INNOVATIVE APPROACH TO ASSESSING THE CONDITION AND CERTIFICATION OF OIL-CONTAMINATED SITES

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Abstract. The article describes an innovative method of volumetric assessment and certification of oil-contaminated land plots, which allows us to give an accurate assessment of the volume content of certain limiting factors. This technique involves building 3D models, tabular systematization of concentrations and volumes of oil pollution, improving the certification of the above-mentioned areas using special QR codes and parcel codes created by us. The method described by us makes it easier and at the same time increases the objectivity of certification of oil-contaminated land plots, reflects the qualitative and quantitative volume and time parameters of plots, increases the convenience, efficiency and reliability of accounting, data transmission and storage.

1. Introduction

Today, the problem of low efficiency of reclamation works on oil-contaminated sites remains an urgent problem at oil-producing enterprises of our country. The difficulties are caused by the lack of spatially ordered ideas about where and how the pollution is distributed, what their concentration and volume parameters are in the soil. This problem entails an irrational waste of finances. As a rule, the return on the spent funds does not exceed 30%.

To solve these problems, we offer a method for representing pollutants in the form of 3D models, tabular systematization of their concentrations and volumes, creation of QR codes and parcel codes.

Scaling table information determines the color content of three-dimensional models. The described method allows differentiation of plots and their parts into reclamation groups. They focus on the targeted use of allocated funds. Tabular systematization and spatially ordered representations of research results produce a synergistic effect. It manifests itself in obtaining a more accurate assessment of the state of oil-contaminated sites, improving the efficiency of reclamation, and making productive use of finances. And the creation of QR codes and parcel codes allows you to simplify the process of accounting and certification of oil-contaminated land plots.

It is known that there are three main degrees of oil pollution of soils: weak – up to 10%; average – from 10 to 40%; strong – more than 40%.

Low pollution dramatically reduces productivity and leads to the death of about 1/2 of vegetation. With average pollution, stands and shrubs die completely within 10 years. Heavy oil pollution completely destroys the phytocenosis in the period up to 1 year.
2. Adjusting the location, borders, and description of oil-contaminated sites.
Their topographic survey and photographing were carried out. The division of the parcel into parts: areas and parcel. Forming a hierarchical system of 3 levels for each section. 1 the smallest level – a parcel, as one of the four layers within the boundaries of the allotment; 2 level- an allotment with a set of four parcels; 3 level – the entire site in the aggregate of allotments and parcels.

3. Sampling of soil at the sites. Conducting quantitative and chemical analysis.
Formatting the analysis results in tabular form.

Oil is a liquid natural solution consisting of a large number of hydrocarbons of various structures and high-molecular resinous-asphaltene substances. It contains a certain amount of water, salts, and trace elements. On the one hand, the world's oil fields are distinguished by a huge variety of types (there are no two completely identical oils from different reservoir deposits), on the other - the unity of its composition and structure, similarity in some parameters. The elemental composition of tens of thousands of different individual representatives of oil around the world varies between 3 and 4 % for each element. The main oil-forming elements: carbon (83-87 %), hydrogen (12 - 14%), nitrogen, sulfur, oxygen (1 - 2%, less often 3 - 6% due to sulfur). Tenths and hundredths of a percent of oil are made up of numerous trace elements, the set of which in any oil is approximately the same.

Components of the light fraction, being in soils, water or air environments, have narcotic and toxic effects on living organisms. Normal alkanes with a short carbon chain, which are mainly contained in light fractions of oil, act especially quickly. These hydrocarbons are better soluble in water, easily penetrate the cells of organisms through the membranes, and disorganize the cytoplasmic membranes of the body. Most microorganisms do not assimilate normal alkanes containing less than 9 carbon atoms in the chain, although they can be oxidized. The toxicity of normal alkanes is reduced in the presence of a non-toxic hydrocarbon, which reduces the overall solubility of the alkanes. Due to the volatility and higher solubility of low-molecular-weight normal alkanes, their action is usually not long-term. If their concentration was not lethal to the body, then over time the normal functioning of the body is restored (in the absence of other toxins).

4. The scaling and color values of pH and the content of oil pollution and chlorides.
Calculation of the volume of allotments, deep layers and contamination (table 1).

| Content of petroleum products, % | Color      |
|---------------------------------|-----------|
| 0 - 1,0                         | green     |
| 1,1 - 3,0                       | yellow    |
| 3,1 - 6,0                       | orange    |
| 6,1 - 10,0                      | light brown|
| 10,1 - 15,0                     | dark brown|
| 15,1 - 25,0                     | pink      |
| 25,1 - 40,0                     | light red |
| > 40,0                          | dark red  |

Identical tables were created for scaling and coloring the values and volume reflection of pollutants (table 2) for the concentration of chlorides and acidity in the soils of the oil-contaminated site.
Table 2. Volume of oil product residues, m³

| Location | Volume of oil product residues, m³ |
|----------|-----------------------------------|
|          | parcel «a» (0,1m) | parcel «b» (0,2m) | parcel «c» (0,3m) | parcel «d» (0,5m) | Total, m³ |
| 83       | -                   | 3,17 (0,012)      | -                  | -                  | 3,17      |
| 84       | 13,64 (0,078)       | 4,06 (0,012)      | 5,72 (0,011)       | -                  | 23,42     |
| 85       | 10,79 (0,072)       | 10,7 (0,04)       | -                  | -                  | 21,49     |
| 86       | 10,96 (0,078)       | 5,25 (0,019)      | -                  | -                  | 16,21     |
| Total    | 35,39               | 23,18             | 5,72               | -                  | 64,29     |

5. Create 3D-models of plots with each parcel displayed in volume and color.
As a rule, the number of parcels within the boundaries of a single plot does not exceed 4, the lower parcel is located no deeper than 2.0 m (in our case, 1.1 m). For reclamation, the top three soil parcels are available: a) - 0-10 cm, b) - 10-30 cm, c) - 30-60 cm; d) - 60-110 cm (hardly accessible) (Fig.1).

![Figure 1. 3D-model of oil contamination of a land plot X-Y-ZZZZ.](image)

Almost all chlorides found in soils - NaCl, CaCl₂, KCl, MgCl₂ - are easily soluble. The chlorides of most trace elements are also soluble, with the exception of silver chloride and mercury chloride. Migration and accumulation of chlorine compounds depend mainly on the temperature and water conditions of the territory. Maximum accumulation is typical for the drainless depressions of arid regions. Negative environmental consequences of excessive chloride content in the soil are possible in the form of deterioration of physical and chemical properties of soils, as well as contamination of ground and surface water.
The acidity or pH of the soil is a biochemical indicator that characterizes its ability to exhibit (neutralize) the properties of acids. During the exchange of hydrogen ions with soil minerals and organic substances, acids and bases (alkalis) are formed in the fertile layer. PH indicates their balance in the soil solution, denote it by numbers from 1 to 14. The lower the pH value, the more acidic the environment.

6. Distribution of plots and their parts into reclamation groups:
   a) areas or parts thereof where biological remediation is required;
   b) the plots or their parts, which do not require the use of biological remediation;
   c) areas or parts of them where it is currently impossible to achieve the required results during biological remediation due to the lack of necessary or insufficient existing technologies;
   d) areas or parts of them where biological remediation is temporarily impractical due to the high probability of their repeated contamination due to insufficient operational reliability of pipelines [1] (table 3).

| Location | Volume of oil product residues, m³ | Total, m³ |
|----------|----------------------------------|-----------|
|          |                                  |           |
7. Create QR codes and parcel codes to improve the process of accounting and systematization of oil-contaminated sites.

This encoding will speed up, objectify, and unify the acquisition and use of information (Fig.4).

**Figure 4.** QR code of a three-dimensional model of an oil-contaminated land plot.

A parcel is the smallest part of an oil-contaminated area that is allocated at the intersection of the point zone and the layer. Each parcel has a number of characteristics and parameters. They can be encoded. For example, X-Y-ZZZZ/84b/350/g. in this case, the cipher indicates: 1) the number of the site; 2) the parcel in the area of the point 84 of layer b; the volume is 350 m³; the excess of the content of petroleum products over the permissible level in the range from 31 to 40%. Options of forms and types of coding you can choose many, the main thing is to be consistent. Parcel coding precedes QR coding.

8. Conclusions.

The proposed method allows us to present the parameters of an oil-contaminated site in three-dimensional and tabular form for a more accurate assessment of the state of oil-contaminated sites. Accurate assessment helps to implement effective reclamation, which allows you to hand over land to environmental services. The 3D model in color reflects the pH, chlorides, and petroleum products in each layer of soil. The use of QR codes will speed up the collection and processing of information, simplify the certification of oil-contaminated sites, and combine a variety of databases from various industries.

References

[1] Mukhametshina E and Aitov I 3D-MODELS AS A METHOD FOR REFLECTING VOLUME AND SPATIAL PARAMETERS OF OIL-CONTAMINATED SITES 2019 E3S Web of Conferences 140, 09003 EECE-2019