TeMA

Journal of
Land Use, Mobility and Environment

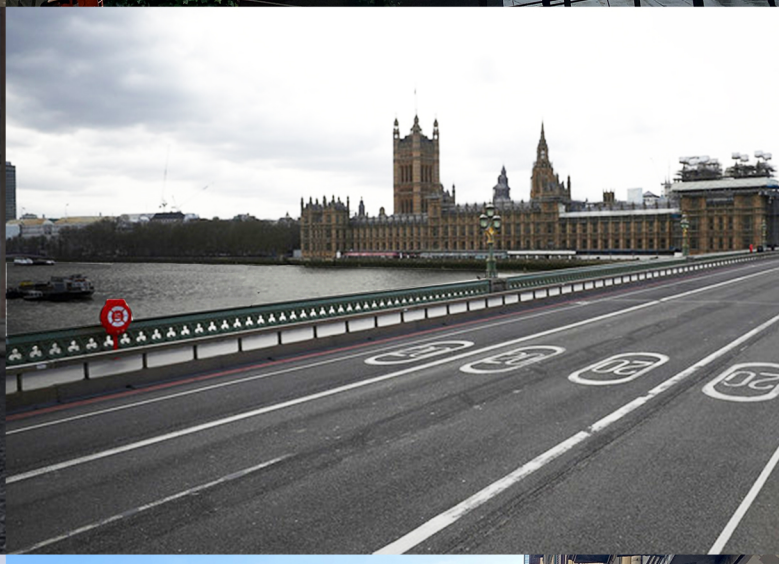
This Special Issue of TeMA - Journal of Land Use, Mobility and Environment, collects twenty-seven contributes of international researchers and technicians in form of scenarios, insights, reasoning and research on the relations between the City and the impacts of Covid-19 pandemic, questioning about the development of a new vision and a general rethinking of the structure and urban organization.

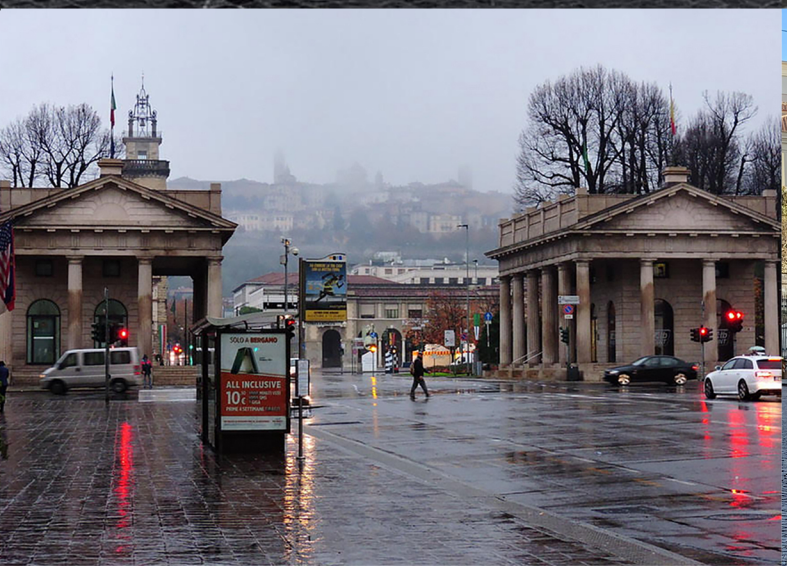
TeMA Journal offers papers with a unified approach to planning, mobility and environmental sustainability. With ANVUR resolution of April 2020, TeMA journal and the articles published from 2016 are included in the A category of scientific journals. From 2015, the articles published on TeMA are included in the Core Collection of Web of Science. It is included in Sparc Europe Seal of Open Access Journals, and the Directory of Open Access Journals.

Special Issue

Covid -19 vs City -20

scenarios, insights, reasoning and research





ISSN 1970-9889
University of Naples Federico II

TeMA Journal of
Land Use, Mobility and Environment

Special Issue

COVID-19 vs CITY-20
SCENARIOS, INSIGHTS, REASONING AND RESEARCH

Published by
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"

TeMA is realized by CAB - Center for Libraries at "Federico II" University of Naples using Open Journal System

Editor-in-chief: Rocco Papa
print ISSN 1970-9889 | on line ISSN 1970-9870
Licence: Cancelleria del Tribunale di Napoli, n° 6 of 29/01/2008

Editorial correspondence
Laboratory of Land Use Mobility and Environment
DICEA - Department of Civil, Architectural and Environmental Engineering
University of Naples "Federico II"
Piazzale Tecchio, 80
80125 Naples
web: www.tema.unina.it
e-mail: redazione.tema@unina.it

Given the short time to produce the volume, the Editorial Board of TeMA Journal carried out the scientific quality audit of the contributions published in this Special Issue.

The cover image is a photo collage of some cities during the Covid-19 pandemic quarantine (March 2020)

TeMA Journal of Land Use, Mobility and Environment offers researches, applications and contributions with a unified approach to planning and mobility and publishes original inter-disciplinary papers on the interaction of land use, mobility and environment. Domains include: engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science and complex systems.
With ANVUR resolution of April 2020, TeMA Journal and the articles published from 2016 are included in A category of scientific journals. From 2015, the articles published on TeMA are included in the Core Collection of Web of Science. TeMA Journal has also received the *Sparc Europe Seal* for Open Access Journals released by *Scholarly Publishing and Academic Resources Coalition* (SPARC Europe) and the *Directory of Open Access Journals* (DOAJ). TeMA is published under a Creative Commons Attribution 3.0 License and is blind peer reviewed at least by two referees selected among high-profile scientists. TeMA has been published since 2007 and is indexed in the main bibliographical databases and it is present in the catalogues of hundreds of academic and research libraries worldwide.

TeMA Journal of Land Use, Mobility and Environment

Special Issue

COVID-19 vs CITY-20
SCENARIOS, INSIGHTS, REASONING AND RESEARCH

Contenets

TeMA Journal of Land Use, Mobility and Environment

TeMA Special Issue | Covid-19 vs City-20, 59-66
print ISSN 1970-9889, e-ISSN 1970-9870
DOI: 10.6092/1970-9870/6904
Received 28th May 2020, Available online 19th June 2020

www.tema.unina.it

About the effects of Covid-19 on solid waste management

Alessandra Cesaro [a*], Francesco Pirozzi [b]

[a] Department of Civil, Architectural and Environmental Engineering, University of Napoli Federico II, Napoli, Italy
e-mail: alessandra.cesaro@unina.it
ORCID: https://orcid.org/0000-0002-6872-6292
* Corresponding author

[b] Department of Civil, Architectural and Environmental Engineering, University of Napoli Federico II, Napoli, Italy
e-mail: alessandra.cesaro@unina.it
ORCID: https://orcid.org/0000-0001-8418-3809

Abstract

Over the last months, spread of the SaRS Co-V 19 virus has been much more than a healthcare emergency. It overrun people's life styles, society's organizational models, welfare systems, the economy and business world, as well as solid waste management schemes.

The critical issues that have emerged require actions to overcome the crisis, while paving the way to achieve sustainable development goals: in this view, the Covid-19 emergency may represent an opportunity, as suggested by the International Institute for the Sustainable Development.

This work discusses the impact of the Covid-19 emergency on both the generation and the management of solid waste originating from both household and healthcare activities. Data about the amount of waste produced and associated ordinary handling procedures were gathered in order to highlight how both have been affected by the measures implemented to cope with the emergency. The vulnerabilities of the overall solid waste management system have been revealed, pointing out the need for a careful rethinking of possible avenues for future development.

Keywords

Environmental protection; Solid waste management; Sustainable development

How to cite item in APA format

Cesaro, A. & Pirozzi, F. (2020). About the effects of Covid-19 on solid waste management. *Tema. Journal of Land Use, Mobility and Environment*, 59-66. http://dx.doi.org/10.6092/1970-9870/6904

1. The management of solid waste

Solid waste refers to all those objects that have reached their end-of-life as well as those disposed by their keepers. Consequently, its composition is extremely heterogeneous and tightly linked to its origin, which allows a distinction to be made between municipal and special waste. The former includes the residues produced from households; the latter refers to all other types of waste. Solid waste is further classified into either hazardous or non-hazardous waste, regardless of its origin and in accordance with its hazardous properties.

In the last decades, management of solid waste has been under intense review, aiming towards an integrated approach, and thus at the maximization of material and energy recovery, as well as at the reduction of landfilling. To this end, solid waste streams are source-sorted by main components and hazardous properties and sent to adequate treatment processes.

The overall management develops through a series of activities that, although pursuing common objectives, are implemented differently, in accordance with the specifications of a complex legislative framework. At national level, the main reference is Legislative Decree no. 152/2006, but additional specific legislation has been enforced to regulate particular kinds of waste: this is the case of medical waste, whose handling is governed by Presidential Decree 254/2003.

In 2018, production of municipal solid waste (MSW) in Italy was reported to be greater than 30 million tons, corresponding to an annual per capita amount of approximately 500 kg, with a 2% increase compared to the quantity registered in 2017. About 58% of the waste produced was collected separately, but some differences in source selection levels can be recognized among Italian Regions (ISPRA, 2019a). In Campania, MSW production was greater than 2.6 million tons in 2018 and almost 53% of this waste was source-selected (ISPRA, 2019a).

Source-sorted waste streams are sent to recycling processes, whereas the remaining unsorted fraction, often mechanically pretreated, is destined to thermal processes in order to produce energy and dispose in landfill only the residues that cannot be valorized by other means.

The integrated MSW management system can be organized according to different schemes, in order to fulfill legislative requirements and recovery targets. The choice must take into account MSW composition, but it is obviously influenced by the availability of waste treatment plants. Despite the progress made in the last decade, several Italian regions have still difficulties in "closing the loop" of waste materials and handling their own MSW in accordance with the self-sufficiency principle.

In 2018 Campania Region exported more than 101.000 tons of waste, corresponding to the 21,8% of the overall waste exported at national level (ISPRA, 2019a). In the same year, the Region exporting the greatest amount of waste was Friuli Venezia Giulia, while some other region became prominent importers. This condition accounts for the existence of a particularly dynamic waste market, not only at national level, but also in Europe and in other areas worldwide.

Europe is tightly dependent on the waste trade with Asian countries to reach its recovery targets: for instance, the trade network for plastic waste involves Asia as the main importer and both Europe and North America as the greatest exporters. The import ban established in 2017 in China, which was the undisputed leader in the global plastic waste trade, had severe effects on the recycling system of several countries and significant streams were redirected towards other Asiatic countries (Wang et al., 2020).

A self-sufficient waste management should be pursued not only for MSW, but also for special waste, including the waste produced by hospitals and medical care services. Although the amount of medical waste is much lower than that generated from households, its features require handling procedures ensuring adequate protection of both human and environmental health, starting from its collection.

To this end, Presidential Decree 254/2003 sets out that medical waste must be source-sorted in accordance to its hazardous properties and destined to appropriate treatments: in the case of infectious waste, this is incineration.

Grosso et al. (2020) pointed out that in Campania more than 90% of the medical waste is classified as hazardous and 77% out of the hazardous waste consists of *Wastes whose collection and disposal is subject to special requirements in order to prevent infection* (European Waste Catalogue code 18 01 03). These data are consistent with those of other Italian Regions, highlighting a uniform approach at national level (Grosso et al., 2020). However, it is worth highlighting that in other States infectious waste represents only a minor portion of medical waste, ranging between 3 and 10%, likely because in Italian hospitals all the waste generated by patients is considered infectious (Cesaro & Belgiorno, 2017).

At regional level, the main treatment process for infectious medical waste is sterilization. Every year around 7300 tons of waste is sterilized and converted into a refuse-derived fuel that by necessity needs to be allocated to incineration plants located out of Campania Region. This amount of waste adds up to 39% of medical waste produced in Campania and exported elsewhere even under ordinary conditions (Grosso et al., 2020).

2. The effects of the Covid-19 emergency on the generation and management of solid waste

2.1 Municipal solid waste

The implementation of measures to contain the spread of contagion has forced an immediate modification of lifestyles as well as the lockdown of several industrial and commercial activities, along with bar and food services. This condition, in turns, has immediately driven significant changes in the field of MSW.

The data currently available about MSW amounts and qualitative characteristics are scarce and fragmented; they mostly refer to the sole month of March 2020, which has been only partially affected by the restrictive anti-Covid-19 measures, so that it is hard to provide a comprehensive overview of the change occurred.

Nevertheless, some considerations can be made on the basis of both the declarations provided by local administrators and the information released by companies working in the field of solid waste management, all highlighting the impact of Covid-19 on both the quantity and quality of the waste generated.

The study by Althesys (available at the link: http://www.althesys.com/) predicts that MSW Italian production in 2020 may drop to 2.5 million tons. The same study highlights that the amount of special waste may decrease as well: such reduction may account between 4.2 and 4.5 million tons for Lombardia, Veneto and Emilia Romagna alone, contributing to a lost revenue for the companies that handle this kind of waste close to 1 billion euro.

Further insights can be obtained from the information circulated about some major Italian cities.

During the meeting of the Committees *Ambiente e Controllo enti partecipati*, the Councilor for Mobility and Environmental Services of Milan, Marco Granelli, informed that a relevant reduction in the MSW collected had been observed already on 21st March 2020. The reduction percentages are given in Tab. 1.

MSW fraction	Reduction [%]
Organic	29
Glass	19
Paper and paperboard	22
Plastic	14
Unsorted waste	25

Tab. 1 Reduction in MSW collected in Milan, as reported by the Councillor for Mobility and Environmental Services of Milan

During the same meeting, the 70% decrease in the production of the organic fraction of non-household origin as well as the 43% reduction of the filling degree of street bins were also reported. Finally, the Councilor listed some provisions adopted to contain Covid-19 spread that impact on the solid waste management system. Among others, street sweeping was reduced; cleaning activities in markets and green areas were suspended and they were decreased by 40% in the city center as well as in nightlife areas. Conversely, the same cleaning activities were intensified in the areas close to hospitals, Civil Defense venues, accommodation centers, shopping malls and grocery stores.

A drastic reduction in MSW production was registered also for Turin, as published on the web page of the Metropolitan city of Turin (http://www.cittametropolitana.torino.it/cms/ambiente/rifiuti/osservatorio-rifiuti/ru-rd-mensili/). The operators handling the waste cycle for approximately 2.3 million inhabitants in the metropolitan area of Turin released the data dealing with generation and separate collection. It was shown that overall MSW production in March 2020 was 11.5% lower than the one registered in March 2019. The highest reduction, around 65%, was observed for the city of Turin, due to the reduction in commuter flows after implementation of the restrictions adopted to limit virus spread. As for MSW composition, the amount of packaging waste showed a relative increase against the organic fraction, due to the greater consumption of pre-packaged food as well as due to the wider spread of online shopping. Significant increases were registered for plastic (4.5%) and glass (6.5%) waste, whereas the reduction in paper and paperboard (-1.9%) was observed along with that in both organic (-5.5%) and unsorted (-10.7%) waste.

Different issues are raised by the analysis of data dealing with MSW generation in the municipality of Naples and provided by the company in charge of urban cleaning and waste collection services. Although overall MSW production in March 2020 was found to be 9.5% lower than the one registered in the same month in 2019, no significant change occurred between February and March 2020 (-1.6%). Nevertheless, in this period, waste composition was seen to have changed: the organic fraction significantly increased (26.4%), likely due to the greater consumption of fresh, bulk food, whereas paper (-11%), plastic (-6.4%) as well as unsorted waste (-2.4%) decreased.

It is also worth pointing out that additional types of waste were produced in this period, as a direct consequence of the large use of disposable individual protection items, such as gloves and masks. A daily use of 4 million masks was estimated during the emergency period and a further increase up to 20 million is expected when most working activities resume. Given these premises, a proper handling of the waste originating from the disposal of such items and the potential healthcare-environmental impact on conventional waste management practices need to be identified.

According to the European Centre for Disease Prevention and Control (ECDC), there is not clear evidence allowing to state that standard waste management procedures are not sufficient to ensure adequate levels of protection against the risk for Covid-19 infection or that MSW may play a role in transmission of the virus. Nevertheless, the same Centre recognized the need to adopt specific prevention and control measures for suspected or confirmed Covid-19 cases self-isolating at home.

Therefore, on 14th of April 2020, the European Commission provided *ad hoc* instructions concerning the management of household waste in these cases (European Commission, 2020).

In this regard, Italy anticipated the European measure, with the interim instructions provided by the National Health Institute (Istituto Superiore di Sanità - ISS) in March 2020 about the management of MSW during the emergency period.

According to the protocol drawn up by ISS (2020), when the waste originates from confirmed Covid-19 cases self-isolating at home or even suspected cases quarantined at home, it has to be considered similar to infectious medical waste as defined by Presidential Decree 254/2003 and treated in the same way. If the

management procedures that this Decree establishes for hospitals are not easy to implement, ISS recommended to suspend MSW separate collection and deliver all waste in - at least - two bags well-closed, as unsorted waste. In all other cases, only single-use individual protection items should be disposed with residual waste.

Finally, ISS recommended the companies involved in MSW collection to define specific routes to collect the bags from houses hosting quarantined people.

Following ISS indications, ISPRA produced a supporting document to clarify that when the waste is collected on a dedicated route, it should be primarily destined to incineration without any preliminary treatment; if not possible, the waste has to be delivered to mechanical biological treatment (MBT) plants, ensuring its sanitation (ISPRA, 2020).

The reason for preferring direct waste treatment via incineration lays in the higher level of protection against virus and pathogens provided by high temperature treatments. Conversely, when the waste is processed in MBT plants, handling of the waste itself may promote the release of pathogenic agents and consequent spread of the contagion. Nevertheless, in Italy the authorized thermal treatment capacity is often limited: since MBTs optimize the characteristics of unsorted waste for its thermal valorization, while reducing the amount to be incinerated, by-passing this kind of plants may not be a suitable solution.

The need to prioritize material recovery over energetic valorization, along with the traditional social opposition to the construction of thermal treatment plants has indeed directed waste management planning towards improvement of the recovery chain. However, recovery processes are not supported properly by highly separate collection levels, nor by policies effectively promoting the recycled products market.

The existing thermal treatment capacity, which is often inadequate even under ordinary conditions, could deal only partially with the overloading resulting from the Covid-19 emergency, also due to the diversion of some potentially recoverable materials to the unsorted stream.

In this regard, Lavagnolo and Pivato (2020), discussing the role of incineration plants within MSW management systems, suggest that regional planning should consider that waste-to-energy treatments may prove to be useful to deal with emergency situations like the one currently ongoing.

A further critical aspect of the MSW management system raised by the Covid-19 emergency refers to the recovery of source-selected MSW fractions. Several companies involved in the waste recycling chain have had trouble in either collecting the different materials (such as metals, glass, paper and plastic) or ensuring the delivery of recycling residues in cement plants.

In Campania, for instance, there are approximately fifty platforms for the storage of source-selected MSW that are experiencing severe difficulties due to the restrictive anti-Covid-19 measures. Suspension of the economic activities receiving glass, metals, paper and plastic have limited their possible recovery, and the same effect was obtained because of the scarce supply of waste materials.

This is the case of some paper mills, which cannot work at their full capacity because they do not receive waste paper. Particularly concerning is the situation of the plastic recycling chain, which is largely based on external trade: the transport paralysis that has followed the spread of the Covid-19 has, indeed, cause saturation of the platforms' storage capacity.

In order to deal with some of the above-mentioned issues, to ensure the regularity of collection and management services, ISPRA (2020) suggested the increase of the authorized capacity of storage areas in both productive and waste treatment plants. This proposal was formalized by the Italian Ministry of the Environment, with Circular no. 22276 dated 30 March 2020 and it was subsequently transposed in the Ordinance of the President of Campania Region no. 38 dated 23 April 2020.

2.2 Medical waste

The impact of the Covid-9 emergency on the waste management system is even more serious in the field of medical waste, which includes the residues originating from hospitals and healthcare facilities. As already pointed out for MSW, the large use of disposable individual protection items has contributed to the increase in waste production. The hospitals in Wuhan (China), epicenter of the Covid-19 pandemic, generated up to 240 tons per day of waste during the emergency, in the face of a daily production below 50 tons under ordinary conditions (Zambrano-Montserrante et al., 2020). Similar trends have also been registered in other regions worldwide as well as in Italy, where the companies supporting the most hit healthcare services during the emergency released some information. Although detailed data on the amounts of infectious medical waste are still not available, adoption of strict protocols to protect healthcare service personnel as well as the working conditions at saturated healthcare facilities resulted in the generation of higher amounts of waste, especially infectious.

Management of this kind of waste has been hard, especially due to the substantial lack - at local level - of dedicated plants for the treatment and disposal of medical waste.

Yu et al. (2020), considering the Chinese experience of Wuhan, suggested that installation of temporary incinerators would have represented a viable solution to deal with the dramatic increase in infectious medical waste during the emergency period, but the location selection of these plants would have raised another issue of great importance.

In Italy, where the difficulties in handling infectious medical waste are related not only to the installed treatment capacity but also to storage capacity, on-site sterilization plants would have been a useful option for several healthcare facilities. This solution, advocated by Presidential Decree 254/2003, may be considered for the wider optimization of the management system of infectious medical waste. On site sterilization would indeed entail a reduction in hazardous waste to be transferred from production facilities to dedicated plants as well as a possible increase of available storage volumes, with obvious sanitary, techno-economic and logistic advantages for the healthcare facilities themselves (Grosso et al., 2020).

3. Concluding remarks

The Covid-19 emergency has greatly affected our society's organizational models and people's daily life, with implications for the management of solid waste that reflect both lifestyle and welfare conditions of an area. The timely adoption of restrictive measure to protect human health has impacted both on the quantitative and the qualitative characteristics of the waste generated.

Facing the immediate consequences of the pandemic crisis, its wider impact seems definitely not relevant. Nevertheless, the steady improvement of the situation in many States worldwide poses the need to analyse the critical issues raised.

In the field of waste management, the strategies adopted to pursue the increasingly ambitious goals of a circular economy have proved to be ineffective. The relative increase in packaging waste originating from households indicates that the policies promoting virtuous behaviour among producers did not have any significant effect on daily life and consumption patterns. Paralysis of the management system for waste streams destined to recycling processes points out that recycling in Europe has been directed towards waste trade rather than the implementation of a self-sufficient system to "close the loop" of material cycles. Furthermore, in this way, the economic value of the materials produced in Europe is exported, but not the costs of the recovery policies. The deficiencies of this system were exacerbated to a greater extent in those regions, widespread in Italy, characterized by the lack of waste treatment and disposal facilities. Finally, the need to authorize additional storage capacities, by derogation from legislative provisions, highlights

shortcomings in waste management system planning, which is used to deal with ordinary conditions but does not consider the risks of the solutions adopted.

The Covid-19 emergency has highlighted the global limits of a system that, far from being sustainable, requires structural intervention to support actual implementation of circular economy principles. In this view, the emergency represents an opportunity to re-think waste management strategies, shaping them to allow greater flexibility as well as actual sustainability.

Acknowledgements

The authors wish to thank Eng. Francesco Mascolo and all the staff of ASIA Napoli S.p.A. for having made available the data on solid waste production in the city of Naples. Alessandra Cesaro would like to thank the Italian Ministry of Education, University and Research (MIUR), who provided financial support for her position as Assistant Professor within the research project entitled "Dipartimenti di Eccellenza" per Ingegneria Civile, Edile e Ambientale-CUPE65D18000820006.

References

Cesaro, A. & Belgiorno, V. (2017). Sustainability of medical waste management in different sized health care facilities. *Waste and Biomass Valorization*, 8: 1819 - 1827. https://doi.org/10.1007/s12649-016-9730-y.

European Commission (2020). Waste management in the context of the coronavirus crisis. Retrieved from: https://ec.europa.eu/info/sites/info/files/waste_management_guidance_dg-env.pdf

Grosso, A., De Palma, G. & Federico A. (2020). *La gestione dei rifiuti sanitari in Campania.* Retrieved from: https://www.snpambiente.it/2020/04/22

ISPRA (2019a). *Rapporto Rifiuti Urbani*. Retrieved from: https://www.isprambiente.gov.it/it/archivio/eventi/2019/12/rapporto-rifiuti-urbani-edizione-2019

ISPRA (2019b). *Rapporto Rifiuti Speciali.* Retrieved from: https://www.isprambiente.gov.it/it/pubblicazioni/rapporti/rapporto-rifiuti-speciali-edizione2019#:~:text=Il%20Rapporto%20Rifiuti%20Speciali%2C%20giunto,la%20Protezione%20dell'Ambiente%2C%20i

ISPRA (2020). *Prime indicazioni generali per la gestione dei rifiuti – emergenza Covid-19. Approvato dal Consiglio del Sistema Nazionale per la Protezione dell'Ambiente in data 23 marzo 2020*.

ISS (2020). Rapporto ISS COVID-19 - n. 3/2020 Rev. Indicazioni *ad interim* per la gestione dei rifiuti urbani in relazione alla trasmissione dell'infezione da virus SARS-CoV-2. Versione del 31 marzo 2020. Retrieved from: https://www.iss.it/altre-pubblicazioni/-/asset_publisher/btw1J82wtYzH/content/rapporto-iss-covid-19-n.-3-2020-indicazioni-ad-interim-per-la-gestione-dei-rifiuti-urbani-in-relazione-alla-trasmissione-dell-infezione-da-virus-sars-cov-2

Lavagnolo, M.C. & Pivato A. (2020). Municipal waste management and Covid-19. *IWWG Short Communications, vol. IV del 03.04.2020*. Retrieved from: https://www.tuhh.de/iue/iwwg/news-messages.html#c107996

Wang, C., Zhao, L., Lim, M.K., Chen, W.-Q. & Sutherland, J.W. (2020). Structure of the global plastic waste trade network and the impact of China's import Ban. *Resources, Conservation and Recycling*, 153: 104591. . https://doi.org/10.1016/j.resconrec.2019.104591

Yu, H., Sun, X., Solvang, W.D. & Zhao, X. (2020). Reverse logistics network design for effective management of medical waste in epidemic outbreaks: insights from the Coronavirus disease 2019 (COVID-19) outbreak in Wuhan (China). *International Journal of Environmental Research and Public Health*, 17, 1770, 1-25. https://doi.org/10.3390/ijerph17051770.

Zambrano-Monserrate M.A., Ruano M.A., Sanchez-Alcalde L. (2020). Indirect effects of COVID-19 on the environment. In press on *Science of the Total Environment*. https://doi.org/10.1016/j.scitotenv.2020.138813.

Author's profile

Alessandra Cesaro

Assistant professor of Sanitary and Environmental Engineering at the University of Naples Federico II, her research interests are in the field of solid waste treatment, with particular reference to the advanced anaerobic processing of organic residues and the innovative recovery of valuable materials from electronic waste. With a Ph.D. in Civil and Environmental Engineering obtained in April 2013, she was visiting researcher at the University of Stuttgart as well as at the Technical University of Hamburg, where she cooperated with Ultrawaves GmbH. She has carried out academic teaching activities since 2016 and

she had teaching experience at the Technical University of Hamburg, at Harbour City University (Hamburg) as well as in the framework of several international Training Schools. Since 2016, she is Member of the Scientific Committee of the International Conference on Environmental Science and Technology and in 2019 she joined the International Advisory Board of the International Conference on Environmental Research and Technology. She is co-author of several works published in either ISI-indexed journals or conference proceedings.

Francesco Pirozzi

Full professor of Sanitary and Environmental Engineering at the University of Naples Federico II, his research interests focus mainly on the treatment of wastewater as well as on the valorization of solid waste. He has coordinated several national and international research projects and he is co-author of more than 240 publications in the field of sanitary-environmental engineering. Former President of both the Master and Bachelor Degree Courses in Environmental Engineering at the University of Naples Federico II from November 2009 to June 2013, he has been the Coordinator of the same courses until June 2019. He was the General Secretary of the Italian Association of Sanitary Environmental Engineering (ANDIS) from May 2004 to October 2014, Vice-President of the Italian Group of Sanitary Environmental Engineering (GITISA) from September 2011 to May 2014 and President of the GITISA from May 2014 to February 2018. Since November 2014, he is the Delegate of the Rector for the building stock of the University of Naples Federico II. He is currently a member of the Environmental Impact Assessment Committee of the Italian Ministry of the Environment.