**Environmental foundations of storage and neutralization of solid household waste at poligons**

Shodmonova Azizaa) , Hasanov Hayitmurod, Ibroximov Giyosiddin,Boboniyozova Jayrona, Tokhtamishova Farangiz, Keldiyorova Fazolat, Tokhtayeva Gulmira

*Termez State University of Engineering and Agrotechnologies, Termez, Uzbekistan*

*a) Corresponding author: aziza.shodmonova@gmail.com*

**Abstract: Municipal solid waste (MSW) has a significant impact on urban ecology. This study analyzes the ecological foundations of MSW storage and disposal in landfills and demonstrates a scientific approach to sustainable waste management using Geographic Information Systems (GIS), Analytical Hierarchy Process (AHP), and Multicriteria Decision-Making (MCDM) tools. The results provide practical guidance for policymakers, urban planners, and local authorities.**

**INTRODUCTION**

* Urbanization of cities and industrial development exacerbate the problem of QMQ management.
* Improper management pollutes soil, water, and air and negatively impacts public health.
* The process of storage and neutralization at landfills should be combined with scientifically based decision-making.

**EXPERIMENTAL RESEARCH**

Solid waste landfills in the Burdur Lake basin were assessed using the Analytical Hierarchy Process (AHP) and Geographic Information System (GIS); the results confirmed the suitability of existing landfills and identified two new sites for future use, which is of practical importance for sustainable waste management.[1] Two strategic sites were proposed by assessing landfill sites in the Kenitra province of Morocco using ArcGIS, remote sensing, and AHP, which serves sustainable waste management, public health, and ecosystem protection in line with SDG objectives.[2] A ML-based system was developed for landfill selection in the Marmara region, with XGBoost 0.8671 accuracy yielding the best result, and SHAP analysis showed that land use and distance to airport and industrial areas are the most impactful factors, providing a reliable tool for sustainable, environmentally friendly, and economically optimal waste management.[3] The study demonstrates the importance of data-driven multi-criteria decision-making tools The integration of GIS and AHP has been effective in optimizing landfill selection, increasing environmental sustainability, and reducing health risks, providing practical guidance to decision-makers in developing sustainable waste management strategies in the context of the Gimba town.

Goals and objectives:

* Determination of landfill areas in accordance with environmental and social criteria.
* Development of a scientifically based methodology for sustainable waste management.
* Ensuring a strategic decision-making process that meets the SDG objectives.

Methodology

* Data: GIS shapefile, land-use maps, topographic and hydrogeological data, population and infrastructure parameters.
* *AHP:* determine the weights of parameters and criteria.
* *MCDM:* Separate areas into suitability classes (high, medium, low, unacceptable).
* *Remote Sensing:* Land Analysis and Land-Use Maps Updates.
* *ML (if applicable):* Increasing the accuracy of polygon selection and identifying important factors.

*Solid household waste* - organic and inorganic waste generated as a result of the life and activities of individuals and the activities of legal entities, as well as waste generated as a result of natural processes on their territory and at landscaping facilities (food and plant waste, textile products, packaging materials, glass, rubber, paper, plastic, wood waste, household items that have lost their operational properties, garbage, as well as waste generated as a result of the use of household stoves and heating boilers operating on solid fuel);

Solid Waste Landfill - a complex structure (waste landfill) intended for the placement, neutralization, and isolation (burial) of solid household waste and ensuring the protection of atmospheric air, soil, surface and groundwater from pollution, preventing the reproduction of rodents, insects, and disease-causing microorganisms.

Solid Waste Landfills (hereinafter referred to as landfills) may be established for settlements of any size. In order to ensure the efficient use of land plots and reduce the costs of transporting solid household waste, it is advisable to organize centralized landfills for nearby settlements.

A properly organized system for the removal and neutralization of solid household waste from the territory of cities and other settlements plays a decisive role in the complex of measures aimed at maintaining the sanitary and epidemiological well-being of the population and reducing the incidence of intestinal infections. Therefore, sanitary control over MSW treatment systems in settlements is one of the main tasks of the territorial centers of the State Sanitary and Epidemiological Surveillance Center of the republic.

MSW includes waste, unnecessary, or unnecessarily discarded materials that are products of human activity, generated in individual houses, public, medical, and other institutions, and are subject to removal from the territory of cities and rural settlements to solid household waste landfills by specialized municipal enterprises of khokimiyats according to a unified centralized system.

The Sanitary Rules are intended for use by employees of the territorial centers of the State Sanitary and Epidemiological Surveillance Center, ministries, departments, and design organizations dealing with the problems of cleaning settlements of the republic from solid household waste.

*Content and properties of solid household waste.* MSW contains various items, materials, materials, and waste that are unsuitable for further use, which are usually divided into the following main groups: paper, food waste, wood, metals, textile products, leather, rubber, glass, stones, coal and ash, room and yard estimates, fallen leaves, other non-classifiable parts and sieves (particles smaller than 15 mm).

The above-mentioned classification of MSW is determined, on the one hand, by the need to identify valuable components of MSW for their subsequent utilization as secondary raw materials for industry or feed for livestock; on the other hand, by the need to choose a rational method of their neutralization.

The average morphological composition of MSW is characterized, first of all, by a significant amount of food waste (up to 38.4%) and paper (18.9%). In recent years, the amount of various products made of polyethylene and plastics in MSW has increased dramatically. The composition of MSW components is not constant and varies by seasons, in particular, in summer and autumn, the percentage of food waste in them increases, which is associated with the population's increased consumption of vegetables and fruits during these periods (HYPERLINK "http://lex.uz/docs/1932114" \l "1932145" Table 1).

**Table 1. Average morphological composition of MSW in cities (as a percentage by weight)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Fractions** | **Main seasons of the year** | | | | **Average in a year** |
| **winter** | **spring** | **summer** | **autumn** |
| Paper | 29.5 | 18.3 | 18.8 | 18.1 | 18.9 |
| Food waste | 35.3 | 36.8 | 39.2 | 42.2 | 38.4 |
| Tree | 4.7 | 4.2 | 3.0 | 7.8 | 4.9 |
| Metal | 5.0 | 3.9 | 2.2 | 2.3 | 3.4 |
| fabric | 3.7 | 3.3 | 3.9 | 4.3 | 3.9 |
| Leather, rubber | 2.0 | 0.7 | 0.4 | 0.4 | 0.8 |
| Glass | 4.7 | 4.5 | 0.3 | 1.9 | 3.7 |
| Stones | 6.4 | 10.5 | 16.8 | 8.0 | 8.9 |
| More episodes | 17.7 | 17.8 | 15.4 | 15.0 | 17.1 |

Solid household waste is quite unique in its physicochemical indicators (moisture, heat generation, organic matter content), therefore they are easily neutralized by biofermentation method in factory installations and special landfills.

The content of organic matter in MSW is quite high (up to 58.3%), and in autumn even up to 66.0%, against the background of high heat productivity (more than 1580 kcal/kg per year on average), which allows them to be processed in waste incinerators at all times of the year ([Table 2](http://lex.uz/docs/1932114#1932215))

**Table 2. Average chemical composition of solid household waste**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Main indicators** | **Main seasons of the year** | | | | **Average in a year** |
| **winter** | **spring** | **summer** | **autumn** |
| % of organic matter relative to absolutely dry matter | 54.3 | 39.1 | 61.0 | 66.0 | 58.3 |
| Humidity % | 46.0 | 43.6 | 38.9 | 48.6 | 44.2 |
| pH value of salt extract | 7.1 | 7.2 | 7.6 | 7.4 | 7.2 |
| Volume weight, kg/m3 | 355.6 | 387.6 | 434.0 | 406.0 | 395.0 |
| Heat capacity kcal/kg | 1972,4. | 1508.4 | 2507.0 | 1647.2 | 1581.2 |

The bacteriological quality of CFU is characterized by low titers of E. coli (10-7 - 10-8), perfringens (10-7); proteus (10-3 - 10-5 ). Therefore, MSW poses a potential epidemic threat to the population.

The bulk density of MSW in cities can vary in a wide range (from 355 to 406 kg/m3); in average annual calculations, figures from 400 kg/m3 can be used. Bulk density can vary within quite wide limits, therefore it is advisable to specify it for individual settlements of a particular region of the republic.

*Rates for the accumulation of solid household waste.* It should be taken into account that MSW accumulates unevenly throughout the year in the territory of settlements. The maximum accumulation is usually observed in autumn (1.6 kg/day), and the minimum in winter (0.8 kg/day). Uneven accumulation of MSW should be taken into account when compiling optimal schedules of transport operations for its rational use.

In settlements, the norm for the accumulation of MSW per capita should be taken as an average of 1,2 kg/day (0.0032 m3) or 453 kg per year (1.1 m3 per year).

**Table 3. Standards for the accumulation of solid household waste (average)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Indicators of MSW accumulation per capita** | **Main seasons of the year** | | | | **Average in a year** |
| **winter** | **spring** | **summer** | **autumn** |
| Average kg/day | 0.8 | 1.0 | 1.3 | 1.6 | 1.2; |
| Average m3/day | 0.0025 | 0.0028 | 0.0030 | 0.0039 | 0.0032 |
| Average kg/year | 292. | 401. | 474. | 584. | 453. |
| Average m3/year | 0.82 | 1.03 | 1.09 | 1.43 | 1.10 |
| Volume weight, kg/m3 | 355.6 | 587.6 | 434.0 | 406.0 | 395.8 |

Due to the fact that in the Republic of Uzbekistan there are still no officially approved differentiated norms for the accumulation of MSW in some public catering facilities, trade and cultural-household institutions, hospitals and polyclinics, it is possible to temporarily use the norms of the Russian Federation "Sanitary Rules for the Collection, Storage, Transportation, Disinfection and Utilization of Solid Household Waste (SMW) in Cities of the Republic of Uzbekistan" (SanPiN RUz No 0068-96).

For certain regions, cities, and districts, these accumulation norms may be clarified by the territorial centers of the State Sanitary and Epidemiological Surveillance Center based on special studies of a sanitary and hygienic nature.

Determination of solid household waste poligons.Solid household waste landfills are special structures intended for the isolation and neutralization of MSW, which must ensure and guarantee the sanitary and epidemiological safety of the population. SSSS can be organized for settlements of any size, but it is preferable to organize a centralized SSSS for groups of settlements.

The organization operating MSW, taking into account the requirements of industrial sanitation for those working at the landfill, develops the operating regulations and regime of the landfill, instructions for the acceptance of MSW, ensures control over the composition of MSW arriving at the landfill, maintains their 24-hour accounting, monitors the distribution of waste, and ensures the technological cycle for waste isolation.

The site selected for the installation of the PTBQ must have a conclusion from the territorial centers of the State Sanitary and Epidemiological Surveillance Center on its compliance with sanitary and epidemiological rules.

Waste from residential buildings, public buildings and institutions, trade and public catering enterprises, street, park, and park estimates, construction waste, and certain types of industrial waste of hazard classes 3-4 are accepted for PTBT. The list of such industrial waste is coordinated with the territorial centers of the State Sanitary and Epidemiological Surveillance Center.

Neutralization of solid, liquid, and paste-like waste containing radioactivity is carried out at special landfills organized in accordance with the basic sanitary rules for ensuring radiation safety in effect on the territory of the republic.

Burial and neutralization of solid, paste-like waste of industrial enterprises containing toxic substances and heavy metals (hazard classes 1-2) (see SanPiN RUz No. 0127-02 "Sanitary Rules for Inventory, Classification and Disinfection of Industrial Waste" and SanPiN RUz No. 0128-02 "Hygienic Classifier of Toxic Industrial Waste in the Conditions of the Republic of Uzbekistan"), as well as flammable and explosive waste, must be carried out at special landfills organized in accordance with SanPiN RUz No. 0127-02 and SanPiN RUz No. 0128-02.

In MSW, the collection of secondary raw materials directly from waste transportation is not permitted; sorting and selective collection of waste is allowed with strict observance of sanitary and hygienic requirements.

Sanitary control of the sanitary condition of soils is carried out by the territorial centers of the State Sanitary and Epidemiological Surveillance Center in accordance with the annual work schedules, guided by these Rules, as well as the hygienic standards for chemical substances in soils (MPC) approved by the Ministry of Health of the Republic of Uzbekistan (see SanPiN RUz No. 0055-96 "Maximum Permissible Concentrations (MPC) and Estimated Permissible Concentrations (MPC) of Exogenous Harmful Substances in Soils") and indicators for assessing the sanitary condition of soils (see SanPiN RUz No. 0057-96 "Sanitary Rules and Norms for Assessing the Degree of Soil Pollution in Various Types of Land Use" and "Methodological Recommendations for Hygienic Assessment of the Hazard Level of Soil Pollution for Public Health," approved by the Ministry of Health of the Republic of Uzbekistan on April 5, 1994.

Consideration:

* Selecting a landfill increases environmental sustainability and protects water and soil resources from pollution.
* Helps improve urban health and economic efficiency.
* The integration of ML and GIS optimizes decision-making.

**RESEARCH RESULTS**

Storage and neutralization of MSW at landfills requires an environmentally sound scientific approach. GIS, AHP, and MCDM tools ensure the selection of the optimal landfill for sustainable waste management and provide practical guidance to decision-makers. This approach harmonizes ecological, economic, and social interests.

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