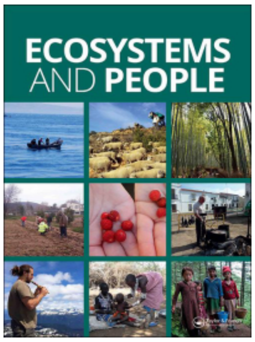

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Where and why is landscape considered valuable? Societal actors' perceptions of ecosystem services across Bavaria (Germany)

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ABSTRACT

Balancing the demand for ecosystem services (ES) with available supply is one key challenge for decision making in sustainable landscape management. ES demand is context-specific. Therefore, the assessment of perceptions articulated by multiple societal actors in different regions can help to identify differences and commonalities in predominant preferences for landscapes and their ES. The goal of this study was to investigate four societal actor groups (citizens, farmers, foresters, nature managers) in 12 study regions across Bavaria, Germany, with respect to their valuation of landscapes and ES provided by certain landscape elements. The 2,438 participants mapped specific locations and selected landscape elements that they perceived as valuable, and further elaborated on this value in open statements. We applied qualitative content analysis, word frequency analysis, spatial location-density analysis, and statistical testing. The perceived value of landscape elements for ES differed across actor groups and regions. Preference for landscape elements was driven by topography and land use and was significantly associated with actor groups. The most apparent differences occurred between farmers and nature managers. Generally, participants preferred forests, water bodies, natural landscapes, and distinct geographical structures. The landscape was mostly valued for its habitat, diverse wildlife, recreational purposes, climate-regulating functions, and provisioning of water and food. We conclude that, although differences exist among societal actors, the study respondents highly valued the importance of functioning and diverse ecosystems. The high perceived value for many ecosystem services and species protection suggests that ambitious policy measures are supported by different societal actors.

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1. Introduction

Understanding the demand for ecosystem services (ES) is essential for meaningful decision making on land management by policy-makers and land managers (Casado-Arzuaga et al. 2013; Wolff et al. 2015). It is a necessary complement to knowing the distribution of ES supply and potential ES stock (Wolff et al. 2015). ES demand can be quantified by focusing on usage and consumption utilizing monetary and biophysical data (Burkhard et al. 2012). Additionally, ES values subjectively assigned by people can be used as a proxy for ES demand, based on peoples' perceptions, desires, preferences, and other socio-cultural attributes (Martín-López et al. 2012; Chan et al. 2016). Contrary to monetary approaches, this socio-cultural ES valuation is found to be more suitable to access abstract, intangible or elusive values of nature and its ES (Jacobs et al. 2018). It better reflects local and individual perceptions across differing socio-demographic contexts and belief systems (Scholte et al. 2015; Faccioli et al. 2020). Additionally, this approach can highlight utilitarian as well as altruistic values (Casado-Arzuaga et al. 2013) and captures intrinsic importance aside from direct use or gain (Johnston et al. 2003; Wolff et al. 2015). Besides studying intrinsic values (illustrating the inherent value of nature as an end itself) and instrumental values (assigned to substitutable benefits people obtain from nature), it has gained momentum to also unravel relational values. Relational values illustrate the meaningfulness of relationships among people and among people and nature (e.g. recreation, sense of place) (Chan et al. 2016; Arias-Arévalo et al. 2017). Furthermore, the assessment of values and perceptions of ES articulated by multiple actors can help to identify predominant preferences, interdependencies and differences, which are especially helpful for sustainable landscape management on local and regional scales (Plieninger et al. 2013; Shoyama et al. 2013; Lamarque et al. 2014; Zoderer et al. 2019).

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Perceptions of ES have already been widely studied and are influenced by personal values interacting with external environmental factors. Landscape properties like topography, dominant ecosystem (Schirpke et al. 2018), and land use (Chan et al. 2012) have been identified to be key drivers of ES perception. Other factors that influenced perceptions of ES included ES supply at hand, prior knowledge on ecosystem functioning (Lamarque et al. 2014), and socio-economic backgrounds like demography, ethnicity, education, and affiliation to social groups (Martín-López et al. 2012; Faccioli et al. 2020; Schmitt et al. 2021).

Many studies assessed values and perceptions of ES with choice experiments or utilize scaling systems (Iniesta-Arandia et al. 2014; Ainscough et al. 2019; Dietze et al. 2019). Both can provide comparable, reproducible, and repeatable study designs and may obtain evidence for apparent preferences. However, they restrict participants to a predefined set of choices that may not meet respondents' needs (Geer 1991; Kane and Schuman 1991). Besides quantitative methods, qualitative analyses allow interviewees to express their attitudes and thoughts more freely and spontaneously, without limiting or potentially steering answers through set restrictions (Schuman and Presser 1979). These qualities can result in more diverse responses (Reja et al. 2003). Qualitative approaches have been increasingly used to unravel the plural values of nature and ES (Jacobs et al. 2018).

In studies on socio-cultural ES valuation with a spatial component, collaborative mapping has emerged as a widely used tool (García-Nieto et al. 2015). The use of such public participation GIS (PPGIS) allows to assess the spatial distribution of ES according to perceptions and knowledge of different stakeholders (Jacobs et al. 2018). Actors were asked to identify which services were useful and valuable to them and indicate these on a map (Wolff et al. 2015). Assessing the spatial distribution of ES values can reveal the relationship among people and their surroundings. This is important for landscape management and for identifying potential land use conflicts (Brown and Fagerholm 2015; De Vreese et al. 2016; Fagerholm et al. 2019). Although there is growing literature on the assessment of perceptions and values of ES attributed by different stakeholder groups, there is still a need to further analyze combinations of active stakeholders (e.g. farmers, foresters) and the public outside of the agricultural sector (Walz et al. 2019). This is important because such a large-scale approach can channel local preferences into regional landscape planning. In this study, we integrate spatial and comprehensive qualitative analyses at the landscape context intending to capture distinctive perceptions as well as patterns. With this approach, the study aims to contribute to existing knowledge on interdependencies of ES perceptions and landscape using a large-scale survey across different study sites.

The goal of this paper is to investigate the societal actors' perceived value of landscape elements and associated ES. We do not differentiate perceived values into instrumental, intrinsic, and relational domains (Chan et al. 2016), but rather along the concept of ES. Here, perceived values are defined in line of social values, which are 'values perceived by the stakeholders, based on how and where respondents both experience and value the landscape they engage with' (Petrakis et al. 2020). We specifically aim to (i) identify differences among farmers, foresters, nature managers, and citizens regarding the landscape elements they selected and (ii) investigate the perceived values relating to ES associated with those elements. The research hypotheses are that perceived values driving selection of landscape elements and openly stated reason for their selection vary among societal actors' groups, in line with previous research. We suggest that provisioning services are perceived to be most important to farmers as land managers, while habitat ES and biodiversity are favoured by nature managers (Iniesta-Arandia et al. 2014; Bidegain et al. 2019; Zoderer et al. 2019). We further hypothesize that perceived values vary regionally, as perceptions regarding ES have been found to be context- and site-specific (Costanza 2000), and prone to local differences (Lamarque et al. 2011).

2. Material and methods

2.1. Study area

We conducted our research in Bavaria, Germany (Figure 1). Bavaria is a federal state spanning 70,542 km^2 of surface area (StMWi 2019) and populated by approximately 13 million inhabitants (LfStat 2021). Land cover is composed of agriculture (46.5%), forests (35.3%), urban areas (12.0%), and other land cover (i.e. vegetation-free, peatland, swamp, and water). Land use intensification and habitat loss historically impacted biodiversity and ES in such a typical Central European landscape. The regional composition of land cover differs according to population density, with the highest share of urban area located around the metropolitan regions of Nuremberg and Munich (StMELF 2018; StMWi 2019). Bavarian landscapes are shaped by a diverse topography, ranging from lowlands, river valleys, and low mountain ranges to the German Alps up to 2,969 m.a.s.l. Moreover, Bavaria hosts two National Parks, two Biosphere Reserves, 18 Natural Parks, and more than 2,000 protection sites of national and international categories (Bayerische Staatsregierung 2021; LfU 2021). It is particularly interesting to study perceptions of valuable locations of landscapes in

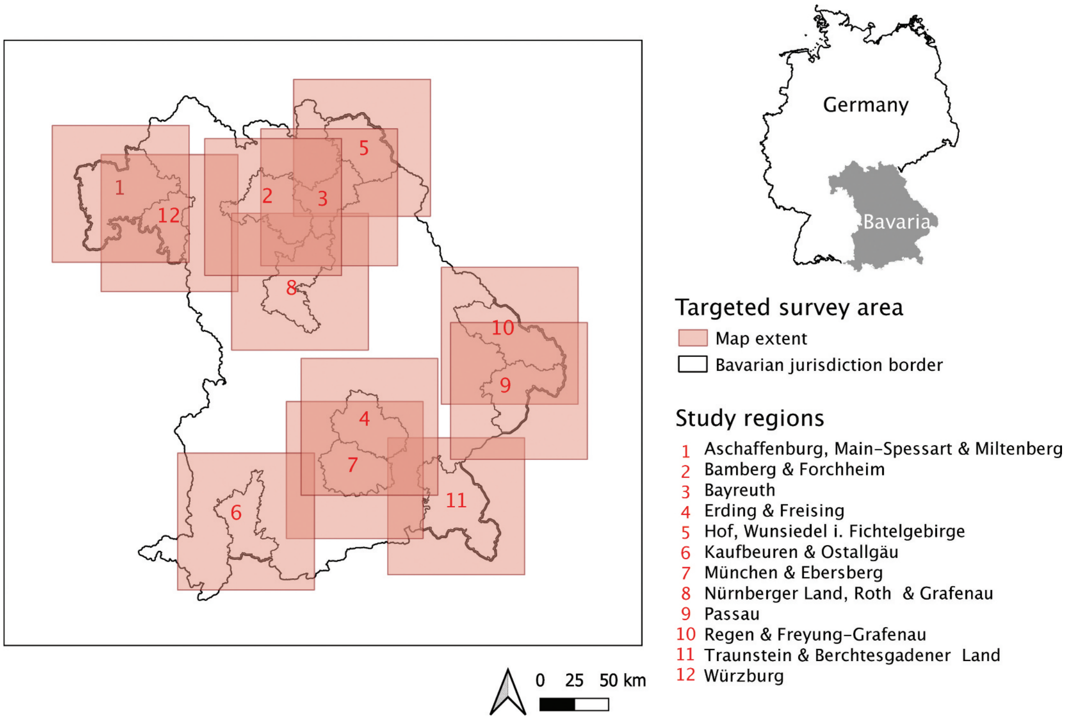


Figure 1. Study area in Bavaria (Germany). Twelve sampled study regions based on jurisdictional districts and extent of maps (red squares) provided in the mapping task of the survey.

Bavaria, Germany, as a recent referendum on more biodiversity protection on agricultural land was held in 2019 (Hartmann et al. 2021).

2.2. Data collection and sample characteristics

From January to July 2020, we conducted a survey involving four different societal actor groups, namely: citizens, farmers, foresters and nature managers (i.e. professionals and volunteers working with near-natural areas). These actor groups were selected because they demand ES or have a direct influence on the supply of ES with land use decisions. The sampling strategy covered a gradient of land cover (i.e. agricultural, near-natural, and natural) as well as climate (mean air temperature between 5.6 and 9.8°C and annual precipitation ranging from 614–1820 mm) across Bavaria (see Redlich et al. (2021) and Figure S1). Data collection methods differed slightly between societal actor groups (for more details on the survey, refer to Thiemann et al. (2022). For citizens, 44,244 households in the study regions received a postal card with an invitation to take part in the online survey. We addressed farmers (i) in person at their respective Offices of Agriculture, Forestry and Nutrition during an application phase for subsidies for agri-environmental schemes, and (ii) per e-mail via offices of the Bavarian farmers association of selected districts. In both cases, they filled in the same online survey either on tablet computers we brought to the offices or on their computer at home. Foresters received an e-mail invitation to the online survey via the same offices as farmers or the Bavarian State Forest Enterprise. To contact nature managers, we sent survey links to coordinators and central authorities that they forwarded to practitioners on the local level. All surveys were conducted anonymously using the survey software Qualtrics and analyzed separately from personal contact data optionally provided by respondents). At the end of the questionnaire, participants agreed with their answers being stored and used for scientific purposes.

As part of a larger survey on nature perception and ecosystem services, we asked participants to indicate valuable landscape elements and expand on their perceptions. The complete questionnaire had the following sections Q1: introduction, Q2: personal relationship to nature and landscape, Q3: perceived importance of ES, Q4: knowledge on ES, Q5: land use trade-offs, Q6: spatial preferences and values of ES, Q7: enhancement of ES, Q8: perception of climate change in – general, Q9: perception of climate change – on own land, Q10: climate change adaptation, Q11: farm/forest/grassland management, Q12: socio-economic data, Q13: follow-ups and& feedback. All questions in the survey were optional.

In this paper, we focused on sections Q6, Q12, and Q13. Questions applied in the survey consisted of semi-structured and open-ended inquiries, choice experiments, and a mapping task. The mapping task aimed at collecting data on allocation and perceptions of valuable landscapes for each of the 12 study regions (Figure 1 and Figure S2). The mapping task was split into three parts. First, participants were asked to indicate where they consider landscape to be especially valuable within their respective study region. For each participant, we provided a Google Satellite image (100 km x 100 km) depicting their respective study region. Each participant could select up to seven locations by clicking on the map to place points (see Figure S3 for an example). Due to their square extent, some maps exceeded their corresponding jurisdictional district border and, in some cases, even the state border of Bavaria. Most maps had considerable overlaps with neighboring regions. This was necessary for properly reflecting the above-mentioned land use and climate gradients and at the same time for offering respondents a sufficiently large region to select valuable locations. In the second part of the mapping task, participants were asked to identify the landscape elements predominantly associated with their selected locations (for at least three of them). A list of ten landscape elements was provided, consisting of forest, grassland, field, river, lake, mountain, swamp/wetland, settlement, park, and other (to be specified by respondents). We chose to focus on landscape elements as these can be easily identified on the map. In a specific configuration, these landscape elements would form landscape types. In the third and final part, participants were asked to elaborate on the reasoning behind their selections. This open-ended question asked respondents to give a short explanation as to why they considered these specific locations and associated landscape elements to be valuable (Figure S4).

In the mapping task a share of 74.4% of the 3,295 survey respondents participated. On average, participants indicated three to four valuable locations of,and 57.2% ($n = 1{,}395$) of participants marked the maximum of seven possible locations (Table S1). A total of 13,963 locations were selected across the study area, 6% of which were located outside of Bavarian State jurisdiction (803 locations, see Figure 2) or beyond the provided study region extent (18 locations).

In the second part of the mapping task, 95% of participants ($n = 2{,}326$) associated one or more landscape elements with their selected valuable locations. Participants selected four landscape elements on average and 5,834 elements in total. In the third part of the mapping task, 67% ($n = 1{,}196$) of participants who selected one or more landscape elements further elaborated on the reasoning behind their selection (Table S2).

The largest societal actor group participating in the mapping task, primarily due to the initial in-person approach, were farmers (54% of overall participation, with 1,322 surveys analyzed and 7,265 locations selected), followed by citizens (35% of overall

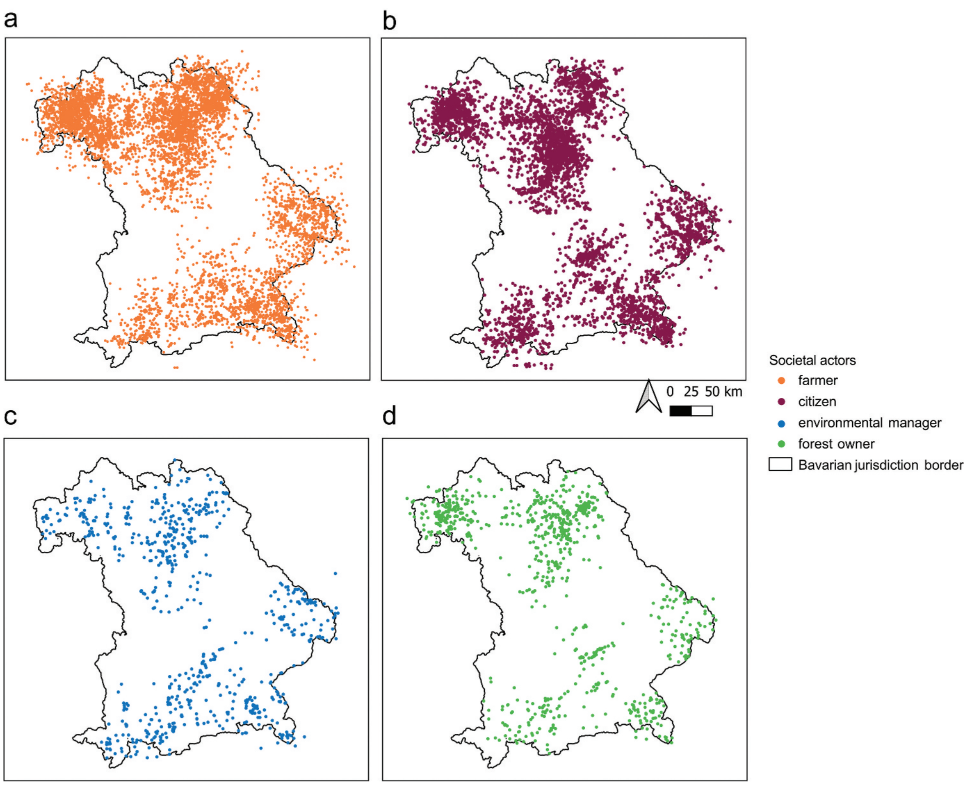


Figure 2. Spatial distribution of valuable locations selected across the study area, displayed for each societal actor group, total locations = 13963, inside Bavaria = 13160. (a). Total of locations selected by farmers (total locations = 7265, inside Bavaria = 6788). (b). Total of locations selected by citizens (total locations = 5114, inside Bavaria = 4848). (c). Total of locations selected by nature managers (total locations = 737, inside Bavaria = 704). (d). Total of locations selected by foresters (total locations = 847, inside Bavaria = 820).

participation, with 860 surveys analyzed and 5,114 locations selected). Nature managers' and foresters' participation was marginal in comparison. 114 nature managers selected a total of 737 locations, while 142 foresters participated and selected 847 locations (Figure 2). For the second and third part of the mapping task, citizens accounted for the largest amount of available data, with 46% on both landscape elements selected (elements = 2,725) and statements given (statements = 1,788) (Table S3). There were also regional differences in sample size. Farmers' share of selected locations was highest for the majority of the study area, but in four study regions, the share of citizens' selections was higher (Erding & Freising, Kaufbeuren & Ostallgäu, Nürnberger Land, Roth & Schwabach, and Passau) (Figure S5).

2.3. Data analysis

For this paper, we analyzed the data obtained from the mapping task of the survey. These data comprise the locations of valuable landscapes, landscape element selection in comparison to Corine Land Cover Classes (Table S4), as well as open statements on perceptions related to ES. In the section below, we focus on the qualitative content analysis of the open statements. For details on other methodologies (i.e. analysis of valuable locations and of valuable landscape elements), consult the supporting material.

We conducted a qualitative content analysis with the responses to the open-ended question addressing the reason why the respondents perceived a specific landscape element as valuable. To identify the central themes of perceived value, we developed codes both deductively and inductively (codes listed in Table 2) following Mayring (2015). We started with a deductive approach using a set of codes of predefined ES (ES): *provisioning ES* ($n = 7$), *regulating ES* ($n = 10$), *cultural ES* ($n = 4$), *and habitat ES* ($n = 1$). The initially included ES corresponded to the selection used in another question item in the same survey. The chosen ES classification is largely based on Rabe et al. (2016) but includes categories of other classifications (TEEB 2010; IPBES 2017) and some own adaptations (see Table S5 for further details on code creation and limitations of code assignments). For example, ES such as primary production and soil formation are not labelled as an ES any more in the most recent classifications (IPBES 2017), because they describe underlying functionality of ecosystems, but are not necessarily a direct ecosystem service to people. We therefore decided to include habitat services and a separate category for biodiversity. We included all statements that either explicitly stated an ecosystem service (e.g. *important for climate protection*, *filtering of groundwater*) or could be associated with one (e.g. *air*, often mentioned for the landscape element *forest*, was coded as *air purification*). We assigned statements with the best fitting code for the stated content, even if only keywords (without further explanations) were stated by survey respondents. We used multiple codes for one statement if they were equally applicable (e.g. *green lung* for the landscape element *forest* was assigned the codes *air purification* as well as *regulation of global climate*; some statements about fodder production were assigned both the codes *fodder production* and *outdoor animal production*). Occasionally, the selected landscape element of a statement was examined to facilitate interpretation of meaning and guide the coding process. Codes were applied at least once per given statement, either to certain words, sections of, or the entirety of a statement depending on the content. Repeated coding for different sections within a single statement was possible if different perceptions of the same code emerged several times. On average, each statement was coded 3.3 times. Using an inductive approach, we added several new codes to the initial ES classification ($n = 5$), to *biodiversity* ($n = 1$), *landscape features* ($n = 7$), and *other perceptions* ($n = 6$), resulting in a total number of 41 codes. Additional codes referring to *landscape features* were created to suit statements that comprised purely descriptive wording such as *large forest*, *cultural landscape*, *National Park* without mentioning any use or benefit. Short definitions and exemplary statements for all codes can be found in Table S5. We conducted the coding in MAXQDA. The first author (LK) conducted the coding and to reduce subjectivity bias, major decisions and cross-checks were done within the author team (LK, TS, RR, MH, TK). Frequency and composition of coding were tested for association with societal actor groups, study regions, and landscape elements by bivariate statistical testing. Pearson's Chi-square Tests and added Fisher's Exact Tests were conducted with a significance level of $p < 0.05$. Statistical analyses were performed in R Studio with R version 3.6.3.

3. Results

3.1. Valuable locations

The locations selected by respondents accumulated around prominent landscape features like water bodies, forests, large cities, and mountains. Moreover, we found that the extent of Bavaria's low and high mountain ranges, encompassing large conservation areas, visually align with most high-density clusters (Figure 3). Locations were also chosen in dependence to the study region. For more details on each study region, see detailed maps and lists of identified, designated localities corresponding to

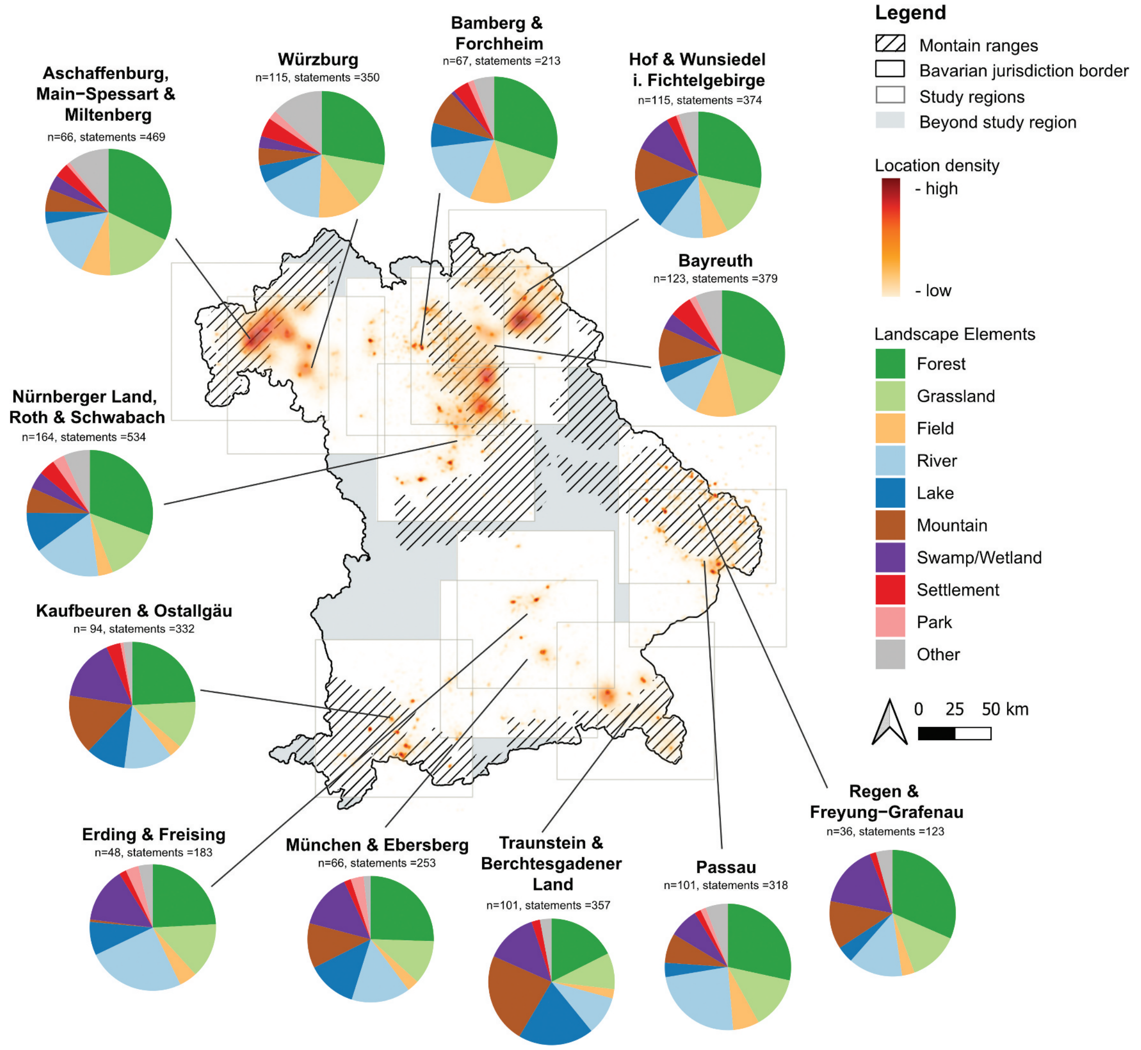


Figure 3. Spatial distribution of valuable locations selected across the study area expressed as heat map of location density (with weighing accuracy radius = 10 km, shown in orange to red) and the extent of main Bavarian high and low mountain ranges (Spessart, Rhön, Franconian Alb, Frankenwald, Fichtelgebirge, Bavarian Forest, Pre-Alps, German Alps). Pie charts show the distribution of valuable landscape elements for the 12 study regions (lines starting at the pie charts are ending in the middle of the respective rectangle of the study region), expressed as percentage of selections from the list provided in the survey (total participants, n = 2,326, landscape elements selected = 5,834).

high-density clusters in the supporting information (Figures S6 – S18).

3.2. Landscape elements valued by stakeholder groups

The frequency of landscape element selection differed, and overall element composition was heterogeneous. Forest was selected most frequently, contributing over a quarter (27.8%) of overall selections. The elements river (15.5%), grassland (13.6%), mountain (9.5%), lake (8.2%) and swamp/wetland (8.0%) followed suit. The lowest share of the overall selection was obtained from the elements park and settlement, representing less than 5.0%. For landscape element ‘other’, participants made a total of 158 specifications, most of which (77.8%) indicated landscape elements absent in the list provided. These specifications described various types of natural, cultural, and artificial landscapes. Word frequency analysis revealed that 19.5% of the further specifications of other landscape elements referred to dry and nutrient-poor grasslands. Fewer specifications (18.8%) stated that value is not exclusively bound to a particular landscape element but rather to landscape in its entirety. We provide a full list of words in all specifications in the supporting information (Table S6).

Based on Pearson Chi-square Test statistics, we found an association between societal actor groups and landscape elements selected ($p < 0.05$) (Figure 4, Figure S19, and Table S7). Forest was most frequently selected across all actor groups, but the composition of valuable landscape elements differed among societal actor groups (Figure 4).

Landscape element selection was significantly associated with the study region (Figure 3, see also Figure S20, and Table S8). Land cover analysis found

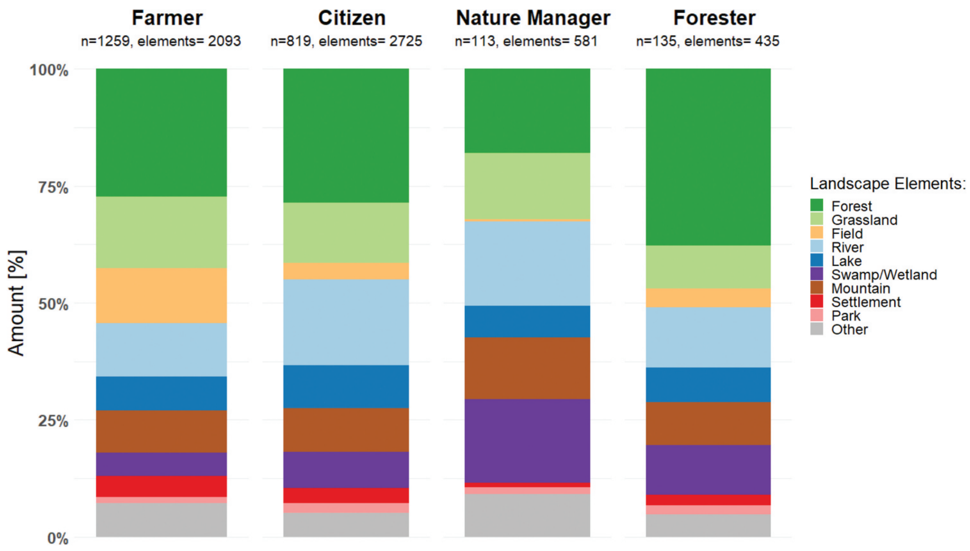


Figure 4. Distribution of valuable landscape elements among societal actor groups, expressed as percentage of selections from the list of landscape elements provided in the survey.

similarities, as well as differences among the actual study area's land cover (CORINE) and selected landscape elements (Table 1, Table S9, and Figure S21). Forests – the dominant land cover class in the study area (43.5%) – covered most selected locations (42.1%) and was the most frequently selected landscape element (29.6%). Share of grassland was also similarly high across selected elements, locations, and the study area's land cover (14.5–19%). The respective ranking of grassland, however, differed slightly. It had the second largest contribution to the land cover of the study area but ranked only fourth among the most frequently selected landscape elements.

We observed the strongest difference between participants' selections and actual land cover for water and natural-seminatural landscapes. Water was found to only cover a marginal share of both study area (0.9%) and selected locations (3.0%). Nevertheless, in landscape element selection, water had a considerably higher share. Rivers and lakes, accumulatively, contributed to a quarter of overall selections (25.2%). The element selection contribution of water to landscape was more than ten times higher than the actual share of water bodies present in the study area. Moreover, natural-seminatural landscape (mountain and swamp/wetland), was selected four times more often

Table 1. Differences between subjective landscape valuation (proportions of selected valuable landscape elements per region as shown in pie charts of in figure 3) and physical land cover (CORINE land cover CLC) per land cover class and region.

Land cover	Delta (selected land cover minus CLC) [%]				
	Aschaffenburg, Main-Spessart & Miltenberg	Erding & Freising	München & Ebersberg	Regen & Freyung-Grafenau	All districts
Cropland	−6.1	−14.9	−10.8	−13.3	−12.3
Forest	−38.4	−18.2	−22.2	−21.8	−19.9
Grassland	13.0	−5.7	−5.0	−3.9	−3.1
Natural-seminatural	11.3	12.3	15.1	22.0	14.9
Urban	−4.5	−8.9	−7.4	−6.2	−4.9
Water	20.3	32.2	28.9	21.5	25.3
	Bamberg & Forchheim	Hof & Wunsiedel i. Fichtelgebirge	Nürnberger Land, Roth & Schwabach	Traunstein & Berchtesgadener Land	
Cropland	−11.8	−18.4	−15.3	−14.8	
Forest	−18.1	−5.8	−17.6	−26.3	
Grassland	−5.0	−12.6	−3.5	−3.6	
Natural-seminatural	13.8	16.2	10.6	17.5	
Urban	−2.2	−3.4	−5.3	−3.6	
Water	21.6	21.6	27.8	29.8	
	Bayreuth	Kaufbeuren & Ostallgäu	Passau	Würzburg	
Cropland	−15.4	−7.8	−10.4	−7.4	
Forest	−10.2	−28.1	−20.1	−23.0	
Grassland	−5.3	0.7	−6.6	−1.1	
Natural-seminatural	13.6	14.4	13.1	7.9	
Urban	−2.9	−6.3	−5.7	−3.4	
Water	16.8	25.6	27.1	22.1	

(18.7%) in comparison to its actual share of land cover (4.8%) in the study area. On the contrary, urban landscape (settlement and park = 5.4%) as well as agriculture (field = 6.6%) were selected less frequently compared to their share of land cover in the study area (urban = 11.8%, agriculture = 19.9%).

3.3. Open statements of landscape elements' values coded as ES

To explore and structure the participants' perception of values of landscape elements, we first analyzed all statements given in the third part of the mapping task for word frequency and then applied qualitative content analysis. Both procedures aimed to capture themes, preferences, and patterns of observed perceptions. A word frequency analysis revealed *place to live/habitat* (*Lebensraum*) to be present in 7% of statements, making it the most frequently stated word across all participants. *Species richness/biodiversity* (*Artenvielfalt*) was found similarly often (6.4%) (Table S10). Words that were present in more than 2.5% of all statements were *recreation* (*Erholung*), *animals* (*Tiere*), *important* (*wichtig*), *nature* (*Natur*), *water* (*Wasser*) and *climate* (*Klima*).

The qualitative content analysis aimed to further structure stated perceptions and make them comparable across societal actor groups, study regions, and landscape elements. We coded statements on landscape elements into 5,839 codes falling into 41 subcategories and 7 main categories, which strongly differed in code frequency (Table 2). On average, three categories were coded per participant, ranging from 1–39 categories.

Table 2. Coding categories applied in qualitative content analysis on statements given in open-ended questions of the mapping task along with code creation approaches (deductive = category based on ES categories in survey, inductive = additional new category), total coding frequency, share of individual codes within a main theme, and share of individual codes on total coded statements (provisioning ES = 909 codes, regulating ES = 1167 codes, cultural ES = 989 codes, habitat ES = 983 codes, biodiversity = 593 codes, landscape features = 742 codes, other perceptions = 453 codes, total codes = 5839).

Main categories	Coding sub-categories	Coding approach	Code frequency	Contribution to main categories [%]	Contribution to overall coding [%]
Provisioning ES	Water	Inductive	354	39	6.2
	Food general	Inductive	281	30.9	4.8
	Production of food crops	Deductive	13	1.4	0.3
	Outdoor animal production	Deductive	49	5.4	0.8
	Fodder production	Deductive	55	6	0.9
	Timber production	Deductive	119	13.1	2
	Energy crop production	Deductive	13	1.4	0.3
	Fish/wild game	Inductive	13	1.4	0.3
	Production of Non-timber forest products NTFP	Deductive	12	1.3	0.2
Regulating ES	Regulation of global climate	Deductive	477	40.9	8.2
	Regulation of local climate	Deductive	69	0.6	1.2
	Air purification	Deductive	311	26.6	5.3
	Flood regulation	Deductive	56	4.8	1
	Groundwater recharge	Deductive	147	12.6	2.6
	Groundwater quality	Deductive	22	1.9	0.3
	Soil fertility management	Deductive	30	2.6	0.5
	Erosion control	Deductive	23	2	0.4
	Regulation of hazards	Inductive	14	1.2	0.2
	Pollination	Deductive	18	1.5	0.3
Cultural ES	Recreation in open landscape	Deductive	718	72.6	12.1
	Recreation in urban space	Deductive	83	8.4	1.6
	Sense of place	Deductive	144	14.6	2.5
	Learning and inspiration	Deductive	44	4.4	0.8
Habitat ES	Habitat general	Deductive	573	58.3	9.8
	Specific species	Inductive	241	24.5	4.1
	Specific habitat	Inductive	41	4.2	0.7
	Rare and at risk	Inductive	128	13	2.2
Biodiversity	Biodiversity	Inductive	593	100	10.2
Landscape Feature	Landscape general	Inductive	111	14.9	1.9
	(Semi-)Natural landscape	Inductive	302	40.7	5.2
	'Wilderness'	Inductive	49	6.6	0.8
	Protected landscape	Inductive	52	7	0.9
	Cultural landscape	Inductive	73	9.8	1.3
	Artificial landscape	Inductive	33	4.4	0.6
	Specific place	Inductive	122	16.4	2.2
Other Perceptions	ES/functions general	Inductive	166	36.6	2.8
	Stewardship/care	Inductive	106	23.4	1.8
	Maintenance of options	Inductive	18	0.4	0.3
	Negative development	Inductive	60	13.2	1.1
	Ideas for improvement	Inductive	76	16.7	1.3
	Economy and energy	Inductive	27	6	0.4

Overall, we found participants to frequently state perceived value in terms of ES, with more than three-quarters (78.9%) of overall coding being related to services and benefits derived from nature. Concerning main categories, *regulating ES, habitat ES, provisioning ES*, and *cultural ES* all accounted for more than 15% each. *Regulating ES* was the most abundant main category and accounted for 20.0% of overall coding. Its most frequent sub-categories were *regulation of global climate* and *air purification* (accumulatively 67.5%) (Table 2). The second most frequent main categories were *cultural ES* as well as *habitat ES* (both 16.9% of overall coding).

3.3.1. Dependence on societal actor group

The word frequency analysis showed no distinct differences in the highest-ranking words stated by the different societal actor groups, although the number of assigned codes was unevenly distributed (*Table S11*). Across all four groups, *place to live/habitat* and *species richness/biodiversity* were stated most frequently. The top ten words included *recreation*, *animals*, *water*, *important*, and *climate* for all, although the ranking differed slightly among societal actor groups. We found nature managers' statements to include more words surrounding species and species diversity, e.g. *diverse* (*artenreich*), *biodiversity* (*Biodiversität*), and *rare* (*selten*). In farmers' statements, *storage* (*Speicher*), *nature* (*Natur*), and *preservation* (*Erhalt*) were found more often in comparison to the other groups. For citizens, *plant* (*Pflanze*) and *insect* (*Insekt*) ranked among the ten most frequent words, both of which did not rank as high for the other societal actors.

Statistical analysis of coded categories revealed that perception of value was significantly associated with the societal actor group. Calculated Pearson p-values were well below the set benchmark ($p < 0.05$) for both main categories (Figure S22, Table S12) and sub-categories (Figure S23). Even though ES-related categories were coded frequently across all societal actor groups (>60% of all codes), the composition of categories differed. Concerning main categories, farmers and foresters contributed most to coding of *provisioning ES* (farmer = 21.0%, forester = 19.3%) and *regulating ES* (farmer = 21.1%, forester = 17%). Citizens' coding for main categories was split relatively evenly across *regulating ES* (20%), *habitat ES* (18.8%), and *cultural ES* (18.1%). Nature managers referred most frequently to the main categories *habitat ES* (22%), *landscape features*, and *regulating ES* (both 17.7%). Moreover, nature managers were the main contributors to the code *biodiversity* (15.0%). On the other hand, their statements contributed the least to the code *provisioning ES* (3.3%).

The distribution of coded sub-categories allowed a more in-depth insight into stated perceptions among the societal actor groups (Figure 5). Concerning *provisioning ES*, we found farmers to have more coding than the other groups for sub-categories beyond the omnipresent *water*, *food general*, and *timber production*. For example, they had the highest contribution to sub-category *fodder production* (2.0%) out of all groups (<0.3%). Moreover, farmers were the only societal actor group whose statements included more coding for *food general* than for *water*, whereas this ratio was reversed for the other three groups. Computed standardized residuals showed that for farmers, *food general* and *fodder production* occurred more frequently than expected by the model based on Chi-squared tests (see Figure S23). Similarly, foresters mentioned *timber production* more frequently than any other group. Concerning *regulating ES*, all but nature managers' coding of sub-categories were split in favor of *regulation of global climate*, followed by *air purification* and *groundwater recharge*. Nature managers were the group with the most coding of *flood regulation*. *Cultural ES* coding mainly consisted of the sub-category *recreation in open landscape*, which was most frequent for all groups. The main category *habitat ES* was coded at a similar frequency across groups. However, a difference was observed in the coding of its sub-category *rare and at risk*. Computed residuals found that nature managers' statements mentioned *rare and at risk* more often than expected by the model. At the same time, farmers' coding for that sub-category was less than expected. For *biodiversity*, nature managers' share of coding was nearly twice that of farmers. The composition of sub-categories aggregated in *other perceptions* showed only marginal differences. Farmers and foresters, gave more negative (sub-category *negative development*) than positive statements on the current state of nature (sub-category *ideas for improvement*) Citizens and nature managers, on the other hand, gave more positive than negative comments.

3.3.2. Difference in perceptions of ES across study regions

Even though the overall distribution of the main ES categories was similar across regions, in some districts, perception slightly deviated from the general consensus (Figure 6). Statistical analysis of code frequency found significant associations between study regions and perceptions of value. The frequency of both main categories (Figure S24, Table S12) and sub-categories (Figure S25) differed among regions. Bay applying word frequency analyses, we observed that no considerable regional differences in wording used. The overall contribution of ES-related coding

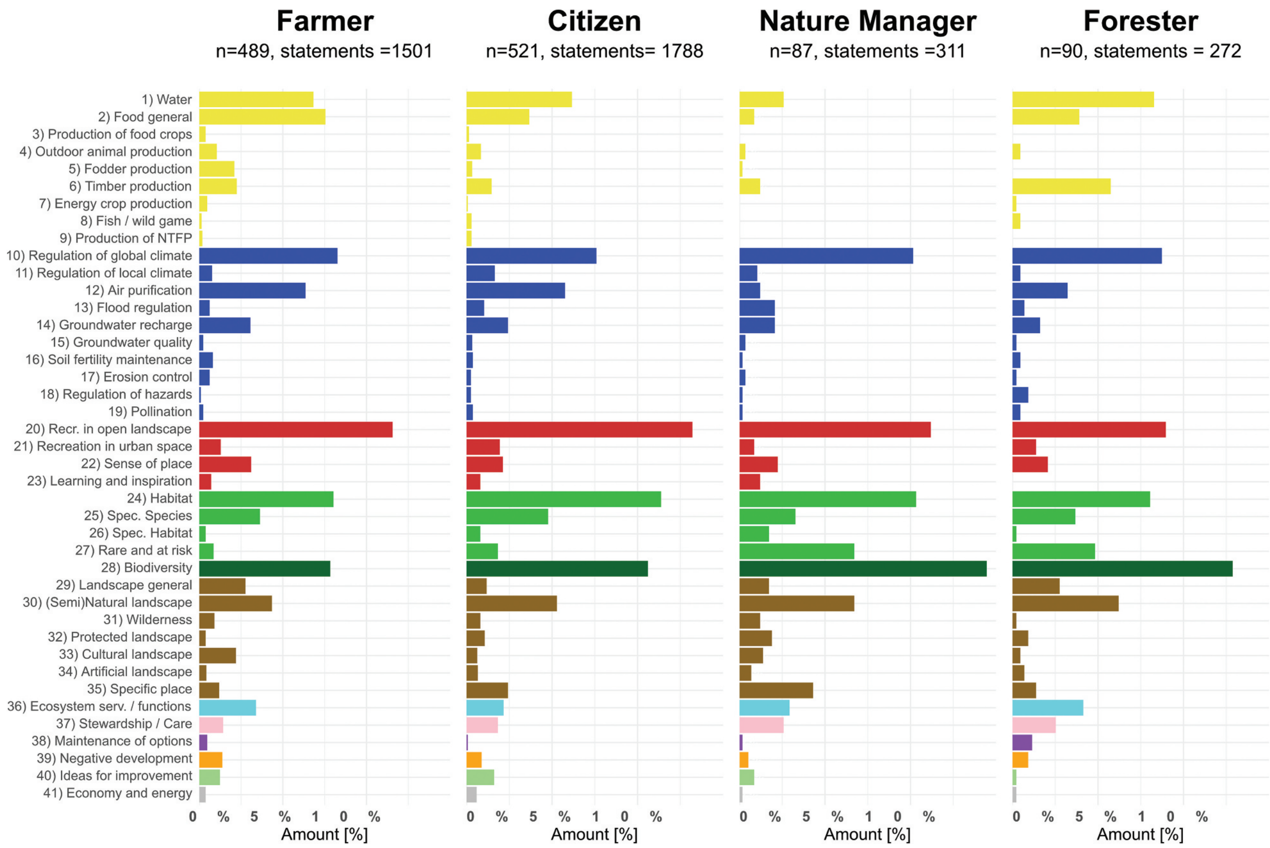


Figure 5. Open statements of values of selected landscape elements coded as sub-categories of ES per societal actor group (participants n = 1,196, statements = 3,872, codes = 5,839, yellow: provisioning services, blue: regulating services, red: cultural services, light green: habitat services, dark green biodiversity, brown: landscape features; other colors: rest).

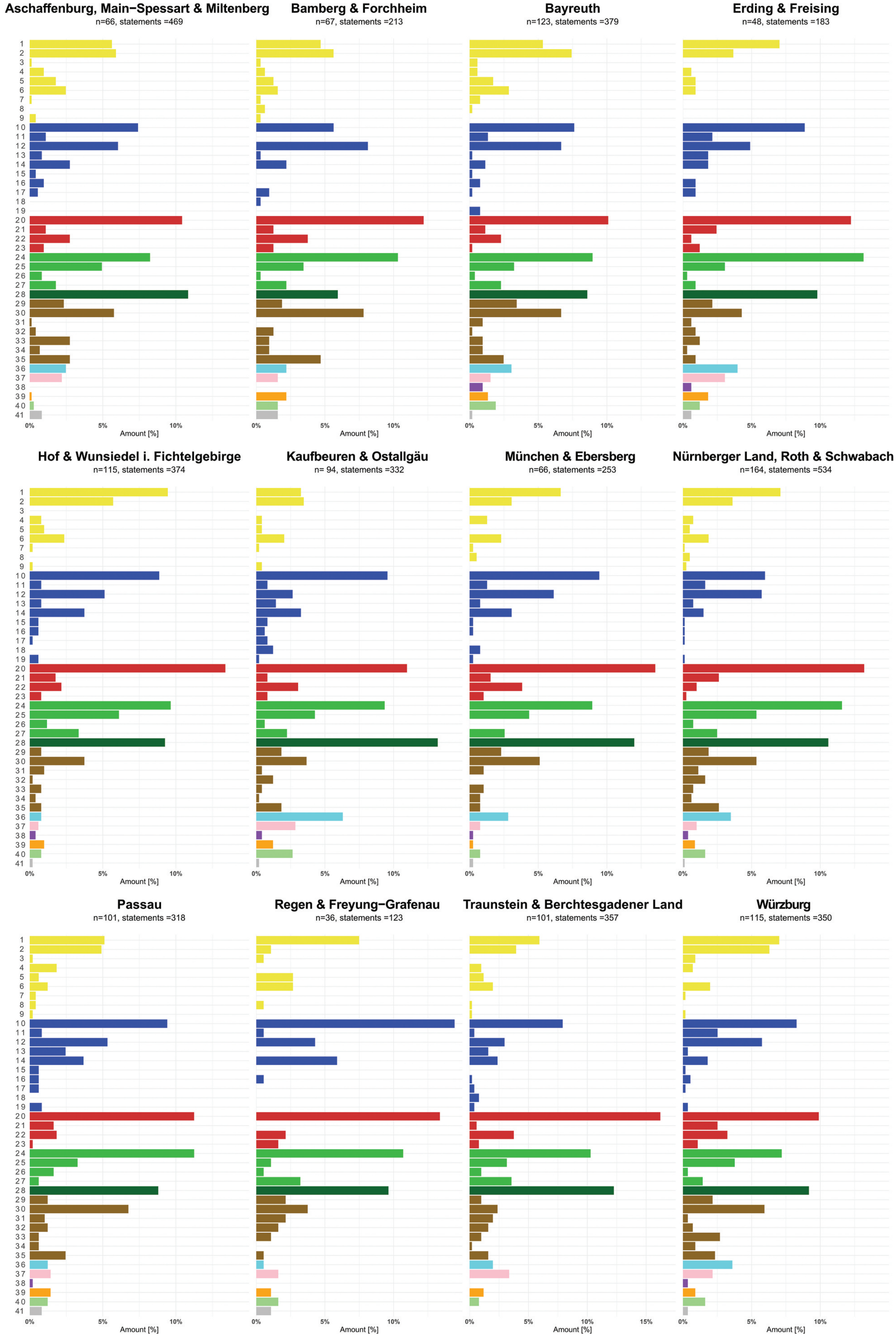
was uniformly high (>60% of statements could be assigned to sub categories of ES across all regions) with only slight differences in the ratio of the four most prominent main categories *provisioning ES*, *regulating ES*, *cultural ES*, and *habitat ES*.

3.3.3. Dependence on landscape elements

Word frequency analysis observed wording to be highly heterogeneous across landscape element selection (Figure 7). Even though the ranking of the most frequent words was found to be similar for some landscape elements, dominant themes differed strongly. *Space to live/habitat* (*Lebensraum*), the word most frequently found in all statements, was observed to be within the five most frequent words for most landscape elements. However, it only ranked top for the landscape element settlement (4.9% of overall words used in affiliated statements) and second for the elements river (6.4%) and lake (6.53%). *Species richness/biodiversity* (*Artenvielfalt*), which was similarly popular overall, only ranked 1st place in statements on the elements grassland (8.9%) and other (2.3%). *Recreation* (*Erholung*) was expressed most often for the landscape elements lake (6.5%), mountain (6.8%), and park (16.9%). For the elements forest (4.0%) and swamp/wetland (9.8%) highest word frequency was found for *CO_2*, whereas *water* (*Wasser*) was most prominent in statements on rivers (7.1%).

Qualitative content analysis and subsequent statistical testing found a significant association ($p <$ 0.05) between the perception of value and the selected landscape element. Standardized residuals were high for the coded main category (Figure S26, Table S14) and sub-category (Figure S27). These results indicated that observed code frequency for several landscape elements was considerably higher than expected. The composition of main and sub-categories (Figure S28) of perceived value were found to be very different for each of the selected landscape elements.

The composition of coded categories proved to be distinctive for each landscape element, with *provisioning ES* mainly arising in statements on the elements river, field, and grassland. *Regulating ES*, however, was found to be mostly associated with forest and subsequently swamp/wetland. *Cultural ES* were most frequently found in statements on the elements mountain, forest, lake, and settlement. *Habitat ES* occurred in statements on various landscape elements, mainly river, forest, grassland, and swamp/wetland. A similar distribution was found for *biodiversity*, although the element grassland was the


Aschaffenburg, Main−Spessart & Miltenberg
n=66, statements =469
Bamberg & Forchheim
n=67, statements =213
Bayreuth
n=123, statements =379
Erding & Freising
n=48, statements =183
Hof & Wunsiedel i. Fichtelgebirge
n=115, statements =374
Kaufbeuren & Ostallgäu
n= 94, statements =332
München & Ebersberg
n=66, statements =253
Nürnberger Land, Roth & Schwabach
n=164, statements =534
Passau
n=101, statements =318
Regen & Freyung−Grafenau
n=36, statements =123
Traunstein & Berchtesgadener Land
n=101, statements =357
Würzburg
n=115, statements =350
Amount [%]
0%
5%
10%
15%

overall strongest contributor to coding for this category. *Landscape features* were mainly associated with the landscape element other, while *other perceptions* were found for an array of statements, mainly for the selection of the elements river and forest (Figure 7). Some observed regional differences in the composition of coded categories were found to be related to landscape element selection. For example, *regulating ES* was the most frequent main category in eight of the ten study regions where the element forest was selected most often.

4. Discussion

This study aimed to investigate ES demand by analyzing perceptions of ES to explain where and why landscape is perceived as valuable. Spatial distribution of selected valuable locations, preference in selection of valuable landscape elements, and stated perceptions of value were analyzed across four societal actor groups and 12 study regions in Bavaria (Germany).

4.1. Valuable locations and landscape elements

The distribution of selected locations was spatially heterogeneous across the study area, with clusters of high location density in all study regions. High location density indicates areas where many participants perceive landscape to be valuable. The range and extent of clusters differed between the study regions. Notably, landscapes that were perceived to be valuable in our study correspond to landscapes frequently associated with cultural ES, such as recreation or aesthetics. On the one hand, our respondents indicated low values for intensively used croplands, which is a prominent finding in literature on aesthetic values of landscapes (e.g., van Berkel and Verburg 2014; Schirpke et al. 2019). For instance, Lieskovský et al. (2017) reported that landscapes in lowlands used for intensive agriculture were less attractive than other landscape types in a study using locations of geo-tagged photographs across Slovakia. On the other hand, landscape types, such as water bodies, forests, and mountainous regions, have been perceived to be highly valuable, all in line with previous research on aesthetic preferences in landscapes (van Berkel and Verburg 2014; Lieskovský et al. 2017; Schirpke et al. 2019). Moreover, de Groot and van den Born (2003) postulate that 'naturalness' is the main contributor to landscape preference. The high number of values associated with the relatively natural ecosystems, forests and water bodies, in our study can also be explained by this high preference for landscapes that are close to natural (Ode et al. 2009; Hermes et al. 2018).

Locations placed in and around cities were very closely packed, while patterns of high-density clusters in open landscapes dominated by agriculture and forests were more scattered. These results showcase that landscape preference in and around cities is spatially limited (for example, to an urban green space, the town center, or city riverbanks). In addition, this is likely influenced by the proportionally high number of people living in urban areas and cultural attractions in cities (Lieskovský et al. 2017; Wood et al. 2020). In open landscapes, spatial preference was more widely and more diversely distributed. Spatial preference in northern Bavaria spanned a larger area with large-scale density clusters. In southern study regions, on the other hand, clusters were confined to more condensed and scattered units. This gradient may also be influenced by the generally higher participation in the northern study regions.

4.2. Open statements of landscape elements' values coded as ES

4.2.1. Dependence on societal actor group

ES that were valued highly across all actor groups related to important topics in society and policy. High values for *habitat general*, *recreation in open landscape*, *global climate regulation* and *water* are related to research from Howley et al. (2014), who found that wildlife protection, accessibility for recreation, climate change, and good water quality are perceived to be important issues. Our findings that

Figure 6. Open statements of values of selected landscape elements coded as sub-categories of ES per study region (participants n = 1,196, statements = 3,872, codes = 5,839). The categories on the Y-axis are labelled as in Figure 5 with provisioning services (yellow) 1) water, 2) Food general, 3) Production of food crops, 4) Outdoor animal production, 5) Fodder production, 6) Timber production, 7) Energy crop production, 8) Fish/wild game, 9) Production of NTFP; Regulating services (blue): 10) Regulation of global climate, 11) Regulation of local climate, 12) Air purification, 13) Flood regulation, 14) Groundwater recharge, 15) Groundwater quality, 16) Soil fertility maintenance, 17) Erosion control, 18) Regulation of hazards, 19) Pollination; Cultural services (red): 20) Recreation in open landscape, 21) Recreation in urban space, 22) Sense of place, 23) Learning and inspiration; Habitat services (light green): 24) Habitat, 25) Spec. Species, 26) Spec. Habitat, 27) Rare and at risk, Biodiversity (dark green): 28) Biodiversity; Landscape features (brown): 29) Landscape general, 30) (Semi)Natural landscape, 31) Wilderness', 32) Protected landscape, 33) Cultural landscape, 34) Artificial landscape, 35) Specific place; Rest (other colors): 36) ES/functions general, 37) Stewardship/Care, 38) Maintenance of options, 39) Negative development, 40) Ideas for improvement, 41) Economy and energy.

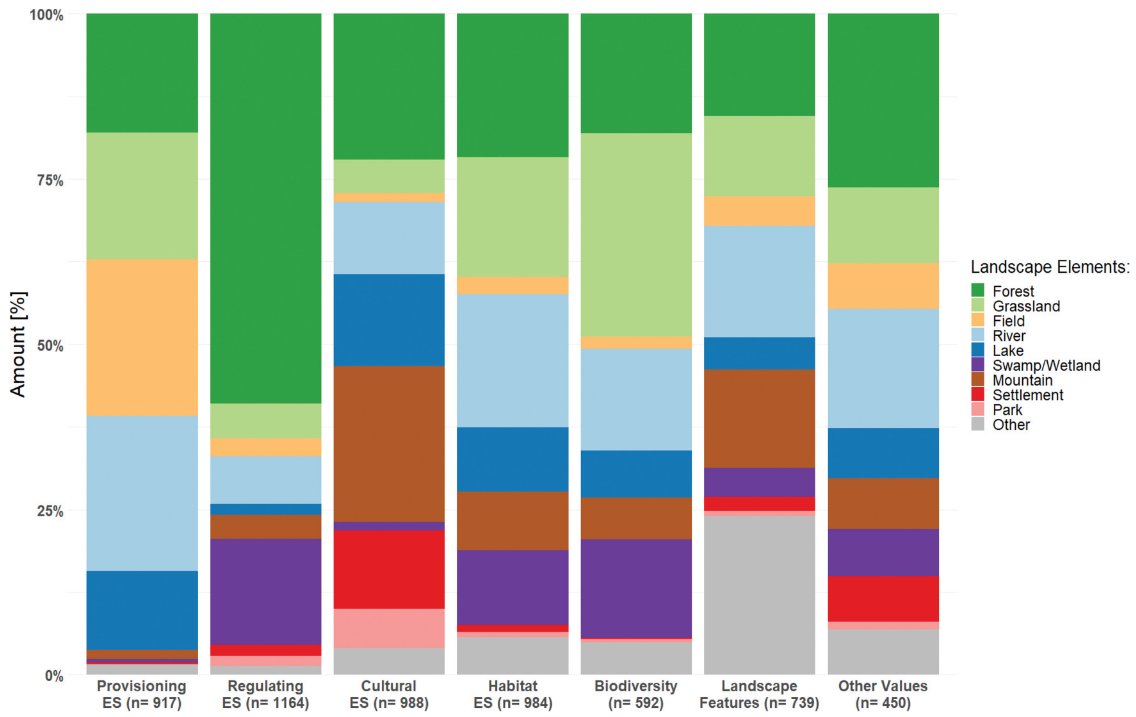


Figure 7. Distribution of perceptions of valuable landscape elements per coded main category for statements of participants across regions (participants n = 1,196, statements = 3,872, codes = 5,839).

biodiversity was frequently stated by participants across societal actors relates to an overall growing knowledge and appreciation of the benefits derived from biodiversity, especially since the Bavarian referendum *Biodiversity and Natural Beauty* in 2019 ('Volksbegehren Artenvielfalt – Rettet die Bienen') (Hartmann et al. 2021).

Apart from these homogeneities, significant differences in both main and sub-categories of perceptions are apparent, foremost between farmers and nature managers. Acknowledging these differences is important as conflicts between stakeholders can arise when they have different priorities (Zoderer et al. 2019). The differences between farmers and nature managers found are hence of major interest, as there is an overall high societal demand for non-provisioning ES from agricultural landscapes, but also high importance of agricultural productivity by farmers (Howley et al. 2014). Compared to nature managers, farmers were four times more likely to state *provisioning ES* in their statements than any other group. This positive association to food-related functions by practitioners making a living from it is supported by previous studies (Bidegain et al. 2019). Nature managers, on the other hand, showed a preference towards *habitat ES* and *biodiversity*. Compared to farmers, they were twice as likely to perceive landscape value in terms of *habitat ES* and *biodiversity*. Moreover, nature managers mention the sub-categories *rare and at risk*, *flood regulation*, '*wilderness*', *protected landscape*, and *specific place* more frequently than any other group. In the case of foresters, their preferences were positively associated with *timber production* and *maintenance of options*. Significantly more of their statements included *forestry*, *timber production*, *wood* or *sustainable forestry practise*. All of these findings align with research by Bidegain et al. (2019) and Zoderer et al. (2019). The perceived importance of services is linked to occupation, with an increase in perception level if a direct economic benefit is derived. Farmers working within an agricultural context, nature managers who are often employed in environmental science and conservation, and foresters who are affiliated with forestry are more likely to perceive value in terms related to their respective fields of work.

An additional observation was that nature managers and foresters show significant preference towards the sub-category *rare and at risk*. In comparison to farmers, both these societal actor groups are five times more likely to express value for biodiversity in general, but also specific species or habitats. A study by Bidegain et al. (2019) found that for scientists, conservation efforts and research are strongly motivated by importance to preserve threatened species This could explain the observed preference since both societal actor groups tend to have a background in natural sciences and are exposed to conservation practices.

Overall high importance for *cultural ES*, especially regarding recreation, was expressed across groups. This contradicts findings by Howley et al. (2014), whose study results suggested a higher affiliation towards recreation by citizens than by farmers.

Nevertheless, we did find differences in the ratio of affiliated *cultural ES* sub-categories. Out of all groups, farmers most frequently expressed value for *sense of place*, while at the same time, citizens contributed most to coding for *recreation in urban space*. This may be due to differences in living conditions of the two societal actor groups. Farms, stables, pastures, and arable land are space-consuming and, thus, seldomly located in urban areas. As a result, farmers are bound to rural areas. In comparison, citizens are more likely to live in cities, at least for a period of time, and therefore may spend more free time in urban green than farmers. Previous research observed that, within an urban setting, residents assign the highest importance to recreation and enjoyment (Riechers et al. 2017). Moreover, as a study by Lewicka (2011) found, place identity perception is higher for a longer residence in the same place, which would be in line with farmers' preference for *sense of place*. We studied sense of place as a cultural ecosystem service (IPBES 2017; Wartmann and Purves 2018). However, sense of place can also be seen as an umbrella term for many cultural ES unravelling the emotional connections of people to their environment (Gottwald et al. 2022). The diversity of sense of place is also recognized in our study and shows the importance of the landscape to people. Participants recognized the importance of landscape for place-specific belonging, such as the German term 'Heimat' (homeland), but also for state-wide identification ('belonging to Bavaria') or general pride and a place to live. Sense of place has frequently also been considered a relational value, which indicates the multiple relationships between people and nature and is distinct from instrumental and intrinsic values (Chan et al. 2016; Pascual et al. 2017). In this regard, sense of place can be created through social and ecological interactions and can contribute to social cohesion and stewardship of nature (Masterson et al. 2017). In a study on values associated with grasslands, Schmitt et al. (2022) found that sense of place, indicating feelings of belonging and home, can also be related to provisioning services as economic uses of the place may lead to maintenance of the cultural landscape and avoid abandonment or conversion to other land uses. This could explain the enhanced preference for sense of place by farmers in our study.

4.2.2. Dependence on study region

Analysis of perceived value for landscape across the study area shows that perceptions are significantly associated with participants' study region. These results are in line with other research on spatial patterns of ES perceptions (Quintas-Soriano et al. 2018; Scholte et al. 2018). However, differences between the study regions were rather small, and ES-related terms for perceived value were omnipresent (>50% of coding) in statements across regions. *Regulating ES* has the highest proportion overall, and the order of main codes second in line (*cultural ES*, *provisioning ES, and habitat ES*) only differs marginally among the study regions. The strongest association was found in Kaufbeuren & Ostallgäu. Participants in this region were more likely to express value in terms of *other perceptions* and *biodiversity* and less likely to include *provisioning ES* in their statements. This might be due to the partly mountainous topography in the respective region with less arable land giving special relevance to biodiversity.

Some other minor differences in the composition of sub-categories are noticeable. However, the overall trajectory shows a preference towards *water* and *food provisioning*, *regulation of global climate*, *air purification*, *recreation in open landscape*, *habitat general*, and *biodiversity* across all regions. Only in Aschaffenburg, Main-Spessart & Miltenberg, Bamberg & Forchheim, and Bayreuth is *food general* coded more often that *water*. This could be due to high participation of farmers in both Bayreuth (250 statements) and Bamberg & Forchheim (225 statements).

The strongest sub-categorical association was found for Kaufbeuren & Ostallgäu, where more statements express value in terms of *ES/functions general* and *regulation of hazards* than in any other region. A third of the coding of *regulation of hazards* came from this study region's statements alone. Proximity to the Alps may be why participants here are more likely to mention *avalanche control*, *protection of residents*, or *protection against disasters*. Montane and alpine threats pose a more pressing risk in mountainous regions than in lowlands. Another positive affiliation is apparent in Aschaffenburg, Main-Spessart & Miltenberg, and Würzburg. Participants in these two study regions are more likely to mention *cultural landscape features* as well as *production of food crops*. These findings could be related to the dominancy of cultural and arable landscapes like orchards and vineyards in this area, also known as 'Fränkisches Weinland' (Franconian Wine Country). The study region Passau was positively associated with *flood regulation* due to frequent selections of the landscape element river. Three large rivers (Danube, Isar, Inn) flow through this region, and the junction is located within the city limits of Passau. The city and its surrounding areas are prone to flood risk because of their geographical location. Severe flood events occur frequently, the latest one in July 2021. The repetitive and recent nature of these events may be the reason why the inhabitants of this area consider flood regulation as a valuable ES, as it improves their quality of life and contributes to their well-being.

4.2.3. Dependence on landscape elements

Results of bivariate analysis, as well as word frequency analysis showed significant association between perceived value for landscape and selected landscape element. For each of the ten landscape elements, perceptions differ considerably. Regulating ES were mainly attributed to forests, provisioning services to cropland, and cultural ES to mountains. And even more so, distinct preferences are apparent for each landscape element. Observed differences in perceptions of value can be linked to differences in selected landscape elements, which is in line with findings of Daniel (2001), Zoderer et al. (2016), and Schmidt et al. (2017). The ES perceived for the individual elements were both individual and collective benefits. For instance, the respondents attributed global climate regulation to forests describing them to be a CO2 storage/sink, but also more individual benefits such as regulation of hazards and extreme events (e.g. avalanche protection). Underlying landscape type is found to be a strong driving factor in socio-cultural valuation of ES.

4.3. Limitations and suggestions for future research

We acknowledge several limitations regarding the results of our study, which should be taken up in future research on perceptions and values of ES.

Firstly, one major restraint of this analysis was the low accuracy of selected locations for the spatial analysis because displayed maps had a rather coarse resolution, and it was not possible to zoom in. Additionally, participants used different devices, including smartphones, further reducing the spatial accuracy. Nevertheless, the precision for selecting valuable locations within the borders of Bavarian jurisdiction was high. Only 6.0% of all selections were located beyond, indicating useful mapping results. Another limitation set by the survey design is the missing link between spatial and qualitative data collection because of technical limitations of the survey software Qualtrics. The exact localization in the first part of the mapping task could not be linked to the following selection of elements and elaborations of value. This considerably limits method application and constricts results to descriptive and synoptic forms rather than comprehensive case-by-case studies. Consequently, we recommend the use of interactive geographic information system (GIS) maps in future spatial studies on socio-cultural valuation, leading to increased accuracy of markings, as well as compatibility with land cover maps (e.g. CORINE).

Secondly, another limitation of the used survey data is the unequal sample size of the targeted societal actor groups and study regions, which is amplified by the spatial overlap of displayed maps per region (see Figure 3). Regional differences, therefore, need to be interpreted with care. In addition, participants are likely not representative of Bavaria's population since our survey attracted persons naturally interested in landscape management and ES topics. Indications are a higher share of organic farmers and those participating in agri-environmental schemes compared to conventional farmers and higher education status of participating citizens in our survey compared to the overall population. The sample is strongly dominated by the societal actor groups of farmers and citizens, due to sampling efforts and number of people being active in the respective sectors. We further acknowledge that the different situations in which the surveys were conducted could have influenced the results. While farmers filled out the surveys on a tablet at a regional Office of Food, Agriculture, and Forestry, the other actors received an invitation to fill out the surveys on their own devices and at a time and place of their own choice.

Thirdly, several assumptions and simplifications had to be made for the qualitative content analysis. Even though qualitative analysis can never be impartial or completely neutral (Mayring 2015), we faced shortness (often one keyword only) and ambiguity of many statements. For example, the most frequently stated German word *Lebensraum*, can be interpreted either as *space/place to live (for humans)* or *habitat (for wildlife)*, so the inclination of participants' statements towards either anthropogenic or environmental value remains ambiguous. Double-coding statements that could fit multiple categories was the most sensible way to reduce subjectivity in interpreting short or imprecise answers. However, this double-coding might have also led to over-representation of certain categories. Due to the added value of analyzing qualitative statements regarding the value of landscape and ES, we recommend further research motivating participants to give detailed answers. This could also help to analyze preferences concerning certain landscapes more explicitly. Another general limitation was the choice to use the ES framework. Not all statements could easily be allocated to a certain ES. To account for this, we inductively added further categories (e.g. biodiversity). More detailed examples of the limitations and decisions made in the coding process are included in the supplement (table S5).

5. Conclusion

Our results can lead to valuable insights for landscape management because including multiple stakeholder views can enrich landscape management decision processes. We observed several regional and societal differences. However, the perceived value of landscapes and derived ES was overall quite similar across all societal groups and study regions. The presence of common perceived values of landscape across societal groups can provide a common ground for understanding between stakeholders and help to propose acceptable solutions to land-use conflicts. For these reasons, socio-cultural valuation and stated preferences need to be included in landscape management. The high number of values associated with natural landscape providing wildlife habitat could help increase local conservation efforts or influence tourism schemes since 'naturalness' and recreational value are not perceived as mutually exclusive. In fact, the observed prevalence of recreational and habitat values assigned to the most commonly selected landscape element forest indicates that experiences of wildlife during outdoor activities may positively influence enjoyment of nature. This, of course, can also lead to unwanted pressure in such ecosystems (e.g. overtourism). Our results support the management of protected sites, specifically wetlands in Bavaria, to account for the expressed importance of habitat, biodiversity, and recreation. Furthermore, the majority of participants highlighted global climate regulation and biodiversity. This indicates that respondents are aware of and acknowledge the importance of diverse ecosystems for non-human life and human well-being. This was impressively underlined by the Bavarian referendum *Biodiversity and Natural Beauty* (Volksbegehren Artenvielfalt), which was undertaken early 2019. Almost one fifth of the Bavarian citizens voted for stronger regulations of agricultural land management in favour of biodiversity. This referendum was leading to ambitious modification of Bavarian nature protection laws, which can not only benefit biodiversity, but also many ecosystem services (Hartmann et al. 2021). Specifically, provisioning of water and food, regulating of global climate, air purification, recreation in open landscapes and habitat services were also highly valued by participants in our study.

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