Austria

National Focal Centre

Umweltbundesamt GmbH (Federal Environment Agency, Austria)
Department of Ecosystem Research and Monitoring
Thomas Dirnböck
Ika Djukic
thomas.dirnboeck@umweltbundesamt.at
Spittelauer Lände 5
A-1090 Vienna
tel: +43-1-31304-3442
fax: +43-1-31304-3533
www.umweltbundesamt.at

Collaborating Institutions

Federal Research and Training Centre for Forests, Natural Hazards and Landscape
Markus Neumann
Michael Englisch
Edwin Herzberger
Franz Starlinger
Barbara Kitzler
markus.neumann@bfw.gv.at
Seckendorff-Gudent-Weg 8
A-1131 Vienna
tel: +43-1-87838-1327
http://bfw.ac.at

Status

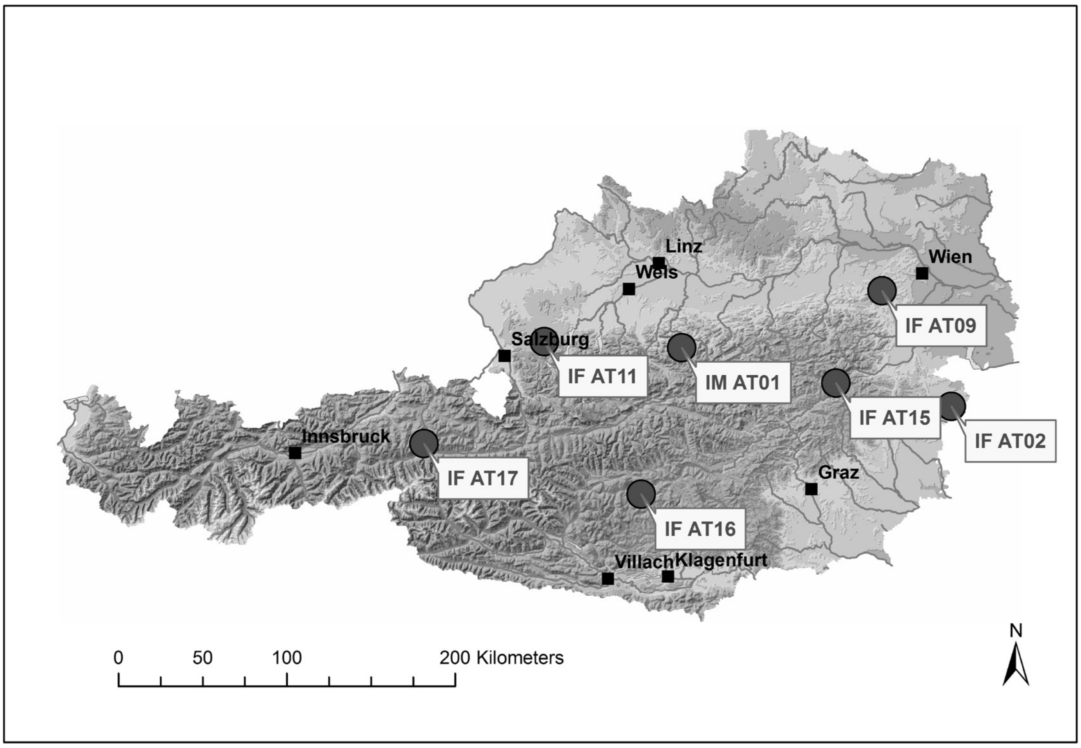
In response to the 2012-2014 Call for Data to test dynamic modelling of vegetation changes at selected sites in a country, the dynamic model VSD+ (including the PROPS module) was calibrated for 8 permanent soil-vegetation plots from the ICP Forests (Level II) and the ICP Integrated Monitoring program. These sites have already been used in the last calls. The improved versions of VSD+ and the new vegetation model PROPS were tested with the available field data. Furthermore, different biodiversity metrics for the detection of eutrophication effects were derived.

Soil-vegetation modelling for sites

Data sources

Dynamic models were calibrated for 6 ICP Forests sites and two plots in the ICP Integrated Monitoring site Zöbelboden (Figure AT.1). Chemical soil parameters, soil water and atmospheric deposition samples were collected frequently and analysed at all sites.

Figure AT.1 Location of the 6 ICP Forests sites and the ICP Integrated Monitoring site (with two plots) used for dynamic soil-vegetation modelling in Austria. See Table AT.1 for site codes and description.



Site description

The ICP Forests and Integrated Monitoring sites are the best investigated forest ecosystems in Austria. They span an altitudinal range from 290 to 1540 m a.s.l., a mean annual temperature between 5 to 9.6 °C and precipitation between 600 and 1600 mm. They are characterised by different soil and bedrock conditions and exposed to contrasting amounts of nitrogen (N) and sulphur (S) deposition. All sites were, at least historically, managed. The main tree species are Norway spruce and European beech (Figure AT.1, Table AT.1). See Neumann et al. (2001) for a detailed description of the ICP Forests sites and the Austrian report to the 2011 CCE Call for Data for the ICP Integrated Monitoring site Zöbelboden.

Parameter setting for VSD+

Soils at most of the sites are characterized by a high proportion of coarse fraction, but the chemical soil parameters were analyzed from the fine fraction (<2 mm). This fact was taken into account by reducing the soil depth by the respective depth of the coarse fraction. All further parameters (CEC, base saturation, etc.) were calculated with the reduced soil depth.

Total deposition of N and base cations were estimated with a canopy exchange model according to Adriaenssens et al. (2013) using bulk deposition measurements. In brief, the total deposition of SO_4^{2-} was assumed to equal the throughfall, whereas the total deposition of NO_3^- and NH_4^+ was calculated based on the throughfall and canopy uptake. Thereto, Na^+ was used as a tracer ion and the weak acids were included in the model and were calculated based on the cation-anion balance. For the canopy uptake of NO_3^- and NH_4^+ we used the relative uptake efficiency of NH_4^+ to H^+ and NH_4^+ to NO_3^- that equals 6. All fluxes are expressed on an equivalent basis per hectare and year. Subsequently, the results were scaled to the modeled EMEP grid cell values. Finally time series were derived from historic depositions of NO_3^-, NH_4^+ and SO_4^-, provided by the CCE. In order to match with measured data, the historical depositions were apriori modified by multiplying with a variable factor, while for the adjustment of the projected depositions a constant factor was used (Schöpp et al. 2003). We defined two N deposition scenarios: a low deposition scenario reflecting potential future emissions under the Gothenburg protocol and a high deposition scenario with no reduction after the year 2010.

Deposition of base cations was taken from van Loon et al. (2005) for the year 2000. An increase of 70% was assumed from 1880 to 2000 and 50% from 1970

Table AT.1 Site description of the ICP Forests and the ICP IM sites used for dynamic soil-vegetation modelling in Austria. Alt: Altitude above sea level; T: mean annual temperature; P: annual precipitation; CLemp: empirical critical load of nitrogen for eutrophication effects.

Site name	Site code	Alt [m]	T [°C]	P [mm]	Soil type(s)	Total N Deposition [kg $ha^{-1}yr^{-1}$]*	EUNIS classes	CLemp [kg $ha^{-1}yr^{-1}$]
LTER Zöbelboden IP1	AT01_1	895	7.2	1618	Rendsic Leptosols/ Chromic Cambisols/ Hydromorphic Stagnosols	26.9	Mixed Abies - Picea - Fagus woodland (G4.6)	10-20
LTER Zöbelboden IP2	AT01_2	879	7.2	1618	Lithic and Rendsic Leptosols	25.2	Mixed Abies - Picea - Fagus woodland (G4.6)	10-20
Unterpullendorf	AT02	290	9.6	630	Eutric Stagnic Vertic Cambisol	15.0	Thermophilous deciduous woodland (G1.7)	10-20
Klausen-Leopoldsdorf	AT09	510	8.2	804	Endostagnic Endoskeletic Luvisol	11.5	Fagus woodland (G1.6)	10-20
Mondsee	AT11	860	7.4	1330		14.5	Abies and Picea woodland (G3.1)	10-15
Mürzzuschlag	AT15	715	6.0	933	Eutric Calcaric Endoskeletic Cambisol	8.3	Abies and Picea woodland (G3.1)	10-15
Murau	AT16	1540	5.0	918	Hyperdystric Endoskeletic Cambisol	1.7	Abies and Picea woodland (G3.1)	10-15
Jochberg	AT17	1050	5.7	1358	Eutric Stagnic Episkeletic Fluvisol	5.0	Abies and Picea woodland (G3.1)	10-15

*mean wet and dry inorganic N deposition between 1995 and 2010

to 2000 (Hedin et al. 1994). A further decrease of 10% until 2009 was estimated from the throughfall data.
Reduction factors (rf*), temperature (TempC) and water retention (Theta) was calculated with the model Methyd on daily (AT01) or monthly (all other sites) meteorological data. C, N, base cation uptake as well as litterfall were modeled with the model GrowUp. Management was defined by a standard forest yield model and field data. After the year 2010 tree thinning was simulated to achieve a steady state of the stand biomass. Tree species specific biomass data were not adapted to measurements but taken from the Growup database. The following pairs of parameters were calibrated with VSD studio: lgKAlBC and lgKHBC, Cpool_o and CNrat_o, Ca_we and Mg_we.
We used PROPS to model the effect of soil chemical changes to vegetation. For each site all plant species of the respective EUNIS class – as defined in PROPS – were modelled (see Table AT.1). Several biodiversity indicators were calculated for each year: Shannon index (Shannon), species numbers (SpecNum) and two specific indices related to species groups (oligotrophic: w_mean_p_Oligo, eutrophic: w_mean_p_Eutro). The latter should reflect eutrophication effects in indicator species according to Ellenberg's nutrient value: First, species with low

(1-3) and high indicator values (7-9) were grouped. Species with low Ellenberg values 1-3 are bound to nutrient-poor sites; species with N values 7-9 prefer nutrient-rich sites. Ellenberg values were transformed in order to upgrade species with extreme site preferences (original values 1, 2, 3 transformed to 3, 2, 1 and 7, 8, 9 to 1, 2, 3). Then we calculated a weighted mean occurrence probability for each year and group. The selection of these indicators were stimulated by the findings of Dirnböck et al. (2014), where only oligotrophic species have shown changes in cover in long-term European forest data.
The simulation period was set to 1950 as the starting year and 2100 (GP Scenario) as the end of the model runs.

Results and Discussion

VSD+ has been changed since the last call for data (2011/12). The integration of a different carbon model (RothC) has significantly improved the model performance. As a result, C pools and C/N ratios can be modelled with satisfactory accuracy (Figure AT.2). Chemistry of soil solution however, is highly variable (Figure AT.3). Since NO_3^- is used as an indicator for changes in plant occurrence probability, predictions should be more reliable. It has been discussed (ICP Modelling and Mapping Meeting 2014, Rome) that C/N ratio should be used instead of NO_3^-, because model accuracy was shown to be higher and because C/N ratio is less prone to confounding effects.

Furthermore, carbonate bedrock is taken into account in the current VSD+ version. However, we were not able to model soil solution pH value with satisfactory reliability (Figure AT.3). Further work is necessary to improve the model output and the model calibration.

Vegetation modelling is still in progress. The PROPS model is currently extended with regard to its underlying soil-vegetation data base and with regard to the derived biodiversity metrics. Our work did therefore focus on first test runs and on the definition of practicable metrics. We conclude that

- It is crucial that a representative set of soil-vegetation data records are used in PROPS to derive statistical response curves of the plant species. The Federal Research and Training Centre for Forests, Natural Hazards and Landscape, Austria has provided approx. 500 such records, and PROPS can be better applied for Austria during the next CCE Call for Data.
- The choice of species should reflect only those species which are "indicator species" in the potential natural plant community which is characteristic of the plot. This should be a suit of 5-15 species selected from national plant community catalogues. In the next call for data, it is intended to apply the BERN model to define the indicator species for each of the Austrian plots.
- The use of the most practicable biodiversity metrics has been discussed and agreed upon at the ICP Modelling and Mapping Task Force meeting in Rome, April 2014. The indices that were

Figure AT.2 Comparison of modelled (VSD+) and measured topsoil C pool and C/N ratio of 8 forest sites in Austria. Soil chemical measurements were taken from the years 1992, 1995, 2004 and 2008.

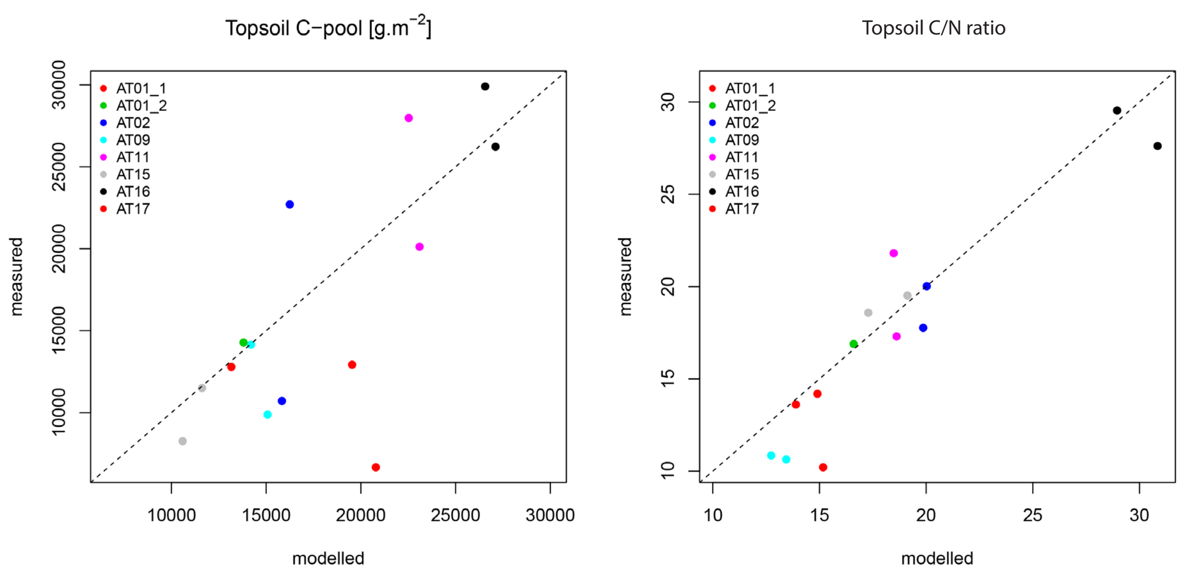
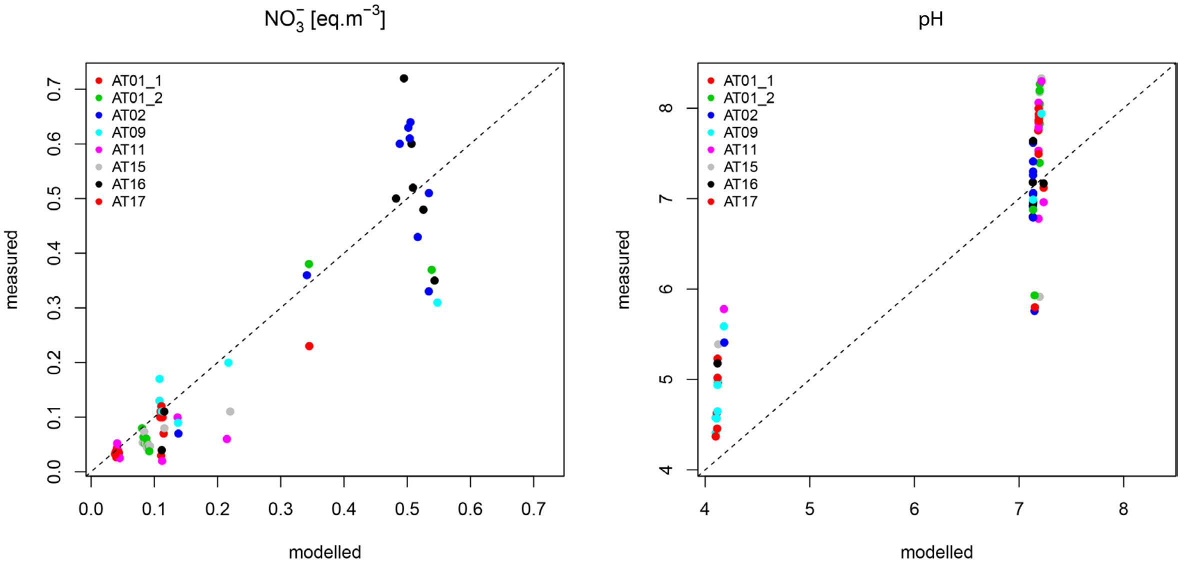


Figure AT.3 Comparison of modelled (VSD+) and measured soil water NO_3^- concentrations and pH values for the 8 forested sites in Austria. Measured annual mean values from the years 1993 until 2009 were used.



used in the Austrian NFC were a valuable input to the discussions. The agreed index, the so-called 'habitat suitability index', will be calculated during the work for the next call for data.

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