Proceedings of the 10th World Congress on Civil, Structural, and Environmental Engineering (CSEE 2025)
Barcelona, Spain - April, 2025
Paper No. ICEPTP 131
DOI: 10.11159/iceptp25.131

Evaluation of the Pollution by PhACs in the Zala River (Spas vs. WWTPs)

Eva Molnar[1], Istvan Fodor[1], Reka Svigruha[1], Zoltan Nemeth[1], Zsolt Pirger[1]
[1] HUN-REN Balaton Limnological Research Institute
Klebelsberg Kuno Street 3, Tihany, Hungary
molnar.eva@blki.hu; fodor.istvan@blki.hu; svigruha.reka@blki.hu; nemeth.zoltan@blki.hu; pirger.zsolt@blki.hu

Extended Abstract

The spatio-temporal distribution of concentration and assessed environmental risk levels of the 3 most frequent pharmaceutically active compounds (PhACs) – caffeine (naturally occurring central nervous system stimulant), carbamazepine (antiepileptic), and diclofenac (nonsteroidal anti-inflammatory drug) – in water matrices globally [1] were investigated in Zala River (Hungary) in related to the local popular spas, wastewater treatment plants (WWTPs), and other pollution sources. The investigated area is famous for its healing thermal water baths/spas (≈4.1 million attendance at the baths of Zala county in the studied year), but the adequacy of treatment of used water from baths, and wastewater is questionable. While approximately 11.5 million m^3 of municipal wastewater is discharged into the Zala River annually, and 2.2 million m^3 of used water from bathing sites. Measurements of PhACs have already been carried out in this area, according to that results 66 active substances out of 134 were detected [2]. In this study, sampling took place at 8 different sites 4 different times within a year. According to our results, the concentration of diclofenac in river waters in the last decade proved to be high in international comparison [2-5] (up to 2530 ng/L), and this compound presented high environmental risk level in the most sampled cases. Concentration changes depending on time of only diclofenac showed correlation with indicators of spa tourism (based on number of medical treatments in baths in Zala county), but only at sampling points near certain popular thermal baths. It can be explained by the fact that the spas with thermal water in the study area have a beneficial effect on joint inflammations and rheumatic pains, just like diclofenac [6]. In other words, the visitors coming for medical treatment in these spas are most likely users of diclofenac, and this increases the level of local use and thereby environmental load by this PhAC. According to our further results, in the main tourist month (August - based on number of guest nights at commercial locations in Zala county) elevated concentrations of the 3 PhACs were not detected which can be explained by the strong and lasting UV radiation. Furthermore, the microbial activity and composition of activated sludge in WWTPs depend on temperature, and these all influence the degradation of the PhACs [7-8]. Summarized, our data suggest that the local WWTPs should be reviewed, additionally necessity of treatment of used thermal water also in term of certain PhACs should be considered for sustainability and protection of aquatic ecosystem.

References

[1] Reyes NJDG, Geronimo FKF, Yano KAV, Guerra HB, Kim L-H. "Pharmaceutical and Personal Care Products in Different Matrices: Occurrence, Pathways, and Treatment Processes" in *Water*. 2021, *13*(9), pp. 1159.
[2] Maasz G, Mayer M, Zrinyi Z, Molnar E, Kuzma M, Fodor I, Pirger Z, Takács P. "Spatiotemporal variations of pharmacologically active compounds in surface waters of a summer holiday destination" in *Science of The Total Environment*. 2019, 677, pp. 545-555.
[3] Kondor AC, Jakab G, Vancsik A, Filep T, Szeberényi J, Szabó L, Maász G, Ferincz Á, Dobosy P, Szalai Z. "Occurrence of pharmaceuticals in the Danube and drinking water wells: Efficiency of riverbank filtration" in *Environmental Pollution*. 2020, 265 Part A, pp. 114893.
[4] de Sousa DN, Mozeto AA, Carneiro RL, Fadini PS. "Electrical conductivity and emerging contaminant as markers of surface freshwater contamination by wastewater" in *Science of The Total Environment*. 2014, 484, pp. 19-26.
[5] Carmona E, Andreu V, Picó Y. "Occurrence of acidic pharmaceuticals and personal care products in Turia River Basin: From waste to drinking water" in *Science of The Total Environment*. 2014, 484, pp. 53-63.

[6] Lonappan L, Brar SK, Das RK, Verma M, Surampalli RY. “Diclofenac and its transformation products: Environmental occurrence and toxicity - A review” in *Environment International*. 2016, 96, pp. 127-138.
[7] Domańska M, Kuśnierz M, Mackiewicz K. “Seasonal prevalence of bacteria in the outflow of two full-scale municipal wastewater treatment plants” in *Scientific Reports.* 2023, 13, pp. 10608.
[8] Liu H, Meng Y, Li J, Wang X, Zhang T. “Mechanistic insights into UV photolysis of carbamazepine and caffeine: Active species, reaction sites, and toxicity evolution” in *Chemosphere*. 2022, 308, pp. 136418.