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Mapping natural and cultural heritage in pond landscapes

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Summary

Pond farming in Upper Lusatia has a long tradition which dates to the 13th century. The continuation of this practice has resulted in a cultural landscape characterised by its biological and structural diversity. The pond landscapes are valued for their ecological importance and for the provision of regional fish products. In addition, this landscape and the practices associated with it, form part of the local culture and tradition. Natural and cultural heritage includes features within the landscape meaningful in the present. This encompasses historical and non-historical objects, landscape features (cultural and natural) and intangible aspects. My thesis aims to research natural and cultural heritage at a landscape scale, analysing its spatial distribution and associations with landscape elements, and in the specific context of the Upper Lusatian Pond landscape. A participatory mapping approach combining qualitative and quantitative methods is employed to gain insights on the interactions between the landscape and the public in a heritage context. Natural and cultural heritage in the study area concentrates in three main hotspots located in the Olba Lake, the Guttau pond group and the "Haus der Tausend Teiche" (the information centre of the Biosphere Reserve Upper Lusatian Heath and Pond Landscape) and is associated with specific landscape elements. Pond landscapes are multifunctional spaces which form part of the identity of Upper Lusatia and are highly associated with heritage. The method proposed needs to be improved and further researched. However, it is a potential approach for larger scale natural and cultural heritage assessment.

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Abbreviations	Full description
BROHT	Biosphärenreservat Oberlausitzer Heide- und Teichlandschaft
CES	Cultural Ecosystem Services
CICES	Common International Classification of Ecosystem Services
ELC	European Landscape Convention
EPCN	European Pond Conservation Network
ES	Ecosystem Services
Esri	Environmental Systems Research Institute
GIS	Geographical Information System
IDW	Inverse Distance Weighted
IfB	Institute of Inland Fisheries
LUIS	Landwirtschaft- und Umweltinformationssystem für Geodaten
MEA	Millenium Ecosystem Assessment
MAB	Man and the Biosphere
PGIS	Participatory Geographical Information Systems
PPGIS	Public Participation Geographical Information Systems
QGIS	Quantum Geographical Information System
STECF	Scientific, Technical and Economic Committee for Fisheries
UNESCO	United Nations Educational, Scientific and Cultural Organisation

1. Introduction

The global total of small waterbodies of less than 10 hectares represents 30% of the world surface area of standing water (EPCN, 2008). Pond landscapes function as biodiversity hotspots and as refuge for migrant species (Céréghino et al., 2014). Farmed ponds contribute to these functions by presenting a prominent level of regional species richness due to the high nutrient content of their waters (Davies et al., 2016; Lewis-Phillips et al., 2019). The conservation of ponds offers the opportunity to address some of the most pressing challenges of our time such as habitat degradation, water resource management, species extinctions and climate change (EPCN, 2008).

In most European countries the number of ponds (natural and man-made) has critically decreased in the past century, threatened by human activities such as urbanisation and intensive agricultural practices, and climate change (EPCN, 2007). For instance, the UK has lost 57.7% of the ponds that were present in the year 1900 (Smith et al., 2022). Furthermore, nutrient-rich ponds are highly impacted by the current abandonment of traditional pond farming practices, due to challenges to remain pond farming as a livelihood (Wezel et al., 2014).

It is not only the environmental value of ponds that is threatened. Ponds are also historical features of the landscape and signs of the development of humans with nature through time (EPCN, 2007). Pond farming is an important part of the history of many communities and has highly influenced their folklore and culture (Hoffman, 1995). For these reasons, there is an increasing interest in heritage, as the public desires to know their surroundings and learn about the uniqueness of their places (EPCN, 2007). Preserving heritage can facilitate the preservation of other ecosystem services (ES) in synergy with heritage and help to raise public support for the protection of ecosystems (Daniel et al., 2012).

In the ES field exist different conceptualisations of what heritage is, without a consensus between different ES frameworks. However, heritage is acknowledged as a cultural ecosystem service (CES) recognised by several frameworks, usually determined using the term “cultural heritage”. Naturkapital Deutschland-TEEB DE uses the term natural and cultural heritage (translated from the German term “Natur- und Kulturerbe”) (Schröter-Schlaack et al, 2016).

This thesis is conducted as part of the project “Safeguarding biodiversity through sustainably managed pond landscapes in Lusatia” which aims to contribute to an improved assessment of pond landscapes, aiming at safeguarding their biodiversity and ecosystem services TeichLausitz (2023). The inventory of ES from Naturkapital Deutschland- TEEB is used as reference ES classification in the project, as the project is conducted in Germany. Therefore, the project operates with the term “natural and cultural heritage”, and so does this thesis. “Natural and cultural heritage” is a term that fits in a current of heritage that considers natural and cultural heritage as interlinked and inseparable (Lowenthal, 2005). New concepts of heritage also include immaterial aspects such as languages and traditional practices (Braaksma et al., 2016) and consider that heritage determination should be both a top-down and a bottom-up process (Tengberg et al., 2012).

Although some cultural ecosystem services (CES) such as recreation and aesthetics have been widely assessed, there is still a lack of assessment of more intangible CES, such as heritage. The immateriality of these services might be the reason for their scarce valuation. An analysis of publications encompassing the terms “heritage” and “ecosystem services” revealed only 10% of the 126 studied publications were cultural heritage focused. This result reflects the existing gap in the research of heritage as an ecosystem service. In the context of CES, heritage is usually mentioned or explained briefly (Hølleland et al., 2017). Thus, more heritage focused studies in the ES field are necessary.

The purpose of this thesis is to contribute to the assessment of heritage in the ES framework by addressing the following questions: How is heritage spatially distributed in the landscape? How is heritage associated with specific landscape elements? Which is the perception of pond landscapes in terms of heritage by the public?

To bridge the above-mentioned gaps, the first objective of this study is to do a hotspot analysis of natural and cultural heritage in the pond landscape. The second objective is to identify with which pond landscape elements heritage is associated. The third objective is to understand how the pond landscape is perceived by the public in the context of heritage.

The thesis is based on a qualitative and quantitative research approach and a case study method. The selected methodology is participatory mapping, an inclusive way in which participants can identify its heritage resources and determine their value (La Frenierre, 2008). The survey provided to respondents consisted of a map of the study area, some open-ended questions in relation to the sites the respondents had previously marked in the map, and a questionnaire to depict the perception of respondents to different aspects of pond landscapes related to heritage. A hotspot analysis, textual analysis, and descriptive statistics were performed. The research methodology is described more thoroughly in chapter 3.

This research begins with a review of relevant literature in chapter 2 related to natural and cultural heritage in pond landscapes as cultural landscapes. Chapter 3 presents a description of the study area and the research methodology employed to attain the object of the study. Chapter 4 provides the findings of the research, which are discussed in chapter 5. Finally, chapter 6 concludes the research.

2. Theoretical framework

2.1 Ponds and pond farming

Ponds can be defined as natural or artificial water bodies with sizes ranging from 1 m^2 to 8 ha in area and a maximum depth of 8 m (Oertli, 2018). However, size limitations that define these water bodies vary in a continuous attempt by authors to differ ponds from small lakes (Biggs et al., 2017). The widespread presence and diversity of pond habitats make them valuable freshwater biodiversity hotspots (Oertli, 2018). In fact, these small water bodies have shown to harbour a similar or higher proportion of endangered species than lakes or rivers (Biggs et al., 2017). In addition to aquatic species, ponds support many terrestrial species such as birds, invertebrates, insect pollinators, bats, and other mammals. The connectedness and heterogeneity of ponds qualify them as steppingstone habitats, acting as important "refuges" in heavily modified landscapes (Hill et al., 2021) and becoming vital in adaptation to climate change, by allowing the migration of species (Céréghino et al., 2014).

Many ponds in Europe are of anthropogenic origin, many of them were created during the Middle Ages and are still used with varying intensities for the production of fish. They are usually emptied every year for harvesting fish and then refilled. These human-made small waterbodies are enriched with high inputs of nutrients to increase their yield. Nutrient-rich ponds are generally associated with low species richness, because in some cases, eutrophication can result in the domination of the most competitive species, decreasing the diversity of the ecosystem. Nevertheless, small waterbodies support high concentrations of nutrients, since eutrophication is part of their natural aging process. Ponds support at a regional scale diverse and sometimes unique biodiversity (Wezel et al., 2014). Pond farming has been positively correlated with bird activity (Davies et al., 2016; Lewis-Phillips et al., 2019). Managed open-canopy ponds are characterised by the extensive presence of submerged and emergent macrophytes, which is associated with high abundance of emergent invertebrate prey (Davies et al., 2016; Lewis-Phillips et al., 2019). Pond landscapes can comprise high diversity of birds, becoming highly valuable in a moment in which farmland bird species are experiencing a decline across Europe (Davies et al., 2016; Lewis-Phillips et al., 2019).

Some of the characteristics that make ponds such valuable ecosystems also make them vulnerable to impacts such as human activities and climate change. These pressures have caused rapid decrease in the number of ponds (Biggs et al., 2017), with losses up to 90% in some countries (EPCN, 2008). Furthermore, a great part of the remaining ponds suffers from degraded buffer zone and littoral vegetation belt, presence of invasive species, loss of

connectivity between the ponds, and pollution, among other problems (EPCN, 2007). Nutrient-rich ponds have the additional pressure of the abandonment of traditional fish farming, and with it the management of these waterbodies and their biodiversity. The profitability of traditional fish farming has declined due to not being able to compete with the relatively cheap prices of fishes from the world market sold by supermarkets. In addition, pond farmers must compete with predators such as cormorants and face declining availability of water resources to refill the ponds after the fish have been harvested due to climate change. The combination of these factors is resulting in an increasing number of pond farmers abandoning their practices (Wezel et al., 2014).

The fishing of common carp (*Cyprinus carpio*) is one of the oldest and longest traditions in European freshwater aquaculture. In Germany, its origins date back almost 1000 years (Lasner et al., 2020). In the medieval Europe, consumption of fish was very high, inducing a potent fishing pressure on the environment, which resulted, for example, in the decline of average body size sturgeon, among other fishes. The fishing pressure continued to a point where legislators of the 13th century complained about overfishing. In order to meet such demand for fresh fish new freshwater habitats were built, the mix of species where modified, and new ecosystems were created. Artificial ponds were created to retain and breed fish as a response to the limited natural supply. Their construction was popular in regions with growing human populations and economy (Hoffman, 1995).

Practices did not advance much until the 19th century, where new techniques and innovations such as the development of inorganic fertilizers meant an intensive carp farming. In some countries there has been a reduction of the total pond area since the 19th century. At the beginning of the 19th century, there were approximately 60.000 ha of carp ponds in Germany, which had declined to 55.000 ha by 1939. An increment of the fish production per unit area might be the reason for this reduction in the pond area (O'Grady & Spillett, 1985).

Through centuries, those regions that had accessibility to marine fresh fish, decreased their pond farming production. On the contrary, regions of inner Europe continued with these practices, and developed a strong culture around the consumption of the carp. The continuation of fish farming and pond management practices in the human-made ponds through time, resulted in the pond landscapes that today harbour a wide variety of species (Hoffman, 1995). This is the case in Upper Lusatia, where ponds were created in the 13th century, and fish farming, especially carp, has been practiced ever since then (BROHT, 2023a).

Currently, traditional extensive polyculture techniques are used in ponds in Europe. Thus, carp farming is still considered a low input aquaculture practice. EU carp production, except for Czechia is produced for domestic markets. In 2018, 75 348 tonnes of common carp were

produced in the EU member states. In that same year, 8525 carp farms were accounted for in Germany (STECF, 2020 p.165). Carp is one of the main farmed species in the German aquaculture sector, which is characterised by small family businesses (STECF, 2020 p. 165-166). Carp pond productions are mainly located in Bavaria, Brandenburg and Saxony, providing more than 80% of the total carp production in the country (STECF, 2020 p.167). The consumption of carp products is nowadays shifting towards other fishes. In response, carp producers have invested in the marketing of more processed carp products to meet the demand for more convenient fish food. In Germany is debated whether carp farms should be acknowledged for their provision of ecosystem services. Carp farmers are nowadays partially remunerated for following specific nature conservation restrictions (STECF, 2020 p.78-80).

2.2 Ponds and ecosystem services

Human-made ponds are of ecological, economic, and cultural interest for society. Their services to humans are multiple and varied, they can be classified under the ES framework. These small waterbodies provide humans with provisioning services, which provide nutritional (e.g. fish) and non-nutritional materials (e.g. plant-based resources) from living systems as well as from abiotic systems (e.g. water supply). Pond living organisms and abiotic elements can also mediate the environment providing regulation and maintenance services such as water purification, flood control, pollination and seed dispersal, global climate change regulation, nutrient retention, and carbon cycling (Hill et al., 2021; Biggs et al., 2017; Haines-Young & Potschin, 2018). Nonmaterial outputs of ecosystems (biotic and abiotic) that affect people physically and mentally, also known as CES, have been associated in multiple studies with pond landscapes. Educational, aesthetic, scientific, sacred and/or religious, and heritage services are a few which have been associated to ponds and/or aquaculture in multiple studies (Popp et al., 2019; Willot et al., 2019; Blayac et al., 2014).

Despite their outstanding value, ponds have received little attention by scientific institutions and governments, only growing interest in the scientific community among recent years (Hill et al., 2021). This lack of interest is reflected in national and international legislation. For instance, the European Habitats Directive Annex I only include “Mediterranean temporary ponds” and “Turloughs” as types of ponds that require designation of “Special Areas of Conservation” (Oertli, 2018). Moreover, despite the recognition of ponds as steppingstone habitats in the Habitats Directive, many states have made limited efforts in improving their conservation. This suggests the need for a stronger commitment of conservation strategies to pond landscapes (Biggs et al., 2017).

Ponds provide a high ratio of biodiversity per unit scale. In the context of global change where freshwater biodiversity is predicted to decline especially rapidly (Heino et al., 2009), artificial ponds, such as fish farming ponds are very valuable as biodiversity hot-spots and carbon sinks. Hence, more attention, research and policy efforts need to be directed towards these ecosystems (Oertli, 2018; Wezel et al., 2014). Although the interest of national and/or global stakeholders may be the conservation of pond landscapes, local stakeholders may attach particular value to local heritage related to the landscape (Hein et al., 2006). These heritage values need to be assessed and included in conservation and sustainability strategies, to build trust and raise awareness of the importance of these landscapes (Plieninger et al., 2013a; Schaich et al., 2013).

CES have been previously assessed in the Biosphere Reserve Upper Lusatian Heath and Pond Landscape using participatory mapping, in the same study area this master thesis is conducted. In the previous assessment, waterbodies were considered important for education, recreation, aesthetics and as heritage sites. A positive spatial correlation was found between heritage and the services of inspiration, social relations and sense of place. Heritage was more associated with outstanding elements of the state of Saxony than with features inside their local communities. This study achieved to assess the “bundled” distribution of CES in the study area. However, no thorough assessment of heritage has been carried out in the region (Plieninger et al., 2013a).

The European Pond Conservation Network (EPNC) remarks the relevance of the historical aspect of ponds and considers that emphasis should be more on the conservation of ponds (EPCN, 2007). Fish farming ponds are part of European and German history, and specifically of Upper Lusatia. Harvesting fish has influenced the livelihoods, economy, cultural expressions, material culture, language use and social conditions of humans. As a result, rich folklore, and new land- and waterscapes were developed (Svanberg & Locker, 2020).

2.3 Cultural Landscapes

The European Landscape Convention (ELC) provides a standardized definition of landscape: “an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors” (Council of Europe Landscape Convention 2008, p. 4). This definition reflects a view of landscape that evolves through time, shaped by natural and human forces while emphasizes the holistic nature of landscapes, where cultural and natural components are looked at together, not separately (Déjeant-Pons, 2006).

The term “Cultural landscapes” was created between the late 19th century and early 20th century by German geographers, and it continued being developed throughout the 20th century (Taylor & Lennon, 2011). These are landscapes deliberatively managed by humans, in which the greater value is not given by pristine, undisturbed ecosystems. On the contrary, in these cases, biodiversity and ES existence is deeply linked with their long and complex history with settlement and land use (Schaich et al., 2010)

Cultural landscapes are formed as consequence of a process of appropriation of the natural environment by humans. Appropriation in this context is understood as the activities that people do that define and/or transform the nature surrounding them. It is through appropriation that humans develop a feeling of belonging towards nature, considering their environment. Appropriation can be achieved through different means: changing nature through work and profit-oriented activities, such as pond farming; and there is symbolic appropriation of nature by means of linguistic terms, artistic representations, myths, and stories. Tradition, spiritual beliefs, knowledge, and experience play an important role in this process. Appropriation is a continuous process, while people appropriate their environment, they modify the landscape, and humans have then to adapt their behaviour and practices to these new changes in their surrounding nature (Kruse-Graumann, 2005). This process makes cultural landscapes highly dynamic environments (Scazzosi, 2004).

Landscapes function as a huge archive in constant change where the tangible and intangible traces of the history of nature and humans are documented (Scazzosi, 2004). Heritage could be understood as the “memories” of the relationships between ecosystems and humans formed over long-time spans, expressed mainly in cultural landscapes (Plieninger et al., 2013a; Tengberg et al., 2012). Those “memories” are visible in different forms such as land planning of places, physical features, practices of cultivation and traditional maintenance, and giving meanings to elements and places (Scazzosi, 2004). The different uses and meanings associated to the landscape are appropriated by the new generations by moving through the landscape, using things, and naming and appreciating things that need to be protected or conserved as natural or cultural heritage (Kruse-Graumann, 2005).

Cultural landscapes are important because they map the relationship of humans with land over time, providing a sense of place and identity- and becoming part of the heritage (Tengberg et al., 2012). Furthermore, the identification of cultural values and the inclusion of local concerns on management actions might build trust and improve environmental outcomes (Plieninger et al., 2013a).

Currently cultural landscapes are undergoing rapid changes in Europe, because of the abandonment of rural areas and the intensification and (peri-)urbanisation. This process is

gradually replacing traditional landscape practices for standardized and mechanized land uses (Plieninger et al., 2013b). Example of the displacement of traditional landscape practices in Germany, is the difficulties that pond farmers encounter to maintain their business profitable. Although the production of some fishes such as trout and carp still have relatively good prospects in Germany, high production costs, ineffective marketing, and limitations in production implemented by nature conservation policies impact the profitability of this practice (Wedekind et al., 2001). This process of land abandonment can lead to a loss of heritage of the landscape (Tieskens et al., 2017).

The loss of cultural landscapes means the loss of living environments, aesthetic and recreational values, scenery, unique biodiversity, and provision of ES (Schaich et al., 2013). Heritage[1] is highly linked to cultural landscapes; therefore, a loss of these environments would mean the loss of part of natural and human history (Scazzosi, 2004).

The pond landscape of the Biosphere Reserve Upper Lusatian Heath and Pond Landscape is a cultural landscape since it was modified by humans in the past with the creation of artificial ponds in the Middle Ages and in which nature and culture are highly interlinked (Mayerl, 2005). This pond landscape is a good example of appropriation of a natural environment. Studying the associations and construction of heritage in the landscape is important to understand the dynamic process of transformation of the cultural landscape and the connections established between the local community and the landscape (Kruse-Graumann, 2005).

In the Biosphere Reserve Upper Lusatian Heath and Pond Landscape an assessment of CES in the landscape was conducted (Plieninger et al., 2013a). One of the conclusions drawn from that assessment was the need for the inclusion and standardisation of socio-cultural studies at the landscape level as part of ES assessments. The field of ES could benefit from some aspects of the cultural landscape approach in order to achieve a balance between the assessment of material and immaterial ES and expand the understanding of intangible CES, which have been particularly difficult to assess in the past (Plieninger et al., 2013a; Schaich et al., 2010).

The cultural landscape research and the ES field share a similar object of study: to explore the human dimension of ecosystems and landscapes. Traditionally they have been characterised by different types of methodologies, being the empirical approach and both quantitative and qualitative methods more used in cultural landscape research, in opposition to the mostly conceptual and quantitative approach used in the ES field. The focus of research also has varied between disciplines, ES research used to concentrate more in ecological and economic

[1] The term heritage will be defined and discussed in the next section.

topics, while cultural landscape research focuses more on social sciences (Schaich et al., 2010). Advances have been made in the last years in the research of CES within the ES field. More socially based assessments are performed to valuate CES. Nevertheless, more assessments that include methodologies such as participatory mapping, which allow the study of complex human connections with the environment are needed (Cheng et al., 2019). Further integration of concepts and methods used in the landscape research field will benefit the ES field to keep advancing in the assessment of CES. For instance, the deeper historic dimension usually included in cultural landscape research would benefit CES assessments, especially in the case of natural and cultural heritage valuation (Schaich et al., 2010).

The synergy between these two disciplines may present some challenges to overcome, such as the spatial scale of the assessments. Cultural landscape research methodologies to assess non-material CES are usually conducted at a local or regional level whereas many ES assessments are regarded at a global or national scale. Thus, defining a scale for a general accounting scheme or assessment is still a major challenge that needs to be addressed (Schaich et al., 2010).

However, spatial challenges are also a major challenge within CES research. The spatial boundaries between the landscape unit and the service it provides are not always clear in CES. Some CES such as spiritual values, are not intuitively linked with any particular landscape element, possibly resulting in inaccuracies in their assessment (Plieninger et al., 2013a).

2.4 Natural and cultural heritage

Heritage is a broad and complex term, which has been conceptualised in different fields of research. In the context of ES, cultural heritage could be defined as features within the landscape meaningful in the present. This encompasses historical and non-historical objects, landscape features (cultural and natural) and intangible aspects (Tengberg et al., 2012). Natural heritage is defined by the Institute for Statistics of UNESCO as “natural features, geological and physiographical formations and delineated areas that constitute the habitat of threatened species of animals and plants and natural sites of value from the point of view of science, conservation or natural beauty” (UNESCO Institute for Statistics, 2009 p.26). It could be argued that the definition provided by Tengberg et al. (2012) already includes the elements that describe natural heritage under the term “natural landscape features”, and therefore, could be used as a general definition for heritage in the environmental field.

Natural and cultural heritage have been classically differentiated as two separate matters. Although this distinction has already been determined as problematic, it continues to be used

in environmental management (Harrison, 2015). The notion of separating nature and culture originates according to Head & Regnell (2012) from the 19th century, in which a shift of mindset occurs and the concept of wilderness changes from a negative to a positive connotation.

Scazzosi (2004) explains how the birth of ecological movements enhanced the divergence of cultural and environmental matters in northern and central European countries such as Germany. This phenomenon has led to clear administrative and conceptual division between issues related to “natural” and “cultural” places. However, when considering landscapes, natural heritage is not the only concern, cultural heritage is also part of landscapes (Speed et al., 2012), especially in a European context. The focus on protecting and recovering undisturbed nature is a conflicted approach especially in Europe, where most landscapes have been modified and used by humans for thousands of years, leaving almost no place untouched. This long-term relationship among humans and their surrounding environments has shaped landscapes and cultures, producing cultural landscapes (Drenthen, 2018). Thus, natural and cultural heritage are highly interlinked within landscapes and could be conceptualised as inseparable, yet they are often managed separately (Speed et al., 2012).

Within the scientific community, there have been several attempts to understand how the natural and cultural world interrelate in the heritage realm (Azzopardi et al., 2022). One of these attempts has been the conception of biocultural heritage, a line of research that has gained popularity in recent years and that aims to integrate biological and heritage conservation in a holistic approach. The biocultural heritage concept is defined as the long-term biological and social relationships which shape the material features of the landscape and the memory, experience, and knowledge, resulting in the formation of cultural landscapes. This approach goes beyond separate considerations of nature and culture and attempts to include more intangible heritage (Lindholm & Ekblom, 2019). However, it leaves behind the abiotic elements of nature, which have been studied to be related to heritage. Examples of these are water heritage, which refers to water systems created by the human being throughout history (Hein, 2019 p.2) and geoheritage (Pijet-Migoń & Migoń, 2022).

There are different opinions and debates about heritage, as it is not a self-defining concept (Harrison, 2009).The different considerations on how natural and cultural heritage are interlinked are a result of how the concept of heritage has changed a lot in the past decades. Traditionally heritage has been reduced to its tangible dimension, such as monuments of aesthetic, historical, anthropological, or scientific value. Leaving the non-material matters relegated to a marginal position in the heritage field (Kirshenblatt-Gimblett, 2015). Intangible heritage gained recognition in 2003, when UNESCO officially declared its importance in the convention for the safeguarding of intangible heritage. In this report, the UNESCO recognizes

the strong interdependence between intangible, tangible cultural, and natural heritage (UNESCO 2022, p.1)

Intangible cultural heritage is defined as the expressions, knowledge, representations, practices, skills (and artefacts and places linked to them) that communities, groups, and sometimes individuals acknowledge as part of their cultural heritage (Robischon, 2015). Harrison (2015) highlights the importance of “preservation” and “inheritance” as key concepts to understand heritage. Therefore, heritage is something that can be transmitted from generation to generation, which can be conserved and inherited and has historic or cultural significance. Hence, in addition to the tangible objects and places, a holistic concept of heritage would also include practices, conserved, and transmitted to the new generations to come. Different cultures might have different heritage associations to the same landscape elements. Therefore, it is important to consider both the ecological and cultural context when assessing heritage in the landscape (Daniel et al., 2012).

Robischon, (2015) argues intangible heritage is not only restricted to the cultural dimension and it can also be found in the nature realm. The author explains how living nature can provide intangible heritage. For instance, the behaviour or another nonmaterial feature of an animal can be a source of intangible cultural heritage. When some species go extinct, they do not only leave behind physical proof of their existence, but also oral stories, which can become part of the folklore of a community.

Ponds have been a resource for humans through history (EPCN, 2007). Populations with a strong pond farming tradition have developed a sense of identity towards this practice rooted in the local gastronomic heritage (Delpero & Volpato, 2022). The perceptions of pond farmers and local communities about the services provided by ponds have been acknowledged in the literature. Both groups have associated ponds with heritage. (Plieninger et al., 2013a; Popp et al., 2019). There is an increasing interest in heritage among the public which desire to know more about their local surroundings and local uniqueness (EPCN, 2007).

Heritage is determined as a CES in the CICES (Common International Classification of Ecosystem Services) classification, in the class of “characteristics of living systems that are resonant in terms of culture or heritage” (Haines-Young & Potschin, 2018). Naturkapital Deutschland- TEEB DE elaborated an important inventory of ES in the context of Germany (Schröter-Schlaack et al, 2016). Naturkapital Deutschland- TEEB DE classifies cultural heritage as a CES but defines it using the term “natural and cultural heritage” (translated from the German term “Natur- und Kulturerbe). Both frameworks consider heritage as a cognitive and emotional interaction with the natural environment (Schröter-Schlaack et al, 2016; Haines-Young & Potschin, 2018).

In the landscape, heritage establishes linkages with other ES. For example, landscape heritage is often aesthetically appealing and even aesthetics can drive construction of heritage (Braaksma et al. 2016). Heritage overlaps and is interlinked with other CES such as cultural identity and recreation (Tengberg et al., 2012). In a participatory mapping study, Helmer et al. (2020) observed how participants associated heritage with outdoor recreation. It is not possible to map a single CES without acknowledging their relation to other services, as many CES such as inspiration or spirituality do not originate from an individual experience but are the outcome of a variety of experiences associated with ES (Tengberg et al., 2012).

Furthermore, heritage has the potential to influence people's sense of place. The heritage context of a place shapes the human attitudes towards that place, resulting from the interaction with the setting. The uniqueness of heritage places, including the influence of time, has the potential to produce a sense of place (Dameria et al, 2020).

In addition, linkages between CES have not only been observed at a conceptual level, but also at a spatial level. Many CES have been noticed to follow a bundled spatial distribution, clustering in hotspot areas. In the Biosphere Reserve Upper Lusatian Heath and Pond Landscape the highest intensity of CES was observed close to lakes, fishing ponds and settlement and camping areas. Recreational activities such as walking or cycling were found to be highly important for participants. Waterbodies were highly important for aesthetics, education, recreation and as heritage sites, whereas forests were relevant for education and spirituality. Cropland and quarry sites were the least associated to CES, forming cold spots. This study also proofs that people do not only associate CES with landscapes of remarkable biodiversity, heritage, or scenery but also with their common surroundings (Plieninger et al., 2013a).

The main challenge researchers face in assessing CES is to accurately assess them. This is mainly due to the subjectivity of human perception of ES (Cheng et al., 2019). Most of the ES literature dealing with the topic of heritage focus on exploring methods for valuing CES. The methods in these studies vary from evaluation methods to interviews and participant GIS (Hølleland et al., 2017). Different approaches to heritage valuation are briefly summarised in the following paragraphs:

Different approaches have been conducted in the assessment of heritage in the landscape. Speed et al. (2012) values natural and cultural heritage differently. Natural heritage was assessed in terms of species richness whether cultural heritage was valuated using the diversity of cultural elements as indicator. This study offers a deeper assessment of the time dimension of the landscape because it uses historical land use data up to contemporary times. For case studies in lack of landscape archaeology publications, this methodology may be

inaccessible. Furthermore, this method keeps the artificial separation between natural and cultural heritage, although they have been proven to be inseparable (Lowenthal, 2005). This study opts for an expert-based determination of landscape heritage (Speed et al., 2012).

Epistemological critiques had been directed towards a concept of heritage understood as an expert-lead activity. Heritage creation is a dynamic process which includes both a top-down process of determining official heritage and a bottom-up construction of heritage based on the relationship between people, places, objects, and memories. Consequently, places always have plural heritages (Tengberg et al., 2012). Ducci et al. (2023) conducted a participatory mapping study to compare local perceptions of landscape heritage with official heritage sites identified by institutions. Not only did local perceptions not always coincide with official sites, but local heritage perceptions went beyond the identified official heritage sites. They also demonstrated that a map-based questionnaire is an effective tool for mapping local heritage perceptions.

Heritage can be a difficult concept to express by respondents and to assess. Braaksma et al. (2016) proposes a framework based on the understanding of heritage as constituted within practices. The practice perspective of heritage considers that material elements can be meaningful to people in a non-linguistic way, in contrast to the classical conception of the discursive production of meaning in heritage, according to which people attach meanings to landscape elements. Practice is understood in this context as routinized behaviours which consists of several interlinked elements: physical activities, mental activities, objects, and their use as background knowledge, motivation, and a state of emotion. Braaksma et al. (2016) provide a framework to study the construction of landscape heritage based on the activities people perform in the landscape, the motivations to do those activities, the landscape elements they identify with those activities, and the meanings people associate with those landscape elements. Helmer et al. (2020) also uses the activities in the landscape mapped by respondents to uncover hotspots of heritage.

This thesis operates with the definition of Tengberg et al. (2012) to describe natural and cultural heritage as landscape features that are meaningful in the present. Both tangible and intangible aspects of heritage are important and should be assessed. Furthermore, this thesis focuses on a bottom-up natural and cultural heritage determination process, reason why participatory mapping was selected as research method. The aim is also to understand how natural and cultural heritage is constructed in the area. The elaboration and details of the methodology will be explained in the following section.

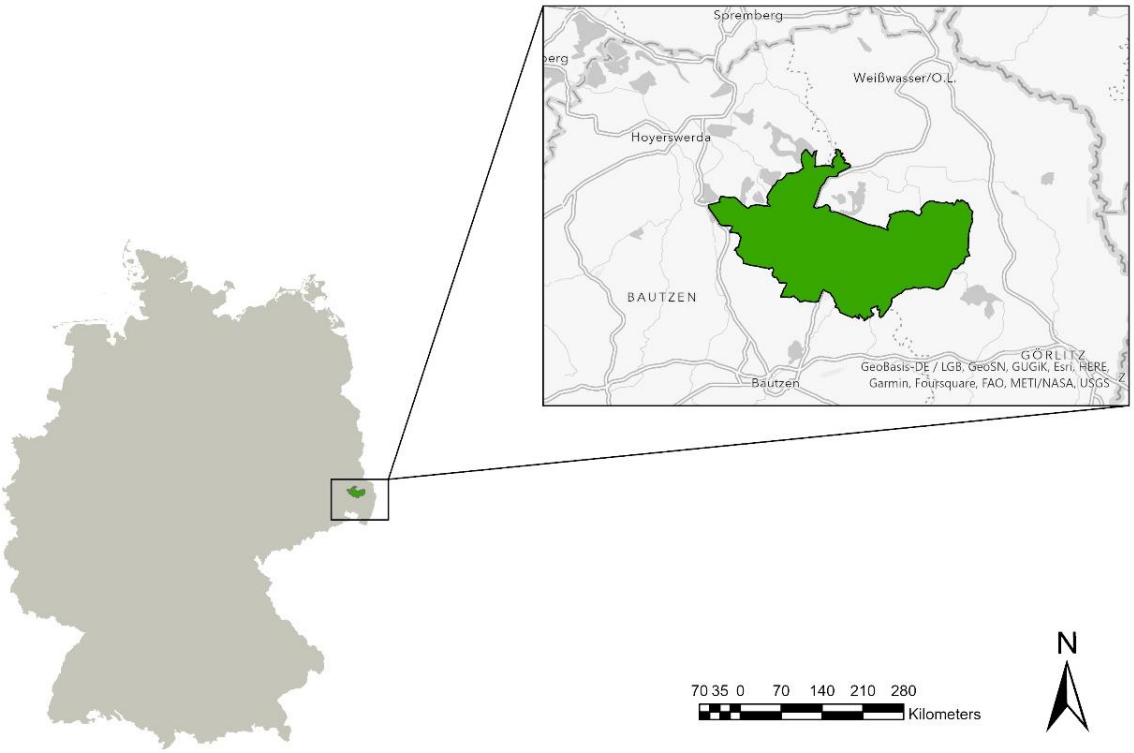
3. Methods

3.1 Case study area

3.1.1 Biosphere Reserve Upper Lusatian Heath and Pond Landscape

The study area of this master thesis is the Biosphere Reserve Upper Lusatian Heath and Pond Landscape, in the eastern part of the state of Saxony. The study area was selected because it is representative of the pond landscape in Upper Lusatia. A representative area of the biosphere reserve was selected to conduct the participatory mapping. This area was selected because of the presence of the characteristic pond landscape and because it is an accessible and frequently visited site. Furthermore, the information centre of the biosphere reserve is located there. The events celebrated at the centre provided the necessary infrastructure and gathering of visitants to conduct the data collections. The biosphere reserve is in the Upper Lusatia region, which comprises one of the largest pond areas in Germany. This biosphere reserve has an area of 30,102 ha and a population of 12,800 inhabitants (BROHT, 2023a).

The biosphere reserve lies in the area of the Lusatian glacial valley and is characterized by an alternation of wide floodplains and river valleys with drier dunes and moraine areas. The migration of dunes in earlier times caused the narrowing and relocation of rivers, resulting in hollow forms, often boggy, which started to be used to create ponds in the Middle Ages. The present topography and local conditions where carved during the Ice Age. For example, the inland dunes were formed during the last glacial period (Weichselian glaciation) (BROHT, 2023a).



Cartography/GIS: González Ramil, IHI TU Dresden, 2023

Fig. 1. Location of the Biosphere Reserve Upper Lusatian Heath and Pond Landscape in Germany. Source: (Esri, 2023).

During the Tertiary, active basaltic volcanism occurred in the south part of Upper Lusatia, forming the Lusatia Volcanic field. In the biosphere reserve rock formations can be found remaining from these volcanic events, like a volcanic explosion funnel (maar) filled with tertiary deposits around lake Olba with Kleinsaubernitz and the basalt hilltop located in the Eisenberg, near Guttau (Büchner et al., 2015, BROHT, 2023a).

In the present, the Biosphere Reserve Upper Lusatian Heath and Pond Landscape has a subcontinental inland climate. Temperature fluctuations (both daily and annually) are slightly higher than the Central European average, whereas air humidity is slightly lower. The annual mean temperature is 8.35 ºC and the mean precipitation is 682 mm (BROHT, 2023a).

Water is a very important element of the biosphere reserve. One of the most distinctive ecosystems of the area are the traditional drainable fishing ponds, created in the 13th century. Currently, more than 350 ponds exist in 39 pond groups, together with other 240 waterbodies which occupy a total area of 2,700 hectares in the biosphere reserve. The ponds usually have an average depth of 0.5 to 1 meter (the winter ponds, where the fish hibernates are the deepest) and their size area ranges from a few square meters to dozens of hectares. The inflow and outflow of the fishing ponds is regulated by a differentiated control system of inflow

and outflow ditches and weirs. This water regime is modified in relation to the management regime and fishing orders (BROHT, 2023a).

Ponds are commonly surrounded by reed belts which give them their characteristic appearance. Reed grows up to a water depth of 150 cm and has an impressive growth and propagation capacity. Species such as *Sparganium, Glyceria maxima* and *Phragmites australis* form the reed belts that surround many ponds. Reed has an important ecological role in ponds by serving as hiding places for larvae and young fish and as breeding sites for birds. Furthermore, it strengthens the banks of the pond and protects them from pounding waves (BROHT, 2023a).

The second most characteristic ecosystem of the biosphere reserve is the heath. Heaths in the biosphere reserve appeared as a result to overexploitation of forested areas in the past. This led to more open landscapes in which only undemanding grasses, heather and small trees could grow. Some of these heathlands were at some point reforested with pine plantations (BROHT, 2023a). Currently, the heathlands at the biosphere reserve are located at former military training areas and opencast mining areas. The disturbances produced in those places prevented the growth of trees and shrubs, favouring the development of the heathland.

Nevertheless, the Biosphere Reserve Upper Lusatian Heath and Pond Landscape is composed by other ecosystems apart from heaths and ponds. Dunes form elevation points in the otherwise mostly flat plain of the biosphere reserve landscape. These dunes have been relocated (carried by the wind) on several occasions, due to climatic changes and human use. Certain dunes are covered with sandy grassland, which colonizes exposed locations such as dune slopes, quarry edges, and shallow sands. Sandy grasslands are capable to resist extreme temperature fluctuations, drought, and wind (BROHT, 2023a).

Due to its unique cultural and landscape value, characterized by a complex mixture of biotopes and landscape elements, traditional land-use forms and handcrafting, the central part of the Upper Lusatia lowlands was designated in 1996 with the protection status of biosphere reserve under the Man and the Biosphere programme (MAB) of UNESCO, becoming the 13th biosphere reserve in Germany (German Commission for UNESCO, 2023). The area of the biosphere reserve is distributed in core areas (1,124 ha, 3.7%), buffer zones (12,015 ha, 39.9%) and transition zones (16,963 ha, 56.4%) (Mayerl, 2005).

3.1.2 Biosphere reserves

The biosphere reserve concept originates from the UNESCO MAB programme, which was launched in 1971 (Ishwaran et al., 2008). The MAB programme set the foundations for the creation of a new kind of conservation areas, the biosphere reserves, which aimed for a balanced development of human and nature. The current conception of the biosphere reserves is further developed in the so-called “Seville Strategy” which was elaborated during the international conference on biosphere reserves in Seville (Spain) in 1995. The “Seville Strategy” extends the zonation of biosphere reserves and includes a new dimension of sustainable development (Ruoss, 2013).

Nowadays, biosphere reserves are a global network of “learning places for sustainable development” comprising 748 sites distributed in 134 countries around the globe with 275 million people inhabiting the biosphere reserves (UNESCO, 2023). Biosphere reserves aim to serve as “living laboratories” to research human-environment relationships and as “model regions” to activate and motivate the transition towards sustainable ways of production and consumption (Kratzer, 2018). An important part of model areas is the inclusion of interested stakeholders in planning and management (Ruoss, 2013). Therefore, these sites have the purpose to serve as experimental areas, in which the environment is monitored, and innovative policies and practices can be tested (Stoll-Kleemann & O’Riordan, 2017).

Model areas make possible to test sustainable ways of resource management and examine ecological, social, and economic alternatives for a sustainable development. An important part of model areas is the inclusion of interested stakeholders in planning and management (Ruoss, 2013). Therefore, these sites have the purpose to serve as experimental areas, in which the environment is monitored, and innovative policies and practices can be tested (Stoll-Kleemann & O’Riordan, 2017).

Biosphere reserves are established by the countries in which they are located, and they are recognised by the UNESCO’s MAB programme. The statutory framework of biosphere reserves states the 3 main functions a biosphere reserve should fulfil: i) on-site conservation of natural and semi-natural ecosystems and landscapes; ii) provide model areas for ecologically and socio-culturally sustainable use; iii) contribute to support monitoring, research, information exchange and education. These principles aim at the sustainable development of these areas based on local community efforts, sound science and education (Ruoss, 2013).

The aims of the biosphere reserve are pursued through the establishment of 3 zones:

- Core area: a strictly protected zone that contributes to the conservation of landscapes, ecosystems, species, and genetic variation. In these areas, all natural processes are allowed, excluding human intervention and influence.
- Buffer zone: located surrounding the core area. These are areas compatible with ecological practices that contribute to scientific research, monitoring, training, and education. The buffer zones contain valuable biotopes, usually as result of human cultivation. Maintenance and utilisation are only performed in the interests of nature and following precisely defined plans.
- Transition area: designated for the development of socio-culturally and sustainable economic practices (UNESCO, 2023).

In the Biosphere Reserve Upper Lusatian Heath and Pond Landscape transition areas are divided into two subtypes: development and regeneration areas. Development areas are the most intensively used areas with less ecological value. Regular agriculture forestry and fishing practices are possible in these areas, while preserving and improving the natural landscape. In regeneration zones, the balance of nature is harmed (i.e., areas with groundwater lowering or very intense agriculture), therefore they need to be restored until they can be included in higher zoning categories (Bastian, 2000).

The MAB programme has not yet defined what is the good practice in biosphere reserves. Nevertheless, some areas have been designated as example of good practice in biosphere reserves. The MAB International Co-ordinating Council recognized seven sites as examples of good practice. Two of these models belong to Germany, and one of them is the Biosphere Reserve Upper Lusatian Heath and Pond Landscape. Its recognition was granted due to its holistic approach that fulfil the three main functions and the biosphere criteria (Ruoss, 2013).

Many biosphere reserves comprise a rich cultural diversity, as a result of the adaption of local people to multiple changing living conditions through history, as in the case of Biosphere Reserve Upper Lusatian Heath and Pond Landscape. Biosphere reserves have become cultural landscapes with diverse knowledge systems and ways that the local people have of dealing with the natural environment. These aspects and an awareness of the dependency between nature and culture are important to achieve sustainable human-nature systems (Kruse-Graumann, 2005).

The Biosphere Reserve Upper Lusatian Heath and Pond Landscape takes measures in protection of several species such as the otter, bats, and the white-tailed Eagle. Measures are also taken to protect biotopes, such as the maintenance of the wet meadow and extensive protective measures with special attention to the maintenance of fisheries and grassland maintenance. The model is directed towards the sustainable management of environmental

resources and environmental education (Heyne, 2005). The environmental education offer is mainly targeted to children and young adults, but also at adults. Among the activities targeted to the younger generations are school project days, nature experience walks and nature-oriented holiday camps. Family activities are also part of the offer of environmental education. Environmental education aims to raise awareness and increase the understanding the relationship between humans and the environment (Heyne, 2005).

3.1.3 Natural and cultural diversity

The complexity of biotopes present in the Biosphere Reserve Upper Lusatian Heath and Pond Landscape provides a great variety of habitats for different organisms. The local climatic and site diversity provide a range of small ecological niches for species from different climatic regions. Over 5000 species of plants and animals have been identified in the area, with 1203 of these species being listed in the Saxon Red Lists. 23 per cent of the species catalogued in the Saxon Red List are located inside the biosphere reserve. The biosphere reserve is home to 47 species of fungi, 350 species of plants, 172 wild animals and 634 invertebrates, all of which have some form of protection status on the Saxon Red List. The number of endangered invertebrates is particularly high. This big number is partially due to a high diversity of invertebrates (3200 species), which have been determined, despite difficulties in their identification, in the biosphere reserve in the last 25 years. Among the groups of invertebrates presented in the biosphere reserve listed in the Saxony's red list, grasshoppers and dragonflies were the most abundant (BROHT, 2023a; BROHT, 2010).

The Upper Lusatian pond landscapes are habitat of 33 species of fishes, of which 3 are protected. Most of the protected native amphibians and reptiles are found in this area, such as the fire-belly toad (*Bombina bombina*) and the tree frog (*Hyla arborea*). The pond landscape is also a relevant bird area, with up to 160 breeding species in the biosphere reserve which is frequently visited by more than 100 migratory bird species (Bastian, 2000).

In addition, Upper Lusatia is considered to host the highest density of otter in Europe, one reason for this concentration of otter population is the highly productive fish farming system. However, the presence of otters and cormorants have been observed to establish a human-wildlife conflict between these animals and the pond farmers, which suffer from damages in their production due to the predation of fish from otters and cormorants (Klenke et al., 2013).

The State of Saxony has elaborated an inventory of natural heritage of the federal state. Fig. 2 presents the natural heritage sites in the Biosphere Reserve Upper Lusatian Heath and Pond Landscape. In the map, waterbodies are in dark grey, and magnifiers show natural heritage sites that are too small to be visible. The natural heritage sites identified in the biosphere reserve comprise meadows, sand dunes, bogs, specific trees, the Kreba fishing facility and the quarry (See Fig.2). It could be discussed whether the documented sites belong only to natural heritage or to both natural and cultural heritage of the landscape. According to the definition used in this thesis to define natural and cultural heritage as interlinked inseparable matters, these elements would be categorised as both natural and cultural heritage. From the inventoried sites, only the Radisch island in lake Olba is located in the study area of this master thesis.

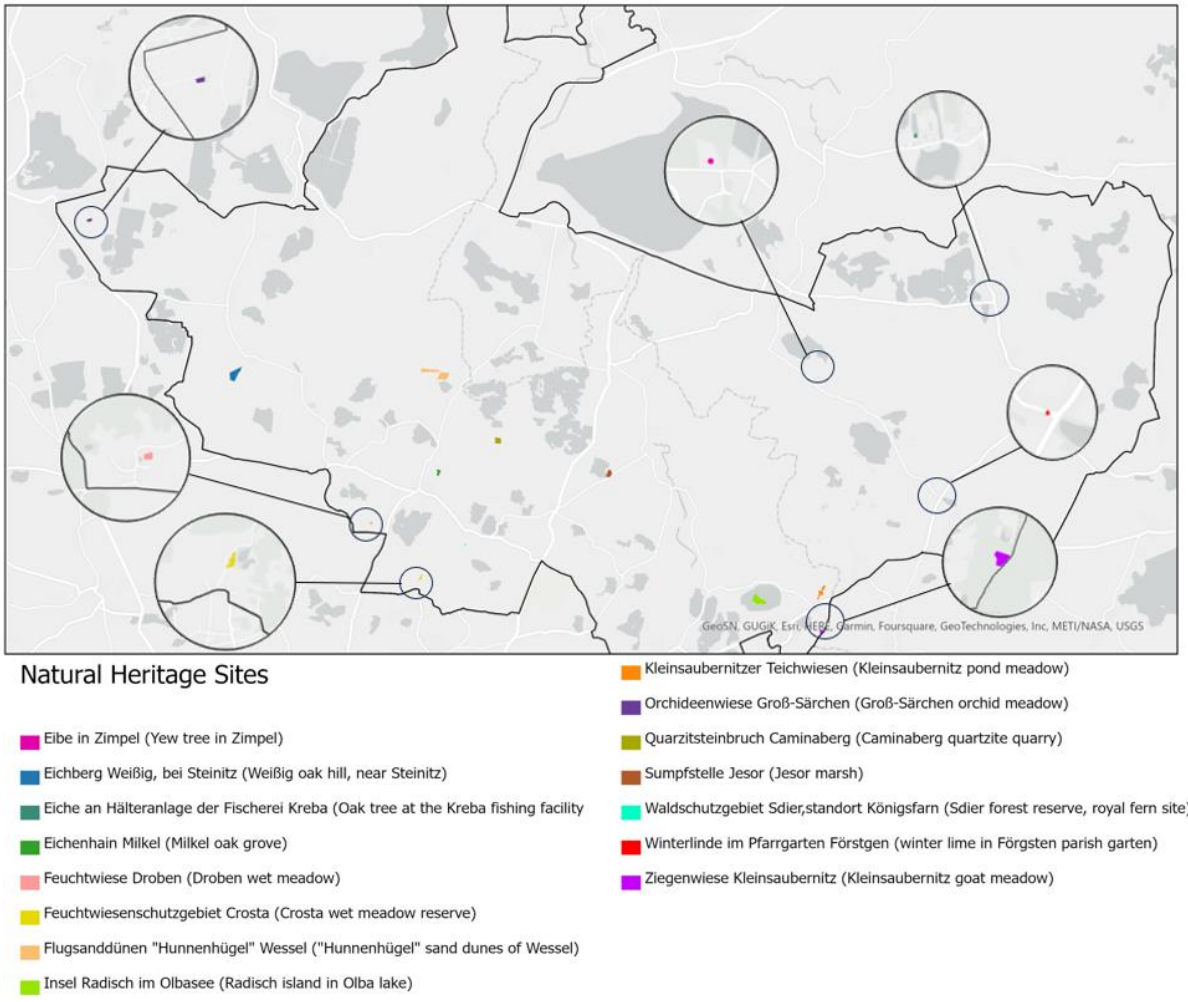


Fig. 2. Inventory of natural heritage in the Biosphere Reserve Upper Lusatian Heath and Pond Landscape. Source: (LUIS, 2019; Esri, 2023).

The cultural diversity is also a remarkable aspect of the region of Upper Lusatia. The Sorbs are a minority group belonging to the Slavic group of people that migrated during the 6th century AD and occupied lands that now form part of East Germany. Nowadays, Sorbian ethnic territory

is distributed between the regions of Brandenburg and Saxony. Sorbs have been living in two main regions for centuries: Upper and Lower Lusatia. Upper Lusatia is the region where sorbic culture and language are more strongly present, with 40.000 sorbs living there (Gageanu & Gudlin, 2017).

One of the most popular aspects of Sorbian Culture are the multiple Sorbian festivals and folk customs occurring through the year. Sorbian population of Upper and Lower Lusatia share many of these customs, however, through the course of time their performance has gained differences among both regions (Kuringowa, 2005). The festival and customs are important parts of Sorbian identity, this is the reason why they have been recognized as part of the intangible heritage of Germany (German Commission for UNESCO, 2023).

3.1.4 Pond farming in Upper Lusatia

Pond farming has a long-standing tradition in Upper Lusatia dating back to the creation of the ponds in the Middle Ages. Today, the pond farming industry in Saxony is dominated by large enterprises, which produce in 56% of the total pond area. In Upper Lusatia, the average pond area per company is 218 ha in the zone of Bautzen and of 2.4 ha in the Löbau-Zittau zone. Carps account for 89% of the total fish production in Saxony (Myšiak et al., 2013).

After the reunification of East and West Germany, state-owned fishponds were returned to their former owners or privatised. Carp production in Saxony has declined since then, mainly due to a reduced consumption of carp by the public. In addition, the inclusion of large part of the pond area in one or more nature conservation support schemes has led to a more extensive production of carp (Myšiak et al., 2013).

As it has been mentioned in the previous section, Upper Lusatia supports one of the most viable otter populations in Europe. This is one of the few areas in Germany where populations of otter are still present. Their presence causes damages to the fish production of pond farmers. The conflict has been ongoing for a long time, there is historical information about the prosecution of otters which almost causes their extinction in the early 20th century (Klenke R.A. et al., 2013). Damages are compensated to fish farmers through a financial compensation scheme according to a set of defined parameters (Myšiak et al., 2013).

3.2 Participatory mapping

Participatory mapping is an umbrella term that comprises a wide range of methods which attempt to uncover associations between land and local communities through a map-making process (Mwanundu & Fara, 2009). This is a multiagent practice which aims to collect participants thoughts, feelings, or knowledge in support of a specific research aim utilizing cartographic visualisation (Denwood et al., 2022). The essence of this methodology is the participation of communities in direct contact with the situation to be studied at all steps of research, planning, and decision-making (Álvarez Larrain & McCall, 2019).

All cartographic representations show partial and subjective visions of the world, and what is shown or hidden relies on the interests of those who produce them. Participatory mapping is a very important concept because it acknowledges the role of maps as instruments of power and uses them to shape new spatial realities (Álvarez Larrain & McCall, 2019). Therefore, if the participatory process is successful, it will achieve to “map the un-mapped”, by designating spatial attributes to elements that formal mapping and planning would not identify (Saija et al., 2017).

The difference between participatory mapping and formal cartography lies on the process of map-making and the utilisation of its outcome. In participatory mapping, the map-making process is not limited to conventional cartographic procedures, with techniques ranging from sticks in the sand to complex online platforms. The multidisciplinary nature of the participatory mapping approach leads to a wide range of methods which can be digital or physical, or a combination of both, with remote or facilitated surveys, focus groups or individual interviews, targeted to a specific demographic group or to the general public. (Denwood et al., 2022).

However, this great variety of methods comes also with a range of challenges. The broad existing array of methods in participatory mapping are accompanied by an extensive variety of terminology. As a result of this variety and as the wide range of disciplines that convey in this methodology, there is a lack of consistency and clarity in the definitions of the different techniques, due to the absence of a standardised classification (Denwood et al., 2022).

The methods public participation GIS (PPGIS) or participatory GIS (PGIS) have gained increasing popularity in the mapping of ES. PPGIS/PGIS refers to spatially explicit methods for collecting and using spatial information. The use of these both terms in the studies is ambiguous, and their characterisation is based on practice (Brown & Fagerholm, 2015). Sometimes the term PPGIS is referred to as a subcategory of PGIS (Denwood et al., 2022).

Attempts of standardisation have been made, for instance, Denwood et al. (2022) proposes a broad simplified classification of participatory methods divided in three main categories: PGIS

(collection of spatial information through digital tools); sketch mapping (non-digital but spatially contextualised mapping methods) and mental mapping (in which respondents represent a perceived space through free hand gestures without supporting spatial context). Nevertheless, this determination of PGIS could lead to confusion as in PGIS projects the data is not always collected with technological tools (e.g., participants marking points in a paper map), but the obtained information is analysed with GIS (Brown & Fagerholm, 2015; Plieninger et al., 2013a).

Representation, understood as the degree in which the depictions symbolize the real-world features, is one of the principal issues in the field. This aspect of the mapping process is problematic because of the way in which participants capture their complex thoughts and feelings in a spatial context. There are two main types of representation: “notation” formal communication such as writing or “indication” informal communication of freehand gestures such as drawing (Denwood et al., 2022). PGIS techniques usually rely on notation modes of representation, being the most common ones, polygons, and points (Brown & Fagerholm, 2015). These forms of representation often limit the depiction of the human experience. Sketch mapping provides more flexibility to the answers of respondents and mental mapping offers participants the opportunity to express their vision in the freest way possible. Nevertheless, sketch and mental mapping produce challenging data to be analysed by the researcher (Denwood et al., 2022).

Accessibility is another challenge participatory methodology must overcome. Participants can be excluded or included to participate based on gender, status, and skill determined by the social and cultural context of the research. Digital barriers are also an accessibility issue, whether it is a matter of experience, access to technology, digital skills, or usage opportunity. Overcoming these barriers will be beneficial for the research, as it would translate in an increment in participation and accuracy of the output (Denwood et al., 2022) .

Another aspect that is important to consider in the participatory mapping research is transparency and replicability. Researchers should provide detailed justifications of why they have chosen a certain method, details about the collection and compilation of data, accessibility, and demographic characteristics of participants to facilitate the reproduction and reflection of proposed methodologies by other researchers (Denwood et al., 2022).

The steady increase of publications in the last years (which augmented after 2015) brought participatory mapping to fields outside geography (Denwood et al., 2022). In the ES field, the usage of this methodology has gained popularity in the assessment of CES (Brown & Fagerholm, 2015). However, heritage as an ES has not been extensively assessed with participatory mapping, likely due to the lack of understanding of how heritage fits in the ES framework (Brown & Fagerholm, 2015; Helmer et al., 2020). There is a lack of publications

focused on heritage in the context of ES, consequently, there is also a lack of participatory mapping research that focuses on heritage as an ES (Hølleland et al., 2017). The work of Helmer et al. (2020) is one of the few examples of research in this topic. They used participatory mapping to represent the perceptions of heritage by the public of the East Cascade (Washington) using questionnaires and polygons as representation modes. In the archaeological and historical landscape field participatory mapping has been utilised to map landscapes for heritage conservation and management, and mapping meaningful landscapes and sense of place, among others (Álvarez Larrain & McCall, 2019).

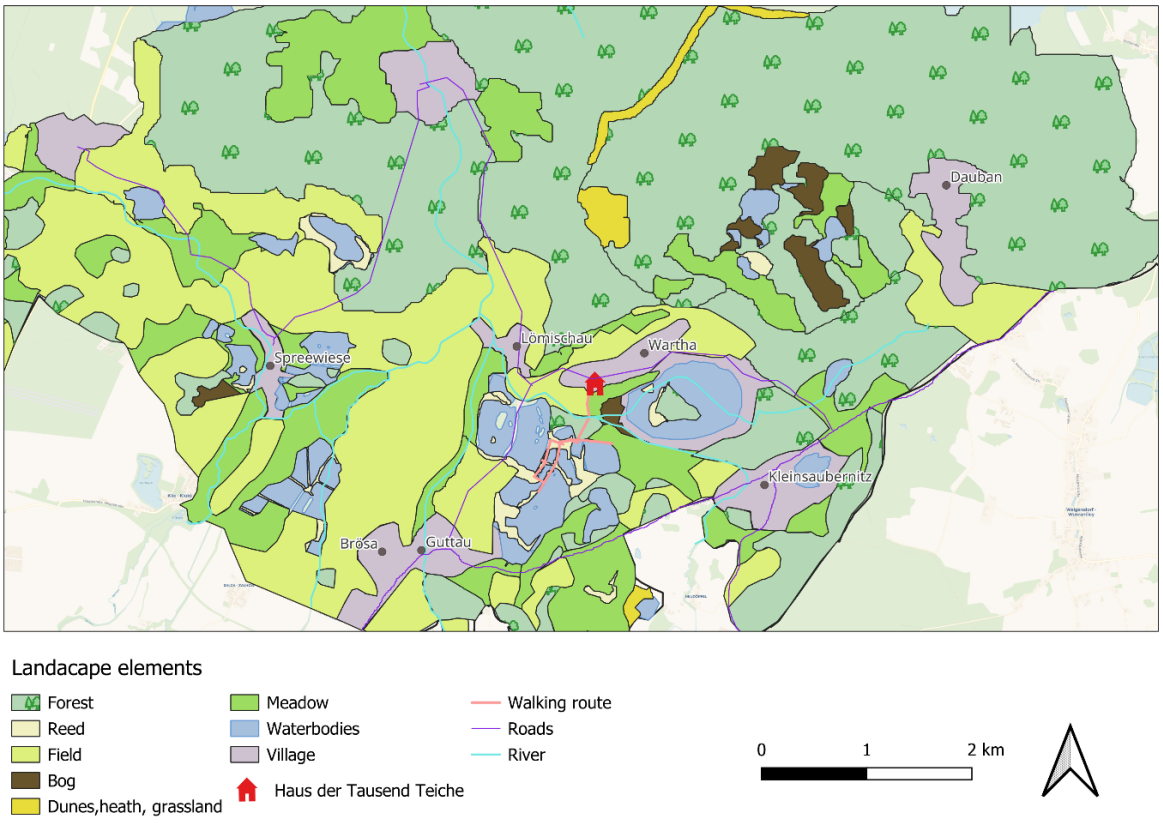
This master thesis applies the PGIS method with an on-site and non-digital collection of data. One of the expected outputs of this thesis is the generation of a hotspot map of perceived natural and cultural heritage. PGIS was selected as mapping method, because it facilitates the digital analysis of collected information with GIS. Although other participatory methods of more qualitative nature such as sketch mapping can also be analysed (Boschmann & Cubbon, 2014), these methods require usually extensive interviews. There were certain limitations to a methodology based on interviews, mostly based on a linguistic barrier and the difficulties to find participants that would agree to participate in such an engaging type of survey. Thus, a questionnaire type of survey was selected to avoid these complications. It was determined that the data collection would be on site, so that people could experience the landscape while answering the survey. The modes of representation were points, which although are limiting in terms of expression, highly facilitate the analysis and digitalisation of the data. However, being aware of the limitation of this mode of representation, open-ended questions were linked to the locations marked by participants, in order to facilitate the expression of their feelings and thoughts towards the places they were selecting. In addition, a questionnaire was included in the survey to underpin the participatory mapping and combine quantitative and qualitative data, while including the site-specific perceptions of participants towards pond landscapes within the context of heritage.

3.2.1 Design of the survey

3.2.1.1 First version of the survey

The map of the study was developed using GIS. During the map-making process different scales were tested to find the most adequate map representation. An image of the vegetation types of the Biosphere Reserve Upper Lusatian Heath and Pond Reserve (BROHT, 2023b) was overlapped and georeferenced on a base map (Carto, 2023). Geographical data of the biosphere reserve was extracted from Geoportal Sachsenatlas (2023) and to set the border of

the area. New layers were created using the georeferenced image as guide to add the main landscape elements to the map (Fig.3). Features such as forest, ponds, dunes, and meadows were included, as well as main roads and rivers. The map (Fig. 3) was designed to be attractive to the eye, easy to comprehend and to orientate, while still being representative of the main features found in the study area.



Cartography/GIS: González Ramil, IHI TU Dresden, 2023

Fig. 3.First version of the map of the study area in the Biosphere Reserve Upper Lusatian Heath and Pond Landscape. Source: (Carto, 2023; BROHT 2023b).

In-depth interviews allow more thorough understanding of participants' perspectives; thus, they are highly valuable methods in CES research although they aim for a small sample of the population (Scholte et al., 2015). Nevertheless, this master thesis had certain limitations to perform in-depth interviews. The survey used in this thesis was the result of a dynamic elaboration process in which the format evolved since the creation of the first version. The survey used to gather data comprised a map, three open-ended questions and a questionnaire. The development from the first version of the survey to the last one will be hereafter explained.

The first version of the survey was planned in 3 parts. The first part was constituted by questions to find out if respondents came from the biosphere reserve, if they have visited before the biosphere reserve, or with which frequency.

In the second part, participants were asked to locate five points they associate with natural and cultural heritage in the map. Secondly, they had to mark in a list of landscape elements those they previously pointed in the map and explain why they had found these elements important.

The third part was formed by four open-ended questions oriented to find out components of heritage that will help to understand participants' idea of heritage related to the environment. The questions referred to local folklore, tales, and personal associations with the landscape. Participants were also asked what they understood by "cultural landscape." The questionnaire was tested in an event prior to the first collection of data. Therefore, a part for feedback and comments regarding the map (Fig. 3) and questionnaire were included at the end of the last one.

The developed material was tested during an event happening in the "Haus der Tausend Teiche" the information centre of the Biosphere Reserve Upper Lusatian Heath and Pond Landscape where many of the activities related to the biosphere reserve take place. The aim of the pilot data collection was to analyse the answers and feedback from participants to improve the survey.

The event consisted of a small walking tour around the ponds (the route taken can be seen in Fig. 3 marked in pink). During the walk, an expert from the biosphere reserve and an invited guest expert from the Potsdam Institute of Inland Fisheries (IfB) introduced the TeichLausitz project and gave further explanations about the ecology, management, and importance of the pond landscapes in the region. At the end of the tour, all the attendants were provided with a questionnaire and a map after a short introduction about the purpose of the master thesis, the topic, and the analysis of the data. The group of 8 respondents was a mixture of experts and general public.

Participants pointed out several challenges they encountered when answering the survey. The spatial scale the questions referred to was not clear enough and it led to confusion among respondents. They addressed the difficulties that entitled the open-ended questions for the general public and suggested a change to a format of choice answers. Furthermore, they expressed the difficultness to orientate themselves in the map (Fig.3) and suggested a topographic map would facilitate the orientation of participants.

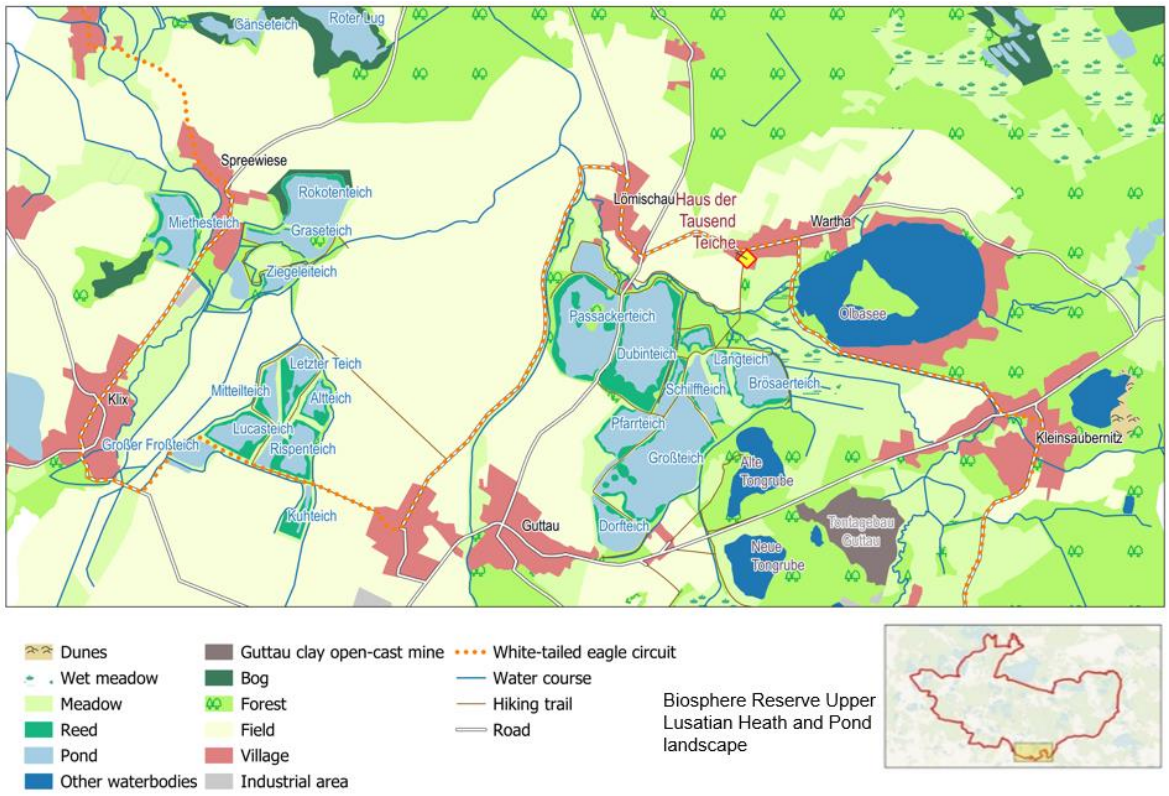
The feedback provided by participants facilitated the improvement of the survey. A topographic map was used to create the new version of map, which would be used in the data collection. Open-ended questions were reduced to three and instead, a questionnaire was created, to facilitate the response from participants. Special attention was given to clarify the spatial scale the questions referred to.

3.2.1.2 Second version of the survey

Based on the feedback expressed by participants during the pilot data collection, the scale of the map was modified to facilitate the orientation of participants (See Fig.4). The new scale of the study area was selected making sure there was still a big variety of ponds represented, while including other landscape features such as forests, meadows, mires, and dunes, among others.

Using a topographic map was one of the ideas provided by respondents in the feedback to facilitate the orientation in the map. Several topographic maps were sampled; however, they were either too simple, which will result in the same outcome, or too crowded which will confuse participants and hinder their orientation. Therefore, as a solution, a topographic map of Saxony was used as a base over which layers of the main landscape features were drawn, coinciding with their location in the base map. The colours of the map (Fig. 4) were changed to colours that are generally associated with topographic maps. In addition to the names of the surrounding villages, names of other elements such as industrial sites, ponds and other water bodies were added to include more reference points participants may be familiar with.

The ponds were separated from other types of water bodies, as pond landscapes are the focus of the study. New elements were added to this second version of the map (Fig. 4), such as hiking and cycling routes, as it was noted the importance of these elements during the pilot data collection and to indicate the recreational infrastructure of the landscape. Furthermore, a small map in the corner of the Biosphere Reserve Upper Lusatian Heath and Pond Landscape signalling the location of the study area to facilitate orientation and give more spatial context to participants.



Cartography/GIS: Rogge, IHI TU Dresden, 2023

Fig. 4. Final version of the map of the study area, used in the survey. This is the map that was finally used for the participatory mapping in the two data collections. Source: (Geoportal Sachsenatlas, 2023).

The first version of the survey underwent many changes after the pilot data collection. Both the structure and content of the questionnaire were changed to maximize the information extracted from respondents. Hereafter modifications made in the questionnaire will be discussed by section.

Section I of the survey, dedicated to extract anonymous information of respondents, was modified to include a question designated to know the range of age of participants. In addition to ask how much time it took the participants to arrive at the study area, they were also asked the means of transport they used and if they came originally from the region of Upper Lusatia (See Appendix).

Section II was designed following the methodology developed by Küchen et al. (2023) to study how participants valued Bavarian landscapes. The structure of section II was included from their research (See Appendix). In section II, participants instead of being asked to locate five points they associated with natural and cultural heritage, they were asked to locate five points they considered relevant in the context of natural and cultural heritage. This change in the selection of words, although it may be subtle, was meant to make the concept more

approachable for participants, as some might feel overwhelmed by such complex and abstract concept as heritage can be. In this section participants were asked to mark the 5 locations in the map (Fig.4) by numbering them from 1 to 5. A list with all the landscape elements depicted in the map (Fig. 4) is included in this section. “Flora and fauna” was included in this section because it is a landscape element difficult to illustrate in the map, but that it is an important aspect of the natural and cultural heritage and the usage of this landscape. Participants would mark the landscape elements with the same number they had marked the point in the map they associated the element with.

Three questions were asked in relation with each location (and associated landscape element): Why do you consider this element relevant? Do you associate specific activities with the element? What is the motivation to do these activities? (See Appendix).

These questions are inspired from the framework developed by Braaksma et al. (2016) to study the construction of heritage in the landscape. In this framework, Braaksma et al. (2016) approaches the construction of heritage from a practice perspective. According to this theory, heritage can be produced through routinized behaviours (practices), which, by repetition of the experience, establish meanings towards artifacts, in this context, landscape elements. The three open-ended questions aim to study how heritage is constructed in the study area by analysing which activities respondents practice in their relevant landscape elements, and the meanings they associate with those elements. This framework was selected to build part of the methodology because it enables the analysis of heritage and its association with specific landscape elements while asking questions that are more approachable and less overwhelming for respondents than direct questions about heritage.

Section III is a Likert scale-based questionnaire (See Appendix) which aims to analyse the perspective of participants towards pond landscapes within a heritage context. Most of the open-ended questions from the first version of the survey were replaced by a more structured closed questionnaire to avoid misunderstandings and leave less room for interpretation. Only two follow-up open-ended questions were included for participants to list the recreation activities they conduct in the area. The questionnaire is composed of 22 statements divided in 5 thematic categories “Perception of the landscape”, “History and tradition”, “Pond management”, “Conservation of the pond landscapes”, and “Use of the pond landscapes for recreational purposes”. These statements were designed to uncover the perceptions people have towards the pond landscape. Part of the statements are directed towards aspects that constitute heritage: such as history, traditions, and preservation.

3.2.3 Data collection

The collection of data was directed towards the general public, without targeting a specific demographic group. However, due to the complexity of the topic children did not participate in the survey. The aim was to acquire between 30 and 40 answered surveys in total, to have a small but relevant sample of the population that could be analysed within the time and resource limitations. The surveys were answered on-site, on paper and participants contributed to the research anonymously. Furthermore, participation was not incentivized with money or any other types of contributions to respondents.

The two data collections took place in “Haus der Tausend Teiche”, the information centre of the biosphere reserve, on the 29th of July and 19th of August of 2023. Conducting the surveys during events celebrated at the study area was a strategy to avoid the recruitment of participants, which would have been a highly time-consuming task.

The event on the 29th of July was called “Rangertag” (Rangerday) aimed at children, in which an educational activity about rangers and agriculture was prepared for the children. At the end of this activity, the adults accompanying the children were asked if they wanted to participate in the survey and the surveys were distributed to those who were willing to participate. The day of the collection, the weather forecast had predicted storms and rain during most of the day, which was an issue as the event was outdoors. However, despite the meteorological adverse forecasted conditions, the first storm did not arrive until the early afternoon (the event started at 10 am), providing a window of several hours for participants to respond to the questionnaire. On the first data collection 15 surveys were conducted in total.

The data collection on the 19th of August was conducted during the event “Kunst bus” (Art bus), an annual cultural celebration in which people are transported in a bus to different destinations which offer performances and activities. “Haus der Tausend Teiche” was one of these destinations. In this event there was a tent at the entrance of the establishment where visitors could take informative programmes of the event and participate in the survey if they wished to. In this event, 20 surveys were answered by participants. In total, 35 surveys were conducted during both data collections.

During both data collections participants were briefly introduced to the aim of the project and explained the sections of the survey and how to fill them. Participants were not guided through the surveys, but they could ask questions about the survey, which few participants did.

3.2.4 Data analysis

All the questionnaires were given a distinctive number, and their data were coded and processed in different ways depending on the analysis for which they were to be used. The three different analyses of the data are described below.

3.2.4.1 Descriptive statistical analysis

The demographic data from part I of the survey were cleansed and coded in Excel. The percentage of responses of each question were calculated and presented in different graphs.

Data from the Likert-scale questionnaire was cleansed and entered into Excel. Data cleansing involved looking for possible inconsistencies and incongruencies in the responses with the aim of resolving them and improving the quality of the data. For example, someone marked “Agree” and “Disagree” for the same statement, this response was invalidated as there was no possibility to know which option the respondent intended to select. The data were entered into an Excel spreadsheet, inserting the valid responses from participants to each statement proposed in the questionnaire. The five response alternatives were entered as “strongly agree”, “agree”, “neither agree nor disagree”, “disagree” and “strongly disagree” rather than assigning a number to each level of agreement.

The response rate and frequency of agreement for each statement was calculated. The input data was distributed to different tables according to their thematic category, where the percentage of the responses was calculated. This information was used to create graphs showing the frequency of each level of agreement to the different statements in the categories.

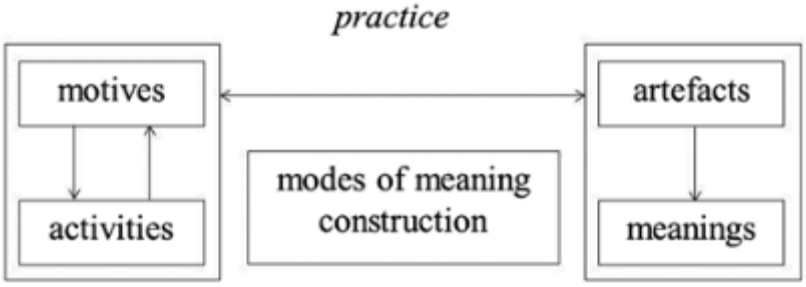
3.2.4.2 Textual analysis

As it has been explained above, the open-ended questions in Part II were designed following the framework proposed by Braaksma et al. (2016) to study the construction of local heritage in the landscape through daily activities. Therefore, the analysis of results follows this proposed framework.

This framework (Fig. 5) identifies five concepts grounded in practice theory: *activities* (in this context understood as routinised behaviours) related to the landscape that can be physical or mental, *motivations* which are the conscious reasons people have to do these activities, *artefacts* (which in this research will be referred as landscape elements to facilitate understanding) objects that are used within landscape practices, *meanings* (assigned to the landscape elements) are the meanings that might comprise landscape heritage within these

practices, *modes of meaning construction* “indicate shared way of understanding and making sense that lies at the heart of landscape practices” (Braaksma et al., 2016, p.65).

An practical example of this framework would be: cultural exhibitions (activity), remembering the history of the village (motivation), village (landscape element), distinctive customs and cultures of previous generations (meaning assigned to landscape element), educating local history (mode of meaning construction).



Source: (Braaksma et al., 2016)

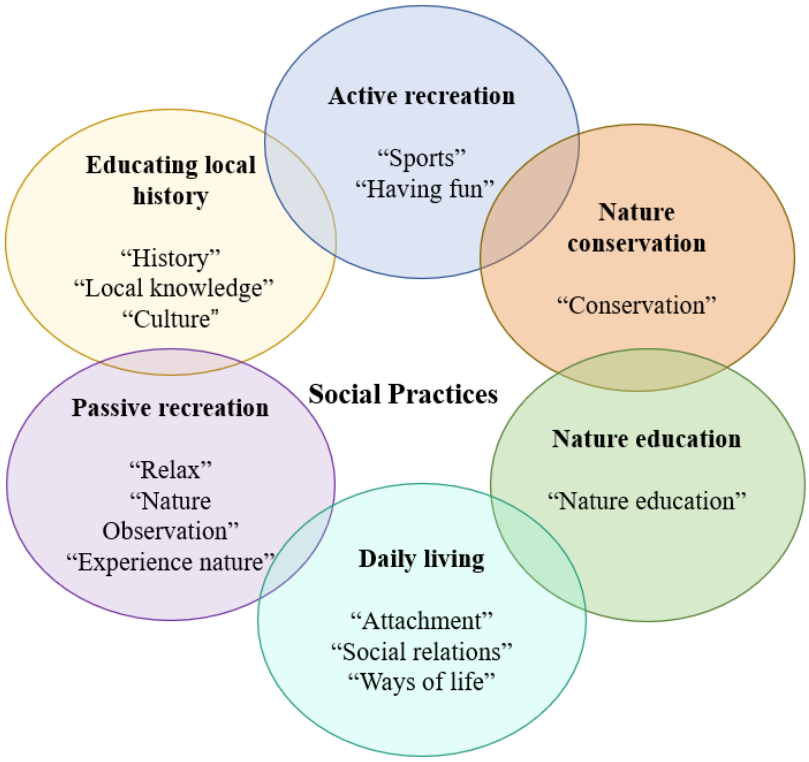
Fig. 5. Conceptual framework for studying landscape practices from.

The statements by respondents were transcript and translated into English. The data was cleansed to detect errors or inconsistencies in the responses. A codebook was created in Excel with the aim to organise and compare the data from part II of the surveys. In the first stage of the coding process, an excel sheet with the responses from participants to the 3 questions in part II of the survey were input in 3 categories: importance of the landscape element, activities, and motivation to do the activity. Each response was input with the assigned number of the correspondent survey. After reading all the quotations in the first stage codebook, labels were determined. These labels aimed to summarize the viewed data in one or two words. Some quotations were assigned more than one label, because some participants assigned several activities or motivations to the same landscape element. More than one motivation was also assigned to some activities. For example, hiking was associated both with the labels “Having fun” and “Relax” because respondents associated the activity with more than one motivation. This would translate in some activities such as hiking being categorised as both “active recreation” and “passive recreation”.

The second stage of the coding process consisted in creating a second excel sheet in which the data was organised according to the labels assigned to the quotations. At this stage, the quotations were read again and grouped with other labels in thematic groups. The groups (social practices) were made based on the comparison of activities, motivations and what people considered important about the landscape element for each label (See Fig.6).

Although the case study from Braaksma et al. (2016) was used as model, their research was based in a different study area with a different historic and landscape context. Only the social practices “Nature conservation” and “Educating local history,” identified by Braaksma et al. (2016) corresponded with the data in my codebook. “Nature conservation” and “Educating local history” were included in this study and new social practices were generated by grouping the previously identified labels (Fig.6).

Finally, the social practices were used to detect the modes of meaning construction presented in the area. The motivations and meanings associated to the landscape elements and the activities expressed in the textual analysis were analysed to compare the social practices. The aim was to identify common understandings between different social practices (modes of meaning construction).



Source: own representation.

Fig. 6. Codes that compose the identified social practices.

Part II of the survey was as well used in the production of one of the hotspot analyses of the selected landscape elements. Furthermore, a map depicting the spatial distribution of the social practices in the landscape of the study area was created. This analysis will be further explained below.

3.2.4.3 Spatial analysis

The points selected in the map by respondents were digitalised in QGIS by placing the points drawn by respondents as accurately as possible in the digital map. A point feature layer was created with all the points selected by the 35 respondents. This layer was used to perform a hotspot analysis. The hotspot analyses were performed on ArcGIS. The selected hotspot analysis tool was the Hotspot Analysis (Getis Ord-G*) which informs about where features with high or low values cluster spatially. This tool analyses a feature within the context of neighbouring features. For a hotspot to be statistically significant, a feature will have a high value and be surrounded by other features with high values as well. The local sum of a feature and its neighbours it is proportionally compared to the sum of all features. The tool calculates p-values and z-scores. The p-value is the probability that the observed spatial pattern was created because of randomness. Therefore, the smaller the p-value ($p<0.05$), the less probability there is for a spatial pattern to be the result of a random event. The z-scores are standard deviations. If the local sum of a feature is very different from the expected local sum and the difference is too big to be caused by random chance, the result is a statistically significant z-score (ArcGIS Pro Documentation, 2023a).

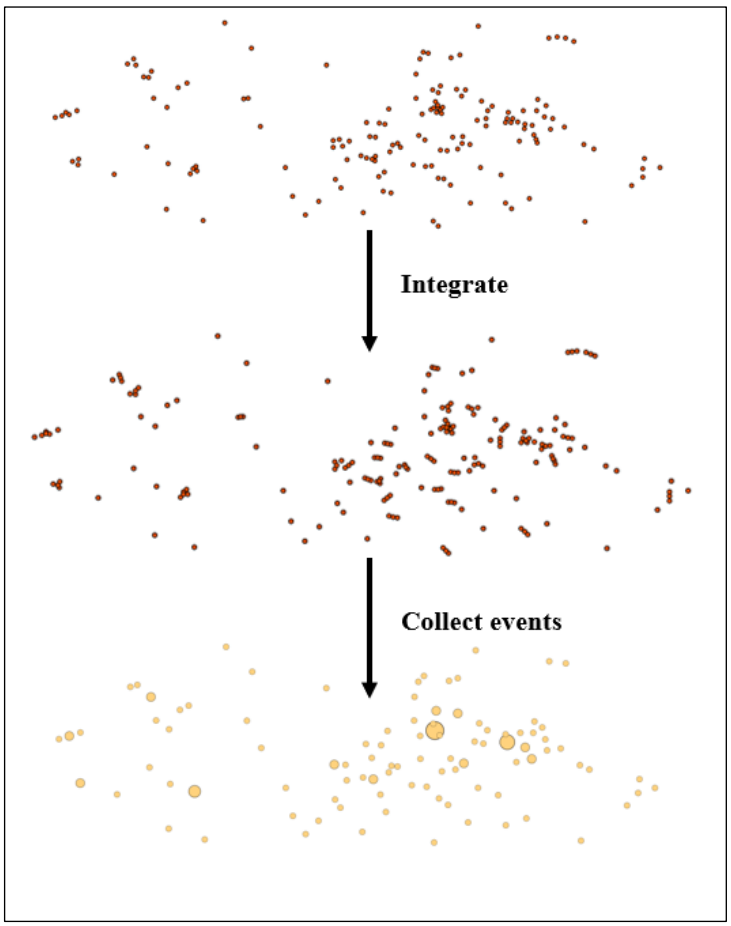
However, for this first hotspot analysis the points had no values assigned to them. Thus, there would not be a difference of values between the points distributed in the map. To solve this problem, the following modifications were carried out in the data before applying the hotspot analysis tool.

The tool “Integrate” which assigns a common geographical coordinate to points that fall within a specified distance was applied to cluster neighbouring points (See Fig.7). This tool has a cluster tolerance option which is used to integrate (cluster together) nearby vertices. The default cluster tolerance is 0.001 meters in real-world units. The ArcGIS guidelines recommend if necessary to readjust the default setting to set the cluster tolerance to the minimum possible, as a too big tolerance could collapse and delete polygons or lines and move vertices that should not move (ArcGIS Pro Documentation, 2023b)

First, the “Integrate” mode was run with the default setting of cluster tolerance. However, it was observed there was not enough clustering to perform the hotspot analysis. Hence, the tolerance setting was adjusted at different distances (elaborating different versions of the map). Different tolerance distances were tested, at 10, 20-, 30-, 40- and 50-meters distance between points. The tolerance setting was adjusted because the sample of points was quite small. Thus, there was not enough quantity of points to constitute significant clusters. The tolerance was set to a maximum of 50 meters to avoid the deletion of points.The location of the points by respondents was in many cases not very accurate, as some of the participants marked a point

referring to an entire area (e.g., a lake) instead of locating specific sites in the map. Therefore, in this case, the accuracy of the located points is a bit more flexible than in other cases.

After testing the “Integrate” tool with different tolerance distances, the tool “Collect Events”, which converts event data into weighted point data (Fig.7.) (Arc GIS Pro Documentation, 2023c), was applied to the map.



Source: Own representation

Fig. 7. Effect of the tools “Integrate” and “Collect events” on the location points.

The hotspot analysis was carried out with the outcome data from the “Collect Events”. Subsequently, the tool Inverse distance weighted (IDW), a form of interpolation, was applied. IDW assumes that the features that are closer to another are more similar than those that are further and that each measured point has a local influence that decreases with distance. This tool was used to calculate the hotspot areas (ArcGISPro Documentation 2023d).

In addition, a Kernel density analysis which calculates the density of point features around each output raster cell was conducted. Conceptually, there is a curved surface above each point. At the location of the point, the surface value is higher and decreases with distance from the point. (ArcGISPro Documentation; 2023e). The output of the Kernel analysis was

compared to the outputs from the hotspot analysis. After comparing them, the tolerance distance was set to 50 meters, as it showed clusters that corresponded with the clusters observed in the Kernel analysis.

A second hotspot analysis was then carried out to analyse the possible hot and cold spots of landscape features associated with natural and cultural heritage. The difference with the first hotspot analysis was that in this case the location points were assigned values. The values corresponded to the frequency with which respondents selected each landscape element. In this way, all points belonging to the same landscape elements had the same value. For example, ponds were selected by 26 participants, so the value of the heritage points associated with ponds was 26 (see Table 1).

Landscape elements	Frequency
Pond	26
Lake	23
Forest	14
Village	13
Reed	11
Bog	7
Wet meadow	7
River	5
Field	2
“Schulmuseum” in Wartha	2
Open pit mine	2
Bike trail	1

Source: own representation

Table 1. Frequencies in which the landscape elements were selected by participants.

It is important to mention that not all the points located by participants were used in this analysis. Only the points in the map that were numbered (and their corresponding landscape element was indicated with the same number or the cases in which it was obvious to which landscape element the points referred to) were included in the second hotspot analysis. After this process, a layer of points per landscape feature was created. All feature layers were then merged into one layer. The new generated output layer was used to perform the landscape features hotspot analysis, which has in consideration the frequencies with which the landscape features were selected by participants. In this spatial analysis, the hotspot analysis (Getis Ord G*) tool was used again, with the exception that these points had values assigned, so there was no need to use the tools “Integrate” and “Collect events”.

Furthermore, a spatial visualisation of the social practices associated with heritage was generated. A series of new layers of points were created, in which each layer corresponded to a social practice. During the survey, respondents were supposed to link each point marked in the map to a landscape element and answer the open-ended questions in relation to that landscape element, like which activities they associated it with.

The second stage of the codebook, in which the direct quotes are organised according to the label they have been identified with, was used to create this visualisation. The labels of each social practice (See Fig. 6) were examined, and the point assigned to the landscape element of each quote was located in the map. A different layer of points was generated for each social practice.The points of the different layers were presented with a particular symbology and colour to facilitate the visualisation of the spatial distribution of the social practices in the map.

4. Results

4.1 Demographic characteristics of participants

The survey was filled by 35 participants. However, participants not always answered to all the questions in the survey. Some respondents left some demographic questions unanswered. In the description of each graphic, the number of participants who answered to the question can be found.

One of the demographic parameters was age. Participants could choose among an array of age ranges. Fig. 8 shows the ages from respondents, which range from younger to older adults. Nevertheless, there is a clear higher incidence of participants over 50-year-old. In the first data collection the most common range was from 30 to 49 years old whereas in the second data collection it was from 50 years old onwards. The results on the gender distribution among participants is shown in Fig.9. Even though the participants were not selected, the proportion of females and males is evenly distributed in the sample. From the total of answered surveys,17 were responded by women and 16 were responded by men.

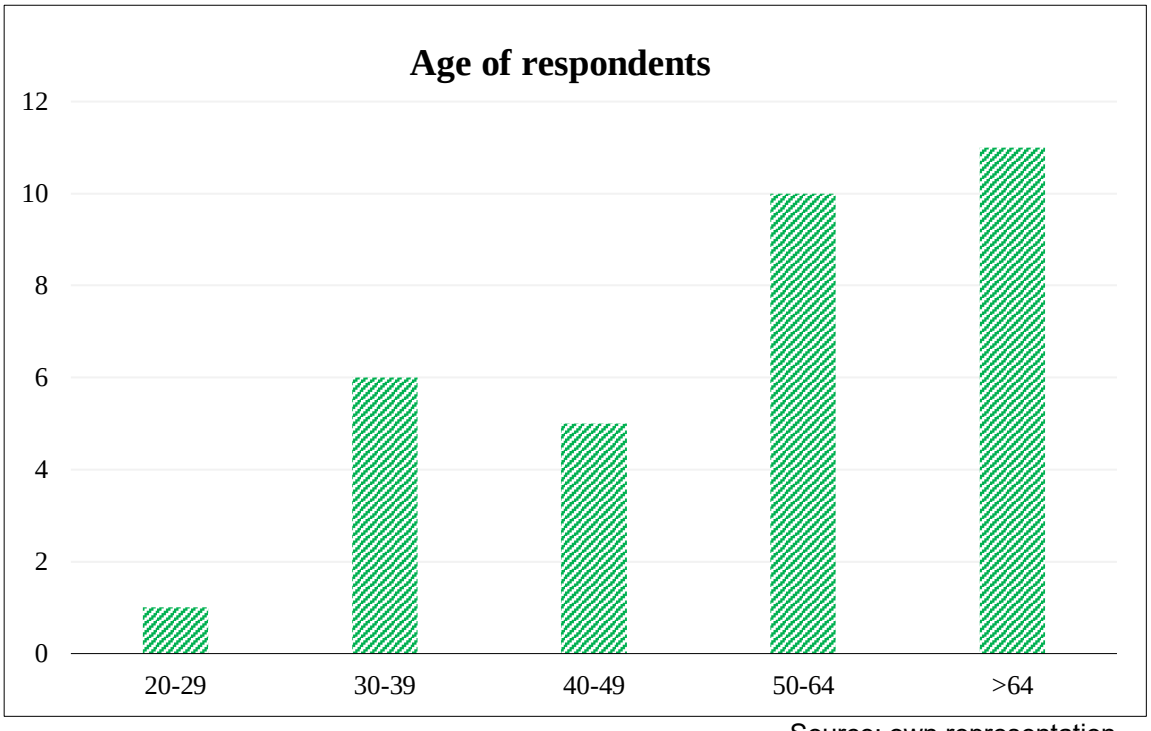


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Fig. 8. Ranges of age among participants. Total number of answers given: 33.

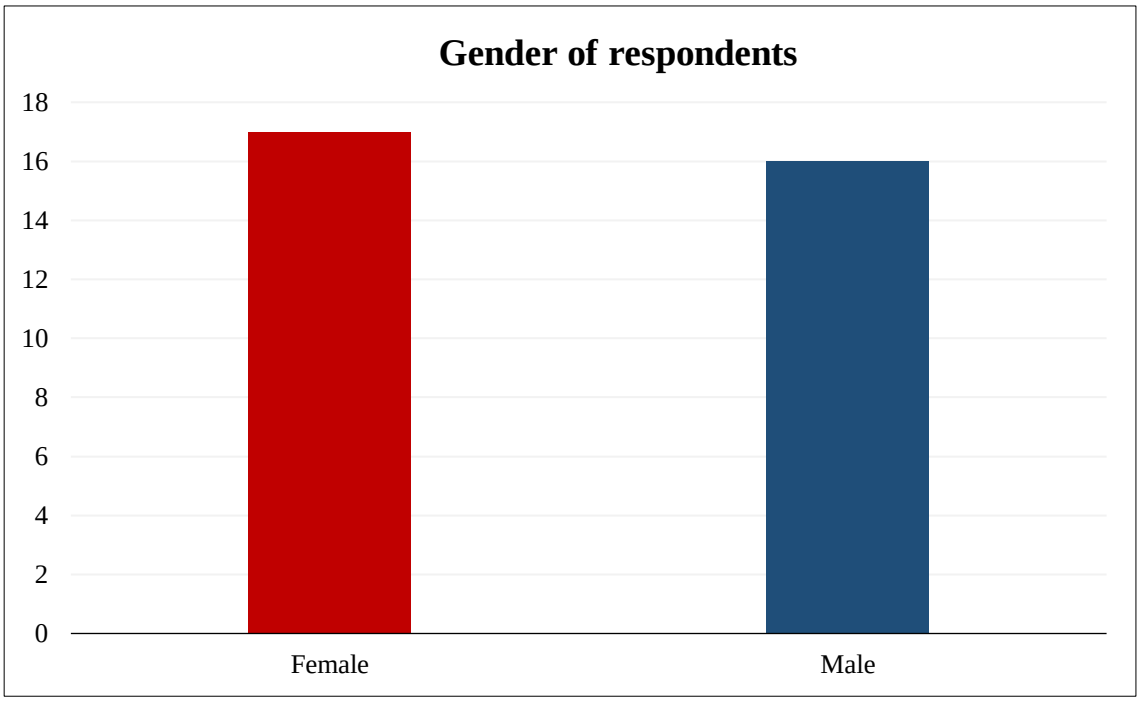

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Fig. 9. Gender distribution among participants. Total number of answers given: 33.

The rest of the questions of this section were aimed to understand the origin of respondents and how far they lived from the study area. For this purpose, participants were asked if they came originally from the region of Upper Lusatia, how much time it took them to arrive to the event that day and the means of transport they used to get there. These questions aimed to uncover the degree of familiarity of respondents with the study area.

A high proportion of respondents (69%) were originally from the Upper Lusatia region (Fig.10). Only 8 respondents were not originally from the area, in comparison with the 24 that came from Upper Lusatia. The ranges of time that took participants to arrive to the event are depicted in Fig.11. Approximately half of the participants arrived at the event in half hour or less. The rest of the participants took between 30 min and 2 hours and a half to arrive to the place. The mean of transport more utilised was the car, by more than half of the respondents (Fig.12). The bus was the second most used mean of transportation, likely due to the event coinciding with the second data collection which was centred around visitors arriving to the site with the “Kunst bus” (Art bus). The bicycle was the third preferred way to get to the event. The incidence “Walking”, “walking and car”, and “train and bus” were means of transport used by the minority of the sample.

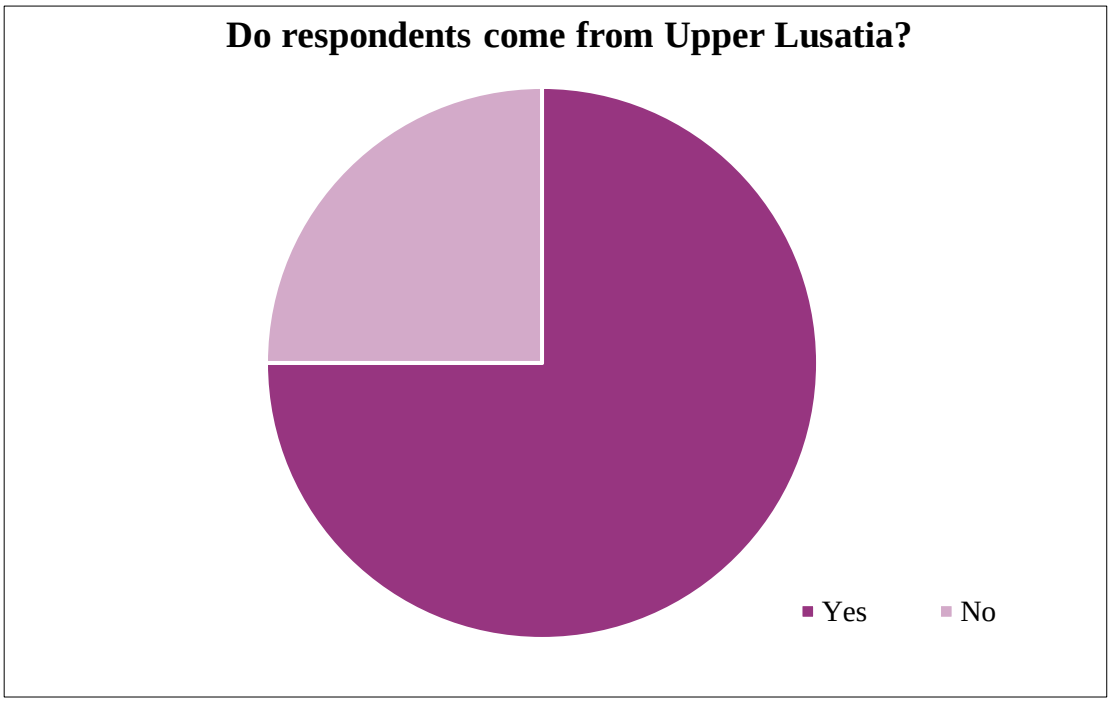

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Fig. 10. Proportion of participants from the region of Upper Lusatia. Total number of answers given: 32.

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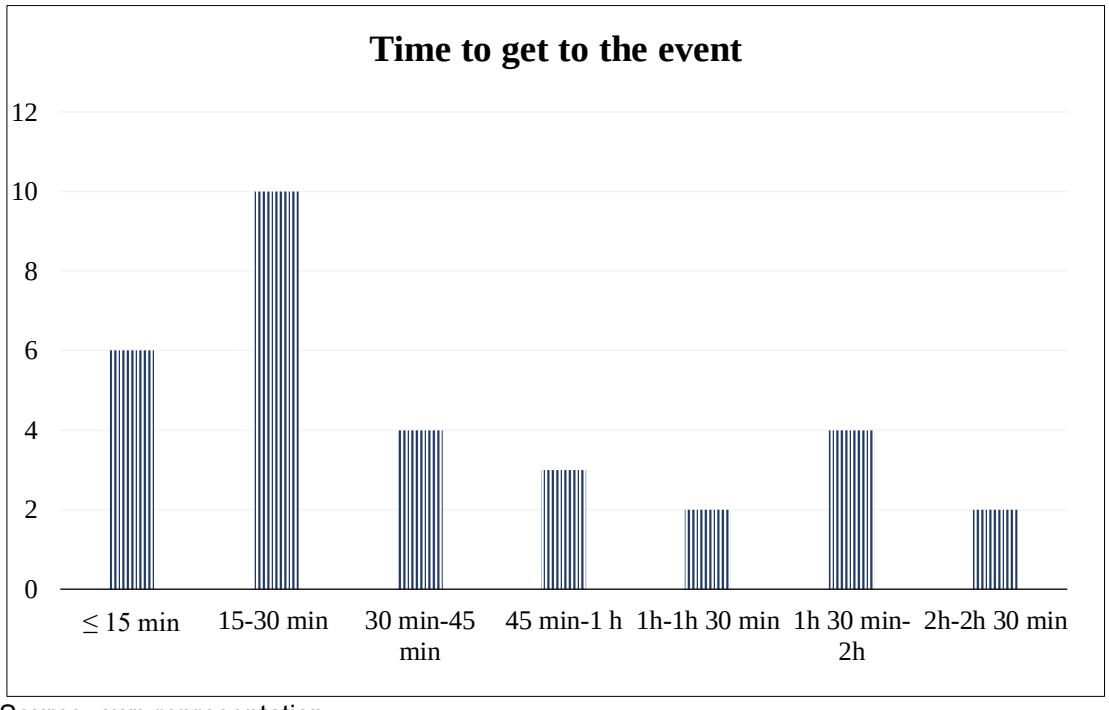

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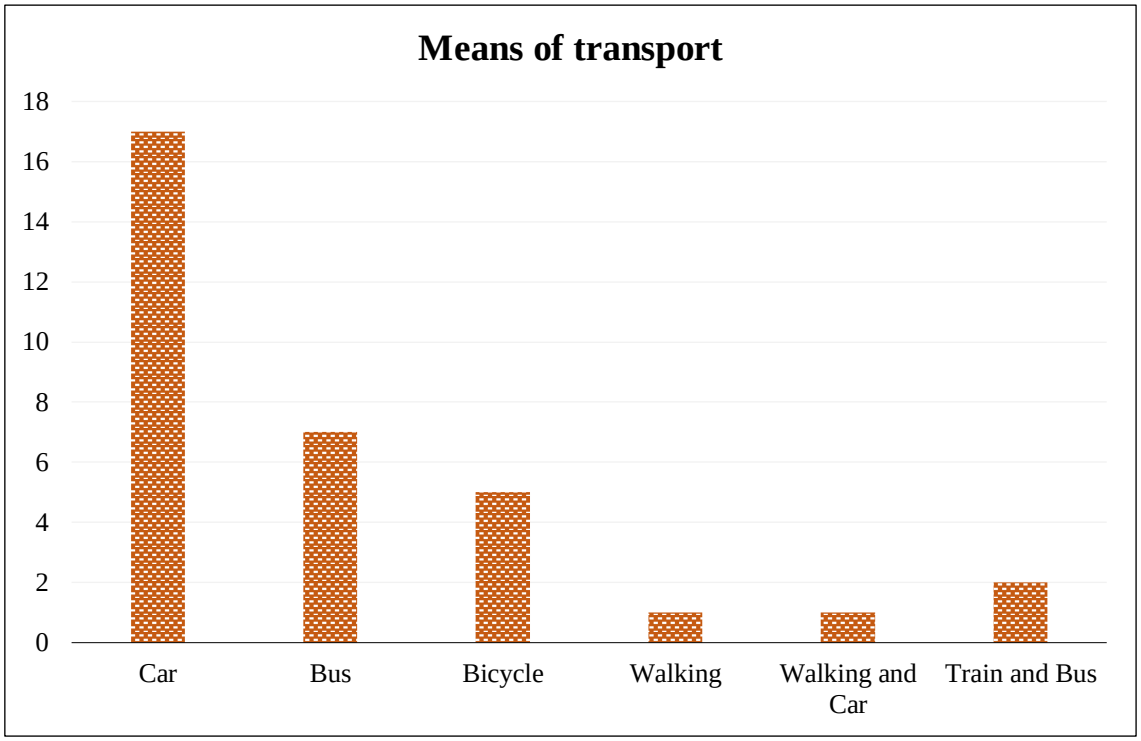
Fig. 11. Time it took the participants to get to the event. Total number of answers given: 31.



Source: own representation

Fig. 12. Means of transport participants took to get to the event. Total number of answers given: 33.

4.2 Construction of heritage in Upper Lusatia

The coded results were analysed, and the activities were grouped into social practices (See Fig.6) and linked to their respective motives. Table 2 summarizes the activities into social practices and shows the motivations of the activities, the corresponding landscape elements and the meanings assigned to them.

4.2.1 Social practices

4.2.1.1 Active recreation

Physical activities in the nature were one of the most abundant entries. Participants mentioned activities such as swimming, sailing, cycling, hiking, and fishing among others. The pond landscape was described as an opportunity to “get out of town” and be in contact with a kind of nature unavailable in more urban contexts such as Bautzen. Lakes were associated with leisure but also with health. Rivers were connected to holidays. Forests were appreciated for their good air quality and as an environment in which to experience nature while being active (Table 2). Data suggests recreational use is associated on one hand with the occasional use

of the landscape, to “escape” from the city and find peace in nature. On the other hand, a daily recreational use, doing activities in the nature as a way to maintain a healthy lifestyle.

4.2.1.2 Passive recreation

This social practice comprises activities related with relaxation, inspiration, and experience of the nature (Table 2). Walking and bathing in the water were mentioned as activities to rest and find calm. Categorising these activities as passive may seem counterintuitive, but they were included in the social practice of passive recreation because some respondents expressed that they did these activities as a form of relaxation.

Respondents included forest bathing, a practice originated in Japan in the 1980s as part of preventive health care and healing in the Japanese medicine. The observed health benefits of this practice, such as increased feeling of happiness, well-being, and cognition, have popularised this activity in the last years (Hansen et al., 2017). Respondents described experiencing nature as a relaxing practice, an example of this was the observation of animals. The soundscape of ponds was also appreciated, associating the sounds of frogs and the sound of the movement of the reed with a feeling of calmness. The beautiful scenery of ponds and bogs was mentioned by participants as well.

4.2.1.3 Nature Conservation

Nature conservation is one of the landscape practices with more entries in the part II of the survey. Respondents linked several landscape elements such as ponds, reed, meadow, forest and bog with the protection and conservation of plant and animal species. Furthermore, bogs and ponds were appreciated for their contribution to water balance. Flora and fauna were considered necessary to maintain a good quality of life (Table 2). Observation of animals was associated with nature protection. The protection of the island in lake Olba and their bird species was also found important. Hunting was associated by some respondents with nature conservation. Hiking was associated with nature conservation (as motivation to hike) by participants.

A considerable number of participants expressed the importance to them of nature conservation in the landscape. Not many respondents identified activities they performed in the landscape in a nature conservation context.

Social practices	Activities	Motives	Landscape elements→ meanings assigned to elements
Active recreation	• Walking • Excursions • Swimming • Cycling • Sailing • Hiking • Going for a picknick • Fishing • Vacation	• Enjoying the landscape while moving • Experience nature • Being active • Maintaining a healthy lifestyle • Finding peace • Enjoy the beautiful landscape	• Ponds → "Getting out of town" • Lake → important for leisure and well-being • River associated with holidays • Bog→ beautiful landscape
Passive recreation	• Going for a walk • Forest bathing • Bathing in the water • Listening to frog sounds	• Relaxation • Observing animals • Rest • Birdwatching	• Ponds→ beautiful place and relaxation point. • Meadows→experience nature • Reed→ relaxing rustle of the reeds. • Lakes and ponds→ relaxing sound of frogs • Bog→ beautiful landscape
Nature conservation	• Observation of animals • Nature protection of the island (referred to the island in Lake Olba) • Hiking • Hunting	• Reflect • Nature protection • Passing on nature conservation.	• Ponds→habitat for rare native species and fish diversity and water balance. • Reed→ breeding ground. • Meadow→habitat of many animals • Flora and fauna→ necessary to maintain quality of life. • Wet meadow→ belongs to nature without intervention. • Bogs→storages water and harbour birds and amphibians. Contributes to climate mitigation.

Social Practices	Activities	Motives	Landscape elements→ meanings associated to elements
Educating local history	• Visit museums • Cultural exhibitions	• Experience history • Spread culture • Educate children about local history • Disseminate information about local history	• Lake→Interesting cultural heritage • Pond→historical reference • Village→knowledge transfer and conservation of rural heritage • Wartha "Schulmuseum" →opportunity to experience local history • Open pit clay mining→ forms part of the landscape and development of the region in the landscape
Nature education	• Environmental educational events e.g. "Rangertag" (Rangerday). • Observation of animals	• Bringing children closer to nature • Teach children and grandchildren things about the nature and get them to know the place. • Acquire knowledge of nature • Discovering new things • Experience nature	• Pond, Forest, Reed, Wet meadow → Observation of animals and plants • Lake→ observation of animals such as the grass snake. • Haus der Tausend Teiche → source of information about the nature and organisation of educational events
Daily living	• Walking • Bathing • Fishing • Cultivation	• Meeting friends • Relaxation • Food production • Feeling of home	• Pond →associated with aquaculture, which is considered a form of livelihood. They are linked with a feeling of home • Village→ living space including nature • "Haus der Taused Teiche" →Place to meet friends

Table 2. Summary of social practices constituted by activities, motives, landscape elements and the meanings associated with the landscape elements, based on the framework proposed by (Braaksma et al., 2016).

4.2.1.4 Nature Education

The activities of this social practice consisted of observing animals and attending to nature educational events such as the “Ranger tag” (Rangerday) celebrated in the “Haus der Tausend Teiche” (Table 2). These activities were associated with the acquisition of knowledge and discovery of new things. They were also important as part of the education of children, teaching them about nature, getting them close to the environment and showing them their own surroundings. Ponds, lakes, forest, reed, and wet meadow were pointed as places to observe animals and plants. The observation of birds and other animals was one of the most commented activities by respondents, frequently linked to the conservation of the landscape. Furthermore, the “Haus der Tausend Teiche” was described as a source of information about the nature and of educational events.

4.2.1.5 Educating local history

The villages, the” Schulmuseum” in Wartha, the ponds and the open pit mine were associated with local history. Villages were considered valuable to transfer local knowledge and conserve rural heritage. The “Schulmuseum” in Wartha is a museum that shows how schools one hundred years ago in the bilingual and multicultural context of Upper Lusatia, where Sorbian and German cultures coexist looked like (Schulmuseum Wartha, 2023). The open pit mine was considered as part of the history of the area, as a landscape element that was significant for the regional development in the past. The ponds were described to constitute part of the heritage of the area.

4.2.1.6 Daily living

The activities comprised in this social practice are walking, fishing, bathing, and cultivation of the fields (food production) (Table 2). Walking and bathing were related to relaxation and meeting friends. Ponds were linked to pond farming, a form of livelihood in the area. Furthermore, ponds were associated with a feeling of home. Villages were described as places of living in contact with nature.

4.2.3 Spatial distribution of social practices

The points marked by respondents in the map of the survey were categorized according to the social practices they have been associated with. Fig.13 shows the spatial distribution of the six identified social practices. The highest concentration of social practices can be observed in the Guttau pond system and in the lake Olba. Lake Olba was mainly related to recreation (both active and passive). The ponds were linked to both types of recreation, but also to nature conservation, nature education and daily living.

Clustering can also be observed in Wartha, in which the two more predominant social practices are daily living and educating local history. Forest was connected mainly with recreation and nature conservation. Interestingly, bogs got a relative high proportion of entries (regarding the size of the bogs in respect to other landscape elements), associated with nature conservation, nature education and active recreation.

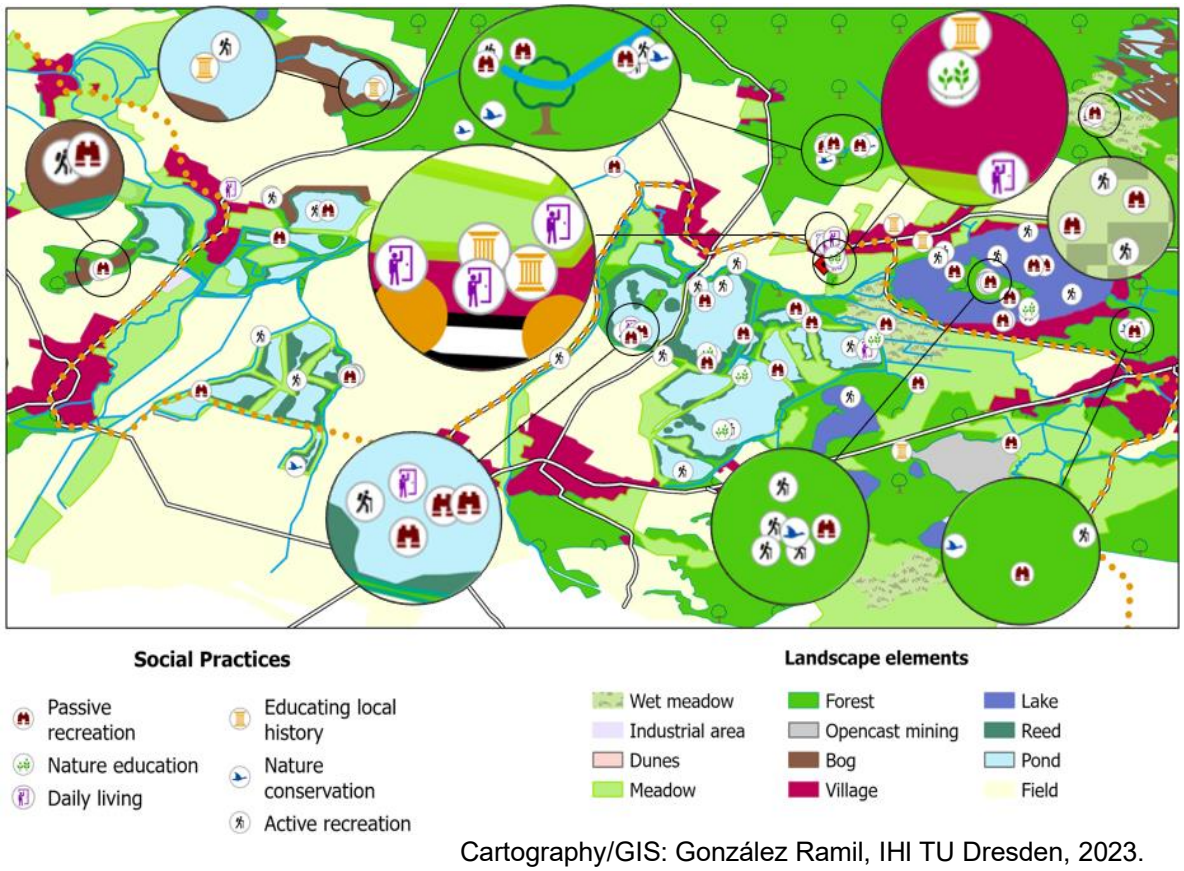


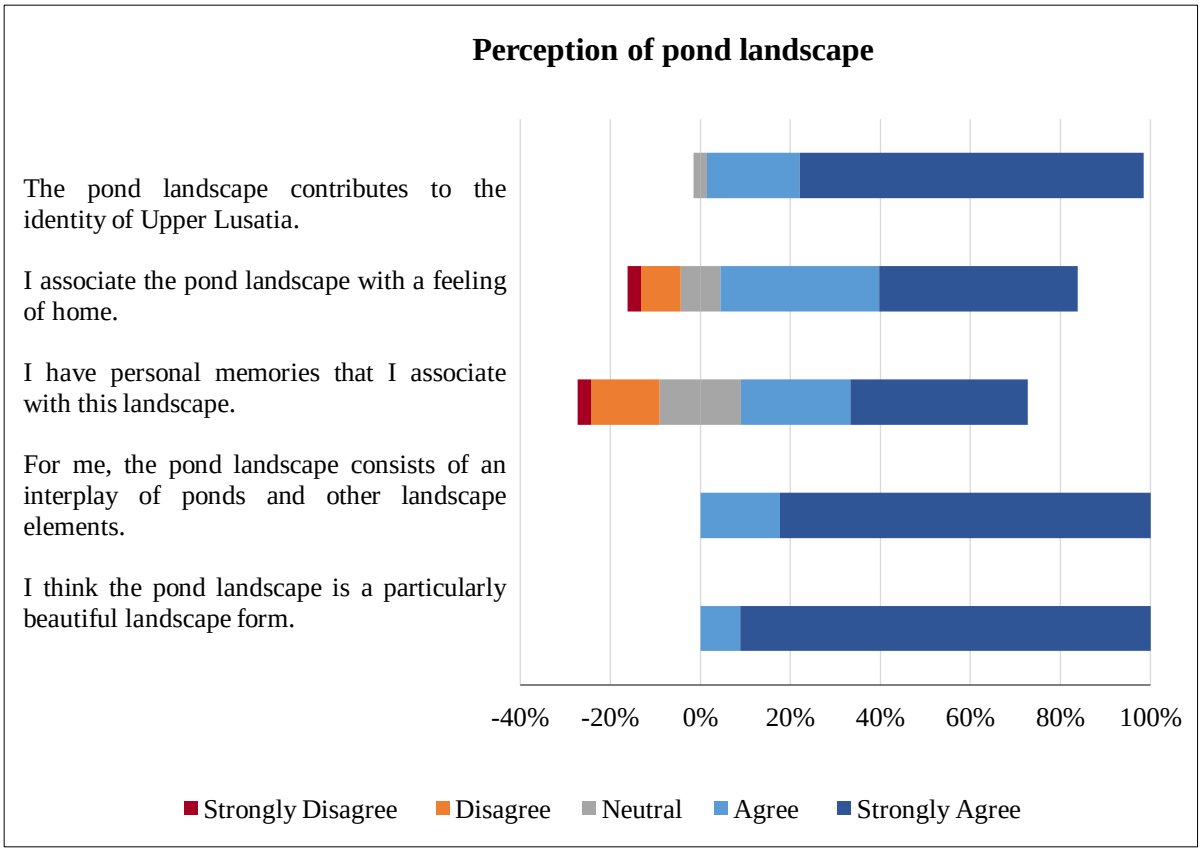
Fig. 13. Spatial distribution of social practices in the study area. Source:(Geoportal Sachsenatlas, 2023)

4.3 Perceptions of the Upper Lusatian Pond landscape

4.3.1 Landscape perception

The first block of answers aimed to uncover aspects of the perception respondents had towards the pond landscape. This block was formed by five statements about feelings and perceptions that have been associated with heritage (Fig.14).

In general terms, there is a high level of agreement by the participants to the five statements that constitute the block. There is a special degree of agreement with the first and last statements shown in Fig. 14 “The pond landscape contributes to the identity of Upper Lusatia” and “I think the pond landscape is a particularly beautiful landscape form”. These two statements refer respectively to the feeling of identity and perception of a beautiful scenery by respondents. In addition, all respondents agreed to the statement “For me, the pond landscape consists of an interplay of ponds and other landscape elements.” This suggests an understanding and appreciation by participants of the diversity of biotopes existing in the biosphere reserve and associated with the pond landscape.



Source: own representation

Fig. 14.Level of agreement about the perception of the pond landscape by participants.

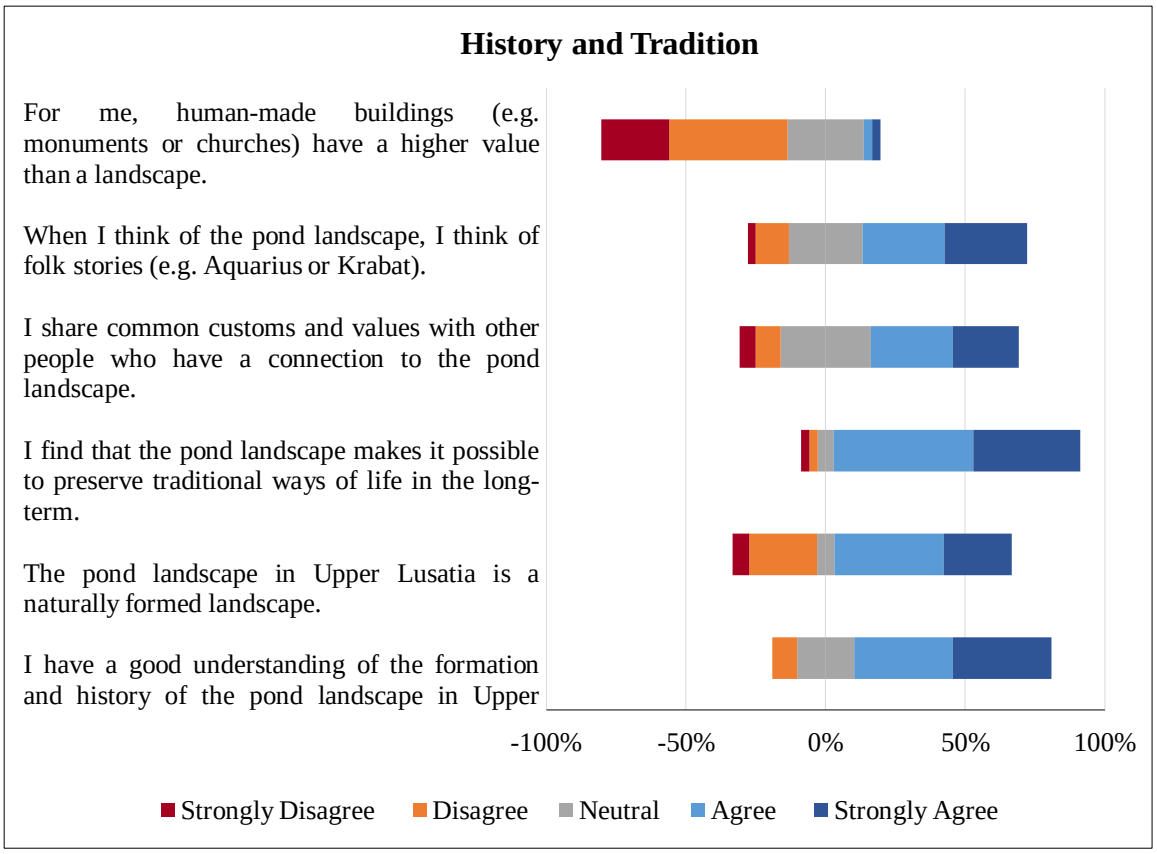
A small percentage of disagreement can be observed in the statement “I associate the pond landscape with a feeling of home” and a bit higher disagreement towards the sentence “I have personal memories that I associate with this landscape.”

4.3.2 History and tradition of pond landscape

The second thematic block of the questionnaire was formed by six statements about different aspects of history and tradition related to the pond landscape (Fig.15).

The level of agreement among respondents is more varied in this block (Fig.15). The biggest degree of disagreement is observed as response to the first statement “For me, human-made buildings (e.g., monuments or churches) have a higher value than a landscape.” The purpose of this statement was to explore the valorisation of people of landscape features in comparison to man-made features. The level of disagreement to this statement showed participants highly value landscape features, even in the context of local monuments. The proportion of agreement to the statement was quite small, whereas there was a moderate percentage of people who neither agreed nor disagreed to the statement. The dichotomy between man-made and natural features kept being explored with the statement “The pond landscape in Upper Lusatia is a naturally formed landscape” (Fig.15). The aim of this statement was to discover I the respondents knew about the origin of the ponds of the area (artificially created since the 13th century).

he results of this statement are quite interesting, as most respondents agreed with such affirmation. Consequently, this result suggests a lack of knowledge on the origin of the pond landscape. Interestingly, 35% of respondents agreed and 35% strongly agreed the statement “I have good understanding of the formation and history of the pond landscape in Upper Lusatia”



Source: own representation

Fig. 15. Level of agreement about the history and tradition of the pond landscape by participants.

The concept of tradition linked to the pond landscape was studied through three statements "When I think of pond landscape I think of folk stories (e.g. Aquarius or Krabat)", "I share common customs and values with other people who have a connection to the pond landscape" referring to tradition as a set of shared customs and values, and "I find that the pond landscape makes it possible to preserve traditional ways of living in the long-term" referring mainly to pond farming as a traditional practice and source of income in the area (Fig. 15).

Approximately 60% of respondents agreed and strongly agreed to the association of the pond landscape to folk stories and that they thought to share customs and values with other people associated with the pond landscape (Fig. 15). The strongest agreement in the block by participants was towards the statement about how the pond landscape preserves traditional ways of living (Fig.15).

4.3.3 Pond farming

The thematic block about pond farming was composed of four questions that aimed to uncover the importance and meaningfulness that participants gave to pond farming (Fig. 16).

Most respondents agreed that they consume regionally produced fish, such as carp (Fig 16). However, there was a bigger disagreement (61% in total) towards the statement “I enjoy visiting fishing festivals”. There was a high proportion of disagreement towards the statement “Pond farming is important exclusively for the production of fish” which suggests that the participants perceive the pond landscape as a multifunctional space.

In contrast, the highest level of agreement happened towards the statement “The pond landscape can only be preserved by managing the ponds” which uncovers a strong collective understanding of the necessity of pond management to conserve pond landscapes (Fig. 16).

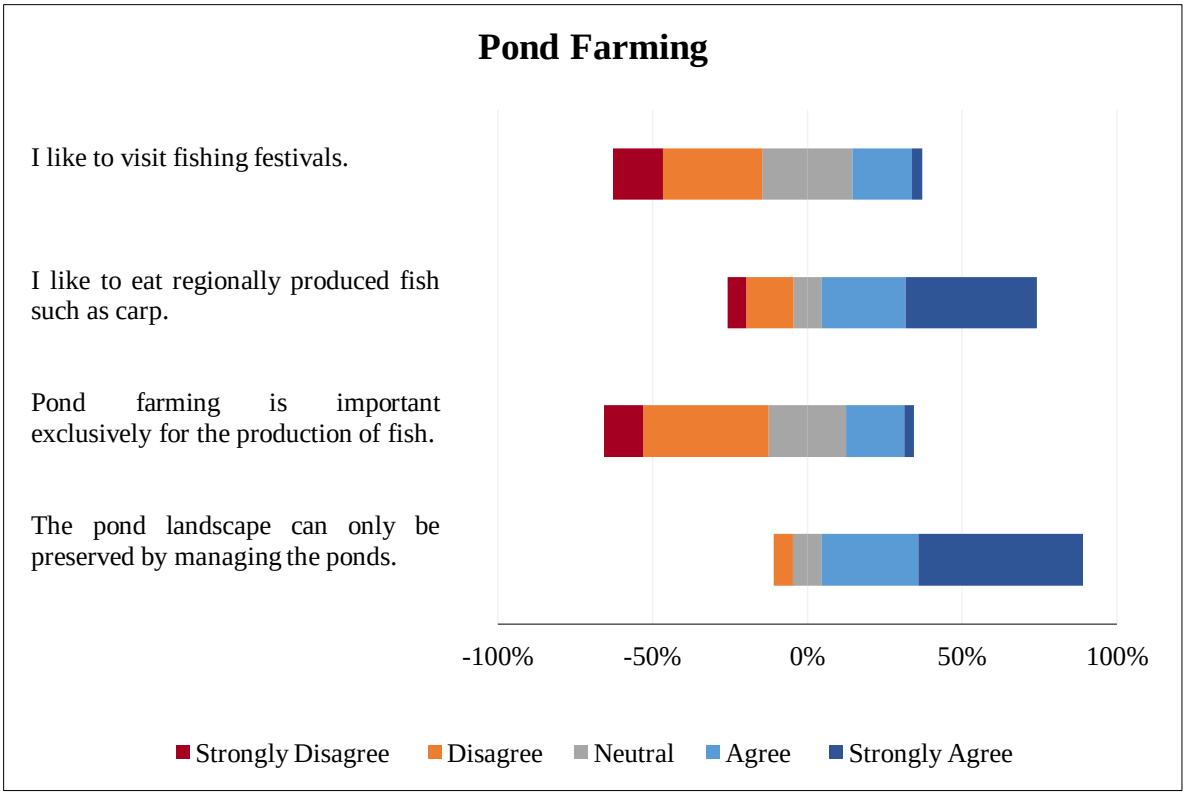


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Fig. 16. Level of agreement of participants towards pond farming.

4.3.4 Preservation of pond landscape

This block of statements aims to understand how relevant is the preservation of pond landscapes for participants (Fig. 17). This block has the highest agreement rate among all the thematic blocks of the questionnaire (Fig. 17) Only one person disagreed with any of the statements. It is also interesting the low per cent of neutral responses, which was generally higher in the rest of blocks. Furthermore, this block has a very high percent of respondents who strongly agreed with all the statements. These results (Fig. 17) already suggest a strong consensus and concern towards the preservation of the pond landscape and pond farming.

The only appearance of disagreement was observed on the statement "I want pond farming to be preserved in the long term," by one respondent (Fig 17). There was also a small number of neutral responses. A 73% of respondents strongly agreed to the preservation of pond farming in the long term. There was a unanimous response from participants towards the preservation of pond landscapes in the long term. These results show the strong importance the pond landscape has in the region.

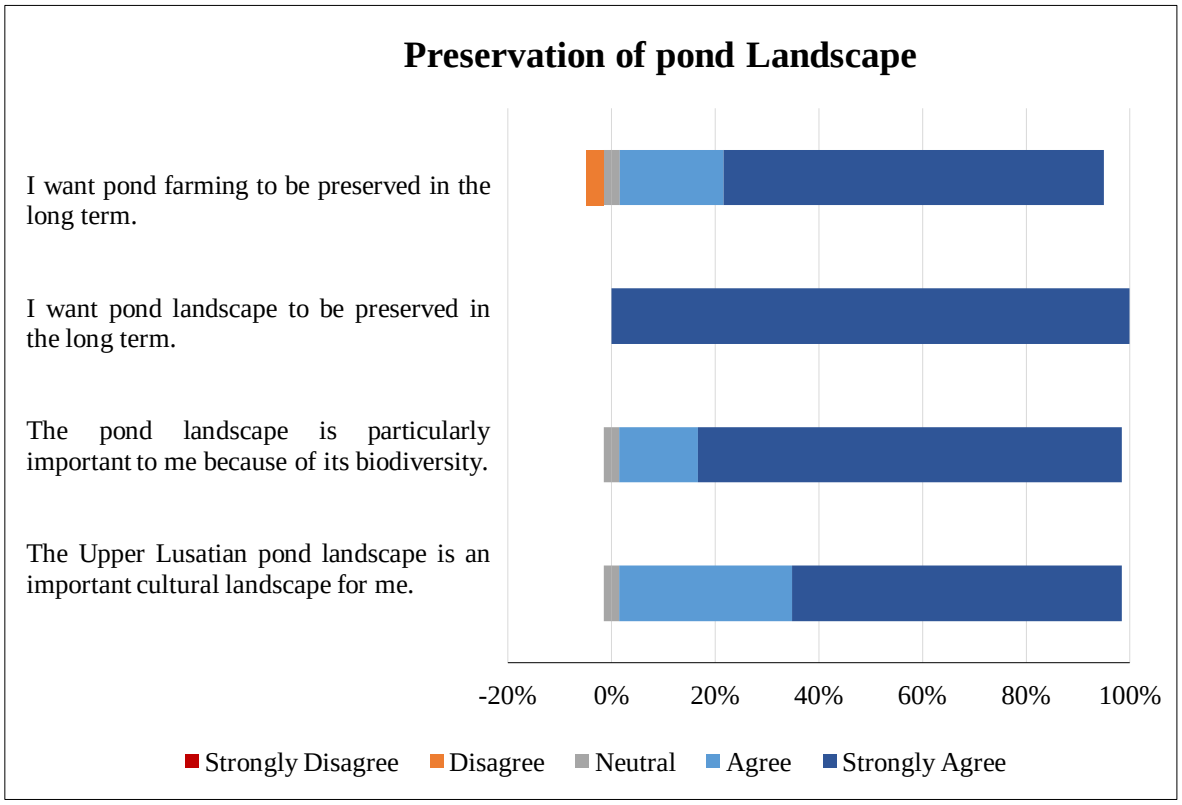

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Fig. 17. Graph showing the responses to the statements about preservation of the pond landscape.

There was a strong agreement by participants to the statements “The pond landscape is particularly important to me because of its biodiversity” and “The Upper Lusatian Pond landscape is an important cultural landscape for me” and a low number of neutral responses (Fig. 17). The participants highly valued the cultural landscape and biodiversity that the pond network of the area offer, which is also visible in the answers from respondents to the open-ended questions.

4.3.5 Usage of pond landscape for recreational purposes

This block of statements aimed to study the types of recreational use participants performed in the pond landscape (Fig. 18). In general terms, a strong agreement was observed towards the statements of this block (Fig. 16). In fact, there was just 3% of disagreement in the statements “I like to use the countryside to experience nature” and “I would spend more than one day (overnight) in the Upper Lusatian Pond landscape”. Nevertheless, the level of agreement with these statements was qui high (73% of respondents strongly agreed with the use of the countryside to experience nature and 66% strongly agreed with the idea of spending more than one day in the Upper Lusatian Pond landscape).

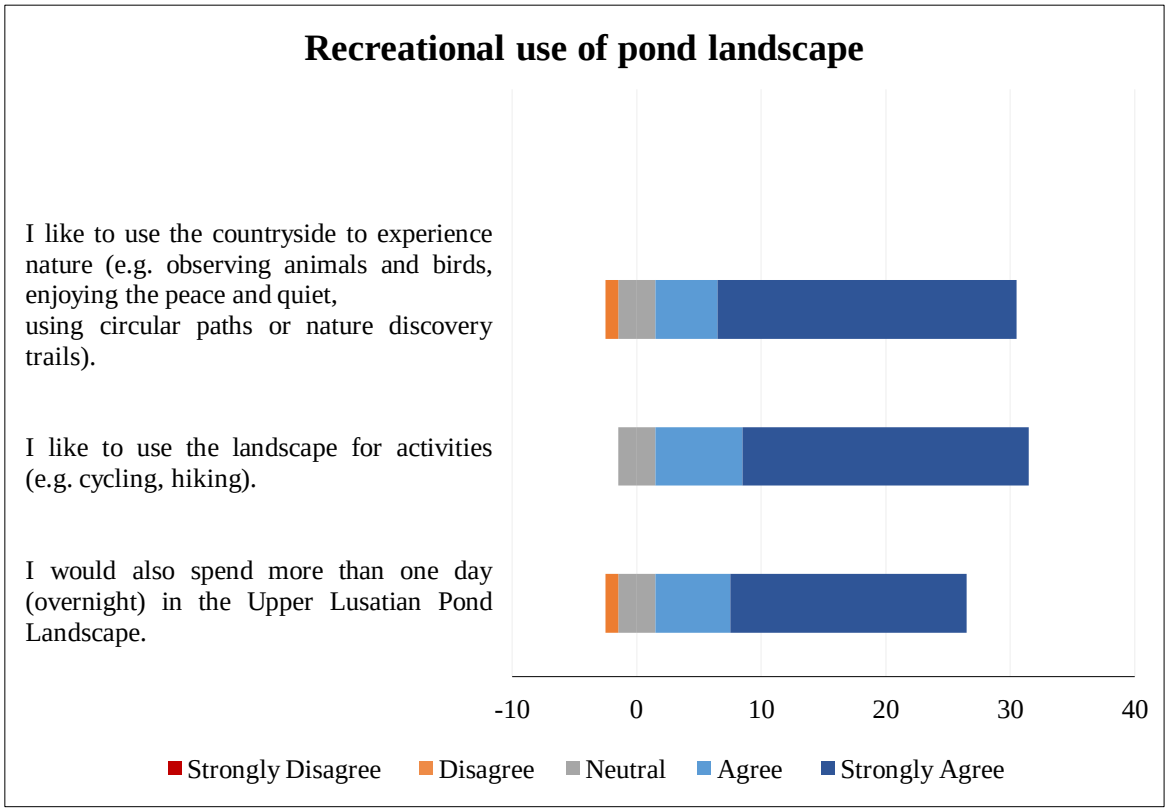

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Fig. 18.. Level of agreement towards the recreational use of the pond landscape by participants.

There was no disagreement towards the statement “I like to use the landscape for activities” and 70% of respondents strongly agreed to this statement. This suggests there is a strong recreational use of the pond landscape (Fig. 18).

In this block, respondents were additionally asked to give examples, if it was the case, of activities they do in the landscape for active recreation and of activities they do in the landscape to experience nature. The responses are displayed in Fig.19 and 20.

The most popular active uses of the landscape among participants were hiking, cycling, swimming, and walking (Fig. 19). Walking and hiking were also popular activities to experience nature (Fig. 20). Observation of nature was the most popular activity to experience nature (Fig. 19). It is important to note that many respondents answered to these questions with more than one activity. Hence, there are more activities that participants (Fig.19 and 20). There are also activities such as walking or swimming that participants determined as both active recreational uses of the landscape and uses of the landscape to experience nature (Fig. 19 and 20).

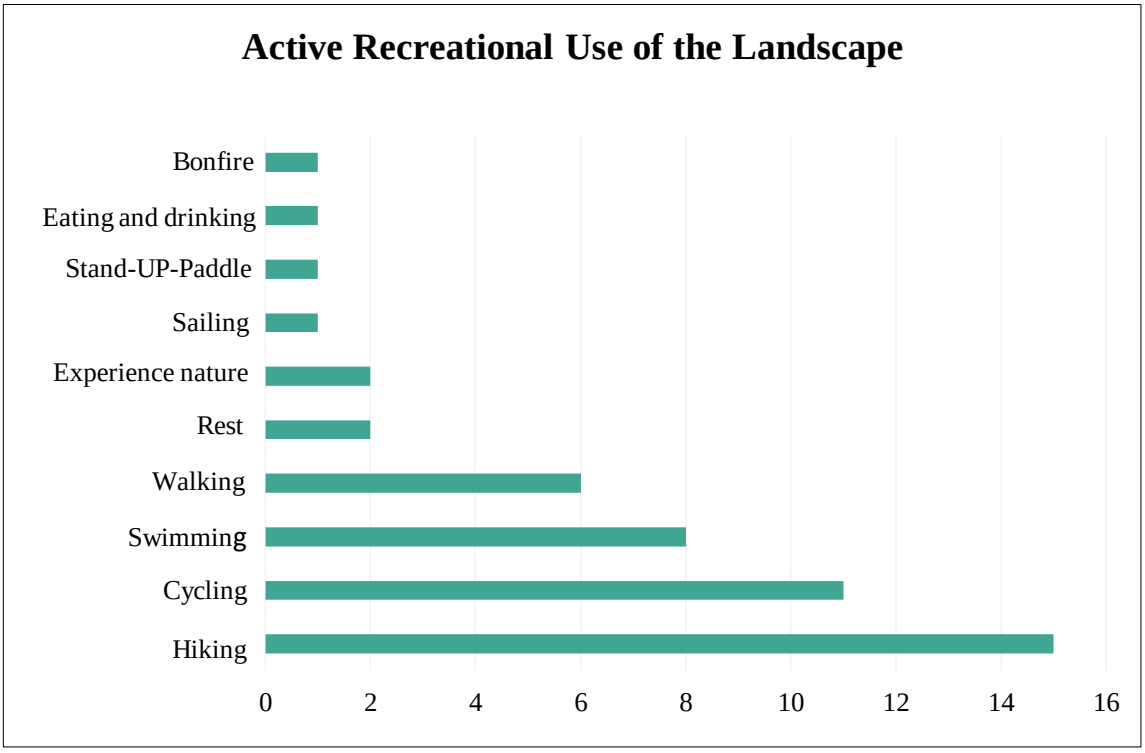

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Fig. 19. Active uses of the landscape of participants.

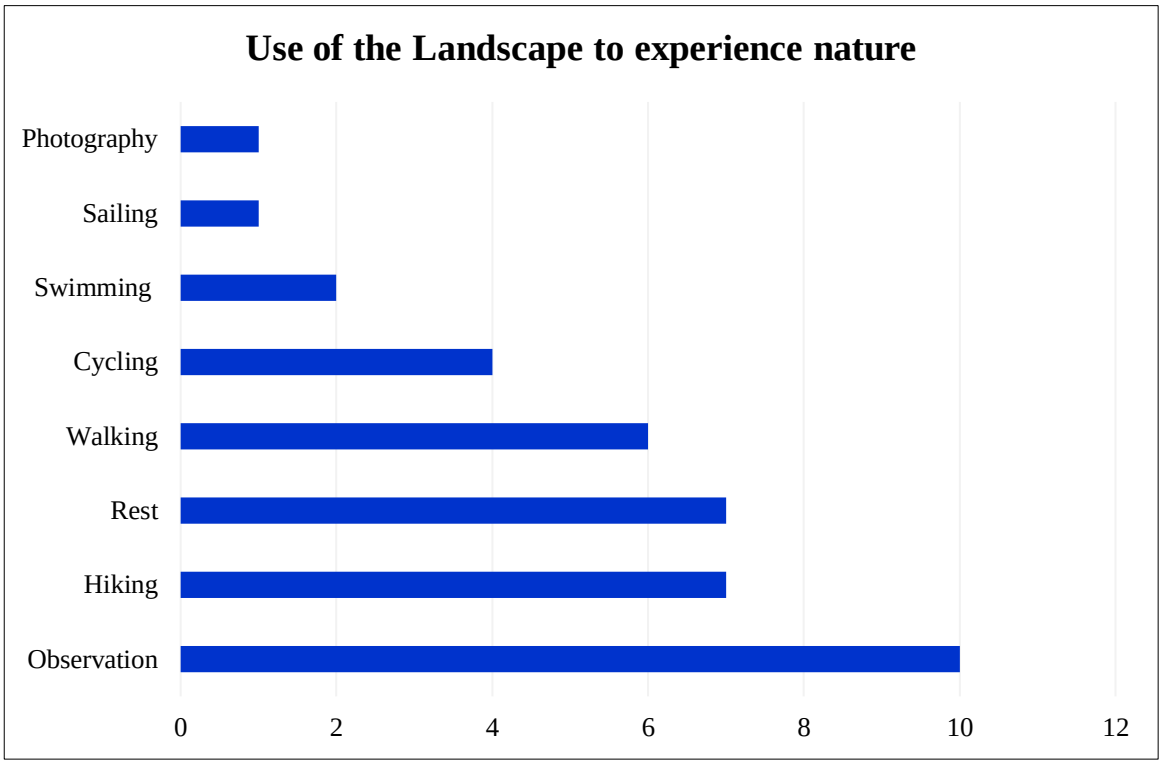

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Fig. 20. Uses of the landscape of participants to experience nature.

4.4 Hotspot maps

4.4.1 Hotspot map of natural and cultural heritage

A natural and cultural heritage hotspot map was generated using ArcGIS (Fig. 21). The points marked by participants as relevant in the context of natural and cultural heritage in the map, were used to perform the spatial analysis. This first hotspot analysis was performed solely considering the different densities of the point clustering in the map. Due to the possible inaccuracies that might occur in the data, a heat map which was created using the Kernel analysis (Fig. 22) was also generated to compare the results from the hotspot map. There are in fact, few inaccuracies in the hotspot map. Regardless these inaccuracies, main natural and cultural heritage hotspots are present in both maps. The hotspot and heat maps shown in Fig. 21 and 22 uncover three main hotspots in lake Olba, the Guttau pond system and “Haus der Tausend Teiche”.

Minor clustering of points is also found in the forest and wet meadow on the East of the study area, the pond system near Klix and the bog at the West of the study area. However, the clustering of these points is not significant enough to be considered hotspots.

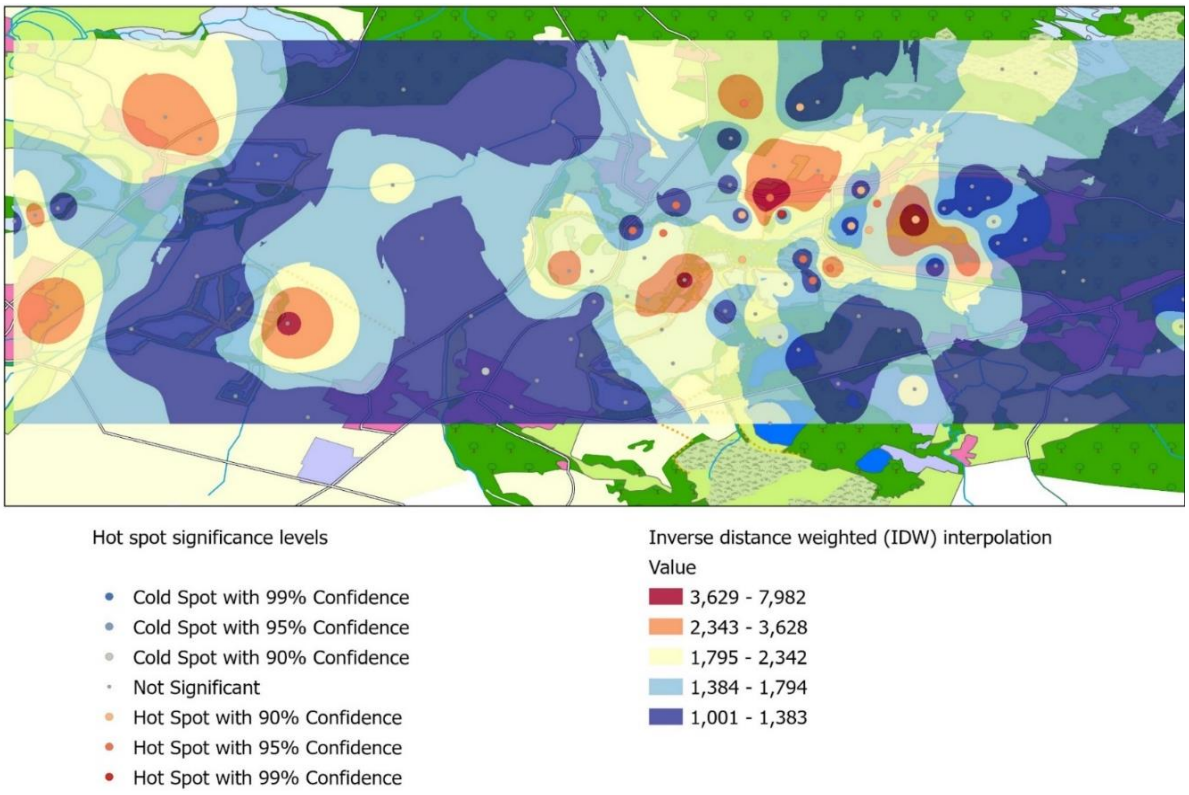
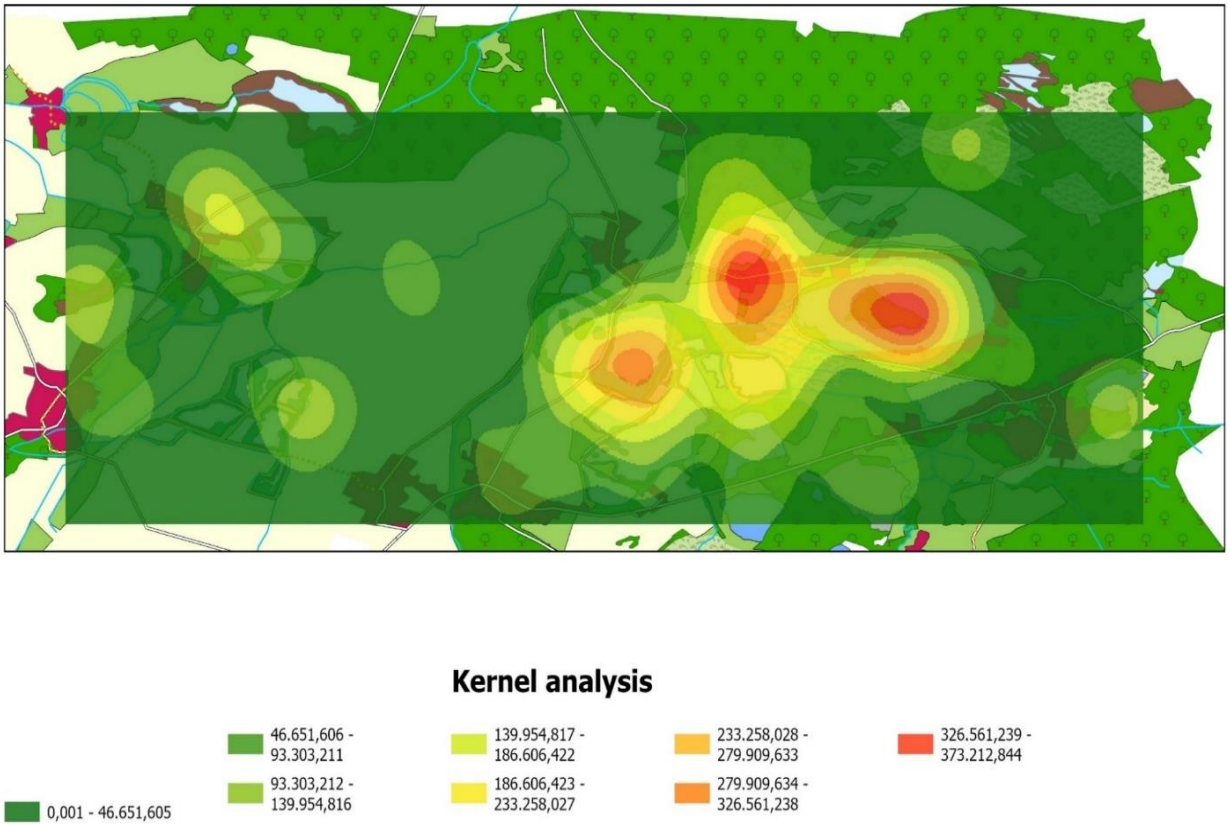


Fig. 21. Hotspot analysis of natural and cultural heritage sites. Source: (Geoportal Sachsenatlas, 2023).



Cartography/GIS: González Ramil, IHI TU Dresden, 2023

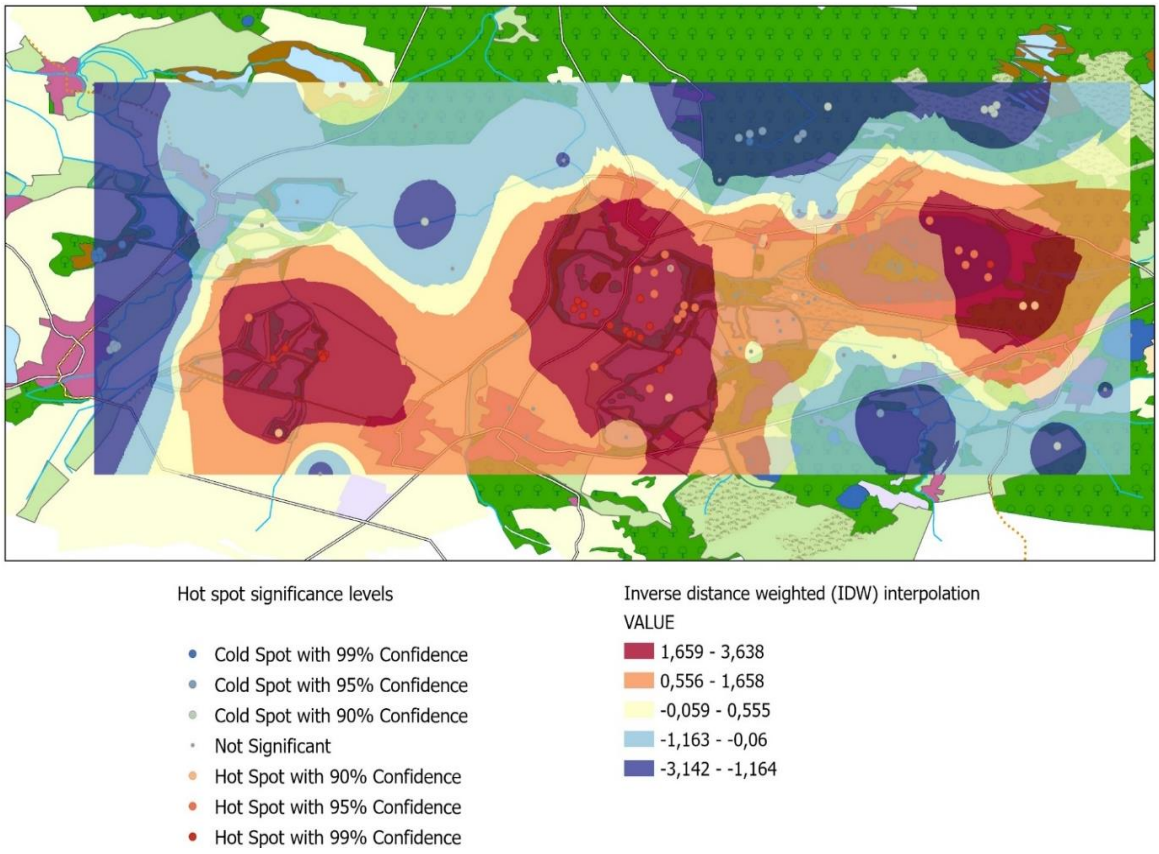
Fig. 22. Kernel density analysis (heat map) of natural and cultural heritage sites. Source: (Geoportal Sachsenatlas, 2023).

4.4.2 Hotspot map of natural and cultural heritage of landscape elements.

Three main hotspots were uncovered in this analysis (Fig. 23). The Guttau pond group, the pond group near Klix (in the West) and the East side of the Lake Olba. These areas had a high input of points by participants and their associated landscape features (pond and lake) were the highest selected in the survey. Although a more moderate number of respondents selected reed as a landscape element important to heritage, hotspots in the reed area can also be observed. Thus, there is a great concentration of points linked to reed in that area. In this analysis, a higher number of hotspots with a 99% confidence were identified.

Cold spots can be observed too in this analysis (Fig.23). One of the cold spot areas is the bog located to the West of the map, with a 99% confidence level. The cold spot in the bog area means a cluster of low values. The points located in the bog have a low value associated to them because a low number of people (7 people) selected bog as a landscape element in the

survey and the map. Cluster of values represented as cold spots also appear in the meadow area next to the open pit mine and up north in the forested area, with a confidence level of 99%. In that forest other cold spots with a level of confidence of 90% are also spotted.



Cartography/GIS: González Ramil, IHI TU Dresden, 2023

Fig. 23. Hotspot analysis of natural and cultural heritage of landscape elements. Source: Geobasisinformation Sachs

5. Discussion

5.1 Natural and cultural heritage hotspots and connection with landscape elements

This master thesis sought to develop a methodology for the assessment of natural and cultural heritage perceived by the public in the landscape. The findings confirm that natural and cultural heritage concentrates in certain places in the study area. Hotspots of natural and cultural heritage are located in the Guttau pond system and the lake Olba (See Fig. 21 and 22 and 23). A third main hotspot referred to the “Haus der Tausend Teiche” (Fig. 21 and 22) which contributed to nature education and as a meeting place for social relations (See Table 2). The natural and cultural heritage hotspots. Some hotspots were also found in the reed area in the Guttau pond group (See Fig. 23). Reed was associated with passive recreation, nature conservation and nature education (See Table 2).

Ponds and lakes were the landscape elements most associated with natural and cultural heritage in the study area (See Fig. 23). In the mapping study conducted by Plieninger et al. (2013a) in the same area, lakes and ponds were also associated by the participants with heritage.

The results of this thesis uncover the pond was the landscape element associated with more diverse social practices, suggesting that they are highly multifunctional sites (See Table 2). Participants considered the importance of pond landscapes went beyond fish production (Fig. 16). The results suggest that pond conservation and pond farming are not perceived by respondents as conflicting issues. In fact, most respondents considered pond management was necessary to preserve pond landscapes (Fig. 17). Fishing was described as a form of recreation and as a livelihood (Table 2) and the majority of participants agreed they like to consume regionally produced carp (Fig. 16). Results suggest a strong sense of identity from participants towards pond landscapes (Fig. 14), which could be partially rooted in local gastronomic heritage around carp. Species and foods can be central elements of regional identities (Delpero & Volpato, 2022) and form part of the natural and cultural heritage of an area (Tieskens et al., 2017).

Elements connected to natural and cultural heritage because of their historical relevance were identified, such as the villages, ponds, the open pit mine or the Wartha “Schulmuseum” (See Table 2). These elements form part of the local heritage because they contribute to the collective memory of the landscape, by remembering aspects of the past. Villages were also perceived as important to conserve rural heritage. Lekakis & Dragouni (2020) explained how

rural structures and their associated collective memories of rural “ways of being” are sometimes transformed into symbols of collective consciousness.

Intangible heritage aspects were identified during the study. More than half of participants agreed that they associated pond landscapes with regional folk stories such as Krabat (a Sorbian folk story) (See Fig.15). Participants attributed villages with the dissemination of local knowledge (Table 2). Folk stories and traditional knowledge are characteristic aspects of natural and cultural intangible heritage (Robischon, 2015). The conservation and preservation of historical elements such as ponds, traditional practices like pond farming and memories of the past, for example, remembering how schools in Upper Lusatia were 100 years ago, also form part of the intangible heritage of the area. The decisions to conserve or not elements and memories from the past form part of the intangible heritage of communities and contribute to the creation of a collective memory (Harrison, 2009).

It is important to note that there can be plural heritages and collective memories in a community (Sather-Wagstaff, 2015). In the sample studied in this master thesis, half of the participants thought they shared values and customs with other people connected to the pond landscape (See Fig. 15). This statement aimed to find out if participants considered they shared a cultural context with other people connected to the pond landscape. The partial disagreement or indifference towards this statement by half of the participants could mean different cultural contexts among respondents, which would also influence heritage. Braaksma et al. (2016) observed how even in a relatively homogeneous cultural local context, different heritage constructions could be identified.

Bogs, meadows, and forests were highly appreciated for their biodiversity (Table 2). Nature observation was linked to educating children about their surrounding environment (Table 2). The feeling to preserve the pond landscapes was highly agreed among respondents. Most of respondents considered the pond landscape important for them because of its biodiversity (Fig. 17). The appreciation of heritage in cultural landscapes has been previously connected to the awareness of participants about the importance to preserve those landscapes (Helmer et al., 2020). The results of this master thesis suggest local people have deeply rooted feelings of care and responsibility towards the pond landscape. The associations of identity, heritage and collective memories with the landscape can result in environmentally protective attitudes as an act of care towards the natural surrounding people relate to (Chan et al., 2016).

5.2 Modes of landscape heritage meaning construction

The modes of construction were detected by comparing the motivations of the activities and the meanings associated to their landscape elements of all the social practices in the textual analysis. The modes of meaning construction are the shared forms of understanding that underline the social practices (Braaksma et al., 2016). Three modes of heritage meaning construction in the landscape were identified: aesthetics and socially belonging modes, which were as well identified in the study of Braaksma et al. (2016). Additionally, the preservation and bequest meaning construction mode was proposed based on the strong sentiment of bequest and conservation, both constituent aspects of heritage (Harrison, 2015), expressed towards the landscape elements.

In the aesthetics mode of meaning construction, the beautiful scenery was considered an important attribute of the landscape. This mode of meaning construction drove the practices of passive and active recreational use. The beautiful landscape was described as a motivation for doing both types of recreational activities. The observation of nature was partially motivated because of its aesthetic value. The nature of the pond landscape was seen as a contrasting landscape to the urban scenery of nearby cities. Heritage elements such as ponds and lakes were appreciated because of their aesthetic value.

In the preservation and bequest mode of meaning construction, “natural” landscape elements were considered relevant and worth preserving. There was a strong component of legacy and bequest in the motivations to experience and conserve nature, and in teaching children to protect and appreciate their surrounding landscapes. Ponds, forests, reed, and bogs were considered important elements to conserve and to learn about nature. However, there was also few respondents that attributed the relevance and motivation for conservation of certain natural features, such as wet meadows, to their intrinsic value. The “Haus der Tausend Teiche” plays a key role in educating nature conservation and passing on the appreciation for the pond landscape to next generations.

The socially belonging mode of meaning construction was focused on the preservation and dissemination of local history and in daily living practices that awaken deeper emotions in the people about their surroundings. This social practice was formed by activities that enforce the identity and sense of place of participants. Ponds were an important element in this mode of meaning construction. They were associated with a traditional livelihood in the area (pond farming) and assigned a feeling of home. The villages and the “Schulmuseum” in Wartha were considered important to experience and understand the local history.

5.3 Linkages of heritage with other CES

It is not possible to map one cultural service without acknowledging its relation with other ES. Many CES are not linked only to an experience but are the outcome of a variety of experiences associated with ES (Tengberg et al., 2012). In the analysis of the data linkages between heritage and other CES were observed. The following paragraphs discuss these connections.

Identity was observed to interact with heritage. 97% of participants agreed that the pond landscape contributed to the identity of Upper Lusatia (Fig.14). My findings suggest natural and cultural heritage of pond landscapes contributes to the sense of regional identity in Upper Lusatia. Heritage collaborates in the development of people's sense of belonging and attachment to a place. (Acott & Urquhart, 2014; Skogheim et al., 2018). More than half of participants agreed to share a cultural context with other people connected to pond landscapes. The long-term traditional use of the ponds in Upper Lusatia could be the reason for the strong sense of identity towards these landscapes.

Aesthetics was observed to contribute to the construction of heritage. The results indicate the appreciation of aesthetic qualities of a landscape element can drive a sense of heritage towards it. Aesthetic experiences can drive attachment, identity, and heritage to a place (Gobster et al., 2007; Scazzosi, 2004). The data suggests the study area provides a favourable natural and cultural context in which aesthetic experiences can contribute to the construction of landscape heritage.

An interaction between recreational uses of the landscape and heritage has been observed in the results. The recreational use of the pond landscape was important for participants. Ponds and lakes were appreciated for their historical value and for the variety of activities that were performed in them. In the participatory mapping research of Helmer et al. (2020), participants associated heritage with outdoor recreation places and activities, and heritage was considered as one of the benefits of conducting the recreational activities in the landscape.

Even though CICES does not include sense of place in its classification, I have considered it important to describe the connection between heritage and sense of place. It is recognised as a CES by other frameworks such as the Millenium Ecosystem Assessment (MEA) (MEA, 2005). A sense of place was recognised in the feeling of home ("Heimat") most participants agreed to attribute to pond landscapes (Fig.14). Furthermore, some participants expressed a feeling of home towards ponds (Table 2). The feeling of home ("Heimat") has been categorised as a facet of sense of place (Wartmann & Purves, 2018). In the literature, sense of place and heritage have been connected and they have been observed to influence each other (Acott & Urquhart, 2014; Dameria et al., 2020). My findings indicate sense of place and natural and

cultural heritage could be interlinked in pond landscapes. However, further research would be needed to explore how these two elements interact in the area.

5.4 Reflection on methodology

This master thesis aimed to contribute to the assessment of natural and cultural heritage as an ES. Participatory mapping was selected as the research method because it allows a bottom-up determination process of heritage.

Executing the participatory mapping through questionnaires was decided based on the language and time limitations. However, the idea of using questionnaires developed into the design of an approach to facilitate heritage participatory mapping at a bigger scale, which is difficult to achieve with other more qualitative methods, such as in-depth interviews.

The questionnaire format presents several obstacles for the research, especially, at the open-ended questions. One of the biggest observed challenges was that some participants did not pay attention to the written introduction (which was more detailed than the spoken brief introduction given to participants before starting the survey) of the survey and sometimes neither to the questions. Consequently, responses were sometimes out of topic. In an in-depth interview, it is easier to make sure the participants understand the context and aim of the research, and there is the possibility to reconduct the conversation if respondents go off-topic. Nevertheless, the questionnaire format still provided valuable data. The method could be improved by asking more specific open-ended questions. Concretely, changing “why is this landscape element important? to “How do you feel about this landscape element” or “What does doing this activity in this place mean to you?” to have more concrete responses about the modes of construction of heritage meaning. The modification of the methodology proposed by Braaksma et al. (2016) offers an option to study the drivers of heritage in the community without asking respondents excessively complex questions, which is complicated when assessing heritage. Furthermore, adding a closed-option questionnaire compliments the information from section I and II with a format that it is easier to answer by respondents. The combination of the map, open-ended questions and the questionnaire is considered successful, as the information from each part complemented the data from the other sections. For example, the points located in the map facilitated a visual representation of the spatial distribution of the social practices in the landscape (Fig. 13).

The list of landscape elements provided made the survey easier to respond. However, there was an imbalance between natural and cultural heritage elements in the list, with the aim to keep the list concise. This may have resulted in a bias towards more natural landscape elements in the research. Therefore, this bias should be taken in account.

The hotspot analysis based on the density of the points (Fig.21) matches most of the hotspots calculated with the Kernel analysis (Fig. 22). Nevertheless, uncertainties are found in this model. The high-density areas calculated by the IDW tool, do not correlate in all the cases with hotspots, pointing as hotspot areas sites that the hotspot tool had determined as non-significant. The quality of the interpolation using IDW tool can decrease if the distribution of the sampled points is uneven (Documentation QGIS 2.18, 2023). Thus, the small sample of scattered points might be the reason for the lack of precision of the IDW tool in the hotspot analysis. The Kernel density analysis (heat map) (Fig. 22), despite being a more simplified hotspot analysis, might provide more reliable results in the case of studying a small sample size of occurrence data points (points without a value associated to them).

The sample was not big enough to provide very robust conclusions. Further research with a bigger sample, for example, at the scale of the entire Biosphere Reserve Upper Lusatian Heath and Pond Landscape, will be necessary. Overall, the proposed methodology could contribute to community heritage determination at local or regional scale. This method does not provide the level of detail and depth that an interview-based method can offer. Nevertheless, this methodology could be beneficial to conduct preliminary assessments of natural and cultural heritage of a determined area.

5.5 Implications for further research

There is a common lack of information about natural and cultural heritage features in Europe, even in protected areas (European Commission, 2019). Furthermore, highly valuable cultural landscapes are undergoing changes due to the intensive means of production in rural landscapes (Plieninger et al., 2013b). Socio-cultural characteristics, such as heritage, and their physical manifestations are essential to maintain and support cultural landscapes (Geleneksel et al., 2021). My findings indicate natural and cultural heritage contributes to people establishing bonds with the landscape, which can result in a feeling of care and responsibility towards the landscape. The bonds people establish with their natural surroundings, are one of the main motivations for people to support and engage in nature conservation (Daniel et al., 2012; Schaich et al., 2010).

Pond landscapes resulted to be highly appreciated by participants and were highly associated with natural and cultural heritage. The preservation of the landscape was observed to drive the construction of heritage in the area. Local stakeholders may attach particular value to local heritage related to landscapes (Hein et al, 2006). Further assessments of natural and cultural heritage of pond landscapes might serve to enhance the involvement of local populations in the protection and conservation of pond landscapes. Bottom-up approaches such as

participatory mapping could facilitate the involvement of local populations in the determination and appreciation of their natural and cultural heritage.

Natural and cultural heritage was observed to cluster in hotspots in the landscape and it was associated with specific landscape elements. More heritage mappings are needed to uncover the spatial distribution and dynamics of heritage in the landscape. This thesis indicates natural and cultural heritage is not a matter only of academic concern. Further research should reflect this reality by including more participatory methods that allow communities to determine their own heritage resources. An interesting approach, conducted by Ducci et al. (2023) compares the mapped heritage elements and sites by respondents with the official heritage sites determined by institutions. Future landscape heritage research could benefit from this kind of approach to research the similarities and differences between the top-down and bottom-up determinations of natural and cultural heritage.

Further research on natural and cultural heritage should consider how diverse cultures experience heritage in diverse ways and towards different elements, even in the same landscape context. These considerations must be included when assessing and researching heritage to avoid simplistic representations of the perceptions and bonds people establish with their surroundings (Tengberg et al., 2012). Future research on natural and cultural heritage in Upper Lusatia could assess the differences in heritage for different cultural contexts of the region (Sorbian and German cultures).

The findings of this master thesis have demostrated the significant role that heritage plays in cultural landscapes. Including a landscape approach as suggested by Schaich et al. (2010) has had a positive effect in the assessment. Considering a landscape scale facilitated the adaptation of methodologies from the landscape research field. The research of natural and cultural heritage should be further explored within the ES field, through the application of qualitative and mixed methods approaches for their valuation.

6. Conclusion

This master thesis aimed to assess how heritage is spatially distributed in the landscape and with which specific landscape elements it is associated. Furthermore, the perception of the pond landscapes as part of natural and cultural heritage by the public was studied.

It can be concluded that heritage associations to the landscape concentrate in hotspots in the study area, concretely in three areas: “Haus der Tausend Teiche” (information centre of the biosphere reserve), the lake Olba and the ponds. The present findings indicate an association of natural and cultural heritage with various elements of the landscape. In addition, results point out participants share a strong connection with the pond landscape, which forms part of their regional identity, and it is highly associated with natural and cultural heritage.

The proposed method of participatory mapping presented limitations in terms of detail and depth in comparison to in depth interviews. The sample was not big enough to provide very robust conclusions. Nevertheless, this methodology has the potential to provide a bigger scale assessment of natural and cultural heritage than in depth interviews.

To better understand the implications of these results, research at a larger scale should be conducted using this approach. Based on these conclusions, researchers in the ES field should consider the adoption of a landscape research perspective to assess heritage services. More participatory approaches are necessary to determine natural and cultural heritage as constructed within communities.

My thesis provides deeper understanding of the heritage associations with pond landscape of Upper Lusatia and the distribution of heritage and relation to landscape elements in the study area. In addition, proposes an approach to assess natural and cultural heritage with a bigger population sample than other more time-consuming methods, such as in depth-interviews. This method could serve as preliminary assessment of natural and cultural heritage at a local or regional scale.

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8. Appendix: Questionnaire

Fragebogen zum Natur- und Kulturerbe der Teichlandschaft

Im Rahmen des BMBF geförderten Projekts *TeichLausitz – Sicherung der Biodiversität durch nachhaltig bewirtschaftete Teichlandschaften in der Lausitz*, untersuchen wir unter anderem die Bedeutung der Teichlandschaft für den Menschen. Unser Ziel ist es herauszufinden, inwieweit die Teichlandschaft zum Natur- und Kulturerbe der Oberlausitz beiträgt. Unter Natur- und Kulturerbe versteht man Elemente in der Landschaft, die in der Gegenwart von Bedeutung sind. Dies beinhaltet historische als auch nicht-historische Objekte, Landschaftselemente (Teiche, Bäume, Wiesen) sowie immaterielle (nicht-greifbare) Elemente (Erinnerungen, Erholung, Inspiration). Im Mittelpunkt unserer Untersuchungen steht der Mensch und wie dieser die Landschaft um ihn herum wahrnimmt. Daher ist Ihre Mitarbeit gefragt!

Im ersten Teil finden Sie eine Karte, welche die Guttauer Teiche und Umgebung darstellt. Diese liegen im südlichen Teil des Biosphärenreservats Oberlausitzer Heide- und Teichlandschaft, wo auch das Haus der Tausend Teiche zu finden ist. Mittels zweier Aufgaben möchten wir verorten, welchen Teil der Landschaft Sie als wichtig empfinden.

Anschließend finden Sie einen Fragenkatalog, den wir Sie bitten auszufüllen. Dieser bezieht sich auf die Bedeutung der Teichlandschaft für den Menschen.

Die Antworten werden vertraulich behandelt. Die erhobenen Daten werden ausschließlich für wissenschaftliche Zwecke verwendet und folgen keinem kommerziellem Interesse.

Allgemeiner Teil

Alter	☐ <12	☐ 13-19	☐ 20-29	☐ 30-39	☐ 40-49	☐ 50-64	☐ >64
Geschlecht					☐ W	☐ M	☐ Divers
Kommen Sie gebürtig aus der Oberlausitz?						☐ Ja	☐ Nein
Wie lange haben Sie heute hier her gebraucht?							
Wie sind Sie heute hier angereist? (Bspw. privates Auto, Bus, Fahrrad)							

Teil I

Auf der nächsten Seite sehen Sie eine Karte der Guttauer Teiche und Umgebung, welche im Biosphärenreservat Oberlausitzer Heide- und Teichlandschaft liegen.

1. Bitte setzten Sie 5 Punkte, die sie im Kontext Natur- und Kulturerbe, für relevant empfinden.

2. Bitte ordnen Sie die gesetzten Punkte den Landschaftselementen in der Tabelle zu.

Welche Landschaftselemente haben Sie markiert?	Warum halten Sie diese Elemente für relevant?	Verbinden Sie bestimmte Aktivitäten mit den Elementen?	Was ist der Grund für diese Aktivitäten?
☐ Teich			
☐ Fluss			
☐ See			
☐ Schilf			
☐ Wald			
☐ Aue			
☐ Wiese			
☐ Acker			
☐ Dünen			
☐ Sumpf			
☐ Flora und Fauna			
☐ Siedlung			
☐ Anderes:			

Teil II

Geben Sie an, in wie weit Sie den folgenden Aussagen zustimmen.

	Stimme voll und ganz zu	Stimme eher zu	Weder noch	Stimme eher nicht zu	Stimme überhaupt nicht zu

Wahrnehmung der Landschaft					
Ich finde die Teichlandschaft ist eine besonders schöne Landschaftsform.	☐	☐	☐	☐	☐
Die Teichlandschaft besteht für mich aus einem Zusammenspiel von Teichen und weiteren Landschaftselementen.	☐	☐	☐	☐	☐
Ich habe persönliche Erinnerungen, die ich mit dieser Landschaft verbinde.	☐	☐	☐	☐	☐
Mit der Teichlandschaft verbinde ich ein Gefühl von Heimat.	☐	☐	☐	☐	☐
Die Teichlandschaft trägt zur Identität der Oberlausitz bei.	☐	☐	☐	☐	☐
Geschichte und Tradition					
Ich habe ein gutes Verständnis von der Entstehung und Geschichte der Teichlandschaft in der Oberlausitz.	☐	☐	☐	☐	☐
Die Teichlandschaft in der Oberlausitz ist eine natürlich entstandene Landschaft.	☐	☐	☐	☐	☐
Ich finde, dass die Teichlandschaft es ermöglicht, traditionelle Lebensweisen auf Dauer zu erhalten.	☐	☐	☐	☐	☐
Ich teile gemeinsame Bräuche und Werte mit anderen Menschen, die einen Bezug zur Teichlandschaft haben.	☐	☐	☐	☐	☐
Wenn ich an die Teichlandschaft denke, denke ich an volkstümliche Geschichten (bspw. Wassermann oder Krabat).	☐	☐	☐	☐	☐
Für mich haben menschlich-geschaffene Bauten (bspw. Denkmäler oder Kirchen) einen höheren Wert als eine Landschaft.	☐	☐	☐	☐	☐
Teichwirtschaft					
Die Teichlandschaft kann nur durch die Bewirtschaftung der Teiche erhalten bleiben.	☐	☐	☐	☐	☐
Die Teichwirtschaft ist ausschließlich für die Produktion von Fisch wichtig.	☐	☐	☐	☐	☐

Ich esse gerne regional-produzierten Fisch wie bspw. Karpfen.	☐	☐	☐	☐	☐
Ich besuche gerne Abfischfeste.	☐	☐	☐	☐	☐
Erhalt der Teichlandschaft					
Die Oberlausitzer Teichlandschaft ist für mich eine wichtige Kulturlandschaft.	☐	☐	☐	☐	☐
Die Teichlandschaft ist für mich wegen ihrer Artenvielfalt besonders wichtig.	☐	☐	☐	☐	☐
Ich möchte, dass die Teichlandschaft langfristig erhalten bleibt.	☐	☐	☐	☐	☐
Ich möchte, dass die Teichwirtschaft langfristig erhalten bleibt.	☐	☐	☐	☐	☐
Nutzung der Teichlandschaft zu Erholungszwecken					
Ich würde in der Oberlausitzer Teichlandschaft auch mehr als einen Tag verbringen (Übernachten).	☐	☐	☐	☐	☐
Ich nutze die Landschaft gerne für Aktivitäten (z.B. Radfahren, Wandern).	☐	☐	☐	☐	☐
Wenn Sie der vorherigen Aussage zustimmen, bitte schildern Sie welche Aktivitäten Sie in der Landschaft nachgehen:					
Ich nutze die Landschaft gerne um die Natur wahrzunehmen (z.B. Beobachtung von Tieren und Vögeln, Genießen der Ruhe, Nutzung von Rundwegen oder Naturerlebnispfade.).	☐	☐	☐	☐	☐
Wenn Sie der vorherigen Aussage zustimmen, bitte schilden Sie wie Sie die Landschaft als Erholung nutzen:					