



# Eleven years' data of grassland management in Germany

Juliane Vogt<sup>‡</sup>, Valentin H. Klaus<sup>§,¶</sup>, Steffen Both<sup>¶,¶</sup>, Cornelia Fürstenau<sup>¶</sup>, Sonja Gockel<sup>«,»</sup>, Martin M. Gossner<sup>‡,^</sup>, Johannes Heinze<sup>˘</sup>, Andreas Hemp<sup>‡</sup>, Nibert Hölzel<sup>§</sup>, Kirsten Jung<sup>‡</sup>, Till Kleinebecker<sup>ˆ,‡</sup>, Ralf Lauterbach<sup>‡</sup>, Katrin Lorenzen<sup>‡</sup>, Andreas Ostrowski<sup>¶</sup>, Niclas Otto<sup>‡</sup>, Daniel Prati<sup>‡</sup>, Swen Renner<sup>§</sup>, Uta Schumacher<sup>¶</sup>, Sebastian Seibold<sup>‡</sup>, Nadja Simons<sup>‡,^</sup>, Iris Steitz<sup>‡</sup>, Miriam Teuscher<sup>¶</sup>, Jan Thiele<sup>⊖</sup>, Sandra Weithmann<sup>‡</sup>, Konstans Wells<sup>ˆ,‡</sup>, Kerstin Wiesner<sup>‡</sup>, Manfred Ayasse<sup>‡</sup>, Nico Blüthgen<sup>^</sup>, Markus Fischer<sup>¶,¶</sup>, Wolfgang W. Weisser<sup>‡</sup>

‡ Technische Universität München, Terrestrial Ecology Research Group, School of Life Sciences Weihenstephan, Freising, Germany

§ Westfälische Wilhelms-Universität, Institute of Landscape Ecology, Münster, Germany

| ETH Zürich, Institute of Agricultural Sciences, Zürich, Switzerland

¶ Technische Universität München, Terrestrial Ecology Research Group, School of Life Sciences Weihenstephan, Freising, Germany

# Martin-Luther-Universität Halle-Wittenberg, Institut für Agrar- und Ernährungswissenschaften, Halle, Germany

⊖ Friedrich Schiller Universität Jena, Institute for Computer Science, Heinz Nixdorf Chair for Distributed Information Systems, Jena, Germany

« Friedrich Schiller Universität Jena, Institute of Ecology, Jena, Germany

» ThüringenForst, Forstliches Forschungs- und Kompetenzzentrum Gotha, Gotha, Germany

^ Swiss Federal Research Institute WSL, Forest Entomology, Birmensdorf, Switzerland

˘ Universität Potsdam, Biodiversity Research/Systematic Botany, Institute of Biochemistry and Biology, Potsdam, Germany

‡ University of Bayreuth, Department of Plant Systematics, Bayreuth, Germany

¶ University of Ulm, Institute of Evolutionary Ecology, Ulm, Germany

ˆ Westfälische Wilhelms-Universität, Institute of Landscape Ecology, Münster, Germany

‡ Justus-Liebig-Universität Gießen, Institute of Landscape Ecology and Resource Management, Gießen, Germany

‡ University of Bern, Institute of Plant Science, Department of Biology, Bern, Switzerland

§ University of Natural Resources and Life Sciences BOKU, Institute of Zoology, Vienna, Austria

¶ Senckenberg Gesellschaft für Naturforschung, Biodiversity and Climate Research Centre BiK-F, Frankfurt, Germany

^ University Darmstadt, Ecological Networks, Darmstadt, Germany

⊖ Johann Heinrich von Thünen Institute for Biodiversity, Braunschweig, Germany

ˆ The University of Adelaide, Department of Biosciences, Adelaide, Australia

‡ University of Ulm, Institute of Evolutionary Ecology, Ulm, Germany

¶ Universität Bern, Institute of Plant Science, Department of Biology, Bern, Germany

Corresponding author: Juliane Vogt ([juliane.vogt@tum.de](mailto:juliane.vogt@tum.de))

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## Abstract

### Background

The 150 grassland plots were located in three study regions in Germany, 50 in each region. The dataset describes the yearly grassland management for each grassland plot using 116 variables.

General information includes plot identifier, study region and survey year. Additionally, grassland plot characteristics describe the presence and starting year of drainage and whether arable farming had taken place 25 years before our assessment, i.e. between 1981 and 2006. In each year, the size of the management unit is given which, in some cases, changed slightly across years.

Mowing, grazing and fertilisation were systematically surveyed:

**Mowing** is characterised by mowing frequency (i.e. number of cuts per year), dates of cutting and different technical variables, such as type of machine used or usage of conditioner.

For **grazing**, the livestock species and age (e.g. cattle, horse, sheep), the number of animals, stocking density per hectare and total duration of grazing were recorded. As a derived variable, the mean grazing intensity was then calculated by multiplying the livestock units with the duration of grazing per hectare [LSU days/ha]. Different grazing periods during a year, partly involving different herds, were summed up to an annual grazing intensity for each grassland.

For **fertilisation**, information on the type and amount of different types of fertilisers was recorded separately for mineral and organic fertilisers, such as solid farmland manure, slurry and mash from a bioethanol factory. Our fertilisation measures neglect dung dropped by livestock during grazing. For each type of fertiliser, we calculated its total nitrogen content, derived from chemical analyses by the producer or agricultural guidelines (Table 3).

All three management types, mowing, fertilisation and grazing, were used to calculate a combined land use intensity index (LUI) which is frequently used to define a measure for the land use intensity. Here, fertilisation is expressed as total nitrogen per hectare [kg N/ha], but does not consider potassium and phosphorus.

Information on additional management practices in grasslands was also recorded including levelling, to tear-up matted grass covers, rolling, to remove surface irregularities, seed addition, to close gaps in the sward.

## New information

Investigating the relationship between human land use and biodiversity is important to understand if and how humans affect it through the way they manage the land and to develop sustainable land use strategies. Quantifying land use (the 'X' in such graphs) can be difficult as humans manage land using a multitude of actions, all of which may affect biodiversity, yet most studies use rather simple measures of land use, for example, by creating land use categories such as conventional vs. organic agriculture. Here, we provide detailed data on grassland management to allow for detailed analyses and the development of land use theory. The raw data have already been used for > 100 papers on the effect of management on biodiversity (e.g. Manning et al. 2015).

## Keywords

Grassland management survey, fertilisation, grazing, mowing, livestock units, Biodiversity-Exploratories, questionnaire, farming practice, grassland maintenance, nitrogen, temporal variation, intensification of grassland use

## Introduction

Grasslands can harbour high biodiversity and fulfil important ecosystem functions and services, such as food and habitat provision for livestock, protection of soil and water resources, carbon sequestration and aesthetic appeal (Carlier et al. 2009, Hönigová et al. 2012, Gossner et al. 2016, Simons et al. 2017). In addition to the conversion of grasslands to other land use forms, grasslands worldwide are also changed by land use intensification. Land use intensification of grasslands includes, for example, increased fertiliser input, application of pesticides, increased number of cuts in meadows or increased stocking densities in pastures (Humbert et al. 2009, Boch et al. 2016, Klaus et al. 2018). As a result of continued land use intensification, high value natural grasslands, i.e. extensively managed grasslands, have seen a decline throughout Europe (Veen et al. 2009).

Increasing management intensity in grasslands has been shown to decrease alpha, (i.e. local, diversity) and also beta diversity, i.e. intensification leads to homogenisation of communities across trophic groups including plant, invertebrates and birds (Humbert et al. 2009, Gossner et al. 2016, Manning et al. 2015, Renner et al. 2014, Socher et al. 2013). Intensification affects biodiversity directly and indirectly. For example, mowing itself and the use of conditioners, i.e. a farm implement that uses mechanical force to promote faster and more even drying of biomass, cause direct mortality of insects (Humbert et al. 2010a, Humbert et al. 2010b). Indirect effects include changes in plant community composition, for example, by increased fertilisation, that can then affect insect diversity.

Until now, little attention has been paid to long-term in-depth assessments of land use practices in grassland systems. The intensity and timing of mowing, grazing and

fertilisation can differ within and between years on particular grasslands (Kleinebecker et al. 2018) and the effect of such variability on biodiversity changes is considerable (but see, e.g. Allan et al. 2014). Grassland management consists of various management components such as mowing, grazing or fertilisation that may jointly or singly affect biodiversity. Moreover, there are interactions between different management activities, for example, fertiliser application results in higher biomass production, which is often associated with more frequent mowing (Blüthgen et al. 2012, Busch et al. 2018, Humbert et al. 2009, Busch et al. 2018). To understand more mechanistically how land use intensification in grasslands affects biodiversity, detailed information on grassland management is needed, ideally for a large number of grasslands over several years.

Within the framework of the *Biodiversity-Exploratories* programme ([www.biodiversity-exploratories.de](http://www.biodiversity-exploratories.de)), we have thoroughly monitored land use of 150 grassland plots for 11 years to investigate temporal variation in land management within three study regions in Germany (Fig. 1). These plots represented gradients of land use intensity typical for our study regions and were managed by mowing, grazing and fertilisation (Fischer et al. 2010). Detailed information on grassland management of all 150 grassland plots was obtained annually from farmers using a standardised questionnaire (Table 1). Here, we present the data of the corresponding management questionnaire that form the basis of most analyses of effects of land use intensification on biodiversity and ecosystem functioning in grasslands within the Biodiversity-Exploratories. With this dataset, we provide knowledge on how land use intensity in temperate grasslands varies across spatial and temporal scales. The components reported here also form the basis on an integrated land use intensity index used in the programme to study its integral effects on biodiversity in grasslands (Blüthgen et al. 2012).

Table 1.

Overview of all variables of the data set: BE\_landuse\_grassland\_2006-2016.csv received from the management questionnaire.

| Variable     | Type of data | Units      | Range of numeric variables (min-max) | Description (English)                                       |
|--------------|--------------|------------|--------------------------------------|-------------------------------------------------------------|
| ID           | Text         | -          | -                                    | Unique identifier composed of the columns PlotID and Year   |
| Study region | Text         |            | -                                    | ALB = Schwäbische Alb<br>HAI = Hainich<br>SCH = Schorfheide |
| Year         | Integer      | yyyy       | -                                    | Year of management                                          |
| Date         | Date         | dd.mm.yyyy | -                                    | Date of interview                                           |

| Variable                                   | Type of data | Units  | Range of numeric variables (min-max) | Description (English)                                                                                                                                                                                  |
|--------------------------------------------|--------------|--------|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| PlotID                                     | Text         | -      | -                                    | Experimental Plot IDs formatted as (A H S)EG with consecutive numbering. Abbreviations are:<br>A = Schwäbische Alb, H = Hainich, S = Schorfheide<br>E = Experimental Plot<br>G = Grassland, e.g. AEG01 |
| Drainage                                   | Text         | -      | -                                    | Measure of drainage and the description of the method (free text)                                                                                                                                      |
| StartDrainage                              | Integer      | yyyy   | -                                    | Starting year of grassland drainage, if applicable                                                                                                                                                     |
| WaterLogging                               | Boolean      | yes/no | -                                    | Activities on water logging, e.g. for water regulation of fen soils                                                                                                                                    |
| Agriculture1981                            | Boolean      | yes/no | -                                    | Use of grassland between 1981 to 2006, i.e. (temporal) conversion of grassland into arable land                                                                                                        |
| SizeManagementUnit_ha                      | Numeric      | ha     | 0.49-187.1                           | Size of the management unit in the survey year, often larger than the 50 x 50 m study plot itself                                                                                                      |
| <b>Grazing</b>                             |              |        |                                      |                                                                                                                                                                                                        |
| StartGrazing                               | Text         | Month  | -                                    | Starting month of the first grazing period in the survey year                                                                                                                                          |
| EndGrazing                                 | Text         | Month  | -                                    | End of the last grazing period in the survey year                                                                                                                                                      |
| Livestock1                                 | Text         |        | -                                    | Type of animal in first grazing period                                                                                                                                                                 |
| StartGrazingPeriod1                        | Text         | month  | -                                    | Starting month of first grazing period for livestock 1                                                                                                                                                 |
| EndGrazingPeriod1                          | Text         | month  | -                                    | Ending month of first grazing period for livestock 1                                                                                                                                                   |
| Livestock, Start/End GrazingPeriod 2-4 ... |              |        | -                                    | Identical information for grazing periods 2-4, if applicable.                                                                                                                                          |
| Cattle6months1                             | Integer      |        | 0-95                                 | For Grazing period 1: Number of cattle with an age up to 6 months (cattle up to 6 months = 0.3 LS* per day)                                                                                            |
| Cattle6-24months1                          | Integer      |        | 0-200                                | For Grazing period 1: Number of cattle with an age between 6 months and 2 years (= 0.6 LS*)                                                                                                            |
| CattlePlus2years1                          | Integer      |        | 0-300                                | For Grazing period 1: Number of cattle older than 2 years (= 1 LS*)                                                                                                                                    |
| SheepGoat1year1                            | Integer      |        | 0-1000                               | For Grazing period 1: Number of sheep or goats with an age up to 1 year (= 0.05 LS*)                                                                                                                   |

| Variable                                                                                                | Type of data | Units                                   | Range of numeric variables (min-max) | Description (English)                                                        |
|---------------------------------------------------------------------------------------------------------|--------------|-----------------------------------------|--------------------------------------|------------------------------------------------------------------------------|
| SheepGoatPlus1year1                                                                                     | Integer      |                                         | 0-1500                               | For Grazing period 1: Number of sheep or goats older than 1 year (= 0.1 LS*) |
| Pony1                                                                                                   | Integer      |                                         | 0-400                                | For Grazing period 1: Number of ponies and small horses (= 0.7 LS*)          |
| Horse3years1                                                                                            | Integer      |                                         | 0-4                                  | For Grazing period 1: Number of horses up to 3 years (= 0.7 LS*)             |
| HorsePlus3years1                                                                                        | Integer      |                                         | 0-46                                 | For Grazing period 1: Number of horses older than 3 years (= 1.1 LS*)        |
| NbLivestock1                                                                                            | Integer      |                                         | 0-2500                               | For Grazing period 1: Total number of livestock                              |
| LivestockUnits1                                                                                         | Numeric      | Number of livestock x conversion factor | 0-1814                               | For Grazing period 1: Total sum of the livestock units                       |
| DayGrazing1                                                                                             | Integer      | days                                    | 0-365                                | For Grazing period 1: duration of grazing (in days)                          |
| GrazingArea1                                                                                            | Numeric      | ha                                      | 0-148.5                              | For Grazing period 1: size of area where livestock grazed                    |
| <b>Numeric variables for grazing 2-4...</b> For Grazing periods 2-4 see description of grazing period 1 |              |                                         |                                      |                                                                              |
| Cattle6months2                                                                                          |              |                                         | 0-73                                 |                                                                              |
| Cattle6-24months2                                                                                       |              |                                         | 0-103                                |                                                                              |
| CattlePlus2years2                                                                                       |              |                                         | 0-120                                |                                                                              |
| SheepGoat1year2                                                                                         |              |                                         | 0-600                                |                                                                              |
| SheepGoatPlus1year2                                                                                     |              |                                         | 0-1200                               |                                                                              |
| Pony2                                                                                                   |              |                                         | 0                                    |                                                                              |
| Horse3years2                                                                                            |              |                                         | 0                                    |                                                                              |
| HorsePlus3years2                                                                                        |              |                                         | 0-18                                 |                                                                              |
| NbLivestock2                                                                                            |              |                                         | 0-1200                               |                                                                              |
| LivestockUnits2                                                                                         |              |                                         | 0-144                                |                                                                              |
| DayGrazing2                                                                                             |              |                                         | 0-165                                |                                                                              |
| GrazingArea2                                                                                            |              |                                         | 0-148.5                              |                                                                              |
| Cattle6months3                                                                                          |              |                                         | 0-72                                 |                                                                              |
| Cattle6-24months3                                                                                       |              |                                         | 0-103                                |                                                                              |
| CattlePlus2years3                                                                                       |              |                                         | 0-120                                |                                                                              |
| SheepGoat1year3                                                                                         |              |                                         | 0-820                                |                                                                              |
| SheepGoatPlus1year3                                                                                     |              |                                         | 0-1300                               |                                                                              |
| Pony3                                                                                                   |              |                                         | 0                                    |                                                                              |
| Horse3years3                                                                                            |              |                                         | 0                                    |                                                                              |
| HorsePlus3years3                                                                                        |              |                                         | 0-25                                 |                                                                              |

| Variable             | Type of data | Units               | Range of numeric variables (min-max) | Description (English)                                                                                      |
|----------------------|--------------|---------------------|--------------------------------------|------------------------------------------------------------------------------------------------------------|
| NbLivestock3         |              |                     | 0-1340                               |                                                                                                            |
| LivestockUnits3      |              |                     | 0-145.5                              |                                                                                                            |
| DayGrazing3          |              |                     | 0-127                                |                                                                                                            |
| GrazingArea3         |              |                     | 0-196.69                             |                                                                                                            |
| Cattle6months4       |              |                     | 0-72                                 |                                                                                                            |
| Cattle6-24months4    |              |                     | 0-81                                 |                                                                                                            |
| CattlePlus2years4    |              |                     | 0-84                                 |                                                                                                            |
| SheepGoat1year4      |              |                     | 0-600                                |                                                                                                            |
| SheepGoatPlus1year4  |              |                     | 0-900                                |                                                                                                            |
| Pony4                |              |                     | 0                                    |                                                                                                            |
| Horse3years4         |              |                     | 0                                    |                                                                                                            |
| HorsePlus3years4     |              |                     | 0-16                                 |                                                                                                            |
| NbLivestock4         |              |                     | 0-900                                |                                                                                                            |
| LivestockUnits4      |              |                     | 0-103.6                              |                                                                                                            |
| DayGrazing4          |              |                     | 0-76                                 |                                                                                                            |
| GrazingArea4         |              |                     | 0-148.5                              |                                                                                                            |
| TotalGrazing_LSUdha  | Numeric      | #Livestock*days /ha | 0-1644.17                            | Total sum of the grazing intensity for all grazing periods                                                 |
| SupplementaryFeeding | Boolean      | yes/no              | -                                    | Additional fodder supply for the livestock                                                                 |
| DescFeeding          | Text         |                     | -                                    | Type and amount of supplementary fodder                                                                    |
| <b>Mowing</b>        |              |                     |                                      |                                                                                                            |
| Mowing               | Integer      | 1/year              | 0-4                                  | Number of cuts per year                                                                                    |
| DateMowing1          | Date         | dd.mm.yyyy          | -                                    | Date of the first cut                                                                                      |
| DateMowing2-4...     | Date         | dd.mm.yyyy          | -                                    | Dates of the second to fourth cut, if applicable                                                           |
| MowingMachine        | Text         |                     | -                                    | Type of machine which was used for mowing, e.g. rotarymower, doubleknife, mulcher                          |
| CutWidth_m           | Numeric      | m                   | 0-12                                 | Cutting width of the mowing machine                                                                        |
| CutHeight_cm         | Integer      | cm                  | 0-15                                 | Cutting height above soil level of the mowing machine                                                      |
| DriveSpeed_kmh       | Integer      | km/h, (mean)        | 0-20                                 | Speed of the mowing machine, normally mean speed value is given                                            |
| MowingConditioner    | Boolean      | yes/no              | -                                    | Presence of conditioner, i.e. did the mowing machine have a conditioner to improve drying of the clippings |

| Variable                | Type of data | Units              | Range of numeric variables (min-max) | Description (English)                                                                                                                                                             |
|-------------------------|--------------|--------------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Fertilisation</b>    |              |                    |                                      |                                                                                                                                                                                   |
| Fertilisation           | Boolean      | yes/no             | -                                    | Addition of fertiliser (not including dung depositions by livestock during grazing a parcel)                                                                                      |
| NbFertilisation         | Integer      |                    | 0-7                                  | Number of fertiliser applications per year                                                                                                                                        |
| DateFertilisation1      | Date         | dd.mm.yyyy         | -                                    | Date of first fertiliser application                                                                                                                                              |
| DateFertilisation2-7... | Date         | dd.mm.yyyy         | -                                    | Date of 2nd to 7th fertiliser applications                                                                                                                                        |
| Manure_tha              | Numeric      | t/ha               | 0-40                                 | Total amount of applied solid manure                                                                                                                                              |
| Slurry_m3ha             | Numeric      | m <sup>3</sup> /ha | 0-80                                 | Total amount of applied pig or cow slurry and biogas residues, respectively.                                                                                                      |
| DescFert                | Text         |                    | -                                    | Description of applied organic fertiliser                                                                                                                                         |
| orgNitrogen_kgNha       | Numeric      | kg/ha              | 0-371                                | Amount of organic nitrogen applied                                                                                                                                                |
| minNitrogen_kgNha       | Numeric      | kg/ha              | 0-170                                | Amount of nitrogen applied, of mineral origin or the organic fertiliser mash from a bioethanol factory (see in DescFert)                                                          |
| totalNitrogen_kgNha     | Numeric      | Kg /ha             | 0-433                                | Sum of applied mineral and organic nitrogen [kg N/ha]                                                                                                                             |
| minPhosphorus_kgPha     | Numeric      | kg/ha              | 0-350                                | Amount of phosphorus applied [kg P <sub>2</sub> O <sub>5</sub> /ha], of mineral origin or mash from a bioethanol factory (not given for other organic fertilisers)                |
| minPotassium_kgKha      | Numeric      | kg/ha              | 0-100                                | Amount of potassium applied [kg K <sub>2</sub> O/ha], of mineral origin or mash from a bioethanol factory (not given for other organic fertilisers)                               |
| Sulphur_kgSha           | Numeric      | kg/ha              | 0-25                                 | Total amount of applied Sulphur [kg S/ha]                                                                                                                                         |
| <b>Maintenance</b>      |              |                    |                                      |                                                                                                                                                                                   |
| Maintenance             | Boolean      | yes/no             | -                                    | Presence of maintenance measures                                                                                                                                                  |
| Levelling               | Text         |                    | 0-4                                  | Maintenance to break up matted grass covers                                                                                                                                       |
| DateLevelling           | Date         | dd.mm.yyyy         | -                                    | Maintenance: date of levelling                                                                                                                                                    |
| Rolling                 | Text         |                    | 0-2                                  | Maintenance: rolling to level unevenness                                                                                                                                          |
| DateRolling             | Date         | dd.mm.yyyy         | -                                    | Maintenance: date of rolling                                                                                                                                                      |
| Mulching                | Text         |                    | 0-4                                  | Partial mulching on some spots, e.g. rank patches. The material remains on site after mowing. We consider this not as a mowing event as only a small part of the area is treated. |

| Variable             | Type of data | Units      | Range of numeric variables (min-max) | Description (English)                                                                                                                                                       |
|----------------------|--------------|------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| DateMulching         | Date         | dd.mm.yyyy | -                                    | Date of partial mulching                                                                                                                                                    |
| ShrubClearance       | Text         | -          | 0-1                                  | Clearance to avoid shrub encroachment. We consider this not as a mowing event as only individual shrubs are targeted.                                                       |
| DateScrubCl          | Date         | dd.mm.yyyy | -                                    | Date of shrub clearance                                                                                                                                                     |
| PlantProtectionAgent | Boolean      | yes/no     | -                                    | Pesticide use: pesticides and herbicides. As pesticides in grasslands are very rare and only used for spot treatment, we do not have further information on this treatment. |
| Seeds                | Boolean      | yes/no     | -                                    | Seed addition                                                                                                                                                               |
| DescSeeds            | Text         | -          | -                                    | Description of usage of the sowing                                                                                                                                          |

\*LS – Livestock

Table 2.

Livestock units derived from the type and age of livestock (Chamber of Agriculture Nordrhein-Westfalen 2018).

| Grazing species         | Age              | Livestock units (LSU) |
|-------------------------|------------------|-----------------------|
| Cattle                  | < 6 months       | 0.3                   |
| Cattle                  | 6 months-2 years | 0.6                   |
| Cattle                  | > 2 years        | 1                     |
| Sheep and goats         | < 1 year         | 0.05                  |
| Sheep and goats         | > 1 year         | 0.1                   |
| Ponies and small horses | -                | 0.7                   |
| Horses                  | < 3 years        | 0.7                   |
| Horses                  | > 3 years        | 1.1                   |

## General description

**Purpose:** The present dataset summaries management information collected from 2006 to 2016 for 150 grassland plots in three different regions of Germany. Data are based on annual interviews with the respective farmers, land owners or tenants involved in land management activity, using a standardised questionnaire.



Figure 1. [doi](#)

The three model regions of the *Biodiversity Exploratories* project in Germany.

## Project description

**Title:** The Biodiversity Exploratories - functional biodiversity research

**Personnel:** *Members of the steering committee of the BE:* Markus Fischer, Wolfgang Weisser, Manfred Ayasse, Christian Ammer, Nico Blüthgen, Ellen Kandeler, Birgitta König-Ries, Marion Schrumpf.

Within the infrastructure programme of the BE, local management teams in each region ensure the maintenance of survey plots and communication between scientists and local stakeholders. Furthermore, the grassland expert (technician) and the local manager (scientist) of each team are responsible for obtaining the information from the land user by carrying out the annual questionnaire, as well as including additional information by their own observations of the grasslands.

**Study area description:** The biodiversity studies are carried out in 150 grassland plots managed in different intensities.

The grassland sites are distributed in three different regions within Germany including i) the Biosphere Reserve Schorfheide-Chorin ii) the Hainich-Dün Area and iii) the Biosphere-Area Schwäbische Alb.

The Schorfheide Chorin Exploratory site is situated in the North-East of Germany with an extent of approx. 1300 km<sup>2</sup>. The geology is characterised by young glacial landscape of altitudes between 3-140 m a.s.l. with different soil types such as brown earth, lessivé, pararendzina, podzols and bog soils, resulting in diverse vegetation. The annual mean temperature is 8-8.5°C and the annual mean precipitation 500-600 mm.

The Hainich-Dün Exploratory site (approx. 1300 km<sup>2</sup>) in Central Germany consists of silty, loamy and clayey soil textures of the calcareous bedrock in altitudes between 285- 550 m a.s.l. The annual mean temperature is 6.5-8°C and the annual mean precipitation 500-800 mm.

The Exploratory Schwäbische Alb site (approx. 422 km<sup>2</sup>) in South West Germany consists of calcareous bedrock with karst phenomena in altitudes between 460-860 m a.s.l. with annual mean temperature of 6-7°C and mean precipitation of 700-1000 mm.

**Design description:** For an advanced biodiversity research, three large-scale and long-term research sites were established in Germany serving as open research platforms for biodiversity and ecosystem research groups. The BE sustained the scientific infrastructure to develop the intellectual framework needed to address critical questions about changes in biodiversity and to evaluate the impacts of those changes for ecosystem processes.

The objectives of the BE are to understand i) the relationship between biodiversity of different taxa and levels, ii) the role of land use and management for biodiversity, iii) the role of biodiversity for ecosystem processes.

**Funding:** The Biodiversity Exploratories are a German Science Foundation funded research project (DFG Priority Programme 1374).

## Sampling methods

**Study extent:** We monitored 150 grassland plots across three regions in Germany for 11 years since 2006.

**Sampling description:** Interviews with the land users took place retrospectively for the previous year on all permanently established 150 grassland sites since 2006, based on a standardised questionnaire, which was identical for all three exploratory regions.

We did not collect any organisms. During the interviews, the land users provided us with information according to their grassland management.

Linear mixed-effect models with logarithmically transformed response variables were calculated to detect temporal trends as well as differences between the exploratory regions (procedure lmer, implemented in R).

Land use intensity in the grasslands of our study regions ranged from low-intensive management, for example, meadows with only one cut per year and no fertilisation, to intensive management with four cuts per year and occasionally up to 400 kg N added per year and hectare. Very intensively-used grasslands which, in Central Europe, are characterised by up to seven cuts per year and regular fertilisation of about 400 kg/ha/yr nitrogen did not occur in our study regions.

Mean mowing frequency (number of cuts per year) across all 50 plots was between 0.6 and 1.5 and highest in the Alb, lower in Hainich and lowest in Schorfheide. Mowing frequency slightly increased in the Alb and Hainich, but decreased over the years in the Schorfheide. Within plots that were mown, mowing intensity was between 1.3 and 2 cuts per year and was highest in Alb, significantly higher than in Schorfheide (Fig. 2a). Mowing frequency within mown plots decreased over time in Schorfheide (Fig. 2a).

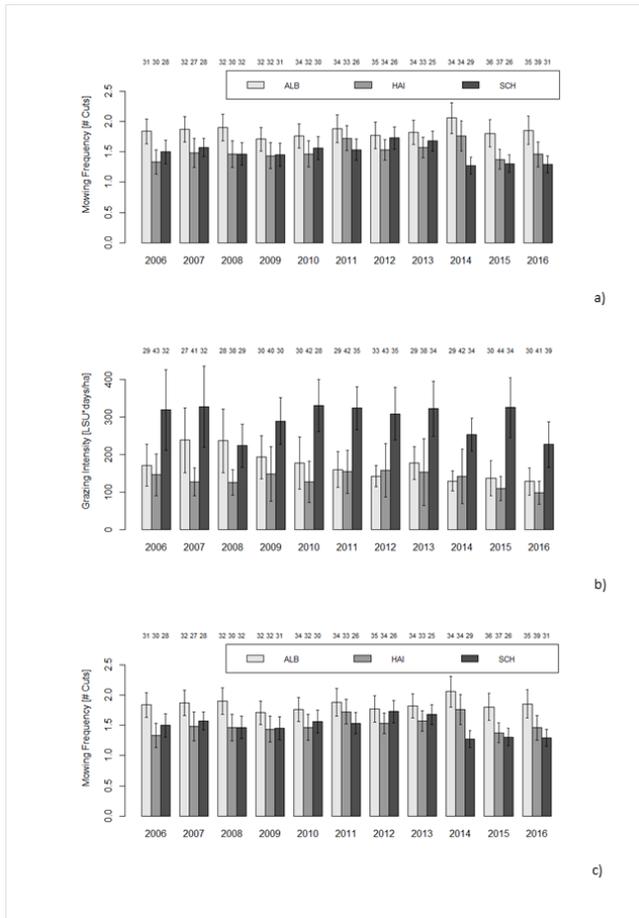


Figure 2. [doi](#)

Annual means and standard error for a) mowing frequency in mown plots, i.e. the number of cuts per year, b) grazing intensity in grazed plots, in livestock unit days per hectare and year, calculated by multiplying the number of livestock by a conversion factor (see Table 3) and the number of grazing days and dividing the product by the size of the management unit and c) nitrogen fertilisation in fertilised plots, calculated as total nitrogen input in kg per hectare and year, in the three study regions of the Biodiversity Exploratories (light grey: Schwäbische Alb (ALB), grey: Hainich-Dün (HAI) and dark grey: Schorfheide-Chorin (SCH)). Only the subset of plots (out of 50 in each region), where the respective management was applied, are included in the figure panels (numbers above the bars).

Table 3.

Nitrogen input conversion factor of manure and slurry.

| Type of manure (t/ha)               | Conversion Factor for total Nitrogen [kg/t] | Literature and Notes                                                                                                                                                                                                                   |
|-------------------------------------|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cattle                              | 5.6                                         | LWK (Chamber of Agriculture) Nordrhein-Westfalen (2014), own measurements analysed by LUFA Nord-West (Agricultural Investigation and Research Institute - accredited laboratory of the Chamber of Agriculture in Niedersachsen) (2017) |
| Horse                               | 4.9                                         |                                                                                                                                                                                                                                        |
| Sheep                               | 8.13                                        |                                                                                                                                                                                                                                        |
| Type of slurry (m <sup>3</sup> /ha) | Total Nitrogen [kg/m <sup>3</sup> ]         |                                                                                                                                                                                                                                        |
| Cattle                              | 3.85 (3.2-4.5)                              | Mean values of slurry ranges were used. (LWK Nordrhein-Westfalen(2014))                                                                                                                                                                |
| Pig                                 | 5.4 (4.3-6.5)                               |                                                                                                                                                                                                                                        |
| Mixed                               | 4.45 (4.0-4.9)                              |                                                                                                                                                                                                                                        |
| Biogas / Digestate                  | 4.4                                         | LWK Baden-Württemberg (2012)                                                                                                                                                                                                           |

Grasslands were grazed by different types of livestock, most commonly cattle and sheep, but also horses and goats. Based on this information, the mean grazing intensity was then calculated by multiplying the livestock units ([LSU], (Table 2) with the duration of grazing per hectare [LSU days/ha]. Grazing intensity across all 50 plots in a region was on average between 120 and 200 livestock unit days per hectare in the Schorfheide, significantly higher than in the Alb ( $z = 3.177$ ,  $p < 0.01$ ) where yearly means were mostly below 100. Mean grazing intensity in Hainich was intermediate with yearly means below 150 (data not shown). In the Schorfheide, grazing intensity across the 50 plots increased slightly over time ( $z = 6.091$ ,  $p < 0.0001$ , data not shown). In grazed plots, the annual grazing intensity per hectare ranged from 5 to 1644 livestock units x days. Mean grazing intensity in grazed plots was higher in the Schorfheide than in the other two regions, but due to high variability, differences between regions were not significant ( $p > 0.05$ , Fig. 2b). Within the grazed plots, grazing intensity in Schorfheide decreased over time ( $z = -3.270$ ,  $p < 0.01$ , Fig. 2b), although the number of plots that were grazed were higher in the second half of the time series (Fig. 2b).

Fertilisation intensity across the 50 plots was highest in Hainich, with means mainly higher than  $20 \text{ kg N ha}^{-1} \text{ yr}^{-1}$ , significantly higher than in the Schorfheide ( $z = 2.343$ ,  $p < 0.05$ ), where there was a significant decrease in fertilisation with time ( $z = -5.017$ ,  $p < 0.001$ ) and where yearly means dropped from  $20 \text{ kg N ha}^{-1} \text{ yr}^{-1}$  to close to zero after 2013, which is largely due to a decrease in the number of fertilised plots to just two (Fig. 2c). Fertilisation in the Alb was intermediate (data not shown). Within fertilised plots, fertilisation ranged

between 15 and 433 kg N ha<sup>-1</sup> yr<sup>-1</sup> and there were no differences between regions or changes over time ( $p > 0.05$  in each case, Fig. 2c).

To summarise, there were significant differences between the regions in main grassland use, meadows in the Alb and pasture in Schorfheide and also in mean land use intensity of meadows, pastures or mown pastures. Changes over time were largely due to changes in the number of plots that were grazed, mown or fertilised, rather than to changes in mowing, grazing and fertilisation intensity within plots. In the Schorfheide, there was an overall decrease in land use intensity, due to increasing regulations in the biosphere reserve Schorfheide Chorin. In the Hainich, the number of fertilised plots decreased from 25 plots in 2006 to 12 plots in 2012 and then increased again to 22 in 2016 (Fig. 2c).

The management of grassland is decisively influenced by subsidies, such as agri-environmental measures (AEM) (Table 4). These AEMs are different within the federal states of Germany, having names such as MEKA or FAKT in Baden-Wuerttemberg and KULAP in Thuringia and Brandenburg, including single measures of different management aspects. The agri-environmental subsidy programmes aim to support environmental friendly and extensive production practices to protect natural resources and to preserve cultural landscapes. These can also be counted as disadvantage compensations and are co-financed by the EU, Germany and the respective federal state. Measures of these programmes determine guidelines regarding organic farming, the timing and type of mowing and grazing or restrictions, according to plant protection agents or fertiliser use (Table 4). Therefore, farmers do not make completely independent decisions by managing their grasslands but follow the regulations of the agri-environmental measures to receive subsidies for their land. Table 5 lists the agri-environmental measures applied for the single study plots for each year. The description of the coding of the agri-environmental measures is found as a legend in Table 6.

Table 4.

The requirements of single agri-environmental measures (MEKA/FAKT for Baden-Wuerttemberg and KULAP for Thuringia and Brandenburg) are characterised by the subprogramme designation listed for every region (ALB- Swabian Alb, HAI- Hainich, SCH- Schorfheide). The abbreviations (R)LSU mean (roughage consuming) livestock units having a livestock-dependent conversion from LSU to RLSU: 1 LSU equals the RLSU for sheep or goat (0.7), horse (0.5), cattle (1).

| Agri-environmental measures                                        | ALB (MEKA, FAKT) | HAI (KULAP) | SCH (KULAP) |
|--------------------------------------------------------------------|------------------|-------------|-------------|
| <b>Requirements</b>                                                |                  |             |             |
| Difficult management due to slope of $\geq 25\%$                   | N-B3             |             |             |
| Adapted, extensive management of biotope (§32 nature conservation) | N-G1.1, B4       |             |             |
| FFH: lowlands- and mountain-meadows                                | B5               |             |             |

| <b>Agri-environmental measures</b>                                   | <b>ALB (MEKA, FAKT)</b> | <b>HAI (KULAP)</b>            | <b>SCH (KULAP)</b>         |
|----------------------------------------------------------------------|-------------------------|-------------------------------|----------------------------|
| Conservation of meadow orchards (eligible up to max 100 trees/ha)    | C1                      |                               |                            |
| Low-nutrient and dry habitats (biotopes maintenance by grazing)      |                         | N21, G21                      |                            |
| Low-nutrient and dry habitats (biotopes maintenance by mowing)       |                         | N31                           |                            |
| Wet meadows                                                          |                         | N23                           |                            |
| Eligible landscape (e.g. Natura 2000)                                |                         |                               | 413A, 423B, 613A, 663      |
| Sheep farming and difficult terrain                                  |                         | N25                           |                            |
| Difficult conditions (regarding terrain, specific management)        |                         | G31, G33, G53                 |                            |
| Location of valuable genetic plants                                  |                         | L4                            |                            |
| Compensatory allowance of disadvantaged sites                        |                         |                               | 33                         |
| <b>Organic farming</b>                                               |                         |                               |                            |
| Farm is managed according to EU eco-regulation                       | N-D2, D2                |                               |                            |
| Introduction or retention of ecological management of the farm       |                         | L1, Ö2                        | 773, 673,882               |
| Retention of ecological management - compensatory allowance          |                         |                               | 623 A,B,C,D                |
| <b>In general</b>                                                    |                         |                               |                            |
| Main fodder site                                                     | B1.2                    |                               |                            |
| Min 5% of eligible site managed after 15 June                        | N-B1, N-B3              |                               |                            |
| Promoting of endangered livestock breeds                             | C3                      |                               |                            |
| No reduction of permanent grassland of the farm                      |                         | N25                           |                            |
| Management plan according to nature conservation authority           |                         | N231, N31, G21, G31, G33, G53 | 663                        |
| Fodder sites are managed at least once per year by grazing or mowing |                         |                               | 413A, 423B, 613A, 663, 673 |
| Management after 1 July                                              |                         |                               | 812C                       |

| Agri-environmental measures                                                                        | ALB (MEKA, FAKT) | HAI (KULAP)         | SCH (KULAP)                    |
|----------------------------------------------------------------------------------------------------|------------------|---------------------|--------------------------------|
| <b>Grazing</b>                                                                                     |                  |                     |                                |
| Livestock min 0.3 LSU/ha on agriculture area                                                       |                  | Ö2                  |                                |
| Livestock max 2 LSU/ha on agriculture area                                                         | N-B1, N-B3       |                     | 773, 673                       |
| Livestock min 0.5 RLSU/ha fodder area                                                              |                  | L4                  |                                |
| Livestock min 0.3 RLSU/ha fodder area                                                              | N-B2, B1.1, B1.2 |                     | 311A, 311C, 773, 673, 661, 411 |
| Livestock max 1.4 RLSU/ ha                                                                         |                  |                     | 311A, 311C, 773, 673, 661, 411 |
| Livestock max 1.4 LSU/ ha                                                                          | N-B2, B1.1       |                     | 311A, 311C                     |
| At least one grazing per year                                                                      |                  | N25                 |                                |
| At least one grazing per year. First grazing period by cattle/horses or sheep/goats                |                  | G21                 |                                |
| At least one grazing per year. First grazing period by sheep/goats                                 |                  | G33, G53            |                                |
| At least one management per year (grazing or mowing and harvesting of the yield) before 15 October |                  |                     | 411, 661                       |
| Maintenance measures after grazing                                                                 | N-B1, N-B2, N-B3 |                     |                                |
| Grazing by cattle/horses with 0.3-1 LSU/ha                                                         |                  | N211                |                                |
| Grazing by cattle/horses with permanent grazing or at least from 2 May to 15 October               |                  | G31                 |                                |
| Grazing by sheep or goats with a min 0.5 LSU/ha                                                    |                  | N213, N25, G33, G53 |                                |
| Grazing 0.3-1 LSU/ha                                                                               |                  | N231                |                                |
| Max 1.5 LSU/ha*d until 1 July                                                                      |                  | N231                |                                |
| First management of the year: at least 80% of area by grazing (up to 20% by mowing)                |                  | N231                |                                |
| First management mowing: grazing possible at least 7 weeks after the first cut                     |                  | N31                 |                                |
| No supplementary feeding                                                                           |                  | N233                |                                |

| <b>Agri-environmental measures</b>                                           | <b>ALB (MEKA, FAKT)</b> | <b>HAI (KULAP)</b>  | <b>SCH (KULAP)</b>   |
|------------------------------------------------------------------------------|-------------------------|---------------------|----------------------|
| No supplementary feeding between 1 May and 15 October                        |                         | G21, G31, G33, G53  |                      |
| <b>Mowing</b>                                                                |                         |                     |                      |
| First management mowing and harvesting the yield                             |                         | N31                 |                      |
| Up to 2 cuts with a time lag of at least 7 weeks                             |                         | N31                 |                      |
| First mowing not before 15 August on min 5% of the area                      |                         | N31                 |                      |
| No mowing before 16 June                                                     |                         |                     | 313A                 |
| No mowing before 1 July                                                      |                         |                     | 313B                 |
| Post grazing mowing not before 1 July                                        |                         | N231, G31, G33, G53 |                      |
| Cut height 10 cm                                                             |                         |                     | 313B, 763            |
| <b>Indicator plant species</b>                                               |                         |                     |                      |
| Abundance of at least 4 indicator plant species out of 28 specific forbs     | N-B4                    | L4                  |                      |
| Abundance of at least 6 indicator plant species out of 30 specific plants    | B3.2                    | G11                 |                      |
| Abundance of at least 7 indicator plant species out of specific plants       | B5                      |                     |                      |
| <b>Fertilisation</b>                                                         |                         |                     |                      |
| No mineral nitrogen fertilisation                                            | B1.1                    |                     |                      |
| No mineral or organic nitrogen fertilisation                                 | B1.2                    |                     |                      |
| No slurry fertilisation                                                      |                         |                     | 311C                 |
| No fertilisation                                                             |                         |                     | 811A                 |
| No chemical-synthetic fertiliser or plant protection agent within the farm   | D1                      |                     | 311A, 311C, 661, 411 |
| No chemical-synthetic fertiliser or plant protection agent on eligible areas |                         | N231, N25; N31      |                      |
| No fertiliser or plant protection agent                                      |                         | G21, G31, G33       |                      |



| EP_Plot_ID | Explo | Latitude | Longitude | 2006         | 2007         | 2008         | 2009         | 2010         | 2011         | 2012         | 2013         | 2014         | 2015                       | 2016                               |
|------------|-------|----------|-----------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------------------------|------------------------------------|
| AEG14      | ALB   | 48.38    | 9.52      | k0n0                       | k0n0                               |
| AEG15      | ALB   | 48.49    | 9.45      | k0n0                       | k0y<br>A12                         |
| AEG16      | ALB   | 48.4     | 9.46      | ocy<br>A4/A5 | ocy<br>A14/11/<br>A12      | ocy<br>A14/<br>A16/<br>A12         |
| AEG17      | ALB   | 48.4     | 9.52      | oay0         | oc00                       | oc00                               |
| AEG18      | ALB   | 48.38    | 9.52      | k0n0                       | k0n0                               |
| AEG19      | ALB   | 48.4     | 9.45      | k0n0                       | k0n0                               |
| AEG2       | ALB   | 48.38    | 9.47      | k0n0                       | k0n0                               |
| AEG20      | ALB   | 48.49    | 9.36      | k0n0                       | k0n0                               |
| AEG21      | ALB   | 48.44    | 9.36      | o0y<br>A5    | o000         | k0n0                       | k0n0                               |
| AEG22      | ALB   | 48.4     | 9.51      | k0y<br>A1    | k0yA7/<br>A10              | k0y<br>A7/A10                      |
| AEG23      | ALB   | 48.42    | 9.51      | k0y0         | ocyA12                     | ocy<br>A12                         |
| AEG24      | ALB   | 48.4     | 9.49      | k0y0         | k0yA15                     | k0y<br>A15                         |
| AEG25      | ALB   | 48.4     | 9.26      | k0y0         | k0yA19                     | k0y<br>A19                         |
| AEG26      | ALB   | 48.4     | 9.4       | k0y0         | k0yA15/<br>A19             | k0y<br>A15/<br>A19                 |
| AEG27      | ALB   | 48.42    | 9.48      | k0y0         | k0yA15/<br>A17/A20/<br>A19 | k0y<br>A15/<br>A17/<br>A20/<br>A19 |
| AEG28      | ALB   | 48.46    | 9.49      | k0y0         | k0yA15                     | k0y<br>A15                         |
| AEG29      | ALB   | 48.42    | 9.36      | k0y0         | k0yA9/<br>A11              | k0y<br>A9/A11                      |
| AEG3       | ALB   | 48.41    | 9.53      | oay<br>A5    | oay0         | ocy0         | ocyA12                     | ocy<br>A12                         |

| EP_Plot_ID | Explo | Latitude | Longitude | 2006               | 2007               | 2008               | 2009               | 2010               | 2011               | 2012               | 2013               | 2014         | 2015              | 2016              |
|------------|-------|----------|-----------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------|-------------------|-------------------|
| AEG30      | ALB   | 48.46    | 9.46      | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0      | k 0 y A15         | k 0 y A15         |
| AEG31      | ALB   | 48.46    | 9.46      | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0      | k 0 y A15         | k 0 y A15         |
| AEG32      | ALB   | 48.47    | 9.49      | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0      | k 0 y A15         | k 0 y A15         |
| AEG33      | ALB   | 48.45    | 9.49      | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0      | k 0 y A15/<br>A11 | k 0 y A15/<br>A11 |
| AEG34      | ALB   | 48.46    | 9.5       | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0      | k 0 y A15         | k 0 y A15         |
| AEG35      | ALB   | 48.48    | 9.29      | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0      | k 0 n 0           | k 0 n 0           |
| AEG36      | ALB   | 48.48    | 9.3       | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0      | k 0 n 0           | k 0 n 0           |
| AEG37      | ALB   | 48.4     | 9.41      | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0      | k 0 n 0           | k 0 n 0           |
| AEG38      | ALB   | 48.44    | 9.43      | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0      | k 0 n 0           | k 0 n 0           |
| AEG39      | ALB   | 48.39    | 9.43      | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0      | k 0 n 0           | k 0 n 0           |
| AEG4       | ALB   | 48.38    | 9.42      | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0            | k 0 n 0      | k 0 n 0           | k 0 n 0           |
| AEG40      | ALB   | 48.41    | 9.57      | k 0 y A1/<br>A19   | k 0 y A1/A19       | k 0 y A1/A19       | k 0 y A1/A19       | k 0 y A1/A19 | k 0 n 0           | k 0 n 0           |
| AEG41      | ALB   | 48.37    | 9.4       | k 0 y A2           | k 0 y A2     | k 0 n 0           | k 0 n 0           |
| AEG42      | ALB   | 48.4     | 9.38      | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0      | k 0 n 0           | k 0 n 0           |
| AEG43      | ALB   | 48.41    | 9.54      | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 n 0      | k 0 y A8          | k 0 y A8          |
| AEG44      | ALB   | 48.38    | 9.43      | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0            | k 0 y 0      | k 0 n 0           | k 0 n 0           |
| AEG45      | ALB   | 48.4     | 9.46      | o 0 y A5           | o 0 y A5     | o 0 y A13         | o 0 y A13         |
| AEG46      | ALB   | 48.4     | 9.43      | o c y A5           | o c y A5     | o c y A16/<br>A18 | o c y A16/<br>A18 |
| AEG47      | ALB   | 48.42    | 9.45      | k 0 y A5/A1/<br>A6 | k 0 n 0      | k 0 y A19         | k 0 y A19         |

| EP_Plot_ID | Explo | Latitude | Longitude | 2006      | 2007      | 2008      | 2009      | 2010      | 2011        | 2012      | 2013      | 2014      | 2015                       | 2016                               |
|------------|-------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-----------|-----------|-----------|----------------------------|------------------------------------|
| AEG48      | ALB   | 48.42    | 9.5       | k0y0      | k0y0      | k0y0      | k0y0      | k0y0      | k0y0        | k0y0      | k0y0      | k0y0      | k0yA15/<br>A17/A20/<br>A19 | k0y<br>A15/<br>A17/<br>A20/<br>A19 |
| AEG49      | ALB   | 48.46    | 9.5       | k0y0      | k0y0      | k0y0      | k0y0      | k0y0      | k0y0        | k0y0      | k0y0      | k0y0      | k0yA15                     | k0y<br>A15                         |
| AEG5       | ALB   | 48.4     | 9.44      | k0n0      | k0n0      | k0n0      | k0n0      | k0n0      | k0n0        | k0n0      | k0n0      | k0n0      | k0n0                       | k0n0                               |
| AEG50      | ALB   | 48.41    | 9.47      | k0n0      | k0n0      | k0n0      | k0n0      | k0n0      | k0n0        | k0n0      | k0n0      | k0n0      | k0n0                       | k0n0                               |
| AEG6       | ALB   | 48.4     | 9.44      | k0n0      | k0n0      | k0n0      | k0n0      | k0n0      | k0n0        | k0n0      | k0n0      | k0n0      | k0n0                       | k0n0                               |
| AEG7       | ALB   | 48.39    | 9.38      | k0y0      | k0y0      | k0y0      | k0y0      | k0y0      | k0y0        | k0y0      | k0y0      | k0y0      | k0yA19/<br>A15             | k0y<br>A19/<br>A15                 |
| AEG8       | ALB   | 48.42    | 9.49      | k0y0      | k0y0      | k0y0      | k0y0      | k0y0      | k0y0        | k0y0      | k0y0      | k0y0      | k0yA15/<br>A11             | k0y<br>A15/<br>A11                 |
| AEG9       | ALB   | 48.39    | 9.5       | k0y0      | k0y0      | k0y0      | k0y0      | k0y0      | k0y0        | k0y0      | k0y0      | k0y0      | k0yA15/<br>A17/A20/<br>A19 | k0y<br>A15/<br>A17/<br>A20/<br>A19 |
| HEG1       | HAI   | 50.97    | 10.41     | k0n0      | k0n0      | k0n0      | k0n0      | k0n0      | k0n0        | k0n0      | k0n0      | k0n0      | k0n0                       | k0n0                               |
| HEG10      | HAI   | 51.28    | 10.45     | k0y0      | k0y0      | o0y0      | oiy<br>H4 | oiy<br>H4 | oiyH4<br>H4 | oay<br>H4 | oay<br>H4 | oay<br>H4 | oayH12<br>H4               | oay<br>H12                         |
| HEG11      | HAI   | 51.28    | 10.46     | k0y0      | k0y0      | o0y0      | oiy<br>H4 | oiy<br>H4 | oiyH4<br>H4 | oay<br>H4 | oay<br>H4 | oay<br>H4 | oayH12<br>H4               | oay<br>H12                         |
| HEG12      | HAI   | 51.08    | 10.58     | k0y0      | k0y0      | k0y0      | k0y<br>H4 | k0y<br>H5 | k0y<br>H5   | k0y<br>H5 | k0y<br>H5 | k0y<br>H5 | k0yH13<br>H5               | k0n0                               |
| HEG13      | HAI   | 51.26    | 10.38     | k0y0      | k0y0      | k0y0      | k0y0      | k0y0      | k0y0        | k0y0      | k0y0      | k0y0      | k0n0                       | k0y0                               |
| HEG14      | HAI   | 51.29    | 10.44     | k0y0      | k0y0      | k0y0      | k0y<br>H4 | k0y0      | k0y<br>H5   | k0y<br>H5 | k0y<br>H5 | k0y<br>H5 | k0yH13<br>H5               | k0y<br>H13                         |
| HEG15      | HAI   | 51.07    | 10.49     | k0y<br>H2 | k0y<br>H2 | k0y<br>H2 | k0n0      | k0n0      | k0n0        | k0y0      | k0y0      | k0y0      | k0y0                       | k0y0                               |
| HEG16      | HAI   | 51.03    | 10.46     | k0y<br>H3 | k0y<br>H3 | k0y<br>H3 | k0y<br>H8 | k0y<br>H8 | k0y<br>H8   | k0y<br>H8 | k0y<br>H8 | k0y<br>H8 | k0yH16<br>H8               | k0y<br>H16                         |

| EP_Plot_ID | Explo | Latitude | Longitude | 2006      | 2007      | 2008      | 2009              | 2010      | 2011       | 2012       | 2013       | 2014       | 2015   | 2016       |
|------------|-------|----------|-----------|-----------|-----------|-----------|-------------------|-----------|------------|------------|------------|------------|--------|------------|
| HEG17      | HAI   | 51.07    | 10.47     | k0y0      | k0y0      | k0y0      | k0y<br>H8         | k0y<br>H8 | k0y<br>H8  | k0y<br>H8  | k0y<br>H8  | k0y<br>H8  | k0yH16 | k0y<br>H17 |
| HEG18      | HAI   | 51.28    | 10.42     | k0y0      | k0y0      | k0y0      | k0y7              | k0y0      | k0y<br>H8  | k0y<br>H8  | k0y<br>H8  | k0y<br>H8  | k0yH16 | k0y<br>H16 |
| HEG19      | HAI   | 51.07    | 10.47     | k0y0      | k0y0      | k0y0      | k0y<br>H8         | k0y0      | k0y<br>H8  | k0y<br>H8  | k0y<br>H8  | k0y<br>H8  | k0yH16 | k0y<br>H17 |
| HEG2       | HAI   | 51       | 10.43     | k0n0      | k0n0      | k0n0      | k0n0              | k0n0      | k0n0       | k0y0       | k0n0       | k0n0       | k0n0   | k0n0       |
| HEG20      | HAI   | 51.22    | 10.37     | k0y0      | k0y0      | k0y0      | k0y0              | k0y0      | k0y<br>H8  | k0y<br>H8  | k0y<br>H9  | k0y<br>H8  | k0yH16 | k0y<br>H16 |
| HEG21      | HAI   | 51.19    | 10.75     | k0y0      | k0y0      | k0y0      | k0y<br>H8         | k0y<br>H8 | k0y<br>H8  | k0y<br>H8  | k0y<br>H8  | k0y<br>H8  | k0yH16 | k0y<br>H16 |
| HEG22      | HAI   | 51.03    | 10.32     | k0y0      | k0y0      | k0y0      | k0y<br>H9         | k0y<br>H9 | k0y<br>H9  | k0y<br>H9  | k0y<br>H9  | k0y<br>H9  | k0yH13 | k0y0       |
| HEG23      | HAI   | 51.13    | 10.34     | o0y<br>H1 | o0y<br>H1 | o0y<br>H1 | oiy<br>H4/<br>H10 | o0y0      | oiy<br>H10 | oiy<br>H10 | oiy<br>H10 | oiy<br>H10 | oiyH12 | oay<br>H12 |
| HEG24      | HAI   | 51.1     | 10.35     | o0y<br>H1 | o0y<br>H1 | o0y<br>H1 | oiy<br>H4/<br>H10 | o0y0      | oiy<br>H10 | oiy<br>H10 | oiy<br>H10 | oiy<br>H10 | oayH12 | oay<br>H12 |
| HEG25      | HAI   | 51.02    | 10.32     | k0y0      | k0y0      | k0y0      | k0y<br>H9         | k0y<br>H9 | k0y<br>H9  | k0y<br>H9  | k0y<br>H9  | k0y<br>H9  | k0yH13 | k0y0       |
| HEG26      | HAI   | 51.28    | 10.37     | k0y0      | o0y0      | o0y0      | oiy<br>H4         | oiy<br>H4 | oiyH4      | oay<br>H4  | oay<br>H4  | oay<br>H4  | oayH12 | oay<br>H12 |
| HEG27      | HAI   | 51.09    | 10.6      | k0y0      | k0y0      | k0y0      | k0y<br>H5         | k0y<br>H5 | k0y<br>H5  | k0y<br>H5  | k0y<br>H5  | k0y<br>H5  | k0yH13 | k0n0       |
| HEG28      | HAI   | 51.27    | 10.5      | k0y<br>H2 | k0n0      | k0n0      | k0n0              | k0n0      | k0n0       | k0y<br>H2  | k0y<br>H4  | kay<br>H4  | oayH12 | oay<br>H12 |
| HEG29      | HAI   | 51.26    | 10.5      | k0y<br>H2 | k0n0      | k0n0      | k0n0              | k0n0      | k0n0       | k0y<br>H2  | k0y<br>H4  | kay<br>H4  | oayH12 | oay<br>H12 |
| HEG3       | HAI   | 51       | 10.43     | k0n0      | k0n0      | k0n0      | k0n0              | k0n0      | k0n0       | k0n0       | k0n0       | k0n0       | k0n0   | k0n0       |
| HEG30      | HAI   | 51.2     | 10.36     | k0y<br>H2 | k0y<br>H2 | k0y<br>H2 | k0y<br>H5         | k0y<br>H5 | k0y<br>H5  | k0y<br>H5  | k0y<br>H5  | k0y<br>H5  | k0yH13 | k0y<br>H13 |
| HEG31      | HAI   | 51.17    | 10.22     | k0y0      | k0y<br>H4 | k0y<br>H4 | k0y<br>H5         | k0y<br>H5 | k0y<br>H5  | k0y<br>H5  | k0y<br>H5  | k0y<br>H5  | k0yH15 | k0y<br>H15 |
| HEG32      | HAI   | 51.08    | 10.57     | k0y0      | k0y0      | k0y0      | k0y<br>H5         | k0y<br>H5 | k0y<br>H5  | k0y<br>H5  | k0y<br>H5  | k0y<br>H5  | k0yH13 | k0n0       |

| EP_Plot_ID | Explo | Latitude | Longitude | 2006                | 2007                | 2008                | 2009           | 2010         | 2011            | 2012            | 2013        | 2014        | 2015      | 2016         |
|------------|-------|----------|-----------|---------------------|---------------------|---------------------|----------------|--------------|-----------------|-----------------|-------------|-------------|-----------|--------------|
| HEG33      | HAI   | 51.11    | 10.43     | k 0 y<br>H2/<br>H18 | k 0 n 0             | k 0 n 0             | k 0 n 0        | k 0 n 0      | k 0 y 0         | k 0 y<br>H2     | k 0 y<br>H4 | k a y<br>H4 | o a y H12 | o a y<br>H12 |
| HEG34      | HAI   | 51.21    | 10.39     | o g y<br>H1/<br>H18 | o g y<br>H1/<br>H18 | o g y<br>H1/<br>H18 | o g y<br>H4    | o g y 0      | o g y<br>H1/H18 | o g y<br>H1/H18 | o g y<br>H4 | o g y<br>H4 | o g y H12 | o g y<br>H12 |
| HEG35      | HAI   | 51.22    | 10.41     | o g y<br>H1/<br>H18 | o g y<br>H1/<br>H18 | o g y<br>H1/<br>H18 | o g y<br>H4    | o g y 0      | o g y<br>H1/H18 | o g y<br>H4     | o g y<br>H4 | o g y<br>H4 | o g y H12 | o g y<br>H12 |
| HEG36      | HAI   | 51.03    | 10.51     | k 0 y<br>H2         | k 0 y<br>H2         | k 0 y<br>H2         | k 0 n 0        | k 0 y 0      | k 0 n 0         | k 0 y 0         | k 0 y 0     | k 0 y 0     | k 0 y H14 | k 0 y<br>H14 |
| HEG37      | HAI   | 51.03    | 10.51     | k 0 y<br>H2         | k 0 y<br>H2         | k 0 y<br>H2         | k 0 n 0        | k 0 y 0      | k 0 n 0         | k 0 y 0         | k 0 y 0     | k 0 y 0     | k 0 y 0   | k 0 y 0      |
| HEG38      | HAI   | 51.12    | 10.34     | o 0 y<br>H1         | o 0 y<br>H1         | o 0 y<br>H1         | o 0 y<br>H6    | o 0 y 0      | k 0 y<br>H7     | k 0 y<br>H7     | o 0 y<br>H7 | o 0 y<br>H7 | o a y H12 | o a y<br>H12 |
| HEG39      | HAI   | 51.12    | 10.35     | o 0 y<br>H1         | o 0 y<br>H1         | o 0 y<br>H1         | o i y<br>H4/H6 | o 0 y 0      | o i y H6        | o i y H6        | o i y H6    | o i y H6    | o i y H12 | o i y<br>H12 |
| HEG4       | HAI   | 51.11    | 10.44     | k 0 y<br>H2         | k 0 n 0             | k 0 n 0             | k 0 n 0        | k 0 n 0      | k 0 n 0         | k 0 n 0         | k 0 n 0     | k 0 n 0     | k 0 n 0   | k 0 y 0      |
| HEG40      | HAI   | 50.97    | 10.45     | k 0 y 0             | k 0 y 0             | k 0 y 0             | k 0 y<br>H7    | k 0 y<br>H7  | k 0 y<br>H7     | k 0 y<br>H7     | k 0 y<br>H7 | k 0 y<br>H7 | k 0 y H13 | k 0 y<br>H14 |
| HEG41      | HAI   | 51.22    | 10.37     | k 0 y 0             | k 0 y 0             | k 0 y 0             | k 0 y 0        | k 0 y 0      | k 0 y 0         | k 0 y 0         | k 0 y<br>H9 | k 0 y<br>H8 | k 0 y H16 | k 0 y<br>H16 |
| HEG42      | HAI   | 51.07    | 10.46     | k 0 y 0             | k 0 y 0             | k 0 y 0             | k 0 y<br>H8    | k 0 y 0      | k 0 y<br>H8     | k 0 y<br>H8     | k 0 y<br>H8 | k 0 y<br>H8 | k 0 y H17 | k 0 y<br>H17 |
| HEG43      | HAI   | 51.3     | 10.44     | k 0 y 0             | k 0 y 0             | k 0 y 0             | k 0 y<br>H6    | k 0 y 0      | k 0 y<br>H8     | k 0 y<br>H8     | k 0 y<br>H8 | k 0 y<br>H8 | k 0 y H16 | k 0 y<br>H16 |
| HEG44      | HAI   | 51.06    | 10.48     | k 0 y<br>H3         | k 0 y<br>H3         | k 0 y<br>H3         | k 0 y<br>H8    | k 0 y<br>H8  | k 0 y<br>H8     | k 0 y<br>H8     | k 0 y<br>H8 | k 0 y<br>H8 | k 0 y H16 | k 0 y<br>H16 |
| HEG45      | HAI   | 51.04    | 10.51     | k 0 y<br>H3         | k 0 y<br>H3         | k 0 y<br>H3         | k 0 n 0        | k 0 y<br>H11 | k 0 y<br>H8     | k 0 y<br>H8     | k 0 y<br>H8 | k 0 y<br>H8 | k 0 y H16 | k 0 y<br>H16 |
| HEG46      | HAI   | 51.21    | 10.75     | k 0 y 0             | k 0 y 0             | k 0 y 0             | k 0 y<br>H8    | k 0 y<br>H8  | k 0 y<br>H8     | k 0 y<br>H8     | k 0 y<br>H8 | k 0 y<br>H8 | k 0 y H16 | k 0 y<br>H16 |
| HEG47      | HAI   | 51.28    | 10.37     | k 0 y 0             | k 0 y 0             | o 0 y 0             | o i y<br>H4    | o i y<br>H4  | o i y H4        | o a y<br>H4     | o a y<br>H4 | o a y<br>H4 | o a y H12 | o a y<br>H12 |

| EP_Plot_ID | Explo | Latitude | Longitude | 2006               | 2007                | 2008                | 2009               | 2010               | 2011                     | 2012                     | 2013                     | 2014                     | 2015           | 2016                  |
|------------|-------|----------|-----------|--------------------|---------------------|---------------------|--------------------|--------------------|--------------------------|--------------------------|--------------------------|--------------------------|----------------|-----------------------|
| HEG48      | HAI   | 51.29    | 10.38     | k0y0               | k0y0                | o0y0                | oiy<br>H4          | oiy<br>H4          | oiyH4                    | oay<br>H4                | oay<br>H4                | oay<br>H4                | oayH12         | oay<br>H12            |
| HEG49      | HAI   | 51.28    | 10.39     | k0y0               | k0y0                | o0y0                | oiy<br>H4          | oiy<br>H4          | oiyH4                    | oay<br>H4                | oay<br>H4                | oay<br>H4                | oayH12         | oay<br>H12            |
| HEG5       | HAI   | 51.22    | 10.32     | k0y<br>H2          | k0y<br>H2           | k0y<br>H2           | k0y<br>H5          | k0y<br>H5          | k0y<br>H5                | k0y<br>H5                | k0y<br>H5                | k0y<br>H5                | k0yH13         | k0y<br>H13            |
| HEG50      | HAI   | 51.28    | 10.42     | k0y0               | k0y0                | k0y0                | oiy<br>H4          | oiy<br>H4          | oiyH4                    | oay<br>H4                | oay<br>H4                | oay<br>H4                | oayH12         | oay<br>H12            |
| HEG6       | HAI   | 51.21    | 10.39     | ogy<br>H1/<br>H18  | ogy<br>H1/<br>H18   | ogy<br>H1/<br>H18   | ogy<br>H4          | ogy0               | ogy<br>H4/H18            | ogy<br>H4                | ogy<br>H4                | ogy<br>H4                | ogyH12         | ogy<br>H12            |
| HEG7       | HAI   | 51.27    | 10.41     | k0y0               | o0y<br>H4           | o0y0                | oiy<br>H4          | oiy<br>H4          | oiyH4                    | oay<br>H4                | oay<br>H4                | oay<br>H4                | oayH12         | oay<br>H12            |
| HEG8       | HAI   | 51.27    | 10.42     | k0y0               | o0y<br>H4           | o0y0                | oiy<br>H4          | oiy<br>H4          | oiyH4                    | oay<br>H4                | oay<br>H4                | oay<br>H4                | oayH12         | oay<br>H12            |
| HEG9       | HAI   | 51.22    | 10.38     | ogy<br>H1/<br>H18  | ogy<br>H1/<br>H18   | ogy<br>H1/<br>H18   | ogy<br>H4          | ogy0               | ogy<br>H4/H18            | ogy<br>H4                | oay<br>H4                | ogy<br>H4                | k0yH16         | k0y<br>H16            |
| SEG1       | SCH   | 53.09    | 13.97     | k0n0               | k0n0                | k0n0                | k0n0               | k0n0               | k0n0                     | k0n0                     | k0n0                     | k0n0                     | k0n0           | k0n0                  |
| SEG10      | SCH   | 53.11    | 14        | k0n0               | k0n0                | k0n0                | k0n0               | k0n0               | k0n0                     | k0n0                     | k0n0                     | k0n0                     | k0n0           | k0n0                  |
| SEG11      | SCH   | 53.11    | 13.99     | k0n0               | k0n0                | k0n0                | k0n0               | k0n0               | k0n0                     | k0n0                     | k0n0                     | k0n0                     | k0n0           | k0n0                  |
| SEG12      | SCH   | 53.09    | 13.97     | k0n0               | k0n0                | k0n0                | k0n0               | k0n0               | k0n0                     | k0n0                     | k0n0                     | k0n0                     | k0n0           | k0n0                  |
| SEG13      | SCH   | 52.97    | 13.82     | oay<br>S2          | oay<br>S6/S2/<br>S7 | oay<br>S6/S2/<br>S7 | oay<br>S6/S7       | oay<br>S6/S7       | oay<br>S11/S8/<br>S12/S9 | oay<br>S11/S8/<br>S12/S9 | oay<br>S11/S8/<br>S12/S9 | oay<br>S11/S8/<br>S12/S9 | oayS17         | oay<br>S17            |
| SEG14      | SCH   | 53.09    | 13.98     | k0n0               | k0n0                | k0n0                | k0n0               | k0n0               | k0n0                     | k0n0                     | k0n0                     | ocy<br>S12/S9            | ocyS15/<br>S17 | ocy<br>S15/<br>S17    |
| SEG15      | SCH   | 53.11    | 14.01     | k0y<br>S3          | k0y<br>S3           | k0y<br>S3           | k0n0               | k0n0               | k0n0                     | k0n0                     | k0n0                     | k0y<br>S10               | k0yS15         | k0n0                  |
| SEG16      | SCH   | 53.12    | 14        | k0y<br>S3          | k0y<br>S3           | k0y<br>S3           | k0n0               | k0n0               | k0n0                     | k0n0                     | k0n0                     | k0y<br>S10               | k0yS15         | k0n0                  |
| SEG17      | SCH   | 53.1     | 13.63     | ocy<br>S14/<br>S12 | ocy<br>S14/<br>S12  | ocy<br>S14/<br>S12  | ocy<br>S14/<br>S12 | ocy<br>S14/<br>S12 | ocy<br>S14/<br>S12/S9    | ocy<br>S14/<br>S12/S9    | ocy<br>S14/<br>S12/S9    | ocy<br>S14/<br>S12/S9    | ocyS15/<br>S17 | ocy<br>S15/<br>S17/S1 |

| EP_Plot_ID | Explo | Latitude | Longitude | 2006                   | 2007                 | 2008                 | 2009                 | 2010                 | 2011         | 2012         | 2013         | 2014            | 2015              | 2016                    |
|------------|-------|----------|-----------|------------------------|----------------------|----------------------|----------------------|----------------------|--------------|--------------|--------------|-----------------|-------------------|-------------------------|
| SEG18      | SCH   | 53.14    | 13.88     | o a y<br>S13/<br>S5/S3 | o a y 0              | o a y 0              | o a y                | o a y                | o a y        | o a y        | o a y        | o a y           | o a y S15/<br>S17 | o a y<br>S15/<br>S17    |
| SEG19      | SCH   | 53.12    | 14.01     | k 0 y<br>S3            | k 0 y<br>S3          | k 0 y<br>S3          | k 0 n 0              | k 0 n 0              | k 0 n 0      | k 0 n 0      | k 0 n 0      | k 0 n 0         | k 0 n 0           | k 0 n 0                 |
| SEG2       | SCH   | 53.09    | 13.98     | k 0 n 0                | k 0 n 0              | k 0 n 0              | k 0 n 0              | k 0 n 0              | k 0 n 0      | k 0 n 0      | k 0 n 0      | k 0 n 0         | k 0 n 0           | k 0 n 0                 |
| SEG20      | SCH   | 53.1     | 13.62     | o c y<br>S14/<br>S12   | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12 | o c y        | o c y        | o c y        | o c y           | o c y S15/<br>S17 | o c y<br>S15/<br>S17/S1 |
| SEG21      | SCH   | 53.11    | 13.61     | o c y<br>S14/<br>S12   | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12 | o c y        | o c y        | o c y        | o c y           | o c y S15/<br>S17 | o c y<br>S15/<br>S17/S1 |
| SEG22      | SCH   | 53.1     | 13.97     | k 0 n 0                | k 0 n 0              | k 0 n 0              | k 0 n 0              | k 0 n 0              | k 0 n 0      | k 0 n 0      | k 0 n 0      | k 0 n 0         | k 0 n 0           | k 0 n 0                 |
| SEG23      | SCH   | 53.11    | 14.03     | k 0 y<br>S3            | k 0 y<br>S3          | k 0 y<br>S3          | k 0 n 0              | k 0 n 0              | k 0 n 0      | k 0 n 0      | k 0 n 0      | k 0 y<br>S10    | k 0 n 0           | k 0 n 0                 |
| SEG24      | SCH   | 53.09    | 14        | k 0 y<br>S5/S3         | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S10 | k 0 y<br>S10 | k 0 y<br>S10 | k 0 y<br>S10    | k 0 n 0           | k 0 n 0                 |
| SEG25      | SCH   | 53.11    | 13.62     | o c y<br>S14/<br>S12   | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12 | o c y        | o c y        | o c y        | o c y           | o c y S15/<br>S17 | o c y<br>S15/<br>S17/S1 |
| SEG26      | SCH   | 53.11    | 14.02     | k 0 y<br>S3            | k 0 y<br>S3          | k 0 y<br>S3          | k 0 n 0              | k 0 n 0              | k 0 n 0      | k 0 n 0      | k 0 n 0      | k 0 y<br>S10    | k 0 n 0           | k 0 n 0                 |
| SEG27      | SCH   | 53.12    | 13.71     | o a y<br>S14           | o a y<br>S12         | o a y<br>S12         | o a y<br>S12         | o a y<br>S12         | o a y<br>S12 | o a y<br>S12 | o a y<br>S12 | o a y<br>S12/S9 | o a y S15/<br>S17 | o a y<br>S15/<br>S17    |
| SEG28      | SCH   | 53.09    | 14.01     | k 0 y<br>S3            | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S10 | k 0 y<br>S10 | k 0 y<br>S10 | k 0 y<br>S10    | k 0 n 0           | k 0 n 0                 |
| SEG29      | SCH   | 53.09    | 14        | k 0 y<br>S3            | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S10 | k 0 y<br>S10 | k 0 y<br>S10 | k 0 y<br>S10    | k 0 n 0           | k 0 n 0                 |
| SEG3       | SCH   | 53.1     | 13.99     | k 0 n 0                | k 0 n 0              | k 0 n 0              | k 0 n 0              | k 0 n 0              | k 0 n 0      | k 0 n 0      | k 0 n 0      | k 0 n 0         | k 0 n 0           | k 0 n 0                 |
| SEG30      | SCH   | 53.15    | 13.83     | o a y<br>S4/S3/<br>S14 | o a y<br>S3/<br>S14  | o a y<br>S12         | o a y<br>S12         | o a y<br>S12         | o a y<br>S12 | o a y<br>S12 | o a y<br>S12 | o a y<br>S12    | o a y S15/<br>S17 | o a y<br>S15/<br>S17    |
| SEG31      | SCH   | 53.15    | 13.84     | o a y<br>S4/S3/<br>S14 | o a y<br>S3/<br>S14  | o a y<br>S12         | o a y<br>S12         | o a y<br>S12         | o a y<br>S12 | o a y<br>S12 | o a y<br>S12 | o a y<br>S12    | o a y S15/<br>S17 | o a y<br>S15/<br>S17    |

| EP_Plot_ID | Explo | Latitude | Longitude | 2006                   | 2007                | 2008                | 2009         | 2010                | 2011            | 2012            | 2013            | 2014            | 2015              | 2016                 |
|------------|-------|----------|-----------|------------------------|---------------------|---------------------|--------------|---------------------|-----------------|-----------------|-----------------|-----------------|-------------------|----------------------|
| SEG32      | SCH   | 53.15    | 13.83     | o a y<br>S4/S3/<br>S14 | o a y<br>S3/<br>S14 | o a y<br>S12        | o a y<br>S12 | o a y<br>S12        | o a y<br>S12    | o a y<br>S12    | o a y<br>S12    | o a y<br>S12    | o a y S15/<br>S17 | o a y<br>S15/<br>S17 |
| SEG33      | SCH   | 52.99    | 13.84     | o a y<br>S2            | o a y<br>S2/S7      | o a y<br>S2/S7      | o a y<br>S7  | o a y<br>S7         | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y S15/<br>S17 | o a y<br>S15/<br>S17 |
| SEG34      | SCH   | 52.98    | 13.85     | o a y<br>S2            | o a y<br>S2/S7      | o a y<br>S2/S7      | o a y<br>S7  | o a y<br>S7         | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y S15/<br>S17 | o a y<br>S15/<br>S17 |
| SEG35      | SCH   | 52.98    | 13.85     | o a y<br>S2            | o a y<br>S2/S7      | o a y<br>S2/S7      | o a y<br>S7  | o a y<br>S7         | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y S15/<br>S17 | o a y<br>S15/<br>S17 |
| SEG36      | SCH   | 52.99    | 13.84     | o a y<br>S2            | o a y<br>S2/S7      | o a y<br>S2/S7      | o a y<br>S7  | o a y<br>S7         | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y S15/<br>S17 | o a y<br>S15/<br>S17 |
| SEG37      | SCH   | 53.13    | 13.88     | o a y 0                | o a y 0             | o a y 0             | o a y<br>S13 | o a y<br>S12        | o a y<br>S12    | o a y<br>S12    | o a y<br>S12    | o a y<br>S12    | o a y S15/<br>S17 | o a y<br>S15/<br>S17 |
| SEG38      | SCH   | 53.12    | 13.68     | o a y<br>S14           | o a y<br>S12        | o a y<br>S12        | o a y<br>S12 | o a y<br>S12        | o a y<br>S12    | o a y<br>S12/S9 | o a y<br>S12    | o a y<br>S12/S9 | o a y S15/<br>S17 | o a y<br>S15/<br>S17 |
| SEG39      | SCH   | 52.98    | 13.82     | o a y<br>S2            | o a y<br>S2/S7      | o a y<br>S2/S7      | o a y<br>S7  | o a y<br>S7         | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y<br>S12/S9 | o a y S15/<br>S17 | o a y<br>S15/<br>S17 |
| SEG4       | SCH   | 53.11    | 14        | k 0 y<br>S3            | k 0 y<br>S3         | k 0 y<br>S3         | k 0 n 0      | k 0 n 0             | k 0 n 0         | k 0 n 0         | k 0 n 0         | k 0 y<br>S10    | k 0 y S15         | k 0 n 0              |
| SEG40      | SCH   | 53.12    | 13.84     | o a y 0                | o a y 0             | o a y 0             | o a y<br>S12 | o a y<br>S12        | o a y<br>S12    | o a y<br>S12    | o a y<br>S12    | o a y<br>S12    | o a y S17         | o a y<br>S17         |
| SEG41      | SCH   | 53.12    | 13.85     | o a y 0                | o a y 0             | o a y 0             | o a y<br>S12 | o a y<br>S12        | o a y<br>S12    | o a y<br>S12    | o a y<br>S12    | o a y<br>S12    | o a y S17         | o a y<br>S17         |
| SEG42      | SCH   | 52.87    | 13.97     | o h y<br>S2            | o h y<br>S2/<br>S12 | o h y<br>S2/<br>S12 | o h y<br>S7  | o h y<br>S2/<br>S12 | o h y<br>S2/S12 | o h y<br>S2/S12 | o h y<br>S2/S12 | o h y<br>S2/S12 | o h y S15/<br>S17 | o h y<br>S15/<br>S17 |
| SEG43      | SCH   | 52.88    | 13.97     | o h y<br>S2            | o h y<br>S2/<br>S12 | o h y<br>S2/<br>S12 | o h y<br>S7  | o h y<br>S2/<br>S12 | o h y<br>S2/S12 | o h y<br>S2/S12 | o h y<br>S2/S12 | o h y<br>S2/S12 | o h y S15/<br>S17 | o h y<br>S15/<br>S17 |

| EP_Plot_ID | Explo | Latitude | Longitude | 2006                 | 2007                 | 2008                 | 2009                 | 2010                 | 2011                    | 2012                    | 2013                    | 2014                    | 2015              | 2016                    |
|------------|-------|----------|-----------|----------------------|----------------------|----------------------|----------------------|----------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------|-------------------------|
| SEG44      | SCH   | 52.88    | 13.97     | o h y<br>S2          | o h y<br>S2/<br>S12  | o h y<br>S2/<br>S12  | o h y<br>S7          | o h y<br>S2/<br>S12  | o h y<br>S2/S12         | o h y<br>S2/S12         | o h y<br>S2/S12         | o h y<br>S2/S12         | o h y S15/<br>S17 | o h y<br>S15/<br>S17    |
| SEG45      | SCH   | 52.88    | 13.96     | o h y<br>S2          | o h y<br>S2/<br>S12  | o h y<br>S2/<br>S12  | o h y<br>S7          | o h y<br>S2/<br>S12  | o h y<br>S2/S12         | o h y<br>S2/S12         | o h y<br>S2/S12         | o h y<br>S2/S12         | o h y S15/<br>S17 | o h y<br>S15/<br>S17    |
| SEG46      | SCH   | 52.98    | 13.83     | o a y<br>S2          | o a y<br>S2/S7       | o a y<br>S2/S7       | o a y<br>S7          | o a y<br>S7          | o a y<br>S12/S9         | o a y<br>S12/S9         | o a y<br>S12/S9         | o a y<br>S12/S9         | o a y S15/<br>S17 | o a y<br>S15/<br>S17    |
| SEG47      | SCH   | 52.99    | 13.83     | o a y<br>S2          | o a y<br>S2/S7       | o a y<br>S2/S7       | o a y<br>S7          | o a y<br>S7          | o a y<br>S12/S9         | o a y<br>S12/S9         | o a y<br>S12/S9         | o a y<br>S12/S9         | o a y S15/<br>S17 | o a y<br>S15/<br>S17    |
| SEG48      | SCH   | 53.1     | 13.61     | o c y<br>S14/<br>S12 | o c y<br>S12/S9         | o c y<br>S12/S9         | o c y<br>S12/S9         | o c y<br>S14/<br>S12/S9 | o c y S15/<br>S17 | o c y<br>S15/<br>S17/S1 |
| SEG49      | SCH   | 52.97    | 13.86     | o a y<br>S2          | o a y<br>S2/S7       | o a y<br>S2/S7       | o a y<br>S7          | o a y<br>S7          | o a y<br>S12/S9         | o a y<br>S12/S9         | o a y<br>S12/S9         | o a y<br>S12/S9         | o a y S15/<br>S17 | o a y<br>S15/<br>S17    |
| SEG5       | SCH   | 53.11    | 14        | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S3          | k 0 n 0              | k 0 n 0              | k 0 n 0                 | k 0 n 0                 | k 0 n 0                 | k 0 y<br>S10            | k 0 y S15         | k 0 n 0                 |
| SEG50      | SCH   | 53.12    | 13.75     | o c y<br>S14            | o c y<br>S14            | o c y<br>S14            | o c y<br>S14            | o c y S15/<br>S17 | o c y<br>S15/<br>S17    |
| SEG6       | SCH   | 53.1     | 13.62     | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12/S9 | o c y<br>S14/<br>S12/S9 | o c y<br>S14/<br>S12/S9 | o c y<br>S14/<br>S12/S9 | o c y S15/<br>S17 | o c y<br>S15/<br>S17/S1 |
| SEG7       | SCH   | 53.09    | 13.98     | k 0 n 0              | k 0 n 0              | k 0 n 0              | k 0 n 0              | k 0 n 0              | k 0 n 0                 | k 0 n 0                 | k 0 n 0                 | k 0 n 0                 | k 0 n 0           | k 0 n 0                 |
| SEG8       | SCH   | 53.11    | 14.02     | k 0 y<br>S3          | k 0 y<br>S3          | k 0 y<br>S3          | k 0 n 0              | k 0 n 0              | k 0 n 0                 | k 0 n 0                 | k 0 n 0                 | k 0 y<br>S10            | k 0 y 0           | k 0 n 0                 |
| SEG9       | SCH   | 53.1     | 13.61     | o c y<br>S14/<br>S12 | o c y<br>S14/<br>S12/S9 | o c y<br>S14/<br>S12/S9 | o c y<br>S14/<br>S12/S9 | o c y<br>S14/<br>S12/S9 | o c y S15/<br>S17 | o c y<br>S15/<br>S17/S1 |

|                                                                               |
|-------------------------------------------------------------------------------|
| Table 6.<br>Description of the agri-environmental measures coding of Table 5. |
| 0 = no description or not applicable (0)                                      |
| <b>Type of farming (1. digit)</b>                                             |
| k = conventional                                                              |
| o = ecological                                                                |
| <b>Ecological directive (2. digit)</b>                                        |
| a = EU-Bio                                                                    |
| b = DE-Bio                                                                    |
| c = Bioland                                                                   |
| d = Naturland                                                                 |
| e = Biokreis                                                                  |
| f = Naturland                                                                 |
| g = Demeter                                                                   |
| h = Biopark                                                                   |
| i = GÄA e.V.                                                                  |
| <b>Agri-environmental measure (AEM) (3. digit)</b>                            |
| n = no                                                                        |
| y = yes                                                                       |
| <b>Description AEM (4. digit)</b>                                             |
| <b>Alb:</b>                                                                   |
| <b>MEKA (1992-2013/2014)</b>                                                  |
| A1 = N-B 1: extensive                                                         |
| A2 = N-B 2: extensive and low livestock density                               |
| A3 = N-B 3: steep slopes (inclination $\geq 25\%$ ) - difficult conditions    |
| A4 = N-B 4: biodiverse                                                        |
| A5 = N-D 2: organic farming                                                   |
| A6 = N-G 1.1: extensive management of protected biotopes                      |
| <b>FAKT (2014-2020)</b>                                                       |
| A7 = B 1.1: extensive, max 1.4 RLU/ha, no mineral nitrogen                    |
| A8 = B 1.2: extensive, min 0.3 RLU/ha, no nitrogen                            |

|                                                                           |
|---------------------------------------------------------------------------|
| A9 = B 3: biodiverse, 4 indicator species                                 |
| A10 = B 3.2: biodiverse, 6 indicator species                              |
| A11 = B 4: extensive management of protected biotopes                     |
| A12 = B 5: extensive management of FFH                                    |
| A13 = C 1: meadow orchards                                                |
| A14 = C 3: cattle breed                                                   |
| A15 = D 1: no chemical-synthetically plant protection agent or fertiliser |
| A16 = D 2.2: organic farming                                              |
| A17 = N 6.1.1: NA (no information)                                        |
| <b>Other</b>                                                              |
| A18 = SG 1: NA (no information)                                           |
| A19 = landscape conservation guidelines: (unspecific, measures unknown)   |
| A20 = forest biotope mapping: (unspecific, measures unknown)              |
| <b>Hainich</b>                                                            |
| <b>KULAP (2000-2007)</b>                                                  |
| H1 = Programme A: unspecific (no information of subprogrammes)            |
| H2 = Programme B: unspecific (no information of subprogrammes)            |
| H3 = Programme C: unspecific (no information of subprogrammes)            |
| <b>KULAP (2007-2014)</b>                                                  |
| H4 = L 1: organic farming                                                 |
| H5 = L 4: biodiverse                                                      |
| H6 = N 21: low-nutrient and dry habitats (grazing)                        |
| H7 = N 211: low-nutrient and dry habitats (cattle/horse grazing)          |
| H8 = N 213: low-nutrient and dry habitats (sheep/goat grazing)            |
| H9 = N 25: sheep farming and difficult terrain                            |
| H10 = N 311: low-nutrient and dry habitats (mowing)                       |
| H11 = N 312: low-nutrient and dry habitats (mowing, difficult conditions) |
| <b>KULAP (2014-2020)</b>                                                  |
| H12 = Ö2: organic farming                                                 |
| H13 = G 11: biodiverse                                                    |
| H14 = G21: biotope management by grazing                                  |

|                                                                         |
|-------------------------------------------------------------------------|
| H15 = G31: biotope management by grazing and difficult conditions       |
| H16 = G33: biotope management by sheep grazing                          |
| H17 = G53: biotope management by sheep grazing and difficult conditions |
| <b><i>Other</i></b>                                                     |
| H18 = FFH: NA (unspecific, measures unknown)                            |
| <b>Schorfheide</b>                                                      |
| <b>KULAP</b>                                                            |
| S1 = 33: disadvantaged sites (no further information)                   |
| S2 = 311A: extensive with no mineral fertiliser                         |
| S3 = 311C: extensive with no fertiliser                                 |
| S4 = 313A: no mowing before 16 June                                     |
| S5 = 313B: no mowing before 1 July                                      |
| S6 = 413A: late and restricted management                               |
| S7 = 423B: late and restricted management                               |
| S8 = 613A: late and restricted management                               |
| S9 = 623B: organic farming                                              |
| S10 = 661: extensive on farm level                                      |
| S11 = 663: late and restricted management                               |
| S12 = 673: organic farming                                              |
| S13 = 763: late and restricted management                               |
| S14 = 773: organic farming                                              |
| S15 = 811A: extensive with no fertiliser                                |
| S16 = 812C: extensive management starts 1 July                          |
| S17 = 882: organic farming                                              |
| <b><i>Other</i></b>                                                     |
| S18 = contractual nature conservation: Mowing after 15 June             |

In accordance with Blüthgen et al. 2012, mowing and fertilisation were correlated such that grasslands that were mown more frequently also received higher amounts of fertiliser. High grazing intensity was correlated with low mowing frequency such that intensively grazed grasslands were not mown and vice versa (Fig. 3a). Nevertheless, many grasslands were mown pastures, i.e. they are both grazed by varying types of livestock and mown using different practices. Timing of mowing and grazing was also variable between years. Correlations between mowing and grazing and between mowing and fertilisation, were

stronger than those between fertilisation and grazing (Fig. 3). Correlations also differed between regions (Fig. 3). For example, in Hainich, there were weaker negative correlations between mowing and grazing compared to the Schwäbische Alb and Schorfheide.

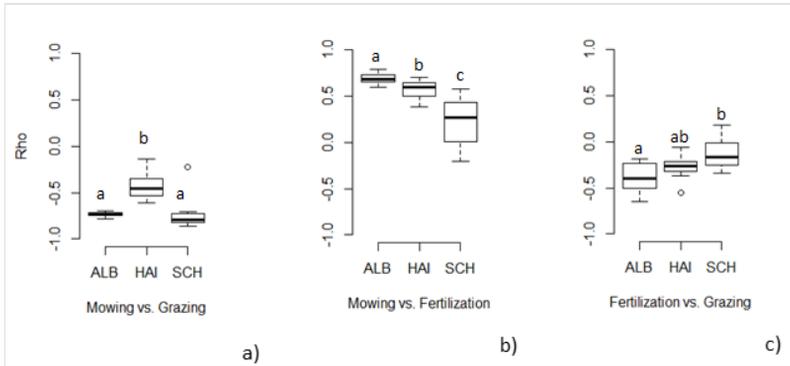


Figure 3. [doi](#)

Boxplots showing the Spearman correlation coefficients (Rho) between the different grassland management components, calculated separately for each 11 years. a) mowing vs. grazing, b) mowing vs. fertilisation and c) fertilisation vs. grazing of the three different regions (ALB- Swabian Alb, HAI- Hainich, SCH- Schorfheide). Boxes with the same letters are not significantly different at  $p > 0.05$  using pairwise Wilcoxon tests with Bonferroni correction.

The value of this dataset lies in the comprehensive and consistent description and characterisation of grassland management of 150 grassland plots over 11 years. Detailed accounting of land-use practices can only be achieved through intensive collaboration between land managers, land users and researchers, as done in our study. The accuracy of the answers given by farmers strongly determined the data quality. While in our study regions, all farmers had to keep records of management, mainly due to regulations of EU agricultural subsidies and cross-compliance obligations, the quality of the records still differed in some detail. To increase the accuracy of the data, members of the BE project additionally recorded data on grassland management over the years, such as cutting and fertilisation dates and maintenance activities. These observations were integrated when questionnaires were filled out together with the farmers. Values for organic fertilisation with slurry or liquid manure were probably less accurate than those for grazing and mowing, due to the fact that often no exact records existed for the amounts of material put on a particular site. Another source of uncertainty was the variation in N content of the material, which depended on many factors, for example, the livestock and the amount of added water etc. Here, we gave raw amounts of slurry and liquid manure, as well as the conversion factors to N per ha (Table 3).

The specific management data, presented here, have formed the basis for analyses of land use effects on the biodiversity and ecosystem functioning in grasslands (e.g. Allan et al. 2014, Manning et al. 2015, Klaus et al. 2018) Suppl. material 2. The data can be coupled with climate data and soil information to disentangle effects of management from effects of

abiotic conditions (Smit et al. 2008). Our data show that ecologists, interested in the effects of land use on biodiversity and ecosystem functions, should pay closer attention to measurements of land use itself, because management can strongly vary between years with significant long-term effects on the target variables measured in any particular year (Klaus et al. 2011, Kleinebecker et al. 2018).

**Quality control:** Quality assurance took place by checking the plausibility of the values by the grassland experts of the local teams in the following ways i) the answers of the land users were compared with own observations before entering the values in the data table. When uploading the data, the values were again checked ii) by the responsible person for the whole dataset looking at the single values and communicating uncertainties back to the interviewers. Further, unusual values were detected by auxiliary calculations, including minimum and maximum of these values and then double checked with the original hard copy version of the interview.

**Step description:** The original interviews are stored in hard copies and the information is entered in the joint data table.

The data are stored on the Biodiversity-Exploratories Information System (BExIS) (<http://doi.org/10.17616/R32P9Q>) at <https://www.bexis.uni-jena.de>. This version is in German due to the annual survey of the land users being carried out in German. The interviews of each grassland site is entered in a default excel data sheet and transformed via a visual basic script before it is uploaded to the joint dataset in BExIS.

Daily backups at the BE repository ensures the storage of the actual version of the land use data table. After project end, all datasets are intended to be stored via GFBio in a domain-specific long term archive.

## Geographic coverage

**Description:** The monitored 150 grassland plots are situated within three regions in Germany, with 50 plots in each region, covering a geographic gradient from the North-East (Schorfheide Chorin), Central Germany (Hainich Dün) and South-West (Schwäbische Alb). The grassland plots experience different land use according to the management.

## Taxonomic coverage

**Description:** We did not collect any organisms. During the interviews, the land users provided us with information according to their grassland management.

## Temporal coverage

**Notes:** We obtained land use data of grasslands between 2006 and 2016.

## Usage rights

**Use license:** Other

**IP rights notes:** The English version of the dataset is added as supplementary material.

The original, slightly extended, dataset is stored on the Biodiversity-Exploratories Information System (BExIS) (<http://doi.org/10.17616/R32P9Q>) at <https://www.bexis.uni-jena.de>. This version is in German due to the annual survey of the land users being carried out in German. Contact is possible via the Biodiversity Coordination Office ([beo@senckenberg.de](mailto:beo@senckenberg.de)). Due to sensitive information, such as personal data, the original dataset is not publicly available. Data access can be given by individual request for access. Guidelines can be checked in the data agreement of the BE: <https://www.bexis.uni-jena.de/PublicData/Files/PublicData-DataAgreement.txt>.

## Data resources

**Data package title:** BE\_landuse\_grassland\_2006-2016.csv

**Number of data sets:** 1

**Data set name:** BE\_landuse\_grassland\_2006-2016.csv

**Description:** The data table (628 KB) contains 1651 rows with records of eleven years on 150 grassland sites, including the variable headers and **116** (Suppl. material 1).

| Column label          | Column description                                                                                                                                                                              |
|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Study region          | ALB = Schwäbische Alb, HAI = Hainich, SCH = Schorfheide                                                                                                                                         |
| Year                  | Year of management                                                                                                                                                                              |
| Date                  | Date of interview                                                                                                                                                                               |
| PlotID                | Experimental Plot IDs formatted as (A H S)EG with consecutive numbering. Abbreviations are: A = Schwäbische Alb, H = Hainich, S = Schorfheide, E = Experimental Plot, G = Grassland, e.g. AEG01 |
| Drainage              | Measure of drainage and the description of the method (free text)                                                                                                                               |
| StartDrainage         | Starting year of grassland drainage if applicable                                                                                                                                               |
| WaterLogging          | Activities on water logging, e.g. for water regulation of fen soils                                                                                                                             |
| Agriculture1981       | Use of grassland between 1981 to 2006, i.e. (temporal) conversion of grassland into arable land                                                                                                 |
| SizeManagementUnit_ha | Size of the management unit in the survey year, often larger than the 50 x 50 m study plot itself                                                                                               |
| StartGrazing          | Starting month of the first grazing period in the survey year                                                                                                                                   |

|                           |                                                                                                                    |
|---------------------------|--------------------------------------------------------------------------------------------------------------------|
| EndGrazing                | End of the last grazing period in the survey year                                                                  |
| Livestock1 (2-4)          | Type of animal in first (second - fourth) grazing period                                                           |
| StartGrazingPeriod1 (2-4) | Starting month of first grazing period for livestock 1 (2-4)                                                       |
| EndGrazingPeriod1 (2-4)   | Ending month of first grazing period for livestock 1 (2-4)                                                         |
| Cattle6months1 (2-4)      | For Grazing period 1 (2-4): Number of cattle with an age up to 6 months (1 cattle up to 6 month = 0.3 LS* per day) |
| Cattle6-24months1 (2-4)   | For Grazing period 1 (2-4): Number of cattle with an age between 6 months and 2 years (=0.6 LS*)                   |
| CattlePlus2years1 (2-4)   | For Grazing period 1 (2-4): Number of cattle older than 2 years (= 1 LS*)                                          |
| SheepGoat1year1 (2-4)     | For Grazing period 1 (2-4): Number of sheep or goats with an age up to 1 year (= 0.05 LS*)                         |
| Pony1 (2-4)               | For Grazing period 1 (2-4): Number of ponies and small horses (= 0.7 LS*)                                          |
| Horse3years1 (2-4)        | For Grazing period 1 (2-4): Number of horses up to 3 years (= 0.7 LS*)                                             |
| HorsePlus3years1 (2-4)    | For Grazing period 1 (2-4): Number of horses older than 3 years (= 1.1 LS*)                                        |
| NbLivestock1 (2-4)        | For Grazing period 1 (2-4): Total number of livestock                                                              |
| LivestockUnits1 (2-4)     | For Grazing period 1 (2-4): Total sum of the livestock units                                                       |
| DayGrazing1 (2-4)         | For Grazing period 1 (2-4): duration of grazing (in days)                                                          |
| GrazingArea1 (2-4)        | For Grazing period 1 (2-4): size of area where livestock grazed                                                    |
| Mowing                    | Number of cuts per year                                                                                            |
| DateMowing1 (2-4)         | Date of the first (second-fourth) cut                                                                              |
| MowingMachine             | Type of machine which was used for mowing e.g. rotarymower, doubleknife, mulcher                                   |
| CutWidth_m                | Cutting width of the mowing machine                                                                                |
| CutHeight_cm              | Cutting height above soil level of the mowing machine                                                              |
| DriveSpeed_kmh            | Speed of the mowing machine, normally mean speed value is given                                                    |
| MowingConditioner         | Presence of conditioner, i.e. did the mowing machine have a conditioner to improve drying of the clippings         |
| Fertilisation             | Addition of fertiliser (not including dung depositions by livestock during grazing a parcel)                       |
| NbFertilisation           | Number of fertiliser applications per year                                                                         |
| DateFertilisation1 (2-7)  | Date of first (2nd-7th) fertiliser application                                                                     |
| Manure_tha                | Total amount of applied solid manure                                                                               |
| Slurry_m3ha               | Total amount of applied pig or cow slurry and biogas residues, respectively                                        |
| DescFert                  | Description of applied organic fertiliser                                                                          |

|                      |                                                                                                                                                                                    |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| orgNitrogen_kgNha    | Amount of organic nitrogen applied                                                                                                                                                 |
| minNitrogen_kgNha    | Amount of nitrogen applied, of mineral origin or the organic fertiliser mash from a bioethanol factory (see in DescFert)                                                           |
| totalNitrogen_kgNha  | Sum of applied mineral and organic nitrogen [kg N/ha]                                                                                                                              |
| minPhosphorus_kgPha  | Amount of phosphorus applied [kg P <sub>2</sub> O <sub>5</sub> /ha], of mineral origin or mash from a bioethanol factory (not given for other organic fertilisers)                 |
| minPotassium_kgKha   | Amount of potassium applied [kg K <sub>2</sub> O/ha], of mineral origin or mash from a bioethanol factory (not given for other organic fertilisers)                                |
| Sulphur_kgSha        | Total amount of applied Sulphur [kg S/ha]                                                                                                                                          |
| Maintenance          | Presence of maintenance measures                                                                                                                                                   |
| Levelling            | Maintenance to break up matted grass covers                                                                                                                                        |
| DateLevelling        | Maintenance: date of levelling                                                                                                                                                     |
| Rolling              | Maintenance: rolling to level unevenness                                                                                                                                           |
| DateRolling          | Maintenance: date of rolling                                                                                                                                                       |
| Mulching             | Partial mulching on some spots, e.g. rank patches. The material remains on site after mowing. We consider this not as a mowing event, as only a small part of the area is treated. |
| DateMulching         | Date of partial mulching                                                                                                                                                           |
| ShrubClearance       | Clearance to avoid shrub encroachment. We consider this not as a mowing event, as only individual shrubs are targeted.                                                             |
| DateScrubCl          | Date of shrub clearance                                                                                                                                                            |
| PlantProtectionAgent | Pesticide use: pesticides and herbicides. As pesticides in grasslands are very rare and only used for spot treatment, we do not have further information on this treatment.        |
| Seeds                | Seed addition                                                                                                                                                                      |
| DescSeeds            | Description of usage of the sowing                                                                                                                                                 |

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## Supplementary materials

### Suppl. material 1: BE\_landuse\_grassland\_2006-2016.csv [doi](#)

**Authors:** Juliane Vogt, Valentin H. Klaus, Ralf Lauterbach, Niclas Otto, Uta Schumacher, Cornelia Fürstenau, Katrin Lorenzen, Andreas Ostrowski, Wolfgang W. Weisser

**Data type:** utf 8 - txt

**Brief description:** The present dataset summarises management information collected from 2006 to 2016 for 150 grassland plots in three different regions of Germany. Data are based on annual interviews of the respective farmers, land owners or tenants involved in land management activity, using a standardised questionnaire.

Standardisation of missing values:

“NA” - if not known,

“0” if something was counted but was zero (e.g. no mowing or no cows or no maintenance). Some dates of maintenance or fertilisation are set to “0”. For example, in case maintenance measurements were applied on that plot during the year but not the specific one, i.e. mulching was applied and is listed with specific mulching date, but no levelling took place, therefore the levelling date is set to “0” instead of “-1” when generally no maintenance measures were carried out on that plot within the year.

“-1” if not possible, for example, if no mowing a “-1” has been given for the question about mowing machine.

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### Suppl. material 2: Bibliography of the land use index [doi](#)

**Authors:** Juliane Vogt

**Data type:** Text

**Brief description:** This library shows the citations of the LUI developed by Brüthgen et al. 2012.

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