IMPACT OF EXPERIMENTAL INTERVENTIONS INSPIRED BY HISTORICAL MANAGEMENT AND ENVIRONMENTAL CHANGES ON THERMOPHILIZATION OF TEMPERATE OAK FOREST UNDERSTOREY.

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theoretical BACKGROUND

DURING GLOBAL WARMING AND OTHER ENVIRONMENTAL CHANGES, VEGETATION OF LOWLAND TEMPERATE FORESTS UNDERGOES CHANGES IN SPECIES COMPOSITION RESULTING INTO LOSS OF BIODIVERSITY. INCREASING NITROGEN DEPOSITIONS, ABANDONMENT OF HISTORICAL FORMS OF FOREST MANAGEMENT COMBINED WITH CLIMATE CHANGE ARE THE MAIN DRIVERS INDUCING PROCESSES OF EUTROPHICATION OR THERMOPHILIZATION OF VEGETATION. SINCE CHANGES IN CANOPY OPENNESS ARE LINKED TO THERMOPHILIZATION DUE TO THE LOSS OF MICROCLIMATE BUFFERING EFFECT, HISTORICAL HUMAN ACTIVITIES ALTERING FOREST STRUCTURE WERE SIGNIFICANTLY AFFECTING FOREST MICROCLIMATE AND THUS LIFE CONDITIONS OF UNDERSTOREY VEGETATION FOR CENTURIES. THEREFORE, TO RESTORE AND CONSERVE BIODIVERSITY IT IS ESSENTIAL TO SET APPROPRIATE FOREST MANAGEMENT TECHNIQUES. IT IS OF PARTICULAR IMPORTANCE TO QUANTIFY RELATIONSHIPS BETWEEN THE STRUCTURE OF TREE LAYER AND MICROCLIMATIC CONDITIONS AS WELL AS TO QUANTIFY THEIR INFLUENCE ON UNDERSTOREY COMPOSITION IN THE CONTEXT OF HISTORICAL MANAGEMENT PRACTICES.

CHANGES in **structure** and **species composition** of the temperate forest **VEGETATION**

CAUSED by — **ENVIRONMENTAL changes** — DRIVEN by

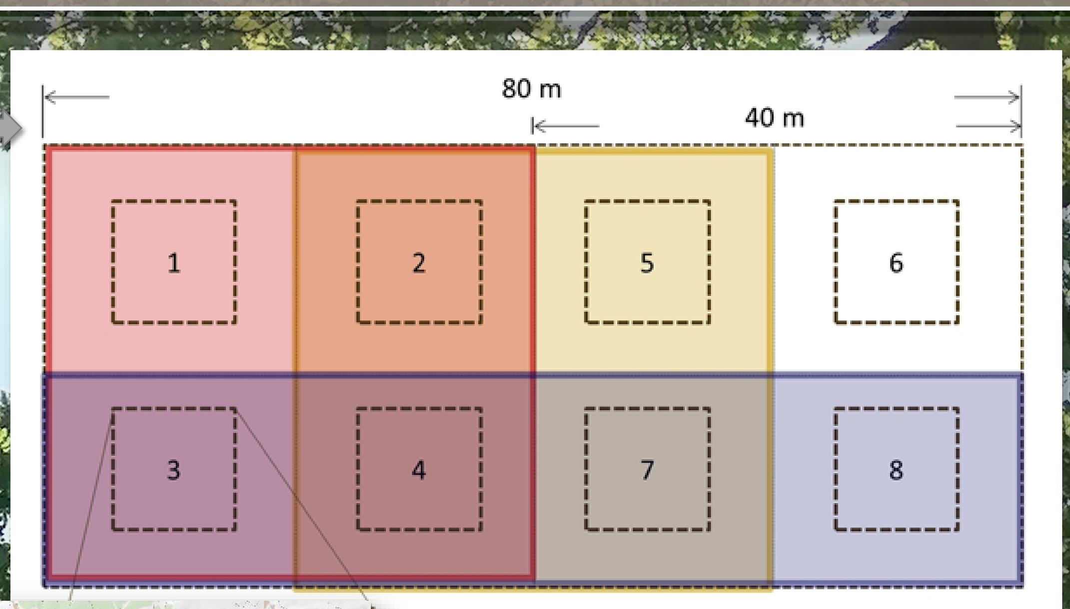
GLOBAL CLIMATE change

Increased deposition of atmospheric POLLUTANTS

Transformation of LAND-USE

Alternations of FOREST MANAGEMENT

Fig. 1 The area is divided into eight 20x20 m subplots. Each of three treatments is applied at half of the subplots in a specific spatial pattern to get all treatment combinations including control without any intervention.



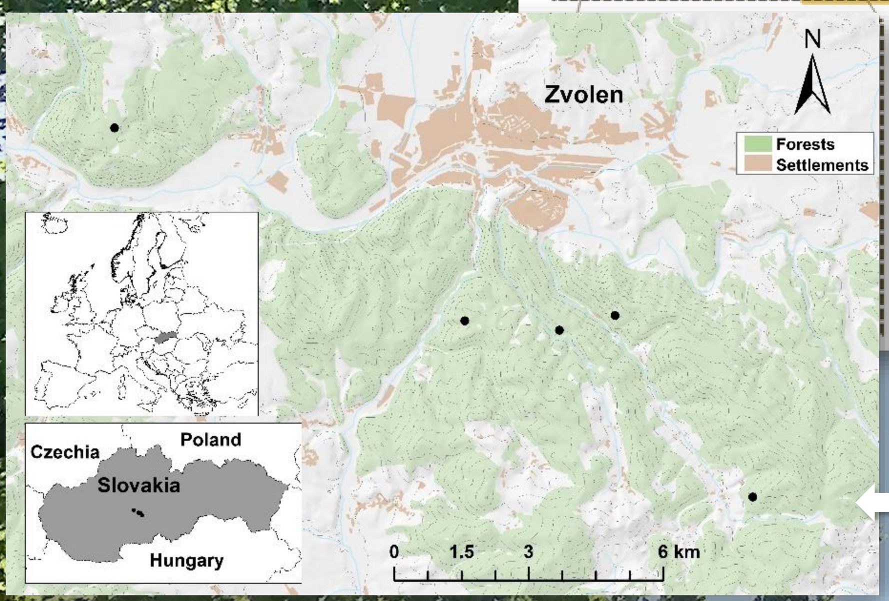


Fig. 2 Map showing the position of experimental sites (black dots) within Slovakia (Central Europe), close to city Zvolen.

METHODS

- WE SET UP A FIELD EXPERIMENT AT CENTRAL EUROPEAN OAK DOMINATED FORESTS WHERE WE ANALYSED THE RESPONSE OF UNDERSTOREY VEGETATION TO THREE TREATMENTS THAT SIMULATE HISTORICAL MANAGEMENT AND INCREASING NITROGEN DEPOSITIONS: I) REDUCTION OF CANOPY CLOSURE, II) LITTER RAKING AND III) FERTILIZATION. EXPERIMENT WAS ESTABLISHED IN 2017 IN FIVE REPLICATIONS. AT EACH OF FIVE SITES THE RECTANGLE OF 40X80 M WAS SET AND SUBDIVIDED INTO EIGHT SUBPLOTS WITH A UNIQUE COMBINATION OF TREATMENTS INCLUDING CONTROL WITHOUT ANY INTERVENTION (FIG.1). THE STUDY AREA IS SITUATED IN SLOVAKIA, WITHIN THE WESTERN CARPATHIAN MTS.(FIG.2) ON ANDESITE VOLCANIC BEDROCK AND UNDER PREVAILING SUBCONTINENTAL CLIMATE WITH MEAN ANNUAL PARTICIPATION 600–700 MM AND MEAN ANNUAL TEMPERATURE 7–8 °C. WITHIN EACH OF EIGHT 20X20 M SUBPLOTS THERE WAS ESTABLISHED THE CENTRAL 10X10 M SQUARE TO SAMPLE ALL VASCULAR PLANTS. VEGETATION COMPOSITION WAS REPEATEDLY RECORDED IN MID-JUNE EACH YEAR FROM 2017 (BEFORE APPLICATION OF TREATMENTS) TO 2020. TO BE ABLE TO COMPARE CHANGES INDICATED BY VEGETATION WITH REAL CHANGES OF MICROCLIMATE, WE INSTALLED DATA LOGGERS AT THE CENTRE OF EACH SUBPLOT WHERE THEY CONTINUOUSLY RECORDED THE AIR TEMPERATURE 10 CM ABOVE SOIL SURFACE AND SOIL MOISTURE IN UPPER 10 CM. TO CAPTURE THE LIGHT CONDITIONS IN THE UNDERSTOREY WE USED HEMISPHERICAL PHOTOGRAPHS TAKEN FROM THE CENTRE OF THE PLOT USING FISHEYE CAMERA LENS.

TO EVALUATE EFFECT OF TREATMENTS ON MICROCLIMATE WE COMPARED DAILY MAXIMUM TEMPERATURE DURING GROWING SEASON SINCE IT IS CONSIDERED AS THE KEY DRIVER OF SPECIES COMPOSITON IN TEMPERATE FORESTS. ADDITIONALY, WE COMPARED ALSO DAILY MEAN SOIL MOISTURE. THE DEGREE OF THERMOPHILIZATION WAS DETERMINED USING THE CLIMPLANT DATABASE, WHICH QUANTIFIES THE REALIZED CLIMATIC NICHES OF THE FOREST VASCULAR SPECIES. TO FIT VEGETATION BASED MEASURES TO CLIMATE PARAMETERS WE SELECTED GROWING SEASON MAXIMUM TEMPERATURE AND PRECIPITATION REQUIREMENTS OF PLANTS. FINAL VALUES WERE CALCULATED AS COMMUNITY WEIGHTED MEANS FOR UNDERSTOREY USING SPECIES COVER ESTIMATES.

RESULTS

- COMPARISON OF THE TEMPERATURES MEASURED AT THE SUBPLOTS WITH TREATMENTS TO CONTROL (FIG.3) REVEALED THAT CANOPY REDUCTION SIGNIFICANTLY INCREASED THE MAXIMUM DAILY TEMPERATURE BY UP TO 2-3 °C. HOWEVER, THE EARLY 3-YEAR RESPONSE OF UNDERSTOREY VEGETATION DOES NOT INDICATE ANY SIGNIFICANT DIRECTIONAL SHIFTS TOWARDS MORE THERMOPHILOUS PLANTS AFTER REDUCTION OF CANOPY CLOSURE (FIG.4). FURTHERMORE, FERTILIZATION ALONE SEEMINGLY DROVE A SLIGHT SHIFT (HOWEVER UNSIGNIFICANT) TOWARDS MORE COLD-ADAPTED SPECIES. IMPORTANTLY, COMBINATION OF LITTER RAKING AND CANOPY REDUCTION INDUCED SHIFTS OF SPECIES COMPOSITION TOWARDS MORE DROUGHT-TOLERANT PLANTS SUGGESTING INCREASED DRYING OUT OF SOIL DUE TO THE LOSS OF LITTER LAYER ISOLATION AND INCREASED DIRECT SUN RADIATION (FIG.5). EVEN THOUGHT, THE COMPARISON OF MEASURED SOIL MOISTUR SURPRISINGLY DID NOT INDICATE ANY DRYING (FIG. 6).

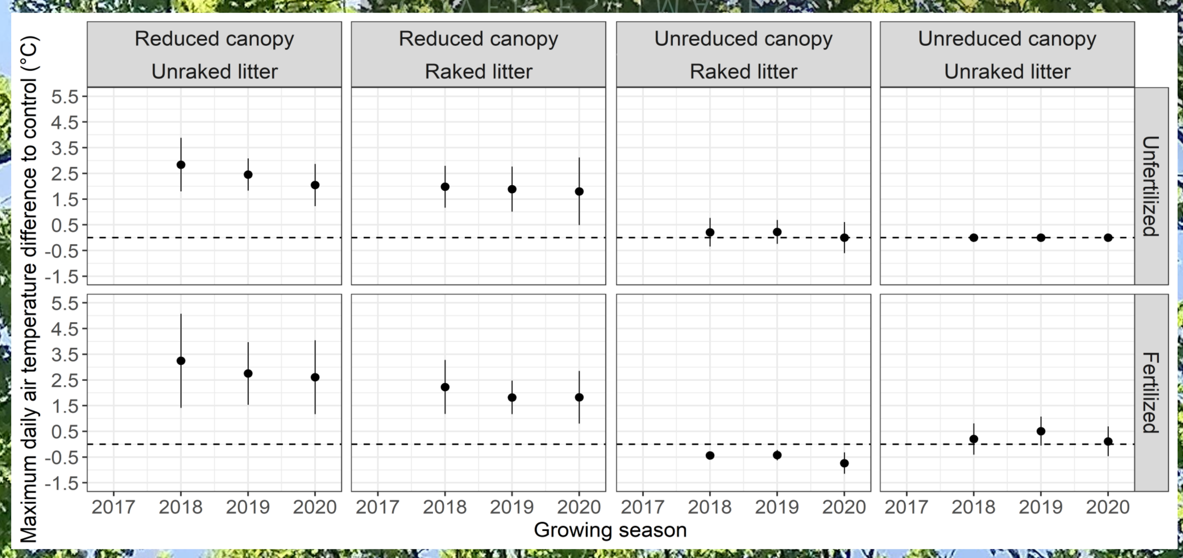


Fig. 3 Maximum daily air temperature difference at each treatment combination to control during three growing seasons from 2018 to 2020 (2017 non measured). Points indicate the mean and vertical lines the standard error from five experimental sites.

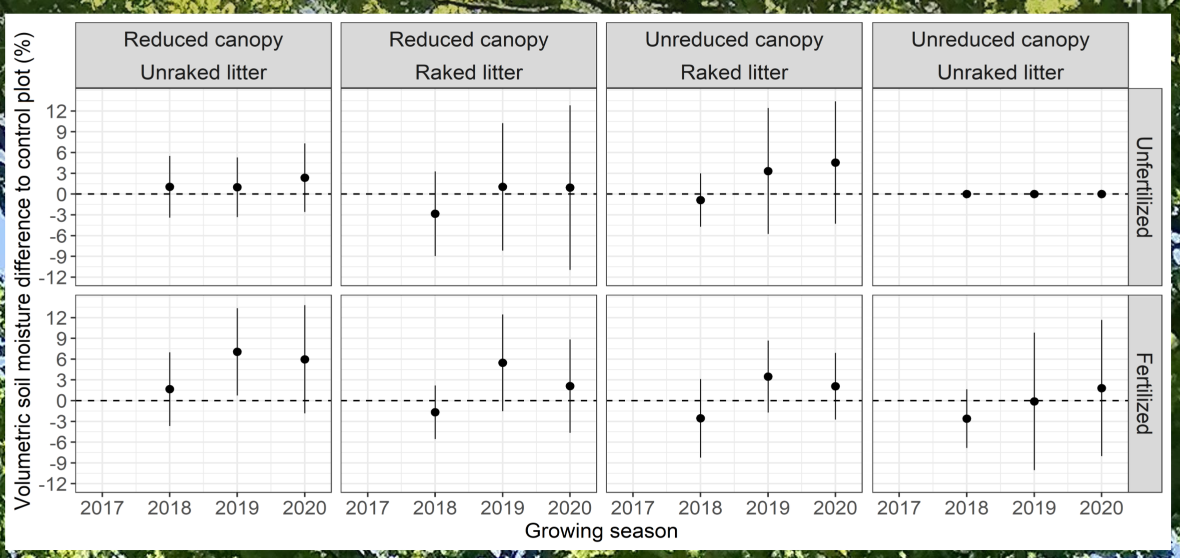


Fig. 5 Mean daily soil moisture difference at each treatment combination to control during three growing seasons from 2018 to 2020 (2017 non measured). Points indicate the mean and vertical lines the standard error from five experimental sites.

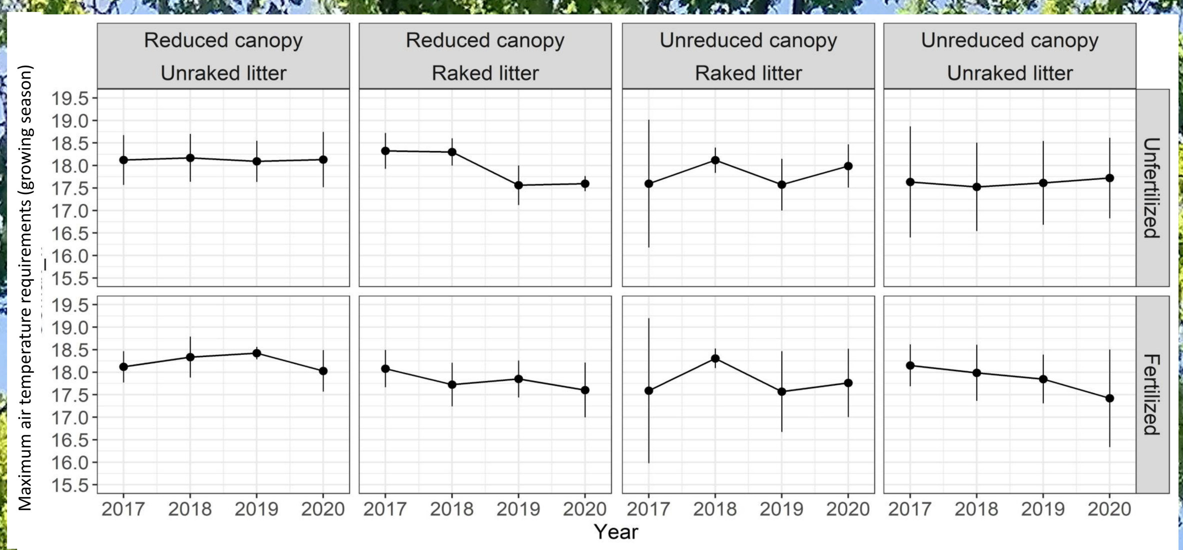


Fig. 4 Changes in the upper edge of the temperature requirements of vascular plants during three growing seasons from the baseline in 2017 (before application of treatments) within different combination of treatments including control (upper right corner). Points indicate the mean and vertical lines the standard error from five experimental sites.

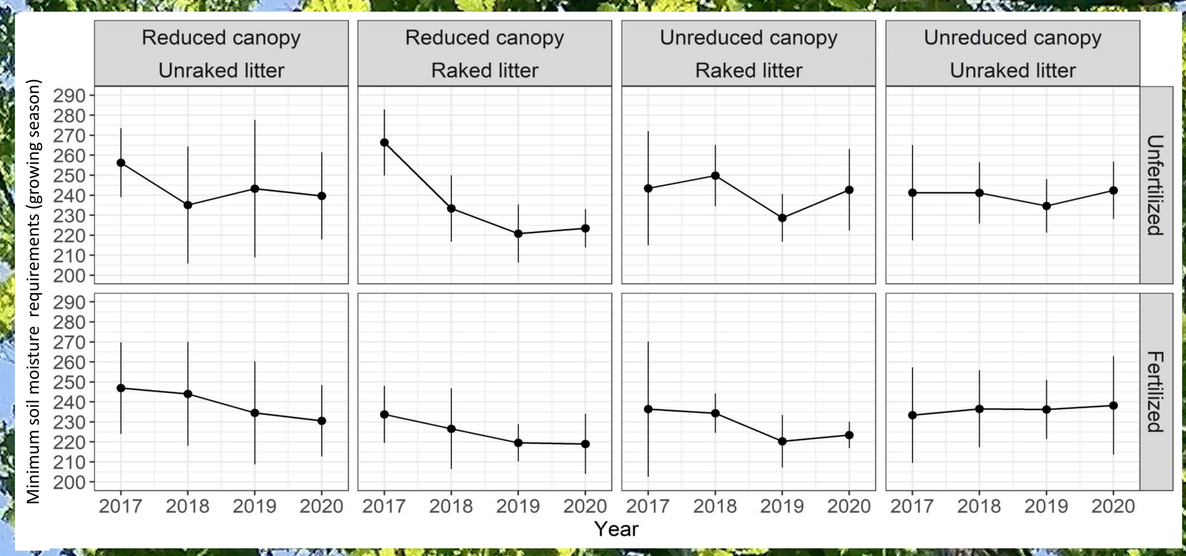


Fig. 6 Changes in the lower edge of the precipitation requirements of vascular plants during three growing seasons from the baseline in 2017 (before application of treatments) within different combination of treatments including control (upper right corner). Points indicate the mean and vertical lines the standard error from five experimental sites.

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