THE ROLE OF THE BLACK SEA SHELF TECHNO-GEOLOGICAL SYSTEM IN THE INTEGRATED MANAGEMENT OF RATIONAL RESOURCE USE

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Main provisions of the techno-geological system (TGS)

Studies in the management of natural processes are becoming more and more relevant. Improvements to such systems are possible by deciding upon the problem in need of control and paying attention to anthropogenic activities and processes. Implementation of long-term quantitative forecast of TGS changes under different technogenic impacts is the most important task.

The main study goal is understanding the Black Sea Shelf Techno-Geological System (TGS) as a system of technogenic impacts that influence the geological environment and determine perspectives on growth and the ways processes can be managed.

The main theoretical models of the TGS are constructed on generalized representations of separate parts of the common systemic processes and events. These models are based on the laws of matter and energy flow, and as such, the main theoretical models are described by some abstract TGS. As a result, there is no need to determine specific parameters of the geo-system and the influence of technical impacts, as this model can be constructed based on a generalized imagination of the TGS structure and the nature of the connections between the parts of that system.

The TGS is the new system that includes:
1. Natural self-organized systems (geological environment);
2. Technogenic systems, i.e., systems under the control of a man-made management system.

TGSs are complicated systems, and the management of that type of system can be provided on a modeling principal. These models should allow us to predict short-term and long-term outcomes of different natural and man-made influences on the geological environment, separately and in common, and to forecast local changes in natural conditions under environmental changes and marine resource extraction (Volkova, 2001; Safranov et al., 2012; Prangishvili, 2000; Egorova et al., 2012). Any geological environment forms a special equilibrium with natural conditions. Under those conditions, the natural equilibrium has a relative level of stability, and even under some external disturbance factors, the equilibrium can be retained—this is the dynamism of the geological environment. The technogenic disturbances are sometimes more powerful. They possess a greater level of variety, some forms of which do not exist in nature at all. Synthetic materials are a good example. As result, the spatial study of the reactions of geological environments to local influences should be the basis of any project exploring marine resource extraction, and especially for mining on the area of the shelf.

Geological part of the GTS. The physical, chemical, and hydrodynamic factors that are studied by specialists in marine geology, lithology, and geochemistry are the main geological factors in the analysis of the Black Sea shelf GTS (Adamenko at al., 2010; Emelianov, 2004; Chepizhko at al., 2013The description of these factors is the same as in other geological sciences. The main difference is the emphasis on the evaluation of the technical impact due to intensive anthropogenic activity in the shelf area. In that case, analyzing and forecasting of TGS changes have a special task that is focused on saving the natural geological environment through the

evaluation and implementation of specific resource-saving actions (Emelianov et al., 2004;Safranov at al., 2012; Golodkovskaya, 1988; Chepizhko, 2012).

In the wide diversity of geological processes, only a few could be defined as having an appropriate level of influence on the geological environment as on the ecological-geological system. That complex of processes includes factors of ecological-geological conditions that are represented by endogenous and exogenous particularities of the area's development and are at the cause of geological formation. These are: (1) geological structure, (2) structural-tectonic features, (3) geochemical conditions, (4) geophysical conditions, and (5) present geological processes (Fig. 1). Contemporary understanding of ecological geology has demonstrated that the condition of biological organisms is significant for geological environment evaluation because it is one of the basic nature-forming elements (Emelianov et al., 2004; Kobolev, 2016; Gozhyk et al., 2006; Egorova et al., 2012; Shnyukov, 1999; Chen and Grimison, 1989; Spadini et al., 1996).

Technogenic part of the GTS. The main reason why the GTS has formed on the shelf areas in common, and on the Black Sea shelf especially, is connected with the high natural resource potential and related technogenic activity. These activities include fishing, geological survey and exploration, oil and gas production, cargo transportation (especially oil and gas transportation), recreation, and traditional crafts in the seashore zone. Oil and gas production and transportation can have a great negative influence on biological resources, which are the basis for fishing and recreation. As a result, there is an opportunity for conflict between different branches of economic activity, endangering the stable existence of the marine ecosystem. The absence of an integrated marine natural resources management system leads not only to the exhaustion of marine natural resources but also to negative results in the economy of coastal countries (Adamenko et al., 2010; Emelianov et al., 2004; Safranov et al., 2012; *Nuuk Declaration*, 1993; Resolution of Ukrainian Cabinet Ministers, 2009; Torata et al., 2005).

Organization and management of the shelf area TGS. The dynamic of processes and development within the TGS is constant, such that the whole system is continuously moving. Changes in external conditions lead to changes in the principal drivers and outcomes of TGS system development. As a result, new systems with other qualitative and quantitative parameters and properties are constantly emerging. Conformity between external factors and system goals is the main requirement for retaining a stable organizing system structure (Volkova, 2001; Safranov et al., 2012; Prangishvili, 2000; Golodkovskaya et al., 1998; Smirnov. 2002; Chepizhko et al., 2013, 2017).

The main goal of the shelf area TGS organization is determined by the geological environment and goals of human activity. But each system has its individual qualitative and quantitative parameters; this means that, together with the main global goal, each system organization should have its individual development goal. The system organization expresses the dynamics and direction of development.

Sea shelf areas, which are natural objects, have a system-type organization. But human activity (transportation, fishing, oil and gas production, etc.) is not a common system. That complex (a set of connections and relations) is still not at a point where it can be integrated for beneficial results. This means that the management of marine economic activity is in the process of formation, but there have been no results yet.

The complex management of marine resource development must come from an ecosystem approach that is based on the main social and economic reasons for saving the oceans and seas with a long-term perspective. On an international level, that ecosystem approach for the management of oceans and seas was presented in the Nuuk Declaration, which was submitted by the Ministers of Foreign Affairs on 12 May 1993 (*Nuuk Declaration*, 1993).

Next, there are the positions presented in the Marine Doctrine of Ukraine extending to the year 2035, which was approved by the Cabinet of Ministers of Ukraine on 7 October 2009:

- The integral approach to marine activity in common and its differentiation in different directions should be based on changes in priority and depending upon the geopolitical situation;
- Conducting of integrated marine research focused on Ukrainian interests, and the development of a marine environment and coastal zone monitoring system (Resolution CM Ukraine, 2009).

That Doctrine secures at the legislative level some important positions governing marine activity, marine economic activity, government directions of marine politics, the goals and tasks of those politics, the marine potential of Ukraine, marine cargo transportation, and other matters. The adoption of the Marine Doctrine is a big step toward the development of a new position in Ukraine concerning questions of marine law. But there are some mechanisms and procedures that should be proposed for using that Doctrine.

System organization is the required condition and basis for any system and determines the purpose of creation, main characteristics, and stable operation under external influences. It means that the organization of any system is an integral part of the environment, and vice-versa, environment is the main factor for the purpose of organization, the principals, and features to be created (Prangishvili, 2000; Golodkovskaya et al., 1998; Smirnov, 2002; Chepizhko et al., 2013). System organization is the main reason for the creation, development, improvement, and stable operation, and such organization reflects the dynamics and level of system stability.

Management processes take a special place in system organization. Management is the property of any system that allows one to determine a mass of elements as if it were an organic whole. The management technique is a complex of purposeful actions that includes assessment of the situation and condition of the object, and choice of management actions and their implementation. Management is the external influence on system operation for reaching some desired goal. The next steps should be taken into account during the management process: goal determination; the ways of deciding upon goals; feedback and establishment of monitoring; forecasting; and improving and correcting the means of reaching the goals (Korolev, 1995; Safranov et al., 2012; Golodkovskaya et al., 1988; Smirnov et al., 2002; Chepizhko et al., 2013, 2017).

Two sub-systems can be defined within management—control and manageability. The manageable sub-system, or object of management, is the part of the whole management that is located under a systematically organized plan of action from a managerial person. The control sub-system or managerial person has managerial powers and can utilize them.

Management is the process of directional influence from a control sub-system (managerial person) to a manageable sub-system (object of management). The process of influence goes through direct and feedback channels. Direct channels conduct the managerial influence. That influence can have material, energy, or informational characteristics. The feedback channel conducts information about management results, that is, the information about new conditions within the manageable sub-system after direct influence (Fig. 2).

Practical importance of the Black Sea shelf TGS in the integrated management of resource implementation. The zoning of the Black sea shelf can be based on the contradiction in understanding between activities of resource extraction and the necessity to save the natural environment of the shelf area. The natural system-forming components of the TGS are represented by elements of the geological environment together with its biological parameters (total biomass). The technological system-forming components include different types of economic activity: the influence of coastal cities, marine cargo transportation, port constructions, oil and gas production and transportation, and the exploration of different types of natural resources. These components can be added as basic parameters and can be mapped so that the mapping of the main locations of technological influence on the shelf area can be the basis for ecological zoning and ecological-geological assessment of prospects for a development strategy on the shelf area.

Another important thing is the detection of marginally acceptable levels of technological influence on the geological environment and those elements that lead to changes in the GTS (Safranov et al., 2012; Chepizhko, 2012). Decision-making regarding that task is possible with detailed forecasting of the TGS's operation. Monitoring of the geological environment can be one of the methods for solving that problem (Fig. 3) (Korolev, 1995; Chepizhko, 2012; Spadini et al., 1996).

Lithodynamic systems that possess sources of solid and liquid material, biological and chemical transformations, and the accumulation of sediments can be defined as one of the main criteria for Black Sea shelf zoning. There are many different pollutants that enter the shelf area together with river flows and aerosols. Because of their connection with sediments, all that material intrudes into and is collected within the water and bottom deposits. Lithodynamic systems are undergoing technological activity, and as such, redistribution and re-accumulation of sediments and pollutants is taking a place.

Ecological-geological survey of the shelf area forms part of a complex regional geological study. Geological survey of the shelf area is the first stage of marine geological work that started with regional geophysical study conducted in order to gain geological and geophysical information for maps, sections, and tables. This information should be the foundation for an integrated environmental study and the determination of a rational natural management strategy. The scale of the geological survey depends on the tasks.

The technical-geological system (TGS) will be established on ecological-geological survey results for the forecasting of geological processes, the search and exploration of natural resources, and other significant capacities.

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