

Monitoring the masting behaviour of beech (*Fagus sylvatica*) in Flanders (Belgium)

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The monitoring of forest condition started in Flanders in 1987 as part of the international ICP-Forests programme and EC-Regulation 3528/86. Today the Level I survey is conducted on 72 plots with 1728 trees. Ten plots are part of the international 16x16 km grid. The other plots are on a regional 4x4 km grid. 11.3% of the trees are *Fagus sylvatica* (n = 196, age > 60 y). Beech trees have been selected in 17 of the Level I plots (23.6%). The Level II survey is carried out in 11 plots and 5 of these plots are in beech forests. Five Level II plots are 'key plots', with intensive monitoring of deposition, soil solution, litterfall,... One intensive plot is a beech plot in the Forest of Zoniën.

The area of the Forest of Zoniën is about 5000 ha, situated South East from Brussels. *Fagus sylvatica* is the main tree species. The oldest trees are more than 200 years and the trees belong to the highest in Europe (> 40 m). The main problems concerning forest health and forest management are air pollution (acidification, eutrophication), soil compaction and a problematic natural regeneration of beech.

Characteristics of the Level II plot - Forest of Zoniën (2004):

latitude/longitude: 50°44' N, 03°48' E

altitude: 120 m

soil unit: Dystric Podzoluvisol (Loess)

vegetation: *Milio-Fagetum* s.a. *athyrietosum*

age: planted in 1906

number of trees: 180/ha

volume: 639 m³/ha

basal area: 36 m²

dominant tree height: 40 m

nearest weather station: Ukkel (KMI) - mean annual temperature 9.9 °C, mean annual precipitation 780 mm

Crown condition

Crown condition assessments are executed yearly in the Level I and Level II plots following the ICP-Forests Manual. Defoliation is assessed in 5% steps. Trees with a maximum of 10% leaf loss are considered as healthy. Damaged trees show a defoliation of at least 30%. Trees are also classified in seed production classes. The seed production assessment started in 2004. There are 4 classes, from 'no seed production (class 0)' to 'high seed production (class 3)'.

Classification of seed production

Class	Seed production	Interpretation
0	no seed visible	none
1	seed visible with binoculars	slight
2	seed visible without binoculars	moderate
3	whole crown with seeds	high

Litterfall

Litterfall is monitored in 5 Level II-plots. Every plot has 10 circular litterfall traps, with an area of 0.283 m², set up near the throughfall collectors (deposition). The litter is collected twice a month during autumn (Sep. - Dec.) and monthly during the rest of the year. The litter is sorted in the laboratory and dried at 40°C. Litterfall monitoring started in 1999. Fruits and seeds are dried and weighed together. The amount of seeds and fruits is expressed in dry weight per hectare.

Results

Crown condition

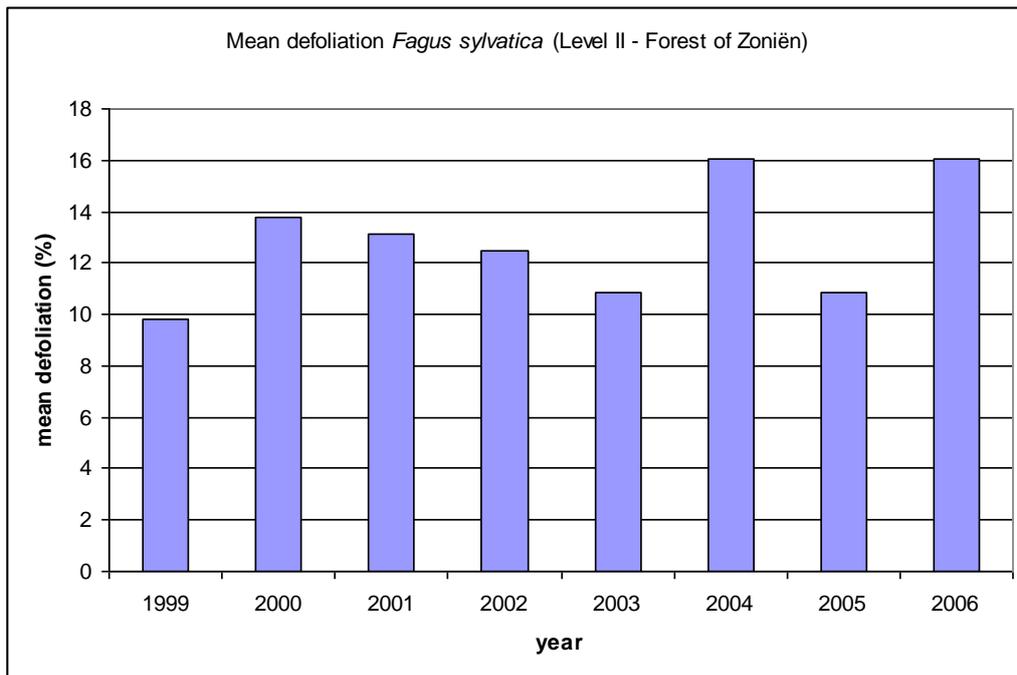
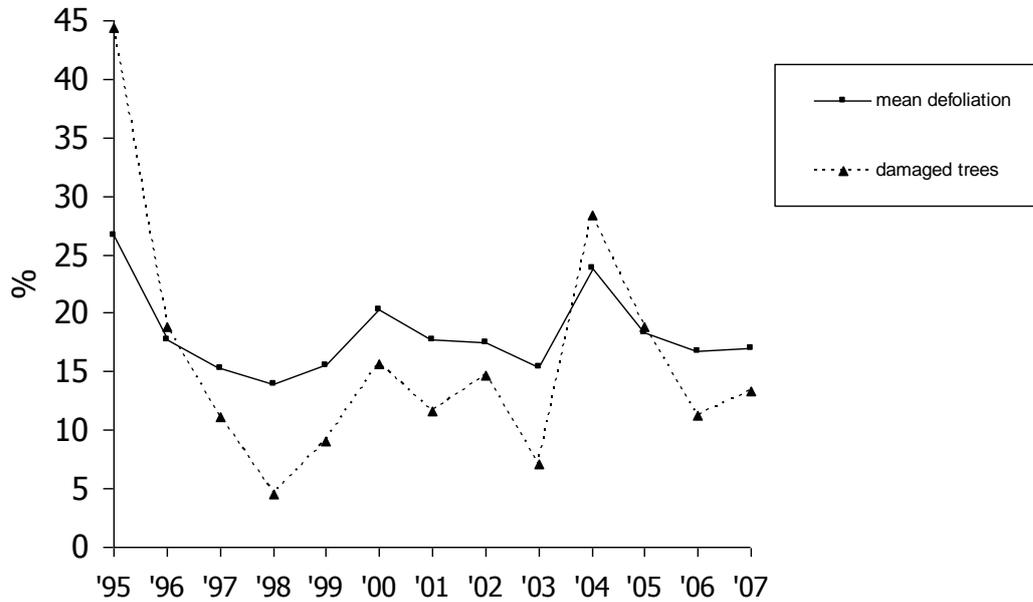
Level I

Mean defoliation of *Fagus sylvatica* is fluctuating from year to year. Insect damage (e.g. *Rhynchaenus fagi*), diseases (e.g. *Discula umbrinella*) or abiotic factors (drought, excess of water,...) are influencing the crown condition. Massive seed production may also be responsible for a higher defoliation score. In 1995, 2000 en 2004 the high mean defoliation is connected with substantial seed production in the beech plots. In 2002, considerable seed production was observed in several plots, but the mean defoliation was not remarkably high.

Level II (Forest of Zoniën)

The beech trees in het Level II plot are in a good condition. There are almost no damaged trees. The defoliation is highest in 2000, 2004 and 2006. In 2000 and 2004, defoliation is also high in the Level I plots. In 2006, there is a high defoliation in the Forest of Zoniën, but in general not in the Level I survey.

Fagus sylvatica (Level I)



Seed production

Level I

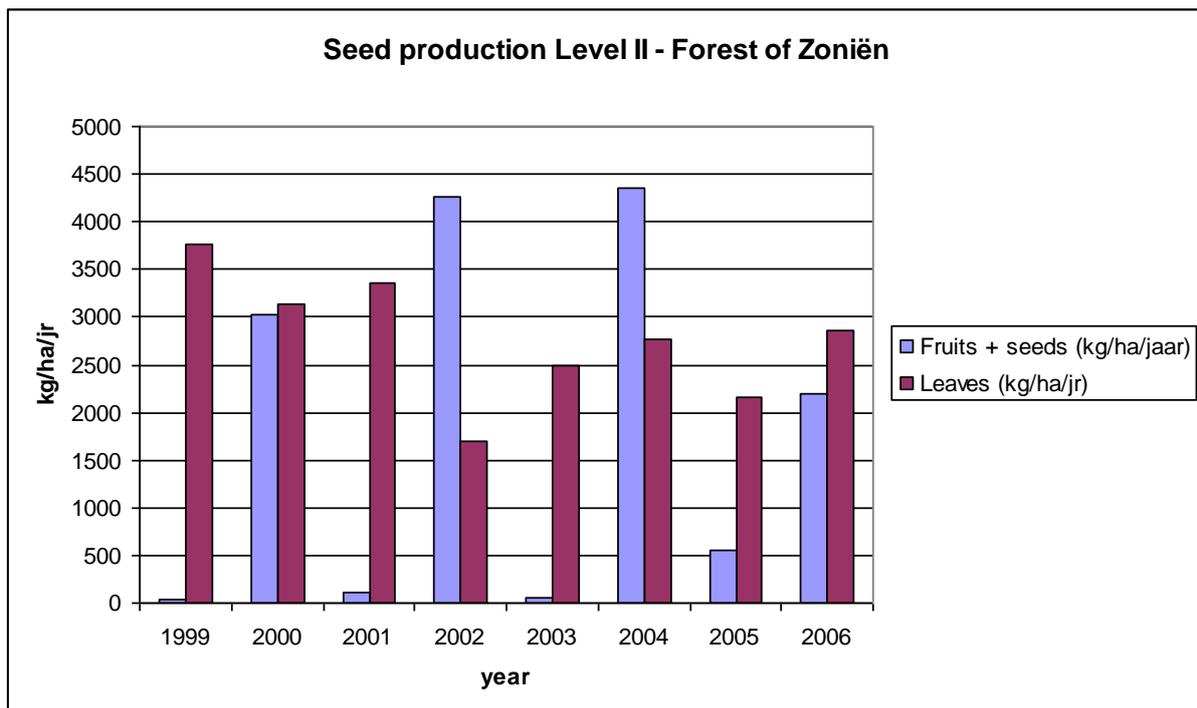
Trees show a good seed production when they are in seed production classes 2 or 3. In 2004, seed production in beech was extremely high. Moderate to high seed production was noticed

on 44.6% of the trees in Level I. This was only 5.1%, 11.7% and 12.7% in 2005, 2006 and 2007, respectively. Data of seed production before 2004 are incomplete, but good seed years were observed in 1995, 2000 and 2002.

Level II (Forest of Zoniën)

The amount of fruits and seeds is fluctuating between 1999 and 2006 from 41 kg/ha.year to 4362 kg/ha.year. The seed production in 2004 was a record-breaker, the lowest production was in 1999. A good seed production was achieved in 2000, 2002, 2004 and 2006. With the exception of 2002, mean defoliation was also highest in these years.

Quantitative data are lacking before 1999. From different sources, we assume that there was a high seed production 1990 and 1995, followed by 1998 and 1992.



Seed production and defoliation

Level I

In 2004, beech trees without visible seed production had a mean defoliation of 17.9% (median 15). Trees with moderate to high seed production showed a mean defoliation of 26.0% to 30.3% (median 25-30). Beech trees showed a significant higher defoliation when they were in a higher seed production class. In this year, each seed production class comprised at least 30 sample trees.

Differences in defoliation of *Fagus sylvatica* (mean and median) between seed production classes in 2004 (Level I, Kruskal Wallis test)

	Sign.	Class 0 (%)	Class 1 (%)	Class 2 (%)	Class 3 (%)
<i>Fagus sylvatica</i>	***	17.9 (15)	22.2 (20)	26.0 (25)	30.3 (30)

Significance level: ***=p<0.001

Level II (Forest of Zoniën)

During some mast years, like 2002, there is less leaf litter collected in the litter traps. In the opposite case, years with low seed production should have a higher leaf litter amount. This is the case in 1999 and 2001.

Crown condition of most trees in this plot is good, irrespective of seed production. The share of damaged trees is not higher during mast years. The mean defoliation is perhaps higher, but not every mast year.

Impact of climate on seed production (Forest of Zoniën)

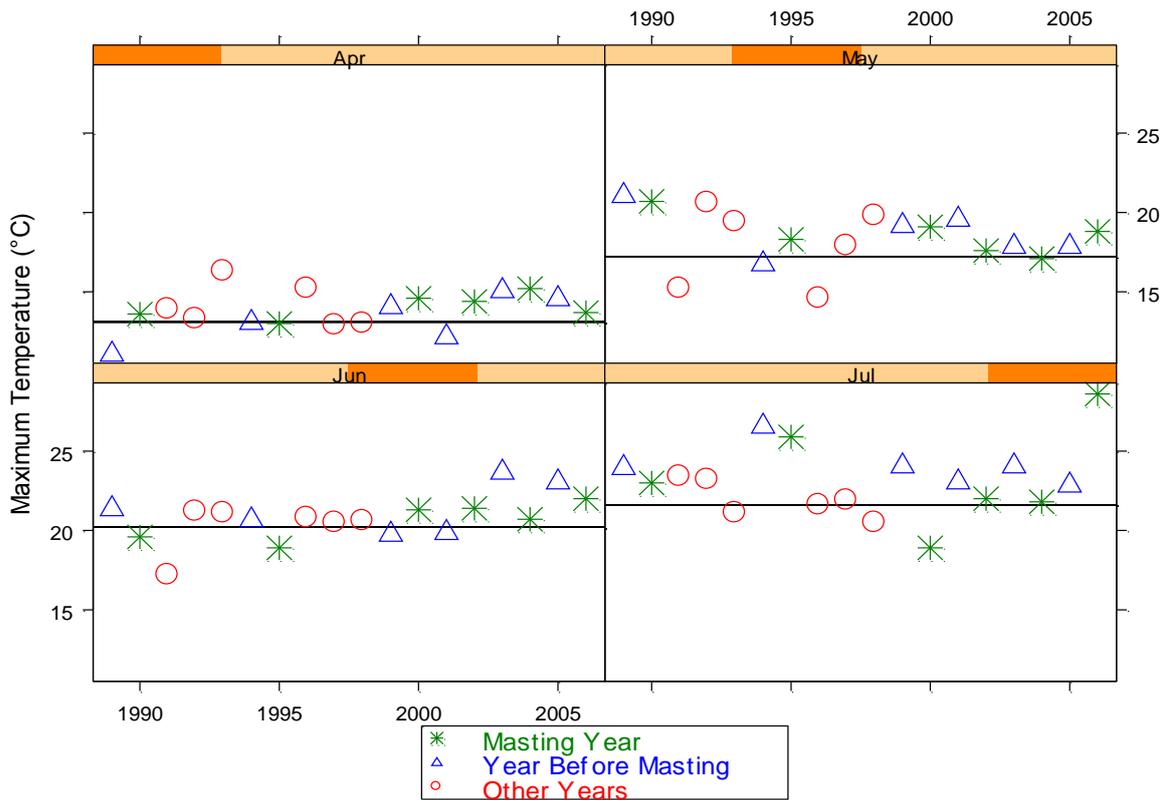
According to climate models, mean summer temperature in Belgium might rise in one century between 2.4°C and 6.6°C (MIRA-T 2004). Many authors write about climate influences on floral induction and seed production of beech. Floral induction takes place in early summer of the year before masting and warm weather circumstances stimulate the induction. (De Vos & Van der Aa, 2001).

In recent years, seed production occurred almost every two year, with high amounts of fruits and seeds (e.g. 2004). In the past mast years were observed less frequently. Two consecutive years with high seed production were not noticed. From the crown condition data (Level I, Level II) and the litterfall data (Level II) we can conclude that there was a high seed production in 1990, 1995, 2000, 2002, 2004 and 2006. The meteorological data from the KMI weather station Ukkel (distance 3 km) show that frost periods were rare during the flowering of the beech trees (after April 15th).

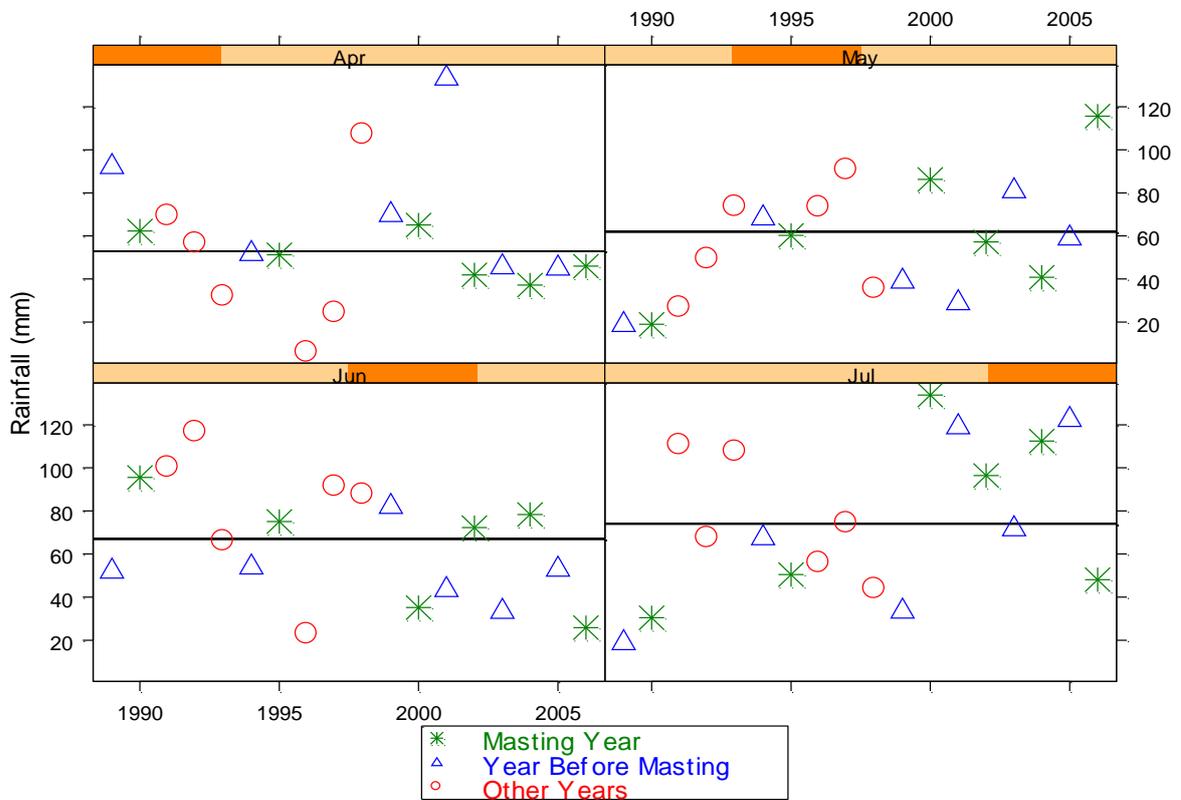
From 1989 to 2006 there was a high mean maximum temperature in July, one year before a mast year. The mean maximum temperature in July is lower during non mast years, not proceeding a mast year. The time series is rather short, but it is remarkable that the long term temperature means are exceeded in many years.

With exception of 1999, years proceeding a mast year also have a lower precipitation in the month of June.

Both the Level I and Level II data show that 2004 was a year with a very high seed production in beech forests. The mean maximum temperature in 2003 was higher than normal during the whole vegetation season (Apr. - Sep.). Precipitation was lower than normal in April, June, August and September. July 2003 was characterized by a normal amount of precipitation.



Mean maximum temperature in Ukkel (KMI weather station) from April 1989 to July 2006 (horizontal line = long term mean)



Monthly precipitation in Ukkel (KMI weather station) from April 1989 to July 2006 (horizontal line = long term mean)

Conclusion

There is concern about the forest condition in Europe and the future of beech forests. In the Forest of Zoniën many old trees show a bad crown condition.

As a consequence of climate change, increasing summer temperatures may influence the masting behaviour in beech. After a warm and dry summer period, without high seed production, there is a chance for masting one year later, except when flowers freeze during spring. Results from the Level II monitoring plot in the Forest of Zoniën show that the maximum temperature in July is important. A correlation between precipitation and the occurrence of masting is not so clear.

Literature

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