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On the Application of the Concept of "Sustainability Resource of Complex Natural Systems to External Influences" in Some Applied Sciences

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The sustainability resource (SR) or resource of resistance to external influences is understood as the ability of natural or natural-technogenic objects and systems to withstand external influences and at the same time preserve and maintain their main functional properties within acceptable or specified limits.

For example, in relation to the geological environment: the stability resource of the soil mass at the base of the building will be determined mainly by the geotechnical characteristics of the soil, hydrogeological conditions, the load from the building, and the design features of the foundation. If the building maintains stability and other performance characteristics throughout its life span, then the SR of the geological environment at the site of its location is sufficient. If, under the influence of external factors (changes in GWL and subsequent subsidence of soils, karst-suffusion processes, seismic impacts, etc.), unacceptable structural violations or a significant deterioration in performance occurred, then the SR was insufficient, the designers evaluated it incorrectly, or preventive measures to increase it (for example, protective drainage, strengthening of the foundation, etc.) have not been implemented.

Our experience in using the SR indicator has shown its effectiveness for fairly complex and diverse natural systems, including taking into account anthropogenic changes. An assessment was made of the stability of the geological and hydrogeological conditions of the territory of the large city of Kharkiv (Ukraine) with an assessment of the risk of developing adverse processes (flooding, soil erosion, landslides) [1]. The SR assessment of the territories of several islands in the southern part of the Indian Ocean was carried out in terms of tsunami hazards, volcanic eruptions, seismicity, and global sea level rise [2]. A methodology has been proposed and tested for using this indicator for urbanized and industrial territories [3], and for large transport infrastructure facilities, in particular the metro [4, 5].

In view of the foregoing, having convinced ourselves of the fair universality of the SR indicator, we made an attempt to compare the main provisions (in terms of conceptual approaches to solving the tasks, methodology for solving them, and evaluating results) in such sciences as engineering geology (EG) and medicine (M). Such an unusual comparison appeared on the basis of the following.

The "man" system - the subject of research and practice of medicine and the "earth" system - the subject of research and practice of engineering geology (among applied scientific areas) are characterized by great complexity, openness, and variability under the influence of external influences and over time, a high level of uncertainty in terms of the timing and parameters of changes, the widespread use of estimates based on related sciences (physics, chemistry, thermodynamics, biology, etc.). After such comparisons, there is a desire to evaluate the possibility of using medical experience that has a thousand-year history in engineering geology, the history of which is about a century.

Some methodological techniques are very similar or even coincide. For example, visual inspection and palpation (M); reconnaissance on the ground, and assessment of soil consistency by touch (EG) The study of information such as medical history, temperature, pressure, pulse rate, rhythm, etc. corresponds to the study of information about the engineering and geological conditions of the site, hydrogeology, geotechnical properties of soils. Of great importance is the genetic predisposition to certain diseases, reactions to external influences and pathogens (M); stability or instability of the territory to seismic, hydrological, and other negative factors (EG). Thus, we conclude that these and many other natural systems can be considered not only as a set united by the need for existence but also as a complex continuously interacting and changing structure, the stability of which was formed with the participation and under the influence of many factors.

In this regard, there is a natural desire to know what were the changes in the environment that did not exceed the limit values and led to modern man and his ability to adapt to adverse external influences and maintain his multifunctional capabilities. In the same direction, the sciences of the surface and underground spheres of the Earth, and the activity of EG processes are developing.

Computer modeling and predictive calculations help to solve practical problems, but so far, we see success only in predicting the possibility of events (changes), and great difficulties in terms of the time of occurrence and event parameters.

It is also important to note such a feature of the already named applied sciences as a large gap in time between the development of theoretical foundations and the corresponding practical achievements. In medicine, this can be attributed to diagnostics, and in engineering geology, to forecasting. The reasons here are the same and consist of deviations from direct dependencies due to numerous external factors. Moreover, if we evaluate the quality of the results according to significant criteria, then we will make sure that in medicine and engineering geology the reliability (in terms of probability and completeness) is quite high, and there are significant deviations in accuracy (time and parameters).

From these reflections, we can conclude that the methods of accelerated development and the introduction of non-standard approaches and methods of thinking are relevant to applied sciences.

This path can lead to the solutions that today we are trying to get through quantitative (not precise) estimates of possible events. Indeed, in almost all cases, we want to assess the risk of any system exiting an acceptable state. And this can be a unifying principle for the abstract representation of many applied sciences. Thus, traditional quantitative assessments acquire new meanings - ideas about risk (risk is weak, risk is significant, extreme situation). Further tactical actions based on this assessment will be actions to manage the states of a particular system in the future.

And now in the management process, trial and error methods are mainly used, which include the already accumulated base of theoretical knowledge and practical experience. Both in medicine and in engineering geology and in many other applied sciences, means and methods are used to correct the state and functionality of an object (process), up to the replacement of essential details, for example, prosthetics, in some cases, and drainage or retaining walls in other cases. In this case, the main goal is to maintain the required functional potential of an object or system. This activity has signs of competition with nature. This not only complicates the task but also often makes it impossible for a given period of development of science and technology.

It is necessary to especially note such a common feature of applied sciences as spasmodic, i.e., the presence of periods of accumulation of theoretical and experimental potential, and then its implementation. In our reasoning, this can be depicted as an endless spasmodic development. With the help of such reasoning, we want to remind you that in reality, a multi-stage (let us emphasize this) development ends with a change in natural and man-made systems in people's lives, provoked by human activity (deforestation and an increase in the number of floods, the development of slopes and landslides, ocean pollution, etc.) or (and this is much worse) natural disasters (increased earthquakes, tsunamis, global climate change).

After such statements, the question arises: what is the way out? Our answer is there is a way! After all, for the sake of this, we touched on this extremely painful topic.

The way out, in our opinion, may seem unrealistic, since it affects the psychological problems and the basics of organizing the life of the majority of the world's population. That is, a certain level of education of the population and its unification with a common goal - survival is necessary. In other words, the preservation of our species is only on a conscious (scientific) basis. In this case, many objections may arise, since such an approach contradicts some well-established postulates. But we regard this as an unscientific attempt to explain the differences and difficulties in the problem of mutual understanding and, as a result, interaction.

Based on the foregoing, the following conclusions can be drawn:

1. Applied sciences have a number of general methodological principles, which makes it possible to act in search of common fundamental laws.
2. Comparison of the effectiveness of the methods of ancient and modern sciences makes it possible to advance in the study of the nature of the stability of various systems to external influences.
3. The position of transition from the widespread probabilistic approach in forecasting events, in a number of applied scientific areas, to cause-and-effect analysis and risk assessment on a scientific, rather than probabilistic basis, is being strengthened. It is understood that the probabilistic approach does not contribute to the development of scientific research, although it makes it possible to use retrospection.
4. The above theoretical conclusions contain an attempt to make more purposeful activity in solving general and specific life problems. At the same time, we hope that we managed to interest the reader and express the hope that our reasoning, based on our naturally limited life experience, will not arouse rejection from the reader.

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