THE PUBLISHING HOUSE
OF THE ROMANIAN ACADEMY

DÂMBOVIȚA – POLLUTION AND SPILLAGE IN THE LAST TWO DECADES

Octav HOGEA[1], Bogdan CIOMAGA[1] and Mircea-Ioan POPA[1,2]

[1] Carol Davila University of Medicine and Pharmacy
[2] Cantacuzino National Military Medical Institute for Research and Development
Corresponding author: mircea.ioan.popa@gmail.com; https://orcid.org/0000-0002-0794-9329

Received April 29, 2024

Studies in the early 2000s found that Dâmbovița River, a tributary of the Argeș River and sub-tributary of the Danube River, and the main supplier of water for Romania's capital, Bucharest, was mainly polluted with organic substances, decomposition products, and oil derricks activity. Because of this, the water quality was established as "class III" out of I–V.

Our study aims to synthesize existing knowledge and offer a comprehensive view of the current situation of the Dâmbovița River.

The methodology of the study was designed to investigate current environmental challenges and rehabilitation efforts concerning the Dâmbovița River, based on studies gathered between 2000 and 2024.

Herein we discuss the main pollutants responsible for water contamination and pollution in the Dâmbovița River: microplastics, heavy metal contamination, and wastewater spillage, and other pollutants. Of these, spillage is the most damaging element, due to the presence of petroleum and oil compounds, chloride, antimicrobials, and other potentially harmful contents.

Though there are significant improvements in Dâmbovița River's water quality, more work still needs to be done. Removing pollution sources and continuously improving the overall quality of Dâmbovița River's waters is essential to preserving its local ecosystem and the lives of the people who rely on it.

Keywords: Dâmbovița, pollution, wastewater

INTRODUCTION

The issue of river pollution in Europe, especially in the case of the Danube River and its tributaries, is a well-known concern. In 2007, the World Wide Fund for Nature (WWF) listed the Danube as among the top ten most threatened rivers in the world, citing the implementation of infrastructure, wastewater spillage, and other polluting activities as the main causes of the destruction of the riverine environment[1].

In response to this growing issue, the European Commission implemented the Water Framework Directive (WFD), a framework of legislation and management for groundwater, inland, transitional, and coastal waters in the European Union[2,3]. According to the WFD, the quality of water in these environments is defined as High, Good, and Moderate status, with each term representing a decrease in water quality; this framework addresses phytoplankton, fauna and flora quality and diversity, hydromorphological quality, and physico-chemical characteristics[4].

The WFD is implemented and maintained through several organizations, each overseeing specific bodies of water. In the case of the Danube River, the International Commission for the Protection of the Danube River (ICPDR) is responsible for overseeing both the river itself and its tributaries, with the stated goal being a cleaner, healthier, and safer Danube[5].

In 2008, a research paper on the impact of human activities on the environment quality in Dâmbovița County mentioned that rivers crossing its territory are mainly polluted with organic substances, decomposition products, and oil derricks activity, with the water quality of the Dâmbovița River, a tributary of the Argeș River and sub-tributary of the Danube River, and the main supplier of water for Romania's capital, Bucharest, being established as "class III" out of I–V[6].

Our study aims to synthesize existing knowledge and offer a comprehensive view of the current situation of the Dâmbovița River.

MATERIALS AND METHODS

The methodology of the study was designed to investigate current environmental challenges and rehabilitation efforts concerning the Dâmbovița River.

Data for this study was sourced from a review of literature available on Google Scholar. The keywords used for the search included "Dâmbovița River", "urban river management", "river pollution", "river rehabilitation", "microplastics", "heavy metals", "Bucharest urban development", and "sustainable urban planning". These keywords were combined using Boolean operators to maximize the search efficiency and coverage.

Inclusion Criteria were established as articles published in English and Romanian from 2000 to 2024, to ensure the relevance and timeliness of the data, studies focusing on urban river management practices, environmental challenges facing urban rivers, community engagement in river conservation, and case studies on river restoration efforts.

RESULTS

General context

A significant amount of research has been conducted within a 2016 review paper written by Zaharia *et al.*[7] on the effects of urbanization on river systems within the Bucharest region. In this report, using the WFD's classification system in order to define water quality based on quality classes I–V (very good, good, moderate, poor, bad), Dâmbovița River samples place it squarely in the III–V bracket of quality class, with class fluctuations depending on the origin point of the samples along the river basin. Downstream of Bucharest, Dâmbovița River quality falls into class V. The review also makes note of the fact that the manipulation of the river's natural flow, the disposal of wastewater further downstream, and the disposal of wastewater from cities further upstream all contribute to a decrease in quality, especially since wastewaters are only partially treated in Bucharest due to the then-partial functioning of the wastewater treatment plant in Glina village.

Dâmbovița River is listed among the main polluted rivers in Romania in the section on the causes and effects of water pollution in Romania of the 2020 book Water Resources Management in Romania, owing to the exploitation of iron, steel, and wastewater collected from chemical factories[8].

Microplastics

Around 2.4 mg/L of microplastics (plastic particles ranging between 125 μm – 5 mm) were present in the Dâmbovița River, upstream of its confluence with the Argeș River. These microplastics mostly consisted of single-use packaging fragments, fibers, and other such materials[9]. Microplastics are harmful to the local flora and fauna, which may present an added risk factor for riverine species, such as the Eurasian otter[10].

Heavy Metal

Heavy metal consumption from freshwater basins can significantly impact human health, with research indicating that bioaccumulation in aquatic organisms poses health risks to humans through contaminated fish or water consumption[11,12]. Long-term exposure is linked to neurological, renal, and skeletal damage[13,14]. Other potential manifestations of long-term ingestion of heavy-metal-contaminated water are gastrointestinal issues, cognitive impairments, and cardiovascular diseases[11].

Recent assessments of heavy metal concentrations in the Dâmbovița River revealed that concentrations of cadmium (Cd), nickel (Ni), mercury (Hg), and lead (Pb) were within normal ranges[15]. However, some of these metals were found to be within the upper limits, suggesting that more sampling and observations may be necessary[16].

Although the water may have within-limits quantities of heavy metals, a noteworthy perspective is the accumulation of said molecules in the roots and leaves of aquatic flora. Not discussing the Dâmbovița River, the study followed how different plants absorb the metal ions present in the water of the rivers[17]. The authors identified a series of plants *(Ranunculus ficaria, Plantago major, Taraxacum officinale, and Achillea millefolium*) that are frequently used in alternative medicine and concluded that although not all plants accumulate metals in a concerning matter, the roots and leaves of some plants, such as *Plantago major* and *Taraxacum officinale,* may accumulate high quantities of heavy metals[17].

Spillage

The findings of a study conducted on the quality of the waters in the Târgoviște Plains, represented

by the Dâmbovița, Argeș, and Ialomița Rivers, revealed that waste spillage is an important factor in these rivers' pollution. Industrial oil scaffolding in the area has led to an increase in oil, petroleum products, and chloride content in the river water, beyond the acceptable levels for class II evaluation according to WFD[18].

Pollution does not only occur in industrial regions but also in urban areas. A recent study of perfluoroalkyl substances in Romanian waters, which are often used in cleaning products, pesticides, medical equipment, cosmetics, and fire-fighting foams, revealed that the waters downstream of Bucharest's wastewater treatment plant held the highest concentration of perfluoroalkyl compounds, at approximately 45 ng/L. With the waters upstream of the Bucharest wastewater treatment plant having the lowest recorded levels among upstream samples, it is clear that the presence of urbanization and the efficiency of wastewater processing facilities plays an important role in Dâmbovița River's water quality[19].

Among pollution sources, wastewater produced by healthcare facilities is also important, mainly due to the release of drug-resistant bacteria, resistance-encoding genes, and antimicrobials into the waters. This is especially true in situations where wastewater treatment plants are only partially functional[7]. For instance, water samples taken downstream from wastewater treatment plants in Dâmbovița River tested positive for genes that encode beta-lactamases, enzymes with a lytic effect on beta-lactam antibiotics; samples taken upstream tested negative[20].

The occurrence of the COVID-19 pandemic has also affected the coliform and enterococcal populations found in the Dâmbovița River, with the wastewater changing the distribution to favor fecal bacteria. Coupled with the fact that enterococci are often involved in horizontal gene transfer and the rise of antimicrobial resistance, this demonstrates that pandemics and the resulting wastewater from healthcare facilities are an added pollution factor[21].

DISCUSSION

In 2020, ICPDR released a Facts and Figures report on Romania, describing that the main issue in regards to the pollution of the Danube River, its tributaries, and sub-tributaries is caused by the disposal of organic substances and nitrates in Romanian groundwater sources. Although the issue is being addressed with projects aimed at limiting these pollutants, their continued presence even two decades after the implementation of the WFD suggests that there is more work needed to properly limit their presence[22].

Several initiatives have been involved in the surveillance of drug-resistant bacteria, resistance-encoding genes, and antimicrobials in freshwater sources as a consequence of spillage from health centers. One initiative that specifically handled the issue of antibiotic resistance gene dissemination from wastewater treatment plants into the aquatic environment was the RADAR project[23]. The research focused on the isolation and identification of antibiotic resistance of the ESKAPE group microorganisms (*Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Enterobacter* spp.). They assessed freshwater sources that could be source-tracked as being potentially contaminated with medical waste. The project was underway between 2018 and 2022, disseminating the obtained information through conventional means (research articles, conferences, and theses)[23]. A list of the aforementioned results can be found on the project's website[23].

A critical aspect of our research uncovered the scarcity of available data in regard to the levels of organic compounds, microplastics, and other pollutants that can be found in the Dâmbovița River. The RADAR project was one of the biggest initiatives addressing the issue of antimicrobial resistance in the aquatic environment. However, the results of the project have to be considered a cornerstone in regard to the quality of the Dâmbovița River, from a microbiological point of view. Further research needs to be conducted in order to properly prevent and control the potential spread of antimicrobial resistance.

CONCLUSIONS

Though there are significant improvements in Dâmbovița River's water quality, more work still needs to be done. The harmful effects of river spillage and the inefficient processing of wastewater are the most significant sources of pollution. Removing these sources and continuously improving the overall quality of Dâmbovița River's waters is essential to preserving its local ecosystem and the lives of the people who rely on it.

Conflicts of Interest. The authors have no conflict of interest to disclose.

Funding. Not applicable.

Ethical Approval. Not applicable.
Informed Consent. Not applicable.

REFERENCES

1. World Wide Fund for Nature. Danube one of top ten world's most threatened rivers [Internet]. [cited 2024 Mar 10]. Available from: https://www.wwf.eu/?97320/Danube- one-of-top-ten-worlds-most-threatened-rivers.
2. Water Framework Directive – European Commission [Internet]. 2024 [cited 2024 Feb 27]. Available from: https://environment.ec.europa.eu/topics/water/water-framework-directive_en.
3. Sousa JCG, Ribeiro AR, Barbosa MO, Pereira MFR, Silva AMT. A review on environmental monitoring of water organic pollutants identified by EU guidelines. J Hazard Mater. 2018;344:146-62. doi: 10.1016/j.jhazmat.2017.09.058.
4. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy [Internet]. Nov 20, 2014. Available from: http://data.europa.eu/eli/dir/2000/60/2014-11-20/eng.
5. International Commission for the Protection of the Danube River. About Us | ICPDR – International Commission for the Protection of the Danube River [Internet]. [cited 2024 Mar 10]. Available from: https://www.icpdr.org/about-icpdr/framework/about-us.
6. Pehoiu G. The impact of human activities on environmental quality in Dâmboviţa county. Present Environment and Sustainable Development. 2008;2:272-85.
7. Zaharia L, Ioana-toroimac G, Cocoș O, Ghiță FA, Mailat E. Urbanization effects on the river systems in the Bucharest city region (Romania). Ecosyst Health Sustain. American Association for the Advancement of Science; 2016;2(11):e01247. doi: 10.1002/ehs2.1247.
8. Breaban IG, Breaban AI. Causes and Effects of Water Pollution in Romania. In: Negm AM, Romanescu G, Zeleňáková M, editors. Water Resour Manag Rom [Internet]. Cham: Springer International Publishing; 2020 [cited 2024 Mar 10]. p. 57–131. Available from: https://doi.org/10.1007/978-3-030-22320-5_3 doi: 10.1007/978-3-030-22320-5_3.
9. Maria C, Deák G, Tudor G, Holban E, Zamfir C, Ivanov AA, *et al*. Investigation of Microplastics Presence in the Dambovita River. Int J Conserv Sci. 2023;14(2):663-70. doi: 10.36868/IJCS.2023.02.19
10. Bouroș G, Barbulescu D, Cioflec V. Urban Otters Of Bucharest, Romania: Threats And Conservation. IUCNSCC Otter Spec Group Bull. 2021;7:66-82.
11. Waqas W, Yuan Y, Ali S, Zhang M, Shafiq M, Ali W, *et al*. Toxic effects of heavy metals on crustaceans and associated health risks in humans: a review. Environ Chem Lett [Internet]. 2024 [cited 2024 Mar 14]; Available from: https://doi.org/10.1007/s10311-024-01717-3 doi: 10.1007/s10311-024-01717-3.
12. Iyorah I. Human Health Risk of Frozen Fish Species Scomber scombrus and Merluccius capensis Sold from Markets in Benin City, Edo State, Nigeria. J Sci Technol Res. 2024;6(1). doi: 10.5281/zenodo.10800982.
13. Soni D, Dass A, Yadav N, Gupta P, Mahesh B. Unveiling the Invisible Threat: A Review of Heavy Metal Exposure and its Devastating Health Consequences. Int J Eng Technol Manag Sci. 2024;8:315-23. doi: 10.46647/ijetms.2024.v08i01.041.
14. Nneoyi-Egbe AF. Assessment of Heavy Metal Contamination in Shrimp and Water from the Great Kwa River: Implications for Human Health and Aquatic Ecosystems. Int J Biochem Res Rev. 2024;33(3):27-35. doi: 10.9734/ijbcrr/2024/v33i3861.
15. Dumitru FD, Deák G, Moncea MA, Baraitaru AG, Gheorghe PI, Ciobotaru IE. Assessing the Contamination of the Dambovita River Through Heavy Metal Indices. IOP Conf Ser Mater Sci Eng. 2020;877(1):012057. doi: 10.1088/1757-899X/877/1/012057.
16. Deák G, Dumitru FD, Moncea MA, Panait AM, Boboc M, Dănălache T, *et al*. Assessing the heavy metals concentrations in the Dambovita River. AIP Conf Proc. 2019;2129(1):020067. doi: 10.1063/1.5118075.
17. Pehoiu G, Murarescu O, Radulescu C, Dulama ID, Teodorescu S, Stirbescu RM, *et al*. Heavy metals accumulation and translocation in native plants grown on tailing dumps and human health risk. Plant Soil. 2020;456(1):405-24. doi: 10.1007/s11104-020-04725-8.
18. Pehoiu G, Murărescu O. Environment and water resources in Târgovişte Plain (Romania). Water and Geoscience. 2010. p. 90-95.
19. Chiriac FL, Pirvu F, Paun I, Petre VA. Perfluoroalkyl substances in Romanian wastewater treatment plants: Transfer to surface waters, environmental and human risk assessment. Sci Total Environ. 2023;892:164576. doi: 10.1016/j.scitotenv.2023.164576.
20. Marinescu F, Marutescu L, Savin I, Lazar V. Antibiotic resistance markers among Gram-negative isolates from wastewater and receiving rivers in South Romania. Romanian Biotechnol Lett. 2015;20(1).
21. Banciu AR, Pascu LF, Radulescu DM, Stoica C, Gheorghe S, Lucaciu I, *et al*. The COVID-19 Pandemic Impact of Hospital Wastewater on Aquatic Systems in Bucharest. Water. Multidisciplinary Digital Publishing Institute; 2024;16(2):245. doi: 10.3390/w16020245.
22. International Commission for the Protection of the Danube River. Romania | ICPDR – International Commission for the Protection of the Danube River [Internet]. [cited 2024 Mar 10]. Available from: https://www.icpdr.org/danube-basin/countries/romania.
23. PN-III-P4-ID-PCCF-2016-0114 Research Projects [Internet]. 2023 [cited 2024 Mar 14]. Available from: https://web.archive.org/web/20231020082629/https://bios.unibuc.ro/Proiecte/pn-iii-p4-id-pccf-2016-0114.html.