station or landfill, even if it's in another regency or region. And the company may then decide to which landfill or recycling facility the waste from the transfer stations should go.

The cooperation between the regencies could also go further by including street cleaning and waste collection. The company would then also do the investments and operations for this part of the value chain, including the collection of the waste from the smaller islands. This would create a potential for optimization because it would bring together all logistical knowledge, collection routes would not be restricted to the territories of the regencies and collection from the islands can be optimized. It would also give the possibility to work with a flat waste management tariff for all households on the island

The maximum level of cooperation could be achieved by also agreeing on uniform waste regulations. This could include a uniform system of administration, monitoring, training, awareness campaigns, fee collection and fee differentiation (i.e. differentiation of household fees across different income groups in order to reach affordability, also for the poorer households, see next paragraph).

The above choices for increasing cooperation and coherence are depicted schematically in Figure 18
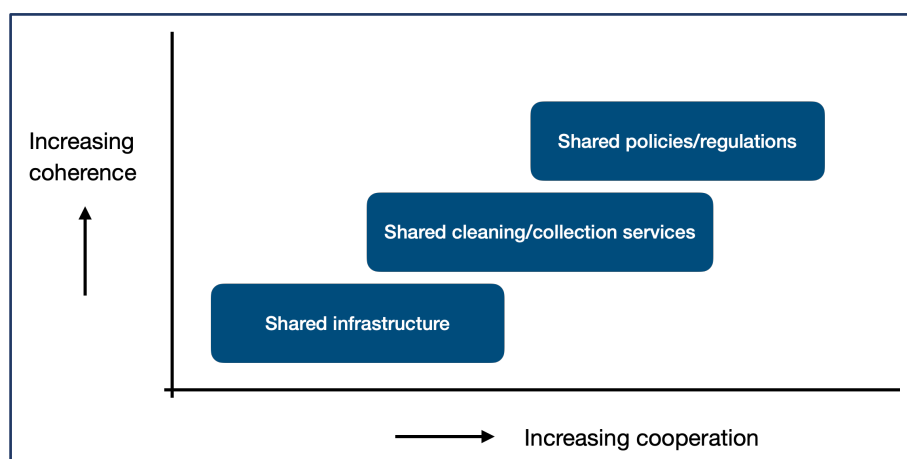
FIGURE 18. OPTIONS FOR INCREASED COOPERATION AND COHERENCE (UNIFORMITY) BETWEEN THE REGENCIES

6.5 Financial implications and financing

Tentatively, the framework described above, would need investments in the order of 1.300 billion IDR. These investments can be spread out over multiple years, depending on the priorities to be set in a Masterplan.

TABLE 16. NEEDED INVESTMENTS.

Investments	Needed numbers	Type	Unit price	Total costs
	(#)		(IDR)	(IDR)
Street containers	25.000	1,1 m^3	4 mln	100 bln
Trucks for rural collection	50	12 m^3 collection truck	1,4 bln	70 bln
Trucks for urban collection	30	20 m^3 collection truck	1,8 bln	55 bln
Transfer station	15	5.000 m^2 area, paved and fenced	10 bln	150 bln
Sanitary landfills	3	10-15 hectares, fully equipped	300 bln	900 bln
Total				~1.300 bln

By adding operational expenses to these investments and translating both to overall costs per household, the financial overview given in Table 17 can be produced.

TABLE 17. CAPEX, OPEX AND TOTAL COSTS PER HOUSEHOLD

Costs per household	Opex per household	Capex per household	Total costs per household
	(IDR/HH.year)	(IDR/HH.year)	(IDR/HH.year)
Waste collection urban	140.000	70.000	210.000
Waste collection rural	130.000	70.000	200.000
Waste collection small islands	200.000	100.000	300.000
Street cleaning	30.000	0	30.000
Waste collection average	140.000	70.000	210.000
Transfer and transport	20.000	10.000	30.000
Sanitary landfills	20.000	180.000	200.000
Total	210.000	260.000	470.000

The framework for waste management on Flores described above, would lead to an average cost per household of 470.000 IDR. In comparison with international standards, this is rather cheap. It is caused by the low waste generation rates that are estimated at this moment and the fact that most organic waste is directly recycled at home.

Implementing a retribution of 470.000 IDR per household per year cannot be done directly in the first year. It has to be introduced gradually and it would have to follow the introduction of improved services so citizens can see what they will be paying for. In case this adaptation period would consist of 5 yearly increases of 20%, an additional financing gap of around 500 billion IDR would arise.

Retributions also have to come from producers of commercial, tourist and harbor waste. Dedicated tariffs have to be made that are tailored to the quantities they produce.

Flores needs support for financing the needed investments and gap of 1,8 trillion IDR. One way would be to apply, with the help of the National government and the Province East Nusa Tenggara, for financing via ADB or one of the other IFIs. For this, Flores needs to follow up on this situation analysis by agreeing on a masterplan preparing for such financing. Another venue could be to apply for the investments to be granted by the National government through the Specific Allocation Fund, DAK. For such a proposal the Flores' regencies have to send the request and planning documents to the Ministry of National Development Planning (Bappenas). In case the Flores' regencies would be successful in applying for a full grant of the investments and the financing gap, the needed fee per household would go down from 470.000 to 210.000 IDR per household per year. Other possibilities are described in section 4.6

6.6 Social implications

Affordability

The benchmark of the United Nations and the World Bank for affordability of family spendings on waste management services is 1% of the per family GDP. A waste management fee or retribution of 470.000 per household per year would use around 0,5% of this per household GDP on Flores. When related to an average family income the percentage would be a little over 1%.

In the case of receiving a grant that covers the entire sum of investments and financing gap, these percentages would change to 0,2% and 0,6% respectively. This is well below the affordability benchmark. If, even under these circumstances, there would be poor families that can't afford to pay such fees, the regencies could consider a system of fee differentiation that would exempt the poorer families and instead have the richer families pay a higher fee.

Awareness and participation

The major challenge for implementing the framework described in paragraph 6.2 may lie in achieving full public participation. Paragraph 4.7 already referred to a deadlock situation based on lack of budget, lack of service quality, lack of trust and lack of willingness to pay. This vicious cycle has to be broken. In order to reach full participation, it will not be enough to start up awareness programs. It needs a concerted program starting with raising service levels. Parallel and after this, the implementation of an awareness program can be set up. Together they must lead to a situation in which raising fees can be justified and will be accepted. The last stage is that of empowering law-enforcement for those not willing to participate.
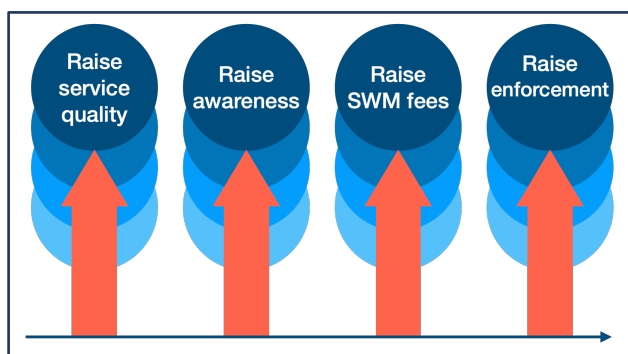
FIGURE 19. ENHANCING PARTICIPATION OF CITIZENS

Economy and employment

The program described in paragraph 6.2 will strongly increase the cashflow through the value chain of waste management. This cashflow will become part of the regional economy and lead to new activities. Part of it goes into creating new jobs. In case of full deployment of the project it can lead to more than 1000 new and permanent jobs in public services on cleaning, collection, logistics and landfill. When introducing separate collection, separation and composting an extra 500 jobs can be expected. Indirect positive effects on the economy and on employment can be expected from boosted tourism as a result of the improved attractiveness of the Regencies.

6.7 A roadmap

A possible roadmap for a program as described in this chapter could show timelines as illustrated below.
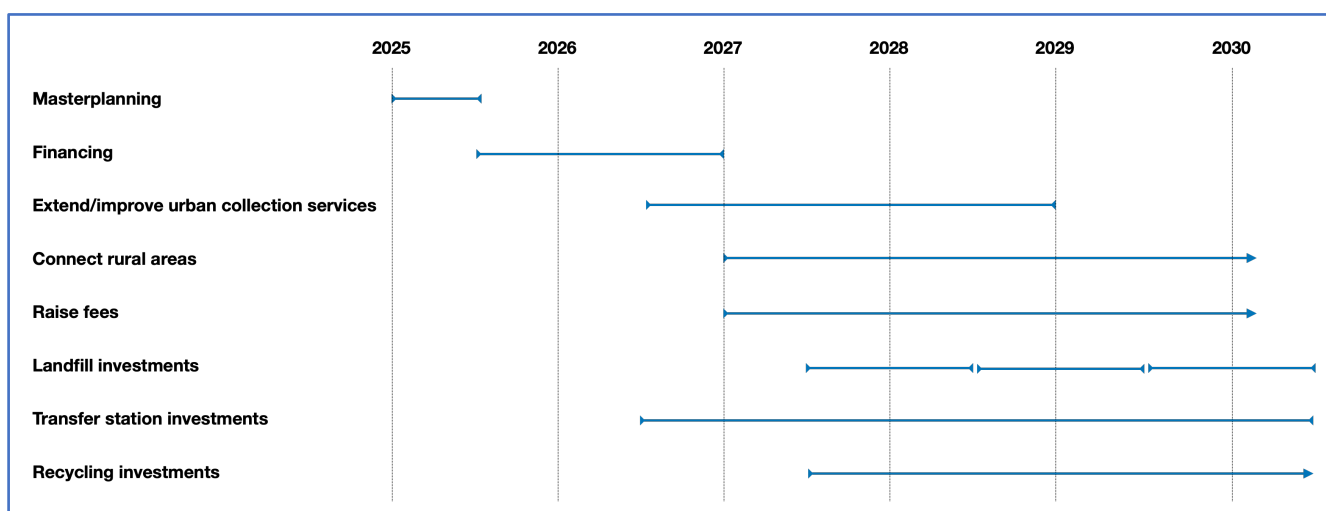

FIGURE 20. TIMELINE OF ROADMAP

It shows that, after master-planning in 2025, designing and financial close could be achieved by the end of 2027. Already in 2026, the regencies could start with extending and improving their collection services in the urban areas and connection of the rural areas could follow in the period 2027-2030. The construction of the three landfills and needed transfer stations could start by the end of 2026 and be finalized by 2030. Parallel to this, the preparation and implementation of full cost coverage can be rolled out with a time horizon until 2030.

7. Conclusions

Based on this situation analysis, the following conclusions can be drawn:

- Flores produces around 350.000 tons per year. Approximately 56% of this quantity can be qualified as unmanaged. This means that almost 200.000 tons of waste are littered, burned, buried or dumped.

- The percentage of reuse/recycling is at 42%, mainly due to direct reuse of a large part of the organic waste as animal feed in the households or its direct vicinity.

- Only 16% of the population has access to waste collection and service levels are low.

- Citizens and regencies seem to be in a deadlocked relation. Services are absent or insufficient so people are reluctant to pay. As a result, regencies have little to no income from waste retributions. The general budget from the regencies is mostly insufficient to provide the yearly money needed for the provision on these services.

- Because of considerations on finances, scale and logistics, the 8 regencies should work together and decide on a shared system of waste management infrastructure and services.

- Only in this way, the island can set up a sustainable and affordable backbone of collection, transfer, landfills and recycling.

- Investments for such a backbone would need 1,3 billion IDR and an additional 0,5 billion IDR to bridge the period for reaching full cost coverage through waste management retributions.

- In the case these retributions would have to cover all investments and operational expenses, an average household would pay 470.000 IDR per year. In case Flores is able to find a source for granting the investments, this retribution would go down to around 210.000 IDR. Overall, these retributions are affordable.

- The system described in this report could be implemented within 5 years.

Annex 1. Overview of meetings, visits and events

Date	Event	Location	Attendees
9 September	Site visits to landfill, waste incineration plant and services facility near Labuan Bajo.	West Manggarai regency	• Team members[33] • IWP/Adupi • Representatives of the Regency of West Manggarai
10 September	Training on waste management, situation analysis and master-planning	IWP learning center, Labuan Bajo	• Team members • Service Office of Environment and Forestry • district government • tourism office • education office • village governments • Environmental NGOs • Regional Development Planning Agency • recycling business • Inspectorate of West Manggarai district
10 September	Meeting with member of parliament in Ende Regency	Labuan Bajo	• Team members • IWP • Member of parliament Ende
11 September	Field visit to Komodo national park	Komodo islands	• Team members • IWP
12 September	Meeting with the Waste management department of Ende regency	Ende	• Team members • Management of the department • Service Office of Environment and Forestry • Acil (waste bank community).
13 September	Training on waste management, situation analysis and master-planning in Sikka regency.	University Nusa Nipa, Maumere	• Team members • IWP • Universities • Service Office of Environment and Forestry • district government • tourism office • village governments • environmental NGOs • recycling business • sub-district head • regional revenue agency • Mahasiswa pecinta alam/Mapala Unipa Maumere (Unipala)
13 September	Site visit to recycling plant of UD Sumber Plastik	Maumere	• Team members • IWP
14 September	Field visit to Pemana island and its two villages. Meeting with Regency-official and village representatives.	Pemana island	• Team members • IWP • village governments • Environmental NGO • village community • press • Universities
15 September	Field visit to dumpsite of Sikka regency. Field visit to the fishermen village Wuring	Maumere	• Team members • IWP

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[33] For team members, see page 5

16 September	Meeting with Mrs. Laura Kola of Sustainable Solutions	Moni	• Team members • Sustainable Solutions
17 September	Meeting with the Waste management department of Ende regency	Regency offices Mbay	• Team members, • WP • regional secretary • Service Office of Environment and Forestry • vice regent.
17 September	Training on waste management, situation analysis and master-planning in Nagekeo regency.	Regency offices Mbay	• Team members • Service Office of Environment and Forestry • Regional Development Planning and Budgeting • University • village governments • district government • tourism office • health department • Communities • environmental NGOs.
17 September	Field visit to Mbay delta and beaches	Mbay	• Team members
17 September	Meeting and dinner with the Bupati of Nagekeo, mr. Raimundus Nggajo	Bupati residency	• Team members • IWP • Bupati Nagekeo • Tourism office.
19 September	Preparations for workshop of 19 September	Labuan Bajo	• Team members
20 September	Hybrid workshop on first findings	Labuan Bajo	• Team members • Service Office of Environment and Forestry • village governments • tourism office • health department • education office • recycling business • communities • environmental NGOs.
27 September	Online meeting with Dutch Embassy and KLHK	Online	• Team members • Dutch Embassy • KLHK