Biodiversity and the Smart City: How can citizen science increase co-operation?

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Abstract

Biodiversity has suffered huge declines in recent decades. Meanwhile, smart city initiatives have become very popular in urban settings as a way of tackling society's problems. The purpose of this study is to look at the extent to which smart city initiatives and urban biodiversity practitioners currently co-operate, to explore factors promoting or hindering co-operation, and to identify how citizen science can synergise the two domains. The study applies an abductive approach to qualitative data produced from a case study of the city of Stavanger in Norway. It draws on document analysis and semi-structured interviews with representatives from public and private smart city actors, the municipal administration, environmental NGOs and academia. The results are discussed using the governmental inter-organisational information integration (GIII) theory of cross-sectoral integration. The research shows that smart city bodies and biodiversity practitioners have had very little contact. Although environmental issues are included in smart city initiatives, this inclusion remains largely limited to issues related to energy use and reducing greenhouse gases. Perceptions of the smart city are key determinants of the willingness to co-operate. In particular, the perception that technology is fundamental to smart city projects presents a key barrier to collaboration. Citizen science approaches have a range of applications in local biodiversity projects, and the skill sets present among smart city actors can be useful in advancing such projects.

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Introduction

Biodiversity has been declining across the world as a result of human activity and we are currently entering a period which some are calling the sixth extinction. Despite a growing number of international agreements aimed at protecting habitats and biodiversity, the rate of decline continues to accelerate (WWF, 2020).

The year 2020 saw the expiration of the Strategic Plan for Biodiversity 2011-2020, also known as the Aichi targets. A new UN Biodiversity Conference, originally planned to take place in the Chinese city of Kunming in October 2020, but postponed due to the Corona virus, will establish a new set of post-2020 targets under the auspices of the Convention on Biological Diversity (CBD). Although some progress has been made since 2010, only six of the twenty Aichi targets were partially achieved, and none were fully achieved[1] (Secretariat of the Convention on Biological Diversity, 2020).

While there is acceptance that the world is facing a biodiversity crisis, the issue has mostly been overshadowed by the climate crisis in recent years (Legagneux et al., 2018; Veríssimo, MacMillan, Smith, Crees, & Davies, 2014). However, my own impression, backed up by a search on Atekst media archive (Mediearkivet.no, 2020)[2], is that biodiversity now seems to be making a breakthrough into public consciousness, after a series of negative reports have gained widespread media coverage. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report states that up to a million species are at risk of extinction presenting a threat to human survival (Watts, 2019). The recent Living Planet Report 2020 produced by the World Wildlife Fund (WWF) has presented data showing

[1] Aichi targets: Goal 9 tackling invasive species was partially achieved with threats identified and some successful eradication projects implemented, but there has been a lack of progress on limiting the spread of invasive species. Goal 11 on the protection of land and marine areas looks likely to be achieved, but is not protecting the most important areas, they are not connected and are often managed inequitably. Goal 16 Enough countries have signed up to the Nagoya Protocol on access to genetic resources for it to come into effect, but it is not necessarily operational or in line with national legislation in many of the countries who have signed up. Goal 17 has also been partially achieved with many countries having submitted NBSAPs (national biodiversity strategy and action plans) but the implementation of these plans is variable. Goal 19: Knowledge about threats to biodiversity has been improved significantly, but there are still gaps concerning how this affects people, and there is limited use of biodiversity knowledge in decision making. Goal 20: Money being made available for biodiversity concerns has more than doubled, but is not enough and is far less than the funds being directed to activities harmful to biodiversity.

[2] A search on the Norwegian terms *naturmangfold* and *biologisk mangfold* shows a doubling in the Norwegian print media from 2018 to 2019. The terms were used 1560 times in 2018 and 2970 times in 2019.

that animal life has declined by around 68% since 1970 (WWF, 2020). Non-fiction books such as Elizabeth Kolbert's *The Sixth Extinction* (Kolbert, 2015) have also introduced growing numbers of people to the science surrounding biodiversity loss. Kolbert has won a Pulitzer Prize for the book (pulitzerprize.org, 2020), as well as generating mainstream media coverage with the author appearing on popular TV shows such as *The Daily Show with Jon Stewart*.

Population growth is one of the five main drivers behind biodiversity loss, alongside habitat loss, invasive species, pollution and overexploitation (McCormick, 2018). At the same time urbanization is increasing, with over 50% of the human population now living in urban areas (United Nations, 2019). Habitat loss is driven by land lost both to agriculture and to urban development. It is therefore clear that there is a link between urban growth and biodiversity loss, especially if we take into account that agricultural habitat loss is driven by the need to feed the increasing urban population (Müller & Werner, 2010).

Despite being a driver of biodiversity loss, cities are also central in driving sustainable practice, presenting both "the problems and solutions to sustainability challenges of an increasingly urbanized world" (Grimm et al., 2008, p. 756). The growth of cities will continue to impact biodiversity negatively if we follow traditional thinking where nature and human society are mutually exclusive, where nature can thrive only when it is isolated from humankind. With the arrival of the Anthropocene era, in which humankind's effect on the Earth and its systems is so great that it is often discussed as representing a new geological era, society increasingly affects the biophysical environment (Steffen, Grinevald, Crutzen, & McNeill, 2011). It is clear then that humans need to find ways to live in harmony alongside other species if society is to prevent impacts from further biodiversity loss. This should include promoting biodiversity in urban areas.

Many municipal governments across the globe recognize the importance of sustainability and are working to become more sustainable. The trend towards smart city projects typifies this desire of cities to improve sustainability. The smart city concept has spread across the world, and there are currently between 30 and 50 smart city initiatives in Norway alone (Kommunal og moderniseringsdepartementet, 2019). However, the definition of what it means to be a smart city can be hard to find (Caragliu, Del Bo, & Nijkamp, 2011). Indeed, the term sustainability itself can be vague. Even if there is an accepted definition of the term sustainable, there is room for the term and definition to be interpreted in many different

ways according to the perspective and interests of the actors using the term. With the concepts of both sustainability and the smart city being somewhat unclear, questions will also therefore arise about the extent to which we can say that smart cities are or should be sustainable.

Climate change and the importance of reducing greenhouse gas emissions has dominated environmental policymaking in recent years, perhaps at the expense of other environmental issues. Such challenges are visible with issues such as the status of wind energy in Norway, pitting different elements of the environmental movement against each other in a struggle of climate versus nature. Similarly, in smart city projects an intended focus on the environment is often limited to a narrow focus on energy saving, rather than seeing environmental concerns as a broad and complex range of issues. Claims of sustainability by proponents of smart cities are therefore undermined by this narrow focus on energy, and smart cities must address a wider range of environmental issues before their claims of becoming sustainable can gain public legitimacy.

Advancements in technology have given rise to a flourishing set of citizen science approaches in recent years. This has had a large effect on conservation biology in particular. Members of the public can easily record and verify sightings, as well as gain access to recordings made by others. Although large scale citizen science projects such as the *Big Garden Birdwatch* in the UK to a large extent influence how many people think about citizen science projects, there are large variations in the scale of and methods used in citizen science (Arts, van Der Wal, & Adams, 2015; Bonney et al., 2014; Dobbs, Hernandez, de la Barrera, Miranda, & Paecke, 2018). Since citizen science projects include elements of both citizen involvement and modern technology, they appear to be a natural fit for smart city projects.

This master thesis focuses in particular on whether issues of sustainability relating to biodiversity and nature are considered in smart city projects. To what extent can the two concepts support one another, or do they instead operate within so-called silos with little contact between the two, instead competing for budgetary resources? It will also consider whether citizen science projects can be utilised as a means to bridge the gap between smart city projects and biodiversity initiatives.

Literature review

In the following literature review I will look at four areas which are key to understanding biodiversity in urban contexts. I begin by considering the literature on biodiversity in general, examining international agreements and the consensus on the implications of biodiversity loss, as well as looking specifically at urban biodiversity. I then go on to study environmental narratives concerning biodiversity, as dominant narratives shape both how we think about the environment and the actions we take towards it. I then review the literature on smart cities to show what smart cities are, the varying forms they can take and look at some critiques of smart cities. Finally, I consider citizen science, exploring some of the different forms it can take as well as the potential benefits it offers, particularly in the field of biodiversity.

Biodiversity and Urban biodiversity

A good place to start when studying issues surrounding biodiversity loss is the *Convention on Biological Diversity* (CBD) from 1992 (United Nations, 1992), and the *Strategic Plan for Biodiversity 2010-2020* (Convention on Biological Diversity, 2010), which was produced by parties to the CBD in 2010. The *Convention on Biological Diversity* came into being at the Earth Summit in Rio de Janeiro in 1992, representing an acknowledgement that biodiversity was in widespread decline in many parts of the world as a result of human activity. The convention's three key objectives were "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources" (United Nations, 1992). The convention recognizes both the intrinsic value of biological diversity, as well as its value to humanity and human society. It established the importance of increasing our scientific knowledge about the state of biodiversity and obliges signatories to establish *biodiversity action plans* to protect vulnerable species or ecosystems. The CBD established a definition of biological diversity that is still widely referred to, and while the convention did not address urban biodiversity in particular, literature on urban biodiversity became more widespread after 1992 (Ossola, Irlich, & Niemelä).

The 10th Conference of the Parties to the CBD met in 2010 and established the Strategic Plan for Biodiversity 2011-2020, which included the Aichi Targets. Described as a framework for implementing the three objectives of the CBD, the plan included twenty targets, divided into five strategic goals. Strategic Goal A is about mainstreaming biodiversity, including increasing the awareness of the general public about biodiversity and its benefits, as well as integrating biodiversity issues into policy making at both national and local level. Strategic Goal B is to reduce pressures on biodiversity and to increase sustainability, for example by reducing over-exploitation of wild animal species. Strategic Goal C is to conserve biodiversity by increasing protected areas and improving the status of endangered species. Strategic Goal D aims to improve the benefits to people of biodiversity and ecosystem services, while Strategic Goal E addresses improving knowledge, planning, co-operation and financing (Convention on Biological Diversity, 2010). Of these five strategic goals, goals A, D and E are most relevant for urban biodiversity because of their focus on people, both in relation to increasing awareness and knowledge, and also by looking at the benefits to people from biodiversity. As mentioned earlier, none of the Aichi targets were fully met, with only six targets being partially achieved (Secretariat of the Convention on Biological Diversity, 2020).

Biodiversity loss is estimated to be taking place between 100 and 1000 times faster than what is estimated to be the natural rate, putting at risk the resilience of ecosystems and other Earth system functions (Hooper et al., 2012; Rockström, 2009; Rockström et al., 2009). Human activity is the main cause of this, in particular land use change. There is consensus that this biodiversity loss is limiting the capture of biologically essential resources and their conversion to biomass, that ecosystem functions are becoming less stable, and that the impacts on ecosystems accelerate as biodiversity loss increases (Cardinale et al., 2012). That biodiversity loss and changes to ecosystems can have an impact on the functioning of human society is reflected in the emergence of the concept of ecosystem services (Costanza et al., 1997; Lele, Springate-Baginski, Lakerveld, Deb, & Dash, 2013).

Urban biodiversity differs from biodiversity generally in that it must be seen from a social and cultural perspective, as well as an ecological perspective. People's thoughts and feelings about nature matter more than in non-urban areas (Nilon, 2011; Werner & Zahner, 2009). We can distinguish between a management approach and a conservation approach to urban biodiversity. Here the management approach focuses on managing biodiversity that has an

"ecological, social or economic value", whereas the conservation approach is more concerned with the conservation of rare species (Nilon, 2011). The heterogeneity of urban environments is often described as an urban matrix – areas of a town will differ according to their usage, for example industry, residential, parks and so on. But also within these categories there will be huge differences due to a number of factors including topography, social and economic factors, and the age of the area in question. Biodiversity in these areas will be influenced by actions taken on a city-wide scale, but also by the choices of individual homeowners. This means that the success of biodiversity conservation and management in urban areas has as much to do with engaging residents and decision makers as it has to do with research and management tools (Nilon, 2011).

Urban biodiversity has often been mentioned as an important issue within the CBD, but there has been a lack of emphasis on the opportunities it presents and it has never been a focus area of the conference of the parties (COP) (Müller & Werner, 2010). Cities are important as centres of power - political, economic and cultural – and these areas are therefore key to developing policy. At the same time most people gain their everyday experience of nature from within urban settings, and this contact with nature, especially in childhood, is key to their future interest in environmental issues. By enhancing urban biodiversity, we therefore increase the chances that environmental matters will be addressed by policy makers, both now and in the future (Müller & Werner, 2010). Although we often consider nature and biodiversity as something separate and distinct from human society, biodiversity in urban settings is important for how humans relate to biodiversity both within cities and elsewhere.

It is now generally accepted that human activity is having large negative effects on biodiversity, and also that this loss of biodiversity will have negative effects on ecosystems and human society. Although international agreements are in place to protect biodiversity, losses of biodiversity continue. Biodiversity in urban settings is seen as important not just to protect species, but also because of the implications this has for policy making and the implementation of measures to protect biodiversity (Müller & Werner, 2010).

Environmental narratives

Narratives are important because they shape not only how we understand the environment, but also how we relate to it, with consequences for our actions. The existence of normative and causal beliefs shapes policy (Sabatier, 1988). Environmental narratives have developed through various forms from the late nineteenth century until the present time, and new ways of viewing the environment and biodiversity are taking root against a backdrop of anthropogenic climate change and biodiversity loss.

A new environmental awareness arose in the late nineteenth and early twentieth centuries, based on protecting charismatic species. The movement was both aspirational, with a view that advanced civilised societies should also take care of natural areas and endangered species, as well as risk-based, with a realisation that depleting nature could lead to a loss of resources and an imbalance in natural systems. This new movement was embodied by the creation of the first national parks and was based on acceptance that human development would have impacts on the natural world, so that there was very little attachment of blame for the emerging threats to nature (Jepson, 2018).

After World War II, a new narrative emerged with a much more apocalyptic character. Destruction of nature was becoming more visible to citizens in Western nations, while books such as *Silent Spring* (Carson, 1962) brought these problems to a wider audience in a scientific manner. An *ecoscarcity* narrative emerged, the roots of which can be traced back through the *Limits to Growth* (Meadows, Meadows, Randers, & Behrens III, 1972), the *Population Bomb* (Ehrlich, 1968), and right back to Thomas Malthus writing in the late 1700s (Malthus, 2001). The ecoscarcity narrative has been criticised for shifting responsibility for threats to nature to developing countries with rising populations, and therefore letting developed Western nations off the hook (Robbins, 2012).

The creation of national parks as spaces where nature could thrive separated from human activity encapsulates the notion that humans and non-human species exist separately. Nature is seen as non-human, backed up by the popularity of TV documentaries about exotic wildlife in which evidence of human life is rarely seen. In this view the natural world ceases where human activity begins. Increasing human impacts on the natural world have been described as heralding the *end of nature* (McKibben, 1990).

This view has been challenged by theories of *political ecology*, which argue that this dichotomy between nature and human society is false, and that the state of nature all around the world is influenced by social forces both global and local (Robbins, 2012). Political ecology challenges dominant themes of our distance from the natural world and reminds us that we as humans are not separate from nature, but a part of nature.

The ecoscarcity narrative is similar to what has been called the *Finite Earth* narrative, being based on environmental limits. Apportioning blame to a number of villains, such as corporations and industry, is central to this narrative, pitting them against noble eco-warriors, such as Greenpeace campaigners standing up against whaling fleets. National and international legislation was seen to be necessary to stop destructive practices. This narrative exuded a sense of despair and gave rise to a preservationist worldview in which nature conservationists strive to freeze nature in its current state or revert it to what it used to be (Jepson, 2018).

From the 1980's environmental narratives became entwined with sustainable development. Biodiversity was regarded as a resource and nature as a source of ecosystem services. Blame was less central to this *Resource Earth* narrative, and economic policy rather than interventionist legislation was regarded as the key means by which the destruction of nature could be controlled. It retained, however, the element of despair, leading to disempowerment as it often generated the impression that individual actions were futile (Jepson, 2018).

A new environmental narrative has begun to emerge in recent years, embodied in the growing field of *Rewilding* (Jepson, 2018). Rewilding is a concept which has emerged over the last couple of decades, and which has been popularised by authors such as George Monbiot. While the concept brings to mind ideas of returning large areas of land to wilderness and reintroducing large predators, there is still much debate and controversy about what rewilding should be. Although there are several competing definitions of rewilding, a unifying definition has been formulated as "the reorganisation of biota and ecosystem processes to set an identified social-ecological system on a preferred trajectory, leading to the self-sustaining provision of ecosystem services with minimal ongoing management" (Pettorelli et al., 2018). For Monbiot, rewilding is less about the number and make-up of different species and more about "their ever-shifting relationships with each other and the physical

environment" (Monbiot, 2013, p. 9). Rewilding is about letting nature control itself, rather than it being controlled and manged by people, although some human intervention is often necessary to set processes in motion.

Rewilding has been interpreted as representing innovation in the management, theory and philosophy of conservation. Jepson calls this the *Recoverable Earth* narrative, and argues that this new, emerging narrative offers hope, vision and ambition, and offers a much more empowering narrative than the *Finite Earth* or *Resource Earth* narratives. While rewilding is about restoring natural processes and learning from the past, it is not about turning back the clock to recreate the nature of yesteryear. It is instead about creating self-sustaining ecosystems and reconnecting natural systems with society and the economy (Jepson, 2018).

In a discussion of cities and biodiversity in urban settings it can be argued that rewilding is not relevant, embracing as it often does large swathes of land and (re)introducing apex predators, but Monbiot also brings a second understanding to the table. He also talks about rewilding of human life, where rewilding represents "an enhanced opportunity for people to engage with and delight in the natural world" (Monbiot, 2013, p. 11). Such interpretations have much in common with the theory of *biophilia*, which stresses that close contact with nature is of great importance to humans, as we have evolved alongside plants and animals (Beatley, 2011; Wilson, 1984). Biophilia theory has been followed up by studies on biophilic design and architecture that are thought to have benefits for human psychological well-being (Joye, 2007; Kellert, 2005). Although humans can live and survive without direct experience of living nature, these narratives stress that contact with the natural world enhances human experience.

The field of urban ecology has also evolved over time, from emphasizing first the ecology *in* cities, then expanding to encompass ecology *of* cities, before developing into ecology *for* cities (McPhearson et al., 2016). *Ecology in cities* is understood as being traditional ecology as practiced in rural or wild habitats applied to green spaces in cities, and which can be useful for suggesting what kind of measures can be useful for increasing biodiversity in cities. *Ecology of cities* develops this to describe cities as ecosystems in their own right, rather than being ecologically barren apart from a few green remnants. Humans play an integral part in this ecosystem, both influencing and being influenced by the ecology found in the city. The dominant concept now is *ecology for cities*, focusing on how ecological processes should be

incorporated into decision-making to provide services for its residents, ranging from physical services such as reducing the urban heat island effect or management of surface water, to the psychological benefits provided by nature to improve the quality of life for urban inhabitants (McPhearson et al., 2016).

Theories of *Resource Earth*, *biophilia* and *ecology for cities* all reflect elements of the *ecosystem services* narrative, in which nature and biodiversity are important because they are beneficial to humans and society. Ecosystem services can be divided into provisioning services, regulating services and cultural services, providing food and raw materials, preventing flooding and other unwanted events, and providing aesthetically pleasing landscapes which can boost recreation (Grunewald & Olaf, 2017). The concept has been increasingly used in national and international governance and reports such as the Millennium Ecosystem Assessment and EU biodiversity strategy, but has also been criticized for reducing ecosystems and biodiversity to being relevant principally in economic terms (Spash & Aslaksen, 2015).

Narratives of biodiversity have therefore changed over time. Narratives have changed away from seeing humans and nature as distinct and separate spheres, to one in which humans are a part of nature. Nature and biodiversity are also increasingly seen as beneficial to human society, contributing to our material and spiritual well-being. However, human activity is often seen as exclusively detrimental to biodiversity, leading to a pessimistic understanding of the effects of society on nature. Some believe that dominant narratives can be shifted from one in which nature is in a hopeless situation due to human actions, to a more empowering one in which humans and nature can reconnect with mutual benefits.

Smart Cities

As mentioned earlier, smart cities have become increasingly popular in Europe and elsewhere over the last two decades, with more than half of European cities with more than 100,000 inhabitants now ascribing to be smart cities (Haarstad, 2017). Despite its popularity, what exactly a smart city is can be difficult to pin down. Indeed, just as cities are all different with unique mixtures of characteristics, it seems that smart city programmes can also be interpreted and implemented differently from city to city.

This lack of a clear definition of the smart city has led some to describe the term as an 'empty signifier', accompanied by criticism that many cities would naturally like to be thought of as "smart", and that it is easy to call yourself "smart" when there is no clear understanding of what this entails, and consequently no easy way to confirm whether a city is smart or not (Hollands, 2008; Wiig, 2015). Haarstad, however, does not see this as problem, arguing that what a smart city does is a more pertinent question than what it is. What it does, he argues, is give a city a discourse or framework with which to tackle problems related to sustainability (Haarstad, 2017).

Despite the difficulties of finding a universal definition, there are certain traits that are common to smart cities. Six main areas which are common to many smart cities can be identified. These are a networked infrastructure, putting business at the heart of urban development, social inclusion in public services, a focus on high-tech and creative industries, the importance of social and relational capital, and environmental sustainability (Caragliu et al., 2011). Caragliu et al. boil these down to create a definition of a smart city as a city in which: "investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance" (Caragliu et al., 2011, p. 70).

Doubts have been raised about the extent to which smart city projects contribute to sustainability (Ahvenniemi, Huovila, Pinto-Seppä, & Airaksinen, 2016). Although sustainability is often a key stated goal of smart city projects, research into smart cities shows that they focus more on social and economic elements, and much less on environmental and sustainability elements. This differs from cities which categorise themselves as *sustainable cities*, which have a greater emphasis on environmental and social targets with far less focus on the economic aspects. There are calls for the two concepts and terms to be merged, creating the new term *Smart Sustainable Cities*, as well as for smart cities to adopt clear goals on reducing energy use (Ahvenniemi et al., 2016).

We can also distinguish between two main strands of smart city. Some cities take a "highly technical, infrastructure-intensive approach" to smart city implementation, while others take a more "citizen-centric approach" (Van Den Bergh & Viaene, 2016, pp. 6-7). Under the former approach smart cites are primarily conceived as using technology to improve effectiveness

and competitiveness, whereas under the latter approach citizen engagement is seen as being the most important element in creating successful smart city projects (Ahvenniemi et al., 2016; Angelidou, 2014; Van Den Bergh & Viaene, 2016).

Smart cities are often seen as places where new technology solves urban sustainability problems, but sustainability concerns can potentially clash and contradict smart city concerns (Martin, Evans, & Karvonen, 2018). Primary of these concerns is that the focus on economic growth is incompatible with sustainability, both in terms of social equity and environmental concerns. Another concern is that the benefits of innovation will be unfairly distributed, while there is also a danger that citizens can be disempowered by the growth of digital solutions. Smart cities can be seen as reinforcing unsustainable forms of economic growth, neglecting social equity and environmental protection (Martin et al., 2018).

There has also been criticism of the role of large corporate actors in smart city development, who are seen as promoting technologies, at the expense of social inclusion and empowerment. In this understanding smart cities are seen as marketing exercises in which large technology companies promote smart projects as solutions to urban problems, while really using these as ways to encourage financially strong actors to buy the company's technology (Hollands, 2015; McFarlane & Söderström, 2017; Wiig, 2015).

Parallels can be drawn here with Jasanoff's writing about *technologies of hubris* and *technologies of humility* (Jasanoff, 2003, 2007; Pfotenhauer & Jasanoff, 2017). Although Jasanoff doesn't address smart cities per se, many of the points she raises are highly relevant to smart city discourse. She describes predictive methods of management and control as *technologies of hubris*, which claim to have the knowledge and answers to social problems. She says that these methodologies are overconfident, prioritising known elements over uncertainty, and claiming to have a complete picture of all possible risks. Further, she argues that this normative view of these technologies' objective truth precludes political debate about the issues at hand. This view of technologies of hubris can be compared with the critical discussion of the role of technology and the normative discourse presented by neo-liberal institutions in the smart city debate. These technologies, she argues, give the impression of risk-free certainty about the best way to solve certain problems, yet history is littered with instances where supposedly safe technologies imposed in a top-down manner have failed causing great human suffering.

Instead, she calls for the advancement of *technologies of humility*. "These are methods, or better yet institutionalised habits of thought, that try to come to grips with the ragged fringes of human understanding – the unknown, the uncertain, the ambiguous, and the uncontrollable" (Jasanoff, 2003, p. 227). To do this she calls for "knowledgeable publics" to be included in policy making and science production, areas that have traditionally excluded the layperson. While the participation of the public in science and policy making should go without saying, she calls for a re-making of participatory politics in which policy makers, academia, business and the public interact in a more meaningful way. This resonates with the visions of citizen involvement found in many smart city projects, especially those that have taken the citizen-centric approach, rather than the technology-intensive approach.

The focus of smart city growth in many cases reflects the issues of the day and changes over time. For example, as computing and internet-based technologies emerged from the late 1990s the focus of smart city projects was on networks. The European Union started supporting smart city projects in the years after the financial crisis of 2008, and this is reflected by the focus on economic growth in smart city projects (Haarstad, 2017). In light of this, one can see the growth in literature which calls for sustainability to be put at the heart of smart city projects, and which emerges from 2016 onward, as a response to the Paris Climate Agreement of 2015 (Haarstad & Wathne, 2019; Silva, Khan, & Han, 2018; Trindade et al., 2017; Yigitcanlar, Han, & Kamruzzaman, 2019).

Smart cities are therefore heterogenous in character, with different elements being prioritised in different cities. These differences can broadly be split into techno-centric and citizen-centric projects. The focus of smart cities also changes over time, from a focus on technical networks, to economic growth, to sustainability issues. There has been much criticism of smart city concepts, although they have become popular in many cities around the world.

Citizen Science

The European Citizen Science Association (ECSA) states that "Citizen Science projects actively involve citizens in scientific endeavour that generates new knowledge or understanding"

(Robinson, Cawthray, West, Bonn, & Ansine, 2018). A key component here is that citizens are active, and therefore very much conscious of what they are doing when participating in citizen science, and differentiating citizen science from other forms of data gathering using, for example, sensors or mobile phone tracking.

While citizens have been conducting science for centuries or even millennia (Bonney et al., 2014), the concept of *Citizen Science* as a field of science in its own right has grown and come to prominence over the last 20 years or so (Hecker et al., 2018). Technological advances have been central to this growth, with computers, internet pages and mobile phone apps being widely used to assist data collection, classification and information. The establishment of practitioner organisations and specialist journals has also helped in the development of best practice and common standards (Hecker et al., 2018).

Early examples of citizen science projects include the *Transit of Venus* project from 1874, which was set up to help measure the distance of the Earth to the Sun with observations being made all round the planet, and the *Christmas Bird Count* from the USA, which was started in 1900 and continues to this day under the auspices of the National Audubon Society (Dickinson, Zuckerberg, & Bonter, 2010). Amongst the largest citizen science projects in the world is the *Big Garden Birdwatch*, run by the Royal Society for the Protection of Birds in the UK. In 2020 more than 485 000 people contributed to this with over 7.8 million bird sightings (RSPB, 2020).

Citizen science can take many forms and be used in different fields. Zooniverse, a website and platform for citizen science projects, lists projects to collect stories from First World War veterans, transcribing handwritten letters from 19th century anti-slavery campaigners, and helping detect gravitational waves amongst the more than 50 projects which are currently operating on its platform (Zooniverse.org, 2020). Although citizen science can be employed in a wide range of different fields as these examples show, it is perhaps most widely used in fields related to ecology and nature.

Citizen science in the field of biodiversity can be broadly split into two types: *surveillance monitoring* and *targeted monitoring*. S*urveillance monitoring* involves participants recording a large number of species without the project having any particular hypothesis in mind. It rather allows data to be produced, which may show patterns when analysed. Both the *Big*

Garden Birdwatch and *Christmas Bird Count* are run along these lines, with large amounts of data being produced which reveal trends over time and can lead to follow-up studies or interventions to address any issues which emerge. *Targeted monitoring* is more focused on a particular species or phenomenon and may address a specific hypothesis, as used for example in projects to track an invasive species or an infectious disease (Nichols & Williams, 2006).

The main advantage that citizen science has over conventional science carried out by professionals is the large data sets that can be collected. Huge numbers of observations can be recorded covering large geographical areas and can also continue over many years (Dobbs et al., 2018). Both spatially and temporally, citizen science allows for larger scale data gathering than would be feasible using only trained experts, and at a fraction of the cost. Indeed, cost is one of the key advantages of using citizen science, with volunteers providing their services for free. An example is Project FeederWatch run by Cornell University in the USA, where the data gathered by participants is valued at around USD 3 million per year (Dickinson et al., 2010).

Additionally, professional scientific projects are usually dependent on external funding, and this is often provided over relatively short-term scales. This leads to challenges for long-term studies (Goulson, 2013), and the long temporal scales made possible by citizen science projects can be a good way of overcoming this.

The benefits of citizen science can also be broadly split into two. It offers benefits to science, but also to those members of society engaging in citizen science. These people gain scientific understanding, seen as especially important in these times when trust in science is often undermined, as well as increased participation in issues concerning the society in which they live (Hecker et al., 2018). Other social benefits include "community empowerment, the democratization of information, social bottom-up integration, social cohesion, knowledge dissemination and community self-education" (Dobbs et al., 2018, p. 240).

On the negative side, doubts are often raised about the quality of scientific data provided by citizen science projects. Generally speaking, citizen scientists simply do not have the expertise of professional scientists, (although some amateurs may be experts in their own right). This quality can, however, be improved through initial training, either by an expert or by on-line training for example, and will also improve as a citizen scientist gains more experience

(Dickinson et al., 2010). The inferior data quality is also offset by the large volumes of data that can be gathered by citizen science projects, which can operate over large geographical areas and can also continue over many years (Dobbs et al., 2018). While a number of studies show that experts are more accurate and comprehensive in making correct observations than citizen scientists, the data provided by citizen science is nonetheless valuable as a basis for scientific study (Fore, Paulsen, & O' Laughlin, 2001; Kremen, Ullman, & Thorp, 2011; Lovell, Hamer, Slotow, & Herbert, 2009).

It is also possible to *improve* the quality of data provided by citizen science by employing big data analysis methods. Technology can be utilized to improve quality of data from large-scale citizen science projects both while it is being gathered, as well as after the fact (Kelling et al., 2015). Data being submitted can be checked against models of what species are expected to occur in the observation location, and any recordings that diverge from these models can be double-checked by asking the observer to confirm that the sighting is correct, and then sending the recording to an expert for corroboration. It is also possible to assess the ability of the observer by comparing the data submitted by any individual user against the average of observations, while taking into account other factors such as the time of day or year and the time spent recording (Kelling et al., 2015). This shows that although data from citizen science can be *fuzzy*, methods can be applied to data gathering and data analysis to improve data accuracy.

Another problem is that citizen science projects often better reflect human population densities than populations of species, as data collection is concentrated where citizens are active, for example in towns and cities. Far fewer records come areas of low human population density, although such areas are often much more biodiverse (Boakes et al., 2010).

While Article 12 of the CBD in particular is clear on the need for increasing research as a first step towards conserving biological diversity, research has shown that the number of expert taxonomists, both amateur and professional, has been declining (Hopkins & Freckleton, 2002). Arguably, the growth of citizen science in recent years has somewhat filled the void, or at least changed the nature of gathering data on biodiversity. However, some worries persist, such as that citizen science allows for the monitoring of well-known groups of animals such as birds but is more difficult for monitoring lesser-known *taxa* such as insects which are less easily distinguished.

Despite these shortcomings, citizen science has been found to be valuable both for society, scientific study and for informing policy (Bonney et al., 2014; Dickinson et al., 2010; McKinley et al., 2017; Roy et al., 2012).

This literature review has looked at four main areas of study that are relevant for this thesis: biodiversity; environmental narratives; smart cities; and citizen science. International agreements have failed so far to tackle threats to biodiversity to a meaningful degree. Mainstreaming of biodiversity into public discourse and policy making is one of the main ways in which threats to biodiversity can be addressed. Social and cultural factors are important in urban biodiversity and the engagement of residents and other stakeholders is important in urban biodiversity initiatives. Although there is generally richer biodiversity away from cities, experience of biodiversity in cities is important for policy making. Environmental narratives are important for how we interact with nature. These narratives have changed over time and may now be changing from a pessimistic view of our relationship with nature to a more optimistic narrative embodied by the concept of rewilding. Rewilding can include rewilding people's interaction with nature, as well as the rewilding of non-human nature.

Smart city concepts have become common in many cities, although the character of such initiatives varies from place to place. The focus of smart cities varies from techno-centric to citizen-centric, and this focus may also change according to the key issues of the time. Citizen science is a concept which has grown in importance over the last couple of decades, helped by new technologies. It allows for large amounts of data to be generated cheaply. It has been found to be valuable for science and policy making, as well as being beneficial for people participating in citizen science projects.

Problem statement

This thesis attempts to identify the extent to which biodiversity conservation and smart city initiatives currently operate independently of one another, consider why this happens, and explore how both could co-operate. It identifies prospective synergies.

The thesis is thus both descriptive and analytical. It attempts to describe the current situation within the case study, and explores ways in which the relationship between biodiversity and smart cities can be developed.

To deconstruct the problem into discrete, tangible units, I address specific questions. These rest on several hypotheses about the interaction of the concepts of biodiversity and smart cities:

Hypotheses

- Smart city projects and biodiversity projects currently operate to a large extent independently of one another, leading to a lack of co-operation and co-ordination between the two spheres. This is despite the concept of sustainability being central to both smart city projects and biodiversity conservation, so that they share a common theme.
- This independence and lack of co-operation is due to conflicting narratives surrounding the two domains, in which smart city narratives promote human intervention and the use of technology as solutions for society's problems, whereas dominant biodiversity narratives regard human intervention and technology as the main source of threats to biodiversity and to nature.
- The perception that smart cities' focus on new technology, big data and economic growth, is incompatible with biodiversity conservation also hinders co-operation between the two domains. Citizen science, however, provides an arena where the interests of biodiversity conservation and smart city development overlap and can thus provide opportunities for synergies between the two.

Research questions

- What is the working relationship between smart city practitioners and biodiversity conservation officers in Stavanger, and how can citizen science initiatives advance it?
    - What factors underlie the engagement or lack thereof between smart city and urban biodiversity practitioners in Stavanger?
    - What scope exists for citizen science to synergise these domains in Stavanger and comparable urban contexts?

Definition of terms

In a study of urban biodiversity, it is necessary to define what the term means for the purposes of this study. The term can be split into two, looking first at what we mean by urban, and then what we mean by biodiversity.

Urban

There are various definitions of the term urban used by both researchers and government institutions. Urban environments can be described as areas where "people live at high densities, and where built structures and infrastructure cover much of the land surface" (Pickett et al., 2011, p. 333). Definitions are generally based around population density, but also include other factors including "abundant built structures, extensive impervious surfaces, altered climatic and hydrological conditions, air pollution and modified ecosystem function and services" (Wu, 2014, p. 210).

Others point out the difficulty in defining the term *urban*. For example, definitions of the term may differ according to the background of the researcher, with social scientists emphasising people and population in their use of the term, whereas ecologists are more likely to define the term with regards to land use and habitats (Farinha-Marques, Lameiras, Fernandes, Silva, & Guilherme, 2011). Even within these groups, *urban* is often defined differently, or only

vaguely. For example, urban areas can also be defined in terms of governance structures or of energy usage (McIntyre, Knowles-Yánez, & Hope, 2000).

It is not enough to describe the term with regard to human disturbance, as many areas which we consider natural are also heavily influenced by human actions. Definitions based on gradient analysis are often used, as this acknowledges that the question is not binary - that an area either is or is not urban – and reflects the heterogeneous nature of urban areas. However, gradient analysis still fails to reflect the multiple ways in which urban areas can be categorised. The myriad ways in which urban areas can be defined reflects that urban ecology is an area in which a multidisciplinary approach is necessary (McIntyre et al., 2000).

When looking at municipalities as political units it should be noted that the same policymakers will control administrative units which may include both urban and rural areas. For the purpose of this thesis we will define urban as areas which are predominantly residential or commercial, but we will also extend the definition to encompass rural areas which exist in predominantly urban municipalities.

The municipality of Stavanger, which will be used here as a case study, has until recently been relatively urban - small in terms of area and densely populated. However, a recent reform of Norwegian municipalities, which came into effect in January 2020, has entailed a merger of Stavanger with the neighbouring rural island municipalities of Rennesøy and Finnøy, thus giving the municipality administrative responsibility for more agricultural areas (see figure 1, page 36). Stavanger is thus an embodiment of some of the problems related to defining what is urban, as it contains both areas that are clearly urban or agricultural, as well as areas that are something in between, all contained within a single political and administrative unit.

Biodiversity

Biodiversity is a contraction of the words biological diversity and was defined by the CBD as “the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems” (United Nations, 1992). The implications of this definition are threefold; first relating to the number of different

species, second the genetic variety of genes within a species, and third the variety of ecosystems and habitats (McCormick, 2018).

Urban biodiversity has been defined as "the animals and plants living … within the more or less contiguous settlement area of a city" (Werner & Zahner, 2009).

For this study then urban biodiversity measures include any measures designed to conserve or increase the number of individuals of a species, to conserve or increase the number of different species or to maintain or improve habitats for these species within the area of a city.

Theory: Cross-sectoral coordination and data integration

This thesis uses governmental inter-organizational information integration (GIII) as outlined by Ramon Gil-Garcia (Gil-Garcia, 2012) as a theoretical framework against which to view the case study city of Stavanger. This theory looks at the way in which governmental organizations increasingly look to new technologies to solve complex problems, to improve efficiency internally and well as enhancing collaboration with citizens and other organizations. This often entails creating network structures with other governmental bodies, non-governmental organizations and private companies, and is often described as a *whole-of-government approach*. Many cities try to achieve these by employing methods embodied by smart city projects.

Whereas much literature on smart cities describe a split between cities employing a technological approach and cities with a social approach (Van Den Bergh & Viaene, 2016), the GIII sees these different concerns as distinct phases along a continuum from social to technical aspects. Inter-organizational information integration begins with social elements and moves towards technical aspects. For Gil-Garcia the first stage is the creation of *trusted social networks*. This consists of communication between different actors in the form of conversations and correspondence, which over time creates trust between the parties. The second stage is characterized by *shared information*, including both formal documents and statistics and tacit information through more conversations and correspondence. In the third stage of *integrated data* more technical elements emerge, with the integration of data elements and standards, while the fourth stage is the creation of *interoperable technical*

infrastructure in which operational systems which can communicate with each other are put into place. GIII is described as "a complex and multi-dimensional phenomenon that includes technology, organizational, institutional, political, economic, and social components". The deeper the level of integration necessary in terms of values, perspectives and cultures amongst other things, the more difficult it is to achieve (Gil-Garcia, 2012).

Gil-Garcia describes a number of potential benefits from inter-governmental information integration. Among the benefits on the technical side he lists reduced data duplication, common technological infrastructures and better information systems. Organizational benefits include reduced costs, improved service quality, enhanced professional networks and better control and co-ordination. These can lead to political benefits such as enhanced public image, value creation, transparency and accountability, integrated planning and better public information.

However, he also outlines a number of challenges with inter-organizational information integration, particularly related to the political nature and diversity of stakeholders. Foremost among these are political and institutional challenges, where institutions have different formal and informal rules which decide how the institutions use technology and interact with others. Politics and politicians are also said to play an important role, with power relations defining how governments work and who can make decisions, which often hinders co-operation. There are also organizational challenges, such as individual's resistance to change, as well as the diverging motivations, priorities and goals of different organizations or parts of an organization. Technological challenges can be related to software incompatibility, lack of technical skills, or problems related to brand new technologies being implemented (Gil-Garcia, 2012).

Gil-Garcia goes on to make suggestions for the next steps in inter-organizational information integration. Firstly, he emphasises the importance that collaboration and information integration should move forward to incorporate different levels of government and function multi-nationally, as well as including private citizens, NGOs and private companies. Furthermore, while participation and collaboration are central elements in concepts such as the smart city, he speculates that extending this further could entail a re-thinking of the relationship between governments and citizens and, potentially, creating a whole new model of governance. He concludes by suggesting that the limits of information integration are

political rather than technical, but also questions whether the end-goal of a smart state in which all data from citizens and businesses are integrated is actually desirable (Gil-Garcia, 2012).

Methodology

This master thesis is based on a case study of the Norwegian city of Stavanger, looking at the city's smart city project, its administration of biodiversity issues and the interplay, if any between these two arenas. In addition, citizen science is explored as a potential link between smart city and biodiversity practitioners.

Qualitative data was gathered from the analysis of documents produced by the municipal government and smart city bodies, as well as from semi-structured interviews of relevant actors from smart city initiatives, municipal administrators, nature organisations, the business community and research community. This data collection aimed to generate insights into the problem, and to show how biodiversity and smart cities are viewed from different perspectives, thus revealing differences or similarities in the approaches used by different actors. Contrasting or complementary views unearthed by these interviews provided insights into problems and opportunities in integrating biodiversity concerns into smart city projects. In using semi-structured interviews, some of the questions were the same for all informants in order to achieve some comparability between the interviews, but other questions were tailored according to each person's role, in order to ensure relevance. Supplementary questions were used to clarify answers or to follow new lines of enquiry elicited from the interviewees' answers.

The Abductive Approach

This master thesis applies an abductive approach to qualitative data generated from analysis of a case study of the city of Stavanger. That is to say that it does not attempt to give unambiguous definitive answers to the questions asked, but rather to understand observable phenomena in specific examples in new ways according to the frameworks we relate them

to. This thesis also uses elements of Grounded Theory, where theories emerge from analysis of the data, rather than imposing theories from the start. Some issues or concepts which emerged from the interviews generated new ideas to be followed up, while others did not. Decisions on which data and lines of enquiry to follow were made as the study developed (Dey, 2004; Glaser & Strauss, 1967).

Different authors attach slightly different ideas to the concept of abductive reasoning. Blaikie's focus is on abductive logic as elevating the everyday actions of individuals and the meanings they give to their actions to a more theoretical level. He describes abduction as "the process of moving from lay description to technical description"(Blaikie, 2019, p. 100). His focus seems to be on the researcher "developing descriptions and generating theory" pertaining to everyday activities.

Danermark et al. have a somewhat different focus, with existing theoretical frameworks being applied to phenomena which are not necessarily new to science (Danermark, Ekström, Jakobsen, & Karlsson, 2002). Their focus is more on seeing social research problems against the background of different theoretical frameworks in order to gain new insight. They say that the new answers proposed in abductive research do not give unambiguous definitive answers to the problem examined but that they give one of many possible answers to how things might be. They stress re-description and reconceptualization, and add:

> Abduction is to move from a conception of something to a different, possible more developed or deeper conception of it. This happens through our placing and interpreting the original ideas about the phenomenon in the frame of a new set of ideas. (Danermark et al., 2002, p. 91)

Danermark et al. therefore seem to place more emphasis on placing new knowledge in existing theoretical frameworks than Blaikie does, with his emphasis more on the researcher developing theories based on the groundwork that has been carried out.

Ian Dey writes of abductive research along much the same lines as Danermark et al., but gives it a slightly different twist by seeing the theoretical framework as a subject of the study as much as the observations of phenomena. We are not just observing these events against the background of a theory, but simultaneously testing that theory to see whether it holds up against a new set of data. In his interpretation theories can prove their worth by their

"capacity to generate insights" (Dey, 2004, p. 91). We are not just discovering new facts, but ways of connecting facts.

Although these three descriptions have different slants in their interpretations of what abductive research is, they agree on the basics that abduction is a way of gaining new interpretations, rather than conclusive causational reasoning, and all talk of the need for users of abductive methods to be creative and imaginative in finding new ways to interpret data.

This master thesis does not attempt to provide any definitive facts, but aims to present new insights into what factors might promote or hinder successful implementation of biodiversity policy at a local level. In addition, information gleaned from the interviews is compared with Gil-Garcia's theory of governmental inter-organizational information integration (GIII) to see to what extent Stavanger fits in with this framework, where elements of the GIII can be identified in the case study and where the case study differs from the GIII.

Case Studies

While I have said that this master thesis is based on a case study of the municipality of Stavanger, I will follow Blaikie's guidelines that case studies do not represent a methodology or research design, but rather that they assist in selecting the material to be studied (Blaikie, 2019).

Blaikie also lists several concerns that have been raised regarding case studies. One of these is generalizability, with some critics arguing that it is extremely difficult to generalize from a single case due to the large number of unique aspects of each case. This makes it difficult to compare data, as we are not necessarily comparing like with like. These criticisms are also relevant for this master thesis, but while the information gathered for this study is unique to the municipality of Stavanger and the respondents, it is likely that they are also at least partly similar to the views and perspectives of similar practitioners elsewhere, and that many of the findings in this study are likely to be generalizable to other cities with a similar focus on smart city projects. This is especially true when concerning cities which can be said to be somewhat

similar to Stavanger, for example for other relatively wealthy, medium-sized cities in Scandinavia or elsewhere in Europe.

Flyvbjerg insists that all study of human affairs is context-dependent and that case studies provide context-dependent knowledge. Case studies do not offer breadth in their scope of study, but depth, producing 'thick' narratives. He continues that the proximity to reality offered by case studies is necessary for advanced understanding. Although it is difficult to generalise from case studies, they nevertheless "add to the cumulative development of knowledge" (Flyvbjerg, 2004).

Interviews

Semi-structured interviews of people with expert knowledge in one or more of the fields of biodiversity, smart city projects and citizen science provide the main source of primary data for this project. Most interviews were carried out face-to-face, while two were carried out using video conferencing software due to restrictions imposed relating to the Corona virus. All the interviews were recorded on a hand-held electronic recording device, and later transcribed using NVivo software. In alignment with Neuman's recommendations for the analysis of qualitative data (Neuman, 2013), open coding was first carried out to identify themes which emerge from the data and assigning codes. Secondly, axial coding was carried out to make links between the responses of the interviewees and the themes that had emerged. Finally, selective coding was used, choosing which parts of data should be used to illuminate the selected themes and allowing contrast and comparison between the responses of the different interviewees.

A core set of questions were created and submitted to NSD (Norsk senter for forskningsdata) in an interview guide protocol (see Appendix), with varying versions according to the professional role of the interviewee to ensure that the questions were relevant. Semi-structured interviews have the advantage of being flexible, allowing the interviewer to follow up interesting elements that emerge during an interview, including asking additional questions that the interviewer might not have considered prior to hearing what the interviewee has to say (Gray, 2009). However, by following a similar structure for each

interview the interviewer also ensures that comparable data will be generated from each interviewee. The use of open questions allows the interviewee to place their own terms on the question being asked, allowing for meaning-making linkages to become more apparent (Holstein & Gubrium, 1995).

While the interviews were intended to reveal information about biodiversity, the smart city and citizen science, or what Rapley calls interview-data-as-resource, he also points out that this is difficult to achieve in practice. He argues that interviews are interactive events in which the participants create a joint reality, and where the interviewees might want to portray themselves as "adequate interviewees" (Rapley, 2004). In the context of these interviews this could mean that interviewees could, for example, give answers that they feel reflect well on themselves, either by giving answers that they feel the interviewer would like to hear or by giving answers that they feel somebody in their professional role should give. This raises questions about the reliability and validity of the data elicited from the interviews. Reliability is compromised by the interview being a joint construct, in which a different interviewer asking the same questions may not get the same answers. Validity is compromised when the answers of the interviewees do not represent the actual reality of the situation (Neuman, 2013).

Another problem with interviews as a research method is described by Alvesson, who argues that language, knowledge and the interviewer are inextricably connected, such that the answers given are subject to the interviewer's interpretation of these answers and are likely to be interpreted differently by different interviewers according to the their beliefs, knowledge and preconceptions (Alvesson, 2003).

Data Sources

Selection of data sources

The municipality of Stavanger was chosen as the subject for this case study for a number of reasons. Firstly, it is a municipality that has an established smart city organisation, which has been included as a so-called *lighthouse city* in the European Union's *Triangulum* project. Secondly, Stavanger is the city where the author both lives and studies. This means that the

author started with some pre-existing knowledge of the municipality's smart city project and biodiversity issues, as well as allowing for easy access to interviewees and reducing the time and cost involved in gathering information. Thirdly, smart city bodies in Stavanger have strong links to the University of Stavanger and are often keen to participate in research of this kind.

Choice of interviewees

Interviewees included representatives of different smart city organisations, people employed by the municipality in roles related to biodiversity and the environment, representatives of non-governmental organisations related to biodiversity and members of the academic community with knowledge of the smart city. The interviewees were invited to participate due to their roles as knowledgeable people within their organisations. Initial invitations were sent out via email, and all stakeholders initially invited to participate were asked for recommendations of further people who could be good interview candidates because of their knowledge of the relevant issues, thus creating a snowball sampling technique. Ten interviews were carried out between August 2020 and October 2020.

Two interviewees worked in Stavanger municipality's *Parks and Roads* department, and a further two interviewees worked for the Smart City Office in Stavanger municipality. Another interviewee was employed by the Nordic Edge smart city innovation cluster, which also organises an annual smart city exhibition. Another worked for Grønn By (green city), an independent network of large local businesses and organisations concerned with sustainability, and was also a member of the Smart City Research Network at the University of Stavanger. Two interviewees were employed by different nature conservation organisations in the region, and two researchers from the University of Stavanger also participated.

The interviewees were offered the choice of answering the questions in Norwegian or English in order that they could express themselves fully and without feeling inhibited by language concerns. The interview questions were asked in English in all ten interviews, with help being given to understand the question when necessary. Six interviewees answered the questions in English, while four chose to answer in Norwegian.

I would have liked to interview a wider range of people for my research. Two people who were asked to be interviewed declined, while a larger number did not respond to the request. It is understandable that many people lead busy lives, both professionally and otherwise, so many cannot find time to be interviewed. Nonetheless, I would have liked to interview, for example, employees of Stavanger Natural History Museum, which has links to biodiversity, citizen science (through a bird-ringing project) and is a part of Stavanger municipality. I would also have liked to interview more senior representatives, for example from the smart city office, in order to get a clearer view of the direction in which influential people want to take smart city projects. Nevertheless, I feel that the range of people who agreed to be interviewed gave a satisfactory spread of organisations and viewpoints.

Urban Scale Case Study – Stavanger as a Unit of Analysis

The municipality of Stavanger lies in the South-West of Norway in the county of Rogaland. The city serves as a regional centre and is known as the hub of the nation's oil industry. Stavanger also houses a large regional hospital and has a university with around 11 000 students.

Stavanger is Norway's fourth largest municipality with a population of around 142 000 people. A recent consolidation of Norwegian municipalities which came into effect from January 2020 (while the writing of this thesis was already underway) saw a significant shift in the make-up of the municipality, increasing its population only marginally from around 134 000, but more than tripling its area from 68 km² to 237 km² (Stavanger Kommune, 2020b). This merger of three municipalities meant that Stavanger went from being a predominantly urban, densely populated municipality with few agricultural or natural areas, to having large areas of agriculture, and natural areas housing many cabins, where Norwegians traditionally like to spend their weekends and holidays.

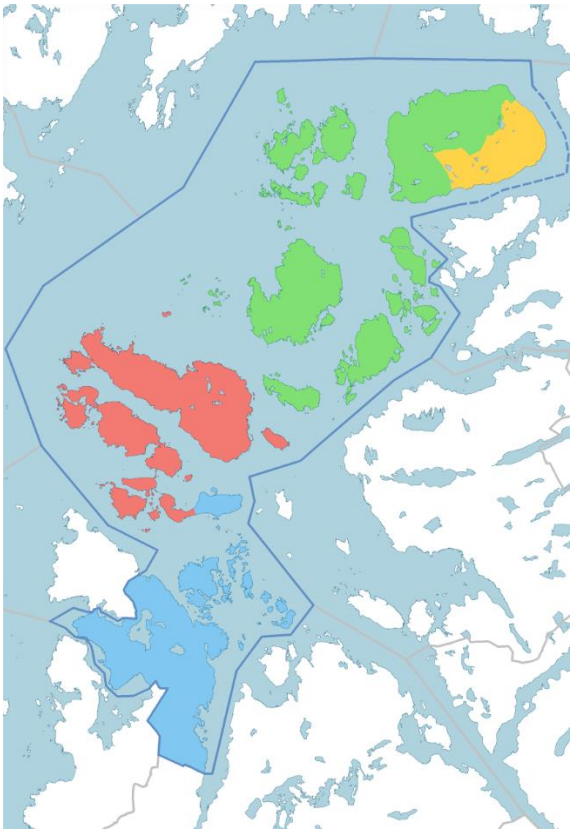

Figure 1. Map of Stavanger municipality (Stavanger Kommune, 2020b)

The map in figure 1 shows Stavanger municipality. The area in blue shows the extent of the municipality until 2019, 60 per cent of which is described as built-up area. The areas in red (Rennesøy municipality) and green (Finnøy municipality) show the two rural municipalities which have been merged with Stavanger since January 2020.

Stavanger Smart City

Stavanger's Smart City Office is a part of the municipal administration and was established in 2015 after the city became a lighthouse city in the Triangulum project, part of the EU's Horizon 2020 initiative. The Triangulum project was initiated alongside local partners such as Rogaland county council, the regional electricity provider Lyse, the University of Stavanger and the Greater Stavanger business organisation. A number of other local initiatives have emerged in Stavanger such as the Nordic Edge innovation cluster, which also organises the annual Nordic

Edge Expo, and the Norwegian Smart Care Cluster for creating smart innovation in the health sector (Stavanger Kommune, 2016).

Findings and Analysis

To address the research questions, I have looked at both government documents and conducted a number of semi-structured interviews. The following sub-sections report on my analysis of these data sources respectively.

Document Analysis

In this sub-section I look at documents produced by Stavanger municipality of relevance to its smart city project and to biodiversity. I examine the documents in general, as well as considering crossover between the two fields. I start by studying the *Smart City Roadmap*, as well as comparing it to publicly available documents from some comparable smart cities. I then examine three government documents relating to biodiversity. These are the *Climate and Environmental Plan* from 2018, the working program for the *Green Plan*, which is due to be approved in 2022, and the *Biodiversity Action Plan 2010-2014*.

Such plans and white papers often show intentions and priorities of professionals and policy makers from when the plans were made. Such plans can function as a basis for action thereafter, but can also sometimes be "put in a drawer" and forgotten about. The inclusion of the forthcoming Green Plan within the Municipal plan makes it legally binding and gives it extra strength and teeth. While the documents give a formalised version of the municipality's positions on the smart city and on biodiversity, the interviews give a picture of how people who work with these things actually think and behave.

Smart City Roadmap

In 2016 the smart city office in Stavanger produced a roadmap, which was approved by the city council in December of the same year. The roadmap is a visually attractive 37-page document full of explanations and photographs. Amongst other things it explains to citizens

what a smart city is, the purpose of the smart city, key drivers and five priority areas of the smart city project. The roadmap includes an appendix of ongoing smart city projects as well as ideas for projects in the five priority areas (Stavanger Kommune, 2016).

In its explanation of what a smart city is the Roadmap says that "a smart city is based on the citizens' needs, and applies new technology to make the city a better place to live, reside and work". It goes on to give three criteria which differentiate smart city projects from ordinary municipal projects. These three criteria are technology, co-operation and citizen involvement. The paragraph which explains more about technology is approximately twice as long as the paragraphs about co-operation and citizen involvement. It reads thus:

> Technology: The solutions make use of modern technology to simplify and improve. For instance, using the opportunities inherent in digitisation, automation, large and open data, sensor technology or "Internet of Things" technology. (Stavanger Kommune, 2016)

In the section on technology as a key driver, the roadmap also adds nanotechnology and materials technology to the list of ways in which technology can be used.

Technology appears here as not just an important element of a smart city, but arguably as the most important element, although the concept is absent from the page on the "vision for the smart city", which focuses instead on the other two key drivers: co-operation and citizen involvement.

The five priority areas of Stavanger's smart city project are: health and welfare; education and knowledge; energy, climate and environment; urban art; governance and democracy. Each priority area is then described further over two pages each, including the rationale for selecting each priority area, the main direction for development of the area, and important choices of route in the smart city work in each area.

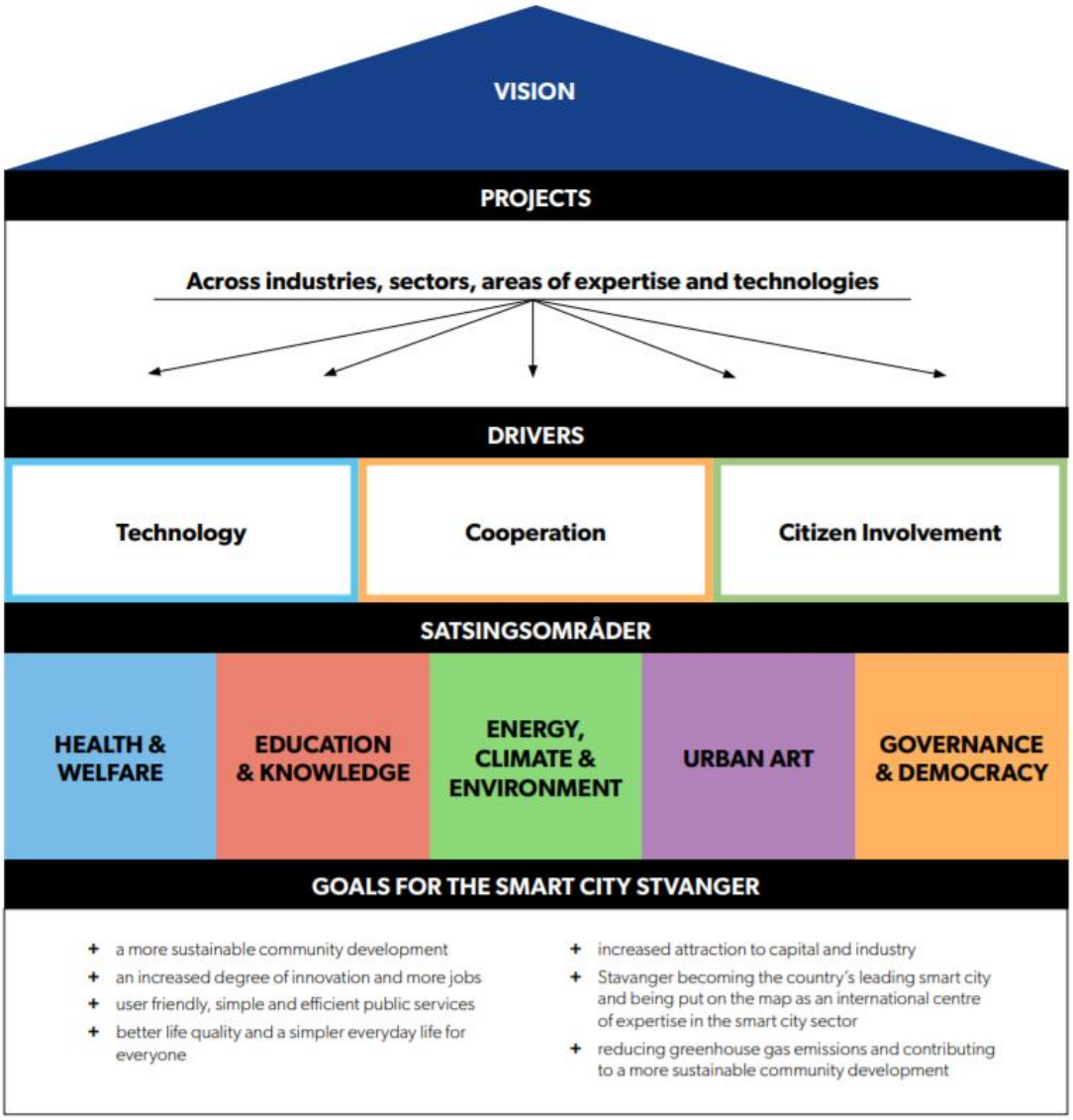

Figure 2. Illustration of the Smart City Stavanger (Source: (Stavanger Kommune, 2016)

Priority area three concerned Energy, climate and environment, so if biodiversity and nature is of interest to the Stavanger smart city project this section would seems to be the best place for it, especially as the image used for these pages is the green leaves of a tree. However, neither biodiversity nor nature are mentioned in this section, nor in any other part of the roadmap. The word *environment* or *environmental* is used five times in this section in addition to its title, but only in conjunction with the words *energy* and *climate*, for example "Stavanger wants … to take an active role in solving the planet's energy, climate and environmental challenges". What the roadmap means by the word *environment* and *environmental* is not explained or defined anywhere in the text.

The section on the *rationale for the selection* of energy, climate and environment as a priority area discusses Stavanger as an energy capital, its existing expertise in the energy sector and how a focus on energy, climate and environment can provide benefits for industrial and commercial development. Under the *main directions* of this area the Roadmap talks about emissions cuts, an ambition to be a climate-neutral city and for Stavanger to "strengthen its position as an energy capital". As *important choices of route*, the roadmap lists seven items:

- the reduction of greenhouse gases
- climate-friendly choices of citizens
- an escalation of green energy
- making extraction of non-renewable energy sources the most environmentally friendly in Europe
- exploring and accelerating solutions that can ensure high climate and energy ambitions in urban development projects
- using eco-friendly technologies in transport
- investigating driverless transport systems

The Roadmap concludes with an appendix, listing project ideas for Stavanger smart city. The title for priority area three has now been shortened to *Climate and Energy*, dispensing with the word environment, under the umbrella of which issues to do with nature or the environment could have been included. None of the thirteen ideas listed deal with biodiversity or nature.

This section therefore seems chiefly - if not entirely - to prioritise energy and climate concerns, and to define environmental problems as being about the climate crisis and very little else.

Triangulum project

The smart city initiative in Stavanger was included as a lighthouse city in the Triangulum project, alongside the cities of Manchester in the UK and Eindhoven in the Netherlands. Triangulum ran from 2015 to 2020 and was supported by 30 million Euros from the Horizon 2020 project funded by the European Commission. The mission statement and ten goals of

the Triangulum project focus on the economic aspects and spreading the knowledge gained to 'follower' cities, with also a brief mention of citizen involvement. As in the Stavanger roadmap, there is no mention of nature or biodiversity (Fraunhofer Institute for Industrial Engineering IOA, Retrieved 11th November 2020).

Other Smart Cities

As part of early research into this project, the author looked up information on nine other smart city initiatives in Norway and elsewhere in Europe, in order to explore whether Stavanger was alone in its neglect of nature and biodiversity in its smart city project. I chose to look at prominent smart cities with information publicly available on the internet in English or Norwegian.

Generally, it seems that biodiversity concerns are lacking in smart city initiatives. Of the five Norwegian cities with written information available on the smart city, only Bodø included anything about nature and biodiversity, and this was in connection with the development of a new suburban area on the site of an old airport. It can be argued that the biodiversity element is present here as a part of the new urban development, rather than a part of the smart city project.

Norway's capital Oslo was named as European Green Capital in 2019 and has also embraced smart city concepts. Although Oslo works to protect the Nordmarka forest area and has made progress in efforts to reopen waterways in the city benefitting biodiversity, these appear separate from smart city projects in the city. The Oslo Smart City Strategy talks of creating a greener city in its vision, but as in Stavanger, the text of the strategy refers only to green energy (City of Oslo, 2015, Accessed 17/12/2020).

Manchester in the UK is another lighthouse city in the Triangulum project, but I could find no mention of nature or biodiversity in public documents here. Staying in the UK I looked up the city of Bristol, which is well-renowned for its environmental efforts. While the city is a smart city and has a comprehensive biodiversity action plan and a climate emergency plan, there was no evidence that these are related to the city's smart city project, which is very much technology focused.

Smart city projects in the Netherlands, however, did seem to have elements concerned with biodiversity to a certain extent. The third Triangulum city, Eindhoven, has three main focus areas: mobility, sustainability and climate, and safety. The focus area of climate and sustainability looks at sustainable energy and energy saving, aiming to boost economic development and transition all homes and businesses away from using natural gas. This focus area also includes "reinforcing the policy of making our city greener and stimulating biodiversity" (SynchroniCity 2020). There is, however, no further information about what form such biodiversity-based smart city projects take. We can again draw parallels with Stavanger, where green issues are referred to in the general smart city visions, but are not translated into actual projects.

Amsterdam is another prominent smart city, and while the six focus areas of circular city, energy, mobility, citizens & living, digital city and smart city academy, do not obviously incorporate biodiversity and nature, several of the projects listed on the smart city website do appear to have nature and biodiversity at their core. These include *Urban Nature Amsterdam*, *Urban Street Forest* and *Rooftop Revolution*. Taking this very limited sample of European cities as examples, it appears that biodiversity issues are included within the remit of smart city projects in the Netherlands, although perhaps not as a central element, but that such issues seem to be absent from smart city projects in the UK and Norway.

Climate and Environmental Plan

Stavanger municipality's *Climate and Environmental Plan 2018-2030* is a 78-page long document which was approved by the city council in November 2018 (Stavanger Kommune, 2018). The plan includes a preamble by the main authors, as well as an introduction discussing the role of the municipality and the structure of the plan, as well as a section on greenhouse-gas emissions. This is followed by sections on 14 different thematic areas, a section on citizen participation, the municipality as an environmental advocate and an appendix. The appendix has seven sections, including a glossary, various environmental standards, and a section relating each of the 14 sections to the UN's *Sustainable Development Goals*.

Nature and biodiversity figure quite prominently in the opening parts of the plan. The preamble describes measures for a society "where the natural world and environment are of value in themselves" and in which "varied and viable nature … increase residents' well-being"(Stavanger Kommune, 2018, p. 3). Furthermore, "pressure on species and natural habitats" is listed as one of the five most serious challenges facing Stavanger, "to protect the living conditions of plants and animal life, and increase biodiversity" is listed as one of four main goals of the plan and "protecting and conserving areas of natural importance and ensuring the viability of biodiversity in urban areas" is one of six key measures that the municipality will take (Stavanger Kommune, 2018, p. 6).

However, the focus on biodiversity tails off somewhat thereafter. Although "Green areas and biodiversity" is the fourth of fourteen thematic areas, it is given just a single page of text, compared with six pages discussing transport, seven pages on energy and material use in buildings and construction, and four pages on consumption and waste management. The plan explains that this section will be dealt with in further detail in the forthcoming Green Plan (see below). Biodiversity is also mentioned in the subsequent sections on agriculture and the aquatic environment.

The smart city project and smart solutions are mentioned just once in the plan, and this is in relation to efforts to curb greenhouse-gas emissions and the electrification of the transport sector. There is therefore no link made in the plan between biodiversity and the smart city.

Climate concerns figure most prominently in the Climate and Environmental Plan and in the public debate surrounding the plan, which included the ambitious and controversial target of cutting carbon emissions from the city by 80% by 2030 (Jupskaas, 2018).

Green Plan – working program

The municipality of Stavanger is currently working on a Green Plan for the city. At the time of writing this work is still in its relatively early stages, and a working program for the plan has been produced. The final version of the plan is not due to be approved by local government until the autumn of 2022. The working program is therefore the document which can be analysed for this study.

The working program is a twenty-page document outlining the background and processes for the Green Plan, as well as the current status of Stavanger's green structure and previous plans concerning this sector. It goes on to describe challenges and opportunities, issues which will be included in the working plan, and its relationship to other municipal plans in Stavanger. The Green Plan relates to green structure and biodiversity in the municipality, with a main goal of securing contiguous and accessible green structure and biodiversity, based on national guidelines. The plan is to be included in Stavanger's Municipal Plan, which will make its provisions legally binding (Stavanger Kommune, 2020a).

Although the plan – at the time of thesis submission – is nearly two years away from completion and is therefore quite general with few details, it nevertheless includes some elements that can be of interest for this study. First and foremost is the statement that biodiversity considerations should be a fundamental principal in all area planning and maintenance. This seems to indicate that issues concerning biodiversity are starting to be given higher priority in Stavanger than previously.

There is also a recognition that privately owned areas are important for biodiversity, so co-operation with private landowners needs to be included in strategies for managing biodiversity. The working plan states that the Green Plan will detail the municipality's cooperation with voluntary organisations, as well as user involvement in planning, use and maintenance of green structures in Stavanger. All these issues could be areas where the smart city's expertise on user involvement and co-operation could be included, although the smart city is not mentioned in the working plan. It should perhaps be noted that the voluntary organisations are at the heart of the municipality's co-operation work, and although user involvement at all stages is a positive thing, there is no mention of raising citizens' levels of awareness and knowledge of biodiversity issues.

The municipality also plans to register and assess biodiversity in natural areas in Stavanger and will work to develop a set of *indicator species* which can help in assessing the state of biodiversity. These two areas could be potentially use data generated by citizen science either to assess what biodiversity exists in Stavanger, or as a way to monitor and keep track of the indicator species. However, citizen science itself is not mentioned in the working plan.

The previous Green Plan for Stavanger was approved in 1991, so there will be a span of over three decades between the approval of the new plan and the previous plan. It could be argued therefore that biodiversity issues have been neglected, or at best not prioritised in Stavanger municipality in the past.

Biodiversity Action Plan 2010-2014 [3]

Stavanger municipality has a Biodiversity Action Plan (Handlingsplan for biologisk mangfold) which was approved by the city council in June 2011 (Stavanger Kommune, 2011). The plan was valid for the years 2010-2014 but has not been replaced. The document consists of a foreword and a short introduction, followed by a long description of measures to be taken presented as a 45-page table, and finally a four-page list of priority actions for the years 2011 and 2012. The tabular format is commonly used in biodiversity action plans.

The document also commits to presenting an annual "green account" (grønt regnskap), a report to politicians about the status of the different measures being undertaken, as well as an updated "green vision". This green account has indeed been submitted to Stavanger's Environment and Building Committee (Utvalg for miljø og utbygging) on an annual basis, although the report for 2019 focuses on the status of different projects and the financial situation of these, whereas any vision for biological diversity is absent (Stavanger Kommune, 2019).

The introduction to the Biodiversity Action Plan includes a paragraph about increasing awareness of biodiversity to increase understanding of its importance and of how to meet both national and international targets for preserving biodiversity (Stavanger Kommune, 2011, p. 5). This had been included in the ideas behind 2010 as the year of biodiversity, as well as being reflected in the Aichi Targets passed in the same year (Direktoratet for naturforvaltning, 2010) (Convention on Biological Diversity, 2010).

The Biodiversity Action Plan includes a number of voluntary organisations with which the municipality co-operates through consultation, maintenance of natural areas and biodiversity assessments. These organisations include Naturvernforbundet, forum for outdoor recreation

[3] Handlingsplan for biologisk mangfold

and nature, the hunting and fishing association and ornithological association. The smart city office in Stavanger had not yet been established, so there is unsurprisingly no mention of the smart city in this document.

While the plan lists a number of measures and concrete actions that the administration was undertaking or wished to undertake at the time of publication, it contains little in the way of targets or principles for how Stavanger wishes to tackle issues related to biodiversity. Its goals are short and general, with a main vision of managing biodiversity in a sustainable manner, and a single main goal of working continuously with measures to preserve and develop biodiversity in Stavanger, and committing the municipality to the national target of halting biodiversity decline by 2010.

Interviews

Ten interviews were carried out between August and October 2020. Perhaps the main impression from the interviews was that people across the board are interested in biodiversity. While this was to be expected from people who work with nature and biodiversity-related issues on a daily basis, I was somewhat surprised by the positive attitudes towards and knowledge of biodiversity issues shown by interviewees with a smart city background.

Another key finding was that biodiversity professionals from the municipality were already in touch with people from the smart city office, exploring ways in which the two units can collaborate. This seemed to simultaneously confirm and refute my assumptions that the two sectors operate independently of one another and do not co-operate – on the one hand showing that this assumption has been true in the past, but that both parties are interested in and have set about changing this situation. Although initial meetings have taken place between smart city people and their biodiversity counterparts, it was still unclear at the time of the interviews how the two units would work together.

It also emerged that the municipality of Stavanger has signed up to the BiodiverCities project, run by the European Union as part of the EU Biodiversity Strategy. This project will look at citizen science amongst other things, as a way to “engage citizens in vision building around

urban nature, monitoring, and solutions to improve urban biodiversity" ("BiodiverCities," 2020). Running from 2020 to 2030, the project is still in its initial stages, so there had not been much involvement or interaction with the project at the time the interviews took place.

The interviews revealed that there had been little contact between NGOs and smart city practitioners, although one of the organisations (Naturvernforbundet) had sporadic contact with Nordic Edge. This contact was often more about matters related to green energy issues, such as a solar power project being run by Naturvernforbundet, and not about biodiversity. Interestingly, the respondent from Nordic Edge described contact between the two organisations as quite frequent, while Naturvernforbundet described such contact as more sporadic.

As part of the interviews the interviewees had been asked to rate on a scale of 1 to 5 how important certain factors were in smart city projects. These were: sustainability, innovation, urban quality of life, protecting biodiversity, generating profits, reducing energy usage, and resilience. Similar questions were asked of urban biodiversity projects, but the issue of protecting biodiversity was replaced with use of traditional methods. My intention was just to get an indication of people's general priorities without placing much emphasis on these scores, but applying a quantitative approach to these numbers gave some interesting insights, also borne out by the comments made by the interviewees.

	Smart City projects	Biodiversity projects
Sustainable	4.9	5.0
Innovative	3.3	2.4
Traditional methods	n/a	3.0
Urban quality of life	4.7	3.8
Protect biodiversity	4.6	n/a
Generate profits	2.9	2.3
Reduce energy use	4.1	2.5
Resilience	4.3	4.1
Fashionable	4.1	3.8
Well-informed	3.7	2.8

Figure 3. Perceived importance of different concepts in projects - average scores out of 5.

For smart city projects, sustainability scored the highest with an average of 4.9 out a possible 5. Interestingly, protecting biodiversity was close behind on 4.6 out of 5, only just behind improving urban quality of life. This level of importance for biodiversity surprised me, as did the low scores for innovation and generating profits, which scored 3.3 and 2.9 out of 5 respectively. These figures undermined another assumption of mine, that smart cities' focus on new technology, big data and economic growth is incompatible with biodiversity conservation. The non-numeric questions and responses backed up these figures, revealing that innovation and technology did not seem to be regarded as particularly important in smart city projects. Instead, there was a focus on finding new solutions, but that these did not necessarily need to be based on technology, even if technology often plays a significant role.

A notable exception on the importance of technology in smart city projects was from the two representatives of NGOs, both of whom regarded modern technology as an important part of smart city projects. In the answers of one of the interviewees from NGOs, this was accompanied by a general scepticism towards modern technology, apps and devices.

The academics who were interviewed also gave interesting insights into the role of technology in the smart city. One pointed out that the smart city concept has arisen out of a technological-optimistic view of solving society's problems, but that the use of technology is less important than solving social problems. The other academic was of the opinion that technology is indeed fundamental to smart city projects, regardless of what people say about it, because smart city projects in practice almost always seem to be centred around the technology involved.

Both representatives from NGOs pointed out that there is a wealth of data that has been generated over many years, but that much of this data is often not gathered in unified, easily accessible systems or databases. They also pointed out that local experts can often be highly knowledgeable about certain localities, and that NGOs and policy makers could benefit by harnessing this knowledge, collating it in some way into usable data. This was also touched on by one of the interviewees from the municipality.

Another question aimed at evincing the interviewee's attitudes towards the smart city and biodiversity, was whether they thought these issues were fashionable. The question is subjective and quite possibly ambiguous, and my intention was to make the interviewee think

and talk about the question. The question was not intended as one to be answered on a scale of one-to-five, but because it followed straight after the other one-to-five questions, many chose to give a one-to-five answer, usually complemented by an explanation of some kind. Of the seven interviewees who gave a numerical score to both smart cities and biodiversity, six considered that smart cities and biodiversity were equally fashionable. The slightly different scores in Figure 1 reflect that one interviewee gave a score for biodiversity but not for smart cities.

The interviews showed that citizen science was not a very well-known concept. Both respondents from academia were well-versed on the subject (one was chosen because he is involved in research into citizen science), as well as one interviewee from the municipality and one from the Stavanger smart city office. Of the others, some had heard of the concept before but had only a basic knowledge of the subject and were unaware of the diverse forms citizen science projects can take. Others did not know the term *citizen science*, but had heard of citizen science projects such as garden bird counting, and had similar basic knowledge to the others. One interviewee had even organised a citizen science project mapping hollow oak trees (Norwegian: hule eiker) but was unfamiliar with the term *citizen science*.

The question of how well-informed about biodiversity in Stavanger the interviewees felt that they were revealed a significant deficit in the levels of information coming from the municipality about biodiversity projects in the city. Even people who described themselves as interested in biodiversity struggled to mention any projects in the municipality. The average score for how well-informed the interviewees felt that they were about biodiversity issues in Stavanger was just 2.8 (those who work directly with biodiversity issues were not asked this question). This score falls to just 2.3 if the answer of one interviewee who gave consistently higher ratings than the others is removed. Coupled with responses that information and involvement in biodiversity projects are very important, this reveals an area where Stavanger municipality has much room for improvement.

Discussion

My research found that issues related to biodiversity are absent from smart city documents in Stavanger, and that this is reflected in publicly available documents concerning other smart cities in Norway and elsewhere in Europe. Environmental plans and documents from the municipality of Stavanger do not prioritise biodiversity, and include few concrete targets. The interviews revealed that there has so far been little contact between biodiversity practitioners and smart city practitioners, although there were signs that there could be more co-operation in the near future. Conflicting perceptions of the role of technology in smart city projects emerged as a key issue, as did the lack of public information around local biodiversity issues.

Based on these main findings, this discussion section is divided into four sections: the first section looks at *co-operation and inter-organisational integration* and answers the main research question about existing working relationships between smart city practitioners and biodiversity conservation officers in Stavanger; the next section on *perceptions and the role of technology* addresses the first sub-question about factors underlying engagement between smart city and urban biodiversity practitioners; the third section about *narratives* discusses opportunities for smart city and biodiversity professionals to learn from each other as well as potential compatibility issues between the two groups; the final section looks at how *citizen science* could be utilized in Stavanger, and the possibility for it to synergise biodiversity and smart city domains in Stavanger.

Co-operation and Inter-Organisational Integration

The theoretical background for this project was Ramon Gil-Garcia's governmental inter-organisational information integration (GIII) which looks at the whole-of-government approach which often gives rise to smart city projects. According to the GIII, the character of these projects evolves through different phases from *trusted social networks*, through *shared information* and *integrated data* and finishing with *interoperable technical infrastructure*.

The interviews revealed that there had been little co-operation between smart city practitioners and practitioners of biodiversity. Respondents who worked with biodiversity in the municipality had not had any contact with people from the smart city project, but at the

time of the interviews had invited smart city practitioners to a meeting. The purpose of this meeting was for employees in the smart city and employees in the "parks and roads" department to familiarise themselves with each other's work as a first step towards finding ways in which the two could work together. The lack of previous contact backs up the assumption that there is little contact and co-operation between these two groups, but the invitation to a meeting showed that there is a growing awareness that the two may be able to help each other. It is likely that the two departments will work together in the future, but what form any co-operation could or should take had not yet been defined at the time the interviews took place.

It is worth mentioning here that some employees within the "park and roads" department have worked on some smart city projects before, for example, on a project using sensors to detect when underground drains are filling up with sand and other blockages. Being a department with a broad remit, not all projects concern nature and biodiversity, but the contacts and experience of co-operation made when working on non-biodiversity related projects could facilitate an easier transition if smart city practitioners start working on biodiversity projects. The trusted social networks that Gil-Garcia refers to in the first stages of the GIII are already partially in place on an institutional level, so the threshold for embarking upon biodiversity projects in conjunction with the smart city may well be lower than it would otherwise have been.

Municipal documents regarding both the smart city and biodiversity policy did not show any evidence that the two fields regarded the other as relevant to their own subject areas. The Smart City Roadmap contains a section on *energy, climate and environment* as a priority area, but this fails to mention biodiversity at all, instead focusing almost exclusively on reducing energy usage and carbon emissions. Of the three municipal documents which deal with environmental concerns, only the Climate and Environment plan makes a brief mention of the smart city project, again related to the reduction of greenhouse gas emissions.

While it might be considered problematic that the Smart City Roadmap does not mention biodiversity, or indeed the environment beyond a narrow view of climate change mitigation, it is not necessarily problematic that the environmental documents make little mention of the smart city. Smart city projects are, or at least should be, seen as a means to solving some of society's problems, rather than being ends in themselves. In other words, there is no point

carrying out a smart city project for its own sake, if it is not helping to find a better solution to a genuine problem faced by the host city. These documents then will identify and address problems which they face but should not necessarily be expected to describe all the methods which can be used to tackle these problems.

Moving away from Stavanger's municipal administration there was some evidence of co-operation between one of the NGOs and a smart city innovation cluster. However, this co-operation related to a project to boost ownership of rooftop solar panels and was therefore not related to biodiversity. Here again it seems energy and climate issues are regarded as falling within the remit of smart city concerns, but biodiversity issues are not.

Both university researchers interviewed were members of the University of Stavanger's Smart City Research Network. One of them worked with smart city topics, but not with biodiversity issues, despite having a personal interest, while the other was involved in a project related to environmental citizenship, but not currently with any smart city projects. Both were able to give insights into both issues but did not engage in any research which links the two fields together. Again, this backs up the impression that there is a lack of co-operation or co-ordination between smart city and biodiversity issues also at the research level.

Co-operation amongst the various actors looked at in this study are therefore mostly in the early phases as described in the GIII, although there are variations according to the different constellations of actors that we look at. Stage 1 involves conversations and correspondence between different actors which over time creates trust between them, while stage 2 is a continuation of this with shared formal and informal information. Integration between some of the actors involved in this project can be described as being well into stage 2 or beyond, while others have perhaps not even entered stage 1.

Smart city practitioners in Stavanger can be split between the smart city office which is embedded within Stavanger municipality, and private smart city actors. The smart city office has strong links to Stavanger municipality in general, with joint projects to gather information and to set up practical projects. Many of these projects are jointly run, and it is difficult to discern how the roles of the smart city office and the municipality differ. Here we could say that these projects have moved beyond stage 3 of integrated data and are into stage 4 with the creation of interoperable technical infrastructure. However, biodiversity practitioners

within the municipality are only just starting to talk with smart city officers so can be placed within stage 1 of having conversations to create understanding and trust. It is possible that this trust-building will be achieved quite quickly because some employees who work with biodiversity have previously worked with the smart city office on non-biodiversity projects, so a level of familiarity has already been achieved between some individuals representing the two institutions. The smart city office and private smart city organisations are also involved in the Smart City Research Network based at the University of Stavanger, so integration here is perhaps at an advanced stage 2, with some projects moving towards stage 3 with the technical integration of data.

Connections between biodiversity practitioners in Stavanger municipality and the nature conservation NGOs are also at stage 2, with the organisations having many years of trust-building co-operation behind them so that information is shared both formally and informally.

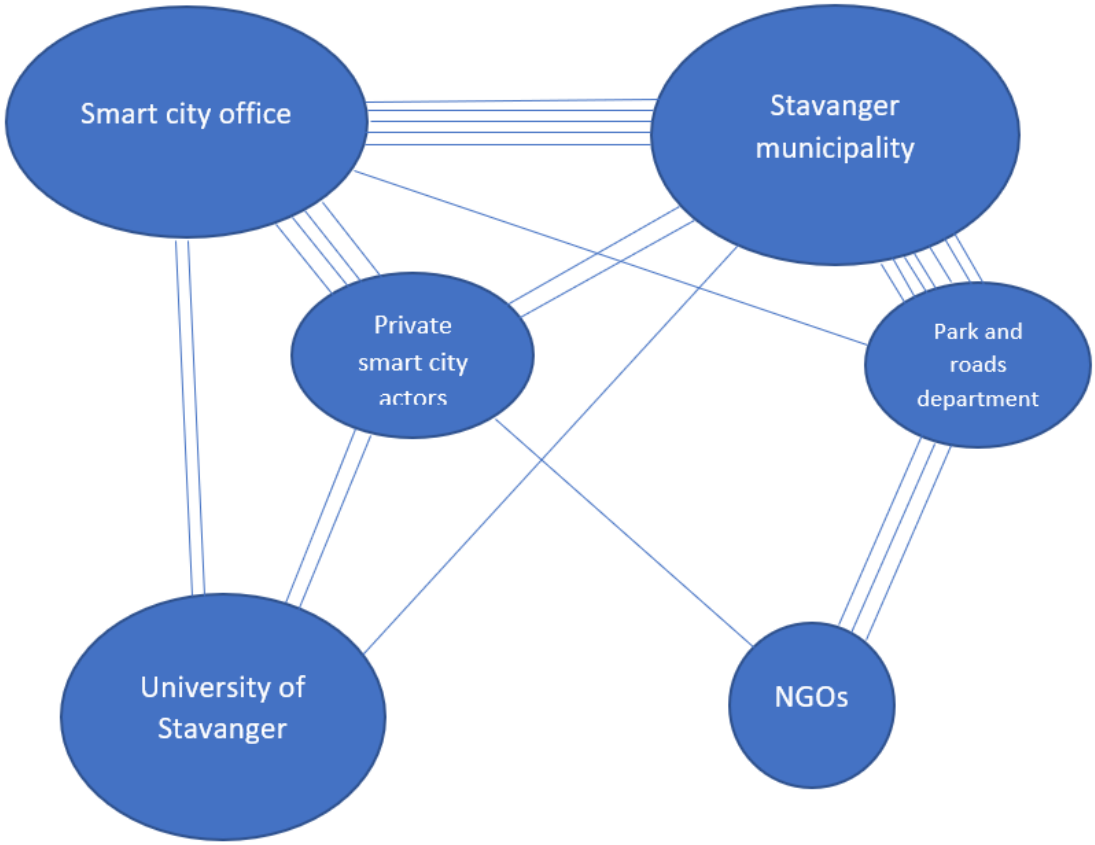

Figure 4. Visualisation of strength of co-operation between different actors in Stavanger.

Co-operation between smart city practitioners and nature conservation NGOs, however, is not well advanced. While there has been some contact between NGOs and privately run smart city-related organisations, there has as yet been no contact between the NGOs and the smart city office. Here co-operation has yet to reach stage 1, while co-operation between NGOs and private smart city actors is the early part of stage 1 as trust between the two is slowly being built. Similarly, there is no evidence of contact between the NGOs and the university, so interaction is at pre-stage 1.

Co-operation between the municipality and the university is quite difficult to place. The University of Stavanger co-operates with several departments within Stavanger municipality, but most formal co-operation takes place via the Smart City Office and the Smart City Research Network. However, the fact that people from the university and municipality are involved in similar EU-based projects relating to citizens and the environment but did not know of the other person's work, suggests that there is room for improvement. It is perhaps not surprising that connections are not always made between two such large and diverse organisations. Perhaps this problem could itself be the subject of a project using smart technology to allow employees of both organisations to connect with people working on similar topics, but without overloading them with unwanted information.

This problem also raises issues about the nature of smart city work and its perceived focus on technology. If the focus of smart city projects is too much upon technology, then projects where there is great potential for inter-organisational co-operation, but which lack the technological component, might not be seen and will miss out on the collaborative opportunities which exist.

Gil-Garcia's GIII theory also lists a number of advantages and disadvantages which can be related to the actors discussed here. The possibility of creating of a unified nature database for Stavanger as discussed earlier would correspond with the advantage of reduced data duplication and better information systems found in the GIII. Similarly, if the municipality was to improve its external communication regarding biodiversity, this would reflect the advantages of enhanced public image and better public information.

Amongst the disadvantages and challenges to greater integration are the political nature of integration and the diversity of stakeholders. Political power is unequally distributed among

these actors, where the municipality has political power to legislate and prioritise as it sees fit, alongside the power to assign funding and its access to large numbers of qualified staff. The university has its own resources but is less able to determine the direction that smart city projects take. The smart city office is entirely dependent on the municipality of which it is an integral part, while private smart city initiatives are dependent on outside funding, some of which comes from the municipality. The NGOs included in this study are perhaps the least powerful with limited resources and staff. The NGOs could benefit by closer collaboration with the municipality and the other actors, who might be able to attract resources to biodiversity projects, but the NGOs might also risk becoming more dependent on these other actors (McQuaid, 2010). One of the NGOs in this study is entirely state-funded, while the other receives money from multiple sources, but also receives project funding and support from Stavanger municipality. Greater collaboration between the two might restrict the NGO's independent voice in holding authority to account by making them increasingly reliant on the goodwill of the municipal administration and political players. Co-operation in smart city projects or with the university might also enable the NGOs to attract more funding to biodiversity projects, but this benefit could be offset by the different actors having divergent priorities and goals.

Gil-Garcia mentions that the attitudes of individuals and their resistance to change also presents a challenge to greater integration. While this can be true in relation to large organisations like the municipality or university, it is perhaps particularly relevant in relation to the NGOs. The two NGOs in this study have one full-time position and 3.5 full-time positions respectively. This is likely to make their attitudes towards things like technology and the smart city highly individual-related, rather than necessarily being institutional. Similarly, trust-building between the NGOs and other actors is likely to be based on personal contact. Both these issues are therefore likely to be heavily affected if personnel changes take place within the NGOs.

Perceptions and the role of technology

One of my hypotheses which led to the research questions was that perceptions of smart city projects and biodiversity projects led to the two fields being incompatible, particularly

regarding new technology, big data and economic growth. Eliciting which perceptions actually existed amongst smart city and biodiversity professionals was therefore a key part of my interviews. This section discusses which perceptions existed amongst those interviewed and looks particularly at perceptions of the role of technology in smart city projects.

As mentioned earlier, the results about how the interviewees rated the importance of various concepts in smart city projects and in biodiversity projects produced some surprising results. Foremost amongst these surprises was that biodiversity issues were given an average rating of 4.7 out of 5 for importance in smart city projects. This score was at the same level as the concept of *improving urban quality of life*, and was only surpassed by *sustainability*. I was also surprised that the concept of *innovation* averaged only 3.3 out of 5 in smart city projects. Similarly, despite smart city initiatives often being framed as a means of stimulating economic growth (Haarstad, 2017), economic growth was not perceived as important in smart city projects by the interviewed respondents.

What can account for the high scores given to biodiversity in smart city projects, and do the interviewees really believe that biodiversity is as important as improving urban quality of life? While it could be that biodiversity really is important in smart city projects in Stavanger, this seems highly unlikely given that there is little evidence of biodiversity being considered in smart city projects at all, as revealed by the lack of co-operation between practitioners in the two fields and in documents such as the *Roadmap*. This then raises questions about the validity of the interview responses.

There are several possible explanations for why biodiversity rated surprisingly strongly in considerations for smart city projects. It could be that we just happened to stumble upon people who are interested in biodiversity, but could also be an example of selection bias. Several of the interviewees were selected as a result of recommendations from others, and they are likely to have been recommended because of their knowledge or interest in biodiversity and environmental issues. Four of the interviewees work with biodiversity on a daily basis and were therefore likely to rate biodiversity as important. In fact, all four of these interviewees gave biodiversity a score of 5 out of 5. It was also not made clear in the question whether respondents should give an answer as to whether the different concepts were actually important in practice in such projects or how important the respondents thought these concepts should be. It could therefore be that the answers show that the respondents

thought biodiversity should be taken into consideration in smart city projects regardless of whether that is actually the case. With hindsight, it might have been useful either to have specified whether answers should reflect the reality or the desired situation, or it might even have been useful to have separate questions for each to assess both how people thought the situation was compared with how it should be. This could have given interesting insight on the relationships between the ideals of smart city projects and the "actually existing smart city" (Evans et al., 2019).

Another possible reason for the high ratings for biodiversity in smart city projects goes back to Rapley's description of "adequate interviewees", in which respondents give answers that they feel the interviewer wants to hear (Rapley, 2004). In the invitation to participate in the interviews it was made clear that the subject would be biodiversity and the smart city, so it is possible that this also skewed the mindset of the interviewees, in some way priming them to talk about biodiversity. In such a situation it is perhaps likely that the interviewee gives the subject more prominence than would otherwise be the case.

Questions of validity also arise with the question of the role of innovation in smart city projects. With technology being a key aspect of smart city projects generally and one of three main pillars described in Stavanger's *Roadmap*, I had expected innovation to be given a higher score by respondents. Literature on the smart city backs up that innovation and technology are key to smart city projects (Haarstad, 2017; Yigitcanlar et al., 2019). Stavanger seems to be a city which sees itself as taking the citizen-centric approach to smart city development, rather than the technical, infrastructure approach described earlier, placing co-operation and citizen involvement in the forefront of smart city projects (Ahvenniemi et al., 2016; Van Den Bergh & Viaene, 2016). However, it is not clear that it has entirely managed to move away from the techno-centric approach. One of the respondents with an academic background was sceptical about whether Stavanger is citizen-centric or not, saying that smart city practitioners often talk about citizen involvement, but that the reality of the projects that exist is that new technology takes centre stage. While it may be true that innovation is not very important in smart city projects in Stavanger, it is also possible that some interviewees felt they should repeat a message often pushed by people higher up in their organisation. In addition, the same issues as above arise over the framing of the question with regard to whether the answer should reflect an ideal or reality. This reflects that, as in Stavanger, there is often gap

between the ideals of smart city thinking and what is termed the *actually existing smart city*, in which smart city projects have to fit in with the existing place-specific situations of the cities where they are implemented (Leitheiser & Follmann, 2019; Shelton, Zook, & Wiig, 2015).

The role of technology and innovation emerged as interesting issues from the interviews. Interviewees close to smart city projects and Stavanger municipality responded that technology is not an important factor in smart city projects, but rather that outcomes and finding new ways of working and collaborating were the most important elements. In the roadmap, however, technology comes across as the central theme, overshadowing in my opinion themes of cooperation and citizen involvement. Thinking about smart city projects in Stavanger might have evolved in the four years since the roadmap was written, but it is not a very long time for attitudes to have changed so fundamentally. With the roadmap being such a key document regarding Stavanger's smart city initiative it would be surprising if the focus really has shifted as much as the interview responses suggest. Here we see again that Stavanger's aspirations to be *citizen-centric* seem to be struggling to break free from the more traditional technical approach.

Furthermore, respondents from the NGOs considered that smart city projects were very much about technology, so much so that it came across in the interviews as the main reason for a lack of interest in smart city projects. Technology was perceived as a double-edged sword by the NGO representatives, offering potential benefits in areas such as monitoring, but with dangers that technology can detract from experiences of nature, alienate existing enthusiasts and that it is in itself partially to blame for many of the threats that nature faces.

The contradictory understanding of the importance of technology in smart city projects is perhaps the key reason why nature conservation NGOs don't see any reason to co-operate with the smart city office in Stavanger, as they don't feel it has anything to offer nature conservation. If this is true it could also be that other organisations in different fields have the same perception and might therefore be limiting the range of potential partners for smart city initiatives. Employees of the municipality and other actors close to the smart city seem to have understood that smart projects are about methods of working and co-operation across different organisations and sectors, but perceptions of many who have not had much contact with the smart city office or projects may well be mismatched with how smart city practitioners would like to be perceived. It also chimes with worries that the growth of digital

solutions can in fact disempower citizens, rather than giving them new opportunities for participation (Martin et al., 2018). "Knowledgeable publics" are therefore not being more strongly included in policy formulation and analysis as might be hoped for (Jasanoff, 2003).

Perceptions therefore appear to be important determinants of how open the actors are to co-operation between smart city and biodiversity projects. Where perceptions of smart city initiatives align, there is a greater openness to co-operation, as we can see between biodiversity professionals in the municipal administration. Where perceptions do not align, as with the representatives of the NGOs, there is less openness to co-operation. It might therefore be wise for Stavanger's smart city office and other smart city practitioners to focus on clearing up these misconceptions, and instead to portray smart city projects as being less closely connected with cutting-edge technology and innovation, and more concerned with co-operation between different organisations and citizens.

The findings from the interviews that most of the respondents regarded smart city projects and biodiversity issues as being equally fashionable is also interesting, and this gave rise to a number of discussions and follow-up questions. One interviewee thought that smart city initiatives used to be very fashionable, finding it easy to gain coverage in the media, but have become less so over the past few years. At the same time several of the interviewees gave the opinion that biodiversity has become more fashionable, gaining more media coverage and even becoming a dinner party topic, according to one respondent.

If these perceptions are correct, it will be interesting to see whether this represents a long-term trend or whether it will be a passing phase. If interest in biodiversity is a short-lived fad, the present time might represent a "window of opportunity" for nature conservation administrators and NGOs to get their issues onto the political agenda and implement conservation measures (Kingdon, 1985). However, it could also be that threats to biodiversity have reached such a level that the issue will establish itself as a mainstream policy area.

Smart city projects have shifted focus in the years since they became widespread reflecting changes in the political concerns of the time (Evans et al., 2019). Early projects focused on utilising new ICT technologies, while in the years after the 2008 financial crisis projects were framed as being part of an economic recovery and should therefore be profitable enterprises (Haarstad, 2017). The more recent focus on energy saving and carbon emission reduction can

thus be seen as reflecting international concern surrounding climate change and embodied by the Paris Climate Treaty of 2015. If biodiversity concerns do indeed become part of mainstream political considerations, representing a broadening of the environmental narrative away from a narrow focus on climate change, it is likely that biodiversity and other environmental issues will also play a greater role in smart city discourse. Such mainstreaming of biodiversity into decision making would meet target 2 of the Aichi targets, which aims for biodiversity to be integrated into national and local strategy and policy (Convention on Biological Diversity, 2010).

The interviews indicated that perceptions of smart city projects and biodiversity are indeed important factors underlying levels of co-operation between practitioners in the two fields. Particularly regarding the NGOs, it seems unlikely that that there will be co-operation with smart city projects as long as perceptions of the importance of technology remain unchanged.

Narratives

The interviews included questions about how smart city practitioners and biodiversity practitioners can learn from each other, as well as about issues that could make co-operation between the two difficult. One issue that was mentioned by several respondents was related to the narratives or story-telling that exist around the two fields, which was mentioned by some as a hindrance, but by others as opportunity.

Issues surrounding biodiversity are surrounded by quite a negative narrative, more about the things we cannot do than the things we can. The most common term we use to discuss biodiversity issues is nature *conservation*, but the word conservation is itself about defending what exists, rather than improving or expanding opportunities for nature, and is therefore very defensive. Advocates for biodiversity are often seen as kill-joys, trying to stop a range of economically profitable activities or things that are fun. Locally, we can use as examples current opposition to wind turbines and a low-carbon data centre, as well as the opposition to various leisure pursuits such as the use of jet-skis or wind surfing close to biologically sensitive areas. Biodiversity and nature are also embedded in extraordinarily complex ecosystems that we don't fully understand. The narrative here is that when humans meddle

with these ecosystems we disturb connections that we might not even be aware of, irreparably upsetting the balance of nature. Such thinking can be found in the *ecoscarcity* narrative or *Finite Earth* narrative, in which humans and nature exist separately (Jepson, 2018; McKibben, 1990; Robbins, 2012).

This contrasts with the very linear and positive narratives surrounding smart cities which one interviewee described as "a teleological, straightforward narrative of progress". Put simply, the smart city narrative involves identifying a problem, collaborating with others to propose solutions, testing these solutions, and sharing experiences of solutions that work. Here people are at the centre of finding solutions and improving quality of life. Whereas smart cities are about streamlining, biodiversity is about complexity.

The question then arises as to whether these contrasting and conflicting narratives create fundamental tensions between the two fields, making them incompatible, or whether co-operation could help create a more positive narrative for biodiversity. Whether with or without the involvement of smart city practitioners, projects that enhance biodiversity and people's awareness and enjoyment of biodiversity in the city can be seen as opportunities to re-wild our city and to re-wild the daily lives of urban residents. They can also be seen as fitting in with the *Recoverable Earth* concept, in which nature is not in a hopeless situation, but in a situation where human activity can lead to improvements in biodiversity and nature (Jepson, 2018). Furthermore, enhancing biodiversity and nature is seen as improving human quality of life, rather than happening at the expense of quality of life. Arguably, narratives surrounding the smart city are more in line with the *Recoverable Earth* narrative than are practitioners of biodiversity. Perhaps co-operation between smart city and biodiversity practitioners could lead to a re-alignment of nature conservation narratives towards the more optimistic perspective of the *Recoverable Earth* narrative.

While questions regarding the narratives surrounding nature and biodiversity are relevant on a national and international scale, something specific to Stavanger is a lack of information relating to biodiversity in the municipality. Target 1 of the Aichi Targets relates to people being made aware of the benefits of biodiversity and what they can do to conserve nature, and is arguably the simplest of the targets for local government bodies to implement. However, most of the interviewees, other than those who work directly with nature conservation, were unable to mention anything specific that the municipality was doing to

enhance biodiversity, despite a majority of those people professing an interest in biodiversity issues. Two interviewees also mentioned that they would not know where to look for information about biodiversity in Stavanger. Given that the people interviewed regard themselves as generally well-informed, it is probable that this reflects the situation in Stavanger's population more widely.

It is possible that information and publicity is an area that the Parks and Roads department in Stavanger municipality does not prioritise or see as part of its core area of work, but given that all the interviewees described citizens being informed about biodiversity issues as very important, it seems clear that this is an area where there is a large potential for improvement. Raising awareness was also listed as one of the measures in Stavanger's biodiversity action plan of 2010, but either doesn't seem to have been acted upon or wasn't acted upon adequately. The working program of the municipality's forthcoming Green Plan makes no mention of raising awareness of biodiversity.

Stavanger was rated 27th out of 356 Norwegian municipalities in a recent survey of how well local authorities in Norway deal with nature (Sabima, 2020), so there is reason to suppose that Stavanger is doing a good job in this respect, but what is lacking is information to residents. On the other hand, with Stavanger being Norway's fourth largest municipality and with the financial and human resources to match, it could be argued that Stavanger should aspire to improve upon this position and be at least within the top ten.

Given that the Green Plan is not due to be approved until autumn 2022, there is still time for targets to be set addressing issues such as raising public awareness. Given the scale of the problems facing biodiversity, Stavanger should set itself targets going far beyond simply raising awareness. Inspiration could be taken from the Aichi targets, or from whichever new set of targets replaces them. Targets could be set for integrating biodiversity values into the planning process, reducing the rate of loss of natural habitats and creating terrestrial and marine nature reserves. Locally threatened species could also be identified and concrete measures put in place to improve the conservation status of these.

The interviewees were asked what they thought were the key things that could be done in Stavanger to improve biodiversity. Employees in the municipal administration picked out area planning as an important field, with guidelines imposed on building projects to take care of

and enhance biodiversity. The representatives from NGOs both highlighted the provision of financial resources and more expert staff to work with biodiversity issues, and one of them called for targets to at least maintain populations of threatened species. Information and awareness were mentioned by several respondents, particularly those with smart city and academic backgrounds. One suggested encouraging citizens to create more diverse gardens and neighbourhoods by providing knowledge and ideas, as well as practical things like free wildflower seed packets.

This resonates with urban matrix theories of urban biodiversity, in which measures can be taken by different levels of actors, from city-wide projects undertaken by the municipal authorities to the individual actions of private landowners and homeowners (Nilon, 2011). Both academics mentioned re-thinking streets, pavements and other currently non-green areas in order to provide habitats for plants and animals. While all of these things could serve as ideas for how to benefit biodiversity in Stavanger, it seems to me that these responses illustrate the dichotomy illustrated by Jasanoff's *technologies of humility* (Jasanoff, 2003). The responses vary between on the one hand giving extra resources for experts to make plans and put them into place, and on the other hand raising awareness amongst citizens and empowering them to make changes beneficial for wildlife, and by extension for themselves.

Several respondents, when asked how biodiversity and smart city practitioners can learn from each other, suggested that people working with biodiversity could benefit from adopting some of the messaging and marketing techniques found in smart city projects, in order to project a more positive, progressive, forward-looking message. This could include information about how the municipality and NGOs are working with biodiversity, as well as information and potentially also assistance on measures citizens can take to improve biodiversity in their gardens or neighbourhoods. Smart city officers or publicity surrounding any potential citizen science projects could help raise the profile of the municipality's work with biodiversity, but are not pre-requisites for an improvement in communication activity in the department.

The lack of effective information emanating from the municipality's parks and roads department, alongside the reluctance of conservation NGOs to engage with technology and smart city projects, raises concerns in a world where interdisciplinary collaboration is widely seen as increasingly important. The term *sustainability* also demands that we think more

broadly about the effects of different activities beyond their immediate sphere. This entails a move away from so-called silo-thinking, in which experts do not really need to think much beyond their own field of expertise. Although this thesis has not gathered any information about the educational backgrounds of the people interviewed, it is still reasonable to speculate about whether people employed to work with nature and biodiversity in public administration and other organisations represent too narrow a range of expertise. Put bluntly, are there too many biologists working with biodiversity issues, and would such institutions benefit from employing people with a wider range of educational backgrounds?

Citizen Science

The majority of the interviewees had only a limited knowledge of the concept of *citizen science*. Both academics were familiar with the term and had a good grasp of the range of possibilities that citizen science represents. The same can be said for one of the representatives working with biodiversity in the municipal administration, and one of the interviewees form the smart city office also had a better than average understanding due to an old friend who had studied the concept. Otherwise understanding of the term citizen science was limited, although many knew of citizen science projects when the term was explained, mostly large-scale bird-counting projects.

One possibility for the lack of understanding for the term could be due to the use of the English term *citizen science* being unfamiliar to the respondents. One interviewee suggested that the concept could become better known if it had a good Norwegian translation. The Language Council of Norway suggests use of the terms *grasrotforskning* (grassroots research) and *folkeforskning* (people research), but as yet these terms are little used and the English term dominates (Språkrådet, Retrieved 26th November 2020). Whatever we call citizen science, it is unlikely to be widely used if the concept is little known.

As discussed earlier, the municipality is a participant in a European project BiodiverCities, which is likely to look at citizen science as a way of engaging citizens in the biodiversity around them. One of the academics was co-ordinating a similar project, EnviroCitizen, which looks specifically at citizen science as a way to “encourage environmental citizenship” (Universitetet

i Stavanger, 2020). Here there is clearly a large degree of overlap and this therefore looks like an area in which Stavanger municipality could co-operate with the University of Stavanger.

The two interviewees closest to these EU projects were both adamant that the benefits of citizen science are more about the effect it has on the participants rather than for the value of any data generated. While there is the potential for large amounts of useful data to be generated by citizen science, the respondent from the municipality was clear that citizen science should not just be used as free labour for data gathering, but that it should contribute to the inclusion of citizens in analysing and formulating policy. This view again resonates with Jasanoff's thoughts about *technologies of humility* and participatory politics by knowledgeable publics (Jasanoff, 2003), as well as with Stavanger's citizen-centric approach to the smart city.

One of the main benefits of citizen science is that it allows data to be generated cheaply on large scales, both temporally and geographically. One interviewee suggested that this makes citizen science more relevant at regional or national scales, but less so at a local level. This could make citizen science less interesting to city governance bodies, at least in regard to the large-scale citizen science projects that often capture people's attention. However, given the broad range of activities encompassed by the concept of citizen science, there must be a range of options that could be of benefit at a local level.

One possibility could be for citizen science to be used in conjunction with Stavanger municipality's plans to identify a number of indicator species, reflecting the broader state of biodiversity in the city. Once the municipality has selected its indicator species it will need to monitor these in order to assess whether these species are flourishing, are stable or in decline. Using a model similar to the *BeeWalks* of the UK might be a good way to keep track of these. BeeWalks is a project run by the British Bumblebee Conservation Trust (Bumblebee Conservation Trust, 2020). Volunteers receive initial training in identifying different bees, before adopting a route or transect, which they walk once a month recording what they see. For the monitoring of Stavanger's indicator species, volunteers could be asked to record species from a list that could well include a variety of taxa, such as birds, mammals, insects, plants and mosses on a regular basis. Appealing for volunteers could occur through traditional and social media, but could also take place through local organisations which are likely to be in contact with people with higher levels of interest and expertise. Organisations could also

be useful in offering training in species identification, if such training is necessary. While the BeeWalk scheme has more than 1900 volunteers across the UK, a local project in a municipality like Stavanger could probably give useful data with as few as ten or twenty volunteers, although more would be better.

Biodiversity on a micro-level is often best understood by local experts who might have detailed knowledge about specific sites, and several interviewees from a range of backgrounds commented on the wealth of local knowledge held by citizens. Representatives both from NGOs and Stavanger municipality referred to this, as well as to how encounters with such local experts are mostly down to chance. Mention was also made of promises by Stavanger municipality to compile a database of local wildlife which have yet to come to fruition, although these promises are reportedly between twenty and thirty years old, and have probably long been forgotten by municipal employees. Nevertheless, the wish for such a database was still present. This too could be an area where citizen science comes into play, being used to gather diverse, often privately held data sets regarding Stavanger's nature. This would also be a natural arena for smart city practitioners who could offer their expertise on converting the range of data into standardised formats and creating a platform where such information would be searchable and accessible, as well as in issues such as privacy and data protection. Such a database would be a natural inclusion among Stavanger's open data sets, another important element of the smart city project in Stavanger.

Given that urban biodiversity differs from biodiversity in general due to its social and cultural importance to urban residents, there might also be potential for citizen science and smart city projects to combine to gather information on what biodiversity urban residents value the most in their neighbourhoods. Information gathered from such a project could be used as a foundation for further initiatives to promote various forms of biodiversity in different areas. Using agile piloting (Norwegian: *kvikktest*) methods that have already been used in Stavanger, residents' input about biodiversity could be followed by a range of different solutions being piloted in order to explore which measures are most beneficial (Stavanger kommune, 2020c).

One of the interviewees from the smart city office suggested *gamification* as a way in which smart city practitioners could contribute to citizen science projects. Gamification involves providing game-related elements to non-game contexts, in order to increase usability, trust and motivation (Basten, 2017). Gamification is also mentioned in the citizen science literature

as a way to encourage users to engage for longer periods and also to reach out to a wider audience (Hecker et al., 2018). Any app-based interface for recording data could be added to with gamification features, which could be as simple as giving a message of thanks for certain numbers of completed data recordings, or appealing to a younger audience by introducing levels or awarding badges after a certain number of recordings. It could also include a systematic way of giving feedback to participants, which has been shown to have a motivational effect as well as improving the educational value of citizen science participation (Hecker et al., 2018).

This discussion section began by placing levels of co-operation between different actors in Stavanger in the various phases described in the GIII. Relationships between biodiversity practitioners and smart city actors were found to be at phase 1 or pre-phase 1. It also discussed how certain advantages and disadvantages of cross-sectoral coordination identified by Gil-Garcia can be related to actors in Stavanger. I have also discussed how issues emerging from the interviews about the role of biodiversity in smart cities relates to discussions about the disparity between smart city ideals and implementation. Diverging perceptions of smart city projects in Stavanger are a key obstacle to co-operation between NGOs and smart city initiatives, although co-operation with the smart city could potentially help bring about a more optimistic narrative surrounding biodiversity.

I have also made a number of suggestions that local actors could consider acting upon. Firstly, smart city organisations should work to ensure that smart city projects are not perceived as being first and foremost about technology. The message that smart city projects are more about collaboration and participation should be better communicated. Secondly, the municipal administration should work harder to communicate to citizens what kinds of measures are being taken in Stavanger to protect and enhance nature and biodiversity, as well as to give more information about what citizens can do themselves to benefit biodiversity. I have also made suggestions for targets that should be included in Stavanger municipality's forthcoming Green Plan. Lastly, I have suggested ways in which citizen science could be used locally, as well as for how smart city practitioners could contribute to citizen science projects.

Conclusion

Against a background of rapidly declining global biodiversity, increasing urbanisation and the popularity of smart city projects to tackle social problems, this master thesis asked what the working relationships between smart city practitioners and conservation officers in the city of Stavanger were. It also asked whether citizen science initiatives can advance these relationships.

This research has shown that smart city practitioners and biodiversity professionals have hitherto had little, if any, contact regarding co-operation and co-ordination of their work. However, initial contact has been made between those working with biodiversity in Stavanger municipal administration and people working with smart city projects. This shows that there is a growing awareness that the two fields can potentially be mutually beneficial and could represent the beginning of co-operation between the two fields. On the other hand, biodiversity professionals outside of the municipal administration seem wary of involvement with smart city projects.

These emerging signs of co-operation reflect generally positive perceptions among those interviewed of both smart city initiatives and biodiversity issues. Smart city initiatives are perceived by many of those interviewed as primarily involving new forms of co-operation between different actors, although some perceived the application of new forms of technology to be at the heart of smart city projects. Creating economic growth was not perceived as being very important to smart city projects.

Perceptions of smart cities are important, since those perceiving smart city initiatives to be based on technology are less likely to be interested in collaboration with smart city actors. Efforts should therefore be made to communicate that the use of new technology is not fundamental to smart city projects in order to attract of wider range of partners.

Stavanger municipality should also improve its communication concerning biodiversity projects in the city, with many people feeling that they know little about what the municipality is doing for nature. Biodiversity has emerged as an important issue in recent years, but increased awareness of global threats to biodiversity is not reflected at the local level. Increased public awareness about threats to nature could create opportunities for increased

resources to be allocated to biodiversity projects. Stavanger municipality should also set itself concrete and measurable targets for its work with biodiversity. Inspiration for these targets could be taken from internationally agreed commitments such as the Aichi targets, or from the new set of targets which are set to be agreed in 2021. These could be included in the city's forthcoming Green Plan.

Citizen science can be used in a number of forms in biodiversity projects at municipal level. Large-scale projects would be more beneficial for their impact on environmental citizenship than the value of data they generate, while smaller-scale monitoring of indicator species could also be useful for the municipality. The expertise of the smart city office could be utilised to create a unified open database, while agile piloting or gamification could be other avenues through which smart city professionals can contribute to citizen science projects.

These findings are based on a case study of the city of Stavanger in Norway, but searches of information regarding smart cities in comparable European cities suggests that smart city initiatives and biodiversity projects also mostly operate independently of one another elsewhere. Similarly, the existence of international environmental citizenship projects, in which Stavanger municipality and the University of Stavanger participate, reflects that cities across Europe share many of the same concerns in this field. The use of citizen science has increased in recent decades, as has the range of different forms of citizen science project. This provides opportunities for municipalities and other local nature organisations to enhance urban biodiversity and citizens' experience of nature, as well as providing scope for smart city initiatives and biodiversity practitioners to co-operate with one another.

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Appendix

Interview Guide

The following interview guide was used in the ten interviews that were held. The questions asked were modified according to their relevance to each interviewee.

Theme	Questions	Notes and possible follow ups
Employment role and tasks	What is your job and main roles?	Short summary.
	What tasks in your job are related to biodiversity?	
	What tasks in your job are related to the Smart City?	
	Which business sectors, government bodies or NGOs do you interact with?	Within and without your own organisation? Daily / Weekly / Monthly / Yearly
Perceptions of the Smart City	What would you describe as the main elements of a sustainable city?	
	What would you describe as the main elements of a smart city?	
	In what ways are smart cities and sustainable cities the same thing and how do they differ?	Can it be smart if it's not sustainable?
	How important is it for smart city projects to be sustainable?	Scale of 1 - 5
	How important is it for smart city projects to be innovative?	Scale of 1 - 5
	How important is it for smart city projects to improve urban quality of life?	Scale of 1 - 5

	How important is it for smart city projects to protect biodiversity?	Scale of 1 - 5
	How important is it for smart city projects to generate profits?	Scale of 1 - 5
	How important is it for smart city projects to reduce energy usage?	Scale of 1 - 5
	How important is it for smart city projects to increase resilience?	Scale of 1 - 5
	Would you say that smart city projects are fashionable?	
Perceptions of biodiversity	What do you see as the main elements in a biodiverse city?	
	In what ways are biodiverse cities and sustainable cities the same thing and how do they differ?	Can it be sustainable without biodiversity?
	How important is it for urban biodiversity projects to be sustainable?	Scale of 1 - 5
	How important is it for urban biodiversity projects to be innovative?	Scale of 1 - 5
	How important is it for urban biodiversity projects to use traditional methods?	Scale of 1 - 5
	How important is it for urban biodiversity projects to improve urban quality of life?	Scale of 1 - 5
	How important is it for urban biodiversity projects to generate profits?	Scale of 1 - 5
	How important is it for urban biodiversity projects to reduce energy usage?	
	How important is it for biodiversity projects to increase resilience?	Scale of 1 - 5
	Would you describe biodiversity as fashionable?	Scale of 1 - 5
	Do you know of any particular biodiversity project that is happening or has happened in Stavanger?	

	Do you think that biodiversity is relevant to your area of work? Why/why not?	
	Are new technologies and big data relevant for biodiversity projects?	Are other factors more important?
Co-operation	Does your work involve biodiversity?	If so, how?
	Do you see any possibilities for biodiversity issues to be included in your sphere of work? Why/why not?	
	Have you been in any meetings with people who work with biodiversity projects?	
	If yes, how often? What was the meeting about? Who took initiative for a meeting?	
	If no, have you ever requested a meeting or been asked to participate in a meeting?	
	Do you or your department/organisation share any information with people who work with biodiversity projects?	
	Do you co-operate with biodiversity people in any other way?	
	Have you met informally with people who work with biodiversity projects?	
	Would it be useful for you or people from your department to co-operate with people who work with biodiversity?	
	Can you think of any (other) ways in which Smart City and biodiversity people could co-operate?	
	Can you think of any factors that would make any such co-operation difficult?	
	Do you think that your field of work has anything to learn from biodiversity projects?	
	Do you think that biodiversity projects have anything to learn from your field of work?	
Citizen involvement	How important is it that citizens are informed about projects to protect biodiversity?	
	How important is it that citizens are informed about Smart City projects?	
	How important is it that citizens are involved in projects to protect biodiversity?	

	How important is it that citizens are involved in Smart City projects?	
	Are you satisfied with level of information and involvement for citizens in Smart City projects in Stavanger?	Elaborate. Why/why not? How can this be improved?
Citizen Science	How familiar are you with the concept of "citizen science"?	
	Have you come across citizen science being used in your field of work?	
	Has data from generated by citizens been used before by your department/organisation?	If yes, how? (not citizen science, per se).
	Has data from citizen science been used before by your department/organisation?	If yes, how?
	Where do you get the data/information you need for your job?	
	What kind of data are you missing that would help you carry out your job?	
	How could data generated by the general public be useful in your work?	What problems do you foresee?
	What advantages and disadvantages do you think there could be with citizen science projects?	
	Can you think of ways in which your orgainisation could use Citizen science in collaboration with biodiversity / Smart City projects.	
General finishing off	What do you think are the key things we can do to improve biodiversity in Stavanger?	
	Do you think that biodiversity can be the basis for a profitable business?	Why/why not? How?
	How well-informed generally are you about biodiversity projects in Stavanger?	Scale of 1 - 5