ONLINE APP FOR THE EVALUATION OF CLIMATE CHANGE IMPACT IN URBAN GREEN AREAS

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ABSTRACT

Information and Communication Technologies (ICTs) play an important role in addressing the major challenges related with climate change and sustainable development. ICTs are tools for the monitoring of climate change, the mitigating and adapting to its effects contributing at the same time to the development of the green economy. Green development is a proposal for a new kind of pioneering development, where the environment and quality is not a parameter or another industry policy, but the main axis and basis of an innovative and alternative development plan of a country in the global socioeconomics. According to researches, the air temperature shows an increasing trend in recent years. Urban trees have an important value in urban ecosystems because they are carbon sinks and they help urban areas to mitigate the impacts of climate change. Nowadays, the new information technologies (ICTs) and their services are modern tools via them a big amount of knowledge and data can be transferred. These tools promote new improved relationships between people and environment that is necessary for a sustainable natural environment. They also provide benefits for both recipients. Aim of this paper is to describe the online app which was constructed within the framework of the project LIFE CliVut (Climate Value of Urban Trees) LIFE18 GIC/IT/001217 and the process by which the phenological data is entered into the app. Online app (lifeclivut.treedb.eu) is a modern tool, an online database that provides data on the behavior of urban trees in climatic conditions via the science of phenology to both experts and citizens. Experts can monitor the behavior of the trees and shrubs over the years and they also will detect changes that happens in the urban species immediately. Online database app was created to be used as a user-friendly tool for environmentalists, biologists, foresters, urban planners, landscape architects, local authorities, aiming to support urban green. This app will help experts to compare data that entered in years and derive results that shows the impact of climate change in phenological stages of urban trees.

KEYWORDS

Climate Change, Urban Areas, Urban Trees, Online App, Phenology, ICTs

1. INTRODUCTION

Green Informatics is a new term in the science of information that describes the utilization of informatics in the frame of the natural environment and the natural resources taking into consideration sustainability and sustainable development (Andreopoulou, 2012). New technologies have significantly entered our lives and online services offer the opportunity for sustainable regional development. Electronic services offered by the new Information and Communication Technologies (ICT's), have proved an important decision making tool (Kirkenidis and Andreopoulou, 2015). Literature suggests that introducing IT tools into urban design provokes a new paradigm that involves new modes of thinking that would increase the quality of the design and decision-making process (Al Douri, 2022). The rapid development and global spread of modern information and communication technology (ICT) led to the implementation of its applications to agroforestry. One of the most important benefits of using ICT is the dissemination of knowledge to extension agencies via appropriate information models can be fed back to the international agroforestry community on research or policy making level (Andreopoulou et. al., 2011). The benefits of Green Informatics are the reduction of energy consumption, the rise of environmental awareness, the effective communication for environmental issues and the environmental monitoring and surveillance systems, as a means to protect and restore natural ecosystems potential (Andreopoulou, 2012). Plant Phenology is the scientific study of biological stages, such as flowering, leaf unfolding, seed set, and senescence in relation to climatic conditions (Davi et. all, 2011). Environmental factors such as temperature and humidity can affect phenological stages (Rousi et. all, 2011). Climate change

affects bioclimatic conditions during the growing period of trees (Meier et. all. 2011; Farooq and Meraj, 2016). Global warming is disrupting the phenological phases (Paltineanu and Chitu, 2020) The time of leaf development, the time of the beginning of flowering, the time of development of fruit, the time of leaf fall are the main phenological stages (Davi et. all, 2011). The recording of the start date of phenological stages and relating them to temperature has an important role in plant phenology study (Tiwari et. all 2021). The sensitivity of phenology to temperature changes makes it an indicator of vegetation response to environmental changes and can be used to monitor the effects of climate change globally (Garcia and Townsend, 2016). As phenology is an indicator to detect climate variability and climate change the monitoring of phenophases of species is important to extract results for climate change. So, the online app in which the data is entered is an important tool that contributes to the processing and extraction of the results. The LIFE CliVUT (LIFE18 GIC/IT/001217) project is coordinated for Greece by the Forestry Laboratory of the Department of Forestry and Natural Environment of the Aristotle University of Thessaloniki. A key objective of the project is to leverage academic expertise to better assess the importance of urban green in climate change mitigation and CO_2 sequestration dynamics. The project partners are the University of Perugia, the Municipalities of Bologna and Perugia, the Italian Institute CESAR and the Portuguese Institute ISG. The main aim of LIFE CLIVUT project is to develop and implement a Strategic Management of Urban Green Spaces, with focusing on the mitigation of Climate Change, adapted to medium-sized Mediterranean cities. Aim of this paper is to enter the phenological data into a database so that it is easier to process them and correlate them over the years as the project provides for observation and data entry for at least 10 years.

2. CLIVUT APP DESCRIPTION

Online app, a tree database, was constructed via the project LIFE CliVut LIFE18 GIC/IT/001217 and contains the data of the monitoring of the phenological stages of the urban trees in the three Phenological Monitoring Areas that also was created within the framework of the same project. Each PMAs contains 100 individuals (5 per species), 10 species of trees and 10 species of shrubs. The forest species are presented in Table 1. The tree database includes: Plant census database which contains the specific dendrometric data for each tree as a botanical species, tree height etc. The phenological data carried out by the trees present in the phenological monitoring areas (PMA), always identical by a genetic point of view, introduced in the public parks. Environmental behaviors of each individual tree species in terms of GHG absorption, particulate matter absorption, shadow effect, biodiversity increase. Georeferenced data of the urban green asset available on the web by a specific GIS server, based on open source software.

Table 1. Species in Phenological Monitoring Areas

Trees		**Shrubs**	
Acer campestre	*Carpinus betulus*	*Spartium junceum*	*Phillyrea latifolia*
Tilia cordata	*Sorbus domestica*	*Euonymus europaeus*	*Salix caprea*
Quercus pubescnens	*Alnus glutinosa*	*Berberis vulgaris*	*Cornus sanguinea*
Quercus ilex	*Fraxinus angustifolia*	*Corylus avellana*	*Ligustrum vulgare*
Prunus avium	*Populus canescens*	*Sambucus nigra*	*Punica granatum*

Trees were planted at a distance of 5m from each other and shrubs were planted at a distance of 4m. The phenological stages of the plants were studied from March to December 2021 and throughout 2022 till now. For each individual, leaf development, flower development, development of fruit and leaf fall were recorded on a weekly basis taking into consideration BBCH scale. BBCH scale as a standard system for describing the phenological stages of plant development has been introduced by The Global Phenological Monitoring Network (Meier et. all 2009). Zadoks et al. (1974) developed the decimal code, which is divided into principal and secondary growth stages.

LIFE CLIVUT project has developed an online app which is available in lifeclivut.treedb.eu to increase knowledge about the trees in the cities and the awareness of their contribution to the environment and climate change mitigation. It is an innovative tool that allows to visualize the trees and their ecosystem contribution. The user can map the trees in an area, and with georeferenced information via GPS, including photos, the data can be acquired for the plant census. This app allows also to identify the best management techniques to maximize the tree climate functions. It reports the climatic and biodiversity value of the trees, for example the $C0_2$ storage per tree, or the PM10 captured. This reliable operative tool enables: Urban planner to design and implement effective Urban Climate Green Assets Strategy valuing all the factors related to environmental benefit, climatic effect, and socio-economic impact. Citizens to monitor and manage the private urban green area adopting climate-oriented and ecosystem-based approach. This app is available for computers, smartphones and tablets and it can be used by experts and citizens. Available application language is English and it is operating independent. There are specific instructions for using the application in the official site of LIFE CLIVUT project (www.lifeclivut.eu). To insert a tree with the necessary information it takes a little time at about 5 minutes. Till now 10 census areas of Thessaloniki exist in the database (Figure 1). There is information for the trees in the parks such as dendrometric characteristics, CO_2 absorption. The user can use other applications in order to recognize the species. Also, is easy to delete the tree in case wrong information was entered. The phenological data of the monitoring in the three PMAs can only be entered by experts. To insert phenological data of trees that exist in other areas, citizens must be trained. The time required for a complete training is about 3 hours. Till now about 200 citizens attended educational seminar about the application. It is expected that more than 10.000 citizens will participate to the plant census. Application related to the planting and management of trees in urban areas in the three countries. In this paper the input of phenological data is described. The home page of the online app is shown in Figure 2.

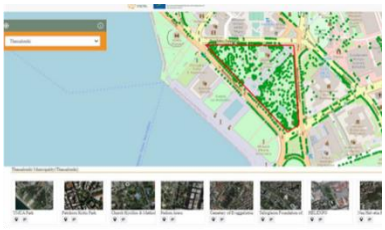

Figure 1. Census areas in Thessalonik

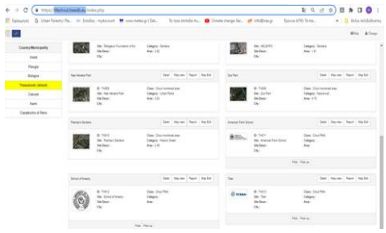

Figure 2. Home page of the online app

Then, we choose the PMA that we want to insert the data. There are two options: PMA and PMA list (Figure 3). The species appears in the left side. We choose the date and the species that we want to insert the data of the monitoring and then, we insert the data in the right stage (Figure 4 and 5). After, after entering the data of the monitoring of the species the information of the phenological montitoring is shown in aggregate for each species (Figure 6).

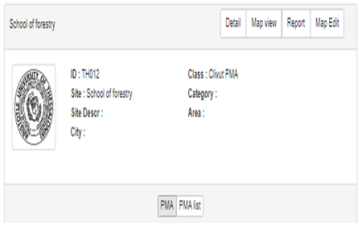

Figure 3. Options PMA and PMA list

Figure 4. Trees and shrubs list

Figure 5. Stages of species on specific dates

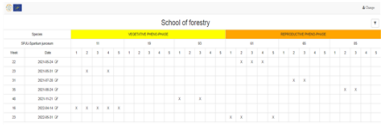

Figure 6. The data of the monitoring of trees and shrubs aggregated

3. CONCLUSION

In the LIFE Clivut web app the data from the phenological monitoring in the three PMAs are entered. The growth of trees and shrubs is clearly visible via the online app. This app shows the phenological stages of each species and provides the possibility for correlations and processing of the data depending on the climatic conditions. Decision making process is an important activity especially in designing of urban green spaces. So, a special attention has to be paid when making decisions in designing open green spaces in urban areas. Once the app is installed in a portable device, it is easy to be used. Therefore, end users of the app are not IT specialists, they do not need to have advanced computer literacy, as the app is especially designed to serve their needs and data registration is facilitated with pre-designed input boxes, with drop down menus of options. Thus, ICT could improve the decision-making in this sector.

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