PhD Candidate Profile

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Area (field) of study:
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Thesis Title:
Innovative strategies for urban wastewater reclamation based on solar and conventional treatment integration.

Abstract:
The advance of science has facilitated an increase in human life expectancy, which is reflected in global growth in population, economic development and urbanisation, but also, unfortunately, in an increase in the over-exploitation of natural resources and an increase in environmental pollution. Water is one of the environmental resources in which persistent and mobile chemicals are often a systemic problem, as it is driven by factors closely related to the prevailing ways of production and consumption. The problem is reinforced by missing advanced and cost-effective water treatment solutions, including remediation and monitoring techniques for the environment, as well as persistent water scarcity problems and/or bad water quality. Within this scenario, there is a clear challenge on finding out alternative water sources. The reuse of wastewater is one of the practices that would increase the resources available, making the management of the resource much more efficient and sustainable, especially in regions with a high level of water stress. This practice is in line with the Sustainable Development Goals (SDGs), especially with SDG 6 on Clean Water and Sanitation, which sets the objective of substantially increasing the reclamation and safe reuse of water in

the world by 2030, as well as with the European Commission's strategy on the circular economy.

The presence of contaminants of emerging concern (CECs), pathogen microorganisms, antibiotic resistance genes, or disinfection by-products among others, are presumed to be harmful to humans and ecosystems. CECs are considered nowadays as one of the main challenges associated with wastewater treatment and reuse (mainly in agriculture for irrigation). Although MWWTPs efficiently fulfil their main objective of eliminating biodegradable organic matter, neither the processes based on activated sludge nor the more conventional tertiary treatments such as filtration or chlorination were designed for the elimination of CECs [Petrie et al., 2015]. In this way, pesticides, hormones, drugs, personal hygiene products and other industrial pollutants are continuously discharged into the environment by MWWTP effluents, being possible to detect these worldwide in practically any body of water at a very low concentration level (ng-µg/L) [Sousa et al., 2018]. Its presence in the environment has been associated with many and various adverse effects such as alterations of the hormonal system (endocrine disrupting effect), feminization of fish or the proliferation of antibiotic resistant bacteria (ARB) and antibiotic resistant genes (ARGs), considered one of the of the greatest risks for humanity in the coming years by institutions such as the World Health Organization (WHO). Furthermore, over the last few years, it has been shown that different classes of CECs can be absorbed through the roots of the plants and then transferred to other parts if crops are irrigated with reclaimed water [Christou et al., 2017].

The European Parliament and the Council have recently published (5th June 2020) the new EU Regulation 2020/741 regarding the minimum requirements for the reuse of water. This Regulation, which will be mandatory from 26th June 2023, establishes provisions on comprehensive water management in order to guarantee the safe use of reclaimed water, promoting the circular economy and supporting adaptation to climate change. As a result of this legislation, Wastewater Regeneration plants have focused the efficiency of their treatments on attaining required water microbiological quality; consequently, chlorination has become the most common tertiary treatment. This is remarkably effective in the inactivation of pathogenic microorganisms and capable of avoiding microbial growth during the storage and distribution of water, it is also a highly competitive process in terms of cost [Du et al., 2017]. However, chlorination has the significant disadvantage of generating toxic and carcinogenic by-products derived from the reaction between chlorine and dissolved organic matter [Park et al., 2016]. Known as DBPs, the most frequent and studied compounds are probably trihalomethanes (THMs) and halogenic acids [Padhi et al., 2019]. In addition, chlorination generates chlorates and perchlorates, substances that are dangerous if they reach food. Perchlorate is mainly considered an anthropogenic pollutant due to its industrial origin or its use as a fertilizer, while chlorate is used in pesticides. Due to their importance, the new revision of the European Directive on drinking water presented the 1st February 2018, requests to set the chlorate content in water at a

maximum value of 0.25 mg/L. Another relevant aspect is the possible generation of by-products with greater genotoxicity from CECs after chlorination [Chai et al., 2018].

In consequence, there is still a need to implement new wastewater integrated technologies that allow adapting water quality for reusing purposes to current restrictions, regulations and challenges.

The main objective will be the investigation of new advanced tertiary treatment integration at pilot plant scale based on green technologies and renewable energy sources for fulfilling European and National regulations to assure safe wastewater reuse in crop irrigation.

Collaborations:

Publications:

Presentations:

Oral presentations:

- 39th IAHR World Congress, Granada (Spain), 2022. "Assessment of new immobilized photocatalysts for wastewater disinfection and decontamination."

- SolLab Doctoral Colloquium, Almería (Spain), 2021. "Innovative strategies for urban wastewater reclamation based on solar and conventional treatment integration."

Poster presentations:

- 11th European Conference on Solar Chemistry and Photocatalysis: Environmental Applications (SPEA11), Torino (Italy), 2022. "Evaluation of new immobilized photocatalyst for simultaneous wastewater decontamination and disinfection."

- X Simposio de Investigación en Ciencias Experimentales, Universidad de Almería (Spain), 2021. "New immobilized photocatalysts for wastewater decontamination and disinfection."