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Research Paper

Factors influencing visual landscape quality perceived by the public. Results from a national survey

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HIGHLIGHTS

- Swiss residents rated visual landscape quality of their municipality positively.
- Alpine and pre-alpine regions were generally rated higher.
- Variance in visual quality ratings was higher within than between municipalities.
- Length of residence and openness of views explained variance within municipalities.
- Biogeographic regions and municipality typology explained variance between municipalities.

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ABSTRACT

In the context of significant landscape changes, understanding how residents perceive landscape quality is crucial for landscape policy-making and planning. However, while significant advancements have been made in measuring physical landscape change, social indicators assessing visual landscape quality perceived by the public are still underdeveloped. In this study, we use an indicator-based assessment of visual landscape quality that was collected through a standardized questionnaire at national scale in Switzerland. The survey was sent out to a representative sample of over 8000 households, with 2814 complete questionnaires returned. We investigated the influence of different factors on how residents assess visual landscape quality. Our results show that across Switzerland, residents rated visual landscape quality of their municipality positively, with some differences between geographic regions. Using a multilevel model, we included explanatory variables both at the individual level and variables on landscape characteristics at the municipality level. How long residents have lived in a region and how well they can see the landscape in an unobstructed way (openness of view) are significant predictors of perceived landscape quality, while gender and educational attainment are not. At the municipality level, the type of municipality and the biogeographic region are significant predictors to explain variance between municipalities. Results from this indicator-based assessment of visual landscape quality among the general public highlight the importance of including public opinion, with results that can potentially be used as a baseline from which to assess future landscape change and effects of landscape policy-decisions.

1. Introduction

Landscapes are important for people as living environments, for their recreation and well-being as well as for individuals' affective relations to specific places (Frick & Buchecker, 2008; Hermes et al., 2018; Manzo & Devine-Wright, 2013; Rewitzer et al., 2017; Ridding et al., 2018; Wartmann & Purves, 2018). In the context of significant landscape changes, understanding how people perceive landscapes becomes crucial for policy-making and planning (Plieninger et al., 2015). For instance, the European Landscape Convention (ELC) defines landscape as '*an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors* '(Council of Europe, 2000). The Convention aims to foster landscape planning, conservation and management in all European landscapes, including assessing how people perceive these landscapes. Political and administrative obligations thus require the development of integrated landscape monitoring

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programmes that include people's views and judgements of visual landscape quality. However, in their review Cassatella and Peano (2011) found that the focus in landscape monitoring has been mostly on ecological assessments and indicators and less on integrating people's landscape perception. Landscape monitoring systems that have been developed focus primarily on environmental indicators (Ståhl et al., 2011), with perception indicators commonly lagging behind those of physical landscape indicators. A noteworthy exception are the landscape character assessments, which classify and describe landscape character (Fairclough et al., 2018a). Although indicators for landscape monitoring are well-established across many European countries (Cassatella & Peano, 2011; Dramstad et al., 2006; Hermes et al., 2018; Kienast et al., 2019; Ståhl et al., 2011; van Herwaarden, 2017) and are used for decision-making, there is a need to further develop and test social indicators that assess landscape quality as perceived by members of the public. Such public assessments contribute to extending expert-based landscape assessments (Butler, 2016; Sevenant & Antrop, 2009) and form the basis for developing policies that take into account public views and opinions.

In this study, we take the example of the Swiss Landscape Monitoring programme (LABES), which is a national monitoring programme that assesses the state of and changes to landscapes and how they are perceived by the public. The monitoring programme LABES evolved from the previous physical landscape monitoring 'Landscape under Pressure' that assessed physical landscape change based on existing datasets between 1972 and 2003 (FOEN and WSL, 2013). In 2011, social data was included in LABES in the form of a first national survey on public landscape assessments, on which this study is based. The LABES results form part of the national environmental monitoring, and are used to inform landscape planning and policy-making at the national and Cantonal level. The monitoring is conducted approximately every ten years and comprises indicators for the physical landscape measured through satellite imagery and topographic data, and indicators on the perception of landscape by residents include visual landscape quality, which is the focus of this paper, and further indicators including place attachment. Social indicators are assessed through a standardised questionnaire sent out to a representative sample of the Swiss population (Kienast et al., 2015). The Swiss Landscape Monitoring programme is therefore an example of an integrated monitoring as advocated for by the European Landscape convention, because the monitoring includes both the physical landscape and how it is perceived and interpreted by the public (Kienast et al., 2019). In this study, our aim is twofold:

1. To analyse the geographic variation of how residents rate visual landscape quality
2. To assess factors that influence visual landscape quality ratings

In order to address these aims we analyse data on the social indicator of perceived visual landscape quality that was collected through a national survey. We analyse the spatial variation in this indicator at the level of Cantons (member states of the Swiss Confederation) as the administrative level responsible for Cantonal landscape policy-making and planning. We then zoom in on the lowest administrative level of municipalities to explain variation between respondents living within the same municipality, and between different municipalities.

The novelty of this paper lies in the quantitative assessment of an indicator of visual landscape quality through a large representative survey at the national scale, and in the use of multilevel modelling as a quantitative social science approach to explain variation within and between municipalities.

In the following, we first briefly present an overview of approaches to assess visual landscape quality. We then describe the survey design and analysis methodology, before presenting results of the spatial patterns and factors influencing perceived visual landscape quality. Finally, we discuss our findings with respect to the literature and highlight implications for landscape monitoring.

1.1. Background

Scenic beauty and aesthetic aspects of landscapes have gained traction as important components to consider in landscape planning and management, which provide an important link between people and ecosystems, and are considered as a 'cultural ecosystem service' (Gobster et al., 2007; Millennium Ecosystem Assessment, 2005). Daniel (2001) defined visual landscape quality as '*the relative aesthetic excellence of a landscape*', and different methodological approaches to assess visual landscape quality have been developed that are rooted in different theoretical frameworks (Daniel, 2001; Lothian, 1999). Lothian (1999) proposes to distinguish between two paradigms of visual landscape quality - the objectivist approach and the subjectivist approach. The objectivist approach sees visual landscape quality as a physical characteristic inherent to the landscape, which can be determined and classified by experts, whereas the subjectivist approach considers visual quality to be a construct arising from the interaction of an observer and the landscape that requires the assessment of people's responses (Lothian, 1999). Daniel and Vining (1983) proposed five models as a typology of visual landscape quality assessment methods, ranging on a scale from objectivist to subjectivist. The literature on visual landscape quality assessments reflects both paradigms. The objectivist paradigm is exemplified, for instance, in expert-based landscape assessments that include landscape classifications and evaluations of landscape quality (Fairclough et al., 2018b; Le Dû-Blayo, 2018; Swanwick, 2002, 2012; Swanwick & Fairclough, 2018; Van Eetvelde & Antrop, 2009). The subjectivist paradigm is illustrated in studies that assess respondent preferences for landscapes and the contribution of physical landscape features to their perceived quality (Daniel et al., 1977; Herzog & Bosley, 1992; Kaplan & Herbert, 1987; Kaplan & Kaplan, 1989; Zube & Pitt, 1981). Methodologically, Likert-scales have been used in such research that measure the agreement to verbal statements as a quantitative means to assess landscape quality (Herzog & Bosley, 1992).

Several theories have been developed to explain landscape preferences. They correspond with dimensions of landscape experience as suggested by the meta-concept of Bourassa (1991), which was later updated by Hunziker, Buchecker and Hartig (2007). Evolutionary theories state that landscape preferences are a result of human evolution. The prospect-refuge theory (Appleton, 1975) postulates a human preference for landscapes that allowed early humans to see (prospect) without being seen (refuge), indicating favourable conditions for survival. Furthermore, the habitat theory (Orians, 1980) states that because early humans evolved in savannah-type landscapes of grasslands with scattered trees and open water sources, there should be a strong visual preference for such landscapes. One of the most influential psychological theories is the information processing theory applied to landscape aesthetics by Rachel and Stephen Kaplan (1989). The theory states that the need for immediate as well as inferred understanding and exploring of a landscape were important during human evolution, which is expressed in a matrix using the four concepts coherence (immediate understanding), complexity (immediate exploration), legibility (inferred understanding), and mystery (inferred exploration). A meta-review on studies assessing these concepts showed that although in seminal studies all four concepts are positively related to landscape preferences, the relationship is not consistent across all studies (Stamps, 2004).

Cultural preference theories in contrast explain preferences as being shaped by social and cultural norms, as well as individual characteristics, memories and experiences (Kühne, 2017; Tveit et al., 2018). Tuan's seminal work on topophilia (1974) has been an influential work in human geography, highlighting the emotional bonds people form with places, and how these bonds create preference for certain places and environments. Another influential cultural theory is the ecological aesthetic (Gobster, 1999), which states that knowledge about the ecological value of certain landscape features (e.g. dead wood in a forest as important for biodiversity) can increase appreciation and acceptance by the public. The ecological aesthetic thus allows to positively influence people's preferences through targeted information. This is important for policy-making, because as Nassauer (1992) highlighted, public perception of landscape is socially constructed and does not always reflect ecological value. For example, a park landscape with green lawns can be perceived as aesthetic, with a high visual landscape quality, but may be of low ecological value, whereas a restored wetland of high ecological value can be perceived as unkempt and therefore assessed as having low visual landscape quality.

The objectivist and subjectivist theoretical framework are not mutually exclusive, and some studies apply an integrated theoretical framework, postulating the existence of some commonalities in preferred landscape features across cultures and individuals, but recognising that there are important cultural and individual differences in how people view landscapes (Kienast et al., 2015; Tveit et al., 2006). We subscribe to this integrated theoretical framework and investigate visual landscape quality as the aesthetic quality of a landscape as assessed by members of the public. Based on this framework we assume that the assessment of visual landscape quality results from how people perceive and evaluate the physical features in a landscape, with some culturally shared preferences for some landscape features over others. Visual landscape quality is thus the result of how individuals evaluate the physical and biological components of landscapes based on their social, cultural and individual background and experiences.

1.2. Research questions

Based on this background, this study assesses the following research questions. How do visual landscape quality assessments by residents differ across the Cantons of Switzerland (RQ1)? We expect a spatial pattern of touristic regions in the alpine and more rural Cantons to be rated as higher visual landscape quality and urbanised Cantons in the Central Plateau as lower by residents in these areas. Moreover, what is the effect of explanatory factors on landscape quality assessments (RQ2)? Specifically, controlling for socio-demographic variables, what is the effect of familiarity with a landscape on landscape assessment (RQ2a), how well respondents can overlook the landscape from their own home (RQ2b) and whether they are generally interested in topics revolving around landscape and nature conservation (RQ2c)? We expect that familiarity, ability to view the landscape and interest in nature/landscape all have a positive influence on visual quality assessments. And furthermore, what influence do characteristics of the landscape have on visual quality assessments (RQ3)? We expect that characteristics of the landscapes will be significant predictors in explaining variation between municipalities.

2. Methods

Visual landscape quality was measured through a national survey that forms part of the Swiss Landscape Monitoring Programme to assesses the state and changes in landscapes from physical as well as social science data in approximately ten year intervals (FOEN and WSL, 2013). The first assessment of social landscape indicators took place in 2011, and we base our analysis on the dataset collected in this first assessment. Although the general results of the indicators have been reported (Kienast et al., 2015; Rey et al., 2017), the analysis in this study is novel due to its focus on the indicator of perceived visual landscape quality and the detailed statistical analysis of how this perception varies between people and between different municipalities.

2.1. Study area

Switzerland has a population of over 8 million people and covers an area of approximately 41,000 km^2. Of that surface area, only about a third are gentle hills or flat topography, and the rest has a moderate to steep terrain (Kienast et al., 2015). The mountains of the Swiss Alps constitute the steepest terrain of the country. The Swiss Alps, together with the Jura Mountains and the Swiss Plateau, form the three main physio-geographic regions. The Central Plateau is the most densely populated area in Switzerland. The mountain areas more sparsely populated, where agriculture and tourism are economically important (FOEN and WSL, 2017). The landscapes of Switzerland are characterised by a mosaic of settlement areas, patches of forest, agricultural land, lakes and rivers. Switzerland recognises four official languages, German, French, Italian and Romansh. Administratively, the country is divided into 26 cantons that form the member states of the Swiss Confederation, with municipalities being the lowest level of administration. Landscape planning and policy-making is divided across the federal, cantonal and municipality level, with the Cantons bearing the main responsibility for landscape development and maintaining or improving landscape quality, but municipalities also bear responsibility, e.g. for the development of city or village centres or provisioning of green spaces (Steiger, 2016). The levels of analysis for this study are the level of the Cantons (26 in total) and municipalities (2551 at the time of sampling) as the main administrative units for landscape planning and policy-making in Switzerland.

2.2. The outcome variable: perceived visual landscape quality

In this study, we focus on the indicator of visual landscape quality assessments by residents in Switzerland, because we argue that of the different social indicators assessed in the monitoring programme (Kienast et al., 2015) visual landscape quality constitutes an umbrella concept that allows us to analyse an overall integral assessment of landscape in terms of how it is perceived by the general public. The outcome (dependant) variable of visual landscape quality was measured in the survey as a scale consisting of four items (verbal statements), to which respondents had to rate to which degree the statement applied on a 5-point Likert-Scale (Table 1). The ends of the scale were labelled with the equivalent of 'does not apply at all' and 'completely applies' in German, French and Italian as the three administrative languages of Switzerland. The ratings for the agreement to each statement were categories from −2 for 'does not apply at all' to +2 for 'completely applies'. The arithmetic mean from the responses to all four statements was taken as value for the indicator 'perceived visual landscape quality'. The Likert-scale for this indicator was developed specifically for this survey instrument and extensively pre-tested. In a pre-test with more neutral Likert-statements, we found a pronounced ceiling effect in that the agreement was very high (between +1 and +2 for most respondents). We therefore reformulated the items into more highly positive ones (e.g., 'the landscape is very beautiful') to reduce this ceiling effect. We did not use negative items for this scale, because our pre-tests showed that

Table 1
Survey items in German, French and Italian for the scale of "perceived visual landscape quality".

Items in German	Items in French	Items in Italian	English translation for items
Die Landschaft in meiner Wohngemeinde ist sehr schön.	*Dans ma commune, le paysage est très beau.*	*Il paesaggio nel mio Comune di residenza è molto bello.*	*The landscape in my residential municipality is very beautiful.*
Die Landschaft in meiner Wohngemeinde ist sehr attraktiv.	*Dans ma commune, le paysage est très attirant.*	*Il paesaggio nel mio Comune di residenza è molto attraente.*	*The landscape in my residential municipality is very attractive.*
Die Landschaft in meiner Wohngemeinde gefällt mir sehr gut.	*Dans ma commune, le paysage me plaît beaucoup.*	*Il paesaggio nel mio Comune di residenza mi piace molto.*	*I like the landscape in my residential municipality very much.*
In der Landschaft in meiner Wohngemeinde gibt es vieles, das ich sehr schön finde.	*Dans ma commune, le paysage offre beaucoup de très belles choses.*	*Nel paesaggio del mio Comune di residenza c'è tante cose che trovo belle.*	*In the landscape of my residential municipality there is a lot that I find very beautiful.*

double verbal negations (e.g., 'I disagree that the landscape is unattractive') were difficult for respondents to understand and therefore potentially misleading. The reliability of the scale of visual landscape quality was assessed using Cronbach's alpha = 0.89 (Cronbach, 1949), which is considered a good internal consistency of a psychometric scale (DeVellis, 2016).

2.3. Explanatory variables

We used different explanatory variables (Table 2). These included, *length of residence in the region* as a proxy for familiarity with the landscape in a municipality, and *membership of an environmental NGO*, which has been used as an explanatory variable in previous studies on landscape preference (Gehring, 2006; Soliva et al., 2010) as a proxy for interest in nature and landscape topics. Furthermore, we included the ability to view landscapes from where they lived, operationalised as a variable with three levels of *obstructedness* (mostly unobstructed, slightly obstructed, very obstructed). As control variables, we included the socio-demographic variables of *gender* and *educational attainment*. We excluded the variable age because of high correlation with our explanatory variable length of residency (Spearman's-Rho: 0.470, $p < 0.001$), which would lead to issues of multicollinearity in our model. We did not include a question of income in the survey, because in the cultural context of Switzerland this may lead to respondents discontinuing filling out the questionnaire. Instead of income, the proxy control variable of *tenancy* was included (with two categories owning property or renting), where home ownership is assumed to be associated with higher income.

At the municipality level, we included *municipality type*, using the official municipality typology with 9 classes (urban centre, suburban, peri-urban, high-income, touristic, industrial and tertiary sector municipality, rural commuter municipality, agrarian-mixed and agrarian municipality) published by the Federal Statistical Office (Federal Statistical Office, 2012). Second, we included the six types of biogeographic regions in Switzerland (Jura, Central Plateau, Northern Alps, Western Central Alps, Eastern Central Alps, and Southern Alps) as a low granularity proxy for overall physical landscape characteristics (Federal Ministry of the Environment, 2001). Additionally, we used *percentage of municipality area classified in the national inventory* 'Bundesinventar für Landschaften, BLN' (i.e. 'areas of outstanding beauty of national importance') as a proxy for an area in a municipality that is of a high formally recognised visual landscape quality (Federal Ministry of the Environment, 2017).

2.4. Sampling and data collection

The survey conducted in 2011 is the first and up to date the only national assessment of landscapes in Switzerland, which consisted of a pen-and paper questionnaire sent to a representative number of Swiss households. The questionnaire had three parts. The first part contained questions about how respondents assessed the landscape in their municipality, which included the items for our outcome variable. The second part of the questionnaire contained questions to assess the living quality of residents, including perceptions of the immediate surroundings of the respondent's residence, which are not reported here. The third part assessed socio-demographic variables. The questionnaire was translated from German to French and Italian (FOEN and WSL, 2013). Printed questionnaires were mailed to 8700 households across Switzerland. If the questionnaires were not returned within the specified time frame, two reminders were sent. This procedure resulted in a total of 2814 completed questionnaires sent back, amounting to a return rate of over 35%. The returned questionnaires were digitised and prepared for further analysis in SPSS (IBM Corp., 2020).

The sample drawn is representative of the Swiss resident population, with the selection of households based on a stratified random sample drawn from the registry of residents in Switzerland by the Federal Statistical Office. Each Canton represents a stratum with at least 300 selected households, ensuring a relatively even spatial distribution of respondents at the national level. However, within each Canton, the random selection procedure selects respondents based on population density. As such, this sample constitutes a typical survey sample exhibiting clusters of geographic areas of high population densities such as urban centres.

Table 2
Explanatory variables and measurement scales.

Variable	Measurement scale
Control variables	
Gender	Nominal (binary)
Educational attainment	Nominal (five categories)
Tenancy	Nominal (binary)
Explanatory variables at level of individuals	
Length of residence in the region	Ratio
Membership of an environmental NGO	Nominal (binary)
Obstructedness of view	Ordinal (three levels)
Explanatory variables at level of municipalities	
Municipality type	Nominal (9 classes)
Biogeographic region	Nominal (6 classes)
Percentage of municipality area designated in national inventory of outstanding landscapes	Ratio

2.5. Analysis

Our analysis is centred around two approaches. First, we map the outcome variable at the level of Cantons to explore the spatial variation at a coarse granularity across our study area, before exploring the influence of different variables at the level of municipalities.

2.5.1. Geographic variation in visual landscape quality

In order to assess the geographical variation of the indicator of perceived visual landscape quality, we calculated the arithmetic mean of visual landscape quality ratings for each Canton and analysed the geographic variation at the Cantonal level. We chose to conduct this spatial analysis at the level of Cantons, because they represent the strata of representative sampling, and allow identifying the distribution of visual quality ratings at the administrative level responsible for landscape planning and policy-making (Steiger, 2016). We used SPSS version 26 (IBM Corp., 2020) to calculate and compare arithmetic means per Canton and mapped the results in QGIS (QGIS Development Team, 2018), using the dataset of swissBOUNDARIES3D from the Federal Office of Topography (swisstopo, 2020) for the Cantonal boundaries.

2.5.2. Multilevel model

For our second aim, we test the influence of different factors on the indicator of visual landscape quality using a multilevel model. We chose a multilevel approach because if we were to apply conventional multiple regression analysis to such a geographically stratified sample, we violate the assumption of independent observations, as many observations will in fact be drawn from the same sub-units, resulting in estimates of standard errors that are too small, which in turn may lead to many spuriously significant results (Hox et al., 2017). Instead, we make use of these geographic clusters and apply a multilevel regression model (variants are also referred to as random coefficient model, hierarchical linear model or mixed-effects model), which was developed as a statistical approach to deal with variables at different levels simultaneously and has been successfully applied to analyse survey data (e.g. Hox, De Leeuw, & Kreft, 1991; Pickery, Loosveldt, & Carton, 2001), also in the context of landscape research (Hegetschweiler et al., 2017). For our multilevel model, the individual respondents are the lower level (level 1), nested within the higher level of municipalities (level 2). We chose municipalities as our higher level, because respondents were specifically asked about the landscape in their municipalities. Our sample consisted of 2814 questionnaires distributed across 1009 municipalities of a total of 2551 municipalities when the survey was distributed. The median of questionnaires per municipality was 4 (mean: 11.0 ± 15.2), and 518 municipalities had only a single observation. We included these single observations, because although increasing number of observations for level 2 groups increases the statistical power to estimate random effects (Austin & Leckie, 2018), small sample sizes for level 2 groups were not found to lead to serious bias (Bell et al., 2008; Maas & Hox, 2005). Using a simulation study with level 2 groups containing only single observations showed that, provided the number of level 2 groups was large, the small group sizes had little impact on bias and Type I error control (Bell et al., 2008). Given that the number of level 2 groups in our study was more than 1000 municipalities, we thus kept also groups with single observations.

We used a conceptual model where the dependent variable of perceived visual landscape quality is influenced by independent variables found both at the individual level, as well as variables at the level of municipalities that represent the characteristics of landscapes in the different municipalities. We thus built a linear mixed effect model with perceived visual landscape quality as a dependent variable. We tested the assumptions of normality of residuals, homoscedasticity and absence of multicollinearity for a multilevel model were met. The probability-probability (PP) plot showed only a slight deviation for the standardised residuals, leading us to conclude that the assumption of the normality of residuals was fulfilled. We assessed homoscedasticity by plotting predicted values and residuals in a scatterplot and found no pattern in the data to indicate heteroscedasticity. Finally, we tested for multicollinearity among predictor variables and found no correlation among predictor variables to indicate multicollinearity. We used listwise deletion for all missing values, retaining a sample of N = 2482 for the multilevel model. We used the maximum likelihood (ML) estimation method, as it is standard practice in multilevel modelling (Silva et al., 2019) and has the benefit of allowing to compare two models based on their deviance. In order to remove conflation between higher and lower level variance, we applied group-mean centering to all lower level variables (Bell et al., 2018; Enders & Tofighi, 2007). As a first step, we calculated an unconditional model to determine the Intraclass-Correlation-Coefficient or ICC (Snijders & Bosker, 2011). Secondly, we added the control variables *gender*, *education level*, and *tenancy* as fixed effects at the level of individuals for our first model. We then added the explanatory variables length of *residency in a region*, *membership of an environmental NGO*, and *obstructedness of view from one's home* as Level 1 fixed effects to explain variation in visual landscape quality ratings for our second model. For the third model, we included three variables *municipality type, biogeographic region*, *percentage of municipality area designated in national inventory of outstanding landscapes* as fixed effects at the municipality level.

We compared the resulting models based on the statistical significance of difference in deviance and used Akaike's Information criterion (AIC) to assess model fit (Silva et al., 2019). The proportion reduction in error variance was calculated separately for the level 1 and level 2 using the formula given by Kreft and De Leeuw (2002).

3. Results

3.1. Demographic composition of survey respondents

Of the 2814 respondents, 1284 were women, 1518 male, and 12 did not indicate gender. Of the returned questionnaires, 2008 were German, 490 French and 316 Italian. Respondents over 40 years of age were overrepresented compared to the age composition of the resident population in Switzerland (Table 3). As only respondents aged 18 or older were asked to filled out the questionnaire, this part of the population is underrepresented.

Table 3
Age composition of sample compared to the Swiss resident population.

Category	Landscape survey (total of 2814)	Sample universe of the adult Swiss resident population in 2012 (total residents 8,039,060)
19–39	17.0%	33.5%
40–64	55.1%	44.6%
Over 65	27.9%	21.9%

3.2. Geographical variation in visual landscape quality assessments

On a scale from −2 to 2, the mean visual landscape quality rating across respondents at the national scale was 1.02 (±0.84), indicating an overall relatively high perceived visual landscape quality. At the level of Cantons, the highest ratings were in Obwalden (mean: 1.64 ± 0.54, n = 40), Appenzell-Innerhoden (mean: 1.53 ± 0.66, n = 22) and Nidwalden (mean: 1.40 ± 0.75, n = 48). The lowest ratings were in Geneva (mean: 0.48 ± 0.99, n = 63), Ticino (mean: 0.71 ± 0.93, n = 340) and Basel-Stadt (mean: 0.75 ± 0.93, n = 82). Differences between Cantons were significant (Kruskal-Wallis-H = 205.745, $p < 0.05$, df = 25). Mapping the quantile distribution of ratings shows that Cantons in the centre of Switzerland, as well as Cantons in the Alpine region show higher visual quality ratings, except for Ticino (Fig. 1). The lowest visual quality ratings are observed in densely populated Cantons of the Central Plateau (Fig. 1). After observing the broad spatial patterns at the level of Cantons we now focus on variation within and between municipalities. Descriptive statistics for visual landscape quality ratings at the level of municipalities for biogeographic regions and municipality types are provided in Supplementary Materials.

3.3. Factors influencing visual landscape quality

The Intraclass-Correlation-Coefficient ICC in the null model was 13.36%, indicating that only 13% of variance was between groups in the null model. The first model with the control variables *educational attainment*, *gender*, and *tenancy* showed that none of the control variables was significant at the α = 0.05 level (Table 4). Adding those variables did not significantly improve model fit (χ^2-test for significance of difference between model deviances, p = 0.1718). Adding the level 1 predictor variables *environmental NGO membership, length of residency in the region* and *obstructedness of view* in model 2 significantly improved model fit (χ^2 –test; $p < 0.05$). The explanatory variable *length of residency in the region* had a small positive and significant effect on the perceived visual landscape quality of the landscape in one's municipality (Table 4). Thus, the longer someone lived in the same region, the higher they rated visual landscape quality, indicating that familiarity positively influences how people rate the landscape in their municipality. Obstructedness of the view from one's home was a significant negative predictor. The more obstructed the view from one's home is, be that through buildings obstructing the view or because one's home is located at the bottom of a valley floor where topography limits visibility, the lower the respondents rate the visual quality of the landscape. NGO membership was not a significant predictor.

Finally, we added the level 2 predictor variables at the municipality level in model 3. Adding the three predictors of *municipality type*, *percentage of municipality designated as national landscape inventory* and the *biogeographical region* significantly improved overall model fit (χ^2-test: $p < 0.05$), and the predictors themselves were also all significant (Table 5). Using the estimates for the variance components of our unconditional model and comparing them to the variance components of the final model, we find the proportion reduction of variance at level 1 was 5.6% and 59.65% at the level 2.

4. Discussion

In order to assess landscapes from an integrated perspective, we need

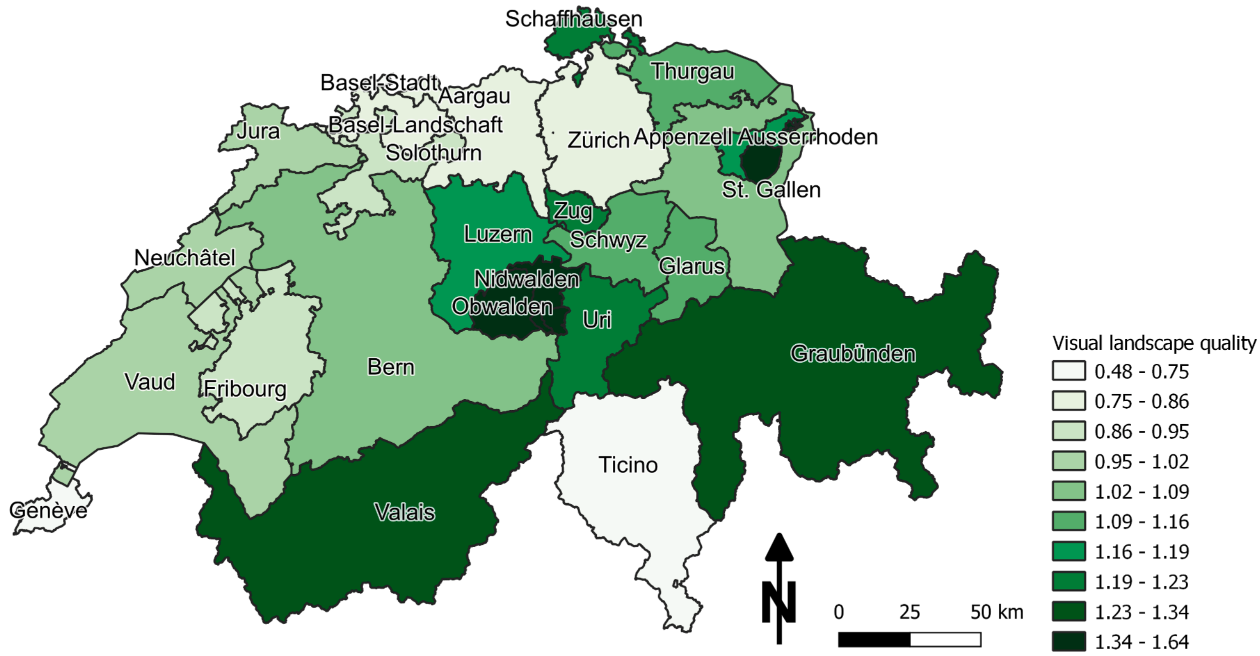

Fig. 1. Quantile distribution of mean visual landscape quality ratings per Canton (on a scale from −2 to +2).

Table 4
Tests of Fixed Effects (* indicates significance at 0.05 level).

	Unconditional model	Model 1 (adding control variables)	Model 2 (adding level 1 predictors)	Model 3 (adding level 2 predictors)
Source	F	F	F	F
Intercept	2409.6050*	2410.7118*	2421.3142	1028.7594*
Control variables				
Educational attainment		1.2456	0.4979	0.5092
Gender		0.8111	2.0749	2.3820
Tenancy		2.4846	0.7243	0.6078
Level 1 predictors				
NGO membership			1.5544	1.6632
Length of residency			4.7116*	4.7616*
Obstructedness of view			78.5878*	79.2080*
Level 2 predictors				
% area as national landscape inventory				26.8054*
Biogeographic region				9.1989*
Municipality typology				10.5042*

to take into consideration physical measurements of landscape composition and land use/land cover, as well as how landscapes are perceived by the people who live, work and recreate in these landscapes. Such an approach that integrates people's perception is also called for by the European Landscape Convention (Council of Europe, 2000). However, while assessments of bio-physical landscape indicators are abundant, there are still relatively few studies on social science indicators for assessing public perception of landscapes and their quality (Cassatella & Peano, 2011; Fry et al., 2009; Hedblom et al., 2020; Kienast et al., 2015). This lack of social science landscape indicators means that data on the public perception of landscapes are not available for evidence-based decision making, e.g. on landscape policies. In this study, we aimed to address this gap by analysing data from a national survey on landscape perception among a representative sample of the Swiss population. We focused on three main research questions. Firstly, how do visual landscape quality assessments by residents differ across the Cantons of Switzerland (RQ1)? Secondly, what is the effect of explanatory factors on landscape quality assessments (RQ2)? And thirdly, what influence do characteristics of the landscape have on visual quality assessments (RQ3)? To address these research questions, we mapped mean ratings of visual landscape quality at the spatially coarse granularity of Cantons across Switzerland (RQ1), before zooming in on the variation within (RQ2) and between municipalities (RQ3) using a multilevel modelling approach. In the following, we discuss our findings with regards to these research questions.

4.1. Geographical variation in visual landscape quality ratings across Swiss Cantons

The spatial distribution of mean visual landscape quality across Cantons showed that residents rated visual landscape quality positive across Switzerland, but with higher ratings in alpine and pre-alpine regions, and generally lower ratings in Cantons of the Central Plateau, specifically in heavily urbanised Cantons such as Geneva or Basel-Stadt. The exception is the Canton of Ticino, where the mean visual landscape quality was also rated lower, which consists of alpine regions as well as pre-alpine areas and population centres in the main valley floors. We argue that the lower ratings of the Canton Ticino are related to the sample being a population sample. In Ticino, despite parts of the Canton being Alpine regions, the population is concentrated in the lower valley floors, in highly industrialised settlements with large urban sprawl. The results of this survey therefore do not represent the visual quality of the remote Alpine valleys in Ticino, but the municipalities where many residents live and work. Those municipalities – in the views of their own residents - do not seem to be rated as having high visual quality.

Differences between Cantons were significant, suggesting that there are differences between Cantons in how residents rate the landscapes of their residential municipality. These ratings of the Canton were spatially not random but seemed to follow geographic differences across Switzerland. Cantons in the Alps were generally rated higher. This

Table 5
Estimates of fixed effects, covariance parameters and information criteria (* indicates significance at 0.05 level).

	Unconditional model	Model 1 (adding control variables)	Model 2 (adding level 1 predictors)	Model 3 (adding level 2 predictors)
Estimates of fixed effects	Est. (SE)	Est. (SE)	Est. (SE)	Est. (SE)
Intercept	1.0269 (0.0209)*	1.0268 (0.0209)*	1.0273 (0.0209)*	1.0470 (0.1361)
Control variables				
Educational attainment		−0.01410 (0.01261)	−0.0090 (0.0128)	−0.0091 (0.0127)
Gender		−0.0357 (0.0397)	−0.0567 (0.0394)	−0.0603 (0.0391)
Tenancy		0.0676 (0.0429)	0.0364 (0.0428)	0.0331 (0.0425)
Level 1 predictors				
NGO membership			−0.0636 (0.0510)	−0.0654 (0.0507)
Length of residency			0.0022 (0.0010)*	0.0021 (0.0010)*
Obstructedness of view			−0.2598 (0.0293)*	−0.2590 (0.0291)*
Level 2 predictors				
% area as national landscape inventory				0.0039 (0.0007)*
Biogeographic region:				
Jura				0.2704 (0.0712)*
Central Plateau				0.2399 (0.0617)*
Northern Alps				0.4519 (0.0679)*
Western Central Alps				0.5069 (0.1095)*
Eastern Central Alps				0.4169 (0.1385)*
Southern Alps				0[a]
Municipality typology				
urban				−0.4041 (0.1307)*
suburban				−0.5658 (0.1294)*
high-income				−0.2618 (0.1520)
periurban				−0.4306 (0.1332)*
touristic				0.0419 (0.1528)
industrial				−0.3352 (0.1313)*
rural commuter				−0.3260 (0.1378)*
agrarian-mixed				−0.1155 (0.1334)
agrarian				0[a]
Estimates of covariance parameters				
Residual: unexplained lower level variance (ε_{ij})	0.6140	0.6127	0.5856	0.5796
Intercept variance: unexplained between-group variance (u_{oj})	0.0947	0.0949	0.1027	0.0382
Information criteria				
AIC	6112	6113	6016	5870
−2LL	6106	6101	6034	5824

[a] this redundant parameter was set to 0.

observation is in line with alpine and pre-alpine landscapes as touristic hotspots with iconic mountain scenery that are highly valued for leisure activities (Buijs et al., 2006) and are also highly preferred landscapes (Soliva et al., 2010). Thus, touristic hotspots with iconic scenery were also rated higher in terms of visual landscape quality by residents in these landscapes. However, while mean ratings are lower in the Central Plateau, they are still positive, suggesting that also residents living in these areas generally assess landscapes in their municipality positively, which is in line with findings from work on public assessment of urban and suburban as well as rural landscapes in Switzerland (Ströbele & Hunziker, 2017; von Wirth et al., 2016). A main caveat of the use of our scale for visual landscape quality is that the statements were formulated highly positively (e.g. 'the landscape is very beautiful') in order to avoid the pronounced ceiling effect of high agreement with more neutral statements, where most respondents simply select the highest possible agreement. Therefore, using such highly positively formulated verbal statements allowed us to find more variation, with what we assume are generally positive ratings of landscape, but this results in a potential bias towards more positive assessments. To address this caveat, future national landscape assessments in Switzerland should include other aspects of landscape quality and statements that allow a more nuanced assessment across the range of positive, neutral and negative assessments of landscape quality.

While mapping the mean values of visual quality ratings per Canton provides a general overview, this approach has several limitations. First, Cantons are uneven in their population size, with some Cantons such as Graubünden having low population size but are geographically large, leading to a small number of cases from the sample defining the value of a large Canton, which can be visually biasing. Given the use of a representative sample at the level of Cantons, a further limitation of this study is that within the Canton, the sampling according to population results in urbanised, highly populated areas of a Canton to contribute more to the overall sample. Thus, in Cantons that are highly diverse in terms of their landscape composition, with larger cities, suburban and more rural areas, solely focussing on this higher administrative level carries the risk of glossing over important differences within Cantons. In order to address some of these limitations, we therefore included an analysis at the level of individual municipalities, acknowledging that not all municipalities across Switzerland were sampled.

4.2. Factors influencing visual landscape quality ratings

Using a multilevel model approach, we portioned the variance observed in visual landscape quality ratings to variation between respondents within municipalities, and into variation between municipalities. Length of residence in a region was positively related to ratings, suggesting a link between familiarity or place attachment to how people assess landscapes, which has been shown in other case studies (Bonaiuto et al., 2002; Carrus et al., 2005; Lewicka, 2011). Furthermore, we found the openness of views to be highly positively related to visual quality ratings, which is in line with the prospect-refuge theory (Appleton, 1975), where openness or the ability to prospect leads to a preference for a landscape. Furthermore, this finding is in line with previous empirical studies indicating the importance of openness in landscapes as predictors for landscape preference (Coeterier, 1996; Ströbele & Hunziker, 2017; M S Tveit et al., 2006). The openness of views we investigated is a compound measure, because it includes both the built-up environment (how well can you see past other houses) as well as topography (are you living on a valley floor or at the side of a hill), but also the individual living situation (residents of a high rise building have high visibility of the landscape higher up, in a heavily urbanised setting). We did not collect addresses of respondents, and were unable to retrospectively assess the location of their home in relation to topography or land cover (e.g. urban vs. rural settings). As openness of the landscape from one's home was a significant predictor, we suggest to further investigate this variable in future research to differentiate openness due to topography of the landscape or due to building height and how it influences visual landscape quality ratings. Despite several significant predictors in our model, a large proportion of variance at the individual level remains unexplained, which is in line with other studies such as public perceptions of forest quality where most variation between individuals remains unexplained (Hegetschweiler et al., 2017). Results from these studies indicate the need for integrating other explanatory factors at the level of individuals that may influence landscape assessments (e.g. political views, time spent outdoors, more general views on nature), but which were not assessed in this survey due to constraints in length.

At the municipality level, the typology of municipality characteristics (Federal Statistical Office, 2012), the biogeographic regions and the percentage of designated in national inventory of outstanding landscapes were significant in explaining variance between municipalities, suggesting that landscape characteristics influence visual quality ratings between municipalities. This corroborates former findings on the large and significant influence of the settlement type on landscape assessment (Ströbele & Hunziker, 2017). We found a small but significant positive relationship between the amount of area in a municipality designated in the national inventory of outstanding landscapes. This small positive relationship suggests that people may be aware of protected areas in their vicinity, and this existence influences ratings.

4.3. Assessing visual landscape quality – limitations and future work

Our findings are based on survey responses of residents, and therefore reflect the perspective of people living in the landscapes that they rated. In contrast, visual landscape quality assessments are often made by outside experts, which has been criticised as imposing an outsider view on local perspectives of landscape (Butler, 2016). Studies that take into account public landscape perception are often limited in geographic scope to smaller regions, for which photographic prompts can be generated that are assessed by members of the public (Howley, 2011; Scott, 2002) or make use of general visualisations for landscapes respondents are not familiar with (Lindemann-Matthies et al., 2010). Such studies have highlighted general preference for small landscape structures and varied landscapes that can guide for example agricultural policies, but they do not indicate where residents rate visual landscape quality as high or low. Where fieldwork is conducted outdoors to assess landscapes *in situ*, this typically limits the scope of the study to a small number of study sites (Wartmann & Purves, 2018). While comparisons between different perspectives on landscapes have been reported for relatively small study areas (Conrad et al., 2019; Kianicka et al., 2006), comparative research across larger spatial scales may highlight similarities and differences between perspectives on landscapes, for example between visitors and residents. For future research, we propose to compare ratings of visual quality collected from residents with landscape aesthetics extracted from crowdsourced data, for example by contrasting monitoring data from the national landscape assessment survey with openly accessible landscape images.

4.4. Monitoring public perception of visual landscape quality

Data from the national survey on landscape perception showed that overall, the visual landscape quality across Switzerland was rated positive, with some geographic differences, and that characteristics of individual respondents, as well as characteristic of the landscape in municipalities was able to explain variance in visual landscape quality ratings. Thus, despite considerable change to the landscapes in Switzerland through urbanisation and agricultural intensification (Hersperger & Bürgi, 2010; Kienast et al., 2015), visual landscape quality was still rated positively across Switzerland, with some regional differences. From a policy-perspective, in terms of monitoring, repeated assessments of this survey will allow to track changes of landscape perceptions through time and potentially also show whether policy-instruments in Switzerland, e.g. for urban densification and limiting urban sprawl have resulted in maintaining or improving visual landscape quality as perceived by residents. For example, with important legislation on limiting urban sprawl having come into effect in 2014 after this survey was conducted, a repeated assessment of this survey may be used to test whether the implementation of this policy had any influence on visual landscape assessments. Public assessments are an important addition to expert-based assessments of physical landscapes in guiding landscape-management and planning, and we argue that an integrated monitoring has the potential to deliver important information as a basis for landscape planning and policy-making.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2020.104024.

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