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Research Article

The Impact of Climate Change in Phenophases of Forestry Species in Urban Areas

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Abstract

Urban areas are major contributors to climate change as they produce more than 70 per cent of greenhouse gas emissions and they also accept the impact of it. 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. Aim of this paper is to collect data about the impact of climate change on forestry species in urban areas via the monitoring of the science of phenology. Plant phenology is affected by temperature, solar radiation and water availability. The increase of temperature in recent years has affected the phenophases of the plants. Three Phenological Monitoring Areas (PMA) were created in three urban spaces in Thessaloniki, in December 2020, within the framework of the project LIFE CliVut (Climate Value of Urban Trees) LIFE18 GIC/IT/001217. Each PMA contains 20 species (10 species of trees and 10 species of shrubs), 100 individuals (5 individuals per species) in order to appreciate the impact of climate change to species. The monitoring of the phenological stages of the forestry species was carried out throughout a year on a weekly basis according to the protocol that was created in the frame of the project taking into consideration BBCH scale. In this paper, two years of data of one area are presented.

Keywords: Climate change; Phenophases; Monitoring; Urban areas; BBCH scale

Introduction

Phenology is the study of the temporal occurrence of biological events that repeat each year, the occurrence of which depends on biotic and abiotic factors [1,2]. Plant Phenology is the scientific study of biological stages, such as flowering, leaf unfolding, seed set, and senescence in relation to climatic conditions [3]. Environmental factors such as temperature and humidity can affect phenological stages [4,5]. Climate change affects bioclimatic conditions during the growing period of trees [6,7]. Temperature is the major abiotic factor that affects the phenological stages of the trees [8]. Global warming is disrupting the phenological phases [8,9]. 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 [3]. The recording of the start date of phenological stages and relating them to temperature has an important role in plant phenology study [10]. 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 [11,12]. 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.

Materials and Methods

The Phenological Monitoring Area was created in School of Forestry on December 2020, within the framework of the project LIFE CliVut (Climate Value of Urban Trees) LIFE18 GIC/IT/001217. It contains 100 individuals (5 per species), 10 species of trees and 10 species of shrubs. The forest species are presented in Table 1.

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 [13]. Zadoks et al. (1974) developed the decimal code, which is divided into principal and secondary growth stages [14]. (Table 2)

Table 1: Species in Phenological Monitoring Area in School of Forestry.

Species			
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*

Table 2: Stage Description-Code.

BBCH Stage	Description
BBCH11	Leaf unfolding (First leaves visible and unfolded): Looking a singular plant we would notice at least the 10% of the leaves as unfolded.
BBCH19	First adult leaf: Looking a singular plant we would notice the 90% of the leaves that have reached the complete morphological development (adult leaf).
BBCH93	Leaf senescence: Looking a singular plant we would notice the first fallen leaves (senescence).
BBCH61	Flowering beginning: Looking a singular plant we would notice at least the 10% of the flowers as open with evidence of anthers releasing pollen
BBCH65	Full Flowering: Looking a singular plant we would notice at least the 50% of the flowers as open with evidence of anthers releasing pollen.
BBCH85	Advanced ripening: increase in intensity of cultivar-specific color: Looking a singular plant we would notice the majority (>50%) of the fruits increasing their specific fruit color.

Results

Table 3: Data of trees in PMA in 2021 and 2022.

Species	School of Forestry					
Trees	(BBCH11)		(BBCH61)		(BBCH93)	
	2021	2022	2021	2022	2021	2022
Prunus avium	29/03	21/04		14/04	13/10	
Populus canescens	17/05	28/04			01/11	
Fraxinus angustifolia	28/06	28/04			09/11	02/11
Acer campestre	29/03	21/04		14/04	09/11	02/11
Carpinus betulus	17/05	28/04			01/11	
Quercus ilex	29/03	14/04				02/11
Tilia cordata	06/05	28/04		10/05	21/10	17/10
Quercus pubescens	12/04	28/04			06/12	02/11
Alnus glutinosa	29/03	10/05		14/06/	09/11	27/10
Sorbus domestica	17/05	21/04			21/11	

Table 4: Data of shrubs in PMA in 2021 and 2022.

Species	School of Forestry					
Shrubs	(BBCH11)		(BBCH61)		(BBCH93)	
	2021	2022	2021	2022	2021	2022
Punica granatum	28/07	04/05	28/07	27/06	09/11	02/11
Spartium junceum	28/06	14/05	28/06	31/05	21/11	

Cornus sanuinea	29/03	14/04	06/05	21/04	27/10	
Salix caprea	12/04	28/04		31/03	09/11	31/05
Berberis vulgaris	06/05	21/04			09/11	
Ligustrum vulgare	28/06	04/05		31/05	06/12	
Phyllirea latifolia	29/03	28/04	06/05			
Corylus avellana	05/04	28/04			21/11	02/11
Sambucus nigra	29/03	21/04	12/04	14/04	01/11	
Euonymus europaeus	06/05	21/04	06/05	28/04	21/11	02/11

The results of the two-year monitoring in PMA of School of Forestry are presented below. (Tables 3 & 4)

Conclusion

According to the above data the differences between two years are presented below:

Acer campestre, *Alnus glutinosa* and *Quercus ilex* developed their leaves earlier in 2021.

Prunus avium, *Fraxinus angustifolia*, *Carpinus betulus*, *Sorbus domestica* and *Populus canescnes* developed their leaves earlier in 2022 than 2021.

Tilia cordata, *Quercus pubescens* did have not a big difference in leaf development between two years.

Punica granatum, *Spartium junceum*, *Cornus sanguinea*, *Salix caprea*, *Berberis vulgaris*, *Phyllirea latifolia*, *Sambucus nigra* developed their leaves earlier in 2022 than 2021.

Ligustrum vulgare, *Euonymus europaeus* did have not a big difference in leaf development between two years.

Corylus avellana developed its leaves later than 2021.

Acknowledgment

None.

Conflict of Interest

The authors declare no conflict of interest.

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