ISSN 0145-8752, Moscow University Geology Bulletin, 2012, Vol. 67, No. 1, pp. 52–57. © Allerton Press, Inc., 2012.
Original Russian Text © V.T. Trofimov, V.A. Korolev, 2012, published in Vestnik Moskovskogo Universiteta. Geologiya, 2012, No. 1, pp. 49–53.

Engineering Protection of Territories and Buildings in the System of Engineering and Environmental Protection

V. T. Trofimov and V. A. Korolev

Faculty of Geology, Moscow State University, Moscow, 119899 Russia

e-mail: trofimov@rector.msu.ru, korolev@geol.msu.ru

Received May 25, 2011

Abstract—This article examines the role and place of engineering protection of territories, buildings, and construction objects in the overall ecological safety, engineering, and environmental protection methods. It is shown that traditional systems of engineering protection of territories, buildings, and construction objects should be included as subsystems of a more general system of engineering and ecological protection.

Keywords: engineering protection, area, buildings engineering and environmental protection, engineering ecosystem protection, public safety, geo-ecology, environmental geology, ecological geology, ecosystem management.

DOI: 10.3103/S0145875212010103

INTRODUCTION

Engineering protection of territories and construction objects is a very important element for newly reclaimed areas and for already developed or built-up areas. On any built or developed area, certain geological processes exist or become active. Many of these are unfavorable or dangerous and may be a threat to cultural objects, as well as ecosystems. Every geological engineer understands that if building development occurs without engineering protection, it can lead to accidents with disastrous consequences, up to the destruction of erected engineering objects and buildings, as well as the loss of life and degradation or destruction of ecosystems. On already developed areas engineering protection prevents the activation of dangerous engineering and geological processes, or the emergence of new adverse processes that were absent during construction. Based on this, the value of engineering protection for humans and the biosphere as a whole is enormous.

Nevertheless, recent attention to engineering protection and works on its justification has been clearly reduced. There are several reasons for this. First, as is known, SNiPs (construction norms and regulations) have been canceled, along with other regulatory and development systems for the engineering protection of areas, buildings, and construction objects that have become unrequired and were moved into the category of documents of free use (SNiP 22-02–2003; SNiP 2.06.15–85; SNiP 2.01.09–91). The process of updating old and creating new regulations has been tightened. Secondly, customer demands contribute to reducing the cost of facilities that are constructed by savings on engineering protection. Thirdly, local governments that are in charge of issues of building projects often do not realize the capabilities of modern engineering protection and have little knowledge of this field.

Another important task is the necessity of revision of the structure, area, and function of the engineering area protection system in connection with worsening environmental problems. This article is concerned with this issue.

THE TRADITIONAL VIEW OF ENGINEERING PROTECTION

According to SNiP 22-02–2003, *engineering protection of territories, buildings, and construction objects is a complex of engineering facilities and activities aimed at the prevention of hazardous geological, environmental, and other processes on the territory, buildings, and construction objects, as well as protection from their consequences*. This is the traditional definition of engineering control.

The increasing importance of engineering protection of territories, buildings, and construction objects is due to the increasingly high scale and pace of development activities, and the increasing complexity and responsibility of facilities and infrastructure. The evolution of the techno-sphere in the world is moving towards the sustainable growth of its volume and com-

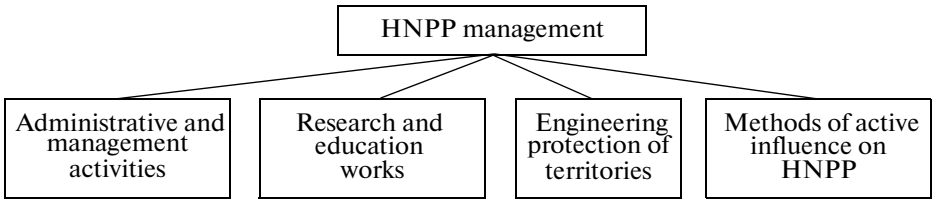

Fig. 1. Arrangements for the management of hazardous natural processes and phenomena (HNPP).

plexity of its internal construction and organization. Therefore, ensuring the reliability of all elements of the techno-sphere, their safety in certain environmental conditions, their independence from dangerous geological processes, etc. has become of paramount importance. Engineering protection of areas, buildings, and construction objects focuses on the insurance of this safety.

Proper engineering and geological studies and effective organization of engineering protection on reclaimed areas allow one to construct various engineering construction objects and residential buildings without prejudice, thus reliably excluding the possibility of catastrophic consequences and harm from hazardous geological and geotechnical processes. The system of engineering protection is an essential part of the group activities for the management of hazardous natural processes and phenomena (Fig. 1).

This also determines the main practical and economic importance of engineering protection of territories, buildings, and construction objects. At the same time, engineering protection ensures public safety and the safe operation of buildings and construction objects (Bezopasnost' ..., 1999).

For historical reasons engineering protection (at least up to the 1970–1980 period) was traditionally viewed as a system of measures and protective construction objects designed only to *preserve built and operated engineering construction objects and apartment buildings from failures* for publicity security; thus, it originally had a purely anthropocentric nature (Bezopasnost' ..., 1999; SNiP 22-02–2003; SNiP 2.06.15–85; SNiP 2.01.09–91).

Due to the worsening of environmental problems, including those arising from dangerous geological processes, the role of engineering protection has been increasing steadily: gradually it was realized that engineering protection of areas and buildings should be oriented not only to protect of the population, but also to protection of ecosystems in a whole. Engineering protection of territories, buildings, and construction objects, along with engineering protection of people against emergencies, as well as engineering environment protection, consists of an essential set of practical safety engineering organizational and environmental activities that allow modern civilization to function normally.

A NEW LOOK AT ENGINEERING PROTECTION

Currently, engineering protection should be seen not only in terms of traditional anthropocentric orientation, but also from a biocentric position.

However, unfortunately, the practical realization of this important position is far from the design and completion stages. The problem is that most regulations that have been developed to date on the protection of areas of engineering and different construction objects from hazardous processes only have an anthropocentric orientation. At the same time, protecting the public from hazardous processes is regarded as indirect and is defined primarily by the protection of engineering construction objects (residential buildings or construction objects in which people work or may be situated). The calculation was simple: the protection of buildings from destruction automatically provides public safety. This is why the vast majority of the previously adopted regulations in the field of engineering protection were aimed primarily at safeguarding engineering construction objects (residential, industrial, energy, linear construction objects, etc.) from the effects of hazardous geological and other natural and technogenic natural processes. The preservation of ecosystems was not involved, was not considered, or at best was discussed only indirectly. The biocentric approach, which is currently implemented and increasingly dominates the anthropocentric approach in Geoecology, Environmental Geology, and in everyday life, takes a different approach to assessing the role of engineering controls. Based on this *the goal of engineering protection is ensuring public safety and prevention of the adverse effects of dangerous natural and anthropogenic natural processes in areas of building and construction, as well as unique natural and ecosystem monuments*. Thus, there is a widening scope to engineering protection.

ENGINEERING AND ENVIRONMENTAL PROTECTION AND ITS STRUCTURE

The widening scope of engineering protection from the level of facilities to the level of ecosystems requires the development of fundamentally new approaches to its implementation and scientific rationale; in essence, the field of engineering protection of areas and con-

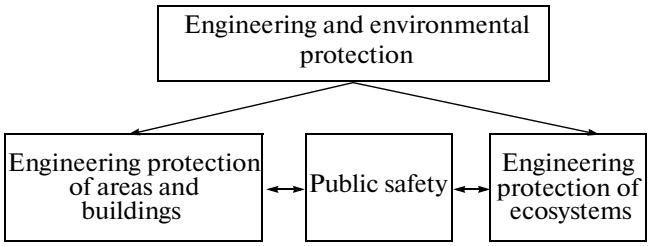

Fig. 2. Place of the engineering protection of areas and buildings in the system of engineering and environmental protection.

struction objects is expanding to the scope of engineering protection of the Earth's biosphere as a whole. The role of engineering protection of areas and construction objects in the overall system of engineering protection of the biosphere has a subordinate character (Fig. 2).

In this case, the system of such protection should be called *engineering and environmental protection*, which is understood as *a complex of engineering construction objects and measures aimed at the prevention of adverse effects of hazardous geological and other natural processes and their effects on territories, buildings, and natural monuments, as well as on ecosystems*.

From the scheme shown in Fig. 2, it follows that public safety is inextricably linked with both traditional engineering protection of areas, buildings, and construction objects, and with engineering protection of ecosystems. Here, the population is not considered as an isolated part of an ecosystem, but as its specific (anthropogenic) subsystem.

ENGINEERING PROTECTION OF ECOSYSTEMS

Engineering protection of ecosystems solves the practical problems of the preservation of natural ecosystems under different types of anthropogenic impacts on them or during the anthropogenic development of territories. In this case, in contrast to the engineering protection of territories and buildings from hazardous processes, engineering protection of ecosystems uses a wide range of techniques, technologies, and protective measures in its arsenal, because protecting and ensuring the preservation of ecosystems is much more difficult than buildings. Moreover, the complex methods of engineering protection of territories and buildings should organically be a part of the system of engineering protection of ecosystems.

Thus, the engineering protection of ecosystems is *a complex of engineering construction objects and measures aimed at preventing the negative impacts of hazardous geological and other natural processes and their effects on ecosystems considered as a subsystem of engineering and ecologic protection*.

What are the specific differences of engineering protection of ecosystems from the engineering protection of territories and buildings? First, they determined by *differences in the objects of protection*: in the first case, the object of protection is an ecosystem, in the second, engineering works (or complexes), which, in technologically developed areas, are a part of techno–natural ecosystems. Secondly, the protection of ecosystems from hazardous processes involves measures for the conservation its functioning, that is, for providing its *fundamental ecological functions* and conservation of ecological and geological conditions.

Thirdly, ecosystem protection requires protective measures for the restoration of already broken environmental (including ecological and geological) conditions of ecosystems that have been subjected to various anthropogenic impacts.

ENGINEERING AND ENVIRONMENTAL PROTECTION AND ECOSYSTEM MANAGEMENT

From the scheme shown in the Figure 2 it follows that engineering and environmental protection is a comprehensive means to manage the state of ecosystems and their components. Therefore, to a great extent *environmental engineering protection acts as a set of certain practical measures on the management of ecosystems that provides their safety and protection from natural hazards and techno–natural processes*.

Based on this concept, methods of engineering and environmental protection are essentially a mechanism for managing environmental features of the lithosphere or *a mechanism for managing the state of ecosystems*, which, as is known, (Kurylenko, 2000; Trofimov and Ziling, 2002) are divided into administrative, legal, economic, scientific, technological, and international mechanisms (Fig. 3).

Here, *legal and administrative mechanisms* are based on the possibility of adapting specialized environmental information by the direct users in the area (regional administrations, heads of enterprises, government agencies of environmental control, ministries, and departments). This adaptation is implemented on the basis of existing legal and regulatory

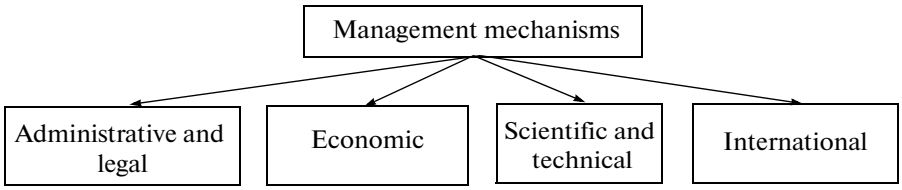

Fig. 3. Command instruments of the state of the ecosystem environment.

documents with designated maximum allowable levels of the anthropogenic loads on ecosystems.

Economic mechanisms are based on the extensive use of methods for the economic evaluation of environmental damage, based on reasonable quantitative assessments of the damage to the environment and human health. These assessments form a complex of methods and techniques that allow one to determine violations of environmental conditions through the transformation of the abiotic and biotic components of ecosystems.

Scientific and technical means are connected with use of a wide range of engineering and technological and other measures to control the state and protection of ecosystems. In particular, they are widely used for environmentally oriented transformations of rock massifs and other components of the lithosphere, giving them certain properties that provide normative functioning of ecological and geological litho-engineering systems. They are also based on making specific geological (geotechnical, permafrost, etc.) decisions on the development of practical methods and techniques for the management of the state and properties of rock massifs in order to preserve ecological features and functions with their help, to develop methods and formulations for the disposal of toxic industrial wastes, as well as the justification and proposals for direct *engineering protection of territories, facilities, and buildings* from natural and anthropogenic geological processes that reduce ecological potential (Trofimov, Ziling, 2002).

International governance mechanisms are also of significant importance. Here, the question is cardinal, structural, technological, and institutional restructuring; revision of the value system of the entire international community; and the necessity for the execution of formulated international environmental requirements by all countries and their governments.

The concept of the transition to a model of the sustainable or managed development of society should be developed and adopted by all countries. It involves the use of all regulatory mechanisms of ecological conditions, including the worldwide view.

COMPLEX SCHEMES FOR ENGINEERING AND ENVIRONMENTAL PROTECTION

One of the key issues in the development of methods for the engineering and environmental protection and ecological restoration of disturbed areas is *justification for the overall scientific strategy for the management* of ecological and geological systems. The theory of the management of the geological environment should make a substantial contribution in its development (or "geo-cybernetics" by G.K. Bondarik (Bondarik et al., 2009)); attention to this field is increasing. It is necessary to proceed from the fact that the immediate implementation of control should be provided as administrative law methods (including economic methods) and methods for directly targeting various components of ecological and geo-ecological systems (EGS).

In our opinion, a *Complex Scheme of engineering and environmental protection of the territory* should be central in the development of such a management strategy in relation to any particular object (territory, ecological, and geological system, etc.) under which we understand a *set of uniform protective engineering construction objects and measures aimed at ensuring the environmental safety of an area*.

This scheme should be the basic document that regulates all matters of justification, development, and operation of the system of engineering and environmental protection of a particular area.

This scheme on the condition of development (anthropogenic disturbance) of territories may appear in two forms: (1) for newly developed areas, in the form of the scheme of the Engineering and Environmental Protection of the territory and (2) for anthropogenic waste lands, in the form of a Complex Scheme for the ecological restoration of anthropogenically disturbed territory.

A Complex Scheme for the ecological restoration of anthropogenic waste land is the main document that justifies the entire volume of necessary arrangements for the area aimed at its environmental remediation and restoration (Korolev, 2009). This document, together with the Complex Scheme for the engineering protection of the territory that is traditionally developed by engineering geology and which has obtained significant theoretical and methodological support, is a program of actions and the basis of geo-

logical studies for the management of geological environmental systems. These documents have much in common, but have different goals, objects, methods, etc., yet they must be mutually linked.

The main and compulsory sections of the Complex Scheme of ecological restoration of anthropogenic waste land should be the following (Korolev, 2009):

– Ecological and geological evaluation of the current state of disturbed areas, which identify the main sources of harmful and hazardous industrial impacts on the ecosystem and management objectives;

– The justification of controllable objects, control mechanisms, and the subjects of management;

– The development and justification of a rational complex of methods for the ecological restoration of disturbed areas (rehabilitation of ecosystems).

The first section of the scheme (in fact, its subsidiary) is realized by means of pursuing exploration of the environment and laboratory research on the studied area according to the special program or in the frameword of an environmental impact assessment (EIA). Its final assignment is to identify and define key elements (causes and origins) that cause a negative, dangerous, or catastrophic condition in the surveyed ecological and geological system. The logical consequence of this section is the formulation of a particular administrative objective for the management of the area.

The second section is created to achieve this goal. It is a geological substantiation of a specific strategy for managing the analyzed ecological and geological system in the following series: subject of management $\longrightarrow$ mechanism of management $\longrightarrow$ object of management.

The third section is the key one. It specifies the planned program of actions. Its immediate implementation is based on direct and indirect methods of management. *Direct methods* include:

– Methods for making a direct impact on the geological environment (methods of engineering technical amelioration, purification methods for soil, surface, and ground waters from pollutants; methods for the engineering protection of territories; methods for agro-, phyto-, and hydro-technical amelioration, recultivation, etc.;

– Methods for influencing the technical facilities of ecological and geological systems (EGS) (methods for regulating the operation of technical systems, etc.);

– Methods for influencing the biotic components of an EGS (methods of biodiversity management, methods of recovery (compensation), of biocoenoses, sanitary arrangements, etc.).

The implementation of these methods should be not be dispersed, but be systematically based to organically include the complex scheme of engineering protection and organization of ecological and geological monitoring on it as one of the methods of EGS control.

Indirect methods of control are based on the previously mentioned administrative and legal methods (standards, guidelines, regulations, EIA, environmental assessment, audit, insurance, certification, licensing, certification, and prohibitions) and economic methods (fines, etc.), as well as regulatory mechanisms for environmental activities in the area of the rational use of the subsoil and other natural resources (Kurylenko, 2000; Trofimov and Ziling, 2002).

The justification of the rational interaction of direct and indirect methods for EGS management is the key to the success and effectiveness when developing the Complex Scheme. Obviously, the cost of the implementation of such schemes can be quite significant, but they should not be funded as a residual. Therefore, one of the requirements for such schemes should be cost minimization and their economic effectiveness. In connection with this, an important role should belong to environmental Audit Committees, which are aimed at an objective assessment of environmental damage on an anthropogenic waste land and cost recovery.

CONCLUSIONS

Our analysis suggests that the role and place of traditional engineering protection of territories, buildings, and construction objects in the overall system of public safety has been altered.

First, the engineering protection of territories, buildings, and construction objects from an anthropocentric direction proceeds to a *biocentric* one.

Secondly, the engineering protection of territories, buildings, and construction objects is a subsystem of the more general system of *engineering and environmental protection*.

Thirdly, the *subsystem of engineering protection of ecosystems* belongs to the system of engineering and environmental protection, along with the subsystem of engineering protection of territories, buildings, and construction objects.

Fourthly, the system of engineering and environmental protection is considered as *the mechanism for the management of the state of the environmental ecosystem*.

REFERENCES

Bezopasnost' Rossii. Pravovye, sotsial'no-ekonomicheskie i nauchno-tekhnicheskie aspekty. Regional'nye problemy bezopasnosti s uchetom riska vozniknoveniya prirodnykh i tekhnogennykh katastrof (Safety of Russia. Legislative, Social-Economical and Scientific-Technical Aspects. Regional Safety Issues with Respect to Risks of Natural and Technogenic Catastrophes), Moscow: Znanie, 1999.

Bondarik, G.K., Chan, M.L., and Yarg, L.A., *Nauchnye osnovy i metodika organizatsii monitoringa krupnykh gorodov* (Scientific Fundamentals and Methodology for Monitoring in Large Cities), Moscow: PNIIIS, 2009.

Korolev, V.A., Theoretical and Methodical Fundamentals of Ecological Restoration of Technogenically Damaged Territories, *Ekologo-geologicheskie problemy urbanizirovannykh territorii: Tez. dokl. II Vseross. nauch.-prakt. konf.* (Ecological-Geological Issues of Urbanized Territories. Abstr. II All-Russian Theoretical and Practical Conf.) (Yekaterinburg, 2009), Yekaterinburg: UGGU, 2009, p. 51.

Kurilenko, V.V., *Osnovy upravleniya prirodo- i nedropol'zovaniem: Ekologicheskii menedzhment* (Fundamentals of Nature and Subsoil Resources Management: Ecological Management), St. Petersburg: Izd–vo SPbGU, 2000.

SNiP 2.01.09-91. Zdaniya i sooruzheniya na podrabatyvaemykh territoriyakh i prosadochnykh gruntakh (Construction Norms and Regulations 2.01.09-91. Buildings and Facilities on Subsided Territories and Collapsing Soils), Moscow: Gosstroi, 1992.

SNiP 2.06.15-85. Inzhenernaya zashchita territorii ot zatopleniya i podtopleniya (Construction Norms and Regulations 2.06.15-85. Engineering Protection of Land from Flooding and Saturation), Moscow: Gosstroi SSSR, 1986, p. 25.

SNiP 22-02-2003. Inzhenernaya zashchita territorii, zdanii i sooruzhenii ot opasnykh geologicheskikh protsessov. Osnovnye polozheniya (Construction Norms and Regulations 22-02-2003. Engineering Protection of Territories, Buildings and Facilities against Hazardous Geological Processes. Principal Points), Moscow: Rosstroi, 2003.

Trofimov, V.T. and Ziling, D.G., *Ekologicheskaya geologiya: Uchebnik* (Ecological Geology. Textbook), Moscow: ZAO "Geoinformmark", 2002.