### ­­­­Data description:

**Supplementary Table 1**: Overview about the used datasets in the analysis. We detail the parameters included in the main analysis by their type as response, main explanatory variable and covariate. All listed variables are part of datasets archived in the database BExIS (https://www.bexis.uni-jena.de/) from the Biodiversity Exploratory infrastructure project (https://www.biodiversity-exploratories.de/), the variables without entry for Dataset ID are general for all Biodiversity Exploratories contributing projects.

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| **Study parameters** | **Type of parameter** | **Number of plots** | **Year** | **Sampling method [units]** | **Dataset ID** | **Data Contact person** | **Project name** | **References** |
| Plant communities | Response | 150 | 2008-2018 | Vascular plants were sampled in 4 m × 4 m subplots in each plot once every year in early summer. Data on relative abundance of occurring species was used to calculate indices of α and β diversity. | 24247 | Ralph Bolliger | Botany (core) | *Datasets:*  Bolliger et al. 2020  *Application:*  e.g. Socher et al. 2012 |
| Arthropod communities | Response | 150 | 2008-2017 | Arthropods were sampled by sweep netting along a 150-m long transect  comprising three of the virtual borders of a site by conducting 60  double sweeps per site. Sweep netting was only conducted on days without rain, low wind speed and after morning dew had dried.  Plot-year combinations with insufficient sampling quality were removed from the data set following Seibold et al. (2019).  Division into trophic groups (herbivore, secondary consumer, decomposers) based on their known food source as adults (Gossner et al. 2015). Decomposers were excluded from the dataset as there were too few species to reliably estimate plot-level temporal trends.  Data on relative abundance of occurring species was used to calculate indices of α and β diversity for arthropod herbivores and secondary consumers. | 21969  26008  27706 | Wolfgang Weisser  Eric Allan | Arthropods (core),  Synthesis (core) | *Datasets:*  Weisser et al. 2023  Weisser et al. 2024  Allan et al. 2024  *Application:*  Simons et al. 2014, 2015  Gossner et al. 2015 Seibold et al. 2019 |
| Land-use-intensity | Explanatory variable | 150 | 2008-2018 | Based on the annual land-use questionnaires by the local management teams with land-owners complemented with observations by the local management teams, the land management compounds (mowing, grazing, fertilisation) were quantified. Mowing represents the number of cuts per year. Grazing was measured as number of livestock units \* days / ha, summed up for all grazing periods. Livestock units were calculated based on species group (cattle, sheep, goat, ponies, small horses, horses) and age. Fertilisation was measured as the amount of applied nitrogen within the fertiliser per ha (calibrated for different fertiliser types: manure of cattle or sheep, slurry of cattle or pig, mixed and biogas/digestate). Land-use intensity (LUI) was calculated following (Blüthgen et al. 2012): sqrt((Fertilisation / Global mean Fertilisation) + (Mowing / Global mean Mowing) + (Grazing / Global mean Grazing)) and subsequently calculating the mean for each year between 2008-2018. | 25086 | Katrin Lorenzen | LMT (core), BExIS (core) | *Datasets:*  Lorenzen et al. 2023  *Application:*  e.g. Blüthgen et al. 2012, Vogt et al. 2019 |
| Geographic position | Explanatory variable | 150 | 2008 | Decimal coordinates of exact plot centre [degrees]. | 20826 | Jens Nieschulze | LMT (core), BExIS (core) | *Datasets:*  Nieschulze et al. 2023  *Application:*  e.g. Gossner et al. 2016, Le Provost et al. 2021 |
| Year | Explanatory variable | 150 | 2008-2018 | Year of sampling to calculate temporal distance between samples as explanatory variable. | 25086 | Katrin Lorenzen | LMT (core), BExIS (core) | *Datasets:*  Lorenzen et al. 2023  *Application:*  e.g. Allan et al. 2014, Bazichetto et al. 2024 |
| Grassland permanency | Covariate | 150 | 2008 | Grassland permanency was calculated based on historical land-use maps quantifying the stability of grassland covers between 1820/50 (1820: Schwaebische Alb; 1850: Hainich, Schorfheide-Corin) and 2008 within 500 m radius of each plot | 31018 | Peter Manning | BEFup | *Datasets:*  Manning 2023  *Application:*  e.g. Le Provost et al. 2021, Scherreiks et al. 2022 |
| Grassland isolation | Covariate | 150 | 2009 | Grassland isolation was calculated as described in Gossner et al. (2016). Based on arial photographs with 40 cm resolution from 2008 we measured the cover of all potential grassland habitats within a 500 m radius of each plot; one minus this grassland proportion was used as an estimate of grassland isolation. | 18148 | Catrin Westphal | InsectScale | *Datasets:*  Westphal et al. 2017  *Application:*  e.g. Gossner et al. 2016, Le Provost et al. 2021 |
| Soil conditions (pH, soil nutrients) | Covariate | 150 | 2011 | 14 soil cores (5 cm diameter) in the upper mineral soil (0-10 cm depth) were taken in May 2011 as part of the soil sampling campaign along two 20 m transects (3 m distance) on all EPs. They were combined into a composite sample of each plot. 10 g of the sieved (<2 mm) and air-dried samples were analysed for pH (CaCl2) and soil nutrients (nitrogen stock, total soil nitrogen, organic carbon stock, soil inorganic carbon, soil organic carbon, soil C:N ratio) according to Birkhofer et al. (2012). These variables were summarized into the soil properties PCA (see methods). | 14446  14447  17086 | Ingo Schöning | Soil (Core) | *Datasets:*  Schöning et al. 2023  Schöning 2024a,b  *Application:*  e.g. Birkhofer et al. 2012 |
| Climatic conditions | Covariate | 150 | 2008-2018 | Climatic conditions were included through the annual sum of mean day air temperature at 2 m above surface and the number of rainy days in each plot. Temperature data were measured with data loggers on each plot. Information on rainy days is based on precipitation data from the German Weather Service (Deutscher Wetterdienst, <https://www.dwd.de/>). | 24766 | Falk Hänsel | Instrumentation & remote sensing (core) | *Datasets:*  Hänsel et al. 2024  *Application:*  e.g. Bazichetto et al. 2024 |

**Assembled data sets**

The assembled data set containing pairwise comparison of responses in plant and arthropod community diversity (alpha, beta) to spatial and temporal changes in land-use intensity and environmental covariates are archived in the Information System of the Biodiversity Exploratories Infrastructure Project (BExIS, https://www.bexis.uni-jena.de/) under the following names & IDs:

1. **Spatial diversity responses of plant communities:**

Spatial pair-wise comparisons of plant-community and land-use data (all

experimental plots 2008-2018) (ID: 31924)

1. **Temporal diversity responses of plant communities:**

Temporal pair-wise comparisons of plant-community and land-use data (all

experimental plots 2008-2018) (ID: 31921)

1. **Spatial diversity responses of arthropod communities:**

Spatial pair-wise comparisons of arthropod-community and land-use data (all experimental plots 2008-2017) (ID: 31926)

1. **Temporal diversity responses of arthropod communities:**

Temporal pair-wise comparisons of arthropod-community and land-use data (all experimental plots 2008-2017) (ID: 31925)

**References**

Allan, Eric, Oliver Bossdorf, Carsten F. Dormann, Daniel Prati, Martin M. Gossner, Teja Tscharntke, Nico Blüthgen, et al. 2014. “Interannual Variation in Land-Use Intensity Enhances Grassland Multidiversity.” *Proceedings of the National Academy of Sciences* 111 (1): 308–13. <https://doi.org/10.1073/pnas.1312213111>.

Allan, Eric; Penone, Caterina; Blüthgen, Nico; Boch, Steffen; Bonkowski, Michael; Goldmann, Kezia; Goßner, Martin; Wolters, Volkmar (2024): Assembled species information from grassland EPs (2008-2020) for multidiversity synthesis - November 2020. Version 6. Biodiversity Exploratories Information System. Dataset. https://www.bexis.uni-jena.de. Dataset ID= 27706

Bazzichetto, M., Sperandii, M.G., Penone, C., Keil, P., Allan, E., Lepš, J., Prati, D., Fischer, M., Bolliger, R., Gossner, M. M., & de Bello, F. (2024). Biodiversity promotes resistance but dominant species shape recovery of grasslands under extreme drought. Journal of Ecology, 112, 1087–1100. <https://doi.org/10.1111/1365-2745.14288>

Birkhofer, Klaus, Ingo Schöning, Fabian Alt, Nadine Herold, Bernhard Klarner, Mark Maraun, Sven Marhan, et al. 2012. “General Relationships between Abiotic Soil Properties and Soil Biota across Spatial Scales and Different Land-Use Types.” *PloS One* 7 (8): e43292. https://doi.org/10.1371/journal.pone.0043292.

Blüthgen, Nico, Carsten F. Dormann, Daniel Prati, Valentin H. Klaus, Till Kleinebecker, Norbert Hölzel, Fabian Alt, et al. 2012. “A Quantitative Index of Land-Use Intensity in Grasslands: Integrating Mowing, Grazing and Fertilization.” *Basic and Applied Ecology* 13 (3): 207–20. <https://doi.org/10.1016/j.baae.2012.04.001>.

Bolliger, Ralph; Prati, Daniel; Fischer, Markus; Hölzel, Norbert; Busch, Verena (2020): Vegetation Records for Grassland EPs, 2008 - 2018. Version 2. Biodiversity Exploratories Information System. Dataset. https://www.bexis.uni-jena.de/ddm/data/Showdata/24247?version=2

Gossner, Martin M., Thomas M. Lewinsohn, Tiemo Kahl, Fabrice Grassein, Steffen Boch, Daniel Prati, Klaus Birkhofer, et al. 2016. “Land-Use Intensification Causes Multitrophic Homogenization of Grassland Communities.” *Nature* 540 (7632). https://doi.org/10.1038/nature20575.

Gossner, Martin M, Nadja K Simons, Roland Achtziger, Theo Blick, Wolfgang H.O Dorow, Frank Dziock, Frank Köhler, Wolfgang Rabitsch, and Wolfgang W Weisser. 2015. “A Summary of Eight Traits of Coleoptera, Hemiptera, Orthoptera and Araneae, Occurring in Grasslands in Germany.” *Scientific Data* 2 (1): 150013. <https://doi.org/10.1038/sdata.2015.13>.

Hänsel, Falk; Forteva, Spaska; Wöllauer, Stephan; Nauss, Thomas (2024): Öffentlich verfügbare Klimadaten der Exploratorien / Open Climate Data of the Exploratories Project. Version 6. Biodiversity Exploratories Information System. Dataset. https://www.bexis.uni-jena.de/ddm/data/Showdata/24766?version=6

Lorenzen, Katrin; Vogt, Juliane; Teuscher, Miriam; Ostrowski, Andreas; Thiele, Jan (2023): Input Data for LUI Calculation Tool of all grassland plots since 2006 - revised 2019. Version 11. Biodiversity Exploratories Information System. Dataset. <https://www.bexis.uni-jena.de/ddm/data/Showdata/25086?version=11>

Manning, Peter (2023): Aggregated environmental and land-use covariates of the 150 grassland EPs used in "Contrasting responses of above- and belowground diversity to multiple components of land-use intensity". Version 5. Biodiversity Exploratories Information System. Dataset. https://www.bexis.uni-jena.de/ddm/data/Showdata/31018?version=5

Nieschulze, Jens; Schulze, Ernst-Detlef; Fischer, Markus; Ayasse, Manfred; Weisser, Wolfgang; Ostrowski, Andreas; König-Ries, Birgitta (2023): Basic Information of all Experimental Plots (EPs). Version 7. Biodiversity Exploratories Information System. Dataset. https://www.bexis.uni-jena.de. Dataset ID= 20826

Provost, Gaëtane Le, Jan Thiele, Catrin Westphal, Caterina Penone, Eric Allan, Margot Neyret, Fons van der Plas, et al. 2021. “Contrasting Responses of Above- and Belowground Diversity to Multiple Components of Land-Use Intensity.” *Nature Communications* 12 (1): 3918. https://doi.org/10.1038/s41467-021-23931-1.

Scherreiks, Pascal, Martin M Gossner, Didem Ambarlı, Manfred Ayasse, Nico Blüthgen, Markus Fischer, Valentin H Klaus, et al. 2022. “Present and Historical Landscape Structure Shapes Current Species Richness in Central European Grasslands.” *Landscape Ecology* 37 (3): 745–62. <https://doi.org/10.1007/s10980-021-01392-7>.

Schöning, Ingo; Trumbore, Susan (2023): Soil carbon and nitrogen concentrations - soil sampling campaign 2011, all experimental plots (EPs), 0-10 cm. Version 22. Biodiversity Exploratories Information System. Dataset. <https://www.bexis.uni-jena.de/ddm/data/Showdata/14446?version=22>

Schöning, Ingo (2024a): Soil pH - soil sampling campaign 2011, all experimental plots (EPs), 0-10 cm. Version 9. Biodiversity Exploratories Information System. Dataset. https://doi.org/10.25829/bexis.14447-1.10.28

Schöning, Ingo (2024b): Soil bulk density and organic carbon and total nitrogen stocks - soil sampling campaign 2011, all experimental plots (EP), 0-10 cm. Version 8. Biodiversity Exploratories Information System. Dataset. https://www.bexis.uni-jena.de/ddm/data/Showdata/17086?version=8

Seibold, Sebastian, Martin M. Gossner, Nadja K. Simons, Nico Blüthgen, Jörg Müller, Didem Ambarlı, Christian Ammer, et al. 2019. “Arthropod Decline in Grasslands and Forests Is Associated with Landscape-Level Drivers.” *Nature* 574 (7780): 671–74. https://doi.org/10.1038/s41586-019-1684-3.

Simons, Nadja K., Martin M. Gossner, Thomas M. Lewinsohn, Steffen Boch, Markus Lange, Jörg Müller, Esther Pašalić, et al. 2014. “Resource-Mediated Indirect Effects of Grassland Management on Arthropod Diversity.” *PLoS ONE* 9 (9): e107033. https://doi.org/10.1371/journal.pone.0107033.

Simons, Nadja K., Martin M. Gossner, Thomas M. Lewinsohn, Markus Lange, Manfred Türke, and Wolfgang W. Weisser. 2015. “Effects of Land-Use Intensity on Arthropod Species Abundance Distributions in Grasslands.” *Journal of Animal Ecology* 84 (1): 143–54. https://doi.org/10.1111/1365-2656.12278.

Socher, Stephanie A., Daniel Prati, Steffen Boch, Jörg Müller, Valentin H. Klaus, Norbert Hölzel, and Markus Fischer. 2012. “Direct and Productivity-Mediated Indirect Effects of Fertilization, Mowing and Grazing on Grassland Species Richness.” *Journal of Ecology* 100 (6): 1391–99. https://doi.org/10.1111/j.1365-2745.2012.02020.x.

Weisser, Wolfgang; Goßner, Martin; Pasalic, Esther; Lange, Markus; Türke, Manfred; Gallenberger, Iris; Simons, Nadja; Staab, Michael (2023): Sweep net samples from grasslands since 2008: Araneae, Coleoptera, Hemiptera, Orthoptera. Version 11. Biodiversity Exploratories Information System. Dataset. https://www.bexis.uni-jena.de/ddm/data/Showdata/21969?version=11

Weisser, Wolfgang; Seibold, Sebastian; Ambarli, Didem; Staab, Michael (2024): List of plots without complete sampling for sweepnetting of arthropods on grassland EPs 2008 to 2019. Version 6. Biodiversity Exploratories Information System. Dataset. <https://www.bexis.uni-jena.de/ddm/data/Showdata/26008?version=6>

Westphal, Catrin; Bellach, Michaela; Steckel, Juliane; Rothenwöhrer, Christoph; Steffan-Dewenter, Ingolf (2017): InsectScale - Landscape Coverage in plot surroundings from 250 - 2000m (2009). Version 2. Biodiversity Exploratories Information System. Dataset. <https://www.bexis.uni-jena.de/ddm/data/Showdata/18148?version=2>