Environmental information system for monitoring landscaping objects

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Abstract. Today, as a result of the ongoing processes that take place in production, many pollutants enter the atmosphere, which have a negative impact on the environment. The city has accumulated many environmental problems, and the population is not fully aware of these gaps. And also for their solution, for the optimal organization of the activities of various management structures, complex cartographic information is needed. The relevance of the topic being developed is due to the fact that landscaping and gardening is the most important area of activity of the municipal economy. The tasks of optimizing the ecological urban environment, eliminating the consequences of negative impact on the environment, planning various natural-economic and sanitary-hygienic works, as well as the accumulation, processing and provision of information through the introduction of an ecological information system are being solved. The goal is to increase the level of ecology of the city by introducing a balanced ecological system of landscaping, combining urban and suburban green spaces; in the continuity of the processes of its qualitative renewal in space and time.

1. Introduction

With the growth of the city, the development of industry, the problem of environmental protection, creating conditions for human life and activities is becoming more and more complex.

A systematic generalization of information on the state of the natural environment, ecological problems in Krasnoyarsk is necessary both for substantiating environmental programs and making managerial decisions, and for wide acquaintance with this problem of city residents, representatives of environmental organizations and social movements.

An important component of the territory management process is the cartographic support of environmental monitoring. Environmental monitoring should be viewed not only as monitoring the pollution of environmental objects, but also as monitoring green spaces, which is very important in creating an optimal city environment.

The adoption of management decisions by the relevant supervisory and governing bodies in order to optimize the anthropogenic load on the environment, improve the living environment of the population and the city's greening system is possible on the basis of an ecological information system by integrating information, integrating structures, integrating solutions.

At the moment, there are a number of similar ecological information systems for monitoring green spaces, which solve this problem.
For example, the software and analytical system "Environmental Monitoring" of the Kaluga region. This system functions as a website and is used for the collection, analytical processing and presentation of information on the state of the environment only in the Kaluga region.

The implementation of the Vienna tree map project looks much more attractive and the interface is more user-friendly. It is possible to select the desired tree on the map and find out this information: number, address, name, planting date, height, trunk and crown girth.

The advantage of this project is the ability to download a list of all trees with all related information.

However, this system has a number of disadvantages: the map is not optimized, the objects overlap. The interface is overloaded with various functions, which makes it difficult to select the desired object.

Most of these ecological systems and environmental monitoring have little functionality, lack of usability, or are narrowly focused on the geographical location of the monitoring area.

The main goal of this work is to develop the ecological system of the city of Krasnoyarsk. This project will allow you to track up-to-date information about the state of the environment and display up-to-date data on the environmental situation for certain periods of time, which allows you to analyze the ongoing environmental situation in the city in real time and timely organize measures to improve it.

Thus, this will make it possible to promptly identify the causes and mechanisms of disturbance in the stability of urban plantings, taking into account the dynamic changes in the environment, to analyze and predict environmental situations, and use this information to substantiate effective technological and managerial decisions and conduct environmental expertise of projects.

2. Methods

Environmental Information System (EIS) - systems for storing, processing, transforming, transmitting and updating information about the environment using computer and other equipment.

Environmental monitoring is an information system for observing, assessing and forecasting changes in the state of the environment, created to highlight the anthropogenic component of these changes against the background of natural processes, which is presented in the form of a block diagram in figure 1 [1].

![Figure 1. Monitoring system block diagram.](image)

The main goal of environmental monitoring is to provide a management system for environmental protection and environmental safety, based on timely and reliable information.

In the EIS, three levels can be distinguished, focused on solving various problems of environmental monitoring and differing in the methods of working with environmental information. The upper level is made up of software modules to support decision-making, the middle is software that allows a systematic analysis of information about the state of the environment, and the lower level is the modules for processing primary environmental information [2].

The architecture of the environmental monitoring system is shown in figure 2.
Figure 2. The architecture of the environmental monitoring system.

The information-measuring part is a set of sensors, gas analyzers, necessary for measuring the state of air in park areas to assess its quality. This is necessary in order to be able to predict changes in the life state of the tree in the future, since air quality directly affects the life state of the planting object [3].

An information and measurement network that unites control points must be concentrated within one territory.

The data transmission network provides data transmission information to the monitoring center for further processing of the results. The network can be built using wireless communication devices.

The monitoring center is a device united into one local Ethernet network, which will perform the function of receiving and transmitting information among users on decisive issues of environmental control (figure 2). The data received from the sensors are transmitted to the server and loaded into the database. Then in real time we can observe the record of the last air quality measurement.

It is best to use a GPS tracker to determine the coordinates of the location of the landscaping object. The function of this module is to transmit the signal received by the receiver with coordinates to a computer or smartphone. It is according to the coordinates obtained from the GPS tracker that the point on the map of the landscaping object will be located [4].

Figure 3. Block diagram of the measuring part.

With the help of the system of accumulating the history of the measurement process, it is possible to track the readings of the instruments for any period of time.
In the process of monitoring the state of urban landscaping objects, the following stages are performed:

1) observation and data acquisition - measurements and accounting (passport of the landscaping object);
2) mapping of the planting object;
3) interactive layout of the landscaping object.

Mapping and creation of an interactive layout is carried out on the basis of specialized information and analytical monitoring systems.

The database for monitoring the state of urban greening objects should be based on an electronic map of the city and its greening objects.

Monitoring of landscaping objects begins with the procedure for selecting an object and examining its condition.

The condition of woody plants is determined using photographic or video equipment and a specially designed scale bar. A photograph is taken for each woody plant. The height and diameter of the crown from photographs is determined by the Compass 3D v 10 program (with a scale correction). The trunk diameter at a height of 1.3 m is determined through the circumference \( D = 2\pi R \). Crown projection area \( S_{kr} = \pi R^2 \). Phyto saturation is determined from photographic materials in the program "Fractal analysis of phyto saturation of crowns of woody plants" [5]. The object's vital state is filled in according to table 1.

| Score | Condition assessment | Key features | Shrubs |
|-------|----------------------|--------------|--------|
|       |                      | Trees        | Shrub  |
| 1     | Excellent            | Woody plants are healthy, with a well-developed crown and branches without any noticeable damage, with dense foliage, with large juicy green leaves. Perform their functions | Plants are healthy without signs of damage and develop a normal bush. High decorativeness. |
| 2     | Good                 | Woody plants look healthy, but with an irregularly developing crown, with a slightly curved trunk. | Plants with the presence of overgrown, with the presence of partial damage by pests, small foliage, the appearance of dry shoots (up to 12 ... 15%). |
| 3     | Fair                 | Significant, but not life-threatening injuries or wounds, with branches having dry shoots (up to 10 ... 15%). Urgent care is required. | Plants with the presence of overgrown, with the presence of partial damage by pests, small foliage, the appearance of dry shoots (up to 15 ... 40%). While performing their functions, however, they need urgent care and elimination of deficiencies. |
|   | Unsuccessful | Extremely unsatisfactory |
|---|--------------|-------------------------|
| 4 | Woody plants with a deformed crown, with the presence of dry shoots and branches, with small and pale foliage, with a curved trunk. | Shrubs have overgrowth, dry shoots (up to 60%) and skeletal branches, small foliage. |
| 5 | Plants with wounds and signs of fungal diseases, with infestation with pests that threaten their lives. The question is raised about removing and replacing. | Shrubs have overgrowth, dry shoots (up to 60%) and skeletal branches, small foliage, the appearance is oppressed, the decorative appearance is lost, a plant replacement is required. |

3. Results
This project is a consolidation of data on street trees in the city from their existing information, collected earlier in excel tables.

On the map, different types of trees are marked with different colors (figure 4), indicating the vital state of the object (good, satisfactory, unsatisfactory). When you click on an object, information is provided: name, time of addition, coordinates, trunk diameter, crown diameter, tree height and other main characteristics (figure 5,6) [6].

![Tree Analysis System](image)

**Figure 4.** EIS working area.
**Figure 5.** Pop-up window with brief information about the tree.

**Figure 6.** Window for viewing detailed information about the tree.
4. Conclusion
The result of the work done testifies that the implemented prototype of such an information resource will automate the process of collecting information about the greening objects of the city of Krasnoyarsk and will improve the ecological situation in the city.

As a result of the research, the following scientific and practical results were obtained:

- the basic concept of the system was formulated;
- were formulated the pros and cons of analogs;
- the design was carried out;
- the functionality of the system prototype was implemented.

In the future, it is planned to create wider functionality and the ability for users to customize the system for themselves: add the markers they need on the maps, filtering data, tabular access to the list of trees, as well as a moderator panel, which would allow more extensive and convenient work with data.

References
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