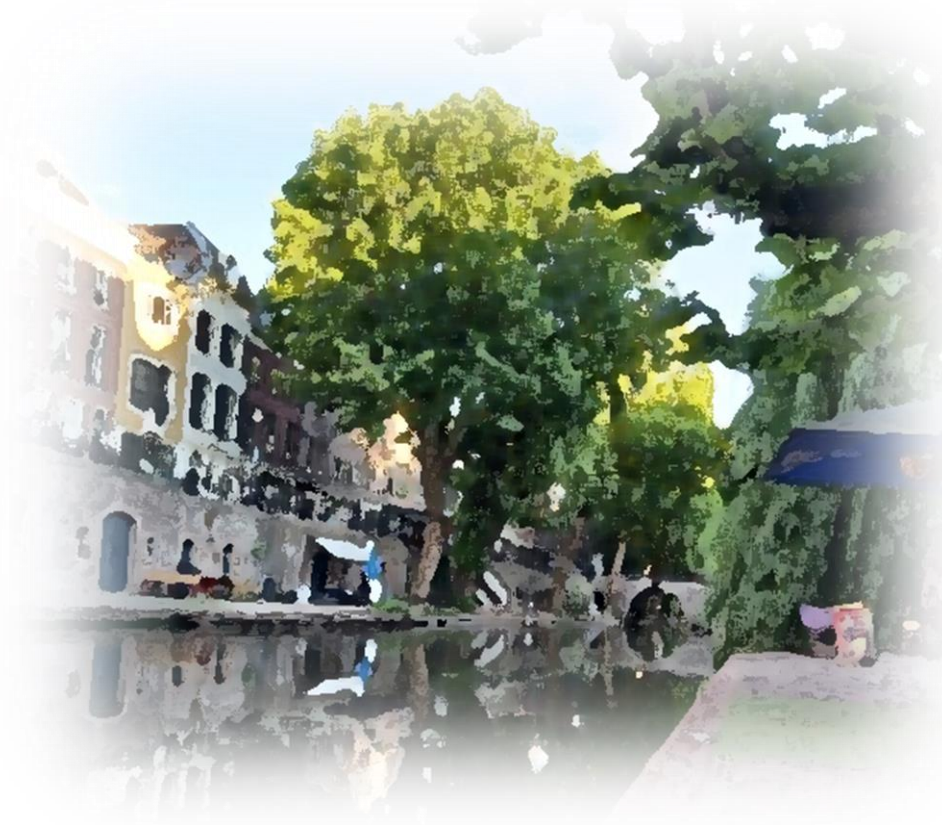# *Will green investments lead to green cities?*

An analysis of the potential of the new EU Taxonomy on sustainable finance for Urban Nature-Based Solutions

MSc Thesis in Sustainable Development

Faculty of Geosciences

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Abstract

The important role of cities for adaptation and mitigation to climate change is emphasized by academic research and international agreements. Future development of urban environments will define the quality of life for most human beings worldwide. An emerging practice to enhance sustainability in cities is to use the natural properties of ecosystems when planning urban spaces. Urban nature-based solutions, such as green roofs or city lagoons, have the potential to limit impacts of climate change, while also providing multiple other environmental, social, and economic benefits. Despite the numerous benefits, urban nature-based solutions struggle in securing long-term investments. The aim of this paper is to investigate the potential of the *EU taxonomy on sustainable finance* in tackling the challenges encountered in the financing of UNBS. The EU taxonomy is a new type of financial standard for sustainability developed in 2020. The rationale behind the taxonomy is that it will allow European investors to determine whether an economic activity is environmentally sustainable. Thus, the implementation of this new standard can be defined as a governance practice for sustainability. This research applies mixed methodologies to explore the governing modes of the EU taxonomy, the most relevant challenges for the investors, how different urban nature-based solutions are framed in the taxonomy, and the current investment patterns of different investors in European cities. On the one hand, this research highlights that the EU taxonomy holds potential for addressing several of the challenges encountered in the financing of UNBS. On the other hand, it emerges that the road to realizing this potential is still long. First, the urban dimension of sustainability needs to be further integrated into the financial standard. Second, the application of the ET to this sector depends on the actions of public stakeholders, who play a key role in UNBS financing. In the short term, the ET can provide a basis for investments in the protection of wetlands; green areas for centralized wastewater management, and external building greens (green walls, façades, and roofs), with the latter being particularly suitable for public-private partnership.

Acknowledgments

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List of abbreviations

EC: *European Commission*

ESG: *Environmental, Social and Governance*

EP*: European Parliament*

ET: *EU Taxonomy for sustainable finance*

EU: *European Union*

FAO*: Food and Agriculture Organization of the United Nations*

NBS: *Nature-Based Solutions*

PPP: *Public Private Partnership*

PRI: *Principles of Responsible Investments*

PSF: *Platform for Sustainable Finance*

SFM: *Sustainable Forest Management*

R&I: *Research and Innovation*

TEG: *Technical Expert Group on sustainable finance*

UN: *United Nations*

UNBS: *Urban nature-based solutions*

I. Introduction

In December 2019, the European Commission (EC) committed to the goal of a climate-neutral Europe by 2050. To achieve this ambitious target, it is estimated €1 trillion investment towards climate action is required (EC, 2018a; EC, 2018b). A new investment plan entitled the *European Green Deal* is intended to guide this transition (EC, 2019a). Under this initiative, the European Parliament and the Council agreed with the EC's proposal to create the world's first-ever "green list" – a classification system, or taxonomy, for sustainable economic activities (EC, 2019b).

The EU taxonomy (ET) was developed by the *Technical Expert Group* (TEG) on sustainable finance. The aim is to generate a consensus on a unique EU standard for sustainable finance in order to steer meaningful investments and increase transparency in the field (TEG, 2019). The ET is a tool itself, but it also forms the basis for future regulations to steer sustainable finance (Claringbould et al., 2019). It sets performance thresholds for 138 economic activities which contribute to climate change mitigation and adaptation, without harming other EU environmental objectives (TEG, 2020a). It is a pioneering project that aims to establish a common understanding of the economic activities which can be considered environmentally sustainable (Claringbould et al., 2019). In the future, the number of economic activities screened in the ET will be extended and the criteria will be periodically reviewed (EP & Council, 2020).

What is so innovative about the ET? When embedding the ET in the broader universe of financial standards for sustainability, it represents one of the first standards to be developed by a public actor and to form a basis for regulation (Weber, 2019). Other financial standards for sustainability (called *financial sector voluntary codes of conduct* in this thesis) provide sustainability guidelines for financial sector participants. However, these are not legally granted (Weber, 2018). Based on this, the ET is conceptualized as a new type of financial standard: a *sustainable finance regulative standard.* A more extensive overview of the history, content, and future of the ET can be found in Appendix A.

As the ET develops, it is relevant to understand its role in governing climate change action in the EU in terms of making different responses more or less attractive to investors. This thesis is exploring this by looking at *Nature-Based Solutions* (NBS) as a specific kind of response where initial research suggests that making an investment case is difficult (Fraivre et.al, 2017; Frantzeskaki et al., 2019). NBS are defined as:

> "actions inspired by, supported by or copied from nature; both using and enhancing existing solutions to challenges, as well as exploring more novel solutions, for example, mimicking how non-human organisms and communities cope with environmental extremes. Nature-based solutions use the features and complex system processes of nature, such as its ability to store carbon and regulate water flows, in order to achieve desired outcomes" (EC, 2015a, p. 24).

This research focuses specifically on the urban applications of NBS called *Urban Nature-Based Solutions* (UNBS). These are endorsed by the EU for their high potential for climate change mitigation and adaptation in cities (EC, 2015a). Some examples of UNBS are green roofs, urban forests, and blue areas. UNBS undertake both purely social needs such as water, food security, and human health and the transversal environmental challenges of climate change and biodiversity loss (Cohen-Shacham et al., 2016; Lafortezza, 2018).

Figure 1: "The Vertical Forest", based in Milan (Italy), is an example of UNBS. It belongs to the category "green external building". (Boeri S. architetti, 2020).

Despite the multiple advantages, UNBS are still placed in the "innovation" domain, meaning they are not a mainstream practice in European cities yet. Technology-driven solutions are more common (Droste et al., 2017). In fact, realizing UNBS requires political, economic, and scientific challenges to be tackled. First, more political willingness to disengage from conventional practices in favor of environmentally friendly alternatives is needed (Maes and Jacobs, 2017). Second, for investors and practitioners to make such a choice, larger temporal and spatial scales must be considered and diverse values must be integrated into decision-making (Adams 2014; Dendoncker et al. 2014). Third, research is needed to design nature-based innovations that effectively contribute to sustainable economic growth and to understand which governance tools and models are needed for implementation (Faivre et al., 2017). In order to address these challenges, significant investments are required to obtain the scaling-up and mainstreaming of NBS in European cities (Frantzeskaki et al., 2019).

This thesis is written in cooperation with the EU-funded research project Naturvation which guaranteed access to its database on UNBS in European cities. Moreover, while developing the thesis project, the author performed a research internship at the financial institution PGGM, working closely with a member of the TEG. This experience not only granted access to the final text of the ET before its official publication but allowed the author to gain a deep understanding of this innovative instrument and its application in practice. This thesis aims to serve as a bridge not only between two different EU projects but also between theory and practice in the fields of environmental governance and sustainable finance.

In the following section 1.1, the research questions and research framework are presented. Afterward, the scientific relevance (1.2) and social contribution (1.3) of the thesis are further specified.

1.1 Research aim and questions

The scope of this research is to analyze the potential of the new ET in steering investments towards UNBS. Adopting an environmental governance perspective, the research focusses on the content of the ET

as a governance tool, in relation to UNBS as an EU goal. By "connecting the dots" in previous research on financial standards for sustainability and investing in UNBS, this research adopts an in-depth investigation of the content of the ET. The aim is to clarify how we can expect this governance tool to target challenges encountered in financing UNBS. Subsequently, the thesis analyzes the current behavior of investors in relation to UNBS financing. Integrating this knowledge can unveil eventual misalignments between the literature, regulation, and practice. Above all, it provides the basis for a reflection over the potential consequences of the ET for UNBS financing. In order to achieve this, a mixed-method approach will be applied to assess the governing modes of the ET, the most relevant challenges for the investors, the conceptualization of UNBS in the ET, and the current engagement of different UNBS investors. To steer the research, the following overarching research question has been developed:

How and with what potential consequences is the EU Taxonomy able to address challenges encountered in the financing of urban nature-based solutions?

Each step of the analysis is addressed by the following sub-questions:

1.According to the literature, how can we understand the role of the EU Taxonomy in governing sustainable finance?

2.According to the literature, which are the main investor-specific challenges for financing nature-based solutions in European cities?

3.Which of the challenges identified in the literature are addressed by the EU taxonomy and in which terms?

4.Which urban nature-based solutions are addressed in the EU taxonomy and in which terms?

5.Which investors are currently investing in which urban nature-based solutions and to what extent do they cooperate?"

As presented in the Research Framework (Graph 1), each sub question steers a different research phase. First, it is relevant to understand how financial standards can serve as governance tools. Second, the investor-specific challenges in financing nature-based solutions are identified. The analysis tackles the remaining sub-questions by exploring (3) the investor- specific challenges that are potentially addressed by the ET, (4) the way UNBS are conceptualized in the ET's text (5) the current engagement of different investors in UNBS. Finally, the results are integrated, and the overarching research question is answered.

How and with what potential consequences is the EU Taxonomy able to address challenges encountered in the financing of urban nature-based solutions?

Understanding the potential of the ET as governance tool

Categorization of investor-specific challenges in investing in UNBS

Analysis of the challenges that are potentially addressed

Analysis of the conceptualization of (U)NBS in the ET

Analysis of actors that invest in UNBS in the EU

Discussion of the results

Graph 1: Research framework

1.2 Knowledge gap

The literature on standards for sustainable finance mostly focuses on the motivations of stakeholders in engaging with voluntary standards and on how these are implemented by different investors. According to several authors, the main problem is the inconsistency in implementation (Paetzold & Busch, 2014; Barman, 2018; Talan & Sharma, 2019). The ET started as an attempt to bring homogeneity to the field (TEG, 2019). However, only a few studies on a preliminary version of the ET have been conducted. These studies have tried to map the potential and limits of the new tool and of the upcoming EU regulations on sustainable finance (Dirk, 2018; Claringbould et al., 2019). It should be noted that the final version of the ET was only published in March 2020 and the scope and content of it are significantly changed since the previous version published in June 2019. This thesis investigates the most recent version of the taxonomy which is largely unexplored in academia.

The literature on UNBS addresses the related economic benefits, the challenges that different types of nature-based solutions are facing in terms of financing, and alternative models of finance with which municipalities might engage (Bockarjova & Botzen, 2017; Toxopeus & Polzin, 2017;) Other studies focus on developing evidence-based recommendations by collecting and elaborating on successful examples of engaging with NBS (Droste et al., 2017; Frantzeskaki et al., 2019). So far, there is no knowledge of how financial standards might shape investment towards NBS.

By addressing an unexplored and innovative tool such as the ET, this thesis contributes to understanding the role of sustainable finance regulative standards in governing environmental issues. In particular, the potential influence of the ET on UNBS investments is brought to light. The generated knowledge is relevant for several disciplines such as sustainable finance as well as, European and environmental governance. Moreover, by addressing the potential influence of the ET on the challenges of financing nature-based solutions in the urban context, this research provides useful insights for the multidisciplinary fields of urban sustainability and sustainable finance. This thesis is as explorative as the two innovations that it investigates. Being an assessment of the potential of a financial standard for allocating funds to UBNS, this thesis opens a field of research that has not yet been explored.

1.3 Societal relevance

The role of finance in tackling the problem of climate change has been explicitly recognized by the United Nations. Among the list of objectives of the UN's Paris Agreement (2015), Article 2 states the following "Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development" (p. 3). Thus, investigating novel financial tools such as the ET contributes to the social purpose of such a goal.

Moreover, UNBS can contribute to increasing the climate resilience of cities as well as to lowering the environmental impact of cities. With ongoing urbanization, this means contributing to solving two of the most important challenges for environmental governance (Rosenzweig et al., 2018). Thus, understanding how to steer investments towards these practices is critical.

Finally, this thesis explores the synergy between two EU projects that aim to contribute to sustainable development but are pursued separately. Research on policy consistency within the EU is necessary since synergy acknowledgment facilitates the implementation of different regulations and the pursuit of environmental objectives (Nilsson et al., 2012).

II. Standards for Sustainable finance

Chapter II focuses on the ET as a governance tool by drawing from the literature of financial standards for sustainable finance. Together with chapter III, it provides the theoretical basis for this thesis. It is structured as follows: first, section 2.1 defines the key concepts of environmental governance. Second, section 2.2 conceptualizes different types of financial standards for sustainability. Both these sections clarify key concepts that are referred to in the literature review of section 2.3. It this last section, it is finally explained how a financial standard can serve as a governance tool. The content of these sections is drawn from a literature review in the field of European and environmental governance and responsible/sustainable finance.

2.1 Environmental governance

The term *governance* refers to the authoritative use of power characterized by blurred boundaries between public and private (Stoker;1998, Badie et al., 2011). Governance includes the actions of the state and encompasses actors such as NGOs, businesses, and communities (Lemos & Agrawal, 2006). Although the concept of governance is related to the one of government, it is not backed by formal authorities, such as police power for instance (Rosenau et al., 1992). Governance refers merely to the capacity of steering the economy and society toward collective goals (Badie et al., 2011).

When such goals are related to the preservation of the environment, we enter the spectrum of *environmental governance* which is a subcategory of the general term. Young (2016) explains that environmental governance is a matter of steering the society towards socially desirable ends such as the conservation of ecosystems and the maintenance of resources. Scholars have addressed this field from different angles. Some authors understand environmental governance as the establishment, reaffirmation, or change of institutions to resolve conflicts over environmental resources (Paavola, 2007; Ostrom, 2008). Others focus on environmental governance as a process that goes beyond the borders or traditional administrative jurisdictions, which creates innovative networks aiming to cope with the interdependencies in environmental decision-making (Bulkeley, 2005; Newig & Fritsch, 2009). Within this thesis, the following definition of Lemos and Agrawal (2006, p.289) is adopted.

> "Environmental governance is synonymous with interventions aiming at changes in environment-related incentives, knowledge, institutions, decision making, and behaviors. More specifically, we use "environmental governance" to refer to the set of regulatory processes, mechanisms, and organizations through which political actors influence environmental actions and outcomes. Governance is not the same as the government. It includes the actions of the state and, in addition, encompasses actors such as communities, businesses, and NGOs."

This definition is selected among others because it emphasizes the operational aspect of environmental governance by highlighting the role of regulatory processes and mechanisms. This is consistent with the focus of this thesis.

For this thesis, a *governance tool* is defined as an instrument that is conceived to facilitate the achievement of the governance goal. In our case, the overarching goal of the EU projects on sustainable finance and nature-based solutions is to steer environmental sustainability. The ET is a tool that is aimed to facilitate the achievement of such a goal. The term "governance tool" has been used by other authors to refer to environmental standards (Emmelin & Lerman, 2008; Ponte et al., 2011; Marx et al., 2012).

In section 2.3 a literature review on how financial standards can function as governance tools is presented. Before that, some conceptual differences between different types of standards will be clarified in the following section 2.2.

2.2 Financial standards

Sustainable finance is a discipline that "looks at how finance (investing and lending) interacts with economic, social and environmental issues" (Schoenmaker & Schramade, 2018, p.31). It starts from the assumption that there is potential for moving from finance as a goal to finance as a means to serve the

interests of society (Shiller,2013). The idea to integrate sustainability concerns into the financial sector is driven by plenty of initiatives worldwide (Gerster, 2011). This thesis focuses on financial standards for sustainability. Since Weber (2019) was the first to embed the ET into the broader universe of standards for sustainability, his definitions are adopted within this thesis. As already specified in the introduction, the ET conceptualized as a new type of financial standard called *sustainable finance regulative standard*. Forming basis for regulation, it differs from the more established *financial sector voluntary codes of conduct* (Weber, 2018). These codes are not grounded in regulation, but rather provide some guidelines for financial sector participants. Investors can decide independently how to use these standards to integrate environmental and social issues into their businesses. Some examples are the Equator Principles and the Principles for Responsible Investment (PRI) (Weber, 2018).

A comparative overview of all the financial standards that fall into these categories is beyond the scope of this research. However, PRI needs to be introduced because the first version of the ET refers explicitly to the PRI and to the goal of standardizing the implementation and investor interpretation of the related criteria (TEG, 2019). The focus on this specific code of conduct is probably because the engagement with PRI is the fastest-growing strategy of sustainable investment (Talan & Sharma, 2019). This code of conduct was formalized by the United Nations in 2006 and it requires investors to take into consideration the Environmental, Social, and Governance (ESG) records of companies. Investors are encouraged to analyze ESG issues alongside traditional indicators of opportunity and risk while making the initial investment. Moreover, they should become active owners after the investment is made by promoting ESG opportunities (Caplan et al., 2013). The related literature is often referred to within this thesis due to the popularity of this voluntary code and to the explicit reference to ESG criteria in the first version of the ET (TEG, 2019).

The concepts defined until now are the basis of the literature review that is performed in the following section 2.3 on how financial standards can function as governance tools.

2.3. Governing through standards

Reviewing the literature, it emerges that sustainable finance regulative standards can facilitate the achievement of environmental goals in two main ways: either by pushing the targeted actors to comply with the standard, therefore being monitored and guided in their behavior, and/or by providing the basis for sustainability-oriented data disclosures from companies.

First, **standardization** is defined by Ravinet (2008) as a movement from voluntary participation to monitored coordination. In other words, compliance with standards is based on the voluntary enrollment of the actors. Because of the collective pressure and the incentives, it becomes unrealistic and unappealing for the actors not to comply with the standard. Therefore, the issuer of the standard can monitor the actions of the actors and coordinate them (Brøgger, 2019). Some lessons on this process can be drawn by the literature on voluntary codes of conduct. Once a code has been adopted by a financial institution, the adopter commits to following the rules and guidelines of the code of conduct (Watchman et al.; 2006). Several scholars have been researching the motivations behind the choice of some investors to voluntarily commit to these standards. The engagement with such codes reduces reputational risk, increases assessment and evaluation in project financing, and enhances the security and reliability of an obtained project (Yusuf & Basah, 2013). Investors that engage with codes of conduct are recognized as defining the best practices in project financing. This has a positive effect on their reputation and credibility, offering a competitive advantage over investors who do not adopt the codes (Wright & Rwambizambuga, 2006). Moreover, the adoption of voluntary codes of conduct is a form of pre-emptive action: irresponsible practices may attract the attention of regulators and civil society groups. Thus, investors might choose to self-regulate (Watchman et al., 2007). More broadly, the pressure on stakeholders on business to managing sustainability issues can push towards the adoption of financial voluntary codes (O'Sullivan & O'Dwyer, 2009). Issuers of financial standards generally assume that, by making visible the deviations from standards and related norms and benchmarks, the markets would provide rewards and punishment. This would lead subjects to discipline themselves and thus economies would behave as if the financial markets observe, evaluate, punish, or reward (Vestergaard, 2009). While being applied to sustainability issues, standards should not be too demanding, otherwise, the market might reject them (Cashore et al.; 2004). However, if environmental standards are too lax, NGOs and civil society might refuse them, posing questions to their legitimacy (Gale and Haward, 2011).

Standardization is a governance mode that is a characteristic of the European Union. Standardization compensates for the EU's inability to issue direct orders and with the absence of common culture and community of practice between countries and between institutions. Because of these factors, the low specificity of standards as a form of regulation is functional to the EU (Brøgger, 2019). The field of EU environmental regulation is characterized by standards (Kelemen,2000). The main obstacle in EU's standard-based governance in the environmental domain: inconsistency in implementation (Jordan, 1999; Kelemen,2000). It can be claimed that if standards are interpreted differently by the subjects and thus implemented following different rationales, establishing what constitutes a deviation could be ambiguous. Thus, it might be more problematic for the issuer of the standard to monitor the actions of the actors and coordinate them. These same concerns can also be found in the literature on the effectiveness of the voluntary codes of conduct in steering sustainability. It is influenced by the quality and content of the code, as well as by implementation and compliance mechanisms (Weber et al.,2016) The latter highlights a problem that is shared by all the most used financial codes of conduct. Given that each of these codes is voluntary, they are characterized by a lack of a proper mechanism (such as, for instance, an independent governance board) to observe if signatories are acting as they should in line with the dictates of the code (Adeniyi, 2016; Weber, 2018).

Applying this discussion to the case of the ET, the issuer of the standard (EU) provides specific criteria to define which economic activities are contributing to climate change and adaptation without harming other EU environmental objectives (TEG, 2020a). By pressuring and creating incentives for the target group (investors) to comply with this standard, the EU can monitor and coordinate their engagement with sustainable finance. This is claimed to be the potential function of the ET as a governance tool for standardization.

The second way that financial standards can serve as a governance tool is by forming the basis for **disclosure**. The term disclosure refers to firms making information available for external parties (Gelb and Strawser, 2001). Regulative financial standards can play an important role in raising awareness and offer a framework for structuring disclosures. A correlation has been found between responsible investment regulation and best practices by companies (PRI and MSCI; 2016). When standards provide the basis of corporate reporting, the aim of the issuers is to make financial statements reliable and comparable (Ponte et al., 2011).

The need for steering the comparability of the disclosed data is shown by the research performed on the current practices. Barman (2018), highlights how the implementation of PRI in different portfolios is nonuniform. Similarly, after investigating methodologies applied by ESG rating agencies, Escrig-Olmedo et al. (2010) explain that there is no standard methodology for the evaluation of the ESG performance of companies because different rating agencies use different criteria and methodologies. On the one hand, the flexibility of sustainable voluntary codes might be appealing for managers as it allows for greater discretion and autonomy (Espeland & Sauder, 2007). On the other hand, it makes it difficult to comparatively evaluate the performance of firms and it might prevent potential investors from entering this new field (Paetzold & Busch, 2014; Barman, 2018).

The ET will serve as the basis of upcoming regulation on disclosure. Financial market participants will be required to complete their first set of disclosures against the Taxonomy by the end of 2021. Companies will be required to disclose in the course of 2022 (TEG, 2020a). Based on this, the ET will set the standard for mandatory company disclosure of non-financial information. This will allow the investors to screen whether the economic activities of the firms are ET aligned. Moreover, financial institutions will also be obliged to disclose to what extent their portfolios are taxonomy-aligned. By providing a basis for such a disclosure, the ET functions as an environmental governance tool. Disclosure practices and sustainability performance are interrelated (Rezaee & Tuo, 2017). The latter is further improved by the presence of mandatory requirements for reporting (PRI & MSCI, 2016) There are firms that have already started reporting according to the ET since the publication of the first version in June 2019 (EC,2020).

Despite their differences, standardization and disclosure should not be viewed as totally distinct governance processes. While standardization refers to investors behaving according to the guidelines of a specific standard, standard-based disclosure relates to making the necessary information available in order

to comparatively monitor the extent to which these guidelines are followed. The two processes can develop separately but they can also occur in the same moment and strengthen each other (PRI and MSCI;2016).

While the role of the ET as a basis for upcoming disclosure is explicit, its role in achieving standardization is not (TEG, 2020a). The potential of using the ET for this purpose has been suggested by scholars (Claringbould et al.,2019). It is, however, highly dependent on whether the EU will provide enough incentives and pressure to comply with the ET (Ravinet,2008). It should be noted that the combination of voluntary activities leading to standardization with disclosure regulations is welcomed by previous research (Weber, 2018). Since the field of financial standards is characterized by inconsistencies in implementation, the ET could contribute towards tackling this problem (TEG, 2019). Barman (2018) suggests that public regulation is the road to obtaining a shared standard. There is a need to address institutional retrogression (Talan and Sharma; 2019).

In addition, it is important to mention what emerged from the literature concerning the kind of environmental issues that have been addressed by financial standards to sustainability. The topics that have been more frequently addressed are climate change and environmental pollution (Carè et al., 2018), particularly, by facilitating investors in pricing climate risks and addressing investment in renewable energy (Richardson, 2009; Boissinot et al. 2016), and pollution reduction (Wilson 2010). Yet, some important sustainability issues such as biodiversity, health, and education are generally not addressed because they have no material impact on business performance (Weber, 2018). Additionally, while discussing the ET, Schoenmaker (2018) warns that it could stifle innovation. Investors might leave the selection of emerging sustainable companies to the market and focus only on already established companies that meet the thresholds presented by the ET.

In conclusion, this chapter responds to the sub question 1: "According to the literature, how can we understand the role of the ET in governing sustainable finance?" The literature suggests that sustainable finance regulative standards can function as governance tools via two processes: standardization and disclosure. Standardization is defined as a movement from voluntary participation to monitored coordination. Disclosure refers to firms and investors making information available for external parties. These governance mechanisms are independent but not exclusive. The ET holds the potential to form the basis for both standardization and disclosure in the EU. Through standardization, the EU could pressure investors to comply with the ET and monitor and coordinate their engagement with sustainable finance. Moreover, investors and firms will be required to provide disclosures against the ET by 2022. In the subsequent section, the research will focus on UNBS and related financing challenges.

III. **Nature-based solutions**

Section III is dedicated to further defining UNBS and the financial challenges associated with these practices. Section 3.1 presents the benefits of UNBS as an EU goal. Section 3.2 clarifies the fundamental challenge of valuating UNBS. In conclusion, the challenges of financing UBNS are identified by reviewing the findings of existing research (3.3).

3.1 The value of UNBS

The potential of NBS and the growing interest on this topic in the European Union is derived by previous EU-funded research on biodiversity and ecosystems, urban sustainable development, and climate change adaptation and mitigation. Following the findings of these research projects, a research agenda dedicated to *Nature-Based Solutions and Re-Naturing Cities* was implemented in 2015 through *Horizon 2020, the EU Framework Programme for Research and Innovation* (EC, 2015b; Faivre et al., 2017). The EU's interest in steering the development of UNBS is justified by the several benefits that are associated with them. Besides the functions already mentioned in the introduction, UNBS also provides benefits that are specific to the urban context. First, NBS supports the economic development in urban areas which is highly dependent on the amount and quality of natural resources available, such as water for sanitation (Hopkins, 2001; Koné, 2010). By engaging with NBS, new circular, or green business models could emerge leading to greater efficiency in the use of energy and materials (D'Amato et al., 2017). Second, next to the economic aspect, sustainable urban planning with nature-based solutions can increase the resilience of a city to risks such as floods, heatwaves, or droughts. Thus, UNBS positively contribute to the climate adaptation of cities (Emilsson & Sang, 2017). However, there are also opportunities for small-scale climate mitigation through increased carbon storage (Baró & Gómez-Baggethun, 2017). Besides climate change governance, UNBS can be used to steer other environmental goals such as urban biodiversity (Xie & Bulkeley, 2020). Finally, UBNS can also contribute to the social dimension of urban sustainable development. For instance, previous research has assessed the positive impact of UNBS on the health and well-being of citizens (EC, 2015a; Bosch Van den & Sang, 2017).

The field of UNBS can be looked at as an environmental policy but also as a business opportunity (Karanth and DeFries, 2011; Maes and Jacobs, 2017). The EU research agenda is embedded in the growing interest from national governments to explore cost-effective alternatives to grey infrastructure to tackle problems deriving from rapid urbanization, biodiversity loss, and climate change. Besides governments, there is a rising interest within the private sector. As shown by the rising number of initiatives concerning this topic (e.g. the Natural Capital Coalition), there is increasing awareness of the value of managing and steering biodiversity and ecosystem services, as a means of reducing economic risks by ensuring the supply of resources (EC, 2015a). The concept of "ecosystem services" is crucial to understanding the economic dimension of UNBS. These are defined as "the benefits that humans derive from the ecosystem" (Costanza et al., 1997). An example of a UNBS' related ecosystem service is air-filtering, which reduces air pollution and thereby hinders its negative impact on the health of citizens (Bolund & Hunhammar; 1999). Ecosystem services are generally associated with economic benefits as well (Bullock et al., 2011; Wainger & Mazzotta, 2011). Drawing from the literature, some of the encompassing economic benefits of UNBS are listed:

- *Energy savings:* Reducing a city's traditional energy consumption through efficiency gains can expand the local economy simply by saving money for local utility consumers (Schwarze et al.,2018). Increasing the cost-effectiveness of infrastructure spending is considered critical. In 2013, this amounted to about 3.8% of global GDP (EC, 2015a).
- *Sectorial clustering*: enterprises select their locations based on the availability of markets, resource supplies, and/or specialized technological knowledge, and worker skills (Floater et al., 2014). Promoting the investments in ecosystem services is likely to stimulate new sectoral clusters presenting opportunities to the city's economy (Shinkevich et al., 2016).
- *Marketing and reputation:* investing in "green" or "climate-proof" initiatives can have a positive impact on the city's reputation and provide a basis for the city's marketing campaign and therefore facilitate the emergence of new economic opportunities. In this context, investing in UNBS is intended to promote the attraction and retention of skilled workers and businesses (Schwarze et al.,2018).

- *Reduction of health costs:* Actions taken to address climate change in cities have a positive correlation with improved citizen health. This implies lower costs to treat the consequences of pollution or environmental degradation on human health (Barata et al, 2018). Additionally, the recently discovered correlation between air pollution exposure and incidence of COVID-19 suggests there might be potential for ecosystem services in preventing the diffusion of coronaviruses (Andree, 2020).

It would be beneficial to include these types of factors in urban planning, by not only considering the benefits of ecosystem services, but also the costs from ecosystem disservices (Gómez-Baggethun & Barton, 2013).

3.2 The challenge of creating a business model

Despite all the potential of UNBS, the translation of ecosystem benefits in dedicated business models is still a challenge. Several scholars have been working on assessing the monetary value of the ecosystem services provided by UNBS (Chaparro & Terradas, 2009; Remme et al., 2015; Silvennoinen et al., 2017). Nonetheless, the challenge of quantifying and monetizing nature and its benefits in an urban context is still far from being solved. There is large variability in the metrics used to express the value of nature and its services. This heterogeneity hampers the ability to make a congruent comparison of collected values between and across studies (Bockarjova & Botzen, 2017).

A deeper investigation of the methods used to develop related business models is beyond the scope of this thesis, however, it is important to acknowledge that while there is a shared understanding of the benefits of UNBS, it is highly challenging to monetize such benefits systematically. Another obstacle that needs to be mentioned while discussing the economic dimension of UNBS is that the inclusion of the listed benefits into decision making requires a long-term vision which is often lacking (Vuuren van et al., 2012, Bickel& Friedrich, 2013; Gyourko & Rybczynski, 2000). Finally, the overreaching obstacle is the discrepancy between the concept of ecosystem services and mainstream linear economic models, which assume unending resource supplies and do not account for environmental externalities of economic activities, such as pollution (Meadows, 1972; Schoenmaker & Schramade, 2018).

Investors can play a decisive role in facilitating the inclusion of environmental and social aspects in economic and financial practices. Financial institutions can contribute to their inclusion by defining projects which are suitable for lending or not and by influencing the companies in which they invest (Schoenmaker & Schramade, 2018). In chapter II, it was explained how standards as governance tools, can be functional for this purpose. In the next section 3.3, a more detailed overview of the challenges of financing UNBS is provided.

3.3 The challenges of investing in UNBS

Some general challenges that hamper the investment in UNBS have been already mentioned in the previous section 3.2, which include:

- Lack of awareness or understanding of the concept of ecosystem services and difficulties in integrating these benefits in conventional business models.
- Lack of long-term thinking

In this section, these general points are further specified into investor-specific challenges which are drawn from the literature on financing NBS, smart cities, green infrastructure, and climate action in cities.

The thesis focuses on the investors that are addressed by the literature and that are considered relevant for the purpose of this thesis. These are: municipalities (domestic public finance); national governments (national public finance); EU funds (international public finance); commercial banks and corporations (private finance) and pension funds and insurances (institutional finance). Despite being mentioned in some of the literature, a few types of investors have been excluded from this research. Specifically, climate finance funds, development banks, sovereign wealth funds, and venture investors. In the case of development banks and sovereign wealth funds, the literature associates these types of investors

mainly with the financing of cities that are outside of the EU geographical area. This falls outside of the scope of this thesis which focuses on the EU region. Following the same logic, the field of climate finance and related institutions are excluded from this analysis. The rationale behind the exclusion of venturing investors is the following: UNBS belong to the realm of innovation, thus it is needed to mainstream these practices to enhance urban sustainability (Faivre et al., 2017). While aiming to steer the financing of NBS in cities, long-term committed financial capital is needed, thus research should focus on the challenges faced by investors that can provide this type of commitment (Hodaj & Gura, 2020). This assumption is adopted within this thesis as a selection criterion.

The following table 1 summarizes the findings from the literature review on investor-specific challenges in financing UNBS. When the cell corresponding to a type of investor and a specific challenge is colored in red, it indicates that, according to the literature, that challenge hinders the investment in UNBS from that investor. Most of the terminology used to cluster the challenges is based on the literature review of Floater et al. (2019) on green infrastructure (for instance, the terms "imperfect information" or "institutional inertia").

Table 1: Investor-specific challenges in financing UNBS in European cities.

Typology of investor	*Most relevant barrier to UNBS-financing in European cities*					
	Lack of upfront capital	*Institutional inertia*	*The perception of high risk and of low returns*	*Imperfect information*	*Lack of institutional capacity*	*Lack of horizontal and vertical cooperation*
Domestic public finance	🟥	🟥		🟥	🟥	🟥
National public finance	🟥	🟥		🟥	🟥	🟥
International public finance (EU)						🟥
Private finance (Commercial banks & private companies)		🟥	🟥	🟥	🟥	
Institutional finance (Pension funds and insurance)		🟥	🟥	🟥		

The following sub-sections describe each of the barriers and how they manifest for different investors. It should be noted that these barriers are connected and there are not empirical borders among different challenges. The classification is inevitably a simplification of complex phenomena for research purposes. Moreover, further research could find new correlations between barriers and actors that are not yet covered in this framework.

3.3.1 Lack of upfront capital

The first obstacle is that governments can be deficient in the upfront capital to fund their investment priorities. Public budgetary constraints might result from several factors such as slower economic growth, social conflict, political uncertainty, or resigning sovereign debt (Floater et al., 2019). This is aggravated by a lack of borrowing capacity for both national and local governments. In both cases, this is usually due to perceived low creditworthiness (Schwarze et al., 2018; Floater et al., 2019). Creditworthiness is described as the ability of a municipality/country to meet its short-term and long-term financial obligations (Hájek & Olej; 2007). In the case of city governments, creditworthiness may depend on factors such as fiscal stability and governance, including transparency, types of bankability of the municipalities' projects, and by the national financial regulations and institutions (Schwarze et al.,2018). On the national level, the low creditworthiness might be the result of factors such as high debt ratios, low capital reserves, and limited revenue sources (Floater et al., 2019).

3.3.2 Institutional inertia

The challenge of institutional inertia is defined as "the difficulty of changing investment patterns due to institutional, governance, and contractual/financial features present in the market" (Floater et al., 2019, p.19). It has different specificities depending on the investor. In the case of private investors, it refers to established regulation that favors business as usual instead of incentivizing sustainable business. Moreover, operating in an established market entails a series of incumbency advantages such as low-cost operations from amortized assets that are not yet developed in innovative sectors such as UNBS. This might be a detriment to getting involved in this field (Droste et al., 2017; Floater et al., 2019). Business-as usual oriented regulation also consists of a barrier for national governments. The integration of ecological public functions within fiscal constitutional law could incentivize the nature-affine investment behavior of public authorities (Droste et al., 2017). In addition, the barrier of institutional inertia for both public and private financial institutions branches off as built-up experience and networks that favor deal-making with known participants and well-understood technologies and systems (Floater et al., 2019). The financing of UNBS from institutional investors is subjected to a supplementary barrier: they have a stringent fiduciary responsibility and must concern themselves with capital preservation. Thus, they can only accept opportunities if their risk of loss is minimized (Schwarze et al., 2018). This explains their appetite for very large investments, which may miss smaller -urban- scale opportunities such as UNBS (Floater et al., 2019). For municipalities, the challenge of "institutional inertia" is linked with the previous challenge "lack of upfront capital". In fact, the structure of municipal revenues is key for city governments to invest in UNBS. (Dorste et al., 2017). Typically, local governments have only limited opportunities to raise discretionary revenues and are thus reliant on national governments (Floater et al., 2019). The capacity to independently manage revenues and expenses in the local fiscal budget is also linked with the already mentioned creditworthiness. In other words, the independence of a municipality from its national government correlates positively with the municipality's ability to leverage external funds (Schwarze et al., 2018).

3.3.3 The perception of high risk and low returns

Most financial institutions consider it appealing to invest in projects that are at the stage of "growth in mass production", meaning that the process of mainstreaming has already started. Before this phase, the risk is often perceived as too high and it might be forecasted that the investment will generate insufficient returns (Schoenmaker & Schramade, 2019). Urban innovations are characterized by high perceived risks, especially if designated to multiple uses, meaning that they serve more than one purpose (Gyourko & Rybczynski, 2000). For example, a green roof often provides multiple functions such as carbon capture and rainwater harvesting (Mendez et al. 2011). The barriers of high perceived risk and related low returns are relevant for private and institutional investors. These challenges are emphasized by factors such as asset performance uncertainties, counterparty assurances, and regulatory or legal uncertainty or immaturity (Floater et al., 2019; Schoenmaker & Schramade, 2019).

3.3.4 Imperfect information

The barrier "imperfect information" refers to the investors' lack of knowledge or understanding of sustainable finance, UNBS, and related opportunities. Municipalities often lack this specific knowledge (Droste et al., 2017). The ecosystem services of NBS are generally not assessed or accounted for in urban decision-making, although their value is increasingly recognized (Kolbe and Wüstemann, 2014). There is still a lack of awareness regarding climate change-induced problems and the benefits UNBS can provide by mitigating these problems (Kabisch et al., 2016). This is worsened by the lack of established valuation criteria, measurements, and data from cross-investors (Floater et al., 2017).

The barrier "imperfect information" is related to the previous ones of "high risk and of low returns" since there is a positive correlation between uncertainty and risk (Raz et al., 2002). For both public and private financial institutions, the general attitude towards investments is "if it works, we will finance it", which creates an obstacle for innovative urban projects that have not yet generated enough data to make such an assessment. Moreover, the data gathering process that would be necessary for investors to reduce this uncertainty and gain a better understanding of UNBS is a cost itself (Gyourko & Rybczynski, 2000). For institutional investors, infrastructure or urban solutions are historically a minor or absent element in their portfolios, thus most institutions have a limited built-up knowledge base in the asset class. The costs and conditions of this type of investment can vary dramatically due to local conditions as well as differences in procurement, engineering, or management. Sorting through such differences and tailoring financing structuring requires time and is costly (Floater et al., 2019). Besides the additional costs related to gathering new information and gaining a better understanding of UNBS, the barrier of imperfect information also entails the incapability of recognizing the opportunities that do exist in the field (Floater et al., 2019). This, again, applies to both private and institutional investors and relates to the lack of understanding and appreciation of non-financial value (Schwarze et al., 2018; Schoenmaker & Schramade, 2019).

3.3.5 Lack of institutional capacity

Along with the barrier of "imperfect information", the lack of institutional capacity is an obstacle to the financing of UNBS. In the context of this paper, it refers to the ability of the target investors to perform functions, solve problems, and achieve objectives that relate to investing in UNBS (Willems & Baumert, 2003). While the previous challenge refers to the lack of data and knowledge, this barrier translates to a lack of sustainable finance and UNBS-related expertise for national governments, and private investors (Floater et al., 2019). Specifically, governmental institutions often have inadequate budgeting and accounting skills and private investors lack experience with urban project finance (Beazley 2019, Floater et al., 2019). The lack of necessary manpower to steer the financing of UNBS is a challenge for municipalities (Kabisch et al., 2016; Droste et al., 2017).

3.3.6 Lack of horizontal and vertical cooperation

Collaboration among stakeholders and organizations from multiple levels (vertical cooperation) as well as from the same level (horizontal cooperation) is a key enabler for UNBS (Ershad Sarabi et al., 2019). From a financial perspective, more collaboration represents an opportunity to tackle the barriers of imperfect information and lack of institutional capacity by exchanging knowledge and expertise (Droste et al., 2017; Floater et al., 2019). Therefore, the lack of vertical and horizontal cooperation represents a barrier to the financing of UNBS. Lack of cross-departmental knowledge sharing is an obstacle for municipalities investing in UNBS. This is also hindered by insufficient collaboration among different municipalities and with national governments (Droste et al., 2017). The involvement of the latter is also hampered by the poor coaction among different decision-making levels and sectors (Floater et al., 2019). Each department has predefined competencies and fields of responsibility. However, it is challenging to fit multi-use projects such as NBS in these structures (Kabisch et al., 2016). Another hindering factor for the needed cooperation is the use of sectorial language among different departments which produces "sectoral silos" in which knowledge remains trapped (Frantzeskaki & Tilie, 2014; Hansen et al., 2015). The installation of a cross-

departmental and cross-level working group on financing UNBS could be a starting point to steer both horizontal and vertical cooperation (Droste et al., 2017).

Together with enhancing knowledge sharing, cooperation favors coordinated action and consistency among different levels of decision-making. Achieving such coordinated action is a challenge for the European Union that needs to be tackled to foster sustainable finance at the local level (Claringbould et al., 2015). Thus, it consists of a barrier for the European Union as an investor in UNBS. Another related problem is the degree of accessibility to EU funds. Municipalities often find it challenging to apply for EU -funding since it requires time and staff (see institutional capacity barrier). Moreover, these instruments generally require co-financing that, due to the lack of upfront capital, many cities cannot afford (Kabisch et al., 2016). This added complexity, a consequence of the additional layer of bureaucracy and resources that EU-funded projects are subjected to, can be reduced by building up coherence between different levels of governance and their strategies (Carpenter, 2005).

New approaches to governing through financial standards for sustainability are being developed globally and in the case of the EU, this is being pursued through the ET which acts to direct investment through its capacity for disclosing where investment is flowing. Yet it is unclear what this will mean for different kinds of responses to climate change, especially where there are significant challenges in generating investment. In the case of UNBS, these challenges include lack of upfront capital; institutional inertia; perceived high risks and forecasted low returns; lack of institutional capacity, imperfect information, and lack of horizontal and vertical cooperation. The nature of these challenges takes on different characteristics depending on the investor. This chapter provides an overview of the challenges, responding to the research sub question 3: According to the literature, which are the main investor-specific challenges for financing nature-based solutions in European cities?

The thesis will now turn to outline the research methods.

IV. Methodology

Following the introduction and the theoretical foundations of the thesis, this section specifies the structure and methodologies of the analysis. This thesis adopts a mixed-method approach. Multiple perspectives and quantitative and qualitative data are intentionally combined to develop a comprehensive and nuanced understanding of the field of sustainable finance regulative standards and UNBS financing (Creswell, & Clark, 2017). The application of mixed methods is particularly suitable for explorative studies (Clark, 2019). The following graph 2 represents the methods (in red) that are applied for each step of the research.
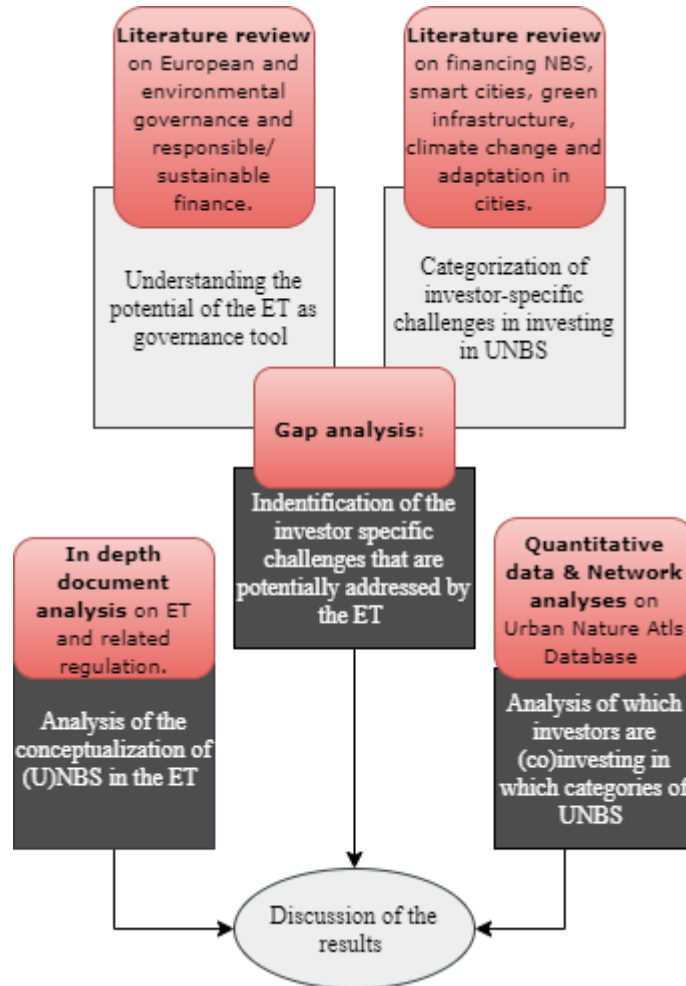
Graph 2: Methodology. The red squares report the methods applied in each step of the research.

The first two research sub-questions of the thesis are addressed in chapters II and III via literature reviews. The following step is to perform a gap analysis between the potential of the ET as a governance tool via the processes of standardization and disclosure (chapter II) and the investor-specific challenges in financing UNBS (chapter III). In this phase, it is identified which challenges derived from the literature are addressed by the ET and in which terms. Thus, tackling the research sub question 3. Then, an in-depth document analysis shows how UNBS are framed in the ET. In this phase, the fourth research sub question is addressed. Finally, the last sub question "Which investors are currently investing in which urban nature-based solutions and to what extent do they cooperate?" is researched. For this purpose, both quantitative data analyses and network analysis will be applied using the data provided by the Urban Nature Atlas database. These findings provide an overview of the potential of the ET in addressing the challenges of UNBS on multiple levels: theoretically and content-wise. Moreover, understanding the current practices in UBS financing helps to forecast the eventual impact of the ET in the field. The results are integrated into the discussion.

The sources that will be analyzed through this research are:

1.*Urban Nature Atlas database:* database from the research group Naturvation (2017) collecting the data of about 1000 UNBS in European cities.

2.*The EU Taxonomy for sustainable finance* published on 09.03.2020 and available online in open access.

3.Other EU regulations referred to in the ET that emerged to be relevant during the analysis.

Specifically: *Directive 2010/31/EU; Directive 2009/125/EC; EU Regulation 2019/2088.*

The different methodologies applied in this thesis are selected according to the scope of the targeted sub-questions and result in both qualitative and quantitative analysis. Each phase of the analysis is guided by some explicit analytical questions which are re-formulations of the research sub-questions. The function of these questions is to organize the different phases of the data collection and related analysis in a logical and systematic way. The application of this approach is aimed at improving the transparency and replicability of the research (Mays & Pope, 1995). Each of the research phases and related methods is described more in detail in the following subsections.

4.1 Challenges: gap analysis

The analytical question that steers the first step of the analysis is:

Which of the challenges identified in chapter 3 are addressed by the ET?

In this phase, the potential of the ET as a governance tool explored in chapter 2 is compared with the barriers for financing UNBS described in chapter 3. This comparison is executed through a **gap analysis**. This methodology is particularly functional for analyzing the suitability of specific governance tools to solve a pre-identified problem or to achieve a pre-identified goal (Verschuren & Dooreward, 2010). By applying this method, the overlaps and gaps between the ET-based governance functions of standardization and disclosure and the investor-specific challenges of financing UNBS are analyzed. The overlaps represent the potential of the ET, while the gaps show the limits of ET in steering investment towards UNBS. The data analyzed in this phase are qualitative, meaning that they do not consist of numbers but rather of information extracted by the literature reviews performed in the previous chapter of the thesis (Verschuren & Dooreward, 2010). This step of the analysis highlights which type of barriers to the financing of UNBS can be expected to be addressed by the ET.

4.2 Conceptualization of UNBS in the ET: in-depth document analysis

The analytical question that relates to the second step of the analysis is:

When are UNBS explicitly mentioned in the ET and in which terms?

The method applied to tackle this question is **in-depth document analysis.** In contrast with other data gathering methods such as interviews and surveys, the information retrieved by document analysis is collected directly from the original legal sources and are therefore less prone to the interpretation and opinions of the actors that are being interviewed or that respond to surveys (Bowen, 2009). This is functional to this research project which is addressing the potential of the ET as regulation and not how it is perceived by stakeholders.

As it can be noted, the definition of UNBS is rather inclusive: any urban activity whose actions are inspired or copied by nature can be addressed as a UNBS. For the sake of clarity and to establish clear research boundaries, this thesis follows the classification provided in the Urban Nature Atlas database. The categorization is based on the urban settings in which different UNBS are implemented (Naturvation, 2017). Referring to this classification is functional within this research project since the same database provides data input in the next step of the analysis. Table 2 lists the categories of UNBS.

Tab 2: Classification of UNBS from Naturvation (2017)

Category of UNBS	UNBS included in the category
External building greens:	green roofs; external walls and facades; balcony green
Urban green space connected to grey infrastructure:	alley and street trees/hedges/green; house gardens, green playground/ school grounds; green parking lots; riverbank green
Parks and (semi) natural urban green areas:	Large urban parks or forests; Pocket parks/ neighbourhood green spaces; botanical gardens; green corridors
Allotments and community gardens:	allotments; community gardens; horticulture
Blue areas:	lakes/ponds; rivers/streams/canals/estuaries, deltas, seacoast, wetlands/bogs/fens/marshes
Green indoor areas:	indoor vertical greeneries (walls and ceilings); atria
Green areas for water management:	rain gardens, swales/filter strips, sustainable urban drainage systems
Derelict areas	abandoned and derelict spaces with the growth of wilderness or green features

In the overview presented in the results, a category of UNBS is referred to as "directly addressed" when it is explicitly mentioned in the ET. A category is referred to as "indirectly addressed" when, despite not being mentioned, some of the principles expressed in the ET regarding other products and economic activities could be extended to the UNBS if applied in the urban context. When neither of these two conditions is met, the category of UNBS is labeled as "not addressed".

During the internship at the financial institution PGGM, the author of this thesis summarized the Technical Annex of the ET, creating an overview of the criteria and products that are eligible. The first step to verify whether each type of UNBS is addressed by the ET is to critically review them against this report. If it is possible to evaluate whether the UNBS aligns with the criteria established by the ET, this shows that the UNBS is at least indirectly addressed.

In addition to this first screening, the categories and sub categories of UNBS as intended by the classification of Naturvation (2017) are researched into the integral text of the Technical Annex using the tool "find". The following example clarifies how this keyword research is performed by using the first category of the database as an example: external building greens. The following words are researched to verify whether this UNBS is mentioned in the ET:

- External building greens (name of the category)
- green roofs (sub category)
- external walls (sub category)
- facades (sub category)
- balcony green (sub category)
- green roof (reformulation of sub category)
- green wall (reformulation of sub category)

This same scheme is re-proposed for all the UNBS included in the Urban Atlas database. Both in the cases of UNBS being directly addressed by the ET or indirectly, eventual guidelines/ criteria for eligibility are collected and included in the results. This encompasses information derived from the analysis of other regulations that the ET might refer to. In conclusion, an additional and complementary word search is performed for the key terms "nature based and "urban" to minimize the risk of missing data due to the use of different terminologies. This step of the analysis provides an overview of which specific types of NBS are addressed within the ET and in which terms.

4.3 Investors that are currently active in the UNBS field: quantitative & network analyses

In the last step of the analysis, the sub question 5: "Which investors are currently investing in which urban nature-based solutions and to what extent do they cooperate?" branches into three analytical questions, each used as the title of the dedicated sub-section.

4.3.1 What is the level of involvement of the different investors in financing UNBS?

To tackle this question, the Urban Nature Atlas database is consulted as the main source. The database collects information about 1000 UNBS in different European cities. It contains data about the *source(s) of funding* for each of the UNBS. This data is quantitative, meaning that the frequency, proportion, or percentage of cases can be calculated (Cramer, 2003). In the case in which the data about funding are unclear or not available, those are excluded from the analysis. The total sampling is therefore 925 UNBS. In this phase, a **quantitative analysis** is performed via the tool "Microsoft® Excel 2019 spreadsheets" which is a popular software for data storage, scrutiny, and representation (Palocsay et al., 2019).

In the database, the sources of funding are divided into the following categories:

- Public local authority's budget
- Public national budget
- Public regional budget
- EU funds
- Corporate investment
- Funds provided by a non-governmental organization
- Private Foundation
- Crowdsourcing
- Other

During the data-gathering phase, it is calculated which percentage of the UBNS has been (at least partially) funded by each of these sources. This numeric value is referred to as "level of involvement". Then, the sources of financing presented in the Naturvation database are matched with the list of investors retrieved in the literature review of chapter 3. The following table 3 presents how the investors and sources of funding are matched.

Table 3: match investors and funding sources

Type of investor *Literature review (Chapter 3)*	Source(s) of funding of the NBS intervention *Urban Nature Atlas database (Naturvation, 2017)*
Municipalities	Public local authority's budget
National government	Public national budget Public regional budget
EU	EU funds EEA funds
Commercial banks and investment companies	Corporate investment
Pension funds and insurance	No correspondence
No correspondence	Funds provided by non-governmental organization Private Foundation Crowdsourcing Other

The results of this section consist of the level of involvement of each type of investor which is based on the level of involvement of the corresponding source of funding (or the sum of the levels of involvement).

4.3.2 For each investor, how are their resources distributed among different categories of UNBS?

Following the same logic of the calculation of the level of involvement, this quantitative analysis is also performed on Microsoft Excel and it considers the data of the Urban Nature Atlas database. Besides the *source(s) of funding* for each of the UNBS included in the database, this step of the analysis considers also the category/ies of which each of the UNBS belongs (named *Urban settings where the NBS intervention(s) was/were implemented* in the database).

To analyze where each investor is allocating its resource, the number of times that each investor financed each type of NBS is counted. UNBS that belong to more than one category are counted twice, once for each category they belong to. The results of this calculation show how the funds that each investor allocated in UNBS are distributed into different categories. Following, the related percentages are calculated and the results for each investor are graphically represented in cake-shaped graphs. Finally, a comparative analysis among investors is performed. In this way, it is possible to identify shared trends and differences among investors regarding which categories of UNBS they invest in.

4.3.3 To what extent do investors cooperate in financing UNBS?

Starting from the same dataset and assumptions of the previous subsections, this last analysis researches how the different investors cooperate in the financing of UNBS. This analytical question is investigated via **Stakeholder Network Analysis** that is a methodology that is particularly useful to identify and visualize relationships among different stakeholders. It makes use of matrices to organize data on the relational ties of stakeholders. Thus, this method is used to visualize the presence or absence of a relational tie (interaction) among the different stakeholders and the relative weight of the tie (Reed et al., 2008). In this dissertation, the ties among investors correspond to the co-financing of UNBS. To analyze this, only the UNBS that are co-financed are selected from the database, meaning that UNBS financed by only one investor

are excluded. This corresponds to 489 UNBS, roughly 53% of the sample. Within the network, the co-financing of one UNBS corresponds to a one-degree tie between investors. Therefore, the weight of the tie between two investors increases with the amount of co-financed UNBS. In this thesis, the network analysis is performed via the software *Gephi 0.9* that is used to visualize the network and the calculation of network metrics. Investors are grouped according to their societal realms, following the same logic presented in table 3. The vertexes or so-called nodes in the network represent the categories of investors while the edges represent their interaction. By assessing the network metrics, it is possible to uncover the structure of the network, thus identifying which investors are more central; which are marginal; and how they cluster together (Reed et.al, 2008). In this research, two network metrics are calculated: network density and network weighted degree centrality. Network density indicates the connectivity of the network, which equals the number of actual relations divided by all possible linkages (Kim, 2019). The network degree centrality assesses the degree of connectedness of each investor, and it is mostly used to identify the hierarchy of structural importance of the actors in the network (Kim, 2019). In this matrix, the weight of the interaction is considered, meaning also the frequency of interactions among the same actors is included in the calculation (Scott & Carrington, 2011). The findings of the network analysis provide an improved understanding of the current practices in UNBS financing in the EU by tackling the cooperation among different investors.

4.4 Covid-19 and consequences for the research process

It should be noted that a critical part of this research is performed after March 2020, when the policies to contrast the global pandemic COVID-19 caused significant restrictions in terms of mobility and human interaction. All the methods applied during the research process are well-suited for on desk research and thus, the quality of the data retrieved is not dramatically compromised by this phenomenon. However, the pandemic did have some consequences for the research process and design. First, the internship at the financial institution PGGM was performed mostly working from home. Second, the general shock for the COVID-19 crisis and the urgency of adequate response kept particularly busy the financial institutions whose behavior is investigated in this thesis. For these reasons, the author gave up on the purpose of validating or expanding the investor specific challenges identified in this dissertation via interviews. This step will be crucial for further research on this topic.

The ET is an innovative tool that aims to steer capital towards sustainable solutions for climate mitigation and adaptation in the EU. Among these solutions, UNBS have great potential to achieve urban sustainability. However, long-term committed investors encounter several barriers to finance UNBS. This chapter focuses on the methods applied in the dissertation to investigate how the ET could address these challenges and with which consequences. These methods consist of both qualitative and quantitative approaches that seek common ground between the two topics; knowledge on how UNBS are framed in the ET and on how the current practices in investing in UNBS look like. The methods are gap analysis, in-depth document analysis, quantitative data analysis, and stakeholder network analysis. The sources are the original texts of the ET and related regulation and the data from about 1000 UNBS from the Urban Nature Atlas database. The findings of the analysis are presented in the next chapter.

V. Results

This chapter presents the findings of the empirical analysis. It is organized into three main sections corresponding to the three steps of the analysis. Starting from "connecting the dots" in pre-existing knowledge on financial standards for sustainability and the challenges of financing UNBS, the results of the gap analysis are presented in section 5.1. These results show how the ET can contribute to solving some of the challenges. Once this is established, section 5.2 shows how UNBS are framed in the ET. Such findings allow an understanding of which UNBS can be expected to benefit from the ET's potential in addressing the financial barriers. Finally, section 5.3 explains all the findings related to investors' current engagement in UNBS. This entails the level of involvement, the distribution of funds per investor across different UNBS, and the network analysis. These findings highlight the consequences of the ET for UNBS, considering the current investment patterns.

5.1 GAPs and common ground between the ET and the investor specific challenges

The results reported in this section are obtained by looking for common ground between the challenges for financing UNBS and the potential governance functions of the ET. This tackles sub question 3 "Which of the challenges identified in the literature can be addressed by the ET and which terms?".

Chapter 2 demonstrated that the ET functions as an environmental governance tool by providing the basis for the governance modes of standardization and disclosure. Standardization is a process by which the actors would voluntarily comply with a standard (in this case the ET). The collective pressure and the provided incentives make it unappealing for the actors not to comply. Therefore, the issuer of the standard (in this case the EU) can monitor the actions of the actors and coordinate them (Ravinet, 2008; Brøgger, 2019). In terms of disclosure, the ET provides a framework for firms to make information available to investors. Linking disclosure to a standard is aimed to make financial statements comparable and reliable (Ponte et al., 2011). ET-based disclosure will be mandatory for both EU firms and investors by the end of 2022 (TEG, 2020a).

These results present how the ET, by forming the basis for the governance processes of standardization and disclosure, can address the financial barriers that emerged from the literature review of chapter 3. These barriers include the lack of upfront capital, institutional inertia, the perception of high risk, the forecasting of low returns, imperfect information, the lack of institutional capacity, and the lack of horizontal and vertical cooperation. For each of these barriers, the following sub-sections present the results of the gap analysis. The conceptual overlaps between the processes of standardization and disclosure and the investor-specific challenges represent the potential of the ET, while the gaps show the limitations of the ET in addressing the barriers related to financing UNBS.

5.1.1 Lack of upfront capital

The challenge "lack of upfront capital" refers to budget constraints for domestic and national governments and to the incapability of obtaining loans due to low creditworthiness (Schartze et al., 2018; Floater et al. 2019). This challenge cannot be claimed to be addressed by the ET. Hypothetically, the engagement with the ET could have some positive effect on the transparency of municipalities' projects and thus improve their bankability and related creditworthiness (Schartze et al., 2018). However, this link is rather speculative, and it is therefore excluded by the results. It might be an interesting relationship for further research in a later stage of the ET's development.

5.1.2 Institutional inertia

The challenge of institutional inertia refers to the difficulty of changing investment patterns due to the features of the market and to business-as-usual friendly regulation (Floater et al., 2019). In the literature, these are claimed to affect national governments and private investors (Droste et al., 2017; Floater et al., 2019). Both the processes of standardization and disclosure can contribute to tackling the challenge of institutional inertia for these investors.

The incentives connected to the process of standardization could challenge the experience and networks that favor deal-making with known participants and well-understood technologies and systems (Ravinet, 2008; Floater et al., 2019). In regard to the features of the market, private investors have incumbency advantages in engaging with traditional technologies (Floater et al., 2017). However, the process of standardization could create new benefits for those that invest in sustainability-orientated projects such as UNBS. Engaging with the ET could have a positive effect on the investors' reputation and credibility, offering a competitive advantage over investors that do not adopt the standard (Wright and Rwambizambuga, 2006).

The disclosure regulation associated with the ET compromises an innovative case of sustainability-related disclosure that is grounded in public regulation. By requiring mandatory disclosure from firms and investors, the ET has the potential to foster consistency and transparency in the field of sustainable finance (Barman, 2018). This is a key step to facilitate change in investing patterns and therefore tackle institutional inertia (PRI and MSCI, 2016; Talan and Sharma, 2019). As learned from the literature, it is important to establish a proper control mechanism to verify the truthfulness of the declarations of compliance with the ET (Adeniyi, 2016; Weber, 2018).

According to the literature, the challenge of institutional inertia assumes specific characteristics for institutional investors and municipalities. For institutional investors, the most relevant obstacles are the stringent fiduciary responsibilities that hinder their involvement with small-scale innovations (Schwarze et al.,2018). For local governments, the dependency on national governments is the main problem. These challenges are not addressed by the processes of standardization or disclosure.

5.2.3 The perception of high risk and forecasted low returns

The involvement of private and institutional investors in financing UNBS is obstructed by high perceived risks and forecasted low returns. These are due to factors such as asset performance uncertainties, counterparty assurances, and regulatory or legal uncertainty, or immaturity (Gyourko & Rybczynski, 2000; Floater et al., 2019; Schoenmaker & Schramade, 2019). Even if it cannot be excluded that the governance processes of disclosure and standardization might impact some of the factors that cause the high perceived risk and low returns, there is not enough evidence regarding these impacts to draw definitive conclusions. Further research could help to gain a better understanding of these relationships. Currently, however, the challenge of high risk and low returns cannot be claimed to be addressed by the ET.

5.2.4 Imperfect information

Imperfect information consists of a barrier for domestic and national public finance and both private and institutional investors. It refers to a lack of knowledge, data, established criteria, or indicators to invest in UNBS (Schwarze et al., 2018; Schoenmaker & Schramade, 2019). The costs associated with gathering more data increase the constraints related to this barrier (Gyourko & Rybczynski, 2000). The ET is found to have the potential to tackle this barrier at several levels.

The ET establishes EU guidelines and criteria that allow companies and investors to determine the sustainability of their products and services (TEG, 2020a). These shared criteria and indicators serve as a medium for addressing the challenge of imperfect information. Additionally, through the disclosure process started with the taxonomy, the EU aims to steer the publication of comparable and reliable data concerning the sustainability of firms and investors' portfolios (Ponte et al., 2011). Thus, the potential of the ET in mitigating this barrier is high. However, as emerged from the literature, the disclosure against the ET must be performed consistently, across investors, for the data to be de facto comparable and meaningful (Escrig-Olmedo et al., 2010; Barman, 2018). Thus, whether the ET will succeed in tackling the listed challenges is highly dependent on consistency in implementation.

Through the process of standardization, the ET can potentially tackle the challenge of imperfect information by providing investors with more clarity on the opportunities that exist in the sustainable finance domain and giving value to non-financial information. Moreover, additional standardization might reduce the cost of gathering information and address this aspect of the barrier (Schoenmaker & Schramade, 2019).

5.2.5 Lack of institutional capacity

The lack of institutional capacity translates into a lack of UNBS financing for domestic and national governments and private investors (Kabisch et al., 2016; Floater et.al, 2019). By providing explicit thresholds for whether an investment should be considered "sustainable" or not, the ET might simplify the screening process. Thanks to the guidelines provided by the ET, investors might not need to define thresholds independently anymore. Moreover, due to the disclosure provisions, the data needed to perform the screening should be easier to obtain and interpret. Thus, less specific expertise might be required. This potential advantage for investors could be an incentive towards increasing their level of conformity with the ET in line with the process of standardization. However, this process of simplification might not occur if the ET will be perceived as too demanding by investors (Cashore et al., 2004).

5.2.6 Lack of horizontal and vertical cooperation

The last challenge is the lack of cooperation and knowledge sharing within different departments of the same organization (horizontal) or among different decision-making levels (vertical). This challenge characterizes public investors (Droste et al., 2017; Floater et al., 2019).

Horizontal coordination is hindered by hyper-specialization that characterizes the different departments of public investors and by the use of sectorial languages that hinder knowledge-exchange (Frantzeskaki & Tilie, 2014; Hansen et al., 2015). In this context, the guidelines and references provided by the ET could be a helpful framework to enable a common language across departments and shared goals. In fact, standards can be used to enhance cooperation among different institutions that are characterized by different cultures and practices (Brøgger, 2019). Thus, the ET might be useful for enhancing vertical coordination within and among the domestic, national, and international levels of public finance. However, for the ET to be used for this purpose, it is relevant to ensure a shared understanding. Diverse interpretations could lead to misunderstandings and inconsistent implementation (Kelemen, 2000).

To summarize, these findings suggest that the ET as a governance tool can contribute to tackling some of the challenges related to financing UNBS. These challenges are institutional inertia (for governments, commercial banks, and companies), imperfect information, lack of institutional capacity, lack of horizontal and vertical cooperation. This responds to the research sub question 3 "Which of the challenges identified in the literature are addressed by the EU taxonomy and in which terms?" The following table 4 represents these results. Red-colored squares signal when an investor is affected by the corresponding challenge (as in table 1). The EU-flag icons point out whether the challenge can potentially be addressed by the ET via the processes of standardization and/or disclosure.

Table 4: Graphic representation of the investor-specific challenges that are potentially addressed by the ET via processes of standardization and/or disclosure.

Typology of investor	Most relevant barrier to UNBS-financing in European cities					
	Lack of upfront capital	Institutional inertia	The perception of high risk and of low returns	Imperfect information	Lack of institutional capacity	Lack of horizontal and vertical cooperation
Domestic public finance	red			red + EU flag	red + EU flag	red + EU flag
National public finance	red	red + EU flag		red + EU flag	red + EU flag	red + EU flag
International public finance (EU)						red + EU flag
Private finance (Commercial banks & private companies)		red + EU flag	red	red + EU flag	red + EU flag	
Institutional finance (Pension funds and insurance)		red	red	red + EU flag		

The literature brought to light some conditions that need to be met during the implementation phase of the ET for it to effectively tackle these same challenges. The conditions are the creation of enough incentives and collective pressure on investors to push compliance with the financial standard; the establishment of proper control mechanisms to verify the truthfulness of compliance with the ET; consistent understanding of the ET guidelines among investors and consistent and comparable disclosure practices. Moreover, the taxonomy should not be perceived as too demanding by investors. Next to this, it emerges that the ET cannot be expected to tackle the remaining challenges of lack of upfront capital, high perceived risks, forecasted low returns, and institutional inertia (as intended for municipalities and institutional investors).

Now that the overlaps and gaps between the governance functions of the ET and the challenges for financing UNBS have been clarified, the next results section reports how the ET relates to UNBS content-wise.

5.2 Conceptualizing UNBS using the words of the ET

This section collects the results of the in-depth document analysis performed on the ET. It responds to the sub question 4 "Which urban nature-based solutions are referred to in the EU taxonomy and in which terms?". In order to understand some of the terms used in this section (for instance, *do not harm criteria*), it is recommended to look at the overview of the structure of the ET provided in Appendix A.

To begin, the explicit references to NBS-outside and within the urban context- are collected. This applies to when the words "nature-based solutions" are explicitly used in the ET. During the in-depth text analysis, the term NBS emerged several times in the ET. This implies that the ET recognizes the concept of NBS. Moreover, NBS are always referred to as desirable, positive practices.

The ET refers to NBS in the overarching screening criterion for substantial contribution to climate adaptation; in the section of the chapter dedicated to the agriculture industry named "addressing synergies and potential co-benefits in agricultural production" (in the context of climate mitigation); in the do not harm criterion for water quality of the economic activity "Production of Electricity from Hydropower" (both in the context of climate mitigation and adaptation); in the do not harm criterion for pollution reduction of the economic activity "Centralized Wastewater treatment " (both in the contexts of climate mitigation and adaptation). First, Criterion A.2.1 refers to the importance of supporting system adaptation meaning that "the economic activity and its adaptation measures do not increase the risks of an adverse climate impact on other people, nature, and assets, or hamper adaptation elsewhere. Consideration should be given to the viability of 'green' or 'nature-based-solutions' over 'grey' measures to address adaptation." (TEG, 2020b, p. 392). Second, in the context of addressing synergies and potential co-benefits in agricultural production it is explained that "many of the measures included in the best-practice tables for substantial contribution to mitigation criteria are agroecological practices or nature-based land management activities […] which are win-win or no-regret measures."(TEG, 2020b p.105). Third, in the case of hydropower, while presenting how to avoid significant harm to the water quality, it is declared that "all necessary mitigation measures should be implemented to reach good ecological status or potential, in particular regarding ecological continuity and ecological flow" And, most importantly, that "priority should be given to nature-based solutions." (TEG, 2020b p.226/465). Finally, while evaluating the economic activity "Centralized Wastewater treatment", some guidelines to avoid significant pollution are provided. It is recommended to "implement appropriate measures to avoid and mitigate combined sewer overflow in case of heavy rainfall, such as Nature-based solutions" (TEG, 2020b, p.297/520).

From these first results, it can be seen how the general concept of NBS receives validation by the ET because the term is explicitly used multiple times and NBS are depicted as desirable and preferable to "grey" measures. However, these are never explicitly associated with the urban context. Overall, the ET is found to be lacking in covering the urban dimension of sustainability. Paraphrasing the words of the TEG itself, further work is needed to include urban and regional planning for low carbon development in the ET (TEG, 2020b, p.10). Despite this, the in-depth document analysis shows that some of the UNBS included in the Naturvation classification are addressed in the ET, even when they are not called "NBS" (for instance, in the case of green roofs). For this purpose, table 5 collects the results by dividing them according to the Naturvation's UNBS categories. A category of UNBS is referred to as "directly addressed" when it is mentioned in the ET. It is indicated as "indirectly addressed" when, despite not being explicitly mentioned, some of the principles expressed in the ET regarding other products and economic activities could be extended to the UNBS if applied in the urban context. When neither of these two conditions is met, the category of UNBS is labeled as "not addressed".

Table 5: Overview of UNBS addressed in the ET

Categories of UBNS	UNBS included in the category	Is this UBNS addressed by the ET?			Which UNBS per category are addressed?
		Yes, directly	Yes, indirectly	No	
External building greens	Green roofs; external walls and facades; balcony green alley and street	**X**			Green roofs; external walls and facades
Urban green space connected to grey infrastructure	Trees/hedges/green; house gardens, green playground/ school grounds; green parking lots; riverbank green			X	-
Parks and (semi) natural green areas	Large urban parks or forests; Pocket parks/ neighbourhood green spaces; botanical gardens; green corridors		X		Large urban parks or forests
Green areas for water management	Rain gardens, swales/filter strips, sustainable urban drainage systems	X			Rain gardens, filter strips
Allotments and community gardens	Allotments; community gardens; horticulture			X	-
Blue areas	Lakes/ponds; rivers/streams/canals/estuaries, deltas, seacoast, wetlands/bogs/fens/marshes	X			Wetlands
Green indoor areas	Indoor vertical greeneries (walls and ceilings); atria			X	-
Derelict areas	Abandoned and derelict spaces with the growth of wilderness or green features			X	-

As shown in the table, most of Naturvation's categories are not addressed in the ET. These are urban green spaces connected to grey infrastructure; allotments, and community gardens and green indoor areas, derelict areas. Even when the ET does address a category of UNBS, generally only one or two UNBS belonging to that category are taxonomy eligible. It is calculated, that only roughly 20% of the UNBS are somehow addressed in the taxonomy. The UNBS that are explicitly addressed in the ET are green roofs; external walls and facades; green areas for centralized wastewater treatments and wetlands.

First, green roofs; external walls, and facades are considered part of the economic activity "Individual measures and professional services" in the real estate industry. This economic activity is defined as "technical interventions aimed at increasing energy efficiency and professional services that are functional to energy improvements" (TEG, 2020b p.368) In this context, the "installation of façade and roofing elements with a solar shading or solar control function, including those that support the growing of vegetation" is always aligned with the ET (TEG, 2020b p. 384). When external walls, roofs (including green roofs) are considered as an addition of insulation to the existing envelope components, they need to comply with specific criteria to be ET-eligible: "Minimum requirements set for individual components and systems in the applicable national regulations transposing the Energy Performance Building Directive (EPBD) and Eco-design requirements pursuant to Directive 2009/125/EC" (TEG, 2020b p. 383). The first regulation, the *Energy Performance Building Directive (EPBD)* does not establish specific guidelines per se but rather provides a framework for single nations to establish minimum requirements in terms of energy efficiency of buildings. A comparative analysis of how this directive has been implemented by different member states and what this implies for UBNS is beyond the scope of this thesis, however, it is relevant to present the general principle presented by the directive. "The requirements should be set with a view to achieving the cost-optimal balance between the investments involved and the energy costs saved throughout the lifecycle of the building" (EP & Council, 2010. Art.10). The second Directive *2009/125/EC* sets a framework for national eco-design requirements for energy-using products. While a detailed overview of all the provisions of the directive is not relevant in the context of this thesis, the phases of the life cycle of the products and the environmental aspects that are thereby established indicate the aspects that should be considered while evaluating external green walls or roofs against the ET. As presented in annex 1 of the directive, the following phases of the life cycle of the product need to be considered: raw material selection and use; manufacturing; packaging, transport, and distribution; installation, and maintenance; use; and end-of-life, meaning the state of a product having reached the end of its first use until its final disposal. The environmental aspects that must be assessed when relevant are predicted consumption of materials, of energy and other resources such as fresh water; anticipated emissions to air, water, or soil; anticipated pollution through physical effects such as noise, vibration, radiation, electromagnetic fields; expected generation of waste material; and possibilities for reuse, recycling and recovery of materials and/or of energy [...] (EP & Council, 2009).

Second, rain gardens and filter strips are covered while referring to NBS for "Centralized Wastewater treatment" in the water, sewerage, waste, and remediation industry. As explained above, some guidelines to avoid significant pollution are provided in this context. The implementation of appropriate measures to avoid and mitigate combined sewer overflow in case of heavy rainfall is required. Among the various options (such as separate rainwater collection systems, retention tanks and/or treatment of the first flush) also nature-based solutions are mentioned. Rain gardens and filter strips can be used for this purpose.

Third, wetlands are referred to several times in the ET as "natural capital" that needs to be protected. These are not assessed as a product itself but rather mentioned in the criteria of other economic activities that need to ensure not to lead to the conversion, fragmentation, or unsustainable intensification of high-nature-value wetlands.

Finally, large urban parks and forests are not explicitly addressed in the ET. However, they are claimed to be indirectly addressed if they are used for mitigation or adaptation purposes. Some of the economic activities of the forestry industry that are included in the ET can be related to this type of UNBS. These are afforestation, reforestation, existing forest management, and conservation forests. Within the ET, increasing the carbon sequestration from forests is declared to be essential to the achievement of a net-zero target by 2050 in Europe and globally. This rationale and the guidelines provided for other economic activities in the forestry industry might be easily extended to the urban context and used by investors to evaluate them. Those guidelines can be summarized as follows:

- Compliance with FAO's Sustainable Forest Management (SFM) requirements.

- The forest carbon sequestration increases and emissions decrease. This should be assessed by measuring only above-ground carbon pools and based on the forest's GHG baseline.
- There is a steady improvement which is measured every 10 years (20 years for rehabilitation & restoration and afforestation) (TEG, 2020b).

To summarize, the general concept of NBS is recognized within the ET which presents it as desirable and preferable to "grey" measures. However, the urban dimension of NBS and of sustainability overall is falling behind. Focusing on the research sub question addressed in this chapter "Which urban nature-based solutions are referred to in the EU taxonomy and in which terms?", it emerges that three categories of UNBS are directly addressed by the ET: external building greens (specifically, green roofs, façades, and walls); green areas for water management (specifically, rain gardens and filter strips), and blue areas (wetlands). For the category "external building greens" some specific criteria for eligibility are established which are grounded in previous EU regulation. The other two categories are always eligible for the ET, without needing further assessments. Next to this, large parks and urban forests are claimed to be indirectly addressed by the ET, meaning the criteria established for comparable economic activities, outside of the urban context, can easily be extended to them. In particular, the guidelines of compliance for the forestry industry. The remaining UNBS (equal to about 80% of the total) are not addressed at all in the ET.

To this point, the literature suggests that the ET has the potential to address several of the barriers that hinder investments in UNBS. However, the in-depth content analysis of the ET highlights that more work needs to be done to integrate UNBS. On the one hand, the general concept of NBS is endorsed by the ET. On the other hand, urban applications are only partially addressed. This is consistent with a general lack of consideration of the urban dimension of sustainability in the ET. The list of UNBS that are included in the ET are: green roofs; external walls and facades; large urban parks or forests (only indirectly addressed); rain gardens, filter strips, and wetlands. Theoretically, these UNBS should benefit from the ET. However, this research makes a step forward by relating this theoretical potential to the current engagement of investors in UNBS. This will show which investors might be expected to validate their investments using the ET as well as any related consequences. An overview of the current engagement of investors in financing UNBS in European cities is presented in the subsequent section.

5.3. Reconstruction of the current engagement of European investors in UNBS

This final section presents the results that address sub question 5 "Which investors are currently investing in which urban nature-based solutions and to what extent do they cooperate?". Since different methods and focuses are applied to tackle this question, the results are divided into three sub-sections. First, the level of involvement is presented (5.3.1). Second, a comparative analysis of how each investor allocates funds among the different UNBS categories (5.3.2). Third, the network analysis and related findings (5.3.3). Finally, the results are integrated (5.3.4).

5.3.1 Level of involvement

From the analysis, it emerges that, in the EU, municipalities are the biggest contributor to UNBS in terms of funding since 55, 6% of the UNBS included Naturvation's sample, received funding from the public local authority's budget. Following, the national governments invested in 33,3% of the UNBS (15,4% from regional budget). The EU contributes to 16,7% of the UNBS. The level of the involvement of the private sector via corporate investment equals 15,3%.

Despite being often mentioned in the analyzed literature for their potential as investors in climate solutions in cities, no correspondence is found between institutional investors (such as pension and insurance funds) and the database. For this reason, it is assumed that this type of investor is not (meaningfully) contributing to financing UBNS in the EU. Thus, it is marked with 0%.

In contrast, some new sources of funding are reported in the database that did not emerge from the literature. These are: funds provided by non-governmental organizations (10,8%); private foundations (9,2%), crowdsourcing (5,8%), and others (9,8%). The latter includes financing coming from public sector institutions (e.g. school or hospital); research institutions and universities, environmental agencies, or big lottery funds. Also, cases of individual donations are reported or funding via membership/entrance fees.

In summary, it emerges that public investors are the most involved in financing UNBS. In European cities, more than half of UNBS are (at least partially) financed by domestic public funds. Following, national governments (33,3% of UNBS); the EU (16,7%) and companies (15,3%.). In contrast to what was expected based on the literature, institutional investors are not active in the field of UNBS, while novel investors emerge. The latter are non-governmental organizations (10,8%); private foundations (9,2%), crowdsourcing (5,8%), and others (9,8%). In the following sub-section 5.3.2, the analysis turns to visualize the distribution of the investments of each investor in the different categories of UNBS.

5.3.2 Distribution of investments per UNBS category

This sub-section reports a summary of the main findings related to the distribution of funds per investor in different types of UNBS. Moreover, it presents the relevant shared patterns and differences among investors. Appendix B can be consulted for a complete overview of the findings of this analysis.

Almost half of the funding derived from Municipalities goes into urban green space connected to grey infrastructure and parks and (semi)natural urban green areas. Followed by Blue Areas (17%) and allotments community gardens (13%). The remaining 22% is distributed among green areas for water management, external building greens, derelict areas, and green indoor areas.

Green areas for water management, external building greens, derelict areas, and green indoor areas are also the least funded by national public funding. However, the category green areas for water management "gains" one position over allotments and community gardens. These receive respectively 11% and 9% of the national government funds. At the podium, we find urban green space connected to grey infrastructure (18%), blue areas (22%), and parks and (semi)natural urban green areas (26%).

Half of EU funding divides between parks and (semi)natural urban green areas and blue areas. Following, urban green space connected to grey infrastructure (17%), allotments and community gardens (10%), green areas for water management (9%). At the bottom, following the same order as for the previous investors, external building greens, derelict areas, and green indoor areas.

From these first results, it can be noted that the distribution of funding from the three public investors is consistent and does not change dramatically from one public investor to another. The categories that receive most of the public funding are parks and (semi)natural urban green areas, blue areas, and urban green space connected to grey infrastructure. Allotment and community gardens, and green areas for water management receive an average of 10% of public funds each. Finally, the categories that receive less funding are consistently external building greens (7% on average), derelict areas (6%), and green indoor areas (0,6%).

Concerning private funding, the distribution does not present radical differences compared to public investors, with one exception: the category "external building greens" is the third most funded (15%). It surpasses "blue areas" which receive 15% of funds. At the top, there are still parks and (semi)natural urban green areas (22%) and urban green space connected to grey infrastructure (19%). The remaining UNBS receive the following amount of funding: allotments and community gardens (13%), green areas for water management (10%), derelict areas (5%), and finally green indoor areas (2%).

Since institutional investors are not active in the field of UNBS (see section 5.3.1), the results thus so far cover all investors that emerged from the literature. However, the same analysis has been performed also for the "new investors" that came up from the database, including crowdsourcing, NGO funds, private foundations, and other sources. In general, the distribution of the funds coming from these investors are coherent with those of the literature-based ones. There is one meaningful difference for what concerns the

UNBS category "allotments and community gardens". While public and private investors are allocating only 10% and 13% of the funds to this category, it is the most funded via crowdsourcing (32%), NGOs (26%), and other sources (24%). Moreover, it is the second most funded by private foundations (19%), following parks, and (semi) natural urban green areas (26%).

To summarize, the distribution of funding towards different UNBS is similar across investors. Overall, the allocation of public funds (from municipalities, national governments, and EU) are divided as follows: the categories on the podium are parks and (semi)natural urban green areas, blue areas, and urban green space connected to grey infrastructure. With approximately 10% of funds each, allotment community gardens and green areas and green areas for water management score in the middle. Finally, external building greens, derelict areas, and green indoor areas receive the least funding. Also, no-public investors follow similar patterns. However, two differences emerge from the analysis. First, companies allocate more resources than others towards external building greens. For this type of investor, this category of UNBS is the third most financed. Second, despite scoring in the middle for other investors, the UNBS category allotments and community gardens is the most funded via crowdsourcing, NGOs, and other sources. Moreover, it is the second most funded by private foundations.

After presenting which investors are active in the field and how they distribute their resources across different UNBS, the last step of the analysis is to investigate co-financing patterns. The following sub-section 5.3.3. presents the stakeholder network analysis. It is the last step to achieve a complete overview of the current engagement of investors in UNBS in European cities.

5.3.3 Co-financing UNBS: the network analysis

The results of the stakeholder network analysis are illustrated in this section. Since more than half of UNBS relies on multiple sources of funding, investor cooperation has been investigated. Graph 3 represents the network of investors that co-financed UNBS in the EU. The red vertices represent each category of investor included in the network, while the grey lines depict the bilateral interaction among them (co-financing of UNBS). The thickness of the lines indicates the weight of the interaction. In other words, the more UNBS have been jointly financed by two investors, the heavier the interaction and the thicker the line.
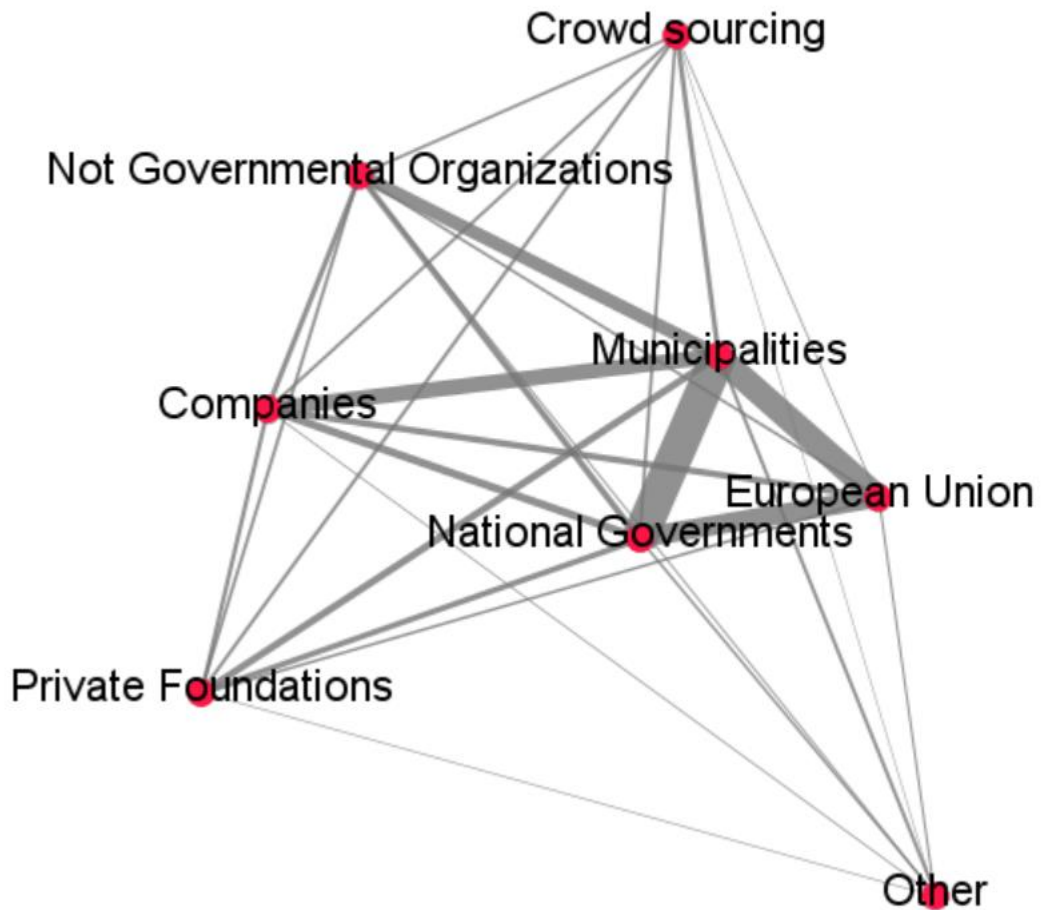
Graph 3: Network of investors co-financing UNBS in the EU

Besides representing the network, two metrics have been calculated: the network density and the weighted degree centralities Network density equals the number of actual relations divided by all possible linkages (Kim, 2019). The value of the network density (d=1) indicates that each investor interacts at least once with all the other investors. This means that all the investors co-financed at least one UNBS with each of the other investors included in the network. The weighted degree centrality assesses the degree of connectedness of each investor considering also the frequency of interactions among the same actors (Scott & Carrington, 2011). The related values are listed in ascending order in table 7. The most connected investors of this network are municipalities, followed by national governments. Crowdsourcing and other sources are the least connected.

Table 7: weighted degree centralities in the network

Type of investors	Weighted degree centralities
Municipalities	451.0
National Governments	348.0
European Union	260.0
Companies	189.0
Not Governmental Organizations	152.0
Private Foundations	120.0
Crowd sourcing	87.0

Other		57.0

By comparing the results of the different analyses on the level of engagement of different investors in UNBS, it is possible to formulate some observations. First, the level of involvement corresponds to the weighted degree centralities. This generally means that the investors that finance the most UNBS are also those that are most frequently cooperating with other investors. The only exception consists of the category "other" and the category "crowdsourcing". Crowdsourcing is the least common source of funding. However, it is characterized by more cooperation than the category "others". Second, a correlation emerges between the investment patterns of public investors and their relative high cooperation. The public investors (EU, governments, and municipalities) represent the stronger coalition within the network, being the ones that co-finance the most UNBS and being the most active investors overall. Therefore, it makes sense that their investment patterns are so similar. However, this reasoning cannot be applied to NGOs, private foundations, crowdsourcing, and other sources. Despite sharing an involvement in allotments and community gardens (category of UNBS that is marginal for the other, more involved, investors), they do not form a coalition.

To summarize, the network shows that each investor interacts at least once with all the other investors. Moreover, most active investors are generally also those who cooperate the most. The only exception concerns the categories "other" and crowdsourcing which switch places. Crowdsourcing is the least common source of funding but is more connected with the rest of the network than the investors included in the category "other". Public investors (municipalities, national governments, and the EU) emerge as the stronger coalition within the network: they are the three most active investors and those that cooperate the most in financing UNBS. Finally, they also share investment patterns.

The next section integrates the findings of the level of involvement (5.3.1) and distribution of resources (5.3.2) with the network analysis and places these findings in the context of the broader analysis.

5.3.4 Integration of the findings

The previous three sections explored the current level of engagement of different investors in UNBS from multiple perspectives. Insights about the level of involvement, distribution of investments per UNBS category, and co-financing behavior are provided. All these findings respond to sub question 5 "Which investors are currently investing in which urban nature-based solutions and to what extent do they cooperate?"

The investors that are active in the field of UNBS are (from the most active to the least): municipalities, national governments, the EU, companies, non-governmental organizations, private foundations, crowdsourcing, and others (category that includes research institutions, schools, hospitals, big lottery funds, or individual donations). These investors follow similar investment patterns which generally benefit the categories parks and (semi)natural urban green areas, blue areas, and urban green space connected to grey infrastructure. However, it is observed that companies allocate more resources than other investors towards external building greens. Moreover, the UNBS category allotments and community gardens is highly funded via crowdsourcing, NGOs private foundations, and other sources. It emerges that 53% of UNBS are co-financed. Each type of investor co-financed at least one UNBS with each of the other types of investors. The most active investors in the fields are generally those who cooperate the most with others. Public investors emerge as having a key role in UNBS financing: they are the three most active investors and cooperate the most in financing UNBS.

The picture drawn by these results is that UNBS in European cities are currently highly dependent on public funding. In fact, the public sector is clearly dominant in this field. Led by municipalities, which are the most involved and connected stakeholders, the coalition of public investors likely influences which UNBS are prioritized over others. The strong influence of the public sector is assumed to induce the similarity of cross-investors investment patterns in the field. While the reason why certain categories UNBS are consistently funded more than others deserves more research, the public sector's dominance as a trend-

setter is claimed to be a factor in this thesis. This suggests that the public sector plays a key role in fulfilling the potential of the ET in steering financing towards UNBS. By engaging with UNBS that are ET-eligible, the public sector could not only validate its own investment as climate-friendly but also influence other investors to become more involved in the field of UNBS through cooperation or best practices.

To recap, the ET is found to have the potential of addressing several of the barriers that hinder investments in UNBS. However, this potential is limited by the lack of urban focus in the ET. Although the general concept of NBS is endorsed by the ET, only few UNBS are eligible. These are green roofs; external walls and facades; large urban parks or forests (only indirectly addressed); green areas for centralized wastewater treatment, and wetlands. To realize the potential of the ET in steering capital towards these UNBS, public investors should mobilize. This is because the coalition formed by municipalities, national governments, and the EU is dominant in the field. Thus, this coalition can have the interest and the power to be pioneers and to develop partnerships with other investors for ET-eligible UNBS funding. The research will now turn to reflect on these results.

VI. Discussion

This thesis researches how the ET, a pioneering type of financial standard for sustainability, can function to steer capital towards a governance goal. Specifically, the focus is on UNBS, practices that have a high potential for climate action but struggle in securing long-term committed funding. In this chapter, the results of the analysis are discussed by coming back to the overarching research question "How and with what potential consequences is the ET able to address the challenges encountered in financing UNBS?". To answer this question, the discussion is organized as follows: first, section 6.1 presents how the ET can tackle specific challenges and the conditions necessary for its success. Second, section 6.2 discusses which UNBS could benefit from the ET and which ones do not. Third, section 6.3 addresses the centrality of public actors and its consequences. Finally, the need for complementary policies for UNBS is discussed (6.4).

6.1 Implementation as a critical phase

Drawing from the literature on voluntary codes for sustainability, financial regulative standards are expected to be able to steer capital towards sustainable investments by initiating two inter-connected governance processes: standardization and disclosure. On the one hand, investors would comply with the ET voluntarily due to collective pressure and incentives. The EU could then monitor and coordinate the actions of the investors, thereby influencing the capital flow. On the other hand, the ET will force both EU firms and investors to disclose to what extent they comply with the ET by 2022. This should increase the reliability and comparability of financial statements in the EU. By triggering these processes, the ET can potentially contribute to tackling several of the financial challenges that discourage long-term financial commitment to UNBS. Complying with the ET might offer new advantages to investors in terms of reputation and credibility. Taken together with major consistency and transparency in the field of sustainable investments, these new advantages, would help to contrast the difficulties that both public and private investors face in changing investment patterns. Moreover, the ET provides criteria and guidelines regarding which investments are sustainable. The establishment of clear guidelines can enhance awareness over opportunities in the sustainable finance domain and have a positive effect on data availability and interpretation. This would improve investors' knowledge and skills in this field. Finally, by providing a shared EU framework for sustainable investments, the ET may contrast the use of sectorial languages that hinder knowledge-exchange. Thus, horizontal and vertical coordination can be facilitated.

For this potential to unfold, some pre-conditions need to be met. First, enough incentives and collective pressure on investors to push compliance need to be created for the standardization process to unfold. Second, the establishment of proper control mechanisms to verify the truthfulness of compliance with the ET is necessary to tackle the challenge of institutional inertia. Third, to solve the challenge of imperfect information and enhancing cooperation, it is necessary to ensure a consistent understanding of the ET guidelines across-investors and comparable disclosure practices. Finally, the ET shall not be perceived as too demanding by investors. This would limit its potential in tackling the barriers of imperfect information and institutional capacity. Except for the last one, these pre-conditions do not refer to the content of the ET but rather to its implementation. The ET was published in March 2020 and will be fully enforced by December 2022, which means that the ET is currently already in its implementation phase. It is therefore critical for the EU to focus on ensuring that these pre-conditions are met. In conclusion, this research suggests the implementation phase is essential for the ET to fulfill its potential to steer capital towards UNBS. It is recommended that the EU establish a control mechanism to verify the truthfulness and quality of compliance with the ET. Furthermore, intensifying the incentives for compliance and the clarity and comparability of both criteria, and disclosure guidelines is recommendable.

6.2 The lack of urban dimension

This research shows that NBS are not only mentioned but also endorsed by the ET. NBS are described as win-win, desirable solutions. They are pictured as a better choice in tackling climate change than "grey measures" Based on this, the thesis claims the concept of NBS is recognized and supported by

the ET. However, the urban dimension of NBS is not acknowledged by the ET, meaning that the term is never mentioned in the urban context. This is consistent with a general lack of attention to the urban aspect of sustainability. The need for "further work" to include urban planning for low carbon development is recognized by the TEG itself (TEG, 2020b). Clearly, this has consequences for how UNBS are addressed in the ET. About 80% of the types of UNBS investigated in this thesis are not included. These are urban green space connected to grey infrastructure (some examples are alley and street trees; green parking lots; riverbank green); allotments; community gardens; horticulture; the remaining green areas for water management such as swales or sustainable urban drainage systems, and urban blue areas such as lakes or deltas; and green indoor areas. Even though the ET might have some indirect positive impact on these applications, this thesis suggests that the direct addressing of these UNBS would enhance the potential of the ET in steering capital towards UNBS.

Despite the poor coverage of UNBS in general, some specific types of UNBS are included in the ET. Thus, the ET can be beneficial for them. The UNBS that are directly addressed by the ET are green roofs and walls, green areas for centralized wastewater systems, and wetlands. These are all deliberated as "always eligible", except for when green walls and roofs are considered as an addition of insulation to the existing building's envelope component. In this case, some guidelines are provided in the ET. If not perceived as too demanding by investors, these criteria should be helpful in providing a framework for investing in this NBS (so, again, tackling the challenges of imperfect information and institutional capacity). Being grounded in previous EU regulation, the criteria should not be perceived as too demanding by European companies and investors.

Moreover, it is claimed that the criteria provided in the ET for the industry "forestry" could be extended to urban forests and large parks. These UNBS could be considered as being aligned to the ET if the criteria of the forestry industry are met. The criteria refer to sustainable forest management and a steady increase in carbon sequestration capacity. Yet, this connection is not explicit in the ET. This research suggests an extension of the criteria to this urban application as a first step to improve the synergy between the ET and UNBS.

The reasons behind the inclusion of some UNBS in the ET are not investigated within this thesis and any conclusion in this sense would be speculative. However, some preliminary observations can be collected and used for further research on the topic. First, to simplify compliance and harmonization among investors, the ET relies on EU regulation or international guidelines. It can be hypothesized that the UNBS that are already highly regulated by EU laws or by other established standards are more likely to be included in the ET. This is the case for green roofs and walls and for the forestry industry (where FAO's SFM standard is referred to). Second, no correlation was found between importance of UNBS for investors and likability of being included in the ET. For instance, the category "Urban green space connected to grey infrastructure" scores relatively high among investors looking at the distribution of investment. However, the UNBS that belong to this category are not included in the ET. Further research is needed to test these hypotheses.

6.3 The key role of the public sector

While selecting which investors to focus on within this dissertation, two criteria have been used: they shall be relevant for the European context and they shall be able to ensure long-term committed funding. The selected investors are municipalities, national governments, the EU, commercial banks and private companies, and institutional investors such as insurances and pension funds. All of them, apart from institutional investors, are found to be active in the field of UNBS. From the analysis, it clearly emerges that public institutions, above all municipalities, are the most active. More than half of the UNBS of the sample were funded by municipalities. Following, national governments and the EU are the most present investors with levels of involvement at 33% and 17%, respectively. Private investors score similarly to the EU, with 15% of UNBS receiving their funds. Moreover, the analysis highlighted the presence of other types of investors: NGOs, private foundations, crowdsourcing and research institutions, schools, hospitals, big lottery funds, or individual donations (conglomerated in the category "others). Based both on their level of

involvement and on the network analysis, these investors have a less central role in financing UNBS than the literature-derived investors. However, it is valuable to acknowledge their contributions and monitor their involvement.

The findings of this research suggest that public investors have a key role in financing UNBS in European cities. They are not only the most present investors in the field but also those which cooperate the most in co-financing UNBS. This is relevant since more than 50% of European UNBS rely on co-financing. This relatively high level of collaboration and centrality in the financing of UNBS is reflected in the way the funds of these investors are allocated among different UNBS: the distribution is highly similar across the public sector. Moreover, public investors are claimed to influence the distribution of funds from other investors towards UNBS as well since they have such a central role in the network. Based on its dominance, these stakeholders are supposed to hold the most interest in applying the ET to this field and have the most influence on other investors. Thus, the extent to which the ET will be applied in this field and its potential impacts rely on the public sector. This limits the capacity of the ET in tackling the challenges encountered in the financing of UNBS. Despite its theoretical potential, the ET remains a tool whose impact is highly dependent on how investors use it. In the field of UNBS, the key investors are municipalities, governments, and the EU itself. In order to pursue the goal of mainstreaming UNBS, the public sector is therefore called to actively engage with the ET when possible. So, how can public investors adopt this leading role? They can start developing best practices by applying the ET's guidelines on the UNBS that are already addressed by the ET. Besides setting a precedent, this can favor ET-aligned partnerships with other investors. For this purpose, the category of external building greens is purported to be particularly suitable for PPP. In fact, private investors are the investors who most value this category of UNBS.

6.4 The need for complementary measures

Based on the findings of this research, there are some challenges for investing in UNBS that cannot be expected to be tackled by the ET. First, the lack of upfront capital which presents a barrier for public investors. Second, there is the obstacle of high perceived risk and forecasted low returns due to the innovative nature of UNBS. This is particularly critical for institutional and private investors. In addition, the involvement of institutional investors with small-scale innovations is hindered by their stringent fiduciary responsibilities Finally, the last challenge is the highly dependent nature of most municipalities on national governments. There is no evidence that the standardization and disclosure processes initiated by the ET will have an impact on these challenges. Based on these results, this thesis suggests complementary governance action is necessary for achieving the goal of mainstreaming UNBS. Listing what exactly this complementary action should entail lies outside the scope of this dissertation, however, the "unsolved challenges" highlighted by this research are considered a top priority for future research on this topic and eventual regulation.

Finally, it is observed that most of the unsolved challenges are relevant for institutional investors, including the stringent fiduciary responsibilities, high perceived risks, and forecasted low returns. Among the financial institutions drawn from the literature, institutional investors were the only investor type found to be inactive in the field of UNBS. It is hypothesized that tackling these challenges could be the key for UNBS to appeal to this type of investor, however, once again, more research is needed to support this suggestion.

In summary, the findings of this thesis provide insights into the modes of governing of sustainable finance regulative standards while exploring how the ET relates to specific solutions that have a high potential for climate action but struggle in obtaining funding: UNBS. This analysis has been conducted prior to the implementation of the ET and provides several suggestions to realize the potential of such a tool in this field. These recommendations concern the implementation phase and the future development of the ET. The key messages of this research, and its limitations, are presented in the following and final chapter. This thesis is highly explorative and inaugurates a new field of research. Thus, the ideas for further inquiry that

emerged through the research process are numerous. The most pertinent ideas are collected in the subsequent chapter as well.

VII Conclusion

The thesis investigated how and with what potential consequences, the ET is able to address challenges encountered in financing in UNBS in European cities. The ET was investigated as an innovative governance tool. It is one of the first financial standards for sustainability to be developed by a public actor and to form the basis for regulation. As a new type of financial standard for sustainability, the ET lays the foundations for standardization and disclosure in the sustainable finance sector. This means that investors are expected to progressively intensify compliance under the ET due to incentives such as reputation gain and pressure from other investors and stakeholders. Moreover, both European investors and firms are compelled to provide information about their compliance with the ET by the end of 2022. This mandatory disclosure aims to increase reliability, comparability, and availability of data in the field of sustainable finance. By setting the stage for these governance mechanisms, the ET holds the potential of tackling several challenges that prevent long-term investors from financing UNBS in Europe. This research suggests that the ET can directly contribute to solving institutional inertia; lack of institutional capacity, imperfect information, and lack of horizontal and vertical cooperation. Also, the thesis highlights some pre-conditions that need to be met during the implementation of the ET to fulfill its potential. The conditions are the creation of sufficient incentives and collective pressure on investors to push compliance with the financial standard; the establishment of proper control mechanisms to verify the truthfulness of compliance with the ET; a consistent understanding of the ET guidelines across investors and comparable disclosure practices. Moreover, investors should not perceive the financial standard as too demanding.

Based on what is stated until now, the ET can be helpful for securing UNBS financing. However, some important limitations should be discussed. These limitations emerge from the analysis of the content of the ET and of the current level of engagement of investors with UNBS. First, even if the ET recognizes and endorses the general concept of NBS, it ignores the urban applications of these practices. Most of UNBS are not mentioned in the ET and the urban dimension of sustainability is generally poorly considered. Second, due to the high dependency of UNBS from the public sector, public investors need to take the lead to apply the financial standard in this field. Thus, the ET is not expected to steer private capital without the public investors taking certain key steps first.

The current version of the ET is applicable to green areas for centralized wastewater system, protection of wetlands, and external building greens (green roofs, façades and walls). The latter is particularly suitable for public partnership because private investors seem to be particularly active towards this type of UNBS. Thus, public investors are recommended to start applying the ET guidelines and disclosing obligations towards these UNBS. The aim must be to develop best practices and to create the ground for more cooperation with the private sector under the ET's emblem.

This research provides some additional recommendations for the future development of the ET: some key actions can favor the inclusion of UNBS in the ET. First, the urban dimension of sustainability needs to be addressed within the ET. Second, the extension of forestry industry criteria to large urban parks and urban forests is recommended. Third, sustainability guidelines need to be investigated for those UNBS that are not yet included in the ET. These are urban green space connected to grey infrastructure (some examples are alley and street trees; green parking lots; riverbank green); allotments; community gardens; horticulture; the remaining green areas for water management such as swales or sustainable urban drainage systems and urban blue areas such as lakes or deltas; and green indoor areas.

The steps listed above can contribute towards realizing the ET's potential in tackling some of the challenges of UNBS financing. However, some of the barriers that hinder investments in UNBS remain outside the scope of the ET. These are lack of upfront capital perceived high risks and forecasted low returns. Thus, complementary measures addressing these challenges are needed to steer capital towards UNBS.

Overall, the ET is a revolutionary tool that kicks off a new way of addressing climate action in the financial sector. However, the urban dimension of the sustainable transition and the big potential of engaging

with nature as an ally needs to receive more attention to build a sustainable tomorrow. This thesis starts a conversation on this important topic, seeking synergy within the fields of sustainable finance and environmental governance and with a hopeful gaze towards the future.

This research is subjected to several limitations which are listed in section 7.1. Afterward, section 7.2 collects the inputs for further research.

7.1 Limitations

This chapter gathers the various limitations that were encountered throughout the research process.

To begin, the quality and availability of sources impacted the accuracy of the research. There is not much academic literature available regarding the ET and the financing of UNBS. Since these two topics were the focus of this thesis, the lack of literature inevitably weakens its theoretical foundation. However, this lack of knowledge also stresses the importance of performing research in these fields. Moreover, the literature on financial standards for sustainability, and financing climate adaptation and mitigation in cities is used to strengthen the theoretical base.

The lack of literature has been particularly problematic in two instances: first, very limited sources analyzing the barriers for international public finance in financing UNBS were found. This created an imbalance between the theoretical foundations of the challenges encountered by other types of investors compared to those experienced by the EU. Second, it was not possible to identify specific challenges for each type of UNBS as originally planned in the proposal phase due to the lack of literature. Future research on these two topics is encouraged.

In regard to the quality of the data, the Urban Atlas database has not been updated since 2017. This implies that newer UNBS are not included. Despite this limitation, it still represents the most complete source of data related to financing UNBS in Europe.

Another limitation that should be mentioned is subjectivity. Despite trying to minimize the bias relying on original documents-grounded methodologies and introducing guiding analytical questions, the interpretation of the data is still inevitably subject to the judgment of the author. In particular, the gap analysis and the matching of the data coming from the Urban Atlas database (which are categorized based on the financial sources) with the categories of literature-derived investors was prone by high subjectivity. The limitation of subjectivity was addressed by extensively explaining the methods and rationale behind the results. The transparency gained by doing so ensures the replicability of the research and strengthens the internal validity.

Concerning external validity, the generalization of the results of this thesis to other contexts is limited. The research addresses a specific standard and policy goal, which are both grounded in the EU's policies. Thus, the results cannot be generalized outside of the EU context. However, the research provides an innovative methodology that can potentially be applied to other regulative standards or other policy goals.

The last limitation is not related to how the research was performed but rather the context in which it was conducted. This thesis investigates the ET in terms of its "potential", prior to its implementation. However, the implementation phase crucially determines whether a standard meets its purpose (Van der Ven et al., 2018). This is very relevant in the case of EU environmental regulation whose impacts have often been compromised due to implementation failures (Kelemen, 2000). Despite this, the results of this thesis provide the basis for recommendations for the implementation phase of the ET and for future steps by the EU in the field of sustainable finance.

7.2 Further research

This thesis presents multiple avenues for further research. The main points are hereby listed.

As presented in the limitations, the literature about the ET and the financing of UNBS is scarce. Thus, research is these sectors is generally needed. Throughout the research process, some specific questions were raised. First, there is lack of literature about specific financial challenges for different types of UNBS. Second, sources are particularly limited regarding the challenges encountered by the EU as investor in UNBS. Third, it is unknown which factors influence the distribution of funds across different types of UNBS. This thesis claims the public sector dominance as a trend-setter in the field of UNBS to be one factor. However, this hypothesis needs more research. Finally, it is crucial to keep monitoring and collecting data about UNBS in Europe. The Urban Nature Atlas database should be periodically updated.

This thesis is the first paper to associate the ET and UNBS, which opens a new field of research. Some suggestions for further research on this topic are hereby listed. First, it is relevant to understand which factors caused the inclusion of some UNBS in the ET. The thesis collected some preliminary hypotheses that need to be investigated. The hypotheses are: UNBS that are already highly regulated by EU laws or by other established standards are more likely to be included in the ET. Moreover, it seems that there is no correlation between importance of UNBS for investors and likability for being included in the ET. Second, it is necessary to explore new geographical dimensions. The EU is a union of countries with different national legislations, governance, financial behaviors and cultures. Thus, it is logical to presume there might be differences both in how the ET is implemented and, in the challenges encountered in financing UNBS in different countries and regions. Finally, the same recommendation given to the EU is extended to academics as well, namely the need for sustainability guidelines for UNBS currently excluded from the ET.

Finally, this thesis provides a categorization of investor-specific challenges for investing in UNBS in the EU that could be useful for future studies. However, this is based solely on literature. It is relevant to validate and expand the investor specific challenges identified in this dissertation via interviews. This would contribute towards strengthening the analysis.

Further research on the topics listed above would improve our shared understanding of financial standards for sustainability and UNBS financing. These fields are insufficiently explored but very relevant, both within and outside academia.

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Appendix A

Appendix A provides an overview of the history and forecasted development of the *EU taxonomy (ET)* (A1.1), together with an outline of the economic activities included in the ET (A1.2). The information provided in this appendix are a simplification of the ET history and structure which highlights the main points of the ET. The purpose is to help the reader of the thesis to have a better understanding of this topic. For further information, please refer to the original text of the ET and to the related regulation which is available online.

A1.1 History of the ET

In December 2016, the *European Commission* (EC) mandated the *Technical Expert Group* (TEG) on sustainable finance to develop a strategy on sustainable finance. The TEG is composed by 35 members from civil society, academia, business and the finance sector, as well as additional members and observers from EU and international public bodies. The first report of TEG was published on 31 January 2018. It calls for the creation of a technically robust EU classification system to establish clarity on which economic activities qualify as 'green' or 'sustainable', starting with climate change mitigation.

Based on this input, in March 2018, EC put forward the action plan on financing sustainable growth. The first action point calls for the establishment of an EU classification system for sustainable activities- the ET. The task of developing the ET was assigned to the TEG.

The TEG published to intermediated reports in December 2018 and June 2019 calling for feedback and gathering views from stakeholders. During its mandate, the TEG also engaged with over 200 additional experts to develop their recommendations.

In the meantime, the EC proposed to the other EU institutions to elevate the legal status of the ET, from simple classification to legal framework. On 18 December 2019, the Council and the EP reached a political agreement on the Taxonomy Regulation. Based on this, the ET will form basis for mandatory disclosure.

On 9 March 2020, the TEG published its final version of the ET. The ET is composed by two parts: a report and a technical annex. The report contains recommendations relating to the future developments of the it, as well as extensive implementation guidance on how companies and financial institutions can use and disclose against the taxonomy. The technical annex contains the technical screening of 70 economic activities for climate change mitigation and 68 for climate change adaptation.

On 22 June 2020, the Taxonomy Regulation was published in the Official Journal of the European Union and entered into force on 12 July 2020.

Based on what is established by the Taxonomy regulation, the current version of the ET will be expanded in the future. This version focuses on screening economic activities based on their substantial contribution to climate adaptation and mitigation. Moreover, it establishes criteria to ensure that these same economic activities do not harm the other EU environmental objectives. These are the sustainable use and protection of water and marine resources; the transition to a circular economy; pollution prevention and control; and the protection and restoration of biodiversity and ecosystems. In the future, the ET will go beyond ensuring that the listed EU objectives are not harmed. The substantial contribution of economic activities to these objectives will be also assessed.

Since the TEG was dismissed in September 2020, the new institution that will be responsible for the ET project is the newly established *"Platform for Sustainable Finance"* (PSF) that will report directly to the EC.

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A1.2 Overview of the economic activities

The Technical annex contains the specific guidelines and criteria for each of the economic activities reviewed in the ET. The criteria are based on:

- substantive contribution to the EU environmental objectives (1) climate change mitigation (2) climate change adaptation.

-do no significant harm (DNSH) to the EU environmental objectives: (3) sustainable and protection of water and marine resources; (4) transition to a circular economy (5) pollution prevention and control (6) protection and restoration of biodiversity and ecosystems.

- minimum social safeguards (e.g., OECD Guidelines on Multinational Enterprises and the UN Guiding Principles on Business and Human Rights).

The following Table A1 contains the list of sectors and economic activities that are currently covered by the ET.

Table A1: List of economic activities reviewed in the current version of the ET.

| Substantial contribution to climate change mitigation	
Sector	**Economic activities**
Forestry	• Afforestation • Rehabilitation, Restoration • Reforestation • Existing forest management • Conservation forest
Agriculture	• Growing of perennial crops • Growing of non-perennial crops • Livestock production
Manufacturing	• Manufacture of Low carbon technologies • Manufacture of Cement • Manufacture of Aluminium • Manufacture of Iron and Steel • Manufacture of Hydrogen • Manufacture of other inorganic basic chemicals • Manufacture of other organic basic chemicals • Manufacture of fertilizers and nitrogen compounds • Manufacture of plastics in primary form

Electricity, gas, steam and air conditioning supply	• Production of Electricity from Solar PV • Production of Electricity from Concentrated Solar Power • Production of Electricity from Wind Power • Production of Electricity from Ocean Energy • Production of Electricity from Hydropower • Production of Electricity from Geothermal • Production of Electricity from Gas (not exclusive to natural gas) • Production of Electricity from Bioenergy (Biomass, Biogas and Biofuels) • Transmission and Distribution of Electricity • Storage of Electricity • Storage of Thermal Energy • Storage of Hydrogen • Manufacture of Biomass, Biogas or Biofuels • Retrofit of Gas Transmission and Distribution Networks • District Heating/Cooling Distribution • Installation and operation of Electric Heat Pumps • Cogeneration of Heat/Cool and Power from Concentrated Solar Power • Cogeneration of Heat/Cool and Power from Geothermal Energy • Cogeneration of Heat/Cool and Power from Gas (not exclusive to natural gas) • Cogeneration of Heat/Cool and Power from Bioenergy (Biomass, Biogas, Biofuels) • Production of Heat/Cool from Concentrated Solar Power • Production of Heat/Cool from Geothermal • Production of Heat/Cool from Gas Combustion • Production of Heat/Cool from Bioenergy (Biomass, Biogas and Biofuels) • Production of Heat/Cool using Waste Heat
Water, sewage, waste and remediation	• Water collection, treatment and supply • Centralized wastewater treatment • Anaerobic digestion of sewage sludge • Separate collection and transport of non-hazardous waste in source segregated fractions • Anaerobic digestion of bio-waste • Composting of bio-waste • Material recovery from non-hazardous waste • Landfill gas capture and utilization • Direct Air Capture of CO_2 • Capture of Anthropogenic Emissions • Transport of CO_2 • Permanent Sequestration of Captured CO_2
Transportation and storage	• Passenger rail transport (interurban) • Freight rail transport • Public transport • Infrastructure for low carbon transport (land transport) • Passenger cars and commercial vehicles • Freight transport services by road • Interurban scheduled road transport • Inland passenger water transport • Inland freight water transport • Infrastructure for low carbon transport (water transport)
Information and communication	• Data processing, hosting and related activities • Data-driven solutions for GHG emission reductions
Construction and real estate activities	• Construction of new buildings • Building renovation • Individual measures and professional services

|	• Acquisition
Substantial contribution to climate change adaptation	
Sector	**Economic activities**
Forestry	• Afforestation • Rehabilitation, Restoration • Reforestation • Existing forest management • Conservation forest
Agriculture	• Growing of perennial crops • Growing of non-perennial crops • Livestock production
Manufacturing	• Manufacture of Low carbon technologies • Manufacture of Cement • Manufacture of Aluminium • Manufacture of Iron and Steel • Manufacture of Hydrogen • Manufacture of other inorganic basic chemicals • Manufacture of other organic basic chemicals • Manufacture of fertilizers and nitrogen compounds • Manufacture of plastics in primary form
Electricity, gas, steam and air conditioning supply	• Production of Electricity from Solar PV • Production of Electricity from Concentrated Solar Power • Production of Electricity from Wind Power • Production of Electricity from Ocean Energy • Production of Electricity from Hydropower • Production of Electricity from Geothermal • Production of Electricity from Gas (not exclusive to natural gas) • Production of Electricity from Bioenergy (Biomass, Biogas and Biofuels) • Transmission and Distribution of Electricity • Storage of Electricity • Storage of Thermal Energy • Storage of Hydrogen • Manufacture of Biomass, Biogas or Biofuels • Retrofit of Gas Transmission and Distribution Networks • District Heating/Cooling Distribution • Installation and operation of Electric Heat Pumps • Cogeneration of Heat/Cool and Power from Concentrated Solar Power • Cogeneration of Heat/Cool and Power from Geothermal Energy • Cogeneration of Heat/Cool and Power from Gas (not exclusive to natural gas) • Cogeneration of Heat/Cool and Power from Bioenergy (Biomass, Biogas, Biofuels) • Production of Heat/Cool from Concentrated Solar Power • Production of Heat/Cool from Geothermal • Production of Heat/Cool from Gas (not exclusive to natural gas) • Production of Heat/Cool from Bioenergy (Biomass, Biogas and Biofuels) • Production of Heat/Cool using Waste Heat
Water, sewage, waste and remediation	• Water collection, treatment and supply • Centralized wastewater treatment • Anaerobic digestion of sewage sludge • Separate collection and transport of non-hazardous waste in source segregated fractions • Anaerobic digestion of bio-waste • Composting of bio-waste

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	• Material recovery from non-hazardous waste • Landfill gas capture and utilization • Direct Air Capture of CO_2 • Capture of Anthropogenic Emissions • Transport of CO_2 • Permanent Sequestration of Captured CO_2
Transportation and Storage	• Passenger rail transport (interurban) • Freight rail transport • Public transport • Infrastructure for low carbon transport (land transport) • Passenger cars and commercial vehicles • Freight transport services by road • Interurban scheduled road transport • Inland passenger water transport • Inland freight water transport • Infrastructure for low carbon transport (water transport)
Buildings	• Construction of new buildings • Building renovation
Financial and insurance activities	• Non-life insurance
Professional, scientific and technical activities	• Engineering activities and related technical consultancy dedicated to adaptation to climate change

Appendix B

In Appendix B, the complete findings of section 5.3.2 are collected. These are graphic representations that represent the distribution of funds in different UNBS per each of the analyzed investors.
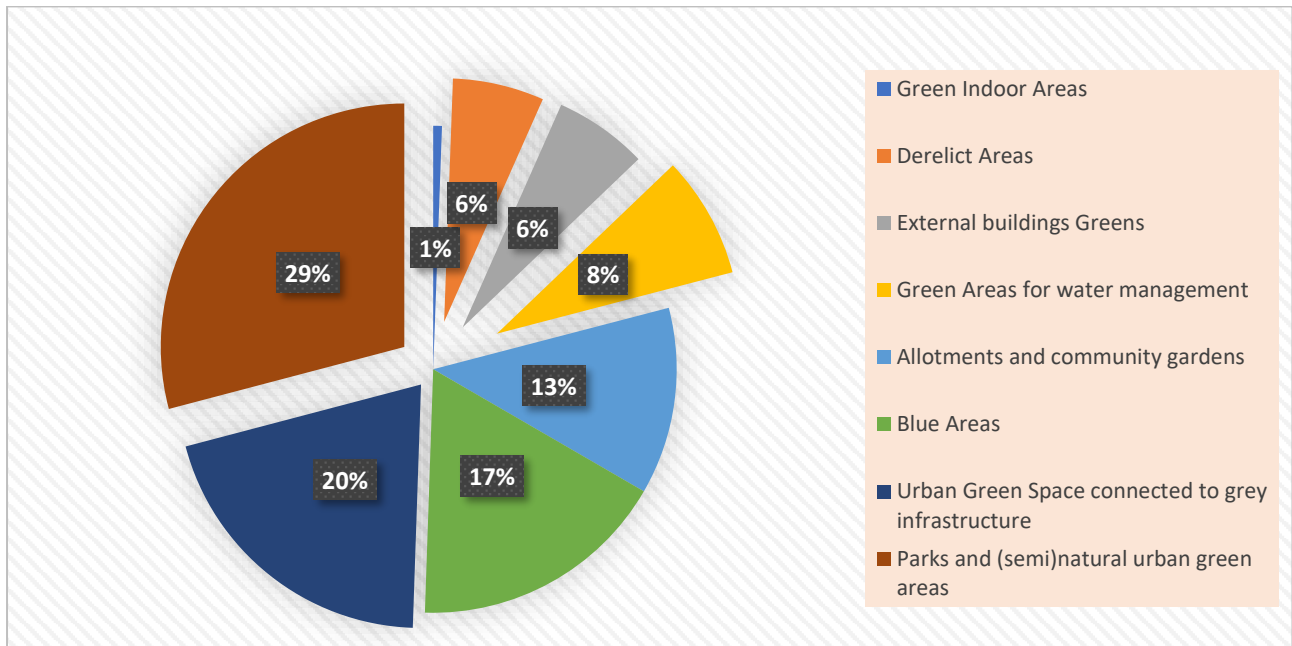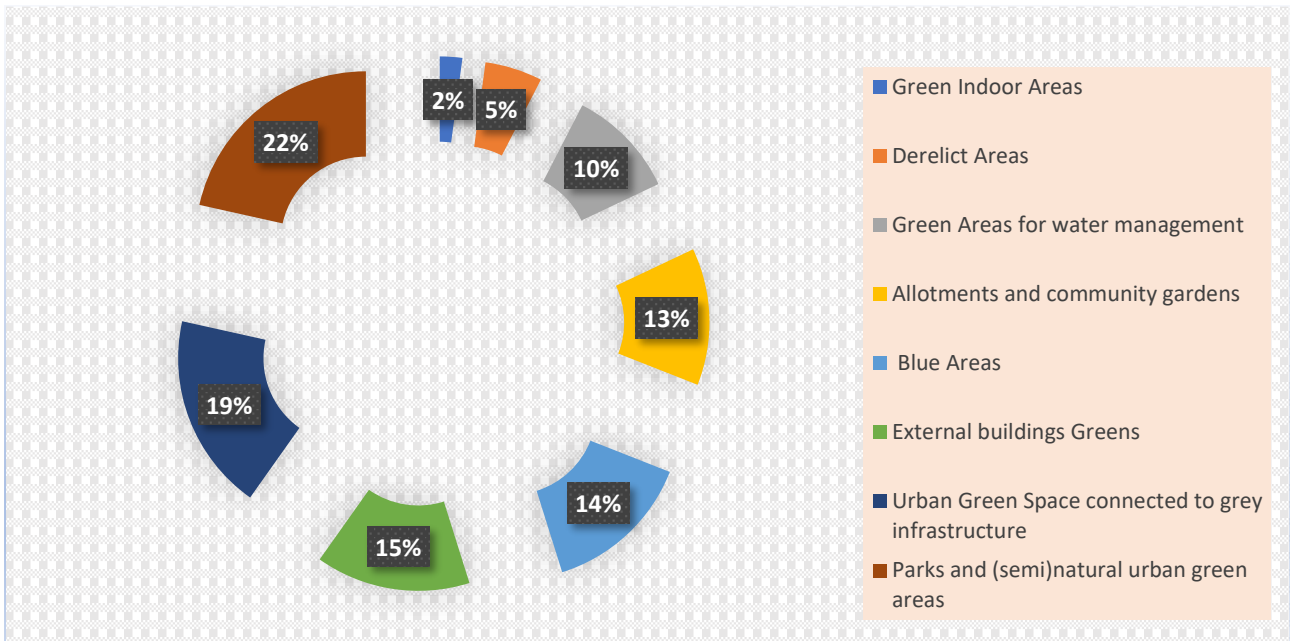

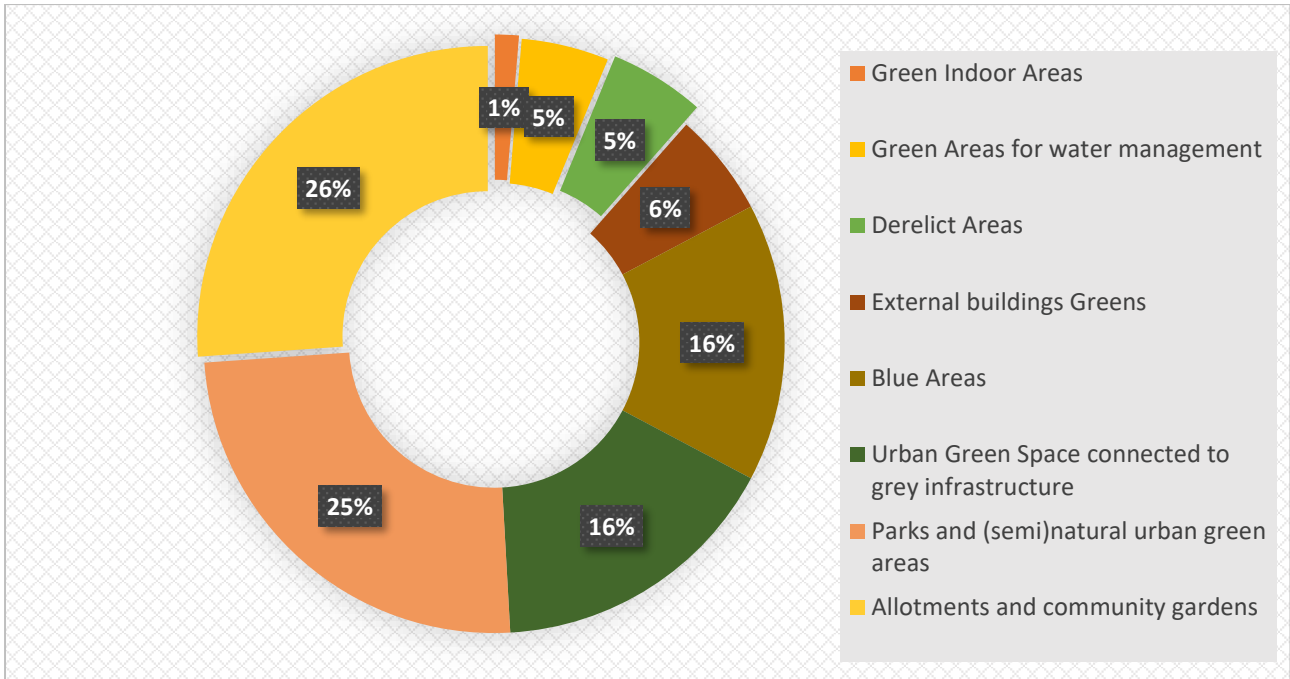*Graph B1 **Domestic public funding**: distribution of funds across different types of UNBS*
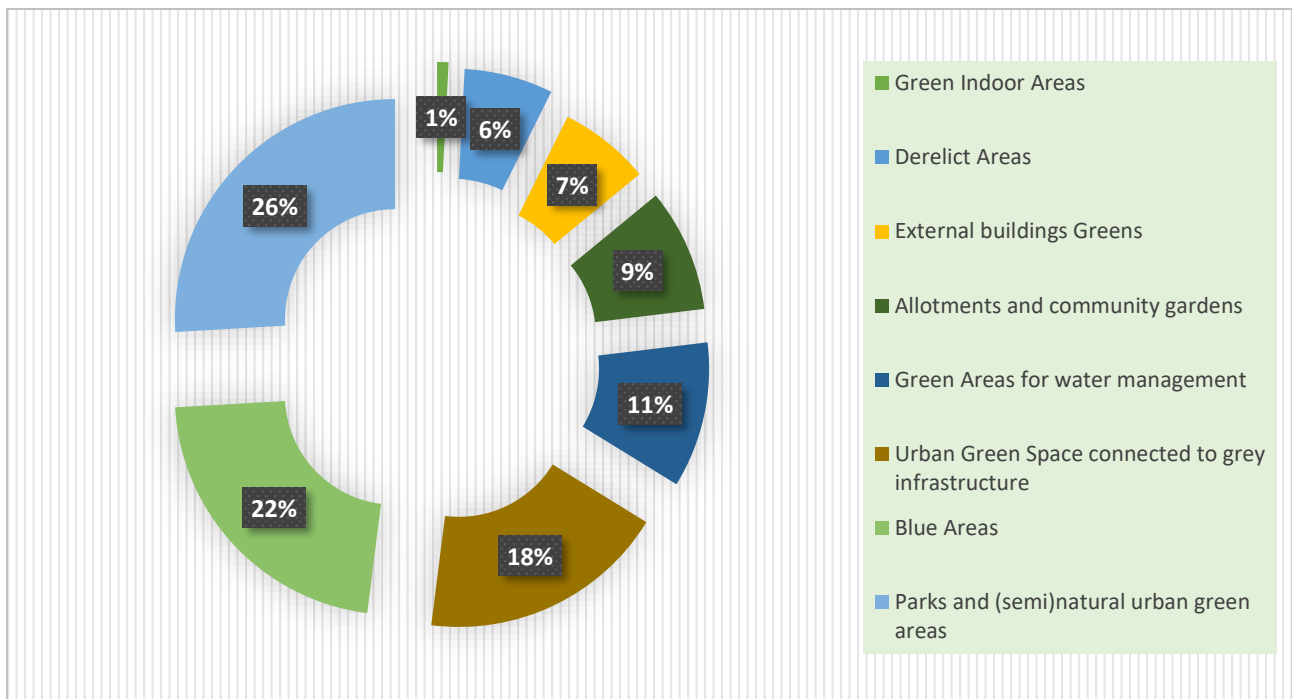
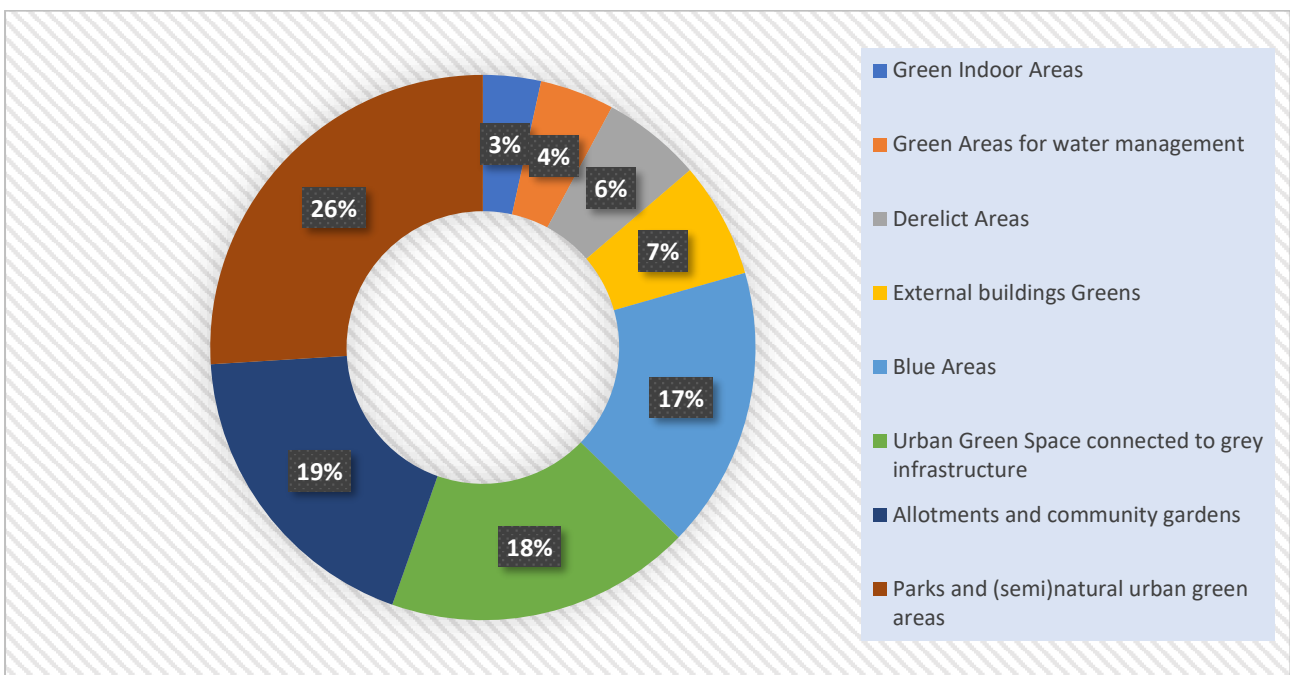*Graph B2 **National public funding:** distribution of funds across different types of UNBS*
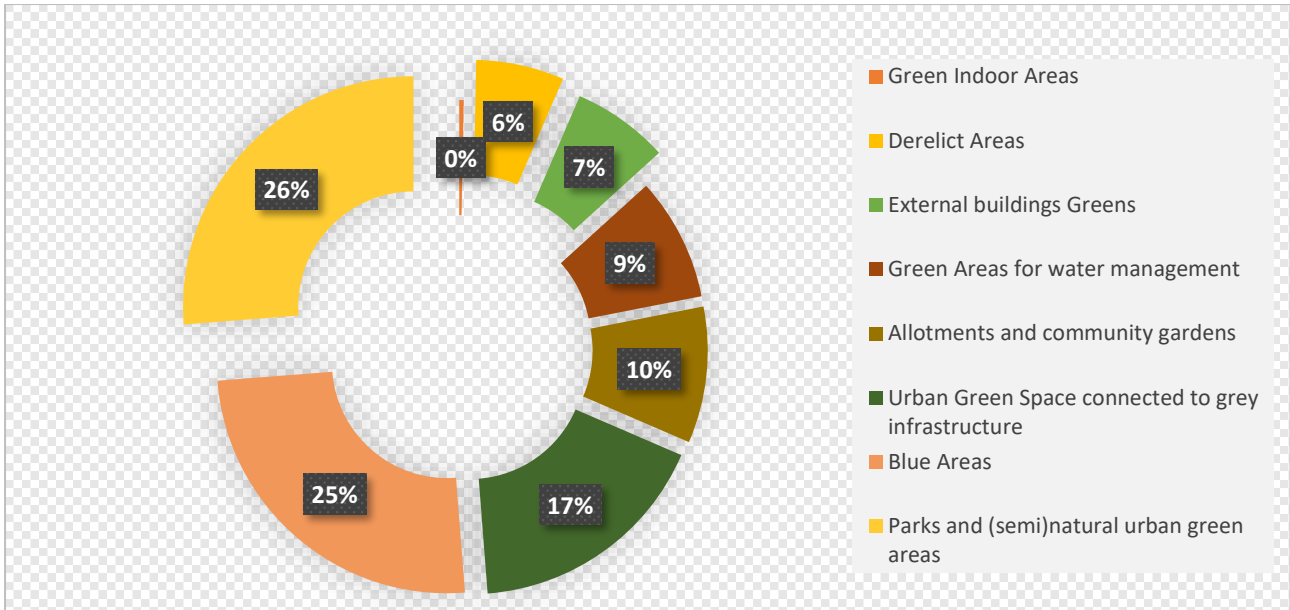
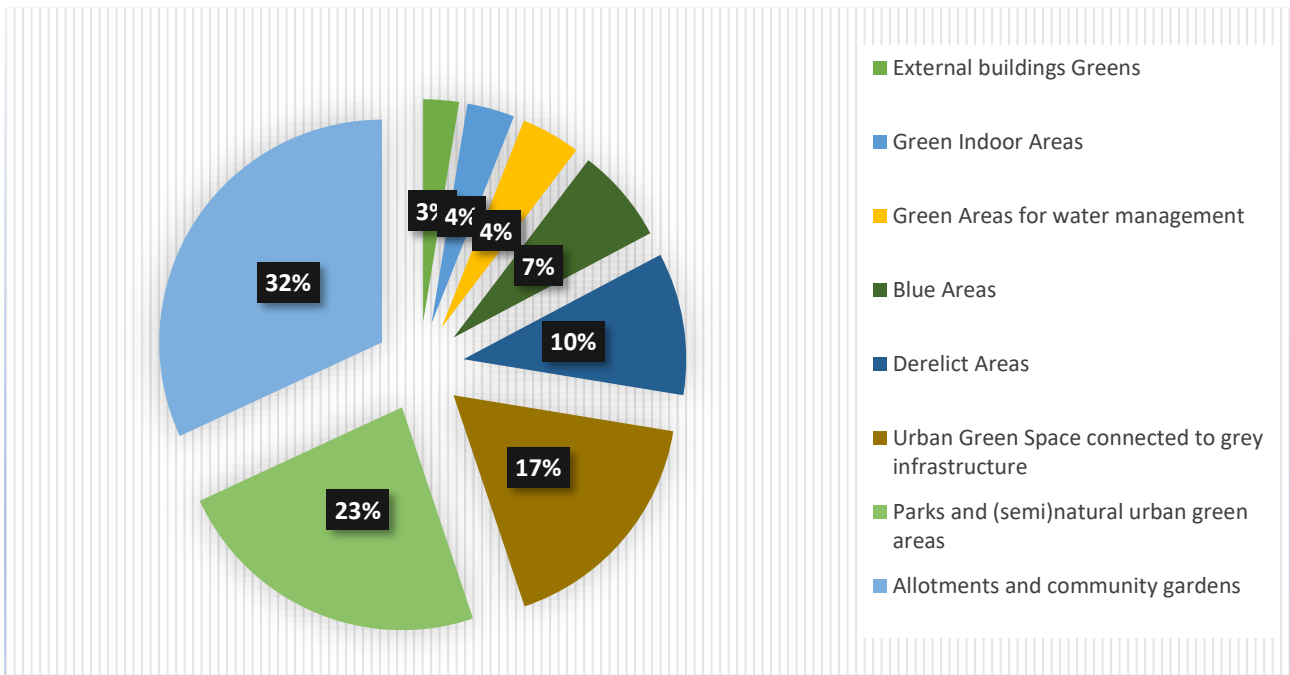*Graph B3* **International public funding (EU)**: *distribution of funds across different types of UNBS*

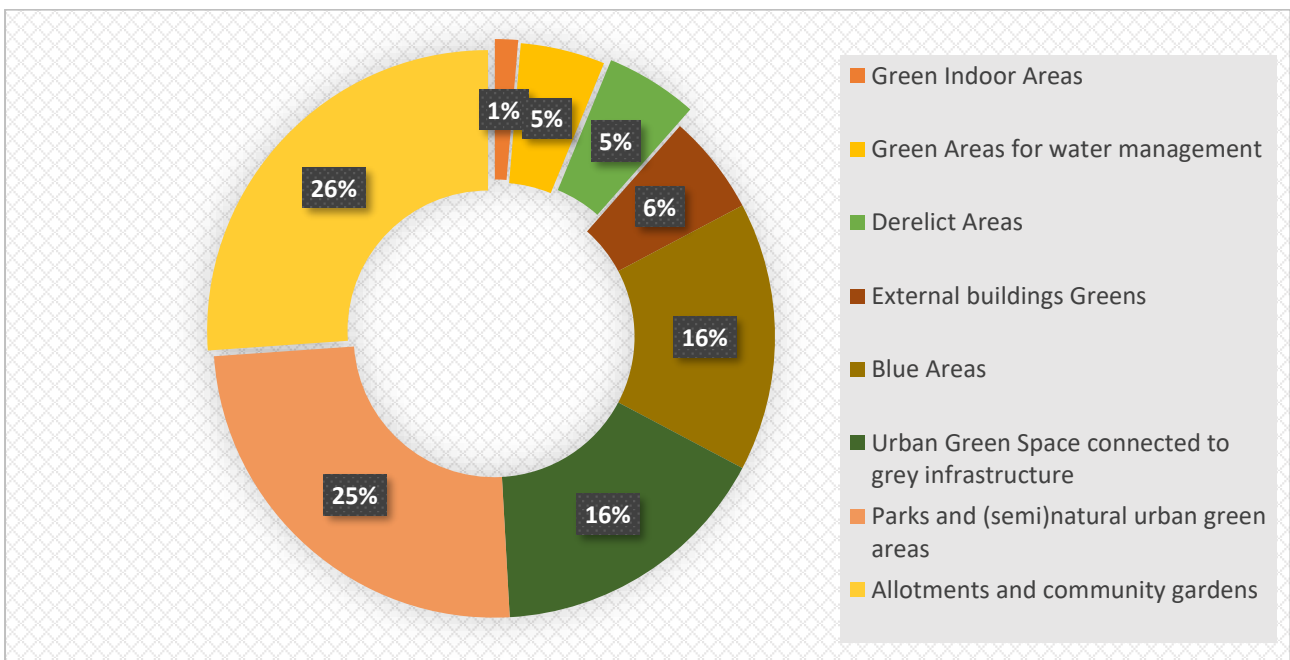*Graph B4* **Private funding**: *distribution of funds across different types of UNBS*

*Graph B5 **Non-governmental organizations funding:** distribution of funds across different types of UNBS*

*Graph B6 **Private Fundations funding:** distribution of funds across different types of UNBS*

Graph B7 **Crowdsourcing:** *distribution of funds across different types of UNBS*

Graph B8 **Other sources:** *distribution of funds across different types of UNBS*