Anthropogenic Transformation of Landscapes and Ecological Risk Factor Assessment

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Abstract

All components of the landscape (especially living nature) are affected by anthropogenic effects, which disrupts the relationships established between them over a long geological time and ultimately leads to a change in the natural complex, which in most cases is of a negative nature and determines its degradation. Ecologically, anthropogenic transformation of wildlife is particularly harmful, which is carried out by taking advantage of the unreasonable, reckless nature of man, which is based on a purely consumerist spirit. When human society affects nature, a new variety of natural-territorial complexes is formed - anthropogenic complexes, which currently occupy a significant part of the terrestrial part of the entire earth. It originated with human society and will exist if there is mankind. Therefore, the essence of anthropogenic landscapes, its features, regularities and tendencies of development, productivity; Also, issues of sustainability, its potential opportunities and protection against external influences are one of the main tasks of geographical science.

Keywords: Geochemical association, anthropogenic landscapes, Anthropogenicity coefficient, Ecological problem, Total fouling rate

Introduction

At the modern stage of the interaction between nature and society, the interaction of society with nature has reached unprecedented levels, and its results have equalled the geological factor itself. There are almost no natural landscapes left in their original form due to direct or indirect human impact. The research of anthropogenic complexes, in particular the issues of their classification, mapping, and rational use of nature, is relevant.

By influencing the nature of human society, various genetic origin complexes—anthropogenic landscapes—are formed. We cannot but agree with the opinion that (Milkov, 1978) the role of anthropogenic landscapes in the structure of the Earth's landscape envelope is growing at such a pace that in this case the role of the anthropogenic factor in the differentiation of modern landscapes is one of the main problems of landscape science.

As for the research of anthropogenic landscapes of Georgia, even though the territory has been inhabited by human society since time immemorial and the anthropogenic impact on nature, in the conditions of the mountainous side, is increasingly growing and intense, its theoretical issues have not been fully studied and agreed upon. In this regard, D. is worthy of mention. Davit Ukleba monograph (Ukleba, 1983), where the theoretical, methodological, and constructional issues of the anthropogenic landscapes of the mountain and intermountain bar of Georgia are discussed for the first time. The close relationship between natural and anthropogenic factors is covered, and their connection with the main types of land use is shown. The author provides a scientific prediction of anthropogenic changes in landscapes, and measures are set for their more effective (optimal) use in the case of economic impacts. Refers to the same issue in the E. Davitaya, Z. Seferteladze textbook (Davitaia & Seperteladze, 2009) for students of higher education, which represents the first attempt at theoretical and practical research of modified landscapes in the native language.

Methods and Materials

Each type of land use leads to the formation of a special category of anthropogenic landscapes. In addition, landscapes formed by one type of use are noticeably different from landscapes formed by other types of impacts. The degree of transformation of anthropogenic landscapes also varies in a very wide range. On an infinitely large area, man has changed its structure through agricultural, forestry, and agricultural impacts, mining operations, hydropower facilities, expansion of industrial enterprises, road construction, and urbanization. It should be noted here that the role of the human factor in arid landscapes is relatively small; mountain tundra, polar and high mountain deserts, as well as some sections of equatorial forest and northern tundra are practically preserved naturally. However, there are also signs of human expansion: separate industrial hubs and transport routes, as well as the results of the Some researchers (Preobrazhensk & Haase, 2003) believe that the change of natural landscapes and, accordingly, the creation of anthropogenic landscapes occurs at the level of elementary landscape (facies) and microlandscape (Urocishche). There is also an opinion that the change of landscapes takes place at other levels of taxonomic units, and not only elementary and micro-landscapes are under anthropogenic influence but also higher-ranked taxonomic units—species (Ukleba, 1983; Davitaia & Kikvadze, 2009) and this is understandable since the landscape The character of one of the main taxonomic units-species and its physiological "face", in addition to zonal and azonal factors, is mainly determined by local physical-geographical conditions and processes, The latter is easily subject to artificial regulation, namely anthropogenic influence. For this reason, as rightly noted by A. Ryabchikov (1974), not infrequently, several anthropogenic landscapes of different genetic order are formed within the same natural landscape. As for the higher rank of the landscape—class-type-subtype—their change is hardly subject to the anthropogenic factor. We share this opinion; we point out that until the fundamental change of the geostructure of the territory and the radiation process-landscape-creating main factors by humans, the complexes of the above-mentioned rank will exist in a natural form. Here we note that in the rank of anthropogenic landscape, at the level of facies and urochishche, it is possible to consider (in mining-industrial regions and riverside) terrykons, earthworks, korghans, guthagrovi, etc.

When studying anthropogenic landscapes, as in the case of studying background (natural) landscapes, different methods are used, more often a complex of methods. Since anthropogenic complexes develop in the core of the natural landscape and represent one of the latter's genetic types, we used all the methods used in the study of natural landscapes in their study. In addition, since any kind of anthropogenic and natural complex is dynamic and constantly changing, a historical, retrospective method was used to study the issues of their dynamics, functioning, and further forecasting.

When analyzing the topical issues discussed in the article, along with all the above-mentioned methods, it becomes necessary to use such effective research methods of anthropogenic landscapes as landscape-ecological and landscape-geochemical. With the latter method according to the local (regional) features of the chemical "behavior" of the main topomorphic elements, we assessed the environmental situation of several objects in Georgia (Seperteladze, et al., 2007; Seperteladze, et al., 2010). planetary migration of man-made waste, etc.

Results

Anthropogenic landscapes are characterized by changes in the exchange and circulation of biophilic chemical elements, disruption of the heat balance, changes in the type and quantity of vegetation and animal world, changes in soil processes, etc. In addition, the transformation of anthropogenic landscapes occurs significantly faster than the self-development of natural (original) landscapes. This indicates, on the one hand, that we should be especially careful and attentive to unwanted changes, which can be catastrophic, and on the other hand, it allows us to regulate and transform them into highly productive cultural systems in a relatively short period of time (one generation of people).

Man's intervention in the natural environment first disturbed its chemical balance. In this case, both the removal of chemical elements from circulation and their technogenic migration into the natural environment are important. As mentioned above, because of human economic impact, a large number of chemical elements and their compounds reach the earth's surface, which, in case of volatility, move to a dispersed state and engage in intensive migration.

The nature of the reaction to the technogenic impact of natural systems depends, first, on the landscape-geochemical situation (state) itself and the geochemical activity of the impact, one of the indicators of which can be considered the Clarks of chemical elements (the higher the Clark, the more natural these elements are). ability to adapt to systems) and chemical forms of substance accumulation. Geochemically inert technogenic flows (Neef, 1974) adapt to practically any natural situation, are not characterized by sharp differences from natural geochemical parameters, and do not cause significant changes. On the contrary, when the technogenic impact is not in agreement with the local conditions, there is a deviation from the state of normal functioning of natural landscapes to the formation of a fundamentally new geochemical situation.

One of the main reasons for the breakdown of internal relations in natural-territorial complexes is the specific nature of human impact on nature. This impact (especially on the ecosystem) in a relatively short period of time is often so sudden, strong, and arrhythmic that the living organism cannot adapt to it. The second important problem is the disruption of biogeochemical cycles in anthropogenic landscapes and chemical balance in natural landscapes, which was formed during the long geological period of their development.

As a rule, because of human economic impact, there is a deterioration (simplification) of landscapes as a material system, as well as an increase in their productivity, which at the same time is accompanied by a decrease in the complexity and diversity of their structure, both qualitatively and quantitatively. A typical example of simplification of a material natural system is monoculture agricultural landscapes. Cultivation of a monoculture, the productivity of which man is interested, is accompanied by monotony of the landscape and deterioration of its balance (disruption). Thus, the high specialization of farming ultimately leads to the formation of monotonous, intensive, and cultural, but at the same time, unsustainable, landscapes. Therefore, one of the important problems is to develop a mechanism for regulating the productivity and sustainability of anthropogenic landscapes and overcoming the contradiction between human economic activity. In addition, it should be noted that the disturbed forest is poor in species composition; the quality of its wood has deteriorated. However, it should be noted here that it is more resistant to external anthropogenic influences; the species that create it are characterized by the ability to easily adapt to new conditions and a wide ecological spectrum. The growing trend of disturbed forest areas indicates that eventually, the natural forest gives way to secondary forests and forest scrubs.

Table 1. Total indicators of chemical pollution of ore waters of Chiatura manganese deposit

#	points	Chemical composition formula	concentration coefficient	Coefficient of total chemical fouling
1	Akhali darkveti	M M2,5 SO475HCO328 (Na +K)62Ca27	194,5	188,5
2	Akhali Itkhvisi	M Mo,85 SO457HCO341 Ca38Mg35(Na+K)26	197,85	190,85
3	Shukruti	M M1,45 SO481HCO317 Ca64Mg28	191,45	186,45
4	Mgvimevi	M M1,44 SO473HCO325 Ca51(Na+K)26Mg23	199,44	192,44
5	Koroxnali	M1,97 SO480HCO318 Ca60Mg18	187,97	172,97
6	Perevisa	M0,98 SO473HCO324 Ca63(Na+K)22	182,98	176,98

Based on the above, it can be noted that the complexes formed by the long-term effects of technogenesis are highly resistant, already adapted, and agreed with the environmental conditions. Because of this, the restoration of such soils and landscapes in general is difficult and often almost impossible.

One of the necessary characteristics for the landscape-ecological assessment of mining regions and their key areas is the indicator of an anomalous level of concentration of chemical elements. For this purpose, the value of the concentration coefficient (K) was determined—the sum of the indices of the elements included in the geochemical formula of the ore. The latter gives a certain idea about the qualitative and quantitative assessment of the geochemical association of the mining region. For the overall quantitative assessment of the level of abnormality, the total rate of pollution was determined for each object by the formula (Sorokina, 1983).

$$Zc = \sum_{i=1}^{n} Kc(i)\ (n\ \_\ 1)$$

where n is the numerical value of the number of chemical elements included in the association, Kc(i)- is the concentration coefficient of chemical elements. According to the mentioned attitude, the total indicators of chemical pollution of ore waters of the Chiatura mining region (Table 1) are a clear confirmation of the rather severe and anomalous ecological level of the technogenic landscapes formed here of concentration.

It is clear from the table that the high concentration of elements and the total rate of chemical contamination are observed directly in the ore mining area (with a radius of 100-200 m). The same regularity is observed in the river Kvirila and in the waters of the Rion, from the ore body to the mouth Kvirila and from the ore body to the confluence in the Rion waters (Table 2).

Table 2. Chemical pollution of Rion and Kvirila waters total figures

#	Sampling location	Chemical composition formula	concentration coefficient	Coefficient of total chemical fouling
1	KKvirila (Above Chiatura)	M M0,23 HCO378SO415 Ca65Na31	189,23	184,23
2	Kvirila (ander Chiatura)	M Mo,41 HCO373SO443 Ca76Mg76	268,41	263,41
3	Kvirila (v. Shoraphani)	M0,23 HCO372SO421 Ca66Na26	185,23	180,23
4	Kvirila (v. Simoneti)	M0,27 HCO355SO425 Ca65Na26	171,27	166,27
5	Rion (under Samtredia)	HCO364SO414 M0,17 Ca59Na30	167,17	162,17
6	Rion (above Poti)	M0,24 HCO375SO414 Ca63Mg19	171,24	166,24

It should be noted that we touched on only a few aspects of the geochemical functioning of the landscapes of mining objects (the geochemical functioning of the atmosphere, underground and surface waters and soils under the influence of technogenesis), and as a result of considering the problem with a complex approach that takes into account the human economic impact on the surrounding landscapes of mining regions, it is possible to study them in every way. Perfect forecasting of the further transformation and planning of the necessary measures that lead to maintaining the sustainability of the environment even in a highly critical ecological situation. In the process of interaction between man and nature, one of the interesting things is to consider the risk factor.

It is generally accepted that risk is an integral part of every living organism. Any unwanted human impact is always accompanied by risk. what is the solution? No impact on nature! This is impossible, therefore there is only one solution - the "risk" assessment of the possible impact, thereby achieving the minimization of the influence of the undesirable factor (Tsaava et al., 2007).

The concepts of danger and safety are also related to the concept of risk. Ecological danger is the possibility of unwanted processes and events in the environment that worsen the ecological condition of the environment. First, the safety of people and the natural environment is important for us. In its quantitative assessment, a "scale" is used, which is divided into risk units. According to the mentioned scale, G is the averaged unit of ecological safety, and the average life expectancy of a person is taken.

It should be noted that one of the main issues of anthropogenic landscape research and environmental monitoring is situational modeling. When modeling natural systems, first we should achieve sustainable development of natural processes. Here, it is interesting how we call development "sustainable". The same system can be sustainable according to one opinion (of the researcher) and unsustainable according to the other opinion. Sustainability is one of the fundamental concepts of BTK. When we talk about ecosystem sustainability, overtly or covertly, we mean the following: there is an ecosystem that experiences anthropogenic or natural impacts, because of which its components or parameters acquire a certain value (positive or negative). This means that when determining the quantitative characteristics of ecosystem sustainability, both the degree of impact and the critical values of ecosystem parameters or components should be determined According to Sumner (2008), an ecosystem's resilience to impacts is its ability to keep its internal structural connections and state or to change to a different type of stable state with different structural connections and state. This can happen when the system is put in a situation that could make it unsustainable. First, it is necessary to assess the amount of risk that brought the system to an unstable state in a certain period. This can happen with strong anthropogenic impacts or with small but frequent explosions. In this case, several scenarios will be played in the model (Fig. 1) and an approximate assessment of the transition of the system to an unstable state will be made. The numerical values of this assumption characterize the "risk" of an unstable system. The last stage of risk management is the correlation assessment of ecological damage and economic profit.

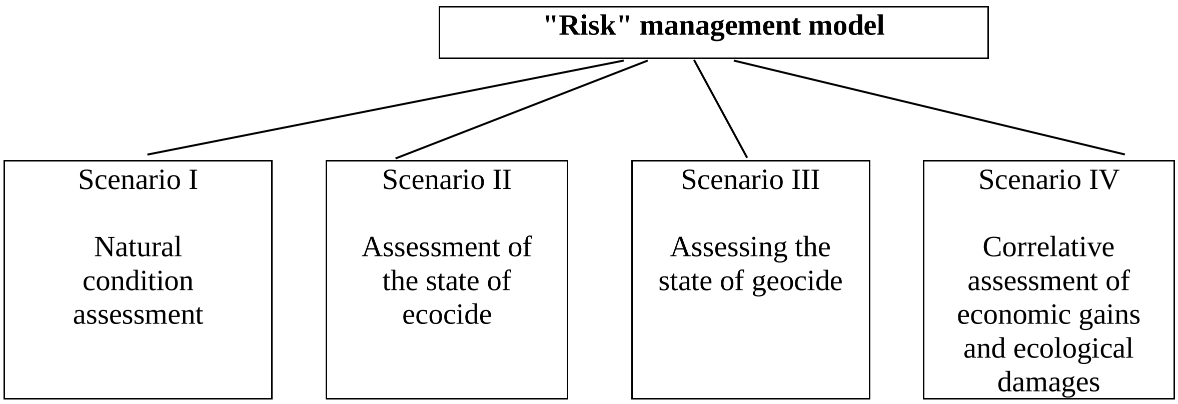

Figure 1. Risk Management Model

Conclusion

An in-depth study of how humans affect the environment and even create landscapes requires first classifying and mapping this system. This needs to be done based on several factors, such as looking at the system in different natural settings, types of farming, the amount of change in created landscapes, their growth, and natural landscapes and how they are connected to human-made changes and others.

Thus, because of the analysis of the geochemical features of underground and surface waters, soils, and atmospheric air of the landscapes surrounding the objects in an ecologically acute state, it can be concluded that in any region technogenic (mining, water, sedimentary, transport- communication, tourist-recreational, belligerent, etc.) as a result of the impact, there is a change in the appearance of both individual components and the entire complex and the deterioration of the landscape-ecological situation (condition). A high concentration of chemical elements is observed directly in the "epicenter" of impact (close to the ore body with a radius of 100-200 m), and in the following areal zones, the geochemical activity of elements is slowed down and depleted of ingredients (Davitaya, 1990).

Considering the above, we considered it possible to separate three main landscape-ecological zones on a separate technogenic region:

I. Ecologically dangerous zone—with significant pollution intensity and strongly expressed zonal-complex anomalies (area zones of the first order of migration of elements).

II. Ecologically less dangerous zone—with average pollution intensity and local-complex anomalies (areal zones of the second order of migration of elements - natural-technogenic and partially recultivated landscapes).

III. Potentially dangerous zone—with insignificant intensity of contamination and weak anomalies of small component composition (active quarries, bulk complexes and reconnaissance-research areas).

Competing interests

The authors declare that they have no competing interests.

Author Contribution Statements

ED and Z.S. developed the theory and performed the calculations. Z. S. and E. D. supervised the project and conclusions of this work. T. A. and N. R. worked out the technical details and performed the numerical calculations of the proposed experiment. All authors reviewed the results and contributed to the final manuscript.

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