

2011 International Conference on Green Buildings and Sustainable Cities

Sustainable waste management criteria for local urban plans

Silvia Bamonti^{a*}, Alessandra Bonoli^a, Simona Tondelli^b

^aDept. of Civil, Environmental and Materials Engineering, Alma Mater Studiorum-University of Bologna, Bologna, 40136, Italy

^bDepartment of Architecture and Spatial Planning, Alma Mater Studiorum-University of Bologna, Bologna, 40136, Italy

Abstract

The paper illustrates a new approach to waste management aiming at developing strategies and actions to be integrated into municipal planning tools. The local structure plan has been recognized as the planning tool in which to integrate sustainability objectives in the field of waste management. The door-to-door waste collection has been selected as the best strategy for guaranteeing high standards of waste separate collection in the new developments and restoration areas in the Bologna municipality. Following, criteria for dimensioning the space to be reserved for waste collection, both at the apartment and at the block scale and at urban scale have been proposed to be acknowledged into the local building regulations. The proposed approach has been verified through the application to a local development plan in the Bologna municipality and its feasibility has been tested both under the technical and economic point of view.

© 2011 Published by Elsevier Ltd. Open access under [CC BY-NC-ND license](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Selection and/or peer-review under responsibility of APAAS

Keywords: sustainable waste management; urban planning; building standards

1. Introduction

This work aims at finding a match point between EU standards in sustainable waste management (dir. 2008/98/EC) and the field of actions of the local planning tools, with particular reference to the urban planning framework defined by Law 20/2000 in the Emilia-Romagna Region.

Waste management is a complex sector because it involves legislative (laws, rules, guidelines on management, responsibilities and competences), environmental (resources use and their optimal management), economic (reuse, disposal and tariff) and urban planning aspects. In Italy, the main urban areas are still far from achieving the EU targets (Dir. 2008/98EC), which foresee a minimum level of recycled material equal to 50% (corresponding with a separated collection for urban waste equal to 65%)

* Corresponding author. Tel.: +39 051 2093166.

E-mail addresses: silvia.bamonti@studio.unibo.it.

in 2012 and, for what concerns construction and demolition waste (C&D) a rate of recycle of material from demolition equal to 70% and the employment of at least the 30% of recycled materials in new constructions (Decree n. 203/2003).

At present, in Italy, the municipal level has no direct competences in the field of waste management and the lower scale in which a waste management tool is available is the Province, that draws a strategic plan defining objectives and management conditions for urban and special waste for the next ten years, according to efficiency, low costs and effectiveness criteria. To the contrary, we believe that part of the present criticalities in the Italian waste management system are due to the lack of a deep consideration of this theme in urban planning; in fact, the municipalities could have a fundamental role in the implementation of the policies defined at provincial level and, urban planning, through local plans and regulations, could give impulse to the enhancement of the separated collections and recovery performances.

The area of interest of this research is the Bologna Municipality, in the Emilia-Romagna Region; here, according to the regional town planning law (n. 20/2000), three main planning tools at the municipal level are available: the Piano Strutturale Comunale (PSC), i.e. a local structure plan which defines development conditions, long term objectives, and environmental restrictions; the Regolamento Urbanistico Edilizio (RUE), that contains the building rules and provides the urban design rules for the developed areas and for the rural areas; the Piano Operativo Comunale (POC), a detailed plan defining developments and public works to be implemented in the following five years. The POC in turn could be implemented through the Piano Urbanistico Attuativo (PUA), a local development plan defining the settlement layout.

The paper is articulated into 3 sections. In the first one, the sustainable waste management objectives for the municipal scale are defined; specific indicators and the relating targets have been proposed for being adopted into the municipality's structure plan in order to permit both the description of the present condition and the monitoring of the plan performances in achieving the sustainability targets which have been defined according to EU, national and provincial indications.

In the second part, the proposed objectives have been acknowledged into the RUE, where they have been articulated into parameters, rules and standards to be adopted into the building process in order to guarantee the achievement of the defined targets.

In the third part, the proposed approach has been verified through its application to a redevelopment area in Bologna. The proposed approach has been verified through the application to a local development plan in the Bologna municipality and its feasibility has been tested both under the technical and economic point of view. This application highlights the benefits of a preemptive approach in the field of waste management: by acting on the municipal urban planning tools, it is possible to obtain high levels of separated waste collection through providing adequate space both at the city, block and flat scale.

2. Objectives for sustainable waste management

Before selecting the objectives for sustainable waste management to be considered in the drawing of the PSC, the analysis of the present situation has been carried on. For this purpose, descriptive indicators have been selected (table 1) from the OECD and EEA core sets, which are based on criteria referring to policy relevance and utility, analytical soundness (indicators have to be theoretically well founded in technical and scientific terms) measurability (indicators have to be readily available or made available at a reasonable cost/benefit ratio; adequately documented and of known quality; updated at regular intervals in accordance with reliable procedures) [1].

Table 1. Selected indicators and their present value in Bologna

Indicators	Present value (2009)
Per capita year production	575 kg/year *inhab
% of separated wste collection	34 %
Construction and demolition waste production	600-700 kg/year *inhab
Construction and demolition waste recovery	~ 10% of the total produced waste
Wasted disposed in collective waste collection systems	3.029.363 kg (~ 4% of the total)
Organc waste Recycled	9.405.900 kg/year (~ 90% of the total collected compost heap)
Urban solid waste to be recycled	~ 78% of the separated waste + ~ 1% of the total not separated waste
Citizens Participation: n. of encounters	46
Citizens Participation: involved population	4.915 inhabitants (1-2% of the total population)
n. of collective waste collection systems	2
waste to be stored in landfills	26.539.636 kg (8% of the not separated waste)
Waste to be disposed by incineration	95.542.689 kg (72% of the not separated waste)

In Bologna, the per capita waste production in 2009 was of 575 kg/year*inhab, whilst the amount of separated waste collection was of 34% [2, 3]. The values are therefore far away from the EU standards, even if they are higher than the national average which is about the 27,5% [4]. With reference to the construction and demolition materials, the situation is even more critical, with only a 10% recovery [5]. Data highlight the need for a radical change in waste management strategies to be adopted at the municipal scale. First of all, this change can be undergone by means of integrating into the PSC new objectives for sustainable waste management that should be able to guarantee the national targets achievement (Decree n. 152/2006) and that should be oriented towards a sustainable approach.

Starting from the analysis of the objectives for sustainable waste management stated at European, National and Regional level, and taking into consideration the strategies defined by the Province Waste Management Plan, the relevant objectives for the municipal level have been selected (table 2). Every general objective has been articulated into specific objectives and, for each of them, indicators and targets have been defined.

The proposed sustainability objectives should be included into the local structure plan according to an integrated approach; in fact, the PSC doesn't deals directly with waste management, but it consists of a general plan addressing the strategies for the municipal territory for a medium-long period.

Door-to-door collection has been chosen as a management system for urban and assimilable waste. In fact, this system is coherent with the European strategies, which aim at avoiding the use of containers along the streets and at enhancing the adoption of containers to be placed into the buildings' private areas. According to this perspective, waste management fully fits into the local structure plan strategies, and in particular it deals with policies concerning urban quality, by means of providing criteria for locating and sizing collective waste collection systems (i.e. accessibility, identification, integration in the urban context, etc.).

For what concerns construction and demolition waste, aiming at enhancing and streamlining the treatment network, the local structure plan could provide minimum target of recycling in developments. Therefore, beyond requiring a specific storage in the building site for separate collection, the local plan should define within the municipal territory areas where to build treatment plants. Furthermore, it should enhance indoor and outdoor quality through the adoption of design strategies taking into account both microclimate and environmental factors and the use of EC labeled products (according to CPD -

Construction Product Directive n. 86/106 EC, that has been acknowledged in Italy through the Regulation DPR n. 246/1993 and the Decree n. 159/2003).

Table 2. Objectives, indicators and targets proposed for the Bologna PSC

GENERAL OBJECTIVES	SPECIFIC OBJECTIVES	INDICATORS	TARGETS
Separated waste collection improvement	Separated waste collection enhancement	Rate of separate collection	65%
		N. of community waste depots	4
		Rate of recovered materials	~50% of the total waste
	Recovery	Rate of urban waste stored into landfills	< 10%
	Stakeholders' participation increase	n. of involved inhabitants	>20%
		n. of actions to involve people (events, initiatives, etc.)	2times per year for each city community
reduction of the urban waste amount to be stored in landfills	Containment of waste flows to landfills	Rate of buildign materials obtained from raw materials	>30%
Reduction of the construction and demolition waste	Control of buildings materials and buildings techniques	Rate of EC labeled products	100%
		Rate of demolition materials used in new buildings	30%
		Rate recycled material from demolition	70%

Finally, the achievement of the sustainability goals in the field of waste management need a strong cooperation between all the involved actors: beyond the Municipality administration, also the Area Agencies, acting as coordinator for the waste management and water supply services on homogenous areas (Ambito Territoriale Ottimale, ATO) and the Provinces.

3. Regulations and parameters for buildings

The adoption of door-to-door waste collection for new developments and regeneration areas has to be implemented through the provision of suitable space for separate waste collection into the flats, blocks, and private areas. As a matter of fact, the proximity of the containers is a determining factor for achieving high rates of separated waste collection and the absence of space dedicated to this equipment could discourage the citizens' virtuous behaviors. The provision of adequate space, together with a proper charging, is therefore addressed as a tool for achieving the European in the field of separated waste collection. Therefore, a technique for dimensioning the dedicated space has been proposed in relation with the population trends in Bologna.

Starting from the population scenarios developed by the Local Authority into the PSC [6], the population maximum increase in 2025 (+ 5,9% from 2006) and the average composition of families (1,95 persons for each family, for a total of 201.550 families) have been calculated. For what concerns waste production, the average value of the period from 2006 and 2009 has been adopted for dimensioning the containers and the space necessary for the separate collection (table 3).

Table 3. Parameters adopted for the future scenario (2025)

Indicators	value	units
Population	393.613	inhab
Total waste production	215.069.549	kg/year
Per capita waste production	546	kg/inhab/year
Families	201.853	Number
Families average dimension	1,95	persons
Year waste production per family	1.065	kg/family/year
Daily waste production per family	2,93	kg/family/day

Further parameters for the containers dimensioning are:

- The target rate of separated collection in the considered period; this parameter determines the volume to be dedicated to non separated collection and the volume to be divided into the different fractions of separated collection;
- The rate of separated collection for each fraction in respect of the total waste collected;
- The maximum containers filling, taking into account also eventual inefficiencies or seasonal fluctuations (in general, the 70% of the total capacity is assumed as maximum filling);
- The rate of real filling of the containers according to the considered material (considered within the conversion factor kg/l);
- The specific weight of each waste fraction;
- The emptying frequency for each waste fraction (according to present data).

From the available data [2,3] it is possible to define the following waste fractions rate and the relating conversion factors [7]. Considering the standard height of home containers and the number of emptyings per year (table 4), it is possible to define the space necessary for placing the separated waste collection containers; for example, in the case of a medium family living in a medium dimension flat, the necessary space is equal to 0,52 m² (table 5).

Table 4. Future scenario: space for waste collection in a medium flat

Material	% of total waste Tot	Conversion factor (kg/l)	Emptyings per year
organic	30	0.15	104
paper	20	0.035	52
plastic	10	0.025	52
glass	5	0.12	52
Not-separated	35	0.1	52

In the same way, it is possible to define the space necessary at the block scale. In this case, the number and dimension of the block flats have to be defined (table 6). The choice of the cans dimension has to take into account the available standard cans dimension, which can vary up to 120 liters, which has been assumed as the maximum capacity for dimensioning the space for separated collection.

The dimensioning has been carried on for medium families (2 people) living in medium size flats (form 60 to 80 m²). For flats of different dimension, a multiplicative factor has to be considered, assuming that the flat dimension variation reflects a variation in the family composition, which takes to an increase of the volumes to be foreseen at block level basing on the number of occupants of the flats. In particular, for flats measuring less than 50 m², we considered 1 occupant and applied to the space for separated waste collection a factor of 0.5; from 80 to 150 m², a linear increase of the inhabitants number has been considered; over 150 m², the increase in the number of inhabitants is lower (fig.1).

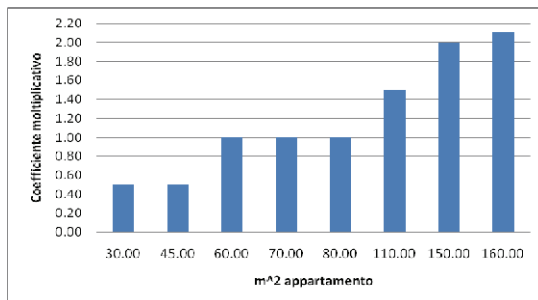
Table.5.Collection system for a medium size family living in a flat of 75 sqm.

Material	production kg/family/year	Theoric volume l/year	Container volume l	Container volume m3
Organic	320.3	2135.3	20	0.02
Paper	213.5	6100.7	120	0.12
Plastic	106.8	4270.5	80	0.08
Glass	53.4	444.8	10	0.01
Not-separated	373.7	3736.7	80	0.08

Table.6. Door-to-door collection system dimensioning for a eight medium flats block.

Material	total waste [%]	Emptying [n. per year]	Containers volume [l]
Organic	30	104	160
Paper	20	52	960
Plastic	10	52	640
Glass	5	52	80
Not-separated	35	52	640

The minimum dimension of the space for waste collection that have been defined consists of building standards to be acknowledged in the Local Building Rules for guaranteeing that the new houses to be built enhance the door-to-door collection system. For what concerns construction and demolition waste, the minimum target for recycle in new buildings has been fixed in 30% and a rate of 70% of reuse of waste from demolition has been proposed.

Fig.1.Multiplying factor for the “waste space” according to the flat dimension (in respect of a medium flat of 75m²)

4. The implementation of the proposed criteria: the Battindarno case study

Aiming at verifying their technical and economic feasibility, the proposed parameters and standards have been implemented in the project for the urban regeneration of the Battindarno area, situated at the periphery of Bologna. It consists of an area of 46.346 m², where a bus deposit is actually located and

where the PSC foresees a new development of about 14.000 m² of residential buildings and 4.500 m² of retail and business activities. The project has taken into consideration the provision of space for door-to-door waste collection both inside the flats and in the blocks private areas (table 7)

Table 7. Volumes for waste collection in the residential buildings

Building typology	n. of buildings	n. of theoretic inhabitants	Plastic [l]	Paper [l]	Glass [l]	Compost heap [l]	Not separated waste [l]
Towers	3	84	3537.69	5053.85	368.51	884.42	3095.48
Blocks	10	80	3369.23	4813.19	350.96	842.31	2948.08
L shape Blocks	4	72	3032.31	4331.87	315.87	758.08	2653.27
Detached houses	10	40	1684.62	2406.59	175.48	421.15	1474.04
Total		276	11623.85	16605.49	1210.82	2905.96	10170.87
emptying [n./week]			1	1	1	2	1
Waste production [l/day]			1661	2372	173	830	1449
Waste production [l/year]			606101	865858	63135	303050	528885

The total waste produced by residents has to be added to the waste produced by the 40 bureaus which have been designed at the blocks ground floor (table 8); according to the present data [3,7], in Bologna each bureau produces on the average 15 l/day of paper and 40 l/day of not separated waste, for a total weekly production of 3000 l/week of paper and 8000 l/week of not separated waste. For each group of buildings, the containers for separated waste collection have been dimensioned (table 9).

Table 8. Cans for separated waste collection dimensioning

		Plastic [l]	Paper [l]	Glass [l]	Compost heap [l]	Not separated waste [l]
3 towers	1 container	2500	2500	360	1100	1500
	1 container	1500	2500			1500
10 blocks + bureaus	1 container	2500	2500	360	1100	2500
	1 container	1500	2500			1500
4 L shaped blocks	1 container		1500			2500
	1 container		1500			2500
	1 container	1500	2500	360	770	1500
10 detached houses	1 container	1500	2500			1500
	1 container	1100	1500	240	660	1500
	1 container	1100	1100			
Total		13200.00	20600.00	1320.00	3630.00	19000.00

As an alternative, an underground waste collection system for paper and non separated waste has been considered. The two alternatives make no difference in terms of space to be provided inside the flats, because, even in case of the underground collection system, the emptying of the containers won't be daily. The two solutions are different in terms of the external blocks area design, because the provision of the underground collection system on public ground replaces the blocks containers. This solution guarantees

both better urban quality and hygienic conditions and it allows to serve a higher number of users, but in the considered case study it appears to be economically inconvenient because it could become competitive only considering at least 250 users. The application of this solution to wider regeneration areas or the possibility to serve the population already living round about the development area, within a distance of 200-250 m, could permit to optimize the underground depot performances, allowing both its technical and economic feasibility.

5. Conclusions

Although in Italy the Municipal Authority has no competences in the field of waste management, we believe that the integration of sustainability criteria in town planning and building regulation tools available at the municipal scale could significantly contribute to the achievement of sustainable waste management objectives. This way, the Municipality becomes responsible of its waste management strategy to be adapted to the local conditions and to the population scenarios.

In the case of a door to door waste collection, it's important to foresee dedicated place in order to encourage a virtuous approach of citizens. Finally, the introduction of minimum space standards for waste collection for the flats encounters also social sustainability; in fact, it allows the citizens to adopt more sustainable behaviors and permits them to undergo the separated collection without compromising the already generally reduced space of the modern flats.

References

- [1] OECD. *OECD Environmental Indicators. Development, measurement and use*. Reference paper, 2003
- [2] ATO Bologna. *Resconto della produzione di Rifiuti Urbani*;2009.
- [3] HERA. *Riepilogo della Produzione di Rifiuti Urbani nel Comune di Bologna 2000-2009*.
- [4] ISPRA. "*Rapporto Rifiuti Urbani*", www.apat.gov.it, Edizione 2009.
- [5] ANPAR. "*La Produzione di aggregati riciclati in Italia*", Edizione 2007 (www.anpar.org/documentazione)
- [6] Comune di Bologna, Settore Programmazione, Controllo e Statistica. "*Scenari Demografici Bolognesi 2006-2021*", Quadro Conoscitivo - PSC Anno 2007 (www.comune.bologna.it/PSC).
- [7] ECOLOGIA SOLUZIONE AMBIENTE. *Isole Ecologiche Interrate* (<http://www.ecologia.re.it/user-area/serie-k>).