Waste and biomass management and valorization

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A large number of waste experts and researchers develop globally waste-related research initiatives, and the present waste management situation can improve substantially so as to make a step towards better life quality, as well as the protection of the environment. This ESPR Special Issue includes 47 environmental papers with emphasis on waste and biomass management and valorization, which have been selected on the basis of novelty and quality standards by the Scientific Committee of the HERAKLION 2019 7th International Conference on Sustainable Solid Waste Management (<http://www.heraklion2019.uest.gr>). The Conference was organized in Crete Island, Greece, starting on Wednesday 26th June 2019 with a duration of 4 days. The participation was high, since 750 participants attended from all over the world.

After the successful organization of six international conference events of this series, three in Athens, the first two in 2012 and 2014 and one more in 2017; one in Tinos Island, Greece, in 2015; one in Limassol, Cyprus, in 2016; and one in Naxos Island, Greece, in 2018, the ambition of the HERAKLION 2019 7th International Conference was to present the recent developments and advanced knowledge in the area of solid waste management and circular economy by sharing and introducing further case studies, technological achievements, as well as aspects and experiences at different levels. This Special Issue constitutes the 3rd Special Issue of ESPR published from this conference series of sustainable solid waste management. The 1st ESPR special issue was published including 25 papers presented in the ATHENS 2017 Conference, while the 2nd ESPR special issue was published with 28 waste related papers from the NAXOS 2018 Conference. We are glad that the 3rd Special Issue includes

47 papers, a much higher number comparing with the previous two special issues, which is another proof of the increasing quality and quantity of the presented papers in the HERAKLION 2019 Conference.

Without doubt, we are pleased that the series of our conferences on sustainable solid waste management goes on attracting the interest of the international scientific and academic society and private and public sector. This is evident by the substantial increase in certain numerical indicators, such as the numbers of the conference attendees, the number of origin countries of the participants flying to Crete, as well as the numerical data of contributions submitted and the number of full papers included in the electronic proceedings of the HERAKLION 2019 conference.

Significant work is undertaken in order to keep high quality standards in the scientific work presented during the conference sessions and improve the visibility of the work presented at the conference. This is demonstrated by the significant increase of the number of collaborating journals (10 for the case of our last conference event) and the relevant high impact factors, as well as the number of research papers published at the end in the collaborating journals. About 250 papers presented during the HERAKLION 2019 Conference have already been published in the collaborating journals or have been accepted for publication. It is also our willingness to offer high quality services and make the participants get familiar with the traditions, hospitality, culture, landscape, cuisine, and hospitality of Greece.

The HERAKLION 2019 agenda was indeed rich, including splendid social events and addressing a wide variety of waste-related topics presented in about 500 oral presentations within 26 oral presentation sessions and the extensive poster session with more than 150 posters. The special issue (HERAKLION 2019) was prepared based on 45 articles of this conference and, of course, has international character involving authors coming from a large number of different countries. A new approach of the HERAKLION 2019 conference was the willingness to provide solutions for the promotion of the application of circular economy in agriculture and livestock production

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through organizing extensive relevant site visits during the last day of the conference.

The 47 articles of this ESPR Special Issue involve different issues of sustainable waste management including biological and waste-to-energy technologies, biotechnology, and bioeconomy. The papers are presented based on the acceptance date of each paper.

The 1st paper presented a novel low-cost biosorbent for the adsorption-desorption of phenolic compounds from olive mill wastewater. The aim of this paper was to investigate the effectiveness of pomegranate seed, a by-product of the juice industry, for the adsorption of phenols within olive mill wastewater. In addition, chemical activation and thermal activation of the adsorbent followed so as to improve total phenols uptake and afterwards, while desorption process in HCl was studied. The paper outcome indicated that pomegranate seed can be utilized as a biosorbent with low cost.

Next, the 2nd paper deals with tomato green waste biochars that are used as sustainable trivalent chromium sorbents. Sorption processes were performed to examine the opportunity to apply biochar derived from waste tomato leaves and stems for Cr(III) ion removal. Biochars were made available through pyrolysis in a wide range of temperatures. The produced biochars were studied using proximate and ultimate analyses, pH point of zero charge, FT-IR, SEM, as well as mercury porosimetry.

The 3rd paper caters with the influence of preliminary processing of end-of-life tires (ELT) on vehicle exhausts emissions and transportation cost. More specifically, the work studies the collection and transportation costs of ELT including preliminary processing of waste tires like cutting, baling, and packing tires in order to decrease the volume of each shipment. The exhaust emissions of the waste collection vehicles were investigated in the different collection scenarios. In this paper, an innovative multi-criteria decision support tool has been used so as to select the best scenario, taking into consideration costs and environmental impacts in the ELT collection. The paper recommends using the ELT compacting at the collection points for ensuring efficient transportation.

The following paper (4th) explores the powerful phytoarsenal of white grape marc against parasites and bacteria that cause important diseases. The present paper performs the characterization of two extracts based on white grape marc, a winemaking by-product, describing their physicochemical features and antimicrobial capacities. The main components of these extracts are flavan-3-ols and their gallates and flavonols and their glycosides, phenolic acids. As a consequence of this complex composition, the extracts presented pronounced bioactivities with potential uses in pharmaceutical, agricultural, and cosmetic applications.

The use of spent coffee grounds (SCG) in growing media for the production of *Brassica* seedlings in nurseries is the subject of the 5th paper. SCG was used in order to substitute

peat in substrate mixtures for producing *Brassica* seedlings. Seeds of cabbage, cauliflower, and broccoli were placed in substrate mixtures containing 0–2.5–5–10% SCG. The mixture of SCG with peat had impact on several physicochemical characteristics of the growing media, offering also mineral elements to satisfy the needs of the seedling growth. The paper showed that SCG can be used for seed germination biostimulants and/or partially replace the peat for producing *Brassica* seedling.

The 6th paper addresses sustainable metropolitan areas perspectives via assessment of the current waste management strategies. Through a Driver-Pressure-State-Impact-Response model analyses, the paper focuses on the assessment of the existing procedures, practices, and outcomes so as to determine whether the municipal solid waste management followed for the case of 3 municipalities in the greater urban area of Attica could be considered sustainable. The outcome is considered useful for local authorities and policymakers towards taking action related to the targets set from the circular economy strategies.

Furthermore, the 7th paper presents the influence of addition of organic fillers on the properties of mechanically recycled poly(lactic acid) that is one of the most used biobased and biodegradable polymers. The aim of this paper was to assess the usefulness of the addition of small amounts of two organic fillers, silk fibroin nanoparticles, and chitosan during the recycling process in order to improve the properties of the recycled plastic. The use of organic fillers is a financially viable and environmentally friendly way for achieving improved mechanical recycling of bioplastics.

Next, a Colombian case study on the implementation of strategies to optimize the co-composting of green waste and food waste is presented. In this paper, three strategies have been put into implementation: (i) addition of unprocessed food and processed foods as co-substrates for green waste to improve the nutrients composition of the substrates at the beginning of the process, (ii) addition of phosphate rock to improve the quality of the product, and (iii) the use of composting of two stages to accelerate the process of degradation.

The following 9th paper presents a detailed analysis of the existing situation to set up an after-use plastics strategy in Emilia Romagna in Italy. The paper investigated the current panorama of the recycling system for plastic waste aiming at finding out to what extent the current performance fulfils the future scenario established by the European Commission. The secondary plastics market has been studied, too. The secondary resources are not considered as waste, and there is no by official data collection scheme for registering and monitoring them. Data coming from official waste databases are integrated with results originating from individual questionnaire submitted to recyclers at local level. Identifying the main polymeric streams and, as a result, exploiting the economic

potential represent the first actions in order to plan an after-use plastic economy with basic target to have all recyclable and/or recycled plastic packaging by the year 2030.

After that, the 10th paper studies how the reaction parameters influence the recovery of nutrients from digestate by struvite crystallization. Lab-scale batch experiments were performed to investigate the effect of supersaturation, Mg and P concentration, temperature, and pH value on struvite crystallization reaction using as raw material the digestate of pig manure from an AD plant.

The 11th paper deals with the preparation of activated carbon from poly(ethylene terephthalate) waste and with the physicochemical characterization of activated carbon and its use as adsorbent of bisphenol A in aqueous solution, while the next (12th) paper presents the detailed composition analysis of municipal solid waste for Nur-Sultan City in Kazakhstan. Among sustainable waste management recommendations addressed for Nur-Sultan and applicable to other cities, composting is a main suggestion because of the high content in biowaste and its high potential to decrease the volume of the landfilled waste and to help towards waste valorization.

The 13th paper deals with Zn²⁺ and Cd²⁺ removal from wastewater using clinoptilolite as adsorbent. After the first part that focused on the hydrotalcites synthesis processes, the review reported on particular environmental applications selected indicatively in several fields (depollution and green chemistry) that have gained increasing attention during the last years, enlightening the links between synthesis route, structural properties, and application using lamellar materials. The 14th paper is a review one on layered double hydroxides and LDH-derived materials in selected environmental purposes.

The 15th paper of the Special Issue addressed enrichment and purification of red pigments from defective mulberry fruit using biotransformation in a liquid-liquid-solid three-phase system. Overall, the system that was developed offered a simple and efficient method for high purity mulberry red pigment production and recycling in the area of promoting sustainability in agriculture.

Next, the 16th paper dealt with methane oxidation of residual landfill gas in a full-scale biofilter with emphasis on human health risk assessment of volatile and malodorous compound emissions. Three different scenarios of landfill gas management were defined, and 9 volatile organic compounds (n-hexane, cyclohexane, 3-methylpentane, 2-methylpentane, xylenes, benzene, vinyl chloride, dichlorodifluoromethane, toluene) were identified. The pollutant concentration at eleven sensitive receptors was measured using the CALPUFF dispersion model.

The 17th study addressed stabilization of expansive soils with biomass bottom ashes for an eco-efficient construction. More specifically, bottom ashes originating from electric power generation facilities using biofuel combustion were

assessed to verify their potential use as expansive clay stabilizers. The authors aimed at:

- Finding a new route about waste that is normally landfilled although it has high potential based on its technical characteristics
- Improving the mechanical properties and reducing the expansive nature of the expansive clays identified during a motorway development

The next (18th) paper made a review on anaerobic digestion of rice straw for biogas production. It reviewed the characteristics, principles of rice straw, and the process variables (volatile fatty acids, pH temperature, metal elements and organic loading rate, carbon to nitrogen ratio) that influence the performance of the rice straw digestion and process strategies which may alleviate the barriers and may strengthen the yield of biomethane. The utilization of rice straw along with other co-substrates and appropriate pretreatment may be a suggested as a solution to prevent health and environmental hazards.

The 19th paper dealt with upscaling the valorization of wheat straw residues with emphasis on alkaline pretreatment using sodium hydroxide, enzymatic hydrolysis, and biogas production. More specifically, alkaline delignification of straw using NaOH was studied prior to enzymatic hydrolysis for producing easily biodegradable sugars. After defining the optimum conditions for the pretreatment scheme, the anaerobic digestibility of the effluents produced was assessed.

Following, the 20th paper addresses the optimization of hybrid treatment of olive mill wastewater through impregnation onto raw cypress sawdust and electrocoagulation, proposing an innovative way for sustainable treatment and handling of olive mill wastewater. It includes the combination of its impregnation onto raw cypress sawdust that is accompanied by the process of electrocoagulation.

The next paper quantifies the advantages of prefabrication as a method for reducing the generated quantities of construction waste in China. Not only would the extensive use of prefabrication decrease the cost related to construction waste management in China, but it could also mitigate the social and environmental impacts of this waste stream at world level.

The title of the 22nd paper is “The journey from products to waste: A pilot study on perception and discarding of electronic waste in contemporary urban India.” Its objective was to make an exclusive pilot study with the potential to replicate the same at a larger scale in big metropolis which are mostly the hubs of intense E-waste generation.

The 23rd paper developed a consumer awareness campaign to reduce household food waste based on structural equation behavior modeling in Hungary. The objective was to explore behavioral patterns behind household food waste with partial least square structural equation modeling. The results were

based on a quantitative consumer survey with personal interviews. The outcome offered behavioral insights to a national level food waste prevention campaign in Hungary, with the name *Wasteless*.

The 24th paper provides a comparative response of mesophilic and thermophilic sludge digesters to zinc oxide nanoparticles. In this paper, the effect of particle size, type, and dose of ZnO NPs on anaerobic sludge digestion was studied under thermophilic and mesophilic conditions. The effect was investigated in two stages with different digester feeding regime.

The 25th paper deals with the removal of imidacloprid (IMI) from water by ozonation (O_3) and photo-ozonation (O_3/UV), paying particular attention to the kinetics, matrix effect, and mechanistic aspects of the processes. The IMI removal by O_3 was considerably enhanced at alkaline pH, resulting in almost complete removal under 20 min with a pseudo-first-order rate at pH 8.25.

The 26th paper presented the DECORUM platform for the improvement of resource efficiency in the construction sector. The objective of this work was to develop a quite simple but at the same time holistic approach to the management of construction projects so as to ensure compliance with technical standards and environmental criteria right from the set-up phase and to save natural resources and foster an increased use of recycled materials. To achieve this objective, a multi-user platform was designed and developed to control and manage the procedures and stages of public work and offer assistance to those working in the different implementation stages.

The following paper dealt with the performance of platinum doping on spent alkaline battery-based catalyst for complete oxidation of o-xylene. O-xylene was selected as the model of volatile organic compound in this paper. Physicochemical properties of the selected catalysts were characterized with the use of FE/TEM, XRD, SEM/EDX, BET analysis, and H_2 -TPR.

What is more, the 28th paper catered with the optimization of SO_2 and NO_x sequential wet absorption in a two-stage bioscrubber for elemental S valorization. Sequential wet absorption of SO_2 and NO_x from flue gas was thoroughly studied in this work in a two-stage bioscrubber towards elemental S valorization pursuing reuse of biological process effluents as absorbents.

The effect of thermochemical pretreatment on the saccharification and enzymatic digestibility of olive mill stones and their bioconversion towards alcohols was studied in the next paper of the special issue. The paper studied the effect of thermo-chemical pretreatment on the enhancement of enzymatic digestibility of olive mill stones. It also investigated its potential valorization through the bioconversion process of the generated free sugars to alcohols.

The 30th paper studied biorefineries based on experimental data, with emphasis on the production of biogas, bioethanol, syngas, and electricity using coffee cut-stems as raw material. More specifically, this study evaluated experimentally a biorefinery producing energy vectors using coffee cut-stems as feedstock. The obtained yields were the basis for environmental and energy analysis, in two different biorefinery scenarios: (i) production of syngas and electricity and (ii) production of bioethanol and biogas.

The development of the collection of statistical food waste data on the primary production of vegetables and fruit was the subject of the 31st paper. The approach included the development of a method in order to collect food waste information about the primary production of vegetables and fruit with the use of a farmer questionnaire. A form for data collection was planned and tested for this reason. The gathered data were relevant to the volumes of different uses of yields and the reasons why part of the yield does not end up in food use. Food potatoes, white cabbage, carrots, and strawberries were among the crop species included in the pilot study.

The 32nd article addresses the potential environmental risks of the utilization of composts from household food waste, while the 33rd one deals with total organic carbon as a proxy for metal release from biostabilized wastes. The authors introduced a simple screening method to predict the metal release from biostabilized wastes as a function of the total organic carbon content of the sample. The method relied on a model that simulates the release of dissolved organic carbon as a function of the applied liquid to solid ratio.

The 34th paper dealt with cost analysis and environmental assessment of recycling paint sludge in asphalt pavements. Paint sludge is a waste product made from spray application of paints in automotive industry. This paper evaluated for the first time the economic costs and environmental implications associated with recycling paint sludge.

The 35th paper referred to the bioelectrochemical treatment of municipal solid waste landfill mature leachate and dairy wastewater as co-substrates. Start-up and operation of two dual-chamber microbial fuel cells with different electrodes' structure, fed with mature municipal solid waste landfill leachate, were discussed in this study. Influent (a mix of mature landfill leachate and dairy wastewater at varying proportions) was fed to the anodic chambers of the units, under different conditions. Operational issues and effects of cells' architecture and electrode materials on systems' performance were discussed in detail.

Next, the 36th paper targeted at an overview of strategies and reuse options for a solar drying facility in Poland towards sustainable management of biological solids in small treatment plants. The issue of sustainable management of biosolids from wastewater treatment is a significant issue worldwide. Residual sludge disposal costs and environmental impact may be significant, and decreasing such costs, as well as the

consumption of energy required for dewatering and drying, is a main issue for ensuring sustainable and safe disposal of sludge, having in mind the recent ban of some disposal options, such as landfilling, in many countries in Europe. Solar drying is another solution. It is characterized by reduced land requirements compared with traditional outdoor drying beds. It also has low-energy requirements in comparison with other thermal drying methods.

The 37th paper presents a strategy for the implementation of water quality-based discharge limits for the regulation of hazardous substances. This paper aimed at the development of a strategy that suits the needs of developing countries for the transition from technology-based discharge standards to water-quality-based discharge limits. A monitoring program at pilot level was implemented in Turkey for the case of the Gediz River Basin.

Next, the paper entitled “Activated carbon production from industrial yeast residue to boost up circular bioeconomy” aimed to obtain activated carbon from yeast residue to boost up bioeconomy. In this way, carbon was prepared from yeast biomass produced by the ethanol industry and after beta-glucan extraction. Carbon was activated with CO₂, water vapor, and a combination of both using an experimental design.

Furthermore, the 39th paper addressed the simultaneous biofiltration of H₂S and NH₃ using compost mixtures from lignocellulosic waste and chicken manure as packing material. Considering that packing materials affect the performance and represent the main cost of installation, this paper aimed at evaluating the biofiltration of H₂S and NH₃ comparing three composted mixtures made from chicken manure and lignocellulosic residues used as packing material. A range of gas concentrations similar to those of a municipal WWTP was used in the biofiltration of a contaminated stream performed on a laboratory scale.

After that, the 40th paper referred to the pre-treatment of pig manure digestate for subsequent valorization by struvite. This paper evaluated the release of P contained in the digestate from the AD of pig manure via an acidification process. The scope of this process was to increase the P amount available in the digestate liquid fraction and, at the end, recover it by chemical precipitation in the form of calcium phosphate or struvite. Different digestate samples were studied. The treatment included the addition of H₂SO₄ to the different digestate fractions.

The following paper addressed nanomodified sugarcane bagasse biosorbent: synthesis, characterization, and application for Cu(II) removal from aqueous medium. The

investigated materials exhibited promising results to be used as biosorbents in the remediation of effluents contaminated with toxic metal ions, such as copper.

The next study presented in the special issue was relevant to the mechanism and role of seeded native grasses to immobilize nitrogen on harvested blanket peat forests for protecting water courses. The results from all three experiments suggested that seeded grasses are a major sink of N on harvested blanket peatland forests.

The 43rd paper of the HERAKLION 2019 Special Issue presented a system thinking approach to getting familiar with the challenges of the circular economy promotion. In this paper, the significance of systems thinking in order to understand the way resource recovery systems operate and promote deep transformational change is discussed.

The 44th paper of the special issue dealt with hexavalent chromium removal from water with emphasis on adsorption properties of *in natura* and magnetic nanomodified sugarcane bagasse. The 45th paper of the special issue addresses sono-oxidation treatment of hazardous ABS/PC surface for its selective separation from ESR styrene plastics.

The 46th paper of the Special Issue presents a multi-elemental analysis, including heavy metals and trace elements in ambient air samples for the case of computers, wires, lead batteries, and iron extraction facilities in Pakistan. The data revealed the presence of several metal elements at recycling facilities for waste from electrical and electronic equipment. The scope of the last 47th paper of this Special Issue was to investigate the occurrence of micropollutants in the Yesilirmak River in Turkey in order to prepare an effective strategy for monitoring.

The Guest Editors would like to express our thanks to the Editor-In-Chief of Environmental Science & Pollution Research, Dr. Philippe Garrigues, for providing us with the opportunity and trust to publish this Special Issue on Waste and Biomass Management and Valorization, and we are also happy that another ESPR Special Issue will include high-quality papers from the THESSALONIKI 2021 8th International Conference on Sustainable Solid Waste Management that will take place virtually from 23rd to 26th June 2021 due to COVID-19 restrictions.

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He has cooperated with the European Commission directly, as he acted as TAIEX expert (institutional building) in many countries. He has long training activity in the field of environment in different countries and has been working for the Hellenic Open University as Collaborating Teaching Staff in the field of solid waste for 7 years. He has already published more than 250 articles in journals and conferences; he has served as Guest Editor in several Special Issues, while he has had the key role in the organization of a large number of international conferences. Indicatively, he is the Head of the Organizing Committee and key member of the Scientific Committee for the successful series of conferences on Sustainable Solid Waste Management.

Maria Loizidou obtained her PhD in chemical engineering focusing on the field of environmental protection at the University of London. She followed an academic career being Professor at the School of Chemical Engineering of the National Technical University of Athens and Head of the Unit of Environmental Science & Technology (www.uest.gr) with great achievements and distinctions.

Her efforts are continuous in the field of the environmental protection and human health, enhancing education, innovation, and research technology. She has been scientific responsible for 200 environmental projects supporting competent authorities, municipalities, and others (<http://www.uest.gr/index.php/projects>). She has more than 600 publications in international scientific journals (<http://www.uest.gr/index.php/publications>) and conferences and about 10,000 citations. Prof. Loizidou is the Head of the Scientific Committee of this series of conferences on Sustainable Waste Management. She has also organized many other conferences in the field of climate adaptation, circular economy, and industrial waste and wastewater treatment and valorization. Prof. Loizidou is the Head of WtERT-Greece since January 2020. She has also won the first Green AWARD with the LIFE SOL-BRINE project that was voted as the best LIFE ENVIRONMENT project for the period 1992–2017 among more than 4000 LIFE projects from all over Europe.