

Institutt for samfunnsvitenskap

A METHODOLOGY FOR MAPPING CO-BENEFITS OF CLIMATE ADAPTATION

Participatory GIS in consultancy

Andreea-Alexandra Florea

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Preface

Throughout the two years spent as a student in social science, I often found it difficult to link theory with practice, and the distance between the two seemed great. I undertook this study in an attempt to bring the two closer together and see how working in a multidisciplinary approach changes the traditional course of a project. Working in Rambøll as a student assistant, enabled me to carry out applied research and gain hands-on experience. The master's thesis gives me a unique opportunity to pursue my academic growth, exploring state-of-the-art methodologies and cutting-edge tools, all while contributing to the department by conducting my research in ongoing projects for existing clients.

Rambøll started as a Danish civil engineering company, which was founded back in 1945. Over time it has expanded in multiple markets, such as Buildings, Transport, Planning & Urban Design, Water, Environment & Health, Energy, and Management Consulting, and it also spread out to include professionals with diverse backgrounds. Rambøll is structured in separate business units, each made up of several divisions. Digitalization, being client-centric and sustainable solutions are strategic building blocks that define Rambøll's focus. The company is fully committed to its clients and their mission, while highly valuing its employees and the social impact. Its mission is to “create sustainable societies where people and nature flourish” (Ramboll, n.d.). Sustainable solutions have become an area for capital investment worldwide, which can be confronted with a great deal of criticism. Nonetheless, there is no clean-cut, so we need to balance the positive and the negative aspects and do our utmost with the available knowledge at that moment.

The Water division handles various infrastructure developments, in Denmark as well as abroad, with projects of all scales and private and public clients alike. My team, International Water and Climate Resilience and it is based in the headquarters, located in Copenhagen. The IW&CR team works in two big areas: IFI (clients representing international financing institutions) and masterplanning projects. It is a multicultural and diverse team, made up of twelve different nationalities, dispersed in locations across six countries, which grew from a small group of fewer than 20 individuals, to now almost 40 employees. The members bring a great variety of competencies to the table, which define the department's unique selling-points, that range from international project management, water networks, multi-disciplinary masterplan developments, climate adaptation, impact assessments, and framework management.

I was lucky to be surrounded by female professionals that I learned from, and who championed for me, so I want to take this chance to encourage other young women and female students to be more daring when considering stepping into technical fields. GIS experts Bunn-Strava and DeArmond stance in Todd's (2018) podcast episode about women working in spatial science, pointed to the fact that women participate in lower numbers in conferences and even fewer women participate as speakers. This happens because women are not as comfortable as speakers, not due to active favouritism of men. But, when one speaks up, she inspires others to do the same, building up bridges between women. And so, my thesis will hopefully prove to younger colleagues that it is possible to perform in mediums that some regard as not that inviting, and the explanation of my journey can show that it was not a dismaying experience filled with anxiety but on the contrary.

Several people supported me throughout the process, and the completion of this thesis could not have been possible without them. I want to express my sincerest gratitude to Camilla Brattland, my esteemed supervisor, who guided me with extreme patience and understanding. Thank you for providing me with insightful advice and immense knowledge as well as numerous revisions. I would particularly like to thank my past manager, Trine Stausgaard Munk, and my colleague Stine Dybkjær, the most inspiring teammates who encouraged me and contributed so thoroughly to my research. I want to acknowledge my colleagues at Rambøll and the Waterboard Limburg team for their great collaboration and for being so eager to support me. Last but not least, I would also like to thank my family and friends, especially my partner, for always being there for me and supporting my effort with technical expertise.

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1 Introduction

Many conventional planning methods have transitioned into a digital medium, responding to diverse societal trends and needs. The geographic-based digital systems have emerged as popular software to support the methods that entail mapping activities. Digital maps constitute the base of what is called ‘GIS’ (Geographical Information Systems), a key instrument in planning, that has been adopted in a multitude of fields that rely on geo-spatial data. Emerging technologies and new data structures continue to unlock the potential of transforming application areas of GIS which consequently continues to evolve with new features at a fast pace. Currently, GIS seems to be underutilized in planning. GIS is depicted as a tool used for ‘mapping’, which is not used to its maximum potential and GIS developers promise that it can bring much more value (Andrew Turner et al., 2020). Sianko and Small (2017) contended that there is a need for researchers to clear out unanswered questions about GIS-based methodologies. The opportunity lies in the openness of young practitioners to experiment, which the present thesis aspires to. By including GIS in my work, I noticed its potential for further application, and I became interested in how GIS, social research, and planning intersect. In research, planning methods are often discussed from the perspective of researchers, administrative bodies, agencies, or NGOs. But in reality, many planners work in architecture, planning offices, or engineering consultancies that are subcontracted by private or public actors. Often masterplans, are mediated by architecture and planning practices. The idea that GIS could have a better contribution to existing processes, led to a collaboration with my department in Rambøll for my thesis. My position is within the International Water and Climate Resilience (IW&CR) department., providing consultancy within infrastructure and climate adaptation, for any phase of a project in the water sector all over the world. The social networks and the social capital in large companies such as Rambøll are great opportunities for knowledge creation. My thesis was guided and supervised by the resilience lead in Rambøll, alongside the supervision I received from UiT.

Participation came to my attention a number of times in different contexts. While traditionally employed with an expert approach, lately practitioners and researchers alike have started to seek ways to engage laymen knowledge in the production of maps (Brown et al., 2020). Participation has gained much attention over the years, often in theoretical terms or in relation to public institutions, but to a smaller degree researched in corporate contexts. The notion of participation is studied on all levels, in different countries, and by a diversity of actors. Digital or non-digital, it is scrutinized nowadays with the hope of more democratic processes and outcomes. Participatory mapping arose about two decades ago (Brown et al., 2020; Rzeszewski & Kotus, 2019), along with a motley of other methods. The term refers to an activity of sharing knowledge, desires and requests

through the creation of maps, in a partnership between community groups and various stakeholders such as public authorities, private consultants, non-governmental organizations or researchers (Corbett, cited in Brown and Kyttä, 2018). The method was developed to respond to the criticism GIS faced, of being exclusivist and presenting biased depictions of space, so participatory GIS (PGIS) was to engage the larger audience in planning dilemmas. But it was also with the hope that it would improve outdated participatory dialogues that are regarded as flawed (García-Díez et al., 2020). It is very recently that the participatory GIS took another step (Brown et al., 2020; Brown & Fagerholm, 2015), and became a mode of localizing and identifying values of places. The mapping of place values puts emphasis on people's relationships with their surroundings and the benefits they obtain from the environment. This process has particularly informed environmental planning and climate adaptation, which has been reflected in the field I work in.

Cartography and the related methods have had a significant say throughout history in recording and communicating place values (Brown et al., 2020). People living in the communities we study, and change have the widest knowledge and understanding of their surroundings, and by gathering local insights we gain location-based knowledge, enabling us to spatialize information. The context of daily citizenship is generated by how and where people experience their day-to-day activities and interact with other people. Moreover, it is residents that benefit directly from maximizing the added values of capital projects. It is then natural to include their needs and wishes in the modification of their immediate landscape. Constituents are typically engaged in planning projects through project owners, regardless of their expertise in the project, or via external partners, commissioned for citizen engagement. From my perspective, contact between planners and residents often seems indirect and gets lost in translation. This research explores alternatives of bringing people, as essential stakeholders, closer to planners with the help of GIS. With digitalization and innovation, local knowledge can be considered in projects in a more streamlined approach. Citizens may feel more encouraged to get involved if they have proper guidance and the necessary tools to do so: easy to use and with user-friendly interfaces.

From laymen to researchers, there has been an ongoing debate regarding the implications of technology on society, and to what extent technology should be part of our habits or practices. GIS is typically employed by experts and has subsequently been criticized for its power. Existing processes in urban planning to integrate feedback from citizens are mostly analogue in the form of general assemblies, handing out paper forms to collect information in a pen-and-paper approach, which are highly inefficient. In this paper I investigate the benefits, limits, and areas of applicability of modern software in a planning task, to understand how our methodologies can be enhanced and how traditional methods can be complemented by digital tools. My thesis aims to have a direct

contribution to the field of practice, by bringing experiential insights to practitioners regarding the use of GIS tools for citizen engagement. Using GIS for citizen engagement is of increased relevance at the moment, not only because we transition towards a digital world, but also due to the covid-19 pandemic, which has been limiting social interaction to such a great extent, that for more than a year it has halted social gatherings across the world and slowed down the planning agendas. As a result, addressing participation in GIS proves to be an area worth investigating further, as it allows for online interaction.

My research aims to bring forth a pragmatic angle, from the perspective of a planning consultant, with GIS-based identification of co-benefits as the field of application. IPCC defined co-benefits in relation to policies, as “*the benefits from policy options implemented for various reasons at the same time*” (IPCC, 2014, p.151). However, in Rambøll, we use the term ‘co-benefit’ to refer to added values gained from the climate adaptation of landscapes. Climate adaptation refers to the steps taken to respond to climate challenges (IPCC, 2014). On a higher level, my main thesis statement concerns **the process of mapping co-benefits of climate adaptation from the perspective of a consulting team, specifically focusing on the use of participatory GIS as the central tool for engaging citizens**. The thesis is also guided by a few more concrete research questions, enumerated as follows:

- What are co-benefits of climate adaptation and how can they be mapped through participatory GIS?
- What are the necessary considerations that the consulting team needs to take in when introducing a new digital method for engaging citizens in the planning team’s workflow?
- What are the implications of embedding citizen knowledge in the development of co-benefit assessments through GIS? Both for the consulting team and for the results of the assessment?

1.1 Research contribution

In this thesis, I describe how the applicability of GIS can be extended to integrate citizen engagement and subsequently citizen knowledge. I will also estimate the implications of informing projects with subjective data collected from non-experts, with the assumption that digital engagement and spatialization of data can bring some benefits to the planning process. The high-level formulation was narrowed down to the planning task of co-benefit assessments, with a prevalence on the qualitative aspects. My research is in line with the direction Ürge-Vorsatz et al. (2014) call for, to advance the research on simplified tools that can assist co-benefit evaluation and bring innovation in this process, to support the wider application. In addition, it works towards the gap identified by Vejre et al. (2010) who point to the ambiguity surrounding the assessments of the

intangible values. Ürge-Vorsatz et al. (2014), noted that no practical methods have been established or accepted so far for this purpose. Why GIS for co-benefit assessments? Maps are seen as strong prevailing instruments that are capable of capturing people's perceptions and spatial predilections. Ryan (cited in Plieninger et al., 2013) underlies that they represent the device that assists planners in getting a rich picture of local contexts. PGIS exhibits a clear prospect of strengthening co-benefit assessments, but there have not been attempts in research to recognize a sound, proven method (Brown & Fagerholm, 2015). This thesis works towards this gap, providing an example by immersing in a concrete organizational context. It has a hands-on approach which entails developing mock-ups and testing the created GIS tools for the mapping of place values with input from citizens. **My thesis will take you through the process of developing and testing a method for citizen engagement in co-benefit assessments of climate adaptation projects.**

1.2 Reader's guide

This thesis has been a process of learning by doing. Therefore, the paper is not the conclusion of the process or a definitive statement, but a study of a particular context. I am making use of two different cases, but the focus is on the entire process of arriving at those cases and their examination, rather than on the cases themselves. The progression of the research unfolded on two fronts: the theoretical and the empirical. The theoretical angle reveals how participatory GIS and co-benefits are handled in research, as well as the perspective towards these concepts in Rambøll - the 'modus operandi'. The empirical research involved an assessment of GIS tools, as well as co-benefit methodologies, to investigate how the latter can be spatialized and digitized using the former. These two courses went hand in hand, to understand needs and opportunities for methodological innovation. While the two cases are not the pinnacle of my research, they do exemplify how the methodology can be leveraged to solve specific problems in application and speak to the importance of the setting in which you apply such a method. The two cases have different contexts, but both in a Western European setting and both Rambøll projects for climate adaptation: Sankt Annæ Plads in Copenhagen, Denmark and Hekerbeekdal, in the province of Limburg, Netherlands. The case studies consisted of engagements with their stakeholder groups, as well as a practical part, where my theoretical findings and tool assessments were put into application. The stakeholders for Sankt Annæ were represented by an internal group – climate risk & co-benefit assessments (R&CBA), while for Hekerbeekdal it was represented by the external project team.

The research is divided into 6 chapters. Chapter 1 outlined an overview of the thesis. Chapter 2 provides a theoretical framework for the development of the participatory co-benefit assessment template, which was guided by the literature on participatory GIS and co-benefits or place values. Chapter 3 addresses the theoretical considerations of the methodology, also sharing reflections on

these and on my positionality. It also explores the approach to the two cases and to the development of the new method. Chapter 4 goes on to detail the entire process and present initial results, which are more explicitly connected to the research questions in Chapter 5. The research is wrapped up, with conclusions being drawn in Chapter 6.

2 Framing the concepts

2.1 GIS and participation

The second chapter brings forth an overview of the two main notions that have informed the thesis, GIS with its participatory approach, followed by the concept of co-benefits and their assessments. It provides a theoretical framework and lays out a few links between research and practice – the consultancy perspective.

Geographical information systems (GIS) refer to a type of software that builds essentially on geographic data that is precisely localized, either generated, collected, or processed in the software via tools and spatial analysis (Ballas et al., 2018). Using maps as part of their usual routines, people gained new abilities that help enrich traditional methodologies used by planners and offer novel ways to answer urban inquiries. This helps diminish the power relationship of expert-laymen roles, which can also be enhanced by capitalizing on the highly visual nature of GIS. Overall, the social applications of GIS emerge out of combining the social data with spatial information (Ballas et al., 2018). By integrating the two, maps bring out significant correlations.

2.1.1 Introducing participatory GIS

The intersection of GIS with social science within urban planning has given rise to a new term, referred to as ‘participatory mapping’. Corbett (in Brown & Kytä, 2018) defines it as a process through which people can generate and transfer knowledge in multiple ways, having maps as the main support. These processes can be initiated or facilitated by a broad range of actors and the participants involved can also vary greatly. Participatory GIS (PGIS) has come to advance the world of maps through a number of contributions. The inclusion of citizen input in GIS was partly sought due to the ongoing criticism that beneficiaries should be more empowered to take part in planning processes (Brown & Kytä, 2018). While conventional GIS is mainly used for geo-spatial analysis and visualization, PGIS adds to that by aiding conversations between stakeholders, with the purpose of facilitating the exchange of information, decision-making and mutual learning, and can adapt to different geographies and the subsequent socio-cultural context (Aberley & Sieber, 2002; Babelon et al., 2017). PGIS expanded the target group of traditional GIS to address a far-ranging group of users and partnerships, and the open-source mentality and crowdsourcing principles also work

towards the democratization of GIS. The increased use of the internet has enabled PGIS to enter the online and enriched it through ample networks and collaboration. Brown & Fagerholm (2015) and Brown & Kyttä (2014) traced the merits of participatory GIS and crowdsourced information through their potential to nurture better-informed decisions and rich responses to challenges, that is upheld by collective knowledge. Participatory GIS is praised for its capability to attract a greater involvement than traditional applications (Kahila-Tani et.al, in Samuelsson, 2019; Jankowski et al., in Rzeszewski & Kotus, 2019), making consultations more accessible compared to traditional applications (Rzeszewski & Kotus, 2019). Rzeszewski & Kotus (2019) detail that the hope for wider engagement experts had, was due to the easy and facile access to the internet from home, and Babelon et al. (2017) also noted the flexibility the method offers, for those who were less willing to commute and take part in live interactions. However, critical GIS scholars stress that GIS can simultaneously empower and marginalize community members (Harris & Weiner, 1998, Harvey, Kwan, & Pavlovskaya, 2005, Sheppard, 1995, cited in Pánek & Glass, 2018). This view is shared by many authors, among which Brown & Kyttä (2018) or Rzeszewski & Kotus (2019). Babelon et al. (2017) emphasized the multifaceted power of GIS, as a platform that allows for people to collectively contribute to a cause, without requiring consensus. Even though PGIS reduces the need for expert knowledge, most approaches under the PGIS hypernym require expert assistance (Brown & Kyttä, 2014). This shifting nature implies that GIS can act as an attracting, or a departing force, empowering certain actors to collaborate while disempowering others through a lack of inclusion. Brown & Kyttä (2018, p. 2) summarized the conclusions from the ‘Mapping for Change International Conference’, highlighting the potential of participatory mapping method, to “(1) enhance capacity in generating, managing, and communicating spatial information; (2) stimulate innovation; and if effective, (3) encourage positive social change.” But in relation to the promotion of social goals, they point to that using GIS in marginalized communities has been criticized for unintentional effects.

A number of concepts have appeared at the intersection of GIS and participation: PGIS (Participatory GIS), PPGIS (Public Participation GIS), VGI (Volunteered Geographic Information). To provide an account of relevant research, the literature search for GIS has focused on participation, hence it was selected by using the keywords ‘PGIS’, ‘PPGIS’ and ‘PPGIS climate’ on the Ebscohost platform and ‘GIS social’ through the Royal library system in Denmark. The results were filtered to show only those relevant to climate adaptation and/or urban planning. I have selected the relevant articles from the first 10 pages of results for each keyword used, out of which I removed the ones that had no relevance. My priority and focus have been on more recent papers, due to the technological advance. The papers before 2000 were disregarded, as more recent works take into account previous experience, know-how and criticism. Even though GIS and PGIS are

newer concepts, there have been many attempts at investigating GIS, both theoretical and in practice within the field of urban planning. As a general observation, the reviewed literature tends to focus on more general effects of using PGIS methods, rather than the effects on the individual projects. Most of the time, the reviewed research papers reflect on the benefits and advantages to the users, the target group for the tool, not the team that employs this method, often looking at whether more democratic practices are enabled via PGIS. I see this as a pitfall, as it overlooks the benefits and hardships or the resources and expectations encountered by planning teams, so I am taking this opportunity to adopt an 'introspective' attitude in my research and study. The focus is on the outcome and rarely on the process, and I believe it is the former to be taken into account by consulting urban planners. The resources and time invested in such a process are always measured through its balance with the outcome to provide adequate arguments for pursuing a specific method.

2.1.2 Contextualizing PGIS

Brown & Kyttä (2014) argue that the concepts surrounding GIS and participation have vague definitions, with no clear cut between them in practice. They identified the ambiguity surrounding the notions as one of the fundamental issues. The terms are used differently depending on the context, with PGIS being primarily used in developing countries, where the focus is less on informing planning decisions, but rather on learning. The process here is driven by non-governmental organizations, while PPGIS sits at the opposite end, being led by public agencies and having a prevalence in developed areas, with more weight towards decision making. The sponsors of the process have a central role in determining the outcome of the participatory GIS. While PGIS may be socially progressive, governmental bodies can steer PPGIS according to their interests. VGI on the other hand is usually, voluntarily initiated by individuals from communities. VGI nurtured the apparition of internet-based applications and open crowdsourced maps. SoftGIS stands out between these notions, as a form of participatory mapping that focuses on the production of experiential knowledge of everyday life (Brown & Kyttä, 2018). Babelon (et al., 2017) in this regard explained that 'softGIS' is used to refer to web-based PPGIS, which raises the necessity to distinguish it from the other forms of participatory GIS as well, for a better understanding of the situational application. The notion of 'soft' is used to imply lay crowdsourced information. Brown & Kyttä's (2014) limitation in the paper, is the lack of inclusion of how planning offices or other consultants are affected by or influence the participatory GIS process. However, this drawback might be due to that in 2014 the method was not adopted to a wider extent.

Babelon (et al., 2017) paralleled the participatory GIS to a cyborg, taking into account the hybrid character that they distinguished, by coupling the factors that lead to its performance. The cyborg character defines its adaptability to a multitude of contexts and its parallel growth with societal

changes and technological advancements. Brown & Fagerholm (2015) captured the fluidity of the term participatory mapping, which refers to any mode of producing maps, that entails a crowdsourcing process of gathering geographic data. I would extend the claim to mention that researchers used the concept of PGIS to generally refer to participatory mapping, that might be later transferred to GIS or not (e.g., in Morse et al., 2020; Babelon et al., 2017), which generates confusion in regard to the extent of including any mapping software in the process. Brown & Kytta (2014) clearly distinguish PGIS, PPGIS and VGI as reliant on technology. I will refer to GIS and PGIS when discussing methods that make use of a digital medium, and ‘participatory mapping’ to refer to analogue approaches.

Data collection is incentivized by the spatialization factor, which can be collected from the internet with the help of geotags or location hashtags or collected at the source (Rzeszewski & Kotus, 2019). The rich, supplementary information can then strengthen and enable the choice of urban solutions. An additional benefit presented in the integration of lay knowledge, is the use of this data as a layer to be evaluated against other sets of spatial evidence or clustered for more complex analysis. By applying PGIS, expert knowledge can be complemented with local insights, e.g., by identifying shortcomings in the urban analysis, inquiring citizen perception on various aspects such as hazards, investigating how citizens move and perceive space. GIS analysis can overlap this information with demographic characteristics, like age, gender, economic class and more (Ballas et al., 2018; Cheung et al., 2016). Accordingly, non-expert and local-based knowledge have been acknowledged as valuable and legitimized. Rzeszewski & Kotus (2019) mention that web-based participatory mapping is easier to scale up. But standardization is a challenge, as maintained by Brown & Kytta (2014). With a broad range of- and detailed citizen input, it is onerous to standardize data and furthermore operationalize conclusions to go into a decision-making process.

2.1.3 New tools new challenges

One of the fundamental weaknesses accounted for participatory GIS in the literature is known as ‘digital divide’ (Babelon et al., 2017; Katz & Gonzalez, 2016, cited in Samuelsson, 2019) when it comes to the sampling of data and it refers to the age limits of people using digital technologies, but also people with higher education (Rzeszewski & Kotus, 2019). Brown et al. (2013, cited in Samuelsson, 2019) also highlight the fact that the group of people that have a prevalence for being engaged in these tools might not be representative for the general public and this issue has not been averted so far. Rzeszewski & Kotus (2019) explained that the digital divide might be a contextual issue, noting a mistrust in the method, which might be caused by the disapproval of authorities, while Babelon et al. (2017) highlighted that especially web-based methods can be exclusionary.

The expertise needed to develop participatory mapping platforms has decreased lately, but a limitation remains in the fact that participants need a degree of spatial literacy to be able to contribute with quality input (Brown & Kyttä, 2018). Within the urban/regional field, PGIS and participatory mapping often confront an entrenched system of local politicians, planning professionals, and development interests that may be viewed as a type of ‘iron triangle’ for urban zoning and land-use decisions. The perceived technical complexity of urban land use and zoning systems contributes to a lay/expert divide in planning knowledge wherein those with power and decision authority can be dismissive of lay knowledge and experience obtained from participatory processes. This is probably one of the reasons why there is limited adoption of participatory tools to inform decisions.

Several other issues were raised regarding participatory mapping, categorized by Brown & Kyttä (2018) on four different topics. For rural areas and small communities, building trust among actors, having a clear aim and understanding of power relationships were the main pinpointed blockades. In processes led by third parties, skepticism has been identified as a roadblock, so more effort was required, and follow-up was needed in order to build up strong relationships with the communities. Difficulties also arise when choosing appropriate incentives for participation, particularly due to a lack of control or awareness of unintentional consequences. On this track the power relationships were most prominent, inviting researchers to reflect towards inclusion, ownership of the data and the actors leading the process. In environmental projects, the main challenge observed was that agencies can exert power, limiting or enabling the projects and decision-making. They hold the power to steer projects and, in this case, clear guidelines on commitment are crucial. The track of urban planning highlighted the complexity of urban settlements, that combine distinct features in so many different ways, that a single methodology cannot be the answer to different types of urban inquiries and there’s no one size fits all. Hence my focus was narrowed down too, to a very specific planning task. An additional criticism is that these methodologies follow a top-down approach and even though it can potentially work bottom-up too, there are few to no examples in this case. Moreover, the need of expert input to create these platforms sets this issue back even more, but with technological advancement and interface improvement, the issue may be overcome over time. It is important to evaluate how these processes follow up and feed into decision-making processes, to ensure they are not just ‘box-ticking’ processes for public participation, as it often happens. Possibly because, as pointed by Rzeszewski & Kotus (2019), participation is a legal requirement in many countries. The technology category emphasized that the digital versions of the methodologies are not ‘intrinsically better’ and sometimes traditional paper-based methods need to accompany these (Brown & Kyttä, 2018). Babelon et al. (2017) observed that PGIS has been often criticized to be

usually practiced as a trial, but it was encountered less often in practice. This changed over the last years, demanding research to catch up in addressing the suite of novel apps. Following mapping activities, Rzeszewski & Kotus (2019) noticed an increase in people's willingness to engage in participatory exercises but were more inclined towards the web-based tools rather than live consultations. Another interesting finding is that their participants stated a preference for a digital mapping activity rather than a paper-based one, but also that a big number was open to only discussing verbally, without any map support. The importance of an appropriate user interface has been highlighted by Babelon et al. (2017) and Rzeszewski & Kotus (2019), the latter identifying it as the leading factor for low usability, as the editing features demand a high mental task for people who are not acknowledged with the spatial understanding and the subsequent editing features, which are abstract and less accessible than verbal language. The high demand that it implies is hinted by their demonstration of drop-out from mapping exercises and that even if people are well acquainted with navigation software such as Google Maps, generating spatial data is an arduous activity. In conclusion, the technical aspects constitute a barrier that needs to be taken into account. The variety of tools and considerations for technical aspects lead to the need of assessing GIS applications for the purpose of my study.

2.2 Co-benefit assessments

The scope of reviewing existing literature in the area of co-benefits emerged out of the need to understand how the subject is handled in research and the perspectives towards it, as I was only familiar with the way it is dealt with in practice, from how we engage with it in Rambøll. The aim was to understand how co-benefit assessments are pursued in other cases, the context in which they were performed and to understand how the process differs from the one in IW&CR, but also find contributions they can bring to Rambøll's approach. More importantly, another aim was to pin down the state-of-the-art methodology for co-benefit assessments, which was however met by significant challenges that will be described in the following. Relevant literature was difficult to pin down due to the ambiguity in terminology. The intention was to narrow down to co-benefits in climate adaptation planning projects, but the search did not return any relevant results. The papers that matched the notion of co-benefit assessment were dissimilar from the way we are working with co-benefits and in a different field of expertise, either policy or in the field of economics (e.g., Favretto et al., 2020; Rogers et al., 2009; van den Bergh, 2004). The covered literature that refers 'co-benefits' or 'added values' does not discuss consultancy perspectives and smaller scales of application. Hence, a broader investigation was necessary. Thus, I came to realize that diverse terms were being used for similar processes, which lead to a large pool of sources, difficult to narrow down as I was not familiar with the newly discovered terms. **This discovery of alternative terms**

and the possibility that co-benefits fit to a great extent with other terms, was a steppingstone in identifying actual methodologies from which I could decide a method that applies in my study. The theoretical introduction described in this section **provides the framework for developing the GIS-based co-benefit assessment template.**

Brown et al. (2020, p. 2) define place values as ‘relationship values’, which constitute “*an operational bridge between held and assigned values*”. The relationship values stress the importance of a specific value to people against the intrinsic value of an object e.g., the preferences communities express: residents’ stand points for land-use, the diversity of which naturally leads to land-use conflicts. This is due to their correlation with the physical landscape characteristics. Held values reflect the personal preferences of an individual, while assigned values indicate the characteristics that stand out in a place relative to other places as a personal cognitive choice. However, these distinctions of relationship values, they argue, are only relevant in research and do not have a practical consequence. The relationship values can naturally lead to opposing views, and eventually to disagreements, that have to be dealt with in the public arena. But what the operational bridge in the relationship values does, is bring to light people’s attachment to places, which can hint towards possible conflict. The processing of place value results and the subsequent decision making should take into account the spatial discounting, as positive values have the power of attracting people, while clusters of elements that people perceive negatively will keep people at a distance from the analysed location (Brown et al., 2020). Brown et al. (2020) indicated a historical absence in decision making regarding the ‘sense of place’ concept, probably due to the position decision-makers adopt in front of this kind of data, which has often been seen as irrelevant.

De Vreese et al. (2016) also noted the potential of mapping to demarcate conflict zones, but also that participatory mapping can emphasize cold spots, areas where the variable in question is lower and it is then favorable for mitigating conflict and delivering solutions with a mutual gain. Data collection is incentivized by the spatialization factor, which can be collected from the internet with the help of geotags or location hashtags or collected at the source (Rzeszewski & Kotus, 2019). The rich, supplementary information can then strengthen and enable the choice of urban solutions. An additional benefit presented in the integration of lay knowledge, is the use of this data as a layer to be evaluated against other sets of spatial evidence or clustered for more complex analysis. By applying PGIS, expert knowledge can be complemented with local insights, e.g., by identifying shortcomings in the urban analysis, inquiring citizen perception on various aspects such as hazards, investigating how citizens move and perceive space. GIS analysis can overlap this information with demographic characteristics, like age, gender, economic class and more (Ballas et al., 2018; Cheung et al., 2016). Accordingly, non-expert and local-based knowledge have been acknowledged as

valuable and legitimized. Rzeszewski & Kotus (2019) mention that web-based participatory mapping is easier to scale up. But standardization is a challenge, as maintained by Brown & Kyttä (2014). With a broad range of- and detailed citizen input, it is onerous to standardize data and furthermore operationalize conclusions to go into a decision-making process.

Added values, secondary aims, co-benefits, ecosystem services, represent a lot of different terms, but the underlying processes the studies described when discussing these terms appeared to be similar. But a notable distinction stemmed from comparing the contexts in which the terms are used, which contributed significantly to answering my main research question. **Added values and co-benefits invoke a change (e.g., effects of a policy or a landscape intervention), while ecosystem services or landscape values usually examine environments that are stable in time.** This makes the difference about the variability of the landscape, about **alteration vs constancy**. The characteristics of each term are not well understood from the way researchers and practitioners engage with them, nor do they describe what they entail. In their cutting-edge paper of 2020, Brown et al. have brought a major advance in this topic, outlining an in-depth review of the terms, **in the context of mapping**. The review has been of great value to inform the thesis as it shed light on the confusion generated by existing literature. The thorough analysis and explanation of terminology provided by them is very comprehensive and seems well-founded, judging by the amount of empirical evidence used, combined with the historic evolution of the terminology. The values reflected by all the terms, incorporate both material and immaterial aspects that beneficiaries might hold, and can describe use values that generate a substantial or physical benefit, as well as immaterial values, such as the spiritual importance of places. Even though generally speaking values are linked to physical landscape features, more abstract values do not always have a direct link to an apparent object (Brown et al., 2020). The terminology around place values has been continuously shifting. The mapping of place values started with the mapping of values people assigned to forests, values that were integrated into a typology, which later became the 'landscape values' typology, due to its application to most landscapes. This has been the most popular term, but other variations arose, such as 'social', 'environmental', 'community values' (Brown et al., 2020, p. 2). The Millennium Ecosystem Assessment (MEA) publication has been referenced in multiple methods I identified in the literature (Plieninger et al., 2013; Morse et al., 2020) and it has been acknowledged by Brown et al. (2020) as a turning point in the terminology.

Due to the growing discussion around the services that ecosystems provide to people and the fact that these values are benefits we have from the ecosystem, the term transitioned towards 'social values for ecosystem services'. Part of the larger 'Ecosystem services' typology, 'cultural services' were included, to refer to values like beauty, recreation, or identity. It has been recognized that the

'social values' match the 'cultural services' category. Ever since, all the terms have been used according to the different discourses or fields of research. Though Sieber & Pons (2015) have not explicitly made a link between place values and ecosystem services, their way of engaging with the terms works towards this view, understanding cities as a "*global network of ecosystems*" (Bolund and Humhammar, 1999, cited in Sieber & Pons, 2015, p. 53) and share the same interpretation with MEA of the related services as "*benefits people obtain from ecosystems*" (Reid et al., 2005, p. 137; Reid et al., 2005 as cited in Sieber & Pons, 2015, p. 54). Brown et al. (2020) seemed to have overlooked the terms 'co-benefits', 'added values', 'secondary or multiple objectives in planning', while Sieber & Pons (2015) alluded to the concept of benefits but did not capitalize on it to provide explanation of the relationship between the terms. A distinction must be made here, since **co-benefits are always used in relation to a planning project, while ecosystem services assessments can be employed regardless of an existing initiative taking place or not.** More precisely, the co-benefits refer to those values that the planning project would add or enhance. Even so, I would assert that the characteristics of co-benefits match the ones described by Brown et al. (2020) for place values.

The ambiguity in terminology extends to the area of co-benefits and it has been captured by Ürge-Vorsatz et al. (2014) who scrutinized and compared the terms. Their review of terms seems to be well-founded and carefully examined, given their ability to capture the wide spectrum of terms and how different actors used them in practice. The study is aimed at climate aspects and discusses the terms in relation to policy, which give the concepts a different outlook as opposed to consultancy, where projects play out in the physical space. Both climate adaptation plans, and policies have proved throughout time that they have multiple effects, besides the climate impact. Their demonstrated consequences contribute to welfare in general, ranging from social, health, economic improvements, as well as positive augmentations of other ecosystem aspects than the targeted ones. Accounting for all these secondary effects, has sometimes outweighed the benefits of the primary objectives. The worth of the secondary benefits often results in a greater commitment to adaptation, as the high investment costs are balanced by multiple gains for the community on various levels. These can be assessed, then monetized and compared with the implementation cost, which can make an adaptation plan more palpable and easier to support in front of taxpayers or the other beneficiaries that bear the costs. The targeted effects of adaptation measures are often projected over decades, even over multiple generations. The primary effect of the mitigation action is felt at multiple scales, but co-benefits are affecting local or regional scales, argue Ürge-Vorsatz et al. (2014). Thus, co-benefits have a more immediate contribution, both in terms of time and scale. It is then only natural that government agencies, political bodies to be concerned more with the short-term gains and target tributary objectives. Ürge-Vorsatz et al. (2014) have categorized the numerous

terms with overlapping definitions used for the secondary benefits of climate adaptations (Figure 1). Their categorization is considering the nature of the effect (positive or negative) and the degree of purposefulness (intentionality).

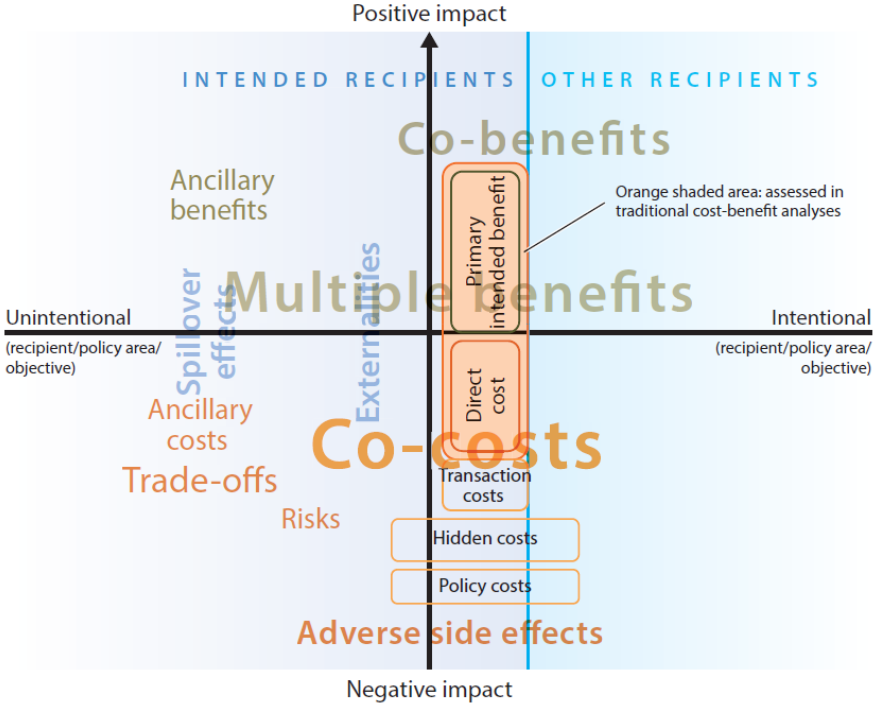


Figure 1 Categorization of terms connected to co-benefits. Source: Ürge-Vorsatz et al., 2014

The other terms in the figure refer to the broad variety of secondary effects, indirect expenses, and benefits. Co-benefits, as defined by IPCC (Intergovernmental Panel on Climate Change) imply a degree of intentionality for simultaneous effects, while ancillary benefits on the other hand are considered to be a side effect. However, it is acknowledged that not all studies communicate a distinction between the two. Non-climate benefits, non-energy benefits and spillover effects are other variations for co-benefits, but the latter focuses on the low intentionality. There are also several terms for the negative unintentional effects, and they also have overlapping definitions: “costs, ancillary impacts, co-costs, adverse side effects, risks, externalities and trade-offs” (Ürge-Vorsatz et al., 2014, p. 556). Noteworthy is that co-impacts, positive or not, are context-dependent and local circumstances dictate the type and scale of the impact. Ürge-Vorsatz et al. (2014)'s account of terminology, omits however alternative terms that are used for co-benefits in consultancy, being added values or multiple objectives, which in consultancy are used synonymously. **Due to the acknowledged ambiguity, in my thesis, co-benefits refer to a specific form of place values, as the added values provided by a climate adaptation project, which has a primary purpose of risk reduction.**

2.2.1 Perspectives on place values assessments

There is consensus among a few authors (Favretto et al., 2020; Ürge-Vorsatz et al., 2014) that co-benefit assessments rarely enter quantifications, or that little evidence exists in research (Fung & Helgeson, 2017). However, Garbarino & Holland (2009), Rogers et al. (2009), van den Bergh (2004) have been found to have opposing views, criticizing the quantitative focus and expressing rather a necessity of qualitative approaches. Van den Bergh (2004) raises fundamental problems linked to quantitative assessments, with a view from the field of economics, demanding empirical analysis with a qualitative dimension and working with concrete cases. However, the way planners understand the qualitative in social sciences is different to van den Bergh's notion of qualitative, which still implies calculations of sorts. But that does not disregard the criticism that cost-benefit practices are lacking qualitative evaluations, supporting the necessity of more situational data. Garbarino & Holland (2009, p. 1) share criticism along the same lines, stating that "*qualitative research plays 'second fiddle'*" to conventional empiricist investigation. Garbarino & Holland (2009) discuss the evaluation of project impacts through quantitative and qualitative methods, from the perspective of a development agency. They stress that studies diving deep into the context of places should not be secondary, but they should assume a bigger role. Practitioners have the tendency of making what they call "*interpretative leaps*" (Garbarino & Holland, 2009, p. 11), focusing on only what is measurable, only due to the fact that those are the things that are tangible, so they feel more real than the others. De Vreese et al. (2016) also noted that it is common practice to focus on specific ecosystem services, omitting others. These remarks are similar to Brown and Kyttä's (2018), who identified that subjective information is considered a threat to projects that might even attract legal consequences, as well as public exposure. Garbarino & Holland (2009), van den Bergh (2004), Sowińska-Świerkosz et al. (2020) suggest that combining qualitative and quantitative would provide more accurate results (see Appendix 2).

Putting a value on the entire biosphere presumes that monetary value can substitute climate change and that it can restore stability (van den Bergh, 2004) and common sense can tell us that there is a whole variety of values deriving from climate stability, besides financial ones, which can be non-quantifiable, such as experiential knowledge. Several authors argued that not each urban intervention can be quantified and monetized (Fung & Helgeson, 2017; Pascual et al., 2017; Rogers et al., 2009; van den Bergh, 2004) and demanded that softer aspects are evaluated in a different, appropriate form, even though there are obvious challenges in distinguishing and measuring them. From a slightly different perspective Plieninger et al. (2013) share the same views, highlighting the non-monetary value of soft services provided by the ecosystem. They state that unlike provisioning and regulating services, cultural services are irreplaceable, giving water as an example - drinking

water from a polluted well can be replaced by bottled water (Plieninger et al., 2013, p. 118). De Groot et al. (2010, cited in Brown & Fagerholm, 2015) support this statement, making a similar point demonstrating that cultural services are connected to people's well-being, which they directly mirror. To take the issue of valuation further, other studies (Garbarino & Holland, 2009; Plieninger et al., 2013; Scholte et al., 2015; Sieber & Pons, 2015) underline that not all indicators are given the same weight in assessments, even though they have a fundamental role in people's experience of space. The difficulties in evaluating softer aspects of spaces are a determinant in emphasizing them and Sowińska-Świerkosz et al. (2020, p. 3) substantiate this argument, contending that leaving out intangible values would neglect "*aspects that are crucial for social coherence, such as a sense of belonging and local tradition*". Plieninger et al. (2013) and Garbarino & Holland (2009) share the same view that these challenges have a methodological nature, hence my methodology aims to give more justice to the intangible services. Garbarino & Holland (2009) suggested indicators should be augmented by narratives when values are not measurable. All in all, immaterial benefits tend to be overlooked in practice, even though bodies like IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) raised the importance of nature's immaterial values, associated with our relationships with nature (Pascual et al., 2017).

2.2.2 Delineating place values

How does one establish what sort of values a place carries? My investigation started from the premise that acknowledged methods or specific guidelines must exist, otherwise the outcome is subject to inaccuracies. Conversely, the vast majority of the studies I reviewed on co-benefits have dealt with the valuation of benefits, while what I was attempting to seek was the identification. Usually, the articles do not focus on the methods themselves, but on describing the outcome of a project, so the methods are described succinctly. It is therefore challenging to appreciate what happened exactly in the contexts where they were used and find out all the details regarding how they adopted them. Sometimes, the benefits are being assessed under the cost-benefit analysis (CBA) procedure or pinpointed in a separate process that is not described in detail. The valuation aspect (CBA) gained a lot of attention and it is investigated across different disciplines, from planning to financial. Naturally, CBAs have been scrutinized because they are often central in backing urban investments, as they enact the consequences of the solutions to be implemented. Several disciplines discuss the topic of co-benefit and cost-benefit, but often the scale of the projects discussed is at city, regional or country level, as the debates are usually in relation to policies or greenhouse gas emissions and less often on palpable climate adaptation projects (Favretto et al., 2020; Rogers et al., 2009; van den Bergh, 2004). This made it particularly challenging to link the methodologies to my context, which deals with smaller sites. It is also imperative to distinguish that

the IW&CR department conducts the evaluation of **potential benefits**, that is prior to project implementation, not as impact assessments. The specific timing aspect is often not explicitly clarified and discussed in the literature.

With these challenges in mind, Brown et al. (2020)'s article and the review by Ürge-Vorsatz et al. (2014) were fundamental in building up my method and setting the base for my intervention. Ürge-Vorsatz et al. (2014) suggested a framework for the identification of benefits and impacts of planning projects. Their taxonomy was crucial in helping me confirm my assumption, that co-benefits are a particular type of place values, and the methodologies for assessments used alike, as most of the indicators suggested by Ürge-Vorsatz et al. (2014) and Brown et al. (2020) overlapped. The values that did not coincide, do not affect this exchange of methodology, as they **do not refer to benefits from physical spaces**, as opposed to this research. The important distinction between co-benefits or added values and other forms of place values such as ES, was noticed by Brown et al. (2020), who observed that **indicated place values are usually stable in time**. Even though the taxonomy proposed by Ürge-Vorsatz et al. (2014) is similar to the typologies for mapping place values, it is built specifically for energy policies, therefore it cannot be fully replicated for climate adaptation of physical landscapes (see Appendix 3). Since we work with landscape, the co-benefits in this particular context refer to services people get from the **modified** ecosystem. In the following, I will investigate this hypothesis through two case studies, one from a modified ecosystem in Copenhagen and one to be developed for climate adaptation purposes, in Limburg, Netherlands. The distinction between the two cases is the phase of the project they are situated in. This has consequences on what co-benefits represent for that specific stage. This will be elaborated on in section 5.1.

3 Methodology

3.1 The process towards testing a method

This chapter will provide an overview of the framework for data collection and analysis, and it will outline the approach to the method development. The study engages with a variety of methods, that are employed under an overarching frame, based on the action research model. The supporting methods are ethnography in my own organization, and targeted case studies of two landscapes subject to climate adaptation measures. Within the case studies, I used online geosurveys as starting points for the PGIS method that I developed for the cases. I employed workshops as a method for collaborative action research in my own organization. For the literature review I used a structured review approach in combination with a snowball approach, identifying relevant research based on papers I examined. The approach has also been touched upon in Section 2.1.1 and 2.2.

3.1.1 Action Research

Action research, which will be referred to as AR, is a methodology that gained popularity in the Nordics and it has been tried out in different environments, such as educational or commercial organizations, in Denmark, Norway, Sweden. An overarching concept, AR defines research methods that imply having a hands-on approach, while the comprehension and observations about the action being undertaken generate knowledge (Coghlan & Brannick, 2005). This is a rather different research practice, as the object of study is not distanced from the researcher but assumes an active role. This is because the researcher engages directly with the subject, both the conceptual subject and the members that are involved, who produce knowledge alongside the researcher. This naturally leads to a process of planning and taking action that generally applies to AR. The majority of the subjects studied in research reverberate in real-life applications, which unsurprisingly leads to a wide spectrum of AR approaches. By doing research in my own organization, the conveyed reality is a contextual field of information, determined by placement in Rambøll and should be understood through its frame of reference. So, the knowledge is situational, produced by my interactions with colleagues, building up on our views and understandings. Subjectivity is consequently implicit.

AR is a double fronted approach that contributes positively to the participating members as they gain new competencies, as well as to the organization through the innovation they spark, and to the scientific body with the new knowledge that is created. Coghlan & Brannick (2005, p. 4) define AR as “research in action, rather than research about action“. It investigates a problem with the people that experience it directly. AR is also “*both a sequence of events and an approach to problem-solving*” (Coghlan & Brannick, 2005, p. 4), in that it tries to tackle practical matters via experimentation, and it does that through iterations of data collection and application. However, my iterations, revolve more between diagnosis, theory, and planning. AR proved to be the natural choice for this pursuit. For me this entails a single cycle of action, constituted by the diagnosis (shaping my research interest and exploring the exact field of opportunity), theoretical grounds, testing, applying and then evaluating (Figure 2). This cycle is somewhat different than the cycle described by Coghlan and Brannick (2005), as the diagnosis is represented by an area for improvement that I identified alone and that taking action for me is divided into two major steps: testing and applying. The learning outcome will provide grounds for further action, outside the scope of the dissertation. Through my dissertation, I am contributing to the identified gaps of co-benefit assessments in the field of PGIS as well as trying to find practical answers to my inquiry. My proposal for innovation acts separately from the current undertakings in the office team.

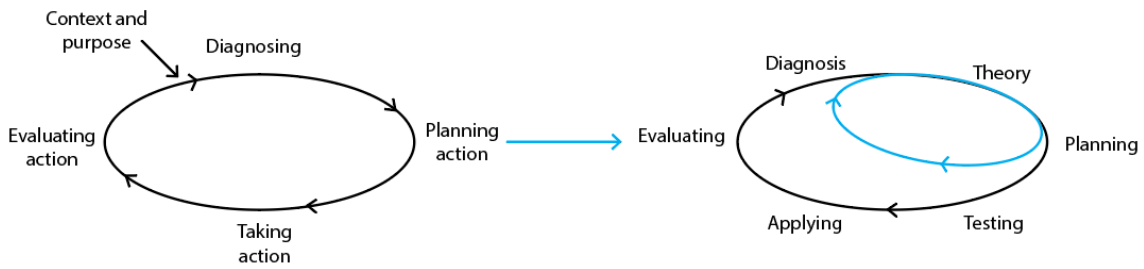


Figure 2 Adapting the action research cycle from Coghlan & Brannick (2005)

My AR takes the form of action learning, since I learn as I go and try to bring learning outcomes that are useful for the organization, to the tasks of the IW&CR department. The action learning is based on Revans' principles (Coghlan & Brannick, 2005, p. 15) that “‘There can be no learning without action and no action without learning’ and ‘Those unable to change themselves cannot change what goes on around them’”. AR will produce for me both experiential and practical knowledge. Coghlan and Brannick (2005) argue that the learning vehicle is triggered by engaging in action followed by reflection. Therefore, personal reflections accompany the various stages of my study. Following my supervisor’s advice, I was accompanied by a journal during the entire process, which helped me develop reflections, about my reasoning and courses of action. This way the process of the research does not follow the traditional timeline where during analysis the researcher tries to detach himself/herself from the studied object. In my work, this happens throughout the entire period, because the analysis and observation steps are not singular, but repetitive, in cycles that correspond to the activities of the research (Mikhaylov, 2017).

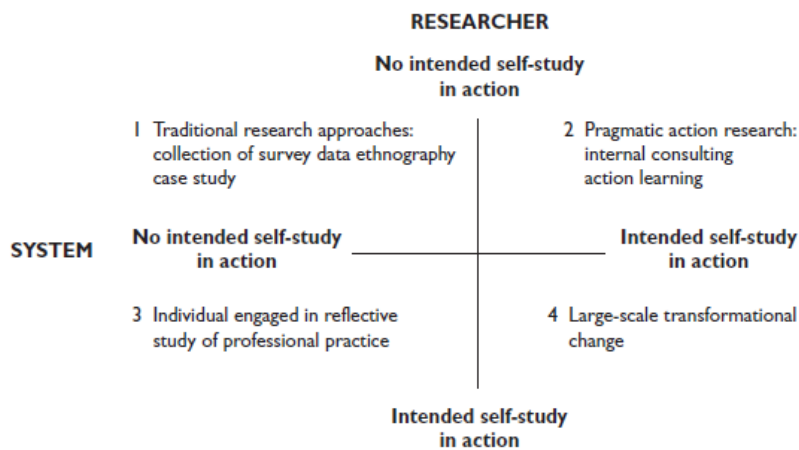


Figure 3 Researcher's focus. Source: Coghlan & Brannick (2005)

Coghlan and Brannick (2005) suggest distinguishing the intention of the researcher between the company’s pursuits and how these two interact. My role identifies with what Coghlan and Brannick (2005) label as “*reflective practitioner*” in quadrant 3 from Figure 3. (Schon, cited in Coghlan &

Brannick, 2005, p. 52), a researcher that starts a study that the system is not pursuing, and that emerges out of his/her own assumptions and the desire to improve practice. Even though the thesis tasks are similar to the department's assignments, they are outside any exact same task. This way, the boundaries of my role are clearly set, since I had a clear goal determined by my personal interest. Coghlan and Brannick (2005) refer to the existing knowledge the researcher has from the organization as preunderstanding, that includes both overt and implicit knowledge. This type of knowledge refers to the one you gain through the daily experiences you live in your culture, behind the curtains so to speak, that is not part of the formal image of the company presents itself with. Normally in ethnographies researchers are expected to immerse themselves in the new culture starting from scratch, without any preconceived images, in order to minimize bias and distinguish between the two roles (Mikhaylov, 2017). However, in AR the preunderstanding is seen as a requirement, as it offers a better picture of the context in its complexity (Coghlan & Brannick, 2005). The preunderstanding of the enterprise's ideology and culture aided me in keeping clearer distinctions between my role as a researcher and my role in the department. Access is usually problematic in AR or in ethnographies in general (Coghlan & Brannick, 2005), but has not been a problem for me, as I was not restricted in any way from any type of material that I needed. Since the process was driven by my own ambition and I formulated the scope myself, there was no issue of power relationships in terms of what and who drives my project. I felt that I was in charge, and I could decide my own direction without any hindrance, because I identified the stakeholders and I decided who had a say. I did not receive any financial support for the thesis from the company, so this put less stress on what I must prove to the company and what they expect from that. My study was overall guided by Mikhaylov's lessons (2017) for researchers who conduct studies in their own organizations.

3.1.2 Participant observation

As a co-worker in Rambøll, conducting participant observation is implicit, as I am involved in both company's activities, but also the daily routines of the department. This implies that the approach I have in my fieldwork is as a participant, and the degree of my participation as a researcher is complete, in a closed setting, which is the Rambøll Headquarters, in Copenhagen. Unlike other ethnographies, access was not an issue for me, on the contrary, my colleagues welcomed the idea of conducting a thesis with the department. Persistence was needed instead to connect the thesis to a project and to keep conversations going. My role is overt, as my colleagues are well-familiarized with my thesis and for those who were not, I made sure to make my position clear, as I did not have any interest in having a disguised position. As I was already part of the team for one year when I started the dissertation, people knew me relatively well and trusted me. The major challenge that is

difficult to overcome in my position, is to be explicit in what I write regarding the tacit aspects of our work and the risk that my positionality will obscure facets that we take for granted. Coronavirus was also a limitation in my fieldwork, as the micro-ethnography cannot be explored to the fullest and the sensorial experience will be limited, since interactions were mostly digital. In this context, subtle messages and people's attitudes are hard to read. Though other senses would not be a priority, the visual and audio are critical in understanding people's positions. This situation, however, makes it easier for me as a researcher to have liberty in taking notes, as there's no risk in people feeling their privacy is intruded if I write down comments at times that might feel odd for any reason. In addition, travelling is not allowed, so I could not visit the Netherlands, to be more familiarized with the case's setting and community.

Bryman (2012) argues that participant observation and ethnography are hard to distinguish from each other. The terms have been used to refer to the same method, and that it was just a matter of change in terminology over time that one was preferred instead of the other. He contends recommendations for this method cannot be generalized, because what happens on the field is not under one's control and situations are different, depending on timing, location and informants. Therefore, I prioritized on elaborating my process. Both terms entail that the researcher is immersed in a specific setting for a longer period of time, looking at factors that are of interest in the research: behaviour, conversations, traditions, mindsets etc. Bryman (2012) suggests that it might be because some researchers see 'participant observation' as solely an activity of observation, even though that is not accurate in practice. While 'participant observation' emphasizes 'observation', ethnography says Bryman (2012), may implicitly refer to the produced output of the research, which describes in-depth experiences and contexts of a certain phenomenon lived by a group. The challenge is in defining what I am actually doing, since my research process seems to be in between. While I am not only observing, because I am also aware of the context, being fully engaged in the setting and active in conversations, I am also not trying to get an understanding of the culture I am immersed in and to develop a study of the members. Moreover, observing behaviour is not my focus. Observation in my case is an activity that could influence how I interpret people's replies. What I had done is that I developed an understanding of a process and its circumstance to find out whether it can be improved, how, for whom, to what extent and what that would entail. My observations have consciously focused on the verbal information, and on understanding terms and facts about GIS or co-benefits, so behaviour or non-verbal communication came second. This is notable because the researcher cannot observe everything during a conversation or a workshop, when there is no time for reflection. In terms of the choice of participants and cases I selected, I used what is regarded as purposive or purposeful sampling. This sampling technique refers to an intentional selection of members, circumstances, that have the strength of producing rich outputs (Palinkas et

al., 2015). The choice reflected my own judgement as to what I considered worth and appropriate for my interest, but also what was manageable given my constraints.

3.1.3 Case studies

The case study is a research approach that examines a particular case exhaustively, in its complexity and circumstances. Alan Bryman, renowned for his literature on research methods, provided explanations on how case studies should be distinguished. He argued the term ‘case study’ should be used when the cases are themselves the focus of the research, unlike the situations when the case *“is a backdrop to the findings than a focus of interest in its own right”* (Bryman, 2012, p. 68). Accordingly, my study brings case-study evidence, as my cases are only used to exemplify the application of my methodology, as fields of application for my GIS inquiry. It was salient in my research to accumulate context-dependent knowledge in an area that has not been explored considerably. Since I am proposing a method in an incipient phase, the role of the case study is to bring evidence on how the social activity plays out in this circumstance, and show observations on an initial example, that can then guide future research in this area and form a basis for more extensive case studies. The disadvantage of my research is that it cannot be generalized, since I am not using extreme or critical cases, as recommended to enhance generalizability (Flyvbjerg, 2006). However, the advantage is that my cases offer variation in the Western European contexts (two different circumstances, the size of the samples, the organization: rural vs urban area, density, type of population, motivation for participation), so they discuss the significance of these factors in the outcome of the process.

3.2 Doing research on your own organization – reflections to the double position

AR tends to bring change not only through the outcome of the research and the methodology, but by challenging the traditional ways of producing knowledge, regarding the planning researchers as ‘agents of change’ (Coghlan and Brannick, 2005). AR recognizes the complexity of projects situated in an organization and for this reason, it is essential to portray my positionality in Rambøll and the context in which the office operates. The IW&CR team puts special attention to the role water plays in cities and nature, a precious resource, which is the main driving factor in most projects in a nature-based approach. The consultancy addresses concerns surrounding climate change, resilience and sustainability, targeting to integrate sustainability goals as well as digitalization and innovation. What stands out in this team is the authentic multi-disciplinarity. Students in the team are encouraged to be their own leaders and are supported in being decision-makers. My background enabled me to assist in many areas from visuals to GIS, in any stage of a project cycle. Interns and

student assistants bring innovation of all kinds in the department, which is welcomed by the other colleagues.

Coghlan and Brannick (2005) and Mikhaylov (2017) highlight the importance of understanding the role of the researcher as a member in the organization. Researchers immersed in organizations, are bound to experience conflictual roles, which might intersect or trigger internal struggles. While conducting my research I did not have many overlapping tasks which helped remove much of the bias and allowed me to be fully immersed in the researcher role. However, the challenges arose due to the process of submitting proposals for thesis collaborations. There is no established process in this sense, so proposals need to be negotiated with the stakeholders of the projects. One major challenge in establishing a connection with an existing project within IW&CR has been, contrary to my expectations, the project opportunities. The difficulty in managing the opportunities is firstly the timing. Preparations must be done in advance so that a first draft of the proposal can be presented to colleagues. Naturally, it is challenging to project a broad image of the proposal when the research is in an initial stage, and if it moves forward, a plan must be laid out and approved by all parties before the actual process commences. Multiple proposals must be kept in balance until one is set in stone, while also pushing the research itself forward. This means keeping in touch, having conversations and at the same time reviewing documentation to establish whether the project and the research interest are a match. To make the connection to any project, the research interest must be broad enough so that it can be adapted to the project's context. In short, the AR process of the thesis became a negotiation between me and myself or myself and others, a continuous construction.

Bryman (2012) mentions the risk of 'going native' when conducting ethnographies, in which your two roles blend into one and cannot distinguish between them anymore, almost like an ultimate bias, where you become one and identify with your object. Despite that I clearly am 'native', I have tried to reduce the shortcomings of this situation by making myself aware of my double position from the very beginning. Understandably so, when conducting research in your own organization, nativity cannot be completely overcome. What also helped to get the better of this situation, was that even though I connected the research to existing projects, my contribution acts as an extension to the project. Since there was no overlap between the team's assignment and my task as a researcher, I could clearly distinguish between the two. My double position poses the risk that some learnings do not come as explicit, as they felt predictable or were taken for granted. Even though my task as a researcher and my task as a student assistant rarely overlapped, distancing myself from the tasks was still thought-provoking. Being part of the team understandably gives the researcher a certain bias. I would more likely say that my roles complemented themselves rather than conflicted,

because what I studied is useful learning point for me daily and in my development as a professional.

3.3 Ethical considerations

There have been a number of ethical dilemmas that I took into account. Since AR is a method conducted in the context of authentic relationships, ethical considerations need to be highlighted. Possible invasion of privacy, deception or conflict of interest have been assessed both by my supervisor and by my manager at Rambøll who was asked to provide feedback in this sense. Any information that might cause harm of any kind was excluded from the research. People who participated in my research did so voluntarily, with no conditions. The research does not engage with vulnerable groups or sensitive topics. Moreover, my thesis project was assessed by the Norwegian Centre for Research Data (NSD) on data management and protection. NSD assessed the type of information used in the paper and the way it is processed, the use of personal information and also the characteristics of the samples involved in my research. NSD offers guidance in complying with the data protection regulations before authorizing the project.

The power that lies in digital tools and information in this context is in the access and inclusion. People who don't have 'digital abilities' or the means to gain access and understand the maps and the tools can be marginalized in this process if they are not provided with solutions in this sense. Inequality has a spatial dimension (Rambaldi et al., 2006) and it is thus reflected in the digital medium as well. It is then critical to reflect upon the medium that is chosen for the exercise (online, live drawing, 3D model building), as mentioned by Rambaldi et al. (2006), but I would add to that the need to understand that of the geographical context and culture one works in. My assumption is that by being part of a western European context, people are familiar with technology and have no issues in dealing with a digital-only exercise. I avoided raising false expectations by clarifying my purpose, but that also had repercussions in the sense that people were not as willing to participate. The fact that I conducted the exercises in partnership with Rambøll and WL, might have determined people to associate my project with politics, due to the association with WL, and have consequences that I am not aware of. It is the stakeholders of the two cases that have access to the data and that will also continue to own the data for a better understanding of the project and for establishing rounds of future projects.

My inquiries for my research are not bound to produce any harm to my colleagues, as the scope is out of the offices' current tasks, so there is limited potential conflict. There is no effect on the courses of the projects studied. The potential danger I see is in people considering it a waste of time to spend time on this task. But thesis projects have been carried out before at Rambøll, so it is

viewed as normal to spend some time assisting students in their projects. And for the case in Sankt Anne, the existence of an established GTN is allowing people to spend time on this task. Coghlan and Brannick (2005) mention the importance of paying attention to how the research might affect the business as usual in the organization. My research concerning the possible improvement of an existing process does not affect the usual course of the use of GIS and co-benefit assessments as they are now and moreover, there are no other projects that conduct citizen engagement in our department at the moment. As Coghlan and Brannick (2005) also advise, to always keep your colleagues updated regarding your 'external project'. Throughout the process, I kept my manager and my closest colleague informed about what I was doing. I am not using documentation that was produced for other projects for my thesis, other than to inform myself on existing processes, that is to say that I did not discuss them nor analysed them in the paper.

3.4 Process

AR investigates a problem with the people that experience it, relying on democratic partnerships, as the subjects collaborate in their path to bringing change (Coghlan & Brannick, 2005). Thus, it is important that any inclusion of data is negotiated between the researcher and the participants. Firstly, my colleagues have been informed regarding my pursuit to collaborate with the office during informal conversations. When the thesis project concretized, participants have been updated about the proceedings. All the participants have been informed early on of the way data is being processed, during workshops or meetings that were organized for the research. This was afterward elaborated through a notification letter and those who denied taking part or did not respond to my inquiry have been excluded. To ensure that the way of processing information is clear and that it is not being forgotten, the letter was sent via e-mail. For privacy purposes, I anonymized the names of all persons involved, using code names. No personal or sensitive information has been collected and no record could establish the link between the names and the code names.

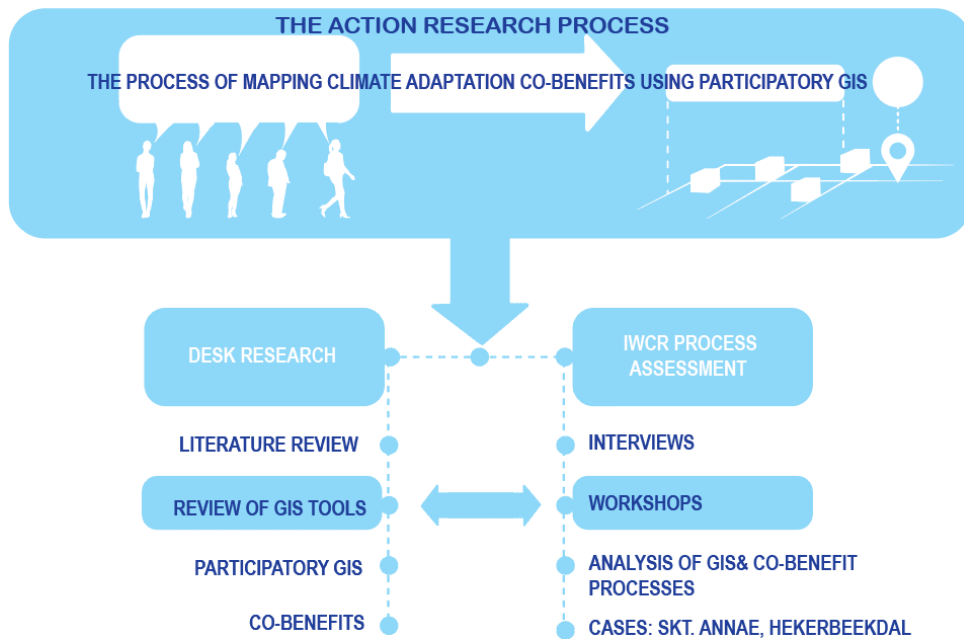


Figure 4 The action research process carried out in IW&CR. Own figure

The initial stage of the study has been divided between desk research carried out by myself, and the interactive part of AR - informal conversations and a workshop with colleagues, that guided my overall journey (Figure 4). A few informants were part of my exploratory conversations and workshop: Andrew – social scientist, Signe- environmental engineer, Thea- lead in resilience and geographer, Fatimah- urban planner and environmental consultant. Through the conversations, I identified potential projects that matched my research ambition, as well as gathered opinions on existing tools, processes, and the possible areas for improvement. These exploratory discussions were spontaneous in nature, completely unstructured and arose either when I found an opportunity or when I had various curiosities. In parallel, I have been getting familiar with the existing literature on participatory GIS and co-benefit assessments, to make connections with the internal processes. After the literature review, an important step was the review of GIS tools that could be fit for the purpose, using various criteria, either identified from literature or established by me, exploring them and finally creating mock-ups to be presented to the stakeholders from the two cases. In the second stage, the approach of my investigation continued to progress on two separate pathways, corresponding to each case. Both paths entailed a series of conversations or workshops with the relevant stakeholders for the cases, where I presented my aim and findings at that moment, I presented the options of tested tools and how they could be applied in each case.

My research started with my assumptions that GIS appears to be a tool of the future, showing potential for innovation in the field of planning, which was one of the motivations that drove me to investigate unexplored areas of usability for it. A more exploratory stance allowed me to understand to what extent this is fact-based, but also how that fits with existing projects in the department.

Moreover, through the workshops I hoped people would contribute with fruitful knowledge that would provide answers to my research questions, but also inform the tool I am working on. Even if the description of the AR methodology might give the impression that the workshops collected very structured information, the topics that were approached led to open-ended or broad questions. When one writes about something that is very practical, it would be irrational to draw conclusions without having hands-on experience. So, the process of searching for tools and testing them was for me to understand what they can do, to reply to questions that I had in relation to the implications of using them in an organization, but also find answers that I did not get from my colleagues. Moreover, the aim of this pursuit was to gain experiential knowledge and get a grasp of the tools myself. Existing studies have helped me understand the context of GIS, what has been done so far, what is interesting to look at, advantages and disadvantages and understand the direction I should take. Research of co-benefit assessments was carried out to see how assessments are reviewed in research and trying to overlay that with what is done in our office and to see how the process can be digitized. Assessing and establishing a co-benefit assessment methodology was critical, as that was the liaison between the abstract strategy and the applied, digital co-benefit assessment.

3.5 Workshop strategy

Organizing and facilitating the workshops entailed extensive preparation: elaborating on the structure of the series, the topics for discussions and the material, and also persuading colleagues to participate. Since the workshops focus on knowledge sharing, utilization, and production, taking people's previous experience as a starting point, I opted for the AR methodology, which has these aspects at its core. The workshops draw inspiration mostly from the future workshop methodology, introduced by Drewes (2007), which tries to bring improvements inside an organization based on the cooperation between employees. Its target groups are of varying sizes so it can be applied in different contexts. The future creation workshops are grounded in the idea that stakeholders should participate in the process of development that is addressed to them, exploring the issue creatively and contributing together with the kind of future they imagine, with a three-part structure: critique, utopian view, reality (Drewes, 2007; Egmoose, 2020). I organized four workshops: two with the R&CBA group, one with two social scientists and one with the client in Hekebeekdal. During the workshops I am observing, as a micro-ethnography task, but I am also contributing actively, as I am the one leading the workshops.

3.6 Approach to the cases

The chapter at hand explains the approach to the two cases, as they unfolded under AR.

3.6.1 Hekerbeekdal

In the Hekerbeekdal case, the key informants are three representatives of Waterschap Limburg (WL): Marlon: technical manager and leader of the project, Kristine: project manager in charge of citizen engagement in Hekerbeekdal and Jeremy: environmental manager. The conversations with WL and the presentations of my thesis asked for general feedback. The online meetings lasted for one hour, were set up in Microsoft Teams (*Microsoft Teams*, n.d.), and other conversations took place via e-mail. I initiated the study of the case by discussing the option with the project manager on Rambøll's side first, and after receiving approval, I expressed my interest to the client through an e-mail. After receiving a positive response, I presented my objective to Marlon in a meeting and how that relates to the already existing project. Marlon's reaction was affirmative, so the next step was to present my aim and suggested course of actions to the rest of the team. After positive feedback and a final consent, we moved on to the implementation, which entailed finishing the tool, translating the material, and preparing a presentation text to accompany it and checking that everything works correctly, before finally publishing it online. Trying to better understand people's views on participation in the Netherlands, I enlisted advice from a researcher. The Waterboard introduced me to B. B, researcher at Twente University, involved in community initiatives in Limburg, with a background in public administration.

3.6.2 Sankt Annæ

The company established a fund to support initiatives of networking and knowledge sharing towards innovation. Under this, a co-working group was established on 'Climate Risk Mapping, co-benefit and cost-benefit analysis', with a current team of 10-15 collaborators from various geographies and with different professions. The group was previously introduced to my thesis' topic and following their interest in the subject area, the tool's expectations were debated with them in three workshops that I used for data collection. Hence, the key informants are my direct colleagues in the department of IW&CR and the working group R&CBA: Signe, Fatima, mentioned above and Irina – economist and environmental engineer, Ivy- environmental engineer, Jane- PhD student studying co-benefits (multiple objectives approach) in planning, Michaela- GIS expert, Maya – geophysics and climate adaptation expert, Layla – environmental economist, Sophia- economics director, specialized in environmental planning and valuation.

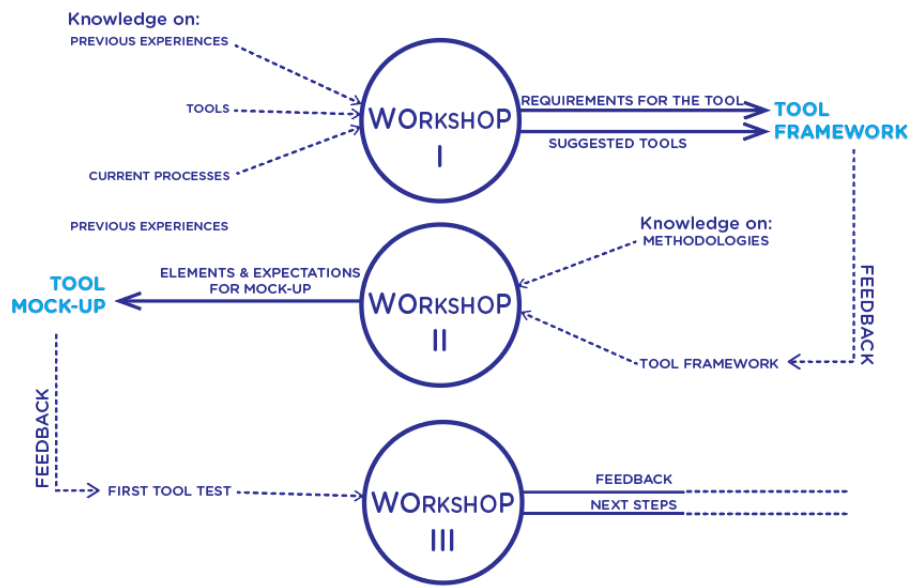


Figure 5 Strategy for the R&CBA workshops. Own figure

All the workshops were set-up digitally, in Microsoft Teams (Teams is the go-to platform for communication in the office), and in Miro (n.d.) - a platform that we often use. Miro is an online application for visual teamwork, which offers digital whiteboards on which people can brainstorm, draw or write. Through the tool people can have access anytime, enabling me to ensure that everyone gets the chance to speak, and that conclusions are validated and reviewed. It is important to mention that even though the workshops guided my approach for the Sankt Annæ case, the aim of the workshops was to inform my research in general (Figure 5), towards answering my research questions. So, there is an **overlap between what were the takeaways specifically for the case and what were the learning points in general and contributed to the entire process.**

3.7 Online georeferenced survey

Geo-questionnaires inquire public opinion in a spatially explicit format, evoked through map interactions. The survey may imply map annotations or sketching, which are then geo-located along with related questions, or alternatively, the survey may record the location of the data collection. Geo-questionnaires are considered to be a type of participatory GIS method, that is computer-assisted, most often web-based with content that is usually filled without supervision (Czepkiewicz et al., 2018; Jünger, 2019). The method I settled on makes use of a georeferenced survey that embeds open questions which relate to a taxonomy of values. Participants were selected through strategic selection, as the entire sample is difficult to determine and randomize. The selection process is described in detail under the results section (4.3.2; 4.4.2).

3.8 Towards testing a method

3.8.1 Establishing a co-benefit identification methodology

The process of developing a technique to be applied through citizen engagement in GIS, started by documenting examples and learning points of value mapping. Lindholst et al. (2015) distinguished that similarities exist between methods but have not been explicitly documented, which was clearly reflected by my challenge of pinning down a benchmarked method, hereby the need to establish my own method. **I have previously argued that the process of mapping co-benefits is a variation of ES or place values identification, a particular form under the umbrella of place values, that investigates the modification of landscapes. Hence, my assessment of methodologies examined documented examples based on any of these terms.** The factors contributing to the selection of the co-benefit mapping method can be examined in Appendix 4.

A few most common questions asked by researchers stood out from the reviewed methodologies:

- favorite places; preferred locations or preference for certain uses of the locations (from (Babelon et al., 2017; Samuelsson, 2019; Sherrouse et al., 2011; Sowińska-Świerkosz et al., 2020; van Riper et al., 2020; Vejre et al., 2010) and places important for particular reasons (Klain & Chan, 2012, Raymond et al., 2009, Scolozzi et al., 2014, cited in Brown & Fagerholm, 2015)
- Questions to understand spatial relationship to the studied area (in García-Díez et al., 2020; Morse et al., 2020; Sherrouse et al., 2011; van Riper et al., 2020; Vejre et al., 2010)
- the use of the área (Babelon et al., 2017; Sherrouse et al., 2011; Vejre et al., 2010)

Determining a rank of preference through social research methods is considered tedious (Sowińska-Świerkosz et al., 2020). As several researchers prompted a prioritization of locations by limiting replies (Scolozzi et al., 2014, cited in Brown & Fagerholm, 2015; Morse et al., 2020; van Riper et al., 2020), I opted to elicit the most preferred place, **ranking values by design**. Based on the recurring themes, my method inquires people's favourite location, as the mapping exercise, and investigates the spatial relationship they have with the mapped locations. Lindholst et al. (2015) identified the use of frameworks as a commonality in the literature, and my assessment of methodologies supports his observation. Consequently, the recorded values are linked to typologies. The method also aims to be utmost extractive, inquiring details regarding the preferred location in various questions that would bring to light the use of the area as well as other possible details that might not have been covered by the inquiry.

The considerations, as they will be explained in section 5.2.1 were incorporated in the co-benefit mapping methodology. The survey is purposefully designed to be utmostly extractive, so it aims to gather in-depth details related to the identified value, but also determine the value in alternative ways when the inquiry based on geolocation fails. The main inquiry that it revolves around is 'What

is your favorite place in the area?’ and tries to elicit this information in a qualitative form and establish a connection to the typologies of values recorded. The other questions set the spatial relationship with the recorded location. The questions included in the survey can be examined in Appendix 5.

3.8.2 Spatializing the method – determining the suitable GIS tool

The tool analysis started with a screening process of articles to select tools and approaches to these (existing studies do not cover the reason for choosing the specific software), followed by the actual analysis of the tools. The criteria were selected mainly from workshops with stakeholders and from Babelon et al. (2017), which addressed the performance of PGIS, towards its uptake in planning practice. Babelon’s analysis spoke to the salient issues regarding implementation in municipal planning, using varied sources for this purpose, which gave the review a solid foundation. The full list of parameters can be examined in Appendix 6. A table (see Appendix 7) was used as a framework for the analysis of applications, and it was continuously restructured as the analysis advanced, by virtue of the identified categories that made the tools unsuitable for my purpose. A few tools were discarded as they proved to be too rudimentary for good accessibility for planners across the team, or if programming skills were required.

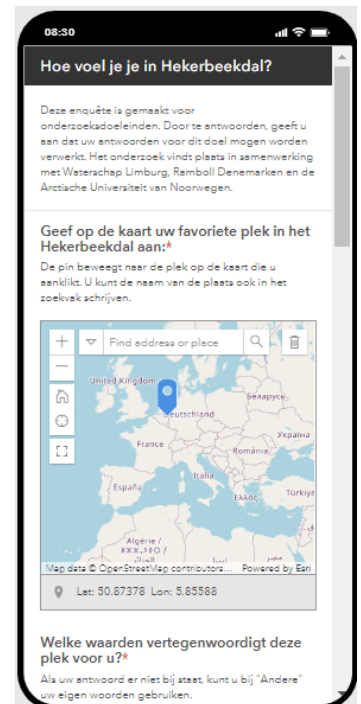


Figure 6 Mock-up Survey 123. Own figure

The choice was simmered down to a number of tools to be discussed in the workshops: Survey123 (Figure 6), Crowdsourc Reporter, Smart Editor, Kobo Toolbox, Maptionnaire and ArcGIS HUB. In these tools, I created mock-ups that were presented to the members. My analysis of tools was pursued to establish the GIS application that fits best for the purpose of delineating place values from citizens’ contributions. Overall, the studied programs prove that any task in the studied area can be made possible, but no tool is perfect. One might have a functionality that another tool does not have but may compensate with other functionalities that the former did not have. For most of the field apps, a desktop set-up is needed a priori. This lengthens the process and quite often requires expert knowledge, making the argument that GIS is accessible to all users debatable. The evaluations of the tools can be consulted in Appendix 8.

4 Action research for the development of a co-benefit delineation model

4.1 Scoping – Consultants’ perspective on GIS

This chapter will walk you through the detailed action research towards the development of the co-benefit model and present you with the two cases and their results. After a few informal conversations that set the direction of the research, a first workshop was organized, to identify potential processes that can benefit from optimization and improvement, in terms of novel approaches to stakeholder engagement. The focus was on GIS and the way we approach social safeguarding. The discussion took place on Microsoft Teams, with Fatima and two colleagues with background in social science and it was informed by the future creation workshop method. Their input was recorded in Miro (see Appendix 9). The two social scientists work primarily on framework projects and often in developing countries.

A driver that can restrict the team’s approaches is the project requirements, as GIS is seen as an extra that is difficult to argue for. Hence, the best opportunity to integrate GIS, is in less strict tasks (e.g., impact and baseline assessments, consultation phases) in which we should bring innovation and make data more visually appealing to make the data collection more efficient and consultations smarter. According to Nick, conducting a qualitative citizen engagement through GIS is not feasible for projects of big scale, as the amount of data is lengthy to collect and troublesome to process. It is preferred to organize focus groups, because it is difficult to find patterns in a pool of information. The user interface is crucial in developing countries, says Andrew, where sometimes communication is difficult, so visual expression is preferred. The pricing was considered an important aspect, and a separate, discussion with Michaela, the GIS expert determined the high costs GIS involves, especially ArcGIS, our go-to software. Another informal talk with the department’s manager revealed that GIS is more accessible for public clients, who are also more open to use it, while for private clients GIS solutions may be too expensive. Nick considered that the methodological approach in the developing countries stopped in the 80’s from a social science perspective, so our team can add value, as other companies still use paper-based solutions. What is more, the consultants contended that the benefit of bringing GIS into more planning subtasks is the ability to relate the responses to the service area. The conclusion was that new tools and methods are always welcome in our workflow, as long as they are effective. The workshop confirmed my assumption that using GIS tools for non-expert knowledge works best for smaller scale projects and for less complex processes that are not conditional on others.

4.2 Co-benefits and establishing cases

Studying citizen engagement makes it difficult to do applied research on real-life projects, as clients might be reluctant about coming in direct contact with residents. Thea suggested the Hekerbeekdal project as a pilot for my study, a conceptual project in an early phase, which makes it more flexible in terms of citizen engagement. This was later confirmed when seeking other opportunities and several discussions were carried out with various project managers, who were interested in applying my concept, but my proposal did not move forward due to a misalignment of timelines and limited budgets. The process for Sankt Annæ was somewhat different. Since the project was already completed a few years back, there was no need to get acceptance from the client. Hence, Thea was to oversee the process, as she was part of the R&CBA, and understood both the group's vision and my aim. Separate conversations were carried out for the two cases with each stakeholder group, to decide the specifics of the model and the GIS tool to be used. Results of the discussed mock-ups are summarized in Appendix 10. Both cases were presented with the same geosurvey.

Once the planning task of co-benefits was set in stone as the field of application for GIS engagement a semi-structured discussion with Signe aimed to clarify some of my questions regarding the process in IW&CR, Signe had considerable experience with the topic and believed my proposal could be useful in our department's workflow. The talk was guided both by my findings and the suppositions about the internal procedure for co-benefit assessments. In IW&CR co-benefits are determined by the circumstantial priorities of a solution. The solutions we generate would be confined to traditional underground infrastructure if we did not capitalize on the added value of climate adaptation. Following the first workshop, I became aware of the possible overlap between social impact assessments (SIAs) and cultural ecosystem services assessments. Signe noted environmental screenings in Denmark are standard procedures, but social impacts are not evaluated to the same extent. It seems that both Environmental Impact Assessments (EIAs) and SIA distinguish and measure undesirable effects, rather than positive. Our present experience shows that spatializing features is more common in SIAs than in co-benefit assessments. Co-benefit assessments are not typically done in our department outside CBAs, and understanding the local context is usually top-down and without integrating laymen knowledge. The process in IW&CR is not standardized and it is usually guided by our understanding of what impact solutions have on the existing terrain and how they relate to the objectives we predefine. Sometimes, these objectives or the co-benefits are projected on a design horizon, starting from the baseline. In Signe's view, it is difficult to see what objectives people could suggest, besides the ones we identify. Signe supports working with typologies, as clustering different values into themes, can offer a good depiction of the outcome of the project. These are predefined before going into conversation with the client and are further

adjusted after discussions with stakeholders. One shortcoming to citizen engagement, is the difficulty stakeholders face in the water sector, in defining co-benefits, according to Signe. It is difficult for them to put a label on a specific co-benefit. Moreover, we often encounter overlapping co-benefits, as well as conflicting views towards problems and priorities (e.g., If one lives in the inner city, flooding might not concern him/her, because of the physical distance. Traffic, however, might be a more pressing issue. To the urban planner, flooding is the main concern, but to the citizen, flooding is just a co-benefit). Signe informed me about an update in the Danish legislation. When submitting funding applications for climate adaptation projects, one can only include costs directly related to damage, and other values is not accepted anymore. She opines this is an opportunity to describe things more qualitatively (co-benefits). What she sees as the major potential of a GIS-based engagement tool for our team, is helping us rank different options, highlight conflict and develop solutions that are more place-specific, focusing on what the citizens from that area really value.

4.3 Case Hekerbeekdal: Client's perspective

Following an exchange of e-mails with the client, my proposal was met with curiosity. WL asked for a meeting with Marlon, who was leading the project on the client side and Signe, from my team. I presented my scope and what benefits citizen engagement in GIS could bring to the task and clarified what my process would entail. They believed this is an opportunity for them to explore novel ways for citizen engagement and have a better-working system, so they proposed a second discussion, to present my proposal in more depth and showcase mock-ups of the co-benefit model. Thus, the review of methodologies was conducted (Appendix 11) and separately, GIS tools (Appendix 7) to build the mock-ups. The participants were me, Signe (Rambøll), Jeremy and Kristine (WL), who is leading the citizen engagement. My methodology assessment concluded that two approaches can be taken for the methodology: emerging from a typology and leading to a typology. In my opinion, both options have advantages and disadvantages, without a clear cut, hence I decided it is best to decide together with the stakeholders, which option to opt for, as well as the tools.

Each mock-up was presented (Kobo Toolbox, Survey 123, ArcGIS HUB and Crowdsourc Reporter – Appendix 8), based on the methodology in an interactive presentation, where the tools could be tested. They were interested to know how the user perceives the product. Kobo was disregarded as it was too 'dry'. Not being able to adjust the map extent could create confusion regarding which specific location is in question. Crowdsourc Reporter was found too complex, and both believed that intuitive design was necessary. One must know what has to be done as soon as encountered with the task and WL believed that too many instructions could also scare people

away. Survey 123 was opted for, for several reasons, but the essential one being the interface. For Hekerbeekdal’s context, Kristine believed the inquiry should be as simple as possible, so one spatial annotation (pin to locate the place) should suffice, with a comment section where people can write if they fail to map a point. Jeremy mentioned it is not only about people’s ability with such tools, but also their lack of familiarity with this kind of process. We discussed various options for the implementation and a few related considerations. Data sharing must be streamlined, and the forms of data need to be utilizable and shareable across teams. While discussing options for outreach, WL contended that social media is a low point, as there is no network in place in the area, so it is difficult to reach the desired small community. From that point onwards, Jeremy assisted me with the implementation. We translated the questionnaire and wrote an article for the website and generated QR codes that were printed along with short introductions and hung in multiple places on site (Figure 7).



Figure 7 Promoting the geosurvey at the location. Own picture

4.3.1 Overview of the case



Figure 8 View from Hekerbeekdal towards Valkenburg. Source: Microsoft flight simulator

Hekerbeekdal is a rural landscape (Figure 8), with a harmonious character, located in Southern Limburg, in-between the small towns Valkenburg and Klimmen, in the proximity of bigger urban hubs: Maastricht, Aachen and Heerlen. Herkebeek, a stream of the Geul river flows towards the municipality of Valkenburg. The area is popular for tourists who want to go on a relaxing getaway in the countryside and is used on a fair amount for agricultural purposes. Waterschaps are the governmental agencies in the Netherlands dealing with water-related issues, from access to water to drought or crisis management. Waterschap Limburg is the water board for the Limburg region and has contracted Rambøll to conduct a conceptual masterplan to handle floods in Hekerbeekdal. WL has sought approaches for cloudburst management inspired by the Danish experience in a pilot project. The thinking process of the climate adaptation solutions involved a focus on co-benefit concepts, aiming to maximize the multifunctionality of the pilot locations, to accommodate multiple uses. The prime objective of the masterplan is the effective management of stormwater for extreme conditions, whilst also contributing to the local community with inspiring urban and rural spaces under normal weather circumstances. It is important to account for all the potential extra benefits that arise from the creation of blue-green infrastructure, as the multifunctionality of the proposed solutions creates a wide range of added values, which are not all quantifiable.

The local governmental agencies have identified the opportunity to restore landscape elements and improve biodiversity, with farming being integrated into the landscape, and subsequent activities conducted in balance with nature. In addition, the area was to benefit from solutions that alleviate heat stress and improve microclimate, as identified in our stakeholder workshop. A number of **16 potential co-benefits**, with environmental, economic and social contributions, have been identified together with the stakeholders during workshops, as having a positive impact in Hekerbeekdal

through their function and design. **These include physical health, recreation, local economy, local identity, sustainable agriculture, calm traffic, microclimate, water and air quality, safety, local food, noise reduction, social inclusion, tourism, education and biodiversity.** The private residents were not included in the workshops with the client and the other stakeholders, as the community consultation process started at a later stage and due to the Covid restrictions, WL decided to pursue digital-only consultations. Hekerbeekdal is a project in an incipient phase, that aims at a conceptual level masterplan.

4.3.2 Residents' responses

The geosurvey was only formulated in Dutch, so the responses were translated with a digital tool and checked with the client. The expectation was that the response rate would be low, as the community is comprised of a few hundred households. There were **12 responses in total** (Figure 9). Noticing the slow response rate, I decided to try different tactics for better outreach. I organized a campaign on Facebook and Instagram, where I targeted people aged 18-65, on a radius of 10 km around Valkenburg. The ad reached a number of 2804 people, mostly aged 18-34 (68,6%). The rest of the age groups were distributed evenly. Reach in this case means people who saw the ad at least once. Out of the reached people, 292 engaged with the post, which means that they took an action involving the ad. The action can refer to viewing a photo, clicking a link, commenting, or similar reactions (Facebook, n.d.). There were no negative reactions and while many people reacted expressing various degrees of affinity towards the initiative, they did not go on to do the mapping exercise. WL also shared the call on their social media networks and included it in their internal newsletter. The survey was also distributed on multiple groups from Limburg area. No groups intended of the neighbouring municipalities could be found, in line with Jeremy's assumption. Later, I decided to write direct messages to all the businesses from the valley, that are registered in Google maps. This more direct approach seemed to bring more involvement (3 out of 15 replied).

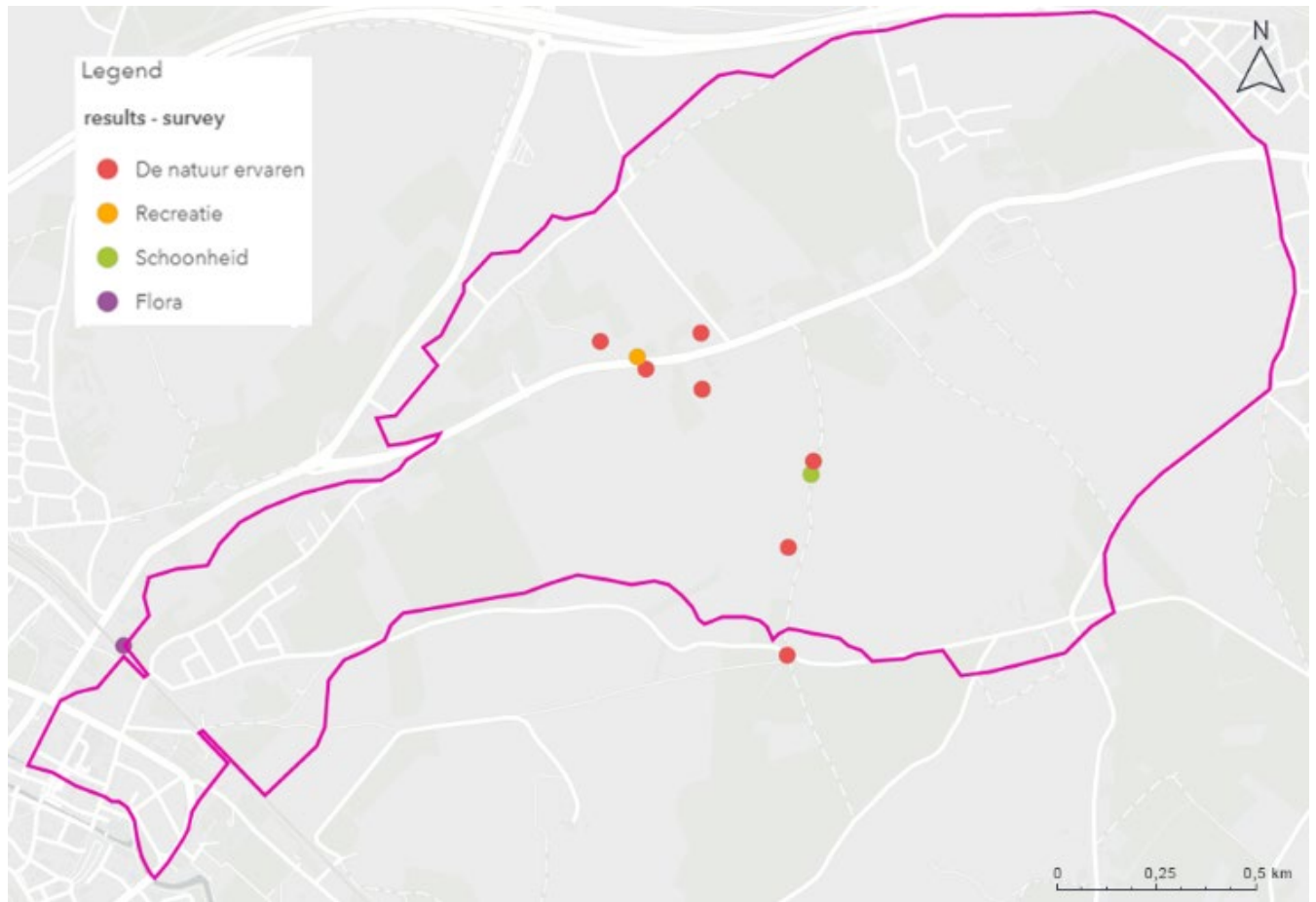


Figure 9 Mapped favourite places (legend top to bottom: enjoying nature, recreation, beauty, flora). Own map



Figure 10 Summary of the mapped values. Own figure

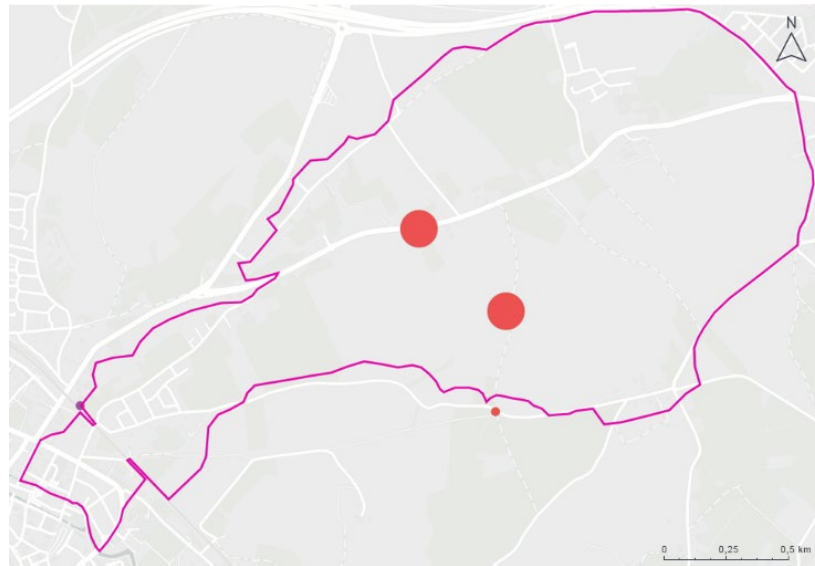


Figure 11 Cluster analysis. Own map

When asked about what they appreciate this area for, the most common themes emerged to be **beauty, landscape, home, peace, hiking and fauna**, in this order (Figure 10). Two skipped the question. Three appreciate the area for the memories they gained over time (e.g., lived there for several years or travelled there often). Having most replies linked to the appreciation of nature emerges not only from the numbers but also from the cluster analysis and it reflects the local conditions, as the area is rich in its natural potential, which can be observed in the overlay of the responses with biodiversity layers. Hekerbeekdal has medium to high biodiversity and bee species diversity levels (Figure 12,13) and also includes areas that are part of the Nature Network - a national network of natural reservations (Atlas Leefomgeving, 2018). The biodiversity layer is based on the number of species present within a given area - grid cell (Atlas Leefomgeving, 2017b). In a similar manner, the bee species diversity measures the number of bee species within a perimeter (Atlas Leefomgeving, 2017a). The data has been extracted from the National Dutch Databases.

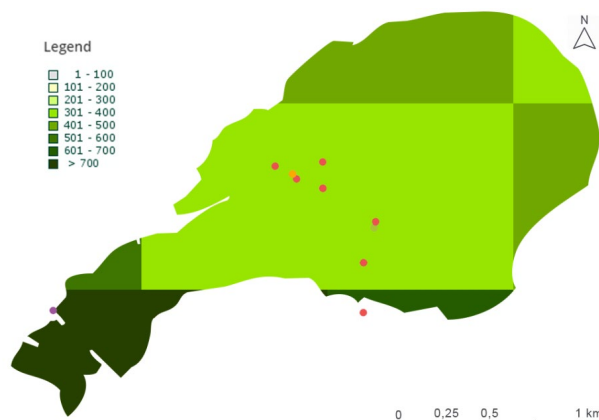


Figure 12 Biodiversity. Own map



Figure 13 Bee diversity. Own map



Figure 14 The Nature Network. Own map

One of the respondents cherishing the nature decided to provide a rigorous account of a couple of issues. The main concern was the speed of the main road crossing the valley, which has been brought to our attention by WL too. According to the informant, this poses a threat to the animals in the valley but also disrupts the tranquillity of the place. This information is consistent with the predictive traffic data (ESRI, 2019), which shows that motorized traffic is moving freely along the main road passing through Hekerbeekdal (Figure 15).

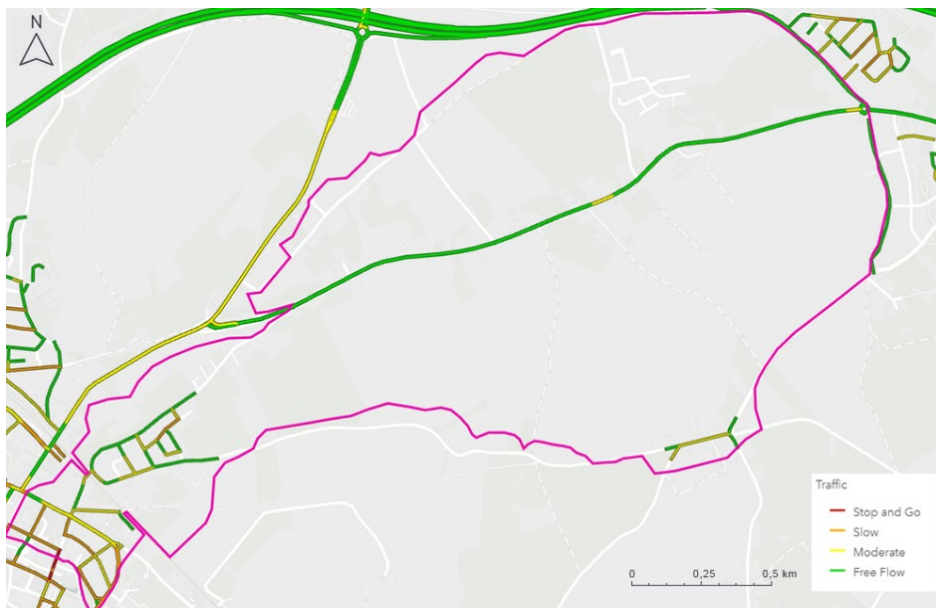


Figure 15 Traffic flow. Own map

The informant also felt that the historical character is not receiving enough recognition and that is being appreciated more by ViaBelgica (Tourist office) than by the municipality. Another contributor pointed to a few more places he or she values in Hekerbeekdal. A more interactive feature was set to capture the travel time to the location, which worked correctly in Hekerbeekdal. Apart from two replies, the respondents live in the valley, as seven of them stated they are walking to Hekerbeekdal, with zero travel time, or maximum 15 minutes. One respondent lives within 30

minutes from the location, while two others travel to Hekerbeekdal by car, in a journey of a bit over two hours. Half of the respondents visit the area daily, while the rest are almost divided in half and visit either weekly or monthly. The blue spot analysis reveals risk areas, where flooding typically occurs in a 100-year event, and the flowlines indicate the direction of the waterflow. As the map demonstrates (Figure 16), the water accumulates and flows towards the main street, which is the inhabited area, and it also concentrates most responses. The project should then reduce the flood risk by storing water upstream and using the opportunity areas for potential blue-green infrastructure projects.

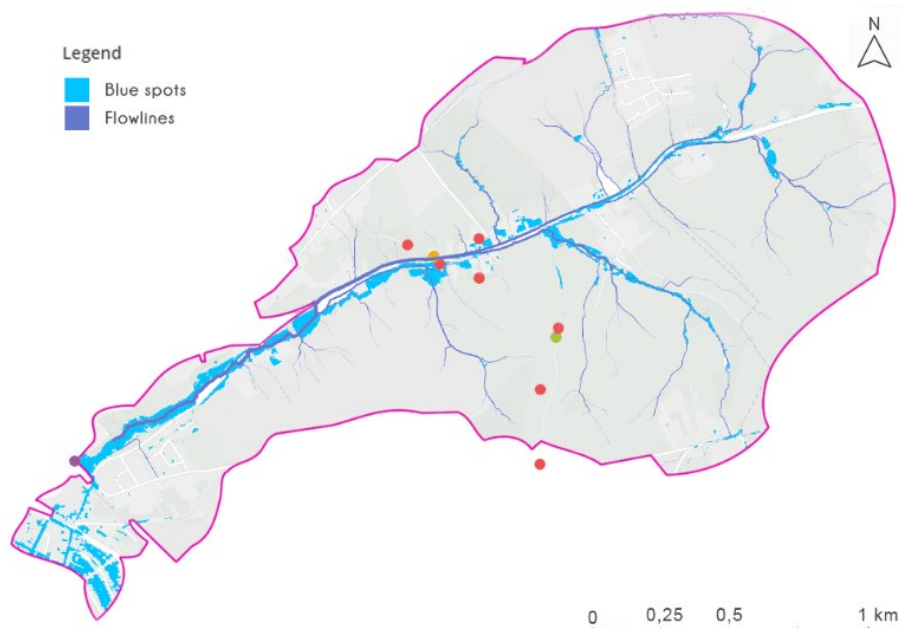


Figure 16 Flowlines and blue spots. Own map

In summary, the correlation between mapped values and other layers of data, reveals a few contributions of this synergy. First, in terms of the capital objective of the adaptation project, the clusters, and the overlay with blue spots, highlight areas to be considered for reducing climate risk. Layers such as biodiversity, which was both remarked by residents and supported with facts, give an indication of what values should be prioritized as co-benefits for the future project. The traffic layer is a good indicator for confirming experts' findings of areas for intervention. Two informants attached pictures of their favourite places, illustrated as follows (Figure 17). One picture was taken on the spot, while the other one was attached. Both pictures reflect the values mapped by the participants.



Figure 17 Pictures attached by respondents to the geosurvey. Survey pictures

On the 18th of May, B.B. introduced me to the Twente University's current initiative, a creek restoration in partnership with the municipality, for me to get a better picture of the Dutch context. The University received substantial funding from the National Government for the project. The municipality created different measures to involve citizens throughout the project stages, combining the digital with the physical. In the early stages, they sent out newsletters frequently and organized information meetings, then created an app for people to follow the project. With the following engagements, they made use of the previously established infrastructure, which they used to promote their surveys, but also went from door to door and hired a neighbourhood concierge. Through the different phases they had varying tactics to participation. What aided them in the end was having multiple mechanisms to get in touch with citizens. B. trusts different channels should be seen cumulatively, and informal methods should not be disregarded, as they work well. From his perspective, the administration is paying, but they are also very interested in the results and want to learn from the project. They are risk averse in the sense that if it is a success, people will demand this in the future for all the developments coming in the public space, which implies high costs for them. It is hard for civil servants to transfer the knowledge to other colleagues because they do not have enough experience organizing participatory projects. People have expectations from municipalities, so agencies are careful in what they do. From B's experience, residents in that area think that governments should take care of their problems, compared to other parts of the Netherlands, people were used to collectively organize themselves since their administrations could not offer them great support.

WL was presented with the results and asked for feedback. Three WL members took part in the session, Milo, Kristine and Jeremy. They were curious to see the results, as they were in doubt I would reach any citizens at all. They found it an important insight to know what effort is needed to

reach people with this kind of survey, compared to a direct approach or others for this context. Discussing the incorporation of people's input in decisions, WL stated that for them hearing out residents is important and that is why they invested in their GIS platform, Metelkaar. WL considers the model should be added to their toolbox, if it is successful in reaching the young because that target group is hard to reach. They are either uninterested or in door-to-door approaches, they cannot be found at home. The channels seem to be important even in-between closer age groups. We discussed an observation that there is a tendency for people 25-35-year-old to use Facebook and the younger to use Instagram. Jeremy argued that in NL the digital connection is very high, 98%, but that might not be precise for that area specifically. They claimed that elderly people are not less connected to the digital world and to their experience their involvement is very high and seems to decrease only at ages over 80. WL organized participatory initiatives around Hekerbeekdal and specified that the digital was comparable with the live meetings before Covid-19 in terms of participation. They think digital is not always a bad thing, not having to travel for meetings. Moreover, in the present they believe live meetings would be a failure. People would not participate, for fears of the pandemic. The Waterboard maintained that the pandemic forced them to explore the digital realm to a wider extent. But when one outreach method does not work, they resort to phones, e-mails, or even written letters to invite people to digital meetings, which usually works. Jeremy was surprised only one person signalled a problem because that is a tendency no matter the task. We considered that maybe my approach brings clarity to the task. Kristine noted another usefulness of my model, by overlaying my results with other sets of data. By comparing with previous maps, it could be easily established whether it is the same audience, which could determine the active group in the community. This can be done by establishing whether the respondents are the same. However, if it's not, it means the method works to reach a greater audience, in combination with other methods. Overall, WL found it valuable that I managed to reach younger groups and asked me to introduce my method to other stakeholder managers from their agency.

4.4 Case Sankt Annæ

The intention for the case in Sankt Annæ was to develop it with the R&CBA group, as they had the relevant expertise. The second workshop with the group narrowed down towards this case. The participants were: Layla, Sophia, Irina, Ivy and Michaela and Signe. I presented them as well with the two methodologies, that **both relate to a matrix of values**. Ivy considered results are easier to be treated if the process started from a typology. Otherwise, an extra step is needed for grouping responses under typologies. However, they believed that with open-ended questions, new benefits that we did not consider may arise. Ivy, Layla, and Sophia noticed that my methods seem to be connected to techniques used by economists (contingent valuation and stated preference methods).

After discussing the methods, I presented the GIS mock-ups, for which we gave endorsement and critique.

We settled that the tool should reflect the purpose and type of engagement, whether physical, digital, or other. They considered it important to have examples of agencies or companies having successfully used the apps. There was a general agreement that simple tools are needed with a broader audience, when people are more detached from the task, whereas more complex tools can bring their value in stakeholder meetings where people are more engaged, and the group is smaller so they can receive guidance. Complex exercises cannot be delivered in mailboxes for people to answer. We determined that the co-benefit model, through its questions and introduction, must support people's knowledge. For this, outlining a context in advance of asking questions is imperative, but also avoiding the introduction of bias. This informed my model in the sense that people were given instructions and a brief description of the project, without describing any of our objectives. Inquiring the typology belonging to the recorded value, was asked only after recording the preferred location by the informant. We agreed that the risk of sending these exercises out as opposed to live interaction, is that the planner might miss the motivation of the person responding, to understand the source of that value. This is something I tried to avert through the open questions and additional comments section. In the end, participants were asked to vote for a tool to be used and for a second favourite. Survey 123 had the most votes, with the clearest layout, while Maptionnaire was runner-up. The analysis and statistics weighed heavily in voting. Pricing was considered the decisive criterion, that would make the difference between apps. If the app works well, we may select it regardless of other apps' features, due to costs. The group was enthusiastic about my proposition and considered it for current projects. Ivy argued that collecting data for further monetization is extremely expensive, which makes my method most useful for tasks normally carried out in-situ, as paper-based formats require significant resources.

4.4.1 Overview of the case



Figure 18 Visualization of flooding in Sankt Annæ. Rambøll picture

Sankt Annæ Plads (Figure 18) was part of the municipality's overarching project Copenhagen Cloudburst Management Plan, which consists of about 300 different projects, planned to be carried out over the course of 20 years. This commitment was determined by two events with extreme precipitation in 2010 and 2011 that produced increased damage in the city. By the time the plan was implemented, there was no knowledge of cities around the world to have a similar approach of the same scale. Rambøll in partnership with the landscape architecture company Schønherr were commissioned in 2013 to deliver the project in Sankt Annæ along with other solutions for different locations in Copenhagen. Sankt Annæ Plads is a plaza in the heart of the city, a location with a rich history, close to the main canal. Though it may not be regarded as the major destination in the city Centre, it is crossed by a big number of people daily, citizens and tourists alike. The buildings surrounding the square serve either a commercial purpose or host high-end housing. Its proximity to the water and the flat terrain makes it prone to flooding and was thus identified as a priority in the Cloudburst Plan.

The vision for the overarching plan is to move away as much as possible from traditional measures where possible and handle water on the surface with the help of blue-green infrastructure (BGI) solutions. BGI is considered to bring added value to public spaces, due to the multifunctional nature of the solutions, while putting less stress on the sewer systems by disconnecting buildings or entire streets from the sewer. Unlike Hekerbeekdal, Sankt Annæ is a project that was already delivered, and it was enacted in 2015. The street network was redesigned for lesser traffic, leaving more space for promenade and leisure. The middle section was lowered to collect water during storms or discharges and was turned into a green space with a highlight on the recreational function. Cloudburst discharge pipes collect runoff from facades, roads and other surfaces, and using gravity,

water is conveyed to the harbour through the streets and through a separate system for rainwater collection. The plaza was connected to the adjacent quay, Ofelia Plads, which also underwent renovation. The consultants established the project would bring **five co-benefits** to the otherwise existing square, and those are **recreation, well-being, calm traffic, biodiversity, local economy**. All in all, the re-design and the modelling of the terrain secure the plaza against torrential rain.

4.4.2 Residents' Responses

A social media campaign was set-up by me for Sankt Annæ too. The ad targeted people from the entire Copenhagen, with the center in the plaza. The post about the co-benefit model reached 2479 people, but only 143 engaged with the post. The post was also shared across multiple groups for Copenhageners on Facebook, and one community group for the residents from the city centre. QR codes to the exercise were hung in several spots with good visibility (Figure 19).

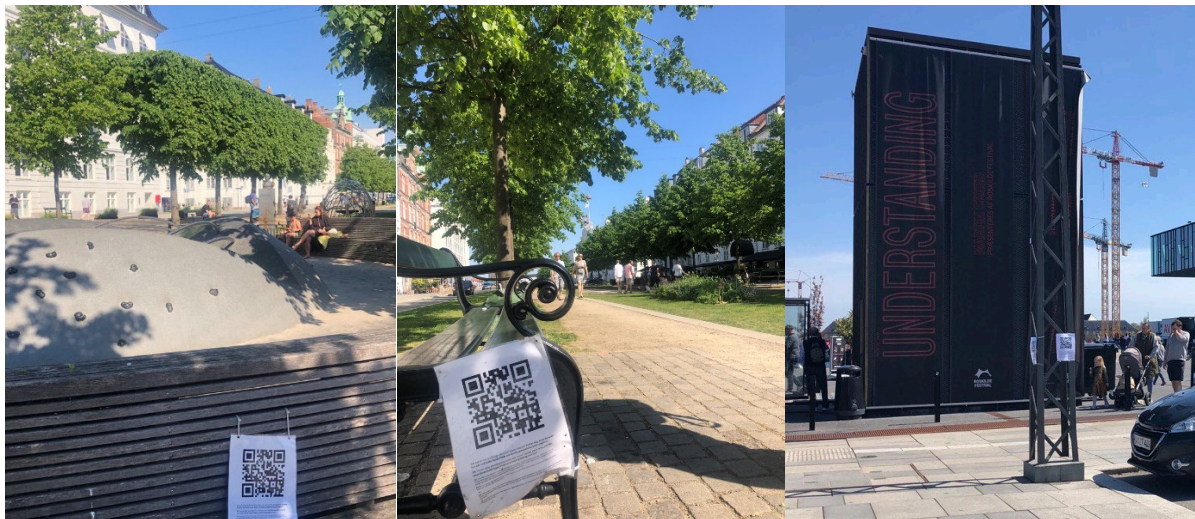


Figure 19 QR codes to the geosurvey distributed in the plaza. Own pictures

Even though the engagement was lower than in Hekerbeekdal, more people went on to do the exercise (35) and they located a number of 42 co-benefits, as can be seen in the map below.



Figure 20 Mapped co-benefits. Own map

The points mapped in Sankt Annæ are almost evenly distributed in the plaza (Figure 20), but clusters can be identified. There are four bigger clusters, two in the plaza's centre, one in the north-west and one at the waterfront. The clusters in the middle of the plaza (Figure 21) had predominant values for well-being and experiencing nature, and they overlap with a petanque field, even though no one mentioned this activity. The two clusters determine a co-benefit hotspot in the centre, in the area that is popular for young people to play on the grass and socialize. The cluster by the waterfront is outside Sankt Annæ, in Ofelia Plads, which is right in the vicinity, and it is a popular place for bathing, swimming and socialization. One point indicated a church building facing the plaza, while another one pointed to a church as well, was completely outside the boundaries of the location. The cluster on the north-western side does not have any predominant values. Out of the responses, one kiosk in the plaza seems to be a location that brings people together for socializing.

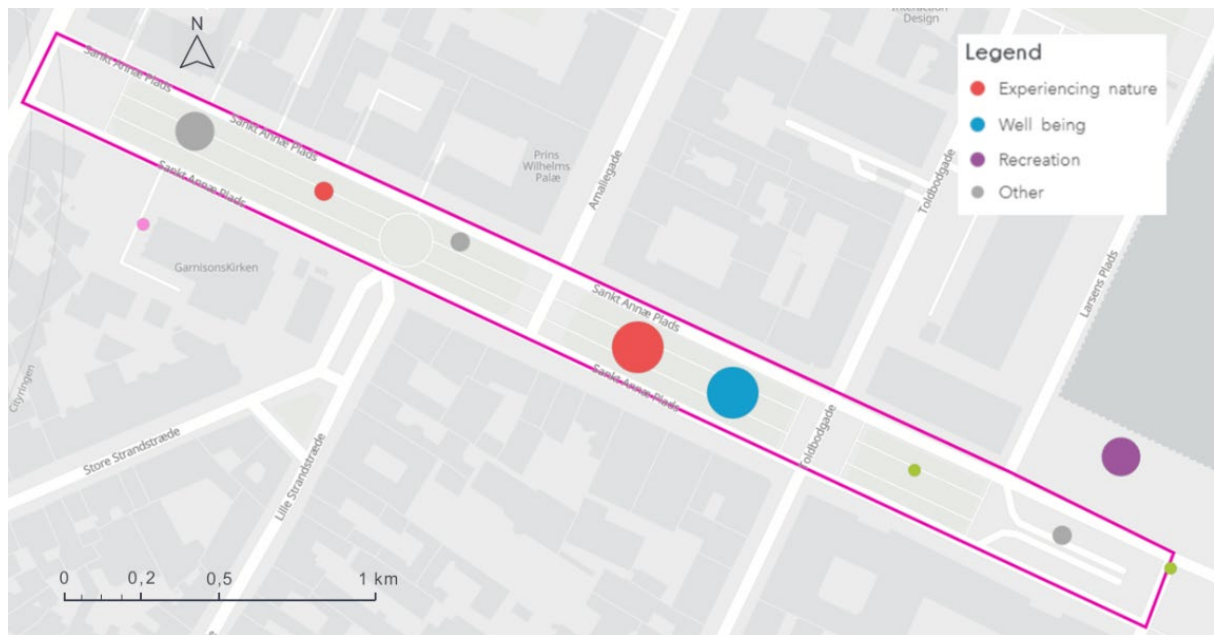


Figure 21 Cluster analysis. Own map

There was almost a balance between men and women respondents of the survey: 54.55% were women, 42.42% were men and one person chose not to state. There was a clear predominance of young people filling the survey, with nineteen responses coming from people aged 25-34. Only two were filled by people over 44 and no underaged replied (a message in the introduction of the survey stated that people under 18 are required to have their parents' consent). There were no respondents without higher education, and the age is probably reflected by the degree, as eighteen participants reached a bachelor's degree, and twelve a master's degree. Language was not a barrier in this case for closed questions, as the survey was built in both English and Danish, and the responses could be associated between the languages. Answers to open questions on the other hand must be translated. One of my Danish colleagues ensured the translations are correct.



Figure 22 Summary of identified co-benefits. Own figure

In Sankt Annæ no participant identified other values besides the ones part of the pre-defined typologies, same as in Hekerbeekdal. Green is the most prominent value out of all the mapped

values, followed closely by well-being (Figure 22). Next comes recreation and socializing, with an equal number of mapped points. Even though most of the plaza is covered by green areas, which are the most appreciated places in the square, Sankt Annæ is not included in any biodiversity maps, not even as a low priority on a local scale. The blue spot analysis together with the flowlines reveals how water from a big neighbouring area is lead to the plaza, where it accumulates (Figure 23). The map shows surface water, which would normally be led to the drainage system. However, in the situation of a 100-year rainfall event, the capacity of the drainage system would be exceeded so the project reduces the risk on the neighbouring buildings, which would otherwise be flooded as concludes from the map, by conveying the water and storing it into the lowered parts of the plaza as well as to the cloudburst pipe.

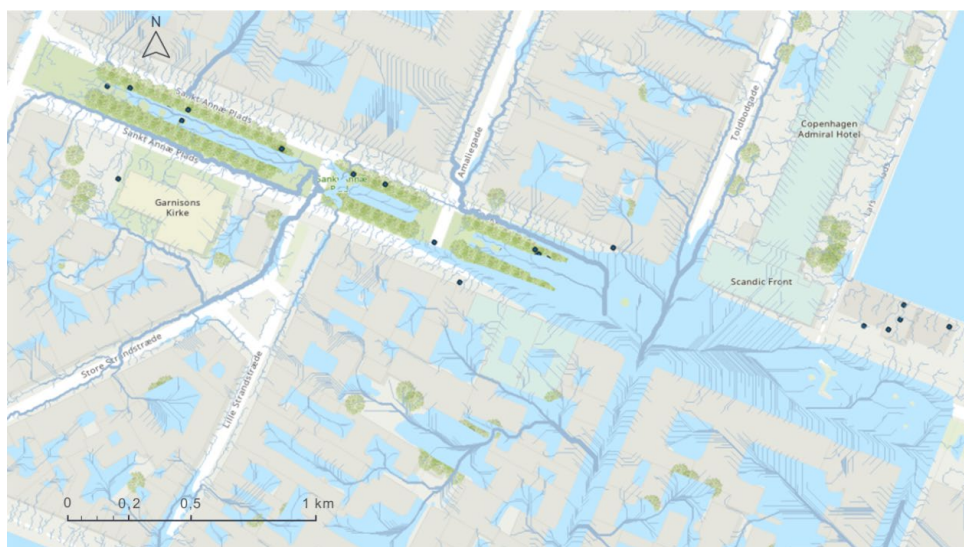


Figure 23 Blue spot analysis and flowlines. Own map

An open question inquired more details about what people enjoy most in the area. The automatic word clouds generated by the program are useful in coding the answers. A few themes stood out from the responses, out of which 'green' and 'nice' occurred most often. While 'green' clearly reflects the value that has been pinpointed the most, 'nice' is an ambiguous reply that would not be able to support decisions. 'Sun' was the next word with more reiterations, but also 'love', with the same weight. 'Relaxing' and 'bench' followed with less occurrence. Words like green or sun can be understood by themselves. But, 'love', calls for a closer look at the context of the reply, to determine whether it stems from the cultural ES. Examining the individual responses, it turns out that the feeling of love comes out of the good feelings people get by sitting in the plaza, a relaxing, calm and green spot, hidden away from the city centre buzz. Through this question, people highlighted a variety of different uses of Skt Annæ, such as a pit-stop in-between travel locations, a place to go out with the dogs and interact with other dog-owners, enjoying the sun, watching



Figure 25 Examples of pictures attached by respondents. Survey pictures

No one is travelling by car to Sankt Annæ and most informants travel to the location by bicycle (18), or on foot (11). Three people responded they use public transport to reach the plaza and one is using other means of travel. A last section invited people to leave additional comments, optionally. Several people (5) expressed a desire to have a playground for dogs, as many residents around Skt Annæ have dogs. One person replied he/she does not have any personal attachment to the place. Someone praised the questionnaire and asked whether it works on mobile.

The R&CBA group was presented the results after the data collection for feedback. A significant part of the discussion was about the outreach phases of engagement processes, with the agreement that the outreach mechanisms cannot be bypassed if representativity must be achieved. Good response rates are easily met, but methods should be diversified according to different groups or sectors of population to achieve representativity. The choice and channels should reflect the groups' characteristics and the goals of the participation. Sometimes it is needed to use all the channels one has access to. This was in line with B.B.'s opinion, that there is no right method, and a combination of methods needs to be used. However, it was surprising for the members of the group that age can play such a big role in the choice of method and that a digital method can spark the interest of the youth. We also concluded that we tend to make assumptions about the communities we study, but every community is different and needs to be tapped into in different ways. The strength of the method was agreed to be the ability to relate responses to very precise locations within the service areas. Consultants can locate the specific area of the public place where people feel a particular value, locate both services and disservices. This takes things to a different spatial level, by depicting the particularities of services or disservices. Applying such a tool can help consultants find precisely located challenges and opportunities, but also what to preserve or enhance and ways to open the discussion towards mitigation.

5 Discussion

5.1 What are co-benefits and how can they be mapped through participatory GIS?

Framing co-benefits was central to my thesis, to understand what they are and how they are defined in research and practice. The literature and the data collected under AR, lead to a better articulation of the distinction between co-benefits, place values and ecosystem services. Based on the literature review and from the analysis of the cases, I found the relationship between place values and co-benefits to be conceptually unclear. Thus, I established a relationship between the two based on the literature on place values and ecosystem services, which I scrutinized against the literature on co-benefits (the policy perspective) in comparison to the way Rambøll engages with co-benefits (landscape adaptation consultancy perspective), as well as with ecosystem services. The explanations of the terms from different angles enabled me to puzzle together the relationship between them, as relevant for our consultancy.

Looking at how the mapping unfolded in the two cases, a few observations are notable. In Hekerbeek people mapped place values, as they are not aware of what is being conceptualized in the area by Waterschap Limburg and Rambøll. Localized clusters appear as obvious, as values are concentrated in the middle of the valley, in the proximity of people's homes. The locations overlapped with opportunities we identified together with the stakeholders, and with areas we decided to capitalize on and improve. But, from the open questions, new benefits arose, that we were not aware of, and that is the historical value provided by the archaeological remnants. Moreover, only one of the stakeholders that took part in the workshop, was aware of the historical site. This certainly strengthens the potential of the method, even in smaller samples and confirms the strength in engaging laymen. No conflicting views have emerged out of the results in Hekerbeekdal, but responses confirmed some of the issues we identified, such as traffic. For the Sankt Annæ case, the results indicated both hotspots and cold spots. The points mapped in Sankt Annæ are almost evenly distributed in the plaza, but two bigger clusters can be distinguished. Most replies are concentrated in the middle of the site, while another concentration of values can be distinguished by the waterfront, in Ofelia Plads. The cluster in the middle of the plaza overlaps with a petanque field, even though no one mentioned the petanque activity as a motivational factor for enjoying the plaza. This suggests that with a good understanding of the location, correlations can be made which help understand the values. It also emerged from the R&CBA workshop that it is not critical to find the values only, but the source from which the values stem from (e.g., sun can be correlated with well-being and petanque with socialization). In Sankt Annæ however, issues were signalled in the open questions, e.g., in relation to the traffic, which was improved but not

enough. Disbenefits arise also out of the comments sections and comments on social media. These indicate that without qualitative input, through a method where underlying messages cannot be sensed due to the lack of physical interaction, significant evidence might be overlooked. The collected data shows that people tend to contribute with cultural services rather than provisioning or regulatory. It may be said that a project has achieved its purpose if the pictures collected through the method reflect positive values that are determined by the alterations of that location (e.g., pictures in Sankt Annæ show the lowered green areas in the plaza). However, the blurry boundary is noticeable in the results from Sankt Annæ: it is not clear if the feelings of love instance are a co-benefit, connected to Rambøll's project, or a quality of the pre-existing area.

Since the population density in Hekerbeekdal is very low, the expectation was that fewer places will be mapped, but also fewer responses recorded due to the use of solely a digital method (Brown et al., 2020). This means that it cannot form a solid ground for decision making by itself. But in Hekerbeekdal, it would not be the sole determinant in decision making, rather inform expert knowledge, confirm, or refute suppositions. In Hekerbeekdal the mapping represents an **assessment of the existing place values**, that can be compared with the potential co-benefits our proposal can bring. The project aims at capitalizing on values that both the consultants and people identified as important for Hekerbeekdal, such as recreation, biodiversity, traffic, and noise. Besides these values, the proposal is intended to create additional values such as physical health, sustainable agriculture, enhanced microclimate, and education. The potential of Sankt Annæ case is to emphasize the positive impact of a project, as it discusses a closed project. The conducted mapping after the delivery of the solution, can be overlaid with the apriori assessments, to determine whether the guaranteed effects have indeed taken place. People identified additional values than the ones foreseen by the consultants (recreation, biodiversity, well-being, calm traffic, and local economy). Recreation, well-being, and the enhancement of green areas weighed the most in people's responses and they were also the primary desired secondary effect of the project, besides the risk reduction function. The issue of traffic and the local economy were touched upon indirectly by residents, so one could argue that the planned project managed to also bring these co-benefits. However, when it comes to other values that residents identified, the blurry boundary between place values and co-benefits can be evidently observed. It is not clear whether the cultural, spiritual and beauty values stem from the modified landscape or the pre-existing one. One would rather say that the spiritual and cultural values at least, were place values, as a church has existed in Sankt Annæ from before the project, and multiple buildings with cultural value (theatres, palaces, museums) are located in the proximity of the plaza. These could have been ruled out if a **place value assessment had been carried out before the project implementation**, similar to how I exemplified in Hekerbeekdal. In managing the results of place value assessments and moving into a decision-making space, spatial

discounting comes into play. The concept (Brown et al., 2020) is particularly relevant to consider when designing solutions starting from people's existing values and culture, as it would then support decision-making towards those benefits that reflect the on-site reality and preferences. These could work towards enhancing the economical added values of the solutions, by increasing the existing place values that residents treasure most and adding others. These would boost the attractiveness of the area and entice people to move in or nurture investments in the area.

The relationship I established between place values, co-benefits and ecosystem services is depicted in Figure 26, with the important remark that place values are discussed here in relation to water, terrain, and blue-green infrastructure. In establishing the difference, the temporal aspect needs to be considered. My assumption, based on my empirical material, is that co-benefits exist at a point in time, and they are ephemeral. Place values reflect the values of stable landscapes, so they reoccur once projects are implemented and settled in and as argued in the review of the concepts, they overlap with the ecosystem services. Ecosystem services, similar to place values, can be identified regardless of a modification taking place, but the modification may alter the existing services. Yet, it remains unclear how place values relate to disservices, as while the literature discusses both disbenefits and disservices, the search in library databases did not return any results on negative place values. The moment when place values become potential co-benefits, is evident, as it is determined by a planning phase in which potential options for alteration come into play, that is the future possible co-benefits. The various options become actual co-benefits once the project is enacted, but when do co-benefits transition back into place values? From the consultancy perspective, it seems fuzzy, but this may be the moment in which the design horizon timeline is over, and a new baseline is settled, as it turned out from my conversation with Signe. For citizens this may be the moment in which the excitement of that 'something new' wears off. All in all, co-benefits blend with place values after the construction of a project, without a clear delimitation.

As a result, I proceeded to the identification of a suitable co-benefit appreciation methodology for the two cases, with the aforementioned assumption that the method can be borrowed from the mapping of place values or ecosystem service assessments. **The main difference is the order in which the assessments are conducted – prior to or after the landscape has been subject to climate adaptation measures.** The examples from various studies have been assessed in the analysis using various criteria in order to establish a co-benefit assessment methodology to be used in my cases. The criteria have been established by looking at a few examples of assessment reviews and selecting the relevant indicators. Noteworthy is that my assessment looked at the individual process of identifying values, in a paper-based format. So, my analysis was regardless of the technology employed, as the tool to be used for deploying the method has been determined in a

separate process, while several studies investigated place values assessments that already used a mapping exercise. This is one of the reasons why the studies and some of their indicators were relevant both for my tool assessment and for my methodology assessment.

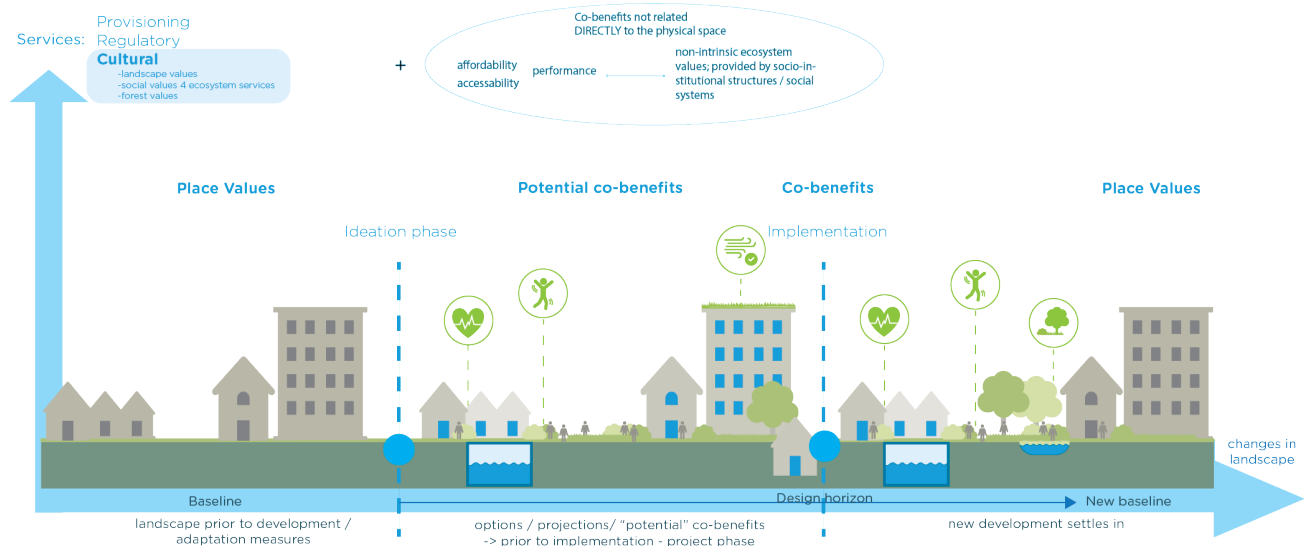


Figure 26 Relationship co-benefits – place values – ecosystem services. Own figure

Co-benefits and ecosystem services may intersect, with two distinctions to be made. Co-benefits look at options, towards an alteration / enhancement of the physical space, where the climate risk is the central point that determines the final added values, while the ecosystem services do not account for climate factors. In addition to that, co-benefits may include benefits that stem indirectly from the landscape and are determined by social and institutional structures (e.g., affordability, inclusion), which is not the case for ecosystem services. On the same timeline, a possible project may have negative possible impacts, and the final implemented project will have specific disbenefits. During the development phase, the aim is for the negative effects to be lowered, but outcomes that have not been accounted for may still arise. Co-benefits are identified and mapped starting from the study of the existing physical space, then assessing what values can be added on top of the present place values. Different project options also imply different co-benefit scenarios. The particular approach to the mapping of place values does not differ from that of mapping co-benefits, but the moment of evaluation gives different perspectives on whether it is place values, services or co-benefits that is being discussed. Consequently, I suggest that the methodology for the specific mapping of co-benefits has similarities to that of mapping place values or ecosystem services, with the significant difference being the temporal aspect. This means that values retrieved from stable landscapes should be different from those obtained from altered landscapes, reflecting the new changes in the environment. All in all, the concepts differ in terms of the temporal scope,

so the delineation of values can use the same mapping technique only if the temporal aspect is considered on the side of this process (e.g., a mapping of co-benefits would look at the existing place values as a baseline and delineate the values that would be added over and above the pre-existing).

5.2 What are the necessary considerations that the consulting team needs to take in when introducing a new digital method for engaging citizens in the planning team's workflow?

Another significant research question for my thesis, investigated the consultant's viewpoints towards the inclusion of citizen perspectives in existing processes and towards new methods. This is central for the adoption of new approaches, as considerations are sometimes divergent from the paths research take. The main concern in the adoption of a digital method for community engagement is the geographical context. The variety of local needs calls for digital approaches that can respond to all the variables and the flexibility of PGIS (Aberley & Sieber, n.d.) turns it into a desirable tool for the planner's toolbox. The 'cyborg' character of GIS (Babelon et al., 2017) is advantageous when it comes to working in different geographical contexts that necessitate various considerations. This was an outcome that stood out from the internal workshops too, as well as from the assessment of tools (Appendix 10), which determined that the plenitude of options available demonstrate high adaptability, for GIS to be used during fieldwork as well at the desktop, or to be used with assistance or by laymen only.

Acknowledging the characteristics of the geographical context brought up the importance of facilitators in the conversations I carried out with the social scientists and the R&CBA group, which were signalled by Üрге-Vorsatz et al. (2014) too. The contextual factors might bring up the need to rely on local people to do the surveys or assist consultations sometimes and it is best when the team is handling this matter, to assist people in the process. The discussions with WL had a different perspective on the way geography should shape the method, in terms of demographics. An elderly population and lower education levels, as is the case in Hekerbeekdal, are characteristics that are critical in creating the task and adapting it to the given circumstances. Not paying respect to the probability of low technical abilities, would most probably lead to a lack of representativity and exclusivist practice. The demographic traits demand caution to the risk of digital divide (Babelon et al., 2017; Samuelsson, 2019), which are tied to the context (Rzeszewski & Kotus, 2019), so a good grip on the setting is essential. On this note, working in contexts different than the ones the planner is familiar with, calls for local partnerships and collaboration with actors from the community, to get an accurate consideration of the local culture, with its norms, expectations, and

characteristics. Jeremy mentioned that it is not only the ability of the people to apply these tools but also that they are not familiar with this kind of process and questions. In this regard, we established with the WL team that the program interface and instructions are crucial for specific demographics since if certain traits are not offered support, they might skew the task and tool requirements. In web-based mapping, facilitation moves beyond the physical boundaries, as can be observed in the two cases. The role of the facilitator metamorphoses and acquires another dimension in the digital world. Facilitation could also be one of the keys to limiting the digital divide, issue raised by a couple of authors (Rzeszewski & Kotus, 2019; Samuelsson, 2019), as technology is not yet accessible to everyone (all ages, all contexts etc). WL's assumption was that people would not drop out in live consultations. Even though Rzeszewski & Kotus (2019) conducted a very precise analysis of the factors that cause mental stress and drop-out in spatial communication, they did not examine how receiving guidance could improve people's engagement in these tasks. The discussion on people's technological abilities confirmed the significance of tools' user-friendliness, which was pointed by Babelon et al. (2017).

In general, the process of a planning task is highly dependent on the terms of reference for the assignment. This is to say that the consultant must deliver what the client hired the company to do, so it can be hard to take ownership of the process and come to an agreement with the client towards using new approaches, but also to change already established internal procedures that stakeholders are familiar with. It is only logical then that when considering new methods, the projects' terms of reference can pose a hard limitation in this regard. The discussions on local legal requirements during workshops emphasized the contextuality of my research. While in Danish consultancy co-benefit assessments might not follow normatives, they might be established processes in other parts of the world, and then altering an existing legally approved framework is a difficult and lengthy procedure. But having no established framework here also gave me more flexibility to suggest and test this method in collaboration with Rambøll. Another more unexpected issue to be considered arose out of the recent worldwide events. Due to Covid-19, WL only pursued digital engagement, as physical was not allowed for the following months. This raised the significance of having back-up plans and being prepared to adapt to various scenarios, as working in the social sphere can be met with surprising unpredicted situations. In situations that limit one to a web-based format only, reaching out to people might be problematic. For the Hekerbeekdal case, since the community was not aware of WL's plans for the area, we considered they would not feel triggered to use such a tool by themselves, so the method needs to be backed with separate, additional support in the form of publicity. Rzeszewski & Kotus (2019) noticed people are enthusiastic about engaging in such innovative activities as conducting tasks on the latest technologies. But even though my ads reached broad young audiences, aged 18-24, they showed no interest in the mapping activity and decided

not to pursue it. The capacity of GIS to attract more people does not seem to be the case for web-based solutions only. But my results are most probably influenced by the fact that the driver of this process was a student and people were aware nothing palpable would out of the study. In Hekerbeekdal it might be the case then, that the method might have acted as exclusionary.

As it was proven as one of the main drivers determining the level of usability (Rzeszewski & Kotus, 2019), a properly designed interface could work towards lowering the digital divide and reduce the investment in resources for facilitation, for facilitators without relevant expertise, and can thus be provided only with short training sessions. The experts favoured a good user experience too. During my workshops, they acknowledged the further contributions of the GIS tools' visual qualities regarding addressing illiterate people or groups with lower education. These were also identified as the primary contributor factors that contribute to the concept of digital divide (Rzeszewski & Kotus, 2019). Nonetheless, the user interface can make technology more accessible overall, (Aberley & Sieber, 2002; Ballas et al., 2017) besides addressing specific groups. That applies to the visual factor too, because spatial information is a demanding mental process (Rzeszewski & Kotus, 2019), which makes it hard to be comprehended not only by the marginalized but by the general public. The results and discussions with WL indicate that in the context of Hekerbeekdal, technology is accessible to elderly people and to those with lower levels of education. Rzeszewski & Kotus (2019) observed that even if age groups tackled the digital mapping differently and show different behaviours, the outcome of the mapping activities is similar. This contradicts some of the supporting drivers of the digital divide. Hence, Rzeszewski & Kotus (2019) drew the conclusion that age is not critical if offered the right support, that is directions and proper digital user experience. Narrowing down to very specific requirements for digital methods, the investigated research does not discuss the choice of basemaps, which can now be varied in terms of abstractization or fidelity to reality. Most tools offer multiple options that planners can choose from. In an abstract map names and text on the map are clearer, while in an imagery map, the physical environment can be distinguished with the entirety of its elements, as seen from top orthographic photography. Since spatial understanding is known to be strenuous, the choice of base layer would aid people's ease of carrying out the tasks, similar to how the user interfaces improve the process. In addition to the choice of specific features that citizens engage with, the drawn characteristics of the sites in question play a role too in citizens' ability to handle the tasks. We, planners, deal with clearly defined sites, but citizens may perceive boundaries in a blurry way. The difficulty of presenting citizens with isolated locations (de Vreese et al., 2016) occurs in Sankt Annæ, where people pinned values in a neighbouring plaza, that is more popular among residents. A church was also indicated, which is a closed space by the plaza. This can lead to debates about whether it should be included or not. Even

if it is a building, for the person mapping this point, the plaza might have a spiritual value because of it. All in all, the visual factor and the UI are key aspects in facilitation and general usability.

Through the empirical material, it emerged that team's and stakeholders' skills as well as software costs need to be considered by the team when a method that makes use of digital tools is pursued. Brown & Fagerholm (2015) distinguished the cost as one of the main drivers in the feasibility of participatory mapping approaches, which emerged from our discussion too. Rzeszewski & Kotus (2019) remarked that it was assumed web-based PGIS programs are more affordable, however my analysis shows otherwise. They became exclusivist tools, and the open-source ones are much burdensome to use. Nonetheless, they may be easier to scale and replicate. The discussion with our GIS expert concluded that the geo-spatial technology is expensive. This was further supported by the head of the department, who argued that GIS is hard to sell to clients. Brown & Kyttä (2018) also pinned as one of the key challenges with PGIS in environmental projects, the difficulty of promoting the value of the method from a management perspective. But also, in relation to facilitation, open source or simple tools are often required, as the budget might not afford for people's training and that is most usually the case. Babelon et al. (2017) take the issue of pricing further, looking at the effectiveness of the tool from an investment vs. gain perspective. They highlight that a good tool can spare resources.

A requirement from the team's perspective, deemed as critical for good incorporation in the workflow, was that for the pursuit of a digital method for citizen engagement, it has to be integrated with CBAs. Literature also accentuated that quantitative assessments are viewed as reductionist of the local contexts. Garbarino & Holland (2009), van den Bergh (2004) argued that the combination of qualitative and quantitative assessments would provide more accurate results of the reality on-site. The incorporation of the two was discussed with Thea, concluding that my suggested approach can be combined with quantitative assessments and typologies may be the connecting bridge, as the valuation process usually starts from a matrix of co-benefits.

All things considered, the considerations towards the adoption of a new method from the perspective of the planning consultant are to a great extent external factors, varied in terms of source, and to a lesser extent determined by the team, even though team affordances play a role too.

5.3 What are the implications of embedding citizen knowledge in the development of co-benefit assessments through GIS? Both for the consulting team and for the results of the assessment?

The main concerns in engaging citizens for co-benefit mapping processes, revolves around general issues about the assessments of values and participation, in terms of outreach. The difficulty of overlapping values has been raised in the literature, calling for attention to avoid double counting (Ürge-Vorsatz et al., 2014), but not as something that cannot be averted. Brown & Hausner (2017), Ürge-Vorsatz et al. (2014) and Pascual et al. (2017) consider that overlapping values occur due to the fluidity of values and synergies between services Brown & Hausner (2017). explain this can spur from a range of factors, such as biophysical or socioeconomic conditions and thus the overlap should be looked into from the perspective of the relationship between the values, though there are few studies in this area. This has been pinned down by colleagues from other departments that contributed to the field of research (Skrydstrup et al., 2020), who identified that the values vary depending on which decision lens you look through. While this represents an obvious constraint in the management of data, Ürge-Vorsatz et al. (2014) suggest that a far-reaching picture of values entails a careful examination of the relationships and interactions between values. Pascual et al. (2017) shared this view, suggesting double counting should be averted by bridging values in participatory processes, in a similar tone to Brown & Hausner (2017). However, this constitutes the primary limitation in generating an ultimate taxonomy of typologies. Distinguishing co-impacts, positive or negative, has been noted as challenging by Ürge-Vorsatz et al. (2014). Co-impacts are context-dependent and local circumstances dictate the type and scale of the impact. Thus, flexible frameworks to work in are necessary. My proposal is a method with a 'core' that is non-contextual (asking about the most preferred location), which can be built on with more circumstantial inquiries. The fact that assessment of place values, ecosystem services, co-benefits are variations of the same concept that maps place values based on typologies, represents a strength for my model because the methodology can be used for multiple purposes, as emerged from the workshops. The critique that co-benefit assessments do not enter quantifications (Favretto et al., 2020; Ürge-Vorsatz et al., 2014) does not seem valid for our team. That might be if CBAs are not seen as a continuation of co-benefit assessments, which is most often the case in for Rambøll Water. Co-benefit assessments are rather seen as a step in the CBAs. Moreover, I have found little evidence of methodologies for qualitative assessments.

The issue of conflict in the delineation of values, as mentioned by Signe, seems to be generally agreed upon by several authors (Brown et al., 2015, 2020; Brown & Kyttä, 2014, 2018). The positionality that non-experts encounter hardships in expressing values of places reflects the

rationalistic approach to planning, indicated by Lindholst et al. (2015). I believe using colloquial language and suitable terms for non-professionals, a more collaborative approach can be reached, by making the topic more accessible. Assisting people in a co-production of knowledge can work towards this, as argued by Garbarino & Holland (2009). Though it might not be applicable for any planning purpose, when it comes to benefits people get from the environment, this can especially be the case. Brown et al. (2020) maintained that place values can be easily understood when formulated appropriately. They argued that they can be operationalized in a way that makes them accessible to laymen and can enter a decision-making space. Skrydstrup et al. (2020) gives another perspective to conflicts, suggesting that they arise because depending on which stakeholder you are, a co-benefit to you might be a primary objective to others. But more importantly, what might be a benefit to one, can be a cost to others. Brown & Kyttä (2018) also mention the issue of reaching consensus between stakeholders as one of the main issues in PGIS. My results indicated conflict areas both in Hekerbeekdal and in Sankt Annæ, and in both cases, they arose not from the geotagged points, but from open-ended questions. In Hekerbeekdal residents signalled that priority given to traffic fluidity is in contrast with the calm people enjoy in the area, prioritizing thus noise reduction and care for the environment to efficient transport along the main street crossing the valley. In Skt Annæ, several residents signalled that there are plenty of uses for the plaza, but no dedicated space for dog-owners and multiple neighbours wish for a dedicated space for pets, as to avoid conflict with other users of the space. Both cases support Skrydstrup et al. (2020) point of view, that disagreements are different perspectives and priorities rather than divergences and appreciating these can offer possible options for mediation. On the whole, as implications for the co-benefit mapping outcome, both new values and conflicts arose from the application of the new method in Hekerbeekdal and in Sankt Annæ. These were rich not in terms of quantity, but in terms of the local specifics that came as additional information, provided as explanations by the citizens. As established in the workshops together with the experts, for proper prioritization of values, it is essential to get a good understanding of the source and particularities of the values. In addition, relating the values to precise service areas, give co-benefit assessments a useful new layer of information.

The conversation with B, and the samples from research (Appendix 11) were instrumental in realizing the significance of having different channels for getting in touch with the community, for reaching good samples and representativity. However, this implies high resource demands and from B's message, it was clear there was a strong driving force behind the project. The examples documented from research were not explicit however about the implications of their recruiting activity, most examples only outlining how they went about this. The discussion with B. also emphasized the contextuality around participation, which is very much linked to cultural and

historical identity. It is highly likely that residents in Hekerbeekdal did not show interest in my geosurvey as they were aware it may not lead to something tangible. Without any promotion or other actions, the chances would have been very low for residents to reach the geosurveys I launched online. But during the period the geosurveys were open, I could notice periods of peaks and lows in responses and relate them to my tactics, which determined me to try various alternatives. I aimed to stimulate participation, through online campaigns via social networks, but my means were limited. In Hekerbeekdal it was more difficult to find organizations that could mass distribute the survey, whereas in Skt Annæ I had a better overview. As I initially started only with the QR codes, the web-posts by WL and by myself, I then decided to follow up with the promotions and social media and the more direct ways of contact. Many people who engaged came through Instagram. Instagram is a photo-sharing platform, while Facebook focuses more on networking and written communication. The number of responses for Sankt Annæ grew from one day to another and it was not by chance. Since I was more aware of the context and of stakeholders, such as local associations, I tried a more direct approach when the survey stalled. Towards the end of the data collection, B. confirmed my then recently formed assumptions that for an efficacious outcome, multiple mechanisms are required. Therefore, the small number of replies should not underestimate and invalidate participation, as willing to participate is different when the process is run by other actors. The validity of the experiment is challenged by the fact that by being in an overt position, responses I get to my tested tool might be low. This might be caused especially because it is a student carrying out the research and not a company or another authority, so people might not feel as tempted or invited to reply and they might not take the research seriously. Also, as an international, it is difficult to get responses without a network in place, as social media is mostly a platform for informal communication. Nevertheless, the economists in the R&CBA groups underscored the high price that comes with outreach mechanisms, especially in live meetings and door to door approaches, which hinder the integration of such methods in planning projects. Overall, significant human and financial resources must be invested in promotional activities.

Altogether, the implications for using participatory processes are influenced by the planning task, in this case the mapping of co-benefits, but also by the tactics on conducting the citizen engagement process, and the outreach mechanisms are paramount in this respect, for methods that are only web-based.

6 Conclusion

My thesis conveyed the creation process of a methodology for mapping co-benefits in a participatory GIS approach. I have produced a unique method of identifying and spatializing co-benefits, that gives a new angle to the existing approaches in the absence of such methodology in the literature. It is unique in the sense that it includes citizens in an otherwise expert-led approach, but also more anchored in the reality of the daily life of citizens. The method is supported and enhanced by the identification of missing links in terminology, expanding on how co-benefits can be understood and framed in a wider context. The thesis presented the two test cases towards understanding 1) the character of co-benefits and 2) if digital platforms manage to successfully encourage people to participate 3) the uptake of the method in consultancy. The short time span did not allow for a collection of responses that could lead to generalization, but it did depict a picture of the high resources needed for outreach mechanisms to lead to effective results. My findings have shown that a single method cannot act as a one-size fits all. The choice of methods is guided by the context and the group characteristics and most of the time a method, be it digital or analogue, cannot be employed by itself, unless a specific group is targeted. An example for the method presented here, could be the situation in which the opinion of the residents in a student housing is being sought since the method is a good approach in reaching out to the young. An interesting finding is that technology seems to be one step ahead, and one can achieve almost everything with the help of apps. However, it is people's familiarity with such tools, new types of exercises that may hinder the utilization of digital methods. By working more with the digital, people will slowly start to understand them more and make progress in this transition. Therefore, the focus weighs so heavily in how to make the user experience better. But it is also a discussion of the planners' role since there is an intersection of different disciplines when it comes to GIS applications.

The contributions of community engagement have multiple dimensions that go beyond the planning task of co-benefit evaluations. Generally speaking, my empirical findings indicated that GIS adds value to projects and brings innovation. Using citizen engagement in GIS would cut on resources, making the process faster and the data easier to manage. The use of digital tools is encouraged both remotely and informal events on site. Visualizing data, which is implicit in GIS, would make any type of consultation more captivating, but also easier to understand for people (Ballas et al., 2018) lacking spatial understanding. Another value that lies in spatializing co-benefits is the ability to connect it to the service area, which would result in a picture of localized clusters of values, possible divergences or synergies. Rich mapping of places with value varying in richness and concentration holds the prospect of giving planners better grounds for reaching conclusions. It turns out that for a planning consultant, the local context and community's characteristics are essential when adopting

a PGIS method, as this needs to be shaped accordingly. The circumstances influence usability too and in this sense, technology accessibility is a critical factor to be considered. The digital divide may impact the outcome of the process, but a good overall user experience goes a long way and alleviate this issue. The projects' terms of reference acts as a backbone for the method, as it may hinder the flexibility in terms of choices to be made and consequently the results. The issue of double counting in co-benefit assessments and the formulation or view on values by various stakeholders, which is often conflicting, are two of the critical implications of integrating residents' views in the co-benefit mapping process. A more introspective factor stems from the resource demands posed by the necessary outreach process.

My research revealed that the process towards testing and implementing a new approach to a planning task is not always straightforward and the course may lead the researcher unexpected paths that have to be explored in order to be able to test a new method, steps that cannot be omitted, otherwise the process might not be fully informed. Such was the case when I stumbled upon the ambiguity in terminology, which hindered me in having a good overview of the literature and subsequent theory and finding an answer to this inquiry became an assignment as big as the development and testing of the method template itself. I believe consistency in the terminology (PGIS, place values, co-benefits) is called for both in research and in practice. Clear distinctions should be drawn between PGIS and participatory mapping (or paper-based vs digital), as it creates confusion regarding the approach. It makes a significant difference for the method if the participatory process is done on the field, with the help of facilitators and results being translated into GIS by an expert or if the collection is done remotely, and the participants do not receive any human supervision or guidance, other than the information they receive on the platform used for the exercise. GIS refers to a computer-based technology, so I fail to see why the term PGIS has been extrapolated and used for paper-based methods as well, even if they use 'maps'. Regarding place value terminology, I previously argued that place values look at existing, stable landscapes, while co-benefits scrutinize altered spaces. This implies that co-benefit assessments have a temporal dimension, which is challenging to capture even with the help of GIS software. According to Ballas et. Al (2018), one advantage in working with GIS is that the temporal context of phenomena is easier integrated and conveyed in GIS, due to the highly visual mode of operating. Using the temporal dimension in GIS is not very straightforward at the moment, but it is possible. Co-benefit assessments in IW&CR look at positive impacts and consider different options, ways in which you can improve the landscape, but the disadvantage is that they lack an overview of the disbenefits. ESIA's on the other hand only look at negative impacts and do not account for various options but consider only one model that is already settled. The way forward may be a more holistic approach, in which both positive and negative sides are accounted for and look at how these two opposite ends

intersect and influence each other in the physical space, for better informed solutions. A step towards this is studying the relationship between place values, co-benefits and on the other end, disbenefits and disservices. An attempt in this direction can be examined under Appendix 12. Moreover, Hekerbeekdal and Sankt Annae proved that the method is successful in mapping place values and co-benefits through a participatory approach that uses residents' input. Hence, I suggest assessments to be complemented by local knowledge, for an enhanced understanding of places, which would also contribute to diminishing the power relationship between experts and laymen.

My proposal was praised by the R&CBA group for the ability of prioritizing solutions and generating solutions that are more fitting into the local context. Brown et al. (2020) perceived an absence in decision making respecting soft concepts and Garbarino & Holland (2009) noted the interpretative leaps in relation to co-benefits, a prevalence for investigating the ones that have a materiality. Understanding these two tendencies, may explain the lack of uptake of citizen-powered co-benefit assessments into a decision space, as measurable values are the ones that support investments because they are tangible and easier for developers to vouch for, while the others might not give them enough credibility in front of the payers. Nonetheless, my empirical material indicates that stakeholders especially seek to obtain community contributions to make informed decisions. I contend that the issue might also be caused by the fact that it is not extensively used as a method, it is not seen as a common approach in planning and it did not become part of planners' usual toolkits. A positive outcome of my proposal is that innovation and research proposals can inspire people to test new solutions, to rethink out of fashion approaches and go the extra mile for doing things better, when that is not considered a priority. Although my thesis presents an early-phase prototype, it inspired both the team in the Waterboard and a few colleagues from the R&CBA group to consider adopting my proposal and integrate GIS-based citizen engagement for other projects.

My thesis is a bridge between theory and practice, highlighting links between several disciplines, demonstrating our necessity to work multidisciplinary. It is rich in that it produces both theoretical and practical knowledge. It does not produce a conclusive affirmation with respect to co-benefits and mapping methodologies, it rather ties ends together and opens the path to the exploration of these from other perspectives, such as consultancy and climate adaptation of landscapes. Thus, it gives space to professionals with diverse backgrounds to create their own frame of reference and learning points from this research.

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Appendix 1

Glossary of Abbreviations and Acronyms

AR – Action Research

CBA - Co-benefit Analysis

EIA – Environmental & Social Impact Assessment

ESIA – Environmental & Social Impact Assessment

GIS – Geographical Information Systems

IPCC – Intergovernmental Panel on Climate Change

IW&CR – International Water & Climate Resilience

PGIS – Participatory GIS

WL – Waterschap Limburg

R&CBA – Risk & Co-benefit Assessment

SIA – Social Impact Assessment

Appendix 2

Integrating qualitative and quantitative methodologies

“The merging of subjective and objective points of view would provide alternative ways of seeing the same object in different contexts, thus presenting an image of a city in a comprehensive manner”.

Sowińska-Świerkosz et al.,2020)

Integrating methodologies as suggested by Garbarino & Holland (2009).

1. Use survey to Identify sample for qualitative investigation
2. Use survey to emphasize priority concerns to be included in the qualitative research
3. Identify knowledge gaps to be covered by the qualitative research)

4. Qualitative research highlights which options are more important to people and their explanations, as qualitative research is highly contextual and should not be subject to standardization
5. Construction of indicators to complement the measurable aspects
6. Define population sub-group sampling frames
7. The qualitative analysis will ultimately generate the socio-demographic aspects for a quantitative survey.

Appendix 3

Taxonomy proposed by Ürge-Vorsatz et al. (2014)

Category of co-impact	Subcategory of impact	Description and supporting literature
Health impacts	Outdoor air pollution related	Energy-efficiency and fuel-switching measures typically reduce emissions of non-GHG pollutants harmful to human health (e.g., NH ₃ , SO _x , NO _x , PM, NMVOC, heavy metals, etc.), which has positive welfare effects in both developed (14, 42, 43) and developing economies (44, 45).
	Indoor air pollution related	Improved cooking stoves in developing countries reduce GHG emissions and alleviate the negative health effects of pollutants (e.g., CO, PM, black carbon) emitted by traditional biomass-based fuels (46, 47). Large-scale human health gains can be expected from the deployment of this technology as indoor air pollution is estimated to cause some 1.6 million premature deaths per year (48). Poor indoor air quality, related to the sick building syndrome, poses health risks to building occupants (49, 50) and can be potentially improved by energy-efficiency and some fuel-switching measures (51). Well-ventilated buildings reduce the presence of outdoor pollutants and can thus improve health and reduce allergies.
	Energy poverty related	Tackling energy poverty-related cold housing in developed and transition economies reduces excess winter mortality and morbidity (52–54). In addition to direct health impacts, cold housing has also negative mental health effects, e.g., increased stress and anxiety levels (55, 56). A large-scale deployment of renewable energy may result in an increase of energy prices and fuel poverty rates, as shown by Germany's energy transition (<i>Energiewende</i>) (57), which may increase cold-housing-related mortality and morbidity.
	Outdoor noise related	Climate investments in the buildings and transport sectors can provide additional protection against external noise, which has positive health effects as noise exposure is connected to a number of diseases and disorders (58). Nighttime noise may deserve particular attention because of the link between sleep disturbance and accidents (59).
	Transport and traffic related	Shifting from private car-based transport to active transport (e.g., cycling) and rapid transit/public transport is expected to reduce road traffic accident injuries, which globally kill 1.3 million people per year, and to prevent diseases related to obesity and physical inactivity, e.g., type-2 diabetes, heart disease, and some cancers (35, 60).
	Heat island related	More efficiently provided energy services can reduce the heat island effect and its related health impacts, i.e., heat-related deaths and illnesses (61) as well as those related to increased smog levels. Such changes can be especially important during extreme events, including heat waves, which are known to increase mortality rates (62, 63).
	Access, affordability, and energy poverty	Access to modern energy services
Affordability of energy services		In developed and transitional economies, residential energy-efficiency investments have the potential to significantly improve indoor thermal comfort levels and reduce the energy cost burden of households living in fuel/energy poverty (53, 67, 68). However, a rapid, large-scale deployment of renewables may have negatively affected the affordability of domestic energy services among low-income households, as shown by the <i>Energiewende</i> , energy transition, in Germany (57).

Category of co-impact	Subcategory of impact	Description and supporting literature
Comfort and living conditions	Thermal comfort	In developed and transition economies, improving the energy efficiency of buildings is reported to have positive effects in terms of the improved thermal comfort of building dwellers and users (69–71).
	Increased other comfort	Many energy-efficient alternatives represent advanced technologies compared to conventional ones and thus often have additional comfort impacts. For instance, high-efficiency lighting has much longer lifetimes, reducing replacement hassles, which is especially important for hard-to-reach fixtures, such as street lamps. The ventilation in high-performance buildings reduces indoor dust and thus cleaning needs.
	Exposure to noise	Residential energy efficiency and use of public transportation reduce human exposure to noise and mitigate GHG emissions (69, 72). However, some renewable technologies, e.g., wind turbines, increase noise levels, harming to some extent the well-being of the population living in surrounding areas (73–75).
Provision of ecosystem services		Ecosystems provide a wide range of provisioning, regulating, habitat, and cultural services (76) that can be potentially enhanced through changes in the emission levels of airborne pollutants (77) and by investing in activities that prevent deforestation and forest degradation, e.g., REDD+ (78), or harm through land-use changes, e.g., forest conversion for biofuel production (79). Renewables technologies, e.g., wind turbines, have an impact on biodiversity by killing birds, bats, and raptors. However, the turbine-related increase in avian mortality is several orders of magnitude below the fatality rates caused by vehicles, hunters, and cats (75).
Damage to building materials		Climate investments can reduce air pollution levels, which results in less damage to buildings and building materials (e.g., stonework erosion and blackening) that can be of particular concern for culturally significant places, e.g., historic buildings (80, 81).
Productivity	Performance of individuals and organizations	In public and commercial buildings, such as offices and schools, better temperature control, indoor air quality, and lighting positively influence the performance of users (82–84). The change in tropospheric ozone emissions from transport is demonstrated to have a significant impact on the productivity of agricultural workers (85). High-efficiency industrial processes improve competitiveness, and many energy-efficient processes also improve process efficiency/productivity.
	Crop yields	The productivity of agricultural land is also known to be affected by the atmospheric concentration of pollutants, e.g., the precursors of tropospheric ozone, NO _x , CO, CH ₄ , and NMVOCs (86). However, some airborne pollutants, e.g., SO _x , have a fertilizing effect on some crops that is beneficial for agricultural productivity (87).
Energy security		Energy security has been defined as the ability to guarantee an “uninterrupted provision of vital energy services” (2, p. 805) and includes the robustness, sovereignty, and resilience of energy systems. It has been estimated that most of the world’s countries are vulnerable to energy security threats by at least one of these three concerns (2). Climate policies that reduce a nation’s energy demands lessen the external risks associated with the consumption of imported energy, e.g., a sudden supply disruption and higher long-term energy costs (88), which are particularly relevant in energy-dependent economies. For the same reason, energy-dependent countries may be tempted to apply measures that conflict with climate goals, e.g., switching

Category of co-impact	Subcategory of impact	Description and supporting literature
Macroeconomic effects		<p>Climate investments are expected to have positive macroeconomic impacts in terms of additional economic growth and employment creation when an economy is operating below its potential production level. Such positive net effects have been repeatedly reported for renewables and energy-efficiency investments in developed economies (89–93).</p> <p>In some developing countries, the production and commercialization of biomass-based energy both for local consumption (firewood) and export-oriented fuel (biofuel) are part of a thriving economic sector with the potential for additional gross domestic product growth and employment creation (94, 95).</p> <p>However, positive effects on employment are not permanent: In the case of renewable power in Germany, after a few years, job losses associated with the increase in the price of electricity may offset the investment-related positive effects of renewable power on employment (96). In the case of building energy efficiency in Hungary, growing permanent job losses in the energy generation and distribution sector may result in negative employment effects after two or three decades (97). Related to this, some climate investments result in unemployment in sectors like energy distribution, which may increase alcoholism, spousal abuse, and increased mental health problems among laid-off employees (8).</p>

The set of factors for selecting the co-benefit mapping technique

- Location of the studied projects - Brown and Fagerholm; Lindholst - The geography in which the projects were carried out together with scale and sample are imperative as they change the course of action, (as research and my empirical collection signposted () the importance of the circumstances for the outcome)
- Mapping technology - Brown and Fagerholm – Significant for user-friendliness (both consultants and target group), but also in observing the extent of the uptake of digital methods
- Mapped services - Brown and Fagerholm - In order to understand the way the methods engage with landscape and ecosystem service/value mapping typologies
- Sponsor of the project - looks at whether the contexts are similar to the ones I am situated in
- Tools – highlighted what tools were used in the cases, to understand how they performed
- Scale - Brown and Fagerholm; Lindholst – important because it dictates how the sample is managed and influences the richness of the responses
- Deployment – user perspective -can the method stand by itself or if other type of facilitation is necessary?
- Spatial mapping method - Lindholst, Scholte - explain the range of mapping methods
- Outreach mechanism - appeared as critical at the end of my empirical data collection, weighing heavily for the success of the method; has been investigated after the surveying started, as it arose later as a relevant indicator
- Benefits - Nummi, Scholte - note more subjective considerations of the methods
- Challenges - Nummi, Scholte - note more subjective considerations of the methods
- Sample - Nummi, Scholte - Investigated the audience the method reached
- Planning question addressed - Brown and Fagerholm; Lindholst - Critical to understand the precise scope of the method and how they engage with place values
- Integration in practice - Lindholst – Integration in practice and furthermore in decision making have been perceived as one of the major issues in the literature () fur further uptake, so the criterion looks at methods that stand out in this regard, whether it was adopted in real-life planning

- Emerging/leading to a typology

Looking at the cases included in the methodology assessment framework, a lot of the methods are concerned with sites of considerably larger size than Hekerbeekdal and Skt. Annae. However, no noticeable difference could be traced between methods of different scales. All the methods are applied in the Global North, which suggests their suitability for my context, but might also imply that different approaches for the Global South may be called for. An advantage is that there are a lot of very recent research examples. The disadvantage on the other hand is that the documented projects are carried out within the same country, so they do not discuss cultural and language barriers, which is a challenge in my study. Most of them used pins as the georeferenced element indicated by laymen. This hints at the probability that polylines and surfaces are complicated, as literature has proven the effort needed to comprehend spatial elements. The time frames for data collection seem to be relatively long, spanning over months or stages over years. This helps acknowledge that having a big sample in a short period of time is not feasible, but also what a consultancy should expect in terms of time commitment for such a project.

Appendix 5

The geosurvey questions

1. Please indicate your favorite place in the area
2. What values does this place represent for you?
3. Please tell us more about why you enjoy this place.
4. Which are the most attractive elements here?
5. Is the studied site located in the proximity of your place of residence?
6. How often do you visit?
7. Please indicate your travel time.
8. To which means of transport does the indicated travel time correspond?
9. Do you have additional comments?

One of the cases included basic personal information:

1. What is your gender?
2. What is your age?
3. What is the highest level of education you have completed?

Appendix 6

- Cost – Babelon – was deemed to be a decisive factor in the uptake, both in research and in practice, as resulted from the workshops with stakeholders
- Integration with software - selected from the workshops- is important because it would make the process easily incorporated in current work in the office.
- Languages - selected from the workshops – having automatic translations would cut on resource demands when working internationally
- Field/remote - selected from the workshops – the tool must have the capacity for remote work, but features for field work are a great advantage, as it lowers the need for multiple platforms

- Mobile/desktop - selected from the workshops – working across platforms is a great advantage, for a good outreach but also for fieldwork
- Online/offline - selected from the workshops – for our team, that works in multiple settings, it is best if the tool worked both online and offline
- Features - Babelon – The capabilities of the software are crucial in accommodating the planning task in question
- Need for account - selected from the workshops - Having no need for an account would improve accessibility
- Overall scope - selected from the workshops – indicates which planning task the tool can address, but also analyzed in connection with its customizability, can indicate to which other tasks it can be tailored
- Access to documentation - selected from the workshops - when a tool is adopted, people should be able to easily get up to speed with it
- The resource demands – adapted from Lindholst and Babelon - were broken into a few criteria: UI, time needed to learn the tool and the need for expert knowledge
- The user interface criteria were studied subjectively, through my own experience of the tools (the experienced of a medium advanced GIS user). It was studied not only in terms of difficulty, but what hinders or enhances usability. E.g. in field maps, when you want to add a pin and try to move it, you start drawing – one should cancel the other. It seems from the profile menu that you can add pictures but cannot find this option. The line markups are very imprecise since you draw freehand – you should have to possibility to select a straight line/shape as well
- Benefits - Nummi, Scholte - subjective evaluation of the tools
- Challenges - Nummi, Scholte - subjective evaluation of the tools

Appendix 7

Source	cyborg ppg	from ws; adapta	from ws	from ws	checkref1	Mine	Mine-v			
Software	Cost	Integration	Languages	Field/remote	Mobile/de	Online/offline	Features	Need acc	Overall scope	Access
Survey 123	Paid	ArcGIS, Hub, Qu	Multiple	Both	Both	Both	Surveys with pin: Yes	Yes	Geosurveys	Yes
Kobo Toolbox	Free	Exp	Multiple	Remote	Both	Both	Current location, No	No	Geosurveys	Yes
Crowdsourcer reporter	Paid	ArcGIS	English	Both	Both	Only offline	Attach photos; y	Yes	Geosurveys	Yes
Web app builder	Paid	ArcGIS	English	Remote	Both	Both	GPS route tracki	Yes	Highly customizable geolocate	Yes
Smart Editor widget	Paid	ArcGIS	English	Both	Both	Both	Surveys with pin: Yes	Yes	Highly customizable data inter	Yes
Experience builder	Paid	ArcGIS	English	Remote	Both	Only online	Communication; Yes	Yes	Highly customizabl data intera	Yes
Maptionnaire	Paid	Exp	Multiple?	Remote	*	Only online	Communication, Yes	Yes	Consultation, information	Yes
ArcGIS Hub	Paid	Not necessary			Both		Communication, Yes	Yes	Consultation, information; flex	Yes
Cartice/Debatomap	?	?	Multiple	Remote	*	?	Communication, pins, sur		Consultation, information	?
CoUrbanize	Paid	*	*	*	*	*	Communication, pins		Consultation, information	?
Mapping For Change	Paid	*	Multiple	Remote	*	*	Communication, No	No	Consultation, information	*
CommonPlace	Paid	*	*	*	*	*	Communication, pins, pol		Consultation, information	?
Qfield	Free	QGIS	English	Field	Mobile					Yes
Field maps	Paid	ArcGIS	English	Field	Mobile		Skechting, pins, i	Yes	Field data collection	Yes
Quick Capture	Paid	ArcGIS, Survey1	English	Field		Both	GPS route tracki	Yes	Field data collection	Yes
Sapelli	Free	*	icon-driven	Field		Both				Yes
Cybertracker	Free	ArcGIS online		Field	Both; Andr	Both			Field data collection	
Gvsig Mobile	Free	Gvsig desktop	Multiple	Field	Both; Andr	Both				
Geopaparazi	Free	Qgis, Gvsig		Field		Both			Qualitative surveys	
Kobo Collect	Free	Kobo Toolbox	Multiple	Field		Both		Yes		Yes
GeoODK	Free	ArcGIS online, ODK		Field	Mobile; An	Both				Yes
OpenMapKit (OmK)	Free	ODK		Field	Mobile; An	Both				
OpenDataKit (ODK)	Free	Kobo Collect; ODK		Field		Both				
GISCloud	Both	QGIS, ArcMap		Both	Both	Both	GPS route tracking, pins, p		Field data collection and basic GIS cap	
Geoform webapp	Paid	ArcGIS	English	Remote			Records only location of collection; similar to Kobo, Kobo more c			
Emotional maps	Paid	*	English, Polish	Remote			No	No	Feeling mapping survey	
Soives	Free	QGIS	English	Remote	Desktop	Both	Data analysis		Social value mapping and anal	Yes
Mapbuilder	Free for An	ArcGIS	English	Both				Yes	Land-use monitoring	

Expert	UI	Time to un	Paradigm	Benefits	Challenges	Link
No	1	5-10 min	Smart city	Easy and straightforward set-up	The survey can record only one question	https://www.esri.com/en-us/arcgis/products/index
No	1	5-10 min	Humanitarian	Very straightforward, but lacks a bit of	You cannot include a map extent; not v	https://www.kobotoolbox.org/
Yes	3	2 hrs	Smart city	Users can anonymously submit nev	three different applications	https://solutions.arcgis.com/local-government/help/crowdsc
Yes	1	15-30 min	Smart city	You can create a template	Difficult set-up for offline work	https://www.esri.com/en-us/arcgis/products/index
Yes	3	2 hrs	Smart city	Can vote points	Not intuitive for citizens	https://www.esri.com/en-us/arcgis/products/index
Yes	2	15 min	Smart city	It embeds Survey 123	The survey can record only one question linked to a map	
No	*	*	Communicative	easy import to Arcgis; used for 50+ projects by consultancies and administrati		https://maptionnaire.com/
Yes	1	15 min	Smart city	Customizable with various apps		https://www.esri.com/en-us/arcgis/products/index
No	*	*	Communicative city; community-driven		No info how to acquire	https://debatomap.reperageurbain.com/
No	*	*	Communicative, inclusive city			https://www.courbanize.com/
No	*	*	Communicative, inclusive city			https://www.commonplace.is/
Yes	1				Needs desktop set-up with plugin	https://qfield.org/docs/index.html
No	1/2	5-10 min	Smart city		Needs desktop set-up	
No, ju	1	15 min	Smart city	Highly visual; Good predefined templates; easy to customize; best interface for fieldwork with people		
Yes					Programming skills needed, seems fast	http://www.sapelli.org/
No	1	5 min		icon user interface design		
						https://blog.gvsig.org/category/products/gvsig-mobile/
					Programming skills needed	https://www.geopaparazzi.org/#/
No	1	5 min	Humanitarian			
		15-30 min		Geoodk, omk, odk work togethe	Surveys setup in excel: for all 3 you need	http://geoodk.com/
		15 min			Rudimentary; XML knowledge required	http://openmapkit.org/
Yes		15 min			Quite rudimentary; Needs setup and X	https://opendatakit.org/
			Rationalistic		not designed for citizen engagement	https://www.giscloud.com/
					cannot modify question headlines	
					very early stage; English version faulty	https://www.pocitovemap.cz/?fbclid=IwAR2Wt0700v1q7ZrF
Yes	3	>2 hrs		For analysis and valuation of already di	predefined value types: limitation	https://www.usgs.gov/centers/geoscience/social-values-er
	*	*	Humanitarian	Does analysis, land-use monitoring	Not dedicated for citizen engagement	https://www.globalforestwatch.org/mapbuilder/ https://my

discarded as the old version was faulty and the new one did not offer any solutions on how to acquire. Mapbuilder was discarded because it has a very narrow purpose, that of land-use monitoring

(yellow highlight – apps only for field data collection; blue – apps only for communication of information; red – only for analysis)

(Question mark in the table indicates where the information was missing.)

(‘Extensive outreach mechanisms’ refers to the use of a variety of methods to recruit respondents. The examples show they appealed to many options: face two face meetings, phone calls, reaching out to key organizations or actors from the community, websites, social media, newsletter etc.)

Appendix 8

Crowdsourcing would be ideal from the consultant's or planner's perspective, because a lot can be achieved, while Survey 123 is just limited to a survey format. What is lacking is guidance and additional written information. Crowdsourcing reporter is the most complex tool: it has a login page, a splash with instructions or other information, it can set a map extent. Participants to the exercise can see what others wrote or pinned on the map (in the others it is not possible), but also comment or vote. It is highly customizable but has a less user-friendly experience. But Survey123 is a bit more pleasant to the eyes, it has improved aesthetics, so it is easy for people to read. Kobo is a free tool that helps you build georeferenced surveys. It is a very simple tool, but the advantage that you can work across languages. Moreover, a map extent can be set in Survey123, which is not possible in Kobo. For Kobo however, you cannot set the scale in advance. Kobo can be integrated in a website, used by itself, and also has automatic language translation. Overall, Survey123 adds a tiny bit more complexity compared to Kobo and also needs less resources, as there is no need to export because results go directly in a GDB. ArcGIS HUB is a website building platform trimmed for planning communication needs, which is good that you can accompany the tools with instructions. A good format and designed to integrate maps, engagement of multiple forms etc. Maptionnaire is similar to HUB, but less customizable: it is dedicated for data collection from citizens. It has an interface where you can show people how to use the tool. This would be useful for other apps too, for those parts that necessitate more advanced spatial and technological skills (e.g. drawing precise polygons/polyline).

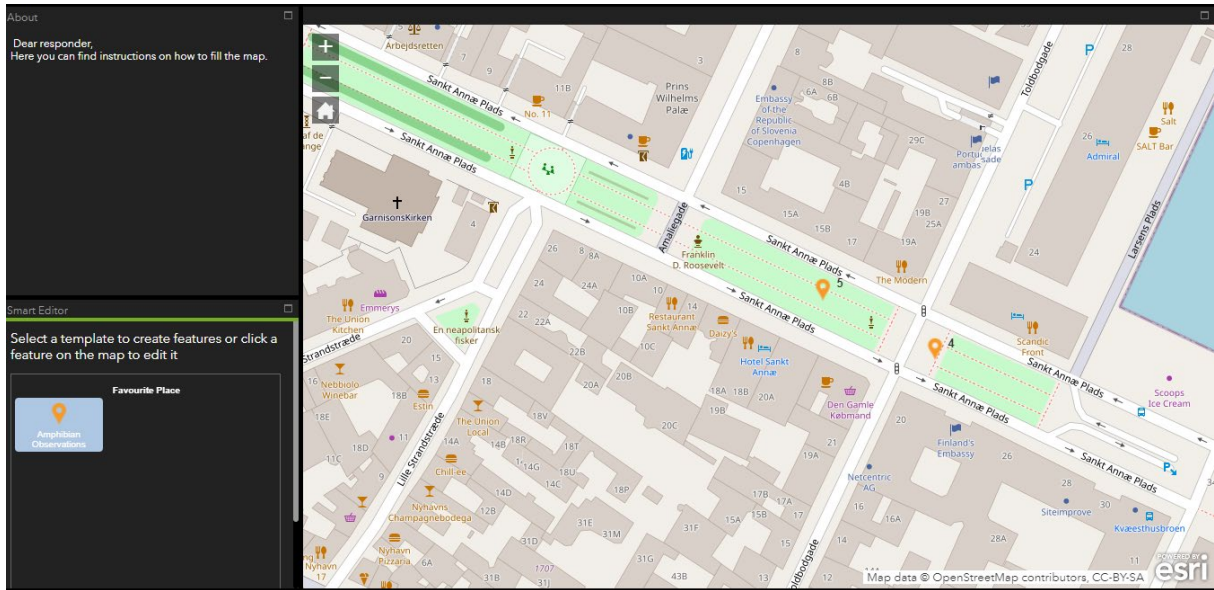


Fig. Smart Editor

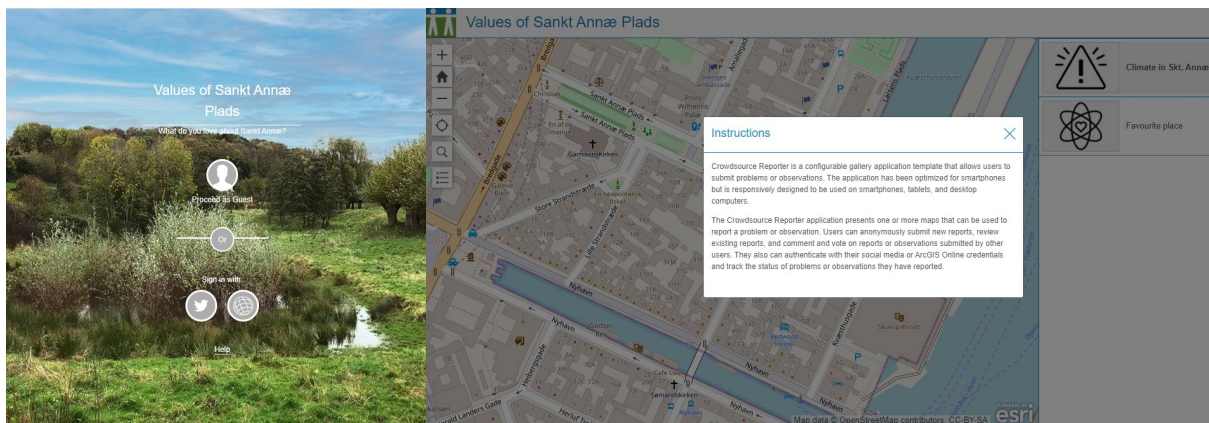


Fig. Crowdsource reporter

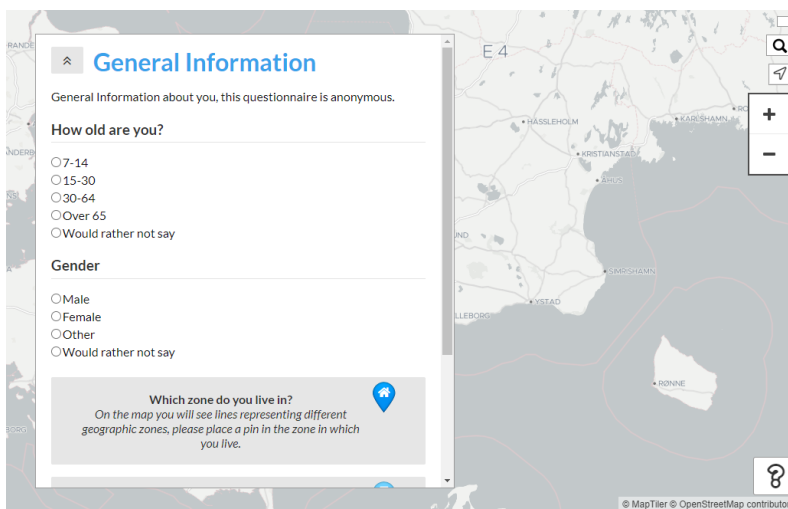


Fig. Maptionnaire



Please follow the instructions in the video for more details on how to fill in the surveys

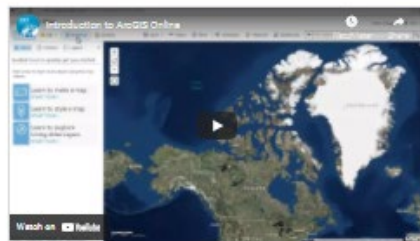


Fig. ArcGIS HUB

Appendix 9

Workshop with the social scientists

Appendix 10

Tool assessment with the two stakeholder groups

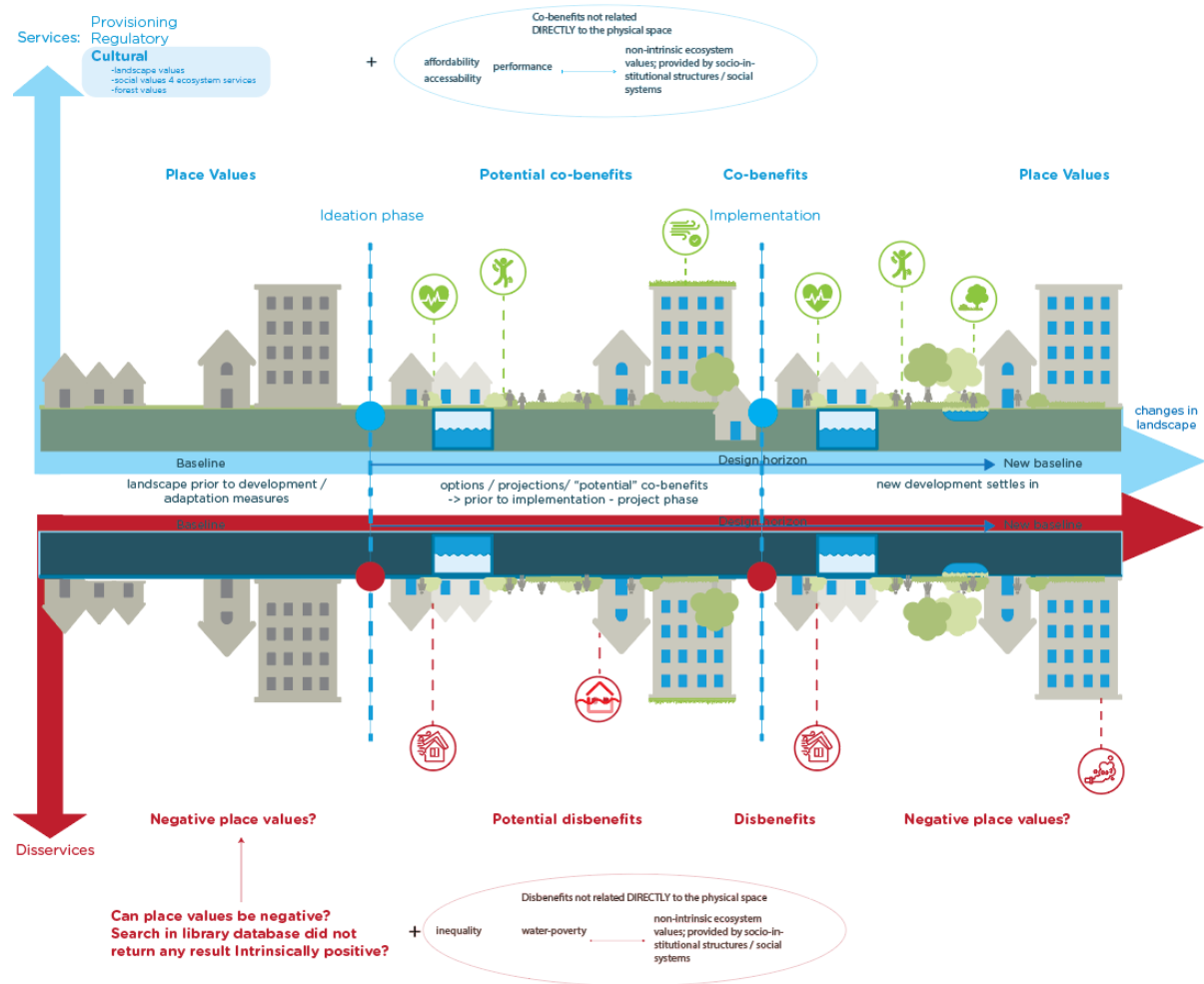
Mock-ups	Advantages	Disadvantages
Kobo Toolbox	-Open-source	-Additional information next to the map that might be confusing (latitude, longitude) that cannot be hidden
	-Multiple maps can be included	-Not having the output directly into a GDB is a minor inconvenience
	-Recording the coordinates at the location of registration (It finds your location)	-Only one map with only one point that can be recorded
	-Working cross-platform (mobile tablet desktop)	-Extra effort needed to make the interface pleasant
	-Ability to attach documents	-Map extent cannot be set
Survey 123	-Automatic QR codes considered a great feature, they can be sent to people's mailboxes	- Drawing polygons is complicated, takes too long and sometimes unresponsive
	-The approximation of shapes in the polygon feature is useful	-Only one map with only one point that can be recorded
	-Dropping pins is very easy	
	-Automatic statistics a huge advantage	
	-Interface feels nice and engaging	
	-working cross-platform (mobile tablet desktop)	
	Ability to attach documents	
	-Information about the project can be integrated in an engaging way	-Not intuitive; very technical look with a lot of information

Crowdsource Reporter	-Highly customizable	-Lack of clear steps: first you are shown what other people replied, the focus is not on what you can do
	-Voting and commenting features	-Cannot be used standalone, needs to be integrated in a website
	-Seeing other people's input	-Instructions are not very obvious when integrated
Smart Editor	-Interface is configurable, leaving a lot of room to improve the user experience	-Cannot be used alone, needs to be integrated in a website
	-Offers guidance as you go, next to the pointer, which is helpful for the participants	-You start working from a legend and people without technical knowledge may not understand the abstractization behind legends and templates, which calls for a different approach (e.g. starting from a question)
		-Introduces bias: results shown first
Maptionnaire	-Seems to be the in-between solution	-Still complicated or overwhelming, but might be due to the format of the mock-up
	-Navigation seemed easier on the phone	Can be structured in a different way
	-More intuitive	Complicated to navigate multiple maps

Appendix 11

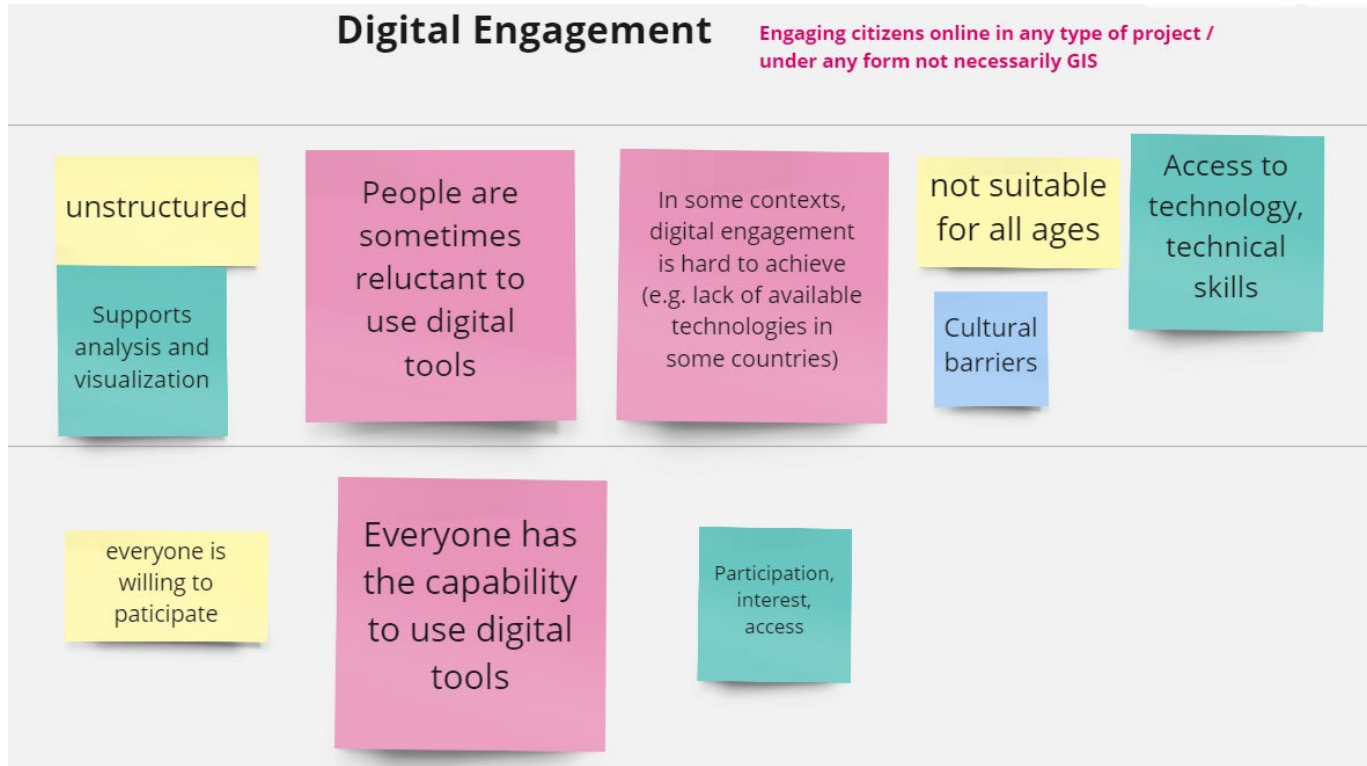
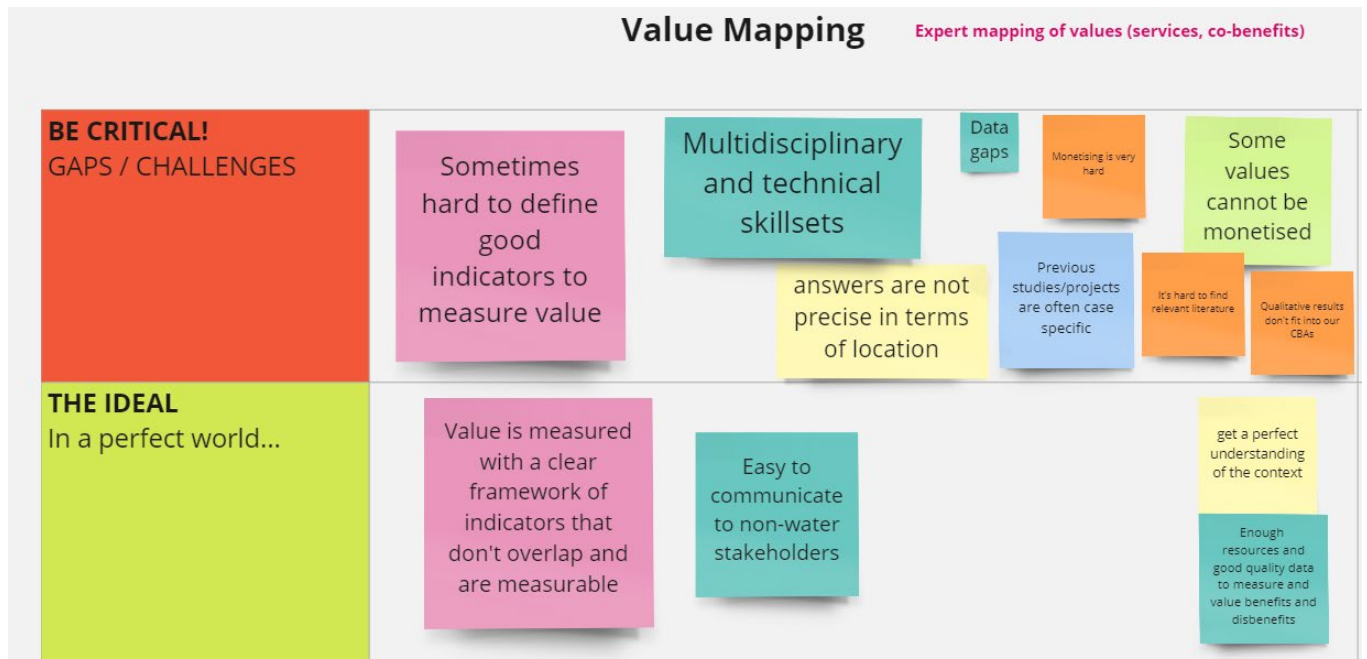
Year	Location	Mapping technology (paper-based or not)	Mapped services/values	Sponsor/Leading actor	Tools	Scale	Deployment	Spatial mapping method	Nummi	Nummi	Nummi	Brown and Lindholm	Self-selected		
2020	Madagascar	Paper-based	Pre-defined typologies	NGO	-	Regional	Mixed: interviews, focus groups	-	-	Methodology is not described	1032	RCQ: Co-located task/question on in-practice	Favretto et al. 2009	Leading to a typology	
2019	Sweden	Web-based	Pre-defined list of attributes	Administration and research	?	Local	Standalone	pins	Only web-based	Methodology	Developed	Yes	Emerging	Extensive promotional	
2006	Sweden	Digitized paper-based	Social values	Research	Quatrics: Solves	Regional	Standalone	Pins	Cross-referenced	reduces cost?	667	Perceptio	Riper et al., 2006	Emerging	Extensive mechanism
2020	USA	Both	Pre-defined social values of ES	Research	Maptionnaire	Local	Standalone	Pins	Asking for the importance of	250	Assessment	Vejrø et al., 2016	Emerging	Household survey	
2020	Spain	Web-based	3 cultural ES	Research	Survey123	Regional	Standalone	Pins	Combined with	80% responder	684	RCQ: Descriptive	Sherrouse et al., 2016	Emerging	Mails
2005	USA	Digitized paper-based	Aesthetics; recreation (ES)	Research	Survey123	Regional	Standalone	Pins	Scale to assess	Data assessed	80	RCQ: Method	Sovirnska-Sylva et al., 2016	Emerging	University recruitment
2020	Poland	Both	Pre-defined landscape values	Research	Survey123	Local	Through interviews	Pins	Statistical analysis	93	Mapping	Pieninger et al., 2016	Emerging	On-site recruitment	
2012	Germany	Digitized paper-based	Cultural ES (MEA)	Research (students)	?	Local	Through interviews	Pins & polygons	Combined with	Low response	468	Crowdsourcing	Muñoz et al., 2016	Emerging	Mails and on-site recruitment
2019	Norway	Web-based	Pre-defined typologies	Research	Custom website	Regional	Standalone	Pins	Combined with	Low response	780	Social interaction	Brown, Reed et al., 2016	Emerging	Mails
2012	USA	Web-based	Pre-defined landscape values	Research	Standalone	Regional	Standalone	Pins	Asked to provide	low response	242	Identify participants	Morse et al., 2016	Emerging	Mails
2020	USA	Digitized paper-based	Pre-defined landscape values	Research	Standalone	Regional	Standalone	Pins	Also in a rural area - may refer	?	38	How social	De Vreese et al., 2016	Emerging	On-site recruitment
2016	Belgium	Digitized paper-based	Pre-defined MIA	Research	Paper-based	Regional	Through interviews	Polygon	Investigates the costs too	?	-	Social interaction	Rogers, Tevelin et al., 2016	Emerging	On-site recruitment
2009	Australia	-	Financial and non-financial	Public agency	Paper-based	Policy	Standalone	-	-	-	-	Social interaction	Richards-Rislove et al., 2016	Emerging	On-site recruitment
2013	USA	Digital	Social integration	Research	ARGIS	-	Standalone	-	-	-	186	Discusses	Nummi, 2016	Emerging	Extensive mechanism
2018	Finland	Web-based	Cultural heritage	Research	Maptionnaire	-	Standalone	-	-	-	-	Discusses	Nummi, 2016	Emerging	Extensive mechanism
-	Developing countries	Paper-based	Pre-defined typologies	Govt. agency	Paper-based	-	Through focus groups	-	Mixed method	reduces cost?	-	Yes	Nummi, 2009	Leading to a typology	

Appendix 12



Appendix 13

Miro Workshop with the R&CBA group



Participatory mapping ? Including citizens in a process of mapping values

People don't agree on what's important

Requires a lot of structure

Added values are very subjective

People don't agree on prioritisations

Appendix 14

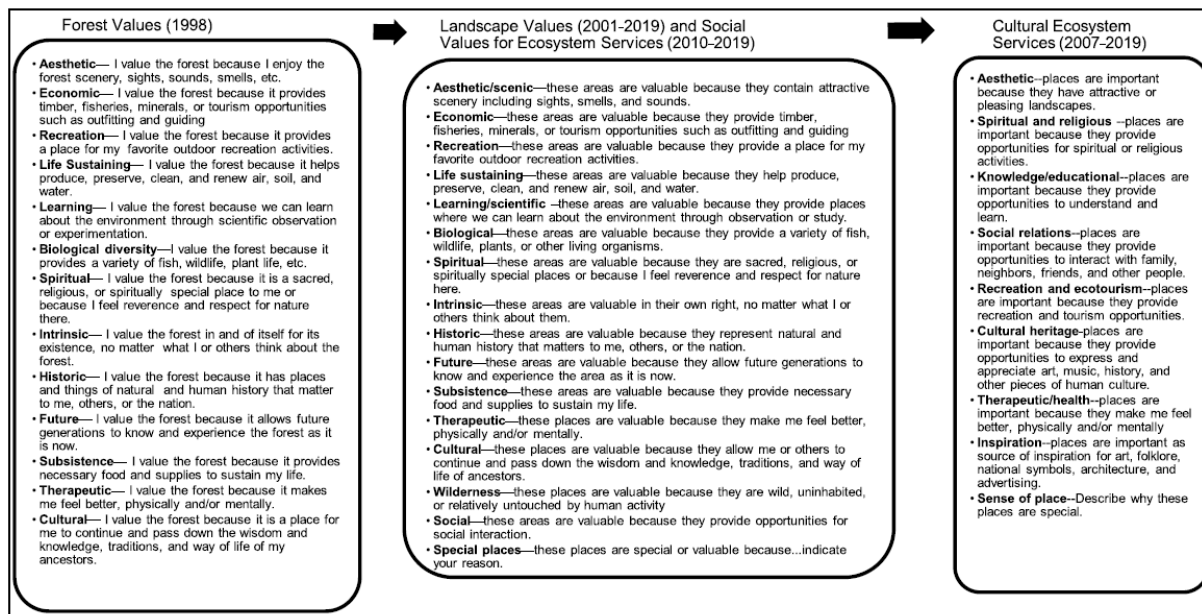
Other pictures attached by respondents





Appendix 15

Historic evolution of place values typologies



Source Brown et al., 2020

