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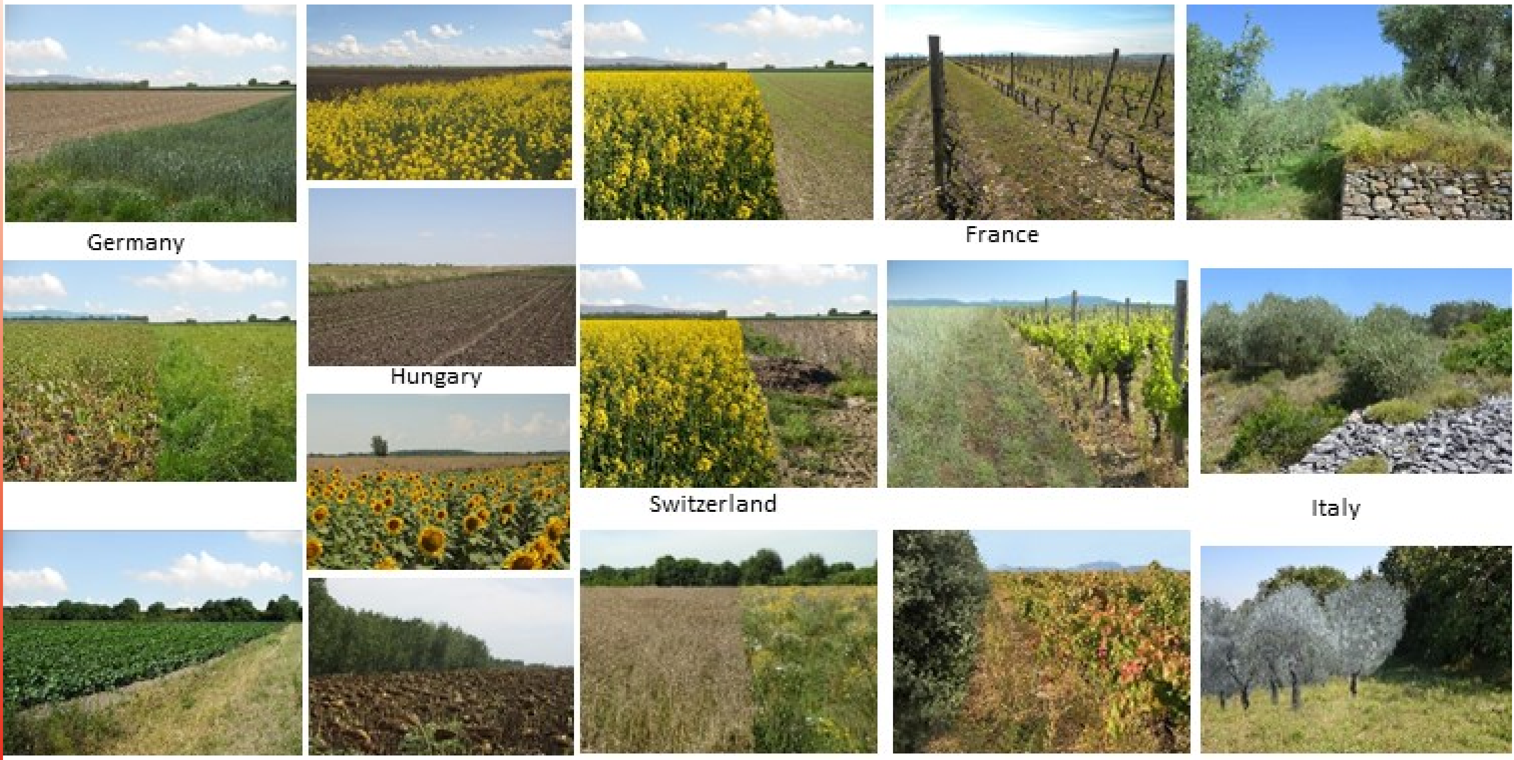

Which attributes explain visual preferences for crops, herbaceous and woody semi-natural habitats?

A comparative study in Germany, Hungary, Switzerland, France and Italy

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Summary

Numerous studies have confirmed the importance of herbaceous and woody semi-natural habitats (SNHs) for biodiversity and for ecosystem services. Here we investigated if – in addition to promoting e.g. birds, pollinators and natural pest enemies – they also enhance the aesthetic value of agricultural landscapes. Their presence has an influence on e.g. the degree of orderliness, the amount of open soil, the share of dry vegetation or colourfulness. Former studies have already confirmed that colours, orderliness and the amount of open soil or green vegetation have an influence on whether a landscape is perceived as visually attractive or not.

In this context, we aimed to better understand visual preferences of citizens from Germany, Hungary, Switzerland, France and Italy for different combinations of crops and SNHs in agricultural landscapes. These landscapes differed in relief, land-use types (arable crops, vines and olives) and climate. We looked for general patterns and possible differences in preferences between countries. In addition to the above mentioned visual characteristics, we also evaluated the impact of the percentage of tree coverage and the openness of the landscape on visual preference.

In each country, a picture-based online choice experiment was performed. During the experiment, 350 participants were shown six or eight choice cards with four pictures each. Each choice card consisted of a picture of each of the four combinations: crop-crop, crop-herbaceous, crop-woody and crop-herbaceous-woody. For each card, the participants had to choose the picture they liked best. Latent class models including the visual characteristics of each picture as attributes were applied to analyse the data. The attributes were the amounts of green vegetation, dry vegetation and open soil in the picture, as well as the colours and degree of orderliness in the picture and the openness and tree coverage.

All attributes made a significant contribution to explaining the preferences. Nevertheless, the preferences for herbaceous and woody SNHs could not be fully explained. The results showed, however, that both crops and SNHs were preferred or rejected because of their visual characteristics. SNHs more often exhibited preferred visual characteristics and were therefore more often preferred than crops. Furthermore, the impacts of the two visual characteristics “colour” and “orderliness” on the participants’ choices showed differences between countries. They were important for explaining preferences in Germany, Hungary and Switzerland, where landscapes dominated by arable crops were evaluated, while their effects were significantly negative in France and Italy, where landscapes with permanent crops, such as vineyards and olive groves, were shown.

Still, overall, herbaceous and woody SNHs were preferred over crops in all the analysed countries. Our results indicate that direct payment for SNHs in agri-environmental programmes for promoting soil, climate and biodiversity protection, also lead to an added aesthetic value for the general public. Yet, preferences for specific characteristics differ between countries and landscapes, land use types and climates in the respective countries.

Zusammenfassung

Zahlreiche Studien bestätigen, dass naturnahe Habitate (nHab) mit krautiger Vegetation (wie extensiv genutzte Wiesen und Buntbrachen, «krautige nHab») und Gehölzen («holzige nHab») für die Biodiversität und für Ökosystemdienstleistungen wesentlich sind. Hier wurde untersucht, ob sie neben der Förderung z. B. von Vögeln, Bestäubern und der natürlichen Schädlingskontrolle auch die ästhetische Attraktivität der Agrarlandschaften erhöhen. Naturnahe Habitate beeinflussen z.B. die (geometrische) Ordnung in der Landschaft, den Anteil an offener Landschaft, an trockener Vegetation sowie an farbigen Elementen. Bereits in früheren Studien wurde bestätigt, dass Farben, Ordnung und der Anteil an offenem Boden oder grüner Vegetation einen Einfluss darauf haben, ob eine Landschaft als attraktiv wahrgenommen wird oder nicht.

In dieser Untersuchung wurden die visuellen Präferenzen von Personen aus Deutschland, Ungarn, der Schweiz, Frankreich und Italien in Bezug auf unterschiedliche Kombinationen von landwirtschaftlichen Kulturen und naturnahen Habitaten in Agrarlandschaften erforscht. Diese Landschaften unterschieden sich in Relief, Anbausystem (Ackerbau, Weinbau und Olivenanbau) und Klima. Dabei suchten wir nach allgemeinen Mustern und möglichen Unterschieden bei den Präferenzen in den jeweiligen Ländern. Zusätzlich zu den oben genannten visuellen Merkmalen wurden die Auswirkungen des Anteils an Baumbedeckung und offener Landschaft auf die visuelle Präferenz bewertet.

In jedem Land wurde eine Online-Befragung durchgeführt. Bei diesem Auswahlexperiment erhielten die jeweils 350 Teilnehmenden sechs oder acht Auswahlkarten mit je vier Bildern. Jede Auswahlkarte enthielt je eine Bild mit den vier Kombinationen Kultur-Kultur, Kultur-krautige nHab, Kultur-holzige nHab und Kultur-krautige nHab-holzige nHab. Die Teilnehmenden wählten auf jeder Karte das Bild aus, das ihnen am besten gefiel. Zur Datenanalyse wurden lantent-class-Modelle verwendet, welche die visuellen Merkmale jedes Bildes als Attribute mit einbezogen. Die Attribute waren der Anteil an grüner Vegetation, an trockener Vegetation und offenem Boden auf dem Bild sowie die Farben, der Ordnungsgrad und die Offenheit der Landschaft und die. Baumbedeckung.

Alle Attribute spielten für die Erklärung der Präferenzen eine signifikante Rolle. Allerdings konnte die Präferenz für krautige nHab oder holzige nHab nicht vollständig erklärt werden. Die Ergebnisse zeigen, dass sowohl landwirtschaftliche Kulturen als auch naturnahe Habitate wegen der oben beschriebenen visuellen Merkmale bevorzugt bzw. abgelehnt wurden. Naturnahe Habitate wiesen häufiger die bevorzugten visuellen Merkmale auf, sodass sie auch häufiger ausgewählt wurden als Kulturen. Die beiden visuellen Merkmale «Farbe» und «Ordnung» beeinflussten die Entscheidungen der Teilnehmenden je nach Land unterschiedlich. Sie waren wichtig für die Erklärung der Präferenzen in Deutschland, Ungarn und der Schweiz, wo von Ackerkulturen geprägte Landschaften bewertet wurden. In Frankreich und Italien, wo Landschaften mit Dauerkulturen wie Weinberge und Olivenhaine gezeigt wurden, war der Einfluss dieser Attribute signifikant negativ.

Insgesamt wurden in allen untersuchten Ländern krautige und holzige naturnahe Habitate gegenüber den Kulturen bevorzugt. Die Ergebnisse deuten darauf hin, dass Direktzahlungen für naturnahe Habitate in agrarökologischen Programmen zur Förderung des Boden-, Klima- und Biodiversitätsschutzes auch zu einem ästhetischen Mehrwert für die Allgemeinheit führen. Die Präferenzen für bestimmte Merkmale unterscheiden sich jedoch in den jeweiligen Ländern je nach Landschaften, Anbausystemen und Klima.

Résumé

De nombreuses études ont confirmé l’importance des habitats semi-naturels (nHab) herbacés (comme les prairies extensives et les jachères florales, «nHab herbacés») et arborés («nHab arborés») pour la biodiversité et pour les services écosystémiques. Les scientifiques ont cherché à déterminer si, en plus de favoriser les oiseaux, les insectes pollinisateurs et les antagonistes naturels des ravageurs, ces habitats augmentaient également l'attrait esthétique des paysages ruraux. Les habitats semi-naturels influencent par exemple l'ordre des éléments du paysage, la proportion de sol nu, la présence de végétation sèche et d'éléments colorés. Des études antérieures ont déjà confirmé que des facteurs comme les couleurs, l'ordre des éléments du paysage et la proportion de sol nu ou de végétation verte jouent un rôle clé dans la perception d’un paysage comme étant attrayant ou non.

Cette étude a porté sur les préférences visuelles de citoyens allemands, hongrois, suisses, français et italiens en ce qui concerne différentes combinaisons de cultures agricoles et d'habitats semi-naturels dans des paysages agricoles. Ces paysages se distinguaient par leur relief, leur système de culture (agriculture, viticulture et oléiculture) et leur climat. L’objectif était d’identifier des tendances générales et d'explorer les éventuelles différences de préférences entre les pays. En plus des caractéristiques visuelles mentionnées plus haut, nous avons évalué l'impact de la proportion de couverture arborée et de paysage ouvert sur la préférence visuelle.

Une enquête en ligne a été menée dans chaque pays. Dans le cadre de cette expérience de sélection, les 350 participants ont reçu six ou huit cartes de sélection contenant chacune quatre images. Chaque carte contenait une image correspondant à l’une des quatre combinaisons suivantes: culture - culture, culture - habitat semi-naturel herbacé, culture - habitat semi-naturel arboré et culture - habitat semi-naturel herbacé – habitat semi-naturel arboré. Les participants devaient choisir l'image qui leur plaisait le plus sur chaque carte. L'analyse des données a été réalisée à l’aide de modèles de classifications par classes latentes intégrant les caractéristiques visuelles de chaque image comme attributs. Ces attributs comprenaient la proportion de végétation verte, de végétation sèche et de sol ouvert sur l'image ainsi que les couleurs, le degré d'ordre et d'ouverture du paysage et la couverture arborée.

Tous les attributs ont joué un rôle significatif dans l'explication des préférences. Cependant, la préférence pour les nHab herbacés ou les nHab arborés n'a pas pu être entièrement expliquée. Les résultats montrent que tant les cultures agricoles que les habitats semi-naturels ont été préférés ou rejetés en raison des caractéristiques visuelles décrites ci-dessus. Les habitats semi-naturels présentaient plus souvent les caractéristiques visuelles préférées, de sorte qu'ils ont également été plus souvent sélectionnés que les cultures. L’impact des deux caractéristiques visuelles «couleur» et «ordre» variait selon le pays d’origine des participants. Ces caractéristiques ont été déterminantes pour expliquer les préférences en Allemagne, en Hongrie et en Suisse, où des paysages dominés par les grandes cultures ont été évalués. En France et en Italie, où des paysages de cultures permanentes comme des vignobles et des oliveraies ont été présentés, l'influence de ces attributs était largement négative.

Dans l'ensemble, les habitats semi-naturels, qu’ils soient herbacés ou arborés, ont été préférés aux cultures dans tous les pays étudiés. Les résultats indiquent que les paiements directs en faveur des habitats semi-naturels dans le cadre de programmes agroécologiques visant à promouvoir la protection des sols, du climat et de la biodiversité apportent également une valeur ajoutée esthétique à la collectivité. Toutefois, les préférences pour certaines caractéristiques varient d'un pays à l'autre en fonction des paysages, des systèmes de culture et du climat.

Riassunto

Numerosi studi hanno confermato l'importanza degli habitat seminaturali erbacei e arbustivi per la biodiversità e i servizi ecosistemici. Qui abbiamo approfondito se, oltre a favorire tra gli altri, gli uccelli, gli impollinatori e gli antagonisti naturali dei parassiti, essi migliorano anche il valore estetico dei paesaggi agricoli. La loro presenza ha un'influenza, per esempio, sul grado di ordine, la quantità di suolo aperto, la quota di vegetazione secca o l'abbondanza di colori. Studi precedenti avevano già confermato che i colori, l'ordine e la quantità di suolo aperto o di vegetazione verde influenzano la percezione di un paesaggio come più o meno piacevole.

In questo ambito abbiamo cercato di comprendere le preferenze visive dei cittadini di Germania, Ungheria, Svizzera, Francia e Italia per diverse combinazioni di colture e habitat seminaturali nei paesaggi agricoli. Questi paesaggi si differenziavano per rilievo, utilizzo del suolo (seminativi, vite e olivo) e clima. Abbiamo cercato tendenze generali e possibili differenze tra i vari Paesi nelle preferenze espresse. Oltre alle summenzionate caratteristiche visive, abbiamo valutato l'impatto della percentuale di copertura arborea e dell'apertura del paesaggio sulle preferenze visive.

In ogni Paese è stato condotto un test online basato sulla scelta di immagini. Durante l'esperimento sono state mostrate a 350 partecipanti sei o otto schede con quattro immagini ciascuna. Ogni scheda consisteva di un'immagine di ognuna delle quattro combinazioni: coltura-coltura, coltura-erbacea, coltura-arbustiva e coltura-erbacea-arbustiva. Per ogni scheda, i partecipanti dovevano scegliere l'immagine che preferivano. Per l'analisi dei dati sono stati applicati modelli a classi latenti che includono le caratteristiche visive di ciascuna immagine come variabili, costituiti dalla quantità di vegetazione verde, vegetazione secca e suolo aperto nell'immagine, nonché dai colori e dal grado di ordine, dall'apertura e dalla copertura arborea.

Tutti le variabili hanno contribuito in misura significativa a spiegare le preferenze, sebbene non sia stato possibile spiegare interamente quelle per gli habitat seminaturali erbacei e arbustivi. I risultati hanno tuttavia dimostrato che la preferenza o il rifiuto delle colture e degli habitat seminaturali è da attribuire alle loro caratteristiche visive. Gli habitat seminaturali evidenziano più spesso caratteristiche visive preferite, pertanto sono stati scelti più spesso delle colture. Sono inoltre emerse differenze tra i Paesi nell'impatto di due caratteristiche visive, ossia colore e ordine, sulle scelte dei partecipanti. Questi hanno dimostrato di essere importanti per spiegare le preferenze espresse in Germania, Ungheria e Svizzera, dove sono stati valutati i paesaggi dominati da seminativi, mentre i loro effetti sono risultati notevolmente negativi in Francia e in Italia, dove sono stati mostrati paesaggi con colture permanenti, come vigneti e uliveti.

Tuttavia, in tutti i Paesi analizzati gli habitat seminaturali erbacei e arbustivi sono stati nel complesso preferiti alle colture. I nostri risultati indicano che i contributi sotto forma di pagamenti diretti agli habitat seminaturali nei programmi agroambientali per promuovere la protezione del suolo, del clima e della biodiversità creano anche un valore aggiunto estetico per la popolazione Le preferenze per caratteristiche specifiche variano comunque a seconda dei Paesi e dei paesaggi, dell'utilizzo del suolo e delle caratteristiche climatiche nei rispettivi Paesi.

1 Introduction

Due to the global loss of biodiversity, there is an ongoing debate about how agricultural landscapes should develop in the future (Lefebvre et al., 2015; Reidsma et al., 2006). Introducing semi-natural habitats (SNHs) was found to be a promising solution for enhancing biodiversity in the European Union (EU). Most SNHs have positive effects on biodiversity; also boosting ecosystem services such as pollination and natural pest regulation (Holland et al., 2017, 2020). Literature also suggests that SNHs enhance visually perceived landscape quality (Junge et al., 2011, 2015; Lindemann-Matthies, Briegel, et al., 2010; Sullivan et al., 2004). Nevertheless, SNHs still face problems of acceptance, especially among farmers, because some farmers think that they are messy and do not show their skills as farmers (Burton, 2012; Burton et al., 2008; Junge et al., 2011; Nassauer, 1995). Therefore, information on the visual appearance of SNH and the preferences of the general population may help in finding a way to better accept SNHs.

Bourassa (1991) defined a theory of landscape preference. The theory assumes that some aesthetic preferences are common to all people, while others are influenced by people's sociocultural backgrounds. A third group of preferences is related to the landscape experiences, wishes, education, age and gender of the individual person. The existence of preferences common to all people and influenced by people's sociocultural backgrounds suggests a sufficient base for the hypothesis, that within a country some common preferences could be detected.

Sociodemographic variables (e.g. age, gender and education) are often used to include individual characteristics in the analysis of (visual) landscape preferences. The literature on landscape preferences including sociodemographic variables as explaining variables has mixed reports on whether such variables influence landscape preferences, and if they do, how. Junge et al. (2011, 2015) found that sociodemographic variables explained only a small part of the variance. Nevertheless, the higher-educated participants in their study preferred ecological focus areas significantly more than the lower-educated participants did. Van den Berg and Koole (2006) reported that younger and higher-educated participants prefer wild landscapes rather than managed landscapes. Recently, Rust et al. (2021) reported that older people (above 55 years old) prefer landscapes with trees or agroforestry.

Based on the aforementioned common ground for landscape preferences, the design of the landscape, particularly the type of (arable) crops, their proportion and the proportion of semi-natural and natural habitats, is important for landscape preference (Junge et al., 2011). Li and Nassauer (2020) and Nassauer et al. (2021) showed the importance of design in an urban context. In an agrarian context, it is known that people prefer meadows containing a mixture of colourful flowering plant species and grasses (Junge et al., 2015; Lindemann-Matthies, Junge et al., 2010). Furthermore, the preferred landscape is one that is species-rich and diverse, as well as managed (Junge et al., 2011, 2015). However, this information is hardly tangible because we do not know exactly what people associate, for instance, with the attribute 'species-rich'. In addition, most of the investigations were conducted in Switzerland, and we do not know the extent to which the results can be generalised and applied to other countries.

To fill the aforementioned gap, Schüpbach et al. (2021) analysed the effects of herbaceous and woody SNHs on an aspect of cultural services: visual preference. This was part of the European QuESSA (Quantification of Ecosystem Services for Sustainable Agriculture) project (Holland et al., 2014; Holland et al., 2020; Rega et al., 2018). Based on pictures with combinations of crops and herbaceous and woody SNHs in Hungary and Switzerland, a choice experiment (CE) was conducted (Schüpbach et al., 2021). The visual qualities of the pictures were described using visual characteristics, such as the amounts of green vegetation and bare soil and the presence of colourful landscape elements. The results suggested that these visual characteristics signified the visual preferences of the participants in Switzerland for herbaceous SNHs. The analysis of the Hungarian results led to the assumption that additional aspects, which were not included in the list of characteristics, had been perceived as negative by the participants. In both countries, the visual preference for woody SNHs could not be explained by the characteristics considered. Therefore, woody SNHs in particular might have additional characteristics influencing visual preference, that were not considered.

The present study aimed to evaluate a list of visual characteristics that could explain preferences for herbaceous and woody SNHs across different European countries. We extended our survey to Germany, France and Italy, in addition to Hungary and Switzerland, to determine whether there were differences between countries in terms of visual preferences for crops or herbaceous and woody SNHs. Through this analysis, we hoped to be able to answer the following research questions:

- What are the visual characteristics that best explain participants' preferences for combinations of crops and SNH in five European countries?
- Are there differences between countries regarding the effects of the aforementioned visual characteristics on choices and regarding visual preferences for SNHs? If so, how can these differences be explained?

2 Materials and Methods

2.1 Experimental design and study regions

To evaluate visual preference as an aspect of cultural services provided by herbaceous and woody SNHs, a survey was conducted in five countries collaborating in the QuESSA project (Figure 1). For this purpose, the QuESSA experimental design was adopted. This design is based on combinations of crops and SNHs. In each country, a core crop had been defined depending on the land use of the country. This core crop was combined with either another adjacent crop or an herbaceous or woody SNH.

Figure 1: The five study regions in Europe.
In each region, several sites were involved. At each site, four combinations with the core crop fields were analysed. These were either a core crop with an adjacent crop or a core crop with an adjacent herbaceous or woody SNH.

Regarding physical landscape conditions, the regions in the five countries considered in the study cover a range of contrasting landscapes (for details, see Appendix 10.1). The German and Hungarian regions are both situated in a plain (Rheinebene and Alföld), while in the Swiss, French and Italian study sites the relief is somewhat hilly. Furthermore, the study sites differ regarding climate: The German and Swiss regions have temperate climates, with warm summers and colder winters. However, they differ in the amount of rainfall. In the German, Hungarian and

French regions the amounts of precipitation are similar, but distributions throughout the year differ. The Hungarian, French and Italian regions are all characterised by dry summers and wet winters, while in the German and the Swiss site, precipitation is distributed over the whole year. Due to the availability of precipitation throughout the year, the grassland vegetation in the German and the Swiss site is more or less intensively green. In the Hungarian, French and Swiss regions, the grassland vegetation is more or less dry in summer. Due to the warmer winter in the Mediterranean climate of France and Italy, the French and Italian vegetation differs from the Hungarian vegetation.

In all study regions, land use intensity has a major impact on vegetation composition. A high amount of fertilizer limits the presence and richness of flowering plant species. In the German and the Swiss region, land use intensity is the major limitation for species-rich grassland. Regarding agricultural characteristics, in the study regions of Germany, Hungary and Switzerland, arable crops dominate the landscape. In the German region, there is a substantial proportion of pumpkins besides vegetables and arable crops. The regions of France and Italy are characterised by permanent crops: vineyards in France and olive groves in Italy. Table 1 shows the core crop and its adjacent crops in each study region. In addition, there were combinations with core crops and adjacent herbaceous or woody SNHs. Herbaceous SNHs are mostly permanent grasslands; in Switzerland, however, the herbaceous SNHs are sown and therefore contain flowers, in contrast to Germany.

Table 1: Core crops and adjacent crops in the study regions of five analysed countries (Germany, Hungary, Switzerland, France and Italy). The experimental design of the Quessa project consisted of two replications each with a core crop and an adjacent crop or an adjacent SNH. The table is restricted on the crops.

Replication	Crop	Germany	Hungary	Switzerland	France	Italy
Replication 1	Core crop	Pumpkin	Sunflower	Rapeseed	Vine	Olive
Replication 1	Adjacent crop	Cereal	Cereal	Cereal	Vine	Olive
Replication 2	Core crop	Pumpkin	Sunflower	Rapeseed	Vine	Olive
Replication 2	Adjacent crop	Rapeseed	Rapeseed	High-input meadow	Vine	Olive

2.2 Choice experiments, attributes and models

2.2.1 Theoretical background

Choice experiments (CEs) have their roots in consumer theory (Lancaster, 1966). They were originally developed in marketing to identify products that provide the highest utility for consumers. Their analytical framework was based on the random utility model (McFadden, 1974). About 10 years ago, surveys based on CEs were introduced in landscape assessment (Arnberger & Eder, 2011; Bidegain et al., 2020; Immerzeel et al., 2022; Rewitzer et al., 2017; Schirpke et al., 2023). The participants were usually shown a number of alternatives represented by pictures of landscapes, which were designed according to a variety of characteristics (e.g. a different number of trees) on several levels, and participants had to choose their preferred alternative. In some cases, the participants simply had to select their most preferred picture (e.g. Arnberger & Eder, 2011). In other cases, additional information, such as the number of species or the costs, was provided, and the participants had to choose the option that best fit the picture and the additional options (e.g. Rewitzer et al., 2017). This additional information was included in the random utility model as an attribute. The output of the model showed each attribute's significance, coefficient height and sign (positive or negative). Depending on this information, the model showed which attributes best explained the participants' choices.

There are three types of choice models: multinomial logit models, mixed logit models and latent class models (Train, 2009), but only mixed logit models and latent class models account for individual preferences (Train, 2009). Individual preferences are important for visual landscape preferences because they influence the latter. As Schüpbach et al. (2021) showed that latent class models best fit the data of Hungary and Switzerland, we decided to also apply latent class models to the present study. Latent class models enable study participants to be assigned to a predefined number of classes (Sarrias & Daziano, 2017) based on the participants' choices and thus according to their visual preferences. More methodological details and additional literature about latent class models can be found in

Schüpbach et al. (2021). Based on the participants' choices, the model assigns a probability of belonging to one of the predefined number of classes to each participant. This process allows participants to belong to more than one class.

2.2.2 Developing attributes and models for the study

In Schüpbach et al. (2021), the following five visual characteristics were defined as attributes: green, orderliness (order), the presence of open soil (NoVeg), the presence of dry vegetation (DryVeg) and the presence of colours (ColAvail). All these attributes were clearly defined on two or three levels: 0 (the specific properties described by the attribute are not available), 1 (the specific properties described by the attribute are partly available) and 2 (the specific properties described by the attribute are abundant).

The attribute 'green' described the proportion of green vegetation in the picture, and the attribute 'order' described the degree of orderliness in the picture. Straight lines (borders), clear patterns (e.g. seed rows) or homogeneous vegetation cover were expressions of orderliness. The attribute 'NoVeg' described the proportion of open soil in the picture, 'DryVeg' described the proportion of dry vegetation in the picture and 'ColAvail' described the presence of clearly visible colours that were not green or brown (i.e. red, yellow, white or purple). The attribute 'ColAvail' was coded on only two levels (0/1).

In addition, a dummy attribute was created for each of the two SNH types (herbaceous and woody), indicating the presence/absence of an herbaceous or woody SNH (0/1). This was done to determine whether the aforementioned visual characteristics could explain the preferences for these landscape elements. These two dummy attributes were named 'grassy' and 'woody'.

Schüpbach et al. (2021), based on findings from the Hungarian and Swiss regions, showed that the selected visual characteristics described the visual preferences for herbaceous SNHs in the Swiss study region well. Nevertheless, the results showed that the characteristics could not fully explain the preferences for woody elements in both countries and herbaceous SNHs in Hungary. In both countries,visual characteristics associated with woody structures had a significant influence on the likelihood of selecting the images but were not included in the list of attributes used then. The same was true for the herbaceous SNHs in Hungary.

To include more aspects characterising the visual preference for woody SNHs, a literature review was conducted on the effect of woody elements on visual landscape preference. 'Tree cover' (Jiang et al., 2015) and 'openness' (Zhang et al., 2021) were revealed to be important aspects. Therefore, the additional attribute 'TreeCov' describing the proportion of the picture covered by trees of any origin was defined on three levels: less than 5% (0), 5%–20% (1) and more than 20% (2). The second new attribute, 'Openness', described the restriction of the view by trees or high vegetation: The view was fully blocked (0), the view was partly blocked (1) and the view was more or less fully free (2).

To evaluate the new attributes, we showed a random sample of 10 pictures out of all pictures of all the involved countries to a sample of about 40 researchers from two Agroscope research groups and asked them to assign a value to each picture and attribute on predefined levels. This was done to achieve more robust values for the attributes compared to the values obtained from the approach used in Schüpbach et al. (2021). However, a statistical analysis of all evaluations for each attribute revealed that it was not possible to assign an integer value to the attributes that represented one of the three levels (0, 1 and 2), as is usually done in choice models. Assigning integer values for each attribute would require expert decisions regarding the initial evaluation of the attributes (Schüpbach et al., 2021). To obtain more robust values, we wanted to avoid expert decisions. Therefore, the mean value was calculated for each attribute in each picture. This resulted in decimal values, which were included in the models.

To explain the participants' choices, all the attributes described above (including tree cover and openness and the two dummy variables herbaceous and woody) were included in the latent class model. Each study region was analysed separately. The Bayesian information criterion (BIC) was used to decide the optimal number of classes. A second criterion was that classes must differ significantly from each other and have a minimal size of 10% of the sample. When these rules were applied, in many cases, two-class models fitted the criteria best; in a few cases, a three-class model would have been slightly better. To facilitate the comparison between study regions, we decided to use the results of the two-class models in all regions to describe and compare the results. The models were run in R 3.3 using the packages mlogit and gmnl. More details about the models can be found in Appendix 10.5.

In addition to the outputs of the models, we used the information on the probability that a participant belongs to a certain class to calculate the proportions of the sociodemographic variables (gender, age and education) for each class. With the same information, we were able to calculate the proportions of the chosen combinations per class. As we knew to which season each picture belonged and which of the two replications each picture was, we were also able to evaluate the choices according to season and replication (see section 2.3).

2.3 Photo editing

The bases of our CE were photographs of sites used in pollination and predation experiments within the QuESSA project (Holland et al., 2014). The project partners took photographs of these study sites. As seasons have a major impact on the visual aspect of the agrarian landscape and its visual preference (Stobbelaar et al., 2004), each site was photographed in the three or four most characteristic vegetation stages. These stages do not directly correlate with the seasons (spring, summer, autumn and winter), so we named them Season 1, Season 2, Season 3 and Season 4. In general, Season 1 represents a stage in (early) spring, Season 2 a stage in late spring–early summer, Season 3 a stage in summer or late summer and Season 4 a stage in (early) autumn. Pictures from winter were not provided, and we included pictures in which the core crop had already been sown or had been harvested recently. Furthermore, we showed the crops and SNHs in stages which clearly differed from each other.

To obtain photographs that were comparable within and among countries, we homogenised them in terms of the background and quality of the depicted crops and SNHs using Adobe Photoshop (Adobe, 2019). Each picture was modified to display an identical background adapted to the study region and the respective stage of the vegetation. Nevertheless, some controlled variations were included. This was achieved by providing two replications (two different pictures) for each combination in each season. If available, the two replications differed in the proportion of flowers or open soil or the degree of orderliness in the picture. Finally, to provide a complete choice set, we created a fourth combination consisting of a core crop with adjacent herbaceous and woody SNHs. Regarding the representation of the combinations, we had an orthogonal set.

Table 2: Seasons and core crops evaluated in the surveys of the different study regions

Study region	Season 1: early spring	Season 2: late spring/early summer	Season 3: summer	Season 4: late summer/early autumn
Germany	No picture	Freshly sown pumpkin	Green pumpkin plants	Pumpkin plants with ripe pumpkins
Hungary	Freshly sown sunflowers, flowering rapeseed	Small sunflower plants	Flowering sunflower plants	Harvested dry sunflower plants and rapeseed
Switzerland	Flowering rapeseed	Rapeseed plants with pods	Harvested rapeseed	No picture
France	Bare vines	Fresh, green vines	No picture	Vines with autumn-coloured leaves
Italy	Olive grove with green grass and a few flowers in one picture	Olive grove with dry grass	No picture	Olive grove with more or less green grass

2.4 Questionnaire and study participants

The CE was conducted as an online photo survey based on a questionnaire compiled in UniPark (QuestBack, 1999, 2012). The questionnaire was developed in English and translated into the languages of the respective countries. Each participant was provided with a questionnaire in the language of their country and evaluated only pictures of their country. For the participants in Switzerland, German and French questionnaires were provided. For more details regarding the development of the questionnaire, see Schüpbach et al. (2021).

As with all CEs, the participants were shown choice cards, each containing one picture of the following combinations: crop-crop, crop-herbaceous, crop-woody and crop-herbaceous-woody SNHs. The participants had to choose the picture they liked best. An example of a choice card for each study region can be found in Appendix 10.2. As described in section 2.3, for each combination, we provided two replicats. Each replicat was shown in the three or four most relevant stages, which were assigned to one of the four seasons (see Table 2). This resulted in two choice cards for each relevant season (one choice card for each replication). The participants in Hungary thus rated eight choice cards containing 32 pictures (four seasons). The participants in Germany, Switzerland, France and Italy rated six choice cards containing 24 pictures (three seasons). For the different seasons and stages in the individual study regions, see Table 2.

In addition to the rating, the participants had to indicate gender, age and education level.

Participants for the survey in the respective country were recruited by Respondi (www.respondi.com) on the level of the whole country. For each country we aimed for a representative sample of about 350 participants. Table 3 shows the number of participants for each country and the dates of the pretest and of the survey. After downloading the data, we checked their quality using a quality indicator provided by Respondi and we ran plausibility checks. For more details see Schüpbach et al. (2021). This procedure reduced the number of participants in each sample to 352. In Switzerland, nine more participants had to be excluded because they did not rate all the choice cards entirely.

Table 3: Overview of the sample size and the dates of the pretest and survey in the different countries

Study region	Number of persons who completed the survey	Number of persons included in the analysis	Date of the pretest	Date of the survey
Germany	401	352	20.5.2015–12.6.2015	15.6.2015–22.6.2015
Hungary	380	352	3.7.2015–17.7.2015	22.7.2015–8.8. 2015
Switzerland	380	341	1.6.2015–8.6.2015	12.6.2015–22.6. 2015
France	417	352	24.3.2016–29.3.2016	5.4.2016–10.4. 2016
Italy	445	352	29.2.2016–16.3.2016	17.3.2016–8.4. 2016

In all countries except Switzerland and France, the age structure of the sample was similar to the age structure of the entire country (Figure 2). In Switzerland, younger people were overrepresented, while older people were underrepresented. In France, middle-aged people were overrepresented, while younger and older people were underrepresented. Regarding gender, in all countries, men and women were well represented by the sample. As for education, in France, medium- and higher-educated people were overrepresented, while lower-educated people were underrepresented. Furthermore, the Swiss sample was representative in terms of the proportions of German- and French-speaking people. The detailed proportions and definitions of the classes can be found in Appendix 10.3.

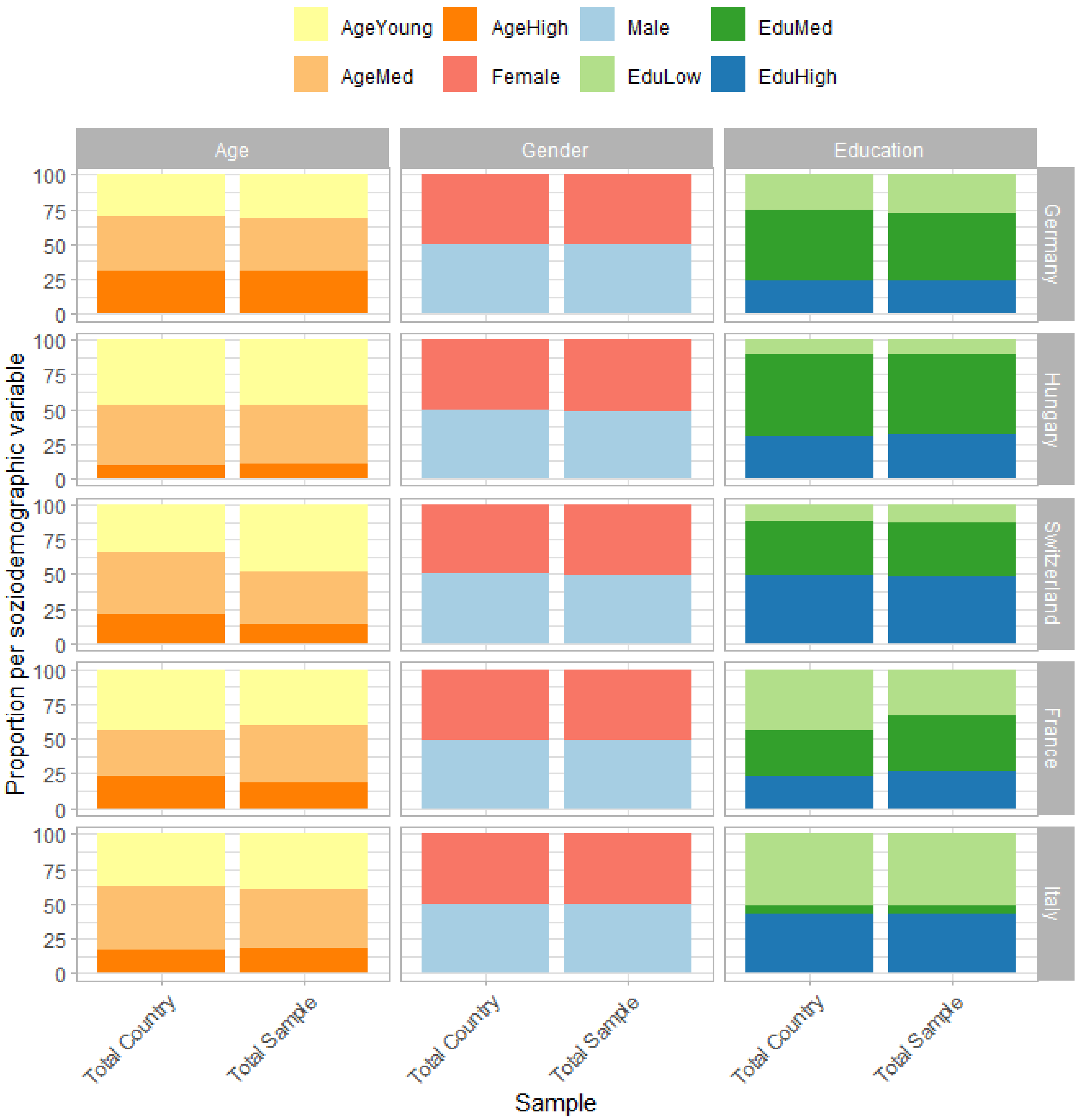

Figure 2: Proportions of age, gender and education in Germany, Hungary, Switzerland, France and Italy.
The first bar on the left represents the whole country, and the second bar represents the whole sample. AgeYoung: 18–39; AgeMed: 40–60; AgeHigh: > 60. EduLow: basic education; EduMed: vocational training; EduHigh: university training.

3 Results

3.1 Description of models, classes and sociodemographic variables

Following the method described in sections 2.2–2.4, we ran a latent class model for each country, dividing the participants into two classes based on their choices according to their preferences. Initially, all attributes were included in the models. However, we had to exclude the following attributes: tree cover (TreeCov) in Hungary, the amount of dry vegetation (DryVeg) in Switzerland and the amount of open soil (NoVeg) in France. It was necessary to exclude these attributes because otherwise, the models could not be solved due to singularity, lack of convergence or the fact that the classes did not significantly differ from each other.

Figure 3 shows the participants' choices as a result of the latent class model. The data are aggregated to the whole sample (left bar) and to the two classes (right bars). Each participant was assigned to a class based on the probability of their belonging to that class. Furthermore, each choice card reflected for each participant which combination was chosen. Compared to the whole sample, the two classes differed in the number of chosen crop-crop and crop-woody combinations. In all countries, we found the same pattern: one class that chose a substantial number of all combinations and a second class that was characterised by a dominance of chosen crop-woody combinations. According to the choices of the two classes, we named the first class the mixed class and the second class the woody class. In Germany, France and Italy, the two classes were more or less of equal size. In Switzerland, the smaller 'woody class' was about a quarter of the sample; in Hungary, it was even less.

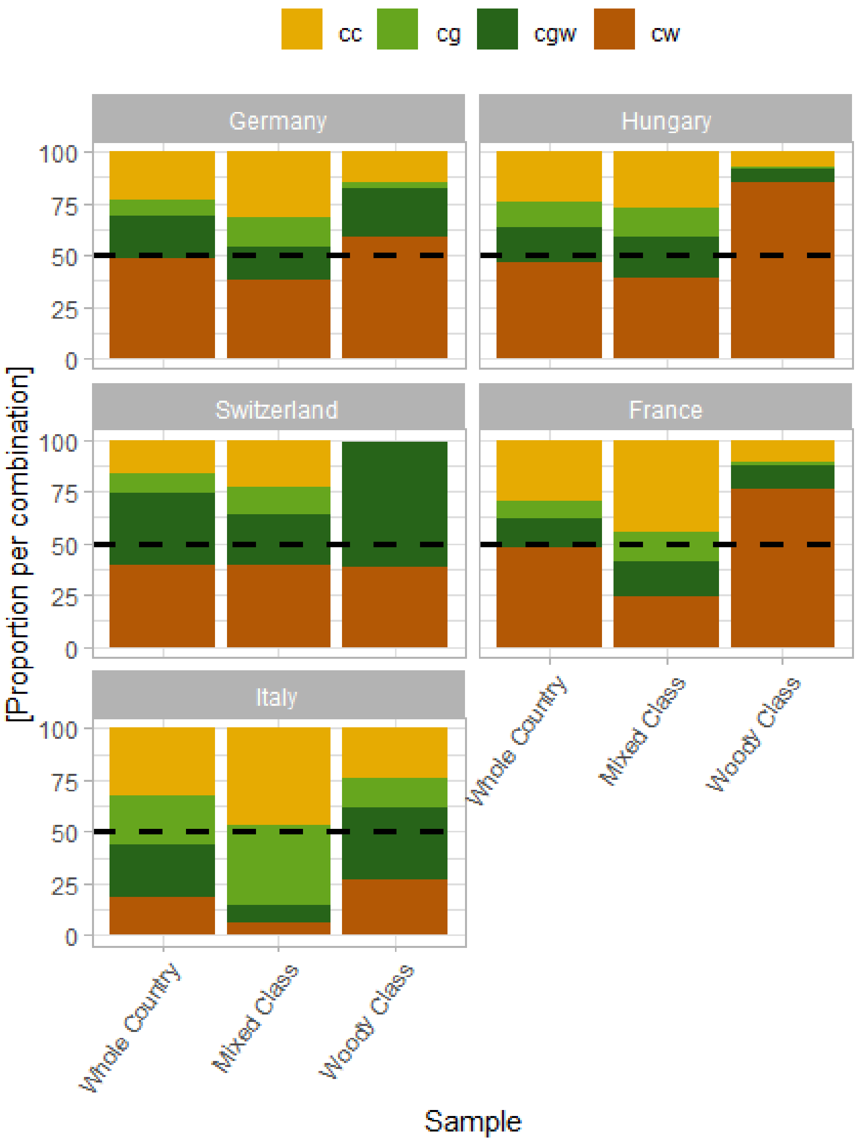

Figure 3: Proportions of the selected combinations.
(cc: crop-crop; cg: crop-herbaceous; cgw: crop-herbaceous-woody and cw: crop-woody) for the whole sample (left bar), the mixed class (middle bar) and the woody class (right bar) in Germany, Hungary, Switzerland, France and Italy. The two classes were defined y a latent class model based on the participants' choices. The proportions were calculated based on the knowledge about the probability that a participant belonged to one of the two classes and the knowledge about the combinations chosen by the individual participants. Germany: mixed class = 49.2%, woody class = 50.8%; Hungary: mixed class = 74.3%, woody class = 25.7%; Switzerland: mixed class = 70.4%, woody class = 29.6%; France: mixed class = 55.4%, woody class = 44.6%; Italy: mixed class = 38.8%, woody class = 61.2%.

Sociodemographic variables significantly affected the participants' choices. For age and education, we found similar trends in most countries: the younger participants chose crop-crop and crop-herbaceous combinations significantly more often than the older participants did and thus tended to belong significantly more often to the mixed class than to the woody class. The same was true for the lower-educated participants; they tended to belong significantly more often to the mixed class, while the higher-educated participants chose crop-woody or crop-herbaceous-woody combinations significantly more often and more often belonged to the woody class. However, education was not significant in Switzerland, and age was not significant in Hungary. For gender, we found mixed effects between the countries. In Germany and Italy, women chose woody combinations significantly more often than men did and belonged to the woody class. In Hungary and France, women chose woody combinations significantly less often and tended to belong significantly more often to the mixed class. In Switzerland, gender was not significant. For more details, see Appendix 10.3.

3.2 Visual preferences for herbaceous and woody SNHs

Overall preferences

More than 50% of all the participants in the present study chose combinations containing SNHs. In contrast, between 15% (Switzerland) and 35% (Italy, left bar in Figure 3) chose crop-crop combinations. Thus, between 65% and 85% of the choices were combinations containing at least one SNH. Crop-woody combinations made up about half of all choices in France, Germany and Hungary, while crop-herbaceous combinations had the lowest share in all countries, except for Italy, where crop-herbaceous and crop- herbaceous--woody combinations made up about 25% each. The highest share of crop-herbaceous-woody combinations was found in Switzerland, at about 35% (Figure 3, leftmost bar).

Preferences of the 'mixed class'

Compared to the entire sample, the mixed class (middle bar in Figure 3) had a higher proportion of choices for crop-crop combinations. In the mixed classes of Germany, Hungary and Switzerland, this proportion was about a third of all choices. In the mixed classes of France and Italy, it was about half of the choices. Therefore, in the mixed classes of all the countries, about half of all the choices contained at least one SNH. In addition, the high proportion of choices for crop-herbaceous combinations (about 30%) in Italy was remarkable.

Preferences of the 'woody class'

In Germany, Hungary and France, the choices in the 'woody class' (Figure 3, bar to the right) were more or less dominated by crop-woody combinations (up to 90%), while in Switzerland and Italy, a high proportion of the participants in the woody class chose crop-herbaceous-woody combinations besides crop-woody combinations. In Switzerland, the choices of the crop-herbaceous-woody combination in the woody class were more than 50%; in Italy, they were more than a quarter. In all countries except Italy, the share of crop-crop combination choices was less than a quarter. In Italy, it was about a quarter.

Influence of season and replication on visual preferences

Separating choices by season and replication (Figure 4) showed shifts in the choices of combinations. In Germany, for example, a high proportion of crop-crop combinations was found in both classes but exclusively for the second replication in Season 2. The same was true for crop-crop combinations in Season 1 in Hungary. In Switzerland, the proportion of chosen crop-herbaceous and crop-herbaceous-woody combinations in the mixed class increased in Seasons 2 and 3. In the 'woody class', this was true particularly for crop-herbaceous-woody combinations. In France, seasonal differences were found in both classes regarding the proportion of chosen crop-crop combination. In both classes, this proportion was lower in Season 1 than in Seasons 2 and 4. In Italy, we found differences in the proportion of chosen crop-herbaceous-woody combinations. The participants in the 'woody class' chose a higher proportion of crop-herbaceous-woody combinations of the second replication than of the first replication. This applied to all seasons.

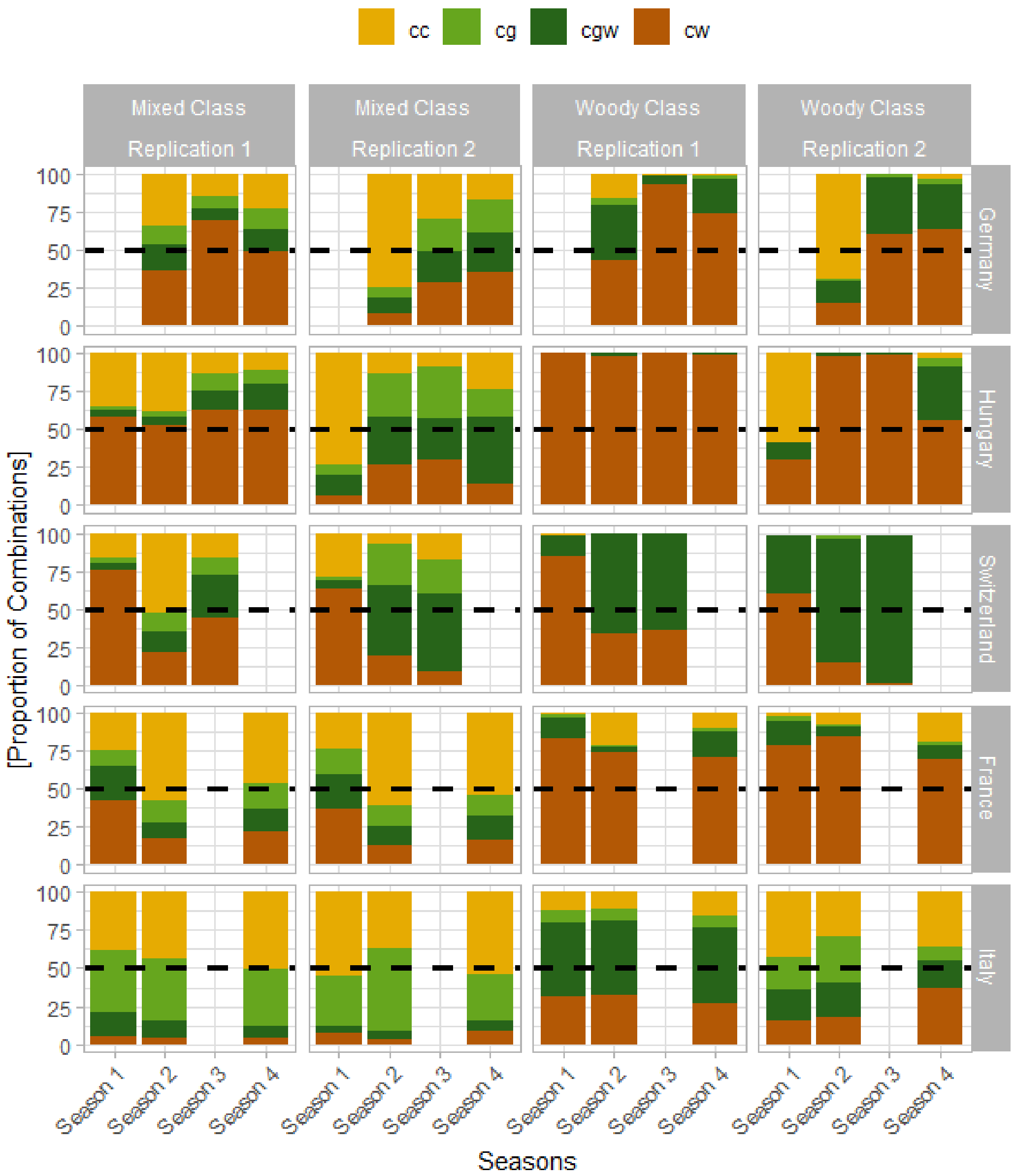

Figure 4: Proportions of the selected combinations.
(cc: crop-crop; cg: crop-herbaceous; cgw: crop-herbaceous-woody and cw: crop-woody) in Germany, Hungary, Switzerland, France and Italy for the whole country and the two classes defined by the model according to the participants' choices. Based on the knowledge regarding the probability that a participant belonged to one of the two classes and the knowledge regarding the combinations chosen by the individual participants, the proportions of combinations were calculated and considering season and replication. Germany: mixed class = 49.2%, woody class = 50.8%; Hungary: mixed class = 74.3%, woody class = 25.7%; Switzerland: mixed class = 70.4%, woody class = 29.6%; France: mixed class = 55.4%, woody class = 44.6%; Italy: mixed class = 38.8%, woody class = 61.2%. Season 1: (early) spring; Season 2: late spring/early summer; Season 3: summer; Season 4: late summer/early autumn.

3.3 The attributes' impacts on the participants' choices

Because, as mentioned earlier, the present study aimed to improve the list of visual characteristics to better explain the visual preferences for herbaceous and woody SNHs, openness and tree cover were added as attributes. The entire list of attributes was also evaluated by a sample of about 40 researchers from two different Agroscope research groups. This resulted in a continuous scale of attribute values between 0 and 2. This is a clear difference from the integer values on two or three levels, which are often used in latent class models. An overview of the range and number of levels of each attribute in each country can be found in Appendix 10.4. There is also an overview of all attributes and their values for each country. In the following section, the effects of these attributes on the participants' choices are described.

Figure 5 shows whether the presence of each visual characteristic in each country had a significant positive or negative effect on the choices or if its effect was not significant. Each bar represents a country. Depending on the proportion of the class, the proportion of each bar is coloured according to the effect of the attribute on the choices in the class and country (green: significantly positive; red: significantly negative; grey: not significant). A table with the coefficient values can be found in Appendix 10.5.

Green vegetation (Green)

The presence of green vegetation had a significantly positive effect on the woody class in all countries except Hungary, where the effect was negative. Green had no significant effect on the choices of the participants in the mixed class in any country.

Orderliness (Order)

Orderliness had a significantly positive effect on the choices of the participants in the mixed classes in Hungary and Switzerland and in both classes in Germany. Its effects on the choices of the participants in both classes in France and in the woody class in Italy were significantly negative. Orderliness had no significant effects on the choices of the participants in the woody classes in Hungary and Switzerland or in the mixed class in Italy.

Presence of open soil (NoVeg)

Open soil had a significantly negative effect on the choices of the participants in both classes in Germany, in the woody class in Hungary and in the mixed classes in Switzerland and Italy. It had no significant effect on the choices of the woody class in Switzerland and Italy or of the mixed class in Hungary. NoVeg could not be included in the model in France.

Presence of dry vegetation (DryVeg)

Dry vegetation had a significantly negative effect on the choices of the participants in both classes in Hungary and in the mixed class in France. It had no significant effect on the choices of the participants in both classes in Germany and Italy and in the woody class in France. The attribute could not be included in Switzerland's model.

Availability of colours (ColAvail)

Colours had a significantly positive effect on the choices of the participants in both classes in Germany and in the mixed classes in Hungary and Switzerland. They had a significantly negative effect on the choices of the participants in the woody class in Italy but had no significant effect on the choices of the participants in the woody classes in Hungary and Switzerland, in both classes in France and in the mixed class in Italy.

Openness (Openness)

Openness had a significantly positive effect on the choices of the participants in both classes in Italy, in the woody class in Germany and in the mixed class in Hungary but had a significantly negative effect on the choices of the participants in the mixed class in France. It had no significant effect on the choices of the participants in either class in Switzerland, in the mixed class in Germany or in the woody class in France.

Tree cover (TreeCov)

The proportion of trees in the picture had a significantly positive effect on the choices of the participants in the mixed class in Germany, in the woody class in France and in both classes in Italy, but had a significantly negative effect on the choices of the participants in both classes in Switzerland. The attribute had no significant effect on the choices of the participants in the woody class in Germany or in the mixed class in France. The attribute could not be included in the Hungarian model.

Presence of herbaceous SNHs (Grassy)

The presence of an herbaceous SNH had a significantly negative effect on the choices of the participants in all the analysed countries. This was true for both classes in Germany and Switzerland, for the mixed class in Hungary and for the woody classes in France and Italy. The presence of an herbaceous SNH had no significant effect on the choices of the participants in the woody class in Hungary or in the mixed classes in France and Italy.

Presence of woody SNHs (Woody)

The presence of a woody SNH had a significantly positive effect on the choices of the participants in both classes in Hungary, in the woody classes in Germany and Italy and in the mixed class in Switzerland. Its effect was significantly negative for the participants in the mixed classes in France and Italy. The presence of a woody SNH had no significant effect on the choices of the participants in the woody classes in Switzerland and France.

Figure 5: Statistical effects of the attributes included in the latent class models of Germany, Hungary, Switzerland, France and Italy. Grassy refers to the herbaceous SNH. Mixed: mixed class; Woody: woody class. Grassy refers to the herbaceous SNH.

4 Discussion

4.1 To what extent do the defined visual characteristics explain the participants' visual preferences?

To understand aesthetic preferences for land use combinations in five European countries, we applied latent class models that included visual characteristics of the agrarian land use combinations as attributes. Our results showed that all the visual characteristics had a significant influence on our models and thus explained preference. However, not all of them had the same influence in all countries. In most cases, the amount of green vegetation (Green) had a significant positive effect on the preferences. The amount of open soil (NoVeg) or dry vegetation (DryVeg) had a negative influence. Former research reported a preference for green vegetation over bare soil or dry vegetation (De La Fuente De Val & Mühlhauser S., 2014; Junge et al., 2015; Sharafatmandrad & Khosravi Mashizi, 2020). Here, we found that these three visual characteristics had the same effect in all countries. Orderliness in the picture, the availability of colours and—to a lower extent—tree cover showed contrasting effects on the participants' choices when the countries were compared. We suppose that these differences are country-related (see Section 4.2). Nevertheless, our results confirm the literature, which states that all attributes significantly help to explain (visual) landscape preferences. Junge et al. (2015) found that orderliness and colourful flowers in the picture increased the preference for farmland landscapes, while Hůla and Flegr (2016), Kütt et al. (2016), Todorova et al. (2004) and Tomitaka et al. (2021) found that colours had a positive effect in urban settings. Jiang et al. (2015) and Zhang et al. (2021) reported the positive effects of trees and openness.

As we were not able to include all visual characteristics in all our models, some could not be tested in all the countries included in the study. The attributes TreeCov, DryVeg and NoVeg were not considered in Hungary, Switzerland and France, respectively. In Hungary, it can be assumed that there was a correlation between the attribute woody SNH and the attribute TreeCov. The model was solved either with Woody or with TreeCov. As TreeCov describes the proportion of trees in the picture (including woody SNHs), we assumed that the Hungarian pictures contained either woody SNHs in the crop-woody or crop-herbaceous-woody combinations or practically no trees in the remaining combinations. The Hungarian pictures therefore fit the experimental design well. In Switzerland, we had to exclude DryVeg because it showed insufficient variation within the pictures of Seasons 1 and 3. In the case of NoVeg in France, we had to exclude it to solve the model because a correlation was found between NoVeg and the availability of green vegetation (Green).

The preference for herbaceous and woody SNHs can be better explained if the defined characteristics (attributes) fully explain the participants' aesthetic preferences. However, despite our efforts to fully explain the preferences by adding the new attributes (tree cover and openness), we did not achieve this. Nevertheless, in France and Italy, tree cover turned out to be important in explaining preferences for trees (or woody plants) in the picture, independent of their type (olive trees or SNH trees). One reason for the reduced explanatory power of the model with regard to herbaceous SNHs as compared to Schüpbach et al. (2021) could be the changed scaling of the attribute values compared. The values of all attributes changed from a two- or three-level integer scale (0/1/2) to a multilevel decimal scale in the current analysis. This may be better adapted to reality, but it can also make the effects more difficult to measure due to the higher number of levels.

The change from two or three equally defined levels to a higher number of levels was due to the results of a pre-test run with about 40 researchers. The goal had been to obtain more robust values for the attributes compared to the first study (Schüpbach et al., 2021), in which only four experts had evaluated the attributes. We had hoped to achieve similar values on two or three levels (0/1/2) but the pre-test resulted in a much more heterogeneous assessment. The perception of what is, for instance, green vegetation or clearly visible flowers varied substantially among people, although we carefully specified the criteria for each level.

Despite all the aforementioned issues and differences, when we compared the current results for Hungary and Switzerland with the results of the first analysis (Schüpbach et al., 2021), we found comparable results regarding the sizes of the two classes and the choices made by the participants in each class. The newly included countries—Germany, France and Italy—followed the pattern of one class whose participants chose a mix of all combinations and a second class whose choices were dominated by crop-woody and crop-herbaceous-woody combinations. It can thus be assumed that the changes in the scale of the attribute values, which deviated from the standard for choice models, had no major impact on the results.

Furthermore, our results show the importance of controlled variation between pictures for a reliable evaluation of visual preferences. Our set of pictures included two types of variations: the seasons and the replication of each combination. The importance of including seasons when analysing visual landscape preferences is mentioned in the literature (Eroğlu et al., 2012; Stobbelaar et al., 2004). We confirmed the impact of the seasons on visual preference and showed that differing replications had an impact on choices and, thus, on visual preference.

The seasons determined whether the flowers in the plots were in bloom, and the replication determined whether there were any flowers in the picture at all. These two mechanisms explain the shifts in the proportions of combinations during seasons and between replications in Figure 4. The colour of a flowering crop (Switzerland and Hungary) and a blooming poppy flower in the field margin in the case of Germany explained the increased proportion of chosen crop-crop combinations in Season 2 in Germany and Switzerland and in Season 1 in Hungary. The reason for the increasing crop-herbaceous and crop-herbaceous-woody proportions in Switzerland in Seasons 2 and 3 was a colourful blooming herbaceous SNH, which was present in both replications.

Furthermore, the differences in the degree of orderliness in woody SNHs can explain the varying preference for crop-woody combinations in Hungary because orderliness had a significant positive effect on the participants' choices in Hungary, but also in Germany and Switzerland. The more orderly crop-woody combination was chosen more frequently than the 'wilder' replication 1. Seasons had no influence on this difference in visual preferences.

It is obvious that the aforementioned variations are important for a realistic evaluation of crops and SNHs because there is a big variation in the visual qualities (e.g. flowering) of crops and of herbaceous and woody SNHs.

4.2 Visual preference for herbaceous and woody SNHs and differences between countries

The results of the present study show that herbaceous and woody SNHs are preferred overall in all the countries included in the study. More than half of all choices contained at least one SNH. Furthermore, in all countries, at least 60% of the participants in one of the two classes (woody class) chose combinations containing woody SNHs. This is in line with the literature (Junge et al., 2011, 2015; Lindemann-Matthies, Junge, et al., 2010; Sullivan et al., 2004). Nevertheless, there are nuances. The proportions of crop-crop combinations in France and Italy were generally higher than in the other countries. In France, this was also true for crop-herbaceous combinations. Furthermore, we found differences between countries regarding the preferences for orderliness, availability of colours and—to a lesser extent—the presence of a woody SNH and tree cover, which are mentioned in section 4.1. These differences have the same pattern as the aforementioned differences in preferences.

We suggest that the differences are due to the landscape and not to differences between countries based on sociodemographic effects because these variables showed the same pattern of differences between the two classes in all countries. However, there is a difference in agricultural management and climate. In Germany, Hungary and Switzerland, the core and adjacent crops were arable crops in a temperate climate. Previous studies on the preference for arable crops and SNHs have shown low ratings for arable crops, except when they exhibit colourful flowering. However, SNHs were mostly rated highly (Junge et al., 2015). Stilma et al. (2009) showed that crops combined with wild flowers are preferred to pure arable crops.

In France and Italy, with Mediterranean landscapes dominated by vineyards and olive groves, respectively, these were both the core and adjacent crops. The literature about the scenic value of landscapes with vineyards and olive trees is more diverse, including aspects of the economy, tourism and recreation. Nevertheless, it suggests that landscapes with vineyards or olive groves are appreciated. For the Douro wine region Medeiros et al. (2024) reported colour diversity and vegetation cover to be among the most important factors explaining visual preference. Olive groves are important for the economy and tourism in Spain (Bidegain et al., 2020; Rodríguez-Entrena et al., 2017). Despite a large variation among the different stakeholder groups and olive-growing systems, a green cover below the trees and stone walls improve their aesthetic appreciation (Rodríguez-Entrena et al., 2017). In a study from Israel, landscapes with olive groves were preferred over landscapes with typical Mediterranean vegetation, such as garigues (Misgav & Amir, 2001). Furthermore, a diversity of colours (Misgav & Amir, 2001) increased the scenic value of a landscape.

Literature therefore suggests that vineyards and olive groves are more appreciated than arable crops because they are generally preferred, while arable crops are preferred only when they are flowering. This is in line with our results because the proportion of chosen crop-crop combinations was larger in France and Italy than in Germany, Hungary and Switzerland. This suggests that crop-crop combinations containing vineyards or olive groves were more attractive for the participants in France and Italy than for the participants in Germany, Hungary and Switzerland, where the crops were arable crops.

The differences we found regarding the effects of orderliness, colours, woody SNHs and tree cover follow the pattern of land-use types; arable crops versus permanent crops. Orderliness and the availability of colours had significantly positive effects on preferences in landscapes dominated by arable crops and significantly negative effects in landscapes dominated by vineyards or olive groves. Thus, we suggest that seasonal variation may play an important role. Arable crops change their visual aspects during the growing season more than perennial crops do. Depending on their type, they can provide colourful flowers. However, when the crops are ripe, they often exhibit dry and perhaps unorderly vegetation cover. Fields are often not orderly after crop harvest, and they display a high proportion of bare soil. Vineyards and olive groves are more stable and orderly, but they do not show any eye-catching bloom. Thus, orderliness and the availability of colours were less important in explaining the choices made in France and Italy.

Contrasting effects of the attribute ColAvail between landscapes with arable crops and landscapes with permanent crops furthermore show a limitation of our definition of the attribute ColAvail. Literature suggests that colours have a significant positive effect on visual landscape preferences in many different environments (Hůla & Flegr, 2016; Junge et al., 2015; Kütt et al., 2016; Tomitaka et al., 2021). It can be assumed that this should apply in our study as well. However, our definition of ColAvail had a focus on different colours provided by flowers and was therefore more adapted to landscapes dominated by arable crops in a temperate climate than to landscapes dominated by vineyards or olive groves in a Mediterranean climate. Our definition therefore neglected the importance of the presence of colour diversity (probably including a variety of green shads), which is important in the Mediterranean landscape (Misgav & Amir, 2001). Since we applied a list of visual characteristics identical across all countries, we were able to show these differences. For a future application, however, it would be better to make the list more adaptable to different countries. In the case of colours, it may be better to define the attribute as diversity of colours, where diversity is defined depending on the availability of colours in each country and its landscape.

Regarding the presence of a woody SNH and tree cover, we found contrasting effects following the same pattern as above-mentioned. Woody SNH had mostly a significantly positive effect on preferences in landscapes dominated by arable crops but a significantly negative effect on preferences in landscapes dominated by vineyards and olive groves. For TreeCov, the opposite was true. In landscapes dominated by arable crops, trees are rare. This could explain why woody SNHs had a significantly positive effect on the participants' choices. In Italy, however, olive groves provide tress. It is likely that the attribute of tree cover had a significant effect on the participants' choices because it included all types of trees, while the presence of a woody SNH only referred to SNH trees. As the proportion of chosen crop-crop combinations in Italy was particularly high, it is reasonable that the effect of TreeCov on preference was positive. In France and Italy, the effect of woody SNHs on the participants' choices was significantly negative in one class. The presence of cultivated trees, however, cannot explain the significant positive effect of tree cover on the participants' choices in France because vineyards are not trees. However, some pictures representing crop-crop and crop-herbaceous combinations show an elevated value for tree cover. This suggests that the participants who evaluated the attribute values (pre-test with 40 researchers) considered vineyards to be tree cover as well. In our basic design, this was not intended, but it is true that vineyards provide three-dimensional structures similar to trees because they can have the height of a small hedgerow.

Overall, it can be said that trees were preferred, but depending on the land use management, the presence of a woody SNH or the overall tree cover could better explain this preference.

4.3 Characteristics supporting beneficial arthropods and society's preferences

As mentioned earlier, the main aim of the present study was to investigate in detail the visual preferences of citizens for various land use types, such as crops and herbaceous and woody SNHs, in the context of several other ecosystem services. Ideally, land use combinations that promote ecosystem services for farmers would also be preferred by the general population for aesthetic reasons. Yet, the results of this study, as well as the literature, show that there is no simple answer to the question of what could explain citizens' visual preferences with regard to land use types. One reason is that preferences depend on the cropping system. Still, our results showed that in all the analysed countries, herbaceous and woody SNHs were aesthetically preferred because more than half of the participants chose combinations containing at least one SNH.

The results of the QuESSA project on pollination and on the promotion of natural pest control (Albrecht et al., 2020; Holland et al., 2016) show that flower strips enhance pollination and natural pest control in crop-dominated landscapes. The effect of woody elements, however, was less evident (Albrecht et al., 2020), although Bartual et al. (2019) showed a positive relationship between woodland edges and the abundance of various natural enemy groups (parasitic wasps and predatory flies).

In vineyard-dominated landscapes, a mixture of extensively managed grassland and woody elements was shown to best enhance the different ecosystem services, such as pollination and predation (Rosas-Ramos et al., 2019). For landscapes dominated by olive groves, this effect is more complex.

For the herbaceous SNH in landscapes dominated by arable crops, particularly in Switzerland, the presence of colourful flowers was a good explanation for preference. Flowers are therefore important for pollination, natural pest control and visual preference in agrarian landscapes. We believe that this would be true for all included countries if there had been flowers in the investigated landscapes, because literature suggests this in various countries and environments (Hůla & Flegr, 2016; Junge et al., 2015; Kütt et al., 2016; Tomitaka et al., 2021).

In addition to their importance for colours in the landscape, SNHs help reduce the amount of open soil and large patches of dry vegetation, which had a negative effect on perceived aesthetics in both classes in all the analysed countries. Avoiding open soil and dry vegetation by SNH, however, has no direct synergies with pollination and pest control services because green vegetation does not necessarily provide flowers for pollinators or beneficial arthropods. During an arable crop rotation, it is difficult to avoid the presence of open soil and dry vegetation. However, this occurs only in part of the year and is reduced in arable landscapes with diversified crop rotation and when including SNHs, as the presence of SNHs enhances the probability for the availability of some green or even flowering elements. A good mix of herbaceous and woody SNHs is important for beneficial arthropods and for visual landscape quality as these elements both have different traits. For visual landscape quality, herbaceous SNHs with a high abundance and diversity of forbs add visually preferred colours to the landscape while woody SNHs help to reduce the proportion of dry vegetation and open soil, which also had a negative effect on perceived aesthetics in all the countries. In Mediterranean landscapes, a diversity of colours (Misgav & Amir, 2001) is important for preference.

5 Conclusion

The present study aimed to determine whether a standardised list of visual characteristics could explain aesthetic preferences for combinations of crops and herbaceous or woody SNHs and to investigate how preferences for the individual characteristics of these landscape elements differ between countries. To attain these objectives, it turned out to be important to provide variations within the shown pictures. This variation was achieved by showing pictures of two replications for each element. Furthermore, each replication was shown in different seasonal stages.

The results obtained confirmed that combinations of crops and SNHs were generally preferred over combinations of two adjacent crops. Cropping elements were preferred only seasonally, e.g. when arable crops were flowering.

Nevertheless, we found differences between countries. While in all countries, herbaceous and woody SNHs were more often chosen than crops, the proportion of chosen crop-crop combinations was higher when the crops were vineyards or olive groves than when they were arable crops. This suggests that olive groves and vineyards are preferred over arable crops. Furthermore, we found differences between countries regarding the effects of our visual characteristics on choices, which could be explained by differences in agricultural management and climate.

Regarding the visual preference for herbaceous and woody SNHs, we still could not fully understand which visual characteristics explained it. Visual preference seems to be dependent on the landscape and on the visual quality of the considered element. Nevertheless, our results also suggest that adding green vegetation, minimising open soil and dry vegetation and providing different colours and trees all have positive effects on visual landscape preference. Promoting flowers in herbaceous SNHs creates synergies with pollination. Adding more woody elements to the agrarian landscape may support beneficial arthropods and at the same time reduce the amount of negatively perceived landscape characteristics such as open soil or dry vegetation. Thus, we conclude that both herbaceous and woody SNHs have visual aesthetic values in addition to their important roles in soil, climate and biodiversity conservation. This broad range of positive aspects legitimises financial incentives for developing SNHs through agri-environmental schemes.

6 Acknowledgements

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10 Appendix

10.1 Study areas

10.1.1 Overview of all study areas

Table 4: Basic geographical data of the study regions in the five involved countries Germany, Hungary, Switzerland, France and Italy.

Country	Germany	Hungary	Switzerland	France	Italy
Region	Upper Rhine valley	Jászság region	North-eastern Switzerland	Langedoc-Roussilion (Hérault)	Pisa Plain, northern Tuscany
Coordinates (N)	49°4’ to 49°27’	47°64’	47°36’ to 47°21’	43°72’ to 43°62’	43°50’ to 43°31’
Coordinates (E)	8°28’ to 8°6’	20°14’	8°17’ to 8°38’	3°30’ to 3°62’	10°17’ to 10°40’
Core crop	Pumpkin	Sunflower	Rapeseed and cereal	Vineyard	Olive grove
Adjacent crop	Rapeseed and cereal	Rapeseed and cereal	Cereal and grass-clover ley	Vineyard	Olive grove
Landscape type	Pumpkins, vegetables, arable crops and few grasslands and forests	Plane with fertile soils dominated by agriculture	Rolling hills; mixed agriculture: arable crops and grassland	Vine-growing region; vineyards of different registered designations of origin	Hills with steep slopes and stone walls
Relief	Flat	Flat plane	Hilly	Hilly	Hilly with steep slopes
Altitude above sea level (m)	90–160		688	50–300	< 350
Climate	Temperate	Continental	Temperate	Mediterranean	Mediterranean
Mean annual temperature (°C)	10.5		9.4		14
Precipitation (mm)	667	522	1053	650	850–1100

10.1.2 Additional information, Germany

Information provided by Sonja Pister, Institut für Agrarökologie und Biodiversität (IFAB)

The study in Germany was conducted in the Upper Rhine Valley between Kandel and Ludwigshafen, Germany (N: 49°4’ to 49°27’, E: 8°28’ to 8°6’). The region has a temperate climate with warm summers, an annual mean temperature of 10.5 °C and 667 mm precipitation (station Landau, German Weather Service). The elevation ranges from 90 to 160 m above sea level (a.s.l.). The region is characterised by intensive agriculture, with only a few grassland and forest fragments. In particular, cereals, maize and vegetables are grown. In 2014, we selected 18 commercial pumpkin fields (Cucurbita maxima Duchesne cv. Hokkaido) with a size of 3 ± 2.6 ha and a minimum width of 52 m. Out of a total of 18 pumpkin fields half of them was managed organically and half of them conventionally. Six pumpkin fields were bordered by an herbaceous and six by a woody SNH. SNHs were defined as any habitat containing a community of non-crop plant species and include herbaceous (e.g. field margins, fallows) and woody vegetation (e.g. hedgerows, forest fragments), with a minimum width of 1.5 m, a minimum length of 50 m and a minimum size of 150 m^2 (Holland et al., 2014). Woody SNHs had at least 30% shrub/tree canopy cover. In addition, the pumpkin fields were located in landscapes differing in the proportion of SNHs (5–49%) and in the proportion of agricultural land in a 1 km radius around the focal field (28–91%). To calculate the proportions, we mapped habitats around the focal field within a 1 km radius. We classified the habitats into 56 categories that included 45 crops (e.g. annual and perennial crop types and orchards), SNHs (e.g. forests, grasslands, hedgerows and grass margins), urban areas, water bodies and other habitats. Any mapped linear element had a minimum width of 1.5 m, a length of at least 50 m or a minimum size of 75 m^2 if it was a surface element. The land use classifications were confirmed through ground-truthing surveys at every site. The minimum distance between fields was > 1.75 km, avoiding overlap of the landscape sectors (only marginal overlap for one pair). Management, adjacent habitat and landscape complexity (measured as proportion of agriculture within a 1 km radius) varied independently of each other.

Table 5: Main crop types in the study region and in Germany as a whole, displayed as a proportion of the cultivated area. Data for Germany (DeStatis, 2016; Statistisches Bundesamt, 2014, 2015).

Crop	Special crop	Study region Quessa DE	Germany, whole country
Cereals		21.1%	32.8%
Maize		27.2%	14.0%
Oilseed rape		1.6%	7.6%
Sugar beet		8.6%	1.8%
Potato		3.9%	1.3%
Vegetables			0.5%
Special crop	Carrot	2.6%	0.1%
Special crop	Onion, leek	2.9%	0.1%
Special crop	Pumpkin and squash	5.2%	0.0%
Perennial crop		11.6%	1.1%
Perennial crop	Vine	4.2%	0.5%
Perennial crop	Asparagus	2.0%	0.1%
Perennial crop	Tree and berry fruits	4.6%	0.3%
Permanent grassland		0.0%	25.6%

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Results on pollination and pest control can be found in the following publications:

Pfister, S. C., Eckerter, P. W., Krebs, J., Cresswell, J. E., Schirmel, J., & Entling, M. H. (2018). Dominance of cropland reduces the pollen deposition from bumble bees. *Scientific Reports 8*, 13873.

Pfister, S. C., Eckerter, P. W., Schirmel, J., Cresswell, J. E., & Entling, M. H. (2017). Sensitivity of commercial pumpkin yield to potential decline among different groups of pollinating bees. *Royal Society Open Science.4*, 170102.

Pfister, S. C., Schirmel, J., & Entling, M. H. (2017). Aphids and their enemies in pumpkin respond differently to management, local and landscape features. *Biological Control* 115, 37–45.

Results on predatory flies and carabid beetles in 69 different SNHs in approximately the same study region between Kandel and Ludwigshafen can be found in the following publications:

Fusser, M. S., Pfister, S. C., Entling, M. H., & Schirmel, J. (2016). Effects of landscape composition on carabids and slugs in herbaceous and woody field margins. *Agriculture, Ecosystems & Environment 226*, 79–87.

Pfister, S. C., Sutter, L., Albrecht, M., Marini, S., Schirmel, J., & Entling, M. H. (2017). Positive effects of local and landscape features on predatory flies in European agricultural landscapes. *Agriculture, Ecosystems & Environmen. 239*, 283–292.

Schirmel, J., Albrecht, M., Bauer, P.-M., Sutter, L., Pfister, S. C., & Entling, M. H. (2018). Landscape complexity promotes hoverflies across different types of semi-natural habitats in farmland. *Journal of Applied Ecology*. *55, 1747-1758* https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/1365-2664.13095

Further results are also published in Sonja Pfister’s PhD thesis:

Pfister, S.C. (2017): Potential of seminatural habitats to support pest control and pollination – including a case study on pumpkin. Dissertation thesis. Environmental Sciences. University Koblenz-Landau, Landau

10.1.3 Additional information, Hungary

Information provided by Mihály Zalai, Hungarian University of Agriculture and Life Sciences

In Hungary, the sites were located in the Jászság region, as an administrative part of Jász-Nagykun-Szolnok County. This region is in eastern Hungary, in the centre of the Great Hungarian Plane, which is the largest geographical region of Hungary (approximately 52.000 km^2 of 93.030 km^2). Although there are no higher mountains in Hungary, the land use is different in the hilly western (Transdanubia) and northern regions compared to the flat southeast regions, such as Jászság (80–90 m a.s.l.).

The Great Hungarian Plane is the largest flat area for crop production; therefore, arable land is mainly typical here, with good soil conditions supplemented by pastures and forests on less suitable soils. On the country level, arable crop production accounts for 46% of the total agriculturally used area, but on the Great Hungarian Plane and in the Jászság region, arable land accounts for more than 60% of the agriculturally used area. In Jászság, the production of winter cereals and sunflower is the most dominant (Hungarian Central Statistical Office, 2022). Grasslands are typically natural and are used as meadows or nature conservation areas dominated by herbaceous species. The occurrence of colourful flowering species is rare. Forests are dominated by acacia, birch and poplar species.

In 2022 (Hungarian Central Statistical Office, 2022), nearly 55% of Hungary's territory, about 5.1 million hectares, were agricultural land, and 82% of this (4,163,000 ha) were arable land.

The territory of Jász-Nagykun-Szolnok County accounts for 6.0% of Hungary, but 8.5% of all agricultural land are located there. This county has the second largest proportion (77%) of agricultural land within all areas (Hungarian Central Statistical Office, 2022).

In terms of arable crop production, the aforementioned branch of cultivation accounts for 87.5% of the county's agricultural area. In 2022, almost 14% of our most important oil crop, the sunflower, were grown in Jász-Nagykun-Szolnok County (96,300 hectares). Regarding the sowing areas of other field crops, they were 46,400 hectares of corn, 97,100 hectares of winter wheat and 4,600 hectares of rapeseed (Hungarian Central Statistical Office, 2022).

The climate is continental. The yearly average rainfall in the centre of Jászság (Szolnok) is 522 mm, with a slightly rainier summer than winter. The monthly average temperature is 28.7 °C / 16.4 °C (daily max/min) in July and 2.6 °C / -3.3 °C in January. The most dominant wind directions are west and south see Hungarian meteo (

Generally, the Jászság region has good soil properties for crop production, but soil maps show high heterogeneity in short distances. Chernozems, fluvisoils and meadow soils are all typical, partly with high salt concentrations (Várallyay, 1989).

Literature

Várallyay, G. (1989). Soil mapping in Hungary. *Agrokémia És Talajtan*, *38*, 696–714.

Websites:

Hungarian Central Statistical Office, 2022: https://www.ksh-hu/?lang=en; access 16.10.2024

Hungarian meteo: https://www.met.hu/eghajlat/magyarorszag_eghajlata/varosok_jellemzoi/Szolnok/; access 16.10.2024

10.1.4 Additional Information Switzerland

Provided by Beatrice Schüpbach based on internal documents and the dissertation of Louis Sutter

The Swiss study was conducted in the north eastern part of the Swiss Lowlands in the Cantons of Zurich and Aargau. This region is characterised by a mixture of arable crops and grassland of different management intensities. The relief is slightly hilly with forests and grassland on steep slopes. Different landscape sectors with a radius of 3 km were selected along a gradient of proportions of arable crops and herbaceous vegetation.

Rapeseed was chosen as core crop as it accounts for a substantial proportion of land use in north-eastern Switzerland and as it is grown both conventionally and organically. Besides natural pest control, pollination was a main interest of the Swiss part of the study. More detailed information can be found in the dissertation of Louis Sutter (Sutter, 2016).

Additional literature

Sutter, L. E. (2016). Quantification of Insect Pollination , Natural Pest Control and their Synergies in Agricultural Ecosystems. In Dissertation zur Erlangung der Doktorwürde.

10.1.5 Additional information, France

Information provided by Brice Giffard, Bordeaux Sciences Agro, Institut des recherches pour l'agriculture, l'alimentation et environnement (INRAE)

The French study sites were located in southwestern France, in the Languedoc-Roussillon region and in the department of Hérault. More precisely, the sites are situated approximately 40 km northwest of the urban community of Montpellier. Vineyards are mostly associated with the registered designation of origin of Terrasses du Larzac, approved by INAO, the Institut national de l'origine et de qualité (in 2014), but there are other vineyards of different registered designations of origin (Languedoc, Montpeyroux and Saint-Saturnin). This region is characterised by a historical production of wines since the Roman times, and the wine-growing activity has particularly increased under the influence of the Benedictine monks. Now, the wine growing area is extending over the vast majority of the territory. Vineyards are planted in a large variety of soils and of altitude (50–300 m altitude) in the foothills of the Causse du Larzac. Wine production follows the AOP (appellation origine controllée) standards which are characterised by the production of high-quality red wines in a production area of about 2,000 hectares. The wines produced are composed of a blend of five typical grape varieties from the Mediterranean vineyards of southern France: Grenache, Mourvèdre, Syrah (the sum of which must make up between 60% and 75% of the grape varieties), and to a slightly lesser extent, Carignan and Cinsaut. The climate is typically Mediterranean, with a strong seasonality of precipitation (about 650 mm per year, with so-called Cévenol episodes: high precipitation quantities, with most of the rainfall occurring in autumn) and high average temperatures, even if the proximity of the Causse and the distance from the littoral coasts accentuate the daily temperature fluctuations.

The landscape is hilly and dominated by vineyards. There are also large areas of urban habitats and SNHs, as well as smaller surfaces of other crops, such as traditional olive orchards, horticulture and annual crops. Plant communities in SNHs and within vineyards are highly dominated by stress-tolerant species due to the high hydric stress in summer, with plant species growing and flowering in early spring and/or in autumn (Bopp et al., 2022). SNHs are mostly dominated by shrubby species, such as Salzmann pine (*Pinus nigra* subsp. *salzmannii*), holm and Kermes oaks (*Quercus ilex* and *Q. coccifera*), species typically associated with the garrigue community in the Mediterranean region. Photos were taken on four different occasions in 2014 to depict the relevant stages of the Mediterranean vegetation (T1: end of March; T2: end of May and beginning of June; T3: beginning of August and T4: mid-October).

Bopp, M.-C., Kazakou, E., Metay, A., & Fried, G. (2022). Relative importance of region, seasonality and weed management practice effects on the functional structure of weed communities in French vineyards. *Agriculture, Ecosystems and Environment*, *330*, 107892.

10.1.6 Additional information, Italy

Information provided by Anna-Camilla Moonen and Fernando Pellegrini, Scuola Superiore Sant' Anna

Geographical information (where in the country it is located):

The area studied is a hilly region approximately 160 km^2 in size called Monte Pisano (43°45´02.92˝N, 10°33´18.61˝E) in central northern Tuscany.

Information about relief:

The maximum height is 917 m a.s.l. There are olive groves in the lower 350 m and steep slopes with dry stone walls.

Climate:

The mean annual temperature is about 14 °C, with dry and hot summers. The climate is typically Mediterranean, with an annual rainfall of 850–1100 mm, mostly in autumn, winter and spring. July is the driest month. An increase in extreme rainfall events has been detected. Thus, the use of terraces as drainage systems, as in the past, has increased in importance.

Vegetation:

Olive groves are alternated with woodlands, with *Quercus ilex*, *Q. pubescens*, *Pinus pinaster* and *Castanea sativa* as the main tree species. Forest fire and landscape degradation have produced a variety of low-density woody vegetation patches—the garigue—replacing the original forest cover (Bertacchi et al., 2004). The more xerothermic habitat of the garigue is characterised by low vegetation, mainly composed of shrubs and herbs.

Agriculture:

Olive groves are characterised by the presence of terraced systems with dry stone walls for water drainage. These were created in the past 200–300 years (Rizzo et al., 2007). The olive groves are managed as low-input systems, with relatively old trees growing at a low density (approximately 100 trees/ha).

In some places, the traditional agro-silvo-pastoral system, which includes olive groves, managed chestnut woods and sheep grazing, has been replaced by a more specialised olive grove system with 300–1,000 trees/ha, although mechanisation is not possible in this area due to the steep hills and narrow terraces. Therefore, this type of specialisation and intensification of olive trees has not yielded the expected economic returns. Land abandonment is frequent, and only a few professional olive growers remain in the area. Most groves are managed by hobby farmers, who do this in their spare time.

The most widespread cultivars in this area are Leccino and Frantoio. Olive orchards occupy the basal belt to a maximum of 350 m a.s.l.

Additional literature describing the study area from different points of view:

Bertacchi, A., Sani, A., & Tomei, P. E. (2004). La Vegetazione del Monte Pisano. Felici, Pisa, 36 pp.

Gennai-Schott, S., Sabbatini, T., Rizzo, D., & Marraccini, E. (2020). Who remains when professional farmers give up? Some insights on hobby farming in an olive groves-oriented terraced Mediterranean area. *Land*, *9*, 168. https://doi.org/10.3390/land9050168

Picchi, M. S., Bocci, G., Petacchi, R., & Entling, M. H. (2016). Effects of local and landscape factors on spiders and olive fruit flies. *Agriculture, Ecosystems and Environment, 222*, 138–147. doi:10.1016/j.agee.2016.01.045

Picchi, M. S., Bocci, G., Petacchi, R., & Entling, M. H. (2020). Taxonomic and functional differentiation of spiders in habitats in a traditional olive producing landscape in Italy. *European Journal of Entomology, 117*, 18–26. doi:10.14411/eje.2020.002

Picchi, M. S., Marchi, S., Albertini, A., & Petacchi, R. (2017). Organic management of olive orchards increases the predation rate of overwintering pupae of bactrocera oleae (diptera: Tephritidae). *Biological Control, 108*, 9–15. doi:10.1016/j.biocontrol.2017.02.002

Rizzo, D., Galli, M., Sabbatini, T., & Bonari, E. (2007). The geoagronomic approach to the rural landscapes management: A methodological path to characterize contemporary challenges. In Bunce, R.G.H., Jongman, R.H.G., Hojas, L. and Weel, S. (Eds): 25 years of landscape ecology: Scientific principles in practice. *Proceedings of the 7th IALE World Congress, Vol. 2* (pp. 805–806). Wageningen.

10.2 Choice cards

10.2.1 Germany




Which of the four pictures do you like best?

10.2.2 Hungary




Which of the four pictures do you like best?

10.2.3 Switzerland

Which of the four pictures do you like best?

10.2.4 France

Which of the four pictures do you like best?

10.2.5 Italy




Which of the four pictures do you like best?

10.3 Sociodemographic variables

10.3.1 Germany

Table 6: Sociodemographic variables in proportion for the whole country, the whole sample and the two classes in Germany.

Sample	Absolute number per sample	Female (%)	Male (%)	Younger people (%)	Middle-aged people (%)	Older people (%)	Primary education (%)	Secondary education (%)	Higher education (%)
Country	82'180'000	50.0	50.0	30.0	38.5	31.5	26.0	50.0	24.0
Survey sample	352	50.3	49.7	31.8	37.5	30.7	27.3	49.1	23.6
Mixed class (49.2%)	173	47.3	52.7	44.0	35.0	21.0	32.9	39.6	27.6
Woody class (50.8%)	179	53.2	46.8	20.1	39.9	40.1	21.9	58.4	19.7

Younger people	20–39 years
Middle-aged people	40–59 years
Older people	> 60 years

10.3.2 Hungary

Table 7: Sociodemographic variables in proportions for the whole country, the whole sample and the two classes in Hungary.

Sample	Absolute number per sample	Female (%)	Male (%)	Younger people (%)	Middle-aged people (%)	Older people (%)	Primary education (%)	Secondary education (%)	Higher education (%)
Country	9'840’000	51.0	49.0	47.0	43.0	10.0	10.0	59.0	31.0
Survey sample	352	51.1	48.9	46.6	42.6	10.8	9.9	58.5	31.5
Mixed class (85%)	299	53.7	46.3	46.8	42.9	10.2	9.9	59.4	30.7
Woody class (15%)	53	36.7	63.3	45.2	40.8	14.1	10.2	53.4	36.4

Younger people	18–39 years
Middle-aged people	40–59 years
Older people (%)	60–64 years

10.3.3 Switzerland

Table 8: Sociodemographic variables in proportions for the whole country, the whole sample and the two classes in Switzerland.

Sample	Absolute number per sample	Female (%)	Male (%)	Younger people (%)	Middle-aged people (%)	Older people (%)	Primary education (%)	Secondary education (%)	Higher education (%)
Country	8'327’126	50.0	50.0	34.0	45.0	21.0	12.0	39.0	49.0
Survey sample	341	50.3	49.4	47.7	38.3	13.7	12.3	39.8	47.7
Mixed class (70.4.2%)	240	51.1	48.9	50.2	37.6	12.2	12.0	40.7	47.4
Woody class (29.6%)	101	48.8	51.2	42.1	40.3	17.6	13.2	38.1	48.8

Younger people	20–39 years
Middle-aged people	40–64 years
Older people	> 65 years

10.3.4 France

Table 9: Sociodemographic variables in proportions for the whole country, the whole sample and the two classes in France.

Sample	Absolute number per sample	Female (%)	Male (%)	Younger people (%)	Middle-aged people (%)	Older people (%)	Primary education (%)	Secondary education (%)	Higher education (%)
Country	63'810'000	51.0	49.0	43.5	33.2	23.3	43.5	33.2	23.3
Survey sample	352	50.9	49.1	40.1	41.2	18.8	33.8	40.1	26.1
Mixed class (55.4%)	195	52.9	47.1	46.7	35.7	17.7	33.8	44.0	22.2
Woody class (44.6%)	157	48.3	51.7	31.8	48.1	20.1	33.8	35.2	31.0

Younger people	18–39 years
Middle-aged people	40–59 years
Older people	60–69 years

10.3.5 Italy

Table 10: Sociodemographic variables in proportions for the whole country, the whole sample and the two classes in Italy.

Sample	Absolute number per sample	Female (%)	Male (%)	Younger people (%)	Middle-aged people (%)	Older people (%)	Primary education (%)	Secondary education (%)	Higher education (%)
Country	60'230'000	50.5	49.5	37.5	45.0	17.5	51.7	5.7	42.6
Survey sample	352	50.6	49.4	38.9	43.5	17.6	51.1	5.7	43.2
Mixed class (38.8%)	137	48.2	51.8	39.1	50.8	10.1	50.5	8.1	41.4
Woody class (61.2%)	215	52.0	48.0	38.8	38.8	22.4	51.5	4.2	44.3

Younger people	18–39 years
Middle-aged people	40–59 years
Older people	60–69 years

10.4 Attribute values

10.4.1 Overview of attributes and their levels and value ranges

Table 11: Attributes and their levels and value ranges for the included countries (Germany, Hungary, Switzerland, France and Italy).

Attribute	Number of levels/range of attribute values	Germany	Hungary	Switzerland	France	Italy
Grassy	Levels	2	2	2	2	2
	Range	0–1	0–1	0–1	0–1	0–1
Woody	Levels	2	2	2	2	2
	Range	0–1	0–1	0–1	0–1	0–1
Green	Levels	5	8	8	8	6
	Range	0–2	0.25–2	0.75–2	0–2	0.75–2
Order	Levels	7	10	7	9	8
	Range	0.75–2	0.75–2	0.75–2	0.4–2	0–1.5
NoVeg	Levels	9	8	9	12	6
	Range	0–2	0–2	0–1.75	0–2	0–1
DryVeg	Levels	8	8	10	10	7
	Range	0–2	0–2	0–2	0–1.6	0–1.75
ColAvail	Levels	4	5	5	7	6
	Range	0–1	0–1	0–1.25	0–0.8	0–1
Openness	Levels	8	11	6	9	5
	Range	0.5–2	0.5–2	0.75–2	0.5–2	0–0.75
TreeCov	Levels	7	9	9	11	3
	Range	0–1.6	0–1.75	0–1.75	0–2	0.75–2

Grassy refers to the herbaceous SNH

10.4.2 Germany

Table 12: Values for each attribute and each picture of the survey of Germany.

Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication 1	Season 2	cc	0	0	1.75	1.75	2	0.5	0	2	0
Replication 1	Season 2	cg	1	0	1.5	1.25	1.25	0.25	0.5	2	0.25
Replication 1	Season 2	cgw	1	1	1.75	1.75	1.75	1	0	1	1.25
Replication 1	Season 2	cw	0	1	2	1.75	2	0.5	0.25	0.75	2
Replication 2	Season 2	cc	0	0	2	1.75	2	0	1	2	0.25
Replication 2	Season 2	cg	1	0	1.5	1.75	1.75	0.25	0	1.5	0.25
Replication 2	Season 2	cgw	1	1	1.75	2	1.75	0.5	0	0.5	0.75
Replication 2	Season 2	cw	0	1	1.5	0.75	1.5	0	0	0.5	1
Replication 1	Season 3	cc	0	1	1.25	1.75	1.75	2	0	2	0
Replication 1	Season 3	cg	1	0	1.5	1.75	1	0.5	0	2	0
Replication 1	Season 3	cgw	1	0	1.5	1.25	1	0.75	0.5	1.25	1.25
Replication 1	Season 3	cw	0	1	2	1.75	1.25	0	0	1	2
Replication 2	Season 3	cc	0	0	0.25	1.5	1.75	2	0.25	1.5	0
Replication 2	Season 3	cg	1	0	2	1.6	1	1.4	0	1.8	0
Replication 2	Season 3	cgw	1	1	2	1.75	1	1	0.25	1.25	0.75
Replication 2	Season 3	cw	0	1	2	2	1.25	0	0	1.25	0.75

Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication 1	Season 4	cc	0	0	1.75	1.75	1.5	0.75	1	2	0
Replication 1	Season 4	cg	1	0	2	1.75	0.25	0.25	1	2	0
Replication 1	Season 4	cgw	1	1	2	1.5	0	0.5	0.5	1.25	1
Replication 1	Season 4	cw	0	1	1.6	1.6	0.6	1.2	1	1.2	1.6
Replication 2	Season 4	cc	0	0	1.75	1.5	0.5	2	0.5	2	0.25
Replication 2	Season 4	cg	1	0	2	1.25	0	0.5	1	2	0
Replication 2	Season 4	cgw	1	1	2	1.25	0	0.5	1	0.5	1
Replication 2	Season 4	cw	0	1	2	1	0.25	0.5	1	1	1

cc: crop-crop combination; cg: crop-grassy combination; cgw: crop-grassy-woody combination; cw: crop-woody combination. Grassy refers to the herbaceous SNH

Table 13: Number of levels and range of the values of all attributes included in the German models.

	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Number of levels	2	2	5	7	9	8	4	8	7
Range	0–1	0–1	0.25–2	0.75–2	0–2	0–2	0–1	0.5–2	0–1.6

Grassy refers to the herbaceous SNH

10.4.3 Hungary

Table 14: Values for each attribute and each picture of the statistical of Hungary.

Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication 1	Season 1	cc	0	0	2	1.75	2	0	0	2	0
Replication 1	Season 1	cg	1	0	0.75	1.5	2	1.25	0	2	0
Replication 1	Season 1	cgw	1	1	1.5	2	2	0.25	0	2	0.25
Replication 1	Season 1	cw	0	1	1.5	1.75	1.75	0	0	1	1.5
Replication 2	Season 1	cc	0	0	1.25	1.5	1.75	0	1	2	0
Replication 2	Season 1	cg	1	0	1.5	1.75	2	0	0	1.75	0.25
Replication 2	Season 1	cgw	1	1	0.75	2	2	1.25	0	2	0
Replication 2	Season 1	cw	0	1	1.5	1.75	2	0.5	0.25	0.75	1.5
Replication 1	Season 2	cc	0	1	1.75	1.5	1	0	0	1.5	0
Replication 1	Season 2	cg	1	0	0.8	1.4	2	1	0.2	1.6	0
Replication 1	Season 2	cgw	1	0	0.75	1.5	2	1.25	0	1.5	0.25
Replication 1	Season 2	cw	0	1	1.75	2	2	0	0	0.25	1.75
Replication 2	Season 2	cc	0	0	1.5	0.5	0.75	0.5	0.25	2	0
Replication 2	Season 2	cg	1	0	1.75	1.75	1.75	0.5	0.5	2	0
Replication 2	Season 2	cgw	1	1	2	1.75	0.75	0	0	1.5	0.5
Replication 2	Season 2	cw	0	1	1.5	1.25	1.75	0	0	0.75	2

Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication 1	Season 3	cc	0	0	0.75	1.75	0	2	1	2	0
Replication 1	Season 3	cg	1	0	1.75	2	0.5	1	1	2	0
Replication 1	Season 3	cgw	1	1	1.75	1.5	0.5	1.75	1	1.75	0.25
Replication 1	Season 3	cw	0	1	1.5	1.75	0	0	1	0.5	1.5
Replication 2	Season 3	cc	0	0	1.25	1	1	1.25	1	1.75	0.25
Replication 2	Season 3	cg	1	0	1.5	1	0	1	1	2	0
Replication 2	Season 3	cgw	1	1	1.6	0.6	0	0.6	1	1.4	0.2
Replication 2	Season 3	cw	0	1	1.75	1	0	0	1	0.75	1
Replication 1	Season 4	cc	0	0	1	1.5	1.25	2	0	0.75	0
Replication 1	Season 4	cg	1	0	1	0.75	0	1.25	0	1.25	0.25
Replication 1	Season 4	cgw	1	1	1.25	0.75	0	1	0	1.75	0
Replication 1	Season 4	cw	0	1	1.25	1.75	1	1	0	1	1.5
Replication 2	Season 4	cc	0	0	0.8	1.4	2	2	0	1.8	0
Replication 2	Season 4	cg	1	0	1.25	1	0.25	2	0	2	0
Replication 2	Season 4	cgw	1	1	1.25	1	0.5	2	0	2	0.5
Replication 2	Season 4	cw	0	1	1.5	0.25	0	2	0	0.5	0.75

cc: crop-crop combination; cg: crop-grassy combination; cgw: crop-grassy-woody combination; cw: crop-woody combination, Grassy refers to the herbaceous SNH

Table 15: Number of levels and range of the values of all attributes included in the Hungarian models

	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Number of levels	2	2	8	10	8	8	5	11	9
Range	0–1	0–1	0.75–2	0.25–2	0–2	0–2	0–1	0.25–2	0–1.75

10.4.4 Switzerland

Table 16: Values for each attribute and each picture of the statistical model of Switzerland.

Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication 1	Season 1	cc	0	0	1.25	1.5	1.5	0	1.25	1.5	0
Replication 1	Season 1	cg	1	0	1.25	1.25	1.75	0	1	1.25	0.25
Replication 1	Season 1	cgw	1	1	1.4	1.2	1	1	1	1	0.8
Replication 1	Season 1	cw	0	1	2	1.25	0.5	0	1	1	1.5
Replication 2	Season 1	cc	0	0	2	2	0	0	1.25	2	0.25
Replication 2	Season 1	cg	1	0	2	1.75	0.75	0.25	1	2	0
Replication 2	Season 1	cgw	1	1	1.5	1.5	0.75	0.5	1	1	0.25
Replication 2	Season 1	cw	0	1	1.75	1.25	0	0	1	1.25	0.5
Replication 1	Season 2	cc	0	1	0.8	2	0	1.2	0	1.6	0
Replication 1	Season 2	cg	1	0	2	1.5	0.25	1.25	0	2	0
Replication 1	Season 2	cgw	1	0	2	1.25	0	1	0	1	0.75
Replication 1	Season 2	cw	0	1	2	1.25	0.25	2	0	0.75	1.75
Replication 2	Season 2	cc	0	0	0.75	1.75	0.5	1.75	0.25	2	0
Replication 2	Season 2	cg	1	0	2	2	0	2	1.25	2	0.25
Replication 2	Season 2	cgw	1	1	1.75	1.75	0	1.5	1	1.25	1
Replication 2	Season 2	cw	0	1	1.5	0.75	0	2	0	1	1.25

Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication 1	Season 3	cc	0	0	0.75	1.75	1.25	2	0	2	0.25
Replication 1	Season 3	cg	1	0	1.75	1.25	1	2	0.75	2	0
Replication 1	Season 3	cgw	1	1	2	1.25	1	2	0.75	1	0.75
Replication 1	Season 3	cw	0	1	1.75	2	0.5	2	0	0.75	1.25
Replication 2	Season 3	cc	0	0	1.75	1.75	1.5	2	0	2	0
Replication 2	Season 3	cg	1	0	1.75	1.75	1.25	1.75	1	2	0.25
Replication 2	Season 3	cgw	1	1	2	1.25	1.25	1.25	1	0.75	1
Replication 2	Season 3	cw	0	1	1.2	1	1.2	1.8	0	1	0.8

cc: crop-crop combination; cg: crop-grassy combination; cgw: crop-grassy-woody combination; cw: crop-woody combination

Grassy refers to the herbaceous SNH

Table 17: Number of levels and range of the values of all attributes included in the Swiss models.

	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Number of levels	2	2	8	7	9	10	5	6	9
Range	0–1	0–1	0.75–2	0.75–2	0–1.75	0–2	0–1.25	0.75–2	0–1.75

Grassy refers to the herbaceous SNH

10.4.5 France

Table 18: Values for each attribute and each picture of the statistical model of France

Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication 1	Season 1	cc	0	0	1	2	1.5	1.25	0.25	1.75	0
Replication 1	Season 1	cg	1	0	1.25	1.75	1	1	0	2	0.25
Replication 1	Season 1	cgw	1	1	1.25	1.5	1	1.5	0.25	1	1.25
Replication 1	Season 1	cw	0	1	1.5	1	1.5	1	0.25	1.25	2
Replication 2	Season 1	cc	0	0	0	1.75	2	1.5	0	2	0
Replication 2	Season 1	cg	1	0	1.25	1.75	1.25	0.5	0.25	1.5	0
Replication 2	Season 1	cgw	1	1	1	1.25	1.5	0.25	0.25	0.5	0.75
Replication 2	Season 1	cw	0	1	1.5	1.25	1.25	0.5	0.75	1	1.5
Replication 1	Season 2	cc	0	0	2	0.8	1.2	0.4	0	1.2	1.2
Replication 1	Season 2	cg	1	0	1.75	2	0.75	1	0	1.5	1.25
Replication 1	Season 2	cgw	1	1	1.75	1.5	0.75	0.75	0	1	1.25
Replication 1	Season 2	cw	0	1	2	0.6	0.4	0.8	0	0.8	2
Replication 2	Season 2	cc	0	0	1.5	1.5	0.5	1	0.25	1	0.25
Replication 2	Season 2	cg	1	0	1.5	2	0.75	0.5	0.25	1.75	0
Replication 2	Season 2	cgw	1	1	2	2	1	0.25	0.5	1.25	0.5
Replication 2	Season 2	cw	0	1	1.75	1.75	0.75	1.5	0	0.5	1.75

Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication 1	Season 4	cc	0	0	1.25	1	0.75	1.25	1	1.25	1
Replication 1	Season 4	cg	1	0	1.25	1.5	0.5	1.25	0.75	1.25	1
Replication 1	Season 4	cgw	1	1	2	1.5	0.25	0	0	0.75	1.25
Replication 1	Season 4	cw	0	1	1.2	0.4	0.6	1.6	0.8	0.8	1.6
Replication 2	Season 4	cc	0	0	1.25	0.75	0.75	1.25	0.25	1	0.5
Replication 2	Season 4	cg	1	0	0.5	1	0	0.5	1	2	0
Replication 2	Season 4	cgw	1	1	1	1.25	0	0.5	0.75	0.75	0.5
Replication 2	Season 4	cw	0	1	1.5	0.75	0	1	1.25	0.75	0.75

cc: crop-crop combination; cg: crop-grassy combination, cgw: crop-grassy-woody combination; cw: crop-woody combination. Grassy refers to the herbaceous SNH

Table 19: Number of levels and range of the values of all attributes included in the French models.

	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Number of levels	2	3	8	9	12	10	7	9	11
Range	0–1	0–1	0–2	0.4–2	0–2	0–1.6	0–0.8	0.5–2	0–2

Grassy refers to the herbaceous SNH

10.4.6 Italy

Table 20: Values for each attribute and each picture of the statistical model of Italy.

Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication 1	Season 1	cc	0	0	2	1	0.75	0.5	0.5	0	2
Replication 1	Season 1	cg	1	0	2	0	1	0.25	0.75	0	2
Replication 1	Season 1	cgw	1	1	2	0.25	0	0	0.75	0.5	2
Replication 1	Season 1	cw	0	1	1.8	1.2	0.6	0	0.4	0.2	2
Replication 2	Season 1	cc	0	0	2	0.25	0	1.75	0.25	0	2
Replication 2	Season 1	cg	1	0	1.75	0.5	1	0.25	0	0.75	1.25
Replication 2	Season 1	cgw	1	1	1.75	0.75	0	1.5	0	0	2
Replication 2	Season 1	cw	0	1	0.75	0.5	0	1.25	0.25	0.25	2
Replication 1	Season 2	cc	0	0	1.25	0.5	1	1.25	0	0.5	2
Replication 1	Season 2	cg	1	0	1.5	0.25	1	1	0	0	2
Replication 1	Season 2	cgw	1	1	2	0.25	0.25	0.25	0	0	2
Replication 1	Season 2	cw	0	1	2	0.5	0.5	0.25	0	0	2
Replication 2	Season 2	cc	0	0	2	0.75	0.25	1	0.5	0	2
Replication 2	Season 2	cg	1	0	2	0.75	1	1	0	0.75	2
Replication 2	Season 2	cgw	1	1	1.75	0.5	0	0.5	0	0.25	2
Replication 2	Season 2	cw	0	1	1.25	0.5	0	0.5	0.25	0.25	2

Replication	Season	Combination	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Replication 1	Season 4	cc	0	0	2	1.25	0.5	0	0	0	2
Replication 1	Season 4	cg	1	0	1.5	0	0.75	1.25	0.5	0.25	1.25
Replication 1	Season 4	cgw	1	1	1.75	0.5	0.5	0.5	0.5	0	2
Replication 1	Season 4	cw	0	1	1.5	1	0.75	0.25	1	0.5	2
Replication 2	Season 4	cc	0	0	1.25	0	0.25	0.5	0.25	0	2
Replication 2	Season 4	cg	1	0	1.25	0.25	1	1.75	0.25	0.5	0.75
Replication 2	Season 4	cgw	1	1	2	1.5	0.25	0.25	1	0.25	2
Replication 2	Season 4	cw	0	1	1.5	0.5	0	0	0.5	0	2

cc: crop-crop combination; cg: crop-grassy combination; cgw: crop-grassy-woody combination; cw: crop-woody combination
Grassy refers to the herbaceous SNH

Table 21: Number of levels and range of the values of all attributes included in the Italian models

	Grassy	Woody	Green	Order	NoVeg	DryVeg	ColAvail	Openness	TreeCov
Number of levels	2	2	6	8	6	7	6	5	3
Range	0–1	0–1	0.75–2	0–1.5	0–1	0–1.75	0–1	0–0.75	0.75–2

Grassy refers to the herbaceous SNH

10.5 Model results

10.5.1 Germany

Table 22: Output of the model of Germany.

Class/attribute	Estimate	Std. Error	z-value	Pr(>|z|)	Significance
class.1.grassy	0.242497	0.202302	1.1987	0.2306489	
class.1.woody	-2.236662	0.325464	-6.8722	6.32E-12	***
class.1.Green	0.264519	0.329364	0.8031	4.22E-01	
class.1.Order	-0.09595	0.227587	-0.4216	0.6733183	
class.1.NoVeg	-0.808074	0.331079	-2.4407	0.0146578	*
class.1.DryVeg	0.044677	0.104392	0.428	0.6686709	
class.1.ColAvail	-0.200655	0.25599	-0.7838	0.4331328	
class.1.Openness	0.87067	0.257288	3.384	0.0007143	***
class.1.TreeCov	0.62504	0.204077	3.0628	2.19E-03	**
class.2.grassy	-0.451011	0.091511	-4.9285	8.29E-07	***
class.2.woody	0.696833	0.159754	4.3619	1.29E-05	***
class.2.Green	1.401568	0.16842	8.3219	< 2.2e-16	***
class.2.Order	-0.973808	0.138515	-7.0304	2.06E-12	***
class.2.NoVeg	-0.018787	0.171546	-0.1095	0.9127943	
class.2.DryVeg	0.035021	0.103296	0.339	0.7345839	
class.2.ColAvail	-0.480935	0.161369	-2.9803	0.0028793	**
class.2.Openness	0.980782	0.187667	5.2262	1.73E-07	***
class.2.TreeCovM	0.88159	0.195516	4.509	6.51E-06	***
(class)2	1.215088	0.179354	6.7748	1.25E-11	***
female:class2	0.301967	0.111461	2.7092	0.0067453	**
class2:AgeJoung	-0.863785	0.177913	-4.8551	1.20E-06	***
class2:AgeMed	-1.134915	0.175727	-6.4584	1.06E-10	***
class2:EDU_Low	-0.047502	0.116238	-0.4087	6.83E-01	
class2:EDU_Med	-0.626368	0.245286	-2.5536	0.0106607	*

p < 0.05*; p < 0.01**; p < 0.001***
Grassy refers to the herbaceous SNH

Table 23: BIC- and AIC-values of the 2-class and the 3-class model of Germany.

Model	BIC	AIC
2 classes	**4748**	**4612**
3 classes	4782	4561

The model in bold letters was the applied model.

10.5.2 Hungary

Table 24: Output of the model of Hungary.

Class/attribute	Estimate	Std. Error	z-value	Pr(>|z|)	Significance
class.1.grassy	2.652601	3.423171	0.7749	0.438401	
class.1.woody_N	4.438075	0.899908	4.9317	8.15E-07	***
class.1.GreenM	-15.9621	6.261042	-2.5494	0.01079	*
class.1.OrderM	6.410681	3.824746	1.6761	0.093717	
class.1.NoVegM	-3.87957	1.759011	-2.2055	0.027416	*
class.1.DryVegM	-9.26718	3.126439	-2.9641	0.003035	**
class.1.ColAvailM	7.324668	6.7257	1.0891	0.276129	
class.1.OpennessM	-6.67423	4.645382	-1.4367	0.150791	
class.2.grassy	-0.65708	0.069445	-9.4619	< 2.2e-16	***
class.2.woody_N	0.507063	0.072507	6.9933	2.69E-12	***
class.2.GreenM	0.021794	0.108359	0.2011	0.840598	
class.2.OrderM	1.06472	0.100311	10.6142	< 2.2e-16	***
class.2.NoVegM	-0.46103	0.074504	-6.188	6.10E-10	***
class.2.DryVegM	-0.66358	0.075709	-8.7648	< 2.2e-16	***
class.2.ColAvailM	1.723547	0.149788	11.5066	< 2.2e-16	***
class.2.OpennessM	0.375743	0.076457	4.9144	8.91E-07	***
(class)2	1.006088	0.16312	6.1678	6.93E-10	***
female:class2	0.737338	0.118145	6.241	4.35E-10	***
class2:AgeJoung	0.130362	0.177871	0.7329	0.463618	
class2:AgeMed	0.188441	0.178321	1.0567	0.290626	
class2:EDU_Low	0.402366	0.213716	1.8827	0.059739	
class2:EDU_Med	0.413093	0.119458	3.4581	0.000544	***

p < 0.05*; p < 0.01**; p < 0.001***
Grassy refers to the herbaceous SNH

Table 25: BIC- and AIC-values of the 2-class and the 3-models of Hungary.

Model	BIC	AIC
2-class, Woody and Openness	**6310**	**6179.636**
2-class, TreeCov and Openness	*6272*	*6142*
3-class: Classes 2 and 3 do not significantly differ.	6306	6074

The model in bold letters was the applied model. The model in italic letters would be slightly better.

10.5.3 Switzerland

Table 26: Output of the model of Switzerland.

Class/attribute	Estimate	Std. Error	z-value	Pr(>|z|)	Significance
class.1.grassy	-1.4565254	0.1523342	-9.5614	< 2.2e-16	***
class.1.woody_N	1.4179263	0.3105516	4.5658	4.975E-06	***
class.1.GreenM	0.0261241	0.1424253	0.1834	0.8544662	
class.1.OrderM	0.2722161	0.1368696	1.9889	0.0467153	*
class.1.NoVegM	-1.4581224	0.1703359	-8.5603	< 2.2e-16	***
class.1.ColAvailM	2.0100517	0.1670779	12.0306	< 2.2e-16	***
class.1.OpennessM	0.247472	0.2566312	0.9643	0.3348906	
class.1.TreeCovM	-0.6582577	0.1720171	-3.8267	0.0001299	***
class.2.grassy	-1.8765807	0.9365034	-2.0038	0.0450898	*
class.2.woody_N	3.8470596	4.260218	0.903	0.3665156	
class.2.GreenM	4.1490808	1.660602	2.4985	0.0124706	*
class.2.OrderM	0.7626684	1.1966718	0.6373	0.5239134	
class.2.NoVegM	-0.4044018	2.9553157	-0.1368	0.8911582	
class.2.ColAvailM	2.3597408	2.605461	0.9057	0.3650998	
class.2.OpennessM	-6.2272887	6.4117794	-0.9712	0.3314356	
class.2.TreeCovM	-3.9771616	1.3489336	-2.9484	0.0031945	**
(class)2	-0.383049	0.1470716	-2.6045	0.0092007	**
female:class2	-0.023677	0.1120697	-0.2113	0.8326766	
class2:AgeJoung	-0.6015322	0.1613666	-3.7277	0.0001932	***
class2:AgeMed	-0.2775009	0.1636273	-1.6959	0.0898987	
class2:EDU_Low	-0.0032653	0.1869719	-0.0175	0.9860662	
class2:EDU_Med	-0.2297591	0.1291668	-1.7788	0.0752761	

$p < 0.05$*; $p < 0.01$**; $p < 0.001$***
Grassy refers to the herbaceous SNH

Table 27: BIC- and AIC-values of the 2-class and the 3-class model of Switzerland:

Model	BIC	AIC
2-class, no DryVeg	**4377**	**4254**
3-class, no DryVeg	4407	4205

The model in bold letters was the applied model.

10.5.4 France

Table 28: Output of the model of France.

Class/attribute	Estimate	Std. Error	z-value	Pr(>|z|)	Significance
class.1.grassy	-0.05431	0.125001	-0.4345	0.663945	
class.1.woody_N	-1.244066	0.174988	-7.1094	1.17E-12	***
class.1.GreenM	0.035827	0.140669	0.2547	0.798965	
class.1.OrderM	-0.766697	0.140376	-5.4617	4.72E-08	***
class.1.DryVeg	-0.728419	0.134937	-5.3982	6.73E-08	***
class.1.ColAvailM	0.016743	0.145375	0.1152	0.90831	
class.1.OpennessM	-1.052164	0.176385	-5.9652	2.44E-09	***
class.1.TreeCovM	0.166151	0.126969	1.3086	0.190671	
class.2.grassy	-0.895398	0.365405	-2.4504	0.014269	*
class.2.woody_N	0.521033	0.351942	1.4804	0.138753	
class.2.GreenM	0.875656	0.280374	3.1232	0.001789	**
class.2.OrderM	-0.909373	0.29423	-3.0907	0.001997	**
class.2.DryVeg	0.116148	0.194289	0.5978	0.549967	
class.2.ColAvailM	0.034872	0.263916	0.1321	0.894878	
class.2.OpennessM	-0.4892	0.445105	-1.0991	0.271739	
class.2.TreeCovM	0.798995	0.287441	2.7797	0.005441	**
(class)2	0.542936	0.194875	2.7861	0.005335	**
female:class2	-0.305142	0.115835	-2.6343	0.008432	**
class2:AgeJoung	-0.691294	0.158446	-4.363	1.28E-05	***
class2:AgeMed	0.128504	0.155212	0.8279	0.407712	
class2:EDU_Low	-0.4108	0.150643	-2.727	0.006392	**
class2:EDU_Med	-0.627903	0.135391	-4.6377	3.52E-06	***

$p < 0.05$*; $p < 0.01$**; $p < 0.001$***

Grassy refers to the herbaceous SNH

Table 29: BIC- and AIC-values of the m2-class and 3-class models of France.

Model	BIC	AIC
2-class, no NoVeg	**4759**	**4634**
2-class, all attributes	4792	4656
3-class, all attributes	4772	4551

The model in bold letters was the applied model.

10.5.5 Italy

Table 30: Output of the model of Italy.

Class/attribute	Estimate	Std. Error	z-value	Pr(>|z|)	Significance
class.1.grassy	0.242497	0.202302	1.1987	0.2306489	
class.1.woody	-2.236662	0.325464	-6.8722	6.32E-12	***
class.1.Green	0.264519	0.329364	0.8031	4.22E-01	
class.1.Order	-0.09595	0.227587	-0.4216	0.6733183	
class.1.NoVeg	-0.808074	0.331079	-2.4407	0.0146578	*
class.1.DryVeg	0.044677	0.104392	0.428	0.6686709	
class.1.ColAvail	-0.200655	0.25599	-0.7838	0.4331328	
class.1.Openness	0.87067	0.257288	3.384	0.0007143	***
class.1.TreeCov	0.62504	0.204077	3.0628	2.19E-03	**
class.2.grassy	-0.451011	0.091511	-4.9285	8.29E-07	***
class.2.woody	0.696833	0.159754	4.3619	1.29E-05	***
class.2.Green	1.401568	0.16842	8.3219	< 2.2e-16	***
class.2.Order	-0.973808	0.138515	-7.0304	2.06E-12	***
class.2.NoVeg	-0.018787	0.171546	-0.1095	0.9127943	
class.2.DryVeg	0.035021	0.103296	0.339	0.7345839	
class.2.ColAvail	-0.480935	0.161369	-2.9803	0.0028793	**
class.2.Openness	0.980782	0.187667	5.2262	1.73E-07	***
class.2.TreeCovM	0.88159	0.195516	4.509	6.51E-06	***
(class)2	1.215088	0.179354	6.7748	1.25E-11	***
female:class2	0.301967	0.111461	2.7092	0.0067453	**
class2:AgeJoung	-0.863785	0.177913	-4.8551	1.20E-06	***
class2:AgeMed	-1.134915	0.175727	-6.4584	1.06E-10	***
class2:EDU_Low	-0.047502	0.116238	-0.4087	6.83E-01	
class2:EDU_Med	-0.626368	0.245286	-2.5536	0.0106607	*

Grassy refers to the herbaceous SNH

Table 31: BIC- and AIC-values of the 2-class and the 3-class model of Italy.

Model	BIC	AIC
2-class, all attributes	**5573**	**5373**
3-class, all attributes	5594	5437

The model in bold letters was the applied model.