

Supplementary Materials

S1. Sample Elemental Concentration Analysis

At the laboratory, the leaf samples were dried at 75 °C for 72 h. The dried shoots were then powdered and passed through a 100-mesh screen. 5 replicates from each treatment were used for each analysis. 5 mL of HNO_3 were added to 0.5 g of sample in a 250 mL dry flask and stirred. Thus, all the material was wet. Then 4 mL of 33% H_2O_2 was carefully added in a well-ventilated hood and slightly stirred after the addition. It was heated on a hot plate and a strong effervescence was produced. When the brown fumes were less dense (7-8 minutes), the solution was allowed to cool. A slightly yellow dissolution and a small white solid quantity in suspension remained. The solution was filtered, washed with 5 mL of (1:1) HCl (density 1.18 g mL^{-1}), and diluted up to 25 mL with distilled H_2O

To determine plant N concentration, we followed the alkaline distillation method [1], In our case, we used the full-auto Kjeldahl distillation apparatus system. We first added 10 ml of deionized water to the distillation flask, followed by a 5 ml sample solution. In the receiving flask, ammonium was trapped by 10 ml H_3BO_3 mixed with 2 drops of the indicator solution. We then distilled the sample solution using steam of 40% NaOH . When the solution in the receiving flask reached 30 – 40 ml, we then stopped the distillation. The N concentration in the Boric acid solution was then determined by titration with 0.01mol/L hydrochloric acid standard solution. Calculations were computed following Equation (S1).

$$\text{N content (g/kg)} = \frac{c(V-V_0) \times 0.014 \times D \times 1000}{m} \quad (\text{S1})$$

Where:

c—the concentration of the titrant used in the titration.

V—volume of the titrant used for the sample solution in titration.

V0—volume of the titrant used in the blank titration.

D—dilution factor

M—mass of the plant sample.

To determine plant P concentration, we followed a colorimetric method by [2] we first diluted the digested sample solution to 100 ml. We then added 5 ml of the digested solution (sample solution), and 2 drops of 2-4 dinitrophenol indicator into a 50 ml volumetric flask. We then

added 12 ml of 6M NaOH and 10 ml of ammonium vanadyl molybdate solution. We then added deionized water to the mark. We then measured the absorbance of the samples including the blank using a microspectrophotometer (SpectraMax iD3 Multi-Mode Microplate Reader, Molecular Devices, Salzburg, Austria) at 450 nm. A standard curve was also computed using a P standard solution with different concentrations and we calculated the plant P concentrations following Equation (S2).

$$P (\%) = \frac{C \times D \times V}{W \times 1000} \quad (S2)$$

Where:

C = Concentration of P obtained from the standard curve in mg/L

D = Dilution factor

V = Total volume of the digested sample solution

W = Weight of the initial plant sample in grams

1000 = Conversion factor to adjust units

S2. Detailed Methods for Soil Characterization

To characterize the soil physicochemical properties, we randomly collected five soil cores (5 cm × 20 cm) within each of the three plots at every elevation level. Samples from the same elevation were pooled together, passed through a 2 mm mesh size sieve to remove roots and debris, air-dried under a shade, and stored in dry paper bags at room temperature for further analyses. The samples were crushed and passed through a 0.05 mm sieve. We then extracted available P following the Bray 1 method [3]. 2.5 g of soil sample was placed into a 50 mL tube (conical bottom, screw cap), 25 ml of the extractant was added and the soil solution ratio used was 1:7 (w/v). Tubes were put on a reciprocal shaker for 5 min at 200 rpm. After shaking, the soil suspension was centrifuged at 6000 rpm for 5 min and the supernatant was collected. The P concentration of the collected extract (supernatant) was determined colorimetrically by the ascorbic acid method according to Kuo, (1996).

We prepared soil extractions for determining available N following the method by (Øien & Selmer-Olsen, (1980). We transferred 4 g air-dried and sieved soil into a 50 ml glass bottle, added 40 ml 2 M KCl, then tightly closed the bottle with a Teflon liner and a polypropylene screw cap. The bottle was shaken by hand (0.5 min) and placed in a water bath at 80°C for 20 h. After

cooling down to room temperature the sample is shaken for 1 min and thereafter the suspension is filtered through Whatman's glass microfibre filter GF/C. The ammonium and nitrate were determined colorimetrically according to a method by Bremner & Mulvaney [6] and Cataldo et al [7].

After completion of extraction, the extractant was transferred into a 50 ml volumetric flask, and deionized water was added to the mark. 10 ml of the sample solution was mixed with 10 ml of deionized water of 50 ml, and close the stopcock connecting the funnel and distillation chamber. Add 5 ml of H_3BO_3 -indicator solution to a 50-ml Erlenmeyer flask marked to indicate a volume of 35 ml, and place the flask under the condenser of the distillation apparatus so that the end of the condenser is about 4 cm above the surface of the H_3BO_3 . Then add 20 ml of 10N NaOH to the funnel of the apparatus, and run the alkali slowly into the distillation chamber by opening the funnel stopcock. When about 1 ml of alkali remains in the funnel, rinse the funnel rapidly with about 15 ml of water. Allow enough of this water to run into the distillation chamber to bring the level of the solution to a mark made previously to indicate a volume of 80 ml. Then close the funnel stopcock, and immediately commence distillation by closing the steam bypass tube at the base of the steam jacket of the distillation chamber. (It is not necessary to interrupt the flow of steam to the steam jacket of the distillation chamber before the addition of the digest and alkali, but the bypass tube of the steam jacket must be kept open during these additions). When the distillate reaches the 35-ml mark on the receiver flask, stop the distillation by opening the steam bypass tube, rinse the end of the condenser, and determine NH_4^+ -N in the distillate by titration with 0.01N H_2SO_4 using a 10-ml burette graduated at 0.01-ml intervals (1 ml of 0.01N H_2SO_4 = 0.14 mg of NH_4^+ -N). The color change at the endpoint is from green to pink.

To determine NO_3^- , we pipetted an aliquot (0.2 ml) of the extract into 50 ml Erlenmeyer flasks and mixed thoroughly with 0.8 ml of 5% (w/v) salicylic acid in concentrated H_2SO_4 ($\text{SA-H}_2\text{SO}_4$). After incubation (20 min) at room temperature, we slowly added 19 ml of 2N NaOH with a pipette (Lab Industries, Inc., Berkeley, CA) to raise the pH above 12. We let the samples cool to room temperature and measured the absorbance at 410 nm using a microspectrophotometer (SpectraMax iD3 Multi-Mode Microplate Reader, Molecular Devices, Salzburg, Austria). Standards containing 1 to 60 μg NO_3^- -N in a 0.2 ml aliquot were analyzed with each set of samples.

Figures

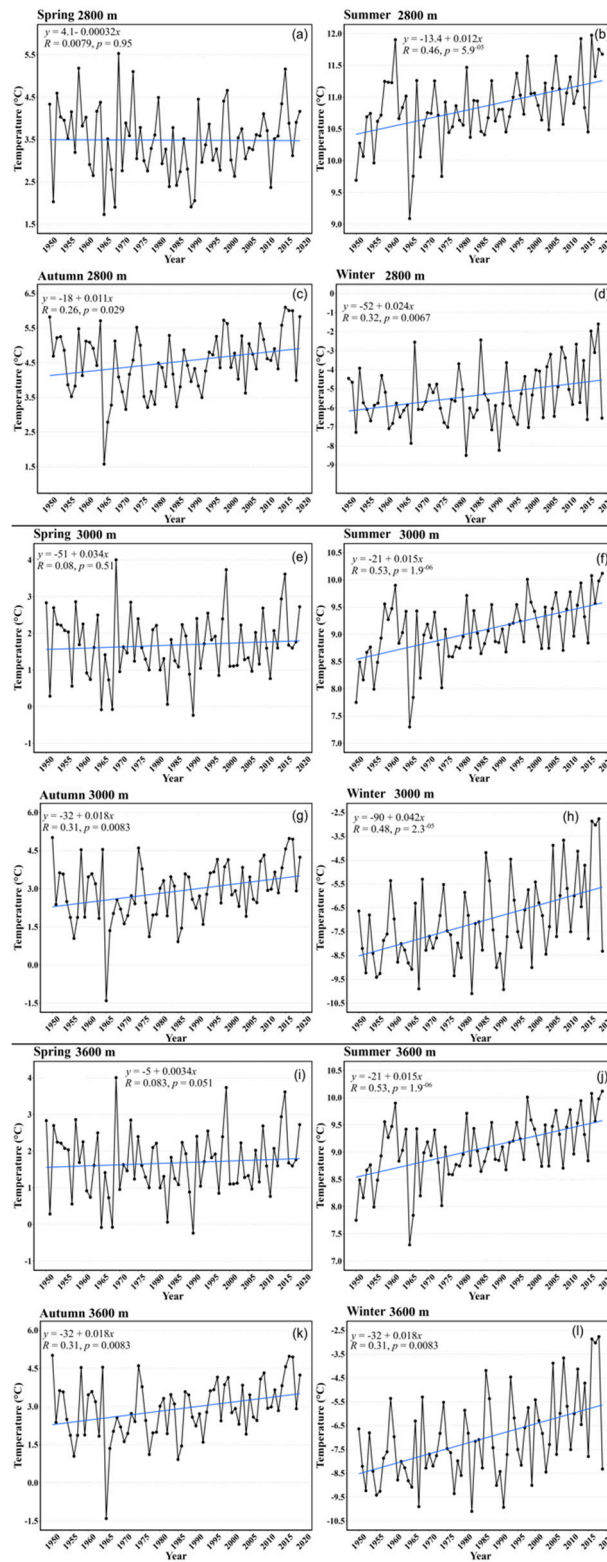


Figure S1. Temporal changes in seasonal temperatures at 2800 m (plots a–d), 3000 m (plots e–h), and 3600 m a.s.l (plots i–l) from 1950–2019. The blue lines show linear regression trends.

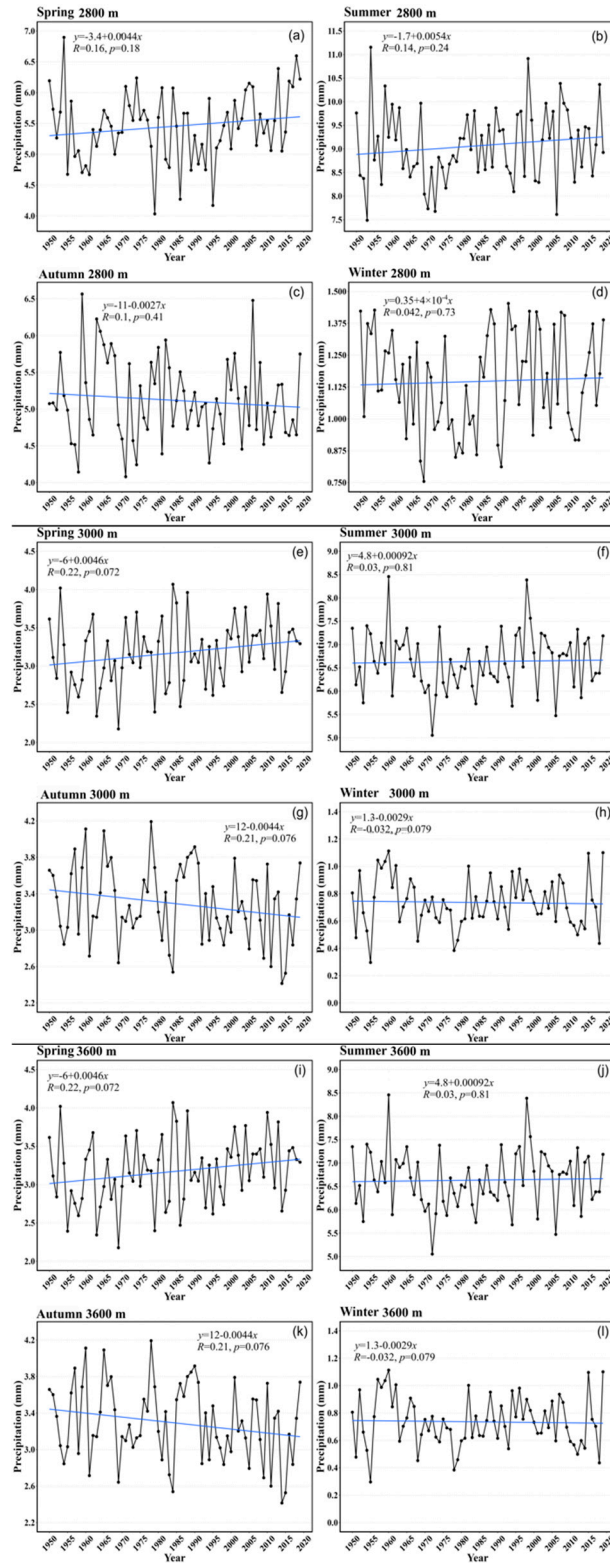


Figure S2. Temporal changes in summed seasonal precipitations at 2800 m (plots a-d), 3000 m (plots e-h), and 3600 m a.s.l (plots i-l) from 1950–2019. The blue lines show linear regression trends.

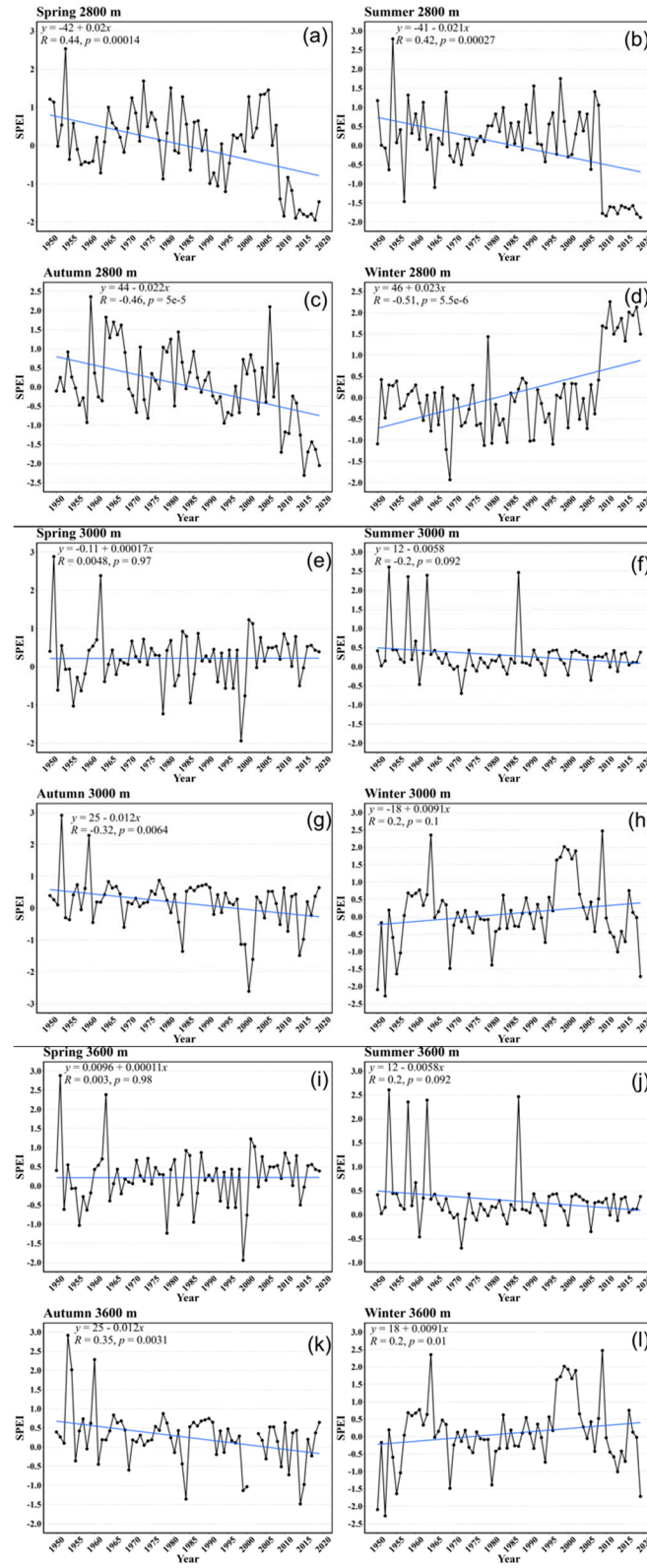


Figure S3. Temporal changes in seasonal SPEI values at 2800 m (plots a-d), 3000 m (plots e-h), and 3600 m a.s.l (plots i-l) from 1950–2019. The blue lines show linear regression trends.

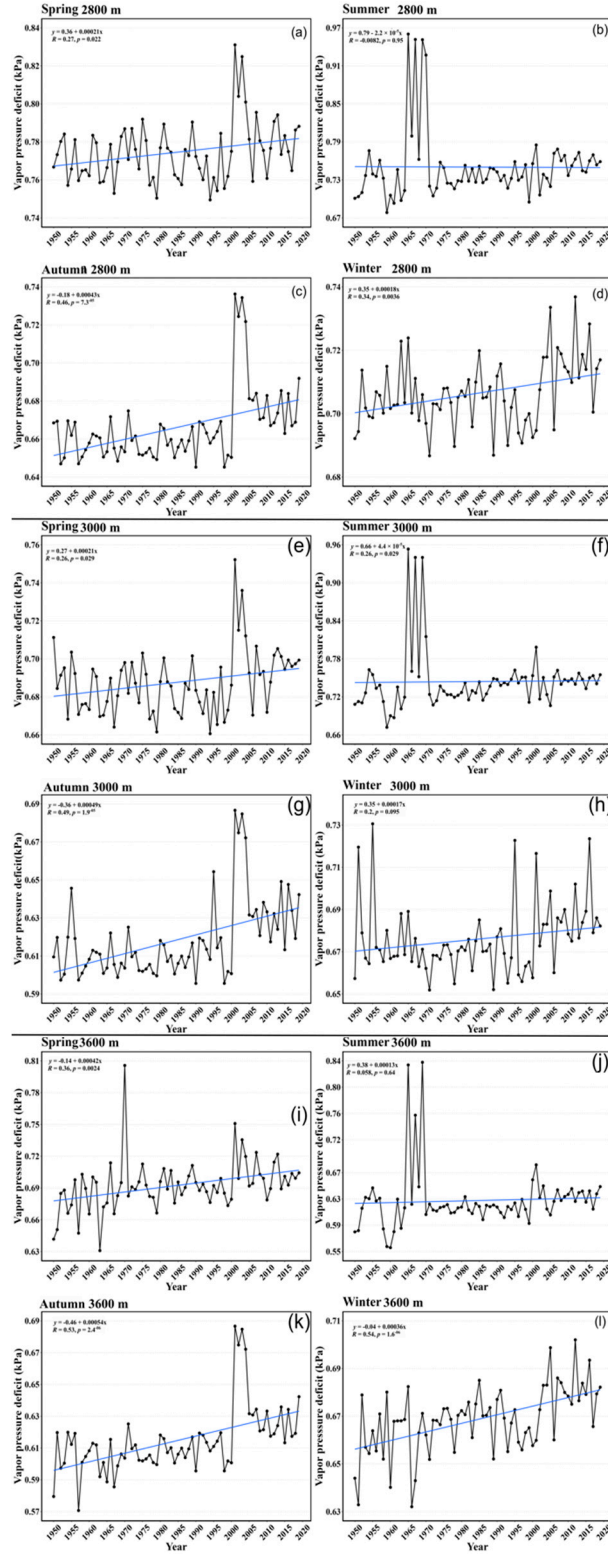


Figure S4. Temporal changes in seasonal VPD values at 2800 m (plots a-d), 3000 m (plots e-h), and 3600 m a.s.l (plots i-l) from 1950–2019. The blue lines show linear regression trends.

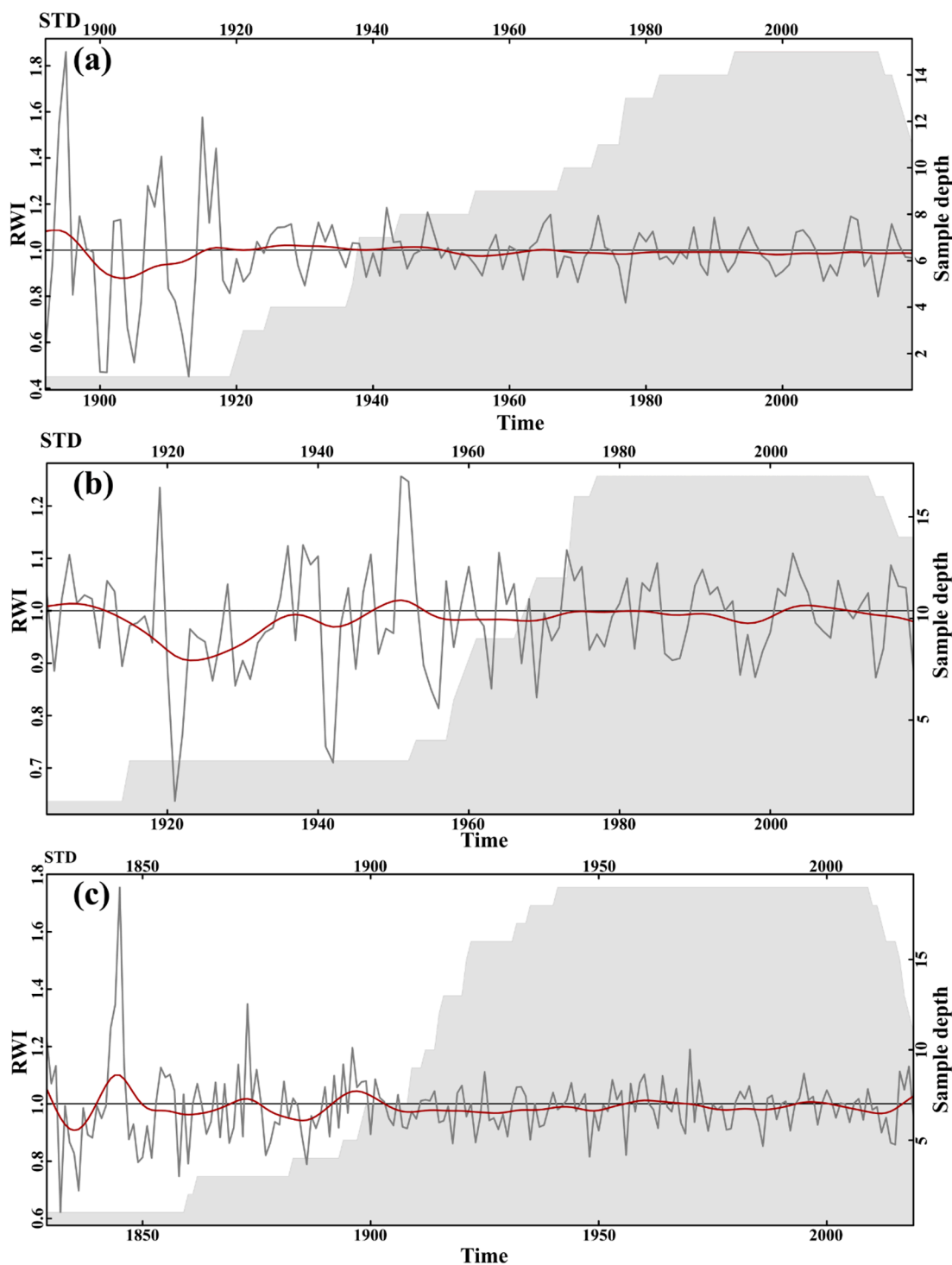


Figure S5. The standard (STD) chronologies for healthy *Abies fabri* sites at (a) 2800 m, (b) 3000 m, and (c) 3600 m a.s.l. The lines show the ring-width indices (RWI) and the grey bars the sample depth (right y axis). A smoothing spline highlights low-frequency variability and the sample depth is plotted on the right-hand side y-axis.

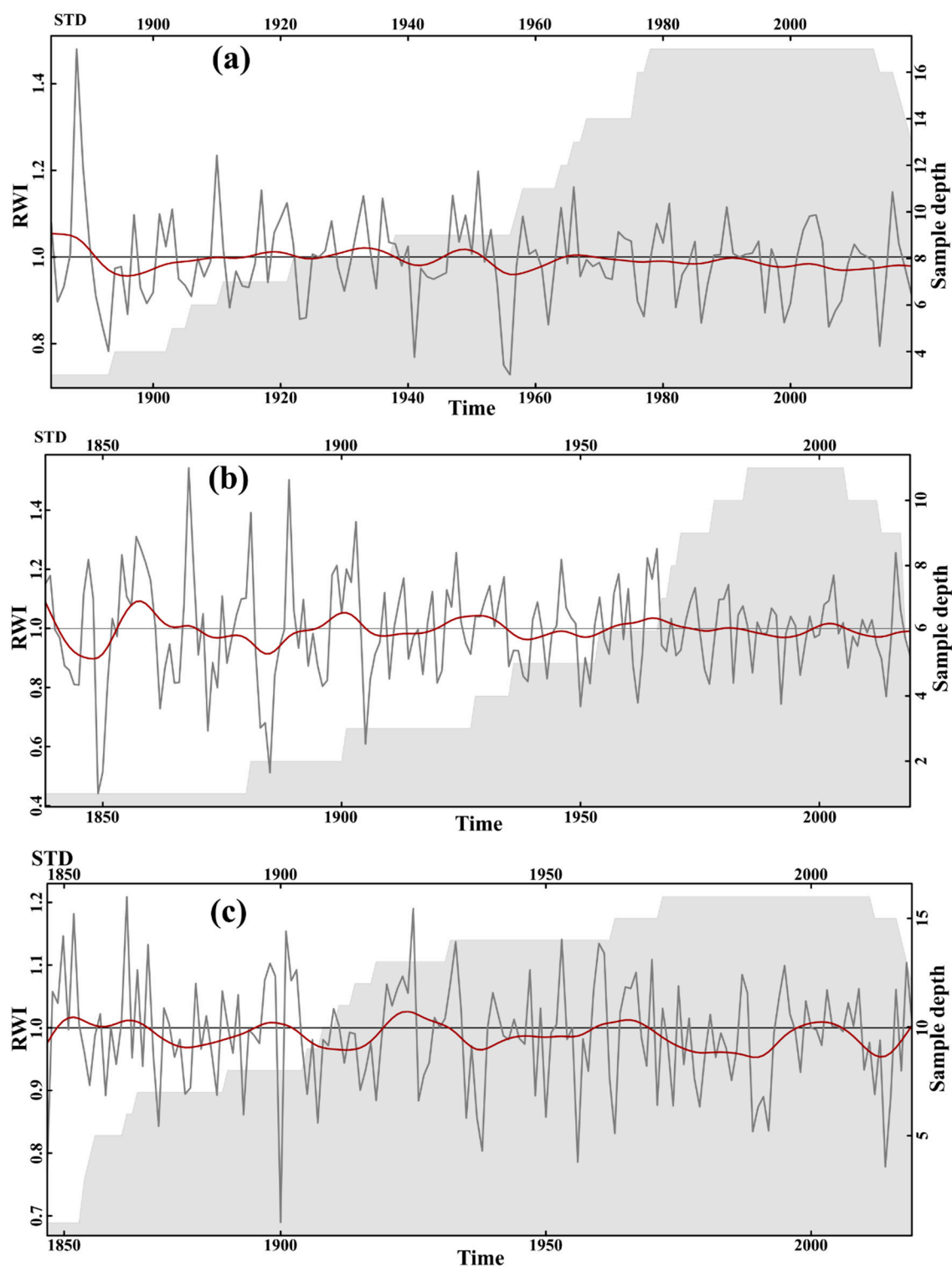


Figure S6. The standard (STD) chronologies for declining *Abies fabri* sites at (a) 2800 m, (b) 3000 m, and (c) 3600 m a.s.l. The lines show the ring-width indices (RWI) and the grey bars the sample depth (right y axis). A smoothing spline highlights low-frequency variability and the sample depth is plotted on the right-hand side y-axis.

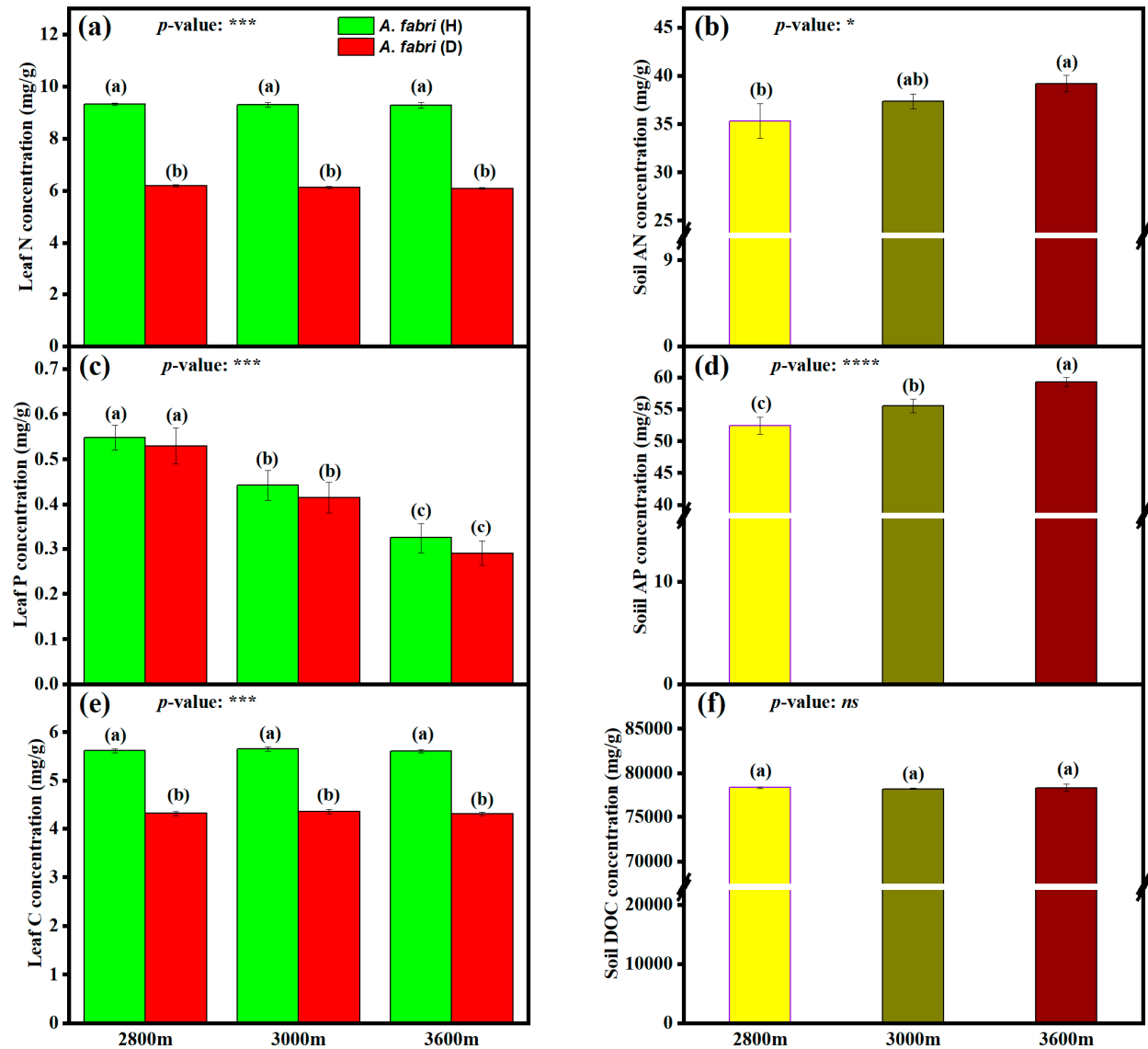


Figure S7. (a) leaf nitrogen (N), (b) soil available nitrogen (AN), (c) Leaf phosphorus (P), (d) soil available phosphorus (AP), (e) leaf carbon (C), (f) soil dissolved organic carbon (DOC) concentration at 2800 m, 3000 m, and 3600 m above sea level. Data (means $\pm$ SD, $n = 15$) followed by different letters denotes significant differences between treatments at $p < 0.05$ according to the Games-Howell Post-hoc test. P-values of one-way ANOVAs of height and altitudes $p < 0.05$, *; $p < 0.01$, **; $p < 0.001$, ***; $p < 0.0001$, ****; ns, not significant.