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Introduction

- Despite clearly documented benefits of agroforestry (AF), implementation remains low. This is particularly prevalent in many temperate regions.
- Lack of direct local evidence on AF systems deters stakeholders such as farmers and policy makers from investing in systems such as AF.
- Case study: German state of North Rhine-Westphalia (NRW), a region largely lacking in registered AF systems.
- Strategy: Creation of a suitability matrix to allow for comparisons between varying temperate site conditions from published studies to those of NRW.
- Suitability Matrix: A matrix reflecting our confidence ratings of similarity between site conditions from compiled studies to NRW. Confidence ratings were quantified to assign weighted land equivalent ratio (LER) values based on suitability to predict productivity outcomes for AF systems in NRW.

Methodology

- Compiled detailed biophysical characteristics for the state of NRW.
- **4132** studies collected using the search query for comparison to NRW: **"agroforestry" + ("land equivalent ratio" OR "LER" OR "yield") + "temperate" -"Africa" -"Mediterranean" -"tropical" -"arid" -"desert"**
- Screened for keyword "LER" (initial analysis) – narrowed to 132 studies.
- Papers reviewed for LER data and biophysical conditions of study site.
- Resulted in 12 articles and 18 study sites relevant for further analysis (Figure 1).



Figure 1. Global distribution of temperate agroforestry studies used for estimating land equivalent ratio (LER) outcomes in North Rhine Westphalia. Yellow markers: Location of study sites; Red outline: North Rhine Westphalia.

- Köppen-Geiger climate classification, World Reference Base for Soil Resources, growing period parameters were supplemented using predictive models.^{1,2,3}
- Site specific information was then run through two suitability matrices to weight the relevance of the study sites to NRW conditions. Each matrix reflects one of the two major Köppen-Geiger regions of NRW; Cfb (temperate oceanic climate) and Dfb (warm summer humid continental climate).
- Weighted LERs were analysed and a probability distribution was run with R (including ggplot and MASS).^{4,5,6}

Table 1. Confidence ratings for the site conditions of our 18 study sites based on the Dfb climate regions of NRW.

NRW Biophysical Conditions	Europe													North American			Oceania	
	Bakovo, Croatia	Taastrup, Denmark	Kirscheandern, Germany	Neu Sacro, Germany	Wendhausen, Germany	Gödöllő, Hungary	Przygorzele, Poland	Petrova, Romania	Cirencester, U.K.	Leeds, U.K.	Silsoe, U.K.	Suffolk, U.K.	Bangor, Wales	St-Edouard, Canada	St-Basile, Canada	Ashland City, U.S.A.	Fayetteville, U.S.A.	Carnaham, Australia
Cfb Climate	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Luvisol	-	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cambisol	●	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Umbrisol	-	-	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Podzol	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Textural Limitation	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Study Tree(s)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Study Crop(s)	-	●	-	●	●	●	-	-	●	●	●	●	-	●	●	-	-	-
Study Pasture	●	-	●	-	-	-	●	●	-	-	-	-	●	-	-	●	●	●
Growing Period	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

● High Confidence ● Medium Confidence ● Medium-low Confidence

Results and Discussion

- The confidence ratings for the study sites used are shown in Table 1.
- The distributions for both the Cfb and Dfb climate assessments were very similar, with the Dfb climate showing a slightly higher LER distribution (Figure 2).

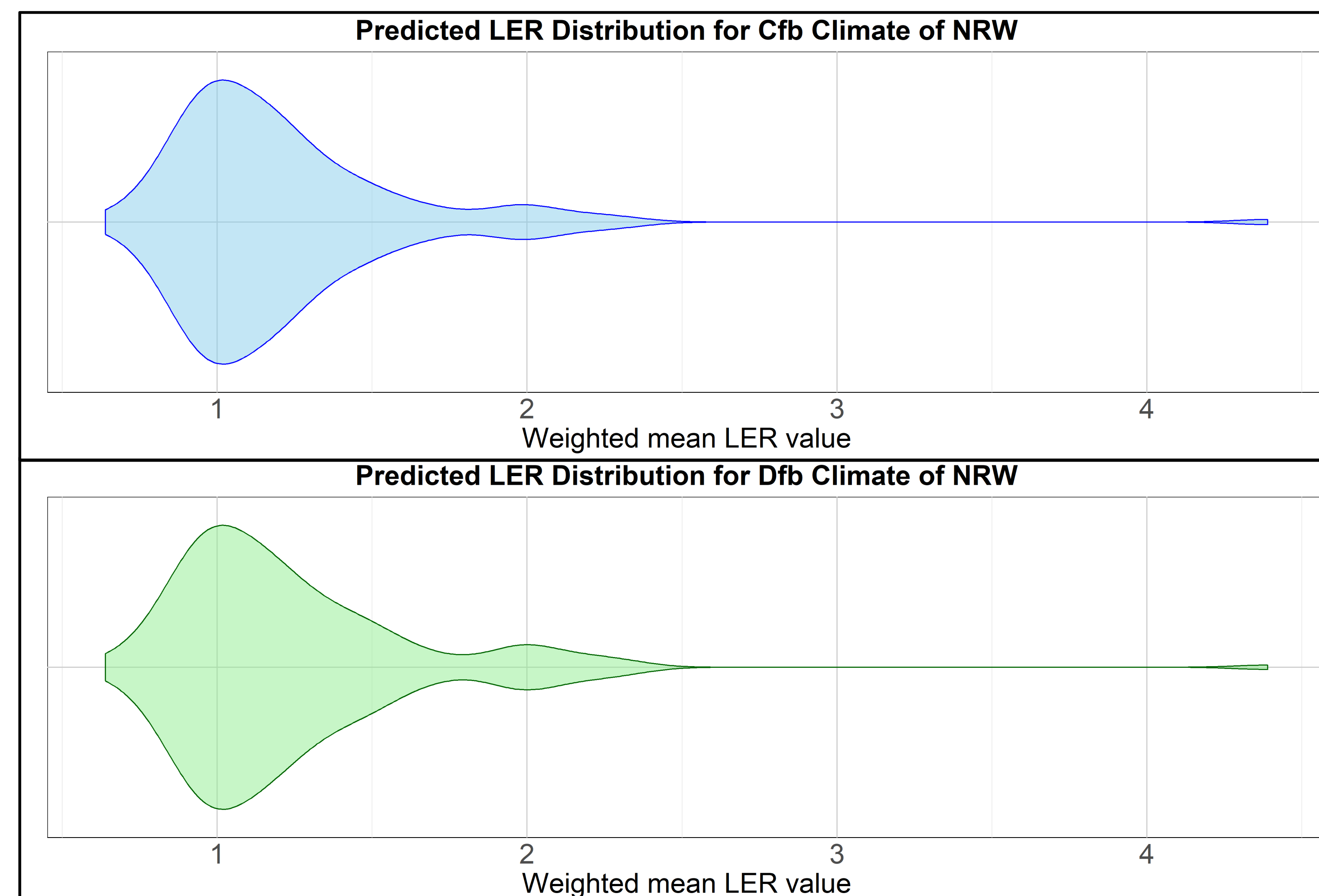


Figure 2. Predicted LER outcomes for NRW based on weighting of LER values from temperate study sites.

- In both climate regions, **the mean predicted LER outcomes for Cfb and Dfb climates had mean values above 1 (1.220 and 1.238, respectively).**
- The higher predicted LER value and distribution in the Dfb climate might be due to more studies originating in Dfb climates (higher weightings).
- Our findings suggest that **biophysical conditions in NRW would result in higher land productivity through agroforestry** when compared to lands being utilized for agriculture, orchards or timber production alone.
- Limitations of small sample size. More robust dataset will be compiled in subsequent research.

Future Aims and Goals

- Systematic review and screening of all articles from search query.
- Further disaggregate NRW into subregions for greater precision.
- Inclusion of studies with measurements of partial system productivity (crop, pasture, woody). Develop methods to apply these measurements to inform complete system productivity.
- Adapt the matrix to account for the future climate change scenarios and the potential effects on agroforestry systems in NRW.
- Analyse system designs and treatments to determine if there are trends or choices resulting in increased productivity.
- Create feasible site-specific designs for NRW that optimize productivity outcomes under local biophysical and socio-economic constraints.

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