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The shifting of climate types: manifestation to phenology and ecosystems structure

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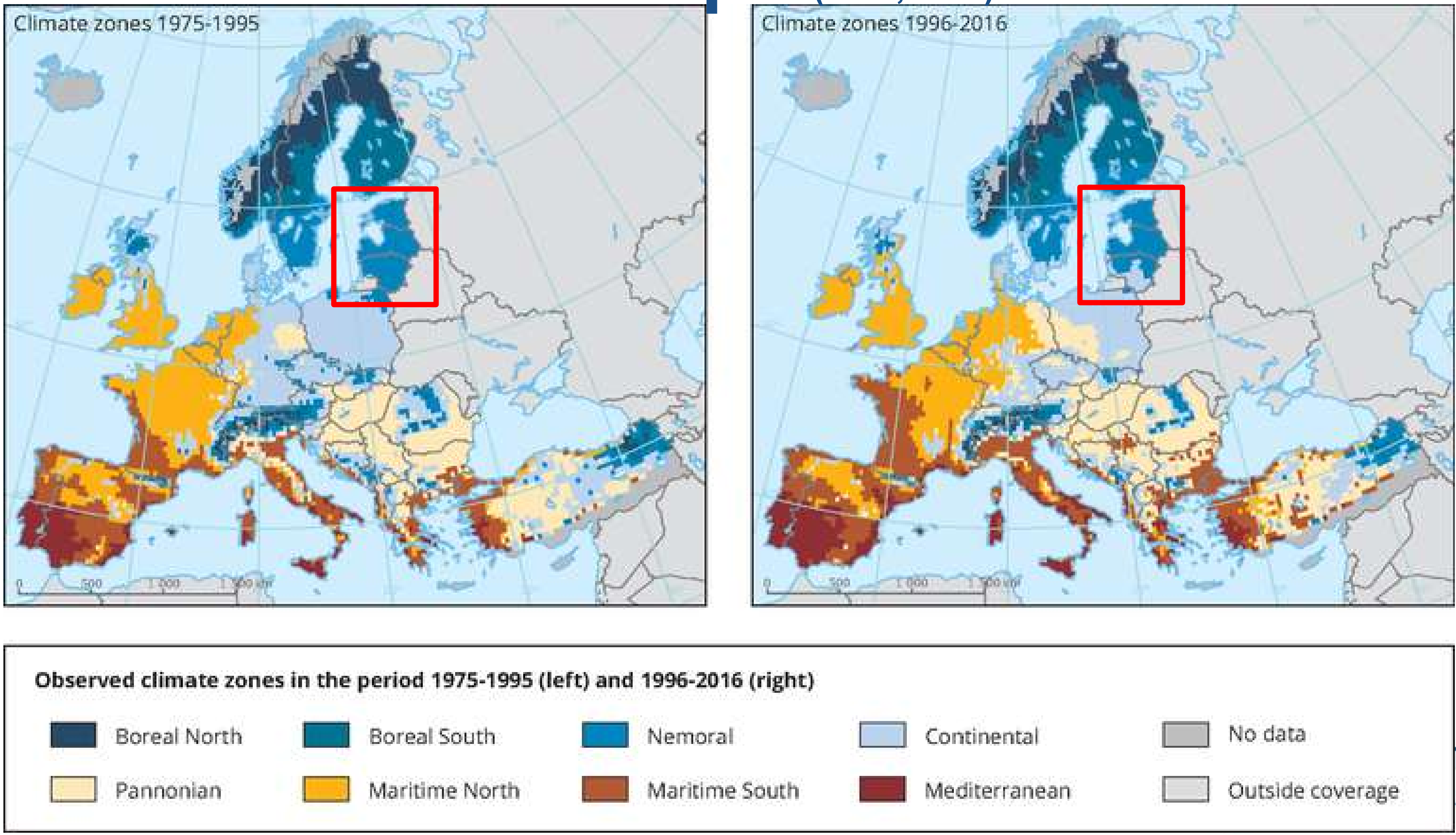
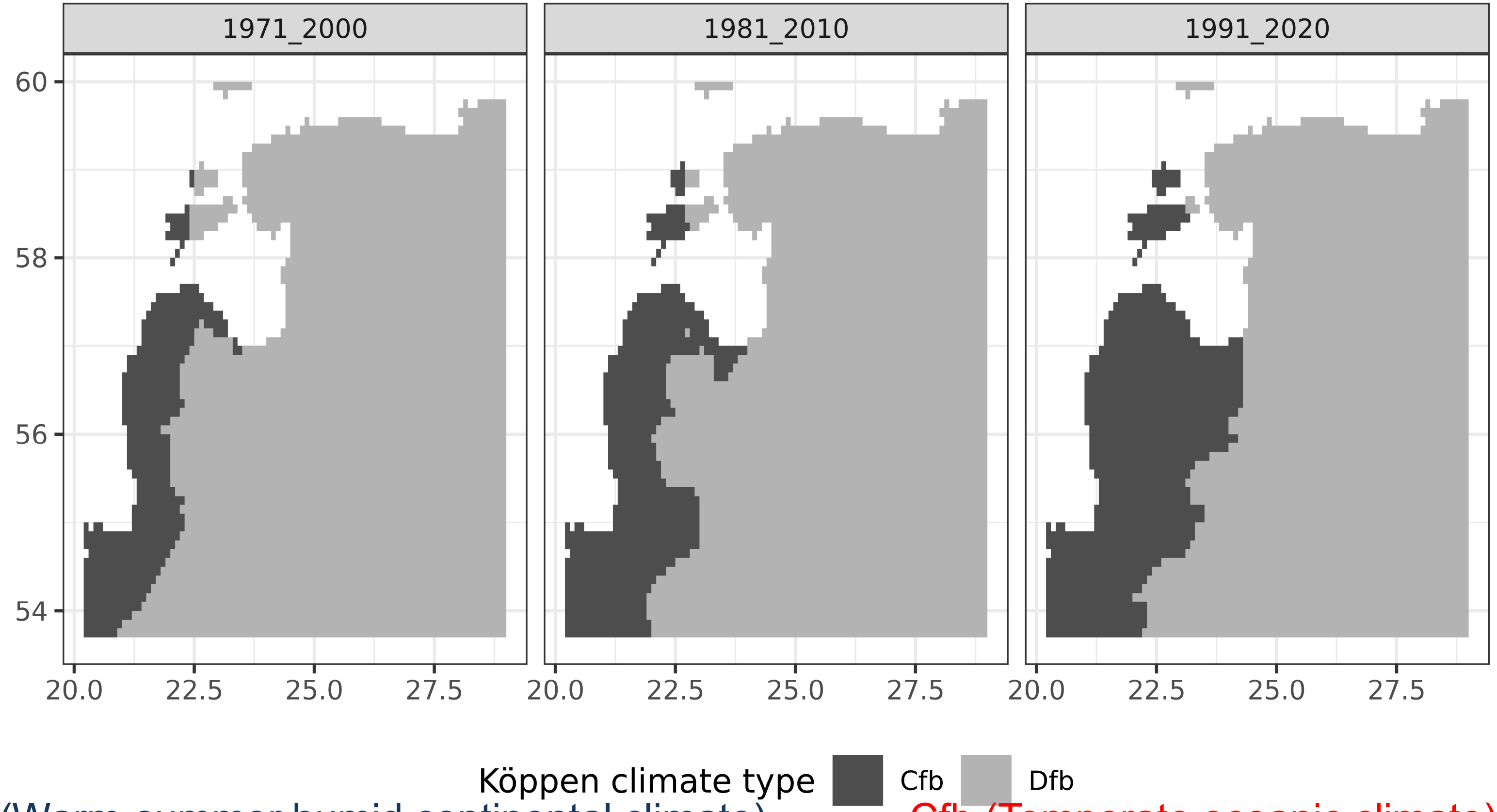
Climate zones in Europe (EEA,2019)



Source: https://www.eea.europa.eu/data-and-maps/figures/observed-climate-zones-in-the

Climate type shifting in Baltics



Dfb (Warm-summer humid continental climate)

Cfb (Temperate oceanic climate)

Daily gridded air temperature data from e-obs version 21.0e (Cornes et al. 2018).

Köppen climate zone attributed based on average air temperature (Tm-min) for on average coldest month for each grid cell for 30-year reference period: Tm-min < -3°C for Dfb (Warm-summer humid continental climate) and Tm-min > -3°C for Cfb (Temperate oceanic climate).

Reference: Cornes RC, van der Schrier G, van den Besselaar EJM, Jones PD (2018) An Ensemble Version of the E-OBS Temperature and Precipitation Data Sets. J Geophys Res Atmos 123:9391–9409. https://doi.org/10.1029/2017JD028200

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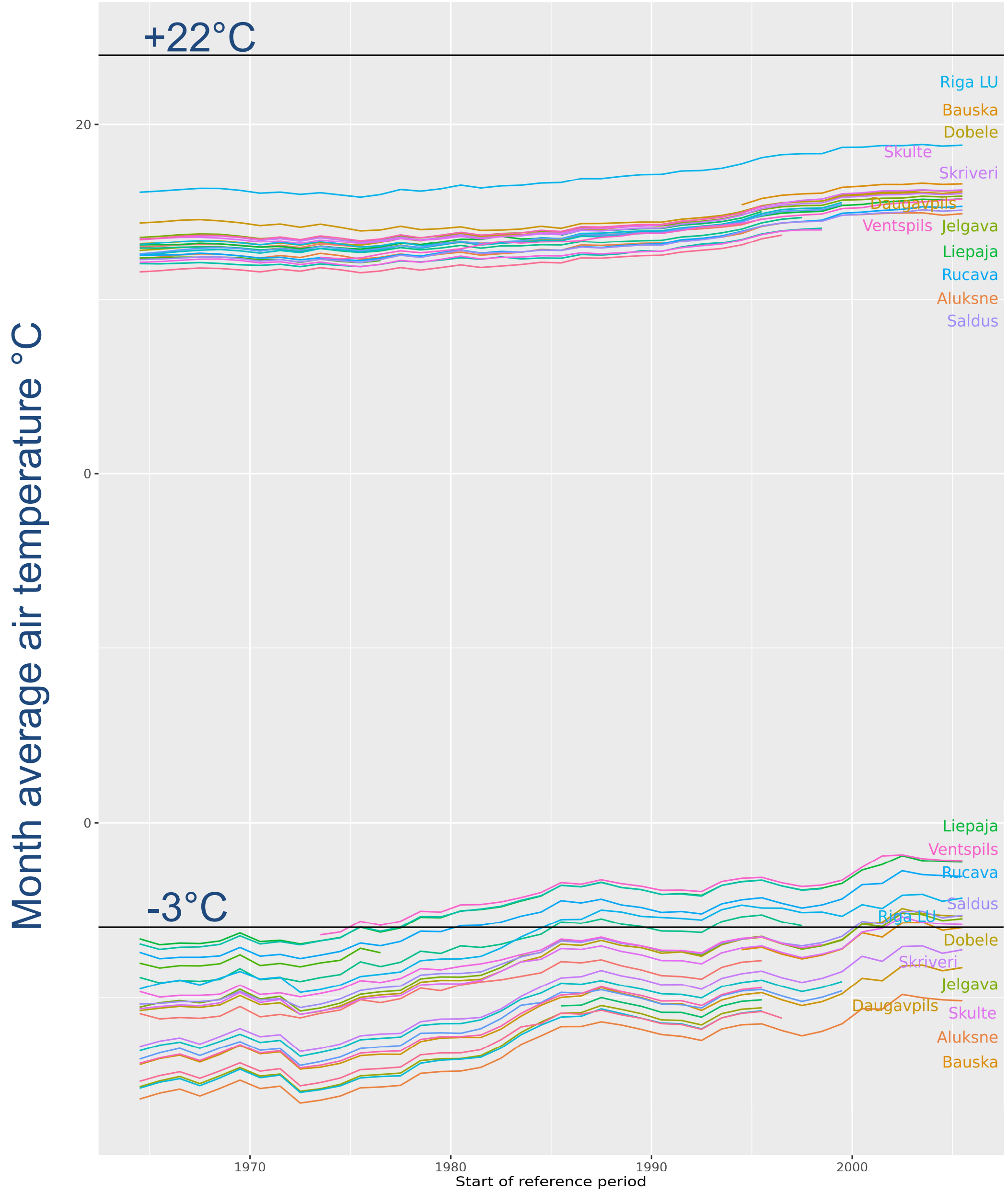
Temperature



Warmest and coldest month average air temperature of 30-year moving window at meteorological observation stations.

Data obtained from Latvian Environment, Geology and Meteorology Centre.

Location of meteorological stations:
https://www.meteo.lv/meteorologijas-staciju-karte/?nid=460

Phenological data

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November 13, 2020

Dataset Open Access

Phenology data set of plants and birds and other taxonomic groups, as well as agrarian activities and abiotic phenomena from Latvia, 1970-2018

Gunta Kalvāne; Andis Kalvans; Andris Ģērmanis

A data set of phenological observations of plants, birds, as well as agrarian activities and abiotic phenomena from Latvia, 1970-2018 is presented. The data include limited number of observations of insects, amphibians, mammals, mushrooms, mollusks and fishes as well. The data was collected by voluntary observers (citizen scientists) and published as paper based yearly bulletins. It includes almost 48 000 individual observations of 159 different phenological phases from 103 locations in Latvia. Each entry is comprised of following fields:

1. Station: name of the observation station
2. Year: year of observation
3. Season: season of observation as indicated in the primary publication
4. Species: English name of the species observed or description of phenomena observed in case of abiotic occurrences
5. Species Latin: Latine name of the species observed
6. Taxonomic_group: taxonomic group of the species observed or grouping of non-biological phases ("Abiotic" for meteorological phenomena and "Agrarian" for agrarian activities)
7. Phenophase: description of phenological phase observed
8. BBCH: attributed BBCH code for phenological phase observed, where applicable

Open-data
~ 48 000 records

Phenological data available:
https://zenodo.org/record/3982086#.YIK4hJAzbIU

https://doi.org/10.5194/essd-2020-347
Preprint. Discussion started: 17 March 2021

Open Access Earth System Science Data Discussions

Long-term phenological data set of multi-taxonomic groups, agrarian activities and abiotic parameters from Latvia, northern Europe

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Abstract

A phenological data set collected by citizen-scientists from 1970 to 2018 in Latvia is presented, comprising almost 47,000 individual observations of eight taxonomical groups, in addition to agrarian activities and abiotic parameters, covering in total 159 different phenological phases. These original data published offline in annual issues of the Nature and History Calendar (in Latvian, *Dabas un vēstures kalendārs*) have been digitized, harmonized and geo-referenced.

Overall, the possible use of such data is extensive, as phenological data are excellent bioindicators for characterising climate change and can be used for the elaboration of adaptation strategies in agriculture, forestry, and environmental monitoring. The data also can be used in cultural–historical research; for example, the database includes data on sugar beet and maize, the cultivation of which was imposed on collective farms during the Soviet period. Thus, such data are not only important in the Earth sciences but can also be applied to the social sciences.

The data significantly complement current knowledge on European phenology, especially regarding northern regions and the temporal biome. The data here cover two climate reference periods (1971–2000; 1981-2010), in addition to more recent years,

Pre-print. Comments are welcome

Find on: https://essd.copernicus.org/preprints/essd-2020-347/?fbclid=IwAR0lYJgmRgLZnmOZ_VHWZnh17djD3q5cio7sN6RUI8jImv5YqPlNYXCvFSw

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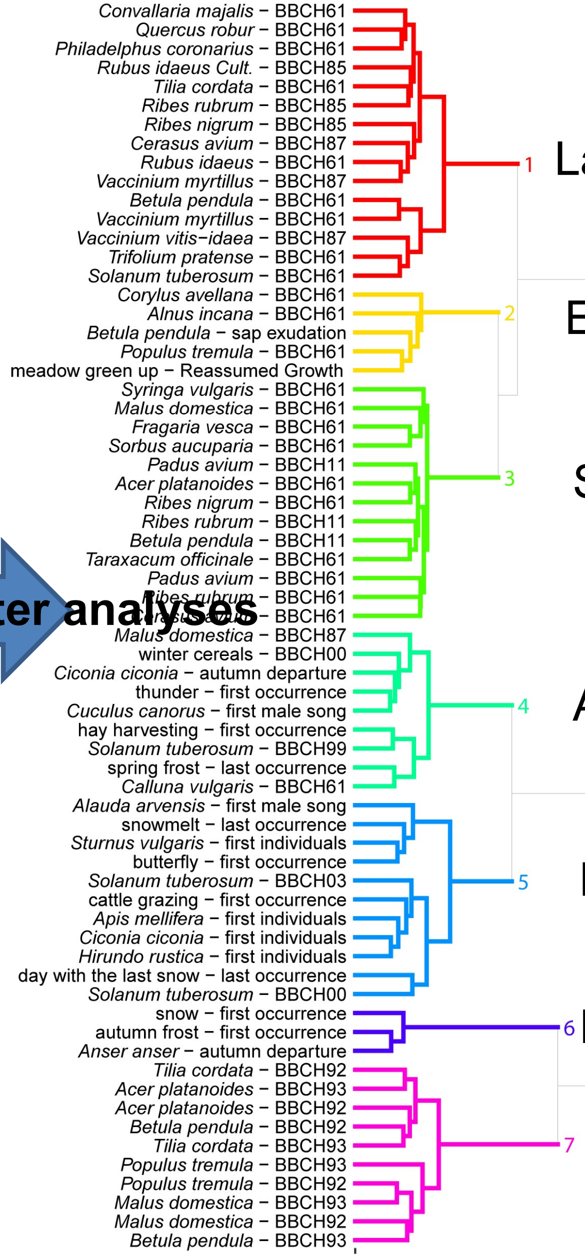
Methodology

Correlation matrix

150 phenological phases

150 phenological phases

Cluster analyses



1 Late spring/summer

2 Early spring

3 Spring

4 Agrarian/abiotical

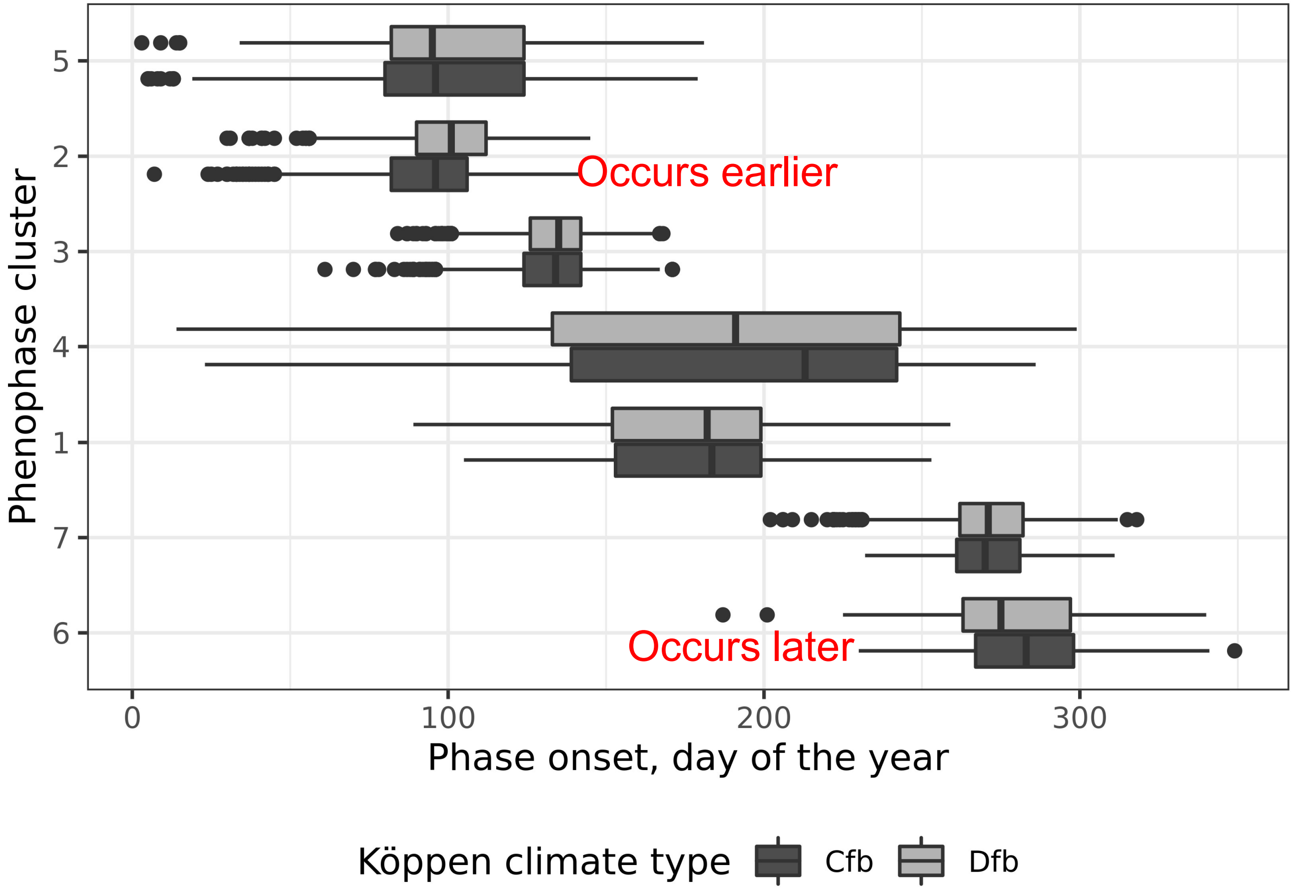
5 Birds

6 Late autumn

7 Autumn

For details see: Kalvāne, G. and Kalvāns, A.: Phenological trends of multi-taxonomic groups in Latvia, 1970-2018, Int. J. Biometeorol., doi:https://doi.org/10.1007/s00484-020-02068-8, 2021

Phenological changes – timing distribution



Clusters:
No 1. early-summer phases, mostly flowering and fruiting of woody plants and domestic berries;
No. 2 earliest spring phases – the earliest flowering woody species like hazel and alder;
No. 3 late-spring phases, mostly flowering;
No. 4 indistinctive grouping of agrarian activities and abiotic occurrences;
No. 5 first spring sighting of migratory birds;
No. 6 start of autumn leaf senescence of woody species
No. 7 late autumn phases such as departure of migratory gees and first snow

**Timing distribution of the phenophase` clusters** for Latvia` stations within where Köppen climate type had not changed between reference periods 1971-2000 and 1991-2020 from Dfb to Cfb.

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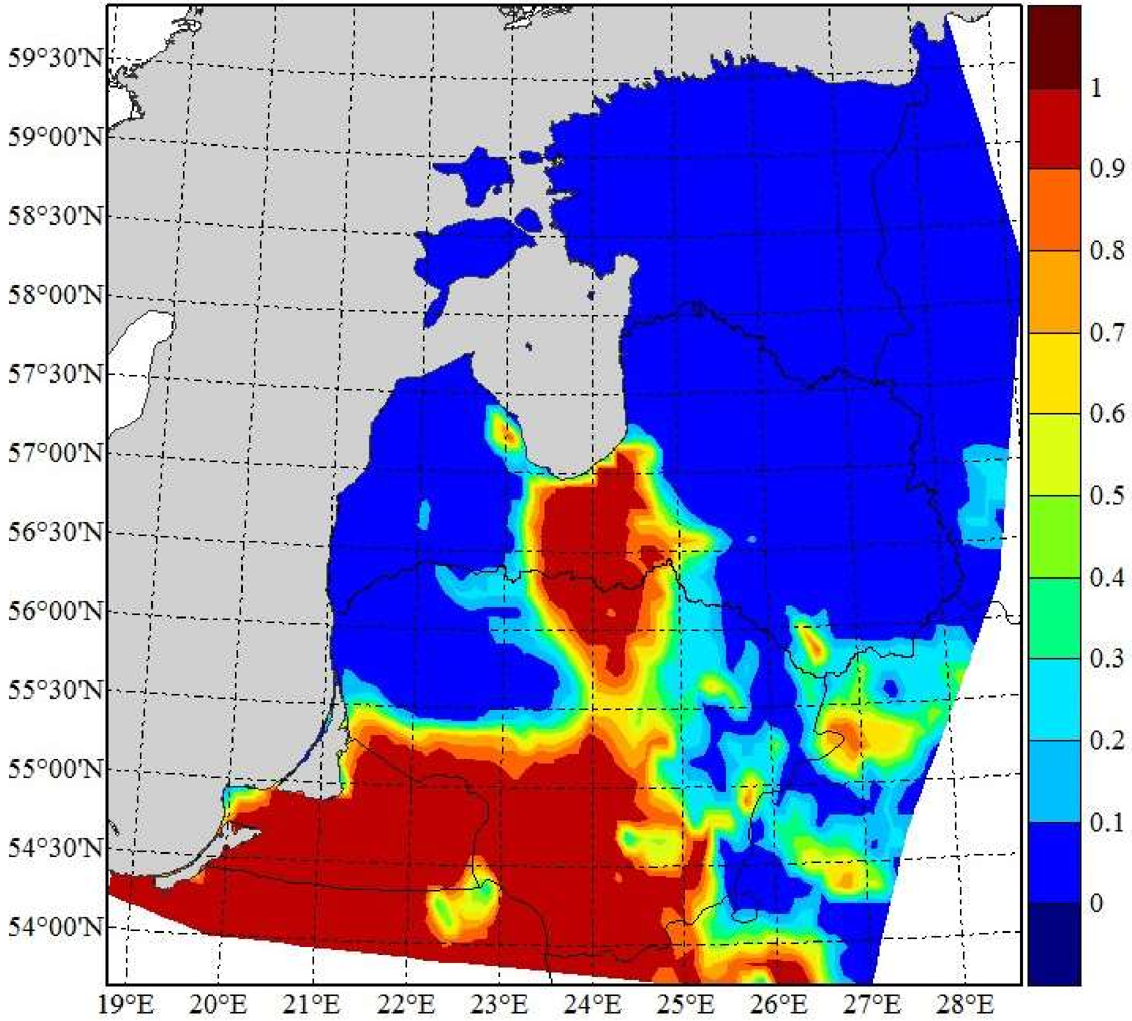
Kalvāne, G. and Kalvāns, A.: Phenological trends of multi-taxonomic groups in Latvia, 1970-2018, Int. J. Biometeorol., doi:https://doi.org/10.1007/s00484-020-02068-8, 2021

Regional differences



Prediction for 26.04.2021. 1 – optimal degree-day status for unfolding; value 0.5 – 50% of degree day sum is accumulated.

A modified degree day phenological model for bird cherry leaf unfolding

by Kalvāns et al. (2015, 2017; DDcos model), driven by operational weather forecasting model HIRLAM of the Danish Meteorological Institute, processed by in-house software FiMAR, at the Institution of Numerical Modelling University of Latvia.

References:

Kalvāns A, Bitāne M, Kalvāne G (2015) Forecasting plant phenology: evaluating the phenological models for Betula pendula and Padus racemosa spring phases, Latvia. Int J Biometeorol 59:165–179. https://doi.org/10.1007/s00484-014-0833-5

Kalvāns A, Sīle T, Kalvāne G (2017) Phenological model of bird cherry Padus racemosa with data assimilation. Int J Biometeorol 61:2047–2058. https://doi.org/10.1007/s00484-017-1401-6

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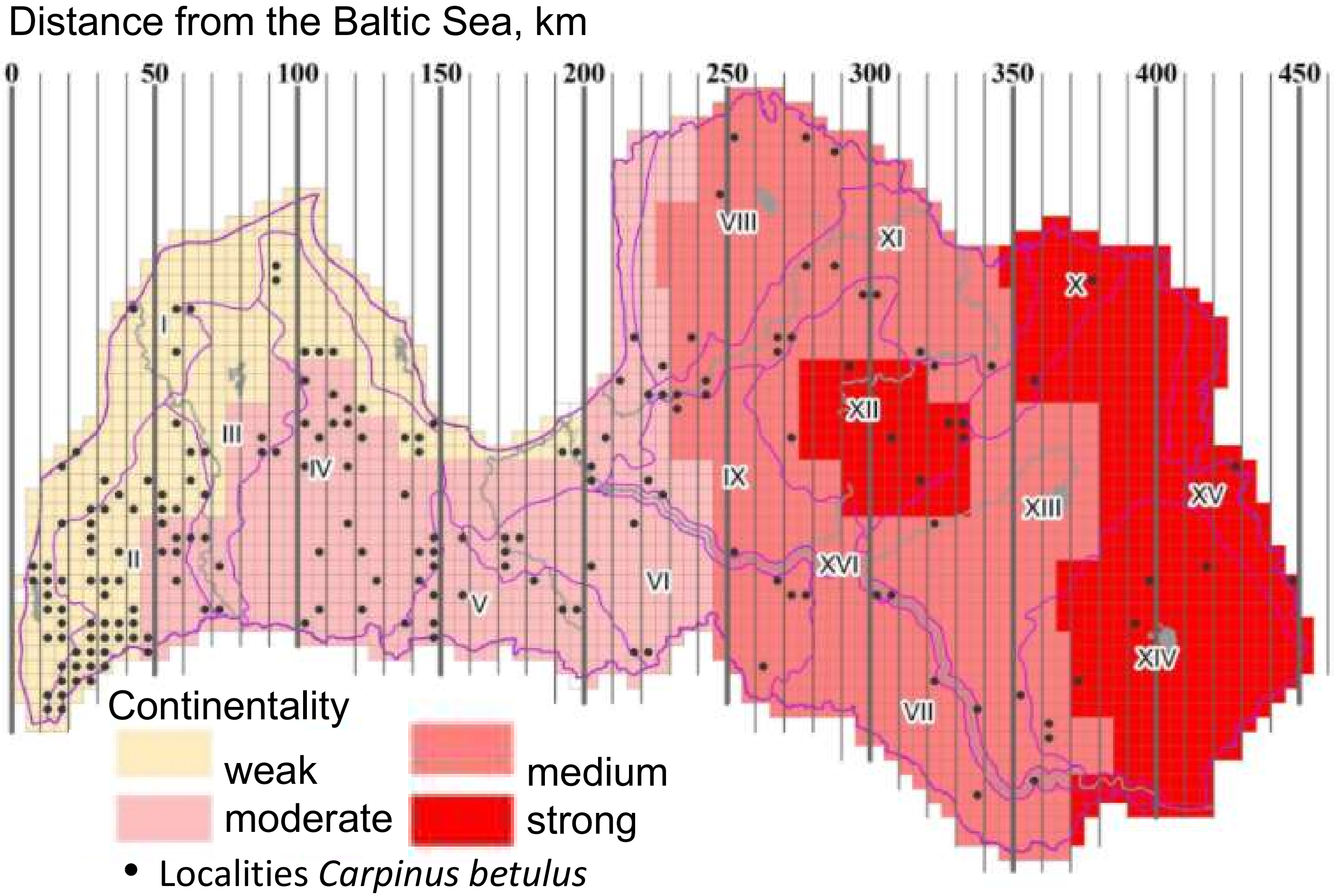
Ecosystems structure: forest

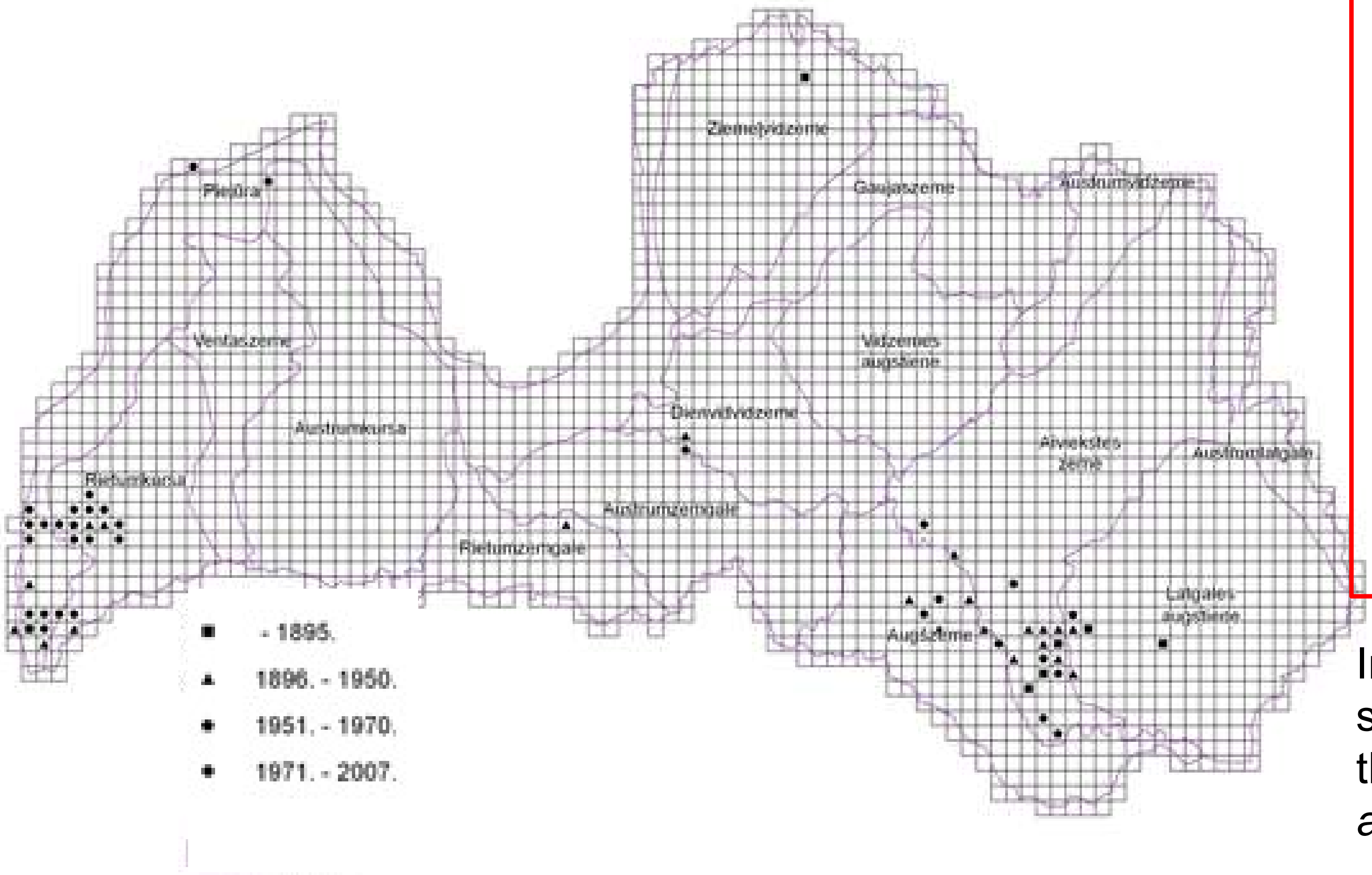


Indicator species of nemoral biome are more common in the western part of the country, while species of boreal coniferous tree biome – in the north-eastern part of the country. Broadleaf species might be characterized with gradient from the Baltic seashore to eastern border of Latvia (west-east direction).

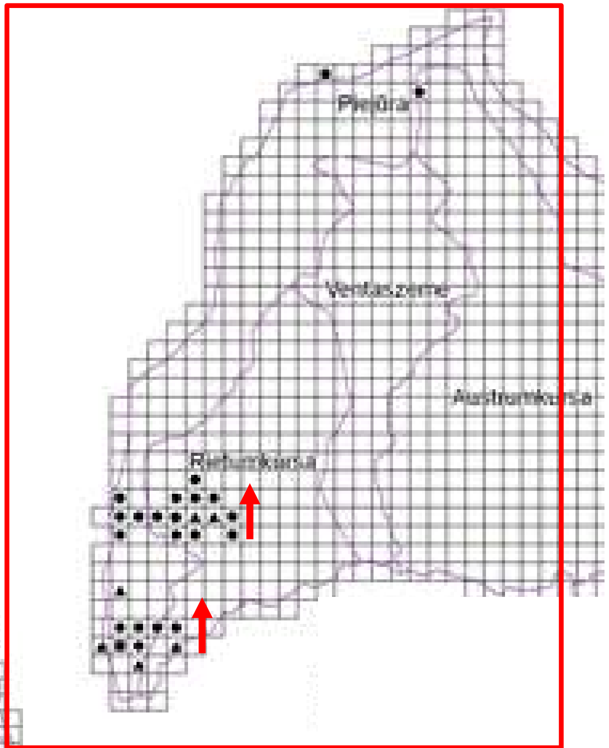
Distribution of hornbeam (*Carpinus betulus*) (native species) in Latvia

References: Krampis I. (2010) Regional distribution of boreal and nemoral biome woody plants in Latvia. Dissertation. University of Latvia, Riga, 129 pp.

Ecosystems structure: forest



Distribution of mistletoe (*Viscum album*) in Latvia

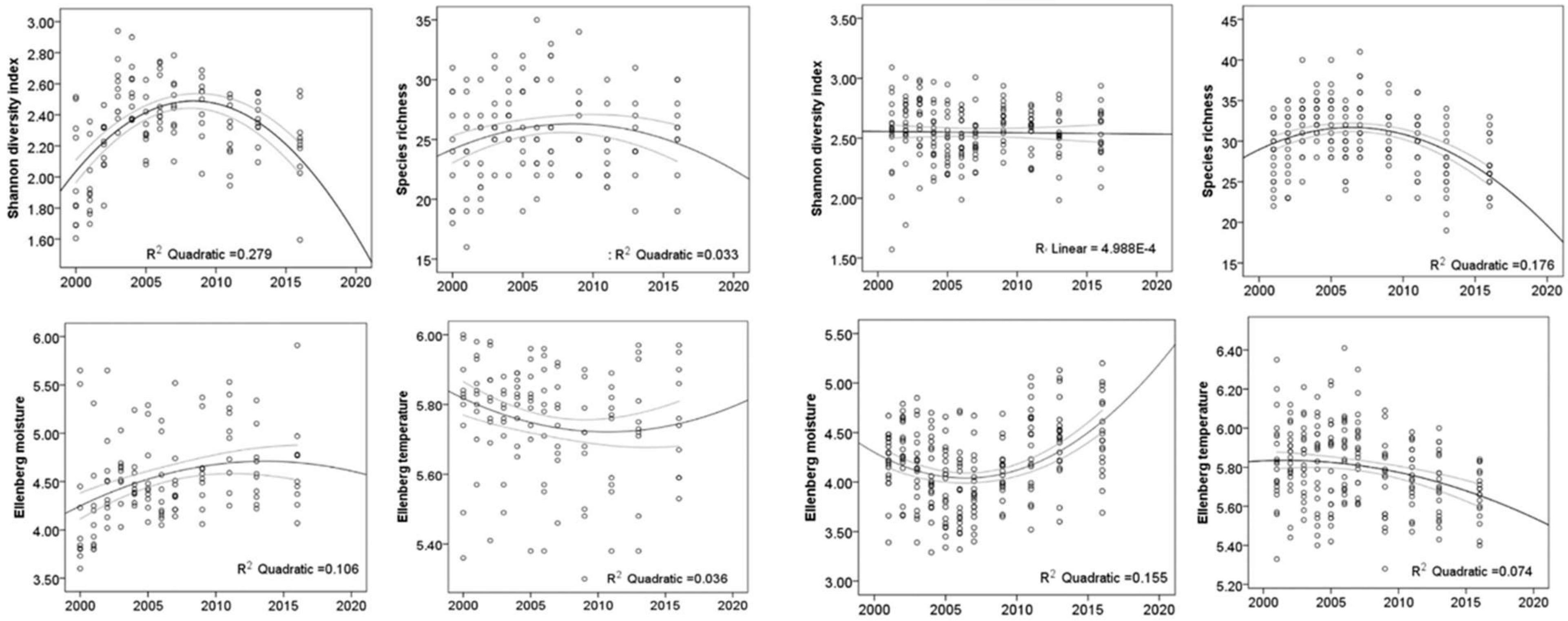


In recent years, there has been a slight shift in distribution south of the localities of mistletoe (*Viscum album*)

References: Krampis I. (2010) Regional distribution of boreal and nemoral biome woody plants in Latvia. Dissertation. University of Latvia, Riga, 129 pp.

Ecosystems structure: meadow and pasture

MEADOW 10 plots (1x1 m2) | PASTURE 18 plots (1x1 m2)



Ellenberg indicator values for temperature and moisture, species richness and Shannon index in two dry calcareous grasslands (meadow and pasture)* (2000-2016) in Abava valey (Western part of Latvia) by Rūsiņa.

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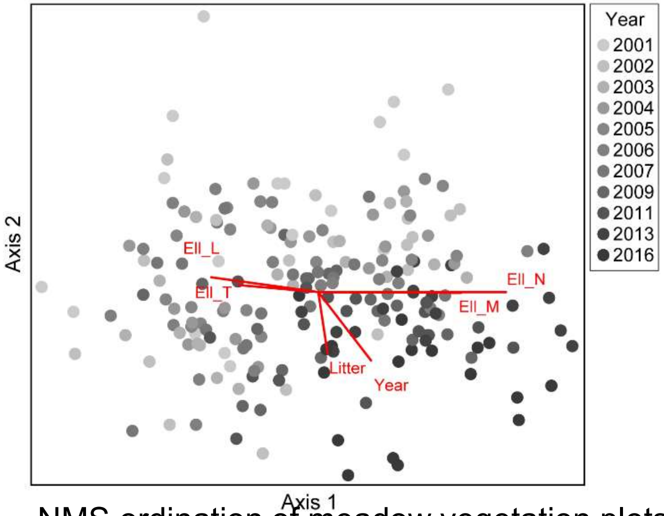
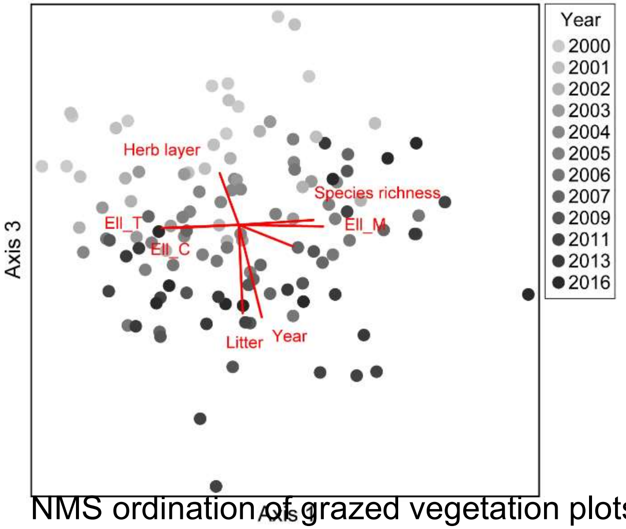
* Both sites were managed continuously without substantial changes in intensity. Thus, response of species richness can be attributed to natural environmental variability.

MEADOW



NMS ordination of meadow vegetation plots (n=10, 1m²)
R^2 after-the-fact evaluation of ordination axes:
Axis 1 – 0.30, Axis 2 – 0.25, Axis 3 – 0.21

PASTURE



NMS ordination of grazed vegetation plots (n=18, 1m²)
R^2 after-the-fact evaluation of ordination axes:
Axis 1 – 0.53, Axis 2 – 0.17, Axis 3 – 0.11

In both sites, no linear trends were detected. Species richness and/or Shannon diversity slightly increased in the first part of the study period and decreased after 2007. Ellenberg moisture values showed slight tendency of increase, while Ellenberg temperature had the opposite tendency.

Overall, as shown by NMS ordination, temporal changes in species composition were associated with accumulation of litter, while differences in other environmental factors were spatially determined.

We conclude, that no clear signs of increased temperatures are manifested to dry semi-natural grassland vegetation at a local scale. As well, no indications for increased summer drought could be detected. On opposite, increased values of Ellenberg moisture are in line with the findings of increase in precipitation in Latvia (Jaagus et al. 2018).

Jaagus, J, Briede, A., Rimkus, E., Sepp, M. 2018. Changes in precipitation regime in the Baltic countries in 1966-2015. Theoretical and Applied Climatology, 131: 433-443

Lesson learnt:

1. During the two last reference periods in the Western par of Latvia the climate type has shifted from Dfb to Cfb, as the average air temperature during the coldest month raised above -3°C.

2. The change in climate type is corelated with phenological variations – in the Western part of the territory, the spring phase start early while the onset of autumn phases are delayed.

3. Climate change signal in forest and grassland ecosystem composition is difficult to disentangle from impact of management practices, however:

   3.1. There is tendency, that nemoral tree species advancing inland, towards more continental regions;

   3.2. A clear climate change impact was not detected in meadow and pastures species composition, however there is tendency of shifting towards more moisture-tolerant species.

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This study was carried out within the framework of the *Impact of Climate Change on Phytophenological Phases and Related Risks in the Baltic Region* (No. 1.1.1.2/VIAA/2/18/265) ERDF project and the *Climate change and sustainable use of natural resources* institutional research grant of the University of Latvia (No. AAP2016/B041//ZD2016/AZ03) and LIFE programme project GrassLIFE (LIFE16NAT/LV/000262)

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