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ORGANIZATION OF GEOINFORMATION MONITORING OF GEOSPATIAL DATA OF GREEN PLANTS OF THE STREET AND ROAD NETWORK OF THE CITY OF ODESA

The purpose of this work is the introduction of a permanent system of real-time observations of green spaces to update geospatial data. Methodology: To achieve this goal, we monitored green spaces with the help of GIS technologies, displaying up-to-date information for each plant and storing the history of changes in each object. This work is divided into two stages. The first stage involves making an inventory of green spaces and compiling an object passport. The second stage involves making real-time changes such as planting, pruning, uprooting a stump, damage due to natural disasters, etc. Thus, there is a database of green plants at any point in time and a chronology of plant care. By incorporating green spaces into the National Spatial Data Infrastructure (NSDI) using consistent methods, we can better understand their impact. Digital topographic data is essential in geoinformation systems for making informed management decisions, creating and maintaining cadastres for various purposes. Scientific novelty and practical significance: The issues of accounting for green spaces in settlements are becoming quite acute in the modern world. Equally important is the issue of maintaining the relevance of the data obtained. The geoportal, "Monitoring of green spaces in the city of Odesa," implements a permanent system of continuous observations to update the geospatial data of green spaces, and tracks changes for each individual tree. This will help in making management decisions regarding urban greening, significantly reduce budget costs for green management in the future, and control the quantity and quality of the work performed.

Key words: inventory of green spaces, GIS, geoportals, green spaces, urban forest, monitoring of green spaces.

Introduction

Green spaces play an important role in the urban environment. As with any resource, they must be taken into consideration. According to the law, local governments evaluate green spaces. It is regulated with "The Inventory Instruction for Green Spaces in Populated Areas of Ukraine," and approved by the order of the State Committee for Construction, Architecture and Housing Policy of Ukraine dated December 24, 2001 No. 226. The inventory of green spaces is accompanied by the compilation of a register of green spaces in the locality. According to Clause 14.2.4 of the Order of the Ministry of Construction, Architecture and Housing and Utilities of Ukraine's "On Approval of the Rules for the Maintenance of Green Spaces in Settlements of Ukraine" dated April 10, 2006, No. 105 [Order of the Ministry of Construction, 2006], these registers are updated at state or municipal property landscaping facilities once per 2 years and in other territories once per 5 years. Thus, it is quite sufficient for the legislature to conduct an inventory, summarize the data in the register, and then wait 2 or 5 years to re-survey the current changes. In this day and age, modern GIS monito-ring enables real-time tracking of changes as they happen. This makes it a more cost-effective and efficient way of keeping plant records, as it eliminates the need for additional funding every 2 or 5 years and provides the community with an up-to-date database at any time.

Goal

The purpose of this work is to develop a constantly operating system of continuous observations of green areas to update geospatial data.

Research Methodology

To achieve this goal, the monitoring system of green spaces with the help of GIS technologies was implemented. It displays up-to-date information for each object and stores its history of changes. The work is divided into several stages. The first stage involves conducting an inventory of green spaces and drawing up a passport of the object. The second is making changes that take place in real-time, such

as planting, pruning, uprooting the stump, damage due to natural disasters, etc. Thus, there is a database of green farming at any moment in time and a chronology of plant care.

By using consistent methods, this approach enables us to include green spaces as a potential element of the National Spatial Data Infrastructure (NSDI). The fundamental principles of digital topographic data relevance are crucial in geoinformation systems as they support management decision-making. They also play a critical role in the automated creation and maintenance of cadastres for different objectives. [Karpinskyi, & Lyashchenko, 2006].

According to the methods of implementation, monitoring is divided into cartographic and geoinformational. Nowadays the segment of production of traditional analog maps on solid media has decreased, and the need for digital and electronic topographic maps has increased many times over. This necessitates a rethinking of the traditional and analysis of additional requirements for topographic maps. Traditional requirements for measuring and visual properties are inherited from the classic map view: relevance, reliability, accuracy, and visibility. At the same time, digital and electronic maps impose additional requirements. They, first of all, include the requirements for the internal structure – the spatial scheme of the geospatial database. A current trend in defining the role and functions of topographic mapping in NSDI is to move beyond traditional maps that simply display information about an area. Instead, the focus is on creating a geospatial database and knowledge.

Thus, a topographic map in traditional, digital or electronic form is the result of a technical request to the topographic database. [Lyashchenko & Cherin, 2011; Karpinskyi & Lazorenko-Hevel, 2020; Kainz, 1987].

According to the frequency, the Topographic Monitoring (TM) is uninterrupted, systematic, and periodic [Karpinskyi, et al., 2011]. Monitoring special objects is characterized by the use of special sensors and devices, including permanent GNSS stations that conduct round-the-clock continuous monitoring of the state of these objects. Systematic monitoring is conducted according to a special plan and rules. According to these rules, object-oriented TM is performed on the basis of mandatory executive surveys of construction objects. Periodic monitoring underlies the current system for updating topographic maps that regulate the frequency of surveying [Karpinskyi, et al., 2011].

Thus, geospatial data on green space objects are subject to traditional cartographic requirements:
– relevance and reliability;
– accuracy;
– detail and informativeness;
– visibility.

The transition from a cartographic paradigm to a geo-information paradigm involves additional requirements:
– formation of the geospatial database as the core of the geoinformation system;
– the geospatial database should not depend on the GIS platform;
– all digital maps are compiled as a result of a request to the topographic database;
– formation of spatial schemes;
– description of the internal structure of the model;
– rules for the digital description of geospatial objects;
– creating a catalog of objects and their attributes;
– topological consistency of geometry;
– metadata formation;
– integration of topographical and thematic data [Lyashchenko & Cherin, 2011; Karpinskyi & Lazorenko-Hevel, 2020; Kent & Hopfstock, 2018];
– transition from cartometric operations to analytical operations of geoinformation modeling [Karpinskyi, & Kin, 2020].

Given the growing cost of making managerial decisions, the requirements for data reliability and their updates are of particular relevance. Updating geospatial data, particularly data on green spaces, is carried out as a result of the introduction of geoinformation monitoring. Changes occur every day since green space is not a sustainable pattern. Using the capabilities of GIS, it is quite possible to display the current state of green spaces with the recording of each element's history of changes. This will make it possible to monitor changes, plan rational approaches to the management of green resources, and draw conclusions about the expediency of these decisions.

This article considers the practical implementation of updating geospatial data on green spaces of the street and road network of the city of Odesa. It is based on the organization of special geoinformation monitoring on the geoportal "Monitoring of Green Spaces of the City of Odesa" developed by the SOFTPRO company with the participation of K. P. Bakova [Monitoring of green spaces … https://greencity.omr.gov.ua] [Bakova & Karpinskyi, 2022; Lyashchenko, 2002].

Research results

With the development of modern information technologies, the process of renewing passports can be continuous. A software product was developed where, through the "add event" function, it is possible to change the status of green space when it happens in real life (Fig. 1).

Thus, when changes occur to a tree, such as damage as a result of natural disasters, planned or unplanned pruning, removal of a tree, uprooting a stump, planting, etc., they are recorded in the database with a display of the date, type of event and photo (Fig. 2). If necessary, the attributes of the passport are changed at the green space.

In this way, the map shows the current state of the city's green spaces. Also, the database tracks the changes that have occurred in the context of each tree place. For example, a stump was inventoried on April 26, 2021 at 9, Deribasovska Street. On December 4, 2021, it was uprooted, and a Linden was planted on February 18, 2022.

We can keep track of what happened using reports. So, if we compile a report on all uprooted stumps for December 4, we will get the number and location of 8 stumps that were uprooted on that day. That is, there are 8 places for planting young trees (Fig. 3).

In the same way, the care of plantings is kept. At the end of April, trees in the central part of the city were trimmed. All works were entered into the database with a reflection of the type of work, the date of the event, the manufacturer of the work, the percentage of crown pruning, and a photo (Fig. 4). Photos of objects can be taken without reference to an event, so this is an additional tool for visually tracking changes that occur with trees.

Scientific novelty and practical significance

The issues of accounting for green spaces in settlements are quite acute in the modern world. Equally important is the issue of maintaining the relevance of the data obtained. The geoportal "Monitoring of green spaces in the city of Odesa," implements a permanent system of continuous observations to update the geospatial data of green spaces and tracks changes for each individual tree [Lyashchenko & Cherin, 2011]. This will help in making management decisions on urban planting, significantly reduce budgetary expenses for the care of green farming in the future, and control the quantity and quality of the work being done.

Fig. 1. Types of events recorded in the system

Fig. 2. Recording current changes in the status of green space

Fig. 3. Report on the events that took place

Conclusions

The geoportal "Monitoring of Green Spaces in the City of Odesa" has brought about a consistent system of ongoing observations to keep the geospatial data of green spaces in the street and road network up-to-date. Its main purpose is to evaluate and forecast the changes in the state of these areas, which would help identify the nature of the effects of natural and human factors that lead to negative changes. The system also provides recommendations to mitigate or eliminate such negative impacts. This permanent updating system, unlike one-time periodic inventories of green spaces, allows tracking their condition almost simultaneously with changes in the terrain. One of the main factors of the effective functioning of the Geoportal on the Internet https://greencity.omr.gov.ua is its publicity and the possibility of involving the public in assessing the condition of green spaces.

Furthermore, a geoinformation solution has been implemented to enable the formation of retro data through an event mechanism. This offers the chance to identify trends in the expansion or degradation of not only green zones but also the historical changes of almost every plant recorded in the system. The retro data function allows for a comprehensive analysis of plant data, which can provide valuable insights.

Fig. 4. Display of the "trimming" event in the database and photo of changes

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ОРГАНІЗАЦІЯ ГЕОІНФОРМАЦІЙНОГО МОНІТОРИНГУ ГЕОПРОСТОРОВИХ ДАНИХ ЗЕЛЕНИХ НАСАДЖЕНЬ ВУЛИЧНО-ДОРОЖНЬОЇ МЕРЕЖІ МІСТА ОДЕСА

Мета цієї роботи – впровадження постійно діючої системи безперервних спостережень за зеленими насадженнями з оновлення геопросторових даних. Методика. Для реалізації поставленої мети за допомогою ГІС технологій запроваджено моніторинг зелених насаджень, де щодо кожного насадження відображається актуальна інформація та зберігається історія змін кожного об'єкта. Зазначені роботи поділяються на декілька етапів. Перший етап передбачає проведення інвентаризації зелених насаджень та складання паспорту об'єкта, другий – внесення змін, які відбуваються в реальний момент часу, на кшталт посадки, обрізки, корчування пня, пошкодження внаслідок стихійних лих тощо. Таким чином, маємо базу даних зеленого господарства на будь-який момент часу та хронологію догляду за рослинами. Такий підхід дає змогу розглядати облік зелених насаджень як можливу складову Національній інфраструктурі геопросторових даних (НІГД) та використовувати ті ж методи, адже принципи актуальності цифрових топографічних даних є базовими в геоінформаційних системах підтримки прийняття управлінських рішень, у системах автоматизованого створення й ведення кадастрів різного призначення. Наукова новизна та практична значущість. Питання обліку зелених насаджень населених пунктів є актуальним у сучасному світі. Не менш важливим є питання підтримання актуальності отриманих даних. За допомогою геопорталу "Моніторинг зелених насаджень міста Одеса" забезпечено впровадження постійно діючої системи безперервних спостережень з оновлення геопросторових даних зелених насаджень та можливістю відслідкувати зміни щодо кожного окремого дерева. Це допоможе у прийнятті управлінських рішень щодо озеленення міст, значно скоротити бюджетні витрати на догляд за зеленим господарством у майбутньому, контролювати кількість та якість проведених робіт.

Ключові слова: інвентаризація зелених насаджень, ГІС, геопортали, зелені насадження, вуличні насадження, моніторинг зелених насаджень.