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Development of a municipal solid waste management decision support tool for Naples, Italy

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ABSTRACT

Naples has experienced serious waste mismanagement during the last several decades. Illegal waste trafficking, the lack of an appropriate municipal solid waste management plan, and the subsidizing of energy generation from indiscriminate waste incineration generated social unrest and an unremitting paralysis of waste services throughout much of the late 1990s and early 2000s. The waste situation in Naples is a "hot spot" that cannot be simply described or explained by theoretical and linear models or analyses based on conventional waste indicators. A novel approach for the assessment of urban solid waste management system performance is proposed to overcome the limitations of conventional methods. When dealing with the production and use of scientific information for governance, scientists, especially those used to just "crunch numbers" have a serious problems in providing a useful input to the process of decision making. This paper presents a method useful for organizing a process of production and use of scientific information in which both scientists and the other social actors can have a bidirectional and constructive exchange of information. The goal of this method is to guarantee the quality of the process of generation and use of quantitative science to generate informed deliberations about policies over Municipal Solid Waste Management. The proposed approach builds on metabolic network theory and multi-scale integrated analysis of societal and ecosystem metabolism (MuSIASEM). The current metabolic pattern of municipal solid waste in the Metropolitan Area of Naples is described and quantified across hierarchical scales and dimensions. The analysis shows that the current Neapolitan waste management system is characterized by an elevated share (60%) of waste treated outside of the metropolitan ambit, and a low rate of separate collection (37%). Simulation of (i) metropolitan self-sufficiency of urban waste final disposal, and (ii) increased recycling rate show, respectively (i) an increase in both financial burden and local environmental impact; (ii) a lessening of the local environmental impact and an increase of running costs and higher need of local waste processing capacity.

1. Introduction

The Italian region of Campania, and in particular its capital Naples, has experienced serious waste mismanagement during the last several decades.

Illegal waste trafficking, lack of an appropriate municipal solid waste management plan, and the subsidizing of energy generation from indiscriminate waste incineration generated social unrest and a unremitting paralysis of waste services throughout much of the late 1990s and early 2000s (D'Alisa and Germani, 2013; De Feo and De Gisi, 2010; D'Alisa et al., 2010; Armiero and D'Alisa, 2012; Arena et al., 2003; Di Costanzo and Ferraro, 2013; Mastellone et al., 2009; Dines, 2013; Capone, 2013; D'Alisa et al., 2012).

Despite newspapers continued reporting of new illicit toxic waste dumping areas1, Neapolitan policy-makers prefer to assert that waste management is no longer a critical issue. Nonetheless, there is a shared common sense that the municipal solid waste management system in Campania is in a very precarious equilibrium because of the strong dependence on waste treatment facilities located outside the region, and that steps toward the

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Acronyms and abbreviations

W	Waste
MSW	Municipal Solid Waste
MSWMS	Municipal Solid Waste Management System
EI	Environmental Impact
SES	Socio-Ecological System
MAN	Metropolitan Area of Naples
MARSS	Material Advanced Recovery Sustainable Systems
MCN	Metropolitan City of Naples
MuSIASEM	Multi-Scale Integrated Analysis of Societal and Ecosystem Metabolism
MCA	Multi-Criteria Analysis
MRW	Metabolic Rate of Waste
DW	Density of Waste
DWD	Density of Waste to be Disposed
CM	Mixed Collection
CS	Separated Collection
MBT	Mechanical Biological Treatment
STIR	Stabilimento Tritovagliatura ed Imballaggio Rifiuti (MBT type)
Lf	Landfilling
Inc	Incineration
WW	Waste Water Treatment
PTSP	Presorting Transfer and Storage Platforms
Comp	Composting
AD	Anaerobic Digestion
R	Recycling Centers
R_{EX}	External Recycling
SRMR	Secondary Raw Material Recovery
Rv	Recovery
W_{EX}	Waste exported out of the system
W_{IM}	Waste imported into the system
Met	Metal
PC	Private waste treatment Companies
TSWT	Total Municipal Solid Waste
W_M	Mixed Municipal Solid Waste
$W_{M\text{-}Lf}$	Mixed Municipal Solid Waste to Landfill
$W_{M\text{-}PC}$	Mixed Waste to Private waste treatment Companies
W_{MBT}	Mixed Municipal Solid Waste to Mechanical Biological Treatment
$W_{MBT\text{-}ww}$	Waste Water from MBT going to Waste Water Treatment plants
W_{MBTex}	Mixed Waste to MBT Plants ex
$Met_{MBT\text{-}Rv}$	Metal coming from MBT to Recovery
FST	Frazione Secca Tritovagliata
FST_{Inc}	Dried fraction coming from MBT sent to Incineration
$FST_{Inc\ EX}$	Dry Fraction sent to Incineration ex
FUT	Frazione Umida Tritovagliata (Humid Fraction from MBT)
FUT_{Lf}	Humid Fraction sent to Landfill
FUT_{Oth}	Humid Fraction sent to Other treatments
FUTS	Frazione Umida Tritovagliata Stabilizzata (Stabilized Humid Fraction)
$FUTS_{Lf}$	Stabilized Humid Fraction sento to Landfill
$Fly\ ashes_{\text{-}ww}$	Fly ashes from Incineration going to wastewater treatment ex
$Bottom\ ashes_{\ Rv}$	Bottom ashes from Incineration going to other Recovery facilities ex
$W_{Inc\text{-}ww}$	Other fractions from Incineration going to wastewater treatment ex
W_S	Separated Municiapl Solid Waste
W_{PTSP}	Separated Municiapl Solid Waste to Presorting Transfer and Storage Platforms
$W_{PTSP\text{-}Inc}$	Refuse from PTSP to Incineration ex
$W_{PTSP\text{-}Lf}$	Refuse from PTSP to Landfill ex
$W_{PTSP\text{-}Rex}$	Waste from PTSP to Recycling Centers ex
$W_{PTSP\text{-}Rv}$	Waste from PTSP to Recovery
W_{AD}	Biodegradable Waste from CS sent to Anaerobic Digestion
$W_{ADDig\text{-}Lf}$	Digestate from AD going to Landfill
$W_{AD\text{-}ww}$	Wastewater from AD going to Landfill
W_{Comp}	Biodegradable Waste from CS sent to Composting
$W_{Comp\&AD}$	Biowaste to Composting & Anaerobic Digestion ex
W_R	Dried Separated Municipal Solid Waste sent to Recycling Centers
W_{RRv}	Waste from Recycling centers sent to Recovery facilities
$W_{R\text{-}Inc}$	Refuse from Recycling Centers going to Incineration ex
$W_{R\text{-}Lf}$	Refuse from Recycling Centers going to Landfill ex
W_{SRMR}	Recyclables from Recycling Centers sent to Secondary Raw Material Recovery facilities

development of a more sustainable system are direly needed. However, the waste situation in Naples is a “hot spot” which cannot be simply described or explained by theoretical or empirical models or analyses based on conventional waste indicators as if it were just another Italian city (D'Amato et al., 2014; Mazzanti et al., 2009; D'Alisa et al., 2012).

Conventional approaches to waste-management systems share a common characteristic: reductionism - i.e. they identify, analyze and measure separately the characteristics of single parts of the process (e.g. collection, processing, disposal). Because of this choice, they lack an adequate holistic view and system-thinking approach (Seadon, 2010).

Quantitative models tend to assume a general validity of their analysis (extensive applicability). As result of this fact, in-depth analysis of the local context as well as detailed waste material analysis and balance are quite rare in the literature. This is a serious shortcoming since it is essential to gather information about the local specificities for the implementation of a viable waste management system.

Another crucial aspect which must be taken into account in relation to the robustness of the assessment of the performance of an MSWMS is social participation. As a matter of fact, policies aimed at improving the performance of a local waste management system must acknowledge the central role of the social actors, whose perceptions, narratives and values necessarily play a key role in policy creation.

When dealing with the production and use of scientific information for governance, scientists, especially those used to just “crunch numbers” have a serious problems in providing a useful input to the process of decision making. Standard problems are: (i) they assume that the narrative they are using to frame the analysis in quantitative terms is “the right one”; (ii) they assume that the way they are representing the system to be described is the most useful; (iii) they assume that the only problem to be faced is to explain to the rest of the society “that what they suggest to do is the best thing to be done”. In the field of science and society this attitude is called the ‘deficit model’ – i.e. scientists know better and to implement policies one has just to explain to the other social actors