

Regional reports on actual waste management situation – Campomarino and Ist

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1 General framework of waste management in Croatia

This Deliverable represents the baseline – report for the involved territories, provided in the framework of WP3, in order to have a clear figure of the actual situation on waste collection and management in terms of strengths, weaknesses, opportunities and threats, as a powerful tool for any future plans and interventions.

Existing data collection in targeted territories is carried out through the knowledge of waste management both at national and at local level.

The knowledge of waste management is aimed at getting a starting baseline and obtaining the following essential information:

- 1) The institutions in charge of waste collection;
- 2) The treatment plants (management companies, capacity in terms of t/y, location, typology of treatment);
- 3) Produced and treated waste quantities (overall, i.e. municipal mixed waste and more specifically from organic/food/kitchen, garden and plastic packaging)

2 General framework of waste management in Croatia

Information was taken from the 3 documents:

- 1) Decision on the adoption of the Waste management plan of the Republic of Croatia for the period 2017-2022 (OG No. 3/17) available at the website : <https://www.mzoip.hr/en/waste/strategies-plans-and-programmes.html>
- 2) Waste management in Croatia: Factsheet, available at the website: http://ec.europa.eu/environment/waste/framework/pdf/facsheets%20and%20roadmaps/Factsheet_Croatia.pdf

- 3) Answers provided by Čistoća to a questionnaire prepared by ENEA (mr. Lorenzo Cafiero) and DRIOPE (ms. Vanja Lipovac)

2.1 Population, surface, waste production and composition

According to a census (2001) shown in [1], general statistical data concerning Croatia are reported in Table 1:

Table 1. - Croatia general statistical data [1]

Surface territory	57000 km ²
Inhabitants	4437000
N° households	1477000

The last data about waste production and management go back to 2015 [1]. Municipal waste production amounts to 1653918 tonnes, or 386 kilogrammes per capita. A slight but not meaningful inconsistency by comparing waste per capita production with data reported in Table 1, can be noted, given that these data are referred to different years. Figure 1 describes the annual municipal waste production since 1995 (source: Croatian Agency for the Environment and Nature (hereinafter: CAEN)) from which one can observe that starting from 2008 this datum has stabilised around 1.6 Mt y⁻¹.

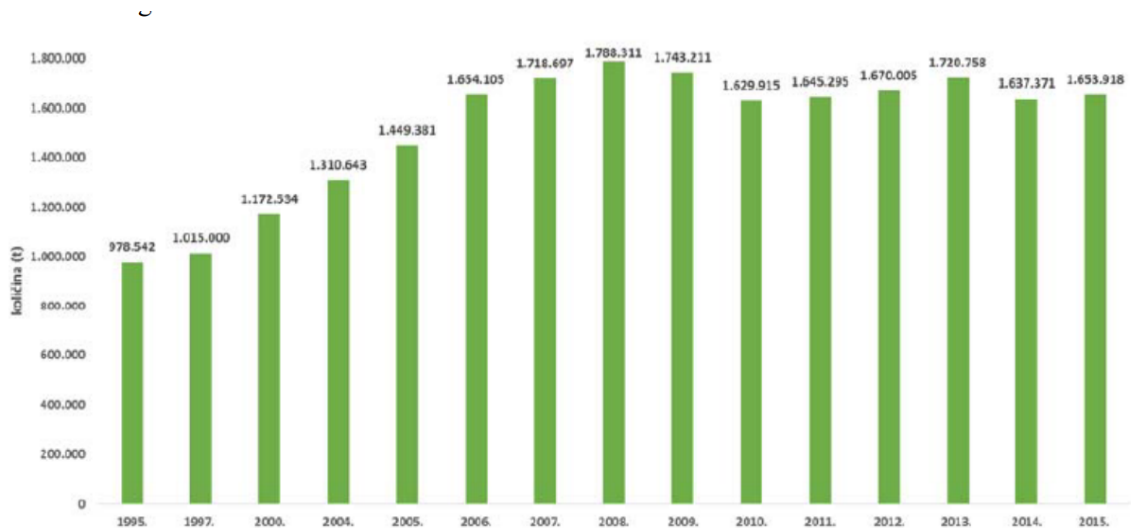


Figure 1 – Yearly municipal waste production since 1995 (source: CAEN)

The waste per capita production is strongly dependent from the province. Touristic territories show higher values than the national average. Zadarska province has a 640 kg in^{-1} and Splitsko-dalamska, 542 kg in^{-1} as one can see from figure 2.

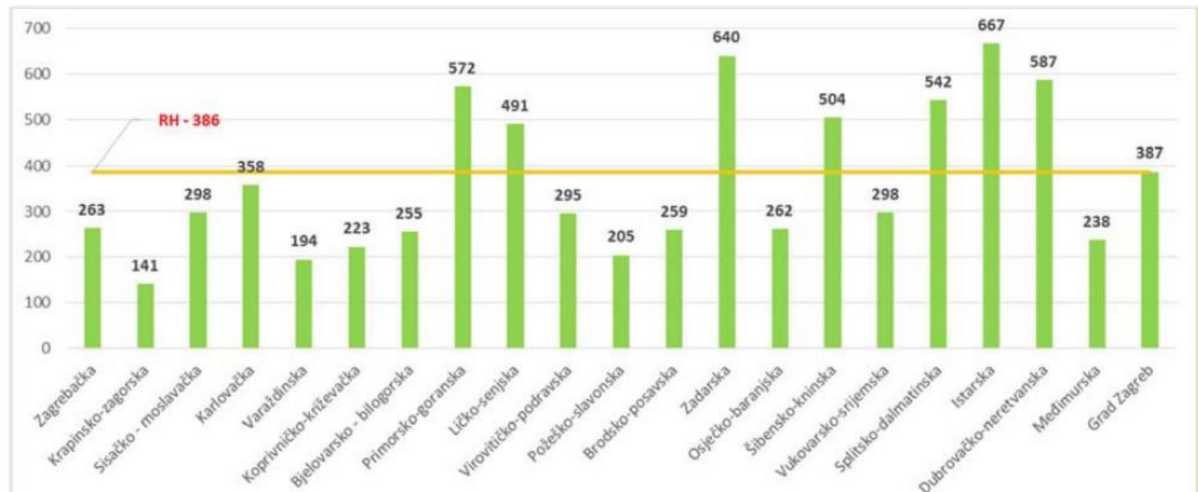


Figure 2 – Municipal waste production per capita referred to the various counties in 2015 (source: CAEN)

The estimated municipal waste composition is reported in Table 2.

Table 2. – Estimated municipal waste composition [1]

Waste category	Percentage (%)
Metals	2.1
Wood	1.0
Textile/clothing	3.7
Paper and cardboard	23.2
Glass	3.7
Plastic	22.9
Gum	0.2
Skin/bones	0.5
Kitchen waste	30.9
Garden waste	5.7

Other waste (soil, dust, sand, undefined)	6.3
Total	100

Source: CAEN

One can observe that overall biowaste (kitchen, yard) represents the largest fraction followed by paper and plastic which come from packaging.

2.2 Waste collection organisation

According to the Croatian Factsheet [2], municipalities (in legal terms, usually referred to as ‘local self government units’, hereinafter LSGUs) are responsible for waste collection. This is also confirmed by Čistoća. Waste collection is physically performed by companies owned by the Municipality. These companies are competent to set fees for their services, and also collect them. Fees are usually dependent on the size of waste containers and the frequency of their collection. € 7 per month for a household is a typical fee level for collection and management of municipal waste. In the Ist island which has been foreseen as location for the pilot action, residents are given 80, 120 or 240 containers for municipal mixed waste.

Separate waste collection concerning just municipal waste [1] concerns the following categories: plastics, paper and cardboard, metal and glass. In particular, a very efficient refund scheme concerning PET beverage containers exists since 2006. It applies for volumes > 0.2 l and amounts to 0.5 kuna (= ca. €0.07). A return rate of bottles is given as 94%, with more than 70% of the returned bottles being PET.

According to the Croatian Factsheet [2] there is no legislation covering the introduction of separate collection for biowaste. However, the Croatian waste management plan [1] reported pilot experiences of biowaste separate collection in a few areas of the country which were organised by 96 municipalities or LSGUs.

In table 3 a list of “environmental contribution fees” established for each waste category in the framework of Extended Responsibility Producer (ERP) schemes is reported.

Table 3. – Environmental contribution fees paid by the consumer for each category originating from packaging waste and belonging to ERP schemes (€ t⁻¹)

Material		Charge per t (ca.)
PET		€ 54
Aluminium cans		€ 54
Iron cans		€ 30
Paper, cardboard		€ 50
Multi-layered packaging with dominant paper/cardboard component	For beverages:	€ 54
	For other purposes:	€ 99
Plastic bags		€ 198
Wood		€ 20
Textile		€ 20
Other polymer materials		€ 99
Glass		€ 20

Source: Croatian Factsheet [2]

Other ERP schemes are forecast for End of Life Vehicles, WEEE, waste oils, waste tyres, and waste batteries / accumulators, asbestos and C&D Waste. The only category which results to be excluded by ERP schemes is biowaste. This circumstance appears as much remarkable as it represents the largest fraction in the municipal waste composition. This is one of the main reasons why no separate collection for biowaste (apart from some pilot experiences) is established.

While separate waste collection is locally managed by LSGUs, ERP schemes have been set up by a state institution named “Environmental Protection and Energy Efficiency Fund” (hereinafter EPEEF). The EPEEF is responsible for the realisation of all recycling and waste treatment infrastructures in the country.

2.3 Waste treatment

Table 3 reports a list of the main waste treatment options linked to the waste categories.

Table 4. – Waste treatment options

Waste treatment option	Waste category
Landfill	Municipal mixed waste
Recycling (recycling yards distributed in various localities in the country)	Plastic, Paper, metals, glass packaging from separate collection
Mechanical and biological treatment (in waste management centres in various localities)	Municipal mixed waste
Incineration with and without energy recovery	
Composting facilities	Biowaste from separate collection

The fate of the main streams of municipal waste categories is described in Table 5.

Table 5. – Fate of the main municipal waste streams referred to year 2015

Waste categories envoyed to various treatments	Quantities (t)	Percentages (referred to municipal waste production)
<i>WASTE COLLECTION</i>		
Municipal waste production	1653000	100%
Collected municipal mixed waste	1263000	76%
Separately collected municipal waste (paper, glass, plastic, metal)	391000	24%
<i>WASTE TREATMENT</i>		
Landfilling	1318000	80%
Temporary depositing	33000	2%
Material recovery	298000	18%
Energy recovery	288	0.02%
Incineration without energy recovery	56	0.003%

<i>RECOVERY</i>		
Material (metals, plastics, paper, glass, ...)	255000	15%
Mechanical biological treatment	8800	0.5%
Anaerobic digestion	5600	0.3%
Composting	27432	1.7%

Elaboration from waste management plan [1]

Examining Table 5, one can see that the practice of landfilling is still the main option for waste treatment. In order to improve the fraction destined to material recovery, biowaste collection and material recovery through composting and anaerobic digestion has to be promoted.

2.3.1 Infrastructures

Given the figures above, an analysis of waste management infrastructures highlights that facilities for composting and waste packaging materials are present in the country.

Regarding composting facilities, a geographical distribution of is reported in the following map (Figure 3). The overall composting infrastructure consists of 11 facilities and it is possible to observe that most of them are located in the north and north east counties, thus far from the Dalmatian archipelagos. The closest one is Perusic plant, 65 km as the crow flies and 155 km through the public road network.

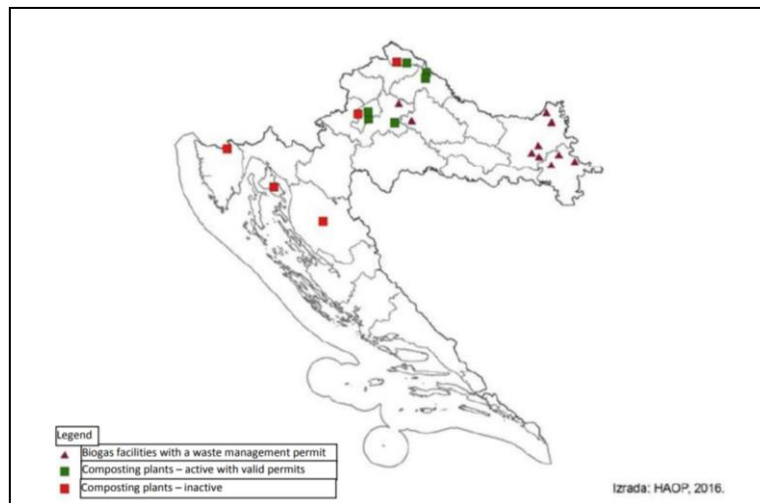


Figure 3 – Composting facilities distribution in Croatia

For what concerns infrastructures for preparation to recycling, named “recycling yard”, they consist of supervised fenced areas intended for separate collection and temporary storage of smaller quantities of special types of waste (e.g. waste paper, metal, glass, plastic, textile, bulky waste, edible oils and fats, detergents, paints, medicine, EE waste, batteries and accumulators, construction waste from smaller household repairs etc.). The country has 84 recycling yards and Zadar possesses three recycling yards. A complete distribution in the geographical area is represented in the map of **Pogreška! Izvor reference nije pronađen.**

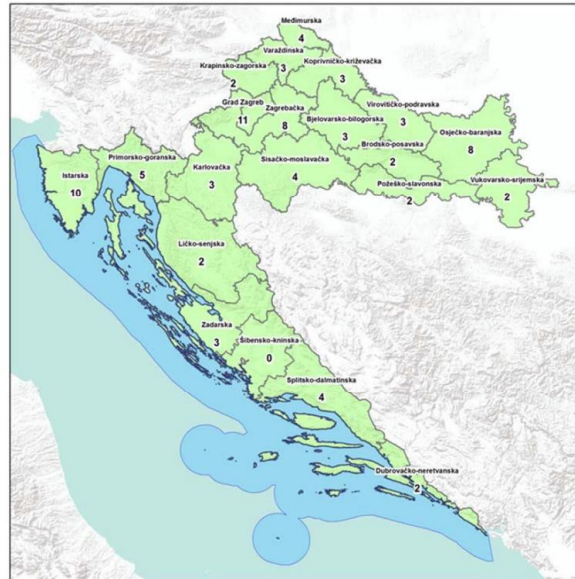


Figure 4 – Recycling yards distribution

3 Existing data of the Croatian targeted territory in Croatia

3.1 Geographical aspects

The pilot experience will be carried out in the Dalmatian island of Ist, in the center-northern area of the archipelago, as one can see from Figure 5.

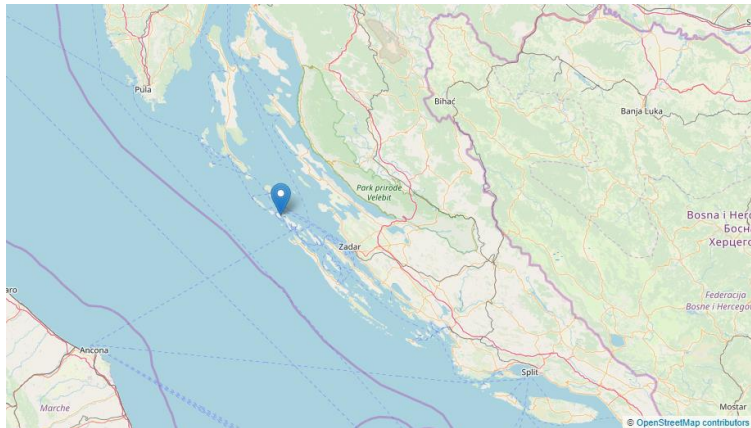


Figure 5 – Position of Ist island in the Dalmatian archipelago

The island has barely 250 inhabitants but its population does sensitively increase on summer because of the tourists number. There are hills, olive groves and vineyards in its interior. Ist is provided with sandy beaches, bays and sandbanks and offers to tourist activities of sports fishing, diving and nautical ones. Anchorage is available in the Mljaka bay where guests are offered accommodation in private holiday houses. Therefore, no large touristic infrastructures (hotels, campsites, restaurants) are present in the island.



Figure 6 – A satellite image of Ist Island where the residential area is shown.

3.2 Stakeholders

Main stakeholders in the island are ČISTOĆA and the harbor authority at Mljaka bay. This last one is a very important touristic infrastructure which is in charge to receive tourists of nautical activities. Accommodation instead, is managed by small bed and breakfasts available in complementary businesses, mostly houses.

As targeted territory for the pilot action, Ist island offers the following benefits:

- 1) ČISTOĆA manages its own infrastructures;
- 2) ČISTOĆA organizes a waste collection based on a door-to-door system;
- 3) a well-equipped harbor for touristic boats is operating.

Moreover, given that the area owned by ČISTOĆA was once a military base, the infrastructure is provided with electric power, water network, and other various services.

3.3 Waste management

Waste management activity consists of waste separate collection and temporary waste deposit. No treatment plants are present in the island. All waste categories are transferred by ship travels to the continent. Waste management is in charge to ČISTOĆA.

3.3.1 Waste collection

Waste collection concerns following waste categories: plastic packaging (EWC 150102), paper and cardboard (EWC 200101) bulky waste (EWC 200307), unsorted waste (EWC 200301). Residents are provided with 80, 120 and 240 L plastic containers and also with dedicated bags for paper and plastic collection, blue one for paper and a yellow bag for plastic. Collection frequency occurs twice on a weekly basis and is carried out by a Čistoća d.o.o. employee. Collected wastes are taken to a deposit station on the island where they are stored in press containers and thus prepared for transport to mainland via a ship concessionaire. Waste is temporarily stored at the transshipping station on the island until the container is filled, and then transported to the mainland. As part of the public service, bulky waste collection is also provided to service users.

A mobile recycling yard is brought to the island once a year for collecting special categories of waste. The transport of mixed municipal waste from the doorstep is carried out with “Piaggio” trucks with a total load capacity of 3.5 t and an average consumption of 7.5 l per 100 km. The average distance travelled by trucks to the collection points is approximately 10 km. Inhabitants of Ist are also provided with composters for composting biodegradable waste in their own garden. Despite this, it emerged that people prefer to deliver their biowaste to an equipped temporary deposit licensed by Čistoća. In this case, residents are provided with plastic containers of 120 l capacity for waste collection. It also emerged that, as an alternative to composting, often people choose to use kitchen waste as food for animals. This last practice can be considered as analogous to autocomposting and the project can propose a tax reduction also for residents who treat their kitchen waste in this way. This will be the object of a change in the rules for tax collection activity.

The temporary waste deposit (or “reloading station”) is equipped with the following containers:

- Retractable container (Rolo) - capacity 30 m³ (3 pcs)
- Compression container - capacity 20 m³ (2 pcs)
- Metallic container – capacity 7 m³ (3 pcs)

The average life of the container is 8 years.

The waste transfer from Ist island to the continent occurs in the following way. For the waste pickup on Ist Island container hookloader “Abrol Kiper” is used with a total load capacity of 26 t and an average consumption of 32 l per 100 km and an automatic container-lifter with a total capacity of 18 t with an average consumption of 26 l per 100 km. The number of planned trips by the ship's concessionaire is 11 times a year, and the distance traveled by the ship on each trip is 65 km.

3.3.2 Waste treatment

All separately collected waste is handed over to authorized collectors, who further submit it for recycling or further treatment, depending on the type of waste that is collected by the collectors. The unsorted (mixed) municipal waste and bulky waste is disposed of at the official “Diklo” landfill in Zadar, where it is disposed of at the landfill body. There is no landfill gas collection system at the landfill, only gas evaporation wells. Recycling facilities for the separately collected fraction lay in the continent, even if not at Diklo or in Zadar territory.

3.3.3 Waste production

Waste production represented by all collected waste categories is reported in the following Table 5. By examining data, one observes that unsorted waste has a very high percentage and no biowaste is separately collected. Given this evidence the strategic aim of the project, which is to try to lower the fraction of unsorted waste by effectively valorising both kitchen and yard waste and reducing the waste ship trips to the mainland, emerge as particularly strategic for the territory.

Table 5. – Waste production in Ist island referred to 2018

Waste category (European waste catalogue number)	Production referred to 2018 (t/y)	Waste category distribution
Mixed municipal waste (200301)	131	75%
Plastic packaging (150102)	4.28	2%
Bulky waste (200307)	38.66	22%
Paper and cardboard (200101)	1.42	1%
Total	175.36	

3.3.4 Costs

Waste collection is a public service and it is fully public. The state does not participate in the co-financing of the separate collection of waste.

Yearly waste management costs are the following:

- Waste collection cost, which is a variable cost, amount to 26,700 € (200,000 HRK)
- Maintenance costs for waste transport vehicles amount to 4,000 € (30,000 HRK)
- Personnel costs which are attributed to salaries amount to 11,000 € (85,000 HRK).

If we refer the total cost (47,000 €) to the number of residents, we obtain a specific cost of 167 €/inh., which appear very high for such a small island without industrial activities. These costs are mainly due to the waste transport to the mainland and to the excessive amount of mixed waste. This fraction can be lowered by the contribution of small scale composting practices subtracting the biowaste fraction. The specific cost referred to 1 ton of the MSW production is 238 €.

4 General framework of waste management in Italy

Municipal waste production, according to Italian National Agency for Environment Protection amounts to 29.59 Mt in 2017. Detail are reported in the Figure 7 hereinafter.

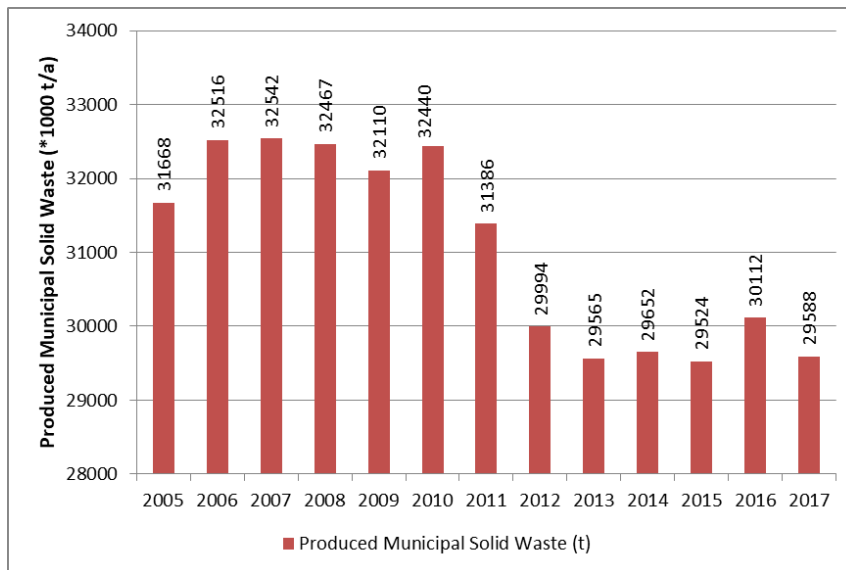


Figure 7 – Municipal solid waste production in Italy in the years 2005-2017

One can observe that Municipal solid waste production in Italy experienced a rapid decrease from 2010-11 to 2012 because of the economical crisis dated back to 2008. The amount of MSW destined to the various management options is represented in Figure 8.

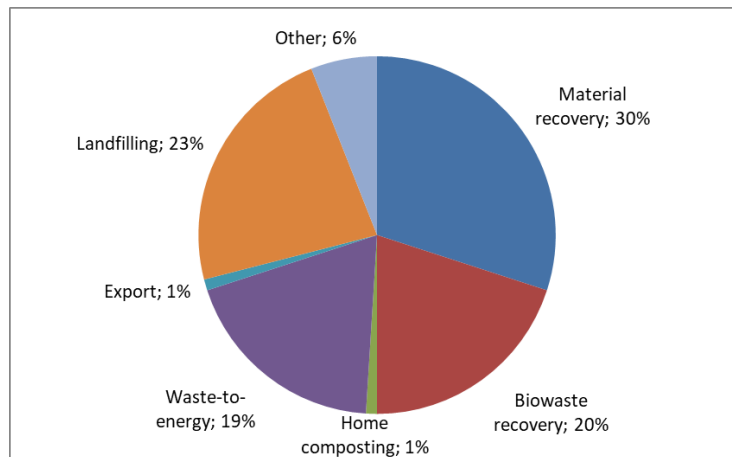


Figure 8 – Fate of the waste among the different waste management options in Italy, 2017

Waste separate collection in Italy achieved 55% overall in 2017. However, the national target foresees a national objective equal to 65% by 2012. Figure 9 shows the detail of waste separate collection by the main waste categories. The collection of the organic fraction performs a satisfactory result because it is estimated to cover at least 80% of the total potential production. Plastics instead, does not manage to achieve 50% with respect to the quantity of input on the market, because of the very strict requirements of the recycling conditions, the strong heterogeneity of the polymeric composition, and waste plastics contamination.

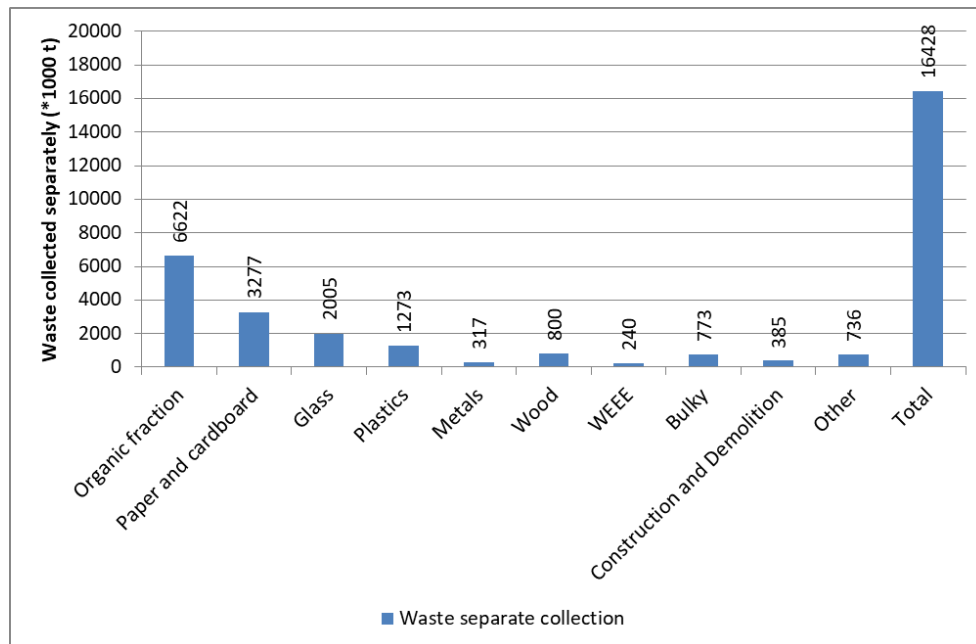


Figure 9 – Separate collection data in Italy, 2017 . “Other” category encompasses a series of waste minor typologies, such as: medicines, fat oils, waste deriving from street sweeping and destined to material recovery facilities, solvents, inks, paints

Packaging waste collection and treatment is organized by packaging producers through the mechanism of the Extended Responsibility Producer principle; mixed and organic waste management is paid by the State. Facilities installed for waste treatment are distributed in the following way:

- Composting: 285 facilities performing an input capacities of 6.12 Mt/y;
- Aerobic-anaerobic digesters: 31 facilities, performing an input capacity of 2.93 Mt/y;
- Waste-to-energy: 49 facilities performing an input capacity of 6.11 Mt/y;
- Mechanical biological treatment facilities: 130 facilities, performing an input capacity of 17.65 Mt/y.

5 Existing data of the Italian targeted territory in Italy

5.1 Geographical aspects

The situation of the Italian targeted territory is being collected through questionnaires. In this section a first group of answers provided by the municipality of Campomarino is reported.

The municipality of Campomarino is set in the Adriatic coast in centre Italy. Its territory covers a surface of 76 km² and has a population of 8,000 inhabitants.

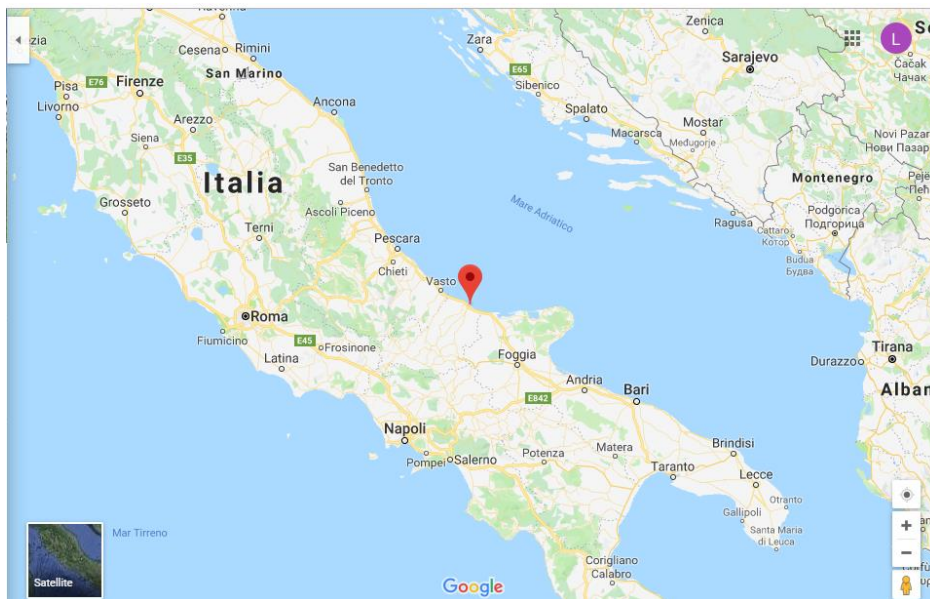
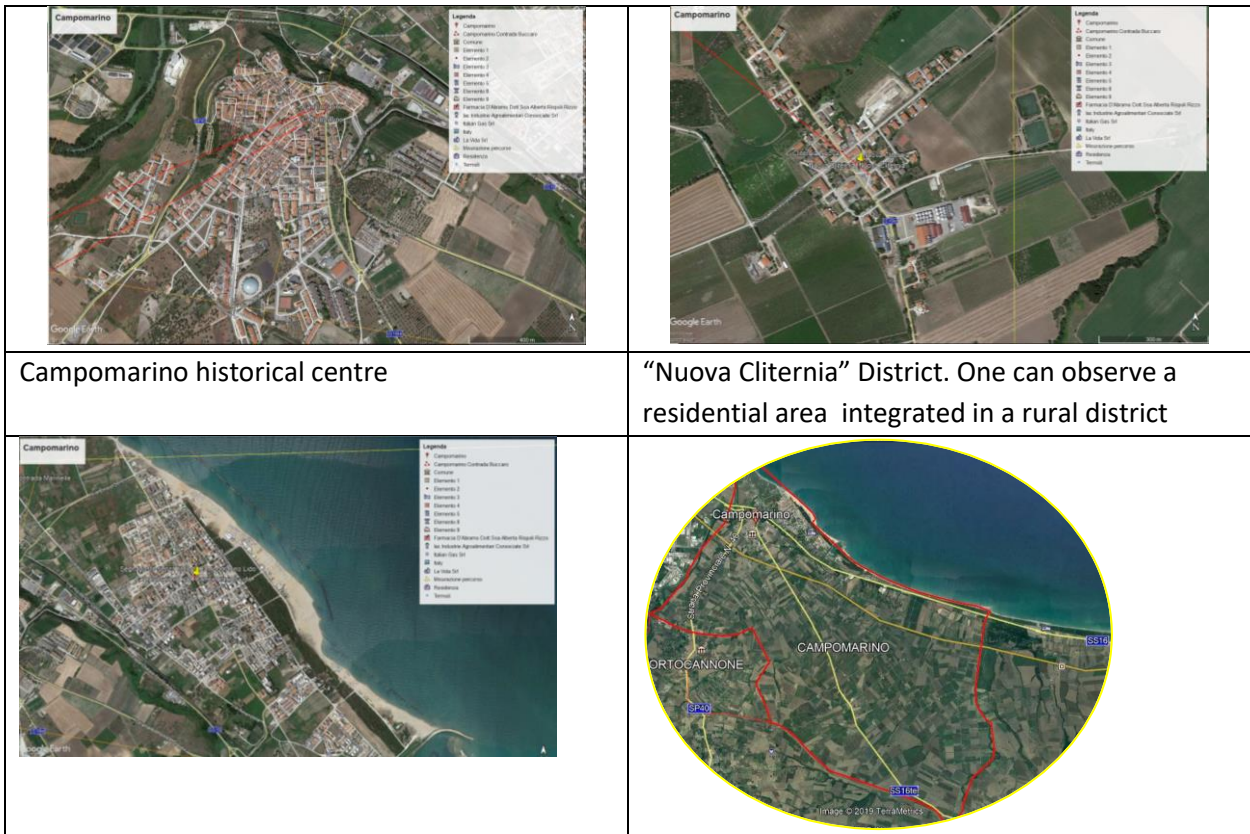


Figure 10 – Position of Campomarino in the Italy map

The territory of Campomarino Municipality is made up of the following districts: Campomarino Centro which encompasses the historic centre of the old village, Nuova Cliternia which lays in the east southern part and gathers settlements of farmers and residential consortia in a rural area, Coccioleto which lays in a western part and is a rural area, Ramitelli, Buccaro, Cianaluca, which are rural areas in the north western part, Campomarino Lido which is a seaside and the most important tourist district where all campsites and most important hotels are placed.



Campomarino historical centre

“Nuova Cliternia” District. One can observe a residential area integrated in a rural district

Campomarino Lido. The touristic district	Campomarino territory
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Figure 11 – The most significant Campomarino districts

5.2 Stakeholders

5.2.1 Schools

A survey of the stakeholders composed by touristic infrastructures (Hotels, campsites, ...) schools has been carried out in order to investigate the most suitable subjects to be involved in the pilot action. First, a list of schools in the Campomarino territory was prepared and reported in Table 6. By a series of phone interviews schools were contacted in order to know which ones among them had: 1) the availability of catering services 2) a kitchen for the preparations of meals 3) a backyard with garden and horticulture activity suitable for compost utilization.

Table 6. – List of schools in Campomarino territory

Address	Number and age of pupils	Catering services
State Elementary School County Nuova Cliternia at Campomarino, tel . 0875 57186 and 0875 5736	Age of pupils: 6 – 11. Number of pupils: 48	No
State Elementary School "F. JOVINE" Via Favorita, 24, 86042 Campomarino CB tel. 0875 530797	Age of pupils: 6 – 11. Number of pupils: 142	
High Technical School ICS Campomarino, via Vincenzo Cuoco, 86042 Campomarino (CB) tel 0875 530986	Age of pupils: 14-19. Number of pupils: 218	

Public Kindergarten " AGAZZI "via Abruzzi, snc - 86042 Campomarino (cb) tel. 0875 539453	Age of pupils: 3 – 6 – Number of pupils: 112	yes, but it has not a kitchen where meals are prepared
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Public Kindergarten "Agazzi" has subcontracted for a year the catering services to a company settled in Termoli, 10 km north from Campomarino. This means that the only available kitchen waste are the residues from the single meals of the pupils but not the residues for the preparation of the meals. For just 112 pupils, it is possible to assume the installation of a manual composter, but not an electromechanical one.

5.2.2 Campsites

Campsites appear to be the most eligible touristic infrastructures to set off a composting activity because it is more probable to have ground available, catering services and can promote an involvement among its guests for environment protection actions. A list of main campsites settled in the Campomarino territory has been prepared. Taking into account air photographs, it has been possible to select those structures which have a more extended ground area available.

- **Residence Albadorata**, Via E. Vanoni, 318, 86042, Campomarino (CB);
- **Smeraldo Camping Village**, Via E. Vanoni, 5, 86042 Lido Campomarino, Campomarino (CB);
- **Camping La Pineta** Contrada Marinelle, 20A, 86042 Campomarino Lido (CB);
- **Camping Village Corrado**, Contrada Marinelle Nuove 22, 86042 Campomarino (CB);
- **Campeggio Marinelle**, Via Marinelle, 26, 86042 Campomarino (CB);
- **Villaggio Diomedea**, Contrada Marinelle Vecchie, 86042 Campomarino Lido (CB);
- **La laguna della Luna (camper resting area)** Contrada Marinelle, 86042 Campomarino (CB).
- Following campsites appear to have sufficient ground areas to arrange a composting activity: Camping Village Corrado, Smeraldo Camping Village and Camping La Pineta.

Following this first selection, a meeting with the technical department of the Campomarino Municipality and the Environment protection Councilor has been arranged in order to receive suggestions and tips. These subjects, in occasion of a meeting held at ENEA research centre of Casaccia (near Rome) on August the 2nd 2019, recommended to take contacts with “Camping Corrado Village” which showed its availability. This structure was visited by ENEA and GAL Molise technicians accompanied by technicians and politicians of Campomarino Municipality on the 19th of November 2019. The director manager of Camping Corrado listened to the proposal for the installation and management of 2-3 manual composter in his structure as a pilot action to be performed in the framework of the project. He agreed and explained that Camping Corrado was open all year long thanks to the catering service offered by the local restaurant. The restaurant personnel can be trained to conduct the composters which are supposed to be fed by the kitchen waste produced by the restaurant; bulking agent can be in turn supplied by the cleaning and maintenance of the green area of the campsite.

5.2.3 Restaurants

Restaurants have been considered those provided with a backyard where it would be admitted to carry out the composting activity. These restaurants can be farmhouses. In Campomarino territory there are the following farmhouses:

- **Agriturismo la Vaccareccia**, Via delle Vigne Nuove, 26, 86042 Campomarino (CB);
- **Agriturismo Casale Madonna Grande**, Via San Leo, 86042 Campomarino (CB).

However, they cannot be considered to install an electromechanical composter because they provide just up to 5 meals a day. Possibly they could be contacted to set off an autocomposting activity.

5.3 Waste management

Campomarino is part of a consortium of 10 municipalities, named “Alto Biferno”, which commonly organizes the waste management, and it is the Municipality characterized by the highest residential population (8074 inhabitants), and the fourth demographic density (105.3 inh./km²).

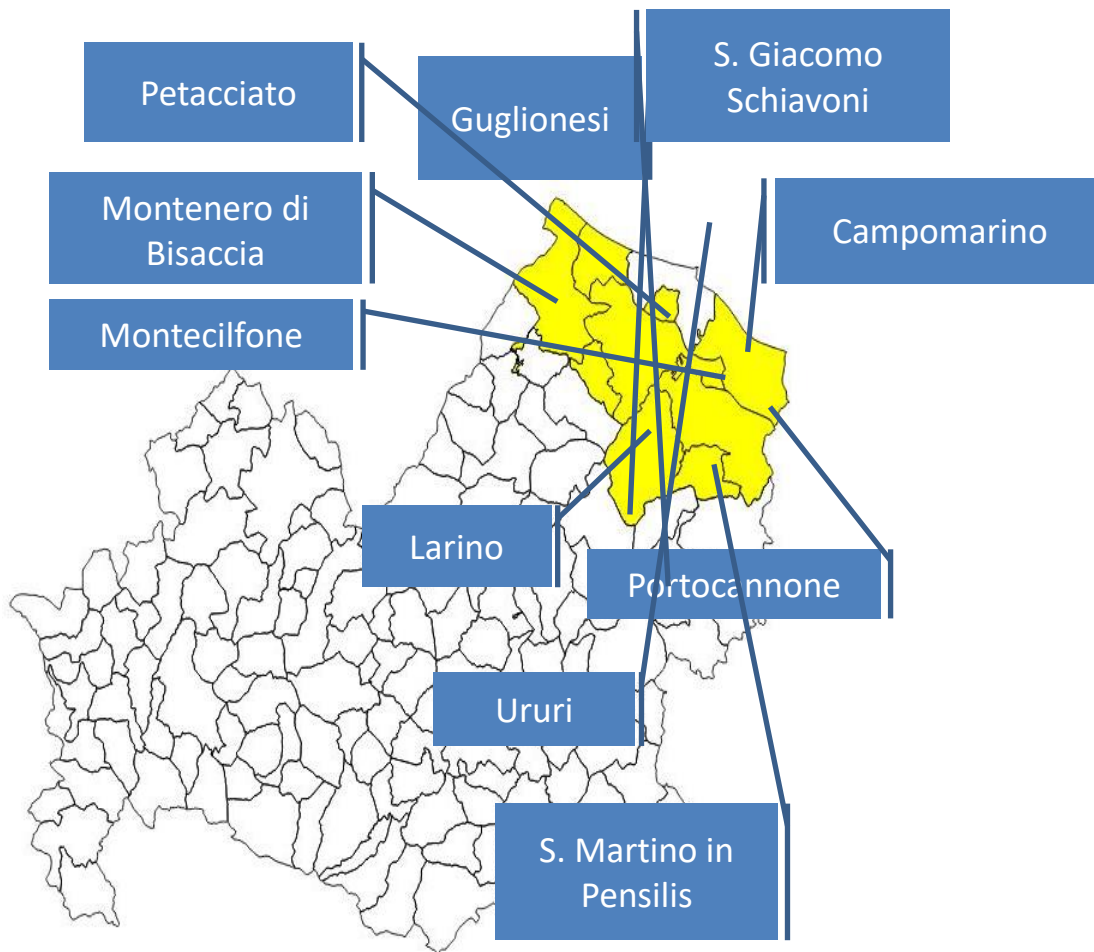


Figure 12 – Distribution of municipalities bound in a Consortium which takes in charge the waste management of the territory

Table 7.– Municipalities of Alto Biferno Consortium which share the waste management options

Municipality	Surface (km ²)	Population (n° of inhabitants, 2018)	Demographic density (n°inhab/km ²)
Campomarino	76.68	8074	105.3
Guglionesi	100.95	5246	52
Larino	88.77	6680	75.3
Montecilfone	22.92	1355	59.1
Montenero di Bisaccia	93.32	6612	70.9
Petacciato	35.4	3811	107.7
Portocannone	13.11	2490	189.9
San Giacomo degli Schiavoni	11.08	1406	126.9
San Martino in Pensilis	100.66	4752	47.2

5.3.1 Waste collection organisation

The waste collection in Campomarino is carried out using rigid containers located on public space, through a door-to-door system or with a mixed system, depending on the type of waste to be collected and the management methods adopted.

The following are the characteristics of the different methodologies applied.

a) Collection using rigid containers (bins, bells or other).

It is carried out using road containers. The waste must be delivered by the user in the containers, ~~where necessary~~ in closed bags suitable for use, possibly supplied by the operators of the waste collection company. The waste truck, according to a weekly schedule, provides to empty the road containers. In the seaside district of “Campomarino Lido, i.e. the touristic area that receives the highest number of tourists on Summer (touristic infrastructures encompasses hotels, campsites, restaurants), computerized road

containers provided with integrated access control system are installed since spring 2019 ” (see Figure 13). These containers are provided with slots (one for each waste category) which open when the user (the resident and the tourist as well) places near the slot his own health care assistance magnetic card. They operate just on summer, while in the other seasons the door-to-door scheme is valid. Roadside containers have a single volume of 1700-2200 l.

b) Collection through door-to-door system

Users are provided with bins of different colours, one for each waste category to be collected. These bins are deposited inside the user’s private property and the operators of the waste collection company provide to pick the bins upon a weekly basis. This system is valid in all rural districts (Nuova Cliternia is the largest one) and in the historical center. In such waste collection scheme, the waste collection company provides different users with appropriate bins:

- Apartment buildings: 5 bins with a volume of 25-35 l;
- Shops and commercial business: 5 containers with a volume of 120-240 l.

c) Waste collection though a system of ecological islands

An “ecological island” is a recycling area which allows the separate collection of various waste fractions, included bulky (furniture, mattresses,...) and WEEE wastes. It is a fenced area, accessible to users only at certain times and equipped with at least one employee.

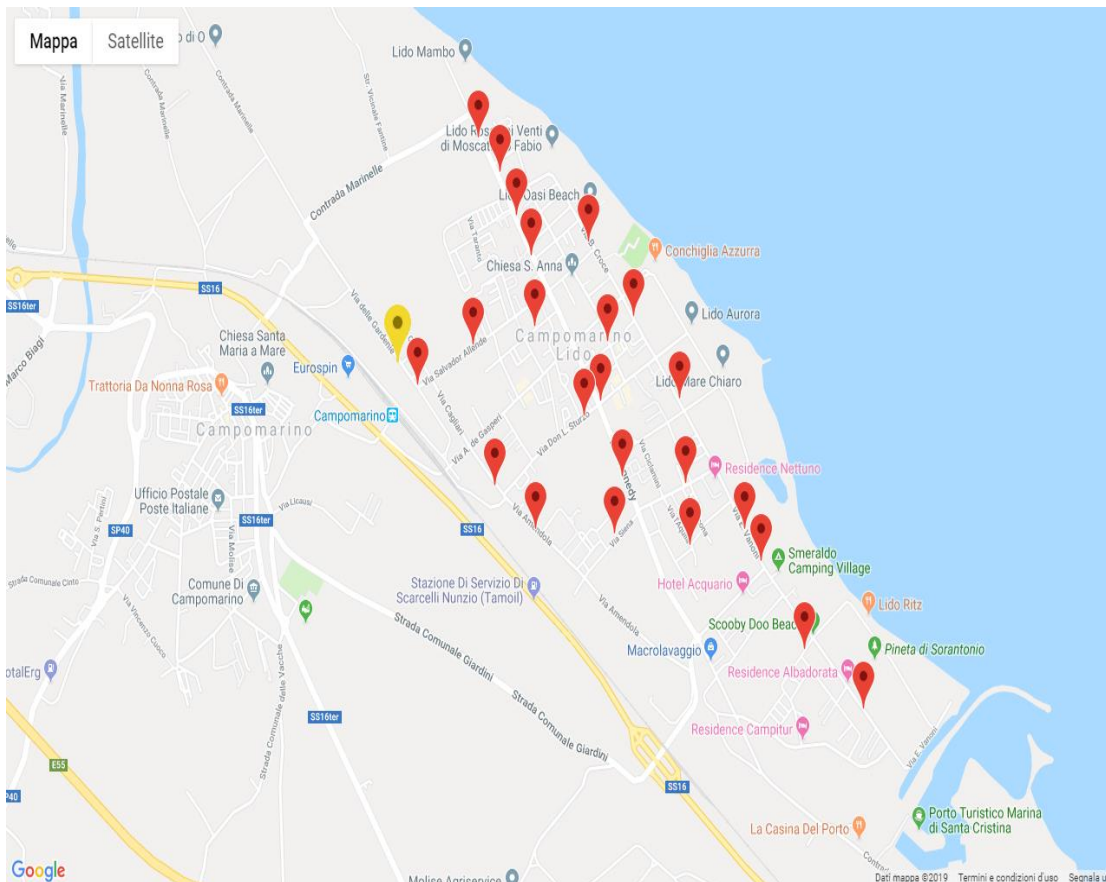


Figure 13 – Distribution of the computerized road containers in the touristic district area at Campomarino Lido

5.3.2 Waste treatment

Campomarino territory has a list of waste treatment facilities available. The Municipality subscribed various contracts with different companies (also in other counties and Italian Regions) where to transport

the collected waste. The following table reports for each waste category the typology of waste treatment, the related waste management company, the distances from Campomarino.

Table 8. – List of the waste treatment facilities where MSW waste in Campomarino are destined.

Waste category	European waste catalogue number	Treatment facility		input capacity (t/yr)	Distance from Campomarino (km)
kitchen waste	200108	Anaerobic digestion	FOGLIA UMBERTO - Digestione anaerobica di Guglionesi (CB)	21900	
yard waste	200201	Anaerobic digestion	FOGLIA UMBERTO - Digestione anaerobica di Guglionesi (CB)		
Paper and cardboard	200101	Material recovery facility	WEST MOLISE - Recupero di Termoli (CB)		7.8
Glass	150107	Material recovery facility	WEST MOLISE - Recupero di Termoli (CB)		7.8
Plastics	150102	Material recovery facility	WEST MOLISE - Recupero di Termoli (CB)		7.8
Metals	150104	Material recovery facility	EUROROTTAMI - Recupero, Stoccaggio di Campomarino (CB)		6.4
Plastics and metals	150106	Material recovery facility	Castelli Service -, ex C.D.C. di Carlo Di Clemente & C. -		33

			Recupero di San Salvo (CH)		
Bulky	200307	Material recovery facility	WEST MOLISE - Recupero di Termoli (CB)		7.8
Construction and demolition waste	170904	Material recovery facility	S. OIKOS – Fratelli Staniscia Recupero di Portocannone, Contrada Cocciolete (CB)		4.4
Waste electric and electronic equipment	several numbers	Material recovery facility	Ri.plastic S.p.A., Balvano (PZ)	30.000	217
Unsorted waste	200301	Landfill	FOGLIA UMBERTO - Discarica di Guglionesi (CB)		17
Roads cleaning waste	200303	Landfill	FOGLIA UMBERTO - Discarica di Guglionesi (CB)		17
Residues from wastewater treatment facilities	190805	Landfill	FOGLIA UMBERTO Srl- Discarica in loc. "Vallone Cupo" at Guglionesi Municipality (CB)		
Mixed packaging	150106	Material recovery facility	WEST MOLISE - Recupero di Termoli (CB)		7.8

The company in charge (up to 2018) to ensure the waste transportation service from Campomarino to the various treatment facilities was named TEKNEKO SISTEMI ECOLOGICI, Massa d'Albe (AQ). Since 2019 Giuliani Ambiente Company took over.

Characteristics of the treatment facilities

The reactor of anaerobic digestion is based on a dry type technology. Temperature conditions in the reactor are maintained within a range of 35-40 °C for a residence time of 15-30 days. Biogas composition is made up of methane (60-65%), CO₂ (35-40%) and impurities (1%) such as moisture, sulfidic acid, siloxanes, particulate matter. The anaerobic digestion facility is provided with a Jenbacher internal combustion engine which develops a power of 990 kWe. The biogas yield is 450 Nm³/h. The biogas has a minimum content of 55% of CH₄. The municipalities of Molise deliver less than 6.000 t/y of waste organic fractions to the anaerobic digester.

Gaseous emission should be subject to the concentration limits reported in Table 9 according to the operating authorisation.

Table 9. – Anaerobic digestion facility concentration limits

Parameter	Limit
PM 10 (1 hour sampling)	10 mg/Nm ³
Acid Chloride (1 hour sampling)	10 mg/Nm ³
Organic substances (TOC) (1 hour sampling)	150 mg/Nm ³
Acid fluoride (HF) (1 hour sampling)	2 mg/Nm ³
Nitrogen oxides (computed as NO ₂)	450 mg /Nm ³
Carbon monoxide	500 mg/Nm ³
Sulfur oxides	200 mg/Nm ³ (half hour average) 50 mg/Nm ³ (day average)
PCDD + PCDF Dioxins	0.1 ng/Nm ³ (8 hours sampling)
Polycyclic Aromatic Hydrocarbons	0.1 mg/Nm ³ (8 hours sampling)

Cd+Pb	0.05 mg/Nm ³ (1 hour sampling)
Hg	0.05 mg/Nm ³ (1 hour sampling)
Heavy metals	0.5 mg/Nm ³ (1 hour sampling)

Source: *Determinazione Dirigenziale n.333*, date: 06/12/2011

The landfill of Guglionesi has an input annual capacity of 37500 t/y and a daily input capacity of 250 t/d. The landfill is provided with a mechanical and biological treatment plant. The landfill was realised in the years 2007 – 2008 and the activity started in September 2009. The landfill has a volume of 508.410 m³. In 2015 the residual volume was equal to 179.626 m³ and expansion of more than 450.000 m³ was authorised. The captured landfill biogas is converted into energy by a cogeneration plant. Electric energy is produced by a Jenbacher internal combustion engine which develops a power of 625 kW.

Table 10. – Operating figures of the Waste treatment facility of anaerobic digestion in 2018

Input and output streams	Quantity (t)	Fate
Biowaste treated (CER 200108)	26.808 t	-
Biogas	3.665.885 Nm ³	-
Electric energy	5.665 MWh	-
Low Heating Value (computed) ¹	5.54 MJ/Nm ³	
Biogas specific production ²	136 Nm ³ /t	
Liquid digestate	9.258 t	wastewater treatment
Solid digestate	783 t	landfilling

¹ The low heating value has been estimated by dividing the electric energy produced in one year by the biogas generated.

² This specific biogas production has been estimated by dividing the electric energy produced by the biowaste treated.

5.3.3 Waste composition

MSW composition figure has been drawn from the results of an investigation carried out at the mechanical and biological treatment plant of the Province of Isernia in Molise Region. This investigation was carried out twice: the first sampling on the 13th September 2018 and the second sampling on the 26th February 2019. The sample taken into examination was unsorted or mixed waste which residues from waste separate collection.

Results are reported in Table 11.

Table 11. – MSW composition of unsorted waste fraction from urban waste separate collection in the Province of Isernia in Molise Region

Waste category	Average percentage	Standard deviation
kitchen waste	13%	0.018266
yard waste	8%	0.041385
metals	1%	0.011749
wood	2%	0.023492
paper and cardboard	32%	0.041842
plastics	26%	0.045429
glass	2%	0.005613
inert waste	0%	0
textiles and leather	5%	0.003392
urban dangerous waste (solvents, varnishes)	0%	0.0009
WEEE	0%	0
diapers	4%	0.035078
underscreens (< 20 mm)	6%	0.023057
others	0%	0.002606

Even if these figures are not strictly referred to Campomarino territory, they give us a useful indication about the effectiveness of separate collection. In fact, we note that there is still room for improvement for the following waste categories: biowaste (whether kitchen and yard), paper, plastics. This confirms that small scale composting can help intercepting a not negligible fraction of organic waste that currently ends up into unsorted (or mixed) waste. This result in some way has been recently confirmed by a sampling carried out at a Campsite where a catering service also in winter season is active in Campomarino Territory. This sampling was conducted in the frame of the actions within the NETWAP project. The sample was taken from the containers dedicated to the unsorted waste. In this case the result is not representative for all urban waste generated in Campomarino. This nevertheless informs us that small scale composting can solve biowaste management for touristic infrastructures of this typology.

Table 12. – Composition of the content of a roadside street container for unsorted (mixed) waste which is situated at a campsite provided with a catering service

Waste category	Quantity (kg)	Composition (wt%)
Organic fraction	69	58%
Aluminum	6.3	5%
Paper and cardboard	5.9	5%
Plastics	15.6	13%
Glass	3.7	3%
Mixed waste	12.7	11%
Screen “unders”	5.9	5%
Total	119.1	100%

5.3.4 Waste production

Given the residential population of Campomarino, which is around 8000 inhabitants, on summer population does sensitively increase. In particular, on summer 2017, 5020 arrivals, corresponding to 36354 tourists number, both Italian and foreign people, have been registered.

Waste management figures, dated back to 2018, show a MSW production equal to 4900 t. Such a production corresponds to a specific production of more than 600 kg/inh./y, which is far larger than the national average of 489 kg/inh./y.

In July and August, a MSW production of 2611 t/y is observed (about a half of the yearly production). Even if this quantity is greater than the monthly average, it is however far less than the one expectably considering the increase in tourists number.

Results from the separate waste collection of 2018 is reported in the following Table 13.

Table 13. – Results of waste separate collection in 2018

Waste category	European waste catalogue number	Quantity collected in 2018 (t)	Fraction with respect to overall MSW production (%)
Kitchen waste	200108	432	9%
Yard waste	200201	155	3%
Paper and cardboard	200101	152	3%
Glass	150107	129	3%
Plastics	150102	81	2%
Metals	150104	0.5	<1%
Plastics and metals	150106	0.44	<1%
Bulky	200307	138	3%
Construction and demolition waste	170904	3.2	<1%

Waste electric and electronic equipment	several numbers	-	-
Unsorted waste	200301	3754	77%
Roads cleaning waste	200303	43.67	1%
Residues from wastewater treatment facilities	190805	5.98	<1%
Mixed packaging	150106	0.44	<1%

Figures of Table 13 show that separate collection results achieved in 2018 were not yet satisfactory, because unsorted waste was by far the largest fraction (77%), while kitchen waste fraction was less than 10%. These results, however did not take into account the advantages brought by the installation of computerized road containers on summer to cope with the great number of tourist arrivals. In this regard, data collected from March 2019 to December 2019 (**Table 14**), even if incomplete, allow to understand preliminary effects of this specific intervention. In particular, it is worth noting a significant reduction of unsorted waste and a simultaneous increase in kitchen waste, and also an appreciable increase in the collection of glass and paper and cardboard.

Table 14. – Results of waste separate collection from March to December 2019

Waste category	European waste catalogue number	Quantity collected 2019/03 –12 (t)	Fraction with respect to overall MSW production (%)
Kitchen waste	200108	1011.78	33.0%

Yard waste	200201	121.7	4.0%
Paper and cardboard	200101	278.1	9.1%
Glass	150107	221.96	7.2%
Plastics	150102	64.65	2.1%
Metals	150104	11.46	0.4%
Plastics and metals	150106	254.08	8.3%
Bulky	200307	155.73	5.1%
Unsorted waste	200301	949.15	30.9%
Exhaust oils	200125	0.2	0.01%

5.3.5 Costs

Waste management costs encompasses 10 items, 6 of which are fixed costs and 4 are considered variable costs. Table reposts the detail of the expenses for Campomarino Municipality related to 2018. For some variable items, it was established to divide the amount by the specific quantity of treated waste in order to assess the specific cost incidence of every expense. Finally, the total waste management cost for 2018 was divided by the number of resident people in Campomarino.

Table 15. – Waste management costs

Number of resident people	8074	
Total amount of waste packaging separately collected (from Table 13)	500 t	
Amount of unsorted waste	3754 t	
Total MSW	4900 t	
Waste management cost, year 2018	Fixed fraction (€)	Variable fraction (€)

roads cleaning service cost	319825	
administrative cost	184237	
Personnel management cost	186000	
common costs	52663	
other operating management cost	14547	
capital usage cost	13576	
waste treatment and disposal		507996
waste collection and transport cost		311500
treatment and recycling cost to which earnings from the sale of separate waste categories are subtracted		38500
waste separate collection cost		180548
Total of fixed and variable costs	770848	1038544
Total waste management cost	1809392	
Some significant specific costs		
total annual waste management cost per inhabitant (€/in/yr)	224	
MBT and landfill cost (€/t)	135	
waste collection and transport cost (€/t)	64	
recycling and treatment cost (€/t)	76	

By examining **Table 15** one notes that fixed and variable costs are roughly identical. Cost reduction can be obtained by introducing improvements in the variable cost part.

One can observe that “waste treatment and disposal” is about 50% of the total variable costs. This cost can be strongly reduced by diverting organic waste fraction into small scale composting instead of landfilling or anaerobic digestion treatment which costs 135 € per each disposed waste ton. Moreover, waste collection and transport costs which represent 30% of variable costs can also be strongly reduced.

Municipal administration can exploit this saving by reducing the waste tax to his resident citizens. SWOT analysis

5.4 Target territory of Ist Island

	Helpful to achieving the objective	Harmful to achieving the objective
Internal origin (attributes of the organization)	<p><u>Strengths</u></p> <p>kitchen waste deliverance to animals is part of everyday life in Ist Island. This can be considered a home composting initiative already in operation.</p> <p>Local harbour authority can take over the organic waste delivered by touristic boats and promote a small scale composting initiative.</p>	<p><u>Weaknesses</u></p> <p>Landfilling is still the predominant option of waste disposal.</p> <p>Difficulty in the involvement of tourists who stay in a B&B and tend to dispose of their waste not separately.</p>

External origin (attributes of the organization)	<p><u>Opportunities</u></p> <p>A small territorial area combined with a very modest population number (ca. 250 residents) makes the territory the ideal site to promote a community spirit and start up the community composting</p>	<p><u>Threats</u></p> <p>Waste management in the Island is entrusted to just one employee. In order to guarantee the success of small composting initiatives, it is advisable to enforce the personnel with more two people so that to ensure the continuity of service.</p> <p>Distance of the island from the mainland and reduced accessibility of the island to ensure repair and maintenance operations of the electromechanical composter</p>
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5.5 Target territory of Campomarino

Helpful to achieving the objective	Harmful to achieving the objective
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<p style="writing-mode: vertical-rl; transform: rotate(180deg);">Internal origin (attributes of the organization)</p>	<p><u>Strengths</u></p> <p>presence of computerized road containers which: 1) achieve a very selective waste separate collection 2) allow waste traceability 3) is addressed both to residents and tourists.</p> <p>A structured waste separate collection organized in different schemes (door-to-door, road collection,...) in dependence of the served district and the season</p> <p>Good level of awareness in public administrators to promote an environmental policy to enhance small scale composting activities giving benefits to the citizenship</p>	<p><u>Weaknesses</u></p> <p>Burden some problems and delays connected to the local public administration: i.e., set up of local regulation procedures and permit release times to start up the local composting initiatives.</p> <p>lack of awareness of the population to respond to the initiatives connected to a new waste management policy which implies the resident's involvement.</p> <p>lack of quality of separately collected organic waste</p> <p>excessive organic matter percentage in residual mixed waste</p>
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