are the large amounts of data existing in user profiles, and the abundance of evaluation possibilities. Different approaches to landscape quality assessment using data from social media have recently been developed and tested (e. g. DUNKEL 2016, FRIAS-MARTINEZ et al. 2012, MONTAÑO 2018). Building on these approaches, an innovative model and method to conducting landscape quality assessments for large areas is presented below.

2 Approach

At the OWL University of Applied Sciences and Arts, we developed an Anticipative-Iterative-Geographic-Indicator-Model for Landscape Preferences (AIGILAP) that supports planning practitioners in social-media-harvesting. Using this model, we are able to conduct landscape quality assessments for large areas (RIEDL et al. 2021).

Social-Media-Harvesting

Every day, social media users voluntarily generate large amounts of photographs, geographic information and text elements, such as descriptions and comments. For planers, these data offer enormous potentials. Photographs including metadata, geographical information and written comments are particularly interesting for planners as they meet most of the needs of landscape quality assessment. Within the approach presented in this paper, the social media network FlickR was used (YAHOO! 2017). FlickR offers the possibility to sort photographs by categories or tags and to find images on particular topics (KAUßEN 2018). As illustrated in Figure 1, different users feed different data, metadata, personal references and photographs into the database of the social network that may be harvested using the application programming interface (API) of Flickr. To make use of the API, a software tool has been developed that is able, by using a set of keywords, to automatically harvest all imagery in a particular geographical space.

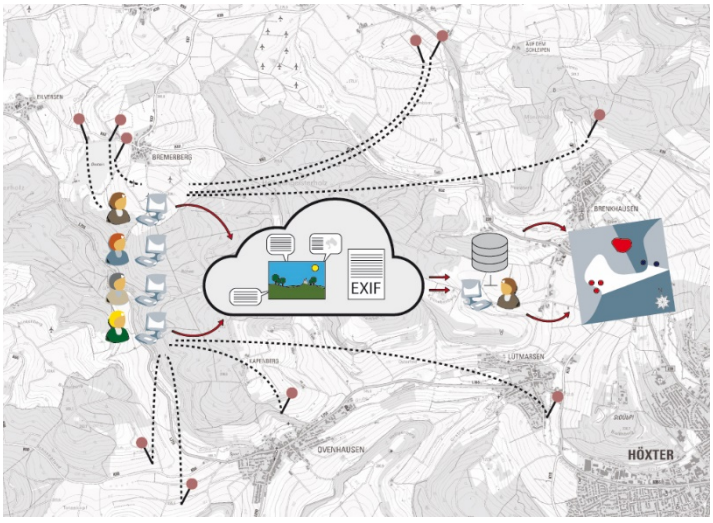

Fig. 1:
Workflow social-media-harvesting (KAUßEN 2018)

The keyword (tags) “landscape” was used in our examples to filter imagery available in Flickr. When a search query is given, the software saves the filtered data in different ways.

On the one hand, all photographs including the selected tag are downloaded, and on the other hand, an Excel-sheet with metadata of the respective photographs is created. Metadata include the title of the photograph, anonymized information about the person who uploaded the photograph, comments from other users, the coordinates (geotag with longitude and latitude) of the place where the photograph was taken, as well as information about the camera and settings, if available.

After data harvesting, it is possible, within five steps of analysis to gain new insights into the perception of landscape through the photographs taken in a certain area. These insights include the following:

- By spatial analysis we learn how photographs are geographically distributed within the given area and this distribution might point to places that social media users find meaningful in certain ways (DUNKEL 2016, MONTAÑO 2018).
- By conducting an image analysis (structure, elements, etc.) of photographs it is possible to find out which landscape elements are depicted in the photographs.
- By analysing the content, the social media community discusses (impact) and combining this content with metadata and written (verbal) contributions (HOKEMA 2013, KOOK 2009, KÜHNE 2006, KÜHNE 2018, LINKE 2018, LINKE 2019, MICHEEL 2012), we might gain insights into people's reasoning or evaluation.
- A text analysis via tokenization (HEROLD 2003) shows which elements are textually highlighted by comments and descriptions, what content is being communicated, how the images are being described, and so forth.
- A network analysis shows which users upload individual images, and who is communicating with whom. Finally, yet importantly, we can gain more knowledge about motives, backgrounds and opinions of the respective users by the network analysis including the user profiles and evaluate how they act in this social network.

Employing results from this data analysis, a characterization of the respective landscapes becomes possible, highlighting valuable elements that correspond with the perceptions of the public. This knowledge is used in the following to evaluate landscape beauty.

Anticipative-Iterative Geographic-Indicator-model for Landscape Preferences (AIGILaP)

Originally, the AIGILaP-Approach was developed for nationwide analysis of general landscape quality and sensitivity against wind turbines in Germany (RIEDL et al. 2021). However, in its original version the tool did not include any analysis of social media data. It was rather based upon existing landscape expert knowledge about landscape-quality that was transformed into a GIS-approach. This approach mostly employs existing land-use data as well as other environmental information to calculate landscape quality and sensitivity.

Taking the limited options for landscape assessment on the nationwide level into account, first, methods for landscape quality assessment, especially those common on other scale levels, were analysed in order to determine which criteria are common in landscape planning and architecture (RIEDL et al. 2021, STEMMER et al. 2019). Then, to select the criteria used for the AIGILaP-Approach, the following conditions were defined:

- The criteria are frequently used in the evaluation methods examined and in practice.
- The criteria are transferable to a nationwide level.
- The criteria can be recorded in a geographic information system (GIS).

To conform with provisions made by the German Federal Nature Conservation Act – BnatSchG the analysis has to consider aspects of landscape diversity, specificity, beauty, naturalness and recreational value (BRUNS & STEMMER 2018). In particular, the attribute 'beauty' is difficult to operationalize and it is not included in many common evaluation methods. One additional challenge was identified during the process of the development of the AIGILaP-Approach; it became apparent that for nationwide assessments of landscape beauty in particular, there is near to no useable information available.

In a follow-up research project[1] a refinement of the approach became possible. Social media data were included to assess landscape-beauty. An overview of attributes, criteria and indicators is presented in Table 1. Indicators characteristic of a particular landscape are processed employing GIS. Several indicators represent individual criteria. The criteria-value as well as the overall landscape quality is calculated by an algorithm by using a grid (Fig. 2). Thus, the model guarantees a transparent and reproducible assessment (Table 1).

The basis for the calculation of "beauty" are the indicators "beauty in protected areas", "perceived dominance of water", and "perceived beauty of landscape" (Table 1). "Perceived beauty of landscape" consists of a number, an area, and their share of valuable landscapes elements that are gained through the analysis of social-media-harvesting imagery.

Table 1: Overview of attribute, criteria and indicators of the AIGILaP

Attribute	Criteria	Indicator
Diversity	Diversity of land use	Number of different types of land use per defined area unit
	Diversity of relief	Terrain Ruggedness Index (TRI)
Specificity	Character of the distribution of land use	Deviation of the usage distribution of a defined area unit from the usage distribution of the associated cultural landscape type
	Landscape change	Landscape change since 1996
Beauty	Beauty in protected areas	Presence of protected areas
	Perceived dominance of water	Proportion of water area per defined unit of area
	Perceived beauty of landscape	**Area share of valuable landscape elements[2]** **Number of valuable landscape elements**
Recreational value	Potential recreational suitability for local recreation	Diversity, specificity, beauty and naturalness
	Potential recreational demand for local recreation	Distance to sparsely populated and densely populated settlement areas
	Potential recreational value for long-distance recreation	Presence of protected areas
Naturalness	Naturalness Land use	Naturalness of the types of land use
	Close to nature in protected areas	Presence of protected areas
	Presence of disturbances	Presence of acoustic and visual impairments

1 Project funded by the Lippe district as part of the Lippe 2025 future concept.
2 Only within the Lippe-District-Project.

For this purpose, land use data are converted into a grid of 12.5m × 12.5m cells that describe valuable landscape elements. Each grid cell is assigned a value as soon as a valuable landscape element is present within the cell. The 12.5m × 12.5m grid is then aggregated to 500m × 500m, with the number of 12.5m × 12.5m cells that receive valuable landscape elements being counted for each 500m × 500m cell. This means that the percentage of valuable landscape elements within the cell can be determined for each grid cell (500m × 500m, Fig. 3-4).

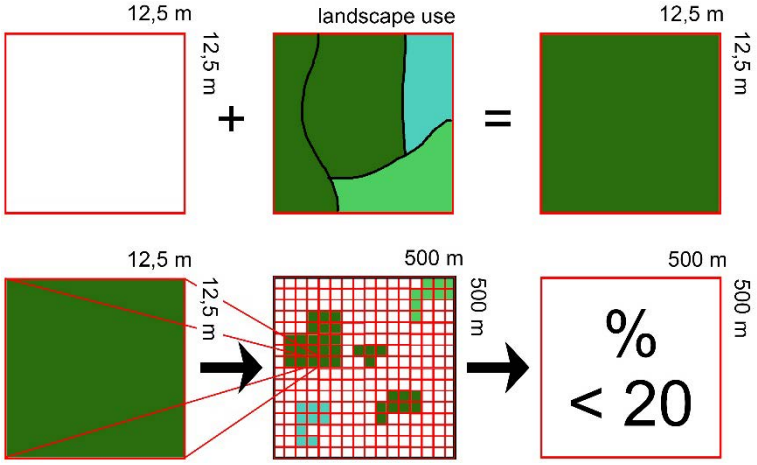

Fig. 2: Calculation of area share of valuable landscape elements (KAUßEN 2021)

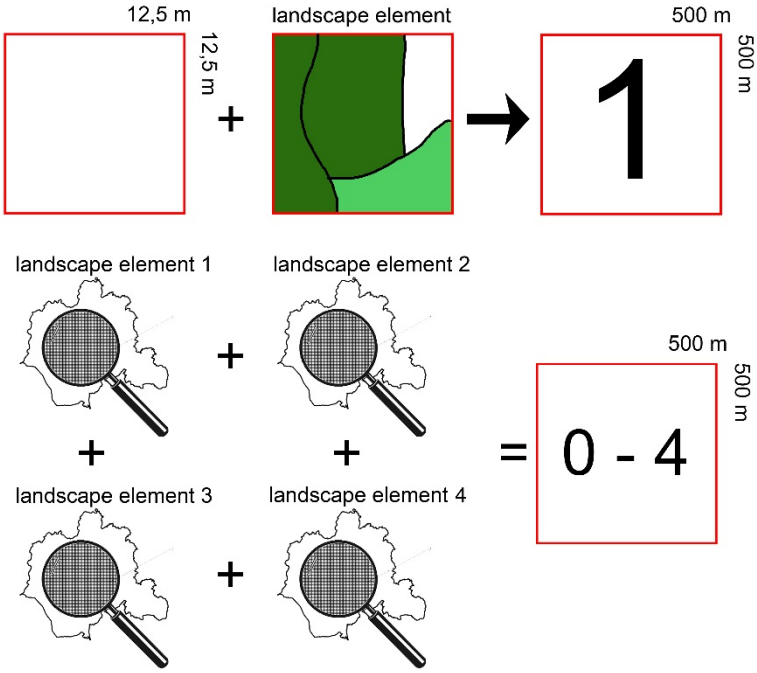

Fig. 3: Calculation of number of valuable landscape elements (KAUßEN 2021)

3 Output

We conducted landscape analysis using variations of the approach in different research projects, different planning assignments and at different scales. At the district level we were able to carry out the analysis in North Rhine-Westphalia within the Lippe-District. At the federal level we applied the approach in a way modified for that scale.

The approach was used for different project-aims. In the Lippe-District the aim was to contribute to the general assessment of landscape values as a contribution to the mandatory landscape plan (Fig. 5) (STEMMER et al. 2020).

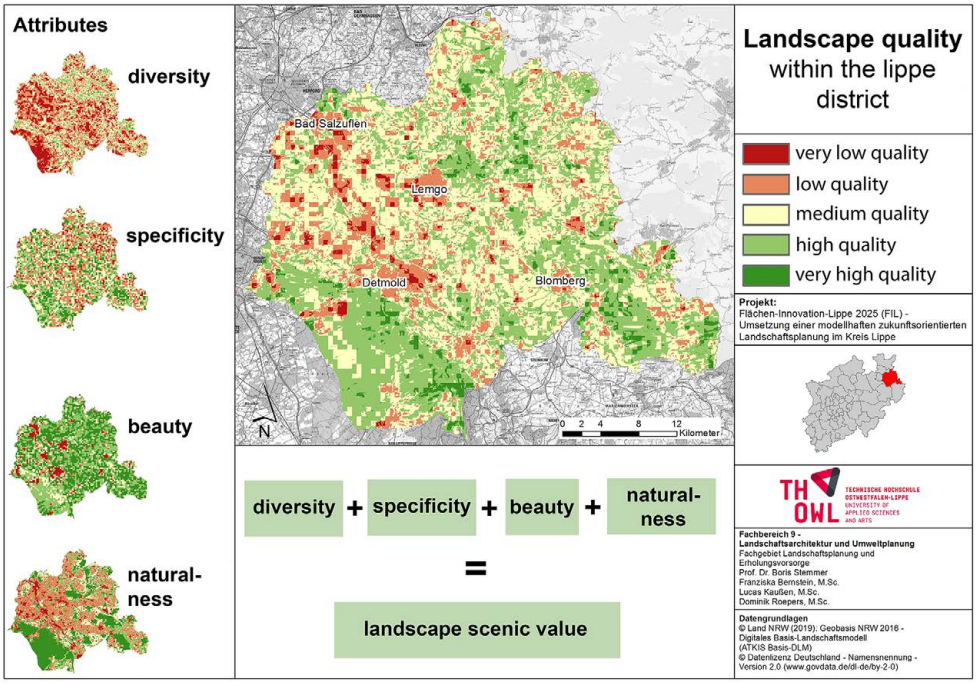

Fig. 4: Landscape quality within the Lippe-District (From green to red: very high to very low quality) (STEMMER et al. 2020)

At the nationwide level, an assessment of landscape sensitivity to wind turbine planning was evaluated[3] (Fig. 5). The approach was slightly modified for this project. With respect to the fact that landscapes across Germany differ al lot, we decided to analyse valuable landscape elements within landscapes of the same type (SCHMIDT et al. 2014). In consequence, we could no longer use the indicator "Area share of valuable landscape elements" (Table 1). Valuable elements within landscapes differ much in typical extent. Therefore, a nationwide evaluation

[3] Research and Development project funded by BfN (Federal Agency for Nature Conservation) with funds from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU)).

standard could not be defined. Other changes in indicators were made but are not listed in detail here. Mostly data availability and homogeneity lead to minor changes within the AIGI-LaP.

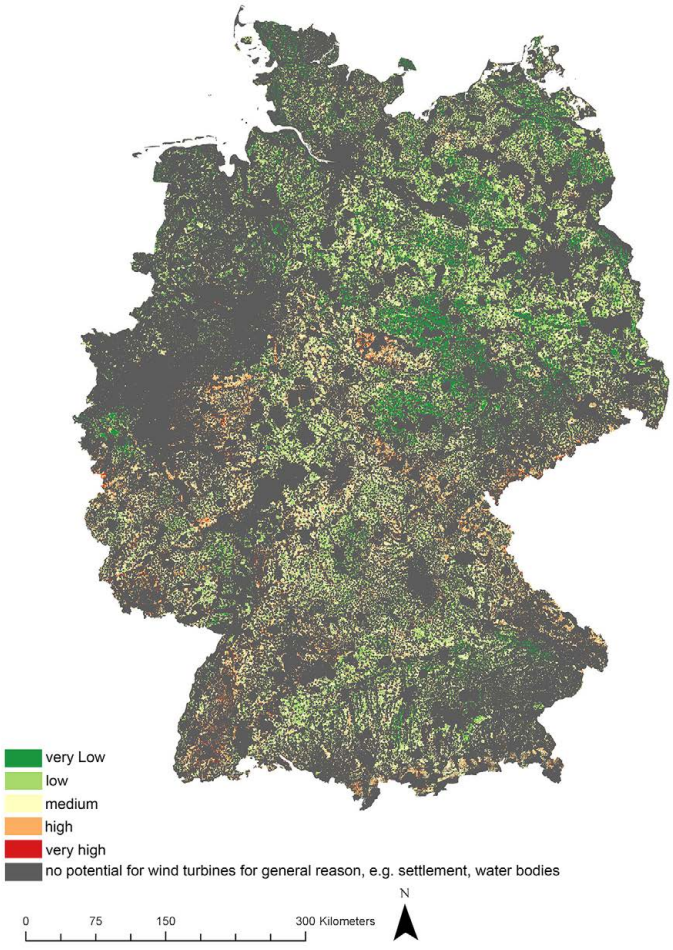

Fig. 5:
Landscape sensitivity to wind turbines within Germany

To date, evaluations of the analysis output was conducted in expert discussions, both on nationwide level as well on the district level at different occasions (regional to local). Two outcomes are that, first, experts considered analysis output to be highly plausible, even and particularly at the regional scale. Consequently, planners showed high interest in using the outcome for upcoming planning tasks for example within regional planning. Second, within the Lippe-project, experts were able to compare outcomes of early versions of our model to the latest versions that then included the new social media harvesting approach. The expert-group clearly stated how remarkable the improvements in output were, that the model made possible in its most recent versions.

4 Outcome

It has to be clear that the approach presented here still is in an exploratory state. Nevertheless, our approach combines expert GIS based methods on landscape quality assessment with data analysis method for social media. In doing so, it offers a couple of advantages compared to other methods of landscape quality assessment. The most important ones are these: The new model does not rely on public participation in landscape assessment with all its shortcomings without neglecting the importance of public landscape perception for landscape quality assessment. Then, even if it were possible to elaborate landscape assessment empowering public participation, as planning areas increase in size, the effort for reasonable participation would constantly grow as well. In contrast, the AIGILaP Approach is usable for a wide range of planning scales from regional to federal planning level. One of the strengths of the model is its ability to help practitioners to evaluate large areas with ever-lower effort. Moreover, the AIGILaP-Approach turned out to be suitable for different project-aims with only few modifications. In this way, it was possible to avoid some challenges of public participatory approaches in landscape quality assessment (STEMMER & KAUßEN 2018).

This approach takes on the challenge to assess all attributes of landscape assessment regulations within the German act of nature conservation: recreational value, diversity, specificity and the most controversial attribute of beauty as well. Especially for beauty the integration of social media data shows that it is possible to find a way of evaluating landscape beauty with respect to public landscape perception.

The output of model application is an area wide evaluation of landscape quality that is based upon transparent criteria. Moreover, it is reproducible at nearly any planning scale. Thus, it meets the demands of planners working on the local, regional and nationwide scale.

However, the approach is not intended to replace lively public participation within the planning process (e. g. mandatory landscape plan). It simply describes a way to integrate public perception of landscape presented in social media into the stage of assessment of landscape beauty. It also delivers a reproducible and transparent assessment of other criteria relevant at least in landscape planning in Germany employing a standardized GIS-process. Therefore, it is important to point out that at other stages of the planning process it is still highly necessary to involve the public directly, depending on the aim and topic of the plan or project (SCHMIDT et al. 2019).

5 Further Research

As mentioned above, until now, an evaluation of the output of the new approach and model was made only with experts. The positive expert opinion is very encouraging to start further systematic evaluation.

With respect to social media harvesting and the analysis of the imagery, there are different starting points for evaluation and further research.

- First, we need more data on how imagery from social media represents public perception within a certain area e. g. Lippe-District. Members of the public might be invited to take part in a survey and asked to evaluate imagery harvested from social media. In addition,

a photo-competition within the region might result in sets of imagery that differ from harvested ones and that might be used for analysis and comparison.

- Second, our approach to imagery analysis needs further refinement for practitioners to reliably identify important landscape characteristics. Besides that, within a survey public should be asked which of the landscape elements that are common in a region they believe are typical for certain landscapes. Finally, it has to be asked if available land use data is appropriate to be used in any analysis of what is considered "valuable" landscape elements (are the relevant elements prevalent in datasets?). In this context, it is also necessary to learn if taking into account combinations of elements would improve analysis outcome.
- Third, it is relevant to conduct longitudinal studies to gain knowledge about the fluidity of outcomes over time. For that purpose, a new dataset (2 years) has been harvested and is currently analysed. Moreover, we plan to take random photos within the district to compare output of the analysis for valuable landscape elements to the harvested datasets.
- Fourth, we have to determine for which scale the outcomes are valid. We have already demonstrated the use of landscape types for this purpose on the nationwide level. Comparable approaches for regional and local level have to be developed and tested.

Until now, the influence of social media analysis within the whole approach is limited to only two indicators as described above. Thus, after answering the further research questions we would rather tend to introduce more and more indicators for not only beauty but also other attributes. That would mean to switch the baseline from a classic expert approach to a new social-media approach.

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