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MSW

FROM POLLUTION/DEGRADATION SOURCE TO RESOURCE

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ABSTRACT

Municipal Solid Waste is one of the biggest challenges that cities are facing: MSW is considered of the main sources of energy consumption, urban degradation and pollution. This paper defines the major negative effects of MSW on cities and proposes new solutions to guide waste policies. Most contemporary waste management efforts are focused at regional government level and based on high tech waste disposal by methods such as landfill and incineration. However, these methods are becoming increasingly expensive, energy inefficient and pollutant: waste disposal is not sustainable and will have negative implications for future generations. In this paper are proposed all the principle solutions that could be undertaken. New policy instruments are presented updating and adapting policies and encouraging innovation for less wasteful systems. Waste management plans are fundamental to increase the ability of urban areas effectively to adapt to waste challenges. These plans have to give an outline of waste streams and treatment options and provide a scenario for the following years that significantly reduce landfills and incinerators in favor of prevention, reuse and recycling. The key aim of an urban waste management plan is to set out the work towards a zero waste economy as part of the transition to a sustainable economy. Other questions remain still opened: How to change people's behavior? What is the role of environmental education and risk perception? It is sure that the involvement of the various stakeholders and the wider public in the planning process should aim at ensuring acceptance of the waste policy.

KEYWORDS:
Urban waste management; Waste governance; Urban degradation.

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城市生活垃圾

从污染源/退化源到资源

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摘要

城市生活垃圾（MSW）是当今各个城市面临的最大挑战之一：城市生活垃圾被认为是能源消耗、城市退化和污染的主要来源。本文定义了城市生活垃圾的主要负面影响，并提出了指导废弃物政策的全新解决方案。当今的大多数垃圾管理工作都集中在地方政府层面，以高科技废弃物处理方式为主，如垃圾填埋和焚烧等。然而，这些方法的成本越来越高，能源效率低下和易污染：废弃物处置不具可持续性，会为后世带来负面影响。本文提出了能采取的所有原则性解决方案。提出了全新的政策工具，更新和调整政策、鼓励减少系统产生废弃物的创新。废弃物管理计划对于增强城市地区有效应对废弃物问题的能力有着决定性的作用。这些计划中必须包括废弃物流和处理方案的草案，提出接下来数年内能极大减少堆填和焚化以利于预防、重复使用和回收的方案。城市垃圾管理计划的主要目的，是启动以零废弃物经济为目标的工作，将其作为向可持续经济体系过渡的一部分。其他问题仍然亟待解决：如何改变人们的行为？环境教育和风险感知的作用是什么？可以确定的是，各利益相关方和广大公众在规划过程中的参与，应以保证对废弃物政策的接受度为目的。

关键词：
城市的废弃物管理：废弃物治理；城市退化

1 THE CITIES' BIGGEST CHALLENGE: MANAGING WASTE GENERATION

One of the biggest challenges that cities will face, in the next years, is connected to waste production. Municipal Solid Waste - MSW1 - generation levels are expected to double by 2025 according to the World Bank: 1.3 billion tonnes per year are estimated to increase to approximately 2.2 billion tonnes per year2. This might represent a significant change in people lifestyle and it will force local, regional and national authorities to find new solutions and policy instruments. Per capita waste generation rates will increase from 1.2 to 1.42 kg per person per day in the next fifteen years2. New life styles and best practices have to be promoted to stop solid waste generation rates. Waste management is more critical in urban areas. Urban residents produce about twice as much waste as people living in the countryside. Considering that all over the world there will be 1.4 more people living in cities it is clear that MSW will be one of the biggest problems that cities will have to deal with. Waste management has already been the main source of expenditure for local authorities in the last 20 years. The increasing urban population made the environmentalists think about the scientific waste management with topmost priority in urban planning (Ahmed 2011). Another factor that influences urban waste production is the income level of a country: high-income countries generate the most waste per capita, while developing countries produce the least solid waste per capita. So it is reasonable to say that for many cities above all in Asia and Africa, but also in South America, the total quantities of waste will increase significantly in the next years. According to the World Bank's report "What a Waste. A Global Review of Solid Waste Management", the amount of urban waste being produced is growing faster than the rate of urbanization (Hoornweg, Bhada-Tata, 2012).

This paper wants to analyze MSW issue from an innovative point of view. The authors3 show in the first three subsections how much municipal solid waste are affecting urban areas both as a source of pollution, degradation and in terms of energy consumption. MSW generates methane that is a greenhouse gas particularly dangerous in short-term. Solid waste, if not managed correctly, could be responsible for air pollution, flooding and public health impacts such as respiratory ailments. A city that reduces, reuses and recycles its waste is more livable, attractive and sustainable.

In the second paragraph are analyzed the main measures for sustainable waste management. The paper proposes new policy instruments for urban waste management. Waste management plans, at a local level, are identified as the best policy instrument to reduce energy consumptions, urban pollution and degradation. A possible structure for these plans it is here proposed to guide urban technicians. Solid waste management is the one thing just about every city government provides for its residents. While service levels, environmental impacts and costs vary dramatically, solid waste management is arguably the most important municipal service and serves as a prerequisite for other municipal action (Kyte 2012). The authors give also some instructions to choose the most suitable best practices depending on city's characteristics (population, geography, morphology…). Different factors have been considered such as pilot area features, people/institution involvement, sustainability aspects… Waste management plans have to fix high objectives: zero waste policy it is the final goal. Some questions remain unsolved: How to change people's behavior? What is the role of environmental education and risk perception? The final paragraph identifies all the aspects that need to be consider and more deeply analyzed in future researches to really define an efficient and sustainable waste management plan. Cities have been the hub of innovation for humanity; such human ingenuity will be needed to address the ongoing and emerging major challenges facing cities: waste management remains one of them (Wilson, Velis 2014).

1 The World Bank defines municipal solid waste as 'non-hazardous waste generated in households, commercial and business establishments, institutions, and non-hazardous industrial process wastes, agricultural wastes and sewage sludge. In practice, specific definitions vary across jurisdictions.'

2 Data reported in What a waste: A Global Review of Solid Waste Management, n°15 Urban Development & Local Government Unit World Bank, Washington.

3 Selena Candia has done an analysis on MSW as a source of urban pollution, degradation and energy consumption (chapters 1,2,3 and 4). Francesca Pirlone has done an analysis on innovative measures for sustainable waste management (chapter 5,6 and 7).

1.1 MSW AS A SOURCE OF URBAN POLLUTION

MSW collection, treatment and digestion can significantly affect urban environment. In the following subsection are defined the principle types of pollution that are due to MSW management[4]. Human health and environment protection have to be at the heart of every waste policy. There needs to be determinate how and to what extent MSW are contaminating contemporary cities.

Municipal waste could be one of the principle causes of water, air and soil contamination. Air pollution depends mostly on greenhouse gases produced during waste collection and digestion especially in landfills and incinerators. Landfills produce mainly CH_4 (methane) and CO_2, incinerators generate other clime-change gases and particulates such as PM_{10}, SO_2. MO_2. Landfills produce a huge amount of planet-warming methane, a greenhouse gas with 25 times the climate impact of carbon dioxide over a 100-year period (EPA, 2010). Methane is produced from biodegradable waste decomposition. Municipal solid waste landfills are the third-largest source of human-related methane emissions in the United States, accounting for approximately 18.2 percent of these emissions in 2014 (EPA, 2014). On the contrary only the 0,5% of CO_2 emissions are related to waste treatment. For this reason, CH_4 reduction represents a big potential to reduce global warming. Moreover, methane lifetime is very short, it can remain in the atmosphere at least 12 years, but CH_4 is more efficient at trapping radiation than CO_2. To stabilize the actual situation, it is sufficient to reduce methane presence in the atmosphere of 8%. Since inappropriate management of MSW in landfills contributes from 4% to 11% of world greenhouse gases emissions, properly managed food waste by means of separate collection and recycling will have positive impacts on climate change; by transforming food waste into compost, the organic matter is stored in soils by means of a low-cost and immediately available technique and not lost into the atmosphere as CO_2 or methane (ISWA –International Solid Waste Association, 2013).

Emissions to soil can occur from slag, from leaking liners under a landfill, and from the storage site of incinerator fly ash. Municipal solid waste that derives from natural products, rotten fruits or vegetables, normally only contribute to soil fertility. However, in a landfill are buried many other materials full of chemicals that lead to soil pollution. This phenomenon has different negative effects both on health of citizens and on growth of plants decreasing soil fertility and changing soil structure. Plants and crops absorb the pollution from the soil and then people eat harmful toxins. This could lead to the sudden surge of different form of illnesses. It is also difficult for many plants to adapt to a soil that changed radically its chemistry in a short period of time. Soil pollution decreases significantly the number of fungi and bacteria in the ground contributing to soil erosion. Emissions to water arise from certain types of flue gas treatment and from the extraction of leachates under a landfill (Spadaro, 2008). Waste settlement seems to be one of the major sources of water pollution which provide many negative impacts above all to urban communities. Many landfills were settled on unsuitable soils which are often too close to groundwater reserves. This is because landfills placed during the 60s and 70s, when there wasn't a stringent European legislation, are still working. The result is that in many cities groundwater is a chemical cocktail reducing drinking water resources.

Carbon dioxide is warming the planet and changing the climate. Disasters such as violent storms, polar melting, floods etc. are growing over time. A sustainable waste management could reduce significantly the level of many greenhouse gases. Recycle is a best practice in this sense, because one ton of material recycled reduces of 30-90[5] kg of greenhouse gases compared to landfills and incinerators (Morris J., 1996). Composting and anaerobic digestion are other smart solutions. Composting is optimal to digest organic waste because aerobic conditions eliminate methane production. Anaerobic digesters are modern systems which use organic waste to produce biogas through an anaerobic procedure. It is a biological process that produces a gas principally composed of methane (CH_4) and carbon dioxide (CO_2), this gas is not dispersed into the atmosphere but it is

[4] The data reported defines globally the main effects of MSW on the environment. Each city has to calculate its level of pollution aggregating the effects here reported (CO_2, CH_4, soil erosion).

[5] It depends on the material recycled.

used to produce energy. Local authorities have to consider environmental impacts related to each form of waste treatment to choose the most sustainable solutions (Tab.1).

WASTE TREATMENT	EVIRONMENTAL IMPACTS
Landfill	50 percent methane (the primary component of natural gas), 50 percent carbon dioxide (CO_2) and a small amount of non-methane organic compounds. Methane is a potent greenhouse gas with a global warming potential that is 25 times greater than CO_2.
Incinerator	Incinerator are responsible for: - different emissions harmful to the atmosphere like NO_x, SO_2 , HCl, particulates, …; - many dangerous greenhouse gases like CO_2 (coming from plastic combustion) and NO_2 that contribute to clime-change. Moreover, only a part of the energy produced is renewable, because generated burning organic waste.
Recycle	Recycle results in a reduction of 30-90 Kg of greenhouse gases for each ton of material. Producing new products using secondary materials can save significant energy (preventing new raw material extraction and manufacturing processes).
Composting	Composting is possible maintaining aerobic conditions eliminating methane production.
Anaerobic digestion	Biological process that produces a gas principally composed of methane (CH_4) and carbon dioxide (CO_2). This gas is not dispersed into the atmosphere but it is used to produce energy.

Tab.1 Environmental impacts due to waste treatment

Researchers in the UK and USA[6] have found how to monetize the social negative effects of CO_2. These studies are very important for local authorities because they give an economic value to support sustainable waste management solutions. The Social Cost of Carbon (SCC) is defined, according to Environment Protection Agency (EPA), as an estimate of the economic damages associated with a small increase in carbon dioxide (CO_2) emissions, conventionally one metric ton, in a given year. In 2015, EPA recommended an illustrative estimate for the SCC of $68/tonne of carbon (tC), within a range of $46 to $138/tC (for year 2025 emissions, see Fig.1).

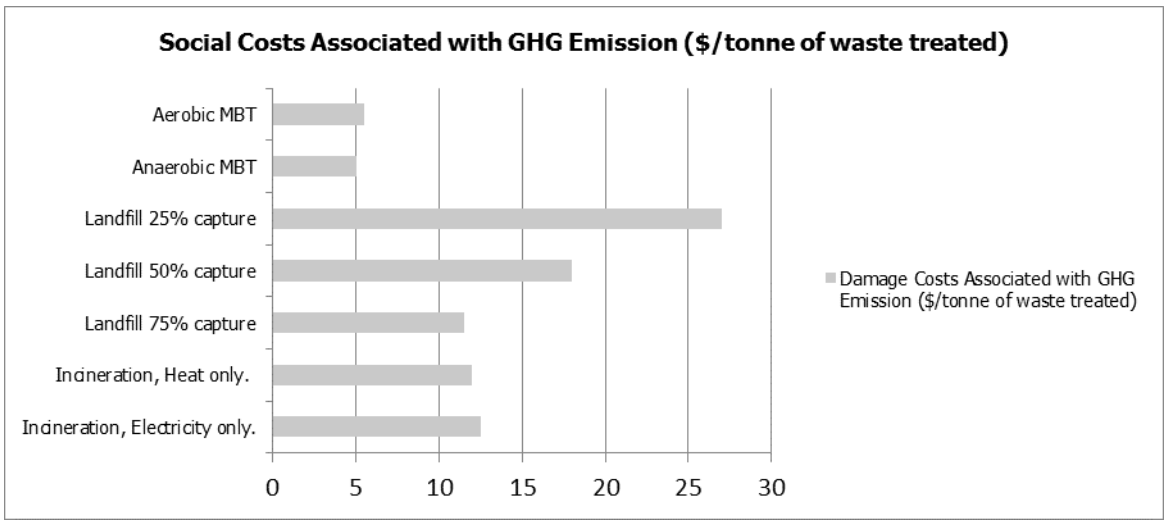

Fig. 1 Social Costs of GHG Emissions from Residual Waste Treatments

6 The Government Economic Service (GES) in the United Kingdom and the Environmental Protection Agency (EPA) in the United States of America.

1.2 MSW AS SOURCE OF URBAN DEGRADATION

MSW is one of the main sources of urban degradation. Problems with waste disposal continue to condition the quality of life in modern cities. In the following subsection are defined the bad effects on urban spaces and on the tourism sector that are due to MSW management. Some case studies are reported to show the strong relationship that exists between a good or bad waste management and urban decay. People involvement is essential to prevent litter and to attract people interest in recycling.

A touristic destination can lose visitors if its garbage is not properly managed. This append in Tunisia in 2011 when a lot of tourists coming back home from Hammamet, Sousse and Djerba reported a negative Word of Mouth. Word-of-mouth advertising is what happens when a tourist talks about his journey with someone else. A negative word of mouth can severely damage or even cancel a touristic destination/city. For this reason, the Tunisian Minister of tourism announced at the World Bank conference (December 2012) that new measures to solve the situation would have been undertaken. Also in Italy some tourists claimed that different destinations are dirty and degraded - according to a research carried out by Alpitour in 2011 -. Despite its huge historical heritage, Italy is only the fifth visited Country in the world. According to Alpitour's questionnaires the cause is due in part to the lack of public transport and urban degradation (dirty streets, inappropriate waste management …).

Urban decay is more evident considering some examples of bad MSW management such as Beirut. The Lebanon's cosmopolitan capital since September 2015 is a surreal and unhygienic city (Fig. 2). The waste crisis begun last July: local authorities decided to close the main landfill of Beirut, and other structures in the surrounding, without thinking to any alternatives. The city center is relatively clean – to avoid public demonstration against the government –; all the rubbish is pushed in the periphery where it is accumulated along the road and the banks of the Beirut River. A study by the American University of Beirut demonstrated (December 2016) that the air in Beirut suburban areas is 400 times more polluted than in the country's industrial area.

The airbone toxin levels have grown exponentially because many municipalities have started to burn rubbish piles on the street. Beirut's hospitals have registered in the last months more and more cases of respiratory diseases consequence of this illegal solution. There is strong evidence linking uncollected household waste to public health, both directly to higher incidence of diarrhea and acute respiratory infections in children and indirectly to flooding and the spread of water-borne diseases via blocked drains (UN-Habitat, 2008).

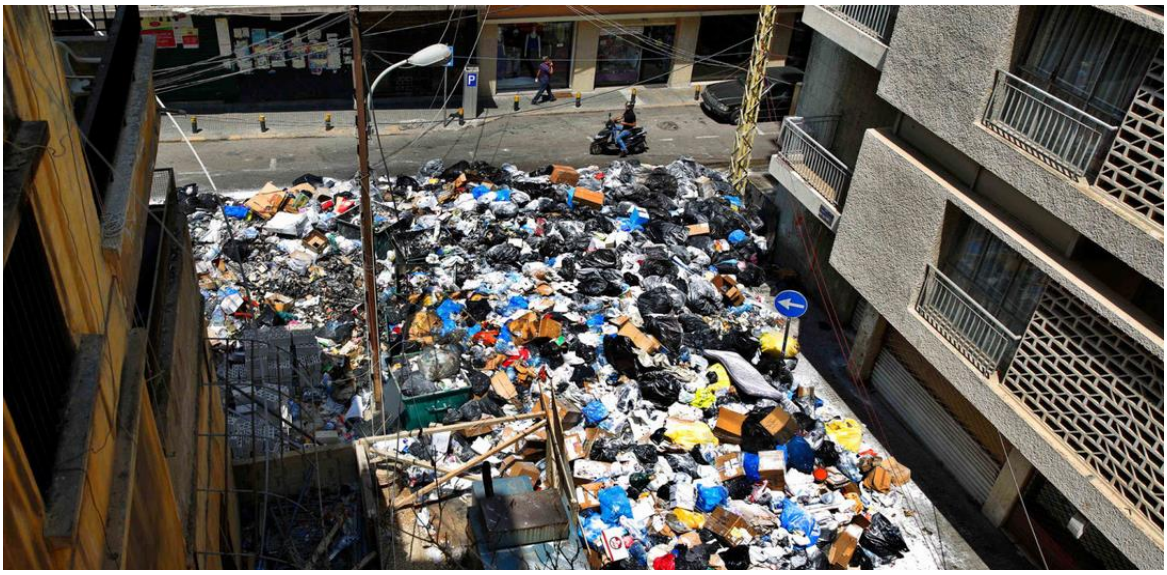

Fig. 2 A motorcycle passes by a large pile of garbage blocking a street in Beirut, July 27, 2015

Inefficient systems of waste management and outdated technologies could degrade significantly urban spaces. Many cities in Europe have found new ways to prevent urban degradation above all in historical areas. Most of them have adopted underground waste bins: this system provides a greener, cleaner and more aesthetic collection solution. Normally underground waste bins can contain larger volumes of waste using less land than common garbage bins. This big volume increases operational efficiency reducing the number of vehicles – that means also a carbon footprint reduction - and of sanitation workers. Underground waste bins are one of the best solution in touristic areas, where it is needed a discrete system of collection that does not affect the historical heritage and the city image. In some cases citizens are primarily responsible for urban degradation: they litter, they do not respect collection time, they prefer to put their trash bag in the closest garbage bin even if it is full and there is another empty within walking distance… Drawing on research from North America, Australasia and Europe, there is a wealth of evidence to suggest that a wide variety of factors influence environmental action; these can be characterized as environmental and social values, situational factors and psychological variables (Barr 2003). For this reason, it is important to do awareness campaign tailored on local situation to make citizens fell part of city waste management. People prefer not to think about garbage and where it will end up. MED-3R project demonstrated that showing to citizens what municipalities do with their waste it is important to improve their confidence in local authorities and their environmental engagement. Awareness campaigns have to reach all kind of target: resident (children, families, shop keepers …) and fluctuant (students, migrants, tourists …). Another initiative carried out by two project's partners – the city of Genoa and the metropolis of Nice – trained a group of citizens to become "Recycling Ambassadors". The training program taught to more than 50 volunteers: How to talk to other citizens about changing behavior to become environmentally friendly; What can and cannot be recycled; The common contaminants in recycling bins. The "Recycling Ambassadors", after the training, have participated in different initiatives organized in every neighborhood to attract people interest in recycling. The results of this operation were very positive and also in this case there was a domino effect.

1.3 MSW AND ENERGY CONSUMPTION

Waste management does not affect only water, soil and air quality but it has many impacts on energy consumption. In the following subsection is analyzed the amount of energy used to transport and treat MSW. Some best practices are reported to show new management systems to reduce energy consumption. Reduce, Reuse and Recycle are the three essential components to save energy.

Urban areas consume a lot of energy to transport and to treat MSW. The energy used for treatment regards above all wastewater treatments. Water and wastewater systems are significant energy consumers with an estimated 3%-4% of total U.S. electricity consumption used for the movement and treatment of water and wastewater (Daw, Hallett 2012). The energy used for transport is manly obtained from fossil fuels and so it is highly polluting. The reduction and modernization of vehicles can significantly cut down energy consumption and curb greenhouse gas emissions. More than 80 garbage trucks in Nice (France) are equipped with a GPS system. This system optimizes waste collection and gives a better service to citizens. Sanitation workers can operate in safer conditions and in a more effective way. Vehicle's progress is monitored in real time (fuel consumption, activities details, level of eco-driving). Thanks to this information each tour is optimized to use less energy. Moreover, the service identifies the amount of waste collected in each city circuit providing data to better define garbage trucks' routes and number. Drivers can now report, in a few clicks, any logistic problem specifying the ongoing trouble. The Metropolis of Nice has also provided 57 000 garbage bins - located in remote areas - with a chip. These chips allow sanitation workers to report, using a portable terminal, all interventions needed: repairing, cleaning, substitution, etc. Another system to optimize waste collection was texted by IBM's researchers in Nairobi. Ten garbage trucks are still equipped with smart devices. Thanks to

these devices city officials can monitor the position and the movement of the fleet in real time. When garbage trucks are driving, they collect both garbage and information to optimize and reroute the vehicles. The device gives real-time information on the amount of fuel used, distance covered and time spent idling or off the job. Other factors that can result in significant energy savings are connected to the three R's of the Environment – Reduce, Reuse and Recycle -. Source reduction is the main contributor to energy reduction because it completely prevents new raw material extraction and manufacturing processes. If we consider the entire cycle of life of a given material, from the cradle to the grave a lot of energy is required. The biggest quantity of energy is normally used during the production phase. Recycling and reusing a product it is possible to save the energy related to material extraction, processing and manufacture. MSW can represent a considerable potential resource. In recent years, the global market for recyclables has increased significantly. The world market for post-consumer scrap metal is estimated at 400 million tonnes annually and around 175 million tonnes annually for paper and cardboard (UN-Habitat, 2009). In global terms this represents a value of at least $30 billion per year (EPA, 2015). This value does not consider the informal and illegal sector that is very active particularly in low and middle income countries. Producing new products using secondary materials can save significant energy. For example, producing aluminum from recycled aluminum requires 95% less energy than producing it from virgin materials (EPA, 2015). The figure presented here demonstrates how much energy is saved per ton of recycled material (relative to landfilling), for example using 1 ton of recycled plastic it is possible to save almost 103 Million of calories (Fig. 3). Only some materials such as dimensional lumber or medium-density fiberboard require more energy to be recycled rather than the energy they can produced during combustion.

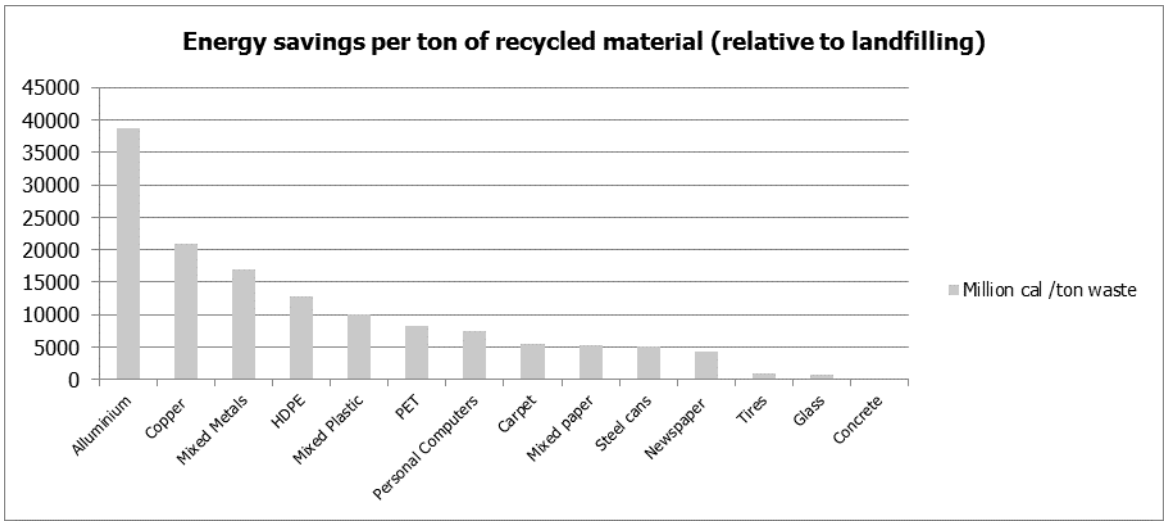

Fig. 3 The table presented shows how much energy is saved per ton of recycled material (relative to landfilling), results are expressed in Million of cal per ton waste

Another way to recover energy from waste is producing heat and electricity with incinerators or anaerobic digesters. According to the UE directive 2008/98 on waste, municipalities have to prefer prevention, reusing and recycling rather than energy recovery from waste. It simply does not make sense to spend so much money destroying resources we should be sharing with the future (Connect, 2013). This directive describes in details the waste management hierarchy that EU Member States shall apply: waste prevention, re-use, recycling, recovery and finally disposal as a last option. According to the waste hierarchy, incinerators in terms of energy should be encouraged over landfills. There are currently 86 waste-to-energy facilities in the United States. According to the Energy Recovery Council, they provide 2,700 MWh of clean electricity on a 24-hour-per-day, 365-day-per-year basis enough to power about 2 million homes (Pyper, 2011). Always in terms of energy

recycle is the best choice, because you can save more energy recycling an object than the energy that you can recover burning it. Incinerating municipal solid waste in an energy-from-waste (EFW) facility recovers a portion of each waste material's heat value as electrical energy. Waste materials recycled conserve energy by replacing virgin raw materials in manufacturing products, thereby reducing acquisition of virgin materials from the natural environment. At the same time, recycling removes materials, some of which have high intrinsic energy content (e.g., paper and plastic), from the stream of MSW available for EFW incineration (Morris, 1996). A research of the Ontario Waste Composition Study demonstrates that for 24 of 25 waste materials, recycling saves more energy than is produced by incinerating MSW in an EFW facility to generate electricity (Morris, 1996). For example, one kilo of newspaper burned produces 18600 KJ but if it is recycled ii is possible to save at least 21300 KJ (Choate, Pederson, Scharfenberg, 2005).

2 MEASURES FOR SUSTAINABLE WASTE MANAGEMENT

In this paragraph are proposed new policy instruments to improve the quality of life in modern cities reducing urban pollution and degradation. Innovative solutions are studied to reduce to a minimum product's impacts from cradle to grave. Waste management plans, especially at a local level, have a key role to play in achieving sustainable waste management. The authors define, in the following subsections, the possible structure of an urban waste management plan, examining which best practices, goals and activities should be considered.

Cities can rely on quite new tools for a good waste governance such as waste management plans. The establishment of a plan allows taking stock of the existing situation, defining the objectives that need to be met, formulating appropriate strategies, and identifying the necessary implementation means (EU, 2012). Waste management plans need to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use. These plans are the best way to manage MSW, preventing urban pollution, degradation and reducing energy consumption in cities. As prevention, re-use and recycling have the highest priority in the EU directive 2008/98/CE, waste management plans should be made in order to aim at reducing the quantity of waste generated and treated in landfills or incinerators. Waste management plans are fundamental to improve the ability of urban areas to effectively manage MSW finding a solution to waste negative effects (as outlined in the subsections 1.1, 1.2, 1.3). These plans have to give an outline of waste streams (for each waste stream, understand all regulatory considerations; who is responsible for each internally, how is each handled, what are the policies and procedures, who are the waste haulers) and treatment options and provide a scenario for the following years that significantly reduce landfills and incinerators in favor of prevention, reuse and recycling.

According to European legislation it is compulsory for every state member to have a national waste management plan, however regional and local authorities are recommended to define their strategies to reach national objectives. A national waste management plan is of a strategic nature, whereas regional or local plans are more action-oriented: operational plans with detailed descriptions of current collection systems, treatment plants. National, Regional and local plans are important tools contributing to implementation and achievement of policies and targets set up in the field of waste management at the national and the European Union level (EU, 2012). The key aim of an urban waste management plan is to set out the work towards a zero waste economy as part of the transition to a circular economy. As direct consequence, cities will become more livable preventing urban degradation and pollution. It is important to establish both short- and long-term goals for waste minimization and integrate them into a meaningful and achievable waste management plan. Target setting allows an organization to set reasonable goals that are consistent with a basic, intermediate or advance approach. Finally, the target goals will inform which performance improvement measures to implement to achieve the goals. Even if cities are most of the time primarily responsible for waste management, in Europe

there are no plans at a local level7. During the EU project MED-3R the authors have defines the guidelines to write a waste management plan at urban scale. There is no rigid pattern for how to structure a waste management plan. However, it may be expedient to structure the plan with three consecutive phases - Background, Status part and Planning Part – and two transversal parts good for all the other planning phases – Participatory Process and Monitoring – as reported in tab.2.

GUIDELINES TO PREPARE AN URBAN WASTE MANAGEMENT PLAN	
CONSECUTIVE PHASES	
1.BACKGROUND	
Overall waste problematic	MSW: increasing per capita waste generation …
Legislative framework	local, regional, national and European legislation
Specific goals for the analyzed area	Main goals: population welfare, environment defense, economic development, resources exploitation …
Working groups	It is suggested to create a working group directly responsible of the definition, control and monitoring of the waste management plan.
2. STATUS PART	
Data collection	Information to consider are: territorial framework, general waste data (waste amounts, waste streams and sources) waste management options, waste collection and treatment, …
SWOT Analysis	With this method it is possible to resume and reorganize all the collected information highlighting the Strengths, Weaknesses, Opportunities and Threats of each analyzed territory
Best practices analysis	There are many best practices on waste management. Local and regional authorities have to identify the most suitable for their territories (see chapter 2.1)
3. PLANNING PART	
Planning condition	Intervention priorities, infrastructure planning and needs, information and tanning needs, budget, …
Main goals	Description of the main goals to reach in the next 5, 10, 15 years
Actions, time, actors and budget determination	It is necessary to define a global picture of the situation considering not only foreseen goals but also actions, times, responsibilities and budget
Connections with other in force programs	The waste management plan has to consider the others plans that manage the territory
TRANSVERSAL PHASES	
4. PARTICIPATORY PROCESS	
This phase crosses all the others. It is addressed to all people involved in waste production (citizens, factories, etc.) and treatment (associations, cooperatives, enterprises, etc.). The participation process is based on: information, communication, awareness and training. There are many possible initiatives to inform and make aware people about the waste issue. To reach an efficient participation, it's important to consider: -The main characteristics of each group involved: age, gender, etc,.. -The communicative content of the awareness message: rational, ethic, touching, alarming; -The instrument typology: TV, radio, internet, newspaper…; -The possible budget.	
5. MONITORING	
The plan application has to respect the legislative framework. Moreover, it is important to do: - A pre-project feasibility study; - An environmental impact study. The monitoring phase have to work during the plan definition and realization. It is necessary to identify the indicators able to control each plan actions.	

Tab. 2 Guidelines proposed by the authors for a waste management plan at a local level

7 According to a research done within the EU project MED-3R (ENPI-CBCMED): F. Pirlone, I. Spadaro, G. Gandino, G. Ferrando, Lignes guides pour la prédisposition d'un plan de gestion des déchets au niveau urbain, 2013

The structure here proposed stem from the reworking of the following documents: Preparing a Waste Management Plan - A methodological guidance note, European Commission 2012; Sfax municipal Plan on waste management, GIZ 2010 and different questionnaires launched in 8 Mediterranean cities (Nice – France -, Genoa – Italy -; Sousse, Sfax – Tunisia -, Aqaba – Jordan -; Byblos and Blat – Lebanon -). All the information contained inside EU guidelines and GIZ methodology were interpolated in a data sheet with cities' needs to find the most suitable structure for a local waste management plan (see Fig. 4).

Fig. 4 Guidelines methodology

2.1 BEST PRACTICES ON WASTE MANAGEMENT

It is important to look more closely at certain aspects of best practices analysis. To write a waste management Plan it is needed an analysis on actions actually realized that could be considered best practices on sustainable waste management. A best practice is an action, exportable to other realities, which allows a municipality, a community or any local government, to move towards forms of sustainable management at a local level (General Directorate of Environment of the European Union, 1997). An action is considered a best practice only if is compatible with the concept of sustainability, that is a model of development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Report - " Our Common Future" UNCED, 1987). In Italy it is possible to point out seven groups of best practices on waste management[8]. These are about:

- Packaging waste prevention activities: substitution of liquid detergents packaged in single-use containers by those distributed 'loose' through self-dispensing systems and refillable containers; tap water instead of bottled water for household consumption; …
- Prevention activities: repair centers;
- Waste sorting: door to door collection; recycling containers in public spaces for tourists; eco-parties with eco-friendly green party supplies, eco-tableware; recycling cooking oil; …
- Reuse initiatives: barter markets for furniture and dresses; creative reuse/upcycling; design to reuse objects and materials; …
- Economic incentives: computerized recycling centers giving points and prizes in exchange for an empty bottle or can; "Pay as you throw" principle; …
- Composting:
- Green public procurements policies:
- Environmental education: theoretical and practical workshops on environmental education; recycling ambassadors; awareness campaigns;

[8] Analysis on waste management best practices done by Francesca Pirlone after Active- Action Vert (EU project: IT-FR Marittimo programme) - http://www.acti-ve.net/file-cabinet.

Local and regional authorities are responsible for defining the most suitable practices for their territories. In this sense the collection of best practices should provide a categorization of: types of experiences, scales and area of intervention (local, regional, national or community), target groups, beneficiaries, budgets, cultural background, implementing subjects such as public and private partnership, types of pilot area (residential, touristic, industrial, …), etc. With regard to cultural background a recent study[9] done by economists George Halkos and Nickolaos Tzeremes demonstrated the influence of major cultural dimensions on ecologic efficiency in 72 countries. High eco-efficiency levels are linked with societies in which skill, wealth, power and status appear to be linked together, where individual interests prevail over collective interests, laws and rights are the same for everyone, ideologies of individual freedom exist and finally the role of the state is restrained (Halkos, Tzeremes 2013). Considering the favorable cultural effect on a country's eco-efficiency levels, a good practice has to look at target groups' cultural background to obtain significant results. A best practice is a real sustainable tool only when it respects at the same time the three aspects of sustainability: environmental, social and economic. For example, door to door collection is a good practice that satisfies environmental and social aspects but it is more expensive than other collection systems. The municipality of Catania cut the costs using volunteers, members of different environmental associations, for the awareness campaign to explain to citizens how door to door collection works. In other village in Sicily, Solarino, door to door collection is made directly by community service volunteers satisfying at the same time the three aspects of sustainability.

TABLE FACTORS TO BE CONSIDERED IN BEST PRACTICE ANALYSIS

PILOT AREA FEATURES	
Typology	residential, touristic, industrial, …
Scale	local, regional, national, …
Population	small, medium, large city, metropolis, …
Topography	plain, hill, mountain, …
PEOPLE/INSTITUTION INVOLVED	
Target groups	children, adults, elders, …
Beneficiaries	private companies, municipalities, associations
Cultural background	target group's environmental attitudes
Implementing subjects	public and private partnership, only public, …
SUSTAINABILITY ASPECTS	
Environmental	environmental benefits
Social	social benefits
Economical	reasonable budget
INNOVATION	
new solutions	ICT, high tech, georeference, …
TRANSFERABILITY	
Transferability of results	results have to be transferable to a range of other communities
REPRODUCIBILITY	
Reproducibility of methods/approaches	methods/approaches have to be transferable to a range of other cases
COMMUNITY RESPONSIBILITY/ENGAGEMENT	
Participation features	consultation, involvement, collaboration in decision-making

Tab. 3 Factors to be considered in best practice analysis. There are many best practices on waste management, local and regional authorities have to identify the most suitable for their territories

[9] 2013, Journal of Environmental Economics and Policy Studies.

Others factors, that have to be considered in best practice analysis, are: innovation, transferability, reproducibility and community responsibility. Best practices are innovative if they produce new solutions or interpret creatively solutions already tested. Transferability and reproducibility are fundamental features that make possible to replicate the proposed model in other contexts or to apply the same solution to other problems. Community responsibility is a very important success factor; the top-down model generally does not produce good results. Best practices are effective if communities are crucial part of the design process and if the practice becomes part of citizens' daily life. Consultation, involvement and collaboration in decision-making are different aspects to be considered to raise community responsibility.

The authors have defined, through a multiple choice frame, the logical relationship that links study case's factors (considered in Tab. 3) and the more common best practices[10]. In Tab 4., it is reported an excerpt taken from the frame over mentioned. The relationship comes from an empirical study on more than 200 best practices on waste management in Europe and their positive or negative effects depending on pilot site's characteristics.

	CHARACTERISTICS					BEST PRACTICES			
	Typology	Topography	Tissue	Target	….	Door to door collection	Waste sorting on the street	Community composter	….
< 45.000 hab. Town/ village	Old town	Plan	Grid plan	Children	….				
	Residential	hill	Organic	Adults	….	**x**	**x**		
	Industrial	mountain	Spread	Elder	….		Only small bins for tourists		….
	Touristic	mix	High density	No residents	….				
	…..	…..	……	…..	….				
> 45.000 hab. < 250.000 hab. City	Old town	Plan	Grid plan	Children	….				
	Residential	hill	Organic	Adults	….				
	Industrial	mountain	Spread	Elder	….		**x**	**x**	….
	Touristic	mix	High density	No residents	….				
	….	…..	….	…..	….				
> 250.000 hab. Metropolitan area	Old town	Plan	Grid plan	Children	….				
	Residential	hill	Organic	Adults	….				
	Industrial	mountain	Spread	Elder	….		**x**		….
	Touristic	mix	High density	No residents	….				
	….	…..	….	…..	….				

Tab.4 Relationship between study case's factors and the more common best practices

[10] Analysis on waste management best practices done by Francesca Pirlone after Active- Action Vert (EU project: IT-FR Marittimo programme) - http://www.acti-ve.net/file-cabinet.

2.2 GOALS AND ACTIVITIES

Waste management Plans are essential to identify local main goals. It is important to set up mid-term and long term goals (in 5, 10, 15 years). These goals have to be aligned to EU's goals expressed in the Directive 98/2008. In particular, by 2020:

- the preparing for re-use and the recycling of waste materials such as at least paper, metal, plastic and glass from households and possibly from other origins as far as these waste streams are similar to waste from households, shall be increased to a minimum of overall 50 % by weight;
- the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste excluding naturally occurring material defined in category 17 05 04 in the list of waste shall be increased to a minimum of 70 % by weight.

A research carried out by Paul Connett[11] has identified the ten steps to zero waste objective (composting, recycling, reusing, non-wasteful product design, etc.). These steps could help municipalities, entrepreneurs and activists responsible for local waste management to set up a strategy to significantly augment their recycled waste. Each step could be considered as an action to reach the main goal: no more mixed waste, landfills and incinerators. In order to better organize and achieve waste management plan's objectives, it is suggested to identify for each action: budget, target groups, beneficiaries, actors, lead-times and references.

TEN STEPS TO ZERO WASTE

Source of separation	Door to Door Collection	Composting	Reduction	Reuse/Repair Community center
Recycling	Economic incentives	Residual separation	Better industrial design	Temporary landfill

Tab.5 Ten steps to zero waste. Source: The Zero Waste Solution: Untrashing the Planet One Community at a Time, Paul Connett 2013

Connett demonstrates how much the situation is changing – in the short term – in many cities that are strongly committed to recycling. The municipality of Salerno achieved 72% waste diversion in only one year, Novara achieved 70% diversion in just 18 months and Villafranco d'Asti has reached 85% diversion. The results obtained so far are encouraging.

3 FINAL REMARKS AND OPEN QUESTIONS

This paper analyses the most effective policy instrument to manage MSW. Waste management plans could significantly reduce urban degradation, pollution and power consumption. Other questions remain still opened: How to change people's behavior and policy makers' attitude? What is the role of environmental education and risk perception? It is sure that the involvement of the various stakeholders and the wider public in the planning process should aim at ensuring acceptance of the waste policy. The authors are developing new researches on these topics to maximize the positive effects of waste management plan at a local level.

Waste policies are essential to increase the amount that a city recycles, developing civic amenity facilities which accept recycling of all types of waste streams from households, and implementing separate collection of residual and mixed dry recyclables. Waste management planning is the cornerstone of any local policy on waste management. There needs to be assurance that Local Authorities have the competency and resources

[11] In the book "The Zero Waste Solution: Untrashing the Planet One Community at a Time".

to fully conduct their responsibilities in the area of enforcement for the benefit of the whole waste management system. The key aim of an urban waste management plan is to set out the work towards a zero waste economy as part of the transition to a circular economy. In particular, this means using the waste hierarchy (waste prevention, re-use, recycling, recovery and finally disposal as a last option) as a guide to sustainable waste management. This paper shows how a waste management plan could be structured, to improve urban waste policies. The professional skills of those who deliver governance have to be continuously maintained and strengthened in order to improve their output and impact. This research is a valuable source of information regarding techniques to reduce a city's exposure to risk caused by MSW bad management. The structure for an urban waste management plan, here presented, enhances the efficiency and effectiveness of MSW services and policies. The aim is to prevent all the negative effects that MSW have on the urban environment: to improve the quality of life in cities and human health by reducing the adverse impacts of the generation and management of waste and by preventing overall impacts of resource use and improving the efficiency of such use. Waste management plans make sure that waste is optimally managed, so that the costs to society of dealing with waste, including the environmental costs, are minimized. There is a need for transparent and consistent methodology across the city for calculating statistics and future waste projections. Waste management plans set out the starting point and the policies that are currently in place to help move the city towards a sustainable vision. It is not however an exhaustive strategy and it necessary to continue to monitor the effectiveness of the policies on waste and resource management to protect the environment and human health. It is recommended to establish a multi-stakeholder sustainability or green team with representatives from departments that share responsibility for the purchase, management, monitoring and/or disposal of particular waste streams.

Much remains to be done to prevent and manage waste to support the growth of the economy and to continue to protect the environment. Some questions remain still opened: How to change people's behavior and policy makers' attitude? What is the role of environmental education and risk perception? Environmental education has a key role to play in achieving sustainable waste management. The public should be included in the planning process but before this phase an awareness campaign on waste's risks should be organized. This is because risk perception is a subjective judgment that affects our decisions. Risk perception is the subjective assessment of the probability of a specified type of accident happening and how concerned we are with the consequences. To perceive risk includes evaluations of the probability as well as the consequences of a negative outcome (Sjöberg, Moen, Rundmo, 2004). Many sustainable solutions studied by experts on waste management and treatment are not supported by citizens. This is because people is more afraid to have a recycling or composting center close to home – even if centers of this type are safe and do not produce armful gases – rather than a landfill or an incinerator 10 Km further. People perceive as a risk only what they have under their nose, they do not consider that greenhouse gases even if produce in another country could affect their life. For this reason, is fundamental to teach how to recognize real risks. Marine litter is another global concern, which represents a risk for the ecosystem and for people life. This is because we are eating fishes that in their turn have eaten plastic (Miranda, 2016). Despite this, citizens are more worried about the placement of a new garbage bin on the street. For this reason, according to different studies (Slovic, Weber, 2002) the risk perception links to waste is generally high, but these researches consider only evident risks connected to landfills or incinerators and not the general exposition to polluted air, soil and water. Waste management is not considered as a risk factor, even if it could be one of the first causes of pollution: municipalities that do not recycle or reuse, even if are keeping the city clean, are affecting the environment and their citizens. This is an objective risk that is not perceived. According to a study done by the American Biological Safety Association (ABSA) risk perception is strongly conditioned by the Epictetus theory: People are disturbed, not by things, but by the view they take of them (Hadot, 2006). Consequently, people go on

producing more and more rubbish without wondering where this rubbish end, the only important thing it is that they do not have to see it near home. Environmental education is not only important for citizens, also decision makers, entrepreneurs, associations … have to be conscious of this topic. Political support and understanding of the need to draw up a waste management plan is crucial. This is to be done according to the various levels of administration concerned, reflecting cultural traditions and political organization (European Commission Directorate-General Environment, 2012).

There needs a common "waste consciousness" (for policy makers, citizens, entrepreneurs …) underlying sustainable waste management plans. Without the general consensus it is impossible to follow zero waste strategies and to apply best practices: everyone has a role to play to get cities more sustainable and livable.

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IMAGE SOURCES

Cover fig.: Cities and Municipal Solid Waste. Sky 24

Fig. 1: EPA (2015). *Social cost of carbon*. EPA FACT SHEET, Washington DC.

Fig. 2: Photographer: Hassan Ammar/AP Photo

Fig. 3: EPA (2005).

Fig.4: elaborated by the authors

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