

Wastewater treatment in Central Asia: a review of papers from the Scopus database published in English of 2000–2020

J Musirmonov^{1*}, *L Gafurova*², *O Ergasheva*², and *M Saidova*³

¹Research Institute of Ecology and Environmental Protection, Tashkent, 100000, Uzbekistan

²National University of Uzbekistan, University street 4, 100174 Tashkent, Uzbekistan

³Tashkent State Technical University, University street 2, 100095 Tashkent, Uzbekistan

Abstract. Today the world is facing a major problem of getting rid of wastewater safely so that it does not disrupt the environment. This study analyzed global research trends through wastewater treatment technologies from 2000 to 2020 using Scopus databases. The objective of this article is to carry out a bibliometric analysis regarding the production and impact of scientific research related to wastewater treatment indexed in the Scopus databases. The purpose is to know key aspects such as the progression of production over the two decades, maturity in research, coverage of the subject, identifying the most discussed topics and as a result of identifying the gaps, the most relevant authors and the core of journals through which knowledge in this area is disseminated, as well as its impact through the analysis of citations. Scopus revealed a total of 44 journal articles, 19 conference proceedings, and 1 review paper during this period, with the keywords' wastewater, treatment. As per the analysis, Kazakhstan and Uzbekistan painted the greatest publications connected with wastewater.

Keywords: Wastewater, treatment, pollution, technologies, Central Asia, citations, review treatment.

1 Introduction

The wastewater treatment regime is crucial for conserving the environment, economy, and society. As per the statistics, wastewater effluents from industrial and municipal treatment plants have been recognized as the world's leading causes of water pollution [1]. The main goal of wastewater treatment is to utilize water and convert it into a usable and nontoxic resource for further use without harming the natural environment, humans, and animals. Wastewater treatment plants (WWTPs) are designed to reduce wastewater pollution and minimize negative impacts on human health and the environment [1]. However, due to material, energy consumption, and emissions, Wastewater treatment factories can cause environmental impacts [2]. Thus, the selection of a specific wastewater treatment

*Corresponding author: jamoliddinmusulmanov@gmail.com

technology should not be focused solely on technological insight, but should also integrate the human and environmental activities surrounding it; that is, optimize the balance between technology and environment. Over the past two decades, the wastewater treatment sector has shifted from conventional high-cost methods to high-efficiency and economical methods [3,4]. Among the water pollution, micropollutants have drawn attention, demanding a change in the treatment technologies for successful treatment.

Many methods have been suggested to calculate the achievement of such a balance. The most frequent in wastewater technologies include decision support systems for designing sustainable technologies by (multi)objective optimization [5]; and aggregating indices, including the use of sets of (mainly local) indicators that incorporate environmental, societal, and economic sustainability; life cycle impact assessment (LCA) energy analysis [6]; socio-eco-efficiency analysis [7]; a variety of footprints [4]; and eco-efficiency [8].

A number of small-scale treatment systems have been developed for small rural communities, which are adapted to the needs of these areas. These WWTPs have also good applicability in developing countries as they require less investment and have less technically demanding maintenance operations common in large centralized facilities [9]. Given the need for alternative solutions, priority has been given to technologies that have minimum energy requirements, simple operational procedures, and a sufficient level of inertia when facing large fluctuations in the flow and water quality [8]. Several types of decentralized wastewater treatment technologies for rural areas include: (i) active sludge systems (AS), anaerobic sludge reactors (e.g. septic tanks), stabilization ponds, constructed wetlands [10], infiltration systems [11], and hybrid nature-based systems [12].

The present manuscript is a bibliometric study using the database of Scopus to analyze the trends, leading to an understanding of the progress in research in wastewater treatment technologies for laying the past, current, and future research landscape. Scopus is considered one of the major peer-reviewed repositories covering a wide range of topics.

2 Methodology

Based on the objective of the research, four subject areas were selected from the Scopus database for the period of 2000-2020 for the Central Asia region. Name of subject areas: 1. Agricultural and Biological Sciences - 4205 publications 2. Earth and Planetary Sciences – 4998 publications 3. Environmental Science – 4020 publications 4. Engineering – 10213 publications. All papers were analyzed and reviewed using wastewater treatment as the keyword. A total of 64 Central Asia-based publications were sorted out for a further analysis of wastewater treatment issues. The ‘Results analysis’ function in Scopus was then used to statistically scrutinize the documents, in terms of publications per year, research institutions, and countries. Therefore, a database was categorized including the year of publication, journal names, authors’ names, countries, the type of publication, the number of citations per paper, the number of citations per journal, and the percentage of publications by the topic cluster name. In the end, we analyzed the role of remote sensing and demonstrated the information about wastewater treatment systems of Central Asia.

3 Results and discussion

3.1 Published papers on wastewater treatment

A number of published papers on a particular issue illustrate the importance of that issue for the region. A total of 64 papers were published in the period 2000-2020 on Central Asia on wastewater treatment issues. Figure 1 shows that for over ten years between 2000 till 2012

just 9 papers were published. In 2005, 2006, 2009, 2010, and 2011 there were no publications on a given topic. From 2013 we can see a gradually increasing in the number of publications. About 14 % of papers were published within the first decade and the rest 86% in the second decade. The years 2018, 2019, and 2020 were the most inventive for the wastewater treatment issue in Central Asia. Almost 58% of the total number of publications were published in 2018, 2019, and 2020. The data obtained helped to evaluate the growth trend and contribution of a research field from different countries, institutions, categories, journals, and researchers [13].

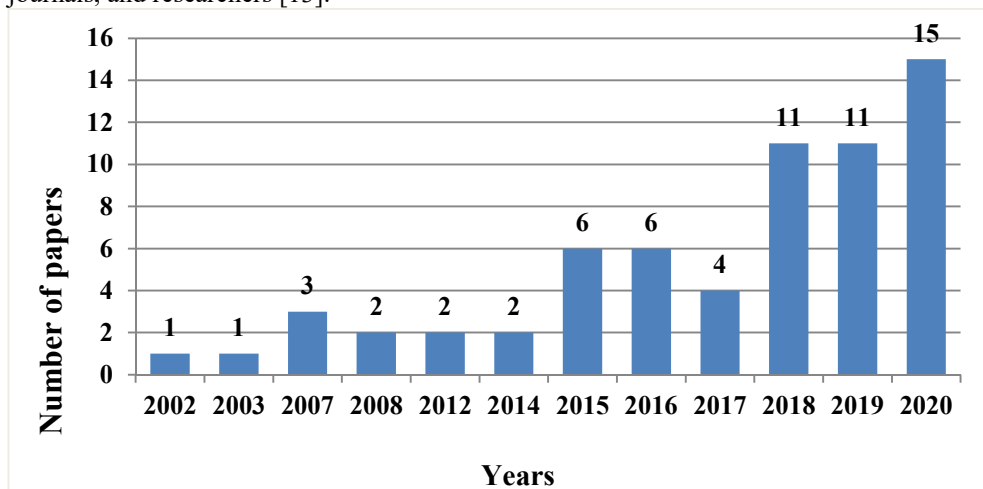


Fig. 1. A number of papers on wastewater treatment by the year of publication in Central Asia.

3.2 Journals on wastewater treatment

Selection of the appropriate journal is essential during publication. Scopus-based 64 papers on wastewater treatment issues were published in 44 different journals. About 50 of the total number of papers published in the first 11 journals are given in Table 1. The given Key journals showing wastewater treatment issues in Central Asia are 26th International Mineral Processing Congress, IMPC 2012: Innovative Processing for Sustainable Growth - Conference Proceedings, Applied Catalysis B: Environmental and ARPN Journal of Engineering and Desalination and Water Treatment, Journal of Hazardous Materials, Journal of Industrial Pollution Control, Journal of Water Chemistry and Technology, Journal of Water Process Engineering, Chemical Engineering Journal, Clean - Soil, Air, Water and E3S Web of Conferences. These journals illustrate an impact factor of 1.812 and 7.616 and belong to International Water Association Publishing and Elsevier BV publishers correspondingly.

Table 1. List of journals on wastewater treatment in Central Asia.

Scopus Source title	Number	Scopus Source title	Number
26th International Mineral Processing Congress, IMPC 2012: Innovative Processing for Sustainable Growth - Conference Proceedings	5	Journal of Hazardous Materials	4
Applied Catalysis B: Environmental	4	Journal of Industrial Pollution Control	3
ARPN Journal of Engineering and Applied Sciences	2	NATO Security through Science Series C: Journal of Water Chemistry and Technology	3
Chemical Engineering Journal	2	Journal of Water Process Engineering	3
Clean - Soil, Air, Water	2	Khimiya i Tekhnologiya Vody	1
Desalination and Water Treatment	2	Microporous and Mesoporous Materials	1
E3S Web of Conferences	2	NATO Security through Science Series C: Environmental Security	1
Ecological Engineering	1	News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences	1
Environmental Science and Technology	1	PLoS ONE	1
Fresenius Environmental Bulletin	1	Potravinarstvo Slovak Journal of Food Sciences	1
IMPC 2018 - 29th International Mineral Processing Congress	1	Proceedings - 2018 IEEE International Conference on Environment and Electrical Engineering and 2018 IEEE Industrial and Commercial Power Systems Europe, IEEEIC/I and CPS Europe 2018	1
Integrated Environmental Assessment and Management	1	Remediation	1
International Journal of Mechanical Engineering and Technology	1	Sustainability (Switzerland)	1
International Multidisciplinary Scientific GeoConference Surveying Geology and Mining Ecology Management, SGEM	1	Sustainable Cities and Society	1
IOP Conference Series: Earth and Environmental Science	1	Transactions of the American Nuclear Society	1
IOP Conference Series: Materials Science and Engineering	1	Water (Switzerland)	1
Izvestiya Vysshikh Uchebnykh Zavedenii, Seriya Tekhnologiya Tekstil'noi Promyshlennosti	1	Water and Ecology	1
Journal of Alloys and Compound	1	Water Research	1
Journal of Chemical Technology and Metallurgy	1	Water Science and Technology	1
Journal of Ecological Engineering	1	Environmental Science and Engineering (Subseries: Environmental Science)	1
Journal of Environmental Hydrology	1		
Journal of Environmental Management	1		

3.3 Top authors on wastewater treatment

Authors play an important role in the development of a particular field of research in any region. During the last two decades, a total of 305 different authors worked to publish 64 papers on the wastewater treatment issue in Central Asia. We could see only one of the papers published by a single author, while the rest part published by two, three, or a group of authors. One author Tumkert, V.A. published his paper as a single author. In the review, we took the first 6 top authors who published at least 2 and more papers (Figure 2). From the list, we can see that almost half of the top authors are from Central Asian countries, and they have jointly published papers in a high-ranked journal. Authors Ospanov, K., Meiramkulova, K., and Heaven, S. are leading the list of top authors with a number of papers 4, 4, and 3 correspondingly.

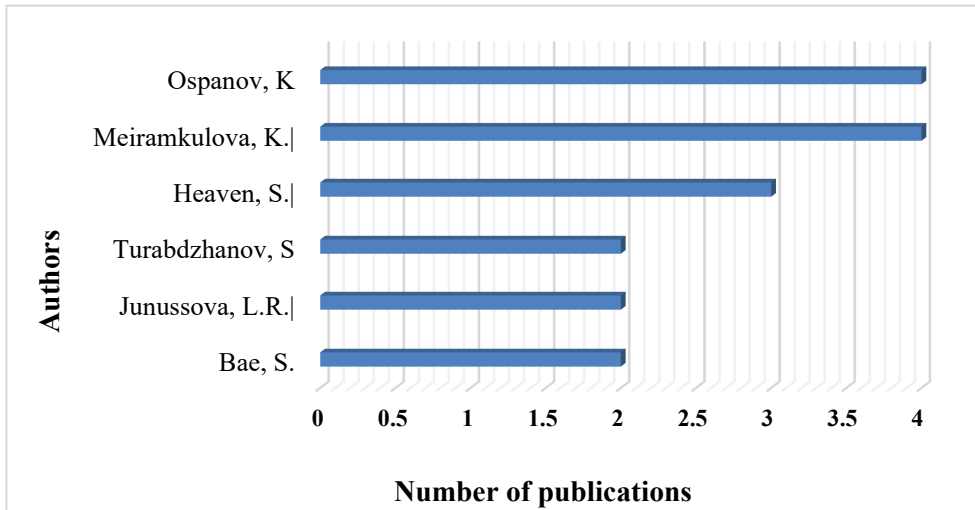


Fig. 2. List of top authors published on wastewater treatment issues in Central Asia.

3.4 Top countries on wastewater treatment

A number of countries that participated in the research activities on a specific topic show the degree of internationalization of the region. A total of 19 countries jointly worked on wastewater treatment issues in Central Asia from 2002-2020. We have selected the top 10 countries that participated in the publishing of at least 1 and more publications (Figure 3). The top countries Kazakhstan, Uzbekistan, the United Kingdom, and South Korea are leading the list by the number of publications 43, 7, 5, and 4 respectively. Fourteen European countries actively cooperated in writing the wastewater treatment papers for Central Asia. Among them, researchers from Germany published in a co-authorship 5 papers. Among Central Asian countries, Kazakhstan leads the list. Almost 66 % of total publications are published in cooperation with Kazakh scientists. Researchers from Uzbekistan participated in the publication of 11% of the total papers. The next places go to Kyrgyzstan, Tajikistan, and Turkmenistan with 2%, 2%, and 2% respectively.

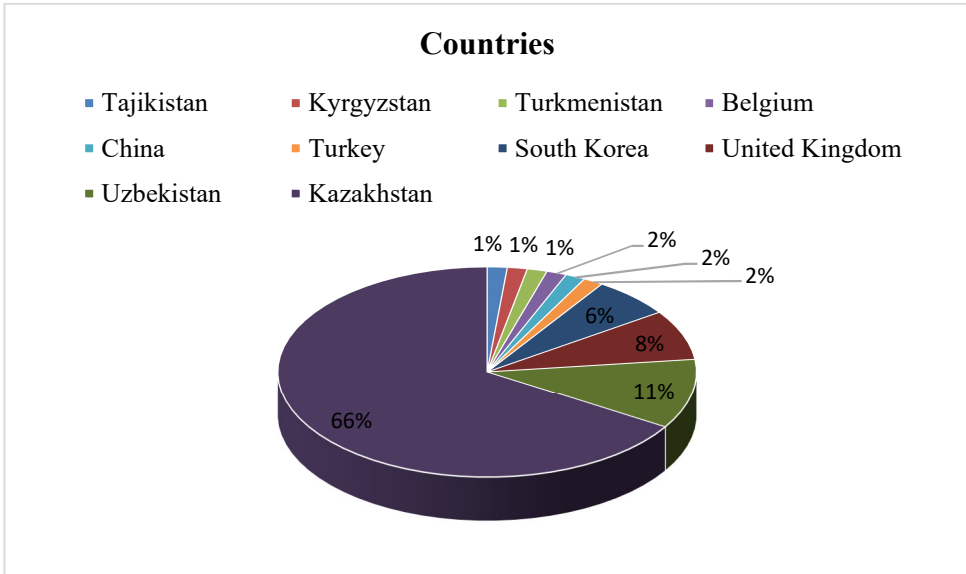


Fig. 3. List of top countries on wastewater treatment issues in Central Asia.

3.5 Top institutions on wastewater treatment

The ranking of institutions is mostly based on the quality of the papers published by the researchers of that institutions. One hundred five different institutions worked in cooperation to publish 64 papers on land degradation in Central Asia for the period of 2000-2020. L.N. Gumilyov Eurasian National University, Satbayev University, the University of Southampton, South Kazakhstan State University (SKSU), Nazarbayev University, Almaty Institute of Power Engineering and Telecommunication leading the list of top institutions (Figure 4). Each of these institutions published 7 and 4 papers in cooperation with other institutions. In Figure 4 we showed institutions where 2 and more papers were published. Six institutions were included in the top list 5 from Kazakhstan and only one of them from the United Kingdom.

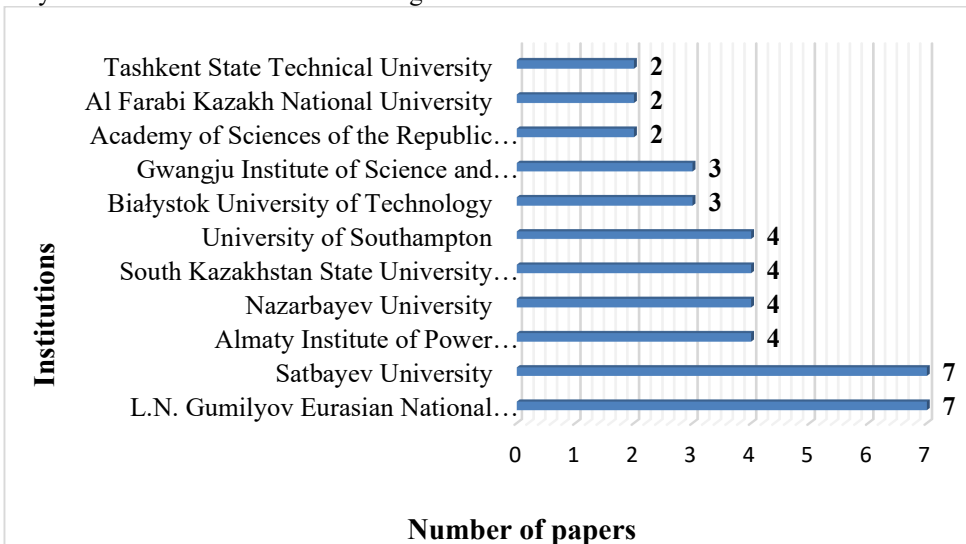


Fig. 4. List of top institutions on the issue of wastewater treatment in Central Asia.

3.6 Publication type on wastewater treatment

There are different publication types where researchers can show their results. Papers published on wastewater treatment issues in Central Asia for the given period are presented in 3 different publication types (Figure 5). Forty-four research articles were published on wastewater treatment issues. Next comes the conference type of publication with 19 papers from the total publications. All 19 conferences were published during this period of analysis. Only one review paper was published during the second decade.

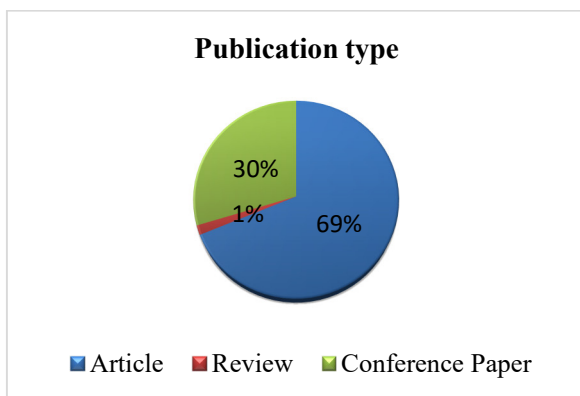


Fig. 5. Publication type on wastewater treatment in Central Asia

3.7 Top cited papers on wastewater treatment

A number of citations demonstrate the quality and novelty of the conducted research. The ten mostly cited papers on wastewater treatment are shown in Figure 6. A total of 261 citations were given to 64 publications on wastewater treatment for Central Asia for the given period. Three of the top cited papers were published during the first decade and the rest Seven during the second. Almost 65% of citations were given to 10 papers from the Figure 6. The first 10 top cited papers are consisting of 8 conferences, one review, and one research article.

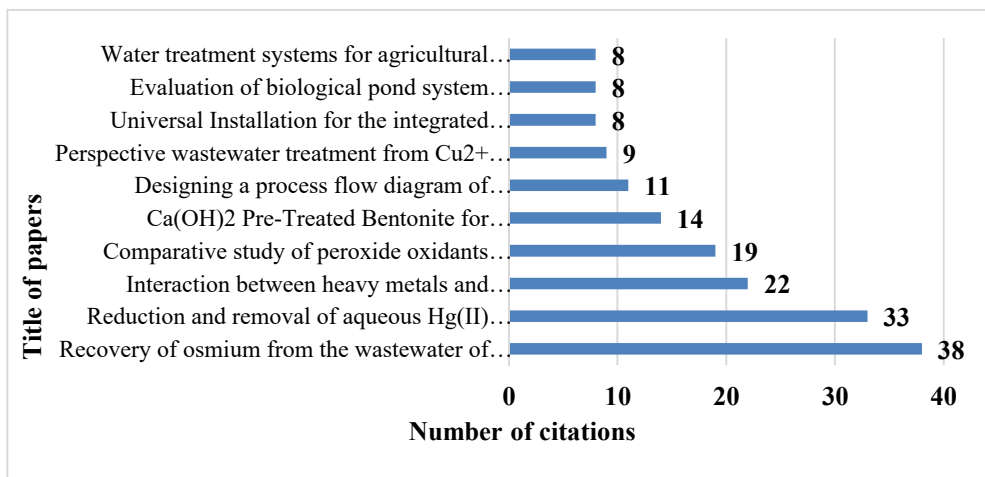


Fig. 6. List of top-cited publications on wastewater treatment in Central Asia.

3.8 Top cited journals on wastewater treatment

A total of 42 journals were selected to publish 64 papers on wastewater treatment in Central Asia for the period of 2000-2020. The top cited 10 journals were selected and shown in Figure 7. Almost 86% of total citations were given to papers published in these 10 journals. Recovery of osmium from the wastewater of copper production, 26th International Mineral Processing Congress, IMPC 2012: Innovative Processing for Sustainable Growth - Conference Proceedings and Applied Catalysis B: Environmental, ARPN Journal of Engineering and Applied Sciences journals are leading the list of top-cited journals with the number of publications 5, 4, 2 respectively. Around 15% of total citations were given for the papers published in 26th International Mineral Processing Congress, IMPC 2012: Innovative Processing for Sustainable Growth - Conference Proceedings.

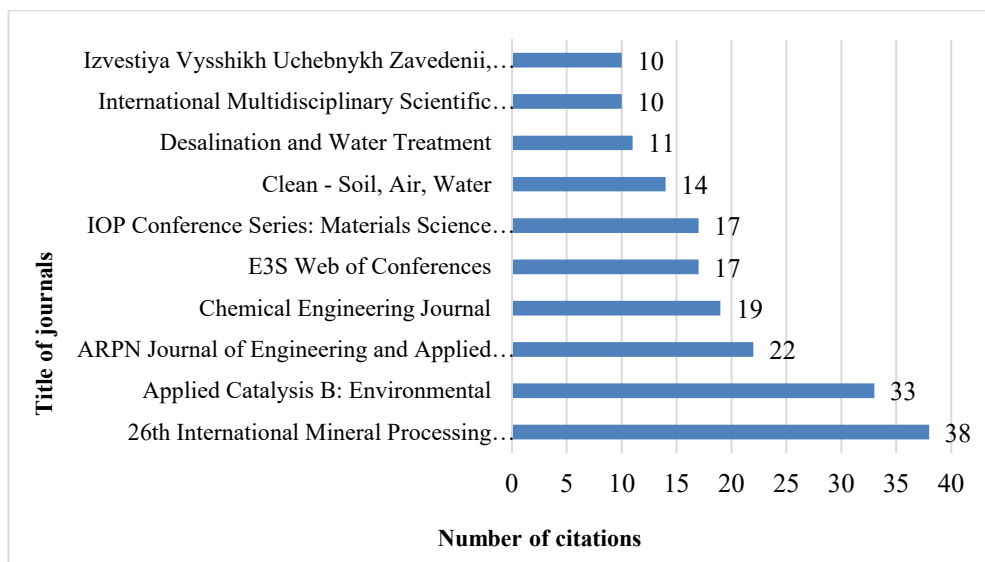


Fig. 7. List of top-cited journals on wastewater treatment in Central Asia

3.9 Publications by the topic cluster name on wastewater treatment

There are different topic cluster names available for the subject areas given in the Scopus database. Most of the papers published on wastewater treatment issues in Central Asia belong to 4 different topic cluster names (Figure 8). Ozonization, Degradation, Waste water treatment topic cluster name covers 41% of total publications, while Microbial Fuel Cells, Anaerobic Digestion, Bioreactors 32%, Adsorption, Adsorbents, Activated Carbon 19%, and Heavy Metals, Soils, Cadmium cluster covers 8% of total publications.

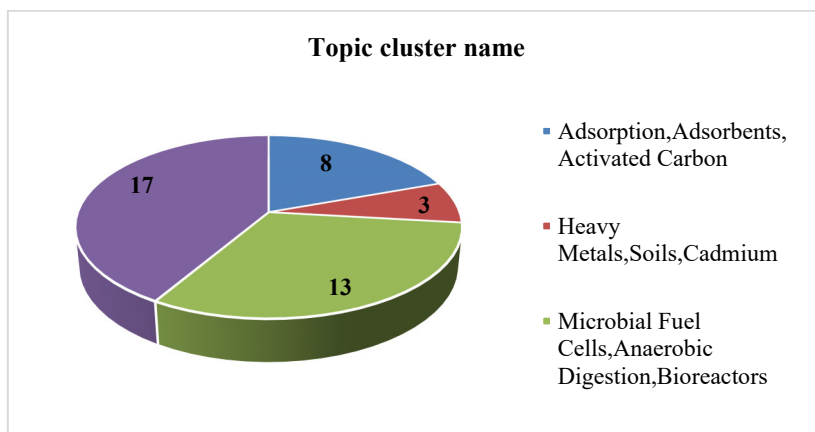


Fig. 8. Top topic cluster name on wastewater treatment in Central Asia.

4 Conclusions

Wastewater treatment is a crucial topic for the Central Asia region. Based on the Scopus database we tried to analyze papers published on wastewater treatment issues in English for Central Asia over 2 decades. We analyzed a number of papers published and a number of top journals on wastewater treatment issues. Ospanov, K., Meiramkulova, K., and Heaven, S. are top authors for Central Asia. A total of 19 countries worked in cooperation to publish all papers and Kazakhstan, Uzbekistan, the United Kingdom, and South Korea are the top countries on wastewater treatment issues. L.N. Gumilyov Eurasian National University and Satbayev University, University of Southampton, Tashkent State Technical University leading the list of top institutions. Almost 68% of total publications on wastewater treatment was published as research article. Wastewater treatment publications got a total of 261 citations and we listed the top 10 publications and journals. Recovery of osmium from the wastewater of copper production, 26th International Mineral Processing Congress, IMPC 2012: Innovative Processing for Sustainable Growth - Conference Proceedings and Applied Catalysis B: Environmental, ARPN Journal of Engineering and Applied Sciences journals are top journals in the field of wastewater treatment for Central Asia. 1. Ozonization, Degradation, Wastewater treatment, 2. Microbial Fuel Cells, Anaerobic Digestion, Bioreactors, 3. Adsorption, Adsorbents, Activated Carbon, and 4. Heavy Metals, Soils, and Cadmium have mostly used topic cluster names for wastewater treatment papers.

Researchers all over the world are continually working to come up with enhanced technologies for applications in wastewater remediation. It has gradually evolved from the core subject “Agricultural and Biological Sciences “and “Engineering” to a multi-disciplinary approach, combining chemistry, energy, material science, biochemistry, and agricultural and biological sciences, resulting in a further tremendous rise in the research in wastewater treatment, with development of new concepts and treatment technologies.

Acknowledgements

I express my appreciation to the project "English for Science", implemented by the Ministry of Innovative Development of the Republic of Uzbekistan for the direction and inspiration for carrying out this research. In addition, I am grateful to the anonymous reviewers of earlier drafts for constructive comments that helped to improve the manuscript.

References

1. Y. Zang, Y. Li, C. Wang, W. Zhang, W. Xiong, *Towards more accurate life cycle assessment of biological wastewater treatment plants*, a review, *Journal of Cleaner Production* **107**, 676-92 (2015)
2. A. Capodaglio, G. Olsson, *Energy Issues in Sustainable Urban Wastewater Management Use*, Demand Reduction and Recovery in the Urban Water Cycle Sustainability, **12**, 266 (2019)
3. J. Sandino, G. Crawford, L. Fillmore, D. Kinnear, *Energy Efficiency in Wastewater Treatment in North America: A WERF*, Compendium of Best Practices and Case Studies of Novel Approaches *proc water environ fed*, 3333-46 (2010)
4. R. K. Henderson, N. Subhi, A. Antony, S. J. Khan, K. R. Murphy, G. L. Leslie, V. Chen, R. M. Stuetz, P. Le-Clech, *Evaluation of effluent organic matter fouling in ultrafiltration treatment using advanced organic characterisation techniques*, *J. Membrane Science*, **382** pp 50–9 (2011)
5. C. Cossio, J. Norrman, J. McConville, A. Mercado, S. Rauch, *Indicators for sustainability assessment of small-scale wastewater treatment plants in low and lower-middle income countries*, *J. Environmental and Sustainability Indicators*, **6**, 100028 (2020)
6. A. Meneses-Jácome, A. A. Ruiz-Colorado, *A new approach of ecologically based life cycle assessment for biological wastewater treatments focused on energy recovery goals*, *J. Environ Sci Pollut Res*, **28**, 4195-208 (2021)
7. H. Anwar, M. Shahid, N. Natasha, K. Niazi, S. Khalid, T. Z. Tariq, S. Ahmad, M. Nadeem, G. Abbas, *Risk assessment of potentially toxic metal(loid)s in Vigna radiata L. under wastewater and freshwater irrigation* *Chemosphere*, **265**, 129124 (2021)
8. S. Dong, N. Masalha, M. J. Plewa, T. H. Nguyen, *Toxicity of Wastewater with Elevated Bromide and Iodide after Chlorination Chloramination or Ozonation Disinfection*, *J. Environ. Sci. Technol.*, **51**, 9297-304 (2017)
9. H. E. Muga, J. R. Mihelcic, *Sustainability of wastewater treatment technologies*, *J. Environmental Management*, **88**, 437-47 (2008)
10. J. Vymazal, *Constructed Wetlands for Wastewater Treatment Five Decades of Experience*, *J. Environ. Sci. Technol.*, **45**, 61-9 (2011)
11. A. D. Li, L. G. Li, T. Zhang, *Exploring antibiotic resistance genes and metal resistance genes in plasmid metagenomes from wastewater treatment plants*, *J. Front. Microbiol.*, **6**, (2015)
12. A. G. Capodaglio, *Pulse Electric Field Technology for Wastewater and Biomass Residues Improved Valorization*, *J. Processes*, **9**, 736 (2021)
13. J. V. Teixeira, S. Miranda, R. A. R. Monteiro, F. V. S. Lopes, J. Madureira, G. V. Silva, N. Pestana, E. Pinto, V. J. P. Vilar, R. A. R. Boaventura, *Assessment of indoor airborne contamination in a wastewater treatment plant*, *J. Environ Monit Assess*, **185**, 59-72 (2013)