Landscape-ecological assessment of "Volodymyrivska dacha" forestry reserve's territory for environmental management

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Summary. The work was based on the original approach to landscape planning procedures, based not on administrative principle, but on studying environmental protection area. "Volodymyrivska Dacha" forestry reserve's territory has been studied on the basis of the author's technique on landscape-ecological planning for nature protection area. Landscape-ecological planning has been evaluated by soil sampling outside the testing points on the network and their laboratory analysis. The results of the evaluation phase were illustrating on geochemical maps on the soil cover of forestry reserve's territory "Volodymyrivska Dacha".

The article presents cartographic models of the chloride anions, carbonates spatial distribution in the forestry soils, water and salt extraction pH. The obtained pH_{H2O} and pH_{KCl} values indicate that majority of soils forestry reserve's territory "Volodymyrivska Dacha" have acid reaction, alkalization of soils localized in areas with high anthropogenic pressure, which in most cases is caused by presence of carbonates. The area of soil alkalization is mainly localized in the periphery - in places with a high level of nature conflicts. The results of various aspects landscape-ecological study of the forestry reserve's territory "Volodymyrivska Dacha" allow to develop optimization pattern for nature use and to organize environmental management for this territory.

Key words: forestry reserve "Volodymyrivska Dacha", landscape, nature use, landscape-ecological planning, geochemical analyses, soils.

INTRODUCTION

Most environmental problems encountered in the process of harnessing nature and existed as a result of collision of stakeholders interests can lead to negative consequences.

Integration of Ukraine into the European political, economic, educational and scientific space opens opportunities for the development of domestic science, and gives us the opportunity to share methodological basis of the study. One of the research directions that have evolved in Europe is landscape planning. In some countries, especially in Germany, the implementation of landscape planning of territories with different administrative levels is a legally binding procedure. Landscape planning provides consistency in natural features and economic needs of particular areas.

Despite the benefits of landscape planning for the environmental management of the territories, in Ukraine this method is not widespread. The performance of the international Ukrainian-German project "Implementation of landscape planning in Ukraine" (2010-2014) by the Institute of Geography of the NAS of Ukraine gives more questions than answers [1]. That is why, in our opinion, the embodiment of the international best practices of landscape planning in our country requires a more flexible approach.

The study of landscape structure and anthropogenic pressures is important for the development of landscape planning because it allows you to identify minor-disturbed natural areas, which are of great importance for maintaining the ecological balance. From this point of view, an important step in the study is a landscape-geochemical one. In connection with the results of the laboratory analysis, it becomes possible to make objective assessment of the status of the territory.

RESEARCH PROBLEM

Landscape planning is widely used in European countries for area planning in accordance with environmental regulations [2-7]. Use the landscape-ecological planning (hereinafter - LEP) [8-10], as a tool for balanced territorial organization of nature has many advantages compared to many other approaches and methods, including the famous landscape planning in Europe [11-15].

Firstly, it takes into account more fully the natural specificity, uniqueness, dynamics and development of landscape and ecological significance of its components; secondly, it allows to implement correctly human activity in the natural landscape, according to its resistance to anthropogenic pressure. And finally, in the decision-making process, which involves various stakeholders, it allows to coordinate the interests of all land users [16].

For best results LEP for areas and sites of ecological network should consider some of their features. These areas experiencing lowest influence of anthropogenic pressure, but researchers have the difficult task - preservation landscape and biodiversity areas.

At the objects of nature reserve fund with legally fixed borders, use of nature is governed by environmental legislation, including Law of Ukraine "On Nature Reserve Fund". The need for and feasibility of the procedure for LEP of these areas determines the governing body of particular object (management of the park, of the reserve, of the botanical garden, etc.) and is planning to implement derived from LEP recommendations.

Analyzing unique of LEP important territory of ecological network, we should note that the counting stage for them, besides the usual set of information about

natural ingredients must contain in-depth data on the presence and positional arrangement of natural objects, provided the inclusion of these territories in the Natural-Reserved Fund. It is, as a rule, large volumes of text and tables in which lists of plants, animals and other natural objects and phenomena that need to be protected. As a supplement it is advisable to provide maps regarding the areas of their distribution, or positional location in the landscape (geological outcrops, exposed, etc.).

Also at the inventory stage, the researcher investigates possible sources of conflict on the protected and adjacent territories that will later form the basis of the matrix of conflict and maps of the conflict. The ecological component of this LEP phase was to study the geochemical characteristics of natural components as an objective basis for conclusions regarding the general condition of the site.

Similar studies were conducted by us in forest areas [18, 19] and the territories with urban landscapes [20,21]. Testing methodology in geochemical study of protected areas means the LEP before the survey was not carried out.

To improve the efficiency of environmental management in different territories it is appropriate to use the results of landscape and environmental planning, as they integrally characterize natural and socio - economic conditions. Furthermore, the supplements proposed by the authors [20] to the classical landscape planning procedures, including geochemical studies, can develop more informative models of the area. Applying modeling processes to landscapes and forecasting of future changes depending on the selected model can significantly reduce the role of the subjective factor and increase the effectiveness of management decisions.

STUDY AREA, MATERIAL AND METHODS

For conducting research on LEP of nature protection object selected forestry reserve’s territory “Volodymyrivska Dacha”, which is located on the territory National Park "Slobozhansky". Located forest reserve’s “Volodymyrivska Dacha” near the village Pylnyanka Krasnokutskii district, Kharkiv region (Ukraine) (Fig. 1).

The purpose of the - the protection and preservation of the unique landscape complex, which creates conditions for growth are a number of boreal species peculiar to the northern regions of the forest zone. For most of them, this is an extreme point south-eastern refuge area. All they need to protect and preserve the monument and an increase of past geological eras, including ancient glaciation.

The system of physical and geographic zone, the reserve "Volodymyrivska Dacha" refers to East-Poltava increased Areas of the Left Bank Dnieper forest-steppe zone of the Province of the East European Plain.

Terrain features cause different conditions – from the dry tops of the mounds with underdeveloped poor soils to excessively moist, fairly rich soil and wetlands, which affects the diversity of vegetation. Gray wooded and podzolized (nesmith and eroded) soils are mainly loess rocks. On-site is dominated by indigenous groups pine forests. There is growing valuable genetic relation to the local population of Scots pine. In depressions of upland terraces to happen grassroots sedge and sphagnum-sedge bogs. The groundwater level fluctuates, which leads to changes as herbaceous vegetation in the swamp, and the wood around them.

The purpose of the work is to assess the ecological conditions forestry reserve's territory "Volodymyrivska Dacha" has been studied on the basis of the author's technique of landscape-ecological planning for nature protection object.

Landscape-ecological planning has been evaluated by soil sampling outside the testing points on the network and their laboratory analysis. The results of the evaluation phase were maps illustrating the geochemical situation in the soil cover of forestry reserve's territory "Volodymyrivska Dacha". The results of the study are part of forestry reserve's territory "Volodymyrivska Dacha" environmental assessment with the aim of its further optimization development of forestry reserve's "Volodymyrivska Dacha" by means of landscape and environmental planning.

In soil is can be accumulated pollution, which can be an indicator of contamination of landscape. We conducted an experiment with spatial environmental assessment of soil of reserve. The scheme for soil sampling in forestry reserve's "Volodymyrivska Dacha" is shown in Fig.2. Samples were selected by an envelope method (5 samples on each test section) in accordance with the existing guidelines and standards - GOST 17.4.3.01-83 GOST 17.4.4.02-84, ISO 4287: 2004. Samples were taken at 0-10 cm, 10-20 cm and 20-30 cm depths; afterwards soil samples from different depths were mixed. Thus, the surface layer of soil was analyzed and evaluated. In total, during the fieldwork 95 mixed soil samples were selected (5 per each from 19 test sites).

Chemical analysis of samples was performed in the laboratory of analytical environmental research, V.N. Karazin National University. To assess the alkaline-acid conditions of elements migration we measured pH of water and salt extract of soil and determined the index of anionic composition - bicarbonate ions content. PH was determined according to generally accepted certified techniques conducted on the potentiometer via electrodes EVL - 1M4 15-11 and ECL-connected digital ionometer pH-150. Carbonates CO_3^{2-} and HCO_3^- hydrocarbons were identified by a two-step titration with sulfuric acid.

Treatment of empirical material was carried out by methods of mathematical statistics (software Statistic 6.0, Microsoft Excel). To establish the nature of the spatial distribution of the studied parameters the obtained results were interpolated by method (Natural Neighbor) in GIS environment.

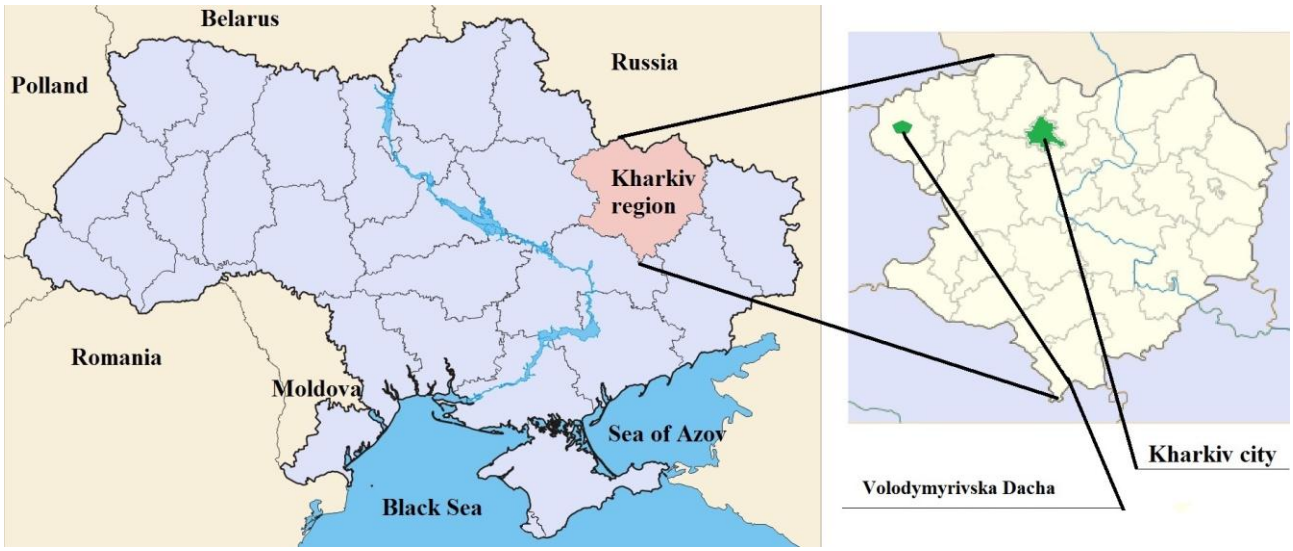

Fig. 1. Territory of the study on the map of Ukraine and the map of Kharkiv region

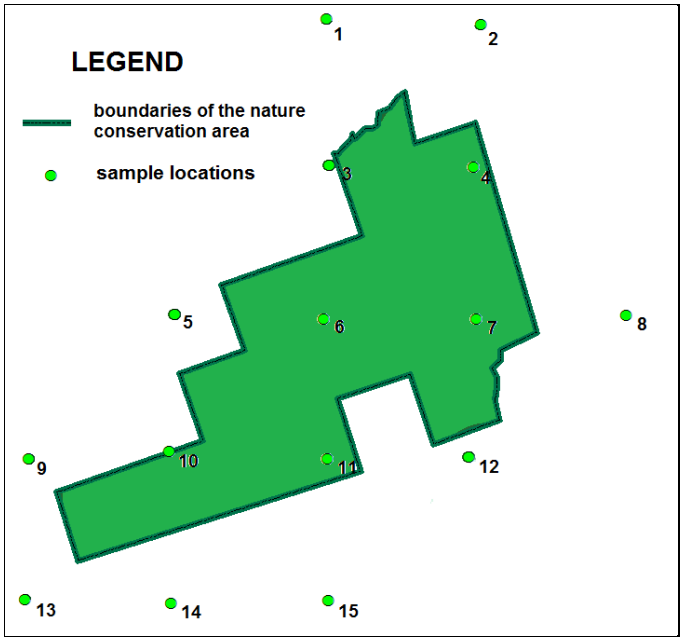

Fig. 2. Sampling points on the map of forestry reserve "Volodymyrivska Dacha"

THE MAIN RESULTS OF THE RESEARCH

Soils advisable to study through solid shooting, based on what is possible to create a mapping model of the landscape with certain characteristics. Making landscape-geochemical assessment of ecological status of nature protection object does not involve strict formalization set of indicators to assess soil. Depending on the specific area and the LEP purpose, a set of indicators can vary.

The forms, in which a particular item migrates, and, correspondingly, its migration intensity are closely associated with pH. The reaction of the medium is an important indicator because this figure mostly characterizes migration ability of various chemical elements and compounds. Thus, the stability of the complexes formed by the interaction of humic substances with metal ions, depends primarily on the pH and ionic strength. These conditions determine possible binding of heavy metals with soils in general, and separate components. It is known that increase of pH from 4 to 5.5 leads to increased adsorption of zinc on iron and aluminum hydroxide. At pH 7.5 zinc solubility increases by the formation of complexes with organic matter [22]. Thus, a variation in pH changes the role of soil components in heavy metals sorption.

Changes in pH also affect the activity of microorganisms through activation of some groups and oppression of others.The level of soil's enzyme activity connected to a large degree with microbiological processes depends on concentration of hydrogen ions. This, in turn, affects the mineralization and humification rates, as well as a rate of humus accumulation.

It is known that the reaction of the soil environment depends on the balance of free ions H + and OH- in it and is caused by the combined action of water-soluble substances (salts, acids, bases) of inorganic and organic origin, colloids, specific and non-specific nature (humic and fulvic acids, oxalic citric, acetic, formic, etc.) acids and clay minerals. Moreover, the reaction of the soil environment is affected by the secretion from plant roots which together with organic acids contain ions H +, OH-, NSO3-, SO32- [23]. A significant contribution to the formation of soil environment's reaction is made by the products of soil microorganisms' metabolism.

The reaction of the medium also directly affects the mobility of elements. One reason for this is that at higher pH redox potential of oxidation reactions reduces, i.e at higher pH the element may be in the oxidized, while at a lower value - in the reduced state at the same meanings Eh of environment [24].

The main factors that determine the nature of migration processes in soils are: acid-alkaline conditions, humus soil and the ability to migrate, absorption and retention elements. Our results of study geochemical characteristics of the "Volodymyrivska Dacha" forestry reserve's territory provide an opportunity to describe the main of these factors in terms for nature protection object. It is known, that intensity of a chemical element migration is closely related to pH [22, 25].

For determination of the acid-alkaline conditions of elements migration within the district in the evaluation phase of LEP was measured pH of the aqueous extract of the soil and pH of salt extract of the soil. The results are presented as maps (Fig. 3 – 6).

The results of water (Fig. 3) and salt (Fig. 4) extracts, pH level determination have showed that soils are predominantly weakly acidic and acidic, but on the verge of residential landscapes (on the south-east) there is an increase in the pH level – 7,5 – 8,0 (Fig. 3 and 4).

To assess the conditions of migration agents in landscape we may determine the content of various chemical elements in soils. Fig. 5 and 6 demonstrate results on HCO_3^- and Cl^- content in soils of forestry reserve "Volodymyrivska Dacha".

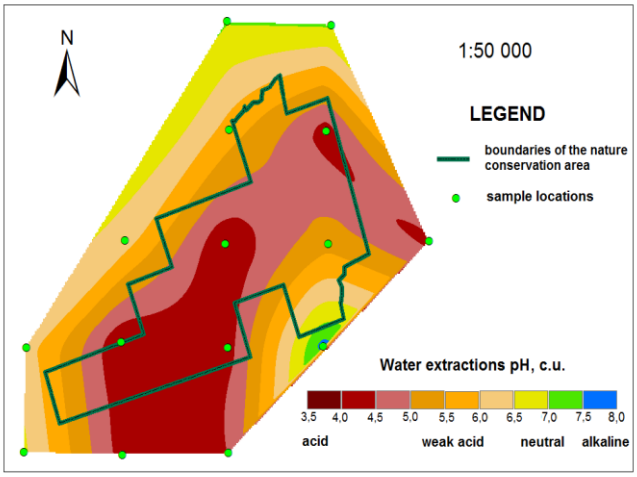

Fig. 3. Distribution of water extraction pH within the study area

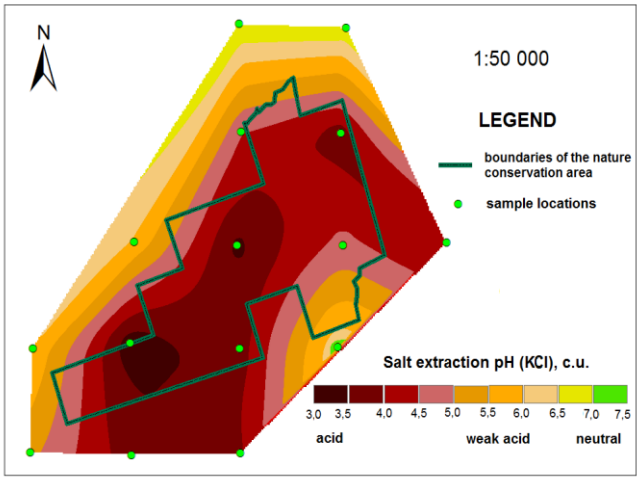

Fig. 4. Distribution of salt extraction pH within the study area

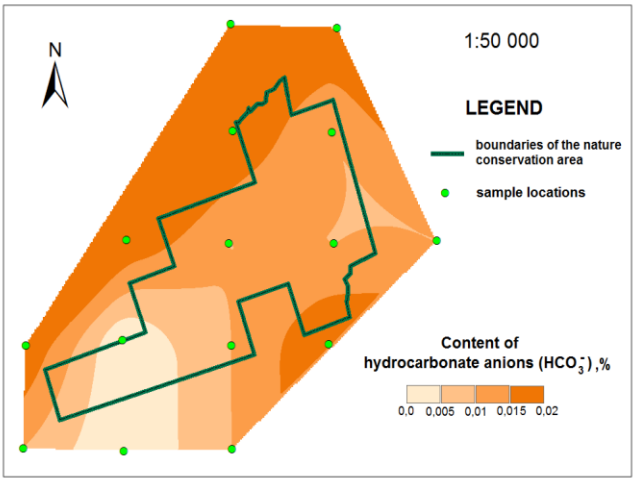

Fig. 5. Distribution of carbonates within the study area

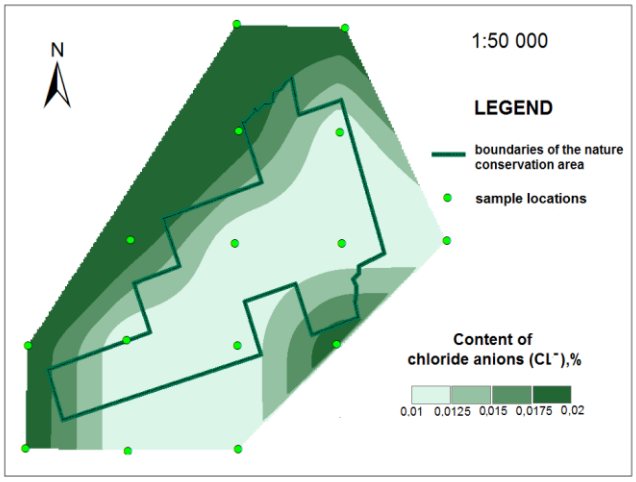

Fig. 6. Distribution of chloride anions within the study area

The laboratory analysis has showed that within the study area (Fig. 5) the content of carbonates is mainly on level from 0,01% to 0,02%, decreasing level of carbonates is observed in areas without anthropogenic activity, on south of forestry reserve "Volodymyrivska Dacha".

The content of chloride anions is mainly on one level 0,01%, increasing level of carbonates is observed in areas with anthropogenic activity - on the borders forest. In such places the level increases to 0,02%.

The majority of the soils at the territory of forestry reserve "Volodymyrivska Dacha" have acid reaction (Fig. 3 and 4) The surface layer of forest soil has quite a large range of pH_{H2O} amplitude - from 3,5 to 8,0, pH_{KCl} amplitude range is from 3.0 to 7.5.

In automorphic soil pH of water extraction is primarily caused by HCO^{3-} content (Fig. 5). In hydromorphic soils influence of water-soluble salts on pH is not as clear, and unlike automorphic soils, Cl^- ions (Fig. 6) play a more important role.

The main target for creation of forestry reserve "Volodymyrivska Dacha" is to limitation human intervention in forest ecosystems. However, a task that seems simple than inaction, requires considerable effort. The purpose of this activity is to prevent any interference with the natural development of forests, in addition to the planned forest management (sanitary cutting and other activities). In this area should encourage the development of vegetation, animal migration, and so on. You also need to maintain a territory with a high degree of purity, which is an indicator of acid-base balance of the soil.

In conclusion, the problem of forest management in this case is to preserve forests in the best condition, avoiding human intervention in forest life.

CONCLUSIONS

1. The territory of forestry reserve "Volodymyrivska Dacha" has been studied on the basis of the author's technique on landscape-ecological planning. The results of the evaluation phase were maps illustrating the geochemical situation in the soil cover.

2. Studies of landscape geochemistry are a requirement to provide adequate assessment of the environmental conditions of the forest reserve "Volodymyrivska Dacha".

3. The obtained pH_{H2O} and pH_{KCl} values indicate widespread alkalization of soils in areas with high anthropogenic load, which in most cases is caused by the presence of carbonates. The area of soil alkalization is mainly localized in the periphery of the study area - in places with a very high level of nature conflicts.

4. The resulting materials of geochemical assessment of the soil conditions can be taken into account when providing an integrated assessment of the forestry reserve "Volodymyrivska Dacha".

Decisions in areas of environmental management should be based on the findings of landscape-ecological planning.

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ЛАНДШАФТНО-ЭКОЛОГИЧЕСКАЯ ОЦЕНКА ТЕРРИТОРИИ ЛЕСНОГО ЗАКАЗНИКА «ВЛАДИМИРОВСКАЯ ДАЧА» ДЛЯ ЭКОЛОГИЧЕСКОГО МЕНЕДЖМЕНТА

Н. Максименко, А. Клещ, А. Шумилова

Аннотация. Работа основана на оригинальном подходе к процедуре ландшафтного планирования, основанном не на административном принципе, а на изучении природоохранной территории. Территория лесного заказника «Владимировская дача» изучена на основе авторской методики ландшафтно-экологического планирования природоохранного объекта. Ландшафтно-экологическое планирование было реализовано путем отбора проб почвы на сети контрольных точек и их лабораторного анализа. Результаты оценочного этапа иллюстрируют геохимические карты почвенного покрова территории лесного заказника «Владимировская Дача».

В статье представлены картографические модели пространственного распределения хлорид-ионов, карбонатов в лесных почвах, pH водной и солевой вытяжки. Полученные значения pH_{H2O} и pH_{KCl} свидетельствуют о том, что на большинстве территорий лесного заказника «Владимировская дача» наблюдается кислая реакция, подщелачивание почв приурочено к районам с высокой антропогенной нагрузкой, что в большинстве случаев обусловлено наличием карбонатов. Район подщелачивания почвы в основном локализуется на периферии - в местах с высоким уровнем природных конфликтов.

Результаты различных аспектов ландшафтно-экологического исследования территории лесного заказника «Владимировская дача» позволяют разработать рекомендации для оптимизации природопользования и организации экологического менеджмента на этой территории.

Ключевые слова: лесной заказник «Владимировская дача», ландшафт, природопользование, ландшафтно-экологическое планирование, геохимические анализы, почвы.