



# Exploring Estonian Forests and Urban Green Spaces: A Cultural Ecosystem Services Mapping Approach Using Flickr Photographs

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**Abstract.** With the increasing use of social media, we can analyze digital data to gain insights into social and cultural aspects of landscapes and cities. The understanding of the existing cultural ecosystem services (CES) can help improve human life quality through proper planning and execution of plans. This study aims to locate CES produced by Estonian forests and urban green spaces using Flickr photographs. Quantitative analysis of Flickr photos identified hot spots within the study area and determined the suitable distance of CES accessibility. CES were categorized into four categories: recreation, sense of identity, aesthetic pleasure, and education. The results showed aesthetic pleasure and sense of identity were the most identified CES, while recreation and education were identified less. Factors such as population density, seasonal variation, biodiversity, accessibility, and facilities can impact the identification of CES. While social media data has limitations, combining qualitative research methods with surveys and questionnaires can provide a more well-rounded result. The findings can help stakeholders make better plans and management policies for Estonian forests and urban green spaces.

**Keywords.** cultural ecosystem services, Estonia, forest, urban green area, PUD, Flickr

## 1 Introduction

Ecosystem services are material and non-material benefits that people obtain from ecosystems and the environment. The use and effect of analyzing ecosystem services, in general, are well understood (Zhang et al., 2020). Cultural ecosystem services refer to the non-material benefits that people obtain in relation to their cultural, spiritual, and aesthetic values. However, CES are less not as widely studied, analyzing the underlying relationship between culture and humans and how that impacts our society, economy, politics, and overall life can help us to better

understand the complex relationship that we have with our nature (Csurgó and Smith, 2021). CES is analyzed using different methods such as questionnaires, surveys, photographic analysis, and software, but social media data is the most useful for monitoring and assessing it due to its spatial analysis possibilities and causal associations. The popularity of social media has made it possible to analyze a large amount of CES-related data (Tenkanen et al., 2017).

### 1.1 Forests and Cultural Ecosystem Services in Estonia

Cultural ecosystem services that are easily quantifiable are studied more. Things that can be measured in human activities such as recreation, eco-tourism, cultural heritage, and education are often counted in CES analysis (Chan et al., 2012).

Forests provide material and cultural ecosystem services, such as timber, wildlife, and natural beauty. In Estonia, adults spend time in forests for activities like foraging, walking, hiking and camping, and skiing in winter. This nature-based relationship is supported by the law of everyman's right (Sepp and Lõhmus, 2019). The Estonian state forest management center (RMK), prioritizes environmental protection and sustainability.

This study investigates visitation data and aims to address the lack of spatial components in former CES-related surveys for both urban and non-urban forests and parks in Estonia.

### 1.2 Photo-User-Day and Population Density in CES Analysis

There has been an upsurge in the research of ecosystem services, especially after the influx of social media-based image platforms like Flickr, Instagram, and Panoramio (Sessions et al., 2016). Geolocated social media data have helped the increasing research in the cultural ecosystem service domain both qualitatively and quantitatively

(Zhang et al., 2020). Social media data has advantages compared to traditional data collection methods such as interviews or polls. Typically, users of social media share data in the form of tags, text, images, or videos depending on the social media platform.

Photo-User-Day (PUD) is the indicator of visitation, which indicates, in turn, frequency and spatial density of the use of cultural ecosystem services when visiting. PUD is a unique combination of date and user ID where they represent the number of days when at least 1 photo was taken by 1 user. As many users of the photos take multiple images on a particular location on the same day, PUD analysis helps avoid the biases of multiple photo numbers from the same user on the same day.

Although PUD is a good visitation assessment method, it does not give any idea about explicit CES services. PUD also does not give an idea about spatial distribution such as coldspots and hotspots (Zhang et al., 2020). For these reasons alongside PUD, a content analysis of photos and photo tags is important to understand CES (Rossi et al., 2020).

## 2 Methods & Materials

### 2.1 Study Area

The research area of this study is Estonian forest/green spaces. Estonia has a comparatively high forest coverage rate, over 50% forest coverage, of which 30% is under protection (Zacek, 2022). Moreover, the overall social media and internet literacy rate and content creation are also high among people of younger age in Estonia. This makes Estonia suitable for the CES analysis based on Flickr photo data as active social media users in the country produce a significant amount of crowd-sourced data. Many forest areas of Estonia are managed for recreation by RMK and the number of visits to those areas is increasing every year.

### 2.2 Data and Software Availability

For this study several datasets were used. From the Flickr service, metadata of images uploaded by users that are within Estonia and surrounding Estonia. The data set contained metadata for 103444 previously crowdsourced photographs, in a time range from 2015 to 2020. All Flickr data were geotagged.

From the Landboard of Estonia the topographic database for landuse cover of forests, urban green spaces, and shrubland (ETAK) and the Estonian county border delimitation data were obtained (Maa-amet, 2022).

Finally, the population density grid of Estonia in 1x1 km was downloaded from the Estonian statistics geoportal (VKR, 2022). Figure 1 shows the population density. Urban centres are clearly visible.

All data is publicly accessible from their sources in CC-BY-4.0 or compatible open data licenses.

For all spatial analysis steps, QGIS version 3.16 was used, for processing tabular data we used LibreOffice.

## 2.3 Methodology

As foundational data the PUD were created. The downloaded Flickr data set was geocoded into a point layer and clipped to the territory of Estonia (cf. Figure A5), and aggregated into PUD via their date and user ID, resulting in 37011 PUD data points for Estonia (Figure A6).

Subsequently, we used a buffer analysis to determine the optimal spatial extent for mapping cultural services provided around forest/green spaces in Estonia. Different buffer zones ranging from 100m to 1km around the the ETAK landuse types forest created and the PUD density was counted to understand which buffer zone is appropriate for visitation analysis in terms of CES use. The purpose of the buffer analysis is to account for the landscape (scenic) value of forest/green space, which can be observed from a distance. This was done to decide at what distance from forest and urban green spaces the CES becomes less significant.

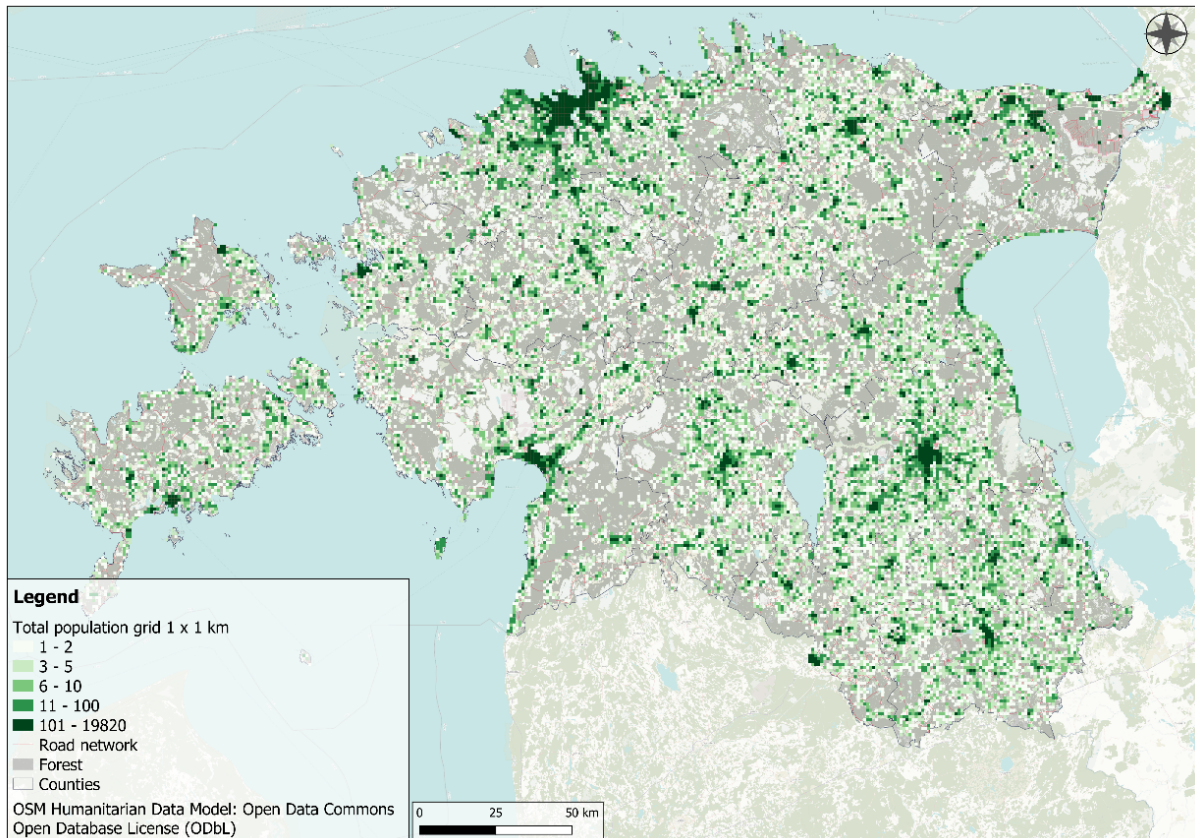
Then, from the 500m PUD buffer zone 2000 photo samples were randomly selected and manually categorized via visual inspection into four main categories recreation, aesthetic pleasure, sense of identity, and educational and intellectual development was taken based on criteria used in Millennium Ecosystem Assessment (Reid et al., 2005). These particular categories were chosen because of their possibility of material analysis compared to other CES categories such as reflection, existence or spiritual value (Zhang et al., 2020). The labeling of the photos was conducted by the researcher. Out of these 2000 randomly selected photos, 290 photos were left uncategorized as they did not fit to any of the main categories.

## 3 Results

While the photo counts with Flickr density points determine the most photographed forest/green space, the PUD Flickr points determine the most visited forest/green spaces in Estonia. From the 2000 selected photos from the overall 37011 PUD photos of the 500m buffer around forests and urban green areas following categories, sub-categories and keywords for the CES were coded:

### 3.1 Aesthetic Pleasure

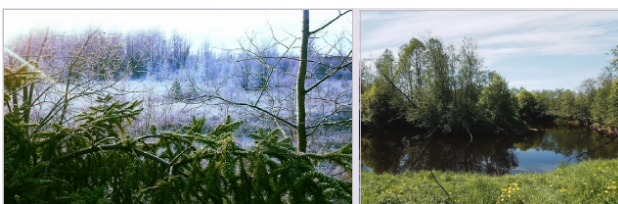
- Natural Attractions - Trees, water bodies, sunrise, sunset, northern lights, flowers, birds, insects, fallen leaves, snow-covered areas, rocks, animals, sky, natural beauty, waterfall, water stream, rocks, sea, sun, moon, fountain;



**Figure 1.** Population density in Estonia 1x1km grid.

- Human-made attraction - Viewing platforms, art installation, designed nature, architecture, graffiti, beautiful design;

Figure 2 shows examples of photos for aesthetic pleasure CES.

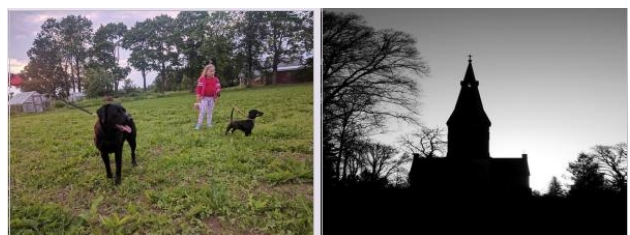


**Figure 2.** Examples of photos for aesthetic pleasure CES

### 3.2 Sense of Identity

- Sense of Identity - Flags, family, symbols, pets, maps, cemetery, tradition;
- Local Culture - Residential houses, museums, social gatherings, grilling, festivals, markets, historical landmarks, status, landmarks, church, monuments, food;
- Historical attractions - Castles, ruins, windmills, old artifacts, old buildings

Figure 3 shows examples of photos for sense of identity CES.



**Figure 3.** Examples of photos for sense of identity CES

### 3.3 Recreation

- Activities - with keywords like: Hiking, walking, swimming, berry picking, mushroom picking, grilling, camping, cycling, fishing, boat, sports, historical site visiting, kayaking, performance, water ski;
- Facilities - Trails, camping hut, grilling spot, sauna, watch towers, benches, tables, fire pit, wood collection spot, recreation centers, campfire, spots, doc, water slide, skate park;



- Attractions - Swimming spot, natural beauty, quietness, wildlife, resting spots, camping spot, camping trail, playground, sea beach;

Figure 4 shows examples of photos for recreation CES.



Figure 4. Examples of photos for recreation CES

### 3.4 Education and intellectual development

- Man-made - Museums, botanical gardens, signs, art and paintings, gallery, old
- Natural - Biodiversity
- Institutional - Guided tours, group hiking,

Figure 5 shows examples of photos for education and intellectual development CES.



Figure 5. Examples of photos for education and intellectual development CES

Aesthetic pleasure contained 949 photos, sense of identity contained 382, recreation contained 293 and educational and intellectual development contained 86 photos. Figure 6 shows the overall distribution of the PUD photos over a 10km grid. Figures A1, A2, A3, and A4 in the appendix show the gridded distributions for the specific categories.

Population density can also have an impact on the Flickr photo density as more people can be social media users and densely populated areas are more likely to be visited for recreational purposes. In fact, at first glance, large clustering of CES photos can be seen in and around city areas like Tallinn, Tartu, Pärnu, Kuressaare, Kohtla-Järve, Jõhvi, and Võru.

Aesthetic pleasure is the most well represented among the other CES categories as it can be seen in almost every major place where there is photo density often in juncture with other CES categories as well.

Spearman correlation analysis shows a positive correlation value between population density and visitation. However, a correlation of 0.26 only indicates a small relationship between population density and PUD. This does not fully support nor reject the hypothesis that a more concentrated population produces more crowdsourced social media data.

## 4 Discussion

The result of this study has shown that CES categories aesthetic pleasure and sense of identity are the most common among all. Zhang and others in their study have shown that aesthetic pleasure and recreation are the most common CES category and the most studied category as well (Zhang et al., 2020).

It can be easily said from the results that CES in terms of forest and urban green areas are mostly concentrated in Tallinn, Viimsi, Haapsalu, Pärnu, Viljandi, Tartu and Põlva. The photo density of CES categories used in this study has been highly represented in all these places and the photo counts in each of these places mentioned above were more than 1000 photos within 500m buffer from forest and urban city areas. This is likely due to the reason that there is high population density in both cities and with high population density, there are more chances of more photos being taken and uploaded (Hausmann et al., 2017).

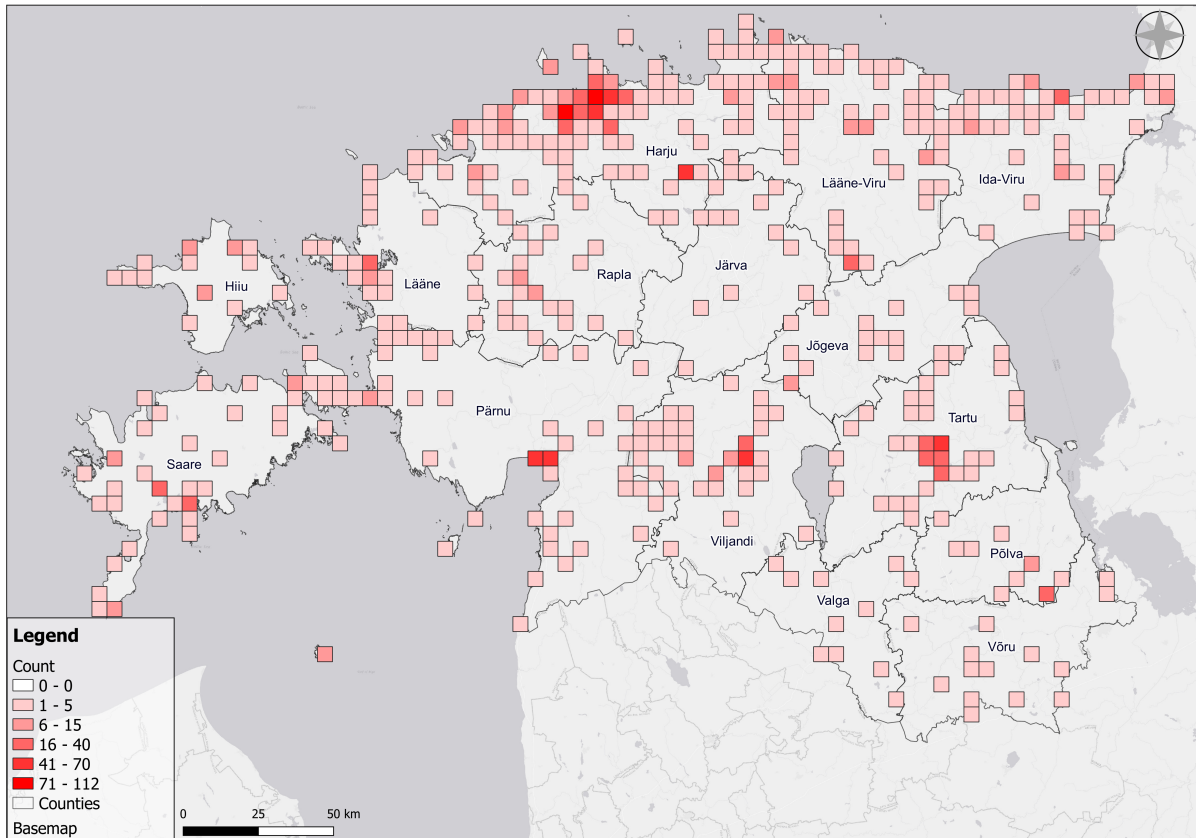
Tallinn especially being the capital city of the country is very well connected to every part of the country and with international transits. This is the reason why Tallinn has a very high number of photos taken especially within the metropolis area compared to the rest of the country and surrounding areas outside of the metropolis.

From the photos analyzed, Tartu has represented all four CES categories while having heavy aesthetic pleasure and sense of identity CES. Having university, parks, river going through the city and providing scenic beauty, the city attracts a lot of students and young people.

As people living in cities have fewer opportunities to access quality CES from within the city, this result of the highest photo density and visitation from this study can help in better planning. The highest number of visits to forests and green spaces nearby can be used as a model for developing more protected green areas in other parts of Estonia regarding CES.

Manual evaluation of the content of the photos for CES categorization has its own benefits, however, it also comes with the bias of the analyzer (Zhang et al., 2020; Rossi et al., 2020). Thus, the results of this study can be easily interoperated differently if analyzed by a different person, which is one of the limitations of this study. Another is that Flickr data has its own biases as well. The data did not contain any gender or age information about the users. Moreover, Flickr data might be more used by tourists, seemingly not a very popular platform for Estonian-speaking





**Figure 6.** PUD aggregation for all four main categories of CES in and around Estonian forest and urban green areas.

users, thus only limited conclusions can be drawn. Nevertheless, Flickr is one of the last free georeferenced image sources available.

Using crowdsourced social media data in this thesis has shown similar qualitative and quantitative mixed-method (Gould et al., 2014; Tenkanen et al., 2017) in the context of Estonia. The results in the study also address the inconvenience of the traditional data use in CES assessments such as field studies, questionnaires, and interviews.

## 5 Conclusions

The aim of this study was to improve the current state of quantitative and qualitative knowledge about CES provided by Estonian forested and urban green areas. The study revealed that a distance of 500m is the most optimal as mostly in urban green spaces and that at distances larger than 500m photos did not portray any elements of greenery anymore, which can be attributed to the fact that urban areas have large enough buildings that block the visibility of urban green areas. Photo density and visitation are higher in cities such as Tallinn, Tartu, Pärnu, Kuressaare, Kohtla-Järve, Jõhvi and Võru which also have higher population density. However, the low correlation allows for the conclusion that this is also due to the overall ease of accessibility to forested areas and green spaces. More tra-

ditional research methods such as questionnaires and surveys have the capacity to enrich this research. Finally, further research on CES related to forest and urban green spaces not only helps in the planning and management of green spaces better but can overall contribute to increasing the overall quality of life for people benefitting from these types of CES.

*Author contributions.* TS and OK designed the study, TS and OK ran the experiments and analysed the data. All authors drafted the manuscript, created the figures, and contributed to the paper writing.

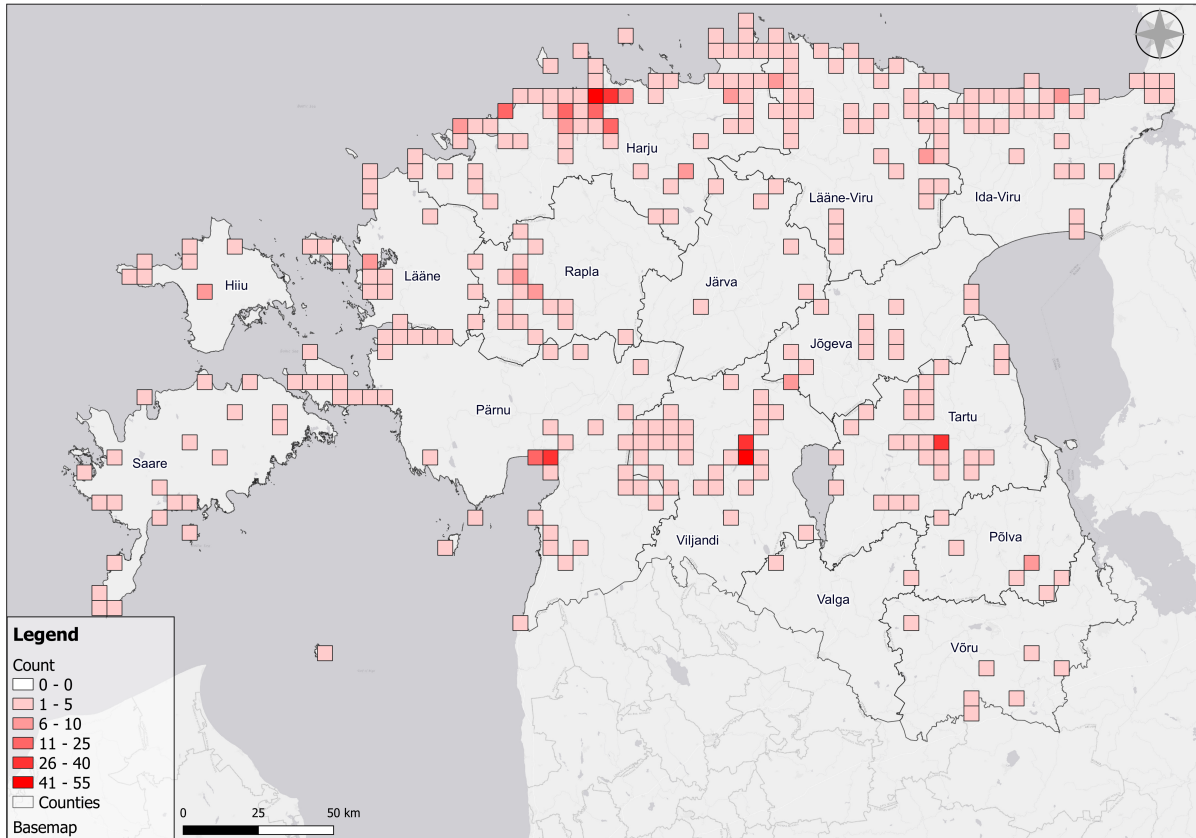
*Competing interests.* The authors declare that they have no conflict of interest.

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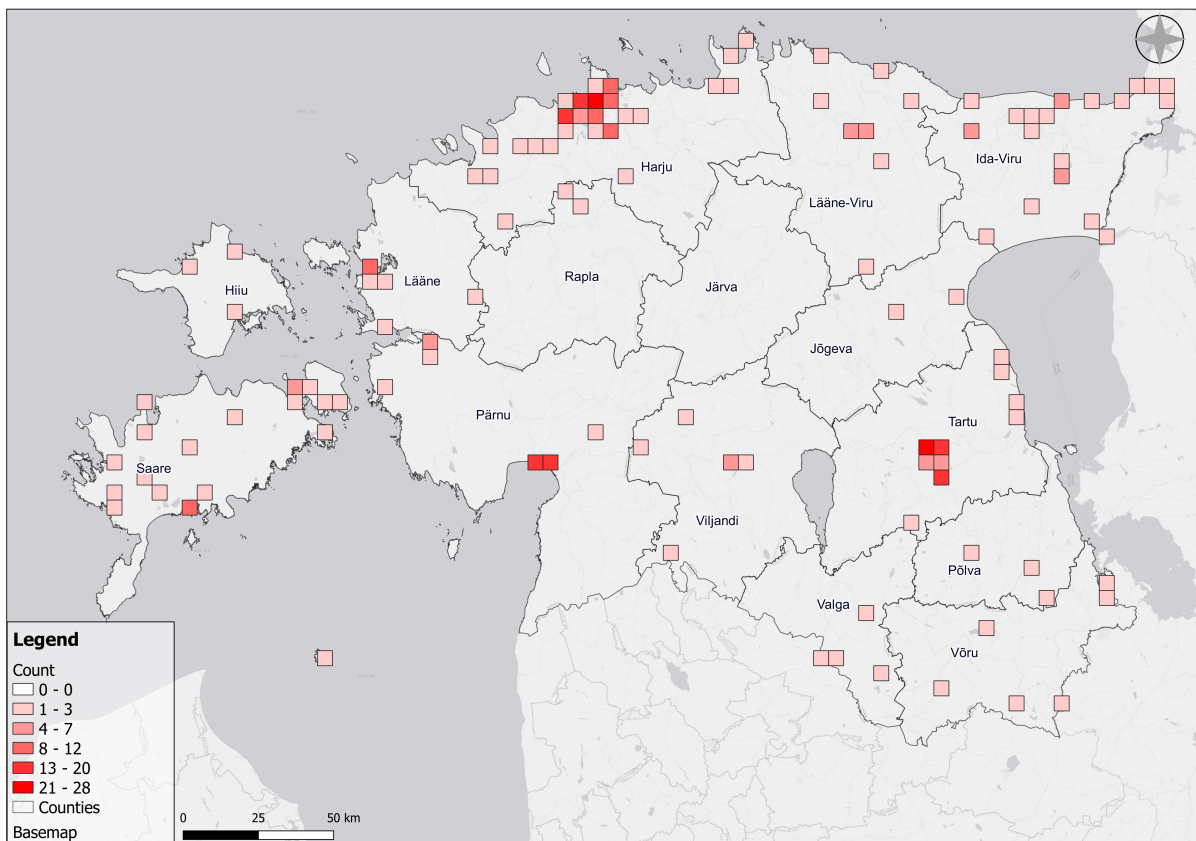
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## Appendix A

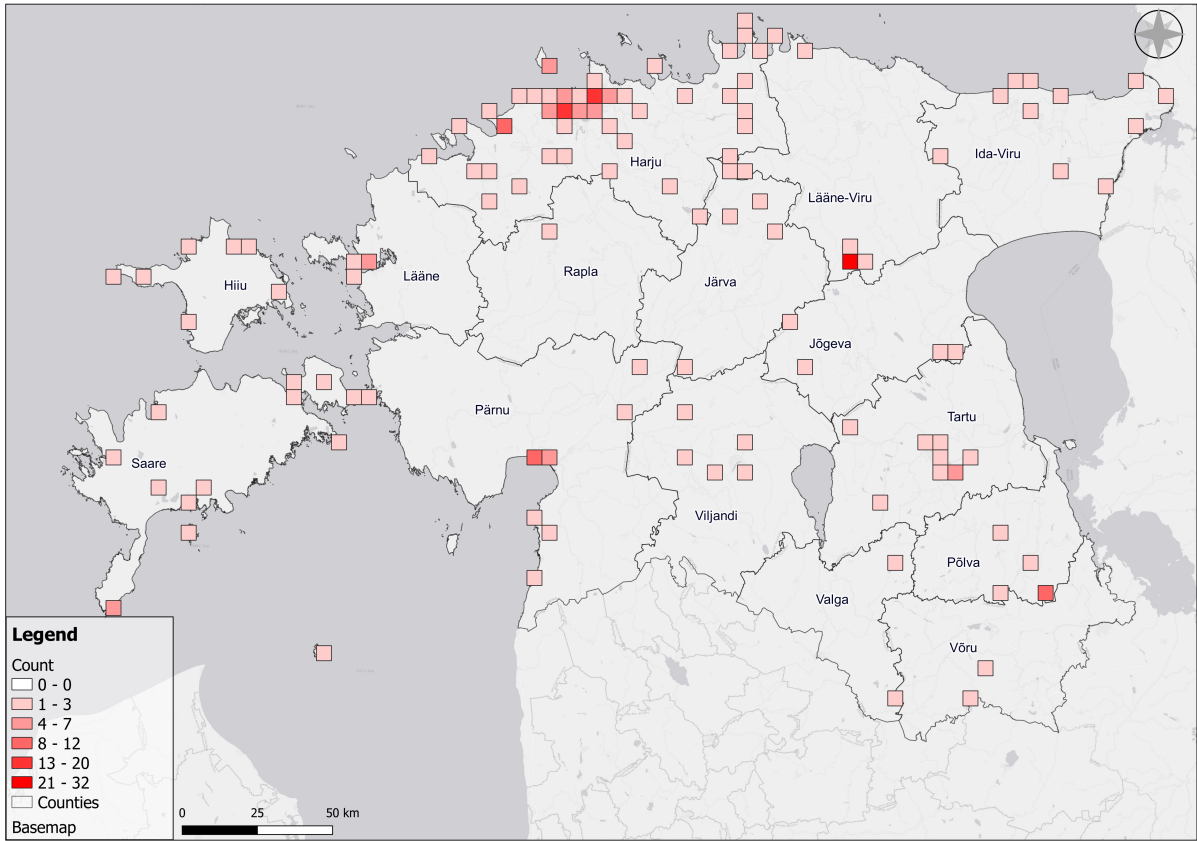


**Figure A1.** PUD aggregation for aesthetic CES.

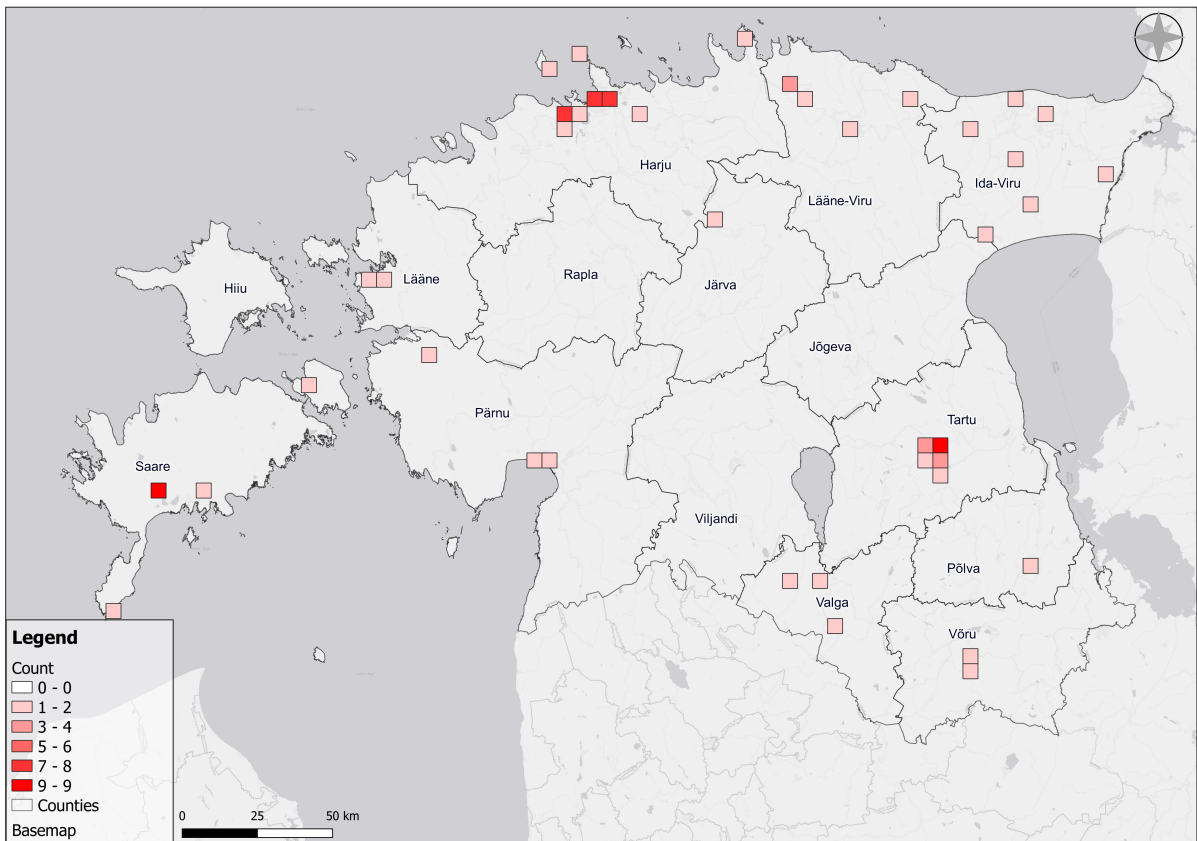


**Figure A2.** PUD aggregation for sense of identity CES.

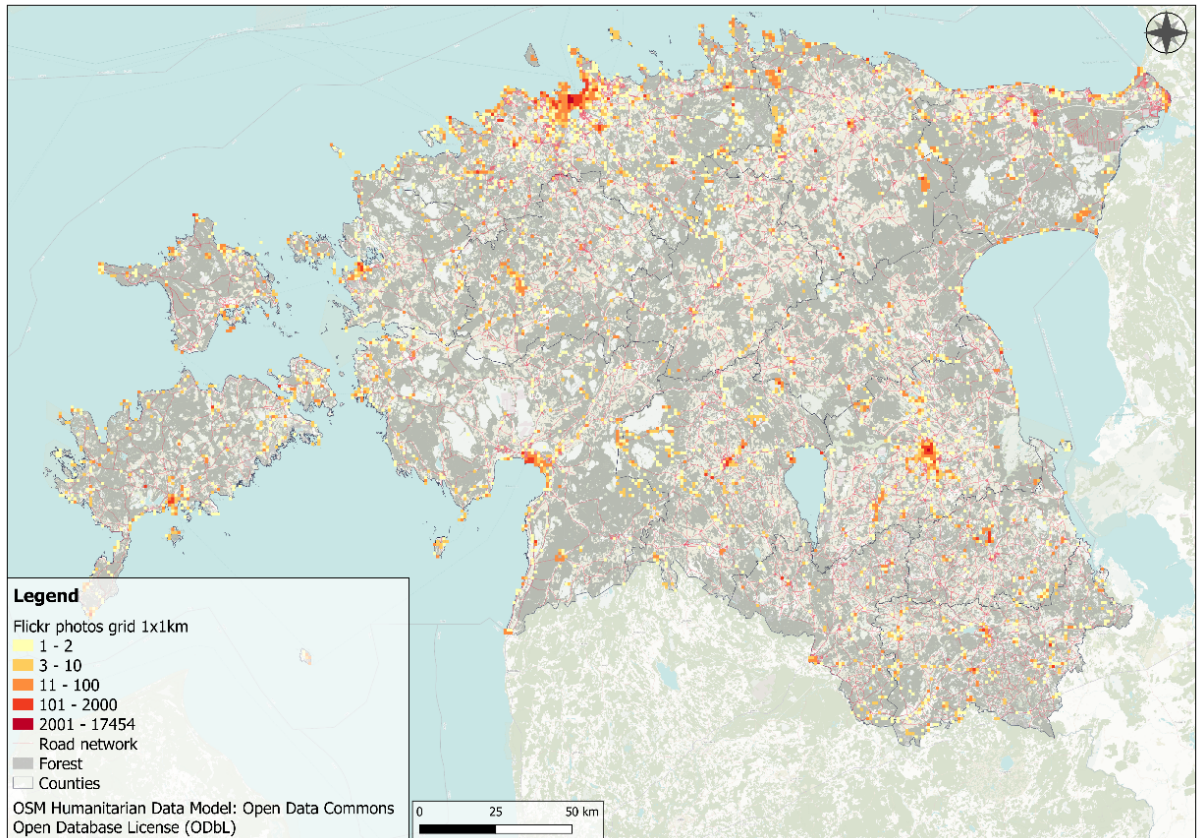




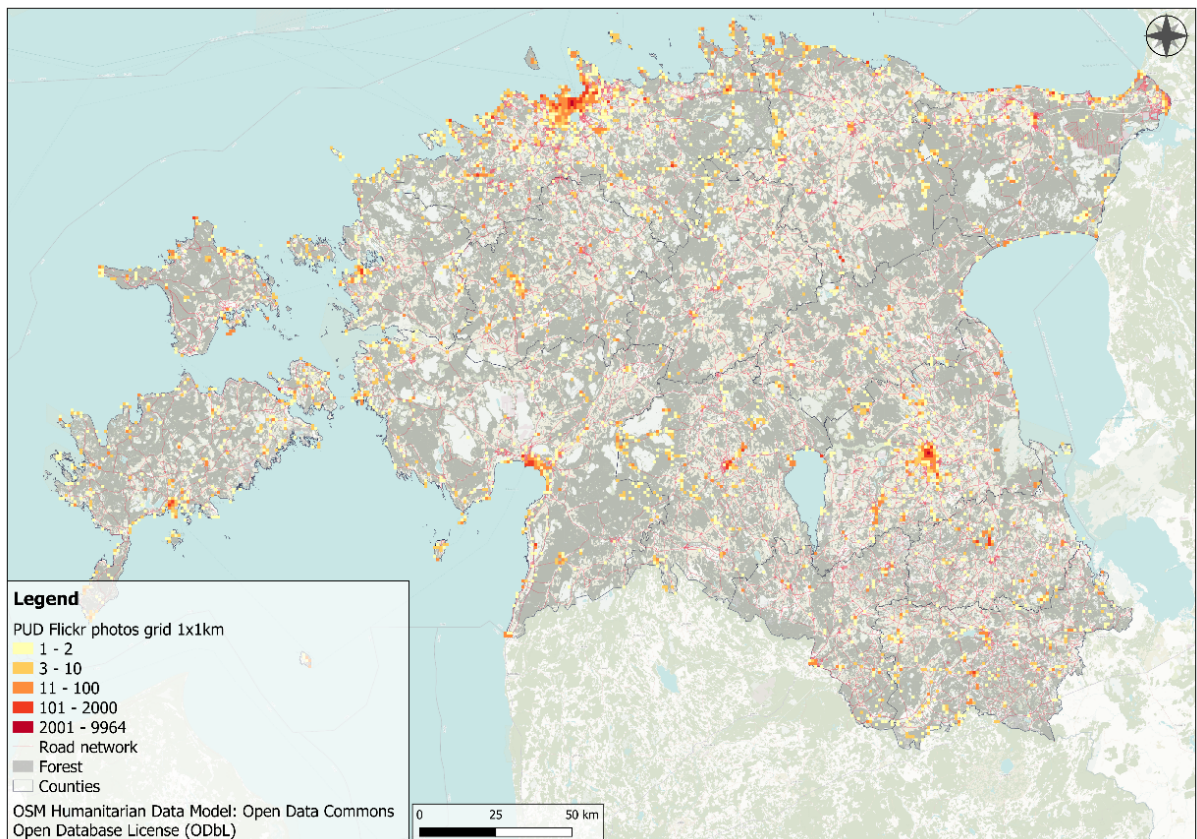
**Figure A3.** PUD aggregation for recreation CES.



**Figure A4.** PUD aggregation for education and intellectual development CES.



**Figure A5.** Total Flickr photo grid 1x1km.



**Figure A6.** Total PUD Flickr photo grid 1x1km.