European Vegetation Archive

Data Request Form

To obtain data from the European Vegetation Archive (EVA), including the ReSurveyEurope Database, please first enquire the EVA database administrator Ilona Knollová (ikuzel@sci.muni.cz) whether the data that meet your needs are available. If they are, please fill in the form below and submit it to Ilona or another member of the EVA Coordinating Board (or ReSurveyEurope Board if you ask for data from the ReSurveyEurope Database).

- Applicant's name:

  Blaise Binama

- Applicant's institutional address:

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- Applicant's e-mail:

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- Project title:

  Spatial and temporal patterns of herbicide resistance in weed species within agricultural fields in Germany

- Are you asking for core EVA data (non-repeated vegetation surveys) or for ReSurveyEurope data (repeated vegetation surveys)?

  Core EVA data

- Brief description of the aims and methods of the study:

  Herbicide resistance in weed species is a growing challenge in agricultural fields worldwide, including in Germany. The persistent and extensive use of herbicides, particularly within intensive monoculture systems, has led to the evolution of resistant weed populations. Since the first discovery of herbicide resistance in common groundsel (*Senecio vulgaris*) to triazine herbicides in 1968, many weed species have developed resistance to multiple herbicide groups (Powles and Yu, 2010). According to previous research, weeds have evolved resistance to 21 of 31 known herbicide action sites and 165 herbicides, posing a substantial challenge to sustainable agriculture (Carvalho-Moore et al., 2021).

  The evolution of herbicide resistance is primarily driven by genetic mutations that allow weed species to survive despite herbicide application (Heap, 2017). Since resistant genes can spread through hybridization between related species, there is the possibility of accumulating resistance genes in different biotypes (Schütte et al., 2017). In addition to genetic mutations, other factors contributing to the development of herbicide resistance include the overuse of similar herbicides, poor weed management practices, and environmental conditions such as soil type, temperature, and crop rotation practices (Powles and Yu, 2010). Despite the critical impact of these factors, there has been a lack of comprehensive spatial-temporal analysis of herbicide resistance trends in agricultural fields in Germany. Understanding these trends is essential for developing effective management strategies that mitigate the spread of resistant weed populations and ensure sustainable crop production.

The main aim of this study is to investigate the spatial and temporal patterns of herbicide resistance in weed species (native vs introduced) within agricultural fields across Germany. This research seeks to understand how herbicide resistance in weeds is influenced by various factors, including environmental conditions (such as soil type, climate, and land use history), agricultural practices (like crop types and herbicide application), and plant traits and genetic characteristics associated with herbicide resistance in weed species.

To achieve these aims, the study will integrate various datasets, including weed resistance records from 1978, weed species distribution data, crop types and arable land data from 1987, weed species traits and genetic data, as well as environmental data that spans historical, current, and future projections. To identify possible hotspots, we will focus on weed species distribution with coordinates and integrate this with the crop dataset to map weed resistance hotspots within Germany. To address the challenge of missing real coordinates for resistance data, we'll use spatial interpolation methods such as Kriging.

The study will analyze temporal trends in the emergence and spread of herbicide resistance, distinguishing between historical (1978-2000) and more recent (2001-onwards) periods. Time-series analyses and regression models will link resistance patterns to past environmental conditions, crop types, and herbicide usage. Predictive models such as Random Forests and Gradient Boosting Machines will be developed to forecast future resistance hotspots based on current data and future environmental projections. These models will consider changes in climate, crop patterns, and land use to predict shifts in resistance patterns. Multiple climate models and herbicide application scenarios will be used to address uncertainty and variability in future predictions.

Additionally, the study will use weed traits and detected genes associated with herbicide resistance to predict potential weeds that have not yet been detected with resistance. By identifying species with similar genetic and phenotypic traits to known resistant species, the study will estimate which other species are likely to develop resistance in the future.

The importance of different environmental, genetic, and agricultural factors in predictive models will be assessed to identify the most influential factors in resistance emergence. Findings from the models will inform agricultural managers and policymakers about regions at high risk for developing resistance and provide guidelines for herbicide application and land use planning to mitigate resistance spread.

References

1. Carvalho-Moore, P.; Rangani, G.; Heiser, J.; Findley, D.; Bowe, S.J.; Roma-Burgos, N. PPO2 Mutations in Amaranthus palmeri: Implications on Cross-Resistance. Agriculture 2021, 11, 760.
2. Heap, I. The International Survey of Herbicide Resistant Weeds. Available online: http://www.weedscience.org/Account/FAQ.aspx#cite (accessed on 26 January 2023).
3. Powles, S. & Yu, Q. (2010). Evolution in Action: Plants Resistant to Herbicides. Annual review of plant biology. 61. 317-47. 10.1146/annurev-arplant-042809-112119.
4. Schütte, G.; Eckerstorfer, M.; Rastelli, V.; Reichenbecher, W.; Restrepo-Vassalli, S.; Ruohonen-Lehto, M.; Saucy, A.-G.W.; Mertens, M. Herbicide Resistance and Biodiversity: Agronomic and Environmental Aspects of Genetically Modified Herbicide-Resistant Plants. Environ. Sci. Eur. 2017, 29, 5.

- Will someone else be involved in data editing or analysis in addition to the applicant?

  Dr. Johan, Prof. Dr. Stefan Scholten

- Estimated time of delivery of results (e.g., manuscript submission):

  End of 2025

- Geographic area needed (e.g., countries or range of geographic coordinates):

  Germany

- Do you need plots to be georeferenced? If so, what is the minimum accuracy of plot location (in metres or kilometres) needed for your project?

  Yes, with kilometer grid accuracy

- Vegetation types needed (syntaxa):

  All plot data from arable in Germany from 1978 onwards. Specifically, data based on syntaxonomic classes (Chenopodietea, Papaveretea rhoeadis, Sisymbrietea, and

Digitario sanguinalis-Eragrostietea minoris sensu) and EUNIS habitat types corresponding to arable land.

- Other data selection criteria:

No

- Envisaged publications:

1-2 papers in Scientific Journals

- Data deposition. Some journals require data used for the analysis to be stored in a public repository to ensure the repeatability of the analysis. According to EVA Rules, you are not allowed to store the original vegetation-plot data obtained from EVA. However, if you plan to publish in such a journal, you may deposit a reduced EVA-derived dataset that (1) would make it possible to repeat the analysis published in the paper and (2) does not contain any information not used in the analysis. For example, such a dataset can contain only a subset of species (e.g., only angiosperms or only neophytes), or replace species names with codes, or replace species cover values with presences/absences, or remove all the header data, or replace the exact plot coordinates by coarse grid-cell coordinates etc. If you plan to deposit reduced information from vegetation plots, please describe here what might be deposited. If the project developed so that you needed to deposit more information than specified here, you would need to ask specific permission from the Custodians of the EVA databases used in your analysis before the dataset is deposited.

Given the limitations set by EVA, we propose the following approach to deposit a reduced EVA-derived dataset: The dataset will include only the subset of species directly relevant to the study, specifically those weed species associated with herbicide resistance and agricultural fields in Germany. To further minimize sensitive information, species cover values (quantitative data on species abundance) will be converted into presence/absence data. This simplification allows for the analysis to be repeated while reducing the level of detail provided about specific vegetation plots.

- Plant trait data from the TRY consortium. If you plan to combine your analysis of vegetation-plot data with plant trait data, you can also request a dataset of 18 gap-filled traits for a large number of plant taxa prepared by the TRY consortium. These traits include Leaf area, Specific leaf area, Leaf fresh mass, Leaf dry matter content, Leaf C, Leaf N, Leaf P, Leaf N per area, Leaf N:P ratio, Leaf delta15N, Seed mass, Seed length, Seed number per reproductive unit, Dispersal unit length, Plant height, Stem specific density, Stem conduit density, and Conduit element length. This dataset can be provided to you by the EVA manager together with the vegetation-plot data. If you use this dataset, you must inform about your project the TRY data contributors who might be potentially interested and invite them as potential co-authors, assuming they will make an intellectual contribution to your paper. The list of the TRY data contributors will be sent to you together with the gap-filled trait dataset.

YES

- Specification of the co-authorship arrangements in publications based on the requested data. Note that the EVA Rules recommend that co-authorship is offered to a representative of each database providing data that are particularly important for the project (e.g., a relatively large proportion of the final dataset used in the analyses or data from unique vegetation types or under-represented geographic areas). This database representative should be an expert in the topic of the project (not necessarily the custodian or deputy custodian), and this person should contribute to the project more than just by providing the existing data, e.g. by intellectual contribution to the concept of the paper, preparation of new data, or helping with data analysis, interpretation of the results or writing parts of the paper (see the IAVS Code of Professional Ethics: https://www.iavs.org/page/governance_code-ofproffesional-ethics). The project leader should enable active participation by regularly informing potential co-authors about the progress of the project from its early stage. The project leader should also make final co-authorship arrangements based on the real input of the individual contributors.

We will provide an offer of co-authorship, in accordance with EVA guidelines, to representatives of databases that are particularly significant to our analysis (i.e., those that contribute at least 1% of the final dataset). However, we anticipate intellectual contributions beyond data provision, such as participation in data analysis or manuscript writing/revision. Additionally, individuals with significant contributions to data analysis (see above) or who supply or analyze other data (gene and trait data) may be asked to collaborate as co-authors.

- Eligibility of the applicant to receive EVA or ReSurveyEurope data. Specify to which EVA or ReSurveyEurope database the applicant has contributed; if the applicant is not the custodian or deputy custodian of an EVA or ReSurveyEurope database, give a name of a custodian or deputy custodian who supports this data request.

Blaise Binama is not a contributor to the EVA data. His application is supported by Prof. Dr. Florian Jansen a custodian of EVA database (EU-DE-001) from the University of Rostock, who is a member of the EVA Board.

- I agree with the terms of EVA Data Property and Governance Rules as approved on 26 May 2012 (http://euroveg.org/download/eva-rules.pdf).
- If I ask for ReSurveyEurope data, I agree with the terms of ReSurveyEurope Data Property and Governance Rules as approved on 6 April 2022 (http://euroveg.org/download/resurveyeurope-rules.pdf).
- In any result obtained based on EVA core data (non-repeated vegetation surveys), I will cite the EVA report article (Chytrý et al. 2016; https://doi.org/10.1111/avsc.12191). In any result obtained based on the ReSurveyEurope data (repeated vegetation surveys), I will cite the ReSurveyEurope report article as soon as it is published. In addition, I will cite individual source databases used in my project (if possible, in the list of References; if not possible, at least as a list of databases in the electronic supplementary material).
- If I ask for the plant trait data from TRY, I agree to invite to my project the TRY data contributors following the list received from the EVA database manager.

[Göttingen, 27 August 2024]

[Blaise Binama]