Elsevier Editorial System(tm) for Landscape and Urban Planning

Manuscript Draft

Manuscript Number:

Title: Integrating elements of environmental justice into urban blue space planning using public participation geographic information systems

Article Type: Research Paper

Keywords: Physical accessibility; distributional justice; participatory mapping; SoftGIS; green infrastructure, blue infrastructure

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Abstract: This study presents a Public Participation Geographic Information System (PPGIS) method for assessing multiple elements of environmental justice and applies it to the Helsinki Metropolitan Area (HMA), Finland. We used Nearest Neighbour Analysis to identify clusters of activities followed by Shannon Diversity Index to examine: 1) how diverse each of the clusters were in terms of activities undertaken there, 2) whether the most diverse clusters were evenly distributed across the HMA, and; 3) the diversity of users in each cluster, representing a composite measure of income, age and family income. Proportionately more high activity and high user diversity areas were found in Helsinki Municipality than Espoo and Vantaa areas. We then created a framework representing clusters with different mixes of activity and user diversity. The framework highlights that contrasting combinations of activity and user diversity (high-low, low-high) show very different spatial distributions, dominating activities and problems, and socioeconomic characteristics. Looking at just one of these two dimension could lead to the omission of potential management areas. The method holds promise for spatially targeting urban blue planning strategies to areas with different elements of environmental justice.

UNIVERSITY OF COPENHAGEN

J.I Nassauer
Editor-in-Chief, Landscape and Urban Planning
School of Natural Resources and Environment
University of Michigan
440 Church Street, Michigan, USA

15th October 2015

Dear Prof. Nassauer,

Attached is a manuscript titled "Integrating elements of environmental justice into urban blue space planning using public participation geographic information systems" for publication consideration in *Landscape and Urban Planning.*

We believe the manuscript is within the aim and scope of the journal given the readership's interests in participatory planning and management. However, if you don't believe the manuscript to be within the aim and scope of the journal, we would appreciate learning of this decision right away so that we can submit elsewhere for publication consideration.

Yours Sincerely,

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Integrating elements of environmental justice into urban blue space planning using public participation geographic information systems

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Manuscript to be submitted to *Landscape and Urban Planning*

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Research Highlights

- Present method for considering multiple elements of environmental justice
- Spatial variations in different combinations of activity and user diversity
- Types of perceived problems also vary according to each combination
- Method enables managers to target different elements of environmental justice

Integrating elements of environmental justice into urban blue space planning using public participation geographic information systems

Abstract

This study presents a Public Participation Geographic Information System (PPGIS) method for assessing multiple elements of environmental justice and applies it to the Helsinki Metropolitan Area (HMA), Finland. We used Nearest Neighbour Analysis to identify clusters of activities followed by Shannon Diversity Index to examine: 1) how diverse each of the clusters were in terms of activities undertaken there, 2) whether the most diverse clusters were evenly distributed across the HMA, and; 3) the diversity of users in each cluster, representing a composite measure of income, age and family income. Proportionately more high activity and high user diversity areas were found in Helsinki Municipality than Espoo and Vantaa areas. We then created a framework representing clusters with different mixes of activity and user diversity. The framework highlights that contrasting combinations of activity and user diversity (high-low, low-high) show different spatial distributions, dominating activities and problems, and socioeconomic characteristics. Looking at just one of these two dimension could lead to the omission of potential management areas. The method holds promise for spatially targeting urban blue planning strategies to areas with different elements of environmental justice.

Keywords

Physical accessibility; distributional justice; participatory mapping; SoftGIS; green infrastructure, blue infrastructure

1. Introduction

Urban blue space represents urban aquatic environments as public spaces, comparable to city parks, plazas and other land-based open spaces (Wessel, 2011). These spaces provide a range of experiences, including opportunities for recreation, relaxation, socializing with friends, as well as health benefits (Faehnle, Bäcklund, Tyrväinen, Niemelä, & Yli-Pelkonen, 2014; Gobster, Nassauer, Daniel, & Fry, 2007). Globally, there is increasing policy interest in engaging local stakeholders in the identification and valuation of these attributes, and for including them in land-use planning and decision-making following principles of environmental justice, as reflected in European Union's Green Infrastructure strategy (European Commission 2013).

Environmental justice is based on the principle that all people have a right to be protected from environmental pollution and to live in and enjoy a clean and healthy environment (Agyeman & Evans, 2004). The concept is particularly important in urban blue spaces given that these landscapes are highly valued for restorative and perceived health reasons by a range of inhabitants (Korpela, Ylén, Tyrväinen, & Silvennoinen, 2010). Usually research focuses on the dimensions of social (race, gender, disabilities, income) and individual exposure to environmental risks (e.g., air pollution, greenspace, climate change) and recreational opportunities (Walker, 2012).

Here we focus on the role of public participation geographic information systems (PPGIS) in elucidating different elements of environmental justice at the place-specific scale. Over the past six years, there have been rapid developments in PPGIS techniques (Brown & Fagerholm, 2014; Brown, Montag, & Lyon, 2012; Raymond et al., 2009; Sherrouse, Clement, & Semmens, 2011; van Riper, Kyle, Sutton, Barnes, & Sherrouse, 2012). Studies have considered multiple elements of environmental justice in isolation such as perceived or physical access (Wang, Brown, & Liu, 2015) or the distribution of perceived qualities in given areas (Brown, Schebella, & Weber, 2014) using the *activity diversity* metric which measures the number of different activity types mapped by survey participants in a given area and also accounts for the evenness of the mapped activities (Brown & Reed, 2011). The diversity of resident's preferred activities

48 (e.g., fast walking, jogging, cycling) can vary according to a park's type (e.g., sport park, natural park,
49 school park) and an area's size (Brown, Schebella, et al., 2014).

50 Another important aspect of environmental justice considered using PPGIS is *user diversity* broadly
51 defined as the mix of users (survey respondents) which access a given area. Although few studies have
52 specifically focused on urban blue space user attributes, it is already known that the distribution and type
53 of values and activities assigned to areas by users can vary according to sample type (Brown, Kelly, &
54 Whitall, 2013), and stakeholders with different types of influence can assign values and preferences in
55 different areas (García-Nieto et al., 2014).

56 Environmental justice has also been considered in PPGIS studies in terms of perceived traffic dangers,
57 unpleasant routes and signs and perceived disorder and care (Kahila & Kytta, 2009; Kyttä, Kuoppa,
58 Hirvonen, Ahmadi, & Tzoulas, 2014), operationalized here as the dominance of *perceived problems and*
59 *unpleasant experiences* (PPUE).

60 However, PPGIS studies rarely considers how multiple elements of environmental justice spatially relate
61 to one another. Understanding such spatial relationships is crucial to ensuring that urban settings are
62 designed in ways which enable diverse kinds of people to frequently interact with local ecosystems and
63 with each other, and in ways which contribute to place-based experiences (Amin, 2008; Low, Taplin, &
64 Scheld, 2005), including social interactions (Leikkilä, Faehnle, & Galanakis, 2013). This is particularly
65 important given that privatization of urban space is weakening access and decreasing urban inhabitants'
66 options to meaningfully interact with local environments and each other (Colding & Barthel, 2013).

67 In this study, we present a PPGIS method for spatially comparing multiple elements of environmental
68 justice (i.e., activity diversity, user diversity and PPUE) in popular areas by the water in Helsinki
69 Metropolitan Area, with the goal of informing urban blue space design and management. Our research is
70 guided by the following objectives:

71 1) To present a method for spatially comparing activity diversity, user diversity and PPUE in
72 clusters within the HMA;

2) To discuss the implications of considering different spatial measures of environmental justice in landscape planning and management.

The results are based on 2 151 responses (8 518 activity points) to a PPGIS survey conducted around the HMA. We first provide a theoretical background to environmental justice. We then discuss the survey and analyses methods and report on the key findings.

1.1 Multiple elements of environmental justice

The environmental justice concept was developed in the United States in connection to the social movement fighting the uneven distribution of environmental risks among ethnic and racial groups. Since then, it has been extended to encompass not only environmental risks and harms to disadvantaged groups but also access to environmental goods and amenities, such as those provided by urban green spaces (Agyeman, Bullar, & Evans, 2002; Agyeman, 2005; Elvers, Gross, & Heinrichs, 2008).

Environmental justice has frequently been assessed through the lenses of perceived or physical accessibility*;* for example, measuring access to urban green areas, the problems or lack of access of different socio-demographic groups and on how this affects public health (see Wolch, Byrne, & Newell, 2014 for a review). Most of the research originates from the United States, the United Kingdom and Australia. For example, a study in Queensland, Australia, revealed that perceived accessibility influences park use behavior (Wang, Brown, Liu, & Mateo-Babiano, 2015), with physical and locational features being the most important factors influencing perceived accessibility to urban parks (Wang, Brown, & Liu, 2015).

However, other factors can determine accessibility and what places people actually use. A study on accessibility of recreational activities by the water in the HMA showed that the mere vicinity of the shore does not always mean that urban residents enjoy a range of activities there. The areas that the respondents actually used were further in terms of both travel distance and travel time. Factors such as income status had a greater influence on usage patterns (Laatikainen, Tenkanen, Kyttä, & Toivonen, 2015). Other

important factors found to influence usage patterns include ease of social access to facilities and services for diverse social groups (Fincher & Iveson, 2008, p. 35; Low et al., 2005), age (Kemperman & Timmermans, 2006) and family situation (Aminzadeh & Ghorashi, 2007). Here, we measure this *user diversity* by combining age, income level and family situation (further defined in methods).

Environmental justice also has an experiential dimension in that people can perform various activities in urban areas, including urban blue spaces (Laatikainen et al., 2015). PPGIS studies have explored and examined the experiential qualities of areas, showing that activities and place-based values are not randomly distributed across the landscape, but rather cluster around special areas such as urban woodlands (Tyrväinen, Mäkinen, & Schipperijn, 2007) and tourism nodes (Raymond & Brown, 2007). Different types of urban spaces can also be associated with different performed activities (Brown, Schebella, et al., 2014). Hence, *activity diversity* is another important consideration in environmental justice studies.

Perceived problems and unpleasant experiences (PPUE) also needs to be considered with respect to environmental justice. Efforts to promote multiplicity in particular space as a principle of urban inclusion might result in a range of PPUEs, including conflicts between activity groups (Tynon & Gomez, 2012; Vaske, Needham, & Cline, 2007). Sometimes perceived problems can be overcome by making special, even separate, provision in public space for certain groups, and for different activities (Amin, 2008; Low, 2013). It may also mean installing infrastructure to reduce unpleasant experiences, including receptacles for disposing of litter (Schultz, Bator, Large, Bruni, & Tabanico, 2011).

In this study, we spatially assess the interrelationships between activity diversity, user diversity and PPUE. In doing so, we move beyond single measures of environmental justice that do not take into account of different forms of spatial diversity, and avoid the false assumption that the identities and needs of individuals could be understood by any one social label such as age, gender, ethnicity or social class (following Fincher & Iveson, 2008).

2. Methods

2.1 Study Area

The research was conducted in Helsinki Metropolitan Area (HMA) which includes the Baltic Sea (Gulf of Finland), fluvial environments (especially River Vantaa), transitional waters (waters in vicinity of river mouths, partly saline, substantially influences by freshwater), lakes, small urban surface waters (e.g. streams and bonds) and wetlands (Figure 1). Helsinki is the capital of Finland and has a population of 620 700 residents. The HMA consists of the municipalities of Helsinki, Espoo (265 500 residents), Vantaa (210 800 residents) and Kauniainen (9 360 residents).

Helsinki has over 130 kilometres shoreline and over 315 islands. The shoreline and archipelago carry rich cultural history and there are also significant natural recreational areas, especially on eastern shores of Helsinki. In Helsinki every city dweller lives less than 10 kilometer away from the shore. Opening this shoreline for everyone has long been a goal of city planning in Helsinki (City of Helsinki 2015). Many of the important blue spaces in Helsinki city centre are public parks which were built in in the nineteenth century mainly for elite classes and to create the identity of the Helsinki as West-European metropolitan city. Urban structure in Espoo is dispersed and networked consisting of five centres and areas of detached houses located close to nature. Espoo has large natural areas including a seashore of 58 kilometres and 165 islands, as well as almost hundred lakes (City of Espoo 2015a, 2015b). Vantaa can be described as semirural. In contrast to the other municipalities (Espoo and Helsinki), Vantaa does not have access to the coast. The River Vantaa is an important landscape feature running through areas characterized by traditional farmlands, natural and urban landscape. Kauniainen is a small suburban, garden town municipality, enclosed by the municipality of Espoo and hence without access to the sea shore. Given the small number of points assigned to Kauniainen, we merged this region with Espoo.

2.2 Study Participants

A random sample of 30 000 residents aged between 15 and 75 years old was drawn from the Finnish Population Registry. Residents were invited by main in autumn 2013 to participate in the PPGIS survey by mail. Only a single mailing round was undertaken, resulting in 2 151 survey responses and 27 000

marked points around the HMA. The sample results showed general consistency with the HMA statistics (Statistics Finland, 2014) on most socio-demographic variables (e.g., city of residence, age, gender, family type, income). However, compared to the region, the sample had proportionately more highly educated people (Master's degree: sample 31 % vs. HMA 17 %), but proportionately fewer renters (sample 32 % vs. Statistics Finland HMA 42 %) and people living in apartment buildings (sample 62% vs. HMA 75%).

2.3 PPGIS Method and Process

We collected activity and user data using Maptionnaire, which is an online PPGIS tool for the collection of experiential knowledge concerning urban environment and its uses and values (Kyttä & Kahila 2011). The study website consisted of an opening screen and then a map interface where participants could drag and drop digital points relating to different types of activities on to a map of the HMA. On the map interface we noted: "How do you **e**njoy the waters and watersides of the capital region? Use the buttons below to mark it on the map! You may mark as many locations as you wish." Survey participants were requested to take into account all seasons when thinking about the use of urban blue spaces. They first identified a place on the map related to each performed activity. For each activity category, there were several types of activities which participants could choose from (recreational activities, relaxing and spending time together; sports activities and nature activities, Table 1).

Survey participants were then asked to map a set of perceived problems and unpleasant experiences (PPUE): 1) the atmosphere is unpleasant; 2) the scenery is not attractive; 3) the location is crowded; 4) I feel that I do not belong there; 5) I feel like an outsider; 6) certain groups of people or use method bothers me; 7) use of the location requires a membership to an association/club; 8) the location lacks necessary equipment, services, safety structures, routes, etc.; 9) the water quality is poor; 10) I have been harassed or discriminated against, and; 10) environmental protection or other administrative rules restrict use of the location. Finally, respondents were asked to answer question about their background, including income (range), birth year, and family situation.

2.4 Analyses

The analyses comprises of: an assessment of activity clusters; activity diversity; user diversity, and; the generation of quarters based on the combination of activity and user diversity. We also considered the dominance of PPUE.

2.4.1 Activity clusters

A cluster analysis was carried out to create boundaries and define popular areas where people carry out activities related to urban blue spaces. Activity clusters were based on an Average Nearest Neighborhood distance of 70 m which encapsulated over half of the activity points. This threshold ensured an adequate number of both clusters and points for statistical analysis. Only clusters with five or more points were taken into account for further analysis, and clusters belonging to the same areas were merged.

2.4.2 Activity diversity and user diversity

We used the Shannon Diversity Index to examine how diverse each of the clusters were in terms of activities in general, and whether the most diverse clusters were evenly distributed across the HMA. The Shannon index is a well-used measure for species diversity in the field of ecology, and more recently has been applied to urban and environmental planning research (Broberg, Kyttä, & Fagerholm, 2013; Brown, Weber, & de Bie, 2014). In this study, the index was weighted by the number of activity categories. A cell size of 250 m was selected in order to include all points in the analyses. The cells were joined to each cluster based on an area overlay. Summary statistics were then generated describing the distribution of the popular areas and their diversity.

The user diversity index was based on three background variables: age, family situation (singles, couples with or without children) and median income. Various studies have shown that preferences regarding recreational activities and usage of natural amenities change over the life time (i.e., as one gets older) (Chiesura, 2004; Jim & Chen, 2006; Kemperman & Timmermans, 2006; Payne, Mowen, & Orsega-Smith, 2002). The diversity in age involved calculating the variance in mean ages.

Family situation (e.g., whether you have a partner or children) also influences the types of performed activities (Aminzadeh & Ghorashi, 2007; Arnberger & Eder, 2007; Christie, Hanley, & Hynes, 2007; Lee, Graefe, & Burns, 2008). Family situation is a categorical variable. The diversity of family situation was calculated based on the diversity of responses within a given activity cluster.

Level of income is one of the factors which most strongly affects accessibility to activity clusters (Laatikainen et al. 2015). Diversity in income was calculated based on the variance of the median values of each of the twelve classes noted in the survey. The thresholds for low and medium-high income were based on median income per household (4922 € per month, Statistics Finland, 2014).

To create a composite measure of user diversity across the three user variables, we first normalized each diversity calculation using a Sigmoid function and then joined them based on their geometric mean.

2.4.3 Generating quarters based on the combination of activity and user diversity

The framework representing different mixes of activity and user diversity were created by calculating the average of each activity diversity and user diversity index inside the activity cluster. To obtain meaningful user diversities for statistical analyses, only clusters containing more than 7 respondents were considered. The 109 activity clusters contained a total of 3 356 respondents (one respondent could mark activities in several clusters). On average 30.8 respondents marked activity areas in one cluster, varying between 2 and 279. A total of 91 clusters were considered.

Quarters showing different levels and combinations of activity diversity and user diversity were then generated based on an average value threshold (activity diversity = 0.66, user diversity = 0.66). The framework thus allows analysis of the four possible combinations between low and high user diversity and low and high activity diversity. To assist with the naming of each quarter, we then examined respondent socio-demographics per quarter, the cluster size and dominant activities per quarter and the spatial distribution of each quarter

221 *2.4.4 Overlay of activity and user diversity with the negative qualities data*

222 To understand the potential for problem between different activity and user groups, we overlaid the
223 activity and user diversity quarters with the PPUE data. Clusters with more than or equal to 12 problems
224 (based on the 75th percentile) were considered as areas of high potential problem.

225 **3. Results**

226 We spatially examined the number and types of activities by cluster (section 3.1), followed by the
227 diversity of activities and users in clusters (section 3.2). We then combined clusters containing different
228 intensities of activity and user diversity into quarters, and overlaid these results with the dominance of
229 PPUE across the HMA (section 3.3).

230 ***3.1 Activity clusters***

231 The activity points formed 109 clusters, varying between 301 and 185 793 m^2 and containing 4091 of the
232 original 8518 points of the HMA (48.03%). The six most frequently mapped activities in the clusters
233 belonged to recreation, except jogging which is a sports activity (Table 1). These recreational activities
234 were non-specialized and included walks on the shore, spending time with family and friends, spending
235 time sitting or sunbathing on the beach, using a coffee shop or picnics by the water. The least frequently
236 marked activities were those which require either expensive equipment and or a special training. They
237 included sailing, ice-skating/tour skating, motor boating and hunting. This exercise resulted in the
238 mapping of 4 091 points and 7 855 activities.

239 The most and the least marked activities inside the clusters were similar to those found across the region
240 without clustering. However, recreational activities dominated when considering only the areas inside the
241 cluster (Table 1, Difference > 1), whereas most of the sports and nature activities dominated when
242 considering all areas marked in the HMA (Difference < 1). This finding is further supported by the
243 Average Nearest Neighbor ratio representing the ratio of observed versus predicted distances. All three
244 activity types showed significant clustering patterns (ranging from 0.37 to 0.51). Recreation activities
245 were the most concentrated (0.37), nature activity points were least clustered (as seen by the dispersed

246 pattern in in the Northwestern area of Espoo), and sports activities showed a pattern in between these two
247 extremes.

248 ***3.2 Diversity of activities and users in clusters***

249 We first examined the *diversity of activities* in the clusters (Figure 2). The diversity index of the popular
250 areas ranged from 0.55 to 0.73 (average = 0.66). Most of the clusters had medium-high indices with a
251 strong peak around 0.70 and a smaller peak around 0.60. There were no significant differences in activity
252 diversity based on type of water body, character of the environment (central, remote, rural or urban) and
253 type of urbanization (sealed, natural and remote areas) ($p > 0.05$). Both high diversity and low diversity
254 clusters can be found on all kinds of: water bodies; central, remote, rural or urban areas, and; sealed,
255 natural and remote areas. Low activity diversity areas were found near the market square in the city centre
256 of Helsinki as well as at the remote pond of Haukkalampi in the Nuuksio National Park in Espoo.
257 Conversely, high activity diversity cluster were found at the centrally located island of Seurasaari in
258 Helsinki as well as at the lake of Kuusijärvi situated in inner Vantaa.

259 The user diversity comprised of the variables of age, income and family situation. The normalized
260 diversity varied between 0.57 and 0.69, with a peak around 0.64 and a mean value of 0.63. Clusters of
261 high and low user diversity were found in all municipalities and in central as well as remote areas. The
262 central island of Seurasaari (Helsinki) as well as the remote pond of Haukkalampi in Nuuksio (Espoo)
263 were areas of low user diversity, whereas the central market square in Helsinki and the remote lake of
264 Kuusijärvi (Vantaa) were areas of high user diversity.

265 ***3.3 Combining activity and user diversity into quarters***

266 *3.3.1 Identifying quarters*

267 When mapping activity and user diversity separately, there were no significant differences among
268 municipalities, and the diversity clusters were distributed rather equally among the region (with many
269 clusters of low diversity located towards the east of the city centre). However, after combining activity
270 and user diversity indices, popular areas in the HMA had different mixes of user diversity and activity

diversity, which were subsequently classified into four quarters in a framework (Table 2). We identified popular areas containing clusters with high user but low activity diversity (Quarter 1); high user and activity diversity (Quarter 2), low user and activity diversity (Quarter 3), and low user but high activity diversity (Quarter 4). The majority of clusters were found in Quarter 2.

We then mapped the distribution of clusters within the four quarters (Figure 4). Overall, the Helsinki area (particularly the western area) had the highest number of Quarter 2 clusters, followed by Espoo and then Vantaa. Quarter 1 and Quarter 4 clusters were mainly found in Helsinki (71.4 and 73.9% respectively) all along the shoreline. Quarter 3 clusters were located mainly along the shoreline of Espoo and Helsinki, with a further two at the river Vantaa and in the Nuuksio National Park. Approximately 27% of Quarter 2 clusters and 22% of Quarter 4 clusters were located on inland waters. Along the river Vantaa there were clusters of all four quarters.

3.3.2 Socio-demographics per quarter

Overall, Quarter 2 had the highest number of respondents (n = 1 471), followed by Quarter 1 (n = 738), Quarter 4 (n = 689) and Quarter 3 (n = 367) (Table 3). The quarters having low user diversity had significantly more respondents of working age (25-65 years) than the more diverse user clusters. In Quarter 4, the proportion of respondents under 25 years was particularly low. Those who lived alone were overrepresented in Quarter 1 and slightly underrepresented in Quarter 4.

We also found significant differences related to income level. Respondents who reported a household monthly gross income of 4 800 € or less were assigned to low income households and those who reported 4801 € or more were assigned to medium to high income households. Members of low income households composed 48% of respondents in each of Quarters 1 and 3, compared with 43% and 42% in Quarters 2 and 4.

295 *3.3.3 Size and activity characteristics of each quarter*

296 All quarters differed in terms of the number of clusters they included; average area of their clusters; and
297 the proportions of different activity categories (Table 4). Quarter 2 was largest in area, and also has the
298 highest number of markings, while the Quarter 3 was considerably smaller. Quarters 1 and 2 (representing
299 a high diversity of users) contain a high proportion of recreational activities while Quarter 3 had a high
300 proportion of sport activities (especially jogging). The proportion of nature points was highest in Quarter
301 4. When comparing activity types across quarters, disproportionate associations were found between
302 nature activities in Quarter 4 (standardized residual = 4.8) and sports activities in Quarter 3 (standardized
303 residual = 2.6). Nature activities were significantly under-represented in Quarter 1 (standardized residual
304 = -2.8) compared with Quarter 4 (standardized residual = 4.8). The associations between all other variable
305 are relatively small.

306 *3.3.4 Spatial comparison of activity and user diversity with PPUE areas*

307 The total number of PPUE in clusters varied between 12 and 61. The most frequently cited PPUE (>10%
308 of all points) throughout all the clusters were “certain group of people or use method bothers me”
309 (15.8%), “the environment is littered or not cared for”, “the water quality is poor” (both 15.5%), and “the
310 location is crowded” (13.6%).

311 Spatial analysis revealed high PPUE clusters: Hietaranta Beach, Kuusijärvi, Eläintarhanlahti, Pikkukoski,
312 Suomenlinna, Vanhankaupunginkoski. Matinkylä Beach, Uutela, Oittaa, Töölönlahti. These clusters were
313 located in all three municipalities, with the majority in Helsinki (7), two in Espoo and one in Vantaa.
314 High problem clusters contained proportionately more respondents (44-162; average 89.4). The most
315 frequent activities in the problem clusters were walking (17.3%) followed by meeting with family/friends
316 (16.3%), going to the beach (14%), having coffee (11.3%), jogging (9.4%) and picnicking (9.2%).

317 Quarter 1 had two high PPUE clusters in close proximity of the Helsinki city centre; namely, Töölönlahti
318 and Suomenlinna. These findings align with known uses of the areas. Töölönlahti is a bay close to the
319 main rail way station, where people mainly jog, but also have coffee or spend time with friends and

family. Suomenlinna, the island connected to the city centre, is a famous recreational destination, mostly used for spending time with friends and family, and walking.

In Quarter 2, six clusters contained high numbers of PPUE (this is more than half of all high problem clusters). Of those, two clusters were found in each of Vantaa, Espoo and Helsinki. In Vantaa, the problem cluster was located on the only lake, which is mostly used for swimming. In Espoo, one of the two clusters was located on the biggest lake of the municipality, which is also dominated by swimming activities. The other cluster can be found in the recently developed area of Matinkylä on the sea shore. Respondents used this spot mainly to enjoy coffee. In Helsinki, there were problem areas close to the city centre (with a dominance of jogging and coffee drinking), but also in the east in a forested area where nature observation was the dominating activity. In Quarter 4, two clusters contained high numbers of problems. Like in Quarter 1, these clusters were in close proximity of the city centre, and close to each other. In both clusters, enjoying coffee, jogging, nature observing and swimming were dominant activities.

Analysis of the geographic distribution of high problem clusters reveals that those areas with high diversity of users and low diversity of activities, and vice versa (Quarters 1 and 4), were concentrated in the city centre of Helsinki. However, when both diversities are high (Quarter 2), problem clusters were present in all municipalities. There were no problem clusters when both user and activity diversity were low. The activity diversity inside the high problem clusters varied between 0.65 and 0.73, with an average of 0.69. This is higher than the average activity diversity of all clusters ($Dact_t = 0.66$). The user diversity in the problem clusters varied between 0.62 and 0.66, with an average of 0.64. Also in the case of user diversity the value in the problem cluster is higher than the total value (Duser= 0.63).

4. Discussion

The aim of this study was to present a method for spatially assessing multiple elements of environmental justice with respect to urban blue space planning. We provided a framework (Table 2) for understanding these complex interrelationships among activity diversity, user diversity and perceived problems and unpleasant experiences (PPUE), and a PPGIS method for spatially assessing these different elements of environmental justice. We found distinguishing sets or Quarters based on the diversity of user profiles and performed activities (Table 5). For example, in areas of low activity diversity relatively high number of respondents are low income, working age people. In those areas proportionately more respondents undertake sports activities and associated these areas with litter problems (Quarter 3). The framework provides an important contribution to the assessment of environmental justice which has traditionally focused on assessing environmental risk and access to environmental goods and amenities without considering different mixes of user profiles and activity needs (Agyeman et al., 2002; Agyeman, 2005; Elvers et al., 2008).

Our methods and findings also provide an important contribution to the PPGIS literature which has traditionally focused on spatially assessing single elements of environmental justice such as the links between preferred activities and park type or size (Brown, Schebella, et al., 2014), or the modelling of the determinants of perceived accessibility (Wang, Brown, Liu, et al., 2015; Wang, Brown, & Liu, 2015). We found that the diversity metric (Brown & Reed, 2012) was a useful way to integrate a range of activities and socio-demographic variables together. Contrary to these studies, important differences emerged across combinations of elements of environmental justice (Table 5). The contrasting situations of high and low diversities (Quarters 1 and 4) showed very different geographic distribution pattern, dominating activities and problems, and socioeconomic characteristics. Considering just one of these two dimensions could lead to the omission of important elements of environmental justice.

Clusters in Quarter 1 had a relative high amount of respondents under 25 years old, singles and with low income (< median income). The clusters were mainly distributed in the city centre of Helsinki and the western part of the municipality, they were dominated by recreational activities and the problems are

mainly related to poor water quality. This finding can be explained by the fact that low income people are unlikely to be able to afford travelling large distances for recreation. In contrast, clusters in Quarter 4 had proportionately fewer respondents under 25 years old, the lowest share of singles and the highest share of medium-high income (≥ median income) respondents. The clusters were distributed mainly in the eastern part of Helsinki (around and east of the Vanhankaupunki bay), they show proportionately more nature activities and the problems are mainly related to feeling bothered by a certain group of people or use method. Medium-high income people can afford to travel longer distances, and to engage in more specialized recreation. However, often nature-based recreation enthusiasts can have competing goals, including those of mountain-bikers and hikers (Wolf, Wohlfart, Brown, & Bartolomé Lasa, 2015), which may explain the perceived activity conflict.

The intensity and type of PPUE can vary according to the distribution of activity and user diversity. In quarters of low activity diversity (1 and 3), PPUE were related to the condition of the environment (poor quality, littered). In quarters of high activity diversity (2 and 4) the PPUE were more likely to be associated to intra- and intergroup issues (e.g., crowded place and feeling bothered by a group of people or their activities). The presence of diverse activities therefore seems to magnify intergroup conflicts which is consistent with findings from the recreation literature (Carothers, Vaske, & Donnelly, 2001). Problems also varied in magnitude, with the most problems found in Quarter 2, and the least problems found in Quarter 3. Most respondents were found in Quarter 2 suggesting that the magnitude of problems is related to the number of users within a given area.

Our methods have some important limitations. We focused on performed activities (actual behavior) as opposed to activity preferences. The activity diversity metric therefore provides a representation of current activity needs, but no clarity on future, desired needs which is often needed in planning contexts. Future work could compare and contrast the results generated through the measurement of performed vs. preferred activities. While our method for spatially presenting environmental justice is more nuanced than previous PPGIS work, we acknowledge further research is needed to understand the complexities of environmental justice at the place-specific scale. Qualitative research, for example, could investigate the

generalizations in activity and user diversity made here. We did not include minorities, such as different ethnic groups in our analysis. Their performed activities could be included in urban blue space planning instead of just groups with different age, family situation or income profiles. We also did not consider strategies for resolving conflict in problem areas, which would require follow up work regional planners in the HMA.

Notwithstanding these limitations, our method provides a means for landscape planners to spatially identify opportunities for recreation, sport and leisure infrastructure management in accordance with different elements of environmental justice. This entails respecting the activity choices of different users and providing spaces affording high diversity of activities, but also low diversity of activities. It is not problematic to have low activity diversity areas, but possibilities for accessing many activities should be equal. It also provides landscape planners a way to spatially target management to areas of perceived problems and unpleasant experiences, reducing the potential for conflict among different user groups.

The finding that low user, high activity diversity areas are associated with nature-based activities and high income people (Quarter 4) raises important ethical questions about how to encourage more diverse people to connect to nature. In this case, we recommend increasing possibilities for mobility, including providing reasonably priced access to natural areas by public transport. However, this may lead to increased perceived problems related to crowing or activity-based conflicts. To this end, we recommend studies into the social and physical barriers (and drivers) to nature-based interactions among different socioeconomic and demographic groups, and the interrelationships between mobility and intra- or inter-group conflicts in urban blue spaces.

Another logical step is to consider aspects of procedural justice alongside elements of environmental justice. One possibility is to empirically compare and contrast the results of instrumental and deliberative paradigms to valuation (Raymond, Kenter, Plieninger, Turner, & Alexander, 2014) with respect to different indicators of procedural justice such as the level of self-reported trust in the process, and the perceived legitimacy, transparency and accountability of the process. Further, studies could examine whether the diversity of activities mapped by different user groups vary across different types of mapping

procedures and planning processes, thereby closing the loop on the three key elements of environmental justice in landscape planning and management.

5. Conclusion

The methods and results of this study provide support for the integration of multiple elements of environmental justice into urban blue place planning, including activity diversity, user diversity and perceived problems and unpleasant experiences. Contrasting combinations of activity and user diversity (high-low, low-high) show very different spatial distributions, dominating activities and problems, and socioeconomic characteristics. Looking at only one of these two dimension could lead to the omission of potential planning and management areas. We encourage landscape planners to cater for the activity choices of different users and provide spaces with a high diversity of activities, but also a low diversity of activities. The framework and methods provide a means for spatially targeting recreation, sport and leisure infrastructure to these different mixes of activity and user diversity.

References

Agyeman, J. (2005). *Sustainable Communities and the Challenge of Environmental Justice*. New York: New York University Press.

Agyeman, J., Bullar, R., & Evans, B. (2002). *Just Sustainabilities: Development in an Unequal World*. London: Earthscane.

Agyeman, J., & Evans, B. (2004). "Just sustainability": The emerging discourse of environmental justice in Britain? *The Geographical Journal*, *170*(2), 155–164.

Amin, A. (2008). Collective culture and urban public space. *City: Analysis of Urban Trends, Culture, Theory, Policy, Action*, *12*(1), 5–24.

Aminzadeh, B., & Ghorashi, S. (2007). Scenic landscape quality and recreational activities in natural forest parks, Iran. *International Journal of Environmental Research*, *1*(1), 5–13.

Arnberger, A., & Eder, R. (2007). Monitoring recreational activities in urban forests using long-term video observation. *Forestry*, *80*(1), 1–15.

Broberg, A., Kyttä, M., & Fagerholm, N. (2013). Child-friendly urban structures: Bullerby revisited. *Journal of Environmental Psychology*, *35*, 110–120. h

Brown, G., & Fagerholm, N. (2014). Empirical PPGIS/PGIS mapping of ecosystem services: A review and evaluation. *Ecosystem Services*, *13*, 119-133.

Brown, G. G., & Reed, P. (2012). Social Landscape Metrics: Measures for Understanding Place Values from Public Participation Geographic Information Systems (PPGIS). *Landscape Research*, *37*(1), 73–90.

Brown, G., Kelly, M., & Whitall, D. (2013). Which "public"? Sampling effects in public participation GIS (PPGIS) and volunteered geographic information (VGI) systems for public lands management. *Journal of Environmental Planning and Management*, *57*(2), 190–214.

Brown, G., Montag, J. M., & Lyon, K. (2012). Public Participation GIS: A Method for Identifying Ecosystem Services. *Society & Natural Resources*, *25*(7), 633–651.

Brown, G., Schebella, M. F., & Weber, D. (2014). Using participatory GIS to measure physical activity and urban park benefits. *Landscape and Urban Planning*, *121*, 34–44.

Brown, G., Weber, D., & de Bie, K. (2014). Assessing the value of public lands using public participation GIS (PPGIS) and social landscape metrics. *Applied Geography*, *53*, 77–89.

Carothers, P., Vaske, J. J., & Donnelly, M. P. (2001). Social values versus interpersonal conflict among hikers and mountain bikers. *Leisure Sciences*, *23*(1), 47–61.

Chiesura, A. (2004). The role of urban parks for the sustainable city. *Landscape and Urban Planning*, *68*(1), 129–138.

Christie, M., Hanley, N., & Hynes, S. (2007). Valuing enhancements to forest recreation using choice experiment and contingent behaviour methods. *Journal of Forest Economics*, *13*(2-3), 75–102.

City of Espoo (2015a) Information about Espoo. Accessed Online: 8th October, 2015. http://www.espoo.fi/en-US/City_of_Espoo/Information_about_Espoo

City of Espoo (2015b) Population structure in Espoo 2014/2015). Accessed Online: 8th October, 2015. http://www.espoo.fi/download/noname/%7BBB6B16E5-EB94-4399-A80B-9856590AABE7%7D/60182

City of Helsinki (2014) City Planning Department's Report on Sea Areas of Helsinki for Proposal for Helsinki City Plan. Accessed Online: 8th October, 2015 http://www.hel.fi/hel2/ksv/julkaisut/yos_2014-15.pdf

City of Helsinki (2015) Facts about Helsinki 2015. Accessed Online: 8th October, 2015. http://www.hel.fi/hel2/tietokeskus/julkaisut/pdf/15_05_28_Facts_about_Helsinki_2015_Askelo.pdf

City of Kauniainen (2015). History of region. Accessed Online: 8th October, 2015. http://www.kauniainen.fi/en/the_city_and_public_decision-making/facts_about_kauniainen

Colding, J., & Barthel, S. (2013). The potential of "Urban Green Commons" in the resilience building of cities. *Ecological Economics*, *86*, 156–166.

Elvers, H.-D., Gross, M., & Heinrichs, H. (2008). The diversity of environmental justice. *European Societies*, *10*(5), 835–856.

European Commission. (2013). Green Infrastructure (GI) — Enhancing Europe's Natural Capital. Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and The Committee of the Regions. Accessed Online: 10th October, 2015. http://eur-lex.europa.eu/resource

Faehnle, M., Bäcklund, P., Tyrväinen, L., Niemelä, J., & Yli-Pelkonen, V. (2014). How can residents' experiences inform planning of urban green infrastructure? Case Finland. *Landscape and Urban Planning*, *130*, 171–183.

Fincher, R., & Iveson, K. (2008). *Planning and diversity in the city. Redistribution, recognition and encounter*. New York: Palgrave Macmillan.

García-Nieto, A. P., Quintas-Soriano, C., García-Llorente, M., Palomo, I., Montes, C., & Martín-López, B. (2014). Collaborative mapping of ecosystem services: The role of stakeholders′ profiles. *Ecosystem Services*. *13*,141-152-

Gobster, P. H., Nassauer, J. I., Daniel, T. C., & Fry, G. (2007). The shared landscape: what does aesthetics have to do with ecology? *Landscape Ecology*, *22*(7), 959–972.

Helsinki Region (2015) News about the region. Accessed Online: 8th October, 2015. http://www.helsinginseutu.fi/hki/hs/The+Region+of+Helsinki/Home_1.

Jim, C. Y., & Chen, W. Y. (2006). Recreation-amenity use and contingent valuation of urban greenspaces in Guangzhou, China. *Landscape and Urban Planning*, *75*(1-2), 81–96.

Kahila, M., & Kytta, M. (2009). SoftGIS as a Bridge Builder in Collaborative Urban Planning. In *Planning Support Systems Best Practice and New Methods* (pp. 389–411). UK: Springer.

505 Kemperman, A., & Timmermans, H. J. P. (2006). Heterogeneity in urban park use of aging visitors: A
506 latent class analysis. *LEISURE SCIENCES*, *28*(1), 57–71.

507 Korpela, K. M., Ylén, M., Tyrväinen, L., & Silvennoinen, H. (2010). Favorite green, waterside and urban
508 environments, restorative experiences and perceived health in Finland. *Health Promotion*
509 *International*, *25*(2), 200–9.

510 Kyttä, M., Kuoppa, J., Hirvonen, J., Ahmadi, E., & Tzoulas, T. (2014). Perceived safety of the retrofit
511 neighborhood: A location-based approach. *Urban Design International*, *19*(4), 311–328.

512 Laatikainen, T., Tenkanen, H., Kyttä, M., & Toivonen, T. (2015). Comparing conventional and PPGIS
513 approaches in measuring equality of access to urban aquatic environments. *Landscape and Urban*
514 *Planning*, *144*, 22–33.

515 Lawrence, D., & Low, S. (1990). The built environment and spatial form. *Annual Review of*
516 *Anthropology*, *19*, 453–505.

517 Lee, B., Graefe, A., & Burns, R. (2008). Family Recreation: A Study of Visitors Who Travel with
518 Children. *World Leisure Journal*, *50*(4), 259–267.

519 Leikkilä, J., Faehnle, M., & Galanakis, M. (2013). Promoting interculturalism by planning of urban
520 nature. *Urban Forestry & Urban Greening*, *12*(2), 183–190.

521 Low, S. (2013). Public Space and Diversity: Distributive, Procedural and Interactional Justice for Parks.
522 In G. Young & D. Stevenson (Eds.), *The Ashgate Research Companion to Planning and Culture*.
523 Surrey, UK: Ashgate.

524 Low, S., Taplin, D., & Scheld, S. (2005). *Rethinking Urban Parks Public Space and Cultural Diversity*.
525 Texas: University of Texas Press.

526 Payne, L. L., Mowen, A. J., & Orsega-Smith, E. (2002). An Examination of Park Preferences and
527 Behaviors Among Urban Residents: The Role of Residential Location, Race, and Age. *Leisure*
528 *Sciences*, *24*(2), 181–198.

529 Raymond, C. M., & Brown, G. (2007). A spatial method for assessing resident and visitor attitudes
530 toward tourism growth and development. *Journal of Sustainable Tourism*, *15*(5), 520–540.

531 Raymond, C. M., Bryan, B. A., MacDonald, D. H., Cast, A., Strathearn, S., Grandgirard, A., & Kalivas,
532 T. (2009). Mapping community values for natural capital and ecosystem services. *Ecological*
533 *Economics*, *68*(5), 1301–1315.

534 Raymond, C. M., Kenter, J. O., Plieninger, T., Turner, N. J., & Alexander, K. A. (2014). Comparing
535 instrumental and deliberative paradigms underpinning the assessment of social values for cultural
536 ecosystem services. *Ecological Economics*, *107*, 145–156.

537 Schultz, P. W., Bator, R. J., Large, L. B., Bruni, C. M., & Tabanico, J. J. (2011). Littering in Context:
538 Personal and Environmental Predictors of Littering Behavior. *Environment and Behavior*, *45*(1),
539 35–59.

540 Sherrouse, B. C., Clement, J. M., & Semmens, D. J. (2011). A GIS application for assessing, mapping,
541 and quantifying the social values of ecosystem services. *Applied Geography*, *31*(2), 748–760.

Statistics Finland. (2014). Statistics Finland database 2014. Identity number 2014..27.10.

Tynon, J. F., & Gomez, E. (2012). Interpersonal and social values conflict among coastal recreation activity groups in Hawaii. *Journal of Leisure Research*, *44*(4), 531–543.

Tyrväinen, L., Mäkinen, K., & Schipperijn, J. (2007). Tools for mapping social values of urban woodlands and other green areas. *Landscape and Urban Planning*, *79*(1), 5–19.

Van Riper, C. J., Kyle, G. T., Sutton, S. G., Barnes, M., & Sherrouse, B. C. (2012). Mapping outdoor recreationists' perceived social values for ecosystem services at Hinchinbrook Island National Park, Australia. *Applied Geography*, *35*(1-2), 164–173.

Vaske, J. J., Needham, M. D., & Cline, R. C. (2007). Clarifying interpersonal and social values conflict among recreationists. *Journal of Leisure Research*, *39*(1), 182–195.

Walker, G. (2012). *Environmental Justice: Concepts, Evidence and Practice*. New York: Routledge.

Wang, D., Brown, G., & Liu, Y. (2015). The physical and non-physical factors that influence perceived access to urban parks. *Landscape and Urban Planning*, *133*, 53–66.

Wang, D., Brown, G., Liu, Y., & Mateo-Babiano, I. (2015). A comparison of perceived and geographic access to predict urban park use. *Cities*, *42*, 85–96.

Wessels, A.T. (2011) The ultimate team sport?: Urban waterways and youth rowing in Seattle. In S.E & S.P. Kemp. *The Paradox of Urban Space. Inequality and Transformation in Marginalized Communities*. Palgrave Macmillan.

Wolch, J. R., Byrne, J., & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities "just green enough." *Landscape and Urban Planning*, *125*, 234–244.

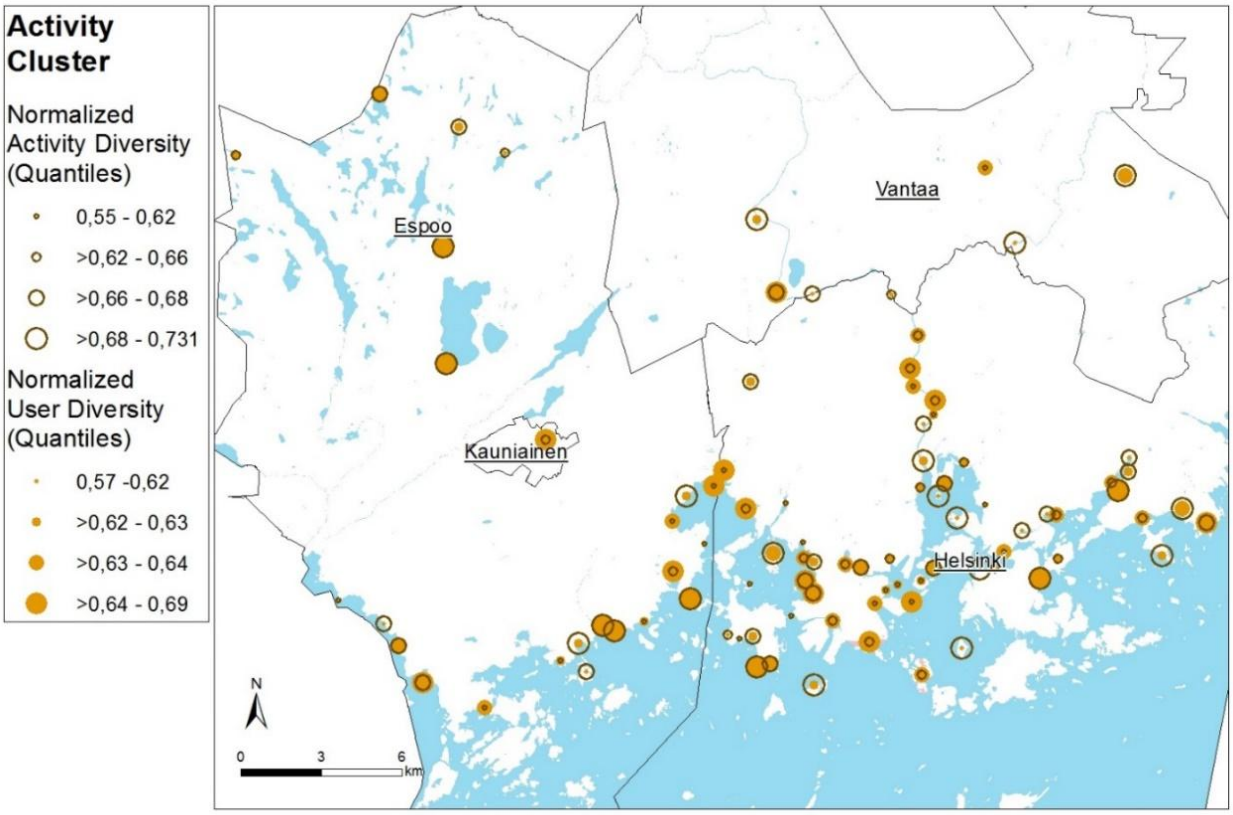
Wolf, I. D., Wohlfart, T., Brown, G., & Bartolomé Lasa, A. (2015). The use of public participation GIS (PPGIS) for park visitor management: A case study of mountain biking. *Tourism Management*, *51*, 112–130.

567 **LIST OF FIGURES**

568

569 *Figure 1 The Helsinki Metropolitan Area.*
570 *Note: Reference points represent locations in the study region which we will refer to in latter sections of the paper*

571



572

573 *Figure 2 Diversity of activities and users in the clusters.*
574 *Note: the size of the circles represent the magnitude of diversity.*

575

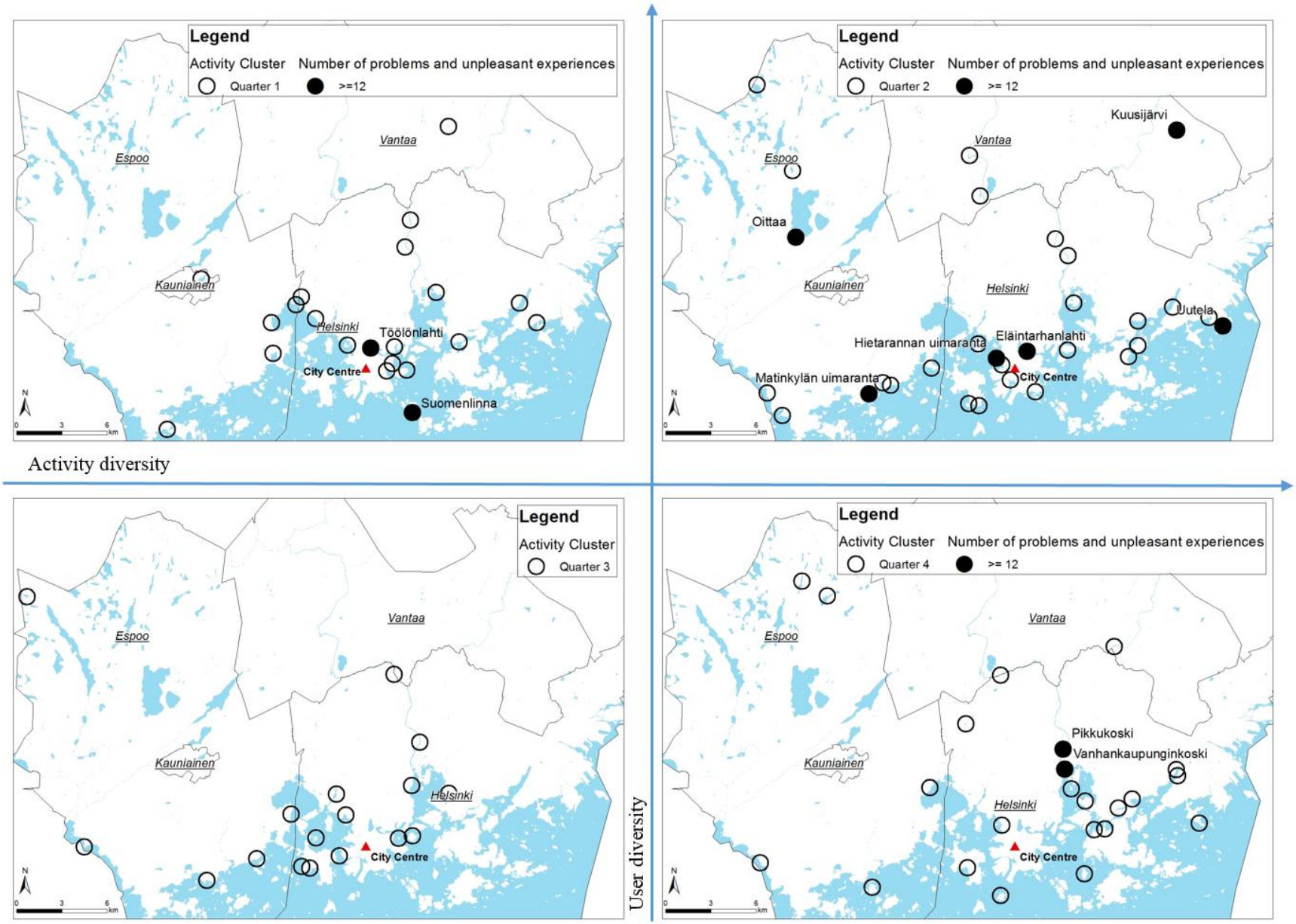


Figure 3 Spatial distribution of clusters in the different quarters

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Table 1 Proportional differences in the number of activity points placed inside and outside of the clusters

Activity type	Total number of points across region	% across region	Points inside cluster Number of points in cluster	% in cluster	Difference (Points in Cluster/Total points)
Walks on the shore	2 181	14.6	1351	17.2	1.18
Jogging	1 971	13.2	893	11.4	0.86
Spending time with family or friends	1 894	12.7	1157	14.7	1.16
Spending time, sitting, sunbathing on the beach	1 695	11.4	1073	13.7	1.20
Use of a coffee shop, terrace, etc. by the water	1 264	8.5	889	11.3	1.34
Picnics by the water	935	6.3	567	7.2	1.15
Other nature observation	891	6.0	328	4.2	0.70
Hiking	692	4.6	229	2.9	0.63
Skiing on ice or on the shores	635	4.3	185	2.4	0.55
Swimming in natural waters	616	4.1	346	4.4	1.07
Taking the kids swimming	439	2.9	290	3.7	1.26
Birdwatching	334	2.2	124	1.6	0.71
Taking the dog swimming	233	1.6	109	1.4	0.89
Fishing	228	1.5	54	0.7	0.45
Canoeing or rowing	210	1.4	58	0.7	0.53
Ice skating, tour skating on natural ice	153	1.0	30	0.4	0.37
Sailing	144	1.0	37	0.5	0.49
Enjoying sauna by the water	129	0.9	46	0.6	0.68
Motor boating	120	0.8	19	0.2	0.30
Winter swimming	79	0.5	42	0.5	1.01
Water area reconditioning or other environmental management work	34	0.2	10	0.1	0.56
Diving, snorkeling	25	0.2	10	0.1	0.76
Jet skiing, water skiing, or other motorized water sport	14	0.1	3	0.0	0.41
Hunting	13	0.1	4	0.1	0.58
Riding snow mobiles on the shore or ice	3	0.0	1	0.0	0.63
Total points	**14 932**	**100.0**	**7 855**	**100.0**	

Note: If Difference > 1 then share of points inside cluster are greater than outside cluster; if Difference < 1 share of points inside cluster are less than outside cluster; if Difference =1 share of points inside cluster and outside clusters are equal; colors: from dark grey to white: recreational activities, relaxing and spending time together; sports activities; nature activities

Table 2 A framework representing different mixes of activity and user diversity

		Activity Diversity	
		Low	High
User Diversity	High	**Quarter 1** (High User, Low Activity Diversity) 21 clusters	**Quarter 2** (High User, High Activity Diversity) 30 clusters
	Low	**Quarter 3** (Low User, Low Activity Diversity) 17 clusters	**Quarter 4** (Low User, High Activity Diversity) 23 clusters

Table 3 Comparison of socio-demographics by quarter

Response variables	Categories	n	Quarter 1	Quarter 2	Quarter 3	Quarter 4	x^2	*p*
				%				
Family type	Living alone	762	27.4	22.7	22.7	21.2	9.17	0.027
	Other family types	2 490	72.6	77.3	77.3	78.8		
	Total	3 252	100	100	100	100		
Age	Under 25	299	10.7	11.5	9.8	4.7	25.83	0.000
	25-65	2 638	84.6	83.1	85.6	90.7		
	Over 65	154	4.7	5.4	4.6	4.6		
	Total	3 091	100	100	100	100		
Income per month	< HMA median	1 366	48.1	42.9	47.9	41.7	8.82	0.032
	≥ HMA median	1 711	51.9	57.1	52.1	58.3		
	Total	3 077	100	100	100	100		
	Less than 1600	329	13.2	10.9	10.3	7.8	68.52	0.000
	1601-3200	500	17.7	16.3	18.2	13.5		
	3201-4800	537	17.2	15.7	19.4	20.4		
	4801-8000	1 022	30.6	32	33.2	38.5		
	8001-12800	537	15.9	17.8	17.9	18		
	More than 12801	152	5.3	7.2	0.9	1.8		
	Total	3 077	100	100	100	100		

Table 4 Size and activity characteristics per quarter,

			Quarter1	Quarter2	Quarter3	Quarter4	*Total (all quarters)*
	Cluster	Count	21	30	17	23	91
	Area in m2	Total	336 013.50	768 974.70	166 325.30	304 160	1 575 473
		Average per Cluster	16 000.64	25 632.49	9 783.84	13 224.35	17 312.89
	Respondents	Total	738	1 471	367	689	3 265
		Average per Cluster	35.14	49.03	21.59	29.96	35.88
Activity areas	Total	Count	850	1 916	397	800	3 963
	Recreation	Count	482	1 099	193	420	2 194
		%	56.7	57.4	48.6	52.5	55.4
		Standardized Residual	.5	1.2	-1.8	-1.1	
	Sport	Count	287	586	155	227	1 255
		%	33.8	30.6	39.0	28.4	31.7
		Standardized Residual	1.1	-.8	2.6	-1.7	
	Nature	Count	81	231	49	153	514
		%	9.5	12.1	12.3	19.1	13.0
		Standardized Residual	-2.8	-1.1	-.3	4.8	

Note: the overall association between quarters and activity categories is significant (X2=50.03, df=6, p<0.001), standardized residuals less than -2.0 (light grey) and greater than 2.0 (dark grey) are highlighted.

Table 5 Summary of key findings from the assessment of the spatial interactions between activity diversity, user diversity and PPUE

Quarter 1 (high user, low activity)	Quarter 2 (high user, high activity)
Distribution:	***Distribution:***
Mainly in Helsinki: Western part of the municipality	Vantaa and Espoo, shoreline of Helsinki, many inland waters
Description:	***Description:***
21 clusters	30 clusters (majority of clusters)
Low income	Medium-high income
High share under 25	Highest under 25
Highest share living alone	Low share living alone
Recreational activities	Recreational activities
'The water quality is poor' (20%)	'The location is crowded' (17%)
2 high intensity problem clusters	6 high intensity problem clusters
	Highest number of respondents and markings
	Largest cluster (size)
Quarter 3 (low user, low activity)	**Quarter 4 (low user, high activity)**
Distribution:	***Distribution:***
Mainly along the shorelines of Espoo and Helsinki, and Nuuksio	Mainly in Helsinki: close to the city centre, eastern shoreline
Description:	***Description:***
17 clusters	23 clusters
Low income	Medium-high income
Working age people	Working age people
Low share living alone	Lowest share living alone
Sport activities	Nature activities
'The environment is littered or not cared for' (29%)	'Certain group of people or use method bothers me' (23%)
0 high intensity problem clusters	2 high intensity problem clusters

Acknowledgement

The authors would like to acknowledge the support of the Academy of Finland who funded the research project named ENJUSTESS (Environmental Justice and ecosystem services: Access, equity and participation in the use and management of aquatic environments in the Helsinki region) from which this paper derives. We also wish to thank all project partners as well as the residents of Helsinki Metropolitan Area who participated in the project, and the Innovatiivinen Kaupunki® program which also funded this research. The authors are very grateful for the support of the Sports Department and the Environment Center of the City of Helsinki.