

Classification of Methods and Techniques for Determining the Volumes of Waste and Sediments

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Abstract – Many modern hydrographic and geodetic methods allows you to choose the most appropriate one, according to the task and the type of the object. In turn, each method has advantages and disadvantages and is characterized by its precision and features of use. Therefore it is needed to distinguish objects on the source and method of creation, and classify methods for determining the amounts and their geometrical parameters in terms of the type of object and measuring accuracy.

Keywords – remote and contact methods of data acquisition, industrial and household waste, sediments, volume.

I. Introduction

Excessive concentration of industrial enterprises and agriculture in Ukraine leads to the accumulation of substances that are formed as a result of anthropogenic human activities (dump tailings landfill, reservoir hydro, rates - coolers nuclear, hydro, tar lakes, ponds - tank mine water), causing catastrophic pollution of air, water and soil. Analysis of the main trends and factors change the nature of environmental safety regions proves that maintain high energy and capacity resources economy Ukraine in conditions of further depletion of land, water, mineral and biotic resources will inevitably lead to the formation of large-scale threats to national security in environmental and natural-technogenic areas [8].

II. Classification of storage facilities and waste bottom sediments

According to the Law of Ukraine "On Waste" states that waste - is any substances, materials and objects that formed in the production or consumption, as well as goods (products) that wholly or partially lost their consumer properties and have no further use for the place of their creation or identification, and from which the owner gets rid of, intends to or must get rid of by recycling or removal.

Sources of waste is a potentially dangerous objects that are presented in "classifiers potentially hazardous objects".

According to this classification we distinguish major potentially dangerous objects that accumulate wastes and sediments:

- **enterprise for the production and supply of electric and thermal energy** (nuclear power, hydropower, thermal power stations CHP plants)
- **enterprises of mining ores and non-metallic minerals** (mines with underground coal mining, sections of open-pit mining coal waste heaps of coal mines operated, inactive dumps height of over 30 meters, which are exposed to combustion, inactive dumps height of

50 m, which is not prone to burning, coal preparation plants, mining - processing plants, plants)

- **sanitary buildings of municipal purpose** (solid waste, incineration and garbage recycling plant);
- **hydro buildings** (reservoirs, tailings, sludge ponds, a sludge, gold drives, ponds, settling tanks (illuminators), slime water, mine water);
- **transport objects;**
- **pipelines and buildings on them;**
- **storage of gas, oil and petroleum products.**

From the list of potentially dangerous objects it can be said that they do not constitute waste and sediments, which can be defined geodetic or hydrographic surveying methods.

So, consider the basic facilities which can accumulate these substances. Much of the industrial waste produced by such energy sectors as fuel and electricity industry. Consider them more.

Fuel industry. The determining of domestic sources of energy for Ukraine is coal. Coal reserves are concentrated in the Donetsk, Lviv - Volyn and Dnipro basins. In the mining and processing of coal there is a significant amount of waste and waste rock that forms dumps (slagheaps). Another important object for study are ponds, mine water settling tanks in which the water is pumped out.



Fig. 1. Slagheap and pond sump Central mill "Chervonogradska" in Lviv

Heaps has negative impact on the environment caused by the fact that they occupy a considerable area and volumes, they are undergoing a process of spontaneous combustion and smolder, is the subsidence of the earth's surface and flooding, as well as a negative impact on the health of local people. Another source for electricity is oil and gas. In territory of Ukraine allocate 3 oil and gas area: Eastern, Western and South Ukraine. Waste oil industry is oil sludge, tar and sludge. Oil sludge formation in tanks to store oil in wastewater treatment plants, as well as the system of water recycling and clearing reservoirs at. Given that oil sludge can be disposed of by different methods a more acute problem of tar lakes that accumulate sludge and dangerous substances. According to the calculations of the State Environmental Inspection in Lviv oblast harm caused to the state due to pollution of surface waters oil products is about 72 million. UAH., Land 18 mln. UAH [12].

The impact of oil and gas production processes results in:

- pollution of air, soil and water objects;
- presence of a large number and volume of waste; Products danger (fire - and explosive).

The basic branch of the economy of Ukraine is the power, which includes the production and transport of electricity. The main part of electric power produced in Ukraine:

- ✓ nuclear power plants (NPP);
- ✓ thermal power plants (TPP), which include (TPP and CHPP);
- ✓ hydroelectric power plant (HPP), that is divisible by (HPP and PSP).

NPP. The main fuel for nuclear power plants is radioactive elements (uranium, thorium, plutonium) and energy based on the reactions of radioactive decay of these elements. For example, in South NPP cooling pond is working in a very intense mode. On hot summer months its cooling performance is reduced. A necessary volume of water required temperature is not enough for all of power units stations. For this reason the total nuclear capacity is limited [9]. Thus, you may need to determine the volumes of water. It should also be noted that in these reservoirs silting is much smaller than at HPP.



Fig. 2. Pond - cooler South Ukrainian NPP [9]

TPP. The main raw material for thermal power plants is coal that is burned and the resulting combustion ash and slag formed. Where are accumulated and stored waste from thermal power plants is called tailing dumps.

Tailings (pool to collect liquid waste production) - artificial hydraulic engineering construction in the natural landscape that can be closed for storage of liquid tailings, which can be toxic and environmentally hazardous transported from their formation hydraulic way [6].



Fig. 3. Kalush tailing

The appearance of such objects as tailing entails the following negative consequences:

- change the natural landscape;
- contamination of groundwater runoff;
- removal of large areas under zolo- dumps where

piled up a large number of heavy metals and have elevated level of radioactivity;

- flooding and underflooding of of land, salinization and waterlogging of;
- violation soil structure.

HPP. Although HPP is a waste of electricity production process, but at the bottom there is an accumulation reservoir sediments, which are different in composition, properties and origin. They are formed by the destruction of the products coast and the bottom. Reservoir siltation reduces the useful volume of water directly affects the operation of HPP, changing all the physical, chemical and biological properties of the surrounding area and the most important thing is to reduce the useful volume of the reservoir.

The main raw material for hydroelectric power is the water pressure, which is provided with certain hydraulic structures, which include dams, canals, reservoirs and others.



Fig. 4. Reservoir Tereblyaritskoyi – HPP

Household waste. Questions waste is extremely urgent problem today, which concerns all of us. In Ukraine evident trend increase in solid waste (MSW) near major cities, towns and villages. If the problem is somehow solved dumps in the cities, while small towns and villages is a critical issue since produced more and more illegal dumps.

In scientific literature singled classification of waste aggregate state, namely solid and liquid.

As the liquid waste is stored in special reservoirs and there are a number of methods of treatment (mechanical, physical, chemical, biological and others) they can bring much less harm to the environment.

We know the following methods of MSW:

- is their main warehousing and storage dumps (landfills);
- destruction by incineration.

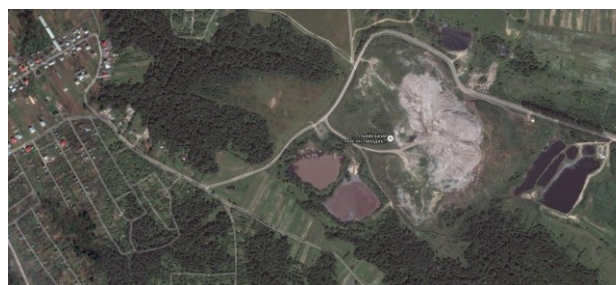


Fig. 5. Lviv landfill and tar lake on satellite imagery Google Earth

Rubbish dumped in landfills that take hundreds and thousands of hectares of land around cities and towns, pollute the air, groundwater, soil, distort the surrounding landscape.

We have proposed the following classification of substances that have the ability to accumulate as a result of anthropogenic human activities in terms of surveying methods and technologies used to study objects of different types (Fig. 6)

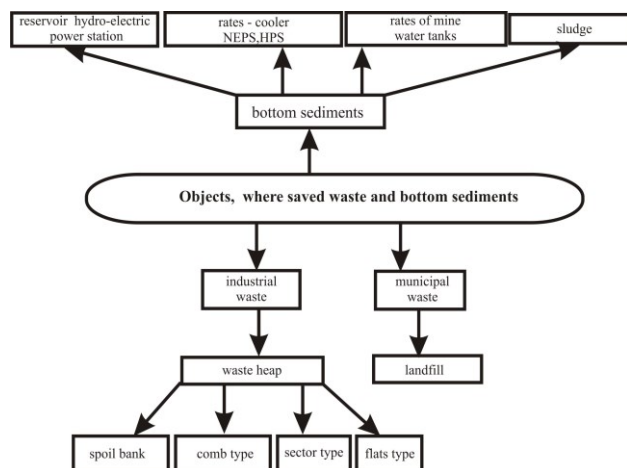


Fig. 6. Classification of storage facilities and waste bottom sediments

After analyzing the energy industry sector it is safe to say that the accumulated wastes and bottom sediments are very dangerous objects that need constant research, determination of areas where they are located and volumes of waste. These studies must be performed at regular intervals, as always there is a risk of contamination of the hydrosphere, atmosphere, lithosphere.

III. Classification of methods and techniques for determining the volumes of waste and sediments

Techniques of remote sensing (RS) and contact methods are used for determining the volume of research in modern conditions. Consider them in more detail.

Among publications found studies [1] relating to the calculation of area, volume and surface area of the side blade, conducted by scientists of Donetsk National Technical University. Also among national scientists workers Zhytomyr State Technological University [14] considered calculating the volume of finished product warehouses using various methods of using the software AutoCAD Civil 3D 2012, are examples of deviations from the reference value volume quantities. Among foreign publications can be identified [10,11,2,5,15]. In [11] describes the physical, chemical characteristics of materials, and also the geometrical parameters (angle, height), volume and area coverage dumps. Results presentation of 3D-model and profiles dumps. In the final section, the results and the comparison determining volume obtained by different methods and with different density measured points. The ability to use tacheometric, GNSS, lidar, satellite and stereo output of terrestrial laser scanning found in [2]. This paper compares defined area, volume, tonnage, time spent on the removal and processing and ultimately rating score of each presented methods. Efficiency photogrammetric method and the

method of laser scanning coverage in [15]. The authors defined volume and determine volumes are differences and their accuracy percentage. Comparison of the standard method and scanning method using Topcon Imaging Station with a density of 0.3 m. and 0.1 m considered in [5]. When using the method of scanning accuracy of the volume reached 99.95% of the actual volume, and 94.66% for the standard method. When using the method of scanning a fairly high percentage shows that scanning method is more accurate in calculating the volume, and the results were almost identical to the actual volume. The results of this method is much higher than the standard method for speed and accuracy.

Method for determining the volume of water in the tailings and tailings fill in mining - beneficiation plants Kryvbas considered in [4]. In this experiment the authors invoked surveying work of filling the tailings, which included the hydrographic survey of the bottom area and topographical survey of dry tailings beaches. Processing of the results was performed using the software package CREDO TOPOPLAN, CREDODAT resulting in a digital plan of tailings cross-section horizontals through 1.0 m.

3D modeling of technogenic zones using laser scanning technology and GNSS- considered in [7]. As a result of this work the authors constructed a model TIN- slag piles, but not specified in the length of these piles.

Workers of the National University "Lviv Polytechnic" has defined Tereblya silting reservoirs, particularly in [13] defined volume of silting them, built profiles of different parts of the reservoir, which is displayed siltation, the authors do silting forecast for 2010-2020.

In Ukraine, the first study on landfill using remote sensing were carried SSPE "Nature", in [3] examined the possibility of using satellite images to analyze the placement of landfills, their mapping, studying the dynamics of the size of landfills.

Space removal. Currently there are many satellite images of various spatial distinction. According to the classification [11] they can be divided as follows:

- very low distinction 10 000 - 100 000 m;
- low distinction 300 - 1 000 m;
- middle distinction 50 - 200 m;
- high resolution:
 - relatively high resolution 20 - 40 m.;
 - high resolution 10 - 20 m.;
 - very high resolution 1 - 10 m.;
 - high distinction 0,3 - 0,9 m.

Air photography. In recent decades, the traditional aerial photography is an effective tool to perform various kinds of geodetic work, performing a number of tasks, namely: preparation of topographic maps, determining certain numerical characteristics of land and water resources, study topography, landscapes, search, and other minerals.

Given that update data on a particular object is fairly costly, alternative to the classic aerial photography from airplanes is the use of *unmanned aerial vehicles (UAV)*, which is widely used in Ukraine and the world.

Definition siltation can be performed using this method as bathymetry. Bathymetry is a study of groundwater relief from the oceans, seas, rivers and small ponds.

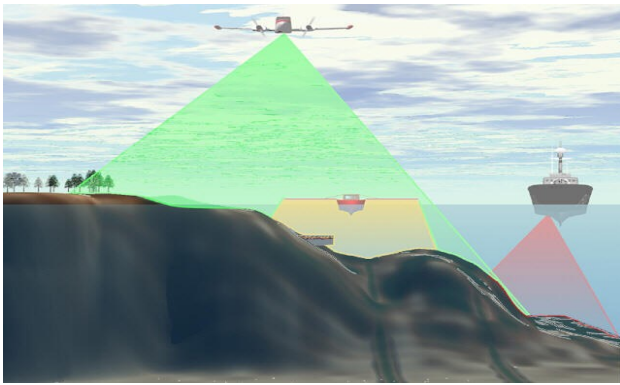


Fig. 7. Types bathymetrychno removal and comparing bandwidth output of different systems

Terrestrial laser scanning (TLS). TLS is increasingly used in industrial and scientific purposes, as it enables higher accuracy (up to 2 mm) and speed (up to 1mln.za second) to obtain information about certain objects.

Terrestrial digital capture (TDC). TDC - a removal areas with special devices - fototeodolits and stereofotokamer.

Contact methods.

GPS observation. With unceasing development of modern technologies GPS observation have become almost an integral part of any geodetic work.

Tacheometry survey.

Using electronic total stations is quite broad from engineering geodesy, construction, topography, to inventory. Modern electronic total stations can operate in two modes: with and without reflex reflector modes.

Cartometry way. Cartometry way based on the use of existing maps which depicted the topography, which then can vektorize semi-automatically or automatically. Maps that depict topography are using for contour allow all without exception measurements and calculations.

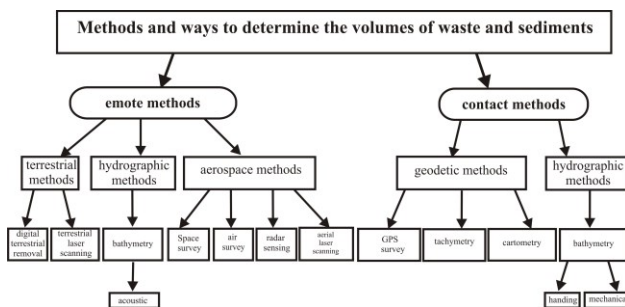


Fig. 9. Classification methods and ways to determine the volumes of waste and sediments

Conclusion

It should be noted that these contact methods as tacheometric removal and GPS observations in terms of safety in all cases is dangerous at such sites as dumps is almost constant burning. An alternative method is the removal of digital terrestrial and terrestrial laser scanning which due to its distancing possible to perform the study of geometric properties of objects. It should also take into account the peculiarities of the investigated object (its volume) for example when it comes to stocks of minerals it is best to use land-based remote methods in the study of

piles large enough would be better to carry out research using a UAV or a combination of these methods . The use of space and better use aero-photo sensing for landfills. Bathymetric removal is recommend for defining such objects as silting ponds - tanks, tailings, slag, sludge, with using manual, mechanical or acoustic sonar.

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