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Methodological aspects of using information technologies in revealing the genesis and composition of modern accumulative-beach deposits in the north-western part of the Black Sea

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SUMMARY

This paper describes a theoretical statement of the use of information technology to uncover the genesis and process of sedimentation in the north-western part of the Black Sea, as the Black Sea shelf, is of interest at the moment, as a potential source of minerals. But at the moment, their extraction is unprofitable, but over time, with a decrease in the number of traditional deposits, production technologies will also improve.

Paper also describes the main parameters selected for modeling geological processes and tools that will be used to achieve a given goal. The data presented in the work were obtained in several ways. The mineralogy of the rocks was selected manually at the site of the study area. The rest of the data is like the speed of currents, wind directions were taken from open sources. The main purpose of this work can be considered the study of the methodological aspects of using information technologies in revealing the genesis and composition of modern deposits of the coastline. This paper are introductory and theoretical.

Introduction

The Black Sea is a potential source of many minerals. Hydrocarbons have already been discovered and are being developed on the shelf as well as Industrial fields of gas hydrates have been established on the continental slope. Deposits of building sands, iron-manganese nodules, balneological and agrochemical raw materials are known in the coastal zone.

The north-western part of the water area is mostly shallow, limans and saline lakes are developed along the entire length of the coastal zone; overflows, spits and beaches are widespread. This area discharges the largest water arteries: Danube, Dniester, Southern Bug, Dnieper. Here is the discharge of solid, suspended and soluble material carried from the vast segment of the European Platform and adjacent areas.

The coastal zone of the north-western part of the Black Sea is now exposed to intensive urbanization. There is a rapid construction of holiday homes, boarding houses and other facilities for mass recreation. Therefore, natural balance of geological processes and the ecology of the environment is seriously affected in the coastal zone.

For full and comprehensive assessment of the conditions of formation and accumulation of those or other components in the coastal zone, taking into account all of these factors, information technology, namely modeling will be used in calculations. It will allow to specify a volume of modern river hard drain, to establish the mechanism of distribution, redistribution and concentration of ore and nonmetallic components in a coastal zone, and also to estimate influence of anthropogenic processes. This also makes it possible to determine the possible facial boundaries of the deposited material deep into the water area, which is important for paleogeographic reconstructions.

The proposed work will describe the main theoretical aspects of modeling, present data to be used, the methodology and modeling parameters.

Data for modeling

The initial materials for modeling are real rock samples from coastal accumulative sediments of the shoreline of the study area. Approximately 200 samples are expected to be collected and examined from different sites, which are identified by attributes of the feeding segments of rivers. All samples will be collected and examined using the same methodology. In the first field season the coastline from the entry of the Danube to the Dniester estuary was studied. In this area 35 samples were collected and preliminarily analyzed (Figure 1). In addition, several samples were taken for research from field materials of other expeditions in the Danube section.

The initial mass of the sample was 1 kg. Samples were taken from the middle part of beach sediments from a depth of 20 cm. In each point and between them the section of the shore and the width of the accumulative body were described, a note was made about the presence of cliffs, landslides, slope formations and other features. Data will also be taken on the presence along the shore of currents, their speed and direction. Wind rose and the nature of storm events will be plotted.

Important for modeling will be data of feeding provinces, quantitative and qualitative composition of each of the large rivers. For this purpose, we will build schemes of drainage zones by feeding basins of Danube, Dniester and Dnieper and take into account their share in the total balance. Peculiarities of lithological composition of beach deposits and data on mineral composition of feeding provinces will

allow to display more correctly the role of marine environment in sorting and formation of final composition of accumulative deposits. All data are expected to be digitized for modeling convenience.

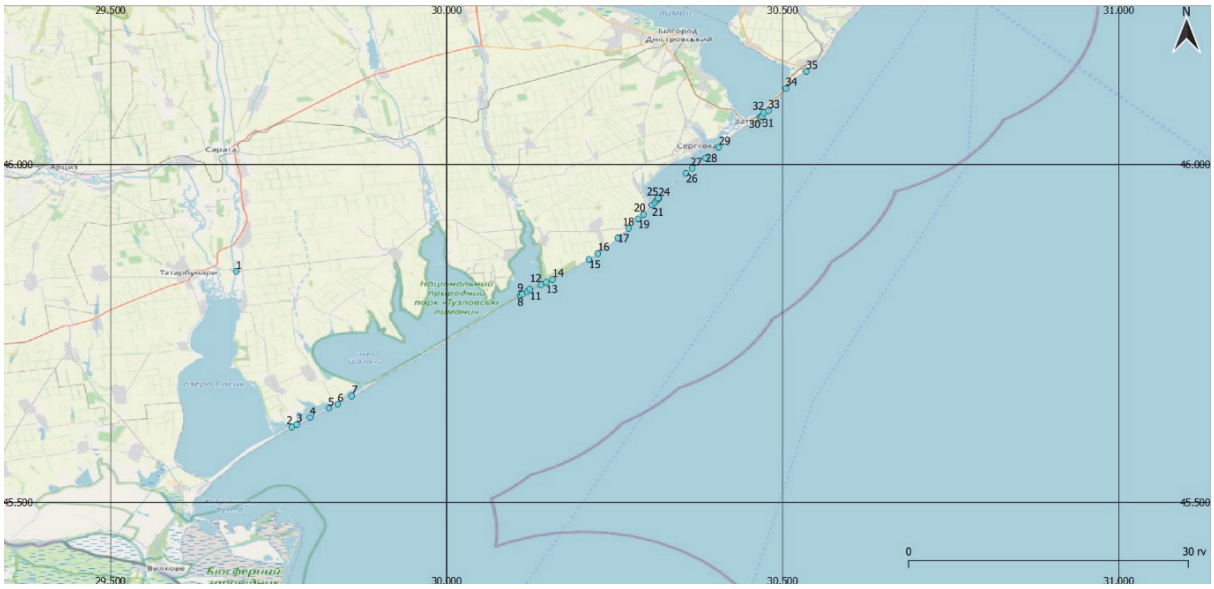

Figure 1 *Schematic map of beach sediment sampling locations for 2021*

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Modeling methods and parameters

To build a model of sedimentation of coastal-marine accumulative sediments, several options for tools and methods of construction can be proposed.

If we talk only about the tool, it is possible to use GIS systems for basic analysis and model building. At the moment any GIS system has basic analysis tools. Even open sorts GIS have many tools for model building and analysis of resulting data. And built-in automation tools will make the process faster and clearer for the user without knowledge of the internal system.

As GIS we are going to use QGIS. This choice was made because of the fact that this project has the open source code, and its packages are written in language Python. As it is known Python at the moment is one of the most suitable languages for using different kinds of tools for scientific purposes. Selected GIS has built-in libraries such as GDAL, GRASS, SAGA. They will greatly facilitate modeling of processes, including geological. SAGA GIS toolkit also includes tools for segmentation and recognition, which can also help in modeling.

It is also possible to use very popular today neural networks for modeling. Neural networks are extremely powerful modeling method that allows to reproduce extremely complex dependencies. Neural networks solve dimensionality problems, which allow using many parameters. Keras library is

the most successful for building and training neural networks today, as well as Tensorflow. Keras library is written in the Python programming language, which we have already mentioned above. Tensorflow library is the most popular for recognizing and working with polydimensional data, which is written in Google. These solutions allow to create a neural network architecture in the shortest possible time or use off-the-shelf solutions.

To talk about methods of building a model, here are two ways presented. The first one is to build mathematical model with all known techniques. The second way is to build statistical model. Each of these approaches has its pros and cons. For example, the mathematical model is highly dependent on knowledge of a researcher and right choice of methodology. The statistical model is very much dependent on the amount of data and correctness of their selection, which in turn is determined by the researcher. Also, very important factor is the correct interpretation of data obtained with help of chosen model, since results can be interpreted incorrectly by the researcher for one reason or another.

Examples of modeling sedimentation and marine phenomena

There are several examples of modeling marine phenomena and sedimentation.

In the NEMOS (Nearshore Modelling of Shoreline Change) "Model for Abrasion Mitigation at the North Coast of Ambon Bay" was a study to analyze factors that cause and prevent shoreline abrasion. The study was conducted to measure NEMOS modeling using a generalized model for shoreline modeling (Kakisinaa et al., 2016).

Research report "Unified framework for modelling sediment fate from source to sink and its interactions with reef systems over geological times" proposed new approach based on a reduced complexity model that is calculated over geological times, transportation of sediment from land to coast, reworking of marine sediment by coastal currents and development of coral reef systems. In this work, methods for modeling such processes as external forcing, landscape evolution, wave transformation, long-term wave sediment transport, and reef growth were used (Salles et al., 2018).

The article "Sediment modelling in a shelf sea" (North Sea) extends suspended sediment modelling at the local coastal scale to sediment modelling at the North Sea scale, focusing on presenting sediment patterns and their seasonal distribution. Simulations include sensitivity study in which model results are evaluated using surface suspended sediment concentration models (Gerritsena et al., 2000).

In article "Modelling of sediment transport and morphological evolution under the combined action of waves and currents" morphological models are discussed. Morphological models are useful tools for predicting such impacts and evaluating the effectiveness of protective structures for various scenarios. The processes modeled by a morphological model depend on the complexity of the model. For example, underwater currents are not accounted in coastal models, which is a limitation for modeling evolution of beach profiles over long time periods. This paper describes more flexible approach that can be generalized to three-dimensional models (Guilherme et al., 2017).

Suggested Research Algorithm

Having studied published materials on the subject and obtained data, we can sort the parameters for modeling (Lessin et al., 2018). These parameters can be divided into parameters that are related to physical phenomena and parameters that are related to the properties of the transported material.

Among main physical parameters it is necessary to allocate sea currents, both above-water and underwater. No less important parameter is wind direction and its strength as well as amount of material carried by rivers. Another parameter is current river velocity. Not an unimportant parameter is the geological structure of the coastline and territory where rivers pass.

Among parameters that are related to properties of transported material are physical and chemical stability of the source rocks and minerals, their specific gravity, and duration of transportation.

In the process of research, it is possible to add new parameters that weren't taken into account, which will be identified and in some way may affect the results of modeling.

Conclusions

It is necessary to choose the most optimal model for modeling. The choice between mathematical and statistical models remains open. Basic parameters of modeling are determined and will be supplemented in the course of work and final choice of model. Real data for modeling will be obtained from sediment samples, also literature data will be taken into account.

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