

INFLUENCE OF WASTE INCINERATION AND OBTAINING ENERGY FROM IT TO THE PUBLIC HEALTH FOR CERTAIN TERRITORIES: A BIBLIOMETRIC AND SUBSTANTIVE STUDY

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Abstract: *About 40 years ago, plastic packaging was almost never used in Ukraine. Food products were sold in glass bottles, iron cans or in paper wrappers, which were decomposed in the environment or handed over to recycling centres. However, in recent years, the situation has fundamentally changed all over the world. Almost all products have several layers of packaging made of synthetic polymer materials. It has led to the significant growth of landfills and, therefore, to the emergence of a new problem – their proper maintenance. Landfills are areas of land where household, construction and other wastes are stored without control. To reduce the volume of waste, landfills are often set on fire. This approach is unacceptable, as landfills are a serious source of soil, air and water pollutions. Arbitrarily created waste disposal points are not equipped appropriately, the products of waste decay fall into the soil and groundwater, which is the source of water supply for a large number of the national population. The decay temperature in some cases is so high that it often leads to their ignition, and large amounts of harmful substances are released into the air. In this article, the authors conducted a study of the terminological orientation of scientific publications in the context of identifying the impact on human health of the waste conversion into energy compared to the impact of the landfill operation. Bibliographic information about scientific publications in peer-reviewed publications were preliminarily acquired from the Scopus database. The obtained results showed that researchers are investigating the impact of landfills on the population health, mainly focusing on such concepts as “health”, “landfills”, “waste incineration”. The authors analysed the dynamics of scientific interest levels in this topic and determined that the highest rate would be in 2022. It confirms the growing relevance of the researched problem in the modern world. All authors’ considerations are illustrated by corresponding diagrams and tables.*

Keywords: bibliometric analysis; health; public health; landfill; waste disposal; waste-to-energy; waste management; municipal solid waste; waste incineration; e-waste; public health on certain territories.

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Introduction. Nowadays, the change in consumption conditions has caused an increase in the amount of household waste, which has led to emergence of many unauthorized landfills. The spontaneity of their growth has become a big problem: such landfills are one of the main sources of environmental pollutions (Bilan et al., 2022). Besides, existing landfills often do not operate properly. It leads to waste contamination of large areas and causes irreparable damage to the environment through toxic substances in soil, air and groundwater. Consequently, the human health itself is affected (Vasylieva et al., 2023). Treatment of such waste is also carried out in different ways, which, in turn, determines the level of impact on environment and local population (Wołowiec et al., 2022). The article purpose is a comparative analysis of the sorted and non-sorted waste incineration and its influence on human health.

Literature Review. The authors used the Scopus database (Scopus, 2023) to study the orientation and current trends of scientific publications in the concept context: "health" AND "landfills" and "health" AND "waste incineration". The selection of publications was obtained by applying the TITLE-ABS-KEY filter. The sample contains publications dated from 2000 to 2022 (Figure 1).

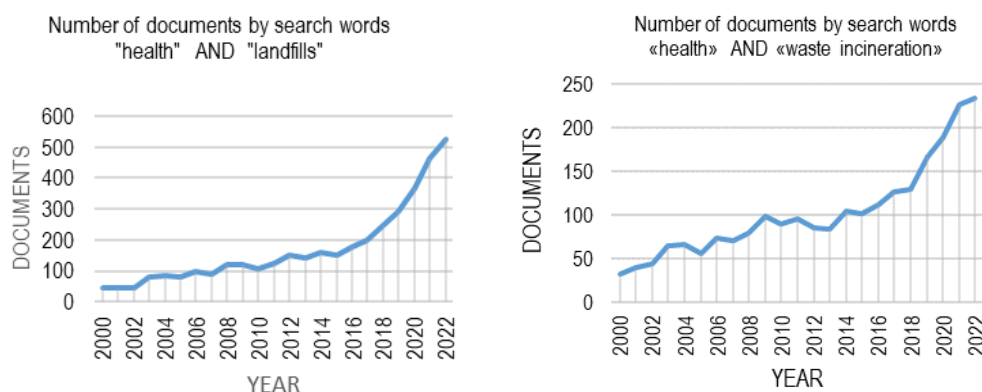


Figure 1. Dynamics of documents in the Scopus database according to TITLE-ABS-KEY filters by groups of search words: $\langle\langle\text{health}\rangle\rangle$ AND $\langle\langle\text{landfills}\rangle\rangle$ and $\langle\langle\text{health}\rangle\rangle$ AND $\langle\langle\text{waste incineration}\rangle\rangle$

Sources: developed by the authors on the basis of (Scopus, 2023).

Research of sorted and non-sorted waste incineration as well as landfill functioning on human health is becoming increasingly relevant today (Yelnikova and Kwilinski, 2020).

To investigate the terminological orientation in the impact identifying context of waste-to-energy conversion compared to the landfill operations impact on human health, the Scopus base (2023) was selected. It contains bibliographic information about scientific publications in peer-reviewed journals, books and conferences. The analysis was carried out according to the following groups of search words: $\langle\langle\text{health}\rangle\rangle$ AND $\langle\langle\text{landfills}\rangle\rangle$ and $\langle\langle\text{health}\rangle\rangle$ AND $\langle\langle\text{waste incineration}\rangle\rangle$. These words show the research problem in the best way (Tait et al., 2020; Cole-Hunter et al., 2020; Litovtseva et al., 2022).

As a result of conducting research using the search words $\langle\langle\text{health}\rangle\rangle$ AND $\langle\langle\text{landfills}\rangle\rangle$, an initial sample was obtained, which amounted to 4,632 Scopus publications. The highest level of interest in the topic is determined in 2022. In turn, the search terms $\langle\langle\text{health}\rangle\rangle$ AND $\langle\langle\text{waste incineration}\rangle\rangle$ yielded 3,044 documents.

In particular, Figure 1 represents the relevance of the selected research topic.

Countries such as the United States, India, China, the United Kingdom, Italy, Malaysia, Canada, Brazil, Australia, Spain are leaders in publications for the search terms $\langle\langle\text{health}\rangle\rangle$ AND $\langle\langle\text{landfills}\rangle\rangle$. According to the filters $\langle\langle\text{health}\rangle\rangle$ AND $\langle\langle\text{waste incineration}\rangle\rangle$, scientific publishing activity is actual in the countries of the United States, China, India, the United Kingdom, Italy, Germany, Spain, Japan, Canada, Australia.

Among the authors who devoted the largest works to identifying the landfill impact on public health, we can mention: Levis et al. (2014); Wang et al. (2021); Vaverková (2019); Paleologos et al. (2020); Hater (2007). Also, there were studies to define the public health impact from the waste-to-energy transformation: Domingo and Nadal (2009).

Scientific interests (Rudenko et al., 2020; Samoilkova and Kunev, 2020; Sotnyk et al., 2021) in the for the landfills impact on public health is shown by the following organizations: Chinese Academy of Sciences, Ministry of Education China, United States Environmental Protection Agency, University of Johannesburg, Universiti Teknologi Malaysia, Consiglio Nazionale delle Ricerche, Tongji University, University of Florida, National Environmental Engineering Research Institute India, Universiti Kebangsaan

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Methodology and research methods. This study takes a data analysis and visual approach to examine the human health impacts of waste incineration versus landfill operations or unsorted incineration. For a bibliographic study of this problem, the authors analysed scientific publications indexed in Scopus (2023). VOSviewer (2023), Google Trend (2023), Google Books Ngram Viewer (2023) were used to visualize the obtained bibliographic results.

Results. Household waste incineration is a process of waste destruction in high temperature conditions. This process can have both positive and negative effects on human health and environment. The positive impact of this process is that it can help reduce the waste volume, reduce pollutants and disease risks (Kolosok, 2021; Agaton et al., 2020). However, if the incineration is not carried out in special facilities with proper control of the harmful substance emission, it can lead to serious environmental problems. Reasons why garbage burning can be dangerous include:

1. Emissions of toxic substances. During combustion, toxic gases and combustion products such as dioxins, furan compounds and heavy metals are formed, which can cause various diseases of the pulmonary, cardiovascular and nervous systems;
2. Dissemination of pollutants. During garbage burning, dust and other pollutants are formed, which can become airborne and worsen the air quality in certain territories;
3. Emissions of greenhouse gases. Garbage burning can also cause the release of greenhouse gases such as carbon dioxide and methane, which leads to climate change and global warming;
4. Damage to biodiversity. During garbage burning, vegetation and animal life near landfills can be damaged;
5. Spread of infections. Garbage can contain bacteria and other microorganisms that can be spread by air and water during burning. It can cause diseases and infections.

A place designated for waste disposal is called a landfill. It is often confused with a garbage dump. The difference is that landfills are designed according to requirements. An officially registered solid waste landfill is dangerous since there is no waste sorting equipment or waste processing machinery on its territory. In contrast to it, a natural garbage dump is much more dangerous due to the lack of control. Therefore, there are no environmental protection measures and tax payments on these areas (Sedmíková et. al., 2021; Pimonenko et.al., 2022).

A natural garbage dump can contain various wastes of an extremely high danger. In addition, they are placed without sanitary rules and norms. These are usually areas of forest strips close to settlements, ravines along highways, shores and steppe zones. Here, large areas are affected by poisonous substances, rare species of flora and fauna die. Settlements receive polluted water and acrid stench from air vapours. As you can see, waste causes significant damage to the environment and public health. Improper waste handling can make the situation even more complicated (Stepovic, 2019; Ferronato and Torretta, 2019).

To study the terminological focus of scientific publications in terms of identifying the relationship between health risk, public health, landfills, risk assessment, waste disposal and waste management, the Scopus base (2023) was selected. It contains bibliographic information about scientific papers in peer-reviewed journals, books and conferences. A publications sample was obtained using the search terms «health» AND «landfills» in article titles, abstracts, and keywords without the expertise field filter. In general, the original sample consisted of 4,632 publications for the years 2000-2022. The visualized conceptual network is presented in Figure 2.

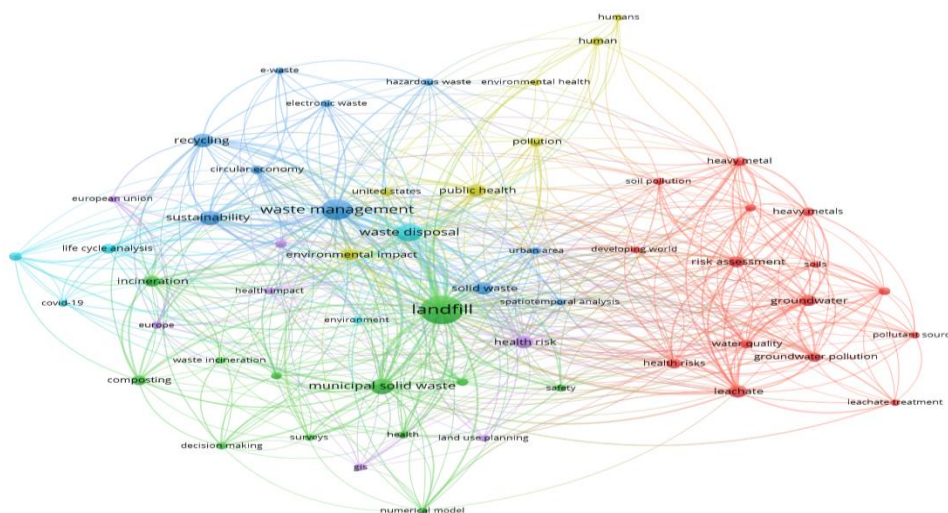


Figure 2. Clusters of studies according to the filters TITLE-ABS-KEY «health» AND «landfills» in 2000-2022

Sources: developed by the authors on the basis of (Scopus, 2023).

The software application made it possible to single out several research clusters for the interaction of «health» AND «landfills». Let us explain Figure 2. In the green cluster (first), the ecological component of the relationship (municipal solid waste, waste incineration, composting, safety) is defined. In the blue cluster (second), the importance of effective waste management for sustainable development (sustainability, recycling, solid waste) is determined. The yellow cluster (third), distinguishes the combination of public health and ecology (pollution, public health, environmental impact, environmental health). In the purple cluster (fourth), an interesting combination of research on the relationship between health risk, land use planning and the European Union is defined. The light blue cluster (fifth) highlights the relationship between waste disposal, COVID-19 and the environment. The red cluster (sixth) reflects the impact of environmental pollution on public health (risk assessment, soil pollution, water quality, groundwater pollution, pollutant source, leachate treatment, health risks, heavy metals, developing world).

In Figure 3, clusters of studies for 2000–2022 are displayed according to the filters TITLE-ABS-KEY «health» AND «waste incineration» (Scopus, 2023). The initial sample was 3,044 documents.

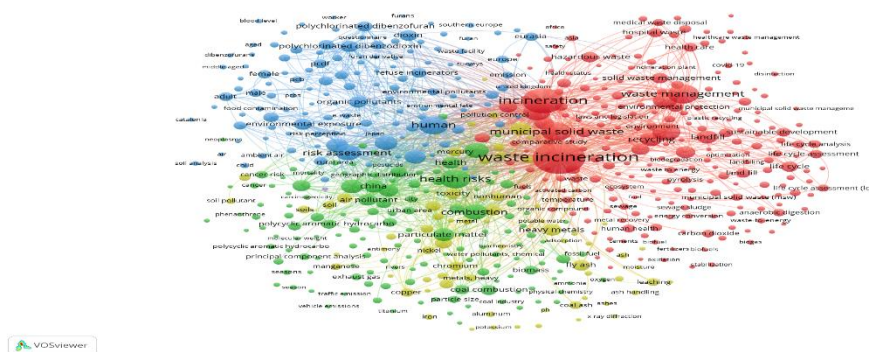


Figure 3. Clusters of studies according to the filters TITLE-ABS-KEY «health» AND «waste incineration» in 2000-2022

Sources: developed by the authors on the basis of (Scopus, 2023).

The analysis results showed that the first cluster (red) reflects the relationship between waste incineration, effective waste management and sustainable development. In the second cluster (green), the significance of waste incineration impacts on population health is determined (health risks, combustion, pollutants, hydrocarbon, urban area). Other clusters highlight the impact of harmful substances on public health risks.

The Google Trends software (2023) was used to identify the level of public interests in the investigated topic. Filters were set during the data analysis: «the whole world», «the last 5 years», «science». Figure 4 shows the most frequently encountered search terms during the cluster analysis.

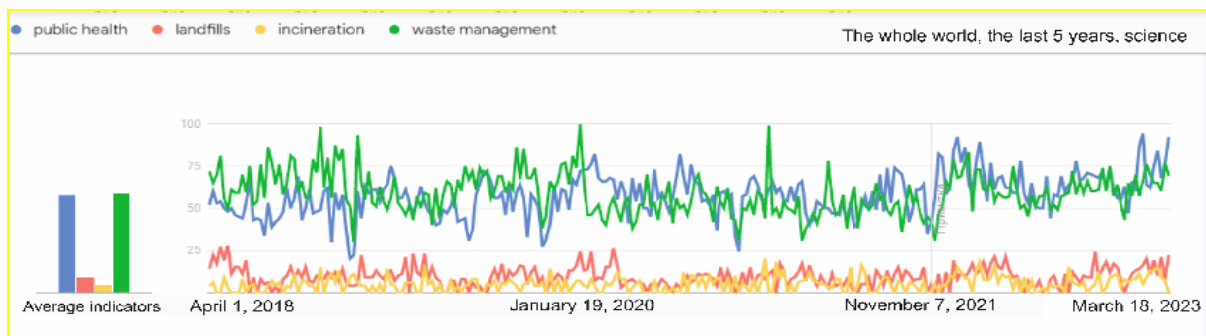


Figure 4. Identification of public interests in the investigated topic over the world for 2018-2023
Sources: developed by the authors on the basis of (Data of the Google Trends, 2023).

Figure 4 shows that the request frequency for waste management and public health is greater than for the corresponding indicators of landfill and incineration. At the same time, the most popular query “waste management” was in 2018-2021. The incineration request becomes most relevant in 2021. Regarding the query “landfill”, it was the most popular in 2020. The incineration and landfill queries are on the same level in popularity terms.

The waste management, public health, landfill, incineration requests have a different popularity trend in Ukraine (see Figure 5). They all have approximately the same interest level. Frequency of all requests is high. Kyiv pays special attention to these topics.

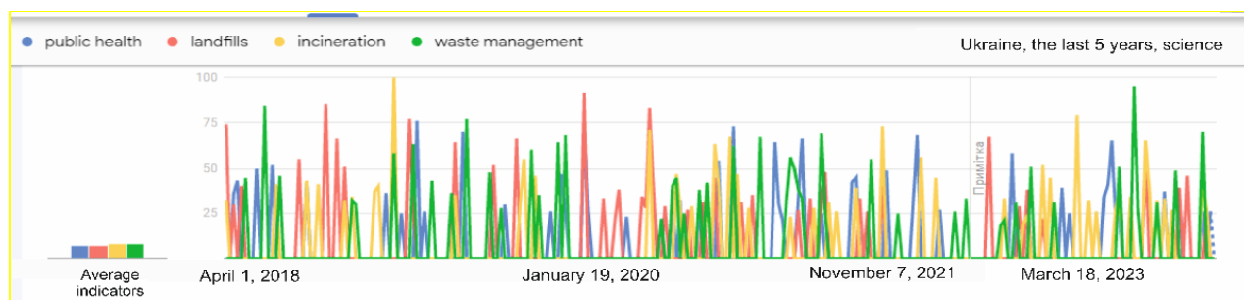


Figure 5. Identification of public interests in the investigated topic in Ukraine for 2018-2023
Sources: developed by the authors on the basis of (Data of the Google Trends, 2023).

The Google Trends software (2023) allows to compare search terms and see a world map showing their popularity (Figure 6). The popularity of a search term is correlated with the total number of Google searches for a certain period of time in a certain region.



Figure 6. Popularity of search queries «waste management», «public health», «landfill» and «incineration» by countries
Sources: developed by the authors on the basis of (Data of the Google Trends, 2023).

The popularity analysis of the search queries «waste management», «public health», «landfill» and «incineration» shows the top five countries with the highest waste interest. They are Canada, Hong Kong, Ireland, Egypt, Sweden.

The frequency comparison of the requests «waste management», «public health», «landfill» and «incineration» by leading countries (Table 1) confirms the general trend: the phrase «public health» is the most popular.

Table 1. Frequency comparison of the requests «waste management», «public health», «landfill» and «incineration» in the leading regions

Country	Keyword queries (%)			
	Public health	Waste management	Landfill	Incineration
Canada	59%	28%	11%	2%
Hong Kong	66%	18%	11%	5%
Ireland	41%	38%	11%	10%
Egypt	55%	30%	11%	4%
Sweden	67%	22%	11%	0%

Sources: developed by the authors on the basis (Data generated via the Google Trends software, 2023).

Along with the requests «waste management», «public health», «landfill» and «incineration», similar topic queries were also found. It received a significant breakthrough under modern conditions: «international journal of environmental research and public health», «archives of public health», «executive order on protecting public health and environment and restoring science to tackle the climate crisis», «which of the following are ways that humans increase the amount of greenhouse gases in the atmosphere?», «compare the use of groundwater in pre-industrial times with industrial times», «carbon footprint», «landfills meaning», «incineration of garbage», «biodiversity», «greenhouse gases», «which initiatives can cause a zero waste to landfill», «loss of biodiversity is caused due to» (Loizidou et al., 2021; Malinauskaite and Jouhara, 2019; Dashti et al., 2021; Bazaluk et al., 2020).

It is also relevant to take into account the category of public interests in these topics (Table 2).

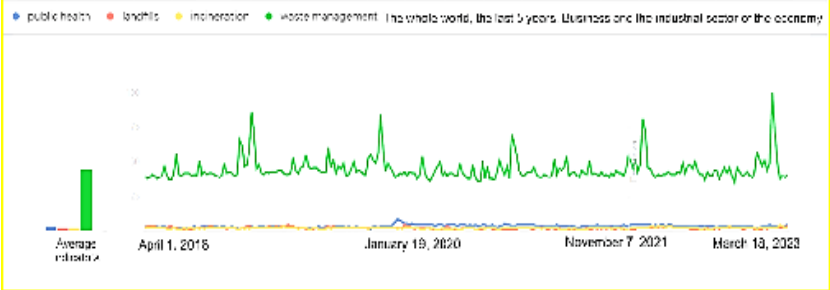
The results of Table 2 indicate that when the «all categories» filter is installed, the «public health» topic is the most popular in the world. At the same time, the popularity peak of this topic falls on 2019-2020. Such interest in the health field may be formed due to the COVID-19 emergence. Data analysis using the «science» filter determines the most interesting topics such as «public health» and «waste management». Also, issues related to «landfill» and «incineration» are investigated in interconnection.

For business and the economy industrial sector, the waste management issue is the most interesting.

Table 2. Dynamics of request popularity by filters

Filter	Dynamics of request popularity	Leading countries
All categories		Canada, Great Britain, Nigeria, Ireland, Ethiopia
Science		Canada, Hong Kong, Ireland, Egypt, Sweden

Continued Table 2

Filter	Dynamics of request popularity	Leading countries
Business and the economy industrial sector		New Zealand, the USA, Philippines, India, Sri Lanka

Sources: developed by the authors on the basis (Data generated via the Google Trends software ,2023).

Besides, the Google Books Ngram Viewer (2023) analysed the trends in citations from 2010 to 2020 of the main phrases highlighted in this study (Figure 7).

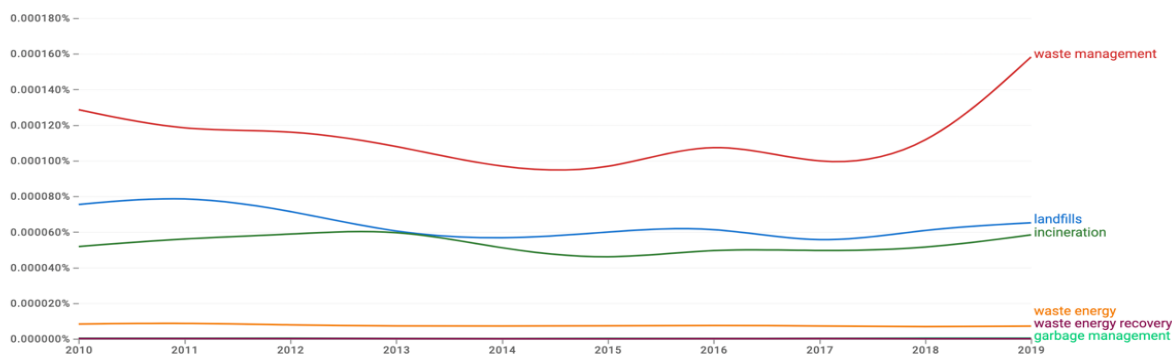


Figure 7. Dynamics in the citation of keywords for the query «waste energy» in search engines (in English) for 2000-2019

Sources: developed by the authors on the basis (Google Books Ngram Viewer tool, 2023).

Figure 7 shows the number of selected phrase citations in books that are presented in Google. Thus, this diagram fully reflects and confirms the above-mentioned Google Trends results: its is the term «waste management» that is the most popular for the last decade.

According to the requirements of the National Waste Management Strategy, 65% of all waste should be recycled in Ukraine by 2030. For the EU countries, this indicator should be 90%. The first stage to improve waste management is construction of waste processing facilities as well as landfill reclamation. To speed up the recycling mechanisms, the population should be responsible for sorting garbage. Moreover, service companies should ensure the containers are available for separate collection of solid household waste in yards.

Due to the constant EU-oriented reforming of the Ukrainian legislation, the environmental norms are increasing. The foreign experience use can improve the waste management efficiency. The most successful in sorting and processing garbage is Sweden (99%). Via modern technologies, garbage is processed into energy that powers public transport, heats and lights residential buildings and municipal institutions. Poland has strict legal requirements and two tariffs for waste removal. The price policy assumes that the price for sorted garbage is much lower than for non-sorted waste. There is also a system of fines for refusing to sort waste. In Austria, with the help of biotechnology, plastic is broken down for processing into new textiles and other products. All of these are good results and examples that Ukraine can use in their way to effective waste management and energy recovering.

As you can see, the world is moving to more effective ways of managing household waste. The study results confirm the undeniable relevance of the issue to protect public health and environment.

Conclusions. Today, the issue of finding new effective ways and technologies for waste processing is extremely important. At the same time, one of the most urgent questions for Ukraine is the post-war energy recovery via waste management optimisation. On the one hand, there is a need to use those approaches that would be able to satisfy population demands. On the other hand, we should protect environment. Such

technologies are emerging in developed countries. So, the foreign experience use in waste management can increase the efficiency of corresponding mechanisms in Ukraine. To plan waste processing, two components must be taken into account: it must be not only environmentally friendly but also economically beneficial to the state. Environmental organizations confirm the lack of efficient household waste incineration. Besides, there is another problem: a constant rise of unauthorized landfills with improper maintenance.

Since the waste management issue is relevant today, the authors investigated the terminological orientation of scientific publications. In Scopus, they found interconnections between health risk, public health, landfill, risk assessment, waste disposal, waste management. The VOSviewer software singled out several research clusters within the interaction of «health» AND «landfills» as well as «health» AND «waste incineration». The study has shown a close relationship between the environmental component of landfill maintenance, waste incineration and public health. Therefore, to increase the economic and ecological efficiency of waste management, it is necessary to consider other technologies of their processing (in particular, the sorted waste processing to produce secondary raw materials).

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Вплив спалювання сміття та отримання з нього енергії на здоров'я населення окремих територій: бібліометричне та змістовне дослідження

Ще декілька десятків років тому в Україні майже не використовувалася пластикова упаковка. Продукти харчування продавалися в скляних пляшках, залізних бляшанках чи у паперовій обгортці, які розкладалися у довкіллі чи здавалися до спеціальних пунктів прийому вторинної сировини. Проте в останні десятиліття ситуація докорінно змінилася в усьому світі. Майже всі продукти мають декілька шарів пакування, виготовлених із синтетичних полімерних матеріалів, що призвело до розростання площ сміттєзвалищ, а отже, і до появи нової проблеми – їхнього належного обслуговування. Звалища – це ділянки землі, на яких безконтрольно зберігаються побутові, будівельні та інші відходи. Для зменшення об'єму відходів звалища часто підпалюють. Такий підхід є неприпустимим, оскільки звалища є серйозним джерелом забруднення ґрунту, повітряного та водного середовища. Самовільно створені пункти скидання відходів не обладнані відповідним чином, продукти гниття і розпаду відходів потрапляють у ґрунт і ґрунтові води, які є джерелом водопостачання для великої кількості населення. Температура гниття в деяких випадках настільки висока, що часто призводить до займання відходів, унаслідок чого в повітря викидається велика кількість шкідливих речовин. У поточній статті авторами проведено дослідження термінологічної спрямованості наукових публікацій в контексті виявлення впливу на здоров'я людей перетворення відходів в енергію порівняно з впливом від функціонування сміттєзвалищ. Дані, що містять бібліографічну інформацію про фахові публікації в рецензованих виданнях, отримані з наукометричної бази даних Scopus. Результати показали, що експерти досліджують вплив сміттєзвалищ на здоров'я населення, головним чином зосереджуючись на таких поняттях, як «health (здоров'я)», «landfills (сміттєзвалище)», «waste incineration (спалювання відходів)». Авторами проаналізовано динаміку рівня фахової зацікавленості даною тематикою та визначено, що найвищий показник припадає на 2022 рік, що підтверджує зростання актуальності досліджуваної проблеми.

Ключові слова: бібліометричний аналіз; здоров'я; громадське здоров'я; сміттєзвалище; утилізація відходів; перетворення відходів на енергію; управління відходами; міські тверді відходи; електронні відходи; громадське здоров'я на конкретних територіях.