# The effects of different silvicultural treatments on microclimate in oak-dominated forests: results of a 4-year experiment


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## INTRODUCTION

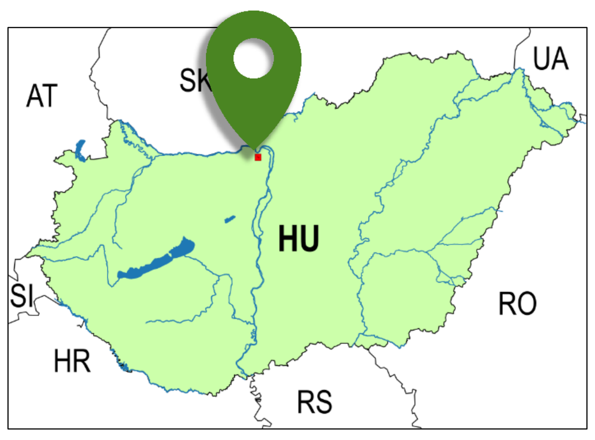
- stable below-canopy microclimate of forests is essential for the biodiversity and ecosystem functionality
- forest management necessarily modifies the buffering capacity of woodlands (clear-cutting has the most drastic effects)
- lack of information about:
  - the specific effects of different silvicultural treatments on microclimate
  - the temporal recovery after the interventions

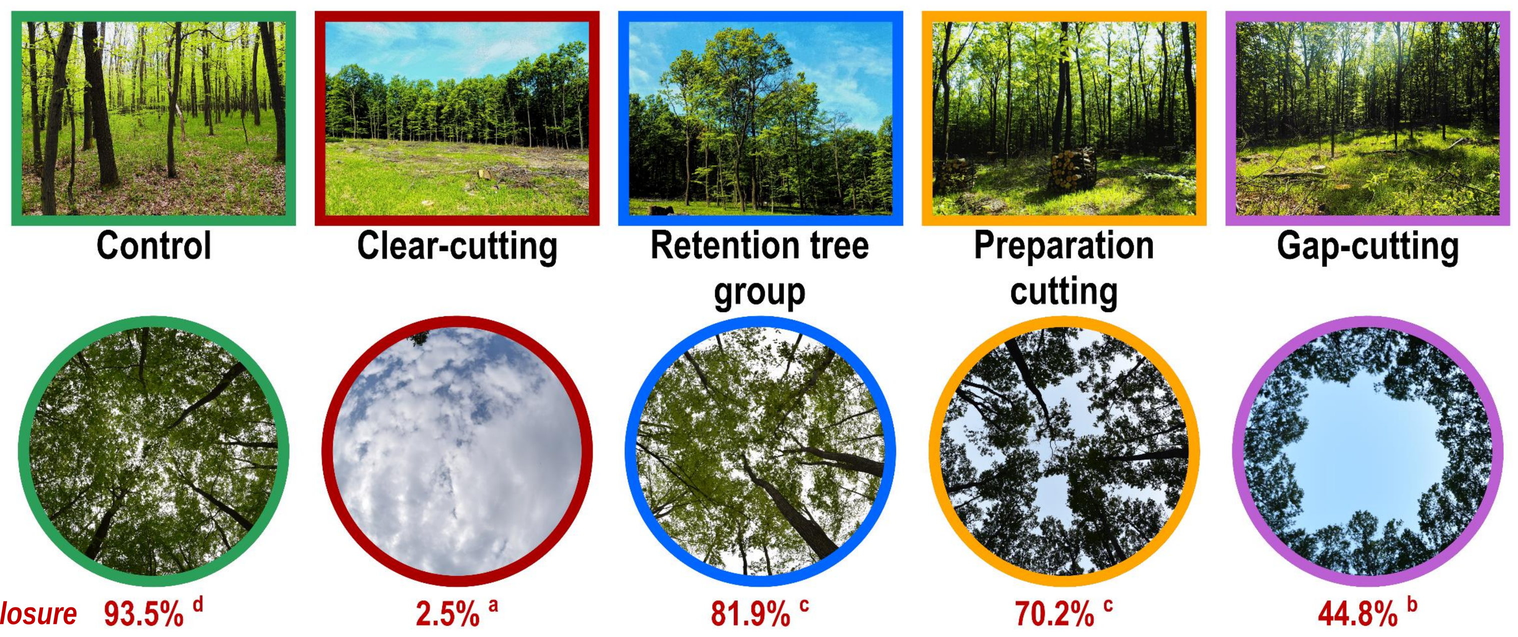
## MAIN GOALS

- to better understand the forest management – microclimate – regeneration and biodiversity interactions
- to explore
  a) the effects of several forest management practices applicable in Central Europe
  b) the temporal changes during the first three growing seasons in these treatments
  c) the most determinant microclimatic variables in the separation of the treatments
- to formulate suggestions for practitioners

## STUDY SITE

- **location**: Pilis Mts., Northern Hungary (47°40' 13" N, 18°54' 55" E)
- **topography:** 370-470 m a.s.l., moderate (<10°), North-facing slopes
- **bedrock:** sandstone and limestone with loess
- **soil type:** Luvisols and Rendzic Leptosol, soil depth 0.7–2.4 m
- **regional climate:** humid continental (9.0–9.5°C; 650 mm/yr)
- **vegetation type**: sessile oak – hornbeam forest (91G0)
- quasi-homogeneous stand (due to long-standing shelterwood system)
  - two-layered stand (*Quercus petraea*: h≈21 m; *Carpinus betulus*: h≈11 m)
  - low abundance of admixing species
  - scarce shrub-layer; cover of herb-layer ~40%



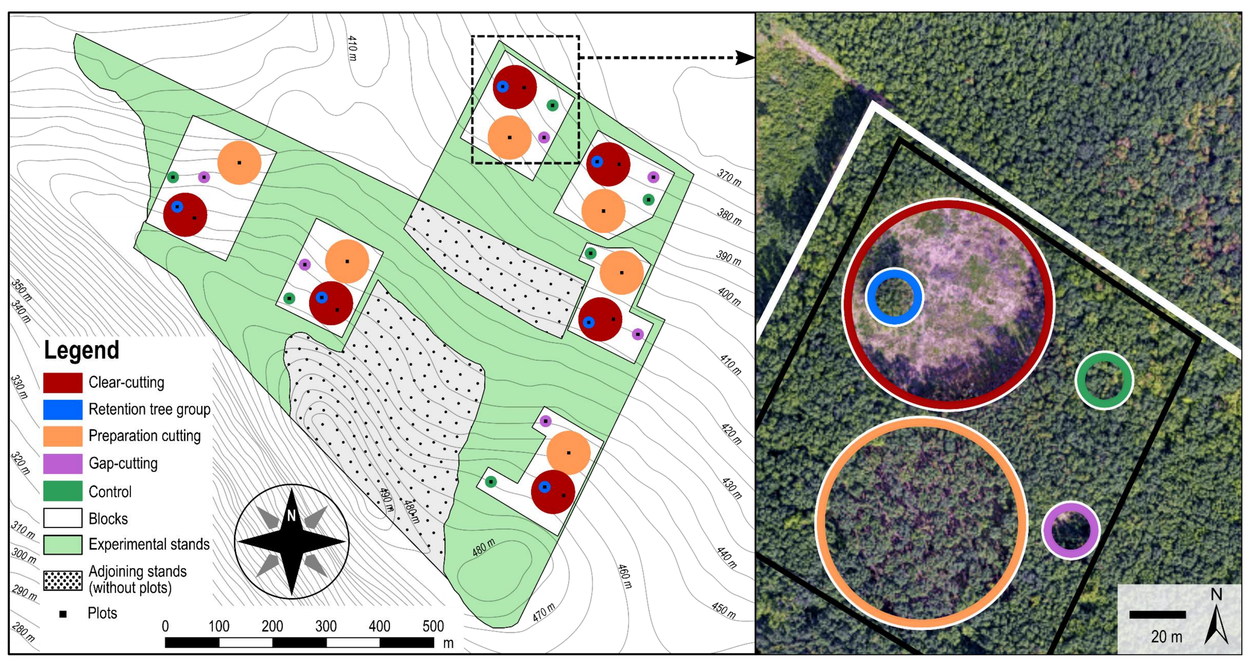

## STUDY DESIGN

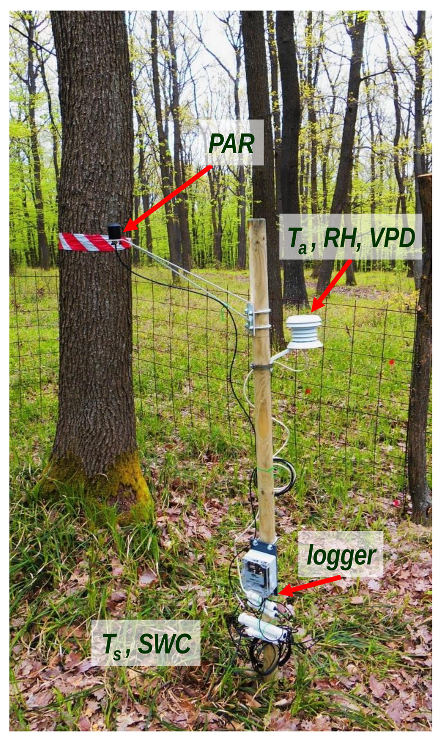
***complete block design***, five treatments in six replicates (blocks)

1. **CC: clear-cutting** (d=80 m)
2. **R: retention tree group** (d=20 m; in the clear-cuts)
3. **P: preparation cutting** (d=80 m; 30% of the BA)
4. **G: gap-cutting** (d=20 m; one tree height)
5. **C: control** (uncut managed forest)

(1–3: rotation forestry; 4: continuous cover forestry)

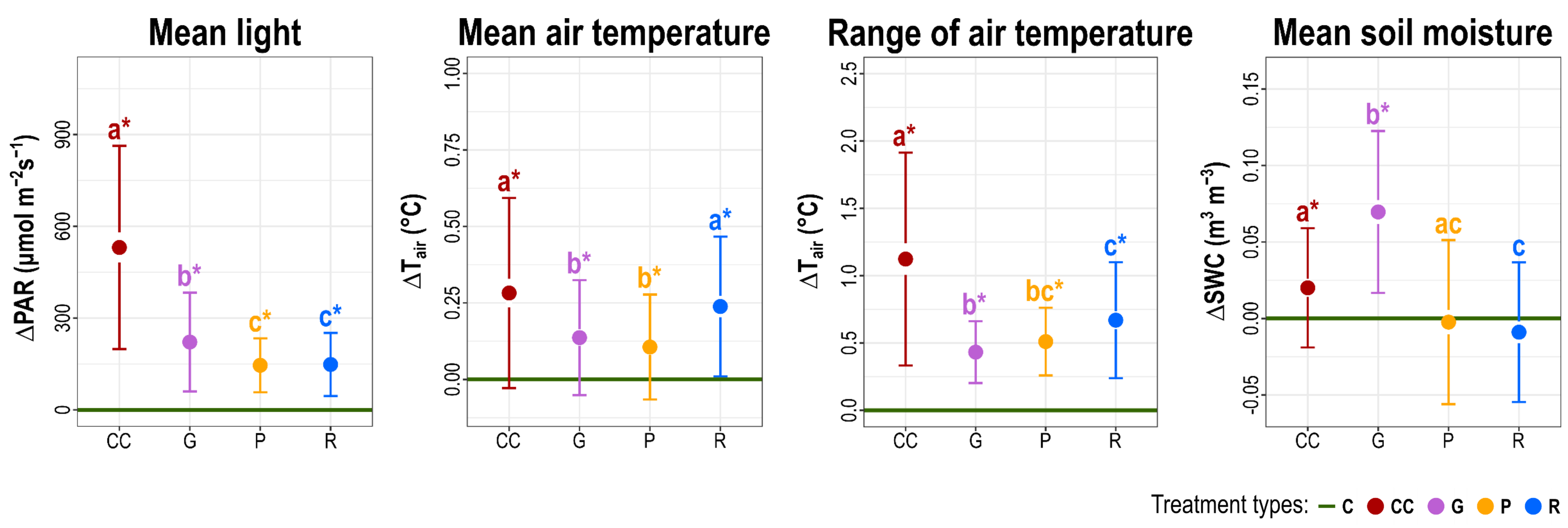
Before-After Control-Impact sampling design, implementation: 2014




## RESULTS

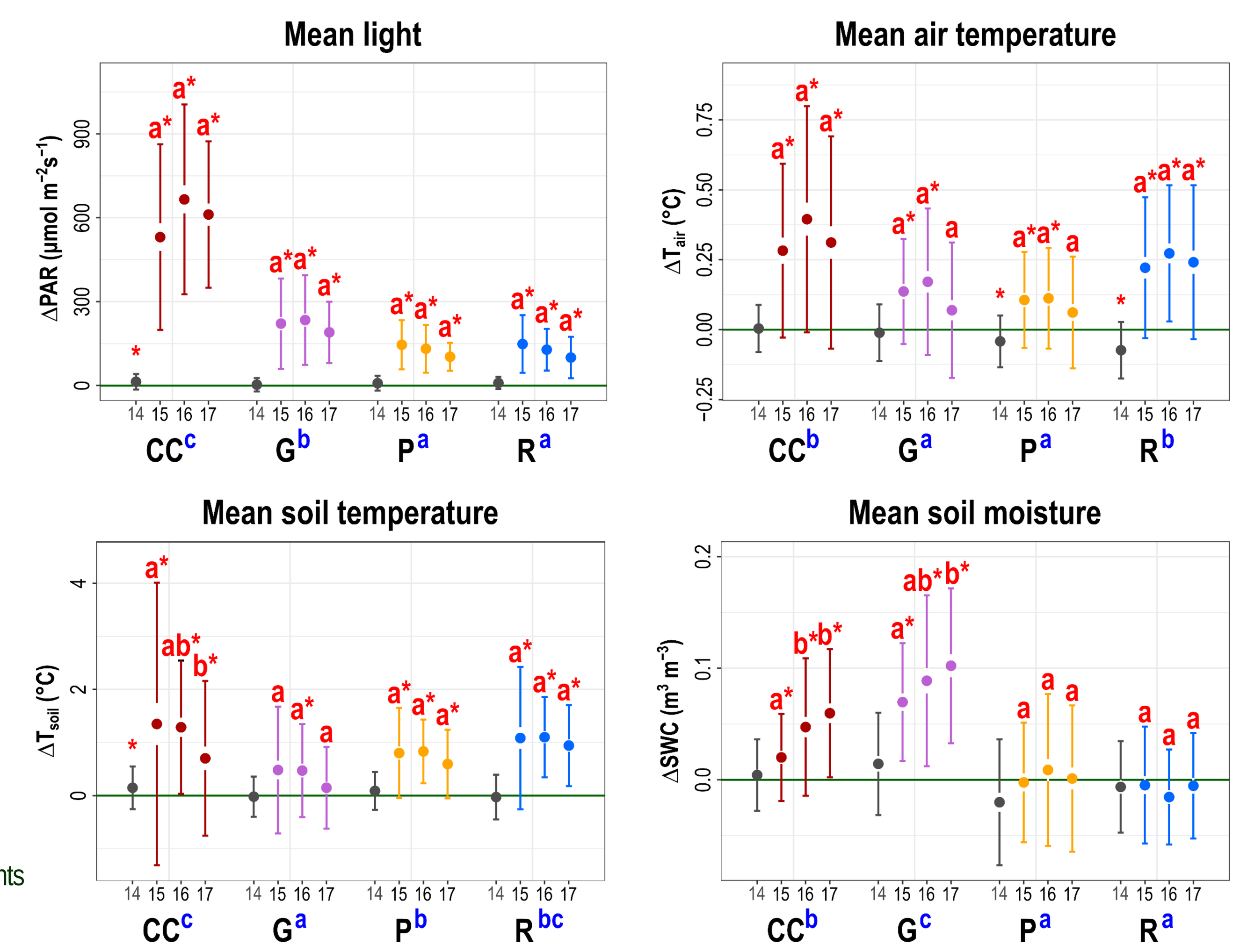
**the treatments modify the below-canopy microclimate immediately after the harvests**
**(the general treatment effect is more pronounced in summer than spring or autumn)**



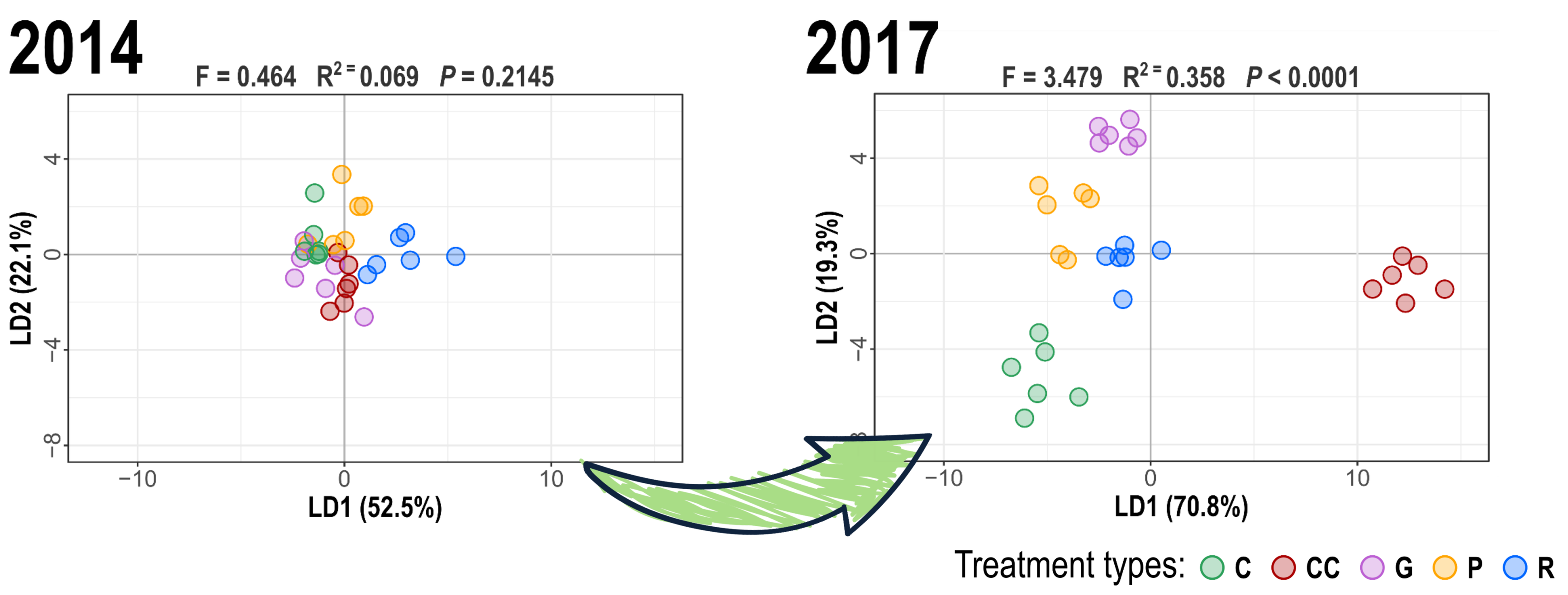

for most variables, there were no sign of microclimate recovery within three years, mean light and mean air temperature showed similar pattern in all years

however,
- soil temperature ⬇
- soil moisture ⬆

significant differences from * control; abc between years; abc between treatments




**high separation that is induced mainly by the maxima and the range of variables that are related to incoming energy (temperature, vapor pressure deficit)**




## CONCLUSIONS

- we found that
  (1) microclimate changes immediately after the harvests
  (2) the effect sizes among treatment types were consistent throughout the years
  (3) the climatic recovery time for variables appears to be far more than three years and
  (4) the applied silvicultural methods diverged mainly among the temperature maxima
- spatially heterogeneous and fine-scaled treatments of continuous cover forestry (gap-cutting, selection systems) are recommended
- by applying these practices, the essential structural elements creating buffered microclimate could be more successfully maintained
- forestry interventions would induce less pronounced alterations in environmental conditions for forest-dwelling organism groups

## MATERIALS AND METHODS

**Sampling**

- at plot centers; 72-hr data sets from every month between 2014 and 2017 (still ongoing); 10-min logging intervals
- 24-hr data sets were extracted for the analyses: one randomly chosen diurnal dataset per month; relative data (differences from control within a block)
- Onset HOBO H21-002 data loggers – permanent logger+sensor sets
  - light: PAR at 150 cm a.g.l and additionally once a year: diffuse light at 130 cm a.g.l.
  - air temperature and relative humidity sensors at 130 cm a.g.l.
  - soil temperature sensors: 2 cm b.g.l.
  - soil moisture sensors: averaging the 10–20 cm soil layer

**Analyses**

- uniform modelling framework: linear mixed effects models (fixed effect: treatment+year+treatment:year; random effect: blocks); F-statistics for the fixed factors; Tukey-type multiple comparisons (α=0.05)
- for the separation: linear discriminant analysis and permutational multivariate analysis of variance (for each year)
- for separability power of the microclimate variables among treatment levels: Wilks' lambda with F-test approximation performed in multivariate analysis of variance or each separate year

## CREDITS

Forest Ecological Research Group


**Notes:** This work was performed within the framework of the „Pilis Forestry Systems Experiment" that belongs to Péter Ódor's Lab (Forest Ecological Research Group) at the Centre for Ecological Research, Hungary. ✉ odor.peter@okologia.mta.hu; kovacs.bence@okologia.mta.hu.
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