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Assessing the response of a Hellenic *Fagus sylvatica* population to interannual climate variability via monitoring the phenology of various phenological traits

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Illustrations by Marija PRELOG

INTRODUCTION

Monitoring of phenology is the tool to assess the shifts of phenophases of biological phenomena due to interannual climate variability. Phenology is affected by environmental, physiological, as well as genetic factors. Phenological monitoring is thus essential to understand how the genetic material, (species, populations or even individuals) responds to changing environmental cues and to identify the potential limits of this response. the phenology of flowering and its synchronization determines the levels of genetic variation present in the produced seed crop. Consequently, prolonged flowering discrepancies, due to climatic changes, may lead to reduced genetic variation of the produced seed and consequently the natural regeneration.

MATERIALS AND METHODS

The phenological trends of bud-break related to interannual climatic variability, as well as flowering and leaf senescence have been studied for *Fagus sylvatica* in a Hellenic population, based on the assessment performed on 40 adult trees and natural regeneration individuals, growing in a LifeGenMon monitoring plot (Fig. 1). The five bud burst phenophases are shown in Fig. 2, of leaf senescence in Fig. 3, while those of the female and male flowering in Fig 4 and 5 Daily recorded climatic data were used to assess the values of monthly mean temperatures and the monthly precipitation for the four successive years of the study (2016-2019).

Figure 1. Location of *Fagus sylvatica* monitoring plot.

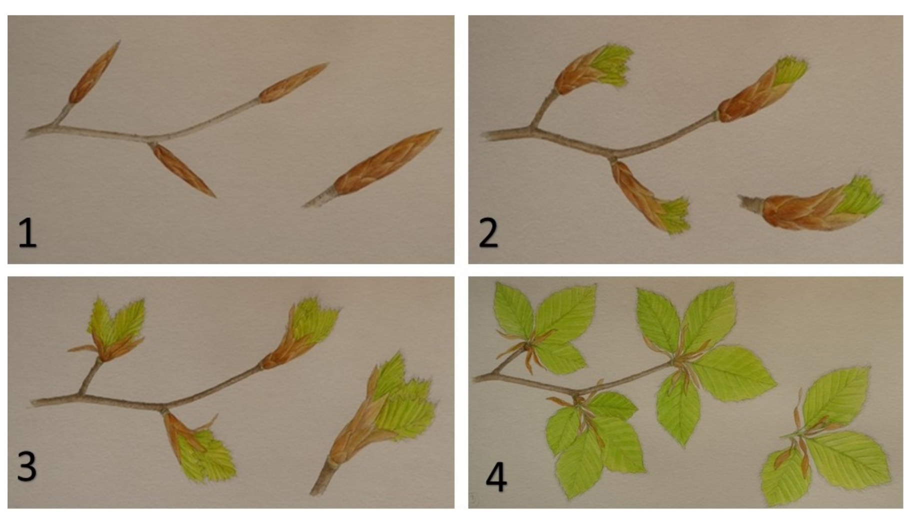


Figure 2. Bud break phenophases

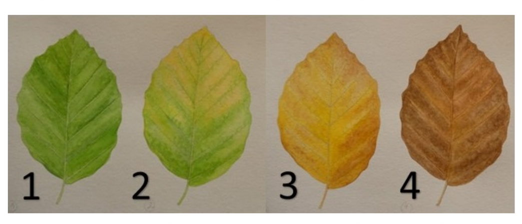
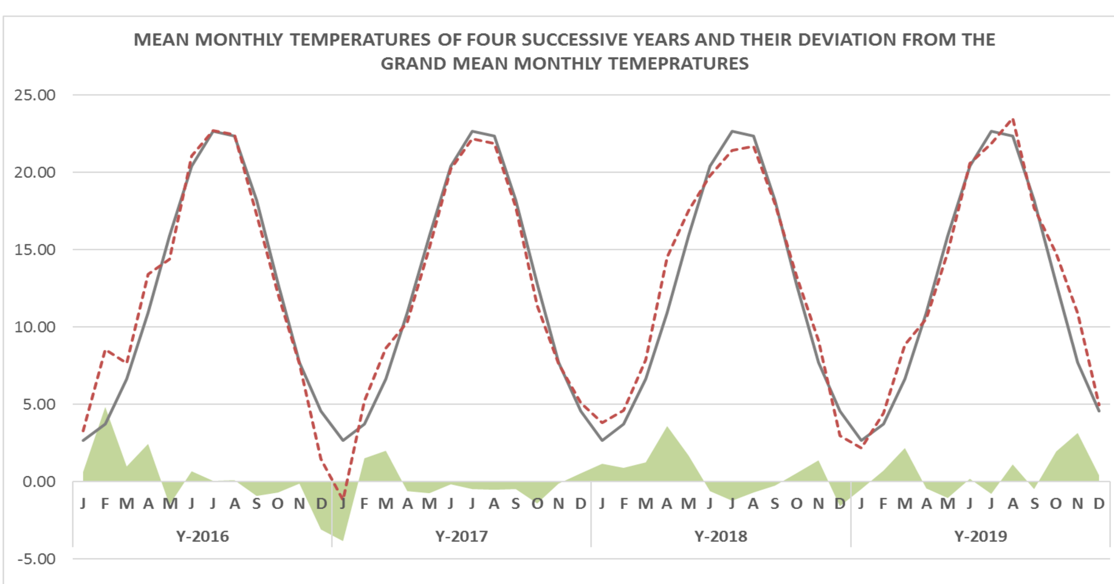


Figure 3. Leaf senescence phenophases

Female flowering was recorded based on two phenophases (receptive and completed), while male flowering was recorded for three phases (closed flowers, shedding pollen, shedding completed).

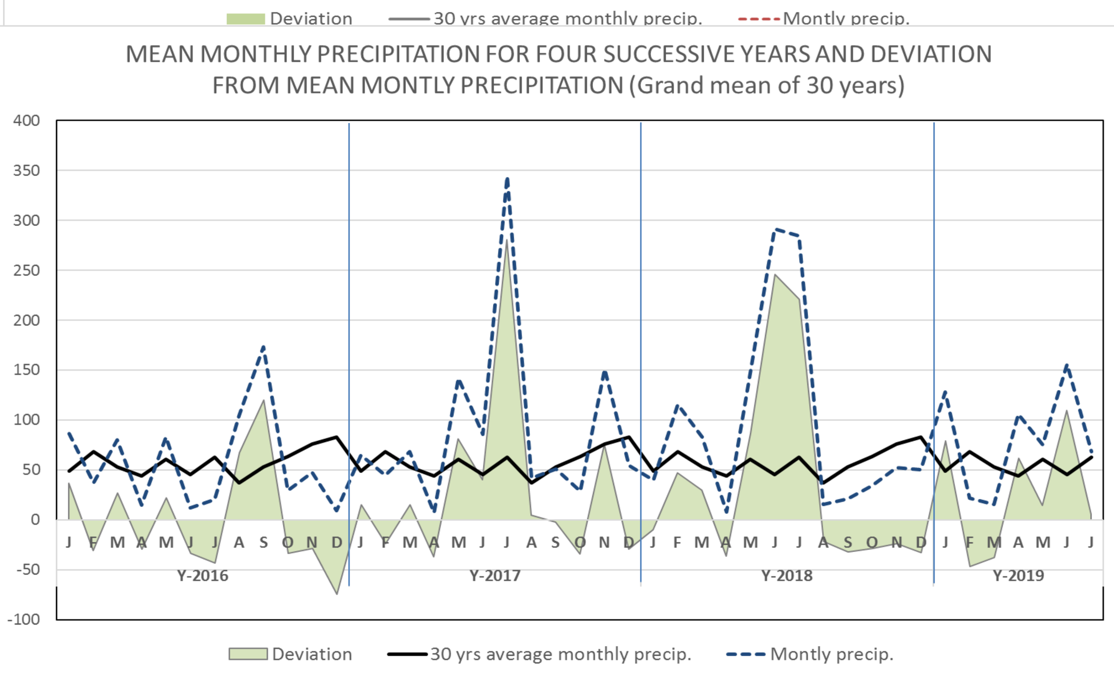
RESULTS



The interannual variation for mean monthly temperature was generally low.

The mean monthly temperatures were close to the grand mean monthly temperatures for all the four years of the study.

Figure 4. Interannual variation of mean monthly temperature values across the four years of the study and their deviation from the grand monthly average (30 years mean).



Notable interannual variation has been recorded for precipitation, as well as deviation of monthly precipitation form the grand mean especially for the fall-winter period that the site received significantly less precipitation, while significantly increased precipitation has been recorded during the late spring and summer period across all the four years of the study.

Figure 5. Interannual variation of monthly precipitation (mm) across the four years of the study and deviation from the grand monthly average (30 years mean).

RESULTS

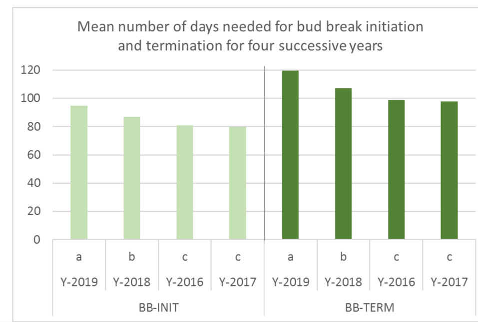


Figure 6. Testing significance of differences among year means (in number of days) for bud break initiation (Duncan Mult. Range test p=0.05)

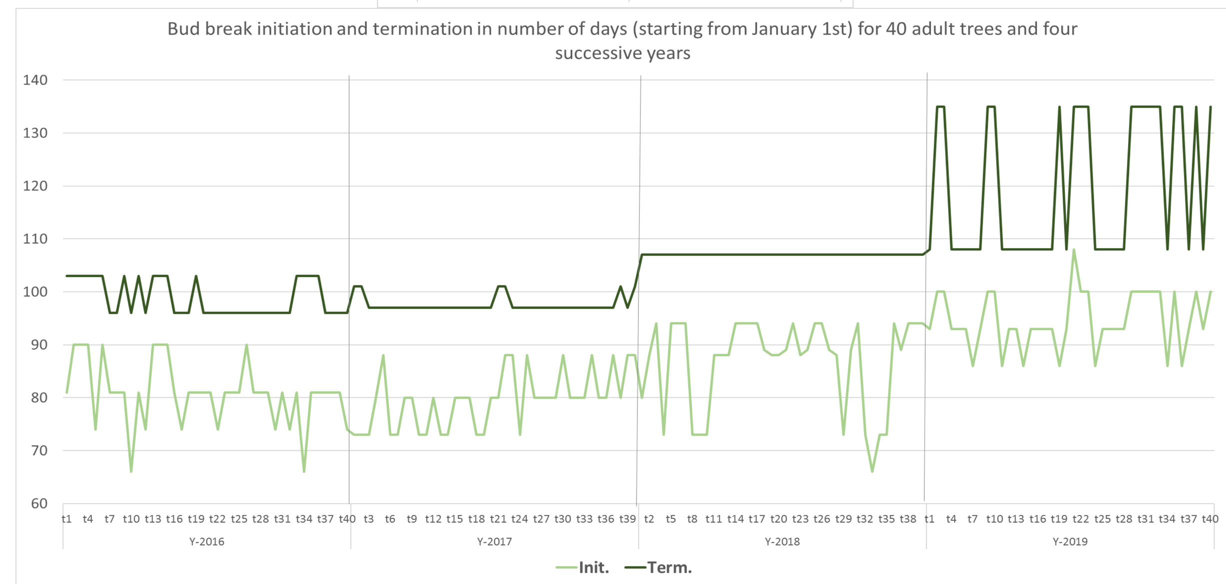


Figure 7. Initiation and termination of bud break in number of days (starting from January 1st) for 40 individuals in four successive years

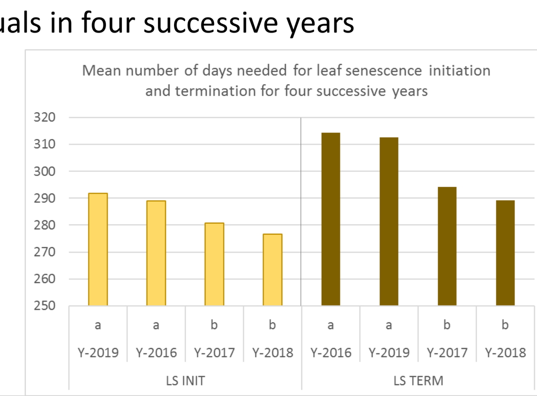


Figure 8. Testing significance of differences among year means (in number of days) for leaf senescence (Duncan Mult. Range test p=0.05)

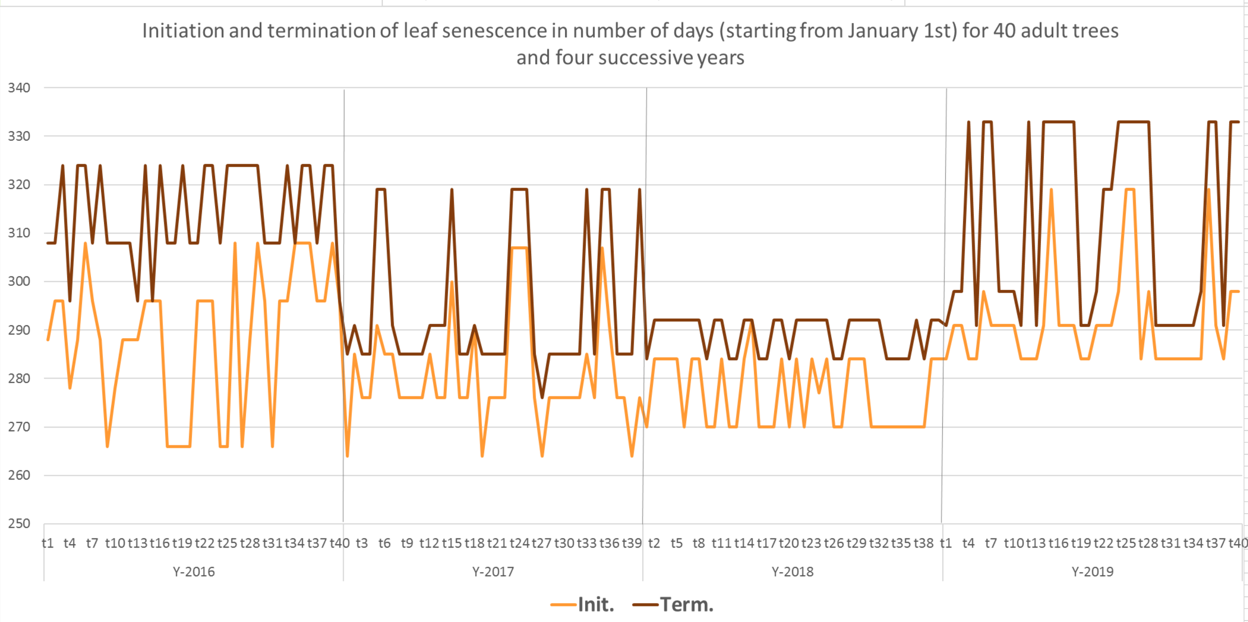
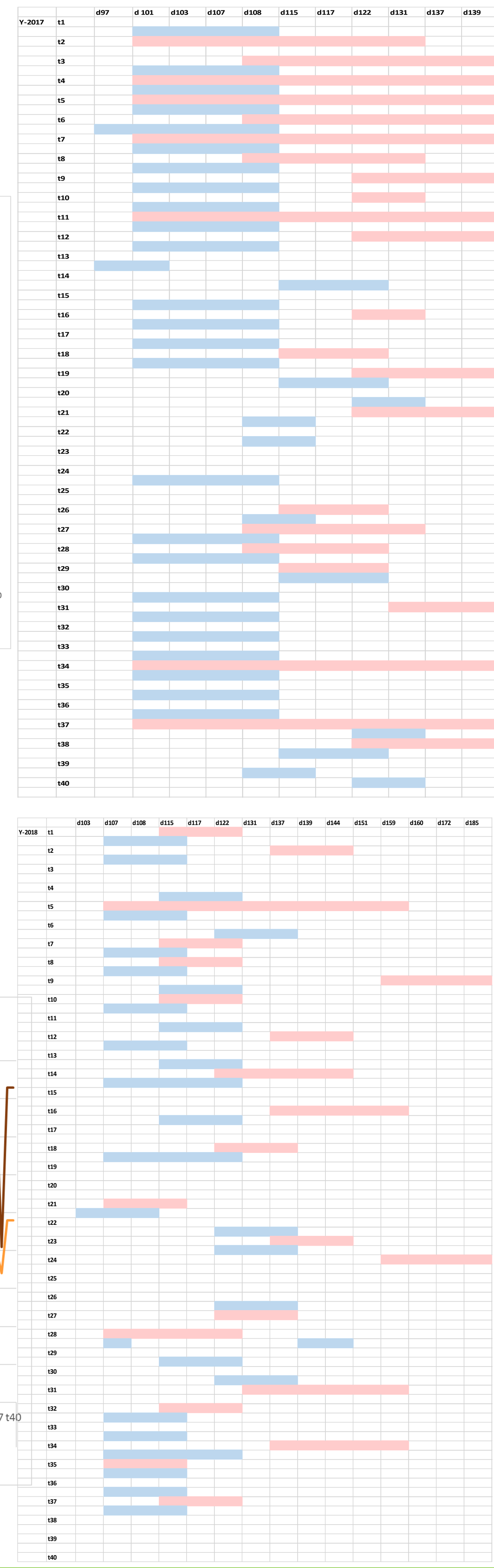


Figure 9. Initiation and termination of leaf senescence in number of days (starting from January 1st) for 40 individuals in four successive years

Figure 10. Male and female flowering phenograms for Y-2017 and Y-2018



CONCLUSIONS

-Interannual climate variation was mainly due to precipitation differences, as for all four years precipitation was lower than the one expected due to the climate of the site (30yrs observations) during several fall and winter months. Precipitation reduction though was especially pronounced during the fall and winter period of year 2019 .

-Initiation of bud break was late in 2019, in comparison to that of the rest three years studied. Leaf senescence in 2019 and 2016 was also initiated later than for the rest of the years.

-Female and male flowering was recorded for two years (Y-2019 there was no flowering) . The results reveal flowering discrepancies for both years, as several trees within each year did not produce any female flowers, but only male ones, while low level of male and female flowering synchronization has been recorded for both years studied(Y-2017 and 2018). This indicates consequences related to the levels of genetic variation present in the produced seed crop per year.

-Drought may thus be a decisive factor, besides temperature, that can affect significantly the initiation, duration and termination of biological phenomena and processes such as bud break, leaf senescence, male and female flowering synchronization (with implications for the genetic variation and quality of the produced seed crop).

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Acknowledgments

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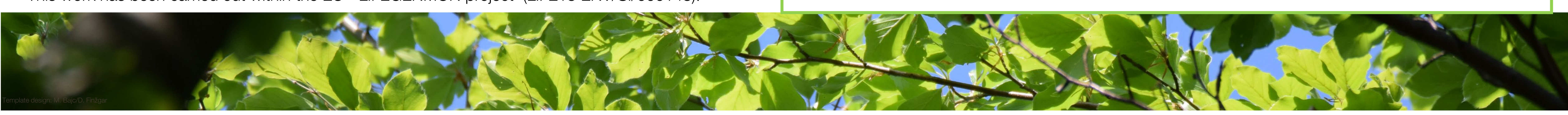

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