ENVIRONMENTAL PROBLEMS

Vol. 7, No. 4, 2022

CURRENT CHALLENGES IN ENVIRONMENTAL EDUCATION: CASE STUDY OF HUMAN-INDUCED LANDSCAPES DYNAMICS

Tamara Dudar, Tetiana Saienko, Iryna Matvieieva, Valentyna Hroza, Tetiana Karpenko, Anna Kozlova, Margaryta Radomska, Volodymyr Savytskyi, Andrian Yavniuk

National Aviation University,
1, L. Huzara Ave., 03058, Kyiv, Ukraine
dudar@nau.edu.ua

https://doi.org/10.23939/ep2022.04.207

Received: 24.10.2022

Abstract. The purpose of the article is to present the research results on the landscape changes dynamics in the frame of the Educational and Professional Program "Ecology and Environmental Protection" developed at the Department of Environmental Sciences at National Aviation University. The noosphere paradigm as the most integral bio-adequate basis of the interaction between the society and ambient environment under conditions of present-day challenges is highlighted. The advantages of education in English are emphasized in terms of the abundance of primary educational sources to tackle environmental challenges especially connected with the warfare activities in the country. Digital technologies and remote sensing development within the framework of the educational and professional program provide students, in particular, with the opportunity to perform landscape changes assessment due to long-term anthropogenic stress. The example of the border region landscapes of the Novgorod-Siverskyi Polissia is considered.

Keywords: noospheric paradigm, environmental education, landscape changes assessment, education in English, remote sensing technique.

1. Introduction

Traditionally, the noosphere (sphere of mind) is identified as a sphere of nature and society, within which intellectual human activity plays a key role in the development of the human environment (Grinevard, Rispoli, 2018). The concept of the noosphere path of society development organically includes the concept of noosphere education as a new paradigm of education in general. There is a lot of talk about the fact that the entire existing education system in the country should get greening (get through ecologization). Society itself should get greened through the system of education (Grinevard, Rispoli, 2018; Ivanov, 2015; Synyakevych et al., 2014; Tunytsya et al., 2015). Nature created man and on this basis, the ecologization of society must be built. Nature has not laid in the mental and social organization of a Man anything that would prevent the destruction of the natural environment. The Nature has not laid in the mental and social organization of a Man anything that would prevent the destruction of the natural environment. Only Nature is the authority to solve social problems in society (Synyakevych et al., 2014; Tunytsya et al., 2015).

It is our deep conviction that environmental education makes a significant contribution to the development of a new style of thinking called planetary thinking (Vernadskyi, 1991). A global understanding of environmental security, a new worldview of science that can influence the constructive political activities of people, is being born and developed. And such a system of views must have a particular philosophical foundation. An integral part of environmental education developing within the noosphere paradigm is the systematic introduction of digital technologies and remote sensing methods in the educational process. This issue was especially acute

For citation: Dudar, T., Saienko, T., Matvieieva, I., Hroza, V., Karpenko, T., Kozlova, A., Radomska, M., Savytskyi, V., Yavniuk, A. (2022). Current challenges in environmental education: case study of human-induced landscapes dynamics. *Journal Environmental Problems*, *7*(4), 207–215. DOI: https://doi.org/10.23939/ep2022.04.207

with the onset of the pandemic in 2020 followed by the war activities in 2022 and online education in progress. The introduction of new digital technologies became an urgent need for all educational levels – universities and schools.

2. Theoretical part

2.1. Statement of the problem

The worldview revolution confirmed the predictions of Volodymyr Vernadsky, who believed that the evolution of the biosphere goes in the direction of consciousness, i.e. the sphere of mind, where intelligent human activity, its creativity will be the main factors and content of life, and intangible thought will materially transform the planet (Vernadskyi, 1986). The noosphere approach based on the cognitive model of cognition becomes the basis of the educational and information environment (EIE) development. The special value of EIE is to integrate educational material from different disciplines to form the worldview of the individual gradually and holistically (through scientific, philosophical, and ethical knowledge of the Universe).

Based on the above, the authors' objectives are to present and substantiate in the giving research example the need for a modern noosphere worldview based on the generalization of more than 20-year experience in the sphere of environmental education in the noosphere paradigm, and define the ways of its further improvement at the Department of Environmental Sciences at National Aviation University (NAU).

Among the tasks put into consideration, the following are of high priority: overview and substantiation of the need for the development of environmental education in the noosphere paradigm through the authors' generalization of more than 20-year experience in the sphere of environmental education; analysis of digital and remote technologies at a certain research example and their role in present-day environmental education.

Regarding the methods of research, the theoretical logical and historical-methodological analysis of the provisions and concepts of noosphere doctrine is mainly used in this research, as well as the conceptual synthesis of philosophical, psychological, pedagogical and sociological literature, analysis of existing curricula, programs, textbooks, research papers, monographs, modelling the content of environmental education in higher educational institutions using digital and remote technologies.

The practical value of the presented research lies in the possibility of using the generalizations obtained by the authors on the long-term modelling of environmental education in national higher education; practical use of the experience of the teaching staff of higher educational institutions in modern conditions; development of curricula, programs, manuals for the dissemination of knowledge about the integrity of the world, noosphere ethics, thinking, worldview, consciousness, culture in general; the importance of building a sustainable, environmentally safe, environmentally friendly, harmoniously balanced society.

2.2. Graduate Department of Environmental Sciences at National Aviation University

The graduate Department of Environmental Sciences at National Aviation University (NAU) was founded in April 2001, and in 2021, it celebrated its 20th anniversary. The training process is currently carried out in accordance with the educational and professional program (EPP) Ecology and Environmental Protection for the first (Bachelor), the second (Master) and the third (PhD) levels of higher education. No less important is the environmental training of the Department's staff provided for other Faculties of the University, which involves delivering environmental courses, round tables, and various environmental activities, including 'National Environmental Safety' all-Ukrainian research and practical conference for young researchers and students (since 2007).

The importance of the environment and its safety for humans and biota, in general, is directly or indirectly considered in many disciplines of the mentioned EPP. Disciplines like Geology and Fundamentals of Mineralogy, Soil Science, and Biogeochemistry take into account environmental hazards of a geological nature, while the discipline Ecology, Aviation and Space introduces students to issues of environmental safety and preservation of the atmosphere for living beings. A series of disciplines such as Environmental Monitoring, Environmental Modelling and Forecasting, Environmental Safety, Remote Sensing in Ecosystem Research, Ecobiosafety and many others emphasize different approaches to safety in today's rapidly changing environment.

From the point of the noosphere approach view, the competencies considered in each individual discipline should be focused on a holistic view of vocational education (holistic bio-adequate thinking, behavior and environmental worldview). The following

aims are thought to be achieved in the environmental education taking into account the noosphere orientations: formation of an idea of the world and the man as a whole, value and moral bases of interaction with the environment, awareness of the globalization processes in the world, necessity of transformation of the education content and educational disciplines, inclusion of students in innovative educational activities, etc.

In this regard, we would like to draw your attention to the development of environmental education in English at the Environmental Sciences Department (Dudar et al., 2019; Dudar, 2021). Our experience ultimately demonstrates the need to use primary sources in the original language to tackle urgent environmental problems, which usually have no administrative boundaries. And this is mostly English-language information On the other hand, the ability to tackle most environmental problems in accordance with the standards of environmental safety in today's world and, therefore, the possibility of employment is real only through international cooperation and grants. Therefore, knowledge of professional English, together with knowledge of the environmental terminology, expands opportunities for young professionals for further employment and career opportunities. The future of environmental education in English in our country is still ahead. So the experience of the Department of Environmental Sciences in this sense will also be repeatedly reviewed.

3. Results and Discussion

3.1. Educational and Professional Program "Ecology and Environmental Protection" and Paradigms of Anthropocentrism and the Noosphere

The peculiarities of Educational and Professional Program (EPP) "Ecology and Environmental Protection" are that it includes a number of fundamental disciplines that form the worldview competencies of higher education seekers at the present-day stage. In this sense, it is worth paying attention to the comparison of present-day paradigms of anthropocentrism and the noosphere in natural science and education.

About seventy years ago, population growth and the level of human interaction with the Earth ecosystem entered a period of unprecedented change. This world-historical turning point after the Second World War was identified as the beginning of the Great Acceleration by the majority in English-language literature (Burchett, 2016; Shoshitaishvili, 2020). The anthropocene paradigm interprets the Great Acceleration as a world-historical process in which humanity becomes a technologically advanced, primarily material planetary force, marking the beginning of a new geological era, significant human impact on Earth's geology and ecosystems, including anthropogenic climate change. Anthropocentric approaches often warn of possible catastrophe for humanity and the living world.

The concept of the Anthropocene belongs to the nomenclature of geochronology and stratigraphy, disciplines responsible for establishing the official geological time. In 2019, the Anthropocene Working Group voted in favor of proposing the establishment of the Anthropocene as the latest geological era for approval in 2021 by the International Commission on Stratigraphy. We will follow how events will develop further in natural science and education.

The noosphere paradigm also treats the present-day anthropogenic change as a world-historical transformation, but less emphasis on the material aspects of the process and environmental catastrophes. Noosphere approaches represent the Great Acceleration as a stage on the path to integrated humanity, which is reaching global significance in globally interconnected culture, technologies, and consciousness. In contrast to the Anthropocene, the noosphere views are primarily more optimistic and encouraging. And theses aspects are specially emphasized in the courses of "Geology and Fundamentals of Mineralogy", and "Ecology and Neoecology" as those, connected with the study of the lithosphere and its importance for human advancement.

In general, the Anthropocene is a key concept for understanding anthropogenic global change among scientists and thinkers in Western Europe and America; meanwhile, noosphere views are increasingly evolving by Eastern European scholars working on the philosophical aspects of similarity of views (Burchett, 2016; Svoboda, Nabert, 1999). However, the main thing is to realize that the consequences of huge anthropogenic changes in the world are not only political and social, but also biological and geological. Newly developed Course Training Programs on the disciplines such as "Biology", "Geology and Fundamentals of Mineralogy", "Theoretical Bases of Biosphere Pollution", "Landscape Ecology" and others should emphasize on that.

According to V. I. Vernadsky geological processes are the basis for all other environmental phenomena on the Earth. He and most of the followers-scientists believed that lithosphere is the most fundamental and reliable element of any ecosystem (Svoboda, Nabert,

1999). Being able to transform the structure and face of ecosystems, humans are said to become a new geological force. However, the most prominent changes of human activity at geological level have taken place in the atmosphere: the consequences are so dramatic that they have violated its natural processes with unprecedented intensity. And now we witness the complex of functional disorders in the atmosphere – climate change, ozone layer depletion, acid rains, smog and global dimming. Most of them have not been seen in the biosphere in the former geological eras.

To recognize the role of mankind in the evolution of global ecosphere of the planet, the current geological period is termed "anthropocene" (Ellis, 2018; Teilhard de Chardin, 1959). However, the attributes of anthropocene are degradation of natural environment quality in terms of all its components. But the transformation of humans into geological force was seen as an element of noogenesis by the ideologists of biosphere evolution – we were supposed to move towards domination of reason over requests. And this is also the reflection of dramatic misleading idea of our society: globalization is not equal to noogenesis.

By propagation of common values and ideas we didn't accomplish the task of harmonization of biological and cultural evolution. However, now we are able to see that the essence of many environmental problems is in the conflict between personal and common good. Thus, most of the human history has supported the idea of individual progress, which finally contributes to the prosperity of the whole society (Sayenko, 2020a; Teilhard de Chardin, 1959). And at the current point of our civilization we have arrived to the idea that we need to reject some excessive benefits and comfort in favor of some hypothetic common good in the future. At the same time, we see that there are things that everyone cares about literally, not caring at all about the common property – the environment, including – man (Sayenko, 2020b).

3.2 Case Study of Human-Induced Landscapes Change

To demonstrate the significant human impact on the Earth's ecosystems and to describe a current challenge approach to the landscape change dynamics we have chosen the North-Eastern part of the Ukrainian Polissia, namely, the Novgorod-Siverskyi Polissia. The main feature of the mentioned above region is that the territory located on the border of Ukraine, Russia and Belarus is a very specific one. The total length of the border with Russia in the Chernihiv region is more than 200 km. The recent war activities made this topic even more important, although we needed to emphasize the methods and appropriate images available. Territories adjacent to the state border differ in socioeconomic and ethnic composition, location and development of various natural groups. In this paper, we consider natural complexes, which with the strengthening of economic impact on nature, suffer both from the peculiarities of nature management and the intensification of anthropogenic impact and changes in natural climatic conditions. Therefore, there is a need for deeper knowledge about the natural potential of landscapes and their management, as well as the patterns of changes in natural complexes in time and space, to provide information on quality management for the current united territorial communities (UTC) of the Novgorod-Siverskyi Polissia.

3.3. Classification of Novgorod-Siverskyi Polissia Landscapes

Landscape classification is of great organizational importance as a basis for research, mapping and scientific description of landscapes. There are no doubts about the practical importance of landscape typological classification. For practical purposes (for example, when assessing natural conditions for agricultural development or reclamation or conservation measures), it may be too difficult and even impractical to study and assess each landscape type separately. More often, it is necessary to develop certain standard norms or measures about typical natural conditions, i.e. to some number of landscape groups. Here we use the classification in which many landscapes are grouped into several species, types, classes, etc.

One of the main tasks of this research work was to correctly classify the landscapes of Novgorod-Siverskyi Polissia so that the classification could cover all landscape diversity types. For the best result of the study, agricultural lands, fields, abandoned areas, cultivated fields, and artificial surfaces were combined into one class – anthropogenic/human-induced landscapes (Table 1). This was done to avoid gross errors in the classification of the territory because the above types of landscapes are very difficult to distinguish during the processing of images, but in any case, they are anthropogenic. Based on the Lansat-5 and Lansat-8 space images as of 1986 and 2018 (changes over 32 years), the following classification was made. Table 1 and also Figure1 below demonstrate the changes that happened to wetlands (violet colour), human-induces

landscapes, and coniferous and deciduous forests (different tints of green, see the Sankey diagram, Fig. 2).

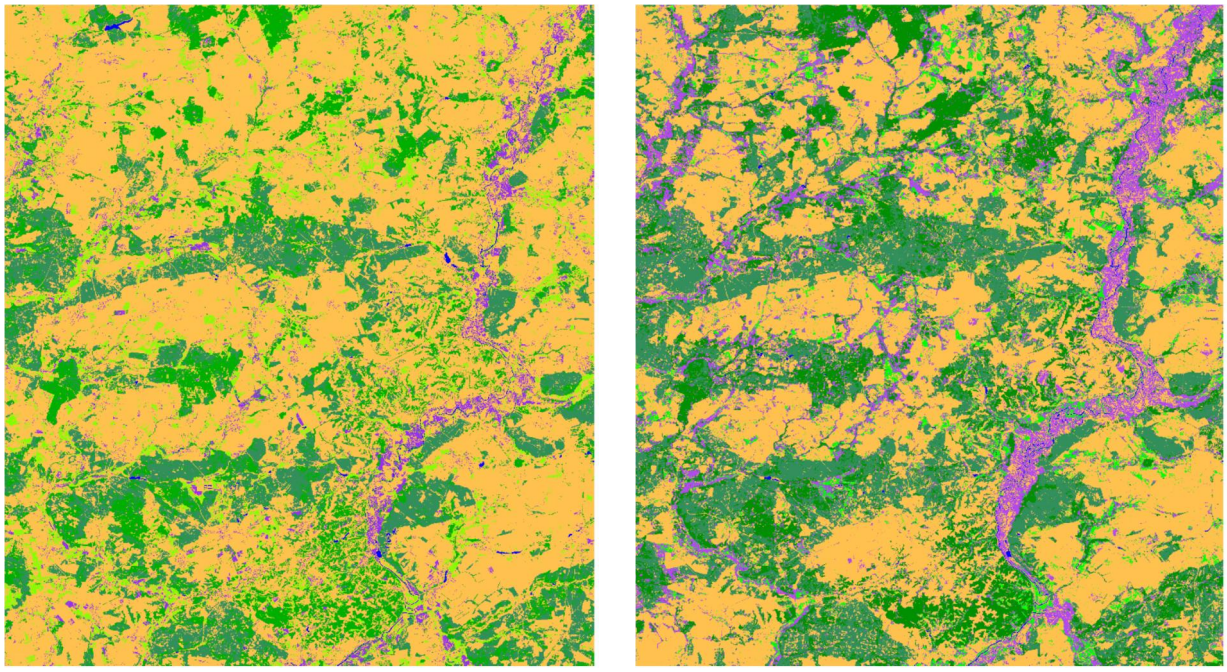
Table 1

Landscape types grouped for further analysis of their dynamics

Landscape classes	1986 (ha)	2018 (ha)
Natural Landscapes		
Wetlands	23676.57	85143.69
Water	2583.18	2754.99
Forest coniferous	93633.12	123833.07
Forest deciduous	91860.03	100434.96
Grass	44139.06	38163.78
Human-induced Landscapes	446108.04	351669.51

Wetlands are areas where the soil is an aquifer with constant or seasonal humidity. On the territory of Novgorod-Siverskyi Polissia, the wetlands' area significantly increased (from 23676 ha to 85143 ha) during the period from 1986 to 2018. Wetlands are one of the most productive ecosystems on the planet. They are a source of biodiversity, water and primary productivity on which many species of plants and animals depend, as well as maintain high concentrations of many species of birds, mammals, amphibians, fish and invertebrates and preserve genetic material. In addition, wetlands provide important and sometimes necessary ecosystem services to ensure the health, well-being and safety of people living within, near, and in some places, even globally.

The interaction of physical, biological and chemical components, such as soil, water, plants and animals, allows wetlands to provide many vital ecosystem services. The number of wetlands is growing due to the active waterlogging of floodplains and the lack of drainage systems in the region. Based on the classification presented in Table 1, we have visually demonstrated (in Fig. 1) the landscape cover changes from 1986 to 2018.



1986 2018

Fig. 1. Classification of landscape coverings as of 1986 and 2018

Human-induced (anthropogenic) landscapes significantly differ depending on the variations in human activities. According to our classification results, the territory of anthropogenic landscapes decreased from 446108 ha to 351669 ha. This trend can be explained by the neglect of previously used territory (for example, afforestation or waterlogging of farmland, etc.).

3.4 Analysis and mapping of landscape change dynamics

Analyzing landscape maps (Fig. 1) and the Sankey diagram (Fig. 2) along with Tables 1 and 2, one can make a conclusion about landscape changes and their transformation from one type to another happening within the study area from 1986 to 2018.

Table 2

Landscape Transformations from 1986 until 2018 (in hectares)

LC Class		*Initial State (1986) ha*						
		Water	Wetland	Forest C	Forest D	Grass	*Human-induced*	Class Total
Final State (2018) ha	Water	1368.63	13.59	156.6	97.2	43.38	1075.59	2754.99
	Wetlands	41.49	11015.55	3052.26	6319.71	13081.5	51633.18	85143.69
	Forest coniferous	116.46	37.35	73985.4	17757.27	794.61	31141.98	123833.07
	Forest deciduous	14.58	2115.81	5554.8	55088.37	6210.54	31450.86	100434.96
	Grass	9.63	1667.52	368.91	768.42	8325.99	27023.31	38163.78
	Human-induced	1032.39	8826.75	10515.15	11829.06	15683.04	303783.12	351669.51
	Class Total	2583.18	23676.57	93633.12	91860.03	44139.06	446108.04	
	Class Changes	1214.55	12661.02	19647.72	36771.66	35813.07	142324.92	
	Image Difference	171.81	61467.12	30199.95	8574.93	-5975.28	-94438.53	

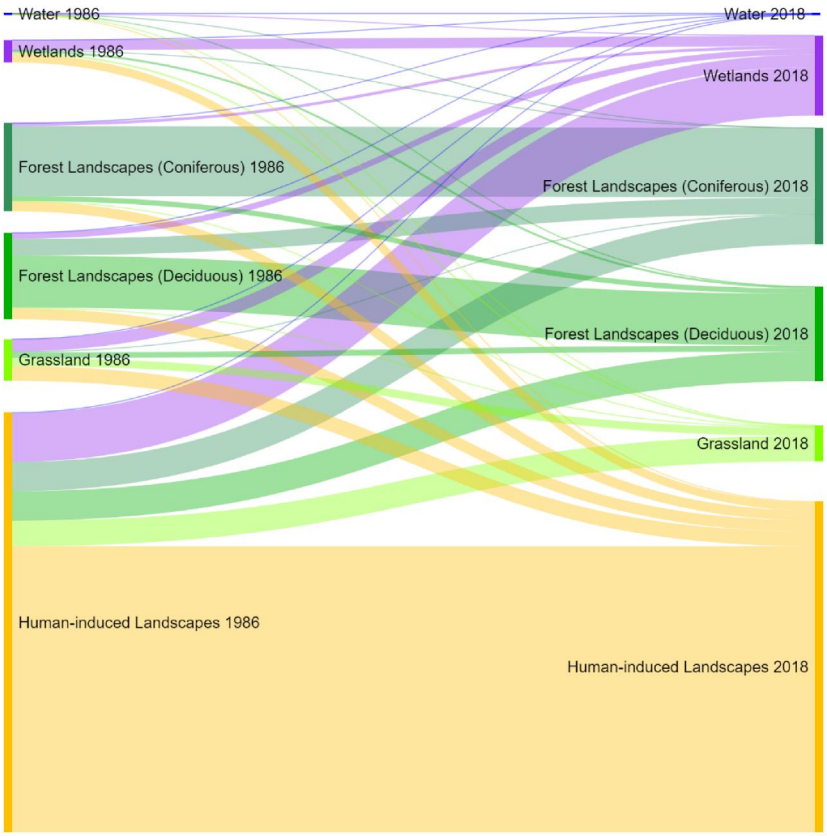


Fig. 2. Sankey diagram of landscape types transformation from 1986 to 2018

Landscape analysis of the territory is crucial to begin any design work on its rational use. Changes in local systems lead to general changes, regional and global, which is entirely due to continuous flows of matter and energy (Popov et. al., 2021). In the study of Novgorod-Siverskyi Polissia, the main idea was to reflect the landscape change dynamics for a particular period to understand the further rational use for the particular unified territorial community.

The Sankey diagram (Fig. 2) shows the flows and their quantitative values in proportion to each other. The width of the arrows or lines is used to indicate the values. The larger the "arrow" the greater the quantitative value of the flow. Arrows or flow lines can be combined or separated at different stages of the process. The colour gamut is used to divide the chart into different categories or to demonstrate the transition from one process state to another.

The Sankey chart shows that the Wetlands area has increased due to human-induced landscapes, grasslands (Grassland), forest landscapes (Coniferous) and broad-leaved forests (Deciduous). The territory of coniferous forests has increased due to the development of mixed forests and anthropogenic landscapes. Instead, the area of anthropogenic landscapes has decreased due to their transformation into other landscape classes.

The diagram in Figure 3 shows how all classes of landscapes were transformed into each other and highlighted in colours corresponding to the map in Fig. 4.

The resulting map of land cover flows reflects the basic patterns of landscape cover change within the study area and clearly shows where and how the number of landscape classes has been increased. Thus, the application of the proposed basis provides a quantitative assessment of changes in landscape covers that occurred within the study area over 32 years (1986–2018) and also reveals the patterns of these changes. Quantitative and qualitative assessment is necessary for further management of the border areas of the Novgorod-Siversk unified territorial community and sustainable nature management.

The presented comparative data of all changed landscape classes allow a better analysis of the situation regarding the landscape transformation for the study area (Kolomiyets, Tarashchuk, 2005; Krasnopir, 2015; Shlyakhy Pokrashchennya, 1999). Analyzing the situation, we can conclude that the areas of wetlands and forest landscapes, in general, significantly increased while the area of anthropogenic landscapes decreased mainly because of their transition to other landscape covers.

Analyzing the resulting map of landscape cover changes (Fig. 4), you can get valuable information for decision-makers on sustainable land management. Imposing a map of the administrative division of the territory, a map of nature reserves, or any other maps of the study area, one can analyze specific issues – the area of which landscape class was increased (decreased) and how much, which artificial covers predominate, which processes occur within agricultural areas (wetlands, afforestation, etc.) and what measures should be taken to improve the environmental situation, land quality, etc.

LC Class		*Initial State (1986) ha*						
		Water	Wetland	ForestC	ForestD	Grass	*Hum Landsc*	
Final State (2018) ha	Water	No Change	Wetland loss	Forest loss	Forest loss	Grass loss	Water gain	
	Wetlands	Wetland gain	No Change	Forest loss	Forest loss	Wetland gain	Wetland gain	
	Forest conif	Forest gain	Forest gain	No Change	Decid loss	Forest gain	Forest gain	
	Forest decid	Forest gain	Forest gain	Decid gain	No Change	Forest gain	Forest gain	
	Grass	Grass gain	Wetland loss	Forest loss	Forest loss	No Change	Grass gain	
	Hum Lands	Water loss	Wetland loss	Forest loss	Forest loss	Grass loss	No Change	

Fig. 3. Semantic scheme of landscape classes transitions

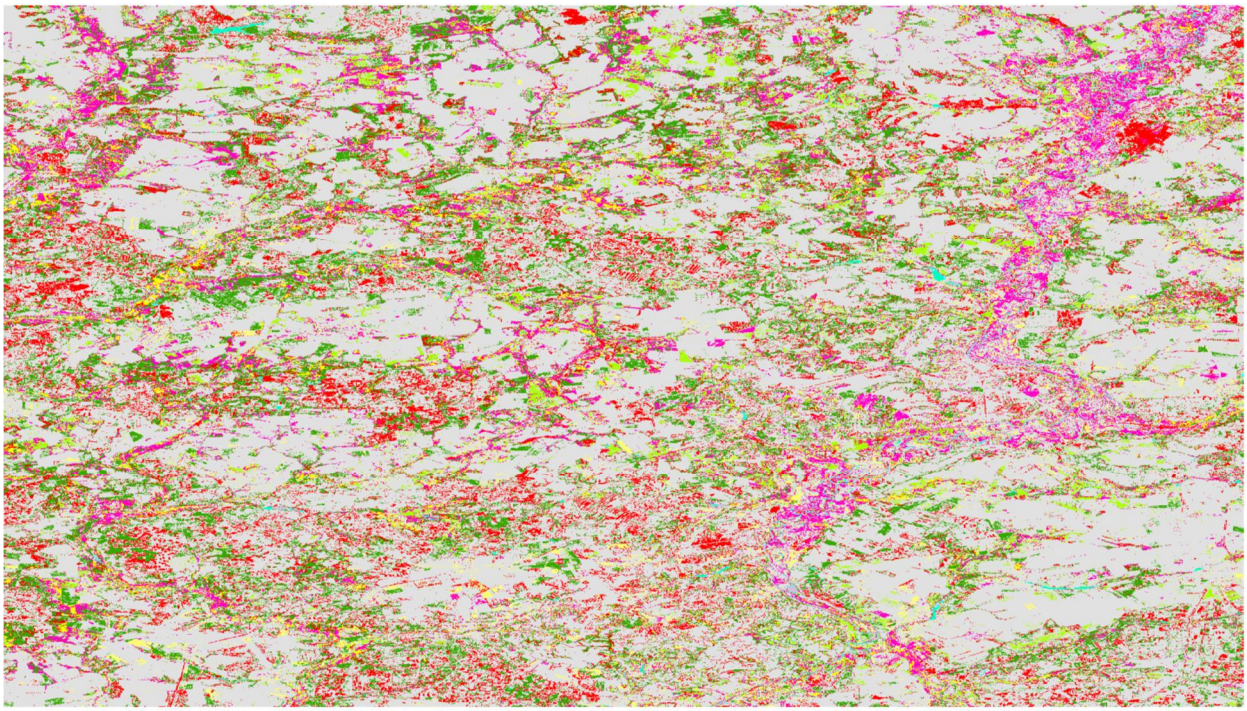


Fig. 4. The resulting map of changes in landscape covers, reflecting the basic dynamics patterns of landscape classes for the period from 1986 to 2018

4. Conclusion

The national transition to noosphere education has to be identified in a specific change in the place of science and education in the society, namely: in prioritizing noosphere education, that noosphere education should be advanced, setting the speed and level of the society development.

In the course of study on Educational and Professional Program "Ecology and Environmental Protection", there has to be formed the perception of the individual as a psycho-bio-energy-information complex, which allows gaining knowledge about the potential abilities of the individual for successful, large-scale self-realization; to comprehend our world not as a space filled only with material things, but as a multidimensional living entity permeated with sense and thought.

Digital technologies, along with the remote sensing of the Earth, provide a broad overview of landscapes and are important sources of data for their qualitative and quantitative analysis. Using the example of the Novgorod- Siverskyi Polissia, with the help of many spectral space images, it was shown that landscape changes can be assessed for the united territorial communities' areas and their sustainable nature management in the future.

Acknowledgement

This work was done in the framework of cooperation between the Scientific Centre for Aerospace Research of the Earth (CASRE) of the National Academy of Sciences of Ukraine and the National Aviation University based on the Agreement on Scientific and Technical Cooperation № 30-нт-18 as of 04Dec2018.

References

Burchett, K. (2016). *Anthropocentrism as Environmental Ethic.* (Doctoral dissertation). University of Kentucky. Kentucky. doi: http://dx.doi.org/10.13023/ETD.2016.259

Dudar, T. V. (2021). On the issue of disciplines on environmental safety taught in English. *Abstract book of the I*st *Internet-conference "Environmental safety – advanced directions and ways for higher education development*". V. N. Karazin Kharkiv National University, 145–146.

Dudar, T. V., Frolov, V. F., & Savytskyi, V. D. (2019). Ekologichna osvita: pryrodnychi nauky v konteksti suchasnych tendentsij rozvytku. *IV Vseukrainska naukovo-metodychna konferentsia "Suchasni aspekty* zabezpechennya *ekologichnoi skladovoi pidgotovky fakhivtsiv"*. KhNADU, 47–50.

Ellis, E. C. (2018). *Anthropocene: A Very Short Introduction*. Oxford University Press. doi: https://doi.org/10.1093/actrade/9780198792987.001.0001

Grinevard, J., & Rispoli, G. (2018). Vladimir Vernadsky and the Co-evolution of the Biosphere, the Noosphere, and the

Technosphere. *Technosphere magazine*. Retrieved from https://bit.ly/3eUlQFy

Ivanov, S. A. (2015). New horizons of environmental education: from the noospheric worldview to the noospheric ethics. *The Education and science journal, 1*(3), 29–45. doi: http://dx.doi.org/10.17853/1994-5639-2015-3-29-45.

Kolomiyets, G. V., & Tarashchuk, S. V. (2005). *Upravlinnya vodno-bolotnymy ugiddyamy miznarodnogo znachennya: Metodychni rekomendatsii do planuvannya i vprovadzennya*. Kyiv.

Krasnopir, O. V. (2015). Analysis of landscape diversity of ukrainian polissia for 2001–2012 years based on classified satellite images EOS/MODIS. *Ukrainian journal of remote sensing, 6*, 14–23.

Popov, M., Michaelides, S., Stankevich, S., Kozlova, A., Piestova, I., Lubskiy, M., Titarenko, O., Svideniuk, M., Andreiev, A., & Ivanov, S. (2021). Assessing long-term land cover changes in watershed by spatiotemporal fusion of classifications based on probability propagation: The case of Dniester river basin. *Remote Sensing Applications: Society and Environment, 22*, 100477. doi: https://doi.org/10.1016/j.rsase.2021.100477

Sayenko, T. V. (2020 a). Energy information potential of personality in the context of noospherogenesis. *Higher Education of Ukraine: Theoretical and scientific-methodical journal, 3*(78), 33–40.

Sayenko, T. V. (2020 b). Noospheric personal development in conditions of transition period. *Proceedings of the National Aviation University. Series: Pedagogics, Psychology, 1*(16), 123–130. doi: https://doi.org/10.18372/2411-264X.16.14688.

Shlyakhy pokrashchennya zberezennya torfovykh ta inshykh vydiv bolit Ukrainy. (1999). Programa Darvinskoi initsiatyvy "Bioriznomanittya torfovykh ekosystem" 1998-1999.

Shoshitaishvili, B. (2020). From Anthropocene to Noosphere: The Great Acceleration. *Advancing Earth and Space Sciences, 9*(2). doi: https://doi.org/10.1029/2020EF001917.

Svoboda J., & Nabert D. (1999). Noosphere. *Environmental Geology. Encyclopedia of Earth Science.* Springer, Dordrecht. doi: https://doi.org/10.1007/1-4020-4494-1_236.

Synyakevych, I. M., Deineka, A. M., & Golovko, A. A. (2014). *Ekologizatsiya lisokorystuvannya v konteksti podolannya globalnych ekologichnych zagroz: monograph.* Kamula.

Teilhard de Chardin, P. (1959). *The Phenomenon of Man*. Collins.

Tunytsya, Yu. Yu., Zagvoiska, L. D., & Maksymiv, L. I. (2015). *Ekonomika dovkillya i pryrodnych resursiv: informatsijnyj paket spetcialnosti.* Afisha.

Vernadsky, V. I. (1986). *The Biosphere*. Oracle, Ariz.: Synergetic Press.