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
_____ Tamara DUDAR
«_____» _____ 2024

BACHELOR THESIS
(EXPLANATORY NOTE)

Theme: «Inventory of green spaces within the enterprise sanitary protection zone using I−Tree Eco tools»

Done by: seeker of EK-402 group**,** Osadchuk Dmitry
(student, group, surname, name, patronymic)

Supervisor: Professor of the Environmental Science Department, PhD (Engineering Sciences), Associate Professor Lesia I. Pavliukh
(academic degree, academic rank, surname, name, patronymic)

Standards Inspector: _____ Andrian IAVNIUK

(signature) (name, surname)

KYIV 2024

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
ФАКУЛЬТЕТ ЕКОЛОГІЧНОЇ БЕЗПЕКИ,
ІНЖЕНЕРІЇ ТА ТЕХНОЛОГІЙ
КАФЕДРА ЕКОЛОГІЇ

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
_____ Тамара ДУДАР
«_____» _____ 2024 р.

КВАЛІФІКАЦІЙНА РОБОТА
(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ «БАКАЛАВР»

Тема: «Інвентаризація зелених насаджень санітарно−захисної зони підприємства з використанням інструментів I−Tree Eco»

Виконавець: здобувач групи ЕК−402 Осадчука Дмитрія Васильовича

Керівник: Професор кафедри екології, к.т.н., доцент Павлюх Леся Іванівна

Нормоконтролер: _____ Андріан ЯВНЮК

КИЇВ 2024

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
_____ Tamara DUDAR
«____» _____ 2024

BACHELOR THESIS ASSIGNMENT

Dmitry V, Osadchuk

1. Topic: "Inventory of green spaces within the enterprise sanitary protection zone using I−Tree Eco tools" approved by the rector on April 3, 2024, No. 504/art.see more

2. Duration of work: from 03.04.2024 to 12.06.2024

3. Output data of work: Output data of work − Photos of green areas, GPS markings of trees, tables with data.

4. Content of explanatory note: Processing of the legislative framework and theoretical data on the inventory of green spaces and the sanitary protection zone of the enterprise and i−Tree tools, processing of inventory data in the i−Tree eco tool

5. The list of mandatory graphic (illustrated) materials: figures

6. Schedule of thesis fulfillment

№ з/п	Task	Term	Advisor's signature
1	Setting up the experiment	03.04.2024	
2	Collection and analysis of the experiment	05.04.2024	
3	Justification of the goal, object and subject of research	07.04.2024	
4	Review of the literary sources	08.04.2024	
5	Collection and analysis of materials	10.04.2024	
6	Writing chapters I of the thesis	20.04.2024	
7	Writing chapters II of the thesis	05.05.2024	
8	Writing chapters III of the thesis	15.05.2024	
9	Issuance of an explanatory note	27.05.2024	
10	Defense of the thesis	30.05.2024	

1. Date of task issue: «_20_» May 2024

Diploma (project) advisor: _____ Lesia I. Pavliukh

(advisor's signature) (S.N.P.)

Task is taken to perform: _____ Osadchuk V. Dmitry

(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
_____Тамара ДУДАР
«____» _____ 2024 р.

ЗАВДАННЯ
на виконання кваліфікаційної роботи
Осадчук Дмитрій Васильович

1. Тема: «Інвентаризація зелених насаджень санітарно-захисної зони підприємства з використанням засобів I−Tree Eco» затверджена наказом ректора від 3 квітня 2024 року № 504/ст.

2. Тривалість роботи: з 03.04.2024 по 12.06.2024 р.

3. Вихідні дані роботи: Вихідні дані роботи − Фотографії зелених зон, GPS-маркування дерев, таблиці з даними.

4. Зміст пояснювальної записки: Опрацювання законодавчої бази та теоретичних даних щодо інвентаризації зелених насаджень та санітарно-захисної зони підприємства та інструментів і−Tree, обробка даних інвентаризації в інструменті і−Tree eco.

5. Перелік обов’язкових графічних (ілюстрованих) матеріалів: рисунки

6. Календарний план-графік

№ з/п	Завдання	Термін виконання	Підпис керівника
1	Постановка експерименту	03.04.2024	
2	Збір і аналіз досліду	05.04.2024	
3	Обґрунтування мети, об’єкта та предмета дослідження	07.04.2024	
4	Огляд літературних джерел	08.04.2024	
5	Збір та аналіз матеріалів	10.04.2024	
6	Написання І розділу дипломної роботи	20.04.2024	
7	Написання ІІ розділу дипломної роботи	05.05.2024	
8	Написання ІІІ розділу дипломної роботи	15.05.2024	
9	Видача пояснювальної записки	27.05.2024	
10	Захист дипломної роботи	30.05.2024	

7. Дата видачі завдання: «20» Травня 2024 р.

Керівник кваліфікаційної роботи: _____ Павлюх Л. І.

(підпискерівника) (П.І.Б.)

Завдання прийняв до виконання: _____ Осадчук Д. В.

(підпис випускника) (П.І.Б.)

ABSTRACT

Explanatory note to thesis «Inventory of green plants of the sanitary protection zone of the enterprise using I−Tree Eco tools»: 65 pages, 25 figures, 0 tables, 26 references.

Object of research – inventory of green spaces.

The subject of the study − the inventory of the landscaping elements of the sanitary and protective zone of the enterprise using i−Tree tools.

Aim of work – inventory of green areas of the sanitary and protective zone of the enterprise using I−Tree Eco, formation of a passport of the greening object in accordance with the instructions for inventory of green areas in populated areas of Ukraine.

Mehods of research: analysis of scientific literature and generalization of scientific theoretical and experimental data

INVENTORY, I−TREE TOOLS, I−TREE ECO, SANTIARY AND PROTECTIVE ZONE

CONTENT

INTRODUCTION

Relevance of the work. The relevance of green and sanitary protection zones has increased significantly due to their key role in preserving public health, environmental safety and general well-being. Sanitary protection zones reduce exposure to harmful chemical, physical and biological factors, which reduces the risk of diseases. They also reduce noise and vibration from industrial facilities and transport routes, creating a quieter living environment. Protecting water resources and green spaces ensures clean drinking water and improves air quality, which supports ecosystems. Economically, disease prevention through these zones reduces health care costs. A healthy environment increases productivity and reduces the number of sick days, improving the quality of life. Monitoring these areas helps identify and eliminate sources of pollution while preserving local ecosystems and biodiversity. It also prevents soil degradation, preserving their fertility and agricultural potential. Compliance with regulatory requirements reduces the risk of fines and sanctions for businesses, promoting transparency and accountability. Thus, sanitary and protective zones are important for preserving the health of the population, protecting the environment and economic viability, creating a safe and comfortable environment for living and working. Regular control and monitoring ensure their effectiveness and compliance with laws.

Aim and tasks of the diploma work

Aim of the work – The aim and objectives of the diploma work are to conduct an inventory, assessment and analysis of the condition of the green areas of the sanitary protection zone of the enterprise, as well as the analysis of these results with the help of I−Tree tools

Objectives of the work:

1. Field research with measurements and analysis.
2. To study the theoretical basis of inventory
3. Study the legal basis of the inventory

4. Conduct an inventory of the sanitary protection zone of the enterprise

5. Familiarize yourself with i−Tree tools

6. Process the results in i−Tree eco

Object of research - inventory of the sanitary protection zone of the enterprise and process the results in the I−Tree tool. i−Tree is a state−of−the−art, peer−reviewed software suite from the USDA Forest Service that provides urban and rural forestry analysis and benefits assessment tools. The i−Tree tools can help strengthen forest management and advocacy efforts by quantifying forest structure and the environmental benefits that trees provide. The essence of the work consists precisely in processing the results in i−Tree

Subject of research - is the sanitary and protective zone of the enterprise. The study was prompted by the need to update data on the state of the sanitary protection zone for the enterprise

Methods of research – This is an inventory with the use of measuring devices, excel tables, GPS and photo registration, as well as I−Tree tools necessary for processing the results.

Personal contribution of the graduate: The graduate was directly involved in the inventory and I also processed the results in I−Tree.

Aprobation: D.V. Osadchuk, T. V. Saienko, "ENVIRONMENTAL AUDIT OF BORODYANKA CENTRAL PARK" ЕКОЛОГІЧНА БЕЗПЕКА ДЕРЖАВИ XVIII Всеукраїнської науково−практичної конференції молодих учених і студентів 18 квітня 2024 року с.82

Publications*:* 1. Dmitry Osadchuck, Lesia Pavliukh. Environmental aspects of paper recycling. ПОЛІТ. СУЧАСНІ ПРОБЛЕМИ НАУКИ. ЕКОЛОГІЧНА БЕЗПЕКА, ІНЖЕНЕРІЯ ТА ТЕХНОЛОГІЇ. XXIII Міжнародна науково−практична конференція здобувачів вищої освіти і молодих учених: 4–7 квітня 2023: тези доповідей Київ, 2023. С. 84−86.

2. L. I. Pavliukh, D.V. Osadchuck. WASTE PAPER RECYCLING METHODS. Екологічна безпека держави. XVII Всеукраїнської

науково−практичної конференції молодих учених і студентів: 20 квітня 2023: тези доповідей Київ, 2023. С. 23−24.

3. D.V. Osadchuk, T. V. Saienko, "ENVIRONMENTAL AUDIT OF BORODYANKA CENTRAL PARK" ЕКОЛОГІЧНА БЕЗПЕКА ДЕРЖАВИ XVIII Всеукраїнської науково−практичної конференції молодих учених і студентів 18 квітня 2024 року с.82

4. Osadchuk D.V. "POST−WAR RECOVERY OF THE ENVIRONMENT OF UKRAINE" ЗБІРНИК наукових праць Міжнародної Карпатської Школи, зимова сесія, 21−25 лютого 2024 року

CHAPTER 1
THE CONCEPT AND ESSENCE OF THE INVENTORY OF THE LANDSCAPING OF THE OBJECTS BE THE LANDSCAPING

1.1. Concept of inventory

In accordance with the requirements of the Regulation on the State System of Environmental Monitoring, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 30.03.98 No. 391, and for the purpose of protecting and preserving green spaces in cities and other settlements, maintaining them in a healthy and orderly state, creating a database for the development programs of construction, restoration and operation of green economy objects, the State Committee for Construction, Architecture and Housing Policy of Ukraine dated December 24, 2001 under No. 226 approved the Instruction on technical inventory of green spaces in cities and towns of the urban type of Ukraine.

In accordance with clause 1.2. Instructions, technical inventory (hereinafter − inventory) of green economy objects is carried out for the purpose of: protection and preservation of green spaces in urban areas and settlements in a healthy and orderly condition; strengthening responsibility for the preservation of plantations of enterprises, organizations and institutions; promoting the creation and formation of highly decorative and ecologically effective and resistant to adverse environmental conditions plantations; use of inventory data during the development of green building plans in cities and towns of the urban type; restoration, reconstruction and operation of green economy facilities and carrying out, in necessary cases, preventive and curative measures. The instruction is mandatory when carrying out work on the inventory of all plantations within the boundaries of urban−type cities and towns, namely: general use, limited use and special purpose.

In accordance with clause 1.4. Instructions, the inventory of green spaces is

carried out by the technical inventory bureau once every five years from April to October and includes:1. Determination of the total area occupied by objects of green economy, including trees, shrubs, flower beds, lawns, paths, etc.; 2. Determination of the number of trees and shrubs by types of plantations, species, age, diameter at a height of 1.3 m of tree trunks and their condition; 3. Determining the value of the object in general and its separate sections; 4. Timely introduction of changes that occurred in the green areas, to the drawings, technical passports of the green economy facilities and aggregated data on the green areas of the settlement.

In the case of development, reconstruction or capital repair of green economy facilities or changes related to the construction of facilities of other purpose in the territories that were under green areas, ongoing inventory work is carried out.

As for buildings, underground and above−ground structures, which are located on the objects of the green economy, they are subject to accounting in accordance with the Instruction on the procedure for conducting an inventory of real estate objects, approved by the order of the State Building of Ukraine dated 05/24/2001 No. 127. As a result of the the inventory for each object of the green economy must contain the following documents (clause 1.6 of the Instructions):

Inventory plan depending on the area of the object (except for plantations along the streets, the plan of which is drawn up only on a scale of 1:500) on the following scales: up to 5.0 ha — 1:500, from 5.0 to 25.0 ha — 1: 1000 or 1:2000, over 25.0 hectares — 1:2000 or 1:5000.

Work diary of accounting for green areas.

Technical passport of the object. All buildings, structures, reservoirs, supports of electric, telephone and radio networks, observation wells of engineering networks, stationary irrigation networks, benches, ditches, trees, shrubs, hedges, flower gardens are applied to the plans of green economy objects. The inventory of green economy objects is carried out in kind using existing plans, geodetic materials, drawings, projects, graphic materials of accounting of road and

bridge constructions, etc. In the absence of plans, the technical inventory bureau carries out the survey of objects. The Technical Inventory Bureau maintains records for each facility and makes the necessary number of copies to provide to the facility's permanent maintenance organization and local governments. (clause 1.9 of the Instructions) Before starting work on the inventory of green economy objects, the technical inventory bureau concludes a contract on the performance of work with the customer (enterprise, institution, etc.). In the process of inventorying green spaces, a working diary is kept, in which information is entered about trees located on driveways, trees located on the territories of public squares, gardens and boulevards, trees located on the territories of registered plots of parks, forest parks, shrubs, lawns, and flower gardens. The qualitative state of trees, the classes of the qualitative state of forest park plantings, the state of sanitary and protective zones, the state of bushes, and the state of flower beds are also noted. Based on the materials received in the preparatory period for the inventory, an inventory plan of the object is drawn up, on which the following are applied: the external boundaries of the object with their linear dimensions: neighboring land users; borders and numbers of plots, curtains, groups of trees; trees of particularly valuable species (unique, historical), which are numbered in red ink with independent numbers within the entire object. On the inventory plans of green spaces of streets, driveways, alleys, squares, embankments, the numbers of the inventory plots and each tree on these plots are placed. The inventory plans of parks and forest parks include clearings, meadows, reservoirs, and other situations. Tree and shrub plantations are marked with conventional signs. All trees, bushes (alley plantings), hedges, flower beds and lawns, group plantings of trees and bushes are marked with conventional signs on the inventory plans of gardens, squares, boulevards, courtyard and home plantings for each inventory plot. During the inventory of green spaces in parks (with an area of up to 20 hectares), squares, and boulevards, a continuous accounting of trees is carried out. In parks, the area of which is more than 20 hectares and which are created on the basis of natural plantings, the plots are outlined on the plans, each of which is dominated by a certain species with an

indication of the average age, height and diameter of the trunk. The technical passport of the green economy object is drawn up on the basis of the technical accounting. The indicators of the technical passport are filled in after all graphic and computational work is completed. The performance of the inventory of green economy objects is checked in kind, as well as during the performance of camera work by representatives of the customer and the technical inventory bureau, which performs the inventory. If significant defects or deficiencies are discovered during the inspection, an act is drawn up and kept in the file [1]. The inventory of green spaces is carried out by subjects, businesses that conduct a technical inventory of real estate objects, enterprises, organizations that have the right to do so, as well as balance−keepers of state or communal property improvement objects that have the technical capabilities, relevant specialists, in agreement with the executive bodies of the city, settlement, village councils once every five years from April to October and provides: Paragraph one of clause 1.4 in the wording of the Order of the Ministry of Construction, Architecture and Housing and Communal Services No. 8 dated 16.01.2007; with changes introduced in accordance with the Order of the Ministry of Regional Development, Construction and Housing and Communal Services No. 134 dated 12.05.2014 [2]. During the inventory, the qualitative condition of the green spaces is noted. The qualitative condition of plantations is determined by the following characteristics:

Condition of trees:

− good − the trees are healthy, normally developed, the leaves are thick, evenly distributed on the branches, the leaves or needles are of normal size and color, there are no signs of diseases and pests, wounds, damage to the trunk and skeletal branches, as well as hollows;

− satisfactory − the trees are healthy, but with signs of slow growth, with an unevenly developed crown, there are few leaves on the branches, there are minor mechanical damages and small hollows;

− unsatisfactory − the trees are very weak, the trunks are bent, the crowns are poorly developed, there are dry and drying branches, the growth of one−year

shoots is insignificant, mechanically damaged trunks, hollows [2].

State quality classes of forest park plantations:

− 1st class − mixed multi−tiered plantations with crown closure of trees of the 1st tier in massifs, groups not lower than 0.7 (not including meadows) or pure, small (3−5 ha) birch groves, oak groves with crown closure of 0.4 and above Plantations are healthy, viable. Undamaged forest litter covers at least 80% of the area. Individual trees, groups of trees are placed unevenly. Lawns of various sizes, picturesque configuration with uniform grass cover, convenient for recreation. Remedial works are not required. There are orderly roads;

− 2nd class − plantations are clean, single−tiered, with an area of more than 3−5 hectares or mixed with crown density of 0.5−0.6, evenly spaced on the territory. They have signs of slow growth and development, up to 20% of dry branches in the crown. Undamaged forest floor is 50−80% of the area, the territory is overgrown. There are few clearings, they are of the same type in shape and size, they are not picturesque enough, they require little work to improve the plantations and reclamation. There are not enough roads;

− 3rd class − plantations are clean and mixed, are in the stage of decay, with the density of tree crowns of the 1st tier of 0.2−0.4 or consist of low−value species (aspen, poplar) with greater density. Trees and groups of trees are placed evenly on the territory. The number of dry branches in the crown exceeds 20%. Undamaged forest floor is less than 50%. A lot of weediness. There are no lawns or they are not suitable for recreation. Considerable work is needed to improve plantations, carry out sanitary measures, or carry out large−scale reclamation works. There are no organized roads [2].

State of sanitary protection zones:

− good − most plants are healthy, with a well−developed crown, without mechanical damage and signs of disease;

− satisfactory − most of the plants are healthy, but with slow growth, an unevenly developed crown, with minor signs of mechanical damage, burns, leaf plates, individual dry sprouts;

− unsatisfactory − the main part of the plants is weakened, with an improperly developed crown, there are dry and drying branches, significant mechanical damage and burns [2].

Condition of bushes:

− good − the bushes are normally developed, healthy, the leaves are thick

the entire height, there are no dry and dying branches, without mechanical ones

damage and damage due to diseases, color and size are normal;

− satisfactory − the bushes are healthy, with signs of slow growth, there are few leaves, there are dry branches, the crown is one−sided, the stems are partially exposed from below, there are minor mechanical damages and damages caused by pests;

− unsatisfactory − the bushes are weakened, overgrown, significantly bare from below, the leaves are small, many dry branches, mechanical damage and damage caused by pests [2].

Condition of lawns:

− good − the surface is well planned, the grass is thick, homogeneous, uniform, regularly trimmed, the color is intensely green, there are no weeds and moss;

− satisfactory − surface of the lawn with significant irregularities, grass is uneven, many weeds, trimmed irregularly, color − green, there are no trampled places;

− unsatisfactory − grassy, sparse, heterogeneous, multi−colored, mostly yellow shade, many broad−leaved weeds, moss and trampled places [2].

Condition of flower beds:

− good − the surface is carefully leveled, the soil is fertilized, the plants are well developed, the same in quality, there are no weeds, regular care;

− satisfactory − the surface is poorly leveled, little fertilizer has been applied to the soil, the plants are normally developed, there are weeds, care and repair of

flower beds is irregular;

− unsatisfactory − the surface has significant unevenness, fertilizers are not applied, plants are poorly developed, there are many weeds, dry leaves [2].

If in the process of surveying the natural plantings within the area being surveyed, groups of individual trees or bushes are found that differ sharply according to the tax indicators (completeness of plantings, composition, condition), then such areas of trees and bushes are taken into account within their boundaries separately and on plans are numbered with serial numbers [2].

1.2. Legislative framework, shortcomings and proposals

The legislative basis for conducting an inventory of green spaces is characterized by two normative legal acts, namely, improvement of territories SBR (State building regulations) B.2.2−5:2011 and Order No. 226 dated 12.24.200 "On approval of the Instructions for the inventory of green spaces in populated areas of Ukraine ".

It is noted in the State Building Regulations B.2.2−5:2011 that these regulations establish general provisions for the design of new construction, reconstruction, and capital repair of public works facilities. These norms must be observed during the design, implementation and acceptance of works on the improvement of the territories of populated areas, and that these norms apply to objects of improvement regardless of their subordination and form of ownership:

− parks (hydro, meadow, forest parks, culture and recreation parks, parks

monuments of garden and park art, sports, children's, historical, national, memorial and other), recreational areas, gardens, squares;

− monuments of cultural and historical heritage;

− squares, squares, boulevards, avenues;

− streets, roads, alleys, driveways, driveways, pedestrian and bicycle paths, stops and structures of city public transport, parking lots;

− beaches;

− cemeteries;

− other public areas;

− residential areas;

− the territories of enterprises and the territories assigned to them under the terms of the contract;

− water protection zones within settlements,

− coastal protective strips within the boundaries of settlements [14].

In the case of my work, it is absolutely necessary to take into account the point specified in this document about the improvement of the territories of enterprises:

− During the design of the improvement of the territory of enterprises, it is necessary

be guided by SNiP II−89.

− The territory of the production enterprise includes the following zones: public purpose, production territory with open areas and auxiliary objects of production and farms, guest parking lots, a recreation area and a landscaping area, including a sports area, as well as a sanitary and protective area.

Public purpose and recreation areas should be isolated as much as possible from the industrial area with open areas and auxiliary objects of production and farms with protective plantings, carriers of sound, light and color information that warn of danger, as well as − permanent and temporary fences of various types. All objects and premises of public purpose and recreation areas must be accessible to groups of people with reduced mobility in accordance with DBN B.2.2−17.

The total area of greening of industrial areas should be determined:

− for territories less than 5,000 m2 with less than 2,500 employees − at the rate of 3 m^2 per employee; in the territories of cities and near highways, this indicator can be reduced to 1 m^2 and compensated by greening of premises;

− for territories with more than 2,500 employees and (or) an area of more than 5,000 m^2;

− at the rate of not less than 10% of the total territory.

In the case of creating green spaces between separate objects of the enterprise, trees should be placed no closer than 5 m from the objects. It is forbidden to plant conifers and other types of trees and shrubs that catch fire easily.

Regarding the inventory, we should refer to Order No. 226 of 12.24.2000 "On the approval of the Instructions for the inventory of green spaces in populated areas of Ukraine". It says that

The inventory of green spaces is carried out by subjects

businesses that conduct a technical inventory of real estate objects, enterprises, organizations that have the right to do so, as well as balance−keepers of public or communal property improvement objects that have the technical capabilities, relevant specialists (hereinafter − executors of works on the inventory of green plantations), in agreement with the executive bodies of the city,

settlement, village councils once every five years from April to October and provides for: The first paragraph of clause 1.4 in the wording of the Order of the Ministry of Construction, Architecture and Housing and Communal Services No. 8 (z0082−07) dated 16.01.2007; with changes introduced in accordance with the Order of the Ministry of Regional Development, Construction and Housing and Communal Services No. 134 (z0544−14) dated May 12, 2014}

determination of the total area occupied by green objects

farms, including trees, shrubs, flower beds,

lawns, paths, etc.;

− Determining the number of trees and shrubs by type of plantings,

species, age, diameter at a height of 1.3 m of tree trunks and

the state of their maintenance;

− determination of the value of the object in general and its individual sections;

− timely introduction of changes that occurred in green areas, in

drawings, passports of green economy facilities and summary data on green areas of the settlement. The fifth paragraph of clause 1.4 with changes introduced

in accordance with the Order of the Ministry of Construction, Architecture and Housing and Communal Services No. 8 (z0082−07) dated 16.01.2007

In case of transfer of land use rights,

significant loss of green spaces as a result of emergency and

emergency situations, the infliction of significant damage to green spaces by illegal actions of individuals or legal entities, ongoing inventory work is performed. { The sixth paragraph of clause 1.4 in the wording of the Order of the Ministry of Construction, Architecture and Housing and Communal Services No. 8 (z0082−07) dated 16.01.2007 [1]

Inventory plan depending on the area of the facility (except

plantings along the streets, the plan of which is drawn up only on a scale of 1:500) in the following scales:

− up to 5.0 hectares − 1:500;

− from 5.0 to 25.0 hectares − 1:1000 or 1:2000;

− over 25.0 hectares − 1:2000 or 1:5000;

When conducting an inventory, a passport of the object of inventory is formed.

Among the shortcomings, it is worth highlighting the fact that it is impossible to identify individual trees in the passport. The passport indicates only general information about the number and condition of trees, which is why we do not know the parameters of the condition of the trees, only general information. It is impossible to plan activities for exploitation and repair of the object in the absence of complete data. Among other things, there is a difficulty in calculating the total book value of landscaping. The balance sheet value does not contain and does not reflect the parameters and functions performed by landscaping, namely:

− Air purification: On average, one cubic meter of a tree consumes a ton of carbon dioxide (CO_2), which is a product of breathing, motor vehicle operation, and many industrial processes. From the consumed carbon dioxide, the same volume of the tree emits more than 0.7 tons of pure oxygen (O_2) into the air. In squares, parks, alleys, the air is 2−3 times cleaner than in other ungreened urban

places. Trees cope with pollution especially effectively in the spring−autumn period, since most of the work falls on the leaves. Some of the beneficial properties of green vegetation are preserved even in winter, both in conifers and in deciduous species [15 .

− Control of water evaporation: Control of the ambient temperature helps to control the evaporation of water into the atmosphere. This affects the humidity of the environment and the humidity of the atmosphere

− Maintenance of temperature balance: Trees create a shade that controls the heating of the area. This affects the general temperature regime, which is very good for the population and workers

− Noise protection: Green spaces form a strip or separate small strips that work as noise insulators or barriers. For example, trees planted near the road will reduce the noise level from cars

− Protection from dust: Green plantings form a strip or separate small strips that work as insulators or barriers that trap dust.

−Oxygen production: The process of producing oxygen is called photosynthesis. Photosynthesis is an important part of life on Earth. The process by which pigments in plants (most commonly chlorophyll) absorb sunlight and synthesize carbohydrates.

Recommendations − include the above−mentioned problems in the structure of the landscaping passport, as well as approve at the legislative level the method of calculating the eco services of landscaping, so that we have a clear idea of how much money we will lose if we remove the plantation, or how much we will save if we decide to restore it.

1.3. The concept of the sanitary protection zone of the enterprise

1.3.1. Definition

Sanitary and protective zone − the territory around a potentially dangerous enterprise, within which it is prohibited for the population to live and conduct

economic activities, the dimensions of which are established by project documentation in accordance with state regulatory documents.

The construction of residential facilities, social infrastructure facilities, and other facilities related to the permanent residence of people is prohibited within the sanitary protection zones.

The sanitary protection zone is the territory located between prom. enterprises and the nearest residential and public, etc. non−industrial buildings. It is created to protect the population from the influence of adverse production factors (dust, gases, noise, vibrations, etc.), the value of which at the border of the sanitary protection zone should not exceed the hygienic standards established for populated areas. The width of the sanitary protection zone depends on the nature and capacity of production, the perfection of technology. processes, the level of adverse factors, wind gusts, the use of gas and dust cleaning devices, the presence of anti−noise, anti−vibration and other protective measures. According to sanitary regulations, industrial enterprises, thermal and nuclear power plants, sanitary facilities and other objects are divided into 5 classes: for objects of the 1st class, the width of the sanitary protection zone must be at least 1000 m, II − 500 m, III — 300 m, IV — 100 m, V — 50 m. Sanitary and protective zones with a width of 1,000 m are established for enterprises producing ores of lead, arsenic, manganese, mercury, and natural gas; sanitary and protective zones of 500 m — for enterprises with the extraction of coal, lignite, etc. coal, phosphorite, apatite, pyrite, iron and polymetallic ores; sanitary protection zones of 300 m — for dolomite, magnetite, etc. mining enterprises, as well as for hydromines, enrichment and briquette factories. A sanitary protection zone of 100 m is recommended for enterprises producing rock salt, peat by milling, etc. The territory of the sanitary protection zone should be greened, which contributes to the reduction of atm. pollution and noise reduction.

More details about the classification of hazardous enterprises according to sanitary standards depending on the composition and amount of harmful emissions and the nature of technological processes can be found in the State Sanitary Rules

for the Planning and Development of Settlements, approved by the Ministry of Health of Ukraine by Order No. 173 of June 19, 1996. According to Article 114 of the Land Code of Ukraine, sanitary and protective zones are created around objects that are sources of harmful substances, odors, increased levels of noise, vibration, ultrasonic and electromagnetic waves, electronic fields, ionizing radiation, etc., in order to isolate such objects units from residential areas. The construction of residential facilities, social infrastructure facilities, and other facilities related to the permanent residence of people is prohibited within the sanitary protection zones. The legal regime of the lands of sanitary protection zones is determined by the legislation of Ukraine [3, 12].

Depending on the sources of influence on the health of the population, a sanitary protection zone can be established on the basis of regulatory documents (Rules No. 173; Law of Ukraine "On Protection of Atmospheric Air", etc.) and based on the results of actual studies of the sources of influence (emission inventory materials, research protocols air of populated areas, research protocols of noise and acoustic pollution [16].

1.3.2. Functions

Sanitary and protective zones are created around objects that are sources of release of harmful substances, odors, increased noise levels, vibrations, ultrasonic and electromagnetic waves, electronic fields, ionized radiation to separate such objects from residential areas.

A sanitary protection zone should be installed:

− for enterprises with technological processes that are sources of atmospheric air pollution with harmful, unpleasant−smelling chemical substances and biological factors, directly from the sources of atmospheric pollution by organized emissions (through pipes, mines) or unorganized emissions (through building lights, smoky surfaces and steam, technological installations and other structures), as well as from places of unloading of raw materials, industrial

products or open warehouses;

− for enterprises with technological processes that are sources of noise, ultrasound, vibration, static electricity, electromagnetic and ionized radiation, and other harmful factors — from buildings, structures, and sites where the equipment (units, mechanisms) that creates these hazards is installed;

− for thermal power plants, industrial and heating boiler houses — from chimneys and places of fuel storage and preparation, noise sources;

− for sanitary and technical structures and installations of communal purpose, as well as agricultural enterprises and objects — from the boundary of the object.

− At the outer border of the sanitary−protective zone facing residential buildings, concentrations and levels of harmful factors should not exceed their hygienic standards (GDK, GDR), at the border of the resort−recreational zone — 0.8 of the standard value.

The territory of the sanitary protection zone should not be considered as a reserve for the expansion of enterprises, rural areas and objects close to them. In sanitary and protective zones, it is also not allowed to place:

− residential buildings with outbuildings, dormitories, hotels, guest houses, emergency villages;

− children's preschool institutions, secondary schools, general and special treatment and rehabilitation institutions with inpatients, drug dispensaries;

− sports facilities, gardens, parks, horticultural societies;

protection zones of water supply sources, water intake structures and structures of the water distribution network.

It is not allowed to use the lands of the sanitary protection zone of enterprises that pollute the environment with highly toxic substances and substances that have a remote effect (salts of heavy metals, carcinogenic substances, dioxins, radioactive substances) for the cultivation of agricultural crops, pastures for livestock [17].

1.3.3. Legislative framework

In accordance with Article 114 of the Land Code of Ukraine [3], sanitary and protective zones are created around objects that are sources of harmful substances, odors, increased noise levels, vibration, ultrasonic and electromagnetic waves, electronic fields, ionizing radiation, etc., in order to separation of such objects from residential areas.

The construction of residential facilities, social infrastructure facilities, and other facilities related to the permanent residence of people is prohibited within the sanitary protection zones.

The legal regime of the lands of sanitary protection zones is determined by the legislation of Ukraine.

So, sanitary and protective zones are territories around harmful objects with a limited land use regime, where it is prohibited to place objects related to the permanent presence of people.

Special provisions on sanitary protection zones are provided for in Article 24 of the Law of Ukraine "On Atmospheric Air Protection" [4], Article 45 of the Law of Ukraine "On the Use of Nuclear Energy and Radiation Safety" [5], Article 15 of the Law of Ukraine "On Mining and Processing of Uranium Ores" " [6], Article 14 of the Law of Ukraine "On the Electric Energy Market" [7], Articles 21 and 32 of the Law of Ukraine "On Energy Lands and the Legal Regime of Special Zones of Energy Facilities" [8].

The size and features of the legal regime of sanitary protection zones are determined by acts of legislation on ensuring the sanitary and epidemic well−being of the population (primarily, sanitary norms and rules): State sanitary rules for the planning and development of settlements, approved by the order of the Ministry of Health of Ukraine dated 19.06.1996 No. 173[9], Clause 3 of the Rules for the Protection of Electric Networks, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 04.03.1997 No. 209[10], by the State Sanitary Norms and Rules for the Protection of the Population from the Impact of Electromagnetic Radiation, approved by the Order of the Ministry of Health of Ukraine dated 01.08.

1996 No. 239 [11], etc.

The dimensions and regime of sanitary protection zones are also determined by regulatory documents in the field of construction: DBN B.2.2−12:2019 "Planning and development of territories"[12], etc.

The basis for the establishment of sanitary protection zones is the sanitary classification of enterprises, industries and objects, which is given in Application No. 4 to the State Sanitary Rules for Planning and Development of Settlements, approved by the Order of the Ministry of Health of Ukraine dated 19.06.1996 No. 173 [13]. Enterprises are divided into 5 classes according to their harmfulness, according to which sanitary protection zones from 50 to 3000 m are established.

1.4. Conclusion to chapter 1

The main problem that we would like to focus on is that it is impossible to identify individual trees in the passport. The passport contains only general information about the number and condition of trees, so we do not know the parameters of the condition of the trees, only general information. It is impossible to plan measures for operation and repair of the object in the absence of complete data. Among other things, there is the difficulty of calculating the total book value of the improvement. The book value does not contain and does not reflect the parameters and functions performed by the improvement. We need to include the above problems in the structure of the landscaping passport, as well as approve at the legislative level the methodology for calculating the eco−services of landscaping, so that we have a clear idea of how much money we will lose if we remove the plantation, or how much we will save if we decide to restore it

CHAPTER 2
METHODOLOGY AND TOOLS FOR ACCOUNTING FOR GREEN SPACES

2.1. Basic information

The method itself consists of the following list of actions:

1. Number the tree

2. Determine the name of the tree

3. Measure the diameter of the trunk, convert to meters

4. Determine the total height using an altimeter in meters, for accuracy, do this several times or use two different altimeters, if possible and necessary

5. Determine the height of a living tree. Usually, it is identical to the total height. It is determined up to the threshold of the available leaves on the crown

6. Height to the lower edge of the crown. It is also determined by an altimeter. From the top of the crown to its lower edge

7. The diameter of the crown from north to south is measured as follows. It is determined where the north is, and where the south is, after which the diameter of the crown is measured from north to south with a tape measure

8. The diameter of the crown from west to east. It is determined where the west is and where the east is, after which the diameter of the crown is measured from west to east with a tape measure

9. Missing part of crown in percentage. A visual analysis of the condition of the crown is carried out. That is why it is important to carry out the inventory in the period when the leaves are still present on the trees.

10. Dying, dry branches in percentage are also determined visually.

11. Illumination of the crown on a scale from 0 to 5. There are 5 sides of illumination − Right, left, front, back and top. It is necessary to determine whether the illumination of the tree is blocked somewhere on these sides. One illuminated

side is equivalent to one point. How many sides are illuminated, so many points we record.

2.2. Tools included in the i−Tree system

2.2.1. MyTree

The MyTree tool allows us to get benefit calculations of the tree we have chosen. It works as follows:

1. Select the location where the tree is located, set a marker on the map to determine the coordinates

2. Select tree species. It is necessary to enter the name of the tree in the search bar and select it. There is a variant with a common name, for example "Chestnut" and a scientific one in Latin, for example "Castanea"

3. Select the state of the tree. There are seven options to choose from, namely Excellent, Good, Fair, Poor, Critical, Dying, Dead. You need to choose the most suitable for your tree.

4. Select the trunk size. There are two options − Diameter and Circumference, for your choice. In meters

5. Specify Sun Exposure. Sun exposure is the amount of sun that reaches the leaves of the tree based on its surroundings (i.e., the presence of additional structures or trees that may shade the tree). Select the sun exposure that best describes your tree [20]. The options to choose from are "Full", "Partial" and "Shade".

6. Is it within 60 feet or 18.28800 meters of the building. If you are not sure or do not know, you can choose to skip.

There are also several additional fields. This is an opportunity to add a descriptive note and type of tree or planting site, where you can choose the following answers: None, existing, New planting, Heritage, Memorial, specimen, Removal, Planting side, Test/Imaginary tree

Approximately everything should look like in Figure 2.3.

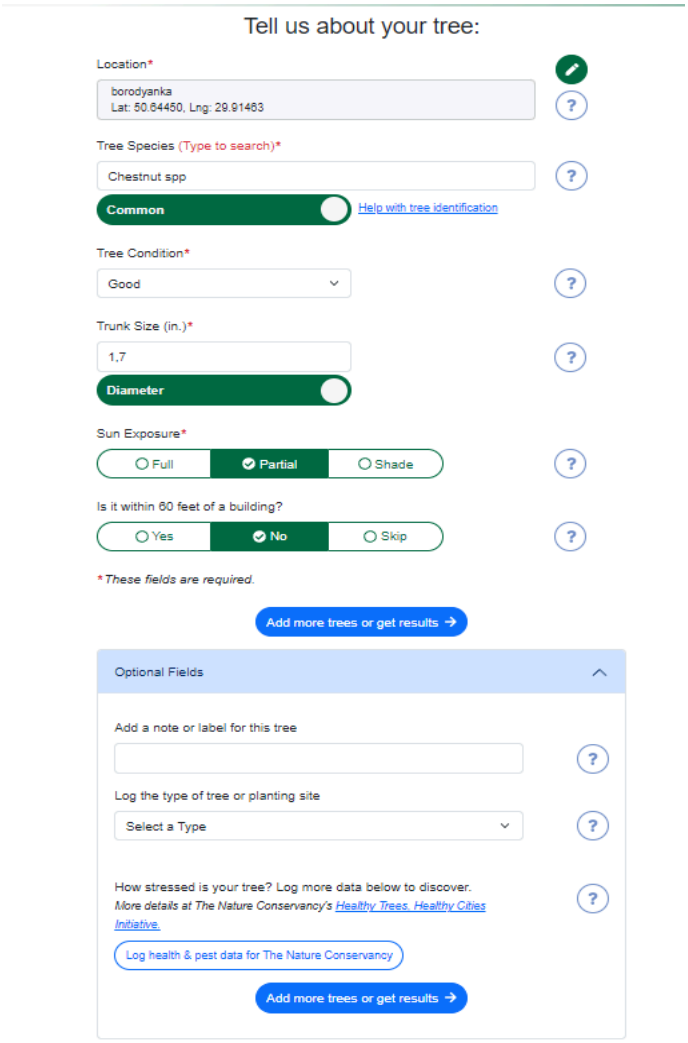


Fig. 2.3. A view of the completed data page

Now we have to click on "Add more trees or get results", after which the report will be available to us. There are two options − for now and for 20 years. In our case, we are interested in 20 years. There is also an "Equivalent" function, which will show the equivalence of tree benefits to different situations, such as the emissions of a gasoline car or filled bathtubs. (Figure 2.4.)

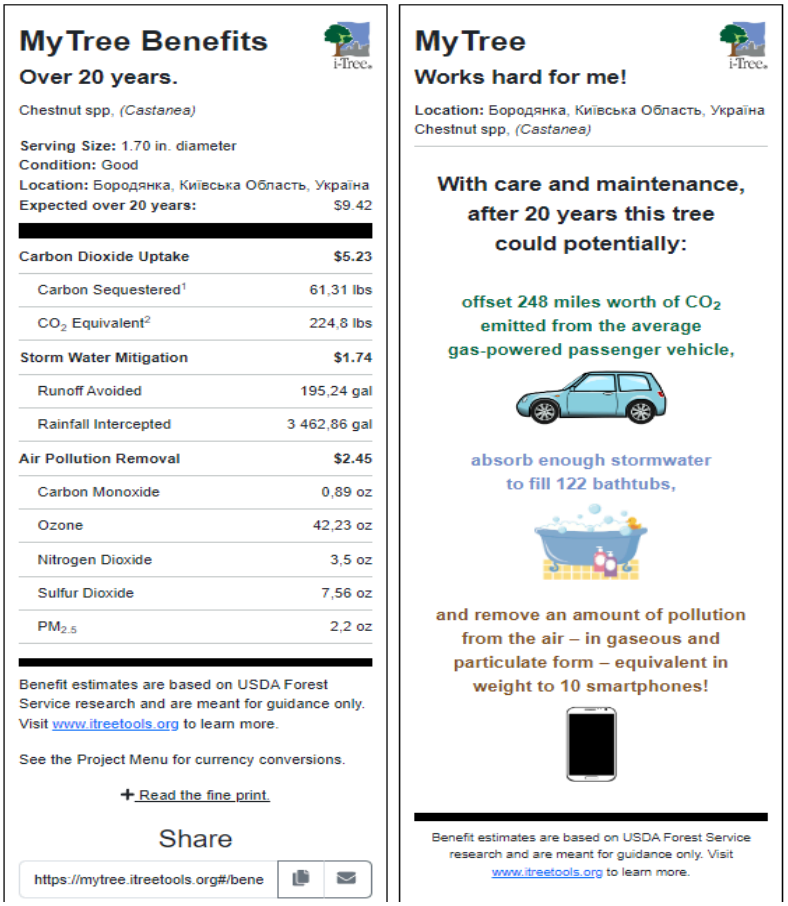


Fig. 2.4. An example of a report

The report indicates the estimated value of the benefits of the tree in total in monetary terms and divided by each item, namely Carbon Dioxide Uptake, Storm Water Mitigation and Air Pollution Removal.

2.2.2. i−Tree Design.

This tool will help you evaluate the benefits of individual trees in terms of carbon dioxide, air pollution, stormwater impact and energy savings.

How to use it:

− put a tree or landing place on the map,

− select its type,

− enter the diameter or circumference of the trunk and

− select the general state of the tree.

− If you take the extra step and draw the outline of the house next door, you can see how your trees affect the building's energy consumption.

i−Tree Design estimates the benefits of trees for the current year and up to 99 years in the future. Also given are the overall benefits to date based on the estimated age of the tree. You can model several trees and buildings [21].

2.2.3. i−Tree Eco

i−Tree Eco provides extensive analysis of the forest and individual trees, including the following:

Functional analysis:

− Pollution removal and impact on human health

− Carbon sequestration and storage

− Hydrological effects (runoff avoidance, interception, transpiration)

− Construction of energy effects

− Biodegradation of trees

− Bird Habitat Suitability (story−based projects; limited to 9 bird species)

− Example of a Bird Habitat Suitability Report

− Ultraviolet radiation (UV) affects wood Example of a UV report

Analysis of structure and composition:

− Status and distribution of the species

− Leaf area and biomass

− The value of the importance of the species

− Diversity indices and relative productivity

Porecasting simulation options including:

− Planting trees

− Extreme exposure to weather and pests

− Annual mortality adjustments

Management information including:

− Phytosanitary risk analysis

− User−defined additional fields

− Analysis of costs and benefits [22].

2.2.4. OurTrees

OurTrees allows you to estimate the amount of carbon dioxide and air pollution that trees remove, as well as the impact of stormwater in a selected area. You only need to choose a community, and the program will do the rest. Since there are problems with choosing the community of Ukraine, I chose the standard Washington, D.C. (District of Columbia). After that, we get 5 reports, namely Benefits, Story, Community, Equity and Scorecard (Figure 2.5.)

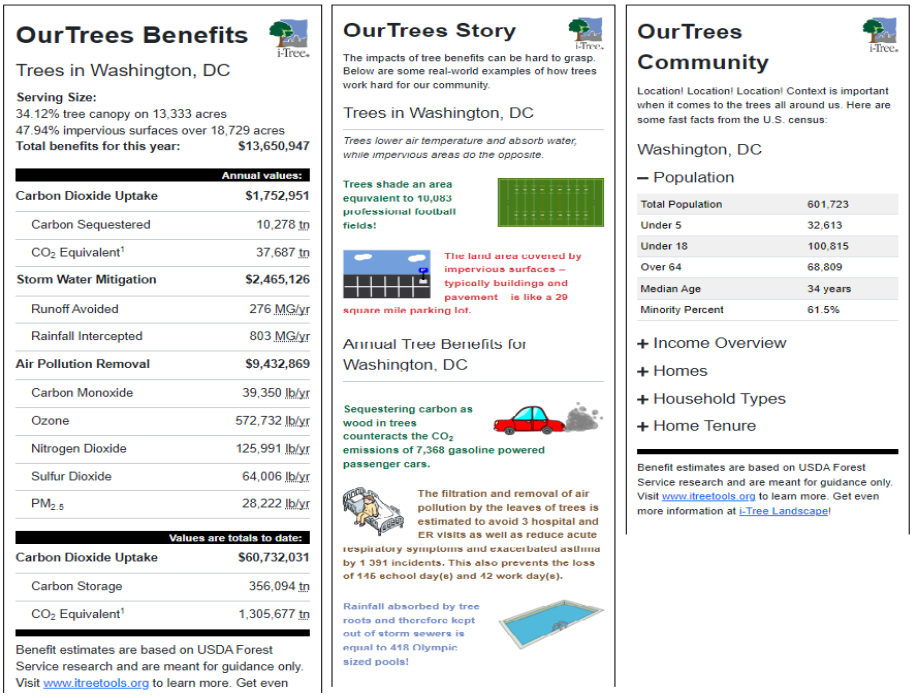


Fig. 2.5. Examples of reports (part 1)

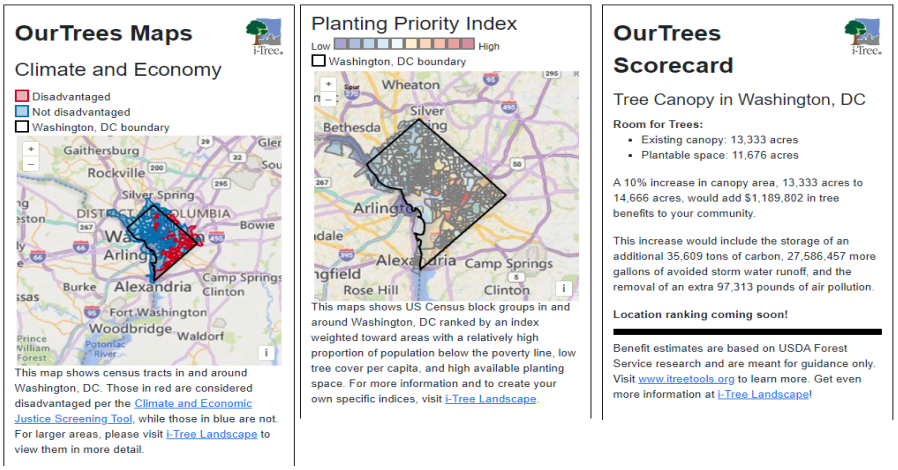


Fig. 2.5. Examples of reports (part 2)

2.2.5. i−Tree Landscape

The i−Tree Landscape tool allows the researcher to examine tree canopy, land cover and demographic information in a selected community. This allows you to review the benefits of the tree canopy in terms of carbon dioxide, air pollution, stormwater impacts, etc., and identify priority areas for tree planting. To get started, you need to select an area of interest and follow the step−by−step instructions provided in the tool itself, freely switching between windows in the program or even viewing them in separate windows each.

After selecting an area of interest, you can explore the following in any order: Location data, tree utility assessment volumes and values, crop priority mapping.

2.2.6. i−Tree Canopy

The i−Tree Canopy tool is used to classify land and tree cover in a given area using a random sample of aerial photographs. With i−Tree Canopy, you can review the benefits of a tree canopy in terms of carbon dioxide, air pollution and stormwater impacts.

Instructions for use:

1. Choose from available geographic boundaries, draw your own project boundaries on Google Maps, or download an ESRI shapefile. You can use multiple non−overlapping borders at the same time.

2. i−Tree Canopy randomly generates sample points and scales each one so you can choose from your predefined list of canopy types for that location.

3. With i−Tree Canopy, you view aerial images of Google Maps at random points to assess the coverage within a defined project area.

Recommended from 500 to 1000 view points for more accurate results; the more points you score, the better the coverage score for your study area. If you assess tree cover, you can also assess the benefits of trees [23].

2.2.7. i−Tree Planting Calculator

The i−Tree Planting Calculator tool is needed to estimate the long−term environmental benefits of a tree planting project in terms of carbon dioxide, air pollution, stormwater impacts, energy savings and canopy cover.

Instructions for use:

1. Enter groups of trees with the following parameters:

− species of trees

− Sizes of trees when planting

− Condition of trees

− Number of trees in the group

− Years of project life

2. With extra data available, you can enter more values to fine−tune your estimates. Here is a list of extra data:

− Distance and direction to the nearest building

− Estimated mortality of trees during the life cycle of the project

− Specific greenhouse gas values for your region

3. The following estimates are calculated in amounts and US dollars:

− Carbon dioxide is sequestered

− Avoidance of carbon dioxide emissions due to reduced energy consumption of the building

− Energy saving

− Air pollutants are captured and avoided

− Rainwater is filtered

− Total tree biomass

− Canopy covering [24].

2.2.8. i−Tree Species

The i−Tree Species tool helps you select the most suitable tree species based on their potential benefits and geographic region.

Instructions for use:

Select your location, then select and rate the importance from 0 to 10 of each desired tree benefit.

The selection of species will be based on three types of information:

1. Endurance – as determined by state and city.

2. Mature height − user−specified minimum and maximum heights.

3. Environmental factors − from 0 to 10:

− Carbon storage

− Removal of air pollution

− Impact of stormwater

− Energy saving of the building

− Lowering the air temperature

− Reduction of ultraviolet radiation

− Pollen allergy

− Decrease in wind

The tool outputs a ranked list of recommended species suitable for local use that maximizes tree benefits.

− The list is based on a combination of winter hardiness, height at maturity and desired benefits.

− Consider this list as a starting point, as it will need to be reduced to meet local and cultural needs and constraints.

− For more information and to learn about the methods used to create i−Tree Species, see the help documentation [25].

2.3. Methodology of inventory

2.3.1. Data model

The inventory data model is a work diary and looks like this:

− Inventory number

− The name of the tree species

− Diameter of the trunk, m

− Age

− Quality condition

− Balance sheet value, hryvnias

− Note

− Origin

− Crown diameter, m

− Height, m

− GPS location N/E

− Disembarkation date

− Link to the photo

This is the most comfortable and optimal option for saving the collected data for further analytical work and processing of the obtained results. Also, this data table is approved in the state instructions for conducting an inventory of green spaces. The process of entering data into the table takes place in the process of collecting information or after the end of inventory work.

2.3.2. Data collection tools

We need the following tools to collect the necessary data on measurements of the condition of trees and their indicators during inventory work with green areas:

− Altimeter

− Measuring tape

− Notebook for notes

− Table for entering data

− GPS navigator

− Chalk or plates for marking and numbering trees

Let's start with the altimeter. In my work, we used the optical altimeter VA (Anuchich's altimeter). (Figure 2.6.)

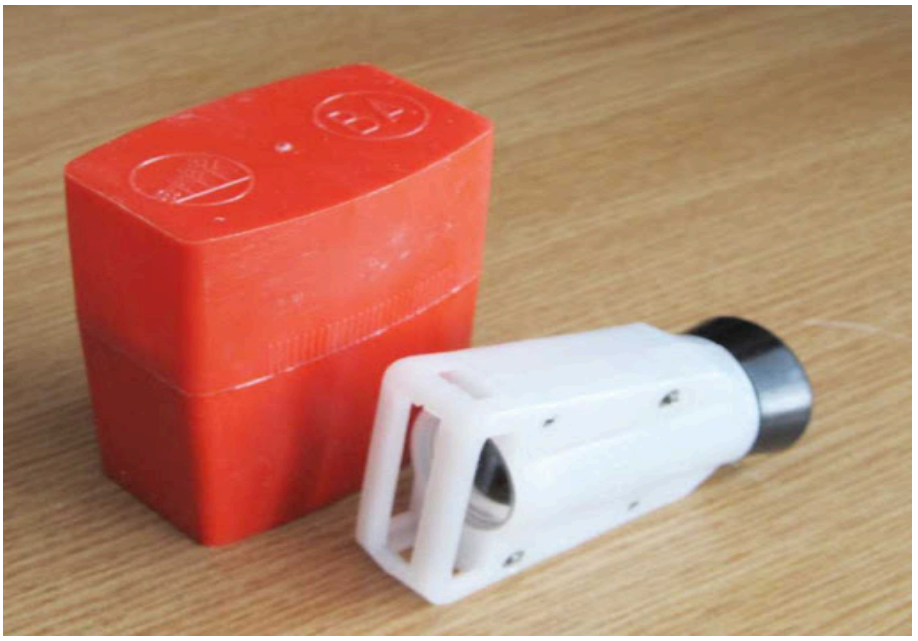


Fig. 2.6. Optical altimeter VA (Anuchich's altimeter). Source: lesovod.com.ua

Optical altimeter VA (Anuchin altimeter) is intended for measuring the height of growing trees, the crown of a tree and the length of the part of the trunk cleared of knots. The altimeter can be used to measure the height of other objects, for example, to determine the height of sagging wires of power lines, to determine heights in geology, construction, etc. The altimeter is light and easy to use and is intended for use by one operator (user).

Technical characteristics of the BA altimeter:

The type of altimeter is optical

Time for one measurement, min., no more than 1

Base distances for measuring heights, m 20 and 30 m

Height measurement range, m:

from a distance of 20 m: 0 − 30 m

from a distance of 30 m: 0 − 38 m

Relative height measurement error ± 4%

Overall dimensions, mm, no more than: 70x48x32

Weight, kg, no more: without case 0.06

Procedure for working with the Anuchin VA altimeter:

The procedure for using the VA optical altimeter is as follows. It is necessary to move away from the measured tree or other object at the selected basic distance (20 or 30 meters), take the altimeter out of the case and bring it to the eye from the side of the subject. Press the eyepiece tightly to the eye. The tree, which is viewed through the optical system of the altimeter, will be visible through the lens in a rectangular hole in the wall, on which two scales are placed. At the same time, the zero stroke of the scale must be aimed at the root neck of the tree being measured. The top of the tree will cut off the distribution that defines its height. In the black and white drawing of the scale with a base distance of 20 meters, the height of the tree was equal to 25 meters.

The scales are attached to the scale carriers at opposite ends. This is done so that when measuring the height from a given base, it would be possible to count on only one scale at the same time. An example of the scale in Figure 2.7.

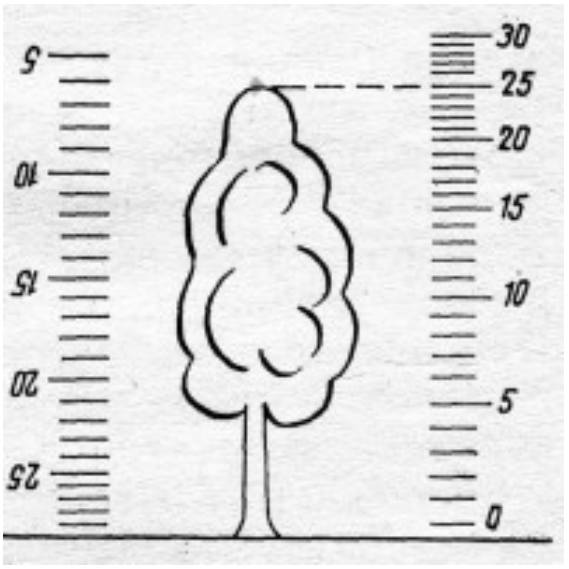


Fig. 2.7. Scale of Anuchin VA altimeter. Source: metrolog.com.ua

Adjusting the altimeter VA:

Before starting to use the altimeter, it is necessary to carry out the so−called adjustment of the device.

For this, it is necessary to perform the following procedures:

1 − Set 2 milestones at a distance of 20 meters from each other on a flat site

free from foreign objects.

2 − from the left milestone at an angle of 90 degrees, lay a line 20 m long, and at the end of this line, a person with an altimeter should stand up to two milestones.

3 − Hold the altimeter in your right hand parallel to the horizon line in such a way that when you look into the lens of the altimeter, the scale at the base distance of 20 meters is relevant. Bring the zero distribution of the altimeter scale (for a base distance of 20 meters) to the left milestone. The right milestone should be located on the 20 meter division of the altimeter.

4 − If the right milestone is not located on the 20−meter division of the altimeter, then with the help of a screwdriver, loosen the screws on the altimeter housing and move the lens to the left or right in relation to the altimeter housing by such a distance as to accurately connect the right milestone with the reading on the 20 m scale height using a screwdriver to tighten the screws on the altimeter housing.

5 – The adjustment procedure is finished [18].

Acceptable error of tree height measurement − 15%

Measuring tape. Measuring tape − a tool designed for measuring lengths and distances using a metal or fiberglass tape with millimeter divisions applied to it, which is wound on a reel and equipped with a mechanism for rewinding the tape. The tape rewind mechanism comes with a return spring (in this case, the tape is wound by itself when released) and with a rotating handle (in this case, the tape is wound when the handle is turned). Typically, a measuring tape of shorter length has a winding mechanism with a return spring, and a longer measuring tape is equipped with a winding mechanism with a handle. The measuring tape can have a painted steel tape (paint and varnish protect the canvas from environmental influences), a steel tape covered with fiberglass (polyamide − such a tape measure does not conduct current and usually has a safety margin for breakage), stainless steel tape (such a tape measure is used in a harsh environment) and a tape measure made of fiberglass or plastic (such a tape measure is very soft, bends well, but at

the same time it stretches and its results are less accurate) [19]. During the practical part, a FISCO RN50/9 tape measure was used − a fiberglass tape measure 50 m long.

In the notebook, records are made about the condition of the trees. All observations about tree damage, the state of the trunk, the state of the crown, roots, possible diseases and visual defects, for further processing and entering into the table. They also record reminders, notes, and, if necessary, make sketches.

Table for entering data. The table includes such data as:

Inventory number

The name of the tree species

Biological species

Diameter of the trunk, m

Height (total), m

Height of a living tree, m

Height to the lower edge of the crown, m

Crown diameter North−South, m

Crown diameter East−West, m

Missing part of the crown, %

Dying, dry branches, %

Illumination of the crown on a scale from 0 to 5

GPS navigator. A GPS navigator is a device that receives global positioning system signals to determine the device's current location on Earth. GPS devices provide latitude and longitude information, and some can also calculate altitude.

A GPS navigator, in order to perform its tasks, must have several important components, which largely depend on the accuracy and quality of the device:

− GPS Chipset — Which is a set of microcircuits in which the processor is the most important part. The processor ensures the operation of the entire device, and also processes the satellite signal coming from the GPS module and calculates the coordinates.

− GPS antenna, which is tuned to special frequencies on which data from

navigation satellites are transmitted.

Display for displaying information. Standard display

RAM. It ensures the speed of the navigator, loading and uploading of data

BIOS memory, which, like on laptop computers, provides communication between hardware and software.

Built−in Flash memory. It is used to store the operating system, software and user data.

Other elements of the board, which include a GPRS module, a Bluetooth module, a radio receiver, etc. The presence of these elements depends on the architecture of a particular model of the navigator. In the one I used, all this was available

Connectors (external interfaces) — an external power connector, a jack for connecting headphones, slots for memory cards and SIM cards. The set of connectors depends on the features of a particular model of the navigator.

In general, the software part consists of BIOS, operating system, software shell, navigation programs and applications.

− BIOS is a firmware that provides the operating system with access to the navigator's hardware. Is a basic program necessary for functioning

− Operating system (OS) — own OS (as a rule, based on existing ones) or third−party OS. The most popular third−party OS is Windows CE, and Linux OS is also possible

− A software shell that provides convenient work with the navigator software and contains libraries necessary for the correct operation of programs.

− Navigation program — May be self−developed by the developer or company or third−party software. The most popular third−party navigation programs are CityGuide, Navitel Navigator, Avtosputnik and others.

− Additional programs — multimedia applications, games and other programs, as a rule, installed by the manufacturer.

In the navigators of some manufacturers, individual elements of the software can be combined. For example, the functions of the software shell can be

performed by the operating system, and applications can be part of the navigation system. Some navigators have multimedia display functions.

In the case of inventory, the main point of GPS is to determine the coordinates of the tree

Chalk or number plates are used to number trees

2.3.3. Technological process of data collection

The technological process of using these tools is as follows:

For the correct operation of the altimeter, it is necessary to perform the following procedure:

1. Calculate the distance from the tree. from a distance of 20 m: 0 − 30 m, from a distance of 30 m: 0 − 38 m.

2. Aim the device at the side of the tree, look into the eyepiece and estimate the height according to the scale in the device

3. Record the result.

To measure the width of the trunk, we use a measuring tape, there are several variations for different situations.

To make tree diameter measurements meaningful and easy to perform, a standard layout and protocol has been developed. Diameters are measured outside the bark at diameter at breast height (DBH), or 135 centimeters above the ground at the top of the tree (Figure 2.8. This location is above most of the joint swelling, over most of the hand, and is in a comfortable hand position for most people [26].

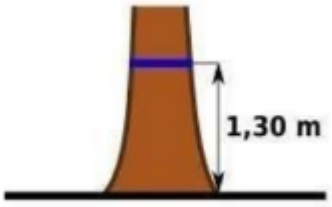


Fig. 2.8. The standard place to measure a tree's diameter is at DBH, 135 centimeters above the ground at the top of the tree.

For most trees in the forest, the measurement of dbh is quite simple. However, there are many irregular trees that require adjustments (Figure 2.8. — 2.14.).

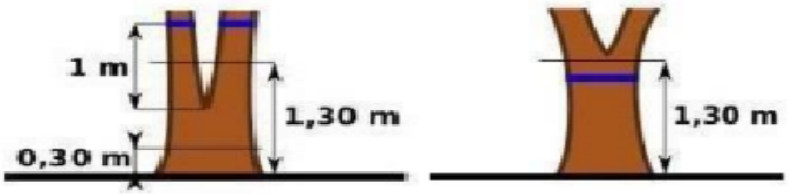


Fig. 2.9. On forked trees, measure as a single tree if the fork occurs at a distance of 135 or greater (right). Measure as two trees if fork meets below 135 (left).

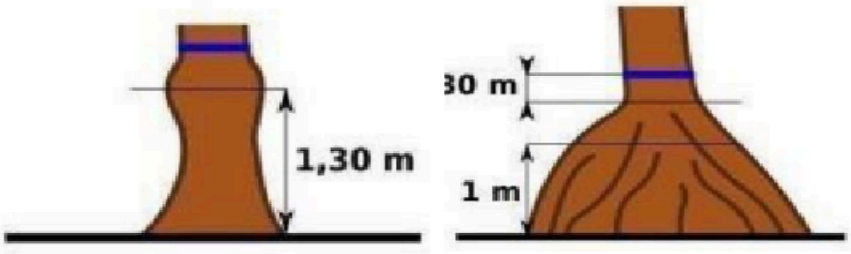


Fig. 2.10. Measure directly above the whorl bulge or branch (left). On trees with a large butt−swell, measure at least 1.5 above the butt−swell (right).

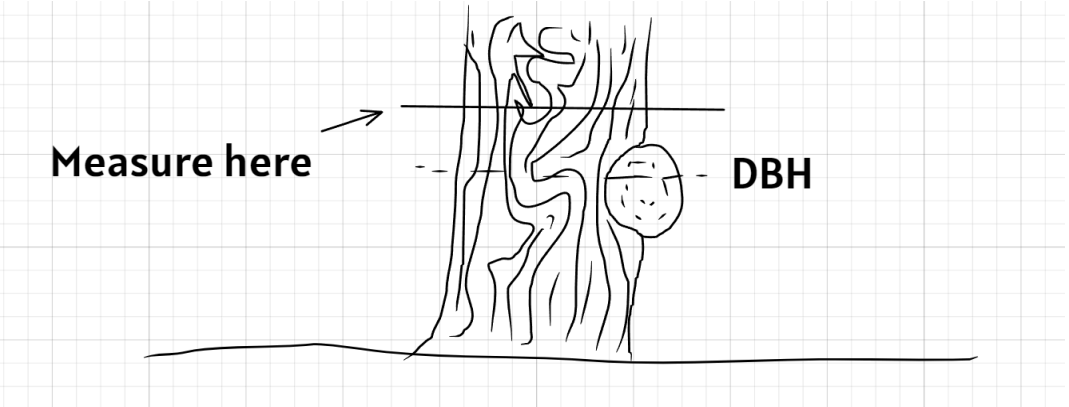


Fig. 2.11. For a large cap, measure above the warp and adjust the diameter down slightly

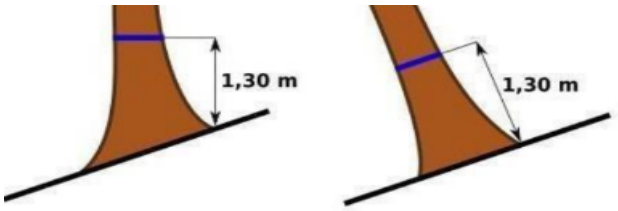


Fig. 2.12. On leaning trees, the tape is held perpendicular to the top of the tree, and measured uphill on the side of the tree, if on a slope (right); lean on the short side if on level ground (left).

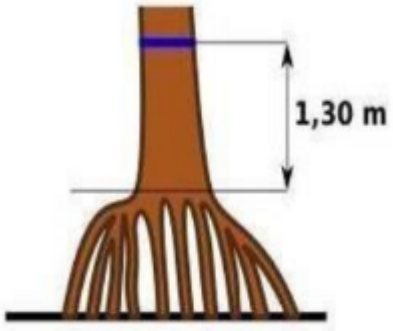


Fig. 2.13. On trees with roots above ground, measure 4.5' above the root crown (below).

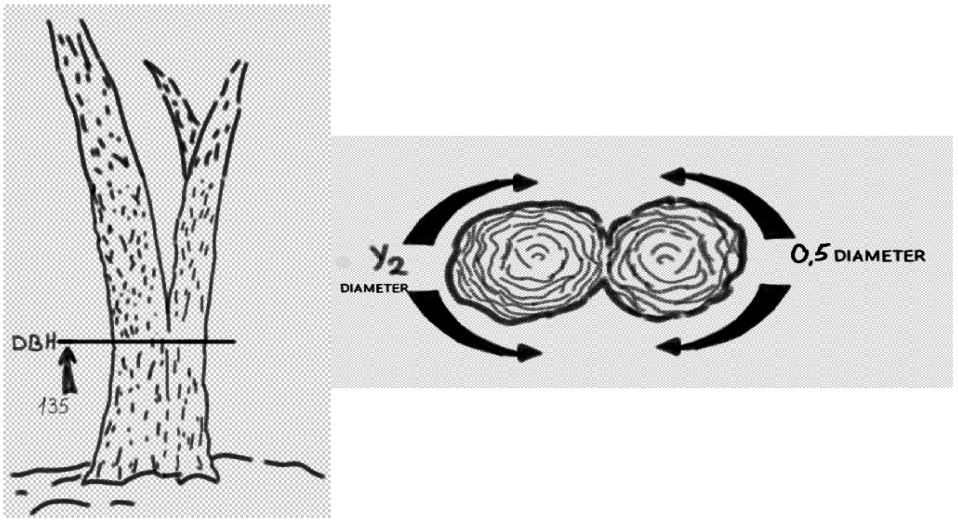


Fig. 2.14. On trees that have grown together, count as two trees. Measure

halfway around each and double the measurement.

We write the necessary comments, observations and information in the notebook.

Enter the received data into the data table.

In the GPS navigator, select the "Show my location" item, go to the tree, and then open the "Show my coordinates" window, which we rewrite. In some models, it is necessary to stand for more accurate guidance of the satellite

We simply mark the trees with chalk or tablets

2.4. Conclusion to chapter 2

To carry out an effective inventory, first of all, a data model and data collection tools are needed. Without tools, it is impossible to get data at all. Among the selected tools, we need an altimeter, measuring tape, notebook for notes, table for entering data GPS navigator, chalk or plates for marking and numbering trees. Technological process of data collection consists in numbering of the tree, then we have measured the diameter of the trunk, measured the width of the crown, measured the height of the tree, collected GPS data, assessed the missing part of the crown, the dying of branches and illuminated.

CHAPTER 3
INVENTORY OF THE SANITARY AND PROJECTIVE ZONE OF THE ENTERPRISE

3.1. Obtaining the necessary data

The process of obtaining the necessary data consisted of several days of preparation and coordination of the action plan. The plan of action was as follows:

1. Studying the instructions. Before starting my activity in the field of conducting inventories of green spaces, I had to fully study at least the main theses of the order "On the approval of the Instructions for the inventory of green spaces in populated areas of Ukraine", as well as for general information, the law of Ukraine "On the improvement of populated areas" and improvement of territories SBR (State building regulations) B.2.2−5:2011. Obtaining such knowledge also helped me better understand the legislative essence of such works and their significance.

2. Completion of courses on working with the i−Tree toolkit. The essence of my thesis is the presentation of the results obtained directly in i−Tree eco. To do this, I took courses on working with i−Tree tools, with each of the eight existing ones, mastering the skills of working with them, namely:

− MyTree
− i−Tree Design
− i−Tree Eco
− OurTrees
− i−Tree Landscape
− i−Tree Canopy
− i−Tree Planting Calculator
− i−Tree Species

MyTree was the easiest to learn due to its intuitive operation. You just need to enter the data and that's it, the result is ready. At that time, i−Tree Eco proved to be the most difficult due to the large amount of data. In the process of work, software errors may also occur, which complicates the work.

I paid special attention to the studied work with i−Tree tools, i−Tree eco, as the most prioritized due to its significance for the completion of the final task of my thesis as a bachelor of the National Aviation University of the Faculty of Environmental Safety, Engineering and Technologies. I developed lectures on webinars, recordings of lectures, manuals and instructions, user guides, and conducted many of my own practices.

3. Preparation of tools. It was necessary to take with you the necessary equipment, such as

3.1. altimeter with at least the following parameters:

− The type of altimeter is optical

− Time for one measurement, min., no more than 1

− Base distances for measuring heights, m 20 and 30 m

− Height measurement range, m:

− from a distance of 20 m: 0 − 30 m

− from a distance of 30 m: 0 − 38 m

− Relative height measurement error ± 4%

− Overall dimensions, mm, no more than: 70x48x32

− Weight, kg, no more: without case 0.06

It was very important that the altimeter was not "knocked down", that is, that the lens did not suffer a defect due to a long period of operation and the old age of the device itself, which would lead to inaccuracy in obtaining data. I was familiarized with the principle of operation of the device before performing the practice, reread the necessary instructions, and received practical application before performing the task. During the initial period, I counted the distance in 20 and 30 meters with a tape measure, but after a while I mastered the ability to measure the distance in steps. We also had to take into account the change in the

height of the landscape and obstacles, such as building walls, fences, flower beds, roads and bicycle paths, which are often busy.

3.2 Measuring tape measure. The optimal option with a length of 50 meters was chosen for optimal use. This tool is almost the most important because without a tape measure you cannot get data on the diameter of the trunk, measure the distance for the altimeter, measure the width of the crown. It is important that the tape measure is not cut at the beginning in order to have accurate measurement data. It is also good to have a manual mechanism for twisting the tape by winding it with a spool because it allows you not to worry that the tape is wound by itself and there will be no need to constantly turn the latch on and off

3.3. The notebook should have enough blank pages for notes and, preferably, have a hard cover, since there is no support for convenient data recording and you have to hold it on a balance in your hand. It is better to record with a pencil to be able to correct or delete records

3.4. The data table can be attached to the notebook. It is recommended to fill in the table with a pencil for the possibility of editing the results

3.5. The GPS navigator must have the function of displaying coordinates and a stable connection with the satellite to ensure fast and accurate coordinates.

3.6. Chalk or boards with numbering are required for numbering the trees. This is a mandatory condition

3.7. A device for photography. It can be a phone or a camera. It is desirable that the quality of the photo should be from 480p. It is not written anywhere, but it is desirable purely technically

Now I will describe the complete process of conducting inventory work:

First, on the chosen day, my manager and I prepared all the devices and agreed on the procedure for performing the work. We solved all the questions on theoretical problems and possible issues that may arise in the process of implementation, after which we arrived at the place of work − a chemical pharmaceutical enterprise. Upon arrival at the site, we met with a full−time ecologist, who led us to the territory of the enterprise's sanitary protection zone.

We started with the numbering of the tree, then we measured the diameter of the trunk, measured the width of the crown, measured the height of the tree, collected GPS data, assessed the missing part of the crown, the dying of branches and illuminated.

Figure 3.1.1. the coordinates of the trees are shown on the map using the Google Earth Pro application, and Figure 3.1.2. an example of designing coordinates.

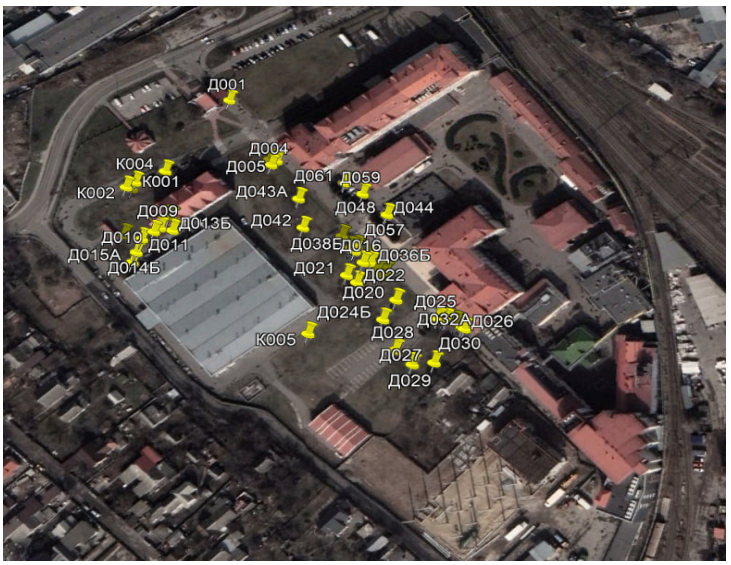


Figure 3.1.1. Coordinates on the Google Earth map

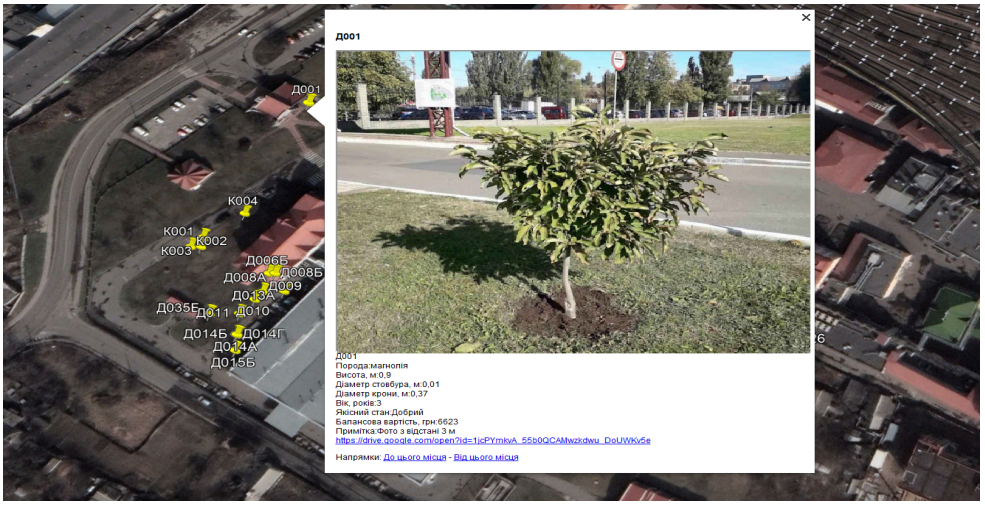


Figure 3.1.2. Layout of coordinates

Next, a photo of the tree was taken for further formation of the inventory diary. A similar action was performed with 63 trees.

Small trees were measured only with a tape measure.

Each tree was photographed. In Figure 3.2.1 to 3.2.5 are pictures of trees are shown

Fig.3.2.1. pictures of studied trees

Fig.3.2.2. pictures of studied trees

Fig.3.2.3. pictures of studied trees

Fig.3.2.4. pictures of studied trees

Fig.3.2.5. pictures of studied trees

Each value and measurement was recorded in a notebook and table. In general, two trips were made to the object.

After collecting the necessary data, it was time to analyze them and fill in the work diary. The work was performed in Microsoft EXEL. In total, we got a table with 116 columns. The table is attached in Application 1. All data collected

were recorded in the diary as required by the protocol. All data, at the end of the work, was transferred to the management of the enterprise.

3.2. Conducting analytical work and drawing conclusions

Tree condition assessment and data collection was done by myself and my project manager. Basically, the assessment of the state of the tree itself was carried out visually live. Each tree was carefully inspected for bark, trunk and crown damage. As a result, 62 trees were graded, of which 3 were unsatisfactory, 15 were satisfactory, and 44 were in satisfactory condition. Among the trees that were evaluated were magnolias, cherry trees, apricots, walnuts, kanzan sakura, spruce, blue spruce, balsam fir, cherry. The largest missing part of the crown is 90%, the smallest is 0%. The average percentage of dying branches is 5%. Illumination ranges from 3 to 5. After conducting the analysis, I can make the following conclusions: The general condition of the trees is satisfactory. The biodiversity is great, and the lighting is also satisfactory. The trees are being cared for, new trees are being planted. There should be no possible problems with the trees. The condition of the leaves is good, only once when 90% of the crown part is missing. The state of dying branches, in general, is 5%, which is a good indicator. Illumination varies depending on the position of the tree, but there are no visible problems for the tree. The overall assessment is satisfactory.

3.3. Conclusion to chapter 3

Based on the collected data, it can be concluded that the general condition of the trees can be considered satisfactory. Out of all 62 existing trees, only 3 are in unsatisfactory condition. The percentages of the missing part of the crown and dead branches are positive, except for one case with 90% absence of the crown. The lighting side is also satisfactory. Given that some trees are new, we expect even better results in the future

CHAPTER 4
PROCESSING OF RESULTS IN THE I−TREE ECO TOOLS

4.1. Data entry

This section is devoted entirely to the processing of results in i−Tree eco. i−Tree Eco is a tool that allows you to get a detailed report based on the data of the conducted inventory work and obtain data on the ecological benefits of trees in monetary terms. i−Tree Eco is a free software tool developed by the US Forest Service that allows users to quantify the ecosystem services provided by trees. These services include things like air pollutant removal, water storage, and carbon sequestration. i−Tree Eco can be used to assess individual trees, patches of trees or whole forests. i−Tree Eco uses a range of methods to assess the ecosystem services of trees, including:

− Tree size: Tree size is one of the most important factors in determining the amount of ecosystem services it provides. Larger trees tend to provide more services than smaller trees.

− Tree species: Different tree species provide different ecosystem services. For example, some trees are more effective at removing air pollutants than others.

− Location of a tree: The location of a tree can also affect the amount of ecosystem services it provides. For example, trees located in urban areas may provide more services related to improving air quality than trees located in rural areas.

− i−Tree Eco can be used to generate reports that describe the ecosystem services that trees provide. These reports can be used to inform tree management decisions, such as planting new trees or removing dangerous trees.

i−Tree Eco is a valuable tool for anyone interested in learning more about the benefits of trees. It can be used to estimate the value of trees to the community and make informed decisions about urban forest management.

To start work, it is necessary to create a project according to the instructions specified in the i−Tree Eco program. To do this, we need to open the i−Tree Eco program, click on "File" and select "New project", then create a path to save the project. Next, the project creation window will appear, where you can choose the type of project, namely "Complete inventory" and "Plot−sample". Select "Complete Inventory". Next, the first of four windows opens, "Project Settings", where we need to specify the name of the project, series name, series year, and confirm the type of project, i.e. "Complete inventory". Enter the necessary data and press "OK". In Figure 4.1. the type of data entered in this window is shown.

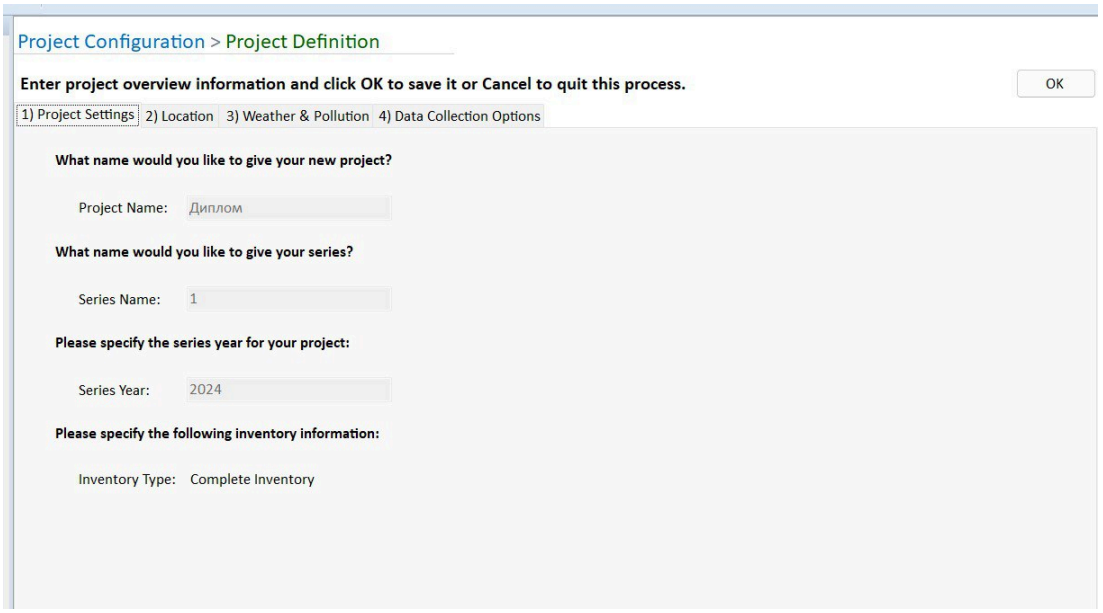


Fig. 4.1. Example of entered data in the "Project settings" window

After that, the second window of four, "Location", opens. There it is necessary to provide information about the location of the site where the inventory was taken for processing and creating the project. We have to specify the Country, region or city, district, population, it will automatically indicate whether it is an urban area. Twice the city because the program was primarily created for the united states of America, and since we and they have a different administrative division, it led to such confusion. Fill in the data and press "OK". In Figure 4.2. the type of data entered in this window is shown.

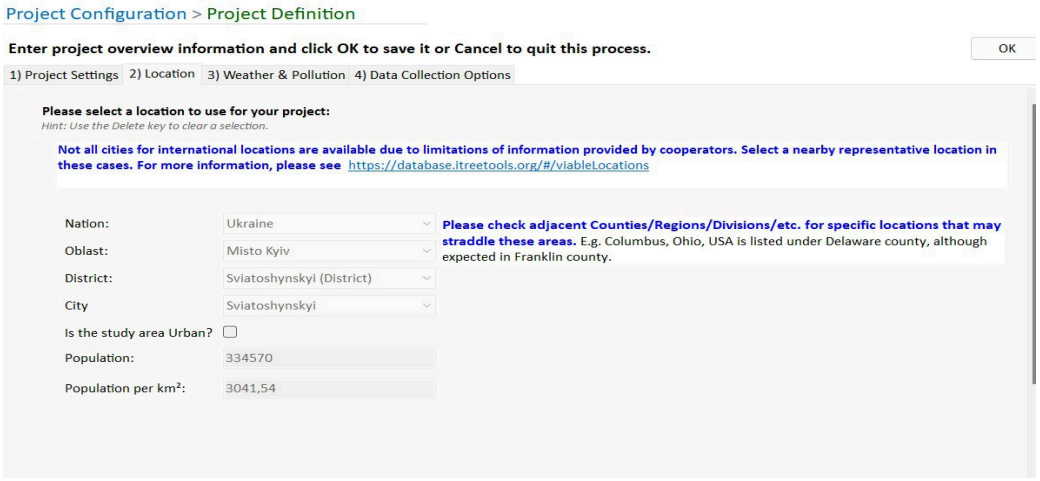


Fig. 4.2. Example of entered data in the "Location" window

It then takes us to the third of four pages, "Weather and Pollution." Here we enter data about weather stations and points for collecting information about weather conditions, and, if available, about emission control points. To enter data, it is necessary to select a year, in our case 2021, because this is the most current data at the time of writing the work. Next, select a weather station. You can enter the code or choose on the map. It is important to take into account that you need to focus on the coverage of the station and choose the one to which your research area is closest. Unfortunately, pollution control points were not available. Fill in the window and click "OK". In Figure 4.3. the type of data entered in this window is shown

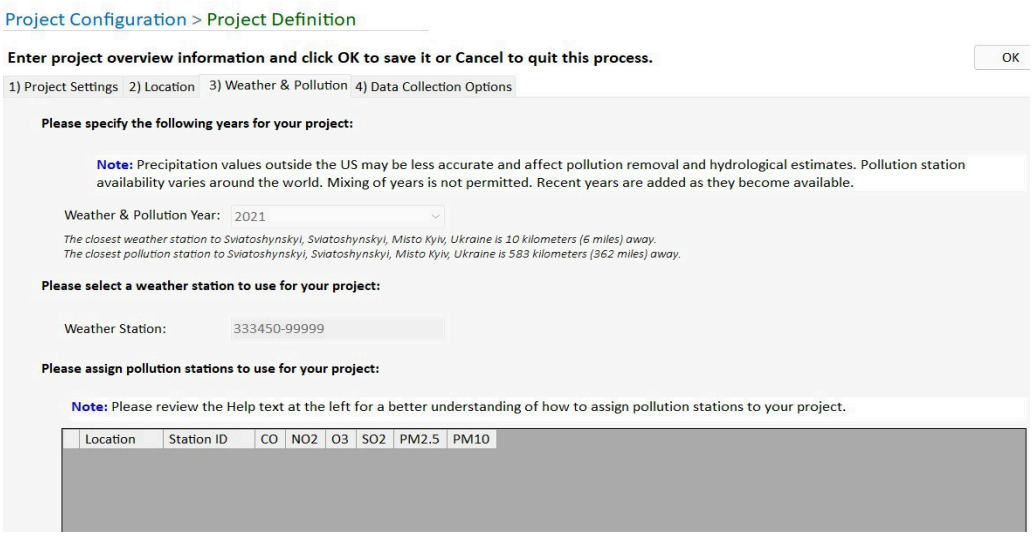


Fig. 4.3. Example of entered data in the "Weather and pollution" window

Next, the fourth, last window opens, "Data collection option". Here we select the necessary fields in the data table. It selects mandatory ones automatically and does not allow you to turn them off. Recommended fields are marked in blue, and optional fields are marked in black. Select the necessary and press "OK". In Figure 4.4. the type of data entered in this window is shown

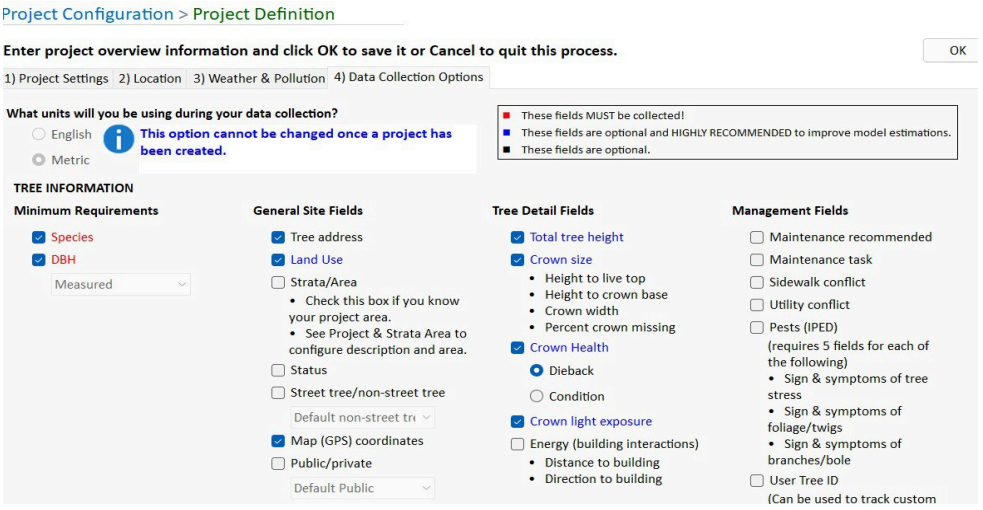
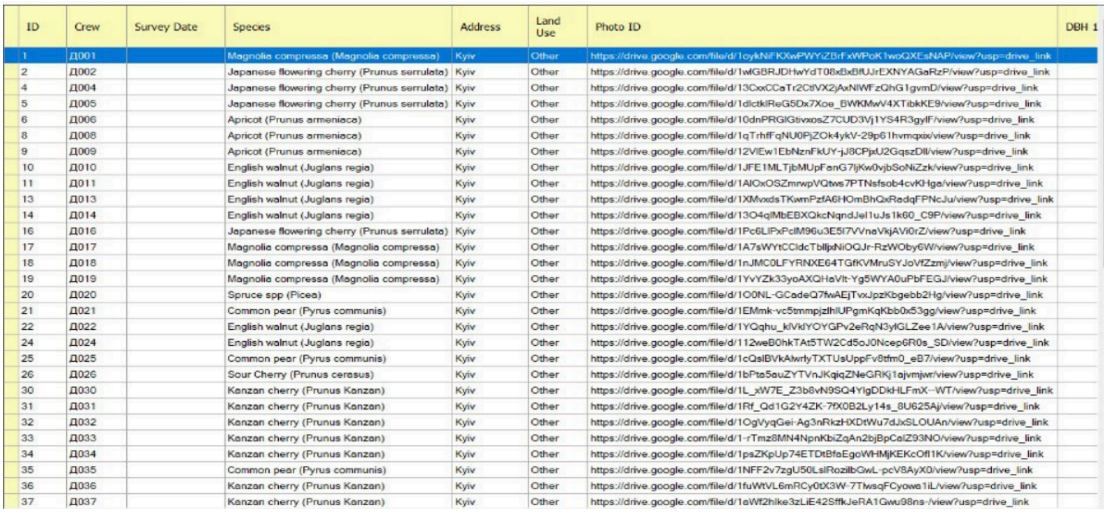


Fig. 4.4. Example of entered data in the "Data collection option" window

Now we have a ready−made project template. All we have to do is enter the data manually or automatically. I did not understand how the automatic import

function works, so I entered manually. I am attaching a screenshot of the table inside the program interface in Figure 4.5



ID	Crew	Survey Date	Species	Address	Land Use	Photo ID	DBH 1
1	Д001		Magnolia compressa (Magnolia compressa)	Kyiv	Other	https://drive.google.com/file/d/1oykNiFKXwPWYiZBrFxWPoK1woQXEsNAP/view?usp=drive_link	
2	Д002		Japanese flowering cherry (Prunus serrulata)	Kyiv	Other	https://drive.google.com/file/d/1wGBRJDHwYdT08xBxBfUJrEXNYAGaRzP/view?usp=drive_link	
4	Д004		Japanese flowering cherry (Prunus serrulata)	Kyiv	Other	https://drive.google.com/file/d/13CoxCCaTr2CtlVX2jAxNlWFzGhG1gvmD/view?usp=drive_link	
5	Д005		Japanese flowering cherry (Prunus serrulata)	Kyiv	Other	https://drive.google.com/file/d/1dlctklRaG5Dx7Xoe_BWKMwV4XTibkKE9/view?usp=drive_link	
6	Д006		Apricot (Prunus armeniaca)	Kyiv	Other	https://drive.google.com/file/d/10dnPRGlGtvxosZ7CUD3Vj1YS4R3gylF/view?usp=drive_link	
8	Д008		Apricot (Prunus armeniaca)	Kyiv	Other	https://drive.google.com/file/d/1qTrhfFqNU0PjZOk4ykV-29p61hvmqxix/view?usp=drive_link	
9	Д009		Apricot (Prunus armeniaca)	Kyiv	Other	https://drive.google.com/file/d/12VlEw1EbNznFkUY-jJ8CPjxU2GqszDll/view?usp=drive_link	
10	Д010		English walnut (Juglans regia)	Kyiv	Other	https://drive.google.com/file/d/1JFE1MLTjbMUpFanG7ljKw0vjbSoNiZzk/view?usp=drive_link	
11	Д011		English walnut (Juglans regia)	Kyiv	Other	https://drive.google.com/file/d/1AlOxOSZmrwpVQtws7PTNsfsob4cvKHga/view?usp=drive_link	
13	Д013		English walnut (Juglans regia)	Kyiv	Other	https://drive.google.com/file/d/1XMwxdsTKwnPzfA6HOmBhQxRadqFPNcJu/view?usp=drive_link	
14	Д014		English walnut (Juglans regia)	Kyiv	Other	https://drive.google.com/file/d/13O4qiMbEBXQkcNqndJel1uJs1k60_C9P/view?usp=drive_link	
16	Д016		Japanese flowering cherry (Prunus serrulata)	Kyiv	Other	https://drive.google.com/file/d/1Pc6LIPxPclM96u3E5I7VVnaVkjAVl0rZ/view?usp=drive_link	
17	Д017		Magnolia compressa (Magnolia compressa)	Kyiv	Other	https://drive.google.com/file/d/1A7sWYtCCldcTbIjpNiOQJr-RzWOby6W/view?usp=drive_link	
18	Д018		Magnolia compressa (Magnolia compressa)	Kyiv	Other	https://drive.google.com/file/d/1nJMC0LFYRNXE64TGfKVMruSYJoVfZzmj/view?usp=drive_link	
19	Д019		Magnolia compressa (Magnolia compressa)	Kyiv	Other	https://drive.google.com/file/d/1YvYZk33yoAXQHeVlt-Yg5WYA0uPbFEGJ/view?usp=drive_link	
20	Д020		Spruce spp (Picea)	Kyiv	Other	https://drive.google.com/file/d/1O0NL-GCadeQ7fwAEjTvxJpzKbgebb2Hg/view?usp=drive_link	
21	Д021		Common pear (Pyrus communis)	Kyiv	Other	https://drive.google.com/file/d/1EMmk-vc5tmmpjzlhlUPgmKqKbb0x53gg/view?usp=drive_link	
22	Д022		English walnut (Juglans regia)	Kyiv	Other	https://drive.google.com/file/d/1YQqhu_klVkIYOYGPv2eRqN3yfGLZee1A/view?usp=drive_link	
24	Д024		English walnut (Juglans regia)	Kyiv	Other	https://drive.google.com/file/d/112weB0hkTAt5TW2Cd5oJ0Ncep6R0s_SD/view?usp=drive_link	
25	Д025		Common pear (Pyrus communis)	Kyiv	Other	https://drive.google.com/file/d/1cQslBVkAlwrlyTXTUsUppFv6tfm0_eB7/view?usp=drive_link	
26	Д026		Sour Cherry (Prunus cerasus)	Kyiv	Other	https://drive.google.com/file/d/1bPta5auZYTVnJKqiqZNeGRKj1ajvmjwr/view?usp=drive_link	
30	Д030		Kanzan cherry (Prunus Kanzan)	Kyiv	Other	https://drive.google.com/file/d/1L_xW7E_Z3b6vN9SQ4YlgDDkHLFmX--WT/view?usp=drive_link	
31	Д031		Kanzan cherry (Prunus Kanzan)	Kyiv	Other	https://drive.google.com/file/d/1Rf_Qd1G2Y4ZK-7fX0B2Ly14s_8U625Aj/view?usp=drive_link	
32	Д032		Kanzan cherry (Prunus Kanzan)	Kyiv	Other	https://drive.google.com/file/d/1OgVyqGei-Ag3nRkzHXDtWu7dJxSLOUAn/view?usp=drive_link	
33	Д033		Kanzan cherry (Prunus Kanzan)	Kyiv	Other	https://drive.google.com/file/d/1-rTmz8MN4NpnKbiZqAn2bjBpCaIZ93NO/view?usp=drive_link	
34	Д034		Kanzan cherry (Prunus Kanzan)	Kyiv	Other	https://drive.google.com/file/d/1psZKpUp74ETDtBfaEgoWHMjKEKcOfl1K/view?usp=drive_link	
35	Д035		Common pear (Pyrus communis)	Kyiv	Other	https://drive.google.com/file/d/1NFF2v7zgU50LslRozilbGwL-pcV8AyXQ/view?usp=drive_link	
36	Д036		Kanzan cherry (Prunus Kanzan)	Kyiv	Other	https://drive.google.com/file/d/1fuWtVL6mRCy0t03W-7TlwsqFCyowa1iL/view?usp=drive_link	
37	Д037		Kanzan cherry (Prunus Kanzan)	Kyiv	Other	https://drive.google.com/file/d/1eWf2hlke3zLiE42SffkJeRA1Gwu98ns-/view?usp=drive_link	

Fig. 4.5. View of the table and interface in the i−Tree eco application

4.2. Data processing

Data processing took place already after entering data into i−Tree eco. After entering and verifying the data, we must click on the "Date" tab and select "Submit data for progress". Because of this, you will have to confirm the data and send it to the i−Tree eco servers to generate a report. This can take anywhere from an hour to a day. The appearance of the windows is shown in Figure 4.6.

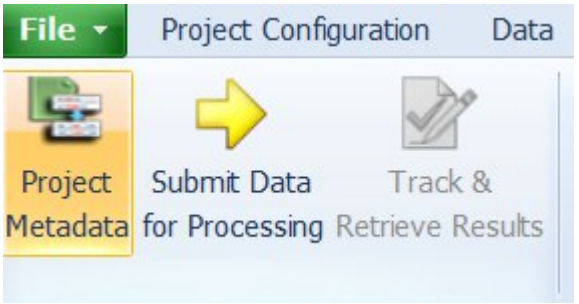


Fig. 4.6. Image of Report icon and Submit data for progress icon

After processing on the i−Tree eco servers, we receive a letter in the mail with the following content: "Your i−Tree Eco data has been processed. Your results can be downloaded through the Eco application by clicking on the "Track & Retrieve Results" button under the "Reports" tab.". By following the instructions, we get a fully prepared report. Among the received data is a general detailed report, and its separate parts, signed as "Benefits and Costs", "Individual Level Result", "Pest Analysis", "Pollution and Weather". An example of icons is shown in Figure 4.7.

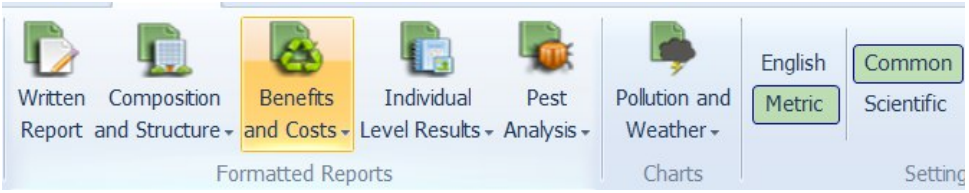


Fig. 4.7. Appearance of the icons "Benefits and Costs", "Individual Level Result", "Pest Analysis", "Pollution and Weather"

I am also attaching an image of the essence of the diploma, namely the assessment of ecosystem benefits. Please pay attention to the fact that some values are equal to zero due to the fact that there is no centralized administration of these data on the territory of Ukraine, not all the averaged data necessary for calculations have been entered. Air quality measurement points were not available on the map because they do not provide i−Tree eco data. The results of the study are shown in Figure 4.8.

Species	Trees	Carbon Storage		Gross Carbon Sequestration		Avoided Runoff		Pollution Removal		Replacement Value
	Number	(metric ton)	(H)	(metric ton/yr)	(H/yr)	(m³/yr)	(H/yr)	(metric ton/yr)	(H/yr)	(H)
Balsam fir	15	0,78	4 291,22	0,04	202,83	0,00	0,00	0,00	0,00	262 099,16
English walnut	8	5,79	31 999,27	0,28	1 538,87	0,00	0,00	0,00	0,00	585 155,67
Magnolia compressa	7	0,01	32,92	0,01	32,57	0,00	0,00	0,00	0,00	10 749,21
Spruce spp	1	0,02	110,20	0,00	19,81	0,00	0,00	0,00	0,00	7 387,53
Blue spruce	4	0,70	3 862,82	0,03	141,79	0,00	0,00	0,00	0,00	155 730,54
Apricot	3	0,44	2 417,29	0,03	182,06	0,00	0,00	0,00	0,00	50 485,64
Sour Cherry	2	1,12	6 200,18	0,03	185,18	0,00	0,00	0,00	0,00	92 207,12
Kanzan cherry	7	0,03	148,13	0,01	72,24	0,00	0,00	0,00	0,00	9 631,29
Japanese flowering cherry	4	0,26	1 419,91	0,03	169,03	0,00	0,00	0,00	0,00	33 953,27
Common pear	4	2,67	14 730,45	0,04	229,21	0,00	0,00	0,00	0,00	278 639,59
Total	**55**	**11,80**	**65 212,38**	**0,50**	**2 773,59**	**0,00**	**0,00**	**0,00**	**0,00**	**1 486 039,02**

Figure 4.8. The results of the calculation of benefits and costs of the studied trees.

4.3. Conclusion to chapter 4

Please note that due to the relatively recent addition of Ukraine to i−Tree eco, there are errors such as incorrect currency indication. He writes the hryvnia as "H", although the correct one is "UAH".

The value of carbon storage and gross carbon absorption is calculated based on the price of 525.625UAH per metric ton. Due to the limitations of available models, i−Tree Eco limits carbon storage to a maximum of 7,500 kg (16,534.7 lb) and does not provide additional storage for any tree over 254 cm (100 inches) in diameter. Any restriction that results in less carbon storage is used. The amount of avoided runoff is calculated at the price of UAH 68,685/m³. A user−assigned weather station reported 0.0 inches of total annual precipitation. Eco will always use the hourly measurement that has the highest rainfall total, or user−supplied rainfall if provided. The cost of pollution removal is calculated based on prices of UAH 0.00. per metric ton (CO), UAH 0.00 per metric ton (O3), UAH 0.00 per metric ton (NO2), UAH 0.00 per metric ton (SO2), UAH 0.00 per metric ton (PM2.5), UAH0 .00 per metric ton (PM10*). Replacement cost is the estimated local cost of replacing a tree with a similar tree. A value of zero may indicate that supporting data (pollution, weather, energy, etc.) is not available for that location, or that the reported volumes are too small to display.

CONCLUSIONS

1. The main problem we want to focus on is that individual trees in the passport cannot be identified. The passport contains only general information about the number and condition of trees, so we do not know the parameters of the condition of the trees, only general information. It is impossible to plan measures for the operation and repair of the object in the absence of complete data. Among other things, there is the difficulty of calculating the total book value of the improvement. The book value does not contain and does not reflect the parameters and functions performed by the improvement. We need to include the above−mentioned problems in the structure of the landscaping passport, as well as to approve at the legislative level the methodology for calculating eco−services of landscaping, so that we have a clear idea of how much money we will lose if we remove the plantation, or how much we will save if we decide to restore it. We would also like to draw attention to the fact that currently nowhere requires the use of auxiliary tools for inventory data analysis, such as i−Tree eco. I insist on revising and updating the inventory guidelines, as well as engaging application specialists to obtain broader and better inventory data and including these applications as a requirement in inventory projects to improve efficiency

2. To conduct an effective inventory, first of all, a data model and data collection tools are needed. Without tools, it is impossible to get data at all. Among the selected tools, we will need an altimeter, a measuring tape, a notepad, a table for entering data, a GPS navigator, chalk or plates for marking and numbering

trees. The technological process of data collection consists in numbering the tree, then we measured the diameter of the trunk, measured the width of the crown, measured the height of the tree, collected GPS data, evaluated the missing part of the crown, the dying of branches and illuminated. It is worth noting that at the present time there is a problem with the accuracy of measurements due to the inaccuracies of the devices themselves. Two different altimeters may show different values. Even the presence of a relatively large error is a confirmation of this.

3. Based on the collected data, it can be concluded that the general condition of the trees can be considered satisfactory. Of all 62 existing trees, only 3 are in unsatisfactory condition and will most likely be removed. The percentage of missing crown and dead branches is positive, except for one case with 90% missing crown. The lighting is also satisfactory. Considering that some of the trees are new, we expect even better results in the future. It is also necessary to know that the site has a high potential for planting new trees, so you should expect their soon appearance

4.When processing the results in i−Tree eco, a report was received with the results of the study and calculations of the cost of eco benefits. Please note that due to the relatively recent addition of Ukraine to i−Tree eco, there are errors such as incorrect currency indication. He writes hryvnia with the letter "H", although it is correct "hryvnia".

The cost of storage and gross absorption of carbon is calculated based on the price of UAH 525,625 per metric ton. Due to the limitations of available models, the i−Tree Eco limits carbon storage to a maximum of 7,500 kg (16,534.7 lb) and does not provide additional storage for any trees larger than 254 cm (100 in) in diameter. Any restriction that results in less carbon storage is used. The amount of avoided runoff is calculated at the price of UAH 68,685/m³. A user−assigned weather station reported 0.0 inches of total annual precipitation. Eco will always use the hourly measurement that has the highest rainfall total, or the rainfall provided by the user if provided. The cost of pollution removal is calculated based

on prices of UAH 0.00. per metric ton (CO), UAH 0.00 per metric ton (O3), UAH 0.00 per metric ton (NO2), UAH 0.00 per metric ton (SO2), UAH 0.00 per metric ton (PM2, 5), UAH 0.00 per metric ton (PM10*). Replacement cost is the estimated local cost of replacing a tree with a similar tree. A value of zero may indicate that supporting data (pollution, weather, energy, etc.) is not available for that location, or that the reported volumes are too small to display.

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APPLICATIONS

Application 1

Table 1

Inventory number	Biological species	Diameter of the trunk, m	Height (total), m	Height of a living tree, m	Height to the lower edge of the crown, m	Crown diameter N−S, m	Crown diameter Ж−Ж, m	Missing part of the crown, %	Dying, dry branches, %	Crown lighting (from 0 to 5)
D001	Magnolia	0,032	1,4	1,4	0,5	1,1	1,3	15	0	5
D002A	Sakura	0,1	1,4	1,4	0,3	0,9	0,85	20	0	5
D002B	Sakura	0,2	1,4	1,4	0,3	0,9	0,85	20	0	5
D002C	Sakura	0,15	1,4	1,4	0,3	0,9	0,85	20	0	5
D004A	Sakura	0,045	2,95	2,95	0,3	0,9	0,85	20	0	5
D004B	Sakura	0,025	2,95	2,95	0,3	0,9	0,85	20	0	5
D004C	Sakura	0,03	2,95	2,95	0,3	0,9	0,85	20	0	5
D004D	Sakura	0,024	2,95	2,95	0,3	0,9	0,85	20	0	5
D004E	Sakura	0,032	2,95	2,95	0,3	0,9	0,85	20	0	5
D004F	Sakura	0,035	2,95	2,95	0,3	0,9	0,85	20	0	5
D004G	Sakura	0,033	2,95	2,95	0,3	0,9	0,85	20	0	5
D004H	Sakura	0,018	2,95	2,95	0,3	0,9	0,85	20	0	5
D004I	Sakura	0,02	2,95	2,95	0,3	1,9	1,9	20	5	5
D005A	Sakura	0,033	1,4	1,4	0,3	0,7	0,7	90	30	5
D005B	Sakura	0,019	1,4	1,4	0,3	0,7	0,7	90	30	5
D006A	Apricot	0,153	8	8	0,3	6,7	7,4	5	5	3
D006B	Apricot	0,194	8	8	0,3	6,7	7,4	5	5	3
D008A	Apricot	0,124	5,5	5,5	0,6	3,3	5,2	20	5	2
D008B	Apricot	0,105	5,5	5,5	0,6	3,3	5,2	20	5	2
D009	Apricot	0,143	3,5	3,5	0,2	4,9	4,7	5	0	4
D010	Nut	0,035	1,6	1,6	0,6	1,5	1,7	25	0	5
D011A	Nut	0,043	6	6	0,7	5,9	5,5	10	0	5
D011B	Nut	0,078	6	6	0,7	5,9	5,5	10	0	5
D011C	Nut	0,076	6	6	0,7	5,9	5,5	10	0	5
D011D	Nut	0,067	6	6	0,7	5,9	5,5	10	0	5
D011E	Nut	0,045	6	6	0,7	5,9	5,5	10	0	5
D013A	Nut	0,115	6	6	0,5	5,5	5,5	10	0	5
D013B	Nut	0,102	6	6	0,5	5,5	5,5	10	0	5
D013C	Nut	0,064	6	6	0,5	5,5	5,5	10	0	5
Inventory number	Biological species	Diameter of the trunk, m	Height (total), m	Height of a living tree, m	Height to the lower edge of the crown, m	Crown diameter N−S, m	Crown diameter Ж−Ж, m	Missing part of the crown, %	Dying, dry branches, %	Crown lighting (from 0 to 5)
D014C	Nut	0,172	9	9	1	11,6	10,2	10	0	3
D014D	Nut	0,151	9	9	1	11,6	10,2	10	0	3

D014E	Nut	0,196	9	9	1	11,6	10,2	10	0	3
D016A	Sakura	0,045	3,4	3,4	0,5	1,2	0,9	5	5	5
D016B	Sakura	0,041	3,4	3,4	0,5	1,2	0,9	5	5	5
D016C	Sakura	0,071	3,4	3,4	0,5	1,2	0,9	5	5	5
D017A	Magnolia	0,027	1,1	1,1	0,5	1,2	0,9	5	5	5
D017B	Magnolia	0,015	1,1	1,1	0	60	65	20	5	5
D018A	Magnolia	0,017	1,15	1,15	0	0,7	0,8	20	0	5
D018B	Magnolia	0,016	1,15	1,15	0	0,7	0,8	20	0	5
D018C	Magnolia	0,016	1,15	1,15	0	0,7	0,8	20	0	5
D019A	Magnolia	0,015	1,2	1,2	0,2	0,6	0,7	40	0	5
D019B	Magnolia	0,023	1,2	1,2	0,2	0,6	0,7	40	0	5
D020	Spruce	0,11	6	6	0	3,2	2,8	0	0	5
D021	Pear	0,392	10,5	10,5	2	6,2	7,8	30	5	4
D022	Nut	0,43	11	11	2,5	11,8	13	30	5	4
D024A	Nut	0,315	11	11	1,5	13	12,7	10	5	5
D024B	Nut	0,373	11	11	1,5	13	12,7	10	5	5
D024C	Nut	0,366	11	11	1,5	13	12,7	10	5	5
D025	Pear	0,586	12	12	1,5	9	8,3	25	5	5
D026	Cherry	0,366	11	11	1,5	9,2	9,2	25	0	4
D030	Sakura Kanzan	0,017	1,55	1,55	0,75	0,5	1	40	0	4
D031A	Sakura Kanzan	0,02	2	2	0,6	0,8	0,9	20	0	5
D031B	Sakura Kanzan	0,025	2	2	0,6	0,8	0,9	20	0	5
D031C	Sakura Kanzan	0,014	2	2	0,6	0,8	0,9	20	0	5
D032A	Sakura Kanzan	0,03	2,2	2,2	0,7	1,2	1,6	30	0	5

Inventory number	**Biological species**	**Diameter of the trunk, m**	**Height (total), m**	**Height of a living tree, m**	**Height to the lower edge of the crown, m**	**Crown diameter N−S, m**	**Crown diameter Ж−Ж, m**	**Missing part of the crown, %**	**Dying, dry branches, %**	**Crown ighting (from 0 to 5)**
D031C	Sakura Kanzan	0,014	2	2	0,6	0,8	0,9	20	0	5
D032A	Sakura Kanzan	0,03	2,2	2,2	0,7	1,2	1,6	30	0	5
D032B	Sakura	0,014	2,2	2,2	0,7	1,2	1,6	30	0	5

	Kanzan									
D033A	Sakura Kanzan	0,033	3,1	3,1	0,7	1,2	1,2	30	0	5
D033B	Sakura Kanzan	0,033	3,1	3,1	0,7	1,2	1,2	30	0	5
D034A	Sakura Kanzan	0,023	1,6	1,6	0,6	0,6	0,6	30	0	5
D034B	Sakura Kanzan	0,012	1,6	1,6	0,6	0,6	0,6	30	0	5
D036A	Sakura Kanzan	0,055	3,3	3,3	0,3	2	2,1	25	0	5
D036B	Sakura Kanzan	0,022	3,3	3,3	0,3	2	2,1	25	0	5
D036C	Sakura Kanzan	0,024	3,3	3,3	0,3	2	2,1	25	0	5
D036D	Sakura Kanzan	0,03	3,3	3,3	0,3	2	2,1	25	0	5
D036E	Sakura Kanzan	0,017	3,3	3,3	0,3	2	2,1	25	0	5
D036F	Sakura Kanzan	0,025	3,3	3,3	0,3	2	2,1	25	0	5
D037A	Sakura Kanzan	0,019	2,5	2,5	0,5	1,3	1,2	25	0	5
D037B	Sakura Kanzan	0,025	2,5	2,5	0,5	1,3	1,2	25	0	5
D037C	Sakura Kanzan	0,048	2,5	2,5	0,5	1,3	1,2	25	0	5
D037D	Sakura Kanzan	0,043	2,5	2,5	0,5	1,3	1,2	25	0	5
D038A	Magnolia	0,012	1,1	1,1	0	0,8	0,9	20	5	5
D038B	Magnolia	0,012	1,1	1,1	0	0,8	0,9	20	5	5

Inventory number	**Biological species**	**Diameter of the trunk, m**	**Height (total), m**	**Height of a living tree, m**	**Height to the lower edge of the crown, m**	**Crown diameter N−S, m**	**Crown diameter Ж−Ж, m**	**Missing part of the crown, %**	**Dying, dry branches, %**	**Crown lighting (from 0 to 5)**
D038B	Magnolia	0,018	1,1	1,1	0	0,8	0,9	20	5	5
D038C	Magnolia	0,014	1,1	1,1	0	0,8	0,9	20	5	5
D038D	Magnolia	0,018	1,1	1,1	0	0,8	0,9	20	5	5
D039A	Magnolia	0,019	1,3	1,3	0	0,9	0,9	25	5	5

D039B	Magnolia	0,015	1,3	1,3	0	0,9	0,9	25	5	5
D039C	Magnolia	0,023	1,3	1,3	0	0,9	0,9	25	5	5
D040A	Magnolia	0,01	0,8	0,8	0	0,6	0,6	5	5	5
D040B	Magnolia	0,007	0,8	0,8	0	0,6	0,6	5	5	5
D040C	Magnolia	0,007	0,8	0,8	0	0,6	0,6	5	5	5
D040G	Magnolia	0,019	0,8	0,8	0	0,6	0,6	5	5	5
D041A	Nut	0,541	14	14	2	15	10,7	25	5	5
D041B	Nut	0,594	14	14	2	15	10,7	25	5	5
D042	Pear	0,471	9,5	9,5	1,7	9,5	10	35	5	5
D043A	Nut	0,439	14	14	2,5	18,5	16,5	5	5	5
D043B	Nut	0,449	14	14	2,5	18,5	16,5	5	5	5
D035B	Pear	0,153	7,5	7,5	1,5	6	5	25	10	5
D044	Balsamic fir	0,226	9	9	0,5	3,8	1,3	10	0	4
D045	Balsamic fir	0,192	9	9	0,5	3,8	1,3	10	0	3
D046	Balsamic fir	0,134	7	7	0,5	3,8	1,3	10	0	3
D047	Balsamic fir	0,201	8	8	0,5	3,8	1,3	10	0	3
D048	Balsamic fir	0,175	8	8	0,5	3,8	1,3	10	0	3
D049	Balsamic fir	0,146	7	7	0,5	3,8	1,3	10	0	3
D050A	Balsamic fir	0,14	7	7	0,5	3,8	1,3	10	0	3
D050B	Balsamic fir	0,08	7	7	0,5	3,8	1,3	10	0	3
D051A	Balsamic fir	0,156	8	8	0,5	3,8	1,3	10	0	3
D051C	Balsamic fir	0,172	8	8	0,5	3,8	1,3	10	0	3
D052	Balsamic fir	0,153	8	8	0,5	3,8	1,3	10	0	3
D053	Balsamic fir	0,14	8	8	0,5	3,8	1,3	10	0	3

Inventory number	Biological species	Diameter of the trunk, m	Height (total), m	Height of a living tree, m	Height to the lower edge of the crown, m	Crown diameter N−S, m	Crown diameter Ж−Ж, m	Missing part of the crown, %	Dying, dry branches, %	Crown lighting (from 0 to 5)
D055	Balsamic fir	0,105	6	6	0,5	3,8	1,3	10	0	3
D056	Balsamic fir	0,213	9	9	0,5	3,8	1,3	10	0	3
D057	Balsamic fir	0,131	7	7	0,5	3,8	1,3	10	0	3
D058	Balsamic fir	0,239	7	7	0,5	3,8	1,3	10	0	4
D059	Cherry	0,414	8	8	2	10	8,5	15	5	5
D060	Spruce dove	0,274	12	12	0,5	5	3,1	0	0	4
D061	Spruce dove	0,261	12	12	0,5	5	3,1	0	0	3
D062	Spruce dove	0,315	12	12	0,5	5	3,1	0	0	3

D063	Spruce dove	0,296	12	12	0,5	5	3,1	0	0	4