

Evaluation of cultural ecosystem services using GIS



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Master thesis, 30 credits, in Geographical Information Sciences

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Abstract

This master project has been carried out in collaboration with a research project named “Valuation of cultural ecosystem services based on contributions to quality of life” at Lund University. In this thesis, Cultural Ecosystem Services (CES) are evaluated from people’s own perceptions. The very aim of the study is to develop a method to assess CES non-monetarily by using a bottom-up perspective. People’s direct emotional response and CES are connected to locations and land cover classes.

Gullåkra mosse, located close to Staffanstorp, was used as study site. A smart phone application was developed for collecting data. It registers answers from participants, GPS coordinates and participants direction of view. All data was analysed statistically and spatially. 18 people participated in the study and each participant was asked to choose three locations which were special and positive according to their own perceptions.

Four types of questions were asked regarding physical elements, environmental qualities, activities and emotional response. The questions capture CES and the affective well-being of the participants.

The location and view direction of each participant were obtained from the registered answers. The CES and its qualities were connected to specific land cover classes. Qualities of CES most closely related to affective well-being were established by selecting the area with the highest perceived affective well-being. A CES index, which makes it possible to rank CES, was developed.

The conclusion is that CES can be evaluated by considering people’s own perceptions. It suggests that it should be possible, with more research, to rank ecosystems in terms of CES on the basis of land cover classes.

Sammanfattning - populärvetenskaplig

Inom ramen för ett masterarbete har en metod utvecklats som kopplar människors upplevelser av natur med den fysiska miljön i form av marktäckning. Deltagarna fick välja tre platser inom ett rekreationsområde som de tyckte var speciella. Med hjälp av en applikation i mobiltelefonen svarade de på frågor om vilka fysiska element som var viktiga, hur de uppfattade miljön, vilka aktiviteter som platsen lämpade sig för och hur de kände sig på platsen. Svaren analyserades tillsammans med klassificeringar av marktäckningen inom området som utgick från flygfoton och observationer på plats. Studien visar att det är möjligt att särskilja och värdera platser utifrån upplevelse i kombination med den fysiska miljön med hjälp av GIS i ett specifikt och småskaligt område. Projektet är utfört inom ramen för Kulturella ekosystemtjänster och livskvalitet, ett forskningsprojekt finansierat av Naturvårdsverket.

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Abbreviations

CES = Cultural Ecosystem Services

EQ = Environmental Qualities

ER = Emotional Response

ES = Ecosystem Services

GIS = Geographical Information Systems

HWB = Human Well-Being

PE = Physical elements

QoL = Quality of Life

1.0 Introduction

There is a large awareness of the importance of preserving, restoring and managing ecosystems (Ninan, 2009). Ecosystems include different processes that are directly or indirectly important for humans, called ecosystem services (ES). The ES are defined by MEA (Millennium Ecosystem Assessment) and TEEB (The Economics of Ecosystems and Biodiversity) as those processes which contribute to human well-being. According to MEA, ecosystem services can be divided into four groups, called; cultural services (e.g. aesthetic value), supporting services (e.g. soil formation and nutrient recycling), provisioning services (e.g. food and water) and regulating services (e.g. climate regulating and water quality). The four groups defined by MEA are accepted terms and are widely used within literature. In 2005 MEA estimated that 60% of the total ES measured was declining. This can lead to dire consequences for humans (Ninan, 2009).

The Swedish government has suggested that all people in Sweden should know what ES are before 2018 (Miljödepartementet, 2013). ES are additionally included as a part of conservation policies in the European Union and as a part to address natural resource management. This has led to a growing interest in how to assess and evaluate ES both from decision makers and private companies (Maes et al., 2012).

Provisioning services are, in many senses, tangible and can numerically be measured. Regulating and supporting services are indirect services. However, research has been done in order to quantify and evaluate those services. Cultural ecosystem services (CES) are not tangible and often considered a subjective and difficult kind of service to quantify and measure (Daniel et al., 2012). CES is defined by MEA as “nonmaterial benefits people obtain from ecosystems” such as, spiritual enrichment, cognitive development, reflection, recreation and aesthetic experience.

Even with the great complexity of CES, it is important that they are being evaluated in order to understand their direct effect on humans. CES has often been “left out” when ES are researched (Satz et al., 2013). The CES are important in people’s everyday lives, which can be seen in studies where man – nature relationships are investigated (Andersson et al., 2015).

There is an ongoing research project at Lund University, Department of Architecture and Built Environment, which aims, based on people's experiences, to describe CES, and to demonstrate how they can be measured in terms of contribution to quality of life (QoL). The name of the research project is “Valuation of cultural ecosystem services based on

contributions to quality of life”. This master project was carried out in collaboration with the research project and supplemented it by using GIS and a developed smart phone app as a tool to evaluate CES based on peoples own perceptions.

1.1 Problem statement

In Sweden and many other countries, urban areas and agricultural areas are expanding, giving less space for “green areas” and “natural ecosystems”. There is therefore a need to assess how ES, and especially CES, affect human well-being (Daniel et al., 2012; Villamagna et al., 2014). The ES approach needs to be incorporated in resource management decisions and in the private and public sector.

Furthermore, there is a knowledge gap in scientific evidence on CES effects on humans, and how methods explicitly have been and can be applied to gather scientific data related to CES (Seppelt et al., 2011). It is therefore essential that tools and methods are being established which can produce scientific data. This is especially true, if policies are to be developed which consider the ES approach in nature management (Cowling et al., 2008).

CES needs to be further developed in terms of methods of assessment for both science and policy decisions. There is today a significant gap in modelling and mapping CES (Nahuelhual et al., 2014). Previous mappings of CES have mostly taken the material benefits (such as economical values of landscapes and fishing) into account and there is therefore a need to include peoples own experiences and perceptions. For this reason, analysing CES needs to be done from a bottom-up perspective instead of a top-down perspective.

1.2 Aim, objective and research question

Evaluation of ecosystems is complicated and it is not easy to decide on evaluation variables. It is however being addressed in today’s world where humans increasingly alter ecosystems. In terms of decision processes, a monetary value is often used or desired. Whether this is a good evaluation variable is debatable (Szücs et al., 2015).

This thesis attempts to evaluate CES, using a bottom-up perspective and Quality of life (QoL) as evaluation variable. This is done by using people’s own perceptions as value of ecosystems instead of a monetary value. It also attempts to shift focus from decision makers or researchers which decide on what is important, to instead the importance of natural environments for each individual.

The aim is thus to develop a method to evaluate CES from people's own perceptions in a specific ecosystem, in this case a wetland, using a smart phone app where locations and direction of view is connected to a set of relevant CES and QoL indicators.

In order to achieve this, the following objective has been formed; to connect CES to specific locations and different land cover classes. The CES will be broken down to meaningful questions which can be answered by participants. CES and land cover types will be evaluated using direct emotional response of participants.

Three research questions have been developed.

Research questions:

RQ 1: Which qualities does a "high valued" CES location contain?

RQ 2: Which CES do participants value highly?

RQ 3: Can an ecosystem be ranked/valued according to CES?

2.0 Background

This section will contain three parts. The first part provides an overview of CES, the second part describes QoL, and the last part will try to explain the role of GIS in the context of this thesis. All the sections will only briefly describe the topic. They are specifically aimed to give an overview of the areas that are being researched and they will focus on the exact use of these areas in this master project.

2.1 Cultural ecosystem services

As described in the very beginning of this thesis, ecosystems give rise to ES which are divided into four groups. CES is one of these groups. To understand CES there is a need to more precisely define what ES are. This can be done by an illustration that gives an overview of ecosystem services. The illustration can be seen in Figure 1.

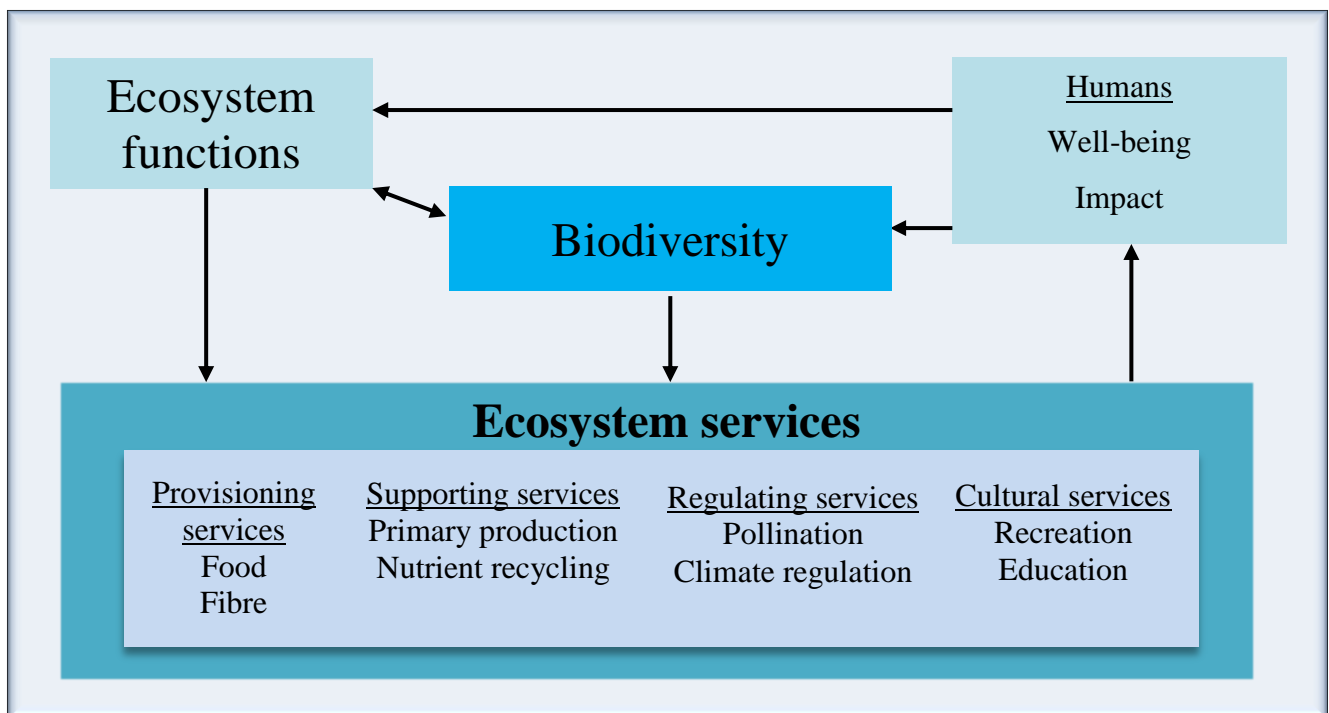


Figure 1 illustration of ecosystem services, modified from MEA, 2005b

The ecosystem which is under study in this project is a wetland. It is the ecosystems functions which yield different ES. The biodiversity is “regulated” and regulates the ecosystem and hence the ES. Supporting ecosystem services (such as photosynthesis and nutrient recycling) and regulating ecosystem services (such as carbon sequestration) are indirect services. It is indirect in the sense that it indirectly affects humans. Humans have an impact on the environment and therefore the ecosystem and biodiversity. The impact arises from exercises

such as agriculture, forestry and many others. Provisioning ecosystem services influence humans directly by providing food and fuel. This thesis concentrates on the Cultural ecosystem services (CES) which directly affect humans.

It is a direct service in the sense that people have positive experiences when visiting nature. Other examples are where natural elements can be directly linked to stress recovery or mental health (Völker & Kistemann, 2013). However, in cases such as in the latter example, it has not been classified as an ES, terminology-wise. There might, therefore, be a gap between studies that connect peoples experience to nature and CES. This problem does also arise due to CES being a relatively new term (2005). Furthermore, the definition set by MEA for CES is vague and abstract. However, there are recent studies that have tried to create a concrete definition of CES (Daniel et al., 2012).

CES will not be any further described in this document. However, because the definition of CES is not well defined, debatable and generally complicated, there is a need for this thesis to explicitly define CES. The definition set by MEA does not provide a good benchmark from where CES actually can be valued. The reason is that the definition does not separate service from value (Chan et al., 2012; Satz et al., 2013). A service gives benefits (which can be a physical element or an activity) which in term are of value to humans (Chan et al., 2012) The explicit definition in this work is taken from Chan et al., 2012: “*ecosystems' contributions to the non-material benefits (e.g., capabilities and experiences) that arise from human–ecosystem relationships*”. Using this definition, it is possible to evaluate CES non-monetarily. This means that it is now possible to move on to the next section which explains the variable of evaluation.

2.2 Quality of life

ES is, as described above, the contribution from nature to human well-being (HWB). Numerous studies in socio-ecology, which connects biological and biophysical processes with humans, have shown a positive relationship between HWB and ES (King et al., 2014). HWB is a multidimensional concept which can be measured by a quality of life (QoL) gradient (Villamagna & Giesecke, 2014). QoL is a concept which has risen from the need to measure other factors affecting people than disease and death. The definition set by World Health Organization (WHO) on QoL is individuals' perception of their position in life (Power, 1999).

As understandable HWB is a very complex matter, as it is also interdisciplinary, covering many fields of research. Thinking about HWB will give rise to many questions such as, what is it? Is it money, is it happiness or is it something else? If choosing money as answer, it would be, not easy, but possible to put a value on it. Choosing happiness as an answer would make it harder to measure. Perhaps, getting closer to the truth, would be to consider happiness, money and any other variables as affecting HWB and measuring and valuing this is of certainty high complexity. However, there are many attempts to measure HWB and there are different indices used, such as the Economist Intelligence Unit's Quality of Life Index (King et al., 2014).

There exists a need to incorporate the HWB and QoL perspective into the ES approach to a greater extent than has been managed thusfar (Villamagna & Giesecke, 2014). Using HWB indices would provide an evaluation tool for putting an actual value on ecosystems. In this thesis, only one part of HWB is studied. The study will consider the bottom-up perspective, meaning that it uses the direct response of participants. The variable that will be measured as a QoL indicator is the affective well-being, which is an indicator of the psychological well-being (Daniels et al., 2014), hence, a part of HWB.

Using the CES definition where it is separated into benefits and values, a hint of what can be measured is given. In order to be able to retrieve measurable variables from humans' experience with nature, a psychological model is used (Figure 2), based on Küller, 1991.

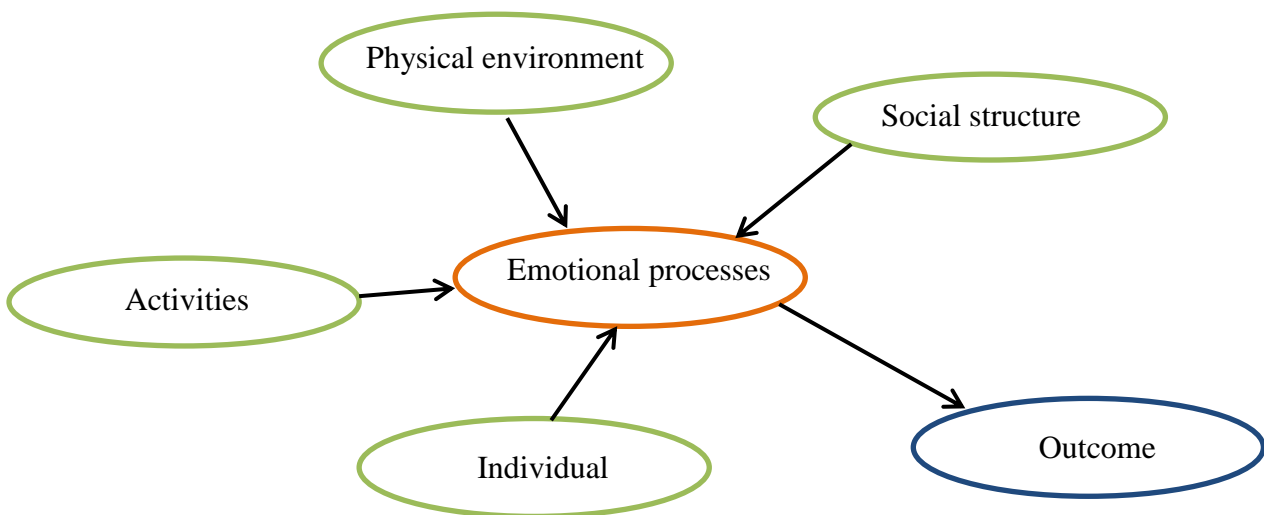


Figure 2 Psychological model of humans' emotional processes, based on Küller, 1991

The physical environment, together with activity, social structure and the individuals' resources, are inputs that affect the emotional resources that are expressed as an outcome.

In this project the input in forms of activity, physical environment and social structure are thought of as the benefits while the outcome is the value. Using this structure, it should be possible to evaluate CES.

The outcome, in this case the affective well-being, will be measured as the positive emotional feeling described by the circumplex model of affect. In the circumplex model of affect, human emotions are represented in eight different states (Knez & Hygge, 2001). The model is in the form of a circle, creating four direct counterparts. The counterparts and states are; passive to active, calm to nervous, elated to bored, and glad to gloomy.

2.3 Why GIS

The nature of human well-being and what makes people happy are perhaps some of humankind most fundamental questions. Linkages to our natural environment are often forgotten. However numerous studies show that contact with nature and increased well-being are related (Daniel et al., 2012). CES may be one of the most important services due to the fact that, regardless of what level of technology the human race can develop, the importance of humans being close to nature is hard to attain or replicate without actually being in nature. For example, regulating services can be achieved by technological inventions but not the emotional feeling of human interaction with nature.

Geographic information systems (GIS) are used to capture, store, manage and analyse spatial data. GIS is a tool that is being used more and more in many research areas, and some of the functionality of GIS should be able to expand analyses regarding ES and CES. ES have a spatial and temporal component and it can change over time. It is also scale dependant. Naturally, GIS is used to measure and analyse spatial data and it is a common tool to use in natural resource management. Furthermore, analysing man-environment relationships where cost/benefits analysis or synergies/trade-offs are needed are well developed in GIS applications (Henke & Petropoulos, 2013).

GIS techniques should, therefore, have the opportunity to improve and develop the analysis of CES. By using GIS it is possible to explicitly show the (degree of) importance in (what) type of location. This study also uses GIS at a large scale, compared to other similar studies where ES are investigated at regional or national scale.

3.0 Study site

The study area is Gullåkra mosse, located approximately at latitude 55°39'21" N and longitude 13°12'37" E. The total area covers 36 hectares. It is a peri-urban wetland, closely located to Staffanstorps city. The location has been chosen as an interesting area by the research project which this thesis collaborates. An aerial photograph over Gullåkra mosse can be seen in Figure 3.

The site is a bog. The bog itself works as flood proofing and as waste water treatment. A treatment plant is build next to it and the water from the treatment plant flows out towards the bog. The study site contains highland cattle which graze in large parts of the area. A bicycle "highway" runs through the wetland. Gullåkra mosse has a dog agility obstacle course, a small outdoor gym, a track for running, and it is frequently used by the local community.

The ecosystem type of a wetland has been chosen because it provides numerous ES, such as high biodiversity, pollutant removal, flood protection, water storage and wildlife support. Furthermore, wetland often provides recreation and nature experience. Wetlands are also a part of Sweden's environmental objectives (Thriving wetlands) and are a subject to many decisions making processes at local, regional and national level.

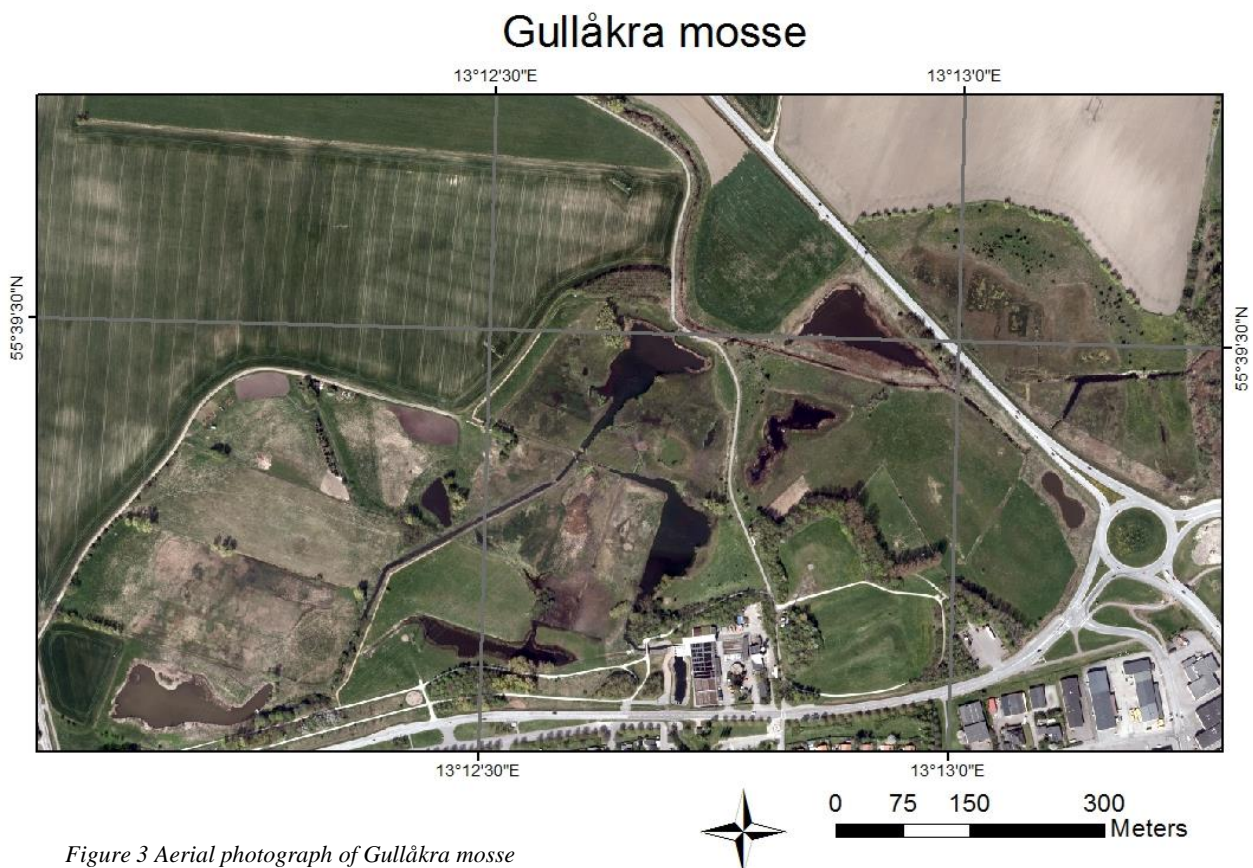


Figure 3 Aerial photograph of Gullåkra mosse

4.0 Method

This part will go through the methods used throughout the thesis. Since, the projects aim is to develop a method to assess CES, this section will be a substantial part of the thesis. What needs to be stated is that not all steps and methods were clear from the beginning. When one part was finished new possibilities of how to best continue arose.

4.1 Workflow

In order to have a structured work plan, the project was divided into 3 phases, each phase leading to an output. The workflow can be seen in Figure 5. Each phase and its individual parts will be explained in the upcoming text.

4.1.1 Phase 1

The first part of Phase 1 consisted of field visits and inspecting aerial photographs. Aerial photographs were downloaded from a downloading service called GET (Geographic Extraction Tool) with maps produced by Lantmäteriet (2015a). One aerial photograph covering the whole study area was downloaded and used as a base map for the whole study. Field visits were done to decide on a correct land cover classification and to decide which land cover classes that participants might be able to separate from each other. The land cover classification is a subjective grouping by the author. After studying the aerial photographs and after field visits, the land cover classes were chosen. The classes can be seen in Table 1 together with a sample picture.

Table 1 Land cover classes used for Gullåka mosse

Land cover
Cropland
Observation tower
Open field
Open grass field
Parking lot
Pasture
Recreation
Reed
Thicket
Treatment plant
Water
Wet meadow



Figure 4 Gullåkra mosse, Hylander 2015

A database was set up to keep track of all materials, to organize the data, and to keep the size of the material as low as possible. To begin with, no vast amount of data existed, and the size and structure of it were therefore of no problem. However, using the database structure is a good practice for preparing for the possibility of future material.

Using the database structure had another advantage as well. Topology rules could be set when digitizing the area into the land cover classes. Using topology meant that spatial relationship between the geographic features could be handled, and thus enhance the quality of the analysis. This is specific features for ArcGIS software geodatabases. The rules were established to ensure that analysis steps in phase 3 would be correct. The rules used were “must not allow gaps” and “must not overlap”. “Must not allow gaps” is used to avoid voids between land cover classes and “must not overlap” was used to ensure that the interior of land cover classes did not overlap. For a more explicit definition of the rules please see ESRI, 2011.

ArcGIS was used for all spatial analysis.

The step by step procedure for phase one together with information about the data is seen below:

1. Downloaded data – data georeferenced in SWEREF 99 TM, Aerial photograph taken: 2014-04-27 with 1m resolution
2. Created Geodatabase
3. Inserted data into database
4. Created rules for database (“must not have gaps” and “must not overlap”)
5. Visited areas, defined land cover classes according to importance for project
6. Classified areal images to vector according to chosen classes

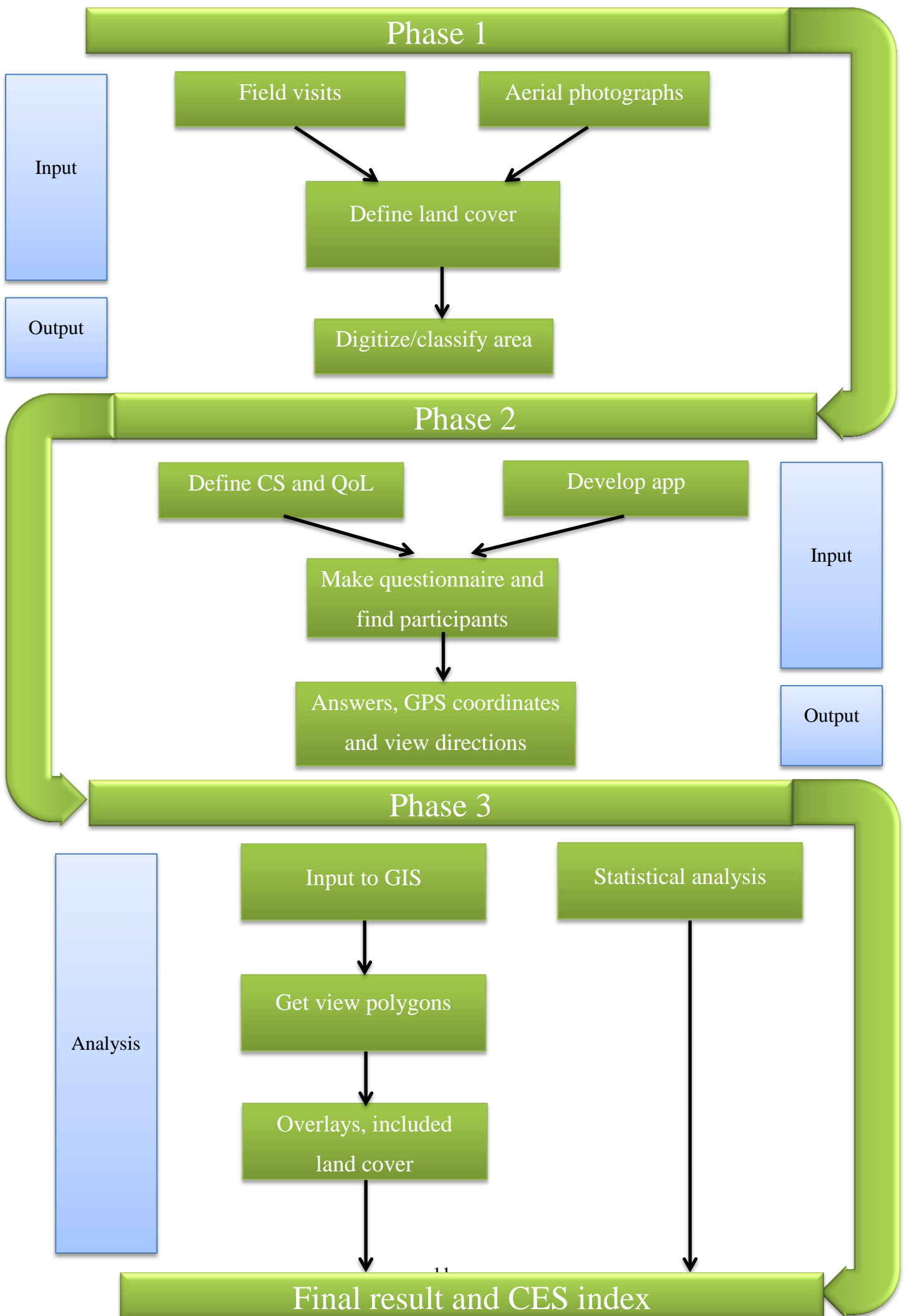


Figure 5 Methodology for the master thesis

4.1.2 Phase 2

Phase 2 involved decisions of how to collect the data and then to collect it. Since the approach is to evaluate CES from a bottom-up perspective, data needs to be in the form of answers from people. The first obstacle to overcome was to determine how opinions about CES could be transformed into questions that participants could answer. CES and its values had to be transformed into meaningful questions. This was done by studying the literature and using materials that already had been tested. By using already tested material the questions should provide meaningful information for this study. The information found in the background chapter about CES and QoL tries to narrow down and explain how CES can be evaluated from a bottom-up perspective.

Simultaneously with, the process of defining the questions, the method of data collecting was designed. To be able to collect spatial data which could answer the research questions successfully, it was decided that necessary material would include; answers from participants to questions, GPS coordinates and the compass direction which the participant faced when answering the questions. All this material can be collected with the help of pen, paper, GPS and a compass. However, today with an ever-developing world with an advancing technology, software applications are used frequently to solve all parts of problems. Therefore, the most efficiently and powerful way of collecting the data is in the form of a smart phone app. All smart phones already have the built in functions which are needed (save input from questions, get GPS coordinates and get compass direction). By using phone applications the possibility to collect a vast amount of data in a short time period arises. Since the idea was to actually develop the application from first principles, a whole section will be dedicated to the development of the app.

4.1.2.1 App development

The application was developed from first principles. Due to the limited amount of time available, and author's knowledge being limited to JAVA and XML, the app was only developed for Android phones. The application was developed in Android Studio. The rest of this section will walk through how the app works. The source code will not be presented, but the most essential functions are shown and explained. A substantial section of this thesis could be spent discussing the development of the app, its functions, and codes. This is something which is outside the scope of this thesis and will therefore be kept to a minimum.

In order for the app to work as an efficient tool for data collection it would have to be able to:

- Ask questions
- Get coordinates
- Get compass directions
- Store the input
- Produce output available to the author

Eight views and activities were developed (for more information about Android development regarding terms such as views and activities, please see Android Developers, (2015a)). The views developed were; “Home view”, “Info view”, four “Question views”, “Compass view” and “Send view”. Three example views from the app can be seen below.

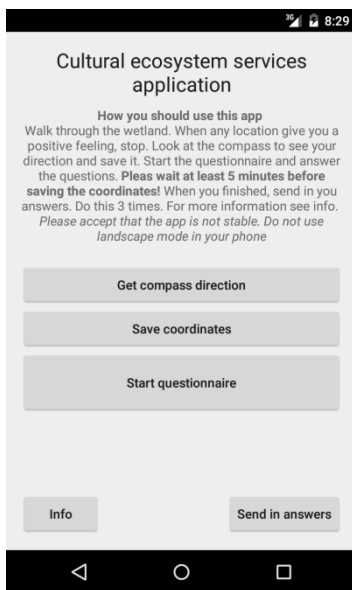


Figure 6 Home view



Figure 7 Compass view

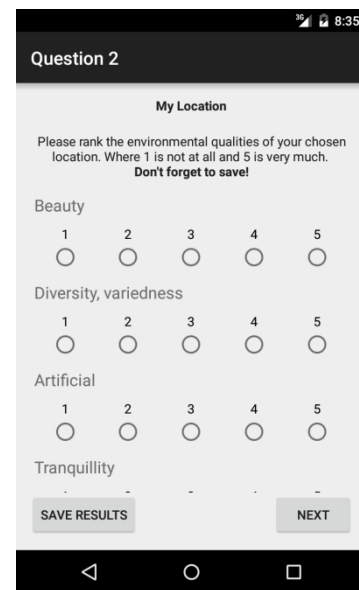


Figure 8 View for question two

The home view includes information about how the survey works. More information about the survey itself can be found below in Section 4.1.2.3 Data collection. The home view contains all the essential buttons to perform the survey, see Figure 6.

In the compass view, a simple picture of a compass is inserted. The activity accesses the phone sensors (which access the in-built functions of orientation in most phones). The compass picture is connected to the sensor activity and hence, rotates as a usual compass would do. Example code can be seen in Appendix 1.

Pressing the save coordinates button in the home view, will save the coordinates for the current location and it will display a pop-up window with the latitude and longitude for the user. The activity accesses the GPS and internet of the phone to get as high accuracy as possible. It uses the Google API to access the Google Play service to be able to use Location

APIs, which is a part of the Google Play service. The Location APIs provides the app with a tool to get the coordinates of the user. This solution is what is recommended for best performance (Android Developers, 2015b). A snippet of the code can be seen in Appendix 1.

Starting the questionnaire takes the user through all four questions. After finishing the fourth question, the user is sent to the home view, where the user needs to press the send button. The exact questions and how they have been designed can be seen in Section 4.1.2.2 Questionnaire.

The send view consists of two questions which the user has to answer, age and gender. The approach of getting the author to retrieve the result was performed by sending all input by email. In the send view, pressing “send in answers” would open the user’s email (by asking which email application, if more than one existed on the phone) with the author’s email address already filled in and all information presented as output in the email. The user only has to press “send in answers” to open their email application on their phone and finally press send on their email application. Example of a final email output can be seen in Appendix 2.

All input was stored internally on the phone by the SharedPreferences method. A snippet of it can be seen in Appendix 1. In the same Appendix an extraction from the XML code, which controls the outlay, is given.

4.1.2.2 Questionnaire development

All questions in the questionnaire are closed questions, meaning that participants cannot provide any other information than what is asked in the question. Having questions which are open would lead to too much information, and a more tedious and harder analysis. The participants were asked to use the questionnaire when any location inside the wetland gave them a special positive feeling.

According to the model in Figure 2, there are inputs (benefits in CES) that affect the outcome (the value of CES). The questions asked would have to capture those benefits and their value. The land cover had been classified in Phase 1. The land cover here is the physical environment in this model. To get more information about the physical environment, a question was asked. Although that focus is on the land cover, it is possible that participants perceive other elements as important, other than those included in the land cover. Elements found within the wetland were given as possible options. Question one can be seen in Table 2. This question is strictly categorical; participants will choose whether the physical element

(PE) is important for their location of choice. The participants had the possibility to choose as many PE responses as they found important.

Question two (Table 3) attempts to capture what the participant perceives while being in the environment. This question also asks about the physical environment, but it captures the outcome, the value, of it. It does this because it asks the participant to rank the environment. The value it captures in this thesis is called Environmental Qualities (EQ). To choose which EQ that might be important, and which EQ that are related to CES, the work of Bieling et al., 2014 is used. In Bieling et al., open questions had been asked, and answers that relate to EQ have been categorized. The most important categories from this study, with small alteration towards the ecosystem under study, are used for this thesis. This question is asked in an ordinal rating scale. The rating scale ranges from one to five, where one indicates “strongly disagree” and 5 indicates “strongly agree”. The ratings are only shown as numerical values for the participants. All EQ had to be ranked.

Question three (Table 4) is designed to capture the activities the participants want to perform at their chosen location. It is a benefit received from CES. The numbers of activities were kept to as few as possible, only capturing the essentials of an activity rather than the exact activity. The essentials, which also relate to the social structure, includes; socializing, relaxing or activating one’s self. This question, as is the case with question one, is categorical. Either the participants want to perform the activity or they do not want to perform it. The participants had the opportunity to choose as many activities as they found important.

The first three questions make use of the cultural value model, designed by Stephenson, 2008. The cultural value model is used to understand what participants perceive as important in this wetland, and what is of benefit for them.

The fourth (Table 5) and final question attempts to capture the outcome (the value) that is a direct evaluation of the emotional process and, hence as close as a value for HWB this study will come. It is here called Emotional Response (ER). The adjectives describing the ER in this study are taken from an already performed study by Knez et al., 2009. This question is presented using an ordinal scale. The ordinal scale ranges from one to five, with the following order as in the given example; Very elated – Somewhat elated – Neutral – Somewhat bored – Very bored.

All four category questions and their respective variables are shown on the next page.

Table 2 Question one which asks about physical parameters (PE)

Please choose if the physical element is of importance to your selected location.

Animal
 Reed
 Bush
 Tree
 Grass
 Other plant
 Water
 Fence
 Bench
 Recreation
 Trail

Table 3 Question two which asks about the environmental qualities (EQ)

Please rank the environmental qualities of your chosen location.

Beauty
 1 2 3 4 5

Diversity, variedness
 1 2 3 4 5

Artificial
 1 2 3 4 5

Tranquillity
 1 2 3 4 5

Familiar
 1 2 3 4 5

Open
 1 2 3 4 5

Unfamiliar
 1 2 3 4 5

Naturalness
 1 2 3 4 5

Noisy
 1 2 3 4 5

Untidy
 1 2 3 4 5

Closed
 1 2 3 4 5

Monotonous
 1 2 3 4 5

Table 4 Question three which asks about activities

Please choose which activity you would like to perform at your chosen location.

Eating and having picnic
 Play and do sports
 Relaxing and meditating
 Exploring animals and plants

Table 5 Question four which asks about emotional response (ER)

Please answer how you feel right now at this place. Where middle point is neutral.

Elated				Bored
•	•	•	•	•
Glad				Gloomy
•	•	•	•	•
Calm				Nervous
•	•	•	•	•
Active				Passive
•	•	•	•	•

4.1.2.3 Data collection

To gather participants, university students and people known by the author were asked to participate. In total, 18 persons participated in the study. Since the thesis in many ways is focused on method development, the size of the collected population was not considered as the most important aspect, but instead the development of how to collect, what to collect and how to analyse was key factors. The material was collected over a time period of three weeks, ranging from the middle of April to early May. The first participant experienced an environment of little flowering, while the last participants experienced a more green and flowered landscape (see Figures 9 and 10). The author was present for some of the participants' experiences, while other participants took part in the study without the presence of the author. The app is developed so that it should be possible to perform the study without any other instructions. For the participants who undertook the study without the presence of the author, an email was sent with information about where the study site was located and where to walk.



Figure 9 Gullåkra mosse in April, Weisner 2014



Figure 10 Gullåkra mosse in May, Hylander 2015

The participants were asked to download the phone application. For those participants who did not possess an Android phone, another participant's phone, or the author's phone was used instead. In no case did any problem arise where Android phones were unavailable or where any problem arose because of participants not having Android. The app itself introduced text information about what to do. The participants were asked to follow the existing nature path trail, which is well marked by signs. The exact path can be seen in Figure 11.

Path taken by participants

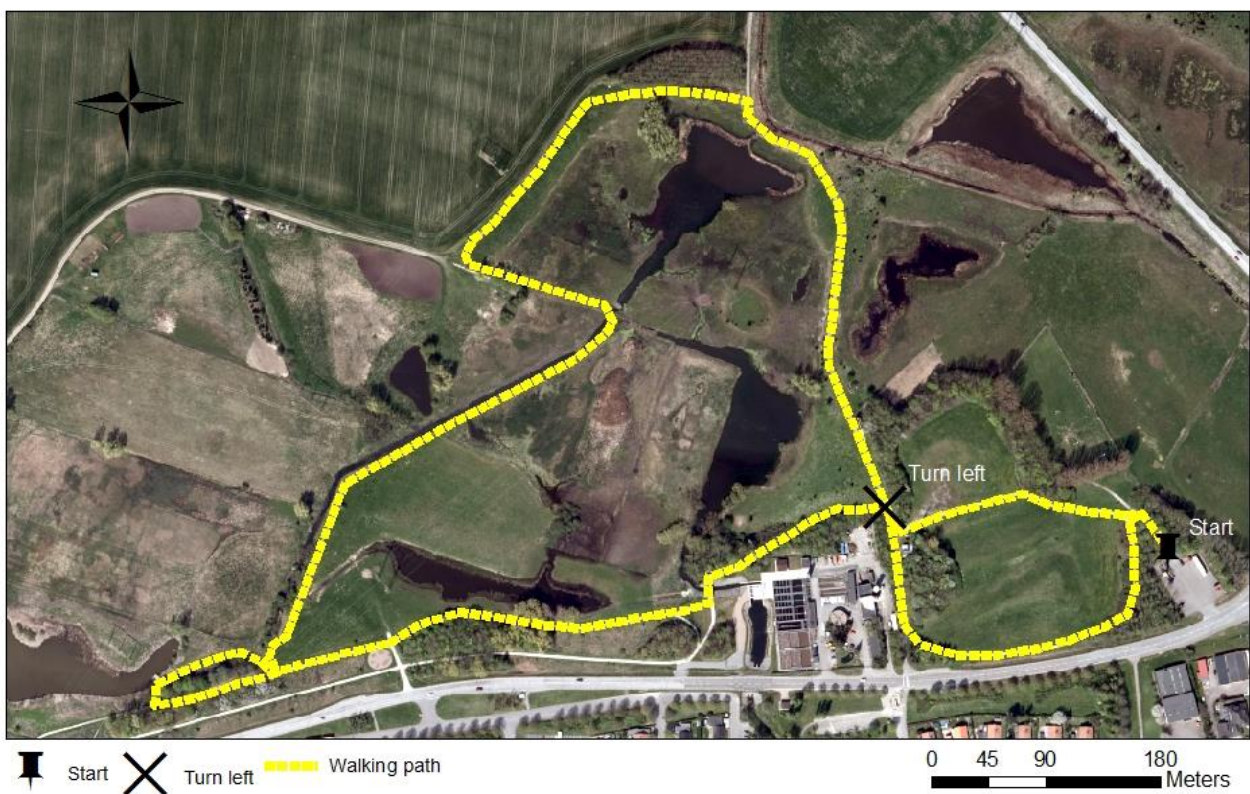


Figure 11 Path taken by participants

Each participant was asked to stop at three locations. The exact question as to where the participant should stop is; “When any location gives you a positive feeling, stop”. In order for participants to choose the three most special and positive places, they were asked to walk the path two times. The first time choosing three locations and the second time stop at them and answer the questions. By only walking the path one time, a participant might choose three locations and come to a fourth location which gives them a more positive feeling than the three already chosen. Three locations were chosen because it was considered as an appropriate number for the size of the wetland. All participants were asked for three locations to maintain the consistency of the data and its statistical validity. The exact instructions of the app can be seen in Appendix 3.

For one participant only two locations were collected. The data was most likely lost somewhere in the process of sending it to the author. Because of this, the total amount of locations were 53 $((18 * 3) - 1)$. All the collected information can be found in Appendix 4.

4.1.3 Phase 3

This phase is the final phase which produced the results. All the answers were compiled in an Excel spreadsheet, which can be seen in Appendix 4. The answers were transformed to contain numbers, in order to be able to perform SPSS statistics and spatial analysis in ArcGIS. The statistics were only performed on the answers and did therefore not relate to any spatial analysis.

4.1.3.1 Statistics

The data were imported into IBM SPSS Statistics 22. Frequency tests were run on age, gender, PE and activities. Descriptive statistics were run on EQ and ER. Analysis of the mean values of ER was used. Whether this is meaningful or appropriate for ordinal scales is debatable. In social science it is, however, frequently used and ordinal scales can often be assumed to be interval scales (Schuur, 2011). In this study, the ordinal scale is treated as an interval scale.

A principal component analysis (PCA) was performed on the EQ to establish if the different variables within EQ were related to each other, that is, if one sampling variable relates to another. By doing this, the number of variables could be reduced (Rogerson, 2010). From the PCA, some variables could be merged. For the variables that are opposite to each other, such as open versus closed, one variable had to be recalculated before merging. For the example of open versus closed, having a participant choosing four as open, would mean that the

participant somewhat agrees with the environment as closed. Choosing closed for two would suggest that the participant somewhat disagrees with the environment as being closed. Merging these two into one variable, the closed variable would have to be reversed. An example table of the PCA analysis can be seen in Appendix 5. The merged variables are presented below.

Beauty, artificial, naturalness and tranquillity were merged to nature perception.

Variedness, diversity and monotonous were merged to variedness.

Open and closed were merged to openness.

Familiar and unfamiliar were merged to well-known.

A reliability test (Cronbach's Alpha (α)) was run on the variables merged to establish their reliability. All the new variables gained from the PCA were used for all the other steps in the analysis, both statistical and spatial.

Other statistics that were tested included correlation analysis between EQ and ER, a one way ANOVA test with EQ by PE and activities, and ER by PE and activities. The last test was a crosstabulation analysis that included a Chi-square between PE and activities.

4.1.3.2 Spatial analysis

The coordinates received from the phone's GPS were in latitude and longitude, georeferenced in WGS 84. The aerial photographs and the digitized vector layer was georeferenced in SWEREF 99 TM. The reference systems of SWEREF 99 TM and WGS 84 only differs some decimals (Lantmäteriet, 2015b). Considering that the accuracy of phones (which depends on the GPS device/chipset in the phone) should not be expected to be better than 5 to 10 meters (see e.g. (Menke, 2014)), WGS 84 and SWEREF 99 TM can be considered as equal in accuracy for this purpose. Therefore, the only conversion needed to insert the coordinates into ArcGIS was to convert the latitude and longitude to SWEREF 99 TM north and east coordinates.

Having all coordinates inserted, each location for each person was represented as a set of points. However, to be able to do more in depth spatial analysis the view area or "viewshed" (inside quotes because it is not a viewshed in the commonly used sense) had to be analysed. The compass direction was answered by all participants. This only represents one line towards the direction the participants viewed, and not an area viewed. To get the view area, new techniques had to be invented.

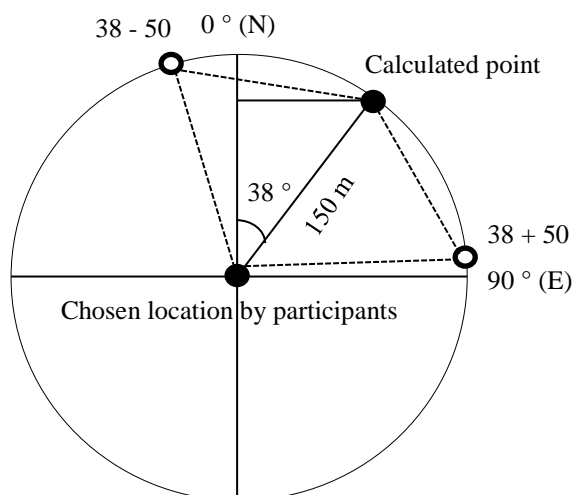
Some parameters had to be decided before doing any computation to get the view area. These parameters include; which distance does the line of sight cover and what is the angle of view. Previous articles that use view angles do so from photographs (e.g. Dramstad et al., 2006). Depending on the size of the area under study, the view distance was set to 150 meters and the angle to 100 degrees.

The approach of calculating the view area can be summed into these steps;

- Calculate three new points (as shown in Figure 12) from each original point and compass direction
- Connect the points with lines
- Create a polygon from the lines

To calculate three new points and from them, the area, basic trigonometric functions were used. Imagine a unit circle centred on the saved coordinate pair (the coordinates are in that of a Cartesian coordinate system), by applying $\text{Sin } A = \frac{\text{opposite}}{\text{hypotenuse}}$ and $\text{Cos } A = \frac{\text{adjacent}}{\text{hypotenuse}}$ it becomes possible to calculate a new point. A is the angle, in this case the saved compass direction and the hypotenuse is that of the chosen distance, 150 meters. Applying the rules of the unit circle, the opposite would give the Y coordinate while X would be given by the adjacent. However, in the case of working with compass direction the unit circle is turned such that north (0 degrees) becomes X while east (90 degrees) becomes Y. Using the compass angle given by participants and 150 meters, one new point was calculated. However, to get a polygon area, which also includes the field of view (100 degrees), 50 degrees was added and subtracted from the compass angle to give a field of view. Below is an example calculation with a given illustration.

Example of calculations for two new points



$$p1x = \text{Sin}(38) = \frac{x}{150} \rightarrow x = 150 * \text{Sin}(38)$$

$$p1y = \text{Cos}(38) = \frac{y}{150} \rightarrow y = 150 * \text{Cos}(38)$$

$$p2x = \text{Sin}(38 - 50) = \frac{x}{150} \rightarrow x = 150 * \text{Sin}(-12)$$

$$p2y = \text{Cos}(38 - 50) = \frac{y}{150} \rightarrow y = 150 * \text{Cos}(-12)$$

Figure 12 illustration of the view area

Calculating three new points for all 53 locations is tedious work if done manually. Therefore a program was written which performed the task. The program produced 53 new CSV files, containing each individual location, with its three new points, and the original answer connected to that specific location. The program created 53 individual files to facilitate analysis in ArcGIS. The files from the program were ready to be directly imported into ArcGIS. The program was written in python using Eclipse. The source code can be found in Appendix 6, together with an example output.

All 53 new CSV files were imported to ArcGIS as point layers; one file contained 4 points as described above. Inside ArcGIS, a line was drawn between each point in one file, creating a line layer. After this, the line layer could be converted to a polygon layer. As when creating 53 new files, doing this by hand would be inefficient and take a considerable amount of time. Therefore a tool was made in Model Builder. The structure of the tool can be seen in Appendix 7.

The polygons created were merged into one file to be used in some of the following analysis. To be able to make overlays, perform mean calculations and find special locations, the polygons were transformed to raster files. The process of doing this was made in Model Builder, in two steps to capture the total area in one raster file, as can be seen in Figure 13.

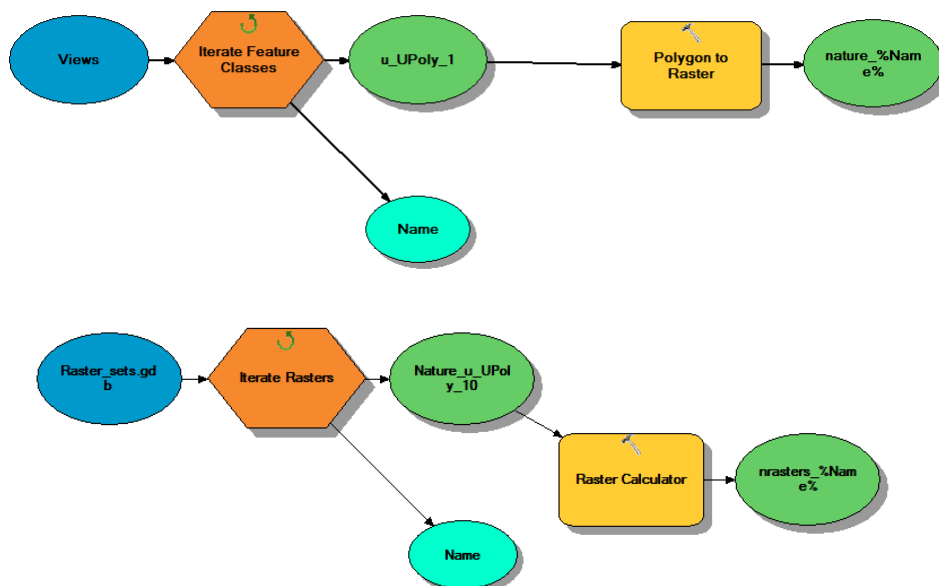


Figure 13 Model to convert polygons to raster

Now all files were ready to be analysed. The next section presents the results.

5.0 Results

This section contains the analysis of the data. The results are structured in a step by step procedure, together with clear statements of the outcome. The results are presented in tables, diagrams and maps. It is divided into two sections, one plainly statistical and the other spatial. Abbreviations are used to keep the size of tables to a minimum. PE = Physical elements, EQ = Environmental Qualities, and ER = Environmental Response.

5.1 Statistical analysis

In total, 18 people participated in the study. Every participant chose three locations, except in one case when only two locations were registered. The total number of registered points was therefore 53 locations, divided between 18 participants.

5.1.1 Descriptive statistics

This section contains descriptive statistics for the answers given by participants. The first two tables present information about age and gender. 35 values are missing due to that the statistics is for every location, but only 18 participated, $53 - 18 = 35$.

Table 6 Age groups

		Age group	
		Frequency	Percent
Valid	< 15	3	5.7
	16 - 30	7	13.2
	31 - 45	1	1.9
	46 - 60	5	9.4
	> 60	2	3.8
	Total	18	34.0
Missing	System	35	66.0
Total		53	100.0

Table 7 Gender

		Gender	
		Frequency	Percent
Valid	Female	10	18.9
	Male	8	15.1
	Total	18	34.0
Missing	System	35	66.0
Total		53	100.0

PE and activities are on a nominal scale and can either “exist” or “not exist”. PE and activities are displayed in a frequency table. Frequency is the number of times the variable has been checked for all the locations. The percent value is the frequency divided by the total amount of locations. EQ and ER are on an ordinal scale and are shown in a mean value table. The mean value is the mean value for all 53 locations.

Table 8 Frequency table physical elements and activities

PE	Frequency	Percent
Animals	17	32
Reed	16	30
Bush	20	38
Tree	33	62
Grass	23	43
Other plant	11	21
Water	35	66
Fence	6	11
Bench	15	28
Recreation	23	43
Trail	15	28
Activities	Frequency	Percent
Eating and having picnic	26	49
Play and do sports	17	32
Relaxing and meditating	29	55
Exploring animals and plants	29	55
Enjoy the view	35	66

Table 9 Mean value for environmental qualities and emotional response

EQ	N	Mean
Beauty	53	3.9
Diversity, variedness	53	3.4
Artificial	53	2.6
Tranquillity	53	3.5
Familiar	53	3.6
Open	53	3.8
Unfamiliar	53	1.8
Naturalness	53	3.5
Noisy	53	2.7
Untidy	53	1.8
Closed	53	2.1
Monotonous	53	1.9
ER	N	Mean
Elated to Bored	53	2.5
Glad to Gloomy	53	1.8
Calm to Nervous	53	1.8
Active to Passive	53	2.9

From Table 8 it is possible to distinguish that some PE occurs more frequently than others. Tree and water are the most selected answers, as important PE, for the participants' chosen locations. Many activities occur often except for "play and do sports". In Table 9, "beauty" has the highest mean value while "unfamiliar" and "untidy" have the lowest. The mean value in ER for "active to passive" is almost 3. Choosing 3 as a participant is equal to a neutral ER.

5.1.2 Correlation

The correlation statistic describes how strongly any variables relate to each other, and whether positively or negatively. The correlation table can be seen in Appendix 8. Correlations are only performed on EQ and ER. The new variables obtained from the PCA are used in the correlation statistics, and will be used in the rest of the results. The procedure to produce the new variables is described in Section 4.1.3.1 Statistics.

There are no strong relationships found between any variables (high correlation variables). For environmental qualities (EQ) "nature perception" has a significant (0.05) negative correlation to "noisy" and to "calm to nervous". "Noisy" has a significant positive correlation to "untidy". An interpretation of the result is; when the location is noisy, the nature perception is perceived lower and participants tend to be more nervous. When the location is noisy it tends to be untidy.

The correlation between emotional responses (ER) shows a significant positive relationship between “elated to bored” and “glad to gloomy”, “glad to gloomy” and “calm to nervous”. An interpretation is; when participants feel bored, they also feel gloomy and when they feel gloomy they feel nervous.

5.1.3 Comparison

The mean value for EQ and ER are compared with PE and activities to decide whether there are any difference where participants e.g. want to have a picnic compared to if they do not want to have picnic. This was tested by one way ANOVA tests. The tables below demonstrate the significant results. Example of output tables produced from SPSS can be seen in Appendix 9.

Table 10 ANOVA test were EQ depend on activity

EQ	Activity	Existing	N	Mean	Significance
Nature perception	Play and do sports	No	36	3.8	0.015
		Yes	17	3.2	
Nature perception	Relaxing and meditating	No	24	3.1	0.000
		Yes	29	3.9	
Noisy		No	24	3.1	0.033
		Yes	29	2.4	

For activities, “play and do sports” has a significant (0.05) difference depending on nature perception. The significance indicates that whether the activity exists or does not exist, the nature perception is different. The mean value for nature perception is higher when “play and do sports” does not exist compared to if it exist. This suggests that with high nature perception, participants tend to not want to play and do sports.

For relaxing there is a significant difference for “nature perception” and “noisy”. High nature perception and low noise gives a relaxing location.

For PE only tree and water was compared to EQ and ER. For EQ no significance existed with tree or water.

Table 11 compares PE and activities to ER. More connections seem to exist for ER than for EQ. Both water and trees tend to make participants passive. If participants feel “calm” they want to “eat or have picnic”, “relax or meditate” or “explore animals and plants”.

Table 11 ER dependant on PE and activity

ER	PE	Existing	N	Mean	Significance
Active to passive	Water	No	18	2.3	0.024
		Yes	35	3.2	
Calm to nervous	Tree	No	20	2.3	0.004
		Yes	33	1.6	
Active to passive		No	20	2.2	0.002
		Yes	33	3.3	
	Activity				
Glad to gloomy	Eating and having picnic	No	27	2.0	0.026
		Yes	26	1.6	
Calm to nervous		No	27	2.1	0.031
		Yes	26	1.6	
Active to passive	Play and do sports	No	36	3.4	0.000
		Yes	17	1.7	
Calm to nervous	Relaxing and meditating	No	24	2.3	0.003
		Yes	29	1.5	
Active to passive		No	24	2.5	0.025
		Yes	29	3.3	
Calm to nervous	Exploring animals and plants	No	24	2.1	0.043
		Yes	29	1.6	
Active to passive		No	24	2.3	0.004
		Yes	29	3.4	
Elated to bored	Enjoy the view	No	18	2.1	0.016
		Yes	35	2.6	
Active to passive		No	18	2.1	0.001
		Yes	35	3.3	

To establish if any activity seem to be connected, in the sense that it wants to be performed, to any PE, the number of times the activity is performed when the PE exists is counted. This was done by a crosstabulation analysis. The tables presented are statistically significant. The significance test is shown in Appendix 10. Below are the resulting tables.

If the place contains grass, the participants will likely want to eat or have picnic.

Table 12 Eating related to grass

Crosstab, Chi-Square 0.009

			Eating		Total
			.0	1.0	
Grass	.0	Count	20	10	30
		% within Grass	66.7%	33.3%	100.0%
	1.0	Count	7	16	23
		% within Grass	30.4%	69.6%	100.0%
Total		Count	27	26	53
		% within Grass	50.9%	49.1%	100.0%

Table 13 Exploring related to animals

Crosstab, Chi-Square 0.00

			Exploring		Total
			.0	1.0	
Animals	.0	Count	22	14	36
		% within Animals	61.1%	38.9%	100.0%
	1.0	Count	2	15	17
		% within Animals	11.8%	88.2%	100.0%
Total		Count	24	29	53
		% within Animals	45.3%	54.7%	100.0%

Table 14 View related to reeds

Crosstab, Chi-Square 0.005

			View		Total
			.0	1.0	
Reeds	.0	Count	17	20	37
		% within Reed	45.9%	54.1%	100.0%
	1.0	Count	1	15	16
		% within Reed	6.3%	93.8%	100.0%
Total		Count	18	35	53
		% within Reed	34.0%	66.0%	100.0%

The tables show that if a location contains grass, participants want to “eat or have picnic”, if a location has animals, participants want to “explore animals and plants” and if a location has reeds, participants want to “enjoy the view”.

5.2 Spatial analysis

This part will go through the spatial analysis. Each part will contain a question which will be answered by maps, tables and graphs. The final outcome of the results will be a CES index.

5.2.1 Distribution

This section will give an overview of the collected data. The question is therefore: Where have participants chosen to stop?

Locations chosen by participants

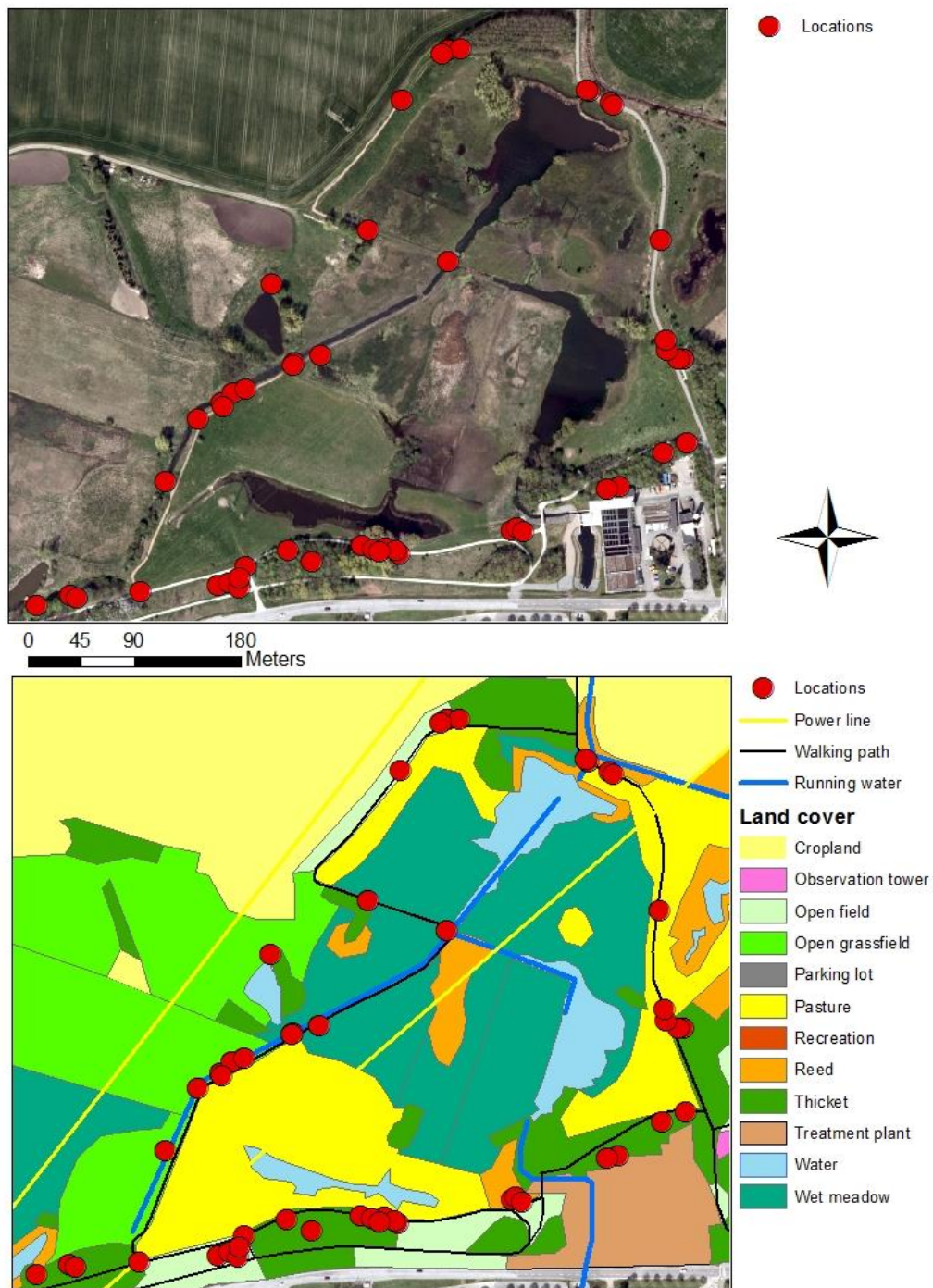


Figure 14 Chosen locations by participants

Visually, one pattern can be seen. Participants tend to stop near thickets. Almost every location is connected, or at least close, to thickets.

Naturally, next question is: Where have participants chosen to look?

View direction for every participant

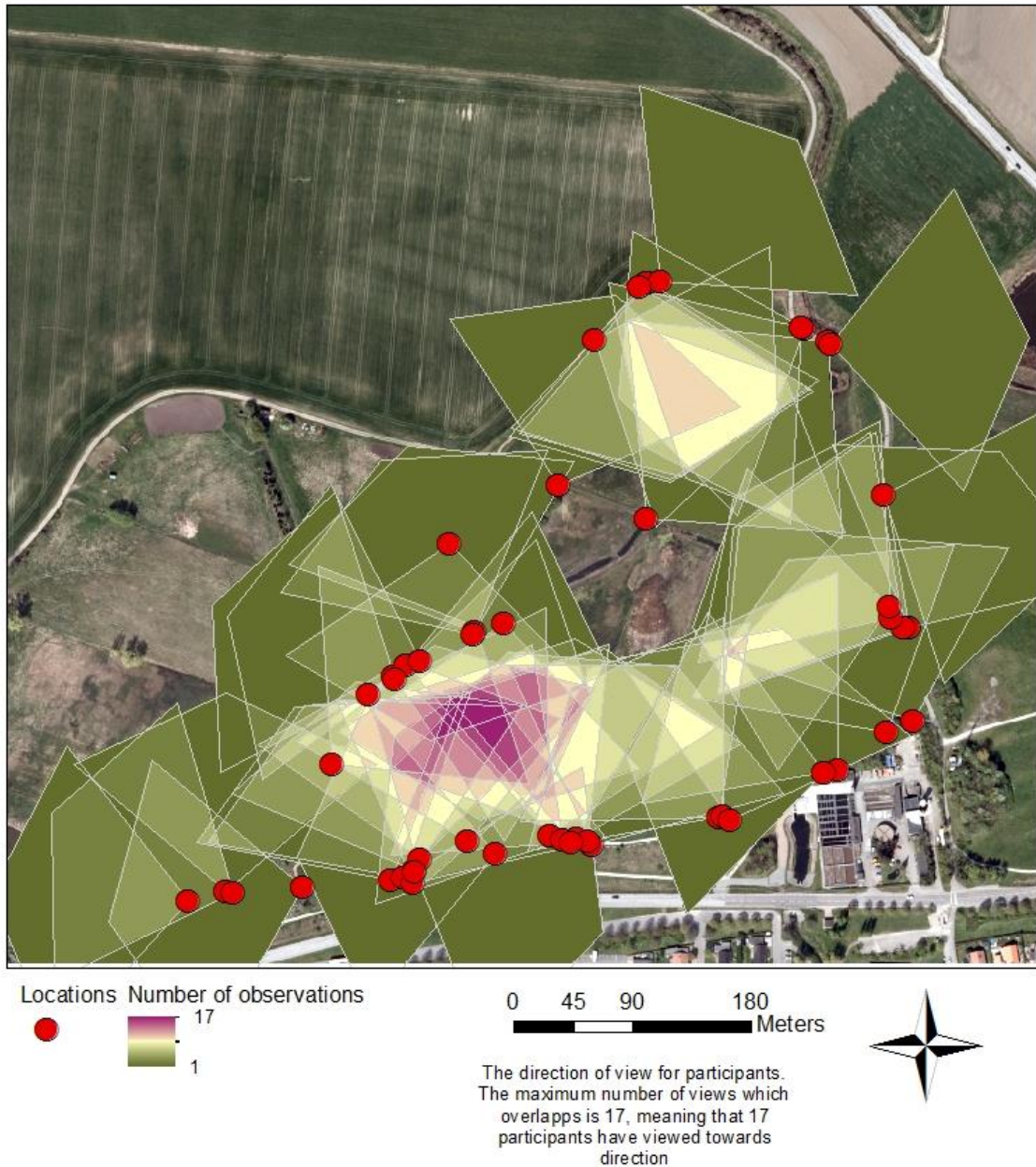


Figure 15 View direction of each location

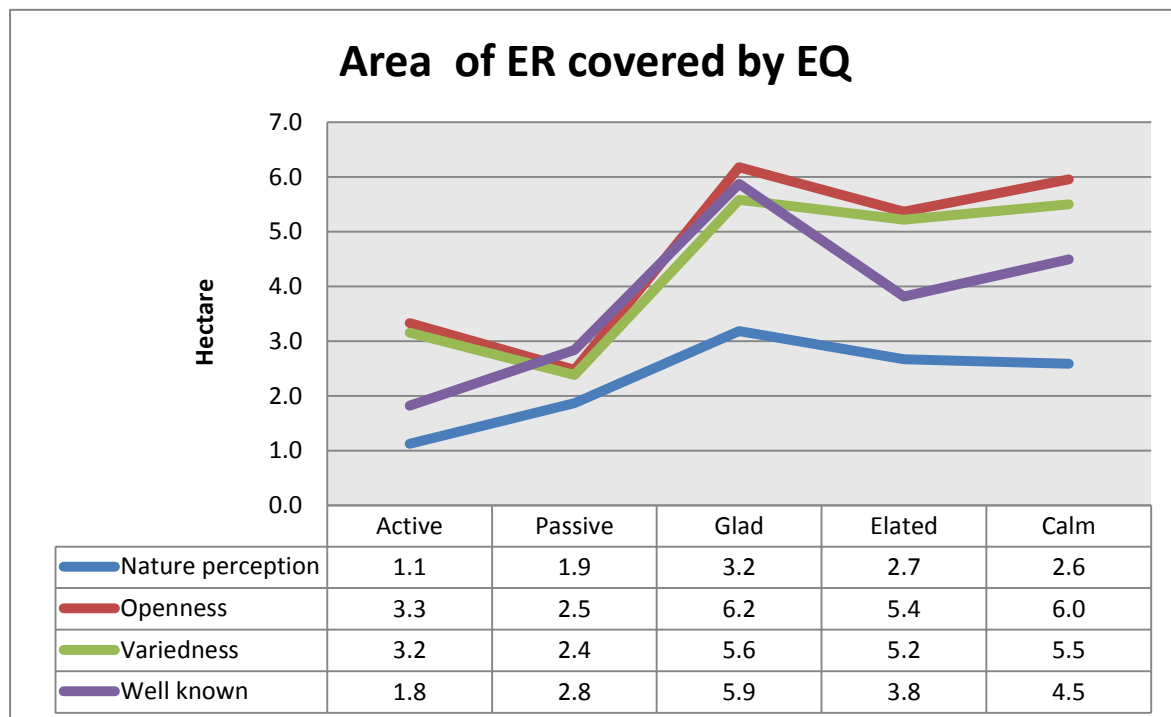
Participants tend to look towards water, thicket, pasture and wet meadow. The total area covered by those classes are; water = 8%, thicket = 12%, pasture = 21% and wet meadow = 24%.

5.2.2 Environmental qualities and emotional response

How do the individuals in this study perceive the environment and what value does this give? One possible solution to this question is to relate EQ to ER. The direct question is therefore; do any certain EQ give a certain ER?

Figure 16 shows how much of an area with high values of ER that overlaps with high values of EQ. The high values have been obtained by only selecting areas where at least three participants ranked EQ as four or five and ER as one or two.

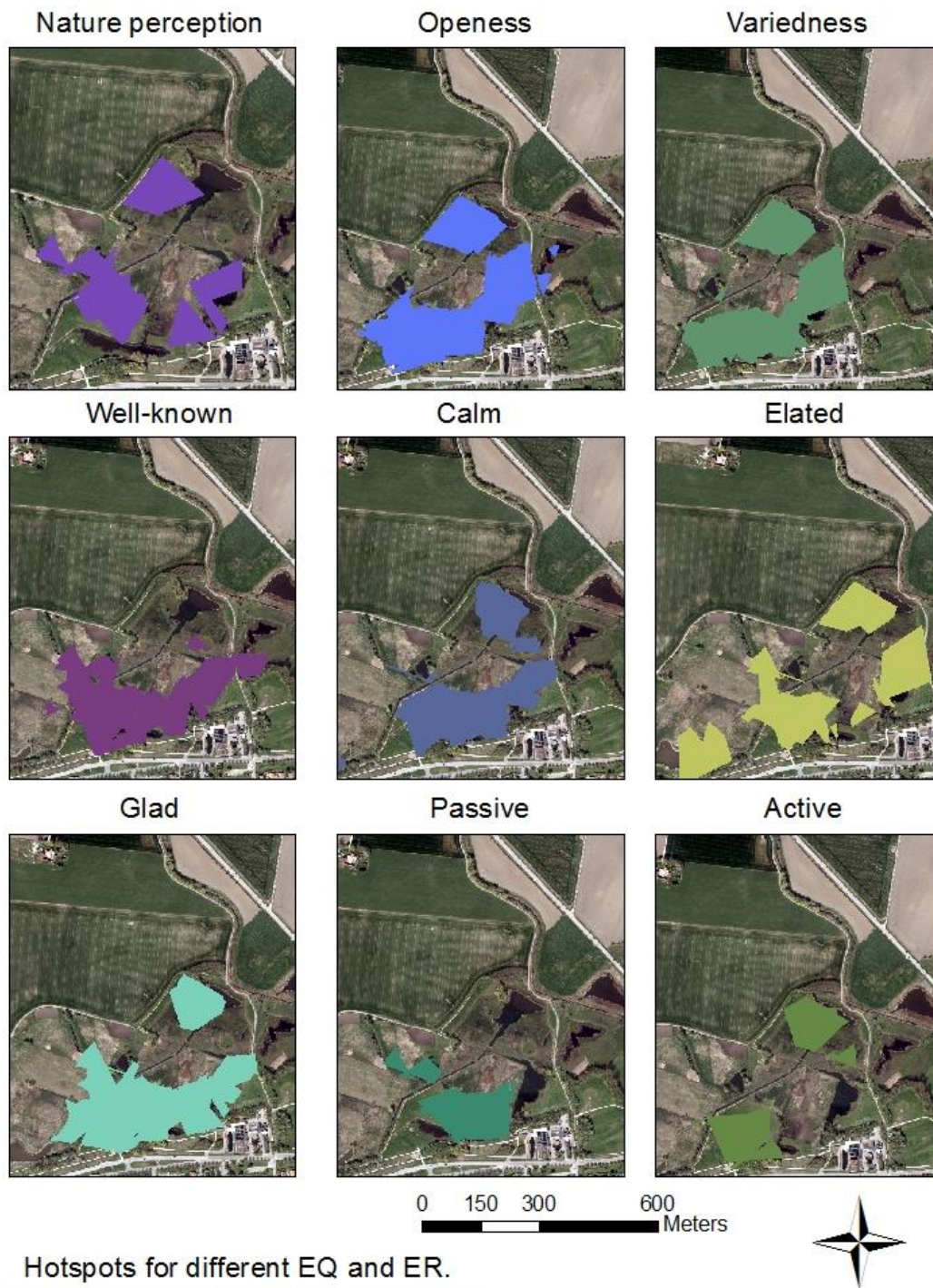
Figure 16 Area of high values for ER covered by high values for EQ



In the diagram, “nature perception” and “well-known” areas give high passiveness, while “openness” and “variedness” give high activity. “Openness” and “variedness” do also seem to have the most positive effect on elated and calm.

In no areas are participants gloomy, bored or nervous. Overall, the hotspots of high values for EQ and ER are in the same locations. This means that when “nature perception”, “well-known”, “openness” and “variedness” are high – participants feel calm, glad and elated. This result confirms that CES affect emotions of participants, which may lead to higher affective well-being for people experience high benefits of CES. Figure 17 shows hotspots for the areas.

Hotspots of EQ and ER



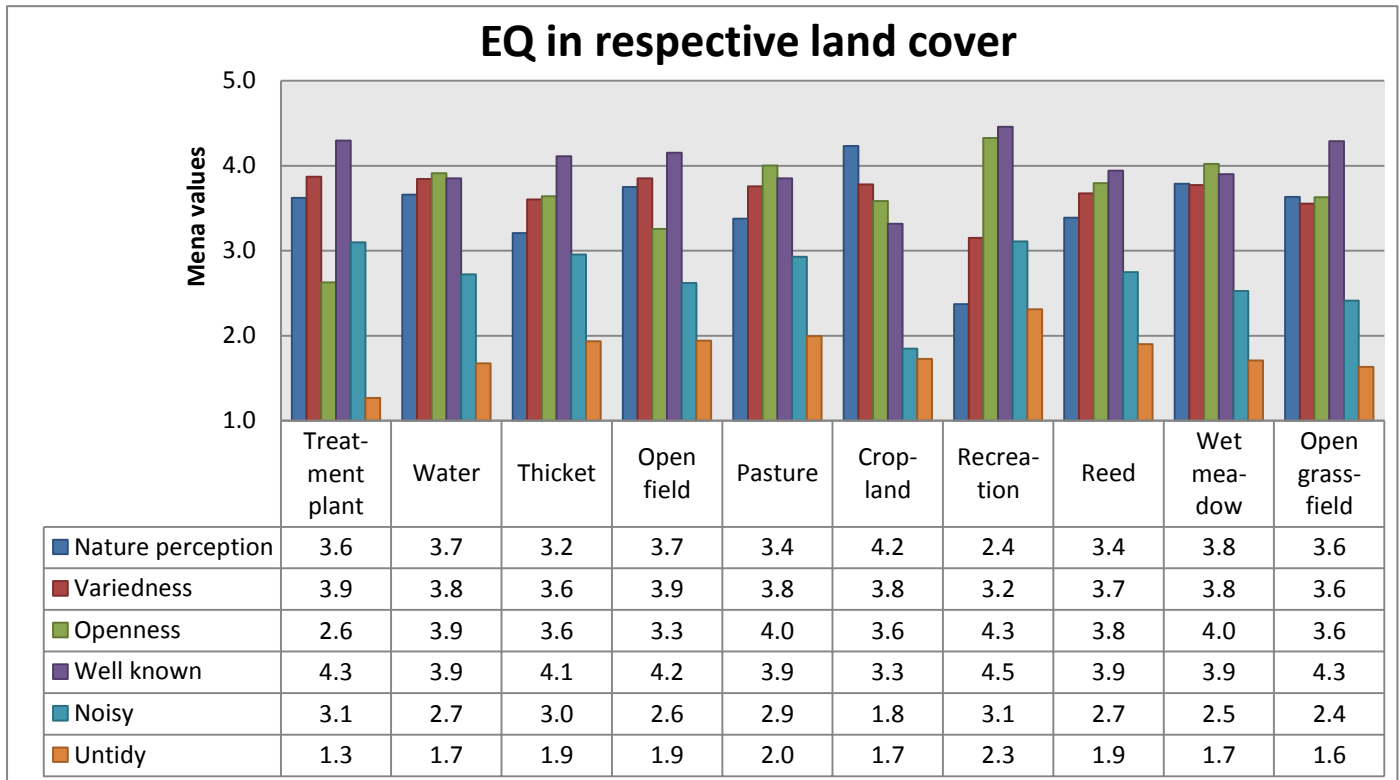
Hotspots for different EQ and ER.
The steps to produce the maps can be found in the method part of the report.

Figure 17 Hotspots of EQ and ER

5.2.3 Land cover

How does land cover affect ER and EQ? Analysing EQ together with land cover makes it possible to establish how land cover affects the perceived EQ. Figure 18 displays the mean values of EQ inside different land cover types.

Figure 18 Mean value for EQ inside different land cover classes



The value for treatment plant is not representative. Only two polygons crossed the treatment plant land cover class. “Untidy” and “noisy” is most likely more related to the specific point of the participants than the view. “Water” and “wet meadow” have similar values between the variables of “nature perception”, “variedness”, “openness” and “well known”. Cropland seems to give the participants a high value of nature perception while “open grass field” and “recreation” contributes to a “well known” ER.

No land cover class seem to distinguish itself as being perceived differently from any other, while comparing different EQ. Figure 19 shows an example picture of the mean “openness” perceived by participants.

Mean openness

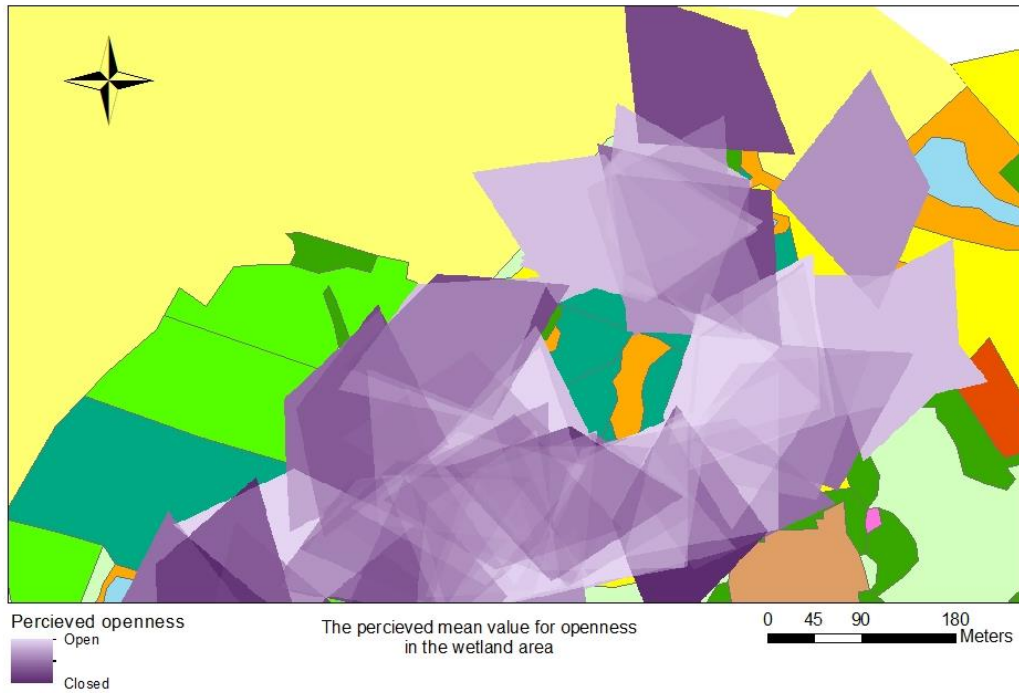
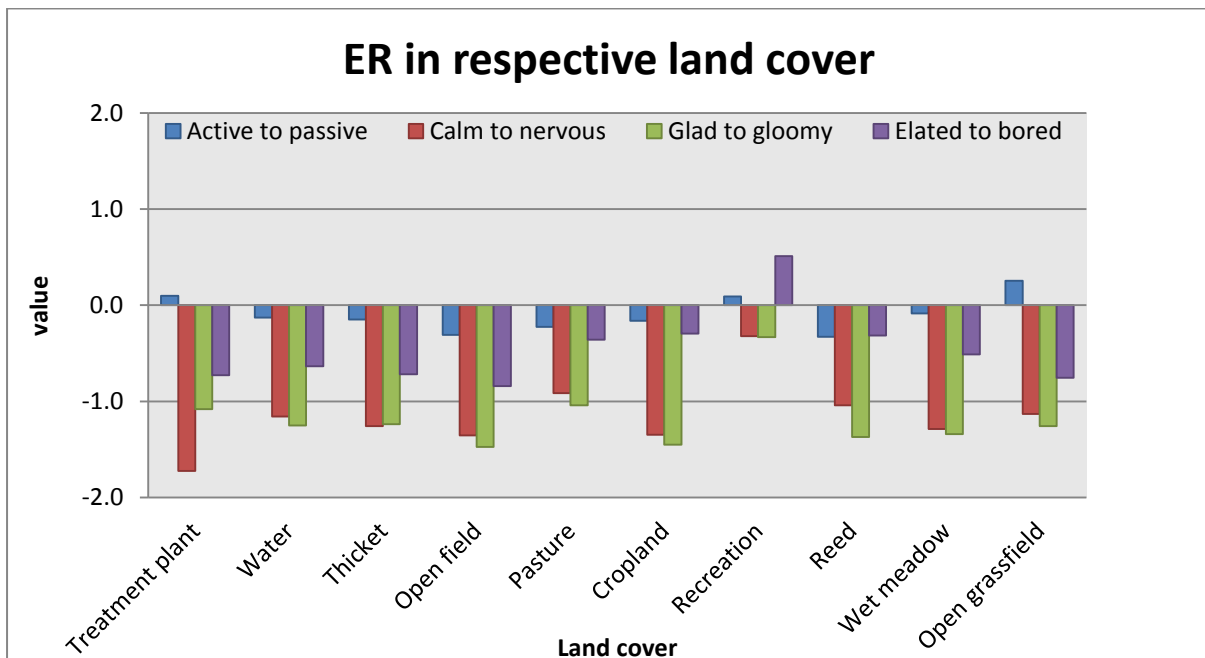


Figure 19 Mean openness

Figure 20 shows the mean value of ER perceived by the participants in different land cover classes. Zero is equal to a neutral ER. The negative values represent the “to” (e.g. active is zero and above, while “to passive” is zero and below).

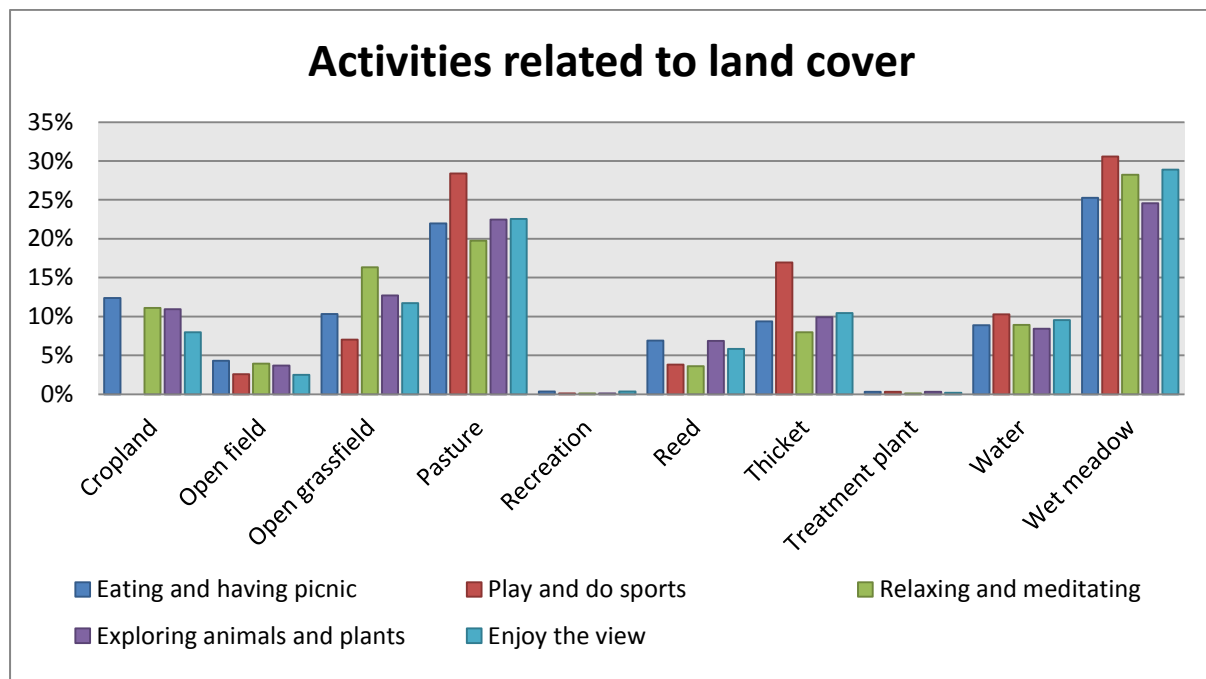
Figure 20 Mean values of ER in each different land cover class



All land cover classes except recreation, give the participants an ER of calm and glad. Recreation does also seem to give the participants an ER of bored while the other classes do not.

Is any land cover class related to an activity? Figure 21 displays which activities that participants want to perform when looking towards different land cover classes. The area of an activity inside a land cover class has been divided by the total area where the activity exists.

Figure 21 Activities which participants want to perform in different land cover classes



Due to the fact that “wet meadow” and “pasture” have the highest area covered by view polygons, those land cover classes have the highest rates of activities. “Enjoy the view” occurs most frequently as an answer (see Section 5.1.1 Descriptive statistics). The participants seem to want to “enjoy the view” most often of wet meadow, pasture and open grass field. If pasture is viewed, it seem like participants want to “play and do sports” more often than the other activities; this is also the case for thicket. “Open grass field” seem to make participants want to “relax and meditate”.

The same type of analysis has been done for PE and land cover. The output diagram for this analysis can be seen in Appendix 11.

5.2.4 Qualities of the perfect spot

Which CES does the “perfect spot” contain? The assumption made is that the “perfect spot” holds values where the participants are glad, calm and elated. The values could be changed, e.g. including ER of active to passive which would lead to another location. The perfect spot have been obtained by inverting the ER values (glad get a high value, five instead of one). Then only locations with values of four or five where selected. The locations were overlaid, and locations which had a value above 20 (e.g. more than five participants have to be really glad (choosing one on the question from the very beginning)) were used.

31 out of 53 polygons overlapped at the “perfect spot”. Because of this, all PE and all activities did exist within the “perfect spot”. The perfect spot is the “perfect spot” just because many people have viewed in that direction. However, to decide which variables that are special for the spot, each variable was divided by the frequency at which it occurred. This means that for, just this spot, this variable is considered to be as this particular degree of importance. For example, if water exists only 50 % of the times in the spot, it is not only important for that spot but also all the other spots, while if it were to occur 100 % of the time in the spot, it would be just for this spot that water would be important.

If the percent value is above 50 %, that variable occurs more frequently in the perfect spot than in any other place. In Table 15, there is some PE that distinguishes themselves from the others. Those are animals, tree, other plant, water and recreation. One possible interpretation is that, the participants want something special to feel extra glad or extra calm; this can be an animal or a plant. Tree and water are the most frequently answered PE and they are an important element for participants to get a positive feeling.

PE	Percent
Recreation	65.2%
Animals	64.7%
Other plant	63.6%
Tree	57.6%
Water	57.1%
Bench	53.3%
Trail	53.3%
Bush	50.0%
Fence	50.0%
Grass	47.8%
Reed	31.3%

Table 15 How many times a PE occurred inside the "perfect spot" compared to other spots

Activities	Percent
Play and do sports	76.5%
Relaxing and meditating	55.2%
Exploring animals and plants	55.2%
Enjoy the view	54.3%
Eating and having picnic	46.2%

Table 16 How many times activities occurred inside the "perfect spot" compared to other spots

The same type of analysis was performed on activities. The output can be seen in in Table 16. Play and do sports seem to occur much more frequently in the “perfect spot” than in any other spots.

Table 17 The mean value for EQ inside the “perfect spot”

EQ	Mean
Openness	3.9
Well known	3.9
Variedness	3.7
Nature perception	3.5

Table 18 Land cover inside the “perfect spot”

Land Cover	Hectare
Pasture	0.324
Wet meadow	0.289
Water	0.219
Thicket	0.029

Table 17 shows the mean value for EQ inside the “perfect spot”. What may be surprising is that no EQ appears to have a high mean value. None of them reaches a mean value of 4. The “perfect spot” cover four land cover classes, which can be seen in Table 18. The highest area of land cover inside the “perfect spot” is pasture and wet meadow. Figure 22 shows the location of the “perfect spot”.

The highest ranked location

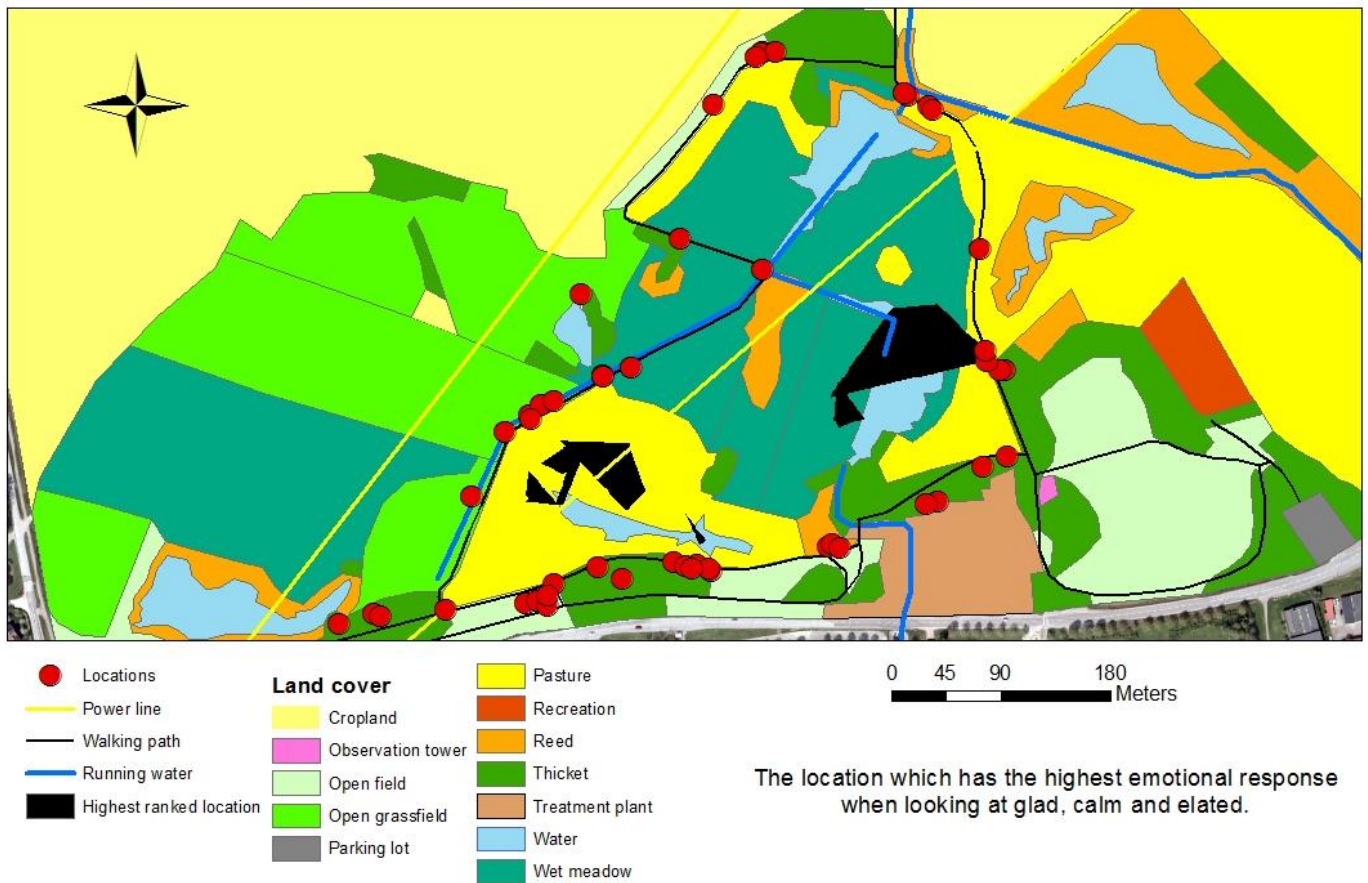


Figure 22 The “perfect spot” if considering it as values where participants are glad, calm and elated

5.3 Summary of results

The final section will summarize the results. This can be done by answering the research questions which were asked in the beginning. The first two research questions were the following:

RQ 1: Which qualities does a “high valued” CES location contain?

RQ 2: Which CES do participants value highly?

The following text tries to answer those two questions: The most prominent features of the wetland are **water** and **trees**. Participants tend to stop near **thickets** and look towards **pasture, wet meadow** and **water**. At all places the participants feel **glad, calm** and **elated**, however when they perceive the environment as **open** and **varied** they experience these feelings to a higher degree. Most often do participants want to **enjoy the view** of **wet meadow, pasture** or **open grass field**. When **animals, other plants** or the possibility to **play or do sport** arise, the participants feel the highest emotion of **glad, calm** and **elated** all together.

RQ 3: Can an ecosystem be ranked according to CES?

An attempt to answer research question three is made by developing a CES index. The index is an example of what a spot, would need, to be classified as having a high impact on HWB (ER). It is only a simple example from the result in this study. It should not be considered as something which is true. The index and how it works is explained below.

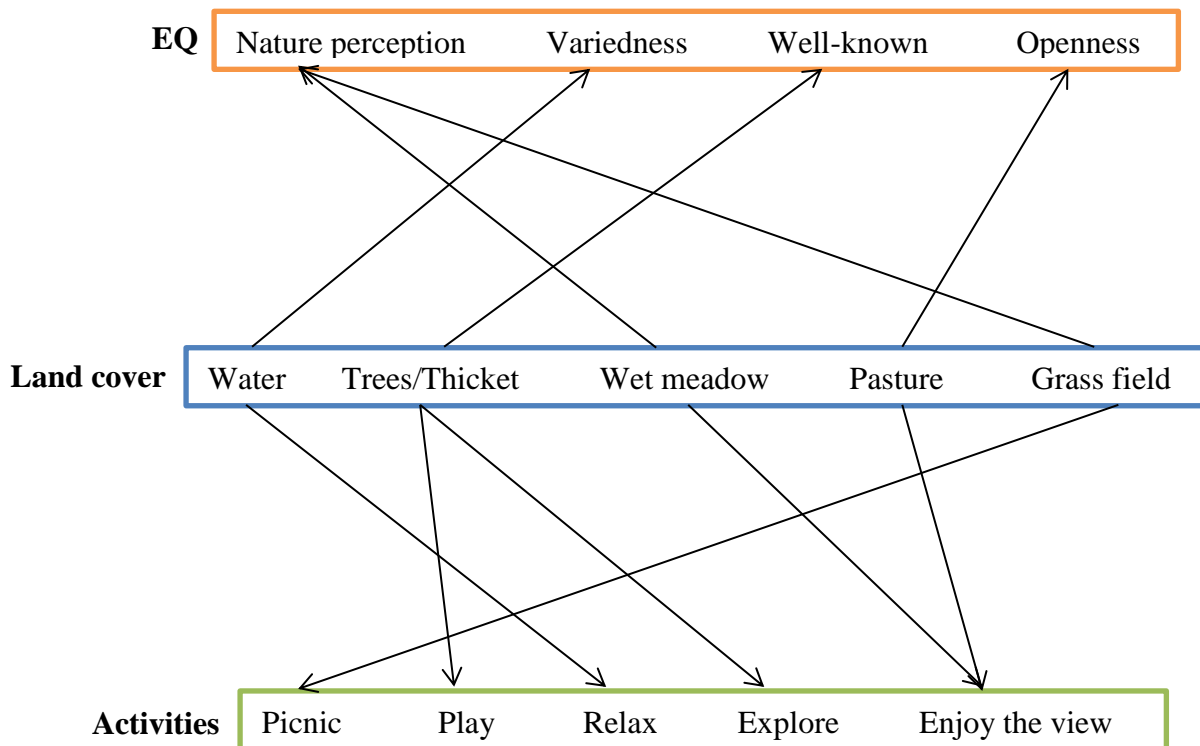


Figure 23 Land cover relation to activities and EQ

The first step of the index consists of deciding which land cover/PE the wetland contains. By doing this, the arrows can be followed from the different land cover classes. The different land cover explains which activity visitors would most likely want to perform and which EQ that they most likely will perceive. When the elements existing in the wetland are established, it is possible to go to the ranking index.

Table 19 CES index

See how many elements that exist in the wetland and count the points they give for calm, glad and elated

ER	Water	Trees/thicket	Wet meadow	Pasture	Open grass field
Calm	2	2	2	1	2
Glad	2	2	2	1	2
Elated	1	1	1	1	2
ER	Nature perception	Openness	Variedness	Well known	
Calm	1	2	2	1	
Glad	1	2	2	2	
Elated	1	2	2	1	
ER	Eating and having picnic	Play and do sports	Relaxing and meditating	Exploring animals and plants	Enjoy the view
Calm	2	1	2	2	1
Glad	2	1	1	1	1
Elated	1	1	1	1	2

Ranking	Calm	Glad	Elated
1	1 – 5	1 – 5	1 – 5
2	6 – 10	6 – 10	6 - 10
3	11 – 15	11 – 15	11 - 15
4	16 – 20	16 – 20	16 – 20
5	> 21	> 21	> 21

Sum the points and rank the index according to calm, glad and elated

In Table 19, points are gathered from which elements that exist in the wetland. All the points are summed according to their respective variable of calm, glad and elated. The wetland can then be ranked according to calm, glad and elated in a five level scale, where five is the highest ranking. The ranking is the CES index and hence an evaluation of the wetland, according to CES. Since the index in this case is inherited from this wetland, Gullåkra mosse gets a CES ranking of five for calm and glad, and four for elated.

6.0 Discussion

The discussion section will be divided into four parts. The first part will discuss the CES in the context of this thesis. The second part will discuss the methods used throughout the study. The third part will go through the obtained results. The fourth and last part will briefly describe the use of GIS for this type of study.

6.1 CES

There is a need to include more information regarding cultural ecosystem services (CES) and how it is related to human well-being (HWB) in this thesis. Considering the definition set by millennium ecosystem assessment (MEA) for ecosystem services (ES); “the benefit people obtain from ecosystem”, the benefits are defined as those that influence HWB. MEA defines HWB as *basic material for good of life, health, good social relations, security and freedom of choice*. The term ES is therefore in itself HWB. One can then argue, does it make sense to measure ecosystem services, in this case CES, in terms of human well-being. Because just by measuring the benefits of ES the HWB is measured. However, as described in Section 2.2 Quality of life, CES has a somewhat problematic definition, especially in terms of evaluation. Hence, another definition for ecosystem services, Chan et al, 2012, than the one set by MEA is used in this thesis.

This thesis does not make any claims of measuring HWB. It does measure the direct affective well-being of participants. The strength of this type of measurement is that it uses a bottom-up perspective, taking “everyday humans” emotional response to nature in account. Here, it is argued that a non-monetary value for CES can be measured by the strength of an emotional response (affective well-being) towards a service (benefit) from nature perceived by participants (CES).

Throughout the study, questions one to three have been regarded as the benefit of CES. Question four has been the evaluation (the value) of the CES. But all measurements and their locations and view directions can by themselves be perceived as CES, depending on chosen definitions. Because of the primary question “When any location gives you a positive feeling, stop” each location has, from the very beginning, been classified by that particular participant as a high valued place and therefore a high valued CES. The location is of CES important due to the fact that the participant stopped there.

6.2 Methods

The methods will be discussed in a chronological order, starting from the methods in the beginning and ending with the analysis. Comparing the methods used in this thesis with other studies has not been possible. There are only few studies which investigate CES spatially and non-monetarily. What separates this study from others is mainly the approach of classifying CES. Examples of studies which have used other approaches are; Szücs et al, 2015, where an indicator catalogue is developed where elements and applications are connected to CES. An example of the indicator catalogue item is “fruit trees which gives a diverse landscape which makes people want to paint”. This approach does not consider individuals perception of nature. Another study, Plieninger et al 2013, asked people whether they could classify which ES they considered important in their community. Here, the direct responses are not either being considered.

Many articles are recently published (2015) that adds information on the subject of CES. Cultural ecosystem services are given more attention and so are methods of how to map it. The approaches of using questionnaires are the most common method to collect information regarding CES. There are, however, few attempts to capture the spatial factor of CES (Scholte et al, 2015).

6.2.1 Phase 1

The digitized area used land classes which could be distinguished when visiting the wetland. They were kept to as few as possible, only covering those which participants might perceive as different. The recreation class consisted of an outdoor gym. The number and the types of land cover classes affect the results. If the method would be used for further studies, a standardized land cover classification would be appropriate. No ground control was taken on the classification due to the small size of the area.

6.2.2 Phase 2

Why the specific questions have been used has already been thoroughly described. There are numerous ways of how to formulate questions, which questions to use etc. Considering the specific questions used, more variables might be added or subtracted. For example, more PE could be included. There is a possibility that participants perceived elements as important which were not available as an option. However, when performing the study the participants were asked if anything was missing and most answered no to this question.

A problem which arose from the method because of the structure of the questions was such that all places were given high values of ER and EQ. This, as discussed in the analysis, made interpretation of results hard. Instead other questions might be asked which do not give this problem. Another approach is to ask opposite questions. Such as, choose two locations that are positive, and choose two locations which are negative. This is done in, Plieninger et al 2013, where participants are asked about disservices. This study shows that it is possible that people perceive nature negatively. However, if the perceived experience is to be a CES, it needs to be positive.

The results from this study are from participants who come from a similar area as the wetland. Most participants do also belong to the same social class and culture. The population collected is only 18. The results might therefore not be representative for a bigger population.

Collecting the data was done by developing a phone application. Using apps to gather data is interesting. Apps provide a platform for quick collection of data which can reach a vast amount of people. In this thesis, the app was only sent by email to participants. Other options would be to put it on the Internet for download, and to ask visitors in the wetland to perform the study. The app could even be put on an information board with a QR code for quick download. Apps are made and used more and more in a research context, especially for retrieving spatial data (Kangas et al., 2015).

The app itself could be developed further to be used in other types of research. It can also be used in similar studies, the app providing consistency for data collecting. The app would provide the same method of collecting between two studies, making it easier to compare them. The app worked fairly well in providing information of what to do for the participants. However, due to the short amount of time in which it was developed, it is not stable and needs to be more worked on if e.g. to be put on the internet for other studies.

When collecting the data the participants were asked to choose three locations. They were not given an open number, meaning that they could not chose how many or how few they would like, because the data would be inconsistent and hard to interpret. Some participants might choose ten while others only choose one. Three was arbitrarily chosen as appropriate for the size of the wetland. The participants were asked to choose the three spots carefully, thinking about what made that spot special. This is also why they were asked to walk the path two times.

6.2.3 Phase 3

The most difficult part of this thesis consisted of analysing the material. It was decided that the participants perceived the environment in the direction which were watched. It is possible that the environment which is perceived instead is an area, encircling each participant. If it is an area encircling each participant, how big would this area be? To decide on what participants observe in an area can be solved in numerous ways. The advantage of using the view direction, which is used in this thesis, is that it is possible to capture areas which the participants look at and not only areas in which they stand. There is most likely a difference whether participants want to look at the area versus if they want to stand in the area. A clear example is the wet meadow, it is nice to look at but to stand in it would be of a different nature. What is interesting is that; all participants have walked on the trail; however, the trail is one of the least frequently given PE. Participants do most likely not perceive the trail as important; it simply exists for their comfort.

Continuing on the theme of what participants actually perceive, the view direction and area of it had to be decided. Human eyes are complex features. How far the participants viewed and at which angle had to be chosen nonetheless. The distance and the angle were decided out of rationality for the given size of the area. A distance of 150 meters and an angle of 100 degrees was used. Naturally, depending on those parameters the results would end up being different.

6.3 Results

Many of the results obtained from the statistics are logical. For example, participants perceived the environment as having low “nature perception” when it was untidy. The statistics, such as the frequency and mean tables, give good information about what participants find important for positive locations. It is important to not forget that simple tests can provide useful information.

The first produced outputs in the spatial analysis, those of “overview of chosen locations” and “view direction”, provide a lot of much information. Visually, clusters can be seen where participants tend to stop and where they tend to look.

The area analysis may be prone to a few sources of errors. For EQ, “nature perception” is composed of four variables while e.g. “openness” is only composed of two. The area which contains a high value for “nature perception” is perhaps much smaller than “openness” because four variables are included instead of two. It might have been better to perform this

analysis with the original variables instead. Since the area of wet meadow and pasture covers such a high percentage of the total wetland, those cover classes contains the highest values for some of the analysis.

Question four asks the participants about their emotional response, ER. From the very beginning, participants were asked to stop at three positive places. Naturally, participants do not stop at places where they feel nervous, bored or gloomy. All values obtained do therefore contain high values for calm, glad and elated. There were no results for areas where people were gloomy or bored. It was, therefore, not possible to produce results which showed any patterns between different ER:es. The analysis might have been improved if the question would have been asked differently. For example, choose three places which are special somehow, not necessarily positive.

The variable “active to passive” in ER, is left out in some of the analysis because it could not be related to a positive response, such as “glad to gloomy” could. It is therefore not considered in the “perfect location”. This variable does instead provide some interesting results when comparing ER to land cover.

The results can be discussed and interpreted further. Considering all of the results, it seems that what participants want from a place are many things. Participants wants to have the opportunity to relax while at the same time be able to play, they want to have a feeling of being in nature while still be able to enjoy a bench, and they need to feel that the place is familiar but at the same time it must contain something which thrills their mind. If a place can have or at least give a perception of those characteristics, it will be considered as a place to enjoy, a place to improve well-being.

The results seem to be reasonable when compared with those of other studies. The reason why participants tend to stop near thickets and look towards the open areas can be explained by the “prospect and refuge” theory from Hildebrand (1991). This theory states that people choose to stand towards walls and look towards open views. At the “perfect location” it does seem like participants wants to experience animals or other plants. This can be explained by the “fascination” humans want to experience in nature. People need to be fascinated to perceive a high emotion of happiness (Aspinall et al., 2015).

Can this study be useful in the sense that its approach can be transformed for use in other wetlands or even ecosystems? The attempt to create an index and to rank the wetland is made just for this purpose. The possibility to transfer the information should be possible, if it were

to be further developed. What needs to be improved are e.g. to decide on a ranking of scores and what is the maximum and minimum score of CES which can be achieved? More parameters, such as land cover types and activities, need to be incorporated and studied

The results provide possible solutions to questions which were not asked in this thesis. It is possible to use the same methods to study what people feel at specific locations. This can be used to decide on questions such as what should be built at this location or should this location be changed to affect people differently.

There are some last parameters worth mentioning which might affect the outcome of the results. The participants could have been asked to not follow the path or to walk outside of it, into the pasture. Depending on the time of the year, such as if it is winter or summer participants may choose different locations. The weather most likely also affects the location of choice. At no time did it rain when performing the study, but it was windy. This may explain some of the reason why participants tend to stop near thickets. During the period of data collection, the highland livestock did not graze. If the livestock would have been present, participants might chose locations close to the livestock and animals would have been a more frequent answered PE.

6.4 GIS

This last part of the discussion exists to put emphasis on what GIS can provide in this type of study. Using an app that saves GPS coordinates of where participants stop provides a simple but important way to collect information regarding where people tend to stop. Retrieving the compass direction of where participants view also gives important information. Those answers could not have been obtained if not using spatial analysis and GIS. Furthermore, land cover classes can be connected to CES by using spatial analysis.

This study looks at CES in a local area and hence uses GIS at a large scale. More often are regional or national areas under study. However, in physical planning, where decisions are about local development, small areas are investigated. For municipalities, this is an especially important GIS application.

7.0 Conclusion

The very aim of this master thesis has been to develop a method to evaluate CES from people's own perceptions, by collecting data with a smart phone app and connecting CES to locations and land cover classes.

CES has been divided into benefits and values which have been transformed to questions used within the smart phone app. Questions regarding physical elements and activities are asked to capture benefits, while questions about environmental qualities and emotional response are asked to capture values. The emotional response provides a measuring tool for affective well-being.

Using the answers from the questions together with GPS coordinates and view directions has provided a method to evaluate CES and to connect it to locations.

The results shows that land cover classes can be connected to different CES. Participants tend to stand near thickets and look towards open spaces. When the environment is perceived as open and varied, participants experience the highest affective well-being.

A CES index which relates CES to locations and land cover classes has been developed. The CES index provides a possible method of ranking ecosystems in terms of CES, solely, on the basis of land cover classes.

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Appendix 1

```
// Accessing sensor in the phone
SensorManager = (SensorManager) getSystemService(SENSOR_SERVICE);

// Get location and show it to the user
mLastLocation = LocationServices.FusedLocationApi
    .getLastLocation(mGoogleApiClient);

// Show location button click listener
btnShowLocation.setOnClickListener(new View.OnClickListener() {

    @Override
    public void onClick(View v) {
        if (mLastLocation != null) {
            double latitude = mLastLocation.getLatitude();
            double longitude = mLastLocation.getLongitude();

            StringBuffer coordinates = new StringBuffer();
            coordinates.append("Coordinates are - \nLat: " +
latitude + "\nLong: " + longitude);

//Retrieve the input from the user and store it internally to use as output
private void checklugn() {

        RadioGroup radioGroup = (RadioGroup) findViewById(R.id.lugn);
        radioGroup.setOnCheckedChangeListener(new
RadioGroup.OnCheckedChangeListener() {

            @Override
            public void onCheckedChanged(RadioGroup group, int checkedId) {
                RadioButton checkedRadioButton = (RadioButton)
findViewById(checkedId);
                String text = checkedRadioButton.getText().toString();
                Toast.makeText(getApplicationContext(), text,
Toast.LENGTH_SHORT).show();

                String vald4 = text.toString();

                SharedPreferences shared4 =
PreferenceManager.getDefaultSharedPreferences(getApplicationContext());
                SharedPreferences.Editor editor = shared4.edit();
                editor.putString("vald4", vald4);
                editor.commit();

            }
        });
    }
}
```

```

<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical"
    tools:context=".MainActivity">

    <TextView
        android:id="@+id/textview1"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="20dp"
        android:layout_marginTop="20dp"
        android:layout_marginRight="20dp"
        android:text="@string/Q1"
        android:layout_gravity="center" />

    <TextView
        android:id="@+id/textview2"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="20dp"
        android:layout_marginRight="20dp"
        android:layout_marginTop="20dp"
        android:text="@string/Q1info"
        android:gravity="center" />

    <ListView
        android:id="@+id/listView"
        android:layout_width="match_parent"
        android:layout_height="0dp"
        android:layout_weight="1"
        android:layout_marginTop="20dp"/>

    <RelativeLayout
        android:id="@+id/relativeLayout1"
        android:layout_width="fill_parent"
        android:layout_height="wrap_content" >

        <Button
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:text="Save results"
            android:id="@+id/show"
            android:layout_alignParentLeft="true"
            android:onClick="showResult"/>

        <Button
            android:layout_width="wrap_content"
            android:layout_height="wrap_content"
            android:text="Next"
            android:id="@+id/tillmiljon"
            android:layout_alignParentRight="true"
            android:onClick="tillfraga2"/>

    </RelativeLayout>
</LinearLayout>

```

Appendix 2

Kön: Male

Ålder: Below 15

Question number: 3

Coordinates are -

Lat: 55.6812238

Long: 13.2038122

Kompass: 264.0

Svara på fråga 1 - The following elements are chosen:

Bush

Grass

Other plant

Water

Svar på fråga 2:

5

2

3

4

4

2

5

4

2

2

1

2

Svar på fråga 3 - Following activities are chosen:

Eating and having picnic

Play and do sports

Svar på fråga 4:

Elated

Glad

Calm

Active

Appendix 3

Home view

How you should use this app

Walk through the wetland. When any location give you a positive feeling, stop. Look at the compass to see your direction and save it. Start the questionnaire and answer the questions. Pleas wait at least 5 minutes before saving the coordinates!

When you finished, send in you answers. Do this 3 times.

For more information see info.

Info view

You should walk through the area one time and search for three areas which you find special. When you have done this, walk to your chosen locations. At the locations, get the compass direction - you can then start the questionnaire - and last save the coordinates.

Your phone will need at least 5 minutes to give accurate coordinates. Therefore you can start with the questionnaire before saving the coordinates.

After each location you should send in your answers. You need to answer all the questions in the send page every time (sex, age and question number).

Appendix 4

Participant Sex	Age	Location #	Coordinates (WGS84)		Direction	Q. 1													Q. 2										Q. 3					Q. 4				
			Latitude	Longitude		Animals	Reed	Bush	Tree	Grass	Other plant	Water	Fence	Bench	Recreation	Trail	Beauty	Diversity, va	Artificial	Tranquility	Familiar	Open	Unfamiliar	Naturalness	Noisy	Untidy	Closed	Monotonous	Eating and Play	and d	Relaxing	Exploring	Enjoy the	Elated - Bored	Glad - Gloomy	Calm - Nervous	Active - Passive	
A	F	15-30	1	55.654403	13.212347	310	0	0	0	1	0	0	1	0	0	0	0	4	4	1	5	5	5	1	4	4	1	1	1	0	0	0	1	1	3	3	3	5
			2	55.654903	13.208917	7	1	0	0	1	0	0	1	0	0	0	1	5	5	5	5	5	1	1	3	1	1	5	1	0	0	1	1	1	2	2	2	5
			3	55.656275	13.207939	340	0	1	0	1	1	0	1	0	1	1	5	5	5	5	5	5	1	5	1	1	5	1	0	0	1	1	1	2	2	2	5	
B	M	15-30	1	55.655053	13.210933	319	0	1	0	1	1	0	1	0	0	0	4	5	4	3	4	5	1	3	3	1	1	1	1	0	0	0	0	3	1	1	5	
			2	55.654469	13.205019	360	0	1	0	0	0	0	1	0	1	1	5	3	2	4	3	5	1	3	2	3	1	2	1	0	1	0	1	3	1	1	3	
			3	55.658317	13.21211	226	0	1	0	0	0	0	1	0	0	0	5	4	4	1	3	3	2	3	4	2	3	3	0	1	0	0	1	4	3	4	2	
C	F	15-30	1	55.655067	13.210989	310	1	1	1	0	1	0	1	0	0	3	3	4	3	4	5	1	2	3	2	1	2	0	0	0	1	1	3	2	2	4		
			2	55.653353	13.206261	46	0	0	1	1	1	0	1	0	0	1	3	2	3	2	4	4	1	3	2	1	1	2	0	0	1	1	1	2	2	1	3	
			3	55.656383	13.213172	27	0	1	1	1	1	0	1	0	0	0	2	2	4	2	4	4	1	2	3	2	1	2	1	0	0	0	0	1	4	3	3	3
D	F	15-30	1	55.654847	13.209417	25	1	0	0	1	0	0	1	0	0	5	4	1	5	3	4	3	5	1	1	1	2	0	0	1	1	1	2	1	1	4		
			2	55.654389	13.204575	272	0	1	0	0	0	0	1	0	1	0	5	4	2	5	4	3	2	4	1	1	2	2	1	0	1	0	1	2	1	2	3	
			3	55.656383	13.213172	300	0	0	0	0	0	0	1	0	0	1	5	4	3	4	2	5	3	2	2	1	1	1	0	0	1	0	1	2	1	1	4	
E	F	15-30	1	55.654853	13.207925	350	1	1	1	0	1	0	1	0	0	4	4	3	4	4	5	2	4	3	2	1	1	0	0	1	1	1	2	2	1	2		
			2	55.655958	13.206981	96	0	0	1	1	1	0	1	0	0	1	5	3	1	5	3	5	2	5	1	1	1	1	0	0	1	1	1	3	1	1	5	
			3	55.658394	13.211814	250	0	1	1	1	0	0	0	0	0	0	5	4	3	4	2	4	4	3	1	2	1	1	1	0	0	1	1	1	2	2	1	4
F	M	15-30	1	55.654889	13.209228	340	1	1	1	1	1	1	1	1	1	3	3	2	3	3	3	3	4	2	2	2	2	1	1	1	1	1	3	3	2	3		
			2	55.658689	13.209908	170	1	0	1	1	1	0	1	1	1	1	4	3	1	4	3	4	2	5	5	1	1	1	1	1	1	1	1	2	2	1	2	
			3	55.656386	13.213105	300	1	0	0	1	1	0	1	0	1	1	5	4	1	4	3	4	2	4	4	2	2	1	1	1	1	1	1	1	1	1	1	1
G	F	Above 60	1	55.654506	13.205956	260	0	0	1	1	0	1	0	0	1	3	3	3	3	5	3	1	3	3	2	3	2	0	1	0	0	0	2	1	1	1	1	
			2	55.658289	13.209292	112	0	0	0	1	1	0	1	0	0	1	3	4	2	1	4	4	3	4	2	1	2	1	1	1	0	1	1	2	2	1	2	
			3	55.654444	13.212944	307	1	1	1	1	1	0	1	0	0	1	4	5	2	3	4	5	1	4	2	4	1	1	1	1	1	1	1	1	2	1	1	1
H	M	Above 60	1	55.655669	13.212925	330	0	0	0	0	0	0	0	0	0	4	3	2	5	4	5	1	4	2	1	3	1	0	1	1	0	0	1	2	2	2	3	
			2	55.655039	13.211081	15	0	0	0	1	0	0	0	0	0	1	3	3	5	3	3	3	3	2	4	2	2	2	0	1	0	1	1	3	2	2	3	
			3	55.655831	13.206678	114	0	0	1	1	0	0	0	0	0	0	4	4	2	4	3	3	2	4	4	2	3	3	0	0	0	0	1	3	3	2	2	
I	F	Below 15	1	55.653383	13.212192	274	0	0	1	1	0	1	0	0	0	5	3	4	5	5	2	1	4	3	1	4	1	1	0	0	0	1	0	2	2	1	3	
			2	55.656039	13.207133	89	0	0	1	0	1	0	0	1	0	0	5	1	1	5	5	4	1	5	2	1	1	4	1	0	1	1	1	4	1	3	3	
			3	55.658681	13.209897	173	0	0	1	1	0	0	0	0	1	0	5	5	1	5	3	4	2	5	1	1	1	1	1	0	0	0	1	3	1	2	3	
J	F	46-60	1	55.654878	13.209067	301	0	0	0	1	0	0	1	0	0	4	3	3	3	5	5	1	2	4	4	1	3	0	0	1	0	1	2	2	2	4		
			2	55.656869	13.207614	186	0	0	0	1	0	0	1	0	1	0	4	3	2	4	4	3	1	4	2	3	2	3	1	0	1	0	1	3	1	1	4	
			3	55.657278	13.212817	112	1	1	1	1	0	0	1	0	0	0	3	4	2	2	4	4	1	2	4	3	1	2	0	0	0	1	1	2	2	2	4	
K	M	46-60	1	55.654772	13.208253	269	0	0	0	1	0	0	0	0	0	4	4	2	5	4	2	2	4	3	3	3	2	1	0	0	1	1	0	3	2	1	4	
			2	55.656069	13.207299	283	1	0	1	1	0	0	0	0	0	0	5	3	1	4	4	3	2	5	3	2	3	2	0	0	1	1	0	2	2	1	5	
			3	55.658692	13.210067	44	0	0	0	1	0	0	0	0	0	0	4	3	1	4	3	3	3	4	2	2	3	3	1	0	1	1	1	3	2	1	4	
L	M	31-45	1	55.654637	13.207288	343	1	0	0	1	0	0	1	0	0	3	3	2	3	2	3	3	3	3	3	3	3	0	0	0	1	1	4	3	4	3		
			2	55.654569	13.207003	331	0	0	0	0	0	1	0	0	1	1	2	4	3	3	3	3	2	3	4	2	3	2	0	1	0	0	0	2	2	3	1	
			3	55.658408	13.211775	233	1	0	1	1	1	1	0	1	1	1	1	2	3	3	3	3	3	2	4	3	1	2	3	0	0	0	1	1	3	3	2	4
M	F	Below 15	1	55.654722	13.207356	355	0	0	0	0	0	1	0	0	1	3	3	4	4	3	4	3	3	4	2	3	2	0	1	0	0	0	2	2	3	1		
			2	55.654453	13.205103	294	1	1	1	1	1	1	0	1	1	0	3	3	3	3	3	3	2	4	4	2	4	3	1	0	1	1	1	2	1	1	3	
			3	55.654594	13.207153	330	0	0	0	0	0	1	0	0	1	1	0	1	2	3	3	3	3	3	3	2	1	3	0	1	0	0	0	3	2	3	1	
N	F	46-60	1	55.654453	13.205103	294	1	1	1	1	1	1	0	1	0	3	3	3	3	3	3	2	4	4	2	4	3	1	0	1	1	1	2	1	1	3		
			2	55.656336	13.208292	187	1	0	0	1	1	1	0	1	0	1	0	3	3	3	4	3	3	3	4	4	4	3	1	0	1	1	1	3	2	2	3	
			3	55.65575	13.213239	339	0	0	0	0	0	0	1	0	0	1	0	4	3	3	2	4	4	2	3	5	2	3	3	1	1	0	0	0	3	3	3	3
O	M	46-60	1	55.655936	13.207	292	0	0																														

Appendix 5

Rotated Component Matrix^a

	Component			
	1	2	3	4
Naturalness	.881	.046	-.061	.092
Tranquility	.809	.192	.090	.139
Artificial	-.745	.121	.278	.365
Beauty	.641	.457	.148	-.028
Diversity,_variedness	.134	.894	-.121	.076
Monotonous	-.093	-.828	-.037	.284
Familiar	.044	-.137	.889	.070
Unfamiliar	.072	-.075	-.865	.146
Closed	-.024	-.018	.124	.917
Open	-.072	.166	.251	-.793

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Component Transformation Matrix

Component	1	2	3	4
1	.835	.513	-.096	-.174
2	.283	-.338	-.580	.685
3	.246	-.067	.800	.543
4	-.403	.786	-.119	.454

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

Appendix 6

```
'''
Created on 29 Apr 2015

@author: Sebastian
'''

print "Loading libraries..."
import glob, os
import math
import csv
print "Done"

"""Read file with coordinates"""
def read_coordinates():
    x = []
    y = []

    #Open the file
    with
open('C:\Users\Sebastian\Documents\GISThesis\MasterThesis\Data\updated_valu
es.txt') as f:
    header = f.readline()
    lines = f.readlines()

    #Read the coordinates separated by tab
    for line in lines:
        line = line.strip()
        parts = line.split('\t')
        x_val = float(parts[0])
        x.append(x_val)
        y_val = float(parts[1])
        y.append(y_val)
        #print parts

    return x, y

"""Read the direction"""
def read_direction():
    direction = []

    #Open the file
    with
open('C:\Users\Sebastian\Documents\GISThesis\MasterThesis\Data\updated_valu
es.txt') as f:
    header = f.readline()
    lines = f.readlines()

    for line in lines:
        line = line.strip()
        parts = line.split('\t')
        dir = int(parts[2])
        direction.append(dir)

    return direction

"""Read the variables"""
def read_variables():
    variables = []
```

```

with
open('C:\Users\Sebastian\Documents\GIS\Thesis\MasterThesis\Data\updated_valu
es.txt') as f:
    header = f.readline()
    lines = f.readlines()

for line in lines:
    line = line.strip()
    parts = line.split('\t')
    var = map(float, parts[3:])
    variables.append(var)

return variables

if __name__ == '__main__':

    #Define distance
    distance = 150

    x, y = read_coordinates()
    print "The coordinates are: ", x, y
    direction = read_direction()
    print "The directions are: ", direction
    variables = read_variables()
    print "The variables are: ", variables

    print "*****"
    """Get the variables to separate files"""
    with open("allvar.csv", "wb") as f:
        writer = csv.writer(f)
        writer.writerows(variables)
        f.close()

    with open("allvar.csv", "r") as f:
        first_var = f.readlines()
        f.close()

    for i, one_var in enumerate(first_var):
        f = open("var" + str(i+1) + ".txt", "w")
        f.write(one_var)
        f.close()

    """Get the new x coords"""
    sine = []
    for d1 in direction:
        sine.append(math.sin(math.radians(d1)) * distance)

    x_coords = []
    for x1 in x:
        x_coords.append(x1)

    #Adds the x value to the coordinates
    new_x = [a + b for a, b in zip(sine, x_coords)]

    print "new x coords: ", new_x

    """Get the y coordinates"""
    cosine = []
    for d1 in direction:
        cosine.append(math.cos(math.radians(d1)) * distance)

```

```

y_coords = []
for y1 in y:
    y_coords.append(y1)

#Adds the y value to the coordinates
new_y = [a + b for a, b in zip(cosine, y_coords)]

print "new y coords: ", new_y

print "*****"

"""Get the two more x values"""
sine1 = []
for d1 in direction:
    sine1.append(math.sin(math.radians(d1+50)) * distance)

x_coords1 = []
for x2 in x:
    x_coords1.append(x2)

#Adds the x value to the coordinates
new_x1 = [a + b for a, b in zip(sine1, x_coords1)]

print "new x + coords: ", new_x1

sine2 = []
for d1 in direction:
    sine2.append(math.sin(math.radians(d1-50)) * distance)

x_coords2 = []
for x3 in x:
    x_coords2.append(x3)

#Adds the x value to the coordinates
new_x2 = [a + b for a, b in zip(sine2, x_coords2)]

print "new x - coords: ", new_x2

"""Get the two more y values"""
cosine1 = []
for d1 in direction:
    cosine1.append(math.cos(math.radians(d1+50)) * distance)

y_coords1 = []
for y2 in y:
    y_coords1.append(y2)

#Adds the y value to the coordinates
new_y1 = [a + b for a, b in zip(cosine1, y_coords1)]

print "new y + coords: ", new_y1

cosine2 = []
for d1 in direction:
    cosine2.append(math.cos(math.radians(d1-50)) * distance)

y_coords2 = []
for y3 in y:
    y_coords2.append(y3)

#Adds the y value to the coordinates

```

```

new_y2 = [a + b for a, b in zip(cosine2, y_coords2)]

print "new y - coords: ", new_y2

"""Write the new coordinates into a new file"""
with open('try.txt', 'a') as newfile:
    new_points = [x, y, new_x, new_y, new_x1, new_y1, new_x2, new_y2]
    for x in zip(*new_points):

newfile.write("{0}\t{1}\t{2}\t{3}\t{4}\t{5}\t{6}\t{7}\n".format(*x))
newfile.close

"""Write each coordinate pair to one file"""
with open('try.txt', 'r') as f:
    first_coords = f.readlines()
    f.close()

for i, one_coord in enumerate(first_coords):
    f = open("point_" + str(i+1) + ".txt", "w")
    f.write(one_coord)
    f.close()

"""Save all outputs in new files with all values from the original
file"""
for i in range(len(new_x)):
    files = glob.glob('*_' + str(i + 1) + '.txt')
    with open("result_" + str(i+1) + ".txt", "wb") as outfile:
        for f in files:
            with open(f, "rb") as infile:
                outfile.write(infile.read())

"""Save all variables in one file to get them later"""
for i in range(len(new_x)):
    files = glob.glob('var' + str(i + 1) + '.txt')
    with open("resultvar_" + str(i+1) + ".txt", "wb") as outfile:
        for f in files:
            with open(f, "rb") as infile:
                outfile.write(infile.read())

"""Format file to be exported to GIS directly"""
with
open('C:\Users\Sebastian\Documents\GISThesis\MasterThesis\Data\updated_valu
es.txt') as f:
    header = f.readline()

allvalues = []
for i in range(len(new_x)):
    with open('result_' + str(i+1) + '.txt') as f:
        reader = csv.reader(f, delimiter="\t")
        allvalues = list(reader)

    with open('resultvar_' + str(i+1) + '.txt') as file:
        reader = csv.reader(file, delimiter=",")
        allvar = list(reader)

    firstcoords = [allvalues[0][0], allvalues[0][1], 1, allvar[0][0],
allvar[0][1], allvar[0][2], allvar[0][3], allvar[0][4], allvar[0][5],
allvar[0][6], allvar[0][7], allvar[0][8], allvar[0][9], allvar[0][10],
allvar[0][11], allvar[0][12], allvar[0][13], allvar[0][14], allvar[0][15],
allvar[0][16], allvar[0][17], allvar[0][18], allvar[0][19], allvar[0][20],
allvar[0][21], allvar[0][22], allvar[0][23], allvar[0][24], allvar[0][25]]

```

```

secondcoords = [allvalues[0][2], allvalues[0][3], 3]
thirdcoords = [allvalues[0][4], allvalues[0][5], 2]
forthcoords = [allvalues[0][6], allvalues[0][7], 4]
allcoords = firstcoords, secondcoords, thirdcoords, forthcoords

with
open("C:\Users\Sebastian\Documents\GISThesis\GISdata\Gullakra\Updatedpoints
\UPoly_" + str(i + 1) + ".csv", "wb") as f:
    writer = csv.writer(f, delimiter = ',')
    writer.writerow(header.split())
    writer.writerows(allcoords)

"""Delete unnecessary files"""
filevarone = glob.glob("allvar.csv")
for f in filevarone:
    os.remove(f)

filevar = glob.glob("var*.txt")
for f in filevar:
    os.remove(f)

filepoint = glob.glob("point_*.txt")
for f in filepoint:
    os.remove(f)

filetry = glob.glob("try.txt")
for f in filetry:
    os.remove(f)

fileresult= glob.glob("result_*.txt")
for f in fileresult:
    os.remove(f)

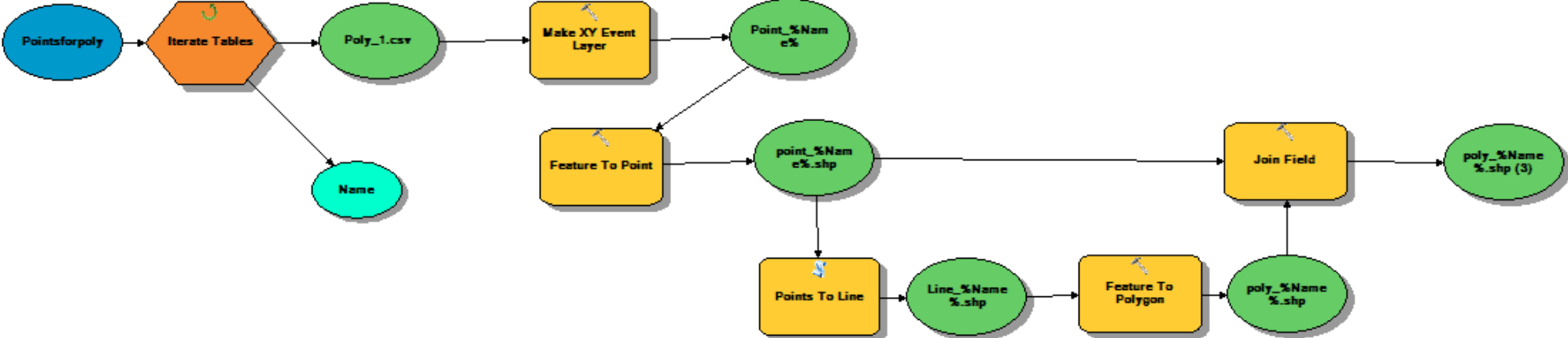
filevarone = glob.glob("resultvar_*.txt")
for f in filevarone:
    os.remove(f)

```

Output from the code

X	Y	Direction	Animals	Reed	Bush	Tree	Grass	Other_pla	Water	Fence	Bench	Recreation	Trail	Beauty	Diversity	Artificial	Tranquil	Familiar	Open	Unfamilia	Natural	Noisy	Untidy	Closed	Monoton	Eating	Play	Relaxing	Exploring	view	ElatedtoB	GladtoGlo	CalmtoNe	ActivetoP
387524.6	6169177	1	0	0	0	1	0	0	1	0	0	0	0	4	4	1	5	5	5	1	4	4	1	1	1	0	0	0	1	1	3	3	3	5
387409.7	6169273	3																																
387524.6	6169327	2																																
387376.9	6169151	4																																

Appendix 7



Appendix 8

Correlations

		Nature_perception	Varied	Well_known	Openess	Untidy	Noisy	Elated_Bored	Glad_Gloomy	Calm_Nervous	Active_Passive
Nature_perception	Pearson Correlation	1	.289*	-.063	.062	-.283*	-.340*	.039	-.245	-.376**	.305*
	Sig. (2-tailed)		.036	.652	.659	.040	.013	.781	.078	.006	.027
	N	53	53	53	53	53	53	53	53	53	53
Varied	Pearson Correlation	.289*	1	-.050	.165	-.310*	-.256	-.236	-.196	-.318*	.126
	Sig. (2-tailed)	.036		.723	.238	.024	.065	.089	.158	.020	.367
	N	53	53	53	53	53	53	53	53	53	53
Well_known	Pearson Correlation	-.063	-.050	1	.055	-.065	.074	-.172	-.074	.052	.187
	Sig. (2-tailed)	.652	.723		.694	.642	.600	.219	.601	.713	.180
	N	53	53	53	53	53	53	53	53	53	53
Openess	Pearson Correlation	.062	.165	.055	1	-.078	-.104	-.084	-.249	-.068	-.048
	Sig. (2-tailed)	.659	.238	.694		.581	.457	.550	.072	.631	.733
	N	53	53	53	53	53	53	53	53	53	53
Untidy	Pearson Correlation	-.283*	-.310*	-.065	-.078	1	.335*	.076	.062	.037	-.134
	Sig. (2-tailed)	.040	.024	.642	.581		.014	.589	.657	.793	.340
	N	53	53	53	53	53	53	53	53	53	53
Noisy	Pearson Correlation	-.340*	-.256	.074	-.104	.335*	1	.018	.311*	.198	-.093
	Sig. (2-tailed)	.013	.065	.600	.457	.014		.900	.023	.155	.508
	N	53	53	53	53	53	53	53	53	53	53
Elated_Bored	Pearson Correlation	.039	-.236	-.172	-.084	.076	.018	1	.423**	.301*	.255
	Sig. (2-tailed)	.781	.089	.219	.550	.589	.900		.002	.029	.065
	N	53	53	53	53	53	53	53	53	53	53
Glad_Gloomy	Pearson Correlation	-.245	-.196	-.074	-.249	.062	.311*	.423**	1	.432**	.172
	Sig. (2-tailed)	.078	.158	.601	.072	.657	.023	.002		.001	.219
	N	53	53	53	53	53	53	53	53	53	53
Calm_Nervous	Pearson Correlation	-.376**	-.318*	.052	-.068	.037	.198	.301*	.432**	1	-.250
	Sig. (2-tailed)	.006	.020	.713	.631	.793	.155	.029	.001		.071
	N	53	53	53	53	53	53	53	53	53	53
Active_Passive	Pearson Correlation	.305*	.126	.187	-.048	-.134	-.093	.255	.172	-.250	1
	Sig. (2-tailed)	.027	.367	.180	.733	.340	.508	.065	.219	.071	
	N	53	53	53	53	53	53	53	53	53	53

*. Correlation is significant at the 0.05 level (2-tailed).

** Correlation is significant at the 0.01 level (2-tailed).

Appendix 9

Descriptives - Relaxing

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Nature_perception	.0	24	3.1354	.83399	.17024	2.7833	3.4876	1.50	5.00
	1.0	29	3.9310	.70361	.13066	3.6634	4.1987	2.50	5.00
	Total	53	3.5708	.85678	.11769	3.3346	3.8069	1.50	5.00
Varied	.0	24	3.7292	.75151	.15340	3.4118	4.0465	2.50	5.00
	1.0	29	3.7759	.90224	.16754	3.4327	4.1191	1.50	5.00
	Total	53	3.7547	.82987	.11399	3.5260	3.9835	1.50	5.00
Well_known	.0	24	3.8958	.73690	.15042	3.5847	4.2070	2.50	5.00
	1.0	29	3.8448	.85673	.15909	3.5189	4.1707	2.00	5.00
	Total	53	3.8679	.79754	.10955	3.6481	4.0878	2.00	5.00
Openess	.0	24	3.9167	.82970	.16936	3.5663	4.2670	2.00	5.00
	1.0	29	3.8448	1.02734	.19077	3.4540	4.2356	1.00	5.00
	Total	53	3.8774	.93493	.12842	3.6197	4.1351	1.00	5.00
Untidy	.0	24	1.750	.6757	.1379	1.465	2.035	1.0	3.0
	1.0	29	1.862	.9901	.1839	1.485	2.239	1.0	4.0
	Total	53	1.811	.8561	.1176	1.575	2.047	1.0	4.0
Noisy	.0	24	3.083	.9286	.1896	2.691	3.475	1.0	5.0
	1.0	29	2.414	1.2397	.2302	1.942	2.885	1.0	5.0
	Total	53	2.717	1.1499	.1579	2.400	3.034	1.0	5.0

ANOVA - Relaxing

		Sum of Squares	df	Mean Square	F	Sig.
Nature_perception	Between Groups	8.313	1	8.313	14.198	.000
	Within Groups	29.859	51	.585		
	Total	38.172	52			
Varied	Between Groups	.029	1	.029	.041	.841
	Within Groups	35.783	51	.702		
	Total	35.811	52			
Well_known	Between Groups	.034	1	.034	.053	.819
	Within Groups	33.041	51	.648		
	Total	33.075	52			
Openess	Between Groups	.068	1	.068	.076	.784
	Within Groups	45.385	51	.890		
	Total	45.453	52			
Untidy	Between Groups	.165	1	.165	.222	.640
	Within Groups	37.948	51	.744		
	Total	38.113	52			
Noisy	Between Groups	5.887	1	5.887	4.776	.033
	Within Groups	62.868	51	1.233		
	Total	68.755	52			

Appendix 10

Chi-Square Tests Grass * Eating

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	6.839 ^a	1	.009		
Continuity Correction ^b	5.466	1	.019		
Likelihood Ratio	6.997	1	.008		
Fisher's Exact Test				.013	.009
Linear-by-Linear Association	6.710	1	.010		
N of Valid Cases	53				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 11.28.

b. Computed only for a 2x2 table

Chi-Square Tests Exploring * Animals

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	11.348 ^a	1	.001		
Continuity Correction ^b	9.444	1	.002		
Likelihood Ratio	12.572	1	.000		
Fisher's Exact Test				.001	.001
Linear-by-Linear Association	11.134	1	.001		
N of Valid Cases	53				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 7.70.

b. Computed only for a 2x2 table

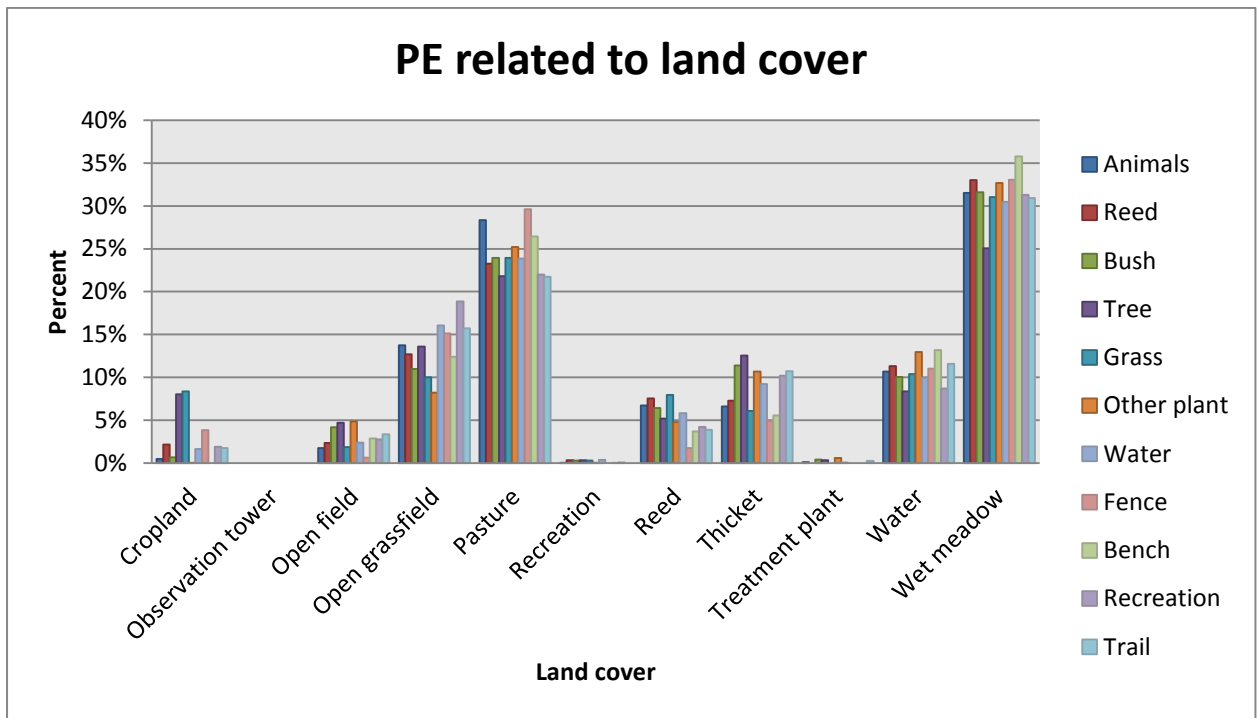
Chi-Square Tests View * Reed

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	7.848 ^a	1	.005		
Continuity Correction ^b	6.178	1	.013		
Likelihood Ratio	9.392	1	.002		
Fisher's Exact Test				.005	.004
Linear-by-Linear Association	7.700	1	.006		
N of Valid Cases	53				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.43.

b. Computed only for a 2x2 table

Appendix 11



Master Thesis in Geographical Information Science

1. *Anthony Lawther*: The application of GIS-based binary logistic regression for slope failure susceptibility mapping in the Western Grampian Mountains, Scotland. (2008).
2. *Rickard Hansen*: Daily mobility in Grenoble Metropolitan Region, France. Applied GIS methods in time geographical research. (2008).
3. *Emil Bayramov*: Environmental monitoring of bio-restoration activities using GIS and Remote Sensing. (2009).
4. *Rafael Villarreal Pacheco*: Applications of Geographic Information Systems as an analytical and visualization tool for mass real estate valuation: a case study of Fontibon District, Bogota, Columbia. (2009).
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