Text S1: Methods description for the calculation of the climatic water balance and creating the Figure 2. & Figure 3.

We downloaded the ERA-5 Land data (NCDF format) from the Copernicus Climate Change Service [28] for monthly mean temperature (converted from K to °C) from 1981-2020, as well as monthly precipitation (converted from m to mm). R software [40] package "ncdf4" [42] was used to read the NCDF files into R. Package "raster" [43] was used to convert both the datasets into raster. Each raster grid is 0.1 x 0.1°, roughly 9x9 km.

We calculated the monthly potential evapotranspiration [37, 38] (PET, mm), by using the latitude information and monthly mean temperature for each grid, in the R package "SPEI" [39]. Monthly climatic water balance (CWB, mm) was calculated as the difference between monthly precipitation (mm) and monthly PET (mm), from 1991-2020. For each grid, we then calculated the sum of CWB over the vegetation period (April to September) for each year, and subsequently the mean and standard deviation over this observation period.

Standardized anomalies in the vegetation period of 2003, 2004, 2018 and 2019 were calculated for each grid as: (the observed CWB in the vegetation period of a year – mean of the summed CWB in the vegetation period from 1991-2020) / (standard deviation from the mean over this period).

We then used ArcGIS software to plot the gridded CWB and the anomalies on the Central European map. Shapefiles of the countries were downloaded from Eurostat [41].

Text S2: Evaluation of the ICP Forests Level I data

ICP Forests Level I crown condition data for European beech at tree level was available for about 350 plots across Central Europe. This was averaged to per plot defoliation and categorized into the defoliation categories as per the ICP Forests Technical Reports [21, 108] as:

0-10% - no defoliation

10-25% - slight defoliation

25-40% - moderate defoliation I

40-60% - moderate defoliation II

60-99% - severe defoliation

100% - dead (not included in this plot level assessment)

Number of affected plots in each category are presented in S3-S7 for each country.

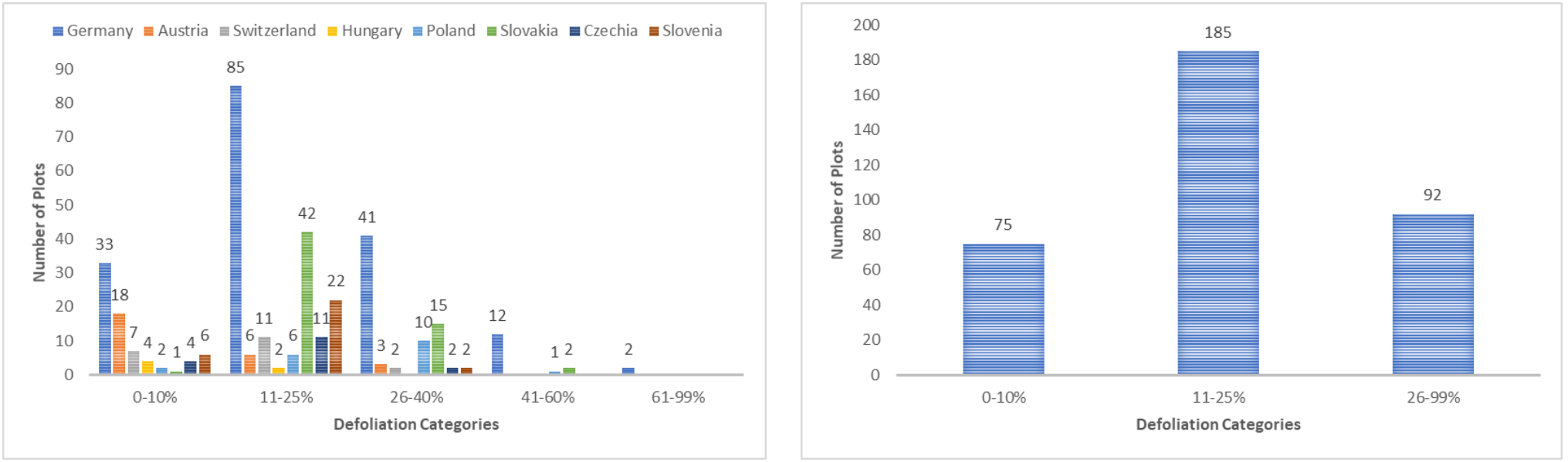


Figure S1: *(left)* Defoliation Plots on ICP Forests Level I in Central Europe in 2003; *(right)* Total number of plots on Level I in Central Europe, in each defoliation category in 2003. Moderate to severe defoliation (>26% and up to 99%) has been shown as a single category.

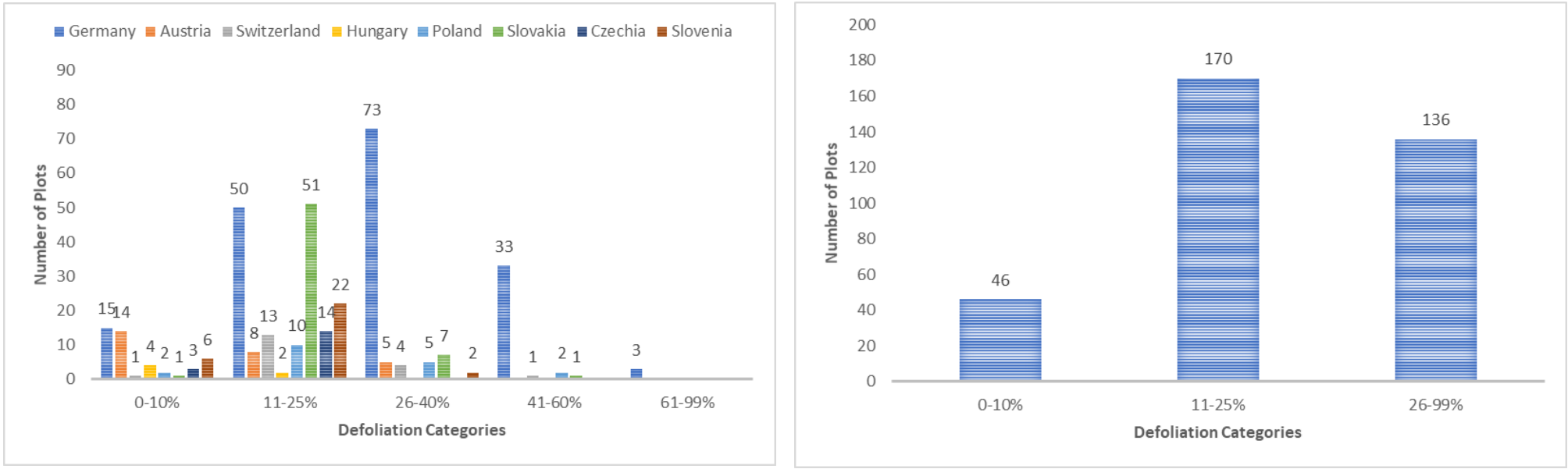
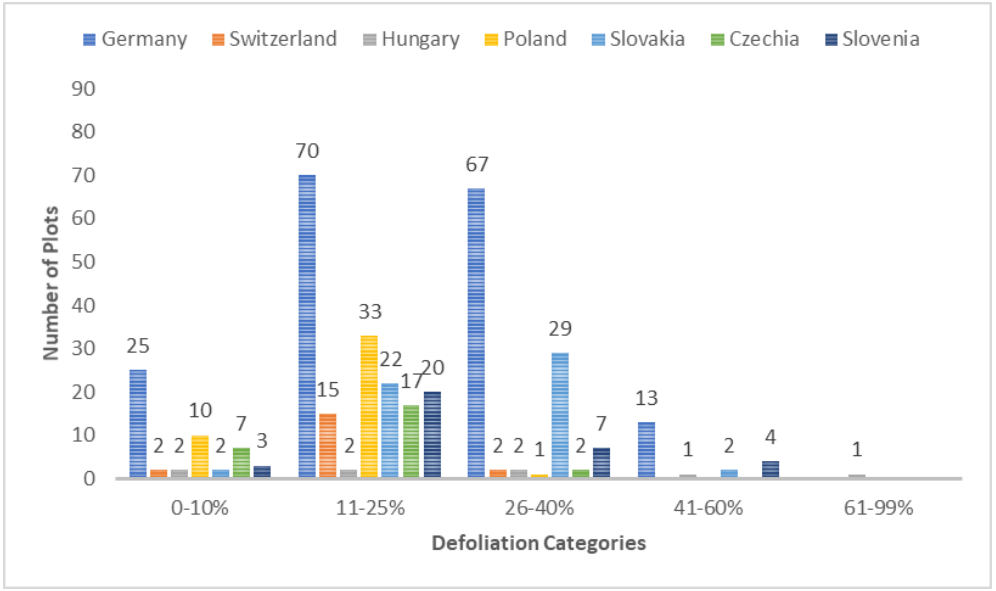


Figure S2: *(left)* Defoliation Plots on ICP Forests Level I in Central Europe in 2004; *(right)* Total number of plots on Level I in Central Europe, in each defoliation category in 2004. Moderate to severe defoliation (>26% and up to 99%) has been shown as a single category.



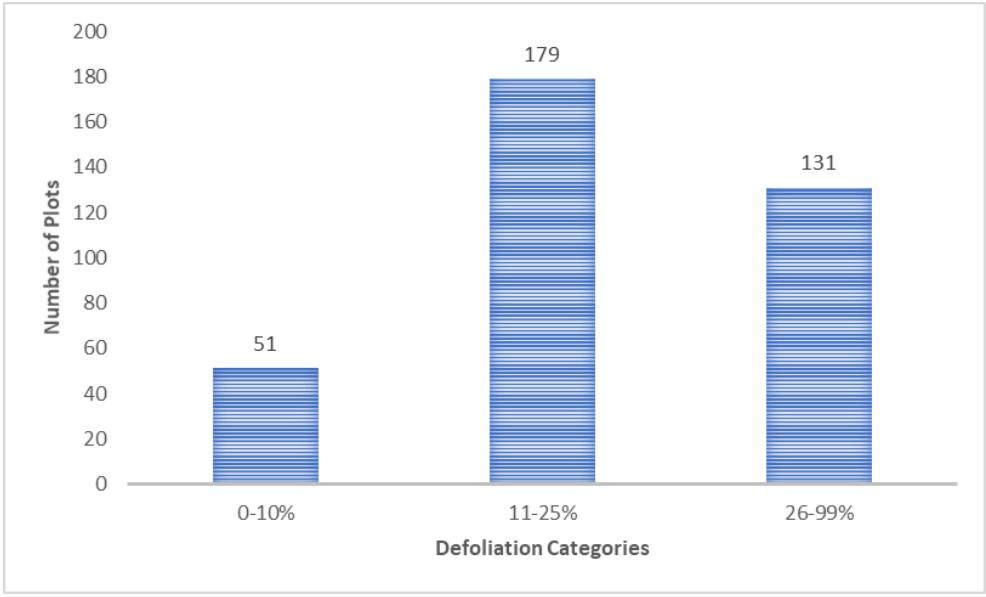
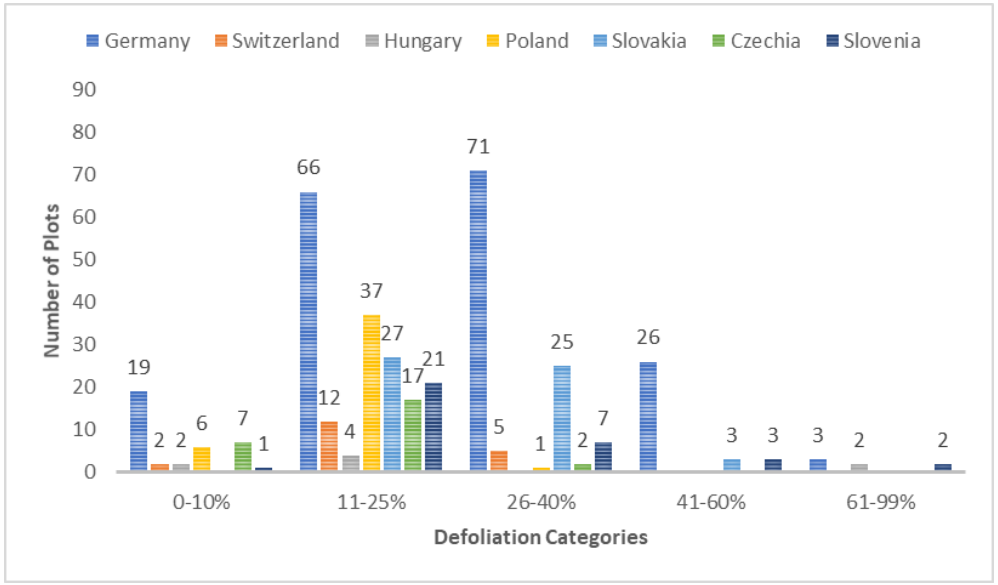


Figure S3: *(left)* Defoliation Plots on ICP Forests Level I in Central Europe in 2018; *(right)* Total number of plots on Level I in Central Europe, in each defoliation category in 2018. Moderate to severe defoliation (>26% and up to 99%) has been shown as a single category.



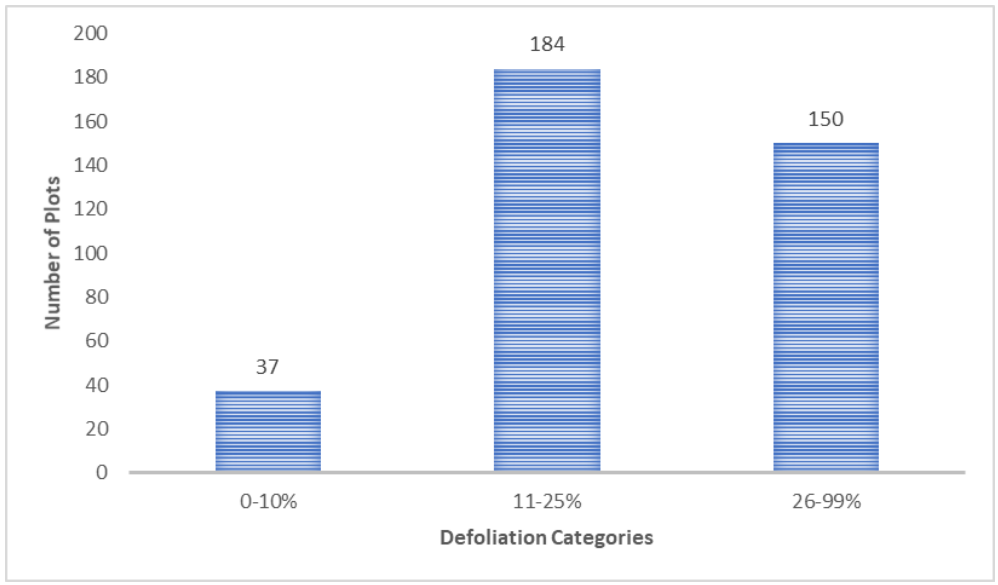
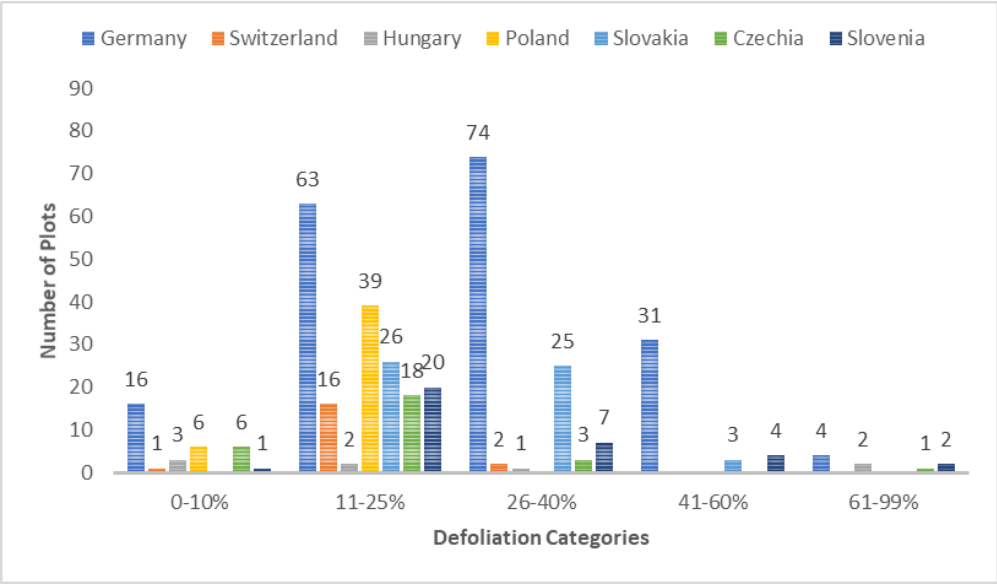


Figure S4: *(left)* Defoliation Plots on ICP Forests Level I in Central Europe in 2019; *(right)* Total number of plots on Level I in Central Europe, in each defoliation category in 2019. Moderate to severe defoliation (>26% and up to 99%) has been shown as a single category.



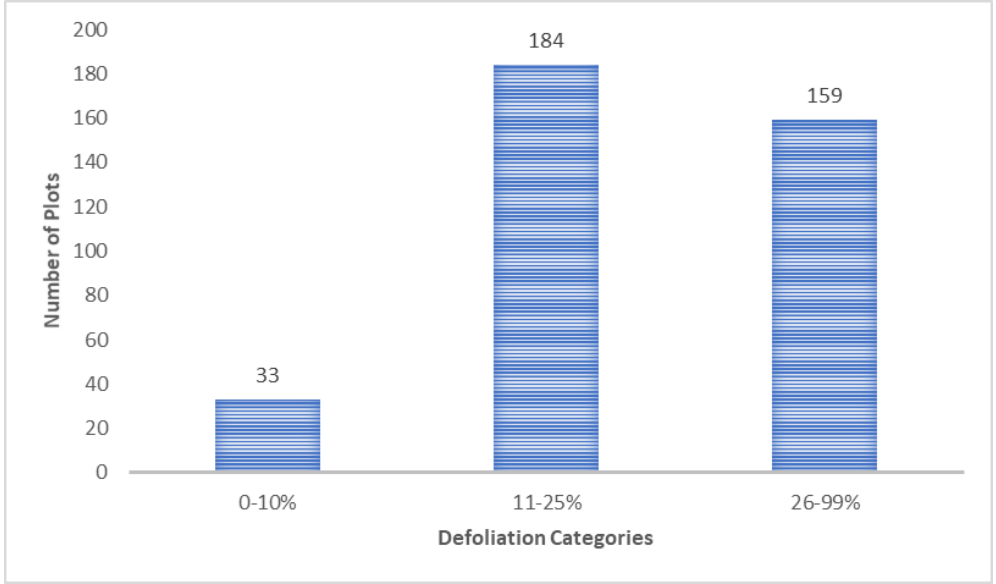


Figure S5: *(left)* Defoliation Plots on ICP Forests Level I in Central Europe in 2020; *(right)* Total number of plots on Level I in Central Europe, in each defoliation category in 2020. Moderate to severe defoliation (>26% and up to 99%) has been shown as a single category.