



Diagnóstico da gestão de resíduos sólidos no município de Dois Irmãos – Rio Grande do Sul

Roberto Naime¹
Karin Luise dos Santos²

Resumo

Neste trabalho é feito um diagnóstico da gestão dos resíduos sólidos no município de Dois Irmãos, situado na região metropolitana de Porto Alegre. São analisados dados pertinentes à municipalidade como população, orçamento destinado ao gerenciamento dos resíduos, situação da coleta e reciclagem, bem como a estimativa do potencial e operação da reciclagem e da destinação final dos demais resíduos, através de levantamentos gravimétricos e de dados registrados pelo Departamento do Meio Ambiente. Possuindo uma população com mais de vinte e quatro mil habitantes que produzem em média uma quantidade de 0,5 kg/dia de resíduos sólidos por habitante. O município passou a realizar desde o ano de 1995 um sistema de coleta seletiva, além de disponibilizar a coleta dos resíduos orgânicos diariamente. Durante estes mais de 13 anos de execução e aprimoramento do processo, o montante de resíduos sólidos passíveis de triagem manteve-se entre apenas 18% do total coletado. Isto se deve à estimada influência direta dos cidadãos como agentes ambientais na segregação dos resíduos nas unidades domésticas, que possivelmente, também pratiquem minimização na geração de recicláveis, redução e

Recebimento: 26/10/2009 • Aceite: 04/06/2010

¹ Doutor em Geologia Ambiental, Professor do Programa de Pós-graduação em Qualidade Ambiental e Engenharia Industrial Química – ICET – FEEVALE End: RS 239, 2755, Novo Hamburgo, 93. E-mail: rnaime@feevale.br

² Discente da Engenharia Industrial Química – ICET – FEEVALE E-mail: karinluise@feevale.br

reciclagem. É notável também que a mudança de hábitos de consumo da população tenha sido insignificante sobre a caracterização e a composição dos resíduos sólidos do município, mantendo em 82% a quantidade de resíduos orgânicos coletados. O baixo volume de resíduos sólidos recicláveis destinados a coleta pública e a eficiente coleta seletiva a partir de uma bem montada rede de educação ambiental que estimula a segregação dos resíduos domésticos na origem das unidades familiares, possibilita a obtenção de dados relevantes na triagem e comercialização de recicláveis, gerando economia de matérias-primas, água e energia, além de relevantes indicadores de inclusão social e geração de emprego e renda.

Palavras-chave: diagnóstico; gestão; resíduos sólidos; reciclagem; município brasileiro

Diagnosis of solid waste management in the town of Dois Irmãos – Rio Grande do Sul, Brazil

Abstract

This paper describes a diagnosis of the municipal solid waste management system in the town of *Dois Irmãos*, which is within the metropolitan district of Porto Alegre, Brazil. An analysis is performed of data relating to the municipality such as population, budget allocated to waste management and the collection and recycling situation, going on to make an estimate of the potential for and operation of recycling and the final destination of the remaining waste, using gravimetric surveys and data held by the Department of the Environment. *Dois Irmãos* has a population of more than twenty-four thousand inhabitants who each produce an average quantity of 0.5 kg of solid waste per day. In 1995 the municipality introduced a recycling collection system, in addition to providing daily collection of organic waste. During these more than 13 years of operating and improving the process, the total proportion of recyclable solid waste held steady at just 18% of the total collected. This is considered to be due to the direct influence of citizens acting as environmental workers, separating waste at home,

and quite probably practicing a policy of minimizing the creation of recyclable waste, of waste reduction and of recycling. It is also of note that changes in the population's consumption habits have had an insignificant effect on the distribution of different classifications of solid waste in the municipality, with the proportion of organic waste holding steady at 82%. The low volume of recyclable solid waste entering the public waste collection system and the efficient recycling collection, aided by a well-structured environmental education network that encourages families to separate domestic waste at home, makes it possible to achieve meaningful results from sorting and reselling of recyclables, saving raw materials, water and energy, in addition to achieving meaningful indicators of social inclusion and creating employment and income.

Keywords: diagnosis; management; solid waste; recycling; brazilian town

Introduction

The increase in urban populations, resulting both from the exodus from the countryside and a lack of family planning among other factors, has significantly increased solid waste creation in cities. However, by introducing a recycling collection process, the recyclable solid waste can be sorted and classified, thereby contributing to reducing environmental pollution in addition to optimizing use of natural resources and saving energy and raw materials. This paper describes a survey of the solid waste situation in the town of *Dois Irmãos*, which is in the metropolitan district of Porto Alegre, RS, Brazil. *Dois Irmãos* has daily collections for organic solid waste susceptible to putrefaction and which produces unpleasant odors and causes a public health risk. For dry waste there is a recycling collection system following a monthly schedule defining days and times for collecting solid waste suitable for sorting, which is then taken to a Recyclers Association.

The Recyclers Association in *Dois Irmãos* has 27 members who between them work two 8-hour shifts. The workers are provided with the infrastructure of a sorting center including two sorting belts with conveyors and changing rooms with bathrooms and individual lockers.

Studies were also founded on the available bibliographic references detailing the proportion of recyclable solid waste included within the total domestic solid waste collected by the majority of Brazilian municipalities.

The main waste materials that can be separated and resold for recycling, in simplified form, are aluminum, copper, nonferrous metals, white paper, cardboard, high-density polyethylene (HDPE), low-density polyethylene (LDPE), polyethylene terephthalate (PET), blue PET and oil PET, sundry scrap plastic and glass.

Aluminum is classified into different categories, with different yields: block aluminum, aluminum from cans or pan aluminum (literally from pans and other cooking utensils). The greater portion is always made up of cans, but as a result of the high resale price that this type of waste commands, there are often only small quantities left in the waste that is sorted at the *Estância Velha* sanitary landfill waste separation center, because freelance environmental workers (collectors), pick up cans from condominiums that sort their recycling or directly off the city's streets.

Copper occurs naturally within the Earth's crust and is an essential component for life. It is also the metal that humans have used for longest. The first copper coins date from 8700 AD. Natural copper

reserves are estimated at 2.3 billion metric tons. Efficient copper usage contributes to saving energy and preserving the environment, which is under constant threat. For example, 43% of Europe's copper requirements are met by recycling. The most significant consumers of copper nowadays are the energy industry and the construction industry. Copper usage breaks down as 65% used for electricity and energy (including cables used in the construction industry), 25% in construction (including architecture and pipe work); 7% for transport and 3% for other uses (coins, design, sculpture, etc.) (BARTONE, 2001).

Nonferrous metals are those metals which do not contain iron as a principle component. These include: copper and its alloys, bronze and brass, aluminum, zinc, magnesium, pewter and lead and are widely recyclable and recycled, with a very stable market.

The main difference between white paper and cardboard from the point of view of recycling is the quality of the paper and the size of its fibers. Paper is made up countless fibers that cross over one another and are responsible for giving the material its resistance. Depending on the type of pulp used to make the paper (which can be from pine or eucalyptus trees or even other vegetable fiber such as cotton, linen, etc.), it will contain longer or shorter fibers and will be more or less resistant. This makes white paper more expensive and even white paper trimmings (scrap paper off cuts) have a higher market value. Every time paper is recycled, the fiber size is reduced and the paper becomes a little weaker. As a result, when the same paper is recycled many times, it is necessary to add a little virgin pulp to improve its resistance.

Another problem is pigmentation in the paper. In order to make white paper, the pulp (whether virgin or recycled) must be bleached chemically. Therefore, the more ink there is in the pulp, the more difficult it will be to make white paper from it.

The many different types of plastic (HDPE, LDPE and the several different types of PET, in addition to polypropylene (PP) and others) are generally considered to be highly polluting materials, but in fact this is only true if they are burnt, since during combustion they release gases and chemical substances that are damaging to the environment. In common with any other solid material, they can contribute to visual pollution, when discarded. Nowadays it is possible to reduce waste by means of plastic recovery methods, starting from systems to separate plastic materials. Around 20% of plastic waste is currently recovered, but it is technologically possible to reclaim

around 90%, through reuse, recycling (mechanical and chemical) and energy extraction (MANCINI et al, 2000).

Brazil produces an average of 890 thousand metric tons of glass vessels per year, using around 45% of recycled material, in the form of broken glass. A proportion of this is factory wastage and some glass is returned to the factory via collections. The United States produced 10.3 million metric tons in 2000, making glass the second most recycled material by mass, surpassed only by newspapers (BRUGGER et al, 2003).

The primary market for used glass vessels is made up by the glass manufacturers who buy the material from scrap merchants, already crushed, or acquire it through their own recycling campaigns. In addition to being reused to produce vessels, scrap glass can also be added to asphalt and road surfaces, used in flood-protection drainage systems and for the production of glass fiber and foam, jewelry and reflective paint.

Previous research

Trash, or waste, is any material considered useless, superfluous and/or of no value, that is generated by human activity and which needs to be eliminated. It is any material the owner of which eliminates, wishes to eliminate or needs to eliminate.

Trash can also be defined as all and any waste within an urban settlement, produced by human activity or generated by nature (ABNT, 2004). It is commonly defined as that which nobody wants. However, this attitude needs to be changed, so that people no longer see solid waste as something that is dirty and entirely useless.

Calderoni (2003) defines trash as that which is swept out of the house, swept up in the garden or the street and thrown away; as rubble; as everything that does not work and is thrown away; as dirtiness, dirt, filth; as useless, old, worthless things and as solid waste that is discarded and has no further use.

The sanitary workers who collect the trash in Brazil are known as "Garys". This is because at the start of the last century, urban sanitation was offered for tender to private industry and the Garys brothers won the franchise for Rio de Janeiro, awarded by the city authorities, to provide waste collection, transport and disposal services. Since then, the people who work collecting the trash have come to be known by their bosses' name: Garys (BRINGHENTI, 2004).

Solid waste is an issue that must be dealt with in a satisfactory manner, both to protect public health and for environmental savings.

Recycling and recovery of materials must be encouraged and promoted, both for the employment, income and social inclusion they generate and also for the raw materials saved, the rationalization of water resource usage achieved and the energy efficiency gains realized (CALDERONI, 2003, MENEGAT et al. 2004).

The town of *Dois Irmãos* is in the *Rio dos Sinos* valley hydrographic basin. Every day, around 13,381.22 kg of domestic trash are collected; the result of the activities of a population of twenty-four thousand inhabitants. The town of *Dois Irmãos* has an administrative area of 65 km² and it is located in the southern foothills of the *Serra Gaucha*, at an average elevation of 175 meters, which has led to it becoming known as the “Gate to the Mountains”.

A national survey of basic sanitation, carried out by IBGE in 2000, found that 28 municipalities within the metropolitan district of Porto Alegre were served by solid waste collection systems. Of these municipalities, just 6 (21.42%) disposed of the waste collected in open air tips or dumps, while for Brazil as a whole, the proportion disposed of in this inappropriate manner is 30.5% (REMÉDIO et al, 2002, CEMPRE(a) 1993, CEMPRE (b). 2003 and CEMPRE (c), 2006).

Recycling of what are known as “dry” materials from urban domestic waste is an activity of interest because it creates employment and income for the environmental workers, who in the past were known as collectors, and because it leads to environmental savings for society as a whole. Saving *in natura* raw materials reduces water consumption, saving water resources, and increases energy efficiency (NAIME, 2005).

Materials and methods

The town of *Dois Irmãos* has approximately 25 thousand inhabitants living in an area of 66.8km². It is located in the *Rio dos Sinos* valley hydrographic basin. It has a gross domestic product of approximately US\$ 257 million, producing flowers, Australian Acacia, fruit and vegetables, footwear, furniture and upholstery and is an important center of service provision. The municipal budget for 2009 is approximately US\$ 9 million. The location of *Dois Irmãos* is shown in Figure 1, below.

Figure 1: Location of *Dois Irmãos* in the *Rio dos Sinos* valley hydrographic basin



The *Dois Irmãos* Municipal Department for the Environment was the primary data source for this study. It provided data on total quantities of waste collected and on the quantities of each sub-classification, from 1995 onwards. These data include the total amounts of dry waste and organic material collected and also figures from the Recyclers Association, who classify the materials they sort.

Dois Irmãos allocates a total budget of US\$ 130,000 to final disposal of waste, outsourced to *SIL Soluções Ambientais* (SIL Environmental Solutions), and spends R\$ 45,000 on the recycling center. The fleet of waste collection trucks costs US\$ 125,000 per month, making approximately US\$ 270,000 a year, which, divided by 12, gives a monthly expenditure of US\$ 22,500 on activities related to solid waste management, including the recycling collections, maintaining the sorting center and providing support to the *Dois Irmãos* Recyclers Association. This works out as an investment of less than US\$ 1.00 per month per inhabitant.

Solid organic waste collected in *Dois Irmãos* is sent to the *SIL Soluções Ambientais* waste processing center in *Minas do Leão*, 80 km from *Porto Alegre*. Since the efficiency of the recycling separation is

not yet very high, many recyclable materials are sent to this center mixed in with the organic waste. This can be confirmed by consulting the data presented and discussed in the analysis of results section below.

On the basis of the data provided and based on bibliographic references, an estimation is made of the prospective potential for recycling of the urban domestic solid waste collected in the town of *Dois Irmãos*, in the *Rio dos Sinos* valley hydrographic basin.

Sortable waste is sent to the town's Recyclers Association, which is equipped with belts, scales, presses, agglomerators, shredders and washers, which are operated by the 27 association members who sort the waste on the basis of material and chemical process.

In the urban area, waste collection coverage is 100% and it is estimated that around 80% of the rural area is covered by collections. Therefore, calculating on the basis of the size of the rural population, it can be stated that the waste collection service reaches something in the order of 99.2% of the population.

This study does not evaluate the unofficial collection of recyclables that also occurs in the town, but whose dimensions and magnitude are difficult to measure.

Analysis of the results

The *Dois Irmãos* municipal authority collects recyclables and has records of the quantities of each material recycled going back to 1995. This makes it possible to perform a careful data-rich analysis. In addition to demonstrating an admirable attitude to environmental issues, this is also a noteworthy example of a community supporting solid waste management through a succession of municipal administrations run by different political parties.

Although the tradition in Brazil, whether in federal, state or municipal government, is for each new administration to start everything anew, without continuing or reformulating the previous administration's work, the example of *Dois Irmãos* shows that continuity is actually possible.

Table 1 below lists the number of metric tons of each type of material recycled for every year from 1995 to 2008.

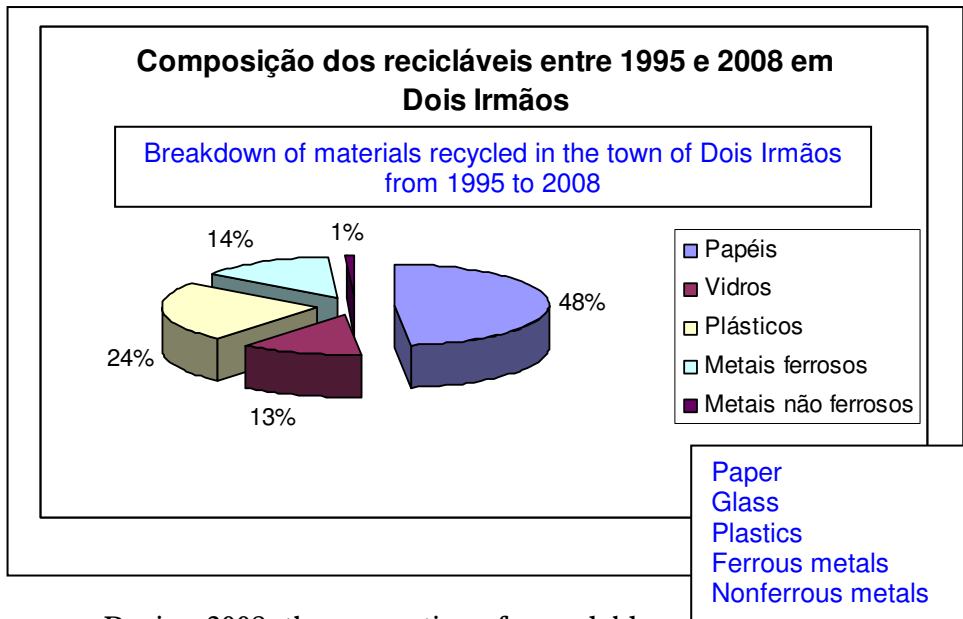
Table 1: Breakdown of materials recycled in the town of *Dois Irmãos*

BREAKDOWN OF MATERIALS RECYCLED 1995 TO 2008 (metric tons)						
Year	Paper	Glass	Plastics	Ferrous metals	Nonferrous metals	Total recycled
1995	164.9	44.3	54.4	66.5	3.4	333.6
1996	239.6	49.1	124.5	82.4	5.7	501.4
1997	280.7	65.6	108.5	80.2	8.1	543.4
1998	319.8	70.1	140.3	93.2	8.9	632.5
1999	325.6	82.4	151.7	94.0	8.1	661.9
2000	316.7	84.4	157.7	92.1	6.4	657.5
2001	326.5	83.6	162.1	90.8	6.6	669.8
2002	385.5	90.9	179.1	97.1	6.4	759.2
2003	304.4	97.7	173.9	93.2	5.2	674.6
2004	309.9	88.9	192.0	93.9	4.2	689.1
2005	330.2	106.2	172.8	99.4	4.3	713.2
2006	414.1	104.1	217.2	109.8	5.5	850.8
2007	443.3	113.2	232.8	117.7	6.0	913.1
2008	433.7	112.1	217.1	114.2	6.4	883.7
TOTALS	4,595.4	1,193.4	2,284.7	1,324.9	85.8	9,484.4

It is important to emphasize the impressive magnitude of these results, because of the employment and income they create for the least well-qualified section of the population. Over these 13 years during which data from *Dois Irmãos* have been tabulated, 9.5 thousand metric tons of paper, glass, plastics, ferrous metals and nonferrous metals were sent for recycling.

Figure 2 below illustrates the data from Table 1.

Figure 2: Quantities of materials separated and sent for recycling from the town of *Dois Irmãos* between 1995 and 2008

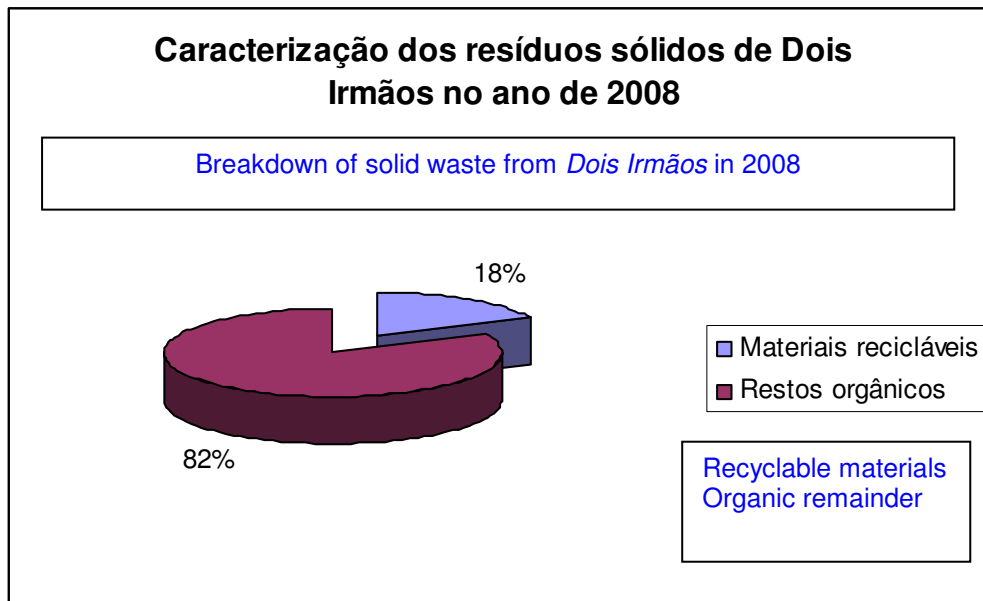


During 2008, the proportion of recyclable material in the solid waste collected in *Dois Irmãos* was 18%, as shown in Figure 3 below, which is well below the average proportion for Brazil, which is from 35 to 55%. This may indicate that the population is already separating and selling recyclables rather than putting them into the public waste collection system or it may be that the town really does produce less recyclable solid waste.

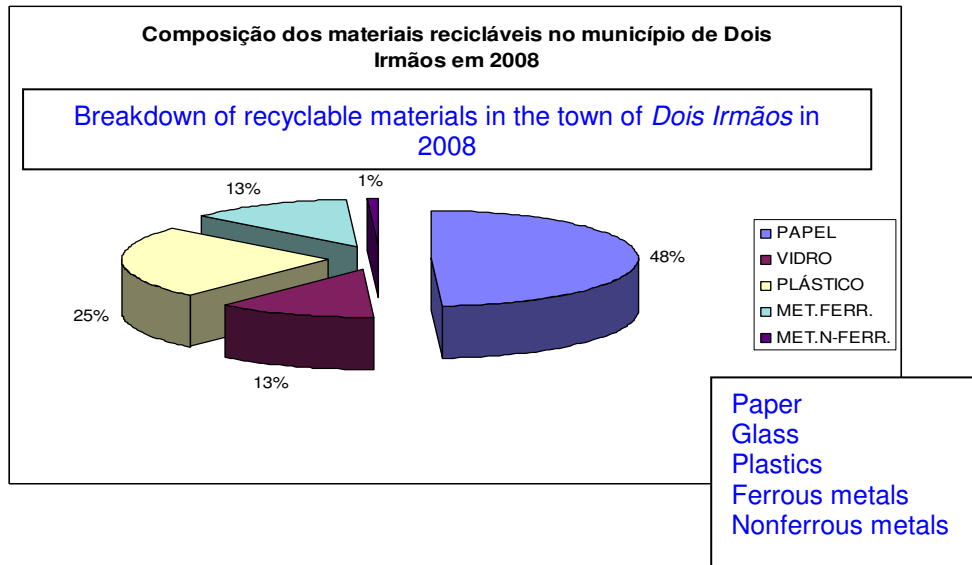
This hypothesis cannot be verified, but in a town with a strong tradition of organization in solid waste management, with a consistent rate of recycling, with social inclusion and employment and income creation for environmental workers, it is valid to suppose that interferences of this type take place.

It should also be pointed out that the town also runs very good environmental education programs, both in municipal schools and in state schools, that are subject to direct intervention by the municipal department for education and culture.

Figure 3: Proportion of recyclable materials and organic remainder in solid waste from the town of *Dois Irmãos* in 2008



The breakdown of *Dois Irmãos*' waste in terms of the materials recycled in 2008 is shown in Figure 4 below. It exhibits great similarity to the percentages of each material recycled from 1995 to 2008, as illustrated by Figure 2 above. In other words, it can be concluded that in almost 2 decades, the town's consumption habits have not changed to an extent that would alter the proportions or classification of its sold waste.

Figure 4: Breakdown of recyclable materials in *Dois Irmãos*

The environmental and social gains offered by recycling are becoming ever-more relevant in the socioeconomic context of Brazil. In the environmental dimension, significant gains are achieved through saving raw materials, water and energy. In the social dimension, real creation of employment and income for environmental workers, who are drawn from the lowest income sections of the population and who, having no professional qualifications, find that this occupation is a way to reclaim the citizenship that they have often lost.

Furthermore, from the perspective of integrated hydrographic basin management, good solid waste management contributes to maintaining urban rainwater drainage systems functioning, since they do not become saturated or obstructed by solid waste. As a result, water capture for treatment and distribution of potable water is facilitated and relieved of the need for additional expenditure on sophisticated treatments. If this scenario could be completed with an efficient and universal sewage treatment system, we would then attain the best conditions for satisfactory integrated hydrographic basin management.

In view of the above, it can be observed that the investment that is most needed in the *Rio dos Sinos* valley hydrographic basin is

integrated management. Our “X-ray” of the solid waste management systems of the municipalities that are located in the *Rio dos Sinos* valley hydrographic basin is intended to contribute to the formulation of coherent and consistent public policies that will contribute to optimizing management of the entire hydrographic basin.

Conclusions

Dois Irmãos has been managing its urban solid waste since 1995. With the implementation of a synchronized recycling collection system, the town made it feasible to found a Recyclers Association, thereby adding a social element to the benefits of recycling.

Therefore, through this work, a part of the population is benefiting from municipal job and income creation policies and from meaningful social inclusion programs. In addition to this social dimension, recycling is also important because of the environmental savings, in the form of reuse of raw materials and reduced consumption of the planet’s water and energy resources. This overall environmental accounting cannot and must not be undervalued by municipal managements, not just in the environment department, but in all spheres of municipal administration.

Organic material and unsellable sorted waste is sent to the waste center run by *SIL Soluções Ambientais* in *Minas do Leão*.

This study analyzed the whole management system and the level of efficiency achieved by the recycling procedures. The homogeneity of the recyclable content, in terms of the proportions of paper, glass, plastics and ferrous and nonferrous metals, exhibited over the last 13 years is both of note and relevant. This extreme homogeneity and reproducibility exhibited by the materials sorted and sold demonstrates the influence that a population’s culture can have on the solid waste its community produces.

References

- ABNT - Associação Brasileira de Normas Técnicas. 2004. **Resíduos Sólidos: classificação**, NBR 10.004. Rio de Janeiro, 2004. 30 p.
- BARTONE, C. 2001. **Infraestrutura** Note W&S N.º UE-3. World Bank, Washington, USA, 2001. p. 11 -19.
- BRINGHENTI, J. R. 2004. **Coleta Seletiva de resíduos sólidos urbanos: aspectos operacionais e da participação da população**. PhD thesis. Faculdade de Saúde Pública/UPS. 2004. 236 p.

BROWN, L. 2003. **Eco-Economia, Construindo uma Economia para a Terra**. Salvador: UMA. 2003, 344 p.

BRUGGER, C.M., SLOMPO, M. e TOIGO, C. A. – **Produção per capita de resíduos sólidos domésticos em Caxias do Sul**. Cadernos de Pesquisa. Universidade de Caxias do Sul, Brasil, 1992.

CALDERONI, S. **Os Bilhões Perdidos no Lixo**. 4ª ed. São Paulo: Humanitas Editions/ FFLCH/UPS, 2003, 346 p.

CEMPRE (a) – Compromisso Empresarial para a reciclagem. **Pesquisa Clicsoft**. Rio de Janeiro, 1994.

CEMPRE (b) – COMPROMISSO EMPRESARIAL PARA A RECICLAGEM. **Manual de Gerenciamento Integrado**. São Paulo. SP. 2003.

CEMPRE (c) – COMPROMISSO EMPRESARIAL PARA A RECICLAGEM. **Relatório Anual 2005**. São Paulo, SP, 2006, disponível em <http://www.cempre.org.br>, acesso em 02.08.2006.

MANCINI, S. D. e ZANIN, M. – **Estudo sobre a relação entre consumo e descarte dos principais plásticos**. *Plástico Industrial*. Ano II, n 25 p 118-125. Setembro de 2000.

MENEGAT, R.; ALMEIDA, G. 2004. (org.). **Desenvolvimento sustentável e gestão ambiental nas cidades: estratégias a partir de Porto Alegre**. Porto Alegre: UFRGS Editions, 2004. 422p.

NAIME, R. 2005. **Gestão de Resíduos Sólidos: Uma abordagem prática**. Novo Hamburgo: Feevale Editions, 2005. 136 p.

REMEDIO, M. V. P, MANCINI, S. D. e ZANIN, M. – **Potencial de reciclagem de resíduos em um sistema de coleta de lixo comum**. *Engenharia Sanitária e Ambiental*, v 7 n 1 jan/mar 2002 e v2 abr/jun 2002.