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A Mobile Phone Application for the Collection of Opinion Data for Forest Planning Purposes

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Abstract The last 30 years has seen an increase in environmental, socio-economic, and recreational objectives being considered throughout the forest planning process. In the Finnish context these are considered mainly at the regional level potentially missing out on more local issues and problems. Such local information would be most efficiently collected with a participatory GIS approach. A mobile participatory GIS application called Tienoo was developed as a tool for collecting location-specific opinions of recreational and aesthetical characteristics of forests and forest management. The application also contains information the user can access regarding the practical details of the area, for instance about the recreational infrastructure. The application was tested in Ruunaa National Hiking Area, North Karelia, Eastern Finland. Through this application it is possible to continuously collect geolocated preference information. As a result, the collected opinions have details which can be located in both time and space. This allows for the possibility to monitor the changes in opinions when the stands are treated, and it also allows for easily analyzing the effect of time of year on the opinions. It is also possible to analyze the effect of the spatial location and the forest characteristics on the opinions using GIS analysis.

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Introduction

The last 30 years has seen changes in the public's attitudes toward forests and how they are managed. Environmental and socio-economic objectives such as biodiversity, game management, scenic beauty, or recreation possibilities are now widely acknowledged and incorporated into the forest planning process of publicly owned forests. While these objectives are readily discussed in the Finnish context, proactive participative forest planning occurs mainly at the regional level, the main application of participatory forest planning in Finland being the Natural Resources Planning of state-owned forests (e.g., Pykäläinen et al. 2007; Hiltunen et al. 2008). These plans are the result of strategic level decision making and rely on regional-level criteria such as harvest levels, employment, or amount of area deemed suitable for recreational purposes.

Focusing on regional-level criteria may potentially lead to missing out on more local issues: while people may well be uninformed and uninterested on the forest management on regional level, they may still be very interested in the effects of forestry in their own neighborhood and in the forests they commonly use themselves. It may also have the effect of marginalizing communities from the planning of forest management activities, if local stakeholders are not interested on the regional-level criteria. While it would be costly to deploy a program of community scoping meetings across the whole country the size of Finland for each forest management unit, there are other solutions to be found to the problem of engaging local communities and visitors to an area alike.

Methods have been developed for collecting local opinions and local information from the stakeholders, with applications in mainly urban forests. One possible method to involve the local people is to collect location-specific values and opinions (see, e.g., Hytönen et al. 2002; Reed and Brown 2003; Brown 2006; Tyrväinen et al. 2007; Kangas et al. 2008; Nordström et al. 2011). Hytönen et al. (2002) mapped verbally given information such as "forests around the lake need to be conserved". In other studies, direct map-based surveys have been used. The map-based surveys have worked reasonably well in urban forests, where it is fairly easy for the respondents to locate their favorite places on a map, for instance. In a forest area, it is much more difficult to point out similar favorite areas on a map, as the areas are larger and less distinguished from the surrounding areas. In Kangas et al. (2008), the stakeholders ended up in defining very large favorite spots, which makes using this information in planning rather difficult.

The use of map-based surveys can also be rather expensive, and the data requires manual digitizing of the marked areas to enable spatial analysis. These surveys can only cover a small portion of the stakeholders, and stakeholders coming from far-away areas can be especially difficult to reach with postal surveys (Brown and Weber 2011). Through improvements in computing, the collection of spatial information has allowed for the movement from paper-based methods to internet-based methods (Pocewicz et al. 2012). These survey methods fall into the realm of participatory GIS, which recommend ways to collect, model, and visualize the local information and opinions with GIS tools. It can also be interpreted as a form of volunteered geographic information (VGI) system (e.g., Goodchild 2007). For instance, in Finland a softGIS application has been developed to collect location specific opinion data (Rantanen and Kahila 2009). In this system, the stakeholders can give either positive or negative feedback on any point of interest for them, and all interested stakeholders can give their opinions. It also allows for analyzing the changes in the values or opinions in time and space. Such methods have been also used for analyzing the perceived quality of urban areas (Kyttä et al. 2011), urban parks (Brown et al. 2014), national parks (Brown and Reed 2009; Brown and Weber 2011), public coastlands (Green 2010; Lowery and Morse 2013), and rural islands (Brown and Weber 2012).

Although it is possible to collect location-specific data for forest planning purposes, some problems still exist. If the system used to collect feedback is composed of only non-structured open-ended questions, the data obtained can be fairly hard to include in a forest planning system, as the opinions need to be classified using methods from a qualitative analysis (e.g., Brown and Reed 2000; Hytönen et al. 2002). That is quite laborious, and the methods are unfamiliar to most forest managers in practice. Therefore, the managers would prefer to obtain numeric information which does not require further classification.

Both classified unstructured or numerical structured opinions need to be further analyzed to make use of them in planning. Brown and Reed (2009) listed 5 domains in which the location-specific landscape values can be analyzed (given that suitable information on the locations is available):

1. the relationships between different values
2. the relationships between values and forest management
3. the modeling of compatibility with existing or prospective forest plans
4. the relationships between values and physical forest conditions and
5. the relations between values and prevailing public uses of land.

However, a way to systematically utilize this opinion data in forest planning is still missing. One attempt published so far was based on classifying the opinion data, and by allowing different treatment options in the zones defined (Nordström et al. 2011). A statistical model describing the relationships between the values of public and the physical conditions, on the other hand, could be directly utilized in optimization calculations.

Another problem relates to the practical use of the participatory GIS application. First, there is a delay between the visit in the forest and the opportunity to give the feedback in the internet, and that may greatly reduce the number of feedback messages actually given and/or affect to the quality of the responses. In psychological research, it is well known that interviews and questionnaires are limited as they represent retrospective responses (Runyan et al. 2013). Thus, in recent years, a new approach has been gaining popularity in psychology, namely the ecological momentum assessment (EMA, Shiffman et al. 2008). The idea behind this concept is that the human behavior is assessed in real time, i.e., the feelings and experiences are assessed while the individual is having the experience. For instance, in a recent study (Jumppanen 2014) it was found out that sounds from the wind in the trees or sounds of the water from the rapids may affect to the opinion on the attractiveness of a given location, and such elements can only be captured with on-site assessments.

Moreover, while it can be fairly easy to identify specific locations for urban areas, in larger forested areas it may be difficult to remember (or know in the first place) the exact location of any point of interest. Thus, the spatially specific feedback given to the internet application may be rather imprecise, even if assisted by an excellent mapping application. In addition, the ability of a person to give location-specific values or information may also depend on how familiar the area is for the person making the valuations (Brown 2012). For achieving real-time opinions that are accurately located, modern mobile phone technology with GPS facilities is highly appropriate. Berry and Bell (2014) used a smartphone application specifically to measure pointing accuracy (i.e., the accuracy of identifying the direction of north), and concluded that it highly depended on visible landmarks.

More and more mobile phone applications for different fields of study have been developed in recent years. Some mobile phone applications are available for collecting local information. For instance, Maisonneuve et al. (2009) developed a mobile phone application for collecting the perceived noise levels in urban areas. Also apps suitable for EMA have been developed. Runyan et al. (2013) developed an app for collecting information of the habits of students. Apps have also been developed for collecting health-related information on participants. For example, Hashemian et al. (2012) collected data concerning the proximity, duration and frequency of human–human interactions, and Gartenberg et al. (2013) about factors related to insomnia. MacKerron and Mourato (2013) developed an app which measured subjective well-being of the respondents through a questionnaire that was sent to the respondents at random times. When the results of the questionnaire were combined with the GPS location and land cover, it was possible to conclude that people are happier outdoors than indoors. However, in their study, 85 % of the responses were obtained from people indoors.

All the apps mentioned above, have been used to collect data for research purposes in specific campaigns. Apps where people could themselves choose, if and about what they wish to give feedback, are less common. Woodcock et al. (2012) collected the opinions of the students concerning the university campus area. The methods tested included e-mails and text messages for unstructured feedback and online form, an iPhone application, and 3 purposely designed electronic kiosks for structured forms. Their experiment run for 12 weeks, and it was promoted beforehand with flyers and adverts.

Our aim in this study was to develop a participatory GIS method for a mobile phone. The developed application is designed for participatory forest planning. The application allows for preference information to be elicited through two methods, the first was through an open (unstructured) feedback form which included geographic coordinates (if enabled by the participant). The second feedback was obtained through engagement of the participants in a game, whereby more specific (structured) preference information can be obtained. The application allows for feedback to be given right when the need arises, and it allows for the smartphone GPS mechanism to take care of the location of the spot. This spatially located, direct preference information will improve the usability of participatory GIS tools for forest planning.

The Mobile Participatory GIS Application Tienoo

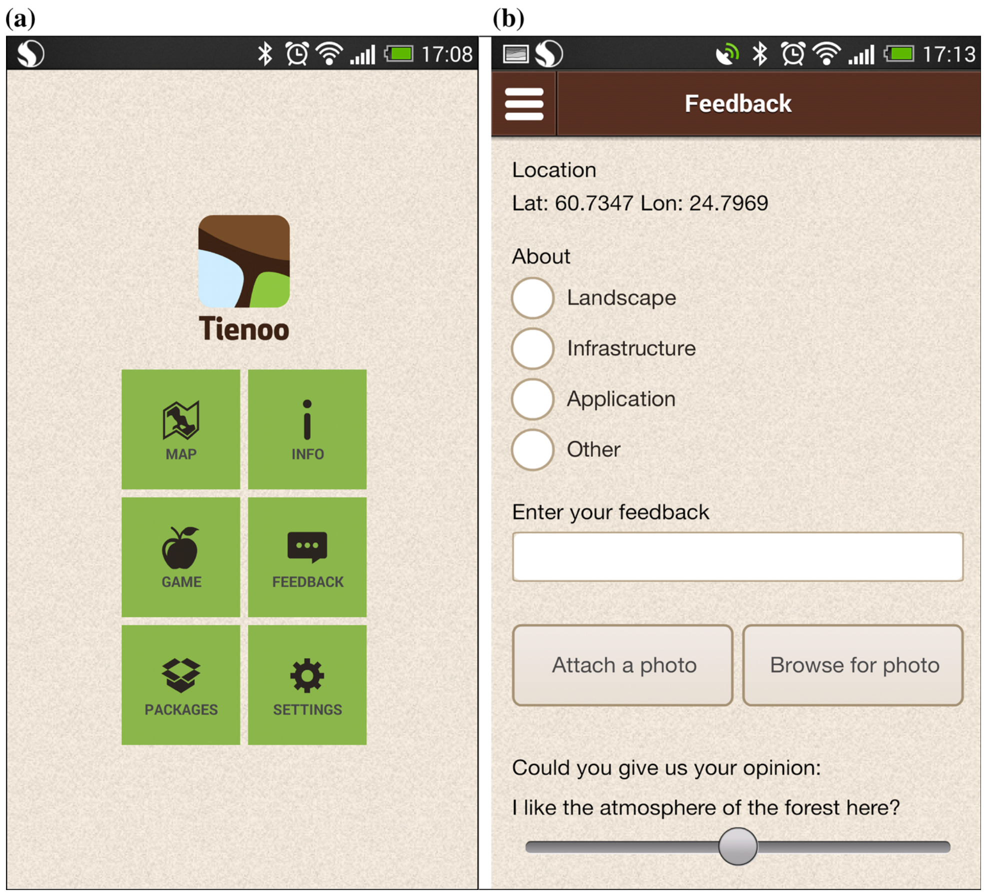
In this study, we created a mobile phone application called Tienoo (surroundings in Finnish). Tienoo was built with three main components (Fig. 1 a):

- An information package which includes useful directions as well as information about trails, ecology, history, and forest management of the area.
- A direct feedback function allowing participants to give their opinion on anything anywhere in the area.
- A geocaching type of game that prompts participants to answer questions at specific points throughout the area.

The information package is meant to provide the visitors with useful information that would enhance their visit and inform them of all the amenities in the area. The package included information regarding the ecology of the forests, the history of the area, forest management as well as more practical information on the amenities of the area, such as trails, local businesses, and accommodation. These features were added to allow for clearly marketable functionality, to promote the use of the application while in the area, and in this way promote the user to provide feedback and opinions. The application was built in four different languages; Finnish, Swedish, English, and Russian. This was done to increase accessibility to as many visitors to the area as possible and it reflects the growing number of visitors from across the nearby Russian border.

The direct feedback function (Fig. 1b) was included in order to gain as wide a spread of opinions as possible throughout the whole area. This page was designed so that participants can stop at any spot in the forest and provide direct feedback to the forest managers about anything that is of interest to them. Each message is given a time-stamp and coordinates, utilizing the GPS properties of the smartphones. In order to gain some consistency, before they are able to submit their feedback, they are prompted to answer an overall question that is also asked at each of the 16 points used in the geocaching game. This function recognizes the fact that not all participants will necessarily be interested in all of the forest management objectives and are therefore able to express opinions outside the experimental design of the geocaching game. It also provides useful functionality to the forest managers as they can use the application in much the same way that they would use a GPS and can therefore map problem areas and maintenance issues such as broken bridges and boardwalks. This function is also designed so that any feedback given can be

Fig. 1 The main menu of the App (a) and the direct feedback page (b). The feedback is collected in four categories: landscape, infrastructure, application itself, and other



directed to the appropriate management unit—planning, harvesting, recreation, etc.

The geocaching game comprises the main part of the experimental design. It consists of 16 points throughout the forest (Fig. 2a). These 16 points cover recreation areas, landscape areas, traditional forest management areas, and the continuous cover forestry (CCF) trials being carried out in Ruunaa. Each point was marked using banners labeled with letter and number codes (Fig. 2b). When the participant arrives at one of these banners they input the code from the banner, and then are prompted to answer three questions relating to the area before moving on to the next point (Fig. 2c).

The questions were asked in the form of statements and participants were prompted to give a score on a 5 point sliding scale from ‘I strongly disagree’ to ‘I strongly agree’. The first question asked at each of the game points was purposefully generic: I like the atmosphere here. After this, each point had a statement specific to the function of the area [i.e., silviculture (questions 2–6), clear felling (12–13), and recreation (14–19)] and this was followed by a randomly generated statement about values people attribute to forest settings: Beauty, Peace and Quiet, Nature and Activeness. The number of different questions was 29 (Table 1). The questions 12 and 13 were related to clearfelling as the points where these questions were asked were in the vicinity of clearfelling areas. The purpose of this was to see if we could find any correlation between what people were experiencing and what they were expecting of the area. In addition, each participant was asked a couple of background questions to facilitate analyzing the data (Fig. 2d).

The system is developed for Android and iOS phones. It is fully functional without being online, e.g., in heavy forest cover conditions or completely outside the coverage of 3G signal. This is achieved by having the full information content for the area packaged as a single data package that is installed on the phone from within the application itself. The data package includes both the textual and image information content, and the map data for the area. In offline use, the game answers and direct feedback from the user sent to the server counterpart of the App when online connection is next established. The server component is responsible for hosting the area data packages, as well as permanent storage of the feedback and game answers. The server can also be configured to forward the feedback by email to persons responsible for the management of the area.

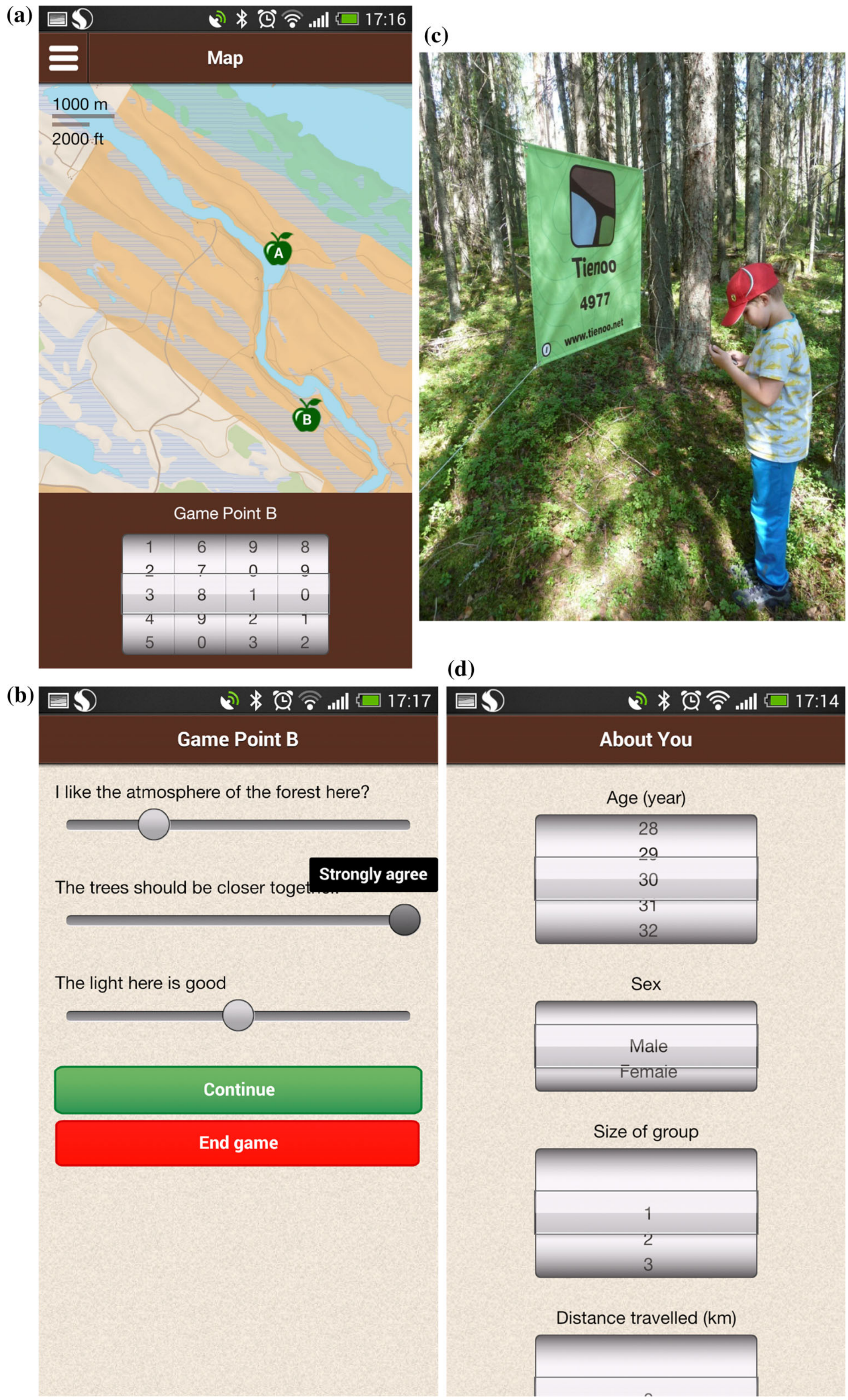


Fig. 2 The map view of the game points and the answer field for the game point number (**a**), the banner with the game point number (**b**), the feedback page for game points (**c**), and the background information page (**d**)

Table 1 The set of questions used in Ruunaa test area

Q1: I like the atmosphere of the forest here
Q2: There should be more trees here
Q3: There should be bigger trees here
Q4: It should be more open here
Q5: The trees should be closer together
Q6: There should be more tree species here
Q12: This view is attractive to me
Q13: This area is of value to flora and fauna
Q14: This site is maintained well
Q15: The view is good here
Q16: The trail which I took here was in good condition
Q17: This site is clean
Q18: This is a good location for a rest
Q19: I like the view here
Q20: This is an attractive area
Q21: This area pleases me
Q22: The light here is good
Q23: It is peaceful here
Q24: I feel relaxed
Q25: The sounds are pleasant here
Q26: This area feels like a true wilderness
Q27: This area feels natural to me
Q28: I feel close to nature/wildlife
Q29: There exist valuable flora and fauna in this area
Q30: This area is managed for wildlife
Q31: I feel invigorated here
Q32: The trails are of good quality round here
Q33: There are enough activities to do here
Q34: I feel healthy here

The system allows the respondents full confidentiality so that the names or the phone numbers of the participants are not stored to the database. However, the respondents could ask for the managers to contact them, and to allow this the possibility to provide an email address was built to the system.

Illustration of the App Capabilities

The application was tested at Ruunaa National Hiking Area in North Karelia, Eastern Finland, governed by state forest enterprise Metsähallitus. This area was chosen due to its relatively high visitor numbers, variety of landscapes as well as the trial areas for continuous cover forestry—a management technique which is being brought forward in the recently accepted Forest Act. The trial areas are unique in Finland, as the CCF has been prohibited by law until very recently.

The application was tested in one specific launch event in the area in August 2013. The launch event involved a group of local secondary school students as well as a couple of adults such as teachers of the students. In the event the respondents were told about the App, and then they could take part in the game or give direct feedback (but taking part was not obligatory). The App was also promoted using flyers and banners, and by advertising the App in local happenings, so that anyone visiting the area could take part if they wanted.

The purpose of the test was mainly to get some feedback on the App, and to generally test its functionalities. We also wanted to illustrate its capabilities for researchers who could use this sort of data collection method in their future research campaigns. Following the launch, the App has been online use ever since, and data is still being collected.

At the end of November 2013, there had been 65 game sessions, with 177 game answers. This data will be used to help in planning the forest management in the area. In addition, there were a small amount of free feedback answers concerning the quality of the App (13). These were related either to the quality of the map in the App (the scale, the information content, etc.), or were questions concerning the possibility to have similar services in other areas.

As the App has a time-stamp on the answers, it is possible to produce a timeline on when people have been playing the geocaching game. There is a peak in the number of game sessions during the launch event at 21.8, but people have been using the game also after the launch event (Fig. 3). This information could be used to analyze how the time of year or even daily weather is affecting the opinions of the visitors. In the figure, the male (black) and female (gray) visitors have been separated, to illustrate how the background information provided can be utilized. The time-stamp is very accurate, so it would also be possible to analyze the time of day people are visiting the area.

The game points were located over the whole Ruunaa area (Fig. 4a,b). The direct feedback opinions were also geolocated (Fig. 4c). Thus, it is possible to locate areas where people have positive or negative opinions, and to see if some places have a large concentration of opinions or where people do not give any feedback at all. For instance in Ruunaa, the direct feedback was concentrated within a rather small area, except for two cases where the feedback was given from points well outside the actual Ruunaa area. When related to total number of visitors, this can provide valuable information as to what places are popular and what places are unpopular. It may also help in analyzing if the complaints people might have actually concern the state forests or not.

As mostly the questions were randomly selected, some questions have been asked more often than others, and one

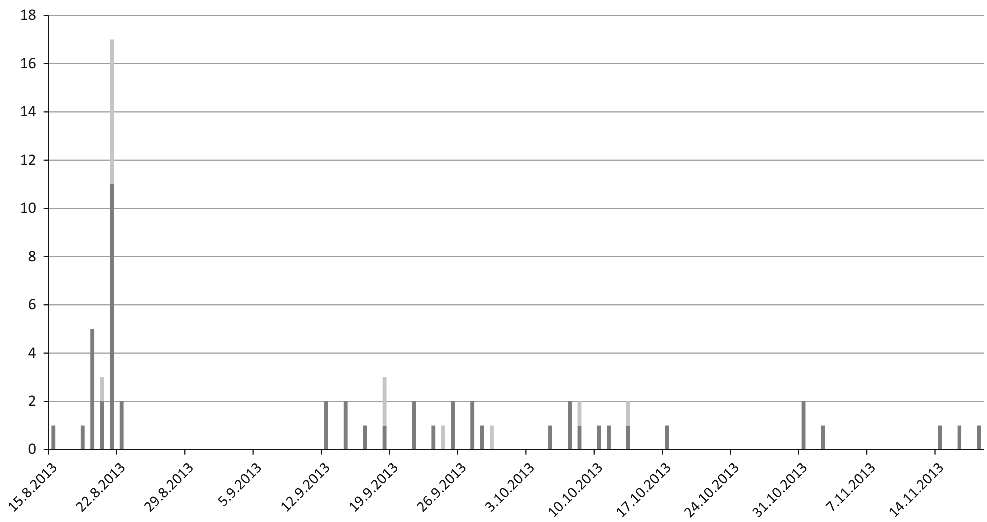


Fig. 3 The frequency of answers as a function of time. Males denoted with *black* color and females with *gray* color

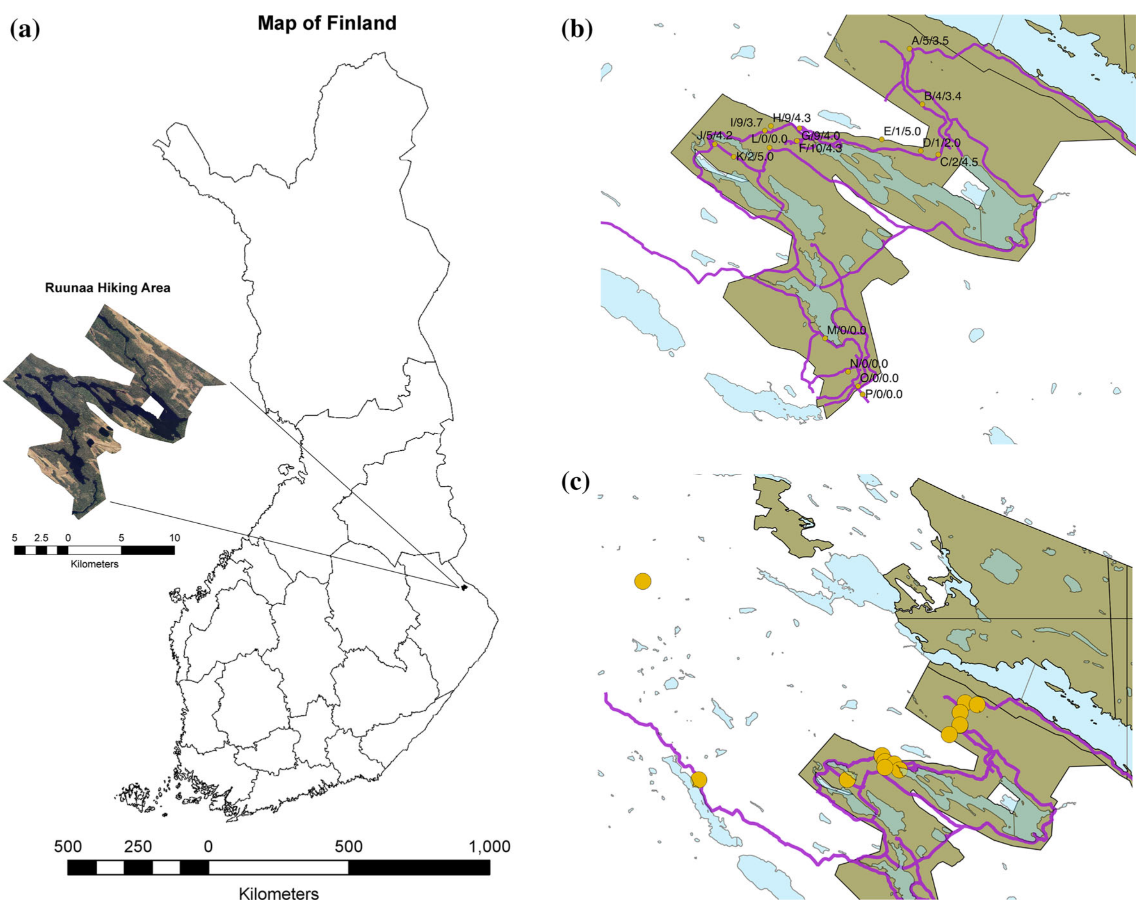


Fig. 4 The Ruunaa area (**a**), the game points (*A–P*), the number of answers and the mean score for each of them (**b**), and the places where direct feedback was given (**c**)

of the questions has not been answered at all (Fig. 5a). Since the number of game sessions is not very high, the variations between different questions are quite high, making statistical inferences challenging. When data accumulates, the proportions of answers should be more even. To illustrate the quality of data collected, the mean answers to the 29 questions are shown in Fig. 5b. These answers are the means across the game points, where the

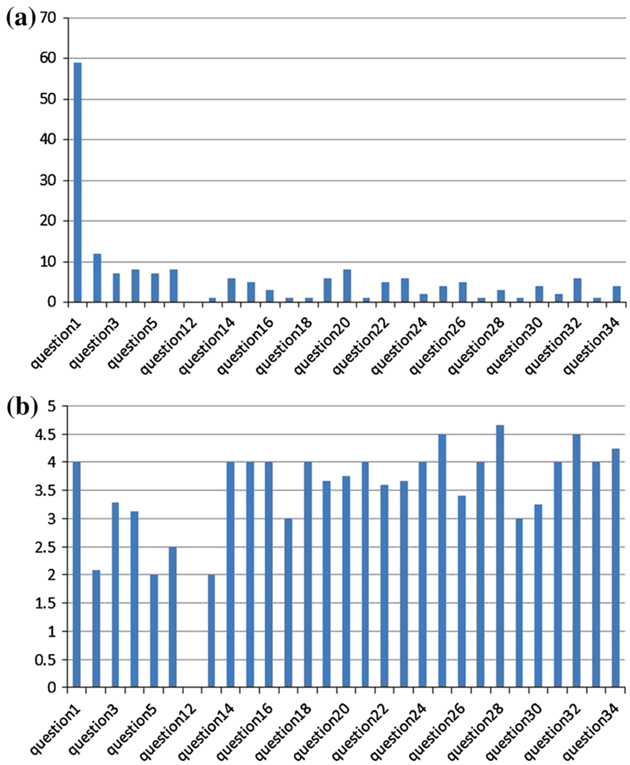


Fig. 5 The number of responses per question (**a**) and the mean answers for each question (**b**)

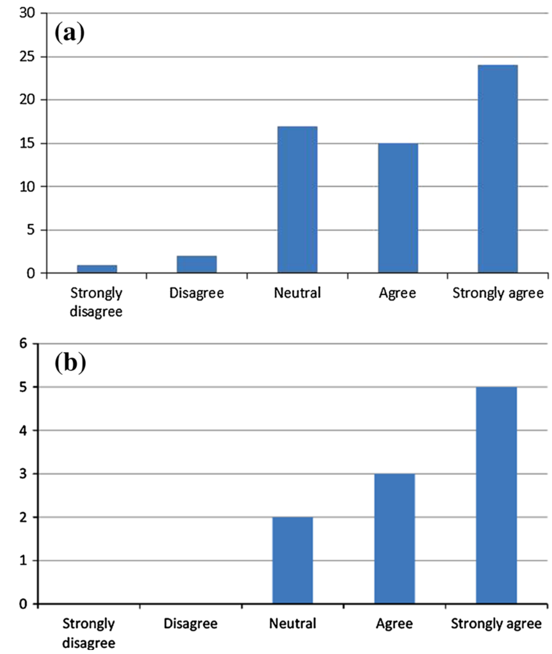


Fig. 6 The overall distributions of the responses for all questions (**a**) and the distribution for the overarching question concerning the atmosphere (**b**)

questions were asked. The lowest mean scores were obtained for questions 2 (There should be more trees here), 5 (The trees should be closer together), and 13 (This area is of value to flora and fauna). The first two are in agreement with most studies concerning scenic beauty in Finland, the people like stands that are not too dense and that have a lot of light (e.g., Karjalainen 2010). The third poor score probably has to do with the fact that the question was asked in the vicinity of a clearfelling area. The highest scores, on the other hand, were given to questions 25 (The sounds are pleasant here), 28 (I feel close to nature/wildlife here), and 32 (The trails are of good quality round here). Especially the answer to the first question indicates that the forest experience depends on many other aspects than forest management. Also the last question 34 (I feel healthy here) got a quite high score. The health effects of forests have also been found in measured indicators of health (e.g., Tyrväinen et al. 2014).

The distribution of answers to the overarching questions describes the quality of the whole area (Fig. 6a). Overall, this question got quite positive responses. Of course popular game spots have a larger number of answers than less popular ones. The least popular ones had 0 game sessions, and the most popular ones 10 sessions. This most popular point F, on the other hand, received only neutral or positive responses to this overarching question (Fig. 6b). In this case only three points, B, D, and I got negative responses at all. Thus, the App helps in locating conflict issues and locations that collect conflicting opinions.

The answers can be analyzed point by point. The average response for the overarching questions for each of the points is shown in the map (Fig. 4a) and Fig. 7. Such graph

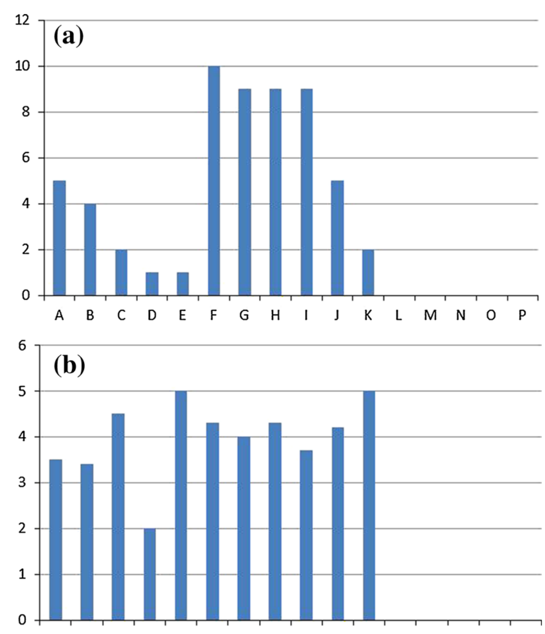


Fig. 7 The number of responses (**a**) and the mean of answers at each game point location (**b**)

was not possible for all the questions, as there are not yet enough answers to calculate point-wise means for all of them.

Discussion

In this study, we presented a new mobile tool for participatory forest planning. The developed tool can be used for collecting information on forest preferences in any area of interest for the forest managers. It can be tailored for different purposes, for instance asking different kinds of questions in urban forests than in more rural areas. It could also be tailored for collecting local information, for instance concerning physical activities in the area (Brown et al. 2014), locations of specific type of vegetation (Brown 2012) or anything else of interest to forest managers or researchers according to each specific area under planning. The set of questions could be formulated to serve a specific research interest, for instance for analyzing health effects of visiting forests like the subjective well-being in different types of forests (MacKerron and Mourato 2013). Tailoring the App requires the map, an information package of the area of interest, setting up the game points (if information from specific points are targeted), and the list of questions to be asked.

In our setting, some of the questions were randomly selected at each given point, while MacKerron and Mourato (2013) used fixed set of questions asked at randomly selected times and as a result, also randomly selected locations. If the area of interest is specific, like Ruunaa in this paper, the use of randomly selected times would require knowledge of people arriving and leaving the area. That in turn, would require a campaign where people would be asked to come to Ruunaa for the specific purpose of participating in research. Our system produces information from a fewer number of points, but there is no need to know when the respondents arrive or leave. On the other hand, the number of pre-defined points can be much higher than in this study, if more variation in the physical conditions is needed.

The mobile phone application will enable us to analyze the number of visitors in the area at different times of year, and also analyze the effect of time of year, weekday, and time of the day or even local weather to the opinions of the participants. Since the App includes a question regarding the size of the group, it is possible to analyze if having company has an effect on the values. Likewise, it is possible to analyze the effect of physical forest characteristics, if they are available from a forest database. When the App has been running for a longer time, it might be possible to analyze the direct effects of forest management at given points by collecting game point opinions before and after the treatment. It will also enable analyzing if the popularity of an area after a treatment diminishes in time. For instance it might be that a harvest will reduce the popularity and/or the proportion of positive answers in a given spot while the harvest residues and other marks of the treatment are visible, but regain its popularity in time.

Such analyzes can of course also be carried out with a more traditional PPGIS approach. For instance, Brown and Raymond (2014) analyzed the conflict potential, Brown and Weber (2012) measured the change in place values, and Brown and Brabyn (2012) the relationships between the values and physical landscape using a participatory GIS approach. One benefit of using a mobile phone application instead of an Internet-based approach would be the increased accuracy of spatial locations due to the mobile phone GPS function. Another important benefit is the possibility to measure real-time experiences (like in EMA), while in Internet-based approach the experiences are reflected in retrospect (see also Reades et al. 2007). However, the most beneficial approach would be to combine mobile phone-based approach and internet-based approach.

Compared to the internet-based systems, Tienoo App has the added potential benefit of encouraging people to visit given spots the managers specifically need to gain information on, through the geocaching game approach. The game may also make it feasible to obtain information from kids and teenagers, who may not be interested in giving feedback on forest management spontaneously. In the study of Woodcock et al. (2012), the tested App mostly collected irrelevant responses (from people around the world not related to the study area), and relevant answers were very few. They conclude that participating in the development of campus area would have required the students to notice the study, be willing to participate, be sufficiently energized by the surroundings to answer, and actually enter their comments. This may be too demanding to expect a large number of participants.

We also collected very little open-ended feedback; although most of it was relevant (only two comments were outside of the area). It thus seems that getting answers at all requires other sorts of engagement, like a game. The test group in Ruunaa consisted of teenagers of around 15 years old, and they seemed happy to join the game and provide feedback through the questions asked; however, only a few of them gave additional open-ended unstructured feedback. In addition to just finding the game points, the participants could also be given other tasks to further engage them. For instance, Metsähallitus is engaging people in another hiking area, Evo, by asking them to visualize famous pieces of arts in the scenery using their mobile phone camera (http://www.matasmetas.fi/en/whats-forest-for-us/). Such a game could be added to Tienoo as well.

In order to get people use a system like this, the usability of an app needs to be carefully considered (e.g., Harrison et al. 2013). In our case, the feedback concerning the App mostly dealt with the map quality, but also some other usability issues like the speed of loading the map and general functioning of the app. Based on the feedback we got from Ruunaa test, we will develop the App further. Moreover, the technique used needs to be familiar to the respondents (MacKerron and Mourota 2013), in order to get people to use it. From that point of view, smartphone apps will be clearly more useful in future, as they have gained huge popularity in recent years.

The spatially and temporally located opinion information has a large potential for practical use in forest management planning. At its simplest form, the aggregated opinion data can be viewed as a confirmation of how the management actions are viewed by the visitors of the region. At a more complicated form, the data can provide tools to model the potential impact of future management actions in a forest, and provide information about the most frequently visited locations of the forest. Thus, forest management actions can be scheduled to enable efficient compromises between competing objectives. In Ruunaa there are competing interests between the economic interests of the state forest enterprise Metsähallitus, the economic interests of the local tourism companies, the social interests of the visitors, and general ecological interests. Through the quantification of the spatially specific information, it is possible generate efficient solutions which balance the competing objectives.

In previous applications which integrated spatially specific opinion data relied on a qualitative description of regions of importance (Nordström et al. 2011). This relied on rules which restricted the kinds of forest management operations which could be taken in the different areas of the forest. The rules, on the other hand were based on the researchers' expert opinion on what the people like in the specified areas, for instance how they value the forest characteristics in these areas. This creates a strict constraint on the development of the forest management plan and potential solutions which deviate even slightly from the strict constraint will never be considered. It also assumes the opinions (and therefore the constraints) static in time.

By using quantitative opinion data, such strict constraints need not be used, and potential forest management solutions which only have only a minor negative impact can be produced. A recent example highlights the use of quantitative spatially specific opinion data in forest management planning (Eyvindson and Kangas 2014). The example utilizes Compromise Programming (Yu 1973) to develop efficient solutions which maximizes both the positive spatially specific opinions and economic benefit. Such an approach requires that the location-specific opinions can be modeled, and the contribution of forest management, forest characteristics and the location in itself can be separated. The data collected will enable that kind of modeling in time, when enough data accumulates. If there is need to separate also the effect of uses of the forest area (Brown and Reed 2009), additional background questions related to the use of forests would enable that.

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