MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
FACULTY OF ENVIRONMENTAL SAFETY,
ENGINEERING AND TECHNOLOGIES
DEPARTMENT OF ENVIRONMENTAL SCIENCE

APPROVED TO DEFENCE
Head of the Graduate Department
_____ T.V. Dudar
«_____» _____ 2021

MASTER THESIS

(EXPLANATORY NOTE)

SPECIALTY 101 "ECOLOGY",
EDUCATIONAL AND PROFESSIONAL PROGRAM
"ECOLOGY AND ENVIRONMENT PROTECTION"

Theme: «IDENTIFICATION AND ECONOMIC VALUATION OF ECOSYSTEM SERVICES OF NATURAL PLANT ASSOCIATIONS»

Done by: student of the FESET – group EC-211Ma, Taras I. Nazarkov
(student, group, surname, name, patronymic)

Scientific Supervisor: Ph. D. in Engineering, Ass.Prof. Margaryta M. Radomska
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Consultant of the chapter "Labor Precaution": _____ Kateryna I. Kazhan
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Standards Inspector: _____ Andrian A. Iavniuk
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KYIV 2021

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
ФАКУЛЬТЕТ ЕКОЛОГІЧНОЇ БЕПЕКИ,
ІНЖЕНЕРІЇ ТАТЕХНОЛОГІЙ
КАФЕДРА ЕКОЛОГІЇ

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач випускової кафедри
_____ Т.В. Дудар
«_____» _____ 2021 р.

ДИПЛОМНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ МАГІСТР

ЗА СПЕЦІАЛЬНІСТЮ 101 «ЕКОЛОГІЯ»
ОСВІТНЬО-ПРОФЕСІЙНОЮ ПРОГРАМОЮ
«ЕКОЛОГІЯ ТА ОХОРОНА НАВКОЛИШНЬОГО СЕРЕДОВИЩА»

Тема: «Ідентифікація та економічна оцінка екосистемних послуг природних рослинних асоціацій»

Виконавець: студент групи ЕК-211Ма Назарков Тарас Ігорович
(студент, група, прізвище, ім'я, по батькові)

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Консультант розділу «Охорона праці»: _____ Кажан К. І.
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КИЇВ 2021

NATIONAL AVIATION UNIVERSITY

Faculty of Environmental Safety, Engineering and Technologies
Department of Environmental Science
Specialty, Educational and Professional Program: specialty 101 "Ecology",
Educational and Professional Program: "Ecology and Environment Protection"
(code, name)

APPROVED
Head of the Department
_____ Dudar T.V.
«____» _____ 2021

MASTER THESIS ASSIGNMENT

Taras I. Nazarkov

1. Theme:«Identification and economic valuation of ecosystem services of natural plant associations» approved by the Rector on 15.09.2021 p. № 1872/ст.

2. Duration of work: from 11.10.2021 p. to 31.12.2021 p.

3. Output work: data of project literature, standards and standardized methods of assessment of ecosystem services, methods of selection and processing of information, methods of statistical data processing, methods of survey of respondents, etc.

4. Content of explanatory note: (list of issues):

- ecosystem services of forest biocenoses and evaluation of ecosystem services;
- general characteristics and features of pluzhne forestry;
- determining the economic value of ecosystem services of pluzhne forestry;

5. The list of mandatory graphic (illustrated materials): tables, figures, charts, graphs.

6. Schedule of thesis fulfillment

№ з/п	Task	Term	Advisor's signature
1	Obtaining the topic of the task, searching for literature sources and analysis of previous research	11.10.21-31.10.21	
2	Writing a review of the problem on the topic of the study (Section I)	01.11.21-14.11.21	
3	Choice of research methodology (Section II)	15.11.21-25.11.21	
4	Conducting experimental research	25.11.21-05.12.21	
5	Formulation of conclusions and recommendations of qualification work	06.12.21-13.12.21	
6	Registration of the explanatory note to the preliminary representation at department, consultation with the normocontroller	13.12.21-14.12.21	
7	Preliminary protection	15.12.21	
8	Taking into account comments, recommendations and preparation for defense	15.12.21-24.12.21	
9	Presentation of work to the department	24.12.2021	
10	Protection of qualification work	28.12-29.12.2021	

7. Consultant(s) of certain chapter(s):

Chapter	Consultant (academic rank, S.N.P)	Date, signature	
		Given by	Accepted by
Labor Precaution	Kazhan Kateryna I.,PhD, Associated Professor of the Department of Civil and Industrial Safety		

8. Date of task issue: 11 «october» 2021

Diploma (project) advisor: _____ Margaryta M. Radomska
(advisor's signature) (S.N.P.)

Task is taken to perform: _____ Taras Nazarkov
(graduate's signature) (S.N.P.)

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Факультет екологічної безпеки, інженерії та технологій

Кафедра екології

Спеціальність, освітньо-професійна програма: спеціальність 101 «Екологія», ОПП «Екологія та охорона навколишнього середовища»

(шифр, найменування)

ЗАТВЕРДЖУЮ
Завідувач кафедри
_____Дудар Т.В.
«____» _____ 2021 р.

ЗАВДАННЯ
на виконання дипломної роботи
Назаркова Тараса Ігоровича

1. Тема роботи «Ідентифікація та економічна оцінка екосистемних послуг природних рослинних асоціацій » затверджена наказом ректора від 15.09.2021 р. № 1872/ст.

2. Термін виконання роботи: з 11.10.2021 р. по 31.12.2021 р.

3. Вихідні дані роботи: дані проектної літератури, стандарти та стандартизовані методи оцінки екосистемних послуг, методи відбору та обробки інформації, методи статистичної обробки даних, методи опитування респондентів, тощо.

4. Зміст пояснювальної записки:

- екосистемні послуги лісових біоценозів та оцінка екосистемних послуг;
- загальна характеристика та особливості Плужненського лісництва, визначення економічної цінності екосистемних послуг;

5. Перелік обов’язкового графічного (ілюстративного) матеріалу: таблиці, рисунки, діаграми.

6. Календарний план-графік

№ з/п	Завдання	Термін виконання	Підпис керівника
1	Отримання теми завдання, пошук літературних джерел та аналіз попередніх досліджень	11.10.21-31.10.21	
2	Написання огляду проблеми за темою дослідження (Розділ І)	01.11.21-14.11.21	
3	Вибір методики дослідження (Розділ ІІ)	15.11.21-25.11.21	
4	Проведення експериментальних досліджень	25.11.21-05.12.21	
5	Формулювання висновків та рекомендацій кваліфікаційної роботи	06.12.21-13.12.21	
6	Оформлення пояснювальної записки до попереднього представлення на кафедрі, консультація з нормоконтролером	13.12.21-14.12.21	
7	Попередній захист	15.12.21	
8	Урахування зауважень, рекомендацій та підготовка до захисту	15.12.21-24.12.21	
9	Представлення роботи на кафедру	24.12.2021	
10	Захист кваліфікаційної роботи	29.12.2021	

7. Консультація з окремого(мих) розділу(ів):

Розділ	Консультант (посада, П.І.Б.)	Дата, підпис	
		Завдання видав	Завдання прийняв
Охорона праці	Кажан К.І., к.т.н., доцент кафедри промислової та цивільної безпеки ФЕБІТ НАУ		

8. Дата видачі завдання: 11 «жовтня» 2021 р.

Керівник дипломної роботи (проекту): _____ Радомська М.М.
(підпис керівника) (П.І.Б.)

Завдання прийняв до виконання: _____ Назарков Т.І
(підпис випускника) (П.І.Б.)

ABSTRACT

Explanatory note to thesis «Identification and economic valuation of ecosystem services of natural plant associations»: 82 pages, 10 figures, 24 tables, 32 references.

Object of research: natural ecosystems functions

Subject of research: provision of ecosystem services by forests

Aim of research: to conduct an up-to-date assessment and identification of ecosystem services, to translate the results into currency for economic evaluation;

Methods of research: information retrieval, analysis and synthesis of information, selection of appropriate methods for research, mathematical evaluation, direct market valuation method, indirect market valuation method, conditional valuation method, group valuation method, willingness to pay method, statistical data processing methods;

The thesis explains the uncontrolled use of natural resources in the form of ecosystem services, which is a serious environmental and social problem that leads to negative consequences for biotic and abiotic components. The scientifically based assessment is still not always correct, and the information obtained is not disseminated to the public. Therefore, there is a need to properly assess ecosystem services and bring information to the public and the public who directly use them.

ECOSYSTEM, ECOSYSTEM SERVICES, NATURE CONDITIONS, ECONOMIC EVALUATION, NATURAL PLANT ASSOCIATIONS, FOREST ECOSYSTEM, PROVISIONING SERVICES, REGULATORY SERVICES OF FOREST ECOSYSTEMS, SUPPORTING SERVICES OF FORESTS, CULTURAL SERVICES

CONTENT

LIST OF SYMBOLIC NOTATIONS, ABBREVIATIONS AND NOTIONS

MEA - Millennium Ecosystem Assessment;

UNEP - United Nations Environment Programme;

SEEA - System of Environmental Economic Accounting;

ECOSYSTEM SERVICES - these are all useful resources and benefits that man can get from nature.

INTRODUCTION

Relevance of the work: misunderstanding, and hence uncontrolled use of natural resources in the form of ecosystem services is a serious environmental and social problem, which leads to negative consequences for biotic and abiotic components. Scientifically based assessment is still not always correct, and the information obtained is not disseminated to the public. Therefore, there is a need for proper assessment of ecosystem services and communication of information to the population and the public who directly use them.

Aim and tasks of the diploma work

Aim of the work : to conduct an up-to-date assessment and identification of ecosystem services, to translate the results into currency for economic evaluation.

Tasks of the work:

1. Collection and analysis of information on existing and relevant methods of assessment of ecosystem services

2. Choice of territory, conditional delineation of its borders, collection of information about its natural and anthropogenic factors

3. Identification and economic assessment of ecosystem services of natural plant associations of the selected area using direct and indirect methods.

4. Conduction of the survey about the willingness of pay for ecosystem services by local population.

5. Assessment of the reliability of the results and formation of recommendations for the support of ecosystem providers

Object of research: natural ecosystems functions

Subject of research: provision of ecosystem services by forests

Methods of research: information retrieval, analysis and synthesis of information, mathematical evaluation, direct market valuation method, indirect market valuation method, conditional valuation method, group valuation method, willingness to pay method, statistical data processing methods.

Personal contribution of the graduate: study and analysis of literature, selection and

preliminary preparation of methods for research, preparation of questionnaires for research, questionnaires of local population and collection of necessary information, economic calculation of services, processing of data, construction and processing of tables.

Approbation of the results:

1. II Міжнародної науково-практичної конференції «Екологія. Довкілля. Енергозбереження», «Полтавська політехніка імені Юрія Кондратюка», м. Полтава, 2 – 3 грудня 2021 р.
2. Екологічна безпека та технології захисту довкілля. - 2021. - №3.

Publications:

1. Nazarkov T.I., Radomska M.M. Evaluation of ecosystem services of the forestry
2. Radomska M.M., Mushta M.A., Nazarkov T.I. Nazarkov T.I. Protection of urban plant associations from climate change pressures to support ecosystem services provision

CHAPTER 1
ECOSYSTEM SERVICES OF FOREST BIOCENOSES

1.1. The concept of ecosystem services

Ecosystem services are the basis of human development and existence. The resilience and balance of ecosystems is the key to the well-being and comfort of the human race.

The concept of ecosystem services has found recognition in the national environmental policies and legislation of many countries. Activities on a wide range of issues related to ecosystem services, including their assessment, the formation of markets for these services and more are being intensified. In general, ecosystem services are considered to be all the valuable, useful and positive resources that humans can receive from nature and use profitably. The living standards of the human race are directly dependent on ecosystem services, as they provide the basic needs for habitat and nutrients. These statements can be considered unanimous, as they are common to most countries in the world and their governing bodies. We can say that ecosystem services have a direct and indirect impact on human existence and well-being [1].

What is more important is that they are no longer considered inexhaustible and free. Most countries in the world understand that this is a value that needs to be paid for, that needs to be preserved and developed.

Over the years, the concept of ecosystem services has changed significantly.

The history of the development of the concept of ecosystem services has been discussed in detail many times in many collective and personal scientific works. If you delve into the concept of ecosystem services, it is generally accepted that the concept of life support and the general interconnection of man and nature was realized by people in ancient times. It is clear that this was not a general opinion, but we can identify signs of awareness in the works of Plato.

The dependence of the very existence of a person on natural conditions and the fact that unreasonable land use can lead to unfavorable consequences has been in a person since

the beginning of his knowledge of himself and his environment. The concept of services, as certain benefits received by a person from nature in its modern sound, is associated with a collective work devoted to critical problems of the state of the environment (Wilson, Matthews, 1970). Environmental issues (Wilson, Matthews, 1970). This term was used in several different sounds: nature services (natural services - Holdren, Ehrlich, 1974; nature's services - Westman, 1977), environmental services (Wilson, Matthews, 1970; public services of the global environment - Ehrlich et al., 1977) and, finally, ecosystem services (ecosystem services Ehrlich, Ehrlich, 1981). However, the term functions‖ (functions) (De Groot, 1992) or a combination of public-service functions of the global environment‖ (Holdren, Ehrlich, 1974) remained more popular in soil science and ecology for a long time.

The situation changed in connection with the preparation of the Millennium Ecosystem Assessment (MEA) (2003, 2005) – a gigantic collective work undertaken at the initiative of UN Secretary General Kofi Annan, expressed in his speech at the UN General Assembly in 2000. – We are the Peoples: The Role of the United Nations in the 21st Century.

The purpose of the assessment was to characterize the current state of the planet's ecosystems and create a scientific basis for the actions necessary for their conservation and rational use for the benefit of humanity. In 2003, a Framework for Assessment was developed; In 2005, 4 volumes of assessment reports and synthesis reports were issued on overall assessment of ecosystem status and trends, biodiversity assessment, desertification assessment, wetland assessment, health impact assessment, and business and industry opportunities assessment.

As in any system, in nature there is also an interaction between all its components, in our case - ecosystems and ecosystem services. There are two main concepts of such interaction: compromise and synergy. Compromise is the process when a person's use of one service weakens another. If, on the contrary, there is a process of amplification, it is a synergy. Both synergies and compromise can be managed in order to reduce shortcomings for society and improve the work, resource and functional potential of ecosystems, thereby improving the welfare of the population.

Different ecosystems provide the necessary services to varying degrees. Therefore, when planning ecosystem measures, it is necessary to maintain an appropriate balance

between the conservation and development of all ecosystems. The most important and scarce ecosystem services need to be purposefully supported. Depending on the type of ecosystem, the service it can provide is to some extent better or worse. Therefore, when planning ecosystem measures, the necessary balance must be struck between the preservation of old services and species and the creation of new ones. First you need to support the old features, and then develop new ones.

Ecosystem services are a prerequisite, we can even say, the basis of a comfortable life. Ecosystem services are a key concept for human well-being. Thanks to the work and services of ecosystems, which we do not always properly perceive and understand, and sometimes do not even think about how much we depend on these services, which even if we do not use, depends on our existence and development. Knowledge of ecosystem services is very important for humans. We need to understand how much we depend on the processes that take place around us, what responsibilities we have, and what part of the work we do in this system. It must be understood that the use of natural resources and ecosystem services is only a gift to be paid for. Pay with your work, understanding of processes, your responsibility, even the financial part. Many of the civilizations we know have ceased to exist because they have made their home territories uninhabitable. They did not think about the fact that for each action you have to pay something. This has happened not in one day, but for many hundreds of years.

Irrational use of ecosystem services has led to the devastation of biodiversity and, as a consequence, the disappearance of habitable areas. Thousands of years have passed, and humanity is still unable to understand nature. Ukraine, which has one of the best ecosystem potentials in the world, cannot understand the truth in the existence of man and nature. The reason for this, in my opinion, is the lack of environmental awareness of the majority of the population, or the reluctance to understand it.

1.2. Classification of ecosystem services

According to the Millennium Ecosystem Assessment, 2003, 2005, the work, prepared under the auspices of UNEP by a team of more than 1,000 scientists from different countries, benefits from ecosystem services can be divided into the following four classes:

1. Provisioning Services represent material direct benefits that people extract from nature, including food, drinking water, timber, wood fuel, natural gas, oils, plants that can be made into clothes and other materials, and medicinal benefits.

2. Regulating Services – are natural process, which make life possible for people: cleaning air and water, decomposition of wastes, prevention of erosion. All these processes work together to make ecosystems clean, sustainable, functional, and resilient to change.

3. Cultural Services are a non-material benefits from nature, which promotes spiritual and cultural development people, through direct reflection and influence on traditions, customs and any form of human creative activity, including music, art, and architecture. This group also includes any form of recreation and education coming from contact with nature.

4. Supporting Services are fundamental process, which make ecosystems themselves able to exist and function. These are natural processes, such as photosynthesis, nutrient cycling, the creation of soils, the water cycle, etc. Without supporting services, provisional, regulating, and cultural services wouldn't exist.

Ecosystem regulatory services are services that support and control the environment indicators for the well-being of people. These services are considered to be the result of the operation of functionally healthy ecosystems, with a normal package of properties and functions. In short, they include: pollination, decomposition processes, soil formation, air and water treatment, erosion and flood control, carbon deposition and local climate regulation. Thus, these services and their main functions are a prerequisite for the protection of other ecosystem services. Also more common are the regulation of physical, chemical and biological conditions (Table 1.1-1.4):

Table 1.1

Regulation of natural factors

• Reduction and prevention of wind erosion
• Regulation of extreme events and movement of air, water, soil
• Hydrological cycle and regulation of water flows (including flood control)
• Regulation of surface water level and runoff
• Groundwater level regulation
• Accumulation and retention of water (including flood protection)
• Protection against soil erosion
• Decrease in wind speed; wind protection

Preservation of life cycle, habitat and protection of gene pool

Table 1.2.

• Pollination
• Seed distribution
• Maintenance of nursery populations and habitats
• Biota production

Pest and disease control

Table 1.3

• Pest control and reduction of invasive species
• Prevention and reduction of diseases

Regulation of soil, water and air quality

Table 1.4

• Soil formation
• Regulation of soil moisture
• Reduction of weathering processes
• Decomposition and fixation processes

end of Table 1.4

• Regulation of chemical and physical quality of fresh water of surface waters (standing and flowing)
• Water purification (lakes)
• Regulation of chemical and physical quality of groundwater
• Carbon deposition (reduction of anthropogenic CO2 emissions)
• Oxygen production
• Filtration and purification of air

In the context of accelerating climate change, it is regulatory services that need to be focused on, or given the highest priority, in the past, people's priorities have been given to supply and cultural ecosystem services. Given the rapid climate change, emphasis needs to be placed on regulatory ecosystem services. Without the regulation of ecosystem processes, the existence of an ecosystem in general is impossible. This is the only way to protect all other services. In fact, it turns out that regulatory services deserve the most attention. Regulation of energy balance and formation of plant biomass, as well as increasing the surface area of green leaves enhances the ability of ecosystems to convert and store light energy. This heat mass can warm and cool the environment, as well as affect the humidity.

Adjacent ecosystems often affect each other: for example, water bodies and forests cool themselves and the surrounding landscapes. Cooled air is transported by air masses to other landscapes, such as settlements. In cooler, protected and wetter ecosystems, the risk of extreme energy events, such as forest fires, is reduced. The efficiency of working with additional incoming energy increases in more mature ecosystems rich in biomass. As for the microclimate, they are affected by various properties such as the nature of the land surface and vegetation. For example, steeper southern slopes are warmed by prolonged exposure to sunlight, shady northern slopes are cooler, and lower basins or depressions in the area may accumulate colder air masses.

Valleys and hills affect the climate in the same way as forests and water bodies. Also, an important process is the regulation of species interaction and biological control. Mature ecosystems with indigenous communities and great structural diversity are characterized by strong biological regulation, ie mass reproduction of individual species and the emergence

of invasive species are quite limited. This is important from the point of view of pest and disease control in agriculture and forestry.

Provisioning ecosystem services are services or they can be called goods that are produced by ecosystems and used by humans. Ecosystems provide people with the following goods / services:

Food:

- Agricultural products (crops, grains, vegetables)
- Fish and organic products (berries, mushrooms, herbs, birch sap)
- Meat and dairy products (livestock)
- Honey (beekeeping)

Materials / raw materials (construction, energy, feed and therapeutic):

- Firewood and fuel materials
- Building materials (wood, reeds, straw)
- Dirt and water used for medical purposes
- Flowers
- Hay

Basic (fundamental) services:

- Fresh and clean water
- Fresh and clean air

Genetic resources:

- Seeds, spores and other plant materials collected to maintain or form a population
- Individual plants used to breed new strains or varieties
- Individual genes derived from plants for the design and construction of new biological objects
- Animal material collected for the maintenance or formation of a population
- Wild animals (whole organisms) used to breed new strains or varieties
- Individual genes derived from organisms to design and build new biological ones.

Cultural ecosystem services - partly natural and natural landscapes are characterized by high recreational, educational and adventure importance.

The structure and state of ecosystems have a complex effect on the human psyche and thus also form an identity, contribute to the restoration of human connection with its environment. In modern society, the interaction of man and nature is very important.

Physical and intellectual interaction with biota, ecosystems and landscapes:

- Education, research and art;
- Contemplation of birds / animals;
- Nature photography, painting, filming;
- Recreational and sports activities;
- Ecotourism;
- Outdoor sports, such as swimming;
- Improving health and sanatorium.

Spiritual, symbolic and other interactions with biota, ecosystems and landscapes:

- Aesthetic value;
- Spiritual value;
- Traditional and cultural value;
- Ethnic value, traditional crafts;

Supporting Services - the natural world provides so many services, sometimes we forget about the most important ones. Ecosystems themselves could not be maintained without the coherence of natural processes such as photosynthesis, the nutrient cycle, soil creation and the water cycle. These processes allow the Earth to maintain basic life forms, not to mention entire ecosystems and people. Without ancillary services, temporary, regulatory and cultural services would not exist.

Providing habitat for plants is another crucial example of supporting services, which is inherent attribute of the biosphere on the whole. Maintenance of plants and animals diversity is the most fundamental precondition of ecosystems formation and provision and is another stunning example of supporting services.

1.3. Peculiarities of forests ecosystems

A forest is a large array of trees and bushes. The first forests appeared relatively recently, and their history covers less than 10% of the time of existence of the Earth itself. Now, more than a third of the land surface is covered with forests or suitable for their development. However, the area occupied by forests is unevenly distributed between the continents and even within each of them. For example, forest covers almost half of South America, about a third of Europe and the United States, and much of Africa and Asia; in Australia, on the contrary, there are very few forests, and some large countries, for example Egypt, are generally treeless. Forests are completely absent in Antarctica and Greenland, but low trees grow in the extreme south of the latter.

Although the most characteristic feature of a forest is the presence of trees and shrubs, it is not just woody vegetation, but a complex ecosystem made up of closely related elements. Like all ecosystems, a forest is formed by a combination of living organisms (biota) and nonliving (abiotic) habitat. In addition to trees and shrubs, forest biota includes other plants (grasses, mosses, fungi, algae and lichens), as well as vertebrates and invertebrates and bacteria. The abiotic component is represented by air, soil and water. All these components of living and inanimate nature are closely interconnected due to the passage of the flow of energy through the ecosystem and the circulation of oxygen and other substances in it.

In most forests, several layers are distinguished, formed by foliage of plants of different heights. The topmost one, consisting of the crowns of the tallest trees, is called the first tier or forest canopy. In some areas, especially in the tropics, individual giant trees rise significantly above the canopy. If there are other relatively solid forest layers under it, they are called the second, third, etc. Shrubs, tall grasses (in some forest types) and low-growing trees form the undergrowth. Not all forests have many layers. The herbaceous layer consists of shrubs and grasses. Mosses, lichens, and creeping plant species form the ground, layer. Organic matter, consisting of fallen leaves, twigs, flowers, fruits, bark and other plant debris, as well as animal feces and carcasses, pupal and larval shells, etc., forms a forest floor on the soil surface. In most forests, litter is the most densely populated layer. It often contains

several million living organisms per square meter - from protozoa and bacteria to mice and other small mammals.

The stratification of forests into layers is due to the different needs of plants in sunlight, water and nutrients, the properties of root systems, the characteristics of the substrate. Plants of the upper tiers are more competitive, light-loving, better adapted to fluctuations in temperature and humidity. Under their crowns create conditions of low light, stable temperature, humidity and the development of tiers of more shade-loving species of plants. Due to the tiers, the space of groups is more densely populated.

The edge of the forest is a transitional strip between it and the adjacent type of vegetation. A characteristic trait of forest edge is that within the forest edge the trees are covered with foliage almost to the very ground, and many shrubs and grasses common here are rare or not found at all in the forest and in neighboring open plant communities. Some species of birds, often considered forest birds, actually live mainly on forest edges, which are also an important habitat for mammals.

There are many types of forests and many ways to classify them. For example, they can be classified by geographic distribution (eastern, tropical, etc.) or by position in the relief (plain, floodplain, etc.). They can also be grouped according to their seasonal aspect into evergreen and deciduous. Sometimes the basis for the classification of forests is the characteristic features of the tree species that form them (coniferous, broad-leaved, mixed, etc.). In another case, the names of forest-forming species are used (pinery, oakery, etc.).

It is believed that the distribution of forests is mainly determined by regional characteristics of the climate, i.e. mainly by temperatures and precipitation, and at a more local level - by the microclimate. Soils, fires, animals and non-woody vegetation play an important role in creating microclimatic conditions. As a result forest ecosystems are well defined and independent formations, with characteristic soils, microclimate and species composition, which significantly differentiate them from other communities at the same climate conditions.

As for the differences in features between the forest, as an environment completely created by nature and forest plantations created by man for the purposeful use and cultivation of wood, the answer, in my opinion, is quite simple.

Based on my own experience, I can say that the main difference in the natural appearance of these areas and their content. It means that if the forest is an independent ecosystem that was created in the process of interaction of many natural factors, without human intervention, then it looks wilder. These areas do not carry out logging, sanitary felling and other activities carried out in forest plantations for better growth and development of wood. Also, the appearance of natural forest is dominated by a mixture of wood species, which is not a characteristic feature of forest stands, in which, as a rule, one species of wood is presented in one area, clearly divided into zones (quarters, allotments).

1.4. Ecosystem services provided by forests and forest plantations

The ecosystem services provided by forests and afforestation are similar, and in most cases the same, except at certain points. As for the mechanism of ecosystem services of forest ecosystems or forest plantations, it is based on close interaction of the forest with environmental components, such as: atmosphere, hydrosphere, soil cover, - and in maintaining their qualitative and quantitative parameters at the optimal ecological level for general coexistence, growth and development. Forest ecosystem services are divided into three main groups:

- provisioning services;
- regulatory services;
- supporting services;
- cultural services.

Each group has its own set of services and characteristics. For a general description, it is enough to name the recreational value of forests, protection of soils from erosion, increase crop yields, conservation of biodiversity, regulation of runoff, oxygen production, carbon dioxide absorption, etc. Particular attention is paid to forest ecosystem services such as hydrological services (water protection and water management), biodiversity conservation services and carbon dioxide uptake services, as these services may be reduced or even lost (in case of deforestation), which in turn will lead to environmental hazards and

additional costs for society at the local level, for example, will cause floods and landslides, and at the global level - climate change.

1.4.1. Provisioning services of forest

These are the direct products obtained from the forests to be for the provision of human needs in material resources, including, wood, fiber, medicinal plants, mushrooms(Table 1.5).

Table 1.5

Provisioning services of forest ecosystems

Name of services	Structure	Function	Profit	Cost
Wood	Plantations in which cutting of the main and intermediate use are carried out	Increasing stocks, the consequences of farming	Export of round wood	Economic cost of round wood trade, employment in forestry
Berries and mushrooms	Habitats of berries and mushrooms (forests, swamps)	Average annual yield (total kg / ha)	Harvested (commercial + for own use)	Sale of berries and mushrooms, cost of own use, health impact from the use of berries and mushrooms

end of Table 1.5

Game	Game habitats (forests, swamps, farms, highlands)	Game population, population reproducibilit, richness of wildlife,	Game hunting	The economic value of game hunting, the value to health and society, and the cultural values associated with hunting
Clean water	Water horizons, fresh bogs and other wetlands, undisturbed forest soils	State of surface and groundwater, reserves of clean water, ability to purify water	Use of fresh water	Economic value of economic and domestic use, the impact of clean water on health, social values associated with the availability of clean water
Genetic material	Number of varieties	Genetic diversity, evolution	Potential for afforestation, benefits from the use of genetic diversity so far (increased yield per hectare, etc.)	The intrinsic value of genetic diversity and evolution
Crops	Areas where cereals are cultivated (agricultural lands), which are under the protection of forests and protective strips	Dynamics of nutrients, yield per hectare, the need for fertilizers and pesticides.	Harvesting	Profit from obtaining additional harvest due to favorable microclimate, values associated with agroforest landscapes (increased yield per hectare, etc.)

1.4.2. Regulatory services of forest ecosystems

Regulatory services are "the benefits of regulating ecosystem processes." In general, it supports the existence of other functions and the ecosystem as a whole.

Regulation of climate, floods, air composition and greenhouse gas concentrations, mitigation of catastrophic events (tsunamis, floods, landslides, etc.), wastewater treatment, erosion prevention, plant pollination, biological control of pests and vectors(Table 1.6).

Table 1.6

Regulatory services of forest ecosystems

Name of services	Structure	Function	Profit	Cost
Regulation of climate and greenhouse gas concentrations	The role of forest ecosystems in biogeochemical cycles (eg CO2 / O2 balance, ozone layer, etc.). Carbon-storing forests reproduce oxygen	Carbon balance, carbon capture coefficient, nitrogen capture coefficient	Stabilization of climate change	Avoiding the additional costs of an unstable, uninhabitable climate
Nutrient content	Type and area of vegetation, no soils were cultivated, such as forests	Nutrient retention rate	Improved water and soil quality	The value and value of clean water from the point of view of society and health, as well as its intrinsic value
Erosion prevention	Type and area of vegetation, no soils were cultivated, such as forests	Particle retention coefficient	Erosion prevention, improved water quality	Avoidance of costs for the use of fertilizers, the cost of high quality surface water
Water regulation Water supply	Non-drained habitats, type and area of vegetation, such as forests	Delay time and possibilities (volumes)	Flow control	Avoiding the costs of flood prevention and repair

1.4.3. Supporting services of forests

Ecosystem support services - services needed to support other ecosystem services. Supportive measures include desertification prevention, soil protection functions, biodiversity conservation, soil formation, and photosynthesis. Such services affect people's well-being indirectly, enabling the formation of flows of security, regulatory and cultural services. Much of the ecosystem services are not products of consumption or objects of use, they are consumed by people indirectly, indirectly, but the quality of human life fundamentally depends on the flow of these services. The main support services of forest ecosystems of Ukraine: water retention, water purification, climate regulation, nitrogen absorption, erosion control, soil quality, nutrient retention, adsorption of waste and toxins, pollination, air quality, noise reduction, etc.

Table 1.7

Supporting services of forests

	Structure	Function	Profit	Cost
Nitrogen absorption	Nitrogen-fixing plants (forests, agricultural lands in the structure of the forest fund)	Nitrogen fixation coefficient	Improving the balance of nutrients and soil quality	Avoid the cost of using fertilizers
Adsorption of waste and toxins	Ecosystem, soil organisms	Impact on waste or its storage due to biological, biochemical or biophysical processes	Improved water and soil quality	The value and value of clean water and soil from the point of view of society and health, as well as their intrinsic value; avoidance of waste management costs

end of Table 1.7

Erosion prevention	Type and area of vegetation, no soils were cultivated, such as forests	Particle retention coefficient	Erosion prevention, improved water quality	Avoidance of costs for the use of fertilizers, the cost of high quality surface water
Air quality	Green infrastructure of cities and villages	Retention of small particles	Improved air condition	The value of clean air for health, avoidance of medical expenses

1.4.4. Cultural services of forest ecosystems

Cultural ecosystem services are intangible services that people receive from ecosystems and that are important for the development of the process of cognition, aesthetic development and spiritual health. Main services: recreation, ecotourism, cultural natural heritage, landscapes, art and popular culture, science and education. Nowadays, in all developed countries, a special place is given to cultural ecosystem services. Aesthetic and cultural aspects of natural ecosystems are especially highly valued - picturesque landscapes, recreational opportunities, etc.

1.5. Forest ecosystem services formation

Forest ecosystem services are one of the most important services in the overall spectrum of human-nature interaction. Even the claim that the forest is the lungs of the planet tells us that forests perform not just an ecosystem service, but a life-sustaining function.

Like all other ecosystem services provided by other ecosystems, the forest also has certain resources and resources needed to form these services. Each group of ecosystem services has its own prerequisites for formation.

For the first group of ecosystem services, provisioning, which include basically all types of raw materials used by mankind, the prerequisites for the formation are somewhat specific. The fact is that these services have become services only for the reason that people began to use, as they believe, the gifts of nature. Let's take wood into account. The precondition for the appearance of wood is not related to man at all, as the growth and development of forests is possible without human intervention. That is, the growth and development of wood is independent. But the service of using wood by man has its own premise.

It is described quite easily and means the need to have building material, material for the production of paper, furniture, in the end, even material for heating homes. That is, in simple words, mankind from the beginning of time had to light a fire for cooking, using firewood extracted in the forest. It can be assumed that the group of provisioning ecosystem services is the oldest, and man has been using it since the days when there may not have been a common language, and prehistoric animals walked the Earth.

So, the formation of these services is based on the most fundamental processes taking place in the biosphere: conversion of solar energy into living matter - edible plants and animals, timber, - and their transformation along the food web. The general laws of life existence are also important for these services, as they produce genetic and species diversity – the one, which provides complex interactions and safety system: the loss of one species is not always followed by collapse of the whole system, because there is diversity of organisms able to substitute the dropped out element.

The second group, regulatory services such as climate formation, protection against floods and other natural disasters, disease control, waste management, water and air purification, pest control, can also be considered prehistoric and distinctive. Their origin did not depend on man, and they became known as services only when people became aware of the existence of these processes. The precondition for the formation of these services can be considered the emergence of pests, after which a certain ecosystem begins to protect itself,

thereby protecting humanity. The same applies to disease control. Due to natural disasters and their prevention, the result of reducing the number of such processes and control over them, in general, can be considered the result of the existence of the ecosystem. There is no special precondition for their occurrence; rather forests are structural subsystems of complex global processes like biogeochemical cycles and functioning of environmental components.

The sources and resources of supporting services are one global forest ecosystem, which is divided into certain areas and massifs, with some insignificant differences. The basis for the formation of ecosystem services, in my opinion, is the independence and purity of ecosystems. The main factor in the normal existence and formation of services is human non-interference in natural processes.

The forth group of services, cultural, is most different from the previous two. Their origin and understanding of the existence of these services came to man when there was a request to use these services. Mankind came to this at a time when all other needs were met. Emotions from communication with nature, a sense of terrain, the environment for the formation of lifestyle, customs and traditions began to be realized by people after we provided ourselves with houses, food and more. Cultural development and industrial progress were a prerequisite for the demand for these services, therefore, the services itself are created by humans [11].

While some services are more related to the structure of ecosystems (such as water treatment of wetlands), others are directly related to their functions, such as pollination. Usually we do not notice them, using them constantly. Only when there is a certain failure in the system, we realize that something was done wrong. For example, when landslides destroy everything in their path, from the soil layer and vegetation, to forests, houses and human lives. Many of the fundamental functions of ecosystems that provide regulatory and maintenance services are performed by microorganisms and vegetation. Vegetation, in turn, plays a key role in many water cycle processes.

1.5.1 Factors influencing the quality of forest services

The quality of ecosystem services can be assessed by the level of comfort of the society living in this area and using these services. The process of provisioning services is multifaceted and not fully defined due to the imperfection of the methods of assessment of the same quality. When analyzing the level of quality of services provided by forest ecosystems, it is necessary to analyze all possible factors that are direct markers and variables in this process. The main factors influencing the quality of forest ecosystem services can be considered the geographical location of these forest ecosystems, the type of forest, the condition of the stand, the type of plants, their quality and quantity.

An important factor is the type of soil and its physical, chemical, bacteriological composition. Vegetation of the lower tiers, which is dominated by trees and shrubs, animals and microorganisms that are typical and other natural components that are biologically dependent on each other in their development. This is because each component of the ecosystem, in our case the forest, has an impact on the others. Therefore, they can change the qualitative and quantitative characteristics of ecosystem services.

In general, a large number of ecosystem services is an excellent feature of the overall health of ecosystems, but it should be noted that in this case we need to pay attention not only to the quantity but also to the quality of these same services.

All the forest ecosystems of the planet have features, most of which are common, but there are always distinctive features. Based on this, each ecosystem has the ability to provide an ecosystem service of a certain type better or worse. Quality is primarily affected by the geographical location of the forest ecosystem. Depending on the climatic zone, forests can be divided into tropical, evergreen, arctic, subtropical, temperate forests and others. The difference in the quality of service can be explained by the example of cultural services, such as tourism or recreational activities. It will be logical to understand that conducting tourist routes in temperate forests is much better and more comfortable than in the Arctic latitudes, with sub-zero temperatures and unpredictable weather conditions. Thus, the quality of some decreases, and others increase.

Also, a great example of the quality of service delivery is the level of genetic or species diversity. For example, the opportunity to learn to legally hunt is much better in forests that abound in the diversity of wildlife.

It is necessary to say about the soil cover, thanks to which there is a possibility of growth and development of certain species of plants that perform, for example, an ecosystem service for carbon retention, or containment of erosion of the same soils on which they germinate.

Forest area, its stratification and type affect the quality of such an ecosystem service as the provision of raw materials, in the form of wood for society, as a building material or fuel.

The type of stand, type of wood, deciduous or coniferous, affects the quality of air purification. This process is an essential ecosystem service.

1.5.2. Threats to forest ecosystem services

Forests are one of the most important ecosystems with the ability to provide services to humanity globally for as long as the forest itself exists. Since the intervention in natural processes and the implementation of anthropogenic impact, over the past millennia, people have destroyed about half of the forests. This means that we self-destruct the system that provides us with clean air, suitable for consumption by water, livelihoods and food.

Uncontrolled, irrational deforestation, irrational forest use, leads to the destruction of not only the stand itself, but also completely destroys the lower layer of the ecosystem, disrupts soil structure and disappears and the biodiversity inherent in this area, some species disappear altogether, others disappear.

Deep ravines, and destructive landslides appear in the areas deprived of forests, the hydrological regime of water bodies' changes, and erosion processes intensify. Improper use of forests leads not only to their destruction, but also to the replacement of coniferous and other valuable species with softwoods, such as birch or aspen, in which the wood is of poor quality. In recent years, the area of old, mature forests, which take at least 70-100 years to grow, has been declining.

It is worth noting that deforestation is not the only threat. Uncontrolled forest fires, which in most cases result from the irresponsibility of people and improper handling of fire, we completely lose hundreds of hectares of valuable trees, developed biocenosis, rare and

unique tree species, plant and animal species. They are all components of one ecosystem, from which humanity receives ecosystem services.

It should be understood that even minimal impact on natural ecosystems causes both regional or local adverse changes and global climate change and disasters.

For example, if we take into account all the forests on the planet for 100%, it would be logical to understand that with each destroyed ecosystem, this percentage decreases. Regardless of the place of interference in natural processes, we generally affect these 100% and each time reduce their quantity and quality. First, there are regional cataclysms, for example, acid rain, floods, mudslides. Soil erosion, changes in groundwater levels, desertification - all these are the consequences of the same uncontrolled changes in forest ecosystems.

And what's next? In this case, the principle of "avalanche" works perfectly, which originates in one place, gradually gaining strength, destroys everything in its path, many hundreds of kilometers from the place of origin. Global changes in the Earth's temperature, which is already causing drastic changes in weather conditions, the emergence of typhoons in places where no one could have thought of them before. And where they were, they are replaced by dust storms and desertification.

1.6. Conclusion to Chapter

Stability and well-being in human existence and ecosystems are interdependent and inseparable. No one can deny the existence of ecosystem services and their direct impact on humanity.

The ecosystem services are a new field of research and study, even though they have existed during all human history. A range of classification methods was developed, but currently there is a widely accepted approach to defining the types and essence of ecosystem services, although mechanisms of their formation and factors, that affect their quality are still under study. However, intensive exploitation of natural resources is obviously a threat for ecosystem services. The four groups of services described above are provided by any ecosystem with different forms and characteristics. Forests are the most diverse and complex

natural ecosystems and as such they are providers of the biggest assortment of services, which must be clearly defined and valuated to be appreciated and protected.

CHAPTER 2
EVALUATION OF ECOSYSTEM SERVICES

2.1. Methods of accounting and description of ecosystem services

Ecosystem services are the main modeling and shaping factors of mutual understanding and coexistence of people and ecosystems, the well-being of the former, and the stable development of the latter. To understand the importance of ecosystem services, it is necessary to conduct a process of their evaluation, which applies the principles of economic evaluation. Services are quantified, using economic methods with all their positive and negative properties. In this case, each of the methods must have its own justification, supported by the purpose of this study, the object of evaluation, its features and characteristics. There should be an analysis of the values and essence of the cost of forest ecosystem services, with a detailed list of all tools and their description.

Many positive environmental changes, which society does not notice, either due to its ignorance in this matter, or due to a neutral attitude to environmental issues, are due to their progress in ecosystem services. Examples include controlling erosion and landscape degradation, managing natural processes, providing services, mitigating the negative effects of climate change, and more. The main ecosystem services were listed in the previous section, but now it is necessary to consider the question of their assessment, methods of accounting and description, the principles of this assessment and the process of their implementation.

Accounting for ecosystem services is a statistical basis for organizing data, tracking changes in the volume and state of ecosystems, measuring ecosystem services and linking this information with economic and other human activities. It is designed to illustrate the benefits that society receives from ecosystems and their services.

More specifically, ecosystem accounts can answer questions such as:

1. What is the volume of wetlands at the national or EU level? How has their volume and condition changed over time?
2. How is the state of the forest ecosystem changing?
3. How much carbon does it hold?
4. Where and in what sector are ecosystem services such as water purification used? Where is the investment in water treatment measures needed?
5. What is the value of outdoor recreation in the EU? How has it changed over time?

The System of Environmental Economic Accounting (SEEA) is an internationally agreed statistical system that brings together environmental and economic information into one common framework. It comprises several areas of interest covered by different SEEA handbooks, including:

1. the SEEA Central Framework (SEEA CF)
2. the SEEA Ecosystem Accounts (SEEA EA)
3. the SEEA Applications and Extensions

The SEEA EA (SEEA Ecosystem Accounting) provides conceptual guidance for developing ecosystem and ecosystem services accounts. It complements the SEEA CF by moving beyond the assessment of individual environmental resources to an ecosystem perspective where ecosystems and the services they provide interact as part of a natural process within a specific spatial area.

The SEEA EA was adopted by the UN Statistical Commission in March 2021 as:

1. the first international statistical standard on ecosystem accounting
2. as internationally recognized statistical principles and recommendations[12]

2.2. Principles of economic evaluation of ecosystem services

The basic idea of economic evaluation of ecosystem services is to fully understand what exactly these services are, how they manifest themselves, whether their full study is

possible, and as a result there will be a full professional evaluation involving economic instruments. There are many difficulties, as it is almost impossible to fully identify and investigate all possible ecosystem services, additionally anticipating their behavior and changes in the nature of behavior as a result of anthropogenic impact. If in theory we can assess the economic value of this service, then in practice there may be a situation when through unqualified research we get results that will be very different from our theoretical expectations. There will be an underestimation of ecosystem services, which is an unacceptable factor for our situation. Forest ecosystem services are one of the most widespread and important on the planet. Their understanding and correct, qualified assessment is an extremely important parameter in the general understanding of the interaction of man and nature. The issue of forest conservation is a priority, and therefore assessing the economic value of ecosystem services provided by forests is a key condition for understanding and making the right decisions in the sustainable use of forests, and most importantly their conservation and dissemination, where possible. By conducting a proper economic assessment, we get a complete set of valuable tools of influence for us, with which we can make further decisions. The full impact of forest ecosystems on society and economic activity can be assessed only with a full understanding of the economic value of forest ecosystem services. Economic assessment will help to analyze and evaluate current indicators, make an adequate assessment of all the benefits and consequences of interfering in forest ecosystems.

It also helps to achieve the comparability of forest ecosystem services with the planned results of investment projects and therefore allows the cost of the environment to be properly included in economic calculations.

Depending on the type, cost, method of using the ecosystem service, they can be assessed in one or more ways and methods. There are usually three main indicators of cost: the cost of direct use, the cost of indirect use, or the cost of non-use. Using a number of economic methods, namely the direct market valuation method, the travel cost method or the conditional valuation method, most forest ecosystem ecosystem services can be quantified. Each method has its advantages and disadvantages. The choice of method for the study should be carefully considered, based on the objectives of the study and the

characteristics of its object. Although one method can be used in the assessment, in my opinion, it is necessary to use at least two, for a more expanded information picture, of course, if possible. As a result, we get a vision of the situation from different projections, we can create a kind of multidimensional visualization, and as a result of critical thinking and analysis of the information to provide more accurate estimates, which will give us confidence in the correctness of forest use, for example.

Like any economic assessment, the assessment of the economic value of forest ecosystem services should show not only the cost but also the distribution of costs and benefits of any changes in forest ecosystems, indicate the objects that will receive these benefits, or possible size and cost forms. In particular, the following facts must be taken into account: the scale of the impact is important.

Estimates of small forest areas often do not take into account the value of forest ecosystems on the scale of large forest areas. However, the larger the scale of the study, the more difficult it is to determine the economic value of forest ecosystem services; the results of the assessment of the economic value of forest ecosystem services are valid only for one specific area and cannot be extended to others; the value of the economic value of forest ecosystem services may change over time, so it is necessary to periodically review and evaluate them;

The results of the evaluation should be widely disseminated. The assessment of the economic value of ecosystem services is determined using assessment methods.

Four approaches to estimating the economic value of ecosystem services have become widespread:

1) *The method of direct market valuation* is the determination of the value of ecosystem services (goods) on the basis of the real market price. Mainly used for the evaluation of goods and cultural services.

2) *Methods of indirect market valuation* - used in the absence of markets for certain goods and services of ecosystems. There are the following valuation methods used to determine willingness to pay or willingness to accept compensation for the receipt or loss of a service(Table 2.1):

Table 2.1

Methods of indirect market valuation

Name of methods	Characteristic of the method	Example
Avoided Cost (AC)	some ecosystem services help society to avoid the costs it may incur in the absence of data;	flood control, soil erosion, groundwater level control, carbon level control;
Replacement Cost (RC)	some ecosystem services can be replaced by man-made system;	natural recycling of waste by wetlands, which can be (partially) replaced by expensive artificial treatment systems;
Factor Income (FI)	many ecosystem services increase revenue;	natural improvement of water quality increases the commercial benefit of fisheries while increasing the income of fishermen;
Travel Cost (TC)	using some ecosystem services requires travel. Travel costs may reflect the cost of this service;	the value of the recreation area, which attracts individual visitors, can be reflected in the funds they are willing to spend on travel to this area;
Hedonic Pricing (HP)	the cost of ecosystem services can be reflected in the price that individuals are willing to pay for the benefits associated with them;	the cost of housing near the park is usually higher than for identical housing near less attractive landscapes;

3) *Conditional assessment method* - this method works on the basis that the cost of ecosystem services can be determined by constructing a hypothetical scenario based on the results of a survey of respondents. For example, respondents could be asked to express their willingness to pay to improve water quality in a river or lake so that they could enjoy swimming or fishing.

4) *Group assessment method* - a method according to which the approach to assessing the economic value of ecosystem services involves the creation of an expert group.

Economic cost estimation methods are used depending on the type of ecosystem service being studied. However, different methods can be used in different studies, and a separate method is already chosen depending on the characteristics and objectives of the study. This is because each ecosystem is a unique creation of nature. Of course, the main components and features are similar, but there are always differences. As practice shows, a plan for the evaluation of one ecosystem and its services may be partially or completely unsuitable for the evaluation of such.

Relationship between services, cost and methods of estimating economic value(Table 2.2):

Table2.2

Services, cost and methods

Ecosystem services	**Type cost of use**	**Common methods of valuation**	**Methods that can be used**
Air quality regulation	The cost of indirect use	Avoided Cost	Group Valuation, Contingent Valuation, Replacement Cost, Factor Income
Climate regulation	The cost of indirect use	Avoided Cost	Group Valuation, Contingent Valuation, Replacement Cost, Factor Income

end of Table 2.2

Soil maintenance	The cost of indirect use	Avoided Cost, Replacement Cost	Contingent Valuation, Group Valuation, Factor Income, Hedonic Pricing
Food	The cost of direct exhausting use, the cost of possible use	Factor Income, direct market, Contingent Valuation	Group Valuation, Replacement Cost
Raw	The cost of direct exhausting use, the cost of possible use	Factor Income, direct market, Contingent Valuation	Group Valuation, Replacement Cost
Recreation	The cost of direct inexhaustible use, the cost of subsistence	Direct market contingent valuation, travel cost	Replacement cost

Christin and colleagues have developed an adaptive RESTS (Restoration Ecosystem Service Tool Selector) framework that enables better decision-making in the selection of tools for reforestation and ecosystem services (Christin et al., 2016). The sample analyzes thirteen tools for assessing ecosystems.

List and descriptions of ecosystem service assessment tools (adapted from Christin et al. 2016, p. 6) (Table 2.3)

Table 2.3

List and descriptions of ecosystem service assessment tools

Abbreviation	**Tool name**	**Developer**	**Tool description & reference**
ARIES	Artificial Intelligence for	Basque Centre for Climate	Framework to integrate multiple modeling paradigms in spatial modeling and mapping of ecosystem services. Supports artificial intelligence-based data and model

	Ecosystem Services	Change (BC3)	selection through semantic modeling to quantify ecosystem service flows from ecosystems to beneficiaries (Villa et al. 2014, http://aries.integratedmodelling.org/).

continuation of Table 2.3

Co$ting Nature	Co$ting Nature	King's College London and AmbioTEK	Mapping and modeling tool for multiple ecosystem services using global datasets. Quantifies ecosystem services as opportunity costs (i.e., avoided cost of producing those services from a non-natural capital substitute) (Mulligan 2015, http://www.policysupport.org/costingnature).
EcoMetrix	EcoMetrix	EcoMetrix Solutions Group and Parametrix	Field-based tool designed for use at relatively fine spatial scales. Primary use is to illustrate the effects of human activities (i.e., development or restoration scenarios) on ecosystem services (Ecometrix Solutions Group 2013, http://www.ecometrixsolutions.com/ecometrix.html).
EnSym	Environmental Systems Modelling Platform	State of Victoria, Australia	Environmental systems modeling platform for researchers to apply process-based models. Designed to provide information on how and where to invest to maximize environmental outcomes (Ha et al. 2010, https://ensym.dse.vic.gov.au/cms/).
Envision	Envision	Oregon State University	GIS-based tool for scenario-based planning and environmental assessment. Enables "multi-agent modeling" to represent human decisions on landscape simulations (Guzy et al. 2008, http://envision.bioe.orst.edu/).
ESR for IA	Ecosystem Services Review for Impact Assessment	World Resources Institute	Method to address project impacts and dependencies on ecosystem services within the environmental and social impact assessment process. It identifies measures to mitigate project impacts on benefits provided by ecosystems and to manage operational dependency on ecosystems (Landsberg et al. 2011, http://www.wri.org/publication/ecosystem-services-review-impact-assessment).
EVT	Ecosystem Valuation Toolkit	Earth Economics	Provides monetary values for natural assets under multiple modules. Includes a Researcher's Library, searchable database of ecosystem service values, and SERVES, a web-based tool for calculating ecosystem service values (Earth Economics2015, http://esvaluation.org/).

InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs	Natural Capital Project	Spatial mapping and modeling of multiple ecosystem services. Includes a diverse set of provisioning, regulating, and cultural services from marine and terrestrial environments. The models primarily provide results in biophysical terms to which valuation can be applied (Sharp et al. 2014, http://www.naturalcapitalproject.org/).

end of Table 2.3

LUCI	Land Utilisation and Capability Indicator	Victoria University of Wellington	Explores the capability of a landscape to provide a variety of ecosystem services. It compares the services provided by the current use of the landscape and its potential capability. The model uses this information to identify areas where change or maintenance of current conditions may be most beneficial (Jackson et al. 2013, http://www.lucitools.org/).
MIMES	Multiscale Integrated Models of Ecosystem Services	Afordable Futures	Modeling platform designed to quantify causal linkages between ecosystems and the economy. MIMES allows an individual to map decisions/policies, and the output those choices affect the economy and ecosystems (Boumans et al. 2015, http://www.afordablefutures.com/orientation-to-what-we-do/services/mimes).
NAIS	Natural Assets Information System	Spatial Informatics Group	Integrated valuation database and reporting engine. The database is integrated with proprietary spatial modeling tools to characterize ecosystems and flow of services on the landscape (Troy and Wilson 2006, http://www.sig-gis.com/services/ecosystem-services/).
SolVES	Social Values for Ecosystem Services	U.S. Geological Survey (USGS)	Spatial mapping and modeling tool primarily for quantifying cultural ecosystem services using public participatory GIS (Sherrouse et al. 2011, http://solves.cr.usgs.gov/).
TESSA	Toolkit for Ecosystem Service Site-based Assessment	BirdLife International	A process using flow charts to describe how ecosystem services benefit society under current conditions and alternative scenarios (Peh et al. 2013, http://tessa.tools/).

2.3. The practice of assessing forest ecosystem services

The practice of assessing forest ecosystem services is an important process in the general understanding of the assessment of ecosystem services. In order to properly allocate forces and resources, it is necessary in practice to hone all the possible nuances of ecosystem assessment, and to understand approximately how much the theoretical miscalculation may differ from the practical result. The practice of this process at this stage of society can be shared by many countries.

In many countries (both industrialized and developing countries), projects aimed at assessing the ecosystem services of certain areas, protected ecosystems, landscapes, including forests and agricultural landscapes, have been increasingly implemented in recent years. The implementation of such projects in turn contributes to the improvement of the theory and methodology of assessment of ecosystem services and the improvement of payment mechanisms for such services. An example is the ARIES (Artificial Intelligence for Ecosystem Services) project, implemented by the University of Vermont (USA) in 2007-2010 to create "intelligent" databases on the spatial structure of the landscape as a basis for assessing ecosystems. Services using these approaches in practice in Puget Sound, Washington, Madagascar and Mexico. In Eastern Europe, with the assistance of WWF, such projects have been launched in Bulgaria and Romania in recent years.

For example, Maria Anaya-Romero and co-authors conducted a study of representative forest ecosystem services in the Mediterranean (Andalusia, southern Spain) for the period 1956-2007, using and analyzing a variety of assessment tools. The region is noteworthy given the rich services of ecosystems, which, however, face numerous threats - deforestation, fires, intensification of agriculture and industrial development. To study the impact of land use change, the researchers analyzed three main forest ecosystem services: carbon storage, soil erosion protection and cork oak through the integration of many common and new methodologies and approaches - for example, the socio-ecological approach was used. for the conceptualization of research objects, for the assessment of vegetation the IPCC method was used.

In the United States, in addition to the conservation easements mechanism, direct payments have been introduced and markets for forest ecosystem services are developing

rapidly. Direct payments can be made to landowners from the government by several buyers, such as power plant companies, to purchase carbon credits from landowners engaged in afforestation. Alternatively, large groups of people can exchange loans for services in emerging markets, such as swamp conservation loans or carbon credits on special exchanges such as the Chicago Climate Exchange. These payments and markets cover a wide range of ecosystem services, from watershed protection, biodiversity and endangered species conservation, to carbon sequestration, wetland protection from transformation, and other benefits.

Significant developments of the state environmental departments of Great Britain. In particular, one of the best examples of guidance material developed to support the implementation of payment for ecosystem services is the Payments for Ecosystem Services: A Best Practice Guide, developed by the Environment, Food and Beverage Division. and Rural Relations of the UK Government (Department for Environment, Food & Rural Affairs). Of particular interest are projects related to the evaluation and integration of ecosystem services into decision-making processes initiated and implemented with the participation of WWF in Bulgaria and Romania. In particular, Bulgaria is implementing the project "Development and implementation of a sectoral policy model focused on ecosystem services (PoliciES)". Work on the project in the pilot area of Western Stara Planina aims to create a first forest management plan at the level of regional government, taking into account the fee for ecosystem services. The project draws on the experience and know-how of a Norwegian partner in integrating forest ecosystem and biodiversity services based on the company's software solutions, providing an opportunity to assess the impact of ecosystem services and biodiversity on forest management. The main idea of the expected results of the PoliciES project is to prove that ecosystem services, climate change adaptation solutions and sustainable forest management should be key elements in the development of regional forest management plans. The approbation of this model and the development of 27 regional forest management plans were performed by the Bulgarian Forest Agency during 2016-2017. It is recommended to consider this practical experience of forest management planning in Ukraine, as the current planning of its management takes into account a limited range of forest functions, while ignoring a wide range of ecosystem services.

2.4. Conclusions to Chapter

Evaluation of ecosystem services includes the collection of information from various fields of scientific activity to create a specific methodology that will result in an adequate assessment of natural components and processes that are an integral part of human life. The concept of environmental and economic assessment includes the involvement of economic methods that will help translate the services into monetary values, which are measurable and comparable. Thanks to the correct methodological approach, with the involvement of knowledge from several fields of science, evaluation methods have been created, most of which are based on mathematical calculations. At first glance, we can say that in the study, the participants are only numbers, but they are only the final stage of a long journey and work done. In my opinion, each of the methods has the right to exist, because each research area is unique and it is possible to test different methods, depending on the purpose of the project, and in the end to analyze the results and make conclusions based on the most relevant assessments. In our further work we will use combination of methods to fully cover all the services, provided by the object of study.

CHAPTER 3
GENERAL CHARACTERISTICS AND FEATURES OF PLUZHNE FORESTRY

3.1. Nature characteristics

Pluzhne forestry is a part of the state enterprise "Izyaslav forestry" and is located in its northern part in the territory of Shepetivka administrative district of Khmelnytsky region. The area of forestry location belongs to the zone of western forests of the Malo-Polissya region. The forest area is 7490 hectares.(Fig 3.1-3.2)

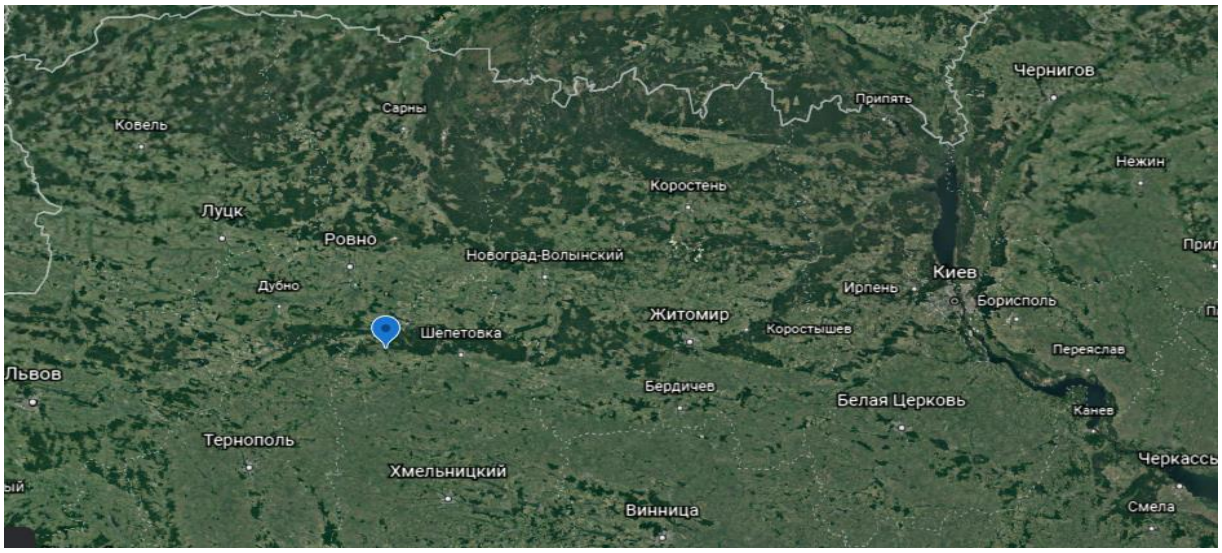

Fig.3.1 Geographical location

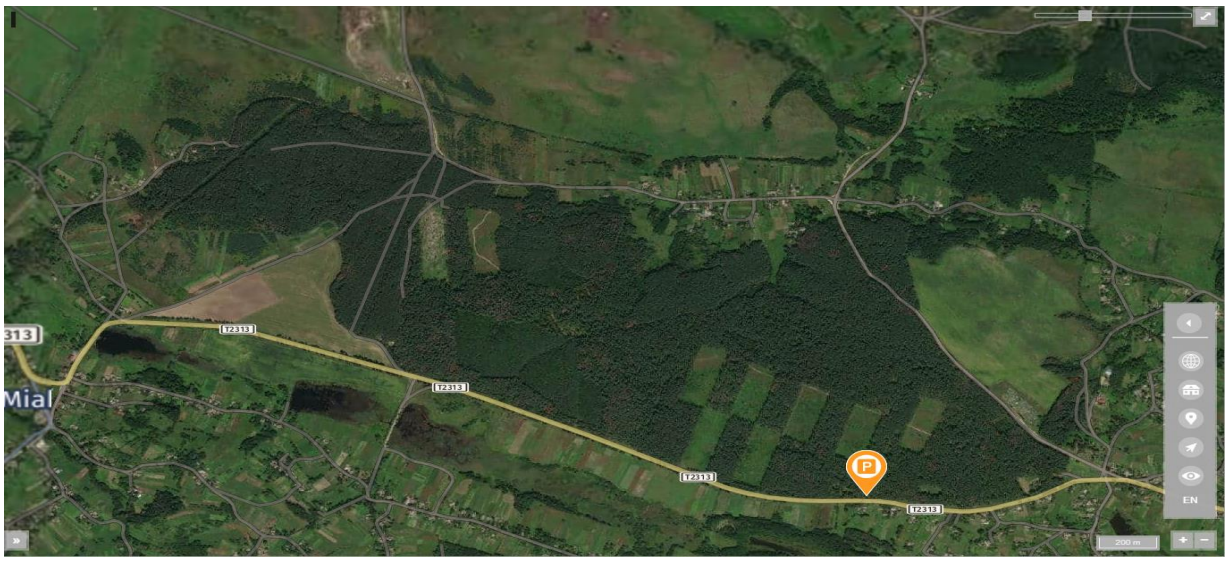

Fig.3.2 Geographical location

3.1.1 Climate conditions

The climate is temperate continental. The average air temperature of the warmest month (July) is +18, + 19 °, and of the coldest (January) -5, -6 °. The maximum temperature in summer reaches +36, + 38 °, the minimum in winter -31, -35 °. The average annual temperature is +7 and + 8 °.[15] The average annual rainfall is 510-580 millimeters. The duration of the growing season lasts for 202 days from April 15 to October 25. The average depth of soil freezing is 73 cm, the maximum - 114 cm.[16]

3.1.2 Characteristics of relief and landscape

A characteristic feature of the studied area of the tract is intensive erosional articulation - the area here is sometimes hilly with gentle slopes. The area is characterized by heavily eroded gray forest and podzolic soils. Coniferous forests are such tree species as Scots pine, Banks, Weymouth, European spruce and European larch. The undergrowth mainly consists of brittle buckthorn, mountain ash, hornbeam, hazel, etc. Wild boars, roe deer, foxes, and hares are found on the territory of the tract. Moose were spotted a few years ago, but have not been seen in these areas recently. The tract includes only forests. There are no water bodies on the territory.

3.1.3 Structure of the forest community

The main tree species on the territory of the forestry are pine (59%), oak (20%), birch (8%), alder (7%), spruce and other species (1-2%). There are many wild animals (foxes, wolves, roe deer, badgers) and birds in the forests.

The annual growth of wood in the tract is 6.7 m^3/ ha per year. Recently, much attention has been paid to European and Japanese larch wood species, which are quite technically valuable wood. it is fast-growing and promising today. The main key task is the rational treatment of forest resources. They are effectively used according to the annual estimated felling.

Typical representatives of the fauna: hare, roe deer, wild boar, fox.(Fig3.3-3.6)

Fig.3.3. Hare

Fig.3.4. Fox

Fig.3.5. Wild boar

Fig.3.6. Roedeer

Typical representatives of the flora: European pine, Weymouth pine, common oak, snowdrop, snowdrop, blueberry, lily of the valley, dog rose, etc.(Fig. 3.7-3.8)

Fig.3.7. European pine

Fig.3.8. Weymouth pine

3.2. Characteristics of resource potential

The main centers of biodiversity conservation in the study area are forests, which have a positive impact on the formation of the microclimate, hydrological regime, as well as protect landscapes from adverse natural and man-made factors. Forests are the most effective means of stabilizing various natural processes. They affect the provision of comfortable living conditions, meet their needs for rest and recovery. In general, Ukraine can not currently meet its own needs in wood, but in the work done, I can conclude that the potential of the Pluzhne forestry is satisfactory, the territory can fully support the local population with all necessary resources at the moment. However, all resources should be protected from excessive consumption and, if possible, restored by all available methods.

Therefore, the following measures are being taken in this area to preserve and maintain resource potential. The main areas of activity are:

1. determining the prospects and priority areas of forestry development;

2. improving management in a market economy;

3. organization of forest management, including measures for the rational use of forests, their restoration and preservation;

4. protection and preservation of forests;

5. conducting forest seed business and nursery management on a forest seed basis;

6. detection and preservation of gene pool and relict plantations;

7. maintaining state forest accounting and state cadastre;

8. procurement of forest resources and production of products from them;

9. protective afforestation;

10. ensuring compliance with the established regime on the territory and objects of the nature reserve fund under its jurisdiction,

11. organization of hunting management, rational use of forest lands;

12. exercising control over the observance of the rules of forest use and reforestation by all users who manage forests, regardless of their subordination and forms of ownership, as well as by citizens.

3.3. Economic and social importance of the forestty

Forest resources are an important part of any local community. Their role is difficult to assess at first glance, because this issue is quite deep and requires more detailed study in terms of not only ecology but also economics, culture, health and others. In the territory we study, forestry is a component of the regional socio-ecological and economic sphere of life. Logging and subsequent activities are carried out on the territory of Pluzhnensky forestry, but these processes extend non-linearly to the local population in terms of comfort of life. Of course, according to the information gathered, there are a large number of people who work directly in forestry, so they assess forest resources as an opportunity for formal employment. As for the rest of the population, it should be noted that forestry as such does not have a significant impact on the local population, but people use forest resources to meet their own needs. The simplest examples are the use of firewood for heating houses or the use of forest products as a building material. Also, the local population harvests medicinal plants, mushrooms and berries, both for their own needs and for sale, so this is also an important area of economic impact of the forest on the population.

As for the social sphere, the forest usually plays a recreational role, providing the local population with places for rest and health. Officially, there is one recreation area at the forestry, called "Pine Forest". Currently, this is the only place that is supervised by forestry workers. It should be noted that the natural resource potential of the territory provides opportunities for the use of larger areas for recreational activities. If you do not take into account financial issues, and consider this area solely through the prism of welfare and recreational comfort of the population, this area is a great place. Due to the predominance of coniferous trees in the forest structure, air quality is significantly improved compared to places where there are no such plantations. The terrain has its own hilly areas, but for walking or creating tourist routes there are great opportunities. If we take into account the general cleanliness of forest areas, it can not be fully used as a recreational complex, as this forest is not an urban forest parks. Many species of animals and birds live in this forest, and human interference in natural processes or even walks in inappropriate places and at the wrong time of day / year can harm animals.[25]

Excursions, creation of tourist routes, ecological routes and other events may be carried out only with the permission of the relevant authorities and in appropriate places.

3.4. Anthropogenic impact on the forest ecosystem of the tract

To date, the problem of anthropogenic pressure on forests has become so critical that even elementary school students know about it, although using their children's terms. This suggests that at this stage, forests are shrinking at breakneck speed. If we take into account the general condition of forests in Ukraine, we can name many more sources of anthropogenic pressure, but as for our territory, they are not so many, but they still exist.

Mass felling also remains the main one. The only difference from the general situation in the country is that they are all allowed and performed according to all requirements. However, this does not negate the fact that this type of economic activity inflicts anthropogenic pressure. As for illegal logging, it is not common in this area, and if it happens, then at the hands of the local population, as illegal logging.

A more serious factor is illegal hunting of animals, which does not meet any legal requirements, does not comply with seasonal terms and catch volumes. Hares, foxes, less often wild boars especially suffer from such process. Hunting methods such as traps and loops are used.

Also, anthropogenic impact can be considered completely uncontrolled harvesting of medicinal plants, berries, mushrooms during which no rules are met. Also, carry out the collection of cones and sonic resin.

3.5. Environmental condition of the studied ecosystem

The general condition of forest ecosystems on the territory of Ukraine varies from satisfactory, such as this area, to unsatisfactory, such as the territory of the Carpathian forests with their problem of deforestation, illegal logging and others. As for the general ecological condition of the territory under study, I consider it satisfactory. At this stage, it can fully provide the local population with all the necessary benefits that are used. The condition of forestry is at a fairly good level due to a large number of forest protection and reforestation measures. The main eco-mass of this area, namely wood, is in good condition. Like all forests, it is exposed to pests, acid rain, etc., but thanks to the right forestry policy, all these factors are almost completely eliminated. As a result of the declining population living in the area, the share of ecosystem services per capita is sufficient, and in some cases even large. Therefore, in my opinion, the ecological condition of the territory from the point of view of benefit for the population can be considered satisfactory.

3.6. Conclusions to Chapter

The analysis of the Pluzhne forestry demonstrated its satisfactory condition and planned exploitation. The arboreal plants are in satisfactory condition, sanitary and protective measures are inmplemented ontime and the work on restoration of harvested section of the forest is active enough to support the stability of the given ecosystem. Flora and fauna are presented by a variety of species; however, the total number is slightly lower

than that typical for communities out of economic use. Thus, the complex of ecosystem services provided by the forestry is full and complete.

The major environmental issuaes are erosive activity due to hilly relief, nonregulated harvesting of secondary forest products and poarching. The natural conditions of the forestry are favourable for the conduction of recreational activity, which is not well developed yet. An important benefit of the forestry is the conduction of educational activity, which contributes to rising environmental awareness of local population.

CHAPTER 4
ECONOMIC VALUATION OF ECOSYSTEM SERVICES OF PLUZHNE FORESTRY

4.1. List and characteristics of services

Humanity is part of the biosphere, its component and one of the main consumers. It actively interacts with and influences nature.

Mainly using the benefits that nature provides for free. From time immemorial, the role of man in the ecosystem has been to receive services despite ecological footprints. For many millennia, mankind has used the services of plant associations for many areas of life, primarily for survival.

Air quality, due to the special composition of which man can exist on the planet, is a consequence of plant life, and in the global understanding of plant communities, which in the process of their growth and development emit oxygen, absorb nitrogen, retain carbon.

The next component of survival is water, because there is a rule proven by the experience of many researchers and tourists, but that a person can live, on average, 3 minutes without air, 3 days without water, and three weeks without food. Clean, usable water is the result of a mass of processes and functions that take place in the soil and on the ground. Services for water purification, control of aquifers, surface runoff control, water quality - are ecosystem services of plants and soils.

The last, but no less important component is food. And although in our time, mankind has long learned to bypass and level the weather and pests, grow products more massively and efficiently, sometimes even harvesting several crops a year, still all this happens on land, based on which processes formed by ecosystem services. The list of ecosystem services can be extended for a long time, so for convenience, all ecosystem services are divided into 4 groups.

This classification was proposed in the Millennium Ecosystem Assessment (MEA) report, prepared under the auspices of the United Nations by an international scientific team, which identifies:

provisioning services - services from products provided by ecosystems: food, water, wood, fiber, fuel, genetic resources, drinking water;

regulating services - services of regulating ecosystem processes: climate formation, protection against floods and other natural disasters, disease control, absorption of human waste, water and air purification, pest control;

cultural services - the contribution of ecosystems to the enrichment of cultural, spiritual and aesthetic aspects of human well-being: emotions from communication with nature, sense of place, environment for the formation of lifestyle, customs and traditions;

supporting services - services that provide the main ecosystem processes: soil formation, primary productivity, basic biogeochemical processes (nutrient cycle, photosynthesis), habitat.

According to the given distribution, there is a much better understanding of the processes that occur in nature, how humanity interacts with ecosystems. To date, human impact on the ecosystem has become almost one hundred percent.

Human intervention in natural processes is growing exponentially. The main impact on the environment is pollution from emissions from all types of industrial production, agriculture, wastewater and others. However, we forget to remind ourselves of services that seem to be invisible until they are taken away from us. To prevent the complete disappearance of ecosystems and their services, it was decided to translate their value into a more understandable plane. Mankind has long understood the language of money, and is therefore the best tool for explaining the value and value of ecosystem services.

This table shows specific ecosystem services in a particular area. Information on the terrain, geographical location, characteristics of soils and reservoirs or their absence, information on representatives of flora and fauna were collected.

Provisioning services of forest

Table 4.1

Name of service	**Subunit**	**Unit of measurement**
Wood	*Round timber*	UAH / m3
	Firewood	UAH / m3
Non-timber products	*Berries*	UAH/kg;
	Mushrooms	UAH/kg (in dry form).
	Hazelnut	UAH / kg
	Resin	UAH / kg
Game	*Roe deer*	UAH
	Boar	UAH
	Fox	UAH
	Hare	UAH
Fodder/hay/pasture	*Hay*	UAH

	Pasturing (cattle+ sheeps/goat)	UAH/head
Medicinal plant	*Rosehip*	UAH/ kg
	Wild strawberries and Blackberry (leaves)	UAH / kg
	Linden	UAH / kg

Regulatory services of forest ecosystems

Table 4.2

Name of service	**Subunit**	**Units of measurements**
Regulation of climate	*Carbon storage in soil*	UAH/t
	Carbon storage in biomass	UAH/t
	Carbon used by phytomass	UAH/t
Soil stability	*Erosion prevention*	UAH/ha
Flood prevention	*Water retention*	UAH/m/km
Airqualityregulation	*Dust retention*	UAH/ha
	Oxygen generation	UAH/kg
	Humidity	UAH/t

Supporting services of forests

Table 4.3

Name of service	**Subunit**	**Units of measurement**
Nitrogen absorption	*Mobilization of atmospheric nitrogen*	UAH / kg
Adsorption of waste and toxins	*Mineralization and decomposition of dead matter*	UAH / kg

Cultural services

Table 4.4

Name of service	**Subunit**	**Units of measurements**
Recreation	*Visitors*	UAH/person
Ecotourism	*Organized tourists*	UAH/person

Aesthetic value	*Scenery*	UAH/ha
Educational	*Venue for education*	UAH/hour/ UAH/ha

4.2. Calculation of the cost of ecosystem services by direct method

According to the aggregate information, we assessed the ecosystem services of this ecosystem using available assessment methods. The results are presented in the table.

Provisioning services of forest

Table 4.5

	Economic valuation			
Name of service	**Subunit**	**Price**	**Number/Units**	**Cost**
Wood **Total: 384,917,000 UAH**	*Round timber*	3,800 UAH / m3	98,959 m3	377,000,000 UAH
	Firewood	400 UAH / m3	19,792 m3	7,917,000 UAH

end of Table 4.5

Non-timber products **Total:108,983,850 UAH**	*Berries*	80-100 UAH/kg;	6,840 kg	615,600 UAH
	Mushrooms	mushrooms (White) 800 UAH / kg (in dry form).	17,640 kg	14,112,000 UAH
	Hazelnut	180 UAH / kg	476,000 kg	85,680,000 UAH
	Resin	150 UAH / kg	57,175 kg	8,576,250 UAH
Game **Total: 243,800**	*Roe deer*	6,000 UAH	25	150,000 UAH
	Boar	7,000 UAH	10	70,000 UAH
	Fox	350 UAH	32	11,200 UAH
	Hare	200 UAH	63	12,600 UAH
Fodder/hay/pasture	*Hay*	1,750 UAH	450	5,868,000 UAH

Total: 5,980,000	*Pasturing (cattle+ sheeps/goat)*	64 UAH/head	1,750	112,000 UAH
Medicinal plant **Total: 3,214,000**	*Rosehip*	382 UAH/ kg	7,000	2,674,000 UAH
	Wild strawberries and Blackberry (leaves)	350 UAH / kg	400	140,000 UAH
	Linden	500 UAH / kg	800	400,000 UAH

Regulatory services of forest ecosystems

Table 4.6

	Economic valuation			
Name of service	**Subunit**	**Price**	**Number/Units**	**Cost**
Regulation of climate **Total: 35,093,626,880**	*Carbon storage in soil*	1,664 UAH/t	2,480,000	4,126,720,000 UAH

end of Table 4.6

	Carbon storage in biomass	1,664 UAH/t	18,600,000	30,950,400,000 UAH
	Carbon used by phytomass	1,664 UAH/t	9,920	16,506,880 UAH
Soil stability	*Erosion prevention*	1,550 UAH/ha	24,800	38,440,000 UAH
Flood prevention	*Water retention*	450 UAH/m/km	5,513	2,480,625 UAH
Air quality regulation **Total: 2,101,409,639**	*Dust retention*	4,500 UAH/ha	24,800	111,600,000 UAH
	Oxygen generation	15.5 UAH/kg	119,040,000	1,845,120,000 UAH
	Humidity	0,25 UAH/t	578,160,000,000	144,540,000 UAH

Clean water	*Filtration of water*	23.32 UAH/100 m3	641,675	149,639 UAH

Supporting services of forests

Table 4.7

	Economic valuation			
Name of service	**Subunit**	**Price**	**Number/Units**	**Cost**
Nitrogen absorption	*Mobilization of atmospheric nitrogen*	19 UAH/kg	2,053,360 kg	39,013,840 UAH
Adsorption of waste and toxins	*Mineralization and decomposition of dead matter*	11.5 UAH / kg	5,559,472,200 kg	63,933,930,300 UAH

Cultural services

Table 4.8

	Economic valuation			
Name of service	**Subunit**	**Price**	**Number/Units**	**Cost**
Recreation	*Visitors*	50-70 UAH/person	8,000 person	480,000UAH
Ecotourism	*Organized tourists*	250 UAH/person	4,000 person	1,000,000UAH
Aesthetic value	*Scenery*	4,801,9 UAH/ha	25,667 ha	123,250,368 UAH
Educational	*Venue for education*	150 UAH/hour +3,600 UAH/ha	Involves 439 ha of the territory; total time of classes per year 400 hours	1,834,800UAH

As a result of processing the received data we can draw the following conclusions:

1) first and second places were divided between support and regulatory services, respectively. In my opinion, these are objective results, because these groups are the basis, foundation of existence and development of all ecosystem services. It is from them and thanks to them that we can use all two other groups of ecosystem services. We can safely conclude that not the main values are not always on the surface. This means that we do not see these services, in most cases we can not hold or buy / sell, but they play a very important role in our existence.

2) As for the other two groups of services, they are no less important, but in this study they show the following figures. Direct cultural services occupy the last place due to their underdevelopment and non-prevalence in this area.

In general, all the data obtained are relevant only for this area and for a short period of time. After all, the processes occurring in nature, factors of anthropogenic load, climate change and other indicators change over time, and over time, the situation and results may change. In my opinion, they will only grow every year. It should be noted that the results of such studies are highly dependent on the educational component, public awareness and environmental policy of the country.

4.3. Contigent assessment of ecosystem services

As the main consumers and users of these ecosystem services are the local population, it was decided to allocate a separate assessment method called "willingness to pay", which is based on the creation of a questionnaire and a survey of respondents.

The survey involved 62 respondents, each of whom is a native of the area and has lived there for more than 10 years in a row. The respondents included some students, but most of them study by correspondence, so they pass the residency requirement. The age of the respondents is 18-75 years. The survey was conducted through a personal meeting with each respondent to adequately assess responses and willingness to participate in the survey. The term of the survey was 12 days. It should be noted that the questions were not personally selected, each of the respondents had an average of 30 minutes to fully provide answers to

all questions. The survey was conducted orally, and the results were recorded in writing. Initially, a short 3-minute information introduction was presented to each respondent.

The first block of questions that all respondents had to answer included general demographic information about the respondents: age, gender, marital status of the respondent, presence of children, duration of residence in the area (Table 4.9).

Table 4.9

№	Sex	Age	Marital status	Number of years of residence in this area	Children
1	man	21	single	more 10	no
2	man	47	married	more 10	yes
3	woman	50	married	more 10	yes
4	man	62	married	more 10	yes
5	woman	63	married	more 10	yes
6	man	22	single	more 10	yes
7	man	23	single	more 10	no
8	woman	44	married	more 10	yes

continuation of Table 4.9

9	man	45	married	more 10	Yes
10	woman	48	married	more 10	yes
11	woman	21	single	more 10	no
12	man	47	married	more 10	yes
13	woman	29	married	more 10	yes
14	man	27	married	more 10	yes
15	man	32	married	more 10	yes
16	man	24	married	more 10	yes
17	woman	72	married	more 10	yes
18	woman	75	married	more 10	yes
19	man	48	married	more 10	yes
20	woman	50	married	more 10	yes
21	man	52	married	more 10	yes

22	man	56	married	more 10	yes
23	man	30	married	more 10	yes
24	woman	29	married	more 10	yes
25	woman	25	single	more 10	no
26	man	27	married	more 10	no
27	man	18	single	more 10	no
28	woman	46	married	more 10	yes
29	woman	44	married	more 10	yes
30	man	25	married	more 10	yes
31	man	65	married	more 10	yes
32	woman	65	married	more 10	yes
33	woman	65	married	more 10	yes
34	man	58	married	more 10	yes
35	man	44	married	more 10	yes
36	woman	49	married	more 10	yes
37	man	53	married	more 10	yes
38	woman	27	married	more 10	yes
39	man	69	married	more 10	yes

end of Table 4.9

40	woman	39	married	more 10	Yes
41	man	48	married	more 10	yes
42	man	56	married	more 10	yes
43	woman	54	married	more 10	yes
44	man	24	married	more 10	yes
45	woman	26	married	more 10	yes
46	man	26	married	more 10	yes
47	woman	48	married	more 10	yes
48	man	46	married	more 10	yes
49	woman	25	married	more 10	yes
50	man	54	married	more 10	yes
51	woman	53	married	more 10	yes
52	woman	28	single	more 10	yes

53	woman	32	married	more 10	yes
54	man	45	married	more 10	yes
55	woman	61	married	more 10	yes
56	man	38	married	more 10	yes
57	man	40	married	more 10	yes
58	woman	65	married	more 10	Yes
59	woman	32	married	more 10	yes
60	man	60	married	more 10	yes
61	man	58	married	more 10	yes
62	woman	27	married	more 10	yes

The next questions dealt with general perception of environmental issues. Does the respondent consider environmental issues important? The answers were closed (yes / no). Also, how important is the issue of environmental protection in the area? (Very important / not very important / difficult to answer). The answers of the respondents are shown in Table 4.10.

Table 4.10

Does the respondent consider environmental issues important?					
yes			no		
62	100%		0	0%	
How important is the issue of environmental protection in your area?					
very important		not very important		difficult to answer	
49	79,03%	8	12,9%	5	8,07%

After a brief discussion of the environment in the area, respondents were given the opportunity to answer questions about the relevance of each of the services provided to them personally, as well as indicate the amount they are willing to pay monthly to receive it (Table 3). Previously, each respondent was briefly explained that they had to determine the amount

of payment for each of the services, provided that now all the resources used will be recorded by government agencies, and it will not be possible to obtain them illegally. The Cost column shows the average value that respondents are willing to pay. If a respondent refused to pay for this service or did not understand how it could happen, the result was rated as “refused to pay”. If a respondent does not use this service, it was rated as "not relevant". This means that the respondent does not use this service, such as a hunting permit, but does not mind paying for this service if it is used(Table 4.11.).

Table 4.11

Name of service	**Cost**	Relevant		Not relevant		Refused to pay in any case	
Wood (round timber, fire wood)	2500-3000 UAH	62	100%	0	0%	0	0%
Berries, Mushrooms, Hazelnut, Resin	200-250 UAH	62	100%	0	0%	0	0%
Game	350-400UAH	27	43,54%	32	51,61%	3	4,83%

end of Table 4.11

Fodder/hay/pasture	350-400UAH	45	72,50%	5	8,06%	12	19,35%
Medicinal plant	200-250 UAH	22	35,40%	38	61,29%	2	3,22%
Regulation of climate	100UAH	19	30,60%	9	14,51%	24	38,70%
Soil stability	100UAH	18	29,03%	9	14,51%	35	56,45%
Air quality regulation	300UAH	23	37,09%	8	12,90%	31	50%
Adsorption of waste and toxins	150UAH	28	45,10%	7	11,29%	27	43,54%
Recreation	50-60UAH	26	41,90%	7	11,29%	29	46,77%
Aesthetic value	25-30UAH	11	17,74%	5	8,06%	46	74,19%

As a result of the survey, all respondents provided their answers to the questions asked. It should be noted that in the process of filling out the questionnaire, aged respondents had a general question why they should pay for these resources, as they were always used for free, from their point of view. The table shows that all respondents are willing to pay for wood and berries (food), because in their opinion, they always pay for them when buying. As for air purification services, recreation and the like, there were disputes over whether to pay for it at all, and where this money will go, who will be responsible for the funds raised, and so on. In my opinion, the results of the table were predictable. Among the local population, aged people are accustomed to using unlimited natural resources, which is largely harmful to the environment. Respondents who answered "relevant" and offered a price belong to the young population. Their age is from 18 to 30 years. In my opinion, this is due to the raised environmental awareness and level of education, that the younger generation is more progressive in terms of environmental protection; they are more interested in ecology and future living in environmentally friendly environments. They advocate for the preservation and development of recreational potential of the area, recreation areas. Then, like the older generation, they are not ready, and in the end they are aggressively adjusted to changes and novelties that they do not understand.

4.4. Evaluation of ecosystem services using indirect method ("willingness to pay")

One of the most common methods of identifying and studying social requirements is the method of conditional assessment. The basis of his idea is to assess non-market goods and services, and in our case ecosystem services by direct survey of respondents.

The main purpose of the survey was to find out the answer to the question of whether locals are willing to pay for the services provided by the ecosystem. The relevance of this method for this work, in my opinion, is that we get "living" results, the opinion of real people living in this area, using all ecosystem services, and as research has shown, some of them without even realizing that.(Table 4.12)

Table 4.12

Ecosystem services

Name of service	**Cost**	**Units of services provided**	Total value, UAH
Wood (round timber, fire wood)	2500-3000 UAH	100,000	270,000,000
Berries, Mushrooms, Hazelnut, Resin	200-250 UAH	500,000	112,500,000
Game	350-400UAH	120	44,400
Fodder/hay/pasture	350-400UAH	450	166,500
Medicinal plant	200-250 UAH	8200	1,845,000
Regulation of climate	100UAH	21,000,000	2,100,000,000
Soil stability	100UAH	24800	2,480,000
Air quality regulation	300 UAH	24800	7,440,000
Adsorption of waste and toxins	150 UAH	24800	3,720,000
Recreation	50-60UAH	8000	480,000
Aesthetic value	25-30UAH	24800	669,600

It is worth noting that the results obtained by different methods are different in values and figures. The lower valuation of services by general public is a usual thing in such assessment. So, the result was expected at the stage of communication with the first participants. The local population is uninformed, and in some places did not understand the essence of the problem and core of the ecosystmem services on the whole.

Almost the same results were received in terms of security and cultural services. In my opinion, the fact is that these are some of the services that are best understood by the public. They focus, or at least roughly, on what these funds are paid for and where they go in the future. But the issue of regulatory and supporting functions is critical for the local population. According to the results of the survey, the respondents could not decide what exactly they should pay for, hence offered small sums or complete unwillingness to pay. For a preliminary conclusion, it would be correct to note that the results will change over time, and in my opinion, the following surveys will show an increase in willingness to pay for such groups of services as regulatory and supportive.

4.5. Recommendations for the support of ecosystem services provision

At this stage of development of environmental education in Ukraine there are certain challenges and needs that require modernization of the basic principles of management in

this area. The provision of ecosystem services to the natural environment has always been free of charge. From the point of view of financial payment, few people understand that all natural resources, even if they cannot be assessed as a market commodity, must be paid for. These funds do not always go to pay for this particular product, as it looks in the eyes of most consumers - "buy fish - pay for fish." I call this example because I want to explain the situation as it is happening in the country, and it leads, unfortunately, to the complete destruction of natural potential, and hence the impossibility of providing ecosystem services by nature. Fishing is "illegal" in most cases, to a greater extent than possible, the sale is not controlled by the authorities, and the funds withdrawn for "goods" do not go to support the cleanliness of water bodies, planting new trees, preserving natural swamps and soils that clear aquifers, thanks to which fish can grow much better, give more offspring and as a result benefit both consumers and the process itself to benefit the environment.

Therefore, to support the provision of ecosystem services, I identify a few key steps:

- invest efforts in the improvement of environmental awareness through the educational actions and creation of TV programs, podcasts on environmental topics and their delivery to public and authorities;

- development of research and educational ecological tourism on thebasis of the forestry;

- updating methodological approaches to the assessment of ecosystem services, creating new or updating the outdated payment mechanism for these services;

- introduction of the closed cycle, or the circulation of funds in the environmental protection system – to self-support of nature at the cost of funds received from its own resources;

- legal regulation of ecosystem services support and protection;

- development of ecosystem services inventory by providers, regions, consumers;

- formation of a comprehensive basic and sectoral register of responsibility for the maintenance of ecosystem services with a clear definition of the state agencies and other organizations, involved in the process;

- development and implementation of payments for ecosystem services.

4.6. Conclusion to Chapter

Economic assessment of ecosystem services in this area is carried out by several assessment methods, in order to obtain more adequate and relevant results. Particular attention is paid to the survey among local population, because they are the main users of most ecosystem services in the area, and they have the opportunity to provide relevant data on the comfort of their living in these areas.

The direct and indirect market valuation was carried out first, and other methods were applied where marketing data were not available or relevant. As a result, the following amounts were obtained:

1. provisioning - 503,338,650 UAH;
2. regulatory - 37,165,036,519 UAH;
3. supporting - 63,972,944,140 UAH;
4. cultural - 126,565,168 UAH;

In my opinion, the results well describe the situation in the study area. Indicators are relevant, but have a tendency to change over time. Amounts for provisional and cultural services are lower than the other 2 groups, due to the small population and the underdevelopment of cultural services as such.

As for the survey, first of all it showed the ignorance towards environmental aspects of life among the population. I believe that this situation can be corrected by informing the population, conducting educational activities, both face-to-face and on television. The question of willingness to pay will depend on whether the locals understand what they need to pay for, and most importantly why and why it is so important.

CHAPTER 5
LABOR PRECAUTION

Any enterprise is obliged to develop methodological recommendations and measures on labor protection in accordance with the Regulations on the development of methodological recommendations on labor protection, approved by the Order of the Committee on Labor Protection Supervision of the Ministry of Labor and Social Policy of Ukraine from January. No. 29, 1998, no. 9.[33] Thus, the subject of this chapter is a specialist - a scientist working in the field of ecology and environmental research (in our case - a public inspector of environmental protection. As work has shown, such a specialist is a combination of different possible working conditions, because his workplace can often be in the office, but there is always a large share of working time that the specialist will spend in the forest fund, as in our case, working with natural resources and their features.[34]

5.1 Organization of the working place of public inspector of environmental protection

Focusing on the fact that the workplace of the public inspector for environmental protection is a combination of two completely different properties, namely a well-equipped office and, of course, their absolute opposite - a natural area, which in narrow circles is called "fields". As for the first, the organization of the workplace in the office is regulated by the Constitution of Ukraine (Part 4 of Article 43), Art. 153 of the Labor Code of Ukraine, Art. 6 and Part 1 of Art. 13 of the Law of Ukraine "On labor protection", as well as the Resolution of the Cabinet of Ministers of Ukraine "Hygienic classification of labor (according to indicators of harmfulness and danger of factors of the working environment, severity and intensity of the labor process") and accompanying sanitary norms.

Briefly about these requirements:

- the area of the premises must be at least 6.0 m2 per 1 workplace; workplaces must be located at a distance of at least 1 m from the wall with a window, and 1.4 m from the

usual wall; the distance between the side surfaces of computers should be at least 1.2 m; the distance between the back of one computer and the screen of another should not be less than 2.5 m.

- it is forbidden to arrange appropriate workplaces in basements or basements of buildings. The use of polymeric materials (chipboard, washable wallpaper, rolled synthetic materials, laminated paper plastic, etc.) that emit harmful chemicals into the air is prohibited. The floor covering should be matte, and the surface - smooth, non-slip, with antistatic properties. - special attention should be paid to the color harmony of office space. Color is a means of creating psychological comfort and increasing productivity. The most favorable for the nervous system are light, pastel tones - greenish-blue, light gray, gold. Bright, contrasting combinations (blue and orange, red and purple) cause fatigue, irritation.

- Wet cleaning should be carried out daily in rooms where computers are used to prevent dust on the floor and furniture. In addition, a room for psychological relief should be equipped. - The design of the desktop and chair of the personal computer user should ensure the maintenance of optimal working posture and ensure optimal placement on the work surface of the equipment used (display, keyboard, printer) and documents.

- Premises for work with personal computers must be equipped with heating systems, air conditioning, or supply and exhaust ventilation. Optimal values of microclimate parameters should be provided in workplaces: air temperature should be 22–25 ° C, relative humidity - 40–60%, air velocity - no more than 0.1 m / s. In case of non-compliance with the specified microclimate indicators in office premises, the working day for workers must be reduced by at least 10%.

-Lighting requirements are very important, as it is known that prolonged work on the computer and with documents in low light conditions can lead to significant eyestrain. Natural lighting must provide a coefficient of natural light (KPO) of not less than 1.5%. It is desirable to use blinds to adjust the level of light with natural light. Workstations equipped with a PC should be located so as to avoid direct sunlight. Artificial lighting of the room must be equipped with a system of general uniform lighting. The use of luminaires without

diffusers and shielding grids is prohibited. The level of illumination on the desktop in the area of the documents should be in the range of 300-500 lux.

-equivalent sound levels are also standardized in office premises (50 dBA for programmers, and 65 dBA for operators in information processing halls on PC and computer set operators).

- requirements for the level of non-ionizing electromagnetic radiation, electrostatic and magnetic fields, as well as the intensity of infrared and ultraviolet radiation fluxes are set in accordance with DSanPiN 3.3.2.007-98 and DSanPiN 3.3.6.096-2002.[35]

5.2 Analysis of hazard factors at the working place

Characterization and classification of harmful and dangerous factors and influences existing in the work of the public inspector for environmental protection at his workplaces is based on his rights and obligations described by the Law of Ukraine on Environmental Protection, Part one of Article 36 as amended by Law. 5456-VI dated 16.10.2012. Including:

a) participate in conducting raids and inspections of compliance with the legislation on environmental protection, compliance with environmental safety standards and the use of natural resources together with employees of state control bodies;

b) conduct inspections and draw up reports on violations of legislation on environmental protection and submit them to state control bodies in the field of environmental protection and law enforcement agencies to bring the perpetrators to justice;

c) provide assistance to state control bodies in the field of environmental protection in activities to prevent environmental offenses. Public control bodies in the field of environmental protection may perform other functions in accordance with the legislation of Ukraine.[36]

In accordance with these rights and responsibilities, there are the following harmful and dangerous factors and influences that exist in the work of the public inspector for environmental protection at his workplace, namely:

1. in the workplace in the office:

- physical - parameters of the microclimate and ventilation in the work area, which deviate from the allowable and optimal (including pressure, temperature, humidity and air circulation);

-physical - non-ionizing electromagnetic fields and radiation;

-physical - inefficient natural and artificial lighting.

2. in a natural place:

- biological (risk of exposure to pathogens and products of their life cycle).

- physical - dangerous parameters of the environment, including attacks on wild animals, insect bites and other unforeseen situations that may occur while working in the fields.

5.3. The microclimate and ventilation

Microclimate is a set of meteorological conditions in the room: temperature, relative humidity, number of air ions, air exchange, air velocity, content of solid particles (dust) in the air, the presence of pleasant odors (aromatherapy), etc. The microclimate is very important for office space, because employees spend a lot of time in it and need comfortable conditions to be as productive as possible.

Basic requirements in Table 5.1 [37]:

Table 5.1

Optimal microclimate parameters values for category Ia premises

Season	**Cold**			**Warm**		
	Microclimate parameters					
	Room temperature	Relative humidity	Room's air velocity	Room temperature	Relative humidity	Room's air velocity
Optimal value	22-24 ºC	60-40 %	0.1 m/s	23-25 ºC	60-40 %	0.1 m/s

5.4 Natural and artificial illumination

Workplace lighting in the office in the case of operation of electronic computing devices is regulated by a number of legislative documents. According to DBN B.2.5-28-2006 "Engineering equipment of buildings and structures. Natural and artificial lighting ", office work with personal computer devices is classified in the VII category of visual works. Since much of the work of the public inspector is done on the computer, this is an important point, all the requirements of which must be met.

The norms are shown in the Table5. 2[38].

Table 5.2

Requirements for workplace lighting

Factor, indicator					
Natural illumination				Artificial illumination	
Coefficient of natural illumination, %		Coefficient of combined illumination, %		Working surface illumination by the visual work	Pulsation coefficient, %
Upper or combined illumination	Side lighting	Upper or combined illumination	Side lighting	200	20
3	1	1.8	0.6		

5.5. Organizational and technical measures of harmful and dangerous factors mitigation

With regard to field work, rationing is difficult for them to determine, but there are some basic rules of conduct for safe stay in the forest to perform the necessary measurements and visual observations carried out by the public environmental inspector:

1. avoid encounters with wild animals;
2. to visit unfamiliar territories accompanied by experienced workers of the given forestry;
3. adhere to the appropriate form of clothing, use clothing of dim colors, it is desirable that it completely covered the surface of the body;

4. to carry out sampling of analyzes and samples adhering to the norms established by the legislation;

5. use the necessary equipment for research according to all the rules, so as not to disrupt ecosystem processes;

5.6. Organizational and technical measures to reduce the impact of harmful and dangerous factors

The main issues of occupational safety in our case are divided into two groups. The first relates to the workplace in the office, the second - in the natural environment. The priority measures that can be taken to improve occupational safety in the office are:

- updating the lighting design of rooms with more modern and bright lighting.
- upgrade obsolete computer equipment to new, more comfortable; replace monitors with more modern ones;
- update the furniture design of workplaces, desks and chairs in accordance with modern standards, have the ability to adjust to human growth;
- establishing a more convenient mode of work before the break, involving staff up to 5 - minute warm-ups to restore blood circulation during sedentary work.
- providing employees with glasses to work on the computer according to their personal characteristics and requirements.

As for the fields, in this case:

- provide the employee with personal protective equipment, overalls, if necessary.
- to instruct on safety and proper behavior in the forest
- provide, if possible, vehicles for comfortable movement during working hours
- provide the employee with an individual first aid kit when working in the fields.

5.7. Fire safety

The category of the office room with computing devices is D “Low fire hazard” in accordance with State Standard ДСТУ Б В.1.1-36:2016 “Definition of Category of Premices, Buildings and External Facilities According to Explosion and Fire Hazard”.

Main fire hazardous and explosive materials and facilities include wiring system and cords, various electric devices (personal computers, copier and scaner devices, mobile phones, chargers, power banks etc.), main power supplying station. Among the most obvious potential fire causes are short circuit, wiring and equipment failure, human factor.

In accordance with the determined category, each floor of the office is equipped with fire shield, which includes: 1 standard fire extinguisher (powder, water-foam or water) with charge weight 5 kg per and 1 auxilliary fire extinguisher with charge weight 3 kg per each room (in general, 3 of each per floor), 1 box with sand, 1 fire cover (blanket), 2 swabs or scraps and a hook, 2 shovels, 2 axes.

A fire alarm system includes the following elements: light and sound alarm, “exit” signs above evacuation outs, smoke sensors (CO_2 type), sprinkler systems and central managing panel. Each room is equipped with one light and sound alarm above main exit and smoke detectors near the main transformer box (power supplying system). The system of fire safety also envisages the constructional decisions, providing emergency exit system

75 composed of two emergency pathways, two emergency doors at a maximum distance of 50 m form the furthest workshop and 40 m from one another and evacuation plans available in each room and in corridors. Other preventive and protective actions include: quaternary personnel briefings on fire safety with evacuation training, daily check of personal electric equipment and monthly check of whole electric provisioning and security, awareness material on fire safety in form of posters in each room.[39]

5.8 Conclusions to Chapter

Thus, as a result of creating a section of the diploma in labor protection, we can conclude that the workplace of the public inspector of environmental protection is multifaceted and diverse. Such a specialist is always on the border of office space and forest. After analyzing the collected data, we can conclude that most of the jobs of this specialist are safe and favorable for work. Deficiencies can be caused by temporary disruptions in the microclimate of offices or adverse weather conditions when working in the fields.

CONCLUSIONS

1. Stability and well-being in human existence and ecosystems are interdependent and inseparable. Natural complexes create conditions for humans' existence through a complex of functional processes and interactions. This forms the modern concept of ecosystem services, divided into provisioning, supporting, regulatory and cultural.

2. Adequate assessment is needed to preserve and maintain these processes, and currently there is a wide range of methods applicable for the valuation of ecosystem services, including direct and indirect approaches. In most cases a combination of methods should be used to obtain accurate results? And the exact methods applied depend on the type of service. The main valuation methods used in the work are direct market valuation, indirect market valuation, the method of willingness to pay with a survey of respondents.

3. Forests are the most diverse and complex natural ecosystems, and as such they provide the widest range of services that need to be clearly identified and valued in order to be appreciated and protected.

4. The object under investigation was Pluzhne forestry, a part of the state enterprise "Izyaslav forestry". This area is characterized by a fairly high level of biodiversity and natural value, despite the anthropogenic impact. The resource potential of the area is good.

5. The list of ecosystem services, provided by the forestry was developed and evaluates first using direct and indirect marketing valuation. The results demonstrated that the value of services defined by marketing methods far exeeds that defined from the survey among the local population - the first users of ecosystem services in the area. The recommendations on the support and maintenance of ecosystem services were given.

6. The results of this work are the basis for further study of the identification of ecosystem services in the forest ecosystems of our country, both at the local and national level.

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