CZECH UNIVERSITY OF LIFE SCIENCES

FACULTY OF ENVIRONMENTAL SCIENCES

DEPARTMENT OF LANDSCAPE AND URBAN PLANNING

MASTER THESIS WORK:

HUMAN PERCEPTION OF NATURE: CONNECTIONS BETWEEN EMOTIONS AND VEGETATION BIODIVERSITY

LIDSKÉ VNÍMÁNÍ PŘÍRODY: PŘIPOJENÍ MEZI EMOCI A VEGETAČNÍ BIODIVERZITA

Author: Olha Almashy

Thesis Supervisor: Doc. Peter Kumble

Diploma Thesis

2021

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Environmental Sciences

DIPLOMA THESIS ASSIGNMENT

Bc. Olha Almashy

Landscape Engineering
Landscape Planning

Thesis title

"Human perception of nature: the connection between emotions and vegetation biodiversity".

Objectives of thesis

Understanding the significance of how people see their surroundings and which key characteristics of nature are more desirable than others, this study focuses on human emotional responses to biodiversity and leads to the research questions:

- Do different levels of biodiversity have an effect upon the psychological and emotional state of humans?
- How can biodiversity contained within green spaces be measured using 2D photography?

The general purpose of this master thesis has been:

- To clarify possible measurement methods for estimating "amount" of biodiversity.
- To formulate a concept of biodiversity's effects on human psychological state depending on its level.

Methodology

To achieve the aim of this study, an online questionnaire study will be used to interview participants. A survey will be created in English; using Google Forms the survey will gather responses of students mainly from natural sciences and design curriculums. The survey will also be posted on social media platforms (Facebook, in the public group called Dissertation Survey Exchange). There are some advantages and dis- advantages to using this method. The advantage of using an online survey might be that it is a fast and cheap tool for researchers to collect feedback, quick to analyse and easy in use for both researchers and participants. But there are also some disadvantages, such as differences in interpretation and understanding, issues with identifying people's true emotions without seeing them.

The interviews will be conducted from the middle of January 2021 till the begging of March 2021. Participation will of course be voluntary and all data will remain confidential.

The proposed extent of the thesis

65 pages

Keywords

biodiversity, human perception, estimating biodiversity

Recommended information sources

Carrus G, Scopelliti M, Lafortezza R, Colangelo G, Ferrini F, Salbitano F, Agrimi M, Portoghesi L, Semenzato P, Sanesi G (2015) Go greener, feel better? The positive effects of biodiversity on the well-being of individuals visiting urban and peri-urban green areas. Landsc Urban Plan 134:221–228

Johansson M, Gyllin M, Witzell J, Küller M (2014) Does biological quality matter? Direct and reflected appraisal of biodiversity in temperate deciduous broad-leaf forest. Urban For Urban Green 13:28–37

Kaplan, Rachel, Kaplan, Stephen & Ryan, Robert L. (1998). With people in mind : design and management of everyday nature. Washington D.C: Island Press.

Kaplan, Stephen. (1995) The restorative benefits of nature: toward an integrative framework. J Environ Psychol 15(3):169–

Expected date of thesis defence

2020/21 SS – FES

The Diploma Thesis Supervisor

doc. Peter Kumble, Ph.D.

Supervising department

Department of Landscape and Urban Planning

Electronic approval: 2. 3. 2021

prof. Ing. Petr Sklenička, CSc.

Head of department

Electronic approval: 3. 3. 2021

prof. RNDr. Vladimír Bejček, CSc.

Dean

DIPLOMA THESIS AUTHOR'S DECLARATION

I hereby declare that the research presented in this thesis is my independent original work under the supervision of doc. Peter Kumble. All literature and publications are listed in Reference chapter.

31.03.2021

Olha Almashy

ACKNOWLEDGEMENTS

Firstly, I would like to thank my supervisor, Peter Kumble, for inspiring me and support during the past three years and leading me in the right direction. Secondly, I would like to express the gratitude to Hiroyuki Sasaki from the National Institute of Livestock and Grassland Science, Japan for providing the “Software for fractal analysis”. Furthermore, I would like to thank all my teachers at CULS and also SLU for encouraging challenging my opinions during classes that influenced this thesis content. I would also like to thank every person who participated in this research as a survey participant or distributor. And last, but not least, huge thanks to my family, friends and classmates who always were ready to help, critique and motivate.

ABSTRAKT

Pochopení principů toho, jak lidé vnímají své okolí, kdy určitý typ okolí vyvolává konkrétní, specifické emoce, může být zcela významné. Tento výzkum se zaměřuje na emoční reakce člověka na vegetační biodiverzitu a možné metody odhadu vegetační biodiverzity z 2D fotografií. Výsledky ukazují jasnou souvislost mezi emocionální reakcí a vizuální složitostí spíše než v souvislosti s vegetační biodiverzitou, která tvrdí, že lidé plně prožívají krajinu. Existují také některé konkrétní přírodní faktory, které mohou ovlivnit lidské vnímání krajiny jako blesk, údržba zeleně a existující vodní prvky s odlišným stavem vodní hladiny. Rovněž byla specifikována doporučení pro budoucí výzkum a navrhování krajiny.

KLÍČOVE SLOVA

Biodiverzita, lidské vnímání, odhad biodiverzity.

ABSTRACT

Understanding the principles of how people perceive their surrounding and which particular emotions those surroundings evoke can be completely significant. This research focuses on the human emotional responses to vegetation biodiversity and possible methods of estimating vegetation biodiversity from 2D photographs. The outcomes show clear connection between emotional response and visual complexity rather than vegetation biodiversity claiming that people experience landscape fully. There are also some particular factors that could influence human perception of the landscapes as lightning, maintenance and existing of water features with different state of water. Recommendations for the future research and design of outdoor landscapes were also specified.

KEY WORDS

Biodiversity, human perception, estimation of biodiversity.

CONTENT

1. INTRODUCTION

People and nature are two momentous components, changing and shaping one another due to mutual actions (Tress and Tress, 2001). Those interactions and relationships between them are the main research focus of environmental psychology (Steg et al., 2013). Certainly, cultural and personal differences influence those relationships, but studies are proving that the human-nature bond is primal (Wilson, 1984).

Living the 21st century lives the fingerprint on our habits and the amount of time that we spend in nature (Gullone, 2000). The majority of us do not need to grow grain or graze livestock to survive as our ancestors did. Nowadays people enjoy interaction with nature in terms of gardening, going on a hike or just chilling with friends in park. They do it not for need but pleasure. Those are just more signs of how substantial the human-nature relationships are. Spending time in nature not only improve immune and cardiovascular functions, strengthen social interactions, but also has a therapeutic effect (Foo, 2016; Scopelliti et al., 2012). Several studies showed pieces of evidence of improving human's psychological and physical health while interacting with nature, nonetheless, the biodiversity aspect is not understood enough (Young et al., 2019). Therefore an assumption that changes in biodiversity could influence human mental state is fairly rational. To reduce stress and create more restorative everyday places for inhabitants in cities, and to make them more environmentally friendly, it is crucial to understand which specific emotions vegetation biodiversity evokes. In turn, this could determine the number of principles that could be used by landscape architects and environmental psychologists in their practice. Accordingly, this research focuses on two main distinguished forms of human emotional responses to biodiversity – understanding and exploring, experiencing calm or active emotions.

This research investigated human emotional responses while observing the 2D photographs contained with different levels of biodiversity and did not rely on the capacity of participants to estimate it precisely. Thus the question "Is the grass always greener on the other side" was not the main concern of the current research but what emotions does that "grass" evoke.

Knowing a particular emotion and the trigger that evoked it could help landscape architects in their practice by predicting the emotional state that person would likely feel in a specific environment.

2. OBJECTIVES

Understanding the significance of how people see their surroundings and which key characteristics of nature are more desirable than others, this study focuses on human emotional responses to biodiversity and leads to the research questions:

- Do different levels of biodiversity have an effect upon the psychological and emotional state of humans?
- How can biodiversity contained within green spaces be measured using 2D photography?

The general purpose of this master thesis has been:

- To clarify possible measurement methods for estimating "amount" of biodiversity.
- To formulate a concept of biodiversity's effects on human psychological state depending on its level.

3. LITERATURE REVIEW

The goal of the literature review is to highlight existing theoretical frameworks of human perception towards nature. It does this by identifying the main aspects of human landscape preferences using the measure of one's the perception of vegetation biodiversity. Literature was obtained from scholarly online databases found in the CULS and SLU University Libraries, Science Direct, SCOPUS, EBSCO, and others scholarly search engines.

3.1. THEORETICAL FRAMEWORKS OF HUMAN PERCEPTION OF NATURE

Human beings have demonstrated the essential connection to and dependence upon nature since the beginning of time. Early humans were using flora and fauna for survival, making shelters from big trees and bones, hunting animals for protein from their flesh and clothing from their hides, and picking mushrooms and berries for food, exploiting water bodies as sources of fresh water and navigation for trade (Heerwagen, 2009). Their lives depended on access to and the availability of natural resources. But today this is much less so. Existence of multi-millionth cities proves that people can live a decent life in the epicentre of highly urbanised areas: they can buy food, not be afraid of predators and use water from the tap. In this context, urbanization is a process which "consumes" more people and forcing them to live in highly dense areas. Some studies showed that there is a connection between high-density areas and stress caused by it (Grahn and Stigsdotter, 2003; Sörqvist, 2016). It also demonstrates that stress-related feelings are evoked less if participants are more

often visiting urban green areas. Previous studies could represent a bond between nature and mental well-being. To diminish the impacts of densely populated areas and create restorative places for inhabitants in cities, the knowledge of how people experience surroundings and which particular features are more preferable in an outdoor restorative environment than others is substantial. Here sensation is the way how people are experiencing their surroundings and exploring space and perception is the meaning of their sensations, emotions that it evokes (Wolfe et al., 2015).

There are few theoretical frameworks which represent the human perception of nature such as The Biophilia hypothesis, the Preference Matrix, Stress Reduction Theory, Attention Restoration Theory, and fractal geometry (Marselle, 2019). These are summarized below:

3.1.1 THE BIOPHILIA HYPOTHESIS

Wilson (1984, p.1) identified biophilia as a hypothesis of "the innate tendency to focus on life and lifelike processes". Innately, here, means a part of human nature, genetically based. Despite biophilia found great support from other interdisciplinary fields; few studies took a critical examination of this hypothesis (Kahn, 1997; Joye and de Block, 2011). The critique is mostly based on the fact that biophilia is still claimed to be a hypothesis and arises a doubt regarding the scientific value of it (Joye and de Block, 2011). The main ideas are that its definition is vaguely described and also misunderstood by the majority of researchers who talked about it in terms of "effective affiliation", but no tendency to focus in life and lifelike processes where last are not well specified. Adequately, researchers do not claim that the biophilia hypothesis is completely wrong, but they do claim that the empirical and conceptual study on biophilia is sloppy.

The work of Joye and de Block (2011) were heard and already in 2013, Kellert and Wilson (2013) defined Biophilia as a hypothesis of "the innately emotional affiliation of human beings to other living organisms". Researchers assumed that somehow human identity connected to its relationship with nature and people are predisposed to psychologically affiliate with living organisms.

3.1.2 THE PREFERENCE MATRIX

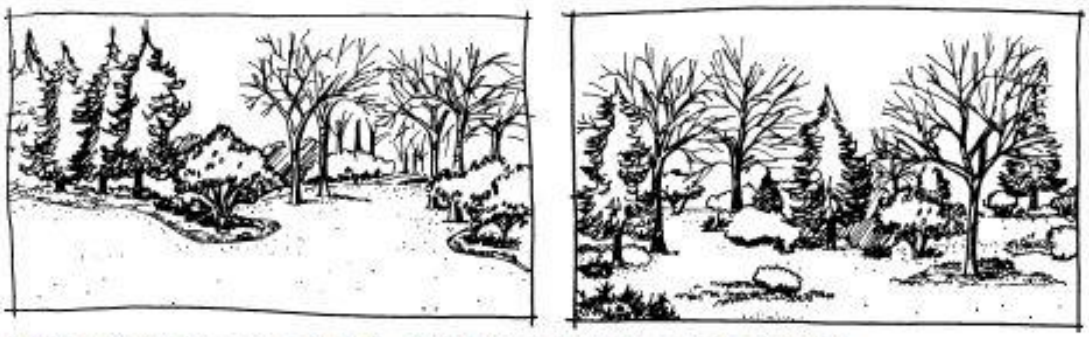
The Preference Matrix developed by Kaplan et al. (1998), also known as the understanding-and-exploration framework established that people's desire of getting information from their surrounding environment was crucial to their sense of well-being. The research was based on the people's responses to photos with the natural environment and showed that there are particular key elements which trigger the person to like (scenes with high preference) or dislike (scenes with low preferences) specific space. Despite using a two-dimensional view and light aspect which would be not the same in real life, researchers refer to the way how people see and perceive pictures with the natural environment. They highlight the four most important factors which are Coherence, Complexity, Legibility and Mystery, where first two are

corresponded to the 2D view and last two to the 3D by imagining respondent within the place (table 1).

Table 1 Preference Matrix

Understanding	Exploration
Coherence	Complexity
Legibility	Mystery

Even small amounts of these qualities could change how a person perceives some scenes. Here coherence is a factor that represents areas organized in an order where scenes are easily understood (Pic.1).



High-coherence scene at left, and low-coherence scene at right.

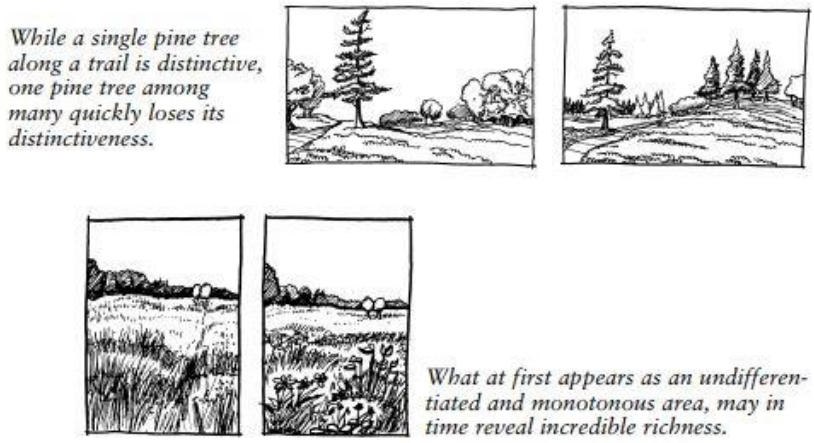
Pic.1. Example of coherent landscape. Source: (Kaplan et al.,1998)

Complexity, by comparison, shows the richness of landscape elements. Nevertheless, some complex areas could also be coherent (Pic.2).

High complexity and still coherent.

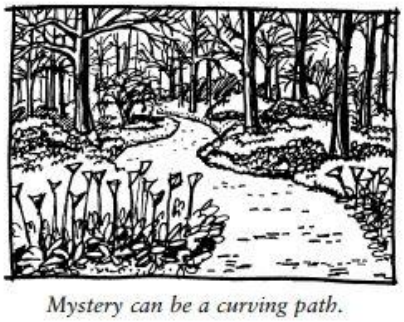
Pic.2. Example of complex landscape. Source: (Kaplan et al.,1998)

Legibility represents areas which are most distinctive, clear and memorable (Pic.3).



Pic.3. Example of legibility landscape. Source: (Kaplan et al.,1998)

Mystery, for its part, is a 'promise' of exploring furthermore places containing curvy paths, vegetation behind each other, or obscured views (Pic.4).



Pic.4. Example of mystery landscape. Source: (Kaplan et al.,1998)

This framework supports the biophilia hypothesis in some ways but also demonstrates that not all natural features are equally preferred.

3.1.3 STRESS REDUCTION THEORY

Stress Reduction Theory described by Ulrich et al. (1991) originates from the study by Ulrich (1979) of the connection of seeing landscapes and psychological well-being. The study was based on responses of 46 students to both natural and urban environments and gave results that different emotional states were evoked. Viewing nature scenes showed a significant difference in perceiving positive emotions compared to American urban scenes. In his discussion, he highlights gaps in this research and already in 1991; study about "Stress recovery during exposure to natural and urban environments" was published.

SRT (Ulrich et al., 1991) represents a positive psychological and physiological impact on human beings while viewing a natural environment. The research-based on physiological measures such as heart period and pulse transit time after viewing

videotapes with natural and urban settings claims that greater recovery of 120 subjects was influenced by nature compared to the urban environment. Researchers explained it in a way that physiologically and psychologically people are more adapted to natural environments than urban due to the long term of living in it (Ulrich et al., 1991). Reduced level of stress while being in or observing natural vegetated landscapes also could be explained as a result of the sense of securing from food scarcity or danger from predators (Joye and de Block, 2011). Apart from stress reduction, Ulrich also assumes that some environmental features evoke particular initial affective reaction as like/dislike without conscious thinking (Figure 3.1).

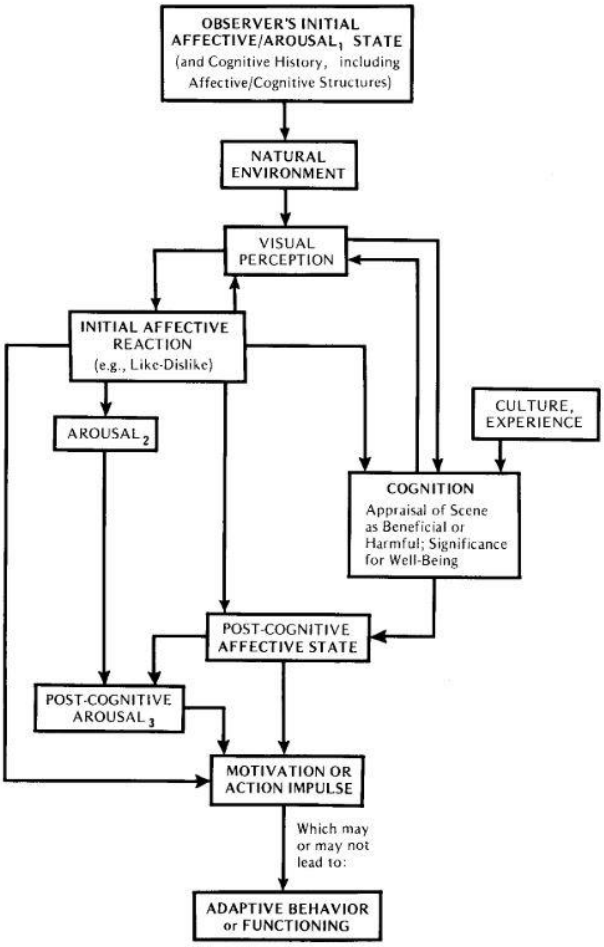


Figure 3.1. Model of affective/arousal response to a natural environment.
Source: (Ulrich, 1983)

Other studies went further and started to examine differences in stress reduction due to different types of landscape. By results of Annerstedt et al. (2010), a hypothesis that broadleaf forests could have higher therapeutic value compared to coniferous in terms of lowering stress showed that there could be significant differences in stress reduction due to the characteristic of the place and landscape elements. This could be explained that character of broadleaves forest is quite similar to those found the savannah landscapes, the most preferable type of landscape by Falk and Balling (2010).

3.1.4 ATTENTION RESTORATION THEORY

Attention Restoration Theory of Kaplan (1995) provides an analysis of relationships between restorative experience and natural environments. This framework represents cognitive mechanisms and suggests that humans have a limited capacity to direct their attention. Mental fatigue here is a feeling of tiredness or information overload with symptoms of having difficulties to focus, irritability. To restore human effectiveness from mental fatigue Kaplan et al. (1998) highlighted four components of restorative environments such as:

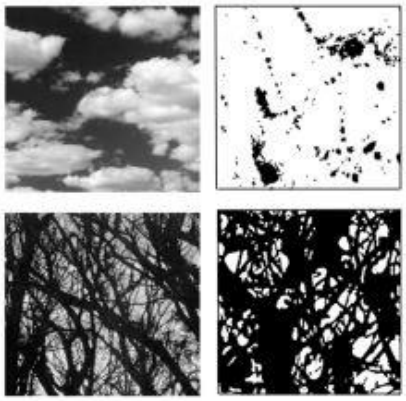
- *Being away.* Here it means recovering by being away from the source of mental fatigue, but not a compulsory distant place, for example looking out a window. Still, the best places for being away are wild places as the seaside, forests, mountains, lakes. Important to notice that "being away" is not equal to "being away in a nice place". Therefore just by this component restorative experience cannot be created.
- *Fascination.* "Fascination" is the central aspect of recovery from mental fatigue. It is a capability of the environment or objects to attract attention. The fascinating environment does not always consist of attracted elements of flora or fauna, but also could be represented as a natural process within some space as growth, survival or predation.
- *Extent.* A component which represents the feeling of being in a whole different world. A well-designed area could also have this aspect even within small scale as a garden.
- *Compatibility.* The concept that provides links between human inclinations and characteristics of the environment.

Researchers also mention that natural environments mostly have all four of these components within; therefore this could explain why people do feel mental recovery after being in nature.

3.1.5 FRACTAL GEOMETRY

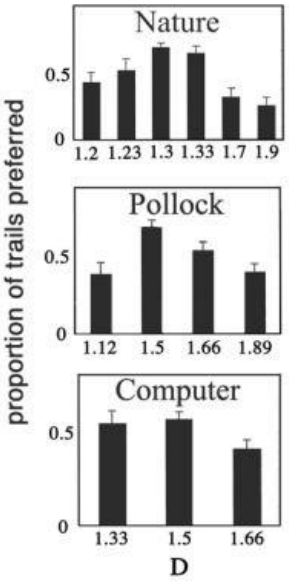
The human perception of nature is strongly connected to the informational aspect in surroundings (Kaplan et al., 1998). The fractals here represent "understanding" by repeating the pattern which for its part makes it easier to perceive (Joye and van den Berg, 2013).

The study of Mandelbrot from 1982, described in Bourke (1991) defines fractal as "a rough or fragmented geometric shape that can be subdivided into parts, each of which is (at least approximately) a reduced/size copy of the whole". The main parameter to evaluate visual complexity is a fractal dimension (D) that explains how the patterns emerge in creating a fractal shape. D lies between one and two, where 1 - smooth line (without fractal structure) and 2 - wholly filled area (also without fractal structure), and determines how complex and rich the structure is (Pic.5) (Taylor et al., 2005).



Pic.5. Examples of different fractal patterns: natural scenery (top left) and drip painting (top right) with D=1.3, a forest (left bottom) and Pollock's painting Untitled 1950 (right bottom) with D=1.9. Source: (Taylor et al., 2005)

A study by Taylor et al. (2005) examined human response to the visual qualities of the fractal. Fractal computer-generated images of different fractal patterns as natural, mathematical and human processes were shown to 24 subjects after direct attention tasks as a minute recovery period. The results have shown that it is not the "naturalness" that impact on stress reduction but the pattern of a fractal dimension where aesthetic quality corresponds to visual complexity. Results of the study indicated according to fractal dimensions and type of pattern, visual preference varied: where low preferences received images with D = 1.1-1.2; 1.6-1.9 and high preferences with D=1.3-1.5 (Pic.6)



Pic.6. Visual preference representation for natural fractals (top), Pollock's (middle), computer (bottom) with D. Source: (Taylor et al., 2005)

A study conducted by Stevens from 2018, discovered that there is a connection between fractal dimensions of a tree silhouette and species richness. The outcome of the study confirmed that D scores corresponded to the habitats with a high amount of species were higher compared to the habitats with a low amount of species. This is significant because it means that an amount of biodiversity can be measured, thus leading to the next question: could the fractal geometry theory predict human preferences in nature? A study conducted by Spehar et al. from 2003, described in Marselle (2019) proves that the mid-range of the D score was preferred the most regarding when they were natural, human or computer made.

It should be noted that there is no study which is aimed to use fractal geometry theory for creating environments in fields of Landscape Architecture or Landscape Design. Although the study of Joye (2007) described an approach of using natural shapes, colours and textures for build environment, nature here rather inspiration than applied method.

All frameworks analyzed above describe the connection between human perception and nature; however there is no framework which describes the relationship between human perception and biodiversity.

3.2 NATURE AND HUMAN PREFERENCES

Understanding human's preferences to natural objects or features could lead us to a deeper awareness of creating a restorative everyday environment. Some researchers showed that there was a strong connection between trees and humans. Cele (2005) in her study about children wrote that trees were one of the most apparent objects in the environment that the majority of children reflected on; using them as a landmark, doing physical activities like climbing, etc. Some of them described the pleasant aesthetic value, making photos with trees, others reflected on an intimate connection as behaving with respect. Experiencing the landscape is not just what we see, but mostly what we feel there. And an important part of decision-making whether people like something or not are colour and form. This subchapter was written by author during courses "Explorations into Landscape Architecture" and "People and environment" at Swedish University of Agricultural Sciences (Almashy, 2019, unpublished; Almashy, 2020, unpublished).

3.2.1 COLOUR PREFERENCES IN NATURE

Human perception to the different colours of vegetation differs depending on specific colour characteristics such as contrast, hues and light, the relative distance between the objects and the viewer, time and seasonal change, and demographic characteristics as age, gender, cultural background and personal preferences (Oleksiichenko et al., 2018; Thorpert and Nielsen, 2014). There have been made a few studies that document human preferences to the colour of the leaves on trees. Kaufman and Lohr (2004), affirmed that green and red trees were rated with the majority of positive responses, regardless of the hue and intention, while orange and

brown trees, on the other hand, received - negative responses. Even so, this could be explained as a connection of tree colour with human's unconsciousness; tree colour could be a hint to survival message meaning that tree colour allows humans to camouflage from the predators (Lohr, 2010). Another study made in Japan about different foliage colours and people's perception of it concluded that different colours of leaves evoked specific emotions. The white-green gave the feeling of expansion, the yellow-green evoked feelings of happiness, the bright-green - pleasure and inspiration, the dark-green had the majority of responses as the calmest and natural (Sadek et al., 2013). Different studies of people's perception of the colour of trees showed that the most preferable is green, evoking feelings of comfort and represent health (Kaufman and Lohr, 2004; Lohr, 2010). So the main human preference to the tree colour has been seen, but studies that describe an emotional aspect have not been found. Even so, the majority of studies about colour preferences have similar results. However, the same cannot be said about studies of the tree forms.

3.2.2 HABITAT PREFERENCES IN NATURE

The study of Balling and Falk from 1982, described in Lohr (2010), found out that there is a difference between the preferable type of landscape for children and adults. For children it was a savannah's type mostly as an innate unconscious preference, however, adults had both: innate and learned preferences. This could be explained that savannah's tree shape with a low trunk, broader than the tall canopy, associated with safety from predators and survival (Lohr, 2010). The study of Lohr and Pearson-Mims (2006) confirmed the same results; observing trees with spreading crown made people feel happier than observing trees with columnar and rounded forms. The study of Summit and Sommer from 1999, described in Lohr (2010), concluded that conical and columnar tree forms are less preferred compared to spreading and globular. In return, another study of Muderrisoglu et al., from 2006, described in Müderrisoğlu et al. (2009) presented results that the most preferable were pyramid-formed trees and the least – spread-formed. It is important to mention that researchers investigated both colour and tree form in this study, and concluded that combination could provoke changes in preferences. Due to their study, blue round-formed trees, bright coloured trees as yellow, etc. with columnar and spreading form and green pyramidal formed trees took the highest ratings. Green colour, except in combination with pyramidal formed trees, affected more negatively than others. Concluding all these studies could give us an answer to people's preferences in tree form and colour, but it will not reply to what exactly they feel.

3.2.3 STRUCTURE PREFERENCES IN NATURE

The same issue occurs with vegetation structure. Some efforts have been made to analyse the possible impact of landscape structure on human perception (Brown and Daniel, 1986). Nonetheless, the study by author from 2020 confirms that tree

compositions with few levels of vegetation rapidly increase the number of positive responses compared to tree compositions with just one layer with identical trees.

3.3. HUMAN PERCEPTION OF VEGETATION BIODIVERSITY

Except for the impact of biodiversity on the physical state of humans in terms of allergies, biodiversity also influences our mental and spiritual state (Marselle, 2019). There are studies about human perception of nature and some key elements of it as colour and form, but there are just a few about human perception of biodiversity.

Biodiversity is “the variety of life on Earth, it includes all organisms, species and populations; the genetic variation among these; and their complex assemblages of communities and ecosystems” (Raffaelli, 2017). The definition includes humans and animals, but in this research, the focus will be just on vegetation. From an ecological perspective, all species supposed to be equal, not taking into account rare species with privilege in protection. Although some species that could be desirable from an ecological perspective, it is important to remember that they might be dangerous or harmful to people (Sjerp de Vries and Robbert Snep, 2019). Consequently focus in this study is on biodiversity but from a psychological perspective.

3.3.1 MEASURING BIODIVERSITY

Majority of researches made in the environmental psychology field focussed on access and availability of nature more than characteristics of natural environments or level of biodiversity (Hartig et al. 2014). Still, it's important to mention that the process of measuring biodiversity can be tricky. Being unable to measure it, this could also influence understanding of rating level of interviewers as there is no specified actual level of biodiversity and responses could rely on personal perceptions (Sjerp de Vries and Robbert Snep, 2019). Not always information on the amount of biodiversity as a variety of species could be taken; the concept of actual versus perceived biodiversity will take place. Perceived biodiversity could depend on the visibility of different species but this would not mean that the area has a low or high level of biodiversity at the first place. Here actual biodiversity is the number of species within a particular area when perceived biodiversity is the visibility of different species (Sjerp de Vries and Robbert Snep, 2019). By the study of Dallimer et al. from 2012, described in Sjerp de Vries and Robbert Snep (2019) precisely perceived biodiversity might influence human psychological state compared to actual. Study by Marselle et al., from 2016 additionally concluded that perceived biodiversity does not influence human emotional well-being directly but does it indirectly over the perception of the restorative environmental quality.

To measure the amount of biodiversity few aspects were highlighted as visual complexity and species richness/species evenness.

3.3.2 VISUAL COMPLEXITY

A study conducted by Ode et al. (2008) made links between the indicators of complexity and landscape preferences and perception, referring to Kaplan's theory (1989, p.14), where complexity is a "richness of elements in the setting". Authors describe indicators of complexity as:

- Distribution of Landscape Attributes – represented by the richness of landscape elements and diversity of land cover;
- Spatial Organization of Landscape Attributes – represented by the way how landscape attributes could be arranged in the environment;
- Variation and Contrast – represented by the degree of contrast, shape and size variation.

Study of Wohlwill (1968), described in Falk and Balling, 2010 has shown the intermediate complexity level to be the most preferred, although for natural landscapes "the effect was weak". Kahn (1997) argued that yet a high level of complexity does not increase the preference by itself. The researcher cited S.Kaplan, 1992 (p.595) "it is not quite clear that there is more to experimental aesthetics than optimal complexity".

An earlier study by Kaplan et al. (1972) described the connection between perceived complexity level and preference. Results of the study remain distinct for urban and natural environments where urban slides were rated as more complex than natural, and researchers claimed that "complexity ratings cannot account for preference across the various scenes" even high complexity rating were correlated to higher preference ratings for both, natural and urban settings.

Some studies have not found any connection between the complexity level and emotional response. Study of Jorgensen et al. (2010) described in Marselle et al. (2019) represents no differences in mood between three green spaces which differ by complexity.

Taking into consideration the controversial results of experiencing complexity in the landscape, it should be noted that the term "complexity" could be used to describe biodiversity in terms of species' richness.

3.3.3 SPECIES RICHNESS

Still, some studies have shown the effect of species richness on mental-wellbeing. Study of Wolf et al. (2017) provides results of people responding positively more to environments with higher biodiversity (four trees on the video) than to environments with low biodiversity (one tree on the video) or urban environments where biodiversity means plant and animal species richness. Using trees and birds on videos to represent species richness, they assumed that results could be eligible for different flora and fauna. Similar results were presented by the study of Carrus et al. (2015) where greater positive effects on well-being were achieved by being in the

environment with high biodiversity compared to low. Here researchers selected four types of green areas with the difference in location (urban versus peri-urban) and level of biodiversity (high versus low).

Study of Johansson et al. (2014) shows that between the high, low and medium level of biodiversity of three broad-leaves forest biotypes, while all presented biotopes received positive emotional responses, photo with the medium level of biodiversity was rated higher followed by high and low thereafter.

However, there are studies that prove another point. Study by Damllimer et al. (2012) claims that there are "no consistent relationship between human well-being and actual species richness"; even more researchers found that well-being decreased when plant richness was higher. Although that could not be said about bird species richness, where well-being increased while estimating bird species richness and no pattern was found for butterfly species richness. Researchers explained that possible reason of this phenomenon could be that human's ability of biodiversity-identification is generally poor.

All frameworks written above describe the connection between people and nature, but just few of them referring to emotions that people perceive during time in nature. Regarding biodiversity aspect, not so many studies were made and this aspect should be investigated more. Moreover, to investigate level of the biodiversity from the 2D photographs only, new methodology should be prepared and described.

4. METHODOLOGY

This chapter will introduce a description of the proposed and chosen methodology used and explain the logic behind why it was selected. As presented in the Introduction of this thesis the goal of the research is to evaluate the human perception of vegetation biodiversity. The driving hypothesizes are those:

(1) there is a different emotional response to views with different "amount" of biodiversity

(2) environments with a high level of biodiversity evoke strong feelings, such as “excitement” or a “desire to explore” while

(3) environments with a low level of biodiversity will evoke calm feelings.

4.1.PREVIOUS METHODOLOGIES

As previous mentioned, biodiversity is not a simple variable that can be measured, it is almost impossible to identify all varieties of species that could occupy a particular area. Here question “Biodiversity of what?” arises. But even narrowing the research to measuring vegetation biodiversity, it still cannot be done objectively from 2D photographs but rather a division of environments with different level of biodiversity as low, medium and high is possible.

Whereas there remain still not so many studies in this field, a few notable attempts were made. The majority of studies focused on human-nature relationships are done using photo-based questionnaires or/concurrently with on-site observations (Gyllin and Grahn, 2015). The question of which method is more objective for perceiving biodiversity remains open. By Sundli et al. from 2013 majority of landscape preference researches were done using photographs as visual stimuli as on-site surveys are more time-consuming. The study by Gyllin and Grahn (2015) was aimed to investigate differences in judgment between perceived biodiversity using pictures and on-site observations. Researchers found a notable difference in that assessments of biodiversity were greater for experts in the biology field while concluding on-site observations; however that can’t be said for non-experts. Hence, the results of the photo-based study showed that responses between biologists and non-experts differ less. Also, it is pointed out that on-site experience could be influenced by participants’ physical efforts and their overall perception coupled with sounds and smells; photo-based studies by the duality in representation when the picture is more artwork than the actual environment. Here one of the negative features in an on-site questionnaire is a surplus of unsuitable information while for photo-based studies, the ambiguous information as often contained in 2D photographs is perceived only visually.

Another aspect is the quantifying of biodiversity by itself. To measure the biodiversity of the 2D pictures, the hypothesis of a connection between fractal dimension and biodiversity of the visual scene takes place (Stevens, 2018). There

exists a variety of software that could be used to count the fractal dimension of 2D photographs. But for each of software application, the transformation of photographs needed to render grayscale, silhouette outline, or extracted edges can be significant. Each transformation changes the original data and summarizes the information into a binary pattern when box-counting analysis takes place (Patuano&Tara, 2020).

There is a variety of different software that can be used for estimating fractal dimension, but the most reliable of them are FracLac, Fractal Count, Fractalyse and "Software for fractal analysis". The average errors for each application are 1.03%, 1.3%, 1.09% and 1.73% respectively and each are easy to use (Hadzieva et al., 2015).

4.2.GENERAL ASPECT

To achieve the aim of this study, an online survey questionnaire study was used to interview participants. The survey with the cover letter was sent to 90 institutions, but just one institution replied. A survey was created in English; using Google Forms which gathered the responses of students from natural sciences and design curriculums well as it was posted on social media platform (Facebook, in the public group called Dissertation Survey Exchange). There are some advantages and disadvantages to using this method. The advantage of using an online survey might be that it is a fast and cheap tool for researchers to collect feedback, quick to analyse and easy to use for both researchers and participants. But there are also some disadvantages, such as differences in interpretation and understanding, issues with identifying people's true emotions without seeing them.

The interview was done from the middle of January till the begging of March. Participation was voluntary and all data remain confidential. The survey was presented as research for the master study that wishes to evaluate the respondent's preferences for different landscapes. Eventually, it helped to understand which improvements could be used for the next studies.

The approximate time for each survey was 10-15 minutes. Gender, age, and nationality were noted for each interview. Interviewed people were asked to give feedback about their emotional responses to the different landscape with different "amount" of biodiversity. Structurally the survey was divided into three parts:

- The first part of the questionnaire consists of general questions (gender/age/nationality/place of residence and education level).
- The second part consists of questions about the perception of nature in general. This part aimed to identify the overall perception of green areas: how often participants are visiting green areas and for how long.
- The third and the last part of the survey consisted of 16 images which should be rated based on the personal perception of the participant. Photos were digitally manipulated using Adobe Lightroom.

4.3.EVALUATION OF LANDSCAPE PHOTOGRAPHS

The main core of the survey is questions about the perception of the different landscapes. For this, 16 photographs made by the author were chosen, where 14 are southern Swedish landscapes and 2 are western Ukrainian landscapes. Such photographs were chosen as they differ in the number of landscape elements, vegetation diversity and complexity. Each photo was asked to be ranked from 0 to 10 where 0 = something commonly found / easy to understand / inviting / feels safe, and 10 = intimidating / mysterious / makes me want to explore more of it. The idea behind this ranking is that it corresponds to Kaplan's Preference Matrix and offers an evaluation of each image on the scale from "understanding" to "exploring".

4.3.1. EVALUATION BY AUTHOR

The biodiversity of each picture was estimated the base upon the research by Ode et al. (2008) as presented below in Table 2.

Table 2. Table of biodiversity estimation by author

Number of the photo/ Variable	Richness of landscape vegetation elements	Spatial organization of landscape vegetation elements	Approximate species richness
n-photo	Value	value	Value

The richness of landscape vegetation elements includes the presence of different landscape vegetation layers (tree, shrub, grass), while the spatial organization of them represents how far they are from the viewer. In both cases, the greater amount of elements depicted in the photo coupled with the closer these elements are results in a value is closer to 3. Approximate species richness is estimated by the difference in size, colour and form of plants on the photo.

The values for each variable remain as Low, Intermediate and High (L, I, H) respectively. Each value corresponded to the point as Low = 1, Intermediate = 2, and High = 3. The mean value was calculated by summarizing values for valuables and dividing the sum by 3. The more mean value was close to 3 as the more visually complex and diverse landscape is.

Photos used in the survey are presented on the following pages followed by the Table 3 of biodiversity estimation of photographs presented in a survey by the author.

Pic.7. Image 1

Pic.8. Image 2

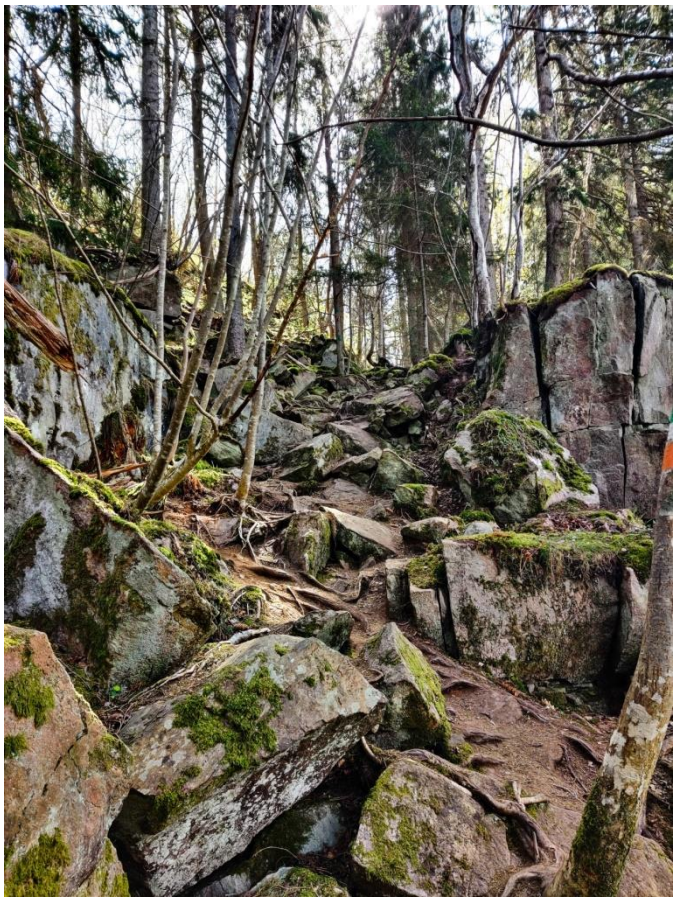
Pic.9. Image 3

Pic.10. Image 4

Pic.11. Image 5

Pic.12. Image 6

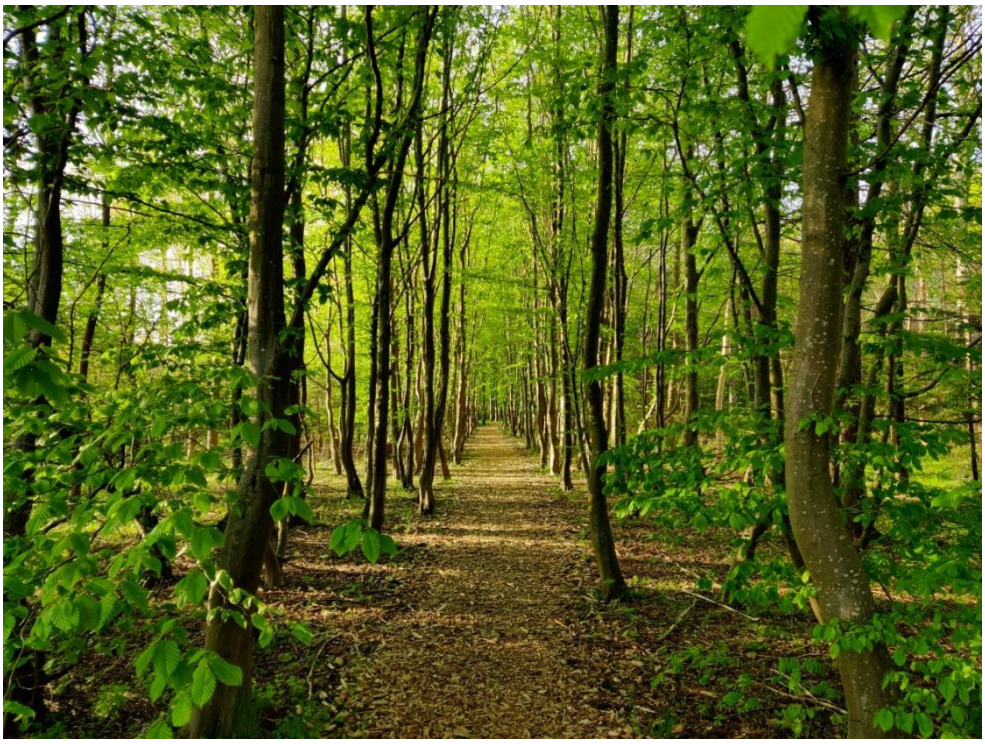
Pic.13. Image 7



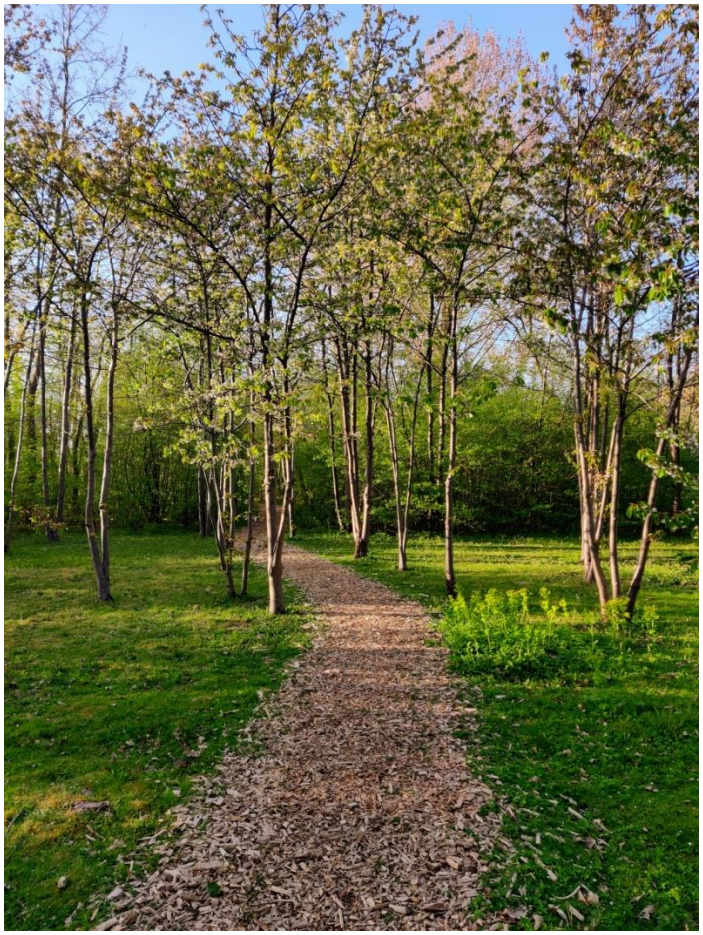
Pic.14. Image 8

Pic.15. Image 9

Pic.16. Image 10



Pic.17. Image 11



Pic.18. Image 12

Pic.19. Image 13

Pic.20. Image 14

Pic.21. Image 15

Pic.22. Image 16

Table 3. Table of biodiversity estimation of photographs presented in a survey by the author

Number of the photo/ Variable	Richness of landscape vegetation elements	Spatial organization of landscape vegetation elements	Approximate species richness	Mean value of the estimated biodiversity
1	2	2	3	I
2	2	3	3	H
3	1	1	2	L
4	3	2	3	H
5	1	1	1	L
6	2	2	2	I
7	2	3	3	H
8	1	2	1	L
9	3	3	3	H
10	3	3	3	H
11	1	2	1	L
12	2	2	2	I
13	1	2	1	L
14	2	3	3	H
15	1	2	1	L
16	1	2	2	I

Mean values of the estimated biodiversity are: L – low biodiversity, I – intermediate biodiversity, H – high biodiversity respectively.

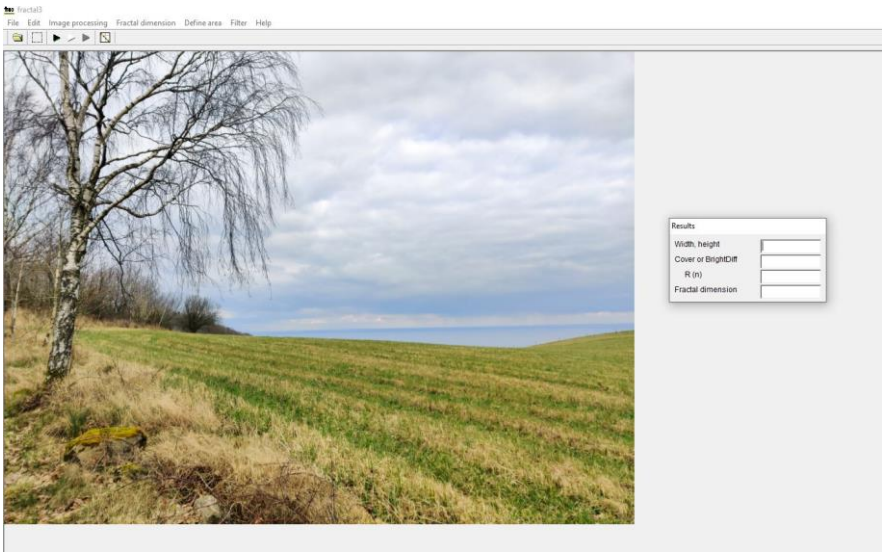
The richness of landscape vegetation elements was estimated by the number of levels of vegetation structure, where 1-2 vegetation structure levels correspond to the value 1; 3-4 levels to the value 2 and 5-6 to the value 3. The spatial organization of landscape vegetation elements represented an ability to see those elements where far from the view is 1, medium distance is 2, and close to the view is 3. Approximate species richness was defined by size and contrast in colour and habitats of species presented where 1-2 species correspond to the value 1; 3-4 species to the value 2, and rest to the value 3. Here it is important to mention that just defined different species took place and it does not represent an actual amount of vegetation species on the photo.

Note that some of the features presented in the photos could cause some misjudgment, such as a variety of stones on Image 5 and 8, water features on Image 5 and 3, partly Image 1 and 7 and type of surface which differs between the images, for example.

4.3.2. FRACTAL ANALYSIS

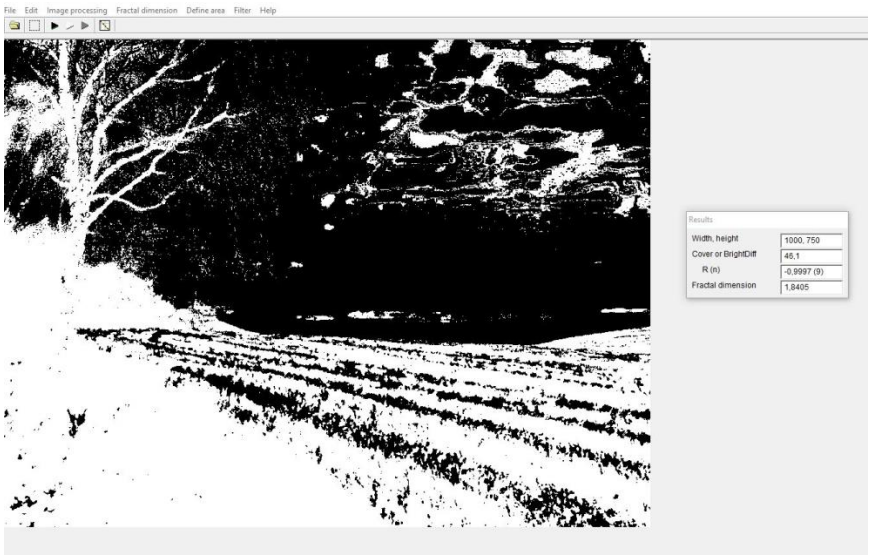
For that, the “Software for fractal analysis” has been used. The software was requested on behalf of the author from Hiroyuki Sasaki from the National Institute of Livestock and Grassland Science, Japan by filling application papers as Submission and Agreement. After finishing research it was signed that software should be deleted and data should be shared with the developer.

Pictures had 1000x750 pixels and were transformed from “jpg” to “bmp” format by using Image. online-covert site (pic.23).



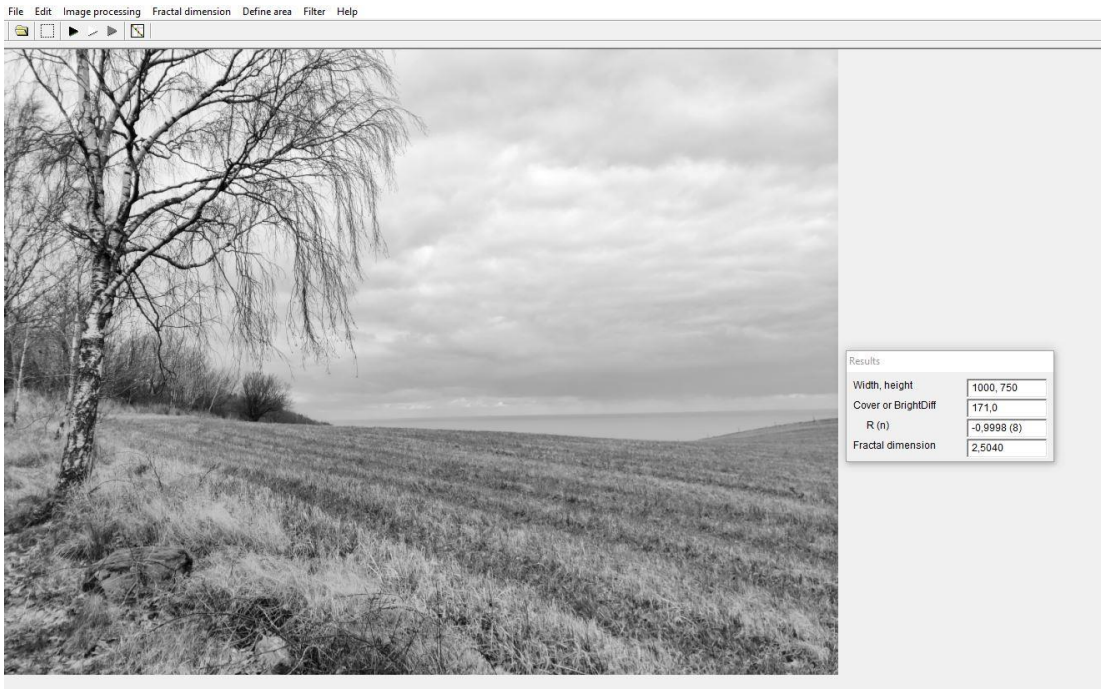
Pic.23. Transformed bmp picture with 1000x750 pixels resolution

Evaluation of the landscape photographs was made in two ways. The first one by extracting green from the photo and estimating fractal dimension of “Black”/“except black” depend on is vegetation was extracted in black or white (pic.24).



Pic.24. A silhouette view, Image 1

Another technique involved transforming the image to grayscale and estimating the fractal dimension of "grayscale" (pic.25).



Pic.25. Transformed to grayscale, Image 1

During the estimation, it was discovered that the method of transforming the image to grayscale and counting the fractal dimension of it is unsuitable because the fractal dimension of the grayscale image represents surface asperity and the values will vary from 2.0 to 3.0. Consequently, the current methodology focused on estimating the fractal dimension from the silhouette by using the box-counting method. Values for fractal dimension here is non-integer between 1 and 2 which represent the complexity of the visual surrounding (Figure 4.1, Appendix 1).

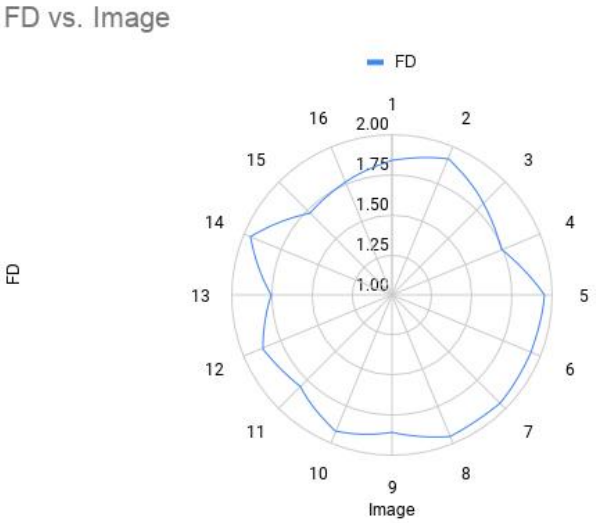


Figure 4.1. Estimated fractal dimension for Images 1-16

To compare it with the author estimation, the value of LIH level of biodiversity were set between 1 and 2 to show how estimations by both methods differ. Low level of biodiversity images got index 1.33, intermediate – 1.66, and high – 1.99. Then charts were combined. Outcomes of both estimations are quite similar (Figure 4.2).

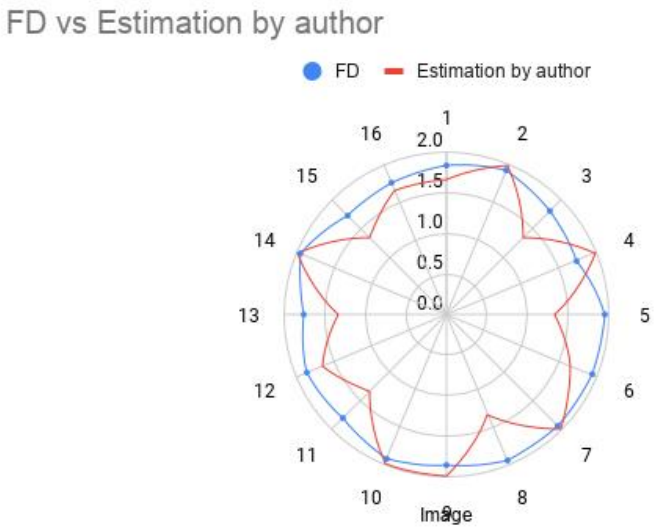


Figure 4.2. Estimated biodiversity level for Images 1-16

As it was mentioned, measuring biodiversity can be tricky. Therefore, this research did not just focus on the author's estimation of the biodiversity but also on estimating fractal dimensions (FD) of each image that shows the visual complexity of the environment. This could provide understanding of the character of the responses and help to clarify patterns of the outcomes.

5. RESULTS

Responses for the survey were collected between the middle of January and the beginning of March 2021. The total number of people being surveyed is 81. All data representation was done by using Google Sheets.

5.1.DEMOGRAPHICS

The gender distribution among respondents was 33 (40.7%) males, 48 (59.3%) females (Figure 5.1.1). No one among survey respondents associated himself/herself as transgender. All 81 respondents replied to this question.

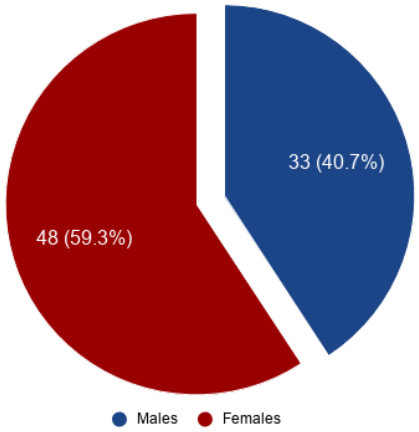


Figure 5.1.1. The gender distribution among the participants

Age distribution among the respondents consisted mainly from three main groups. The dominant group of respondents consisted of 36 (44.4%) people whose age varied from 18-24, the second large group is 35 (43.2%) people whose age varied from 25-34 years, and the thirst biggest age group included 8 (9.9%) people with the age between 35-44 and more. The least presented is age group 55-64 with 2 (2.5%) people (Figure 5.1.2). No one age 45-54 and 65+ have taken the survey. All 81 respondents replied to this question.

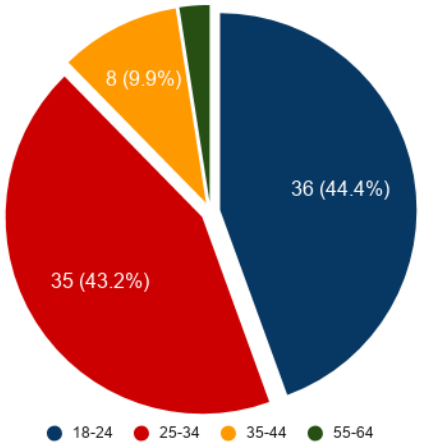


Figure 5.1.2. The age distribution among the participants

Distribution by nationality shows that there are participants of 28 nations (Figure 5.1.3). The majority of them are Iranian – 10 (12.3%), American - 9 (11.1%), British – 7 (8.6%), Indian 5 (6.2%), Ukrainian – 5 (6.2%), Polish -5 (6.2%). 78 (96.3%) people from 81 replied to this question, 2 (2.5%) replied “White”.

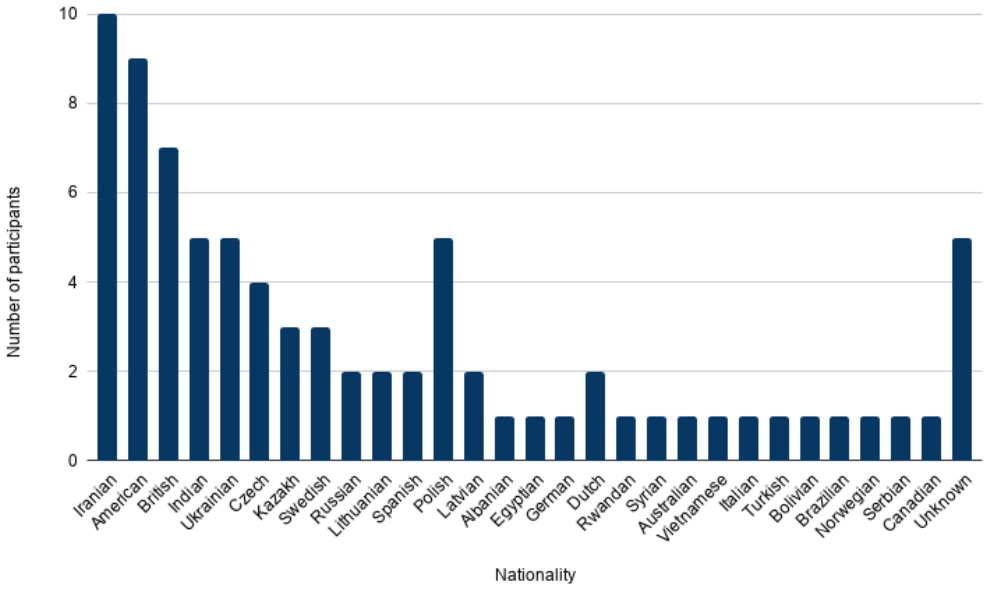


Figure 5.1.3. The nationality distribution among the participants

Distribution by permanent place of residence shows the countries that participants currently live in (Figure 5.1.4). The major group of people who have taken the survey is currently living in the Czech Republic - 18 (22.2%), the second big group is people from the United States of America - 13 (16%), the third big group are people from Iran - 9 (11.1%). All 81 respondents replied to this question.

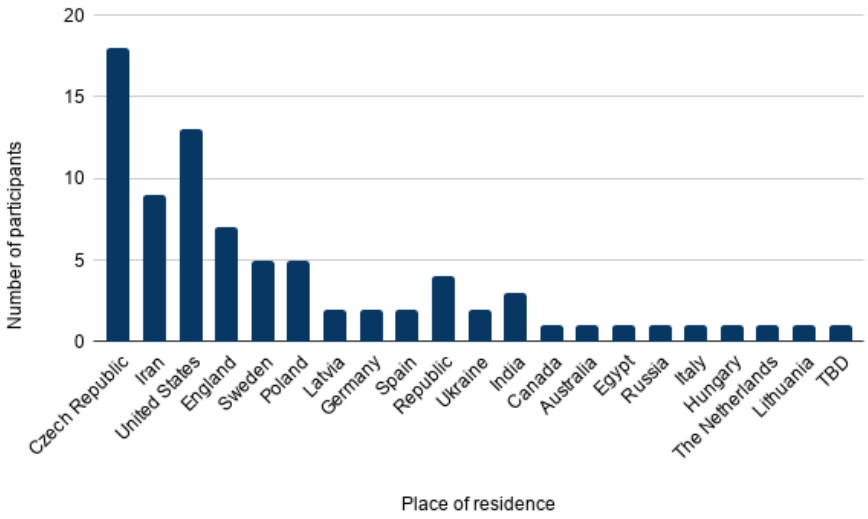


Figure 5.1.4. The permanent residency distribution among the participants

Distribution by the highest level of education achieved mainly consists of two large groups as an undergraduate (college, bachelor) - 40 (50%), and graduate - 30 (37.5%) (Figure 5.1.5). Just 3 (3.7%) have received a PhD or higher level of education. Participants who chose other have received high school education and/or currently studying bachelor - 7(8.8%). 80 (98.8%) people from 81 replied to this question.

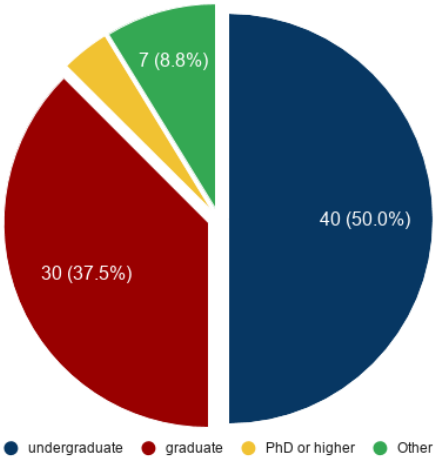


Figure 5.1.5. The highest level of education achieved distribution among the participants

Distribution by degree program represented the number of respondents who belongs to different curriculums. The majority of students 24 (29.6%) were taken a degree in Landscape Sciences, 11 (13.6%) in Environmental Sciences, 6 (7.4%) in Technology. Students with curriculums of Art sciences, Business and Economy, Medical sciences, Social sciences and Law, and Architecture and Civil engineering have also participated in the research (Figure 5.1.6). 22 (27.2%) people from 81 haven't replied or haven't understood the question.

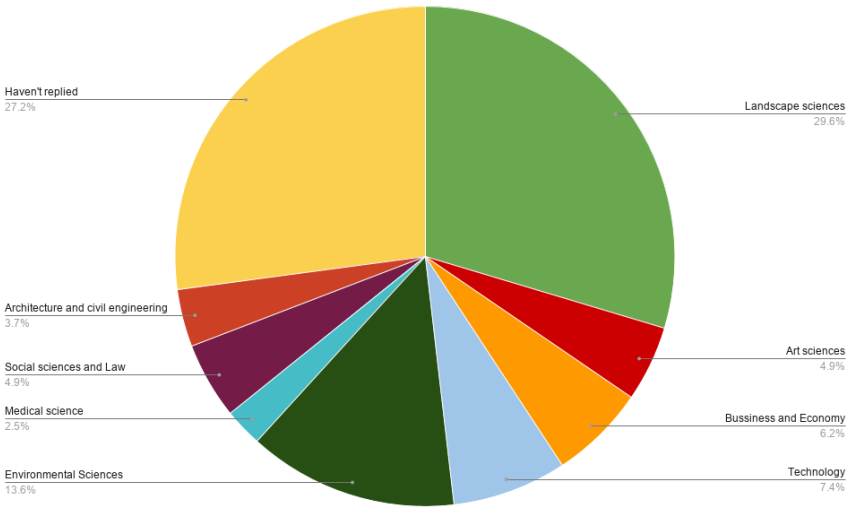


Figure 5.1.6. The degree program distribution among the participants

5.2.GENERAL HUMAN PERCEPTION OF NATURE

In section two, respondents were asked to answer six questions about their general perception of nature. Some of the questions were made for multiple choices; some should have been filled with a short or long answer.

The first question was made to evaluate how often participants visit green areas: 17 (21%) – voted as once per day, 45 (55.6%) – once-twice per week, 13 (16%) – once-twice per month, 6 (7.4%) – rarely (Figure 5.2.1). All 81 respondents replied to this question.

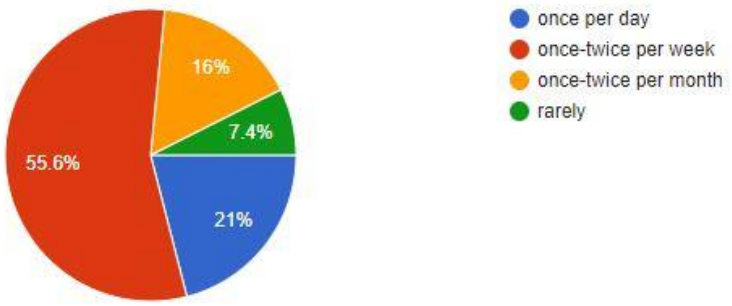


Figure 5.2.1. The frequency of visiting green areas distribution among the participants

The second question was made to evaluate how often participants visit green areas for more than half an hour: 12 (14.6%) – voted as once per day, 31 (38.3%) – once-twice per week, 28 (34.6%) – once-twice per month, 10 (12.3%) – rarely (Figure 5.2.2). All 81 respondents replied to this question.

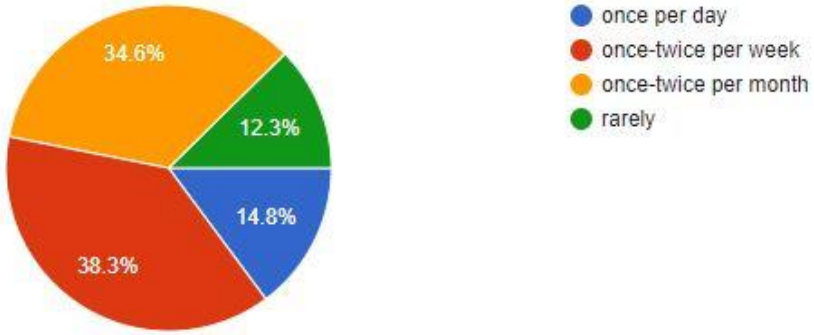


Figure 5.2.2. The frequency of visiting green areas more than half an hour distribution among the participants

The difference between responses to the first and second question shows the difference in length of time in green areas.

The third question aimed to understand why respondents are visiting areas. The reasons which were made could be divided into 4 sections:

- Section 1 – "to relax". There are 25 (31%) participants who somehow referred to relaxation or gaining energy from those places as the main particular reason for visiting green areas: *"they are relaxing and refreshing", "chill", "to breathe some fresh air, clear my head from noise and distraction and regain some of my energy and concentration", "The beauty and good weather of these areas have a good effect on my mood", "To feel relaxed, to exercise (running, fast walking)", "to escape, to feel calm, they are beautiful", "Dog and mental break", "to get peace".* Majority of these responses related to calm activities.
- Section 2 – walking. There are 34 (42%) participants who considered walking alone or with a pet and/or meeting friends as a particular reason for visiting green areas: *"I like to walk in the parks to think, or to walk in a quiet place, without noise, without cars, without big arc buildings that press on you with their grandeur", "I really enjoy being in the city and meeting friends and taking walks. Parks provide the perfect opportunity to walk or relax with friends, while eating a snack or just relaxing (with or without friends)", "walking my dog, and get out of the house, and I love nature, so I don't go insane, to look at squirrels, to feel the sun on my face", "To stretch my legs, clear my mind, to walk. Meeting other people in a safe way, drinking coffee"*. Some responses overlap with previous section. Majority of those responses related to active actions.
- Section 3 – no reason. There are 4 (4.9%) participants who related to *"passing by" or have not had a reason to visit green areas: "When I have really nothing to do", "Passing by or strolling to relax", "Cycling/ way to walk", "not really".*
- Section 4 – utilitarian. It was 1 (1.2%) participant who is working within the green area: *"I work in forestry field, I consider forest as a green area in this case, therefore my reason is work"*

80 (98.8%) people from 81 replied to this question.

The fourth question aimed to understand the common emotional responses to visiting green areas. The emotional responses could be divided into 4 sections:

- Section 1 – calm feelings. 35 (43.2%) respondents described their emotional state as *"calm", "relaxed", "calmly, in harmony with nature, I speak more quietly and enjoy my mother earth", "I feel human, like I can find peace and experience what the world is all about. a beautiful detox after life spent looking at screens", "refreshed with calm energy", "tranquil"*
- Section 2 – active, intrigue feelings. 2 (2.5%) respondents described their emotional state as: *"fresh and intrigued", "energized"*.
- Section 3 – positive feelings, no description of calm or active state. 20 (24.7%) respondents described their emotional state as *"great", "good", "good, healthy", "pleasant and relaxed", "feel fresh", "happy", "clear headed"*

- Section 4 – neutral or negative feelings. 2 (2.5%) respondents described their emotional state as *"4/10", "I feel confined"*.

77 (95.1%) people from 81 replied to this question.

The fifth question was aimed to understand is there a particular reason why walking in green areas feels safe or opposite during night time (Figure 5.2.3). The majority of responses were rated as "Yes" by 34 (42%) people, and 20 (24.7%) people chose "No". Interesting that 27 (33.3%) people chose "Other" and open answers contained phases as: *"Depends on it's a new are or visited before", "It depends on the area", "Depends on specific city and area of city, if I am alone or with someone, and whether or not I am a visiting tourist or a local", "Depends if there are lamps in the area, but mostly uncomfortable if walking alone", "It depends on the lightening in the green area", "yea, unless there's people around who make me don't feel safe. I have my dog, he's cute so not very good defense".* Here majority of responses were focused on lightning and location. All 81 respondents replied to this question.

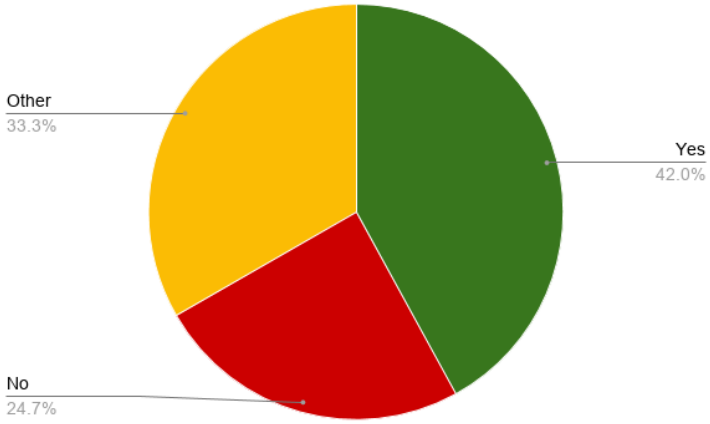


Figure 5.2.3. The distribution among the participants on the feeling of safety in green areas at night

The last question of this section aimed to identify do respondents have a preferred type of landscape more than another. 15 (18.5%) replied "No" or that they don't have a preferred type to this question. 14 (17.3%) respondents prefer forest or 9 (11.1%) forest-like landscapes. 5 (6.2%) specified meadows, 8 (9.9%) – any type of water, 13(16%) included "mountains". Interesting that 7 (8.6%) respondents referred their preferred type of landscape to places where they grow up as: *"I choose the small scale patchwork hedgerow with rolling hills landscape of the west of England, I was born there and it is beautiful. I love it for its poetic history of culture and nature meeting along with integrating a rich history of oppression and class struggle.", "Mountainous landscape because it reminds me of home", "Ocean, I grew up by the ocean".* 13 (16%) respondents clarified words "diverse", "biodiversity", "wild", "rich diversity of plants" while describing their preferred landscape. 68 (84%) people from 81 replied to this question.

5.3.RESPONSES TO PHOTOGRAPHS

As it was mentioned in the Methodology chapter, sixteen photographs with variety of landscapes were chosen. Results of the responses were divided into three category based on the level of biodiversity estimated at Methodology chapter. Note that participants were asked not to rate image based on their perception but on the scale between (0) easy to understand to (10) want to explore. Referring to biodiversity was also noted.

5.3.1. RESPONSES TO THE SCENES WITH LOW BIODIVERSITY

Images 3, 5, 8, 11, 13, 15 were estimated as environments with a low level of biodiversity.

Image 3 – country road with limited vegetation and water on both sides of it. Location - near Kalskrona, Sweden. Majority rated this image as “0” – 11 (13.6 %), “3” - 10 (12.3 %), and “10” – 10 (12.3 %), the least responses rated as “5” - 4 (4.9%) and “7” – 4 (4.9 %) (Figure 5.3.1). All 81 of participants rated this image.

Pic.9. Image 3

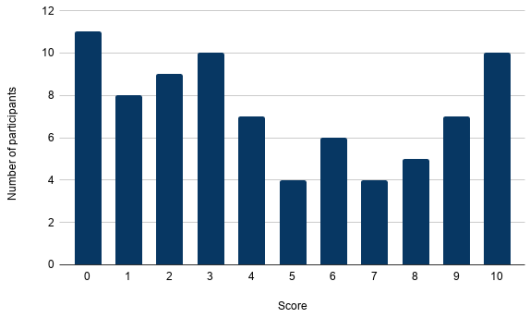


Figure 5.3.1. Survey responses to Image 3

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *“I'm not that knowledgeable on lakes and rivers, but they are common, therefore, they feel safe, understandable. The road across it doesn't invite me to see what's is at the end, because I can see everything from this point of view.”, “This landscape makes me feel light and safe because of the water and bridge, therefore I would enjoy going there and sitting for a couple hours either by myself drawing or with another person.”, “Easy to read, simple structure but more calming because of the water”, “Serene and peaceful. Would sit there rather than exploring.”*
- Responses that evoked active feeling – *“Quite open and clear for perception and understanding as the first sample but intrigues me as the viewer with its further landscape, cause desire to explore and find more”, “The road*

leads me from completely open spaces (the lake) to a mysterious forest. So, that intrigues me to explore more.", "Makes me want to explore more of it: I am interested in where the way is following, what I will meet around the way", "Wouldn't say intimidating, but its visually striking and I would definitely want to explore more.", "want to explore more due to the beauty".

Preference response to this scene could be divided into:

- Positive – *"I live near many of these and like walking on the trails", "I love everything connected with water", "I like seeing water on the landscape, water is life", "Beautiful, relaxing", "I just like it".*
- Neutral – *"It is an ordinary landscape."*
- Negative – *"There is no more option where I could go, just one way. I don't like that. Boring", "Not interesting for me".*

Here, the majority of respondents rated landscape as an environment that evokes calm feelings more than actives while still water feature is a reason for them to decide so as vegetation biodiversity was insignificantly present in this scene. No one from 64 respondents who left a description of their choice referred to this scene as biodiverse.

Image 5 – running water with variety of stones, limited vegetation diversity. Location – near Gränna, Sweden. Majority rated this image as "10" – 18 (22.2 %), "8" - 13 (16 %), and "9" – 11 (13.6 %), the least responses rated as "4" - 1 (1.2%), "0" – 4 (4.9 %), and "2" – 4 (4.9 %) (Figure 5.3.2). 80 (98.8 %) from 81 of participants rated this image.

Pic.11. Image 5

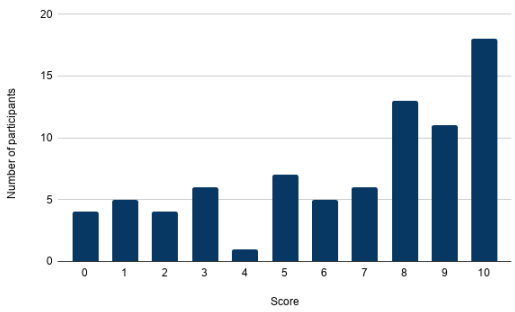


Figure 5.3.2. Survey responses to Image 5

Emotional response to this scene could be divided into:

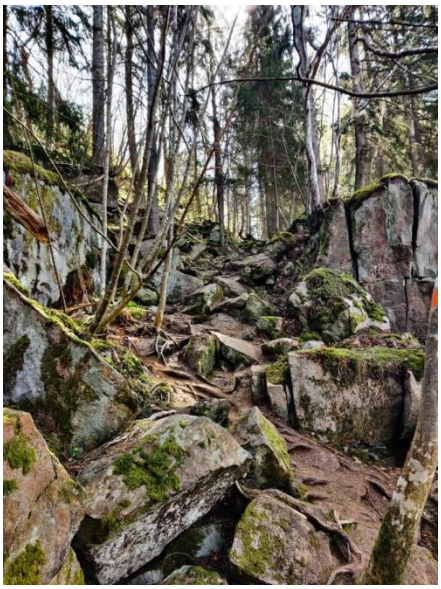
- Responses that evoked calm feelings – *"I love the sound of water, I would love to sit here and think, or draw."*
- Responses that evoked active feeling – *"The interesting placement of the house alongside the stream/running water makes it very interesting and mysterious for me, and i would very much like to explore it.", "Exploring ruins and waterfalls is really fun, it can be exciting and kind of like an adventure around a really cool landscape", "it's beautiful and I want to go there and roll around and swim.", "Interesting and particular place, triggers dangerous a bit due to the water element and massive rocky waterfall", "The juxtaposition of the house over the chaotic falls is mysterious. I would further explore.", "Lovely vertical landscape with lots of detail to explore, plus historic human use", "waterfall together with old, stone house make it intimidating and mysterious", "Very mysterious, I would definitely like to explore this area."*

Preference response to this scene could be divided into:

- Positive – *"Not sure where I'd find this but it's beautiful and I would visit this place", "Looks abandoned but I like area with hiking and water", "Waterfalls are awesome, period. Jealous of the resident in the house because this is his backyard in a way.", "This type of landscape is my favourite."*
- Neutral – *"dirty, untidy, chaos, although the water is good", "This photo doesn't look that mysterious to me but it also doesn't look inviting. Not sure how to feel about this photo, pretty in the middle. I think if it were sunny in this photo, I would like it more and it would feel safer and more inviting*."
- Negative – *"hard to walk to, slippery, wet", "Scary!", "Isolated".*

Here, the majority of respondents rated landscape as an environment that evokes active feelings more than calm while flowing water feature is a reason as the vegetation was insignificantly present in this scene. 2 from 64 respondents who left a description of their choice referred to biodiversity and considered it as "natural".

Image 8 – hiking path with variety of stones, limited vegetation diversity. Location – near Gränna, Sweden. Majority rated this image as "10" – 18 (22.2 %), "7" - 17 (21%), and "8" – 15 (18.5 %), the least responses rated as "1" - 1 (1.2%), "4" – 1 (1.2 %), and "2" – 2 (2.5 %) (Figure 5.3.3). 80 (98.8 %) from 81 of participants rated this image.



Pic.14. Image 8

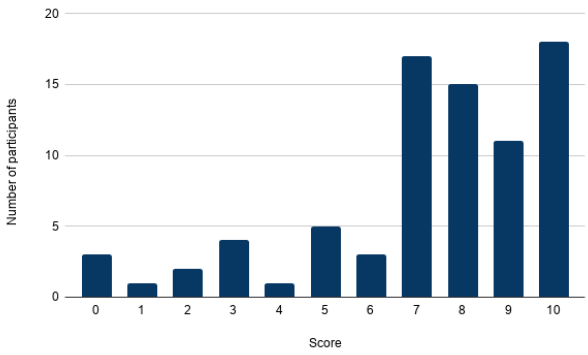


Figure 5.3.3. Survey responses to Image 8

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *"The image represents calmness and greenery not explored by many".*
- Responses that evoked active feeling – *"Wild", "Intimidation would keep some from climbing this feat. This image represents wilderness - a disturbed space but not by humans.", "The forest path in the middle of huge boulders is inviting for exploring. Like mysterious fairytale. You don´t know what you could expect when you come up the hill", "You always can find interesting plant species or mushrooms between rocks so I like to explore such places. Also because of the feeling of such places.", "This landscape does not make me feel safe at all because of the rough rocks but that also makes me feel curious about following the hidden path.", "The jaggy rocks and the lack of a paved path makes me feel adventurous on this trail.", "Mysterious but I wouldn't feel safe".*

Preference response to this scene could be divided into:

- Positive – *"Looks fun and slightly challenging", "it's like a fairytale", "pretty easy to break a knee there, but totally worth it if for the landscape", "Perfect exactly what I like."*
- Neutral – not found.
- Negative – *"Very peaky and sharp landscape, feels quite dangerous, wouldn't feel safe there and wouldn't like to explore more of it", "It is not something that I like.", "Feels unsafe".*

Here, the majority of respondents rated landscape as an environment that evokes active feelings more than calm while the rocky landscape is a reason as the

vegetation was insignificantly present in this scene. 4 from 62 respondents who left a description of their choice referred to biodiversity and considered it as “wild”.

Image 11 – *Fagus sylvatica* L. wooden structure. Location - Alnarp, Sweden. Majority rated this image as “9” – 15 (18.5 %), “8” - 12 (14.8%), and “10” – 12 (14.8%), the least responses rated as “1” - 1 (1.2%), “3” – 1 (1.2 %), and “2” – 3 (3.7%) (Figure 5.3.4). 80 (98.8 %) from 81 of participants rated this image.

Pic.17. Image 11

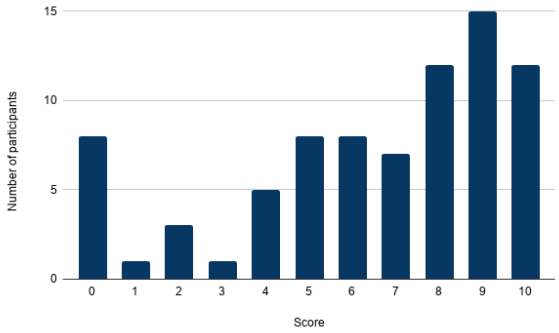


Figure 5.3.4. Survey responses to Image 11

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *“Summer day in fresh safe deciduous forest, path is inviting and whole scene is easy to understand”, “It is uncommon landscape for me, but it feels very relaxing and peaceful”, “Would be very tranquil! I would maybe even stay on the path for this.”, “Super inviting, and feels safe”.*
- Responses that evoked active feeling – *“Stimulating”, “Place has a little bit of mystery because it’s not flat land you cannot see all around you but this can add exploration factor or at night a scared factor”, “It looks so mysterious and makes want to go there to explore it especially with a friend.”, “This tunnel feeling makes the environment very interesting and intimate”, “I would explore more to see where the path takes me to.”, “Would want to know where the path leads to”.*

Few respondents referred to lightning: *“I think this photo is something commonly found in park/forest areas outside city centre. Looks pretty safe (again, maybe the sunlight helps with that) and it also looks inviting. But it also makes me want to explore. And if there was no sunlight, it probably would look more mysterious to me. The lighting honestly influences my impression a lot”, “The abundance of trees and lush greenery makes me want to explore but also makes me feel more safe with the way light passes through”.*

Preference response to this scene could be divided into:

- Positive – *"bewitchingly", "simply stunning", "I like forests".*
- Neutral – *"A pleasant walk, but not a lot of variety & visual interest in the vegetation", "Nice environment, but maybe too monotonous".*
- Negative – *"Not my type of landscape-I don't like forest".*

Here, the majority of respondents rated landscape as an environment that evokes active feelings more than calm while the path that leads to the invisible point is a reason as vegetation biodiversity was insignificantly present in this scene by the homogeneous landscape. 4 from 60 respondents who left a description of their choice referred to biodiversity and considered it as "wild".

Image 13 –wooden structure monoculture. Location Alnarp, Sweden. Majority rated this image as "7" – 13 (16 %), "10" - 12 (14.8%), the least responses rated as "1" - 1 (1.2%), "2" – 2 (2.5 %), and "4" – 2 (2.5%) (Figure 5.3.5). 80 (98.8 %) from 81 of participants rated this image.

Pic.19. Image 13

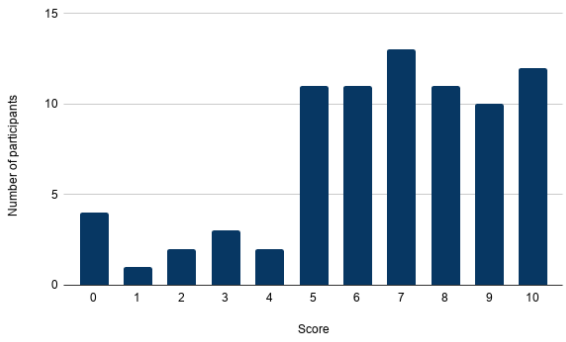


Figure 5.3.5. Survey responses to Image 13

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *"A walkway in forest. It gives me a natural feeling and peaceful.", "Feels safe".*
- Responses that evoked active feeling – *"Wild", "little light, clear path, visible roads and paths feel safe and predictable, but forest is much denser than previous so more mysterious", "I think these types of trees always makes things look a bit more mysterious, even creepy at night or spooky.", "It has very dense trees and no proper route to go it's very exciting place to be", "Another forest but trees are so close to each other makes it more Intimidating", "Same as 11 but more mysterious because of the darker light", "It feels quite intimidating due to density of trees", "mysterious place".*

Preference response to this scene could be divided into:

- Positive – *"feels great, i do visit this king of areas pretty much daily".*
- Neutral – *"Nice, but monotonous".*
- Negative – *"I don't really like plantations.", "Rather boring monoculture", "feels too homogeneous".*

Here, the majority of respondents rated landscape as an environment that evokes active feelings more than calm while the path and denser wood plantation are reasons as vegetation biodiversity was insignificantly present in this scene by the homogeneous landscape. 10 from 57 respondents who left a description of their choice referred to biodiversity and considered it as "dense", "the abundance of trees and lush greenery", "wild" and similar.

Image 15 – rural field, one tree in the front. Location near Mukachevo, Ukraine. Majority rated this image as "7" – 11 (13.6 %), "8" - 10 (12.3%), the least responses rated as "5" - 3 (3.7%), and "2" – 4 (4.9 %) (Figure 5.3.6). All 81 participants rated this image.

Pic.21. Image 15

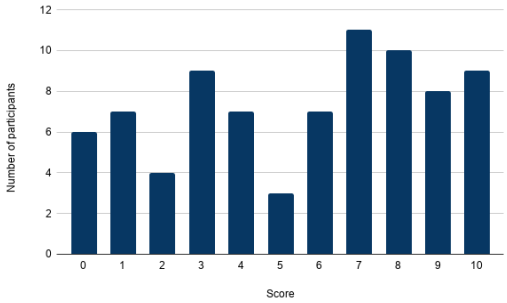


Figure 5.3.6. Survey responses to Image 15

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *"This landscape does not necessarily draw my attention, but the openness does make me relaxed and calm", "It is also a very gorgeous, nice and more natural landscape, feels very inviting", "Common place and feels safe".*
- Responses that evoked active feeling – *"Stimulating", "Want to explore more as not like the UK", "looks like a beautiful place to explore".*

Preference response to this scene could be divided into:

- Positive – *"It is a field of some grain, commonly found anywhere, but for me it reminds of Italy, Tuscany region. I would love to travel there again, so I love it.", "Mountains aren't common to see everywhere so whenever*

you see such landscape it immediately attracts your attention and gaze.", "I deeply wish to be there".

- Neutral – *"Quite open and spare landscape, safe but not very interesting", "Commonly found, but nice view".*
- Negative – *"dense growth is not so inviting, unknown what's hidden, personal worry for ticks", "for me not so inviting place, I like closure around me", "and I'm not very fond of the grass", "Looks like a scary movie scene".*

Here, the majority of respondents rated landscape as an environment that evokes active feelings more than calm while personal negative and positive preferences were named as vegetation biodiversity was insignificantly present in this scene by the homogeneous landscape. 2 from 57 respondents who left a description of their choice referred to biodiversity and considered it as "dense" and "natural".

5.3.2. RESPONSES TO THE SCENES WITH INTERMEDIATE BIODIVERSITY

Images 1, 6, 12, 16 were estimated as environments with an intermediate level of biodiversity.

Image 1 – rural field, with one tree in the front and two more vegetation structures on the background. Location – near Båstad, Sweden. Majority rated this image as "1" – 16 (19.8 %), "2" - 11 (13.6%), and "3" - 11 (13.6%), the least responses rated as "10" - 2 (2.5%), "7" - 3 (3.7%), and "5" – 4 (4.9 %) (Figure 5.3.7). All 81 of participants rated this image.

Pic.7. Image 1

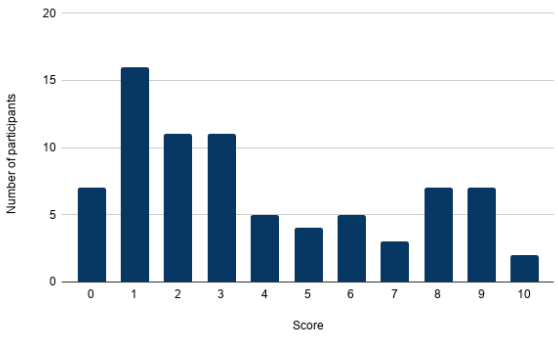


Figure 5.3.7. Survey responses to Image 1

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *"I would feel safer here than in an urban centre. It is inviting, but not necessarily mysterious", "For me, I find it pretty boring because everything you see is the same. Not that inviting for me, but I still would enjoy a nice walk here, would be peaceful I presume", "I think is quite common landscape in Central Europe, big open space with a forest edge surrounding, feels safe, not wild", "Being in Czech Republic this kind of landscape is very common and I feel safe, relaxed and I really appreciated it", "This type of scene is common/well-known in every Europe country which I have already visited. It open and safe", "This landscape does not necessarily draw my attention, but the openness does make me relaxed and calm."*
- Responses that evoked active feeling – *"The water level at the end of the image encourages me to explore it", "You want to explore what is behind the "hill"".*

Preference response to this scene could be divided into:

- Positive – *"the landscape is like my childhood. The plain allows you to look into the distance and consider what is a few kilometres from us", "Nice landscape and clear vision of landscape", "I love area with aquatic and mountains landscape".*
- Neutral – *"Open rows of fields, flat and kind of boring but simple and pleasing to stand in to feel the breeze", "Places like this is everywhere in Iran and isn't something special for me".*
- Negative – *"Looks boring to me, I need to see well designed areas", "empty fields are not exciting me".*

Here, the majority of respondents rated landscape as an environment that evokes calm feelings more than active while the open landscape is a reason as vegetation biodiversity was presented in this scene on intermediate level by few landscape structures. 2 from 69 respondents who left a description of their choice referred to biodiversity and considered it as "naturalistic" and "natural".

Image 6 – pathway near Gränna, Sweden. Majority rated this image as "7" – 12 (14.8 %), "8" - 12 (14.8%), and "9" - 12 (14.8%), the least responses rated as "4" - 2 (2.5%), "2" - 3 (3.7%), and "3" – 4 (4.9 %) (Figure 5.3.8). 80 (98.8 %) from 81 of participants rated this image.

Pic.12. Image 6

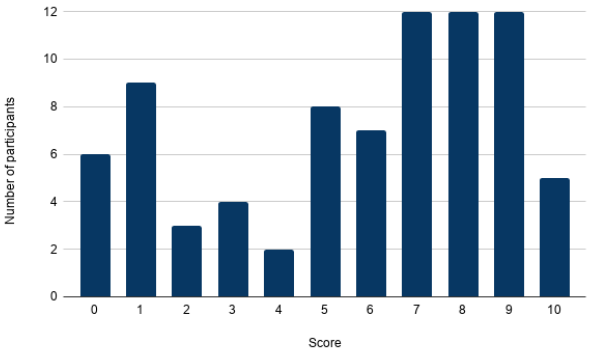


Figure 5.3.8. Survey responses to Image 6

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *"In some countries like Ukraine it's quite common to find such landscapes but it always seems mysterious and interesting to walking there and explore especially if you're with a friend".*
- Responses that evoked active feeling – *"This sort of path is interesting and tests curiosity. The mystery invoked the exploration", "The forest behind is mysterious and inviting. Would want to reach near to it and explore", "The clash of the forest edge with the grassland makes me want to explore this landscape".*

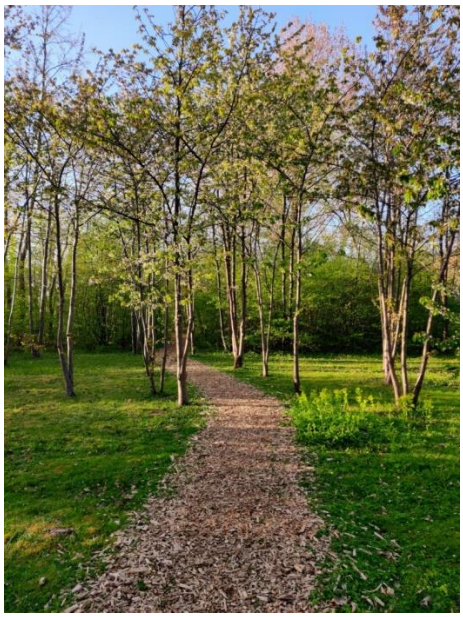
Awareness of animal biodiversity was specified: *"I'm in-between. On one hand it looks very calm and peaceful to be in, but on the other hand it looks like something might come out to get me like a bear".*

Preference response to this scene could be divided into:

- Positive – *"Despite that there is also only one option where to go, this i like better. Maybe because it's more common to Latvia's nature. I like this. Especially in autumn, when there is lot of different colours in landscape and you can pick it up some berries", "looks like a mixed woodland and a wetland, with some tourist path to stop people sinking and dying. I like it as it's probably a nature reserve with interesting species", "I like swamps".*
- Neutral – not found.
- Negative – *"I do not feel safe in a space that is completely surrounded by trees", "doesn't look nice or welcoming", "and feels safe but not attractive", "Common but not inviting", "Dead trees, dry zone".*

Here, the majority of respondents rated landscape as an environment that evokes active feelings more than calm where path and forest behind are main reasons described as vegetation biodiversity was presented in this scene on intermediate level by few landscape structures. 3 from 64 respondents who left a description of their choice referred to biodiversity and considered it as “dense woodland”, “nature reserve with interesting species”.

Image 12 – path at Alnarpsparken, few vegetation structure levels. Location Alnarp, Sweden. Majority rated this image as “8” – 12 (14.8 %), “3” - 10 (12.3%), and “7” - 10 (12.3%), the least responses rated as “2” - 3 (3.7%), “10” - 4 (4.9%), and “1” – 5 (6.2 %) (Figure 5.3.9). All 81 of participants rated this image.



Pic.18. Image 12

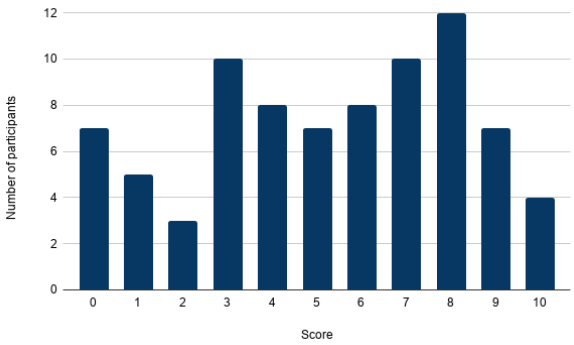


Figure 5.3.9. Survey responses to Image 12

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *“Feeling of calm”, “It gives me a natural feeling and peaceful”, “Small trees, open space...inviting and safe”, “Handmade path gives safety feeling, trees are not too close to each other”, “Not so common but inviting spring park scene, safe feelings”, “Open space next to the path makes it feels safe”.*
- Responses that evoked active feeling – *“It’s not very common to see such landscapes but there are some parks that has sections that is pretty similar to that one, so it’s not mysterious but at the same time it seems fun to go have a walk over there and explore it”, “There is a clear pathway for me to walk down, I want to explore what’s in the bushes”, “The forest behind is inviting. Would definitely want to explore”, “Intriguing”.*

Preference response to this scene could be divided into:

- Positive – *"It is beautiful park with trees and clear sky looks great", "Very pleasant place, open, a lot of light etc.", "Looks like a beautiful pathway to a wedding".*
- Neutral – *"Well managed and super good for walks with family, but not 100% my thing. Need more trees and wildness", "Recreational park, beautiful but i don't get very curious".*
- Negative – not found.

Here, the majority of respondents rated landscape as an environment that evokes active feelings more than calm where path and vegetation behind are the main reasons as vegetation biodiversity was presented in this scene on intermediate level by few landscape structures. . No one from 58 respondents who left a description of their choice referred to this scene as biodiverse.

Image 16 – rural field. Location near Mukachevo, Ukraine. Majority rated this image as "10" – 10 (12.3 %), and "4" - 10 (12.3%), the least responses rated as "5" - 4 (4.9%) (Figure 5.3.10). 80 (98.8 %) from 81 of participants rated this image.

Pic.22. Image 16

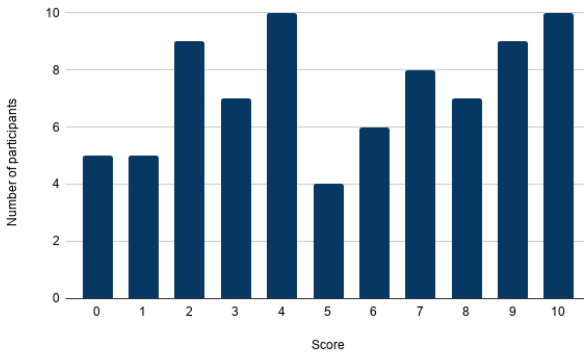


Figure 5.3.10. Survey responses to Image 16

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *"This landscape draws my attention with the colours and mountain view and the openness does make me relaxed, calm and safe", "Easy to understand landscape view, picturesque horizon, safety".*
- Responses that evoked active feeling – *"A bit more interesting than previous one due to the availability of wilderness on the front and clearer perception of mountains in the back", "I would like to go there, it has some cultural landscapes in the distance which give it an mysterious view", "I would like to explore more of it because it's inviting and not intimidating".*

Some respondents mentioned animal diversity: *"Looks like a pretty diverse ley. Probably rich in insects", "open and predictable but grass is tall, worry for ticks".*

Preference response to this scene could be divided into:

- Positive – *"Very beautiful. Feeling of freedom", "Looks simple, but I like this more than picture 15, because there is more colour which seems more inviting and interesting", "Looks beautiful, the colours invite me in and I love the hills in the background", "More exciting than the previous one because of the colour. It feels warmer", "Feels like home!".*
- Neutral – not found.
- Negative – not found.

Here, the majority of respondents rated landscape as an environment that evokes both active and calm feelings. 5 from 58 respondents who left a description of their choice referred to biodiversity and considered it as "wilderness", "rich in insects".

5.3.3. RESPONSES TO THE SCENES WITH HIGH BIODIVERSITY

Images 2, 4, 7, 9, 10, 14 were estimated as environments with a high level of biodiversity where two of those (Images 2 and 7) areas are present in nature and four others (Images 4, 9, 10 and 14) belong to maintained gardens.

Image 2 – trees and stones covered by moss, natural area, not maintained. Location - near Båstad, Sweden Majority rated this image as "7" – 14 (17.3 %), and "8" - 13 (16%), the least responses rated as "1" - 2 (2.5%), "0" - 3 (3.7%) (Figure 5.3.11). No one rated this image as "4". 80 (98.8 %) from 81 of participants rated this image.

Pic.8. Image 2

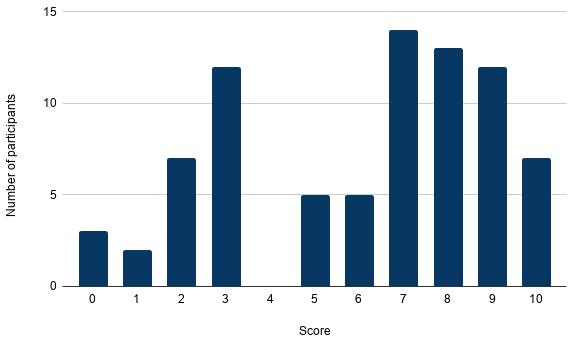


Figure 5.3.11. Survey responses to Image 2

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *"Being in Czech Republic this kind of landscape is very common and I feel safe, relaxed and I really appreciated it".*
- Responses that evoked active feeling – *"It looks harder to access but I like the idea of exploring between the trees and seeing what I can find. However I do feel it would look very scary at night and unsafe if you fall", "Nature combination: underleaved trees and shrubs, stones with moss, setting sun acts together like environment for adventure as well as for some unpredictable scary scene", "This landscape makes me feel curious because of the contrast of the old tress and vibrant moss, and I definitely would want to take a hike and explore", "Because there is no free view you want to know what is around the corner. Also this reminds me of a mystery fairytale forest".*

Some respondents mentioned animal diversity: *"Feeling bit scary in this pic in green areas can be snake".*

Preference response to this scene could be divided into:

- Positive – *"Adventurous and curious landscape, complex with its amount of components but therefore interesting and attractive".*
- Neutral – *"I've seen such landscapes before as well and it's not new for me", "it is all visible, does not make me curious to explore much"*
- Negative – *"I do not like this picture, because stones do not inspire confidence in me that I will pass over them and remain not crippled", "I've never seen vegetation like that before but I'm definitely not exploring by myself", "Close area, no colour, no life."*

Here, the majority of respondents rated landscape as an environment that evokes active feelings more than calm, specifying the words "scary" and "mystery" while describing and focusing on dense vegetation, slippery stones, and the area is closed. 9 from 66 respondents who left a description of their choice referred to biodiversity and considered it as "complex", "dense", "untouched", "diverse elements".

Image 4 – garden in-between residential areas of student accommodation, maintained. Location - Alnarp, Sweden. Majority rated this image as "2" – 12 (14.8 %), "0" - 11 (13.6%), and "6" - 10 (12.3%), the least responses rated as "3" - 3 (3.7%), and "9" - 3 (3.7%) (Figure 5.3.12). All 81 of participants rated this image.

Pic.10. Image 4

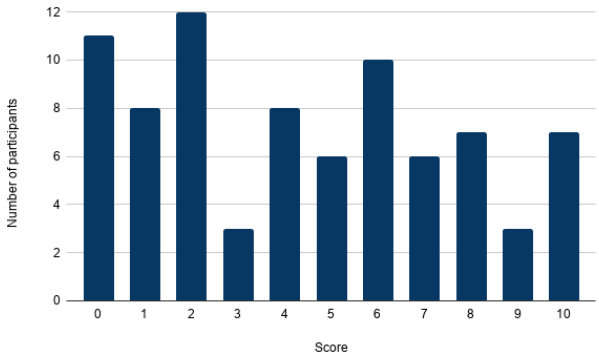


Figure 5.3.12. Survey responses to Image 4

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *"This landscape makes me feel safe too and inviting because of how it seems like it is purposely designed for people", "Garden scene makes me feel like in home place. Inviting", "I prefer to stay and enjoy the beauty of the tree and the falling leaves", "Close to residences, extra feeling of home and safety"*.
- Responses that evoked active feeling – *"It is not a common landscape view for me, so I would like to explore it more".*

Preference response to this scene could be divided into:

- Positive – *"It reminds me of a lot of the villages I live near, very green and welcoming", "Blooming tree is lovely and I want to go closer to it", "Different colours invites to take a walk around", "Variety of colours. Beautiful and different tree"*
- Neutral – *"It's safe but has less nature. Something I would use as pedestrian pathway than a recreational space", "Looks like someone's garden so not very interesting"*.
- Negative – *"it's a boring garden, probably belonging to some businessman who never uses it, but likes to mow it because it makes him feel part of nature even though he's killing it. I actually hate these gardens and think they are worse than monoculture fields", "Not my type of landscape at all", "nothing interesting", "not really inviting or spacey".*

Here, the majority of respondents rated landscape as an environment that evokes calm feelings more than active, some of them described it negatively. 3 from 65

respondents who left a description of their choice referred to biodiversity and considered it as “rich in species”, “different trees”.

Image 7 –.wetland area near Gränna, Sweden. Majority rated this image as “9” – 15 (18.5 %), “7” - 13 (16%), and “10” - 13 (16%), the least responses rated as “1” - 1 (1.2%), “2” - 2 (2.5%) (Figure 5.3.13). 80 (98.8 %) from 81 of participants rated this image.

Pic.13. Image 7

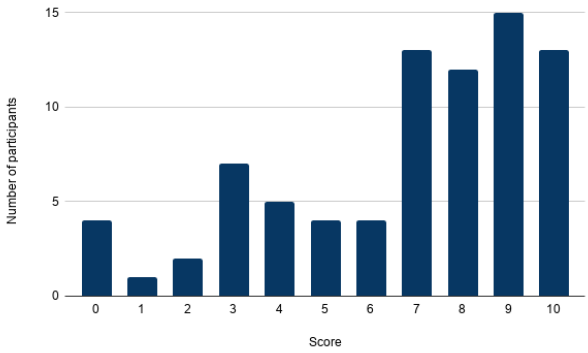


Figure 5.3.13. Survey responses to Image 7

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *“This is very close to my country nature. I like it a lot. I feel save in this kind of areas. I like that is also somehow unmanaged”, “It looks safe because the forest is not really dense”.*
- Responses that evoked active feeling – *“The lighting is neat and the trees give a sense of mystery”, “Since I can't step off the trail, it invites me to go further to see where it leads me. It is more mysterious and intimidating, because closed up space compared to previous picture”, “The swamp-like feel of this photo makes me want to explore it. It seems like water should not be a part of it but it is so I am greatly curious”, “Complex and interesting, rich in elements and their variety, cause desire to discover and explore more of it, interact with components”, “Gives a mysterious feeling, a bit dangerous with narrow path and water bodies around”.*

Some respondents mentioned animal diversity: *“As this is not a normal park in a city so I assume it will be quiet and can hear lots of birds”.*

Preference response to this scene could be divided into:

- Positive – *“It’s lovely; forests have always been a serene place to walk for me. But again would look very scary at night”, “Oh dang is this the continuation of the last forest image dream come true!!”*

- Neutral – *"Pic is nice but can't sit there and not that much satisfying view", "It is not a special one".*
- Negative – not found.

Here, the majority of respondents rated landscape as an environment that evokes active feelings more than calm. Any respondent reacted to the scene negatively. 7 from 63 respondents who left a description of their choice referred to biodiversity and considered it as "rich", "biodiversity hub", "plant richness", and "complex".

Image 9 – botanical garden in Lund. Location Lund, Sweden. Majority rated this image as "0" – 15 (18.5 %), "1" - 15 (18.5%), the least responses rated as "4" - 3 (3.7%), and "8" - 3 (3.7%) (Figure 5.3.14). All 81 of participants rated this image.

Pic.15. Image 9

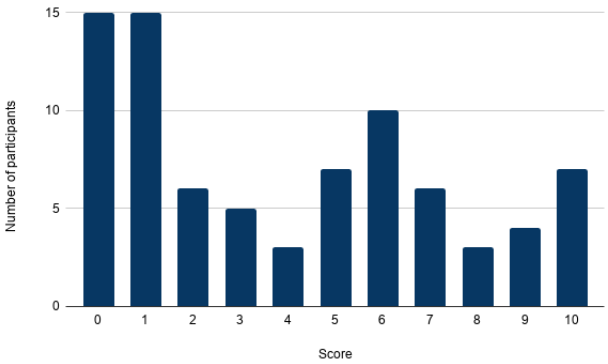


Figure 5.3.14. Survey responses to Image 9

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *"feeling of calm", "I feel very safe here, it seems to have some human intervention and is designed for humans to walk around. The flowers are beautiful to look at", "Feels safe but for me it's visiting an art gallery. Where human tries to mimic the nature. I would not want to explore it more", "Common spring garden scene with tulips is easy to understand, inviting for sense and feel absolutely safe".*
- Responses that evoked active feeling – *"Commonly found garden, feels like more of a regular public exploration location".*

Preference response to this scene could be divided into:

- Positive – *"I always was a spring kid therefore this is majestic!", "Very common looking space but looks very pretty".*
- Neutral – *"Monotonus", "I like flowers here. Generally- neutral feeling: not good, not bad", "not really a flower guy, but it's nice nonetheless", "Seems simple, boring, but safe".*
- Negative – not found.

Here, the majority of respondents rated landscape as an environment that evokes calm feelings more than active, preferring to sit and enjoy the view. Any respondent reacted to the scene negatively. 1 from 60 respondents who left a description of their choice referred to biodiversity and considered it as “biodiverse”.

Image 10 – botanical garden in Lund. Location - Lund, Sweden. Majority rated this image as “0” – 14 (17.3 %), and “5” - 11 (13.6%), the least responses rated as “6” - 3 (3.7%) (Figure 5.3.15). 80 (98.8 %) from 81 of participants rated this image.

Pic.16. Image 10

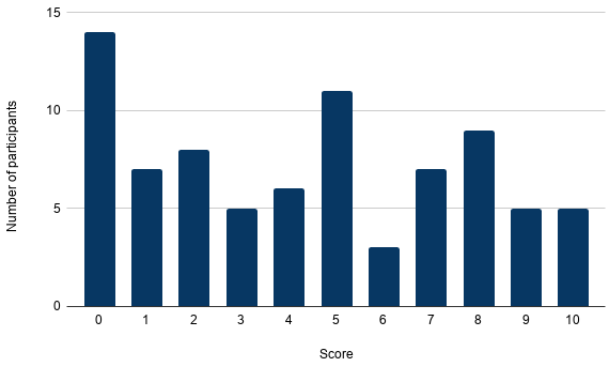


Figure 5.3.15. Survey responses to Image 10

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *“I think the perception of safety in those landscape that has some building/structure is higher”, “Like the other photo, this makes me feel very welcomed and safe as this is designed for humans to meet nature and biodiversity”, “safe and inviting”.*
- Responses that evoked active feeling – *“Also botanical, but this time more mysterious, because of the signs next to the plants”, “The building looks mysterious”.*

Preference response to this scene could be divided into:

- Positive – *“very welcoming and relaxing nice green space”.*
- Neutral – *“Not bad, at least feeling somebody care about garden”, “Nice for walks. But not for everyday walks. Also too urban”, “Feels nice but it is boring”.*
- Negative – not found.

Here, the majority of respondents rated landscape as an environment that evokes calm feelings more than active. Any respondent reacted to the scene negatively. 5 from 62 respondents who left a description of their choice referred to biodiversity and considered it as “diversity”, “biodiverse”, “natural”.

Image 14 – Alnarpsparken Arboretum. Location Alnarp, Sweden. Majority rated this image as “0” – 14 (17.3 %), the least responses rated as “6” - 3 (3.7%), and “4” - 5 (6.2%) (Figure 5.3.16). All 81 of participants rated this image.

Pic.20. Image 14

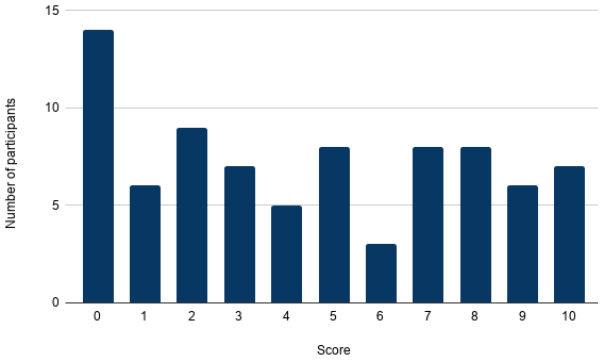


Figure 5.3.16. Survey responses to Image 14

Emotional response to this scene could be divided into:

- Responses that evoked calm feelings – *“wouldn't say commonly found but very inviting, I would like my garden to be like that”, “I don't feel like exploring this, but just looking at it as a whole”, “Special garden, not common but very safe and pleasant”, “Looks simple but also inviting and relaxing”.*
- Responses that evoked active feeling – *“It’s not mysterious but at the same time it makes want to explore it and see what’s over there because of how beautiful it looks like”.*

Preference response to this scene could be divided into:

- Positive – *“Beautiful. As if I came to visit my grandparents”, “Very lovely, the pergola gives me shade, there have been pathways set out for me and i would love to see what has been planted”, “It is a gorgeous and nice view and also very inviting”.*
- Neutral – *“feels a bit odd, it feels like some kind of market, not a landscape”, “not so inviting to stay long but a nice place to walk around”, “Feels nice but it is boring”.*
- Negative – *“Uninteresting landscape”, “boredom.*

Here, the majority of respondents rated landscape as an environment that evokes calm feelings more than active, preferring to sit and enjoy the view. 6 from 58 respondents who left a description of their choice referred to biodiversity and considered it as “variety”, “rich in species”, “biodiversity”.

Interesting that the majority of respondents who referred to biodiversity in the scenes were students of natural and landscape sciences and just a few were not.

6. DISCUSSIONS

It was expected that people's response to different levels of biodiversity will vary; experiencing more calm feelings while observing environments with low biodiversity level and active feelings in high biodiversity environments. But results showed that these preliminary hypothesizes were quite naive. Therefore some patterns of choices made by participants were identified and reasons for the variability in survey responses are described below

6.1.DISCUSSIONS ON THE METHODOLOGY

As it was mentioned in the Methodology chapter, online interviewing has some disadvantages as the information contained in 2D photographs is perceived only visually along with differences in interpretation and understanding of the scale bar. In addition, the duration if time that a respondent has to view a selected image cannot be regulated by the administrator, that also introduces some level of variability in answers. Therefore taking into account the Coronavirus-19 situation and inability to gather people and administer the interview live could explain some of the reasons fir how respondents scored different images. The only option that could have been used in these circumstances in order to give greater validity to this research would have been to use video recordings, such as uTube or QuickTime, that could provide more valuable information, such as sound and increased visibility of plants which may have been not as clearly apparent in the still photographs. But that would on the other hand perhaps introduce a limit upon the amount of the surrounding landscape portrayed in each image. In addition, watching and scoring moving images may have also increased the amount of time required to complete the survey – and possibly as a consequence – reduced the number of survey participants or completed responses. The questions would it be a valuable experience and would it increase the clarity of results remain open.

Regarding the structure and questions of the survey, few participants considered questions of the general part – demographics, education, etc. – too specific and private. Others had difficulties with identifying landscapes between "*easy to understand, inviting*" and "*intimidating, want to explore*" and in some cases they felt both – "*inviting, want to explore*". Therefore for future research, the scale bar of Kaplan's "understanding - exploration" experience should be modified. The scale bar of "calm - active" could be a proper replacement.

The research question that asked, "How can biodiversity contained within green spaces be measured using 2D photography?" was answered in the Methodology chapter by estimation made by the author and calculating fractal dimensions of the photographs. Still, it should be noted that the author does not conclude that chosen methodology applies for all cases as an approximate estimation was done on-site by the author and cannot be compared with the estimation of participants who haven't visited the areas depicted in each image.

Regarding the fractal dimension estimation as a representation of visual complexity, there are studies which have been conducted where fractal geometry is a useful tool for describing visual complexity where the recurrence of the fractal-like information and reduced copies of the whole (Taylor et al., 2005) and effect of restorative feelings could be illustrated by nature's fractal properties (Hägerhäll et al., 2015). This could be also proven by the study of Van den Berg et al. (2016), which discovered that people's psychological response to natural environments is predicted mathematically by a perceived complexity and fractal characteristics within the depicted scene. Researchers also suggest that fractal complexity could be a key characteristic of people's perception of nature, and a greater human affiliation of nature vs. the built environment. This additionally could be an explanation of frameworks presented in the Literature review chapter, but mostly – Biophilia hypothesis. The method of estimating the habitat complexity was also used by Dibble and Thomaz (2009) with a conclusion that the fractal dimension is a feasible environmental measurement of plant complexity at small scales. Moreover, if the author's estimation could be criticized as subjective, the fractal dimension assessment is indeed unbiased.

Therefore, if mathematics is the "queen" of science, it is also then the "queen" of nature. Unfortunately, by this method, we can "count" the amount of nature depicted within a single photograph, yet it is impossible to design an environment based on a desirable visual complexity indicator.

6.2.DISCUSSIONS ON THE RESULTS

The hypothesis that different levels of biodiversity does have an affect upon the psychological and emotional state of humans could be proven by results, however it should be mentioned that there are elements that could be a crucial turning point for a person to experience a particular emotional state. These "elements" are defined below:

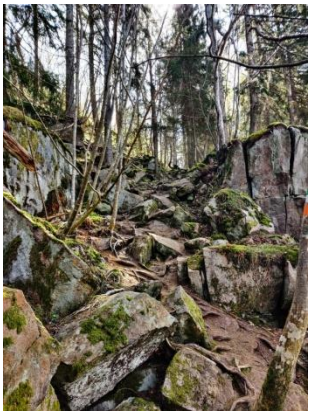
Firstly, it should be mentioned that it is not only the biodiversity of vegetation to which people are referring while experiencing the landscape. It is clearly shown that people experience landscape fully, paying more attention to particular landscape features than vegetation biodiversity. Images 3 (FD 1.81) and 5 (FD 1.95) could be an example of this. Both environments include water, but one is still and another is moving. The results and comments certainly showed that participants referred to water features mostly, not vegetation and it is assumed that they moreover evaluated their emotional experience based on the presence of water in the image(s). Still water features mostly evoked calm feelings, and on the contrary – moving water evoked active. That could refer to the conclusion that water state would influence human emotions increasing peace or desire to explore the area. Similar findings are presented in the study of Lin (2000) where participants rated their emotional state as peaceful while observing images with still water, and conversely they felt excitement while observing moving water. Nonetheless, the study was focused on water features

in urban spaces and current research presented mostly natural or naturalistic areas; it is still rational to conclude that similar patterns could be the foundation to the statement that emotional responses to water features would be comparable.

Pic.9. Image 3

Pic.11. Image 5

Another landscape features that influenced human perception were the presence of large rocks, however the variety of them caused visual complexity. The results have shown that visual complexity will play a greater role than species richness in evoking a particular emotional state. This could also be proven by the assumption of the study of Hägerhäll et al. from 2004 that indicated – found how preferences for the differing landscape elements would depend on their fractal dimension. The great representation of it could be a comparison between results to Image 8 and 9, where the first one is a low level of biodiversity landscape and the second is high. Image 8 evoked more active feelings while Image 9 – calm, taking into account that Image 8 (FD 1.95) – hiking path with a variety of rocks and Image 9 (FD 1.86) – botanical garden in the blooming period.



Pic.14. Image 8

Pic.15. Image 9

It is interesting not note that even the fractal dimension for the less biodiverse environment is higher which leads to the conclusion that visual complexity cannot be part of biodiversity estimation as it should be vice versa. The study by Almashy from 2020 (unpublished) claims that there is a connection between different emotional

response to the number of vegetation levels where people tend to feel boredom while observing one layer of identical trees and creating the same composition with few levels of vegetation could increase landscape preference. However, in current research visual complexity is represented and perceived not just by the physical structure and variety of vegetation but also by other landscape features where they differ. This ultimately leads to the conclusion that visual complexity cannot be evaluated or has the same or equal weight as vegetation biodiversity; it should have greater weighting.

Another important aspect that influenced the perception of chosen environments was lightning. Images 2 (FD 1.92) and 6 (FD 1.94) were described negatively due to the dense planting, lack of sun (Image 2), and perceived dryness (Image 6) with a high and intermediate level of biodiversity respectively.

Pic.8. Image 2

Pic.12. Image 6

Interesting is that the distribution among participants on the feeling of safety in green areas at night shows that just 34 (42%), where 13 (27.1%) were women, replied “yes”, which means that the simple majority (47(58%) of participants) do not feel safe or referring that it depends on a variety of factors as lightning and location of the area. And 35 (72.9%) of them are women. Therefore there are cases like this where a high level of biodiversity and/or lack of lightning in the environment will evoke fear rather than excitement and desire to explore. That would be conventional and correlates with the Biophobia concept described in the study of Patuano from 2020. As Ulrich (1993) illustrated in Patuano (2020), “Biophobia” is the innate genetic tendency to feel fear or strong negative emotions to the particular natural stimuli that could be a threat to the human. Some descriptions of the images of current research could be interpreted as biophobia as fear of snakes, ticks and bears. Notwithstanding while referring to biophilia in the current research, it is important to mention that it is still just a hypothesis and it should be critically assessed testes in future research, due to the inefficiency of considering cultural and personal characteristics.

And on the contrary, there are some cases when even environments with a high level of biodiversity and complex vegetation structure will evoke calm feelings or even boredom. An example of it could be Image 4 (FD 1.74) which has a high level of

biodiversity but appears overly maintained. Despite, the visual complexity counted by fractal geometry for this image was one of the lowest alike.

Pic.10. Image 4

Furthermore, there is a difference in the descriptions of their choices between landscape and environmental sciences student (experts) compared to those who are not studying those curriculums (non-experts). Majority of the respondents who were referring to the vegetation biodiversity while describing their choice were young students highly educated in landscape and natural science. The difference in deeper biodiversity estimation during on-site observations was also mentioned by the study of Gyllin and Grahn from 2015. However, results showed that the actual and perceived biodiversity would differ even for experts. An example of it could be a comparison in descriptions to Image 9 (FD 1.86) and 13 (FD 1.75), where the first one is – a blooming botanical garden, and the second – a monocultutal wooden structure.

Pic.15. Image 9

Pic.19. Image 13

It is intriguing that for Image 9, just one person referred to “nature and biodiversity” while Image 13 has received ten descriptions that refer to the biodiversity aspect, expressions that correspond to word “biodiversity” were taken from the study of Gyllin and Grahn from 2005 plus synonyms were taken into account. Therefore it is reasonable to conclude that participants assumed that environment is biodiverse based on the number of vegetation elements, not taking into account that the same

environment could be a monoculture, results of descriptions to Image 13 as an example of this. Furthermore, participants could mistakenly infer that if the vegetation structure is dense, that would mean the environment is biodiverse as well. In contrast, a study by Lindemann-Matthies from 2010 received results where people underestimated high species richness environment and slightly overestimated those with low species diversity. However, the study suggests that people might not be able to estimate the species richness of grasslands communities as it could be easily overlooked. Another point can be found in a study by Young et al. from 2019 that determined a method of estimating the actual biodiversity simply by asking two questions – about the habitat and species abundance of the garden. Despite the findings that about 50% of the actual habitat heterogeneity could be predicted by using this method, it is important to mention that information taken from participants is just an estimation but not actual data. Consequently, the question can people objectively measure the level of biodiversity remains open, which could also be partly proven by the study of Damllimer et al. (2012).

Moreover, it is important to recall that some environments were described as home-like where the perception of it could be influenced by place attachment to areas similar, what might cause the confusion in analyzing results.

The main question of the current chapter is how the results could be used by landscape architects and environmental psychologists. Besides the fact that fractal geometry cannot help to create a visually complex environment, these findings could be used as a representation of the indirect impact of nature on human's emotions through 2D photography. The environments with high complexity and high level of biodiversity but with sufficient lightning and absence of "scary" features could be used wallpaper in places where evoking active feelings is needed. On the contrary, low complex landscapes with water could be used in places where calm and safety feelings are required.

7. CONCLUSIONS

As was discussed earlier in this thesis, there exists a very strong human desire for, and dependence on, experiencing nature; the emotional, physical, and psychological connections are not only tangible but essential for our sense of physical and mental health. In this research, it was assumed that the human perception of, and preference for scenes depicting, vegetation and the aggregate amount of biodiversity would vary depending on the sum of the last. Unfortunately, this hypothesis cannot be proven fully and there is no straight or clear answer to the question of which particular emotion a person would feel or experience while observing landscapes with different level of biodiversity as depicted in 2D photographs. For that future research is needed using both 2D and 3D photographs and/or videos to test the "flatness" of the 2D images and human emotional responses to find is there main differences in perceiving variance levels of biodiversity contained in each setting. However, this research presents some observations on how people emotionally perceive biodiversity from the 2D photographs, based on specific emotions that are triggered by differing levels of form, colour, texture, complexity, mystery, etc. The research presented in this thesis confirmed that there is a connection between human emotions and visual complexity in a landscape, and particular factors such as lighting or illumination, perceived maintenance, and the density of vegetation are the key factors or triggers why the surveyed participants responded by feeling or experiencing one particular emotion perhaps more than another. Therefore, it is important to mention a the greater value should be given to visual complexity in terms of evaluating the human emotional perception of nature, since vegetation biodiversity is just a part of visual complexity, and should be considered as such but not vice versa. Consequently, the following recommendations for the future research and design of outdoor landscapes are:

- Landscapes (as viewed in 2D images) with a lover-level of illumination will evoke emotions with greater level of fear or uncertainty rather than excitement; however, the exploring rate, here curiosity and desire to explore more, would be greater. Those could be applied for places where active leisure time is envisaged as theme parks;
- Well-maintained landscapes would rather evoke calm feelings than excitement, therefore they could be used for places where calm leisure time is needed as hospital, sanatorium and prison gardens;
- Landscapes with greater visual complexity, such as dense vegetation or variety of the landscape elements would rather evoke an active feeling, thus those could be used in green areas for children and teenagers;
- Landscapes with water would evoke calm or active feelings depending upon the character of the water feature.

The results produced in this research also reflect on the possible measurement methods for estimating the level of biodiversity from the 2D photographs. Those methods are:

- The calculating mean value of the estimated biodiversity by the evaluation of richness and spatial organization of landscape vegetation elements, and approximate species richness;
- Estimation of the visual complexity (by fractal dimension) of the image by using the “Software for fractal analysis”.

Nevertheless, it is important to mention that the results of the research contained in this thesis and the associated findings cannot be claimed as unconditional true and universal to all landscapes. The research does attempt to explain the broad variety of people’s emotional responses to vegetation biodiversity due to gender differences within the survey respondent group, in addition to other unknown factors such as emotional state while taking the survey, disturbing factors, amount of cm of the screen etc., however the findings can and should be used as a guide for a landscape architect, planner or designer in their work to create interesting outdoor places for people experience the natural world that surround us.

8. REFERENCES

1. Almashy, O. (2019). *Vegetation: Colour and structure as a principal properties of an outdoor restorative environment.* Unpublished manuscript.
2. Almashy, O. (2020). *Which emotions are evoked by the colour and level of trees?* Unpublished manuscript.
3. Bourke, P. (2021, March 16). *An Introduction to Fractals*. Paul Bourke. http://paulbourke.net/fractals/fracintro/
4. Annerstedt, M., Norman, J., Boman, M., Mattsson, L., Grahn, P., & Währborg, P. (2010). Finding stress relief in a forest. *Ecological Bulletins*, (53), 33–42. Retrieved from https://www.jstor.org/stable/pdf/41442017.pdf
5. Brown, T. C., & Daniel, T. C. (1986). Predicting scenic beauty of timber stands. *Forest Science*, *32*(2), 471–487. Retrieved from https://www.fs.fed.us/rm/value/docs/scenic-beauty-prediction.pdf
6. Carrus, G., Scopelliti, M., Lafortezza, R., Colangelo, G., Ferrini, F., Salbitano, F., Sanesi, G. (2015). Go greener, feel better? The positive effects of biodiversity on the well-being of individuals visiting urban and peri-urban green areas. *Landscape and Urban Planning*, *134*, 221–228. Retrieved from https://doi.org/10.1016/j.landurbplan.2014.10.022
7. Cele, S. (2005). On foot in the city of children. *Nordisk Arkitekturforskning*, (1), 85–98.
8. Dallimer, M., Irvine, K. N., Skinner, A. M. J., Davies, Z. G., Rouquette, J. R., Maltby, L. L., Gaston, K. J. (2012). Biodiversity and the feel-good factor: Understanding associations between self-reported human well-being and species richness. *BioScience*, *62*(1), 47–55. Retrieved from https://doi.org/10.1525/bio.2012.62.1.9
9. Dibble, E. D., & Thomaz, S. M. (2009). Use of fractal dimension to assess habitat complexity and its influence on dominant invertebrates inhabiting tropical and temperate macrophytes. *Journal of Freshwater Ecology*, *24*(1), 93–102. Retrieved from https://doi.org/10.1080/02705060.2009.9664269
10. Falk, J. H., & Balling, J. D. (2010). Evolutionary influence on human landscape preference. *Environment and Behavior*, *42*(4), 479–493. Retrieved from https://doi.org/10.1177/0013916509341244
11. Foo, C. H. (2016). Linking forest naturalness and human wellbeing-A study on public's experiential connection to remnant forests within a highly urbanized region in Malaysia. *Urban Forestry and Urban Greening*, *16*, 13–24. Retrieved from https://doi.org/10.1016/j.ufug.2016.01.005
12. Grahn, P., & Stigsdotter, U.A. (2003). Landscape planning and stress. *Urban Forestry & Urban Greening*, *2*, 1-18. Retrieved from https://doi.org/10.1078/1618-8667-00019
13. Hadzieva, E., Bogatinoska, D. C., Gjergjeska, L., Shumi-Noska, M., & Petroski, R. (2015). Review of the Software Packages for Estimation of the Fractal Dimension. *ICT Innovations 2015 Web Proceedings*, 201–211. Retrieved from http://ictinnovations.org/2015,%0Ahttp://proceedings.ictinnovations.org/attachm

ent/paper/376/review-of-the-software-packages-for-estimation-of-the-fractal-dimension.pdf
14. Hagerhall, C., Laike, T., Küller, M., Marcheschi, E., Boydston, C., & Taylor, R. (2015). Human physiological benefits of viewing nature: EEG responses to exact and statistical fractal patterns. *Nonlinear dynamics, psychology, and life sciences, 19 1*, 1-12 Retrieved from https://cpb-us-e1.wpmucdn.com/blogs.uoregon.edu/dist/e/12535/files/2015/12/art1901-1LITE-13psjqc.pdf
15. Hagerhall, C., Purcell, T., & Taylor, R. (2004). Fractal dimension of landscape silhouette outlines as a predictor of landscape preference. *Journal of Environmental Psychology, 24*, 247-255. Retrieved from https://doi.org/10.1016/j.jenvp.2003.12.004
16. Hartig, T., Mitchell, R., De Vries, S., & Frumkin, H. (2014). Nature and health. In *Annual Review of Public Health* (Vol. 35, pp. 207–228). Annual Reviews Inc. Retrieved from https://doi.org/10.1146/annurev-publhealth-032013-182443
17. Heerwagen, J. (2009). Biophilia, Health and Well-being. *Restorative Commons: Creating Health and Well-Being through Urban Landscapes*, 39–57. Retrieved from https://www.nrs.fs.fed.us/pubs/gtr/gtr-nrs-p-39papers/04-heerwagen-p-39.pdf
18. Johansson, M., Gyllin, M., Witzell, J., & Küller, M. (2014). Does biological quality matter? Direct and reflected appraisal of biodiversity in temperate deciduous broad-leaf forest. *Urban Forestry and Urban Greening*, *13*(1), 28–37. Retrieved from https://doi.org/10.1016/j.ufug.2013.10.009
19. Joye, Y., de Block, A. (2011). "Nature and I are two": A critical examination of the biophilia hypothesis. *Environmental Values*, *20*(2), 189–215. Retrieved from https://www.jstor.org/stable/23048439
20. Joye Y, van den Berg A (2013) Restorative environments. In: Steg L, van den Berg AE, de JIM G (Ed.) *Environmental psychology: an introduction* (pp. 57–66). West Sussex: BPS Blackwell
21. Kahn, P. H. (1997). Developmental Psychology and the Biophilia Hypothesis: Children's Affiliation with Nature. *Developmental Review*, *17*(1), 1–61. Retrieved from https://doi.org/10.1006/drev.1996.0430
22. Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology*, *15*(3), 169–182. Retrieved from https://doi.org/10.1016/0272-4944(95)90001-2
23. Kaplan, R., Kaplan, S., & Ryan, R. (1998). *With people in mind: design and management of everyday nature.* Island press.
24. Kaplan, S., Kaplan, R., & Wendt, J. (1972). Rated preference and complexity for natural and urban visual material. *Perception & Psychophysics, 12*(4), 354-356. Retrieved from https://link.springer.com/article/10.3758/BF03207221
25. Kaufman, A. J., & Lohr, V. I. (2002, August). Does plant color affect emotional and physiological responses to landscapes? In: *XXVI International Horticultural Congress: Expanding Roles for Horticulture in Improving Human Well-Being*

and Life Quality 639 (pp. 229-233). Retrieved from https://doi.org/10.17660/ActaHortic.2004.639.29

26. Gullone, E. (2000). The Biophilia Hypothesis and Life in the 21st Century: Increasing Mental Health or Increasing Pathology? *Journal of Happiness Studies, 1*(3), 293-322. Retrieved from https://link.springer.com/article/10.1023/A:1010043827986
27. Gyllin, M., & Grahn, P. (2005). A semantic model for assessing the experience of urban biodiversity. *Urban Forestry and Urban Greening*, *3*(3–4), 149–161. https://doi.org/10.1016/j.ufug.2005.04.004
28. Gyllin, M., & Grahn, P. (2015). Semantic Assessments of Experienced Biodiversity from Photographs and On-Site Observations – A Comparison. *Environment and Natural Resources Research*, *5*(4), 46. https://doi.org/10.5539/enrr.v5n4p46
29. Lin, Y. H. (2000). *Human emotional responses to visual aspects of water features* (Doctoral dissertation, The Ohio State University). Retrieved from https://etd.ohiolink.edu/apexprod/rws_etd/send_file/send?accession=osu1396351739&disposition=inline
30. Lindemann-Matthies, P., Junge, X., & Matthies, D. (2010). The influence of plant diversity on people's perception and aesthetic appreciation of grassland vegetation. *Biological Conservation, 143*(1), 195-202. Retrieved from https://doi.org/10.1016/j.biocon.2009.10.003
31. Lohr, V. I., & Pearson-Mims, C. H. (2006). Responses to scenes with spreading, rounded, and conical tree forms. *Environment and Behavior*, *38*(5), 667–688. https://doi.org/10.1177/0013916506287355
32. Lohr, V. I. (2009, June). What are the benefits of plants indoors and why do we respond positively to them?. In *II International Conference on Landscape and Urban Horticulture 881* (pp. 675-682). Retrieved from https://doi.org/10.17660/ActaHortic.2010.881.111
33. Marselle, M.R. (2019). Theoretical Foundations of Biodiversity and Mental Well-being Relationships. In Marselle, M.R. et al.(Ed.). *Biodiversity and Health in the face of Climate Change* (pp. 133-158). Springer Nature. Retrieved from http://library.oapen.org/handle/20.500.12657/22910
34. Marselle, M. R., Irvine, K. N., Lorenzo-Arribas, A., & Warber, S. L. (2016). Does perceived restorativeness mediate the effects of perceived biodiversity and perceived naturalness on emotional well-being following group walks in nature? *Journal of Environmental Psychology*, *46*, 217–232. https://doi.org/10.1016/j.jenvp.2016.04.008
35. Marselle M.R., Martens D., Dallimer M., Irvine K.N. (2019) Review of the Mental Health and Well-being Benefits of Biodiversity. In: Marselle M., Stadler J., Korn H., Irvine K., Bonn A. (Ed.) *Biodiversity and Health in the Face of Climate Change* (pp. 175-212). Springer Nature. Retrieved from http://library.oapen.org/handle/20.500.12657/22910

36. Muderrisoglu, H., Aydin, S., Yerlı, O., & Kutay, E. (2009). Effects of colours and forms of trees on visual perceptions. *Pakistan Journal of Botany*, *41*(6), 2697-2710. Retrieved from http://pakbs.org/pjbot/PDFs/41(6)/PJB41(6)2697.pdf
37. Ode, Å., Tveit, M., & Fry, G. (2008). Capturing landscape visual character using indicators: Touching base with landscape aesthetic theory. *Landscape Research*, *33*(1), 89–117. Retrieved from https://doi.org/10.1080/01426390701773854
38. Oleksiichenko, N., Gatalska, N., & Mavko, M. (2018). The Colour-Forming Components of Park Landscape and the Factors That Influence the Human Perception of the Landscape Colouring. *Theoretical and Empirical Researches in Urban Management*, *13*(2), 38-52. Retrieved from https://www.ceeol.com/search/article-detail?id=677298
39. Patuano, A. (2020). Biophobia and Urban Restorativeness. *Sustainability*, *12*(10), 4312. Retrieved from https://doi.org/10.3390/su12104312
40. Patuano, A., & Tara, A. (2020). Fractal geometry for landscape architecture: Review of methodologies and interpretations. *Journal of Digital Landscape Architecture*, *2020*(5), 72–80. Retrieved from https://doi.org/10.14627/537690008
41. Raffaelli, D. (2017, March 1). What is biodiversity? *Planet Earth*. Natural Environment Research Council. Retrieved from https://doi.org/10.11647/obp.0177.03
42. Sadek, M., Sayaka, S., Fujii, E., Koriesh, E., Moghazy, E., & El Fatah, Y. A. (2013). Human emotional and psycho-physiological responses to plant color stimuli. *Journal of Food, Agriculture and Environment*, *11*(3–4), 1584–1591. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.662.503&rep=rep1&type=pdf
43. Scopelliti, M., Carrus, G., Cini, F., Mastandrea, S., Ferrini, F., Lafortezza, R., Agtimi, M., Salbitano, F., Sanesig, & Semenzato, P. (2012). Biodiversity, perceived restorativeness and benefits of nature: a study on the psychological processes and outcomes of on-site experiences in urban and peri-urban green areas in Italy. In: Kabisch S, Kunath A, Schweizer-Ries P, Steinfuhrer A (Ed.) *Vulnerability, Risks, and Complexity: Impacts of global change on human habitats* (pp. 255-270). Massachusetts: Hogrefe & Huber Publishers Retrieved from https://www.mdpi.com/2071-1050/5/1/160
44. Sörqvist, P. (2016). Grand Challenges in Environmental Psychology. *Frontiers in Psychology, 7*. 583. Retrieved from https://doi.org/10.3389/fpsyg.2016.00583
45. Steg, Linda., Berg, Agnes E. van den. & de Groot, Judith I. M. (2013). Environmental psychology: History, scope and methods. In: Steg L, van den Berg AE, de JIM G (Ed.) *Environmental psychology: an introduction* (pp. 57–66). West Sussex: BPS Blackwell
46. Sundli Tveit M, Ode Sang A, Hagerhall CM (2013) Scenic beauty: visual landscape assessment and human landscape perception. In: Steg L, van den Berg

AE, de JIM G (Ed.) *Environmental psychology: an introduction* (pp. 57–66). West Sussex: BPS Blackwell

47. Thorpert, P., & Nielsen, A. B. (2014). Experience of vegetation-borne colours. *Journal of Landscape Architecture*, *9*(1), 60–69. https://doi.org/10.1080/18626033.2014.898834
48. Tress, B., & Tress, G. (2001). Capitalising on multiplicity: A transdisciplinary systems approach to landscape research. *Landscape and Urban Planning*, *57*(3–4), 143–157. https://doi.org/10.1016/S0169-2046(01)00200-6
49. Taylor, R. P., Spehar, B., Wise, J. A., Clifford, C. W. G., Newell, B. R., Hagerhall, C. M., Martin, T. P. (2005). Perceptual and physiological responses to the visual complexity of fractal patterns. *Nonlinear Dynamics, Psychology, and Life Sciences*, *9*(1), 89–114. Retrieved from https://cpb-us-e1.wpmucdn.com/blogs.uoregon.edu/dist/e/12535/files/2015/12/ResponseNon-linear-28e9hbu.pdf
50. Ulrich, R.S. (1983). Aesthetic and affective response to natural environment. In: I. Altman & J. Wohlwill (Ed.) *Human Behavior and Environment (pp.* 85-1 25*).* Springer, Boston, MA Retrieved from https://link.springer.com/chapter/10.1007/978-1-4613-3539-9_4
51. Ulrich, R., Simons, R., Losito, B.D., Fiorito, E., Miles, M., & Zelson, M.F. (1991). Stress recovery during exposure to natural and urban environments. *Journal of Environmental Psychology, 11*(3), 201-230. Retrieved from https://doi.org/10.1016/S0272-4944(05)80184-7
52. Van den Berg, A. E., Joye, Y., & Koole, S. L. (2016). Why viewing nature is more fascinating and restorative than viewing buildings: A closer look at perceived complexity. *Urban Forestry and Urban Greening, 20*, 397–401. Retrieved from https://doi.org/10.1016/j.ufug.2016.10.011
53. Wolf, L., Ermgassen, S.Z., Balmford, A., White, M., & Weinstein, N. (2017). Is Variety the Spice of Life? An Experimental Investigation into the Effects of Species Richness on Self-Reported Mental Well-Being. *PLoS ONE, 12*(1). Retrieved from https://doi.org/10.1371/journal.pone.0170225
54. Wolfe, J., Kluender, K., Dennis, L., Bartoshuk, L., Herz, R., Lederman, S., & Merfeld, D. (2015). Sensation & perception (Fourth edition.). Sinauer Associates, Inc., Publishers.
55. Young, C., Frey, D., Moretti, M., & Bauer, N. (2019). Research Note: Garden-owner reported habitat heterogeneity predicts plant species richness in urban gardens. *Landscape and Urban Planning, 185*, 222-227. Retrieved from https://doi.org/10.1016/j.landurbplan.2019.01.013

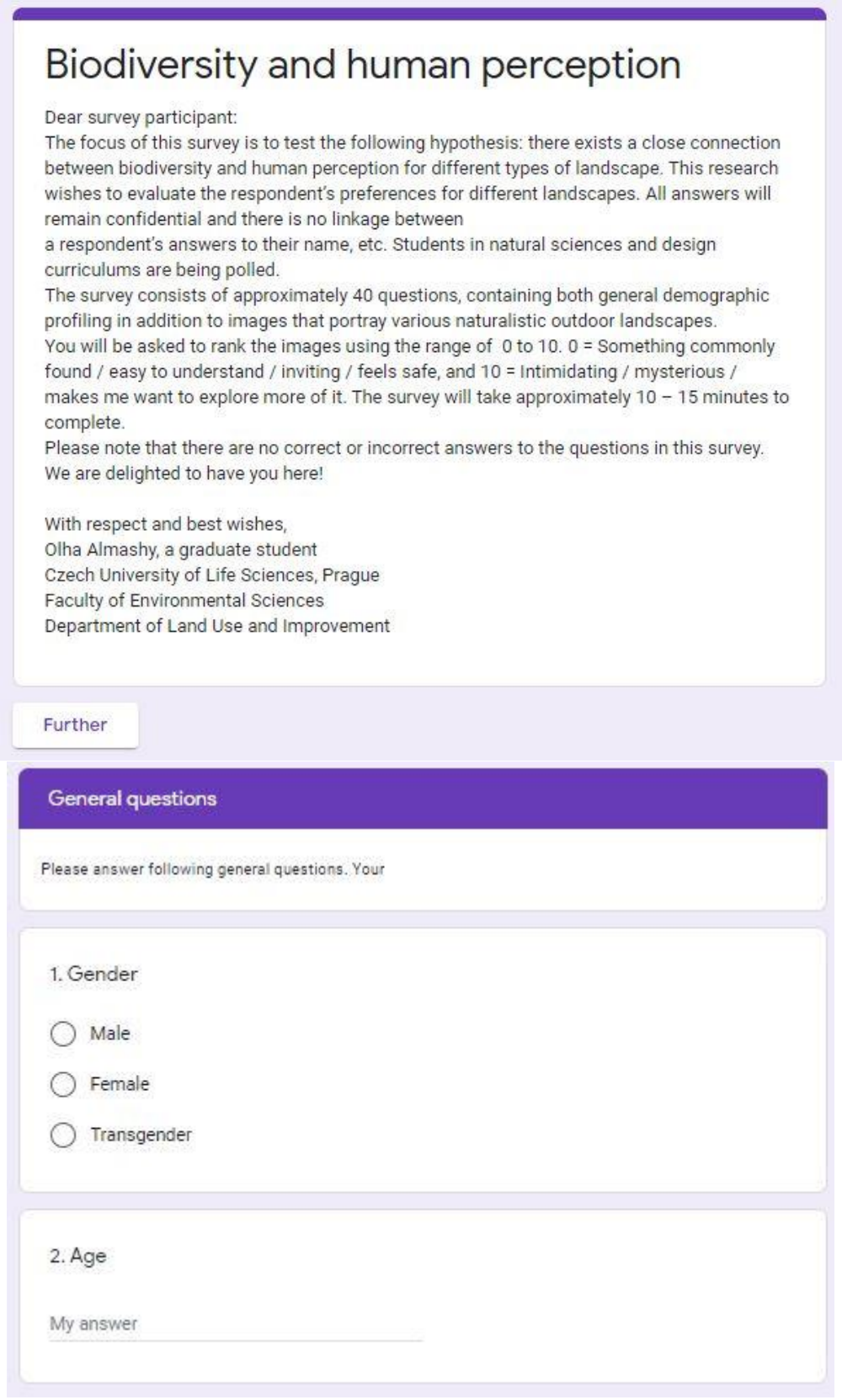
9. APPENDICES

Appendix 1

Table 4. Estimated fractal dimension index to each image

Image	Fractal dimension
1	1.84
2	1.92
3	1.81
4	1.74
5	1.95
6	1.94
7	1.95
8	1.95
9	1.86
10	1.92
11	1.81
12	1.87
13	1.75
14	1.95
15	1.72
16	1.76

Appendix 2: The survey contents



Biodiversity and human perception

Dear survey participant:
The focus of this survey is to test the following hypothesis: there exists a close connection between biodiversity and human perception for different types of landscape. This research wishes to evaluate the respondent's preferences for different landscapes. All answers will remain confidential and there is no linkage between
a respondent's answers to their name, etc. Students in natural sciences and design curriculums are being polled.
The survey consists of approximately 40 questions, containing both general demographic profiling in addition to images that portray various naturalistic outdoor landscapes.
You will be asked to rank the images using the range of 0 to 10. 0 = Something commonly found / easy to understand / inviting / feels safe, and 10 = Intimidating / mysterious / makes me want to explore more of it. The survey will take approximately 10 – 15 minutes to complete.
Please note that there are no correct or incorrect answers to the questions in this survey.
We are delighted to have you here!

With respect and best wishes,
Olha Almashy, a graduate student
Czech University of Life Sciences, Prague
Faculty of Environmental Sciences
Department of Land Use and Improvement

Further

General questions

Please answer following general questions. Your

1. Gender

- ◯ Male
- ◯ Female
- ◯ Transgender

2. Age

My answer

3. Nationality

My answer

4. Permanent place of residence (country)

My answer

5. Highest level of education you have achieved

- ◯ undergraduate (college, bachelor)
- ◯ graduate
- ◯ PhD or higher
- ◯ Other:

6. Which type of degree program are you in / have you taken?

My answer

Back to Further

Perception of nature

How often do you visit green areas (parks, gardens in the city)?

- ◯ once per day
- ◯ once-twice per week
- ◯ once-twice per month
- ◯ rarely

How often do you visit green areas (parks, gardens in the city) and stay there for more than half an hour?

- ◯ once per day
- ◯ once-twice per week
- ◯ once-twice per month
- ◯ rarely

Is there a particular reason why are you visiting green areas?

My answer

How do you feel while visiting green areas?

My answer

Do you feel safe walking in green areas at night?

- ◯ Yes
- ◯ No
- ◯ Other:

Do you have one prefered type of landscape more so than another? If yes, please describe what this is and why.

My answer

Back Further

Perception of biodiversity

Take a look at the following 16 photos. Try to imagine being in the landscape. What do you feel? Do you feel safe, bored, or excited? Rate images based on your personal perception.

Question 1.1. Rate Image №1 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

Question 1.2. Depending on the answer above, please describe why

My answer

Question 2.1. Rate Image №2 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

Question 2.2. Depending on the answer above, please describe why

My answer

Question 3.1. Rate Image Nº3 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

Question 3.2. Depending on the answer above, please describe why

My answer

Question 4.1. Rate Image Nº4 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

Question 4.2. Depending on the answer above, please describe why

My answer

Question 5.1. Rate Image №5 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe

Intimidating / mysterious / makes me want to explore more of it

Question 5.2. Depending on the answer above, please describe why

My answer

Question 6.1. Rate Image №6 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe

Intimidating / mysterious / makes me want to explore more of it

Question 6.2. Depending on the answer above, please describe why

My answer

Question 7.1. Rate Image №7 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

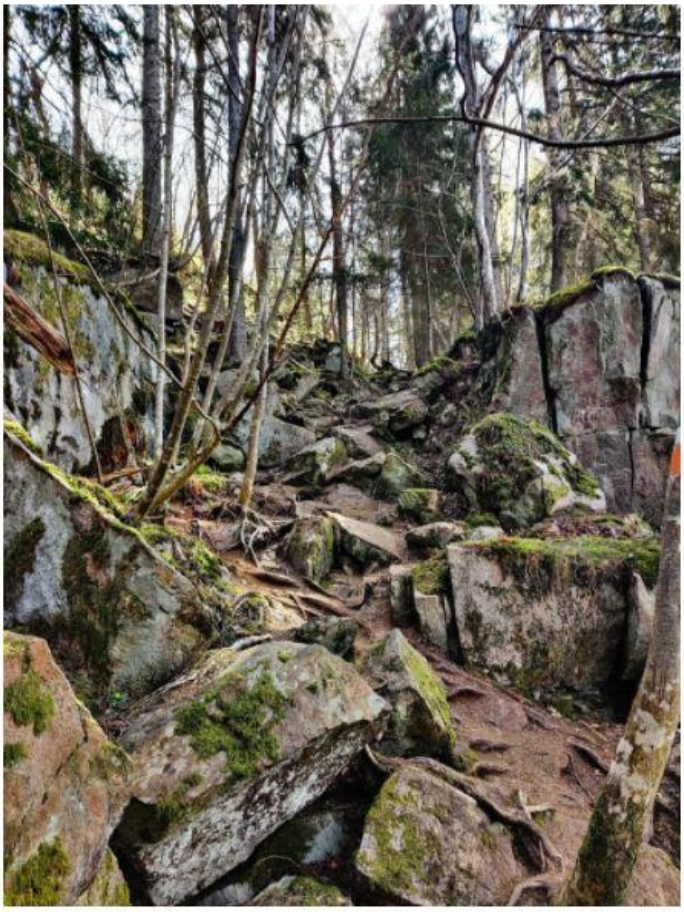
Something commonly found / easy to understand / inviting / feels safe

Intimidating / mysterious / makes me want to explore more of it

Question 7.2. Depending on the answer above, please describe why

My answer

Question 8.1. Rate Image №8 based on your perception of it



0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe

Intimidating / mysterious / makes me want to explore more of it

Question 8.2. Depending on the answer above, please describe why

My answer

Question 9.1. Rate Image №9 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

Question 9.2. Depending on the answer above, please describe why

My answer

Question 10.1. Rate Image №10 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

Question 10.2. Depending on the answer above, please describe why

My answer

Question 11.1. Rate Image №11 based on your perception of it

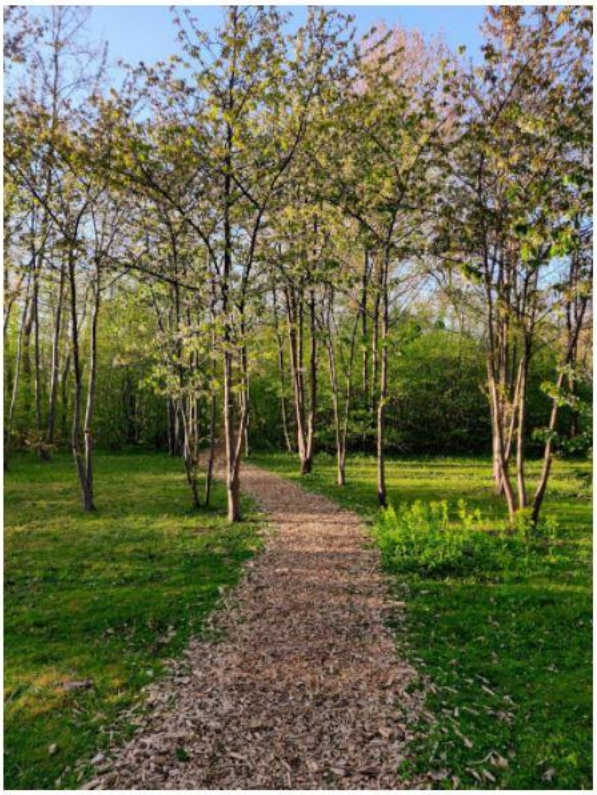
0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

Question 11.2. Depending on the answer above, please describe why

My answer

Question 12.1. Rate Image №12 based on your perception of it



0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

Question 12.2. Depending on the answer above, please describe why

My answer

Question 13.1. Rate Image №13 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

Question 13.2. Depending on the answer above, please describe why

My answer

Question 14.1. Rate Image №14 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

Question 14.2. Depending on the answer above, please describe why

My answer

Question 15.1. Rate Image №15 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it

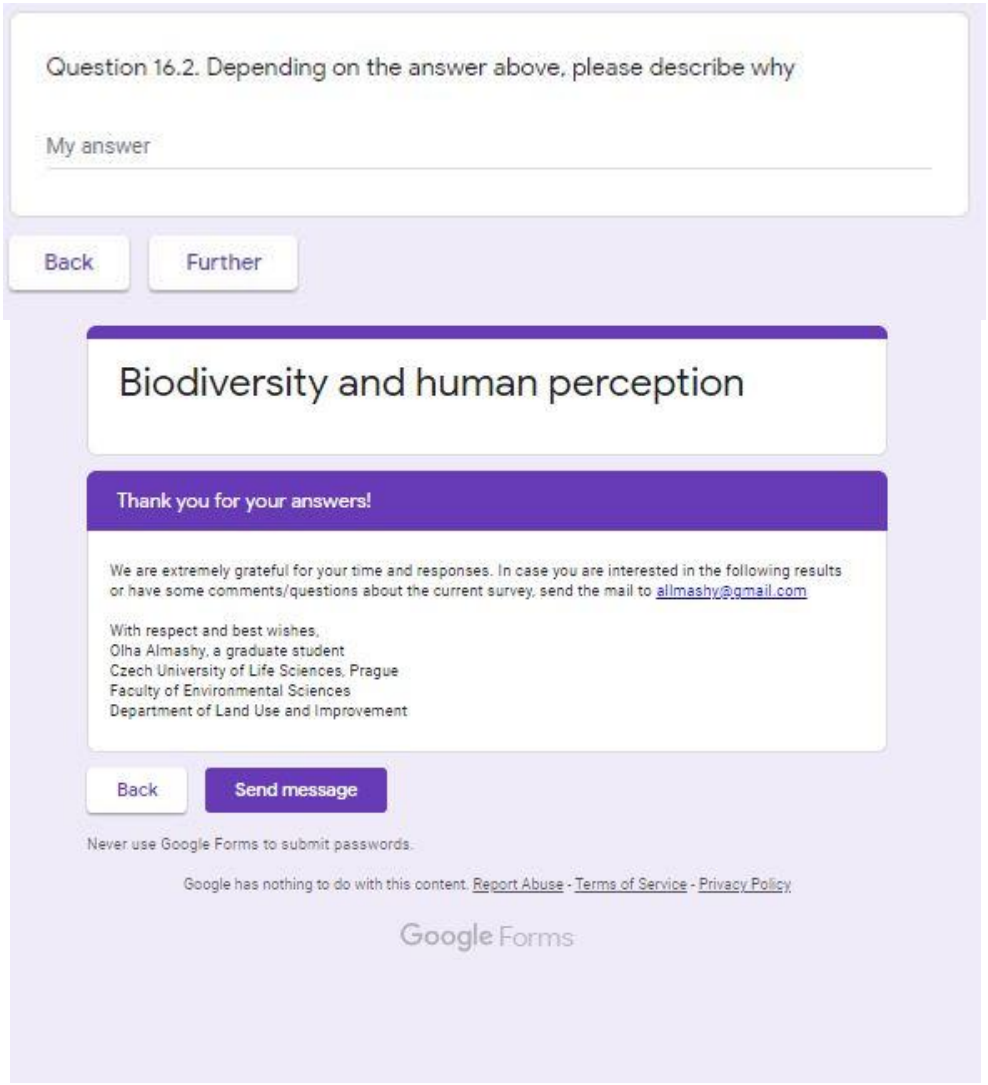
Question 15.2. Depending on the answer above, please describe why

My answer

Question 16.1. Rate Image №16 based on your perception of it

0 1 2 3 4 5 6 7 8 9 10

Something commonly found / easy to understand / inviting / feels safe ○○○○○○○○○○○ Intimidating / mysterious / makes me want to explore more of it


Question 16.2. Depending on the answer above, please describe why
My answer
Back
Further
Biodiversity and human perception
Thank you for your answers!
We are extremely grateful for your time and responses. In case you are interested in the following results or have some comments/questions about the current survey, send the mail to allmashy@gmail.com
With respect and best wishes,
Olha Almashy, a graduate student
Czech University of Life Sciences, Prague
Faculty of Environmental Sciences
Department of Land Use and Improvement
Back
Send message
Never use Google Forms to submit passwords.
Google has nothing to do with this content. Report Abuse - Terms of Service - Privacy Policy
Google Forms