ENVIRONMENTAL APPROACH TO MUNICIPAL SOLID WASTE MANAGEMENT.

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The increase in the accumulation of municipal solid waste (MSW) undoubtedly reflects changes occurring in people's lifestyles. The development of environmentally sound methods for the transformation of the inevitably generated waste masses, under the current level of processing and society's appropriation of natural resources, is driven not only by the problem of municipal solid waste itself.

The objective of this study was to examine modern environmentally friendly approaches to municipal solid waste (MSW) management, evaluate their effectiveness in mitigating adverse environmental impacts, and determine promising directions for the improvement of waste management systems. The study was based on a review of scientific literature, environmental protection and waste management regulations, statistical data on the generation and disposal of municipal solid waste (MSW), and the results of both domestic and international research.

The imperfection of modern industrial technologies does not allow for deeper or complete processing of mineral raw materials; therefore, most of these resources are returned to the environment in the form of waste. According to some estimates, the final annual product accounts for only 1–2% of the total volume of raw materials used, while the remainder becomes waste. This indicates not only an irrational use of resources but also the inefficiency of existing production systems. The example of a city with a population of one million residents illustrates the scale of waste generation: the daily volume of gaseous waste reaches 950 tons, liquid waste 570 thousand tons, and solid waste 2.5 thousand tons. In large cities, the amount of municipal solid waste (MSW) is so substantial that even its removal from residential areas becomes a serious challenge. In the United States, for example, approximately 63,000 garbage trucks are required each day to manage waste collection and transportation. Approximately 8 million tons of household waste are removed from the streets of large cities each year. The major challenge is determining how and where this waste should be managed. Occupying vast areas, waste disposal sites become significant sources of environmental pollution, affecting air quality, water bodies, and soil, especially since not all waste disposal facilities comply with existing environmental standards. Wind-blown dust from such sites can spread over distances exceeding 10 km, directly impacting soil cover. Some waste dumps are prone to spontaneous combustion, releasing smoke and pollutants into the atmosphere. During periods of rainfall or snowmelt, water percolating through waste deposits becomes contaminated with highly toxic compounds, posing additional environmental risks. Hazardous contaminated zones have formed around waste disposal sites. These adverse phenomena are characteristic of virtually all populated areas. The collection, disposal, and complete neutralization of municipal solid waste (MSW) remain complex public health and environmental challenges, becoming increasingly difficult under conditions of rapid urbanization. The complexity of the problem is обусловед, first, by the continuous growth in the volume of waste generated and, second, by the increasing diversity of its components. As is well known, no species can survive indefinitely within the waste it produces. Therefore, the disposal and treatment of waste directly within residential areas are unacceptable.

Nevertheless, in many places the most primitive methods of waste disposal are still practiced, including the open burning of household and street waste in streets and courtyards without any technical control or treatment facilities. Such practices result in significant air pollution and pose serious risks to the health of residents and the environment.

The practice of burying waste in the ground, relying on the natural mineralizing capacity of soils, still persists in some areas. However, this approach cannot adequately solve the waste management problem. As the volume of municipal solid waste (MSW) continues to increase in urban areas, soils within cities and their surrounding territories are subjected to growing environmental pressure.

The accumulation of waste poses a serious threat to ecological balance, contributing to the degradation of groundwater and underground water resources. Leachate from landfills often contains decomposing organic matter, iron, lead, zinc, dyes, detergents, pharmaceuticals, and other contaminants that pollute water bodies and soils. In recent years, research efforts have increasingly focused on developing the scientific basis for maintaining ecological sustainability. Particular attention has been paid to the quantitative and qualitative characteristics of solid waste that may contribute to the disturbance and degradation of natural ecosystems within residential areas.

Solid waste represents an enormous mass of diverse materials generated annually and dispersed across the planet. Due to their extremely slow decomposition, solid wastes accumulate at an increasingly rapid rate. As a result, the waste situation is becoming critical. Consequently, the search for environmentally sound methods of waste treatment and disposal has become a matter of great importance.

Addressing this challenge requires a comprehensive approach to waste utilization, recycling, and disposal. Essential measures include the development of waste databases and information systems on recycling technologies, industry-specific waste accounting, the implementation of economic incentive mechanisms, and the establishment of an effective legislative framework. Experience has shown that countries with well-developed waste management legislation achieve more successful outcomes in waste utilization and environmental protection.

In recent years, various measures aimed at eliminating landfills—the hazardous by-products of urbanization—have been tested and implemented. Household waste is being sorted and processed into agricultural fertilizers or even liquid fuels, while part of the waste is transported and used for filling quarries, ravines, and other disturbed lands. Nevertheless, the problem of municipal solid waste (MSW) remains largely unresolved worldwide. The search for the safest and most environmentally sound methods of solid waste management has become a matter of critical importance.

In the city of Yangiyul, municipal solid waste is generated daily from residential buildings, educational institutions, and other public facilities. According to morphological characteristics, MSW consists of the following components: paper and cardboard, food waste, wood, ferrous and non-ferrous metals, textiles, bones, glass, leather and rubber, stones, polymer materials, miscellaneous non-classified materials, and fine fractions (less than 15 mm in size).

When designing MSW processing facilities, information on the morphological composition of waste in different climatic zones is essential. To assess the feasibility of recovering recyclable materials, a more detailed analysis of waste composition is conducted. For example, paper is classified into relatively clean recyclable paper and contaminated paper; metals are divided into ferrous scrap, tin cans, and non-ferrous metals; plastics are differentiated into packaging materials and plastic products, among other categories.

Seasonal variations in the composition of municipal solid waste (MSW) are characterized by an increase in the proportion of food waste during autumn, reaching 40–60%, which is associated with higher consumption of fruits and vegetables, particularly in cities located in southern climatic zones. During autumn and winter, the content of fine fractions (street sweepings) decreases from 20% to 7% in southern cities and from 11% to 5% in cities of the temperate zone.

Analysis indicates that the composition of MSW changes significantly over time. The proportion of paper and synthetic packaging materials continues to increase. With the transition to centralized heating systems in large cities, the content of coal and slag in MSW has sharply decreased, in many cases approaching zero.

The fractional composition of MSW, defined as the percentage distribution of waste components passing through sieves with different mesh sizes, has a substantial impact on waste collection and transportation technologies, as well as on the design parameters and operational efficiency of waste processing facilities.

Conclusion. Environmentally sustainable municipal solid waste management plays a key role in mitigating environmental pollution, reducing landfill dependency, and enhancing resource recovery. The adoption of source separation, recycling practices, and advanced waste treatment technologies is fundamental to achieving environmental sustainability and supporting the long-term development of urban and residential communities.