Information Support for Monitoring of the Sphere of Solid Municipal Waste Treatment

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1. Introduction

Organization of effective management of municipal waste is a complex management task, characterized by a multiplicity and heterogeneity of the factors that must be taken into account, and multistage associated with different content process applicable at each stage. The initial stage – is the organization of waste collection, followed by their removal from the territory of the settlements and the final stage of recycling or disposal can be represented by separate sub-goals with those of assessment of their achievement. It is no accident for a long time even the federal Russian legislation defines different levels of responsibility of the regional and municipal authorities in the organization of the waste management system. Common to all the stages, however, is the problem of the availability of reliable and timely information to make effective management decisions.

2. Research

In the currently known scientific approaches reasonably considered important to have objective information on the volumes of generated waste. At the same time, today, most scientists disagree on the application of the proposed definitions by different authors calculated the

amount of waste procedures. As a consequence, the vast majority of municipal services, carrying out practical work on coordination in the field of waste management, as a rule, do not have reliable information to enable effective decision-making. An example of what has been said, is the work done by our team to develop a rational scheme of placing container yards in the city district "City of Kaliningrad". So, if conditional, to share all the sources of municipal waste in the housing and the waste of various kinds of legal entities and entrepreneurs, we have to take into account several types of housing and dozens of different types of legal entities by activity.

Oddly enough, the collection and analysis of information on the housing stock, our team did not have big problems. Some difficulties arose only with the question of the formal registration and actual residence of certain groups.

As for the sources of such waste, as legal entities and entrepreneurs, the information it holds there is a big problem, on the correctness of that decision the quality of the entire information database depends largely on, as is traditionally the proportion of waste in volumes this source category is about half. In official statements, we can get information only 5-10% of waste sources. Therefore, the only way to determine in this case the amount of waste is a calculation method using known standards (Academy of Public Utilities and others) and data of state regulatory agencies. Immediately it should be noted that the current classification of businessmen by type of activity is so detailed, that it does not allow for effective regional planning of waste management goals.

The consequence of the above was the development of the author's classification of housing waste and the so-called office waste, designed to reduce the number and greatly simplifies the collection and analysis of available information. Particular attention is invited to pay on account of the factor of geographical place of origin of the waste.

Based on the above stated concepts and basic principles of geographic information systems (GIS) waste management in the village, as well as the author developed a technique of formation of databases and their layered overlay, allowing us to obtain a fairly complete and easy to make management information base decisions. Among the factors taken into account in the formation of a geographic information system, as restrictions were taken into account: firstly, the sanitary legislation re-

quirements; Secondly, urban development regulations. This allows to receive the database reflecting the real picture in the village. Some provisions of scientific approach have been applied by a group of authors in the performance of work to streamline the scheme of allocation of container yards (CY) in Kaliningrad.

Here is the procedure for forming a geographic information monitoring system and management of processes of collection of municipal solid waste (MSW) in the municipal formation (MF), taking into account existing standards and the requirements of environmental legislation.

Stage 1. Preparing the necessary input data sets for a MF, such as:
• layout of housing container yards (CY);
• an array of data on CY housing stock in the form of a table showing the addresses and characteristics of the CY, including property rights, the availability of access roads, turn platforms, lighting, fencing, canopy cover, landscaping; Information about the containers located on the CY: ownership, characteristics, quantity, volume;
• an array of data in a table of all the houses of MF, their address, number of floors, presence of refuse chute, number of living people, the names of management companies (MC, condominium, name of the owner of the private home ownership), presence of an agreement on the export of MSW, settlement amounts waste for every MC home in accordance with the approved standards of MSW formation;
• layout of container yards of enterprises and organizations located in the territory;
• amount of data on the CY (for which there is initial information) of enterprises and organizations in the form of a table with the name of the organization, information on availability of the agreement on the export of MSW, location and characteristics of the CY (property rights, availability of access roads, platforms for turning refuse chute truck, lighting, fencing, carport, concrete pad, landscaping). To be completed by information about the containers located on the CY: ownership, characteristics, quantity, volume of container;
• an array of data in the form of a table with a list of all organizations and CY companies, the addresses of these organizations, the information about activity and the estimated amount of MSW formation for each organization and the enterprise;

• amount of data on the status of land (including the location of the red line), where CY is located. The database is created on the basis of cadastral information.

Stage 2. Solution of graphic tasks for the development of GIS for monitoring and process control in the reference of MSW to MF are as follows:

• Create a layer number 1, which are defined as vector objects all arrays of houses according to the following classification: arrays of houses with refuse chute, arrays of houses without refuse chute. This function is provided to output information on the volume of waste generation for each dwelling house;

• Create a layer number 2, which set all vector objects location of CY for housing. This output provides information about the function of each CY.

The results of the introduction of layer number 2 will be: electronic container yards map, making it possible to obtain information about the formation of volumes of MSW for the selected object (dwelling house), in the long term - for a group of objects and entire administrative MF area. There is a division of the total housing stock in the house with the refuse chute and without them, which creates prerequisites for solving MSW separate collection for residential buildings, equipped with the refuse chute disposal; it is possible to identify the owners of private homes who do not have contracts for the removal of its own MSW.

• Create a layer number 3, where all businesses and organizations are given in the form of vector objects; provided information output function:

- On waste generation volume for each object (enterprise and organization),

- On each CY depending on the core activities.

The results of the introduction of layer number 3: according to the results of the inventory of enterprises and organizations, owners of buildings, facilities and land creates an electronic chart with the release of the array location of enterprises and organizations - sources of waste generation; it is possible to obtain information on the amount of waste from each source (in the future of the Group sources) waste; create an electronic map locations of container yards of enterprises and organizations; it is possible to obtain information from the inventory database (5) for each CY of companies and organizations that have their own CY.

• create a merged layer number 4, in which:

- Given as a vector object - arrays of all the houses (the house with the refuse chute are highlighted in color), has a function of displaying information on the volume of waste generation for each object (dwelling house);

- Given as vector objects all CY location for housing, has a function to output information about each CY;

- Given as vector objects businesses and organizations, has a function of displaying information on the volume of waste generation for each object (companies and organizations);

- Given as vector objects all CY location for businesses and organizations, has a function of outputting information about each CY of companies and organizations.

As a result of the introduction of layer number 5: on the electronic GIS map MF is possible to identify the companies and organizations that do not have their CY and in close proximity to CY housing. The identification of such "grey" object allows you to make cautious assumptions about the methods used by their collection and removal of their own waste. This, in turn, creates the preconditions for the control of the collection and removal of MSW from organizations and enterprises. It is necessary to identify such organizations and businesses, forcing them to comply with the rules of accomplishment in MF.

In addition, the results of this work will help to reduce the capacity of the containers for housing, replace them with smaller, aesthetic and ergonomic, with the possibility of separate collection, creating a substantial saving the cost of collection for residents, transport and disposal of MSW. These measures are proposed as priorities for optimizing the processes of collecting MSW from the public and organizations.

• Create a layer number 5, which for apartment buildings with refuse chute the schematically depicts "ring" with an outer radius of 100 m and an inner radius of 20 m (ie, distances, and no closer than within that of the dwelling house shall be a container); color field rings, their boundaries and crossing several "rings".

As a result of the introduction of layer number 5: on the electronic map GIS MF is possible to determine the said areas for further analysis of the cadastral land, which can be installed back-up CY or CY provided

the separate collection of MSW for multi-storey buildings with refuse chute.

• Create a layer number 6, which schematically shows the "ring" for container housing areas with centers in container yards locations, the outer radius of 100 m, an inner radius of 20 m;

As a result, the electronic map GIS MO makes it possible to visually determine the coverage of all residential buildings (in accordance with the sanitary rules and regulations) with container platforms; identify areas of residential development not provided with CY, and then calculate the number and size of areas for the installation of the new CY, which is also necessary for further analysis of the cadastral land.

If the distance from the existing sanitary CY to the closest dwelling houses is not observed (less than 20 meters), these are indicated by the relevant conventional signs as requiring transfer in order to ensure the gap not less than 20 m.

Identify areas (diameter 100 m), the highest concentrations of CY. Examining each case individually, you can further merge or liquidate a part of container yards.

3. Results of research

In our view, rationality is to maximize economic efficiency, in accordance with current legislation and economic features of the region taking into account the implementation of environmental requirements and ergonomics.

The main criterion of environmental friendliness in the organization of waste collection and disposal (removal) is to ensure the minimum negative impact on the environment. One of the most important tools for environmental friendliness is environmental legislation, a set of sanitary rules and norms.

Following the above, it is advisable to perform the following activities:

1. prohibit open containers for the use of waste collection in the city of Kaliningrad;

2. oblige managing companies to use containers specialized by types of waste for the collection of waste:

- For paper and paperboard;

- For glass;
- For plastic;
- For electro goods and accumulators;
- For mercury lamps.
3. When having separate collection to ensure a ban on the mixing of waste in garbage trucks;
4. To provide separate storage of waste in landfills;
5. Secure container platforms for specific organizations with a requirement for proper sanitary maintenance.

The main criteria of ergonomics for waste collection sites are:
- Beautiful appearance, both the place of gathering, and the containers installed on it, allowing them to incorporate into the surrounding architecture of the city.
- Walking distance to the public;
- Ease of use - ways, entrances, stairs, etc.

Following the above, it is advisable to perform the following activities:
1. Use color to paint containers, depending on separately - collected by type of waste (Yellow, Green, Blue, Red, etc.)
2. Ensure the possibility of closing access to the collecting place and the containers themselves for outsiders.

The economic efficiency of collection and disposal of waste should provide the minimum price to the public, on the assumption of the criteria of environmental friendliness and ergonomics.

When assessing the economic efficiency should be kept in mind that:
1 The greater the capacity of the container, the cheaper garbage removal.
2. The closer the gathering place for the landfill, the cheaper garbage removal.
3. The more regular organized garbage removal, the cheaper it is.
4. The longer term contract for waste removal, the cheaper it is.
5. Removal of sorted waste is cheaper than unsorted.

The main task of achieving economic efficiency of waste sorting is: "It must be economically profitable for population and management companies to sort waste and dispose them in different containers." To do this, the tariff for the export of unsorted waste containers should be max-

imized and the cost of removal of sorted waste should be minimal (ideally – zero).

Container yards, which are located on municipal lands, it is advisable to rent operators on a competitive basis. Terms of the contest must involve efforts to the organization of separate waste collection.

Making a decision on the construction of inter-municipal landfill at a considerable distance from the city, there should be the construction of storage areas in the city, which can be used to store the sorted waste (secondary raw materials) in order to further their implementation.

4. Conclusions

The results obtained have allowed significantly improve the capacity and effectiveness of the decisions made, in particular, on issues such as the optimization of traffic flows, division of human settlements into separate areas on a territorial basis and a reasonable preparation of technical tasks in the organization of tender procedures in the management system of sanitary clearing settlements.

It should also be noted that the thus formed geo-information system for monitoring and waste management can be seen as a higher-order system element, including for complex socio-eco-economic assessment of the status of the region.

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Zaopatrzenie informacyjne monitorowania sfery obchodzenia się ze stałymi odpadami komunalnymi

Streszczenie

Organizacja efektywnego zarządzania odpadami komunalnymi jest złożonym zadaniem, które charakteryzuje się wielością i różnorodnością czynników, które muszą być brane pod uwagę. Jest to wieloetapowy proces związany z różnymi procesami technologicznymi mającymi zastosowanie na poszczególnych etapach.

Problem dostępności wiarygodnej i aktualnej informacji jest wspólny dla wszystkich etapów podejmowania skutecznych decyzji w zakresie obchodzenia się z twardymi odpadami komunalnymi.

Geo-informacijne systemy monitorowania i zarządzania odpadami mogą być postrzegane jako element wyższego rzędu systemowego, również dla kompleksowej oceny społeczno-ekologicznego i gospodarczego statusu regionu.

Głównym zadaniem osiągnięcia efektywności ekonomicznej segregacji odpadów jest: „Ludność i spółki zarządzające, które muszą mieć korzyść z sortowania odpadów i wyrzucania ich do różnych pojemników". Aby to zrobić, taryfy na wywóz nieposortowanych pojemników na odpady powinny być zmaksymalizowane, koszt usuwania odpadów segregowanych powinien być minimalnym (idealnie – zero).

Otrzymane wyniki wskazują na znaczne poprawienie skuteczności podejmowanych decyzji szczególnie w takich kwestiach jak optymalizacja ruchu transportowego, podział na osobne obszary terytorium mieszkaniowego, bardziej uzasadnione przygotowania zadań technicznych w organizacji procedur przetargowych w systemie zarządzania sanitarnych oczyszczeń zamieszkałych obszarów.

Abstract

Organization of effective management of municipal waste is a complex management task, characterized by a multiplicity and heterogeneity of the factors that must be taken into account, and multistage associated with different content process applicable at each stage.

To make effective management decisions we must to decide the problem of the availability of reliable and timely information.

The geo-information system for monitoring and waste management can be seen as a higher-order system element, including for complex socio-eco-economic assessment of the status of the region.

The main task of achieving economic efficiency of waste sorting is: "It must be economically profitable for population and management companies

to sort waste and dispose them in different containers." To do this, the tariff for the export of unsorted waste containers should be maximized and the cost of removal of sorted waste should be minimal (ideally - zero).

The results obtained have allowed significantly improve the capacity and effectiveness of the decisions made, in particular, on issues such as the optimization of traffic flows, division of human settlements into separate areas on a territorial basis and a reasonable preparation of technical tasks in the organization of tender procedures in the management system of sanitary clearing settlements.

Słowa kluczowe:
odpady komunalne, efektywne zarządzanie, ochrona środowiska,
system geo-informacyjny, monitoring odpadów

Keywords:
municipal waste, effective management, environment, geo-information system,
monitoring of waste