TU Delft

BARRIERS & DRIVERS

FOR PRIVATE INVESTMENT IN NATURE-BASED SOLUTIONS

Deltares

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SUMMARY

Unlike other industries that provide marginal effects, the building and construction industry [BCI] and those that surround the generation of infrastructure are known to have a significant impact on the resolution of the environmental crisis (Roders, Straub, & Visscher, 2013). Nonetheless, these areas are characterized by slow knowledge development and difficulties in adopting change on a large scale. In particular, alterations to practices, regulations, and consumption patterns remain insufficient in terms of tenure [not sustainable through time], or in terms of significance [low impact actions] (Loorbach, Frantzeskaki, & Avelino, 2017).

The growing economic dependence of society on the damage of ecosystems, the lack of successful mechanisms to reimburse natural capital, an inability of critical industries to embrace change, and a lack of information on how ecosystem-related projects perform altogether a passive role for the private sector to invest in nature. Without said private capital, there is no meaningful way of dealing with the dwindling financial capacity of governments to guarantee essential services like a reliable supply of water, the preservation of security, and livelihood of human beings [against extreme natural events], among others (Mainka, McNeely, Jackson, & McNeely, 2005).

According to (Robertson & Choi, 2010), in the attempts to deal with the previously mentioned root causes of private investment inaction, both academia and practice have predominantly used a ‘mechanistic‘ approach, in other words, reducing a complex system into its smaller components for its analysis (Metzner, 1999). The criticism of this method is that it offers little regard for larger systems and embedded relationships, and thus, to a certain extent, it is incompatible with complex problems such as climate change (Denhant, 1981). It offers a weak notion of interconnectedness between the economic and social systems in the natural world (Metzner, 1999), and it usually puts much emphasis on controlling and forecasting behaviors of the individual parts, ignoring the self-organizing capacity of systems (Capra, 2002; Jantsch, 1980).

Specifically, in infrastructure, the ‘simplification’ approach has resulted in many studies on systems factors of influence, mostly for project decision-making processes, usually done with quantitative tools and large numerical databases (De Jesus & Mendonça, 2018; O’Donnell, Lamond, & Thorne, 2017; Serpell, Kort, & Vera, 2013). Nevertheless, when dealing with green infrastructure, merely simplifying is insufficient since it does not allow the understanding of the interactions between the more abstract systems, including the environmental and social aspects

of the projects (Nesshöver et al., 2017). Additionally, the literature in this area supports the claim that field research and qualitative tools might be far better at developing explanatory causality models (Mattheu B Miles & Huberman, 1984) (Maxwell, 2004).

Regarding the 'proper' course of action to counteract the private capital stagnation in green infrastructure, the most involved fields of study [building and construction industry, and environmental sciences] tend to disagree due to the fragmented and specialization-oriented character of research and practice. Each field has a different overview of the barriers and drivers to be addressed. Embedded in this context, this research enjoys great importance; it offers a strategy outside the traditional focus, beyond focusing on the most technically sound, or the most financially optimal projects, it explores the overlaps of the concerned areas of knowledge, enhancing trade-offs among the different priorities (EU-Commission, 2019b). The ultimate goal is to furnish a comprehensive, multidisciplinary scope; 'a helicopter view' that positions experts outside their comfort zone, i.e., forcing the building and construction industry [BCI] and climate and environmental sciences [CES] to learn other perspectives on financial concerns when implementing green projects. It also leads to the creation of governance arrangements tailored for common-pool resources (M. Altamirano et al., 2020) and knowledge that enhances the familiarity of investors with nature and resilience. All in with the hopes of speeding up the implementation of green infrastructure in the face of accelerating climate change.

While in the scientific community, there is the notion that green and blue solutions [BGI], a combination of natural landscape elements and proper water management policies (Lamond & Everett, 2019), can be cost-effective (Depietri & McPhearson, 2017), there is no certainty on whether this assertion is valid in practice. Other hybrid approaches, such as Nature-Based Solutions [NBS], that also incorporate natural landscape elements, water bodies, and open spaces, and are being studied on their effectiveness in comparison to grey infrastructure, nevertheless this research is still scarce (Lazurko & Altamirano, 2019), and when existing, it has led to contradictory results (Renaud, Sudmeier-Rieux, & Estrella, 2013). The doubt in practice on the performance and financeability of green and nature-related projects in the field of infrastructure stems from three main reasons:

First, natural assets cannot altogether substitute the services provided by grey infrastructure (Depietri & McPhearson, 2017). Secondly, economic productivity is rarely the focus within climate change-related infrastructure,

cost-benefit assessments are traditionally more about the avoided damages, and less about the performance quantification of Assets (Kabisch, Korn, Stadler, & Bonn, 2017; TEEB, 2008). Thirdly, there is significant difficulty in quantifying financeability due to the multifunctionality of green infrastructure assets (Zuniga-Teran et al., 2019); one asset is capable of producing a vast array of services that are non-excludable [it is not possible to limit access to them], with an unclear value chain creation, and a multitude of favored beneficiaries. This diffuseness of the services negatively affects the accuracy of the project's profitability forecasts, and also creates a lack of reference for a minimum acceptable functionality (Moore & Gassaway, 2007).

The above-mentioned conditions have resulted in nature-related assets that are incredibly complex to execute and maintain, cannot offer a clear perspective of costs and lifecycle profits for more private-oriented mindsets, and are only implemented after severe events (Zuniga-Teran et al., 2019). An example is the construction of the Sweetwater Wetland in Tucson, Arizona, USA; while the solution is considered cost-beneficial due to its future ecosystem services, there is no market ready to support them, and preliminary technical studies were costly in the eyes of investors (Kremer et al., 2016; McRae, 2016).

A mixed-method approach is used to compensate for the limitations of the reductionist approach; integrating both types of data, qualitative and quantitative, which aids to bridge the pragmatic and transformative perspectives (Greene, 2007). The initial blocks of this research focus on gathering the factors that influence the involvement of private investment in Nature-Based Solutions. Consecutive blocks use the resulting information to deduce and map the entire system, as well as providing a deep understanding of the casualties among factors (Health, 2012; Mertens, 2009; Morgan, 2007).

The purpose of this research is to assemble and analyze a database that reflects a consensus among experts on the main barriers and drivers [factors of influence] for private investment in the implementation of Nature-Based Solutions. Later steps in the research will explore the importance of such factors and focus the attention on those that are recognized to be critical, the interactions and importance will be critical in the furnishing governance strategies.

The first step consists of a meta-analysis of drivers and barriers, which derives from a multidisciplinary literature review to collect any suspected mentions of factors that may influence private investment in NBS. Once all factors are gathered, each was analyzed to determine whether they were drivers, barriers, and to perform a

preliminary operationalization. The operationalization starts by defining the factor's 'dimension', which is a word or adjective that hints at the requirements of the root concept. Namely, a factor in which the root concept has been detected to be 'tax regulations' is described by the author as 'too rigid,' from this information, we can infer that the more 'rigid' the tax regulations are, the higher the negative influence of the barrier on the private investment decision when getting involved in a project, in this example, the dimension is determined as 'rigidity.' This analysis concludes with two different filtering processes conducted to make the database manageable for future analysis.

Consequently, after the filters, with the use of Bayesian Belief Network theory [BBT] a system thinking baseline is sketched, the goal of this process is to obtain a hierarchy and a systems perspective of the detected barriers and drivers found in the NBS-specialized and related literature. Information gathered by the Bayesian belief networks includes the factors themselves, the dependencies among them, the direction of these relationships, and their criticality (Trucco, Cagno, Ruggeri, & Grande, 2008). BBN's are directed acyclic graphs [DAG] that have been selected for their capacity to exploit information emerging from the real world, in cases characterized by complex relations between large numbers of variables (Nielsen & Jensen, 2009) and because they are suitable for the creation of reliability and decision-making frameworks for dynamic systems (Boudali & Dugan, 2005). The models constructed based on the literature will be verified by expert opinions in semi-structured interviews.

To test the baseline, this research selects an NBS case study in Medina del Campo, Spain, consisting of an aquifer and related ecosystems, is selected to conduct a deeper BBN analysis. The demo is part of the European NAIAD initiative [NAture Insurance value: Assessment and Demonstration initiative]. The Medina del Campo aquifer is assumed to be a 'typical' case that represents the full variation of NBS, for which different sources of information are available, including interviews, workshop materials, etc.

In terms of the outcomes of this research, initially, the framework yielded a list of 32 relevant connected factors in NBS. Expert validation led to a total of 20 verified aspects. In the final stage, using Bayesian belief theory, information on the Medina del Campo case, and a sensitivity analysis highlighted a hierarchy of factors in a "typical" nature-based solution. In the end, three aspects stood out as the most critical for the case, the size of the market [F22], professional biases [F8], and long-term agenda alignment. Consequently, based on the experience of applying

the baseline for the first time on a real case and the most critical factors detected, this research provides governance recommendations to start analyzing the interactions that can enhance PI in the case.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

NBS	Nature-based solutions
EU	European Union
EUR	Euros
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
US	Dollars
UN	United Nations
CE	Civil Engineering sector
NAIAD	NAture Insurance value: Assessment and Demonstration [initiative]
ESG	Environmental, social and governance [values when investing]
BCI	Building and Construction Sector
CES	Climate and Environmental Sciences
IVS	Investing Sector
SID	Sustainable Infrastructure Development
BBN's	Bayesian Belief Network
BBT	Bayesian Belief Theory
BGI	Blue-Green Infrastructure
MDB	Multilateral Development Banks
BoW	Bag of words [Orange 3.27.1]
SSI's	Semi-structured interviews
CPT	Conditional Probability Table
B-PINbs	Bayesian Belief Network Baseline for Private Investment in Nature-based solutions
SA	Sensitivity Analysis
MCGB	Medina del Campo Groundwater site
TD	Tornado diagrams [sensitivity analysis]
i.a.	among others
i.e.	for example, for instance

1 INTRODUCTION

1.1 The dependency of the world economy on ecosystems

With the weight of increasing consumption and unsustainable urbanization, the world's stocks of natural capital ecosystems, the benefits, and resources they provide have drastically shrunk in the past century (Diaz, Settele, & Brondizio, 2019; Gillespie, 2013). Meanwhile, there is an increasing awareness that a considerable portion of the world's economic wealth has been extracted "free of charge", without any remuneration to the source ecosystems that originated it (Allen & Yago, 2011; EU-Commission, 2019b). In recent decades, biologists and economists, have taken the task of estimating the economic value of the entire planet's biosphere, concluding that the amount which nature services provide (usually rendered outside the market), reaches from US$33 trillion and up to US$54 trillion a year, meaning that these services represent at least a 37% of the annual global gross domestic product of 2019 (Costanza et al., 1998; IBRD-IDA, 2019). In contrast, the establishment of environmental goals in the Paris agreement has shown an investment deficit somewhere between US$2.5 and US$4.8 trillion in nature investments every year (Edwards, 2019).

There are different types of investment needed to address climate change (for the energy transition, the creation of green infrastructure, and the prevention of damage from extreme events i.a) (Rico, 2019), and to meet acceptable sustainability goals. The capital destined for sustainable infrastructure should increase globally by at least US$1.5 trillion of climate finance every year (Bartosch et al., 2018; UN Climate Change, 2017). Only in the European Union, the remaining "gap" of what has been committed in international agreements and what is currently being invested amounts to at least EUR 180 million per year (EU-Commission, 2019c).

1.1.1 *Natural capital reimbursement*

Given the outstanding debt to nature, balancing between the generation of wealth and the constant damage to ecosystems demands a new way to "reimburse" natural capital and a way to increase the flow of climate finance back to mitigation and adaptation measures (Fankhauser, Sahni, Savvas, & Ward, 2016). One subset of these innovative green infrastructure measures is known as Nature-Based Solutions (NBS), defined by (Nathalie Seddon et al., 2020, p. 377) as ecosystem-inspired assets that deal with climate change, water security, disaster risk, among other services. The concept of NBS embeds in discussions related to climate change adaptation, ecosystems, and green infrastructure (Kabisch et al., 2017); the IUCN [International Union for Conservation of Nature] defines NBS as actions

that protect, manage, and restore natural or modified ecosystems (E. Cohen-Shacham, Walters, Janzen, & Maginnis, 2016, p. 18). In contrast, the EU, through a less abstract approach, defines NBS as solutions [tangible or intangible], inspired and supported by nature; that is, they include actions, strategies, and notably, assets that provide environmental, social, and economic benefits (EU-Commission, 2016).

There are four overarching obstacles to their implementation. Firstly, there is restricted availability of public funds and the expectation that these sources remain scarce from this point onward (Fankhauser et al., 2016; Hutchison et al., 2015). Secondly, the outcomes and services provided by the NBS are too diffuse and exposed to many uncertainties (Andersson, Borgström, & McPhearson, 2017) (Potschin, 2015), consequently, the creation of precise-enough business models that appeal to private investment becomes difficult.

Thirdly, the vast array of experts weighing on their respective areas of competence, each one with a different set of priorities and expertise, continues to hamper the mobilization of private capital as the priority to scale-up sustainable projects and thus as a barrier as well for the establishment of a viable NBS market (Martinez & Christiansen, 2018).

While increasing the number of private capital endowments in green infrastructure is a promising alternative to address the financial gap (Bertl, 2016), the fourth challenge is that it is not possible to forecast NBS performance and economic effectiveness (Martinez & Christiansen, 2018) with the same accuracy as in grey infrastructure, which still hinders the participation of a broader private financing pool. In other words, not only do NBS generally require mixed, cross-field management, but they also demand flexibility and open-ended designs to handle the constant change of priorities that long-term public support demands (Depietri & McPhearson, 2017).

Aside from its features, green infrastructure implementation is challenging because of its exposure to deep uncertainty due to climate change, assets experience the effects of extreme events [with raising frequency and intensity](Nathalie Seddon et al., 2020)] (Lazurko & Altamirano, 2019) and the complex socio-economic systems in which these projects are embedded, ultimately leading to a weak reputation of NBS among investors. It is expected by some experts in the literature that these conditions continue to hamper the attractiveness of NBS going forward. Thus, since there is a need to increase the inherent attractiveness of NBS among non-public actors, it is necessary to go beyond the technical development of current adaptive climate measures and look for alternatives to enhance their socio-economic systems and improve the credibility of NBS in the eyes of private actors (Raymond et al., 2017).

In the European Union [EU], research already recognizes the critical role of private actors in the financing of green projects (EU-Commission, 2020), including strategies to design tax-subsidy systems, the setting up of collaborations focused on increasing involvement of innovation-oriented actors, and the creation of a capital's market cross-border value-chains for projects that extends beyond one single governance entity (EU-Commission, 2019a).

However, a high number of studies are single-focused and take care of one specific set of aspects, meaning that, for instance, they concentrate on promoting specific sustainable practices among private investors instead of evaluating the multidisciplinary interactions that result in a certain degree of attractiveness for the private sector.

To provide a reference of how this study differentiates from material existing in academia, and to show some examples of the one-sided, single-focused studies common in the literature, table 1 displays various factor-based sources that deal with barriers and drivers for the involvement of private investment. Papers mentioned in table 1 belong to the three major clusters of literature and "centers of knowledge" that are involved in the execution of green infrastructure [the building and construction industry, the climate and environmental sciences, and the investment sector]. It can be observed that none offer a holistic view with a full array of influencing factors of all the concerned socio-technical systems; they are usually focused only on one of the mentioned clusters, or they only deal with one type of factors, the barriers, or drivers.

Table 1 – Studies on the factors influencing private sector involvement in NBS, GI, and sustainability

Source	Scale	Research objective	Outcomes	Differences with the present study	Methodology
OPPLA scenario development [Step 1]: review potential drivers and indicators [1]	Worldwide	Scenario planning, current trends analysis, and drivers of change for decision-making in biodiversity and ecosystem services	◦ Indirect drivers of change ◦ Direct drivers of change	◦ Not focused on financing ◦ Not focused on NBS ◦ Entirely qualitative analysis	◦ Literature review ◦ Expert judgment
Planning for a Healthy Environment good practice guidance for green infrastructure and biodiversity [2]	UK	Offer to advise planning practitioners on how green infrastructure and biodiversity can be enhanced and protected through the planning system.	◦ Recommendations for GI implementation ◦ Case examples	◦ Focuses on Green infrastructure [not in NBS] ◦ No database analysis [neither barriers nor drivers]	◦ Case studies
Understanding stakeholder values for woodland expansion [3]	Scotland	Scenario development for more resilient policies in the face of uncertainty	◦ Ecosystem services list [according to stakeholders]	◦ Not focused on financing ◦ No database analysis ◦ Entirely qualitative analysis	◦ Literature review [53 docs] ◦ Semi-structured interviews

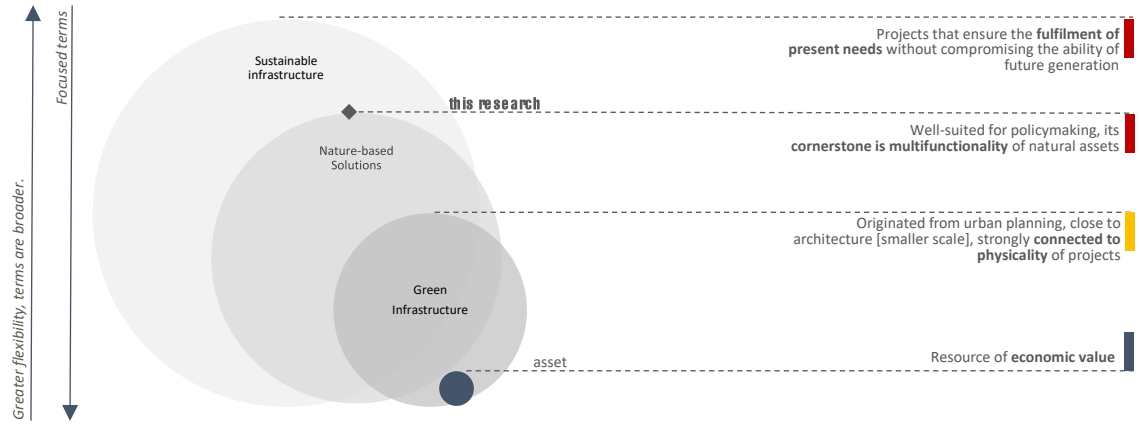
				◦ Focused on only one type of NBS	◦ Workshop with 18 stakeholders
The EU – Brazil Sector Dialogue on nature-based solutions [4]	EU & Brazil	Find out whether NBS are economically smart investment choices	Successful factors	◦ No database analysis [neither barriers nor drivers] ◦ Entirely qualitative analysis	◦ Case studies comparison

As it can be observed in table 1, studies fail to provide a comprehensive multidimensional approach to the analysis of challenges and opportunities on NBS.

1.1.2 *Definitions*

Within the academic discourse, several concepts have gained traction in sustainability debates and discussions in all related realms to the implementation of NBS (Pauleit, Zölch, Hansen, Randrup, & van den Bosch, 2017): sustainable infrastructure, nature-based solutions, and finally green infrastructure, i.a. Nature-based solutions [NBS] are the selected unit of analysis for this research, for more details on the rationale and differences between definitions consult annex 25.

Figure 1 – Different nature-related definitions in academia



The level of Nature-based solutions has been selected since it offers a good mid-point between the broad and abstract definition of sustainable infrastructure and the more rigid concepts of green infrastructure and assets, both prevailing in the construction sector and urbanism. It is important to mention that the decision to use NBS as the working concept in this research puts the primary focus on services instead of the physical features of the projects.

1.2 The sustainability paradigm shift

Mainstreaming sustainable projects like NBS is an objective that not only requires the collaboration of many contrasting stakeholders but that is in itself an extensive process (De Jesus & Mendonça, 2018). For this reason, due to the extensiveness of the implementation of NBS, this research does not focus on a specific stage but NBS in general.

In recent decades, literature has closely intertwined sustainability to the development thinking stream, giving rise to the concept of "sustainable development", a cornerstone and buzzword for many of the cutting-edge research fields. More than a decade ago, Spence defined it as the action of fulfilling present needs without compromising the ability of future generations to meet their own (Spence & Mulligan, 1995). In the construction industry, there is an extra layer of complexity, since projects must strike a balance between environmental protection and the wellbeing and economic prosperity of the affected regions and stakeholders to be considered sustainable (Mutanu Munyasya & Chileshe, 2018). The rising endorsement of sustainable development among experts in the construction industry, as well as other related professional clusters, has created the expectation of mainstreaming this type of project.

There are two main reasons for which the building and construction industry [BCI] has a crucial role in ensuring sustainable development on a global scale. First, this industry has historically provided most physical assets that drive development (Spence & Mulligan, 1995), and therefore has significant leverage to influence the setting of a sustainability benchmark for other industries. On the other hand, considering that the BCI is also a great source of pollution and a significant exploiter of natural resources, it has an enormous amount of responsibility in steering and speeding the adaptive transformation processes and adoption of sustainability practices.

Despite a spreading sense of urgency on the need for a full transition of the BCI into sustainable infrastructure development [SID], the lack of innovation, flexibility, and productivity that the sector showcases, directly hinder the speed at which the transformation takes place (Shabanesfahani & Tabrizi, 2012; Winch, 2003). The former summed up the historical preference for engineering interventions [instead of natural-inspired projects] to face climate change, which arises from a clear bias in investment towards engineered solutions (Nathalie Seddon et al., 2020).

Additionally, the lack of understanding of how the transition takes place is an added barrier to its attainment. As disclosed by (Pelling, O'Brien, & Matyas, 2015), the adoption of SID practices is not a single event but a process of incremental transformation stages of change, a set of "adaptive" responses and pathways (Béné, Cannon, Gupte, Mehta, & Tanner, 2014). For further details and a comparison between the BCI and the CES understanding of SID and transformation processes consult annex 26.

For the future, the next steps in the transformation have the goal of scaling up NBS and sustainable practices, is increasing the sharing the responsibility of the former with third parties [the private sector], thus entailing a conscious effort to [like the one in this research], to first detect the barriers and drivers that the third party faces and secondly, furnish compatible adaptive strategic responses to face the risks and enhance the benefits of the stage.

CONTENTS OF THE CHAPTER

2 PROBLEM STATEMENT AND RESEARCH DESIGN

2.1 Problem analysis

A growing number of experts in the BCI, CES, and INS, report that to provide infrastructure services, alongside designing more “innovative”, efficient projects, it is also worth focusing efforts on learning from nature and mimicking the already efficient, resilient, and sustainable systems and processes existing in nature.

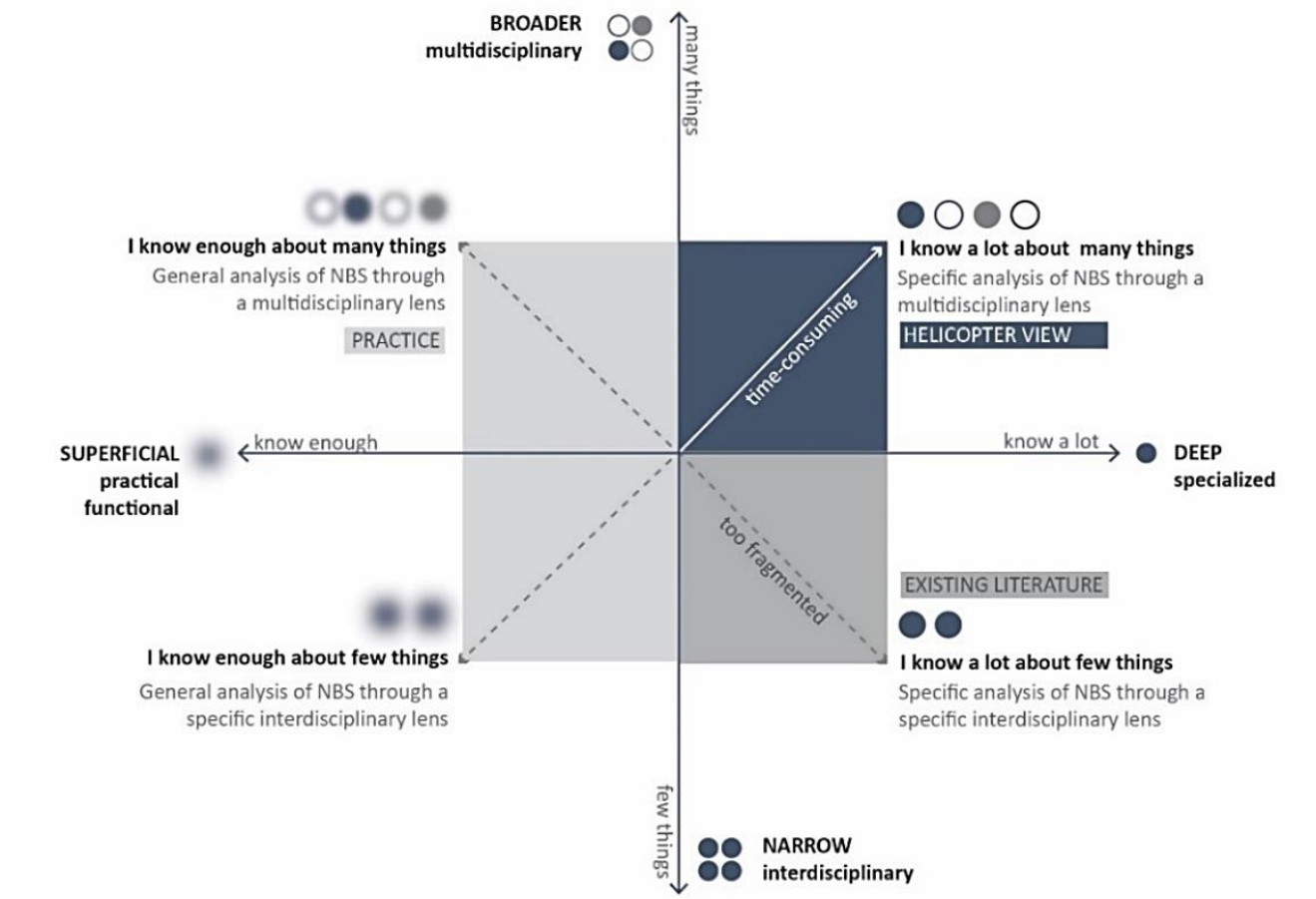
Looking at ways to realize the previous mission, the mentions and interest in Nature-based have grown in literature. They are continuously pinpointed as potential vehicles to restore ecosystems, including several studies developing frameworks to manage, and understand their specific characteristics, to enable crucial not-knowledgeable actors on the implementation of NBS (Deltares, 2020). Nevertheless, each nature-based solution is unique in its benefits and challenges. This uniqueness mostly arises from the distinct context in which each solution is immersed. Therefore, in most cases, implementation frameworks, are required to be structured and guide the specific NBS typology, while also being flexible and tailorable to allow the project’s implementers to comply with very individual requirements.

The unlikeness of NBS among different categories [as well as among solutions themselves], has also forced pieces of literature to fragmentate and to follow very specific, almost case-by-case studies. The former means that they might be more literature coverage on certain types of NBS, for instance, more meaningful information on inland solutions in comparison to coastal, on urban in the face of rural projects, or large scale in comparison to small scale solutions. These asymmetries on knowledge, have created a divided understanding of NBS and thus a split-up image to the eye of more peripheral actors, such as investors.

Climate change has made the mission of learning from nature, a race against the clock; and has put under pressure the engineering way of thinking that favors control and forecasting above anything else.

In other words, looking into the future, researchers will be increasingly confronted with the contradiction between the sense of urgency to restore ecosystems [and to mainstream NBS] and the scientific duty to wait for a complete understanding of NBS before taking any action.

Figure 2 – the broader and deeper approach



Experts increasingly recognize that a more fitting approach is the one that can co-exist with NBS growing complexity, unpredictability, and different types of value. Moreover, NBS pose two very particular requirements from most stakeholders involved throughout their implementation:

- **Extensive specialized knowledge of their technical aspects.** For instance, in this research's case, the *Medina del Campo* aquifer "demands" an understanding even from farmers on the technical challenges of refilling an aquifer [i.e., as to why it is time-consuming], since farmers are a cornerstone for the economic and social well-being of the region and would be crucial in the long-term maintenance of the NBS. This is a big difference

with engineering projects, where specialized knowledge can be fragmented according to the lifecycle stage, [e.g., final users or operators of a bridge are not required to know how the structural analysis was conducted].

- **Constant multidisciplinary dialogue.** Meaning not only that the type of knowledge comes from a variety of disciplines that speak different languages, but that dialogue needs to happen repetitively to make any solution adaptive and resilient to changing pressures posed by climate change.

Following the former requirements, this research adopted a "*broader and deeper*" approach to address the problem of private investment in NBS. Figure 2 showcases the advantages and downfalls of the selected strategy.

Utilizing any strategy from any of the left quadrants of figure 2, in light grey, would provide a superficial, functional analysis that does not comply with the first requirement of specialized knowledge on NBS [*I know enough from*…]. The bottom right quadrant, in dark grey, encapsulates what existing literature in NBS has done up to the moment, assume that superposing different lenses of specialized knowledge will create a meaningful consented solution, nevertheless, this approach has proved to be inefficient in the upscaling of NBS and has created a strongly interdisciplinary fragmented unable to upscale NBS .

The *broader and deeper* strategy while counteractive sounding has the power of creating a helicopter view that allows stakeholders to learn from specialized aspects in other disciplines while also strongly enables the influence of a multidisciplinary array of experts, ensuring the long-term collaboration necessary in adaptive solutions.

The research design described in the following sections, considers the requirements of the problem. It allows a broader approach with the coverage of a wide array of disciplines and factors, while also enabling a deeper, specialized approach by analyzing the interaction between the factors of influence.

2.2 Research objective

The purpose of this research is to identify a database of the most significant barriers and drivers for the involvement of private investors in the implementation of Nature-Based Solutions. Given the similarities between certain types of NBS and grey infrastructure assets, factors influencing the decision of investment of civil projects are

also considered as possible drivers or barriers for the investment in green infrastructure and, therefore, are included in the inventory to be furnished and analyzed.

Through Bayesian Belief Networks theory, the research will display the assumed hierarchization of factors of influence on a given case and provide a series of governance recommendation on the implementation of that particular NBS, that might increase the involvement of private investors.

2.3 Research questions

The following research question and sub-questions have been drafted to cut down the complexity of the exploratory research:

"What barriers and drivers enhance the involvement of private investors in the implementation of Nature-based Solutions?"

2.3.1 *Sub-questions*

1. **What are the drivers and barriers for private investment [PI] in NBS?**

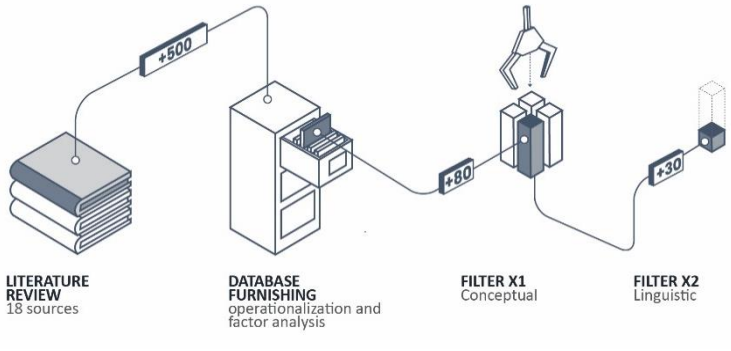
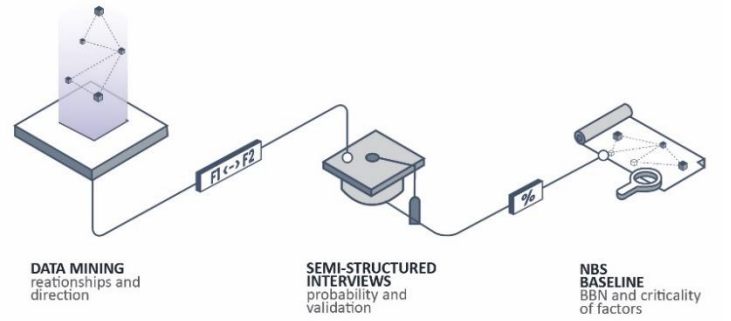
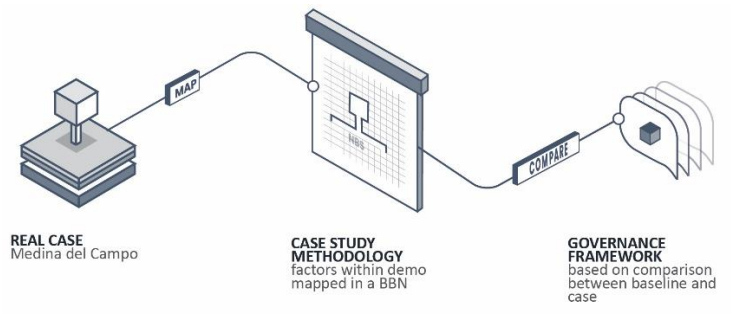
To answer the sub-question, several topics must be addressed. Starting with the creation of a preliminary database of factors that influence the involvement of private investment in NBS, the barriers and drivers will be initially obtained from specialized literature on nature-based solutions and climate change adaptation. Nevertheless, to compensate for the lack of information on the private financing aspects of NBS, also literature about analogous industries will be used, including on the challenges and opportunities in the creation of grey infrastructure and other similar enterprises within the environmental realm. This study considers the following related areas: sustainable infrastructure, mixed [green and gray] infrastructure, climate change, green infrastructure, sustainable innovation, and ecosystems finance.

The goal of including lessons from related areas and comparable industries is to enrich the database with additional suspected drivers that have been detected in these related fields such as for instance grey infrastructure projects, which are presumed to be partially analogous to NBS. The applicability and existence of both factors obtained in specialized NBS literature, as well as the "analogous" elements [observed in comparable projects], is verified through case studies in later steps of the research.

Other aspects to be described under this sub-question are the relationships between the detected barriers and drivers, and the exploration of whether the occurrence of one factor could influence or increase the chances of another factor to take place, this will be addressed through data mining, BBT, and Bayesian belief networks. This question also intends to assess whether each factor can impact the overall process of private investment involvement.

Lastly, a theoretical system modeling approach ["the baseline"] is constructed to map the complexity and relationships of the ensemble of factors. Table 3 shows the handling of the obtained factors.

Table 2 — Factors collection stages, methods, and products

Stage		Method	Product
1		Keyword literature Review and filtering	Preliminary factors database [522 filters] 2 X filtering processes
2		Bayesian Belief Networks Theory and semi-structured interviews	Expert-validated NBS baseline and scorecard
3		Case Study Methodology Medina del Campo	*Real case BBN's* *General Scorecard* *Governance recommendations*

2. What barriers and drivers [factors] are critical in the decision-making of PI in NBS?

This sub-question explores the hierarchization of drivers and barriers, and their influence on the initial appraisal stage of the projects, and whether each one can steer or impede the attraction of private investment into NBS, this is done during the second research stage and with the help of BBT.

The sub-question also examines if the clusters of factors appear during a specific stage of the lifecycle of the selected NBS or other shared features and intriguing patterns that could arise from the previous analysis.

3. **How can the knowledge extracted from the factors help overcome the hurdles of the involvement of PI in the implementation of NBS in the future?**

After obtaining the most critical factors for the given case study, and through the use of BBT, this research describes the most meaningful interactions between factors and proposes a general set of recommendation on the order of action and some general comments to support a governance strategy to enhance PI in the NBS.

2.4 Relevance

2.4.1 *Scientific relevance*

Throughout recent years, substantive literature sources have increasingly focused on the involvement of private capital in the execution of both, grey and green infrastructure (Berg, Pollitt, & Tsuji, 2002; Davis, 2005; Häkkinen & Belloni, 2011; Tang, Shen, & Cheng, 2010).

There are extensive examples of factor-based studies on the drivers and challenges of [1] the mobilization of environmental finance (Bertl, 2016) (EU-Commission, 2017), [2] the creation of successful business models for sustainable technologies and infrastructure (Engelken, Römer, Drescher, Welpe, & Picot, 2016), and [3] other technical (Simonet & Leseur, 2019), and governance-related hurdles (Wamsler, Pauleit, Zölch, Schetke, & Mascarenhas, 2017).

Still, many of these studies are conducted in an isolated manner and do not provide a unified outline of the general barriers and opportunities in NBS.

The scientific relevance of this study is that it aims to provide a helicopter view by inventorying the drivers and barriers for private investment in NBS, and consequently using the knowledge on the respective factors' hierarchy and relationships to furnish an evidence-based framework that can help design tailored governance approaches for NBS in the future.

Figure 3 — Practice clusters involved in the implementation of NBS.

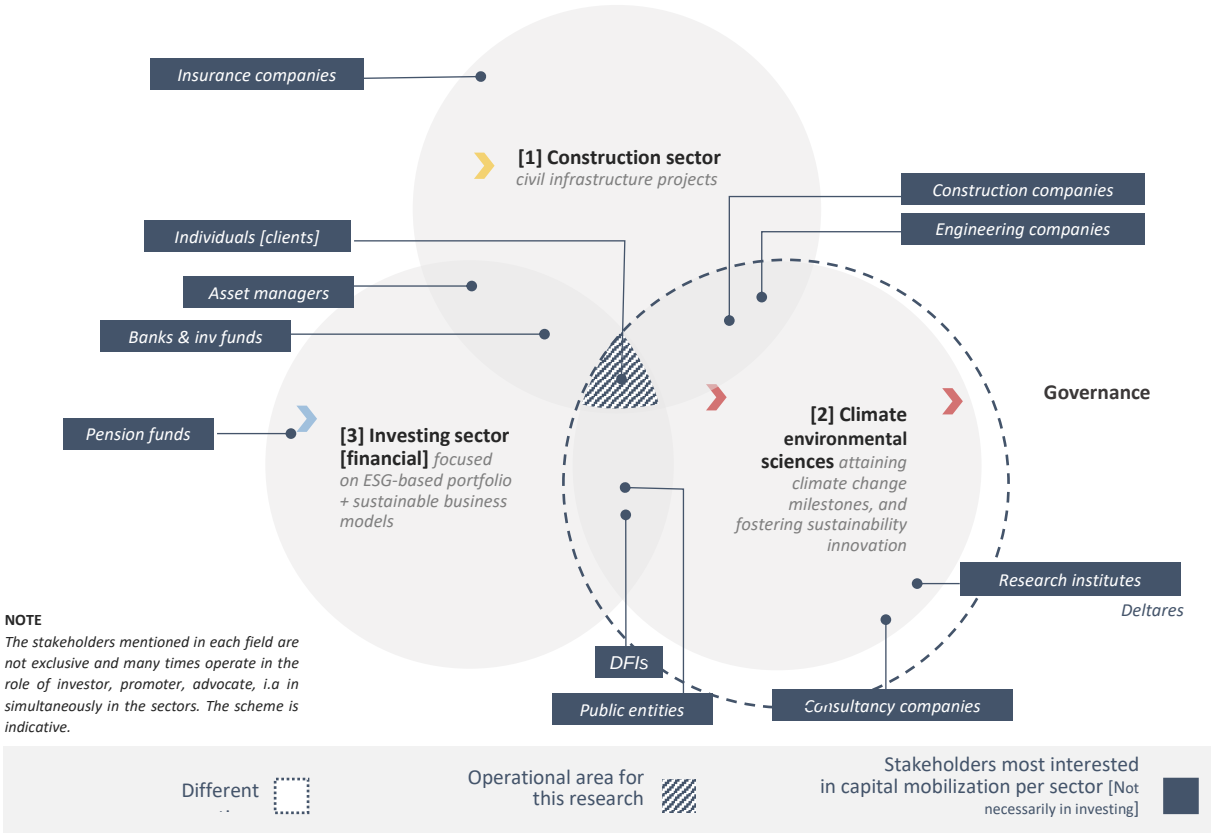


Figure 3 showcases the industry group agglomerations concerned with any aspect of implementing Nature-Based Solutions, they include the building and construction sector [BCI] [1], the climate and environmental sciences [CES] [2], and the investing sector [IVS] [denominations drafted by the author]. Since the activities, responsibilities, as well as interests of the stakeholders, immerse in each cluster, do not neatly belong to one single realm of studies, the diagram also displays some "*overlapping areas*" in which several actors enjoy agency.

As (Kabisch et al., 2017) has noted, the mainstreaming of NBS requires forging cohesive trans-disciplinary networks and knowledge; therefore figure 2 maps the "location" and thus nature of the main stakeholders involved in the increase of NBS; additionally, the position of each actor within one sphere or in any of the overlapping sections, represents the degree of cross-disciplinary nature of each stakeholder´s work.

The first cluster, the **building, and the construction sector [BCI]** execute long lifecycle, capital intensive projects, critical for the economic growth of regions around the world (OECD, 2013). Therefore, the BCI is perhaps the

most knowledgeable sector on the challenges and concerns that private capital faces when adventuring in NBS-analogous projects (Denjeana et al., p. 26).

According to the definition drafted by (De Valence, 2001), the BCI has different sub-categories of production [1], from which, only one is considered relevant in this research, that is, the engineering-construction segment [1.1]. This segment, which encompasses almost 80% of the production of the entire sector, includes activities and actors involved in the execution of grey urban infrastructures, such as roads, bridges, water, and sewage installations, and miscellaneous engineering construction. The other BCI segments that are not valid for this paper are the residential [1.2] and non-residential building activity [1.3], not only because they are not equipped with the expertise to support the production and mainstreaming of green infrastructure but also because they represent only a small margin of the entire BCI industry.

The second practice cluster is the **climate and environmental sciences** cluster [2], it includes areas that focus on meeting the needs of society without compromising the ability for future generations to meet their own needs (United-Nations, 1987), including mitigation efforts to tackle climate change and actions to foster innovation in this direction. The climate and environmental sciences is a sub-set of the overarching realm of **governance** and the overall management of the networks that sustain the solutions, including the actors, resources, rules of the game, and discourses that green infrastructure entails (Ambrose-Oji et al., 2017).

Finally, the **investing sector** [3], includes non-governmental funders with the capacity or willingness to bring capital to mitigation measures, especially usually in the form of investment prioritizing ESG principles [environmental, sustainability and governance]. According to (van Ham & Klimmek, 2017), as explained in the initial chapters, “for-profit” actors are vital partners in the process of meeting global conservation targets. Their importance relies on the fact that the private sector often works as a catalyzer for innovation, and that there is an increasing sense of responsibility among business leaders of their role in building resilience and invest in climate change (Kongrukgreatiyos, 2014).

2.4.2 *Societal relevance*

The main societal contribution for this research is to deal with the problem on the "*angle of approach":* that means, sustainable projects and NBS are still being judged against traditional definitions of attractiveness, efficiency, and efficacy in contrast with civil infrastructure. In the pursuit of increasing the attractiveness of green infrastructure, practitioners, and researchers alike, focus on translating, operationalizing, and rationalizing the unique features of green assets according to civil engineering baselines.

Nevertheless, there is evidence that instead of forcing sustainable projects to adapt to traditional infrastructure expectations, it could be more rational to invest effort in changing those same expectations (Somarakis, Stagakis, & Chrysoulakis, 2020). This research works in this line of thought, by expanding the horizon of what profitable and attractive means when speaking about NBS.

Practical relevance

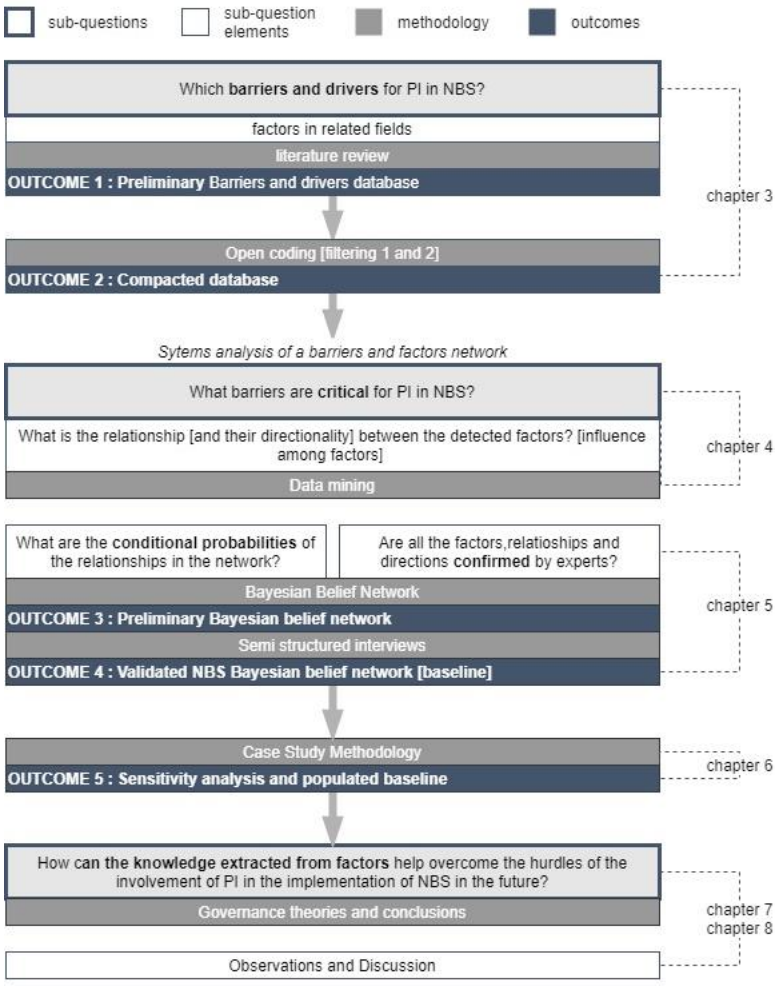
In recent decades, despite the doubts on the risk/return of green infrastructure assets (Cengiz, Braun, & von Nitzsch, 2010; Höchstädter & Scheck, 2015; Jackson, 2013; Louche, Arenas, & Van Cranenburgh, 2012; Mac Cormac & Haney, 2012; Von Wallis & Klein, 2015) and the lack of performance standards and tools for investors to evaluate them (Reeder, Colantonio, Loder, & Rocyn Jones, 2015), there has been an increased interest from private, non-philanthropic investors, in incorporating ESG, environmental, social and governance values in their infrastructure portfolios (Kaminker, Kawanishi, Stewart, Caldecott, & Howarth, 2013). More and more, funders and financers go beyond only finding economic profits, and increasingly include the weight of, i.e., co-benefits and other more diffuse gains in the decision-making (Della Croce & Yermo, 2013).

Nevertheless, the rate at which this paradigm shift is taking place is still not enough to timely address the financial gap and the underlying need to attain the global, European, and local environmental goals (Chavers, Synnott, Parkes, & Pillbossian, 2015). Most importantly, there are no consented tools or frameworks, broadly functional now to enhance such a transition. This research aims to partially address this last challenge. This challenge is especially important for knowledge institutes like Deltares, which offer strategic advice to governments in high-level planning processes. The institute contributes to both public and private projects, usually taking over the role of consultant

(Deltares, 2019). In the realm of infrastructure, it primarily concerns enabling nature-based-solutions: multi-functional designs inspired by nature (EU-Commission, 2015a) (Lazurko & Altamirano, 2019). In practical terms, the main goal of this research which was pursued in collaboration with Deltares is to integrate the newly-acquired knowledge to the implementation blocks of the FFWS [Financing Framework for Water Security], an action research approach that offers an offers an interface between the project delivery and finance community and the water resources planning and watershed conservation communities (M. Altamirano, 2019; M. A. Altamirano et al., Forthcoming)(M. Altamirano, 2017). The FFWS guides stakeholders involved in a water security planning process through several questions to develop the five business cases of the investment program proposed and design fit for purpose implementation mechanisms and thus influencing the implementation and mainstreaming of NBS (OECD, 2012). Research Design and Methodology

This section showcases the research design, it clear that this report relies on a mixed-method approach which differentiated methodologies and outcomes. Figure 4 identifies main operational blocks.

Figure 4 — Methodological approach



Chapter three deals with a systematic literature review, the elaboration of a preliminary barriers' and drivers' database, and the contraction of the number of factors through two different filtering .

Chapter four describes a systems analysis of the network with data mining to determine the relationship between factors, the direction, and preliminary strengths of those correlations.

Chapter five includes a series of system analysis diagrams [Bayesian belief networks] and the elaboration of an NBS baseline as the outcome, illustrating what is presumed to be the "traditional" combination of factors affecting the involvement of private investment in the selected NBS typologies. This information is validated via expert review and semi-structured interviews.

Chapter six confirms the relationships between the factors and their criticality in the baseline by inputting information on a case into the framework [Medina del Campo], this is done through interviews and information provided within the NAIAD initiative of the Medina del Campo demo. Results include a hierarchization of the most prominent drivers and drivers.

Chapter 7 and 8, deal with the integration of the previous results into a cohesive set of recommendations for the elaboration of a governance strategy for the Medina del Campo case. Some general recommendations and a general discussion are also encompassed in these last chapters.

2.4.3 *Mixed Methods Approach*

Research classifications arise from the focus on different research aspects, i.e., the application of the research, its inquiry processes nature, or the objectives it pursues (Kumar, 2019). This section describes the main characteristics of the different research approaches and the reasoning for the selection of the building blocks in the present research (Kumar, 2019).

Research from the application and inquiry perspectives

When focusing on the end application of research endeavors, two distinctive categories become obvious: pure and applied research (Bailey, 2008, p. 17), that entails testing theories and hypotheses that, while intellectually

challenging, might be too abstract to have an immediate application in practice, this with the goal of producing new knowledge and to expand the understanding of the issue among those in charge of handling it (Kumar, 2019, p. 5).

The subject matter of this study is the involvement of private investment in the execution of Nature-Based Solutions. The factors that influence the process and question on how to control, enhance, or change PI involvement are still issues generally unknown in academia. And while the present analysis poses significant intellectual complexities [i.e., for the systematic inquiry of the problem], the nature of this study is indeed applied: the end goal is to understand how change takes place on the private investment involvement if comprehensive knowledge is available for the development of governance strategies.

Another way to typify research is according to the way it is conducted. On the one hand, a structured manner, or quantitative research, has an emphasis on measuring or categorizing variables; it is therefore generally rigid and analytical, allowing it to be reliable and objective. On the other hand, qualitative research is unstructured, centered on empiricism, and is more descriptive (Kumar, 2019, p. 6). This study moves between several over-imposed socio-technical systems; this causes complementary requirements for the research: for stakeholders coming from the BCI and IVS, accustomed to quantitative studies, the focus is on the reliability of results, while those actors in the CES sectors require flexibility. It is for this reason that the present study adopts a mixed approach in terms of the inquiry process.

Research from the objective perspective

From the perspective of the objectives, the present study assumes a mixed-method approach as well, since it encompasses several research objectives: descriptive, correlational, explanatory, and exploratory. For a more detailed description of this research objectives consult annex 27.

The present report presents a **descriptive research** that focuses on statically describing a situation, problem, or phenomenon, and what is critical concerning the issue under study (Lans & van der Voordt, 2002, p. 53). It is also **a correlational study**, because it aims to establish whether there is a dependency among two or more aspects of a problem and aims to paint a systematic picture of the problem variables (Stangor, 2011, p. 16). And finally, It is **explanatory research** in that it handles the “why?” and “how?” questions of the relationships between study variables,

and that it examines an aspect that is vaguely known (Kumar, 2019)(Baskerville & Pries-Heje, 2010, p. 274) (Popper, 2002, p. 28).

Figure 6 summarizes the overarching research typologies selected in this study. The lack of private investment in Nature-based Solutions is a problem that is firmly rooted in practice; therefore, methodological decisions concur with an applied perspective. This research relies on a mixed-method approach, in terms of both outcomes and inquiry processes. The expectation when mixing approaches is that they are complementary, and their joint use maximizes the benefits (Kumar, 2019). The basic unit of analysis: factors of influence in the involvement of PI in NBS, all go through an iterative process composed of distinctive stages, each one with a different goal [descriptive, correlational, and finally explanatory].

Figure 5 — Selected research typologies to be "mixed" in this research.

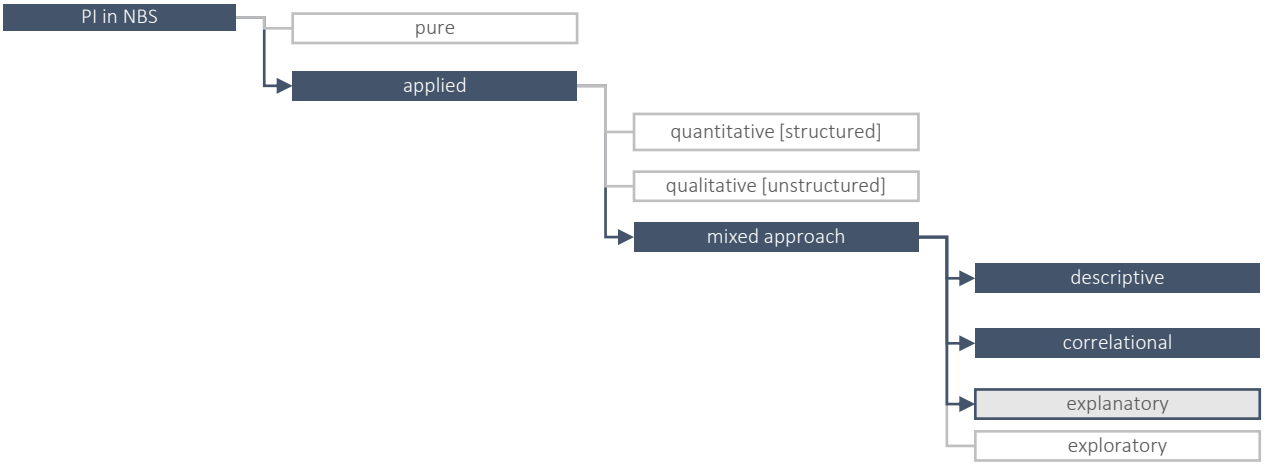


Figure 6 — Summary of methodological decisions

Research sub-question	Research application	Research objective	Inquiry process	Methodology and exemplary sources
Which type of NBS faces the biggest challenges for private investment?	applied	Descriptive research [NBS typologies]	qualitative	Literature review (Snyder, 2019a)
What are the drivers and barriers to private investment in NBS?		Descriptive [factors database]		A meta-analysis [shortened influencing factors list] (Brown, Upchurch, & Acton, 2003; Geyskens, Krishnan, Steenkamp, & Cunha, 2009; Sattler, 2011)
What barriers and drivers [factors] are critical in the decision-making of PI in NBS?		correlational systemic baseline	mixed qualitative	Case Study Methodology [1 case][typical selection]
			mixed quantitative	Bayesian Belief Networks
How can the knowledge extracted from the		Explanatory [strategies: cluster vs. learning cycles]	qualitative	Dimensions analysis (Halbe, Pahl-Wostl, Sendzimir, & Adamowski, 2013; Hanisch

factors help overcome the hurdles in the involvement of PI in the implementation of NBS?		& Wald, 2011; Pahl-Wostl, 2009) Social learning [triple loop learning] (Costanza & Ruth, 1998)

2.4.4 *Literature Review*

Looking to build upon existing knowledge on the challenges and drivers for the involvement of private capital in the execution of natural assets in several realms of studies, a broad-scope literature review has been selected as the first research method. The main benefit of this approach is that it provides a systematic synthesis of the existing research, useful to uncover the areas in which more exploration is needed and to handle disparate and interdisciplinary problems (Brocke et al., 2009; Snyder, 2019). As (Paré, Trudel, Jaana, & Kitsiou, 2015) has indicated, literature reviews are critical for a multitude of purposes beyond only assessing the amount of knowledge on a given subject, i.e.:

[1] determining any patterns or trends in the available information,

[2] aggregating empirical results in subjects that require evidence-supported knowledge,

[3] generating new guidelines and frameworks, and finally,

[4] identifying potential areas of investigation for future inquiry.

Yet, there are some aspects to take care of when conducting literature reviews: the descriptive nature of the method can cause a lack of thoroughness and include ambiguities on whether concepts refer to the intended definitions (Tranfield, Denyer, & Smart, 2003), but most importantly, since this method could allow the adoption of flawed assumptions, the synthesis process must be done critically, in terms of both, the sources and the specific units of analysis extracted from literature (Fellows & Liu, 2015) (Paré, Trudel, Jaana, Kitsiou, & Management, 2015).

figure 5 enunciates those steps that are common in all literature reviews:

Figure 7 — generic literature review steps

2.4.5 *Case Study Methodology*

A case study is used to confirm the existence of the factors found in the literature in a real case scenario, this provides validation of the system diagram **baseline** [BBN] and the elements to conduct a hierarchization of the factors within the case. The case is selected following the guidelines of (Gerring & McDermott, 2007), and represents an average or 'typical' case, which is most likely to fulfill the theoretical prediction established in the keyword literature review [hypothesis of the combination of factors to deal with] in regards to the existing factors and possible relationships.

All the information on the development of the case study was obtained with the support and in collaboration with the Water Resources and Delta Management Department at Deltares [https://www.deltares.nl/en/] and as part of the development of the NAIAD project.

The Nature Insurance Value Assessment and Demonstration initiative [NAIAD for its abbreviation in English] is a European Commission project that, in a nutshell, aims to operationalize and internalize the insurance value of different NBS [http://naiad2020.eu/]. The initiative analyses 9 demonstration sites [demos] throughout Europe. Each demo focuses more in one measure but can also include a range of different measures and ecosystems. This must be considered as a challenge to the transferability of the results of one demo into the enhancement of another.

The NAIAD consortium is composed of more than 30 different partners [ranging from governmental bodies, public educational institutions to insurance companies, i.a], this mix of stakeholders poses many challenges in terms of the degree of consensus and in the integration of the results at the end of the initiative (Jorgensen & van del Keur, 2018).

Four [4] of the total set of NBS typologies define in NAIAD are compatible with the objectives established in this research. Their compatibility is also supported by their prevalence in literature, functionality, and compliance with specific features essential for a project to be considered as traditionally attractive for investment [financial characteristics, i.a.]. The set of requirements enlisted hereunder distinguishes those projects that are valid as examples for the present study. While there is no hierarchy between the requirements to be met, for an NBS to be considered valid for this research, all the features must be undoubtedly met. Discriminating in this way allows the researcher to

focus on generating concrete results for a small sample of NBS and ensure both the legitimacy and impact of the recommendations. Selected categories include projects [NBS]:

A- **within the NBS typologies from H2020 (NAIAD, 2017) and other known sources (UnaLab, 2019)**, *meaning that the projects are commonly classified this way within the CES cluster.*

B- **that are inland**, meaning that they are not coastal projects, 'away from the sea'(Miller & Brown, 2013),

C- **that produces water security services**, like safe water supply risk reduction for flood and, or droughts, i.a.

D- **that have analogue functions,** that are traditionally provided by grey infrastructure assets (Browder, Ozment, Rehberger-Bescos, Gartner, & Lange, 2019). That can be competitive in terms of the services they offer when compared to civil grey projects.

E- **that are scalable,** that can be implemented at a larger scale, and that their services and benefits expand in the same proportion when scaled up(Center, 2020).

F- **that ensure environmental ecosystem impact,** meaning that the measures implemented will have a significant beneficial effect on the ecosystem (Treweek, 2009).

G- **with clear physicality**, projects that are predominantly material [for instance, not actions] that have a somewhat a clear lifecycle,

H- **that are capital intensive,** projects that require large amounts of investment to be implemented,

I- **that require collective investments,** and blended finance, projects that mobilizing combined capital flows from different sources(European Investment Bank, 2020)

The researcher conducted a cross-analysis of the compliance of different NBS to the requirements to consider the NBS for use as a legitimate case study, only four typologies resulted valid for this purpose: forests [re/afforestation], wetlands' construction and restoration, water harvesting, and riparian buffers, for more details on the cross-analysis of the NBS typologies and their compliance with the former requirements, consult annex 20.

The NAIAD initiative has a limited number of demos that were at the disposal of the researcher, these were evaluated following the former reasoning. Their compatibility with the objectives of this research and sufficient amount of information available for study were among the main parameters for the selection of the case, the options

included [1] the Medina del Campo groundwater area [Spain], [2] the lower Danube region and its underlying ecosystems [Romania], and [3] a hybrid Urban Water buffer NBS for the city of Rotterdam [the Netherlands].

Using the requirement categories provided in annex 20, demo case number two was not selected [Romania] because it did not comply in terms of the scope, its goals are too wide to ensure any environmental ecosystem impacts of the B-PINbs [criteria "F"], additionally, the multilayer governance structure is the major component of this demo, once again the NBS does not comply with aspect "G" since it lacks the physicality and does not have a clear lifecycle. Demo three presents scalability problems [aspect "E"] once again, given its limited applicability and scale, this NBS cannot ensure to produce a significant environmental impact. ["F"]. This leaves us with the Medina del Campo demo as the only viable option to continue the analysis in this report.

2.4.6 *Bayesian Belief Networks*

The nature of the issue at hand, the decision of investors to get involved in the implementation of NBS, is one of high complexity with many dependencies. And most importantly, the information on those dependencies is not exact and is usually expressed only in the shape of opinions of experts. The general statements can help to determine whether the interrelationships are negative or positive and a potential directionality, but not further (Agata & Kobus, 2014).

Given that there is a lack of scientifically based, experimental data on the factors of influence for PI, traditional statistical methodologies are not fitted for this research; this section reflects on the reasons for the decision of using Bayesian Belief Theory to map the complete set of the landscape of influencing factors.

Bayesians Belief Networks [BBN's] are acyclic directed graphs designed to model relationships between variables and to capture the uncertainty in the dependencies between these variables using conditional probabilities (Van Der Gaag, 1996). Given their graphical capacities to reflect the structure of a problem, BBN's are proven tools in modeling complex systems involving uncertain knowledge (Oniśko, Druzdzel, & Wasyluk, 2001).

The use of BBN's also enables the incorporation of expert judgment on topics with limited historical data (Cárdenas, Al-jibouri, & Halman, 2012), and they are a good midpoint between very complicated methods for modeling decision making and risks, which could be useless for practitioners (Bromley, 2005; Simon, Weber, & Levrat, 2007).

In comparison to other more mainstream approaches, BBN differ in their use of probabilistic [instead of deterministic] expressions to describe the relationships among different variables (Newton, 2009), this technique is particularly useful in producing insights supporting decision-making processes (Borsuk, Burkhardt-Holm, & Reichert, 2002), this is because BBN are capable of "reasoning under uncertainty" and in scenarios where there is a lack of detailed information (Jensen & Nielsen, 2001). The former conditions also make BBN an optimal approach to deal with environmental problems and natural resource management challenges (Jensen & Nielsen, 2001).

The visual nature of the Bayesian belief graphs, not only serves the functional purpose of ordering the variables but could also enable the communication between the stakeholders involved in NBS projects, such as scientists, decision-makers, among others.

Additionally, the BCI, the analogous practice cluster to NBS [as established in previous chapters], has consistently used BBN's when dealing with elements of tunneling projects (Sousa, 2010), and other various constructions risks (Špacková & Straub, 2011), which provides evidence on their applicability to this research.

Table 3 explores the matches and mismatches between the BBN methodology and this research; gathered from specialized literature and the different requirements of this research:

Table 3— Bayesian belief networks versus this research

Matches between BBN's and the research	Mismatches between BBN's and the research
i. BBN's are a compact representation of causality and conditional probabilities among factors [1][6], ii. BBN's are useful to make informed decisions in case of incomplete, uncertain, imprecise, and ambiguous information [1][9], iii. BBN's are an easy method to investigate quantitative relationships between variables and thus make predictions [2], iv. BBN's have been previously used as decision support tools for evaluating adaptation options for water management [many NBS are concerned with water management] [3][4],	i. BBN's require experience to find the correct balance between uncertainty and scale definition [6], ii. BBN's might include epistemic uncertainties and inaccuracies [7], iii. BBN's include lengthy discretization and time-consuming conditional probabilities' definition in very large models [7], BBN's sometimes nodes are unknown and difficult to represent [9]/
Sources	

v. BBN's can integrate both quantitative and qualitative data to generate probabilistic predictions, useful for the furnishing of adaptation policies [3][5],
vi. BBN's offer a proper bridge between practice and science and are simple for practitioners to understand [6][7],
vii. BBN's allow the non-static representation of the issues [6]
BBN's are an established, state-of-art approach [6],
ix. BBN's are natural for integrative/holistic approach [6],
x. BBN's are appropriate to handle complex uncertainty and real-world problems [6][7][9],
xi. BBN's have conditional probabilities that do not have to be known a priori and can be "learned" using statistical sampling techniques or supervised learning approaches,
xii. BBN's enable the iteration needed for decision-making processes [10].

[1] (Rabbi, Ali, Kabir, Mahtab, & Paul, 2020)
[2] (Jaronski, Bloemer, Vanhoof, & Wets, 2001)
[3] (Phan et al., 2019)
[4] (Batchelor & Cain, 1999)
[5] (Nielsen & Jensen, 2009)
[6] (Smith, Madsen, & Barton)
[7] (Chivatá-Cárdenas, Al-jibouri, & Halman, 2012)
[8] (J. Sigurdsson, L. Walls, & J. Quigley, 2001)
[9] (Mihajlovic & Petkovic, 2001)
[10] (Farmani, Henriksen, & Savic, 2009)

Rationale of BBN

The inference mechanism used in a BBN's is the *Bayes theorem* which makes it possible to compute the probability of an effect on any variable in the model from the probability of a given cause. With two directly related variables, the probabilities can be computed as follows (Chivatá-Cárdenas et al., 2012; Vick, 2002):

$$\boldsymbol{P}[\text{effect}] = \frac{(\boldsymbol{P}[effect/cause] \times \boldsymbol{P}[cause])}{\boldsymbol{P}[cause/effect]} \quad (1)$$

Where:
[1] P[cause] = probability that the cause occurs,
[2] P[effect] = probability that the effect occurs,
[3] P[effect/cause] = conditional probability of the effect, given the cause,
[4] P[cause/effect] = conditional probability of the cause, given the effect

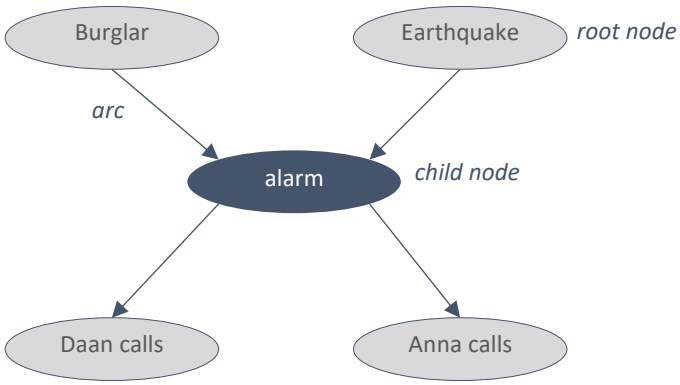
The posterior probability of the cause from the effect can therefore be derived as:

$$\boldsymbol{P}[cause/effect] = \frac{(\boldsymbol{P}[effect/cause] \times \boldsymbol{P}[cause])}{\boldsymbol{P}[effect]} \quad (2)$$

The basic variables of the model are mutually exclusive and collectively exhaustive elements to which a probability distribution can be attributed and encoded based on expert judgment. BBN's result in diagrams, where variables are represented by nodes. Diagram nodes that have interdependencies are connected by arcs, whereas independent nodes are not connected. The direction attached to an arc reflects the direction of causal influence,

which might be indicated by an expert, or scientifically proven. In this research, the establishment of probabilities the interrelationships are provided in semi-structured interviews by experts.

Figure 8 – BBN's features



From barriers and drivers to factors of influence

The rationale in this research is quite simple, all the actions and conditions that increase the probability or enable in any way the involvement of private investors in the implementation of green infrastructure, NBS, or sustainable projects, are considered positive within the system and thus fall under the category "drivers". At the same time, the inverse logic applies to what is viewed as a barrier. Given that the great variety of sources and factors collected, there are three distinctive phenomena throughout the data sample:

01. While most elements are classified by the corresponding authors as enabling [drivers] or hindering [barrier] to the involvement of PI in NBS or similar ambitions, some factors are non-concrete or unclear as to their positive or negative role in the involvement of PI.

02. Some literature sources, instead of classifying the factors, purposely bundle them as influencing forces to avoid perceptive inaccuracies. In these sources, it is assumed that the factors acquire a specific positive or negative connotation depending on the context.

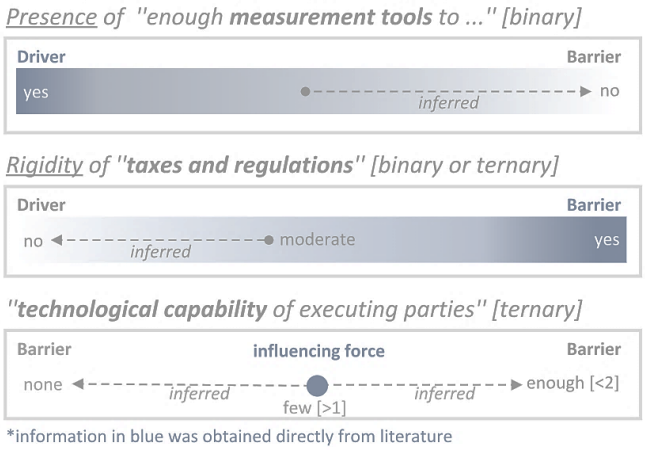
03. There are cases in which the same element has a positive significance in one paper, while in another, it possesses a negative effect on PI, many times, this is due to the specific phrasing of each factor.

Figure 9 showcases the three possible treatment given to the raw factors lists, to standardize them. If a factor has been described by the source author as a "driver" [first example in figure 6], the negative counterpart of this factor will be inferred, i.e., in the "enough measurement tools" which is described as positive in the source, the opposite

[not enough measurement tools] is inferred to a barrier. Likewise, if the author indicates a particular "barrier", the lack of those specific challenges is inferred to be a driver.

Finally, the aspects that have been merely indicted as influencing factors, could be operationalized [and inferred] in both directions; nevertheless, since the core concept is the interest of this research, such factors are left unchanged. Further research could deepen the analysis and operationalization per factor, nevertheless, for practical reasons this step has been limited to the inference of connotation [if necessary], for more information consult Annex 01 with the full database.

Figure 9 — Examples of factor handling.



*information in blue was obtained directly from literature

The above conditions assume and build upon the fact that the element's connotation varies from source to source, meaning that the factors' nature is flexible, the assessment they receive [as a driver or barrier] is subject to perception, is relative to the project and to the actor that emits the judgment. As (Rouwette,1999) stated, actors, conduct a fast explicit or implicit parametrization, which produces positive or negative significance that is only applicable to each system and point of reference. Some examples of how the previous conclusions take place in this research are showcased in table 4.

Table 4 — Factors processing.

#	Direct Literature Fragments		Connotation [in original source]	Parametrization	
	attribute	*root concept*		*Dimension*	*Operationalization criteria [of attribute]*
33	"enough"	"measurement tools to assess green finance activities and impacts"	Driver [positive]	Presence	At least one tool available [enough]
87	"too rigid"	"applying taxes and regulations"	Barrier* [negative]	Rigidity	Above % of project revenue [rigid]

139	-	"technological capability of [the] executing party"	Influencing force [neutral]	# similar projects in experience	At least one previous project in infra

Values in this table are indicative and drafted for descriptive purposes

The above table illustrates the logic behind the processing of the fragments in literature, first, by detecting the parts of the fragment that are "attributes" [adjectives hinting to the connotation that each paper assigns to each aspect] and defining the root concept of the original fragment. In terms of the connotation, there are two possible scenarios; the original author has assigned one to the factor, or not. In the first case, the indicated significance is transported directly from the source to the table. If there is no positive or negative overtone assigned to the factor, then it is assumed following the rationale outlined in figure 6.

In the last stage of analysis, given the unprecise nature of the adjectives, and operationalization step is conducted to assign numbers or specific features to what was determined to be the attribute and, or dimension. This process is conducted after the database is filtered and ordered by hierarchy, in the last chapter, dealing with the governance arrangements and the possible criteria to assess the state of each factor.

The profile of the investors has also been considered in the detection of, mostly, the barriers for their involvement, for more details on the rationale applied, consult annex 28.

Preliminary categories of drivers and barriers according to literature

As it has been established before, despite an extensive plethora of studies dedicated to the implementation of NBS, green infrastructure as well as the attainment of SID principles, there are limited studies on the overall influencing drivers and barriers of NBS (Mutanu Munyasya & Chileshe, 2018). Ahead of the individual validation and processing of the drivers and barriers, some overlaps are already visible on the general thematic categories of influencing elements. These categories are expected to include most factors gathered in the extensive database.

Consult annex 21 for specifics on the analysis of the categories that original authors have detected among factor-based studies. The hierarchy of detected/mentioned categories is as follows.

[1] [G] Administrative [Organization] [9 mentions]

[2] [D] Policy and Governance [7 mentions]

[3] [A] Knowledge Management & Awareness [5 mentions]

[4] [B] Global Markets [Economics] [5 mentions]

[5] [C] Local Markets [5 mentions]

[6] [E] Social and Behavioral [5 mentions]

[7] [F] Legal and Regulatory [5 mentions]

[8] [H] Technical & Implementation Process [5 mentions]

[9] [I] Environmental [3 mentions]

[10] [J] Other [N/A]

Table 6 is obtained by extracting the critical concepts in the definitions of each one of the categories in the consulted sources [far right column on table 5]. This information is critical for the assignation of barriers and drivers to one of the overarching categories after the third filtering process in this research, in other words, the categories in table 6 are the foundation concepts and boundaries to know what should or not be considered as part of a category or not.

Table 5 Critical concepts included in every overarching category.

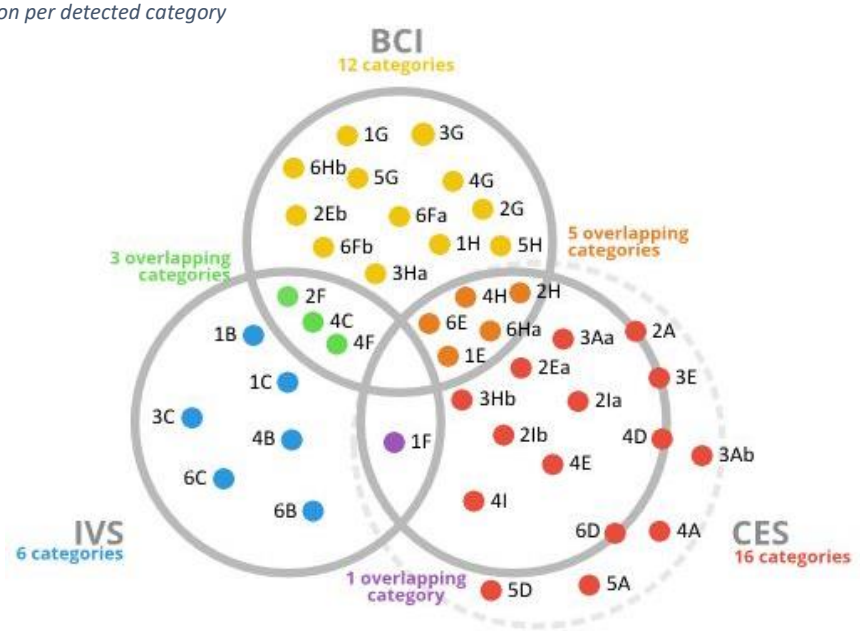
A - Knowledge mgmt. & awareness	B - Global markets	C - Local markets	D - Policy and governance
◦ Stakeholder and authority awareness ◦ Information [availability] ◦ Trustworthiness ◦ Benefits awareness ◦ The burden of habits/inertia	◦ Resources [limitations] ◦ Financial incentives at a global scale ◦ Economics [crisis] ◦ Pricing	◦ The capacity for providing services ◦ Investment costs ◦ Hidden costs ◦ Competitive pricing ◦ Reputation ◦ Access to markets ◦ Risk and uncertainty	◦ Political environment [political commitments] ◦ Policies ◦ Temporality [political cycles and long-term support] ◦ Priorities
E - Social and behavioral	**F - Legal and regulatory**	**G - Administrative [organization]**	**H - Technical & implementation process**
◦ [client/customer] Expectations and understanding ◦ Value creation ◦ Media, societal pressure ◦ Social acceptance ◦ Client priorities and objectives	◦ Rules ◦ Conditions for access to grants ◦ Rewards ◦ Local and financial incentives for investment ◦ Common language and methods for procurement and tendering	◦ Administrative structure ◦ Coordination ◦ Access to data ◦ Expertise ◦ Technologies management ◦ Motivation [vision] ◦ Organizational skills and top management ◦ Ownership [project and/or of actions]	◦ Performance ◦ Efficiency ◦ Cost savings ◦ Technology implementation and automation ◦ Requirements compliance ◦ Evaluation criteria ◦ Skilled and trained personnel ◦ Innovation
I - Environmental	**J - Others**		
◦ Resource availability ◦ Negative impacts of the intervention on the environment ◦ Corporate, social responsibility	◦ External [outside scope of influence] ◦ Internal		

◦ Eco literacy
◦ Sustainable practices

Figure 10 displays on the horizontal axis the overarching categories that have resulted from an extensive literature review on factor analysis studies in the construction, investment, and environmental sciences. The vertical axis shows each one of the utilized sources. The dots represent a category detected in the source x that matches the conceptual definition set for an overarching category *a*, the color of each dot, signals the practice cluster that is most equipped to handle a category.

One example is dot 2B [unacquainted society], which is usually handled through governance actions to increase stakeholder involvement; therefore, the dot is designated as magenta [belonging to the climate and environmental sciences cluster] [for more information on the color palette refer to the section 3.4.1 clusters categorization].

Figure 10 Cluster location per detected category



As figure 10 showcases, most clusters detected in literature belong to expertise related to the Climate and Environmental Sciences [CES] cluster (16 categories). Secondly, groups of barriers and drivers are usually found within the building and construction sector [BCI](12 categories). The Investment Sector [IVS] shows only six categories. This can be due to the lack of familiarity of investors with both infrastructure language and concepts as financial

performance and execution and the environmental aspects of NBS. Some critical observations can be extracted from the information displayed in figures 10:

- Some overarching categories are traditionally under the control of one of the practice clusters, that is the case of “Knowledge Management and Awareness” [A], “Global Markets” [B], “Policy and Governance” [D], “Administrative / Organization” [G] and “Environment and Performance” [I]. The larger population of categories of factors located within individual spheres of knowledge signals an ample amount of research in each area.
- In the case of the overlapping areas, a lower number of categories might hint at the degree of difficulty of the collaboration between the different practice clusters. In other words, it is more common to find authors that study the factors involved in the interactions between the environmental sciences and the construction industry than those dedicated to the factors that enhance or stop collaboration between the investment sector and the climate and environmental sciences.

CONTENTS OF THE CHAPTER

3 SYSTEMATIC LITERATURE REVIEW

According to (Snyder, 2019b) literature review as a methodology has gained importance in recent years because the amount of knowledge generation is accelerating and producing papers that are increasingly fragmented and interdisciplinary, creating the need for a methodology that helps to keep up research on a state-of-the-art status. This integrating capacity of the methodology is one of the main reasons for which this approach has been selected to tackle the fragmented and multidisciplinary landscape of private investment in NBS.

The Building and construction industry [BCI] are considerably behind in the field of data mining and the use of databases, in comparison with other industries, maybe since the legitimacy of the data in one project may apply to another project (Adil-Bari, 2015). (Baumeister & Leary, 1997; Tranfield, Denyer, & Smart, 2003) confirm that literature reviews are efficient systematic methods of collecting and synthesizing previous research and integrating various empirical sources, further supporting the value of using this methodology to map the factors of influence for investors in NBS. In this report, the process has been conducted minding the comments of (Snyder, 2019a) on the requirements for quality of literature reviews, including a clear purpose for the review, appropriate strategies, standards, and guidelines. The following sections describe in a detailed manner the rules and guidelines established in this report to ensure the legitimacy of the gathering stages.

3.1 Thematic source databases

The first step in this research has been to conduct a systematic review search. To avoid bias [geographical, of sources or results](NIH Library, 2020), the literature research includes the following databases: Elsevier Scopus, Sage Publications, Emerald Insight, and Springer Link and focus particularly on the three main clusters involved in the implementation of NBS: CES, BCI, and finally IVS. According to (Falagas,

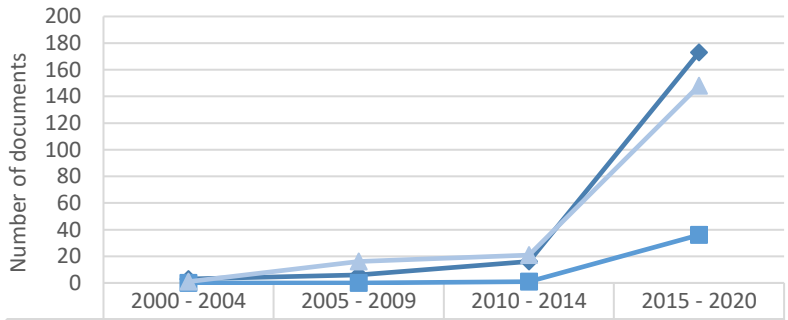
Pitsouni, Malietzis, & Pappas, 2008), among the formerly shown databases, Scopus has a wider subject and journal range and is likely the best available tool for electronic literature search for works published after 2005 (van der Sande, 2019).

The following keywords have been used as search criteria: “Nature-based solutions”, “barriers”, “drivers”, and “private investment”. Three different searches, A, B, and C have been conducted in the preliminary review, each one with a different degree of specificity, from “A”, the least specific, only mentioning barriers and drivers of NBS in general, to the less focused search “C”, extending the search to private investment in Nature-Based Solutions. The results of the preliminary searches are described in table 8.

Table 6 — Scopus preliminary results

Words included					
Search A		Search B		Search C	
Barriers, drivers, NBS		*Barriers, drivers, NBS, nature-based, solutions*		*Private, investment, nature-based, solutions*	
Number of documents found per search					
243 documents		37 documents		188 documents	
Subject areas					
Environmental Science	17.5 %	Environmental Science	41.8 %	Environmental Science	27.7 %
Engineering	12.6 %	Social Science	20.3 %	Social Science	21.9 %
Business, mgmt., and accounting		Energy	11.4 %	Agricultural, Biological Sciences	
	11.2%	Engineering	5.1 %		12.5 %

DISTRIBUTIONS BY YEAR PUBLISHED



	2000 - 2004	2005 - 2009	2010 - 2014	2015 - 2020
Search A	3	6	16	173
Search B	0	0	1	36
Search C	1	16	21	148

The table shows that the amount of research on the topic of NBS has greatly increased during the period from 2010 to 2014. In terms of search “A” the number of documents increased near sevenfold, while in the case of the more environmentally oriented search “B” [since it includes specific terms such as “NBS” and “nature” in the query], the growth is around 40% and can be characterized as significant. Finally, most notably,

in the case of research “C” which explores any of both the aspects, private investment, and nature-based solutions, the amount of papers has increased significantly, around tenfold.

Finally, an interesting observation is that, as can be seen in table 7, the search on Elsevier Scopus, uses similar classifications for the different practice clusters involved in the implementation of NBS: [1] The environmental, agricultural, biological, and social sciences corresponds to what is called the climate and environmental sciences cluster “CES” in this report. [2] What is called the engineering subject area in Scopus encompasses the building and construction cluster or “BCI” in this report. [3] Finally, the business, management., and accounting subject area, is partially constituted by what this report refers to as the investment sector or “IVS”.

For the following steps in the review, in specific the furnishing of a database of factors of influence for PI in NBS, the researcher will select some sources from the pool of resulting reports from the Scopus search. The rationale behind the document selection of specific reports is described in following paragraphs.

3.2 Document selection process

Due to the great number of documents detected in the preliminary search [overall ~ 350 papers] per literature sources’ database, several filtering criteria have been applied to reduce the sample of documents to analyze.

The first selection criterion is to only include formal documents such as books, research reports, and journal pieces. Noticeably, reports developed by the private sector [by i.e., banks, insurance sector] are prioritized over highly academic works, this is because they have a practice-oriented approach, and the evidence for their conclusions comes from experts immersed in real-world cases which makes them valuable for the collection of cutting-edge factors.

(Emmanuelle Cohen-Shacham et al., 2019) has highlighted the importance of flexibility and adaptive governance when dealing with complex ecosystems, the ability to update and identify *pioneering* factors arising from practice is valuable for the upscaling and management of NBS.

As a second criterion, only reports in English have been considered to reduce the time spent in translation and interpretation. A third selection criterion was literature which focussed on Nature-based solutions.

To further condense the list of analyzed sources, those documents whose theme has been assessed as compatible with this research by the fulfillment of the previous requirements, have had a fourth filter applied, the following are the main reasons for exclusion of a paper:

[1] the scale of the project[s] treated as evidence in the paper is too small,

[2] the paper only focuses on one typology of NBS,

[3] the validity of the results offered is limited [i.e., given to small data sets, i.a.].

In conclusion, if the papers cannot ensure an unbiased transference and applicability across a reasonable amount of NBS [including a higher priority to research that has a global outlook], due to any of the reasons mentioned before, the paper in question, will be excluded from the analysis. Table 9 shows the selected papers:

Table 7 – Selected sources

#	Name	Type	Source and year
01	Green Finance Synthesis Report	Synthesis Report	(Green Finance Study Group, 2016)
02	Green Finance Synthesis Report	Synthesis Report	(Green Finance Study Group, 2017)
03	Blended finance: what it is, how it works, and how it is used	Research report	(Pereira, 2017)
04	Climate Change: The investment perspective	Report	(Ernst & Young LLP, 2016)
05	Institutional Investors and Green Infrastructure Investments: Selected Case Studies	Working paper	(Kaminker et al., 2013)
06	Investing in a Time of Climate Change	Sequel report	(Mercer LLC, 2019)
07	Making Blended Finance Work for the Sustainable Development Goals	Report	(OECD, 2018)
08	The next generation of infrastructure	Report	(Bielenberg, Kerlin, Oppenheim, & Roberts, 2016b)
09	Climate value at risk of global financial assets	Refereed article	(Dietz, Dixon, Dixon, & Gradwell, 2016)
10	Natural Assurance Scheme: A level playing field framework for Green-Grey infrastructure development	Research Report	(Denjeana et al.)
11	Financing Green Urban Infrastructure	Regional Development Working Papers	(Merk, Saussier, Staropoli, Slack, & Kim, 2012)

12	Towards an EU Research and Innovation Policy Agenda for Nature-based Solutions & Re-naturing Cities	Expert Group Report	(Bauduceau et al., 2015)
13	Introducing the suspended tree to the market through the application of strategic niche management	MSc degree dissertation	(Arghandeh Jouneghani, 2018)
14	The Law and Policy of Ecosystem Services	Ph.D. dissertation report	(Ruhl, Kraft, & Lant, 2013)
15	A local-level, multiple criteria decision aid for climate protection	Article	(Markl-Hummel & Geldermann, 2014)
16	Aligning Investments with The Paris Agreement Temperature Goal Challenges and Opportunities for Multilateral Development Banks	Working Paper	(Bartosch et al., 2018)
17	Anxious optimism in a complex world	Investor Survey Report	(PwC, 2018)
18	Financing change: How to mobilize private-sector financing for sustainable infrastructure	Report	(Bielenberg, Kerlin, Oppenheim, & Roberts, 2016a)

Consult annex 22 for a synopsis per source, for evidence on the fact that for the furnishing of the raw database, a distributed array of source papers across all the relevant cluster for this study have been selected [sources are labeled by the cluster of origin].

The greatest number of papers considered for the furnishing of the database in this research, are focused in two main areas, the IVS or the CES, [with 8 and 6 papers respectively], a small amount [around 15% of the papers] has a mixed approach, and only one source can be appointed as belonging to the BCI.

3.3 Literature Review: Step-by-Step

3.3.1 *Reading of the documents*

The identification of the factors that affect the involvement of PI in NBS is based on literature resources. Although the presence of consolidated lists of factors in the documents has been an important aspect for their selection in the first steps of the literature search, when gathering and cataloging specific factors, the process has been more thorough.

In the first case, when the source's author[s] reports straightforward about the aspects they consider critical for the implementation and financing of NBS, these explicit barriers and/or drivers have been directly included in the database for this research. However, deep reading of each document unveiled hidden and/or implied [implicit] factors of influence. The numbering assigned to each factor follows a chronological order and depends on the page and sources each factor was first encountered.

The language used in the original papers has not been altered to avoid the introduction of inaccuracies into the data. Factors of influence have been highlighted in yellow in each source. In the case of factors with several repetitions, both a yellow and additional green underlining have been used to signal the repetitive allusion to the factor in the paper.

The process of data extraction and data cleaning in this research has been done following the guidelines by (Adil-Bari, 2015),

Original fragment

The column named “original fragment” refers to the text fragment and exact quote inside the source document that mentions a factor that is assumed to influence another factor. These original text fragments are usually composed of two distinctive elements: **[1] a noun**, and **[2] an adjective**, a word that indicates the attributes of the noun. Both elements are cornerstones of the analysis in BBN's.

Interpretation

The column named “interpretation” describes the definition or the information which describes the overall relationship between the factor and the variable (PI in NBS). In most sources, the factor, or a part of it, will be mentioned on multiple occasions throughout the document. To accurately delimit the definition of each factor, all snippets of information are sometimes necessary and therefore are included in the interpretation column. Eventually, each factor has a positive or negative effect on PI in NBS. When existing, further explanation of the context per element is provided.

To indicate the specific section from which segment is extracted, the following rationale is used: the first segment of the interpretation is mentioned in the column “*original fragment*” in the database. If additional pieces of information must be added, and they come from subsequent pages [after the first sighting of the factor], the extract is preceded by the page in which the new information is found [between brackets], an example of this can be seen in Figure 11, for further inspection, consult source 01 (Green Finance Study Group, 2016), factor number 02, “*inadequate maturity mismatch”.*

Figure 11 – Interpretation composed by information on various pages.

C	D	E	F
numbering	original excerpt	pages	interpretation
2	inadequate maturity mismatch	10,29	difference between supply of long-term funding relative and the demand for funding by long term projects. Infrastructure heavily relies in bank lending for long-term financing, banks are constrained by short tenor of liabilities. Alignment of investor's funds and long-term policy signals. Problem is aggravated in green projects because they require larger up-front investments. [pp. 29] Sub-factors include: lack of appropriate financing instruments for long term green projects.
3	Lack of clarity in green finance [activities and products]	10, 29	lack of clarity of what constitutes green finance activities and products [illegible] inadequate definition of green [illegible] Sub-factors: lack of green loan definition, lack of green bond definition, and lack of green asset definition.

Additional interpretation snippet

Explicit factors

Explicit factors are aspects, drivers, or barriers that sources pinpoint as factors of influence for the implementation, financing, investment decision-making of Nature-Based solutions. Figure 16, shows an example of an explicit factor, located in Source 01 (Green Finance Study Group, 2016), page 21 of 35. The fragment provides enough information, including the three main components: [1] the object *"strategic policy signals"* and [2] their attribute or descriptive words being *"a lack of"* applicable to the object in question. In other words, the original fragment: "*Lack of strategic policy signals''* accurately communicates that an object is deficient, there is no vagueness or ambiguity, and the author is clear on the of this condition for PI in NBS. [3] Other additional details included in the document only add information to the two core elements already distinguished by the original writer, therefore any additional details will be only added in the interpretation column.

Figure 12 – Explicit factor [Screenshot from PDF]

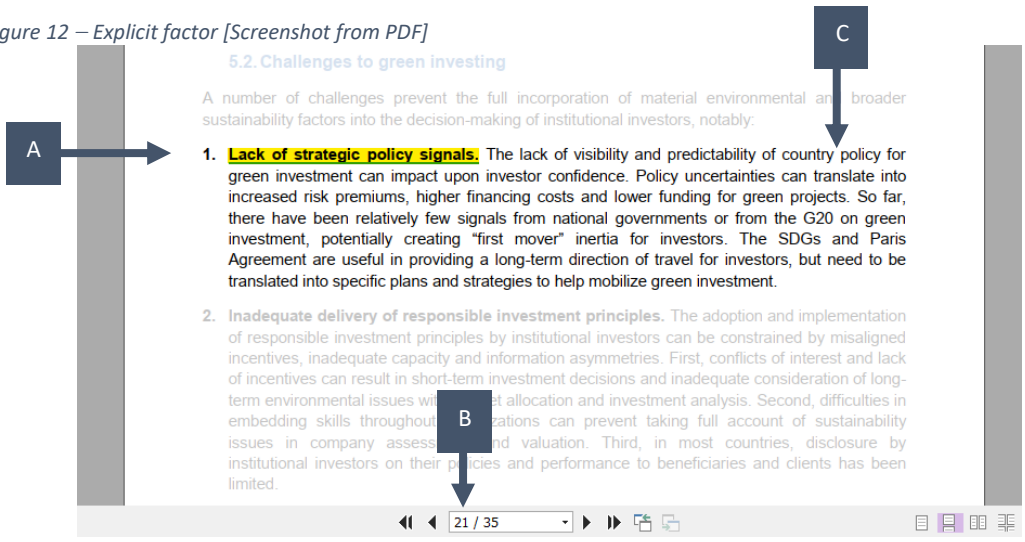
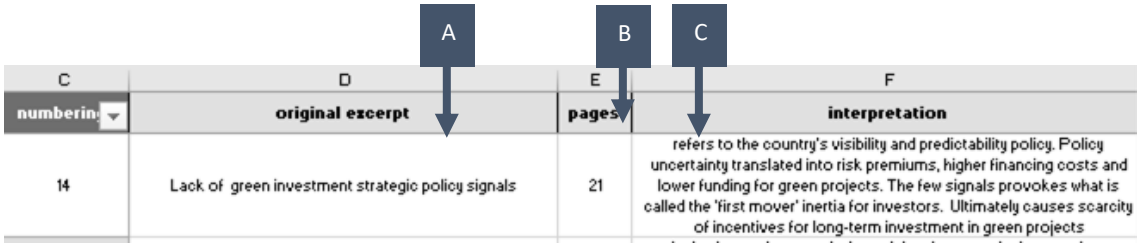


Figure 13 – Explicit factor [Screenshot from PDF]



Implicit factors

Sometimes, for the sake of conciseness, authors have, at the end of their research, delimited the number of resulting factors to a list of most critical aspects. To ensure the comprehensiveness of the literature search in this study, additional suspected aspects are desirable. For this reason, the data collector has focused on identifying descriptive words, including adjectives, verbs, and nouns, such as *challenging, enabling, influencing [a stakeholder], hinders, creates, i.a.,* that usually precede or signal the presence of a factor of influence.

It is sufficient to prove any relationship with the realization, financing, or production of NBS, green infrastructure assets, green investments, for a factor to be considered as relevant and included in the database.

The gathering process is conducted manually, in a factor-per-factor base, and making use of the expert judgment of the researcher, nevertheless, the collector has not changed or edited the vocabulary used by the original authors. The aforementioned is done to avoid misleading results and skewed interpretations, arising from slightly different wording between factors, and conceptual overlapping, among other linguistic challenges. While tracking down implicit factors one by one has been a time-consuming process.

Figures 14 and 15 show an example of the detection and processing of an implicit factor. The original fragment is located in Source 01 (Green Finance Study Group, 2016), page 09 of 35. The segment starts by describing a "*fundamental challenge" [sic]* that indicates the presence of a possible factor of influence ahead. The suspected factor has been highlighted in yellow, in the original PDF.

The green underlying seen in Figure 18 indicates that the factor has several mentions throughout the same document, this is useful when furnishing the interpretation and definition in the excel database [consult

annexes for further information]. As for the rationale to determine if an aspect is implicit or not, in figure 16, it can be observed that while the title of the original fragment is *"externalities",* there is no further description or indication of what feature of the externalities make them a driver or a barrier.

After further inspection of the original text, it becomes evident that what is important about the externalities is their "*cost-effectively internalization"*. The need for further explanation, and the fact that the factor is not accurately pinpointed as one by the author, suggests its implicit nature.

The definition of factors has been extracted and transported to the excel database to be used for further steps of the analysis.

Figure 14 – implicit factor [Screenshot from PDF]

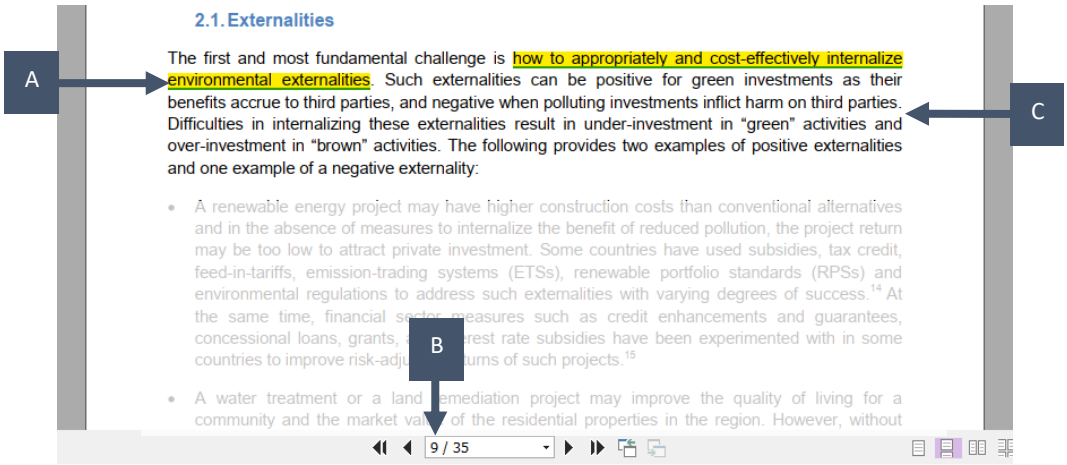
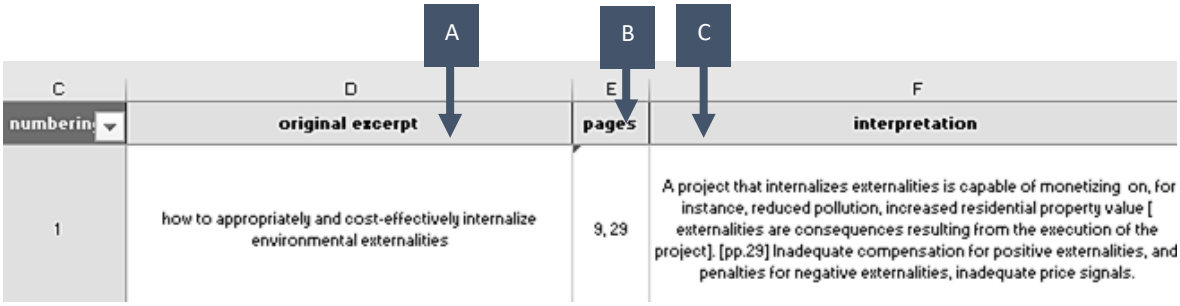


Figure 15 Implicit factor in the database [excel view]



Connotation per factor

According to (Rao, 2017) both, connotation and denotation are two important methods of describing the meanings of words, useful in the understanding of the symbolic weight of language. Acknowledging that

the meaning of factors goes beyond the definition of a noun and its attributes, the database has a special column dedicated to exploring the connotation per factor. The handling and development of the connotative aspects of the database have been done based on the work of (Li & Yamanishi, 2000; Liddy, 2001) on natural language processing and topic analysis, techniques employed to analyze natural occurring texts and achieve human-like processing of the data, through the classification of segments into different topics or categories.

While previous sections have dealt with the denotation of the factors of influence, or in other words, the most basic or specific meanings of a word or fragment; this section, explores the connotation, meaning any idea or insinuation of factors made by the source's author, instead of mentioning or pinpointing the factors by name.

As referred by (Garza-Cuarón, 2013) connotations are binary, meaning that they can be positive or negative, depending on the usage of the words in each description. For this research, when a positive connotation is applied to a factor, the element is described as an enabler or supporting for the initiation and investment of NBS, these factors will be categorized as DRIVERS in the connotation column in the database.

On the contrary, a factor with a negative connotation has been labeled a BARRIER, and it is an aspect or condition that is considered to avoid, hamper, slow or have any negative impact on the decision of private investors to get involved in nature-based solutions, or any of the subordinate processes of the implementation of NBS.

Other elements of the database

Other concepts and information can be inferred from the elements provided in the database after the definition of the factors themselves, their root concepts, interpretation, and attributes [described in the previous paragraphs].

The most important of the possible assumptions is referred to as "binary assessment" in the database, it arises from the information provided by both the interpretation of each factor and its attribute[s]. In a nutshell, it is a preliminary binary operationalization of the factor.

As it was explained in the introduction chapter of this report, factors of influence are a spectrum of conditions, that becomes negative [a barrier] or positive [a driver] according to the specific state of the underlying factor's conditions.

In the binary assessment, the analyst extrapolates the factor to its extreme cases or opposite scenarios in which factor "x" will be a barrier and the scenarios in which it will a driver. An example of a binary operationalization is showcased in table 8, using the explicit factor number 484, gathered from source 18 (Bielenberg et al., 2016a) on pages 5 and 42.

Table 8 – explicit factor binary operationalization

Factor 484

Original fragment [factor]	Interpretation	Root concept	Attribute
"High development and transaction costs"	*"[pp. 5] Projects do not naturally generate the economies of scale that can keep costs down to make projects attractive. [pp. 42] Strategies to tackle this factor are to increase syndication of loans that finance sustainable infrastructure projects, adapt financial instruments to sustainable infrastructure, and increase liquidity"*	Development and transaction costs	High *[as provided by the original author]*
Assumption based on interpretation and attribute			
Too high development and transaction costs are **not acceptable** for investors that want to get involved in NBS.			
Extreme scenarios [inferred]			
Factor as a barrier	Factor as a driver		
Too high [unacceptable]	Acceptable		

3.4 Database reduction procedure

The gathering of factors resulted in a total of 522 individual factors of influence distributed throughout the 18 sources of literature. Based on expert opinion, the initial outlook has shown a wide amplitude of unarranged aspects to address when trying to upscale and increase the private investment in NBS. There is high complexity when handling such a big number of aspects of interest, not only for this research but for the latter development of a functional governance tool for experts in practice, for this reason, two consecutive filtering layers have been applied to the database to reduce its size, each one with distinctive functionality. The steps in the following section follow as reference the guidelines provided by (Merriam & Tisdell, 2015) and (Birks & Mills, 2015) for the development of grounded theory methodology as reference.

3.4.1 *Open coding*

For the reduction and categorizing of the entire database, the method of open coding is used in both filters. Also called inductive coding, open coding starts from scratch and generates the categories at the same time as the analysis of the data, in other words, the categories arise directly from the text fragments and are not produced in advance. While each one of the two filters [FX1 and FX2] has a distinctive rationale of factor clustering, both adhere, in general terms to the following iterative process: reading the data, creating as many categories as necessary to cover the complete sample, re-read the sample and assigning factors to codes, and create new codes if necessary (Medelyan, 2020).

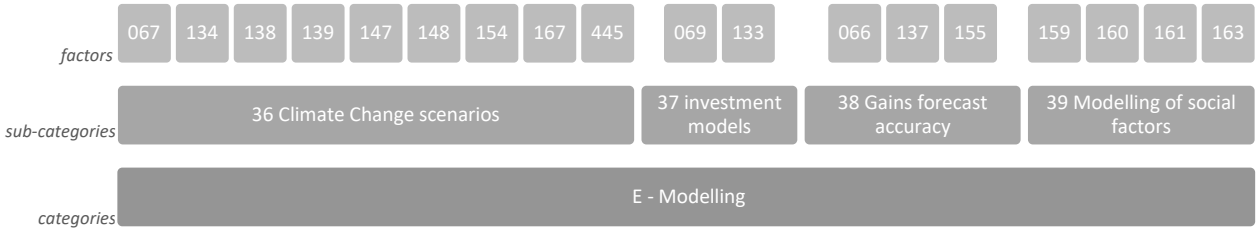
3.4.2 *Filter One [FX1]*

The function of this filter is to eliminate the factors that are repeated. The researcher has backed up this step with the use of in-vivo codes and memo writing (Birks & Mills, 2015), intending to map the emerging thoughts useful for the second filter ahead. FX1 was time-consuming but considered necessary to maintain the context in which each factor is described by the original author and to preserve the original meaning (Morales Ornelas, 2020).

The classification started by reading each factor's interpretation column, aiming to understand what object and attributes each definition describes, immediately after this, the collector has made a post-it with the name of the factor and put it on a whiteboard, this process was repeated until all factors were analyzed. The logic to merge two or more factors was if the language in their interpretation, binary assessment, and connotation columns were the same or similar. The initial FX1 classification resulted in twelve different categories, A to L [for further information on FX1 consult corresponding annexes].

Immediately after the creation of the categories, the second round of concept reading was conducted. Following the same rationale, the collector created *sub-categories* [1 to 81] further grouping individual factors. Figure 16 shows the results of the two rounds of the FX1 filter. The example is category E "*Modelling"*, its underlying sub-categories [36 to 39], and its underpinning factors of influence.

Figure 16 – FX1 factors, sub-categories, and categories of E - Modelling



The resulting thematic categories refer to distinctive objects, general features, or processes in the implementation of NBS. To mention some examples, category *"A – Investment, NBS, project features"* comprises everything about the physical product or project resulting from investment, i.e., the technical requirements of NBS. Differently, category *"B – Asset Management"* refers to the risk and lifecycle management strategies for NBS. While category *"C – Market for natural, sustainability and green vehicles", directs* the attention to the characteristics of the NBS market, including demand, the existence of nature valuation tools or market failures, to mention a few.

The resulting categories and underlying individual factors are broad and do not showcase any evident patterns, or relationships; their clustering is solely linguistical. The different resulting thematic categories are displayed in table 11.

Table 9 – FX1 results, thematic categories [A to L], and factors [1 to 81]

A	Investment/ NBS/project features – Technical challenges and need for technical assistance, – Performance and its measuring, – Specific capital needs and costs, – Scalability and minimal optimal size, – NBS unique features, – Reputation and competitiveness against other industries, – Information, transparency, and definition.	F	44. Awareness of the need for nature, 45. Professional biases, 46. Sense of urgency and inaction consequences awareness.
B	Asset management 8. Adequate asset management expertise, 9. Lifecycle, 10. Risk management.	G	Investment returns and benefits 47. The multitude of functions and services, 48. Challenges tied to service diffuseness, 49. Risk/returns, 50. Potential future savings and damage prevention, 51. Possible societal benefits, 52. Quantifying difficulties, 53. Returns competitiveness and cost-effectiveness, 54. Availability of adequate performance indicators for services.
C	Markets for natural/sustainability/green vehicles 11. Level of domestic and international investment, 12. Market Maturity, 13. Ratings, indices, and listings, 14. Exchange and interest rates, 15. Green bonds issuance and competitiveness [secondary market], 16. Green, sustainable financial vehicles feature, methods, and performance, 17. Scale, 18. The local and international economic landscape, 19. Consumption patterns,	H	Information 55. Publicly available, industry-level, relevant reliable historical database on NBS and green infra, 56. The common understanding of NBS, their activities, and products, 57. Information asymmetry, 58. The high cost of information.
		I	Ecosystems 59. Delimiting challenges, 60. Ecosystem's complexity and interactions.
		J	Investors

	20. Market failures, 21. Demand, 22. Advantages of NBS/green/sustainability investment, 23. Bankability / commercial viability of projects, 24. Methodologies, frameworks, models for nature valuation and impact assessment.		61. Level of fiduciary duty, 62. Investors' capital allocation features and requirements, 63. Investors´ knowledge, experience, and understanding of NBS, 64. Data processing and presentation capacities of investors, 65. Investors´ focus on the rate of return, 66. Investors-driven initiatives, 67. Awareness/interest/sense of urgency in investing to address CC, 68. Investor´s attitude, perceptions, and concerns 69. Short-termism, 70. risk awareness, perception, and understanding, 71. interest for reputation.
D	Risks and metrics 25. Stranded assets, 26. Risks of transition, 27. Physical risks and damages related to Climate Change, 28. financial risks, 29. Legal risks, 30. Policy and regulation risks, 31. Political and economic risks, 32. Green / NBS special risks, 33. Risks' interactions, 34. Availability of information and transparency on project risks, 35. Lack of credible risk management tools and metrics.	K	Funding 72. Blended and funding methodologies, 73. Blending opportunities and challenges, 74. Funding sources, 75. Historical funding strategies.
E	Modeling 36. Climate change scenarios [accuracy through time and scales, updated], 37. Robust, econometric investment models, 38. Gains forecast accuracy, 39. Social factors modeling.	L	Policy, regulation, subsidies, and incentives 76. Existence of adequate, non-competing policies that are stable through time, 77. An enabling institutional environment, 78. Governance, 79. Procurement and bidding processes, 80. Regulatory environment [tax provisions, tariffs, enforcement], 81. Adequate incentives regimes, access to subsidies, and credit guarantees.
F	Network		
	40. Developing/implementing community capacity, 41. Lack of knowledge transference between study realms, 42. Reluctance to change and cultural shifts, Long-term agenda alignment, trust, and transparency among stakeholders,		**Observations:** To consult the specific factors included in each category and sub-category, consult corresponding annexes

3.4.3 *Filter two [FX2] – Theoretical clustering*

While in FX1, the coder has used the linguistic overlaps to shorten the database from 522 to 81 factors, the second filter groups elements by their meaning. This step makes extensive use of the comments and notes from memo writings elaborated during FX1. The rules for FX2 are as follows:

[1] The twelve thematic clusters arising from FX1 are treated as the unit of analysis in FX2, this means that individual factors assigned to a determined category, will not be exchanged between categories.

[2] The analysis "respects" the layer of the categories and does not charge any. Categories A to L are inspected in alphabetical order, picking, and analyzing first category A, then category B, and so on. See figure 20.

Figure 17 – FX2 clustering layer

[3] The researcher starts by reading, for instance, the *sub-categories* and the underlying factors' interpretation of category A, in the search for trends or similarities between *sub-categories* [not between categories or factors].

[4] If the *sub-category* refers to an aspect that cannot be influenced by the increase of private investment or any other stakeholder of the related network, or influencing is extremely complicated, the entire *sub-category* will be excluded. Table 12 shows the *sub-categories* that have been eliminated in this manner.

Table 10 – excluded sub-categories.

Category of origin	Sub-category	
	Original numbering	Name
B	9	Lifecycle
C	14	Exchange and interest rates
C	19	Consumption patterns
D	33	Risks' interactions
I	60	Ecosystem complexity and interactions

[5] If the sub-categorical clusters [1 to 81] are unique and do not show any overlaps with others, they are accurately preserved and transported to the database. Table 13 shows the 14 sub-categories that are kept under this condition.

Table 11 – Sub-categories maintained as consolidated factors.

Original category	Original subcategory	New FX2 numbering	Name
A	4	1	Scale and minimal optimal size
B	8	2	Adequate asset management expertise
C	11	3	Level of domestic and international investment
C	13	4	Ratings, indices, and listings
D	27	5	Physical risks and damages related to Climate Change
F	39	6	Developing/implementing community capacity
F	42	7	Long-term agenda alignment, trust, and transparency among stakeholder
F	44	8	Professional biases
G	46	9	The multitude of functions and services and their challenges
H	56	10	Information asymmetry
J	61	11	Investors' capital allocation features and requirement
L	73	12	Funding source
L	74	13	Historical funding strategies
L	77	14	Governance

[6] The final step of FX2 starts with the collector drawing lines between different sub-categories. Following the alphabetical order mentioned before, a sub-category is selected, it is compared individually against the other clusters and included factors. Consult Annex x to see the factors and their relationships.

The main results of the FX2 are displayed in Figure 18. To being with, a total of 32 *consolidated factors* were obtained, consult table 14 for the full list. Additionally, the collector detected other patterns between *sub-categories* [SC].

Some sub-categories were connected by their meaning to more than one other SC [in numerical order SC 3, 24, 35, 37, 38, 51, 52, 54, 55, 57, 62, 63, 66, 67, 71, 75,79 AND 80], this "multiple connection condition" [shown with a solid hatch in figure 21], might suggest higher importance of those SC within the network, this information will be useful for the assumptions made in the construction of the BBN in future chapters.

In some cases, an SC would relate to another across *consolidated factors* [it would be related but not enough to encapsulate them within the same consolidated factor], these cross-factor relationships are shown with a darker thicker arrow in Figure 21 [from left to right 3 → 57, 75 → 79, 75 → 79, 54 →63, 35 → 63, and 38 → 51]. These relationships were established by manually looking at the language and no inferring process was conducted in this step.

Three nodes of sub-categories can be highlighted as important by looking at their interconnectedness across condensed factors. First, the cluster of factors 75 [existence] *"Historical funding strategies"*, 79 "*Procurement and bidding processes"* and 80 "Regulatory environments *[tax provisions, tariffs, enforcement]"* stands out because while their underlying factors are hardly changeable by the stakeholders involved in the implementation of NBS, these factors could potentially prevent the involvement of private investors if, for instance, the tax provisions were not favorable [this information suggest an important relationship between FX2 F27 and F15].

On the other hand, the group with factors 3 *"NBS specific capital needs and costs"*, 52 *"Quantifying difficulties"*, 55 *"Publicly available NBS database"*, and 57 *"information asymmetries",* seems to show big dependencies of the SC among each other [which suggest the directionality and importance of a connection between FX2 F15, F16, and F17].

The third noticeable cluster encompasses factor 54 *"Availability of adequate performance indicators for services"* which determines the degree of 63 *"Investors´ knowledge, experience, and understanding of NBS"*,

and could prevent a 35 *"Lack of credible risk management tools and metrics"* [this group suggests a relation between FX2 F29 and FF24].

Figure 18 – FX2 results: Relationships between consolidated factors and SC

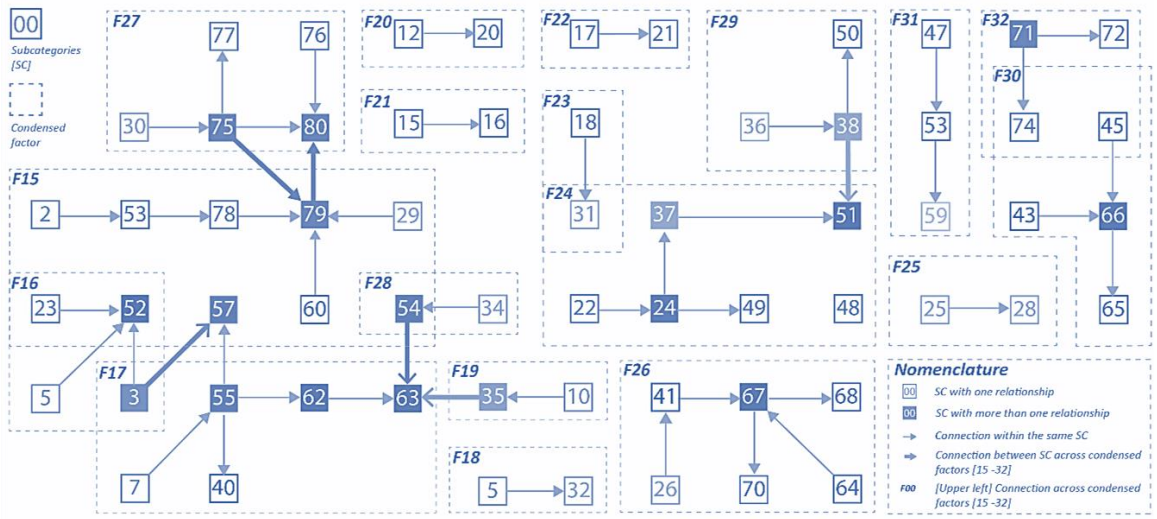


Table 12 – Full list of consolidated factors

#	Name	#	Name
1	Scale and minimal optimal size	17	Knowledge generation and understanding
2	Adequate asset management expertise	18	NBS-specific features and risks
3	Level of domestic and international investment	19	Risk management, metrics, and tools
4	Ratings, indices, and listings	20	Market maturity level
5	Physical risks and damages related to CC	21	Secondary market
6	Developing/implementing community capacity	22	Market size
7	Long-term agenda alignment	23	The political and economic landscape
8	Professional biases	24	Nature valuation and impact assessment
9	The multitude of functions and services	25	Financial risks
10	Information asymmetry	26	Behavioral resistance and transition risks
11	Investors' capital allocation and requirements	27	Enabling institutional environment & policies
12	Funding source	28	Information on NBS
13	Historical funding strategies	29	Modeling climate change scenarios
14	Governance	30	Awareness of nature's importance and sense of urgency to invest
15	Regulatory environment	31	Ecosystems' delimiting challenges and service diffuseness
16	Cost-effectiveness and competitiveness	32	Blended finance

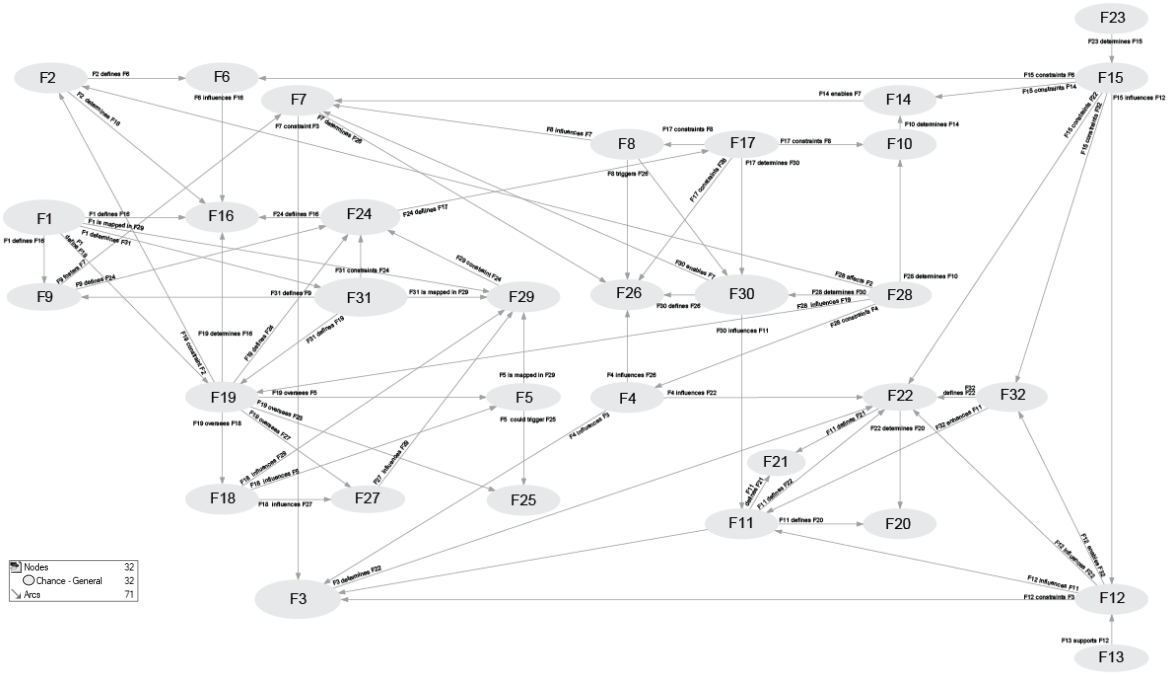
3.5 Conclusion

Following the SAGE guidelines for developing and presenting literature reviews, in chapter seven – of the conducting qualitative dissertation report (Bloomberg & Volpe, 2012), in this step, the researcher has

conducted a synthesizing procedure with the information at the level of the 32 *consolidated factors*, that is, the analysis has been taken beyond the initial assessment, and the collector further determined relationships, patterns or views developed that according to his expert eye could be significant for the modeling process in the future.

The biggest difference between the syncretization and the former steps is that the findings in this section are not mainly based on linguistic similarities but rather on perceptions and insights registered by the expert after getting a greater grip on the entirety of the database, this is done with the used of in-vivo memos written simultaneously as the database is being furnished. Therefore, this inductive approach leads to the development of a conceptual model (Imenda, 2014), or *preliminary NBS baseline map.* Figure 19 displays the results including a summary of the basic features of the network.

Figure 19– Expert direction assumptions



After the two rounds of filtering, and a consolidation of the results, the first one based on linguistic resemblance [FX1] and the second relying on conceptual similarities and meaning overlaps [FX2], the total sample of 522 factors of influence was compressed first to twelve categories amounting to 81 elements, and ultimately to 32 consolidated factors of interest for private investment in NBS. In the consolidation, some preliminary correlations were inferred from the close analysis of the interpretations based on the repetitions

of words+, these serve as evidence for the assumptions for the baseline ahead. At last, a conceptual model has been built by the research, based on the expert judgment developed after the analysis of the complete literature review. For a detailed overview of the contents per consolidated factor consult the corresponding annexes at the end of this document.

CONTENTS OF THE CHAPTER

4 DATA MINING

The process of uncovering helpful patterns in information extracted from existing databases takes very different names throughout literature: data mining, knowledge extraction, information discovery, data pattern processing, among others (Adil-Bari, 2015; Fayyad, Piatetsky-Shapiro, & Smyth, 1996).

The main goal of data mining is to detect correlations and patterns in the data that are valid, understandable, and useful for the resolution of research problems (Fayyad et al., 1996) and has proved to be highly efficient in engineering in areas like informatics and others, but specifically in the improvement of project management, an area complementary to this research.

A successful example of data mining in construction presented in (Adil-Bari, 2015), is where (Kim, Soibelman, & Grobler, 2008) found out unknown information on the causes for delay in projects. Former assumptions indicated that bad weather was the main contributor for delays in construction projects, data mining techniques confirmed that instead, incomplete, or inaccurate site surveys before execution were the main cause, consequent recommendations generated savings upwards of USD 500,000.

Data mining has been selected as an appropriate vehicle to extract knowledge for NBS due to its applicability across fields, and specifically its efficacy within the BCI.

4.1 Procedure

In the search to create a preliminary computational understanding of the model on the factors of influence for PI in NBS, the software Orange version 3.27.1 has been selected. Orange is a data mining and machine learning software, helpful in data visualization and classification. It is compatible with the main operating systems [Windows, Linux, and Mac] and runs a Python code, included in the program's installation (Suchý, 2012). This software has a visual interface and its particularly useful in the transformation of text into

vectors (Morales Ornelas, 2020) which will directly support the consequent creation of the BBN's in future chapters.

4.1.1 *Data preparation*

Up to this point, the database was populated and modified in a .xls document [Microsoft Excel]. For its processing in Orange, the document has been prepared in two steps, first by assigning each factor [1-522] to one FX2 *condensed factor* [1 to 32]. Table 15 shows three examples of this step for individual factors 1, 25, and 32. Note that in the case of factor 25 "*understanding of environmental risks"*, the newly added columns [vi] indicates that this factor has been excluded from the analysis [for the reasoning on this decision consult section 4.5.3 on the excluded *sub-categories* and underlying factors].

Table 13 – First step of data preparation for Orange [on individual factors]

[i]	*[ii]*	*[iii]*	*[iv]*	*[v]*	***added columns [vi]*** ▼	
Individual factor #	root concept	attribute	binary assessment	connotation in paper	FX2 consolidated factor	
1	environmental externalities	[cost-effectively] internalized	internalized / not internalized	neutral	F24	Nature valuation and impact assessment
25	understanding of environmental risks	inadequate	adequate / inadequate	barrier	Excluded from database	
326	multifunctionality of NBS and benefits	N/A	significant / not significant	driver	F9	The multitude of functions and services and their challenges

The second step in the preparation of the data for Orange was to pair up the interpretations of the *individual factors* [1-522] belonging to the same *consolidated factor*, an example of FX2 F1 and its underlying individual factors [115, 224, 332, 492] is shown in table 16.

Table 14 – Second step of data preparation for Orange [on consolidated factor F1]

Individual factor's interpretation ▼

	#115	#241	#332	#492
F1 Scale and minimal optimal	[Direct investing challenge] Min [project] size of $100M deal size; expensive and time-consuming due diligence; higher transaction costs [too big investment, too big risk for some investors]	Often, economies of scale are not sufficient for larger investments[projects are not scalable]		Focus investment on project-preparation facilities and technical assistance to increase the "bankability" of project pipelines (meaning those that have an attractive economic profile). This is the highest-risk phase of the project life cycle; it is critical to get right.

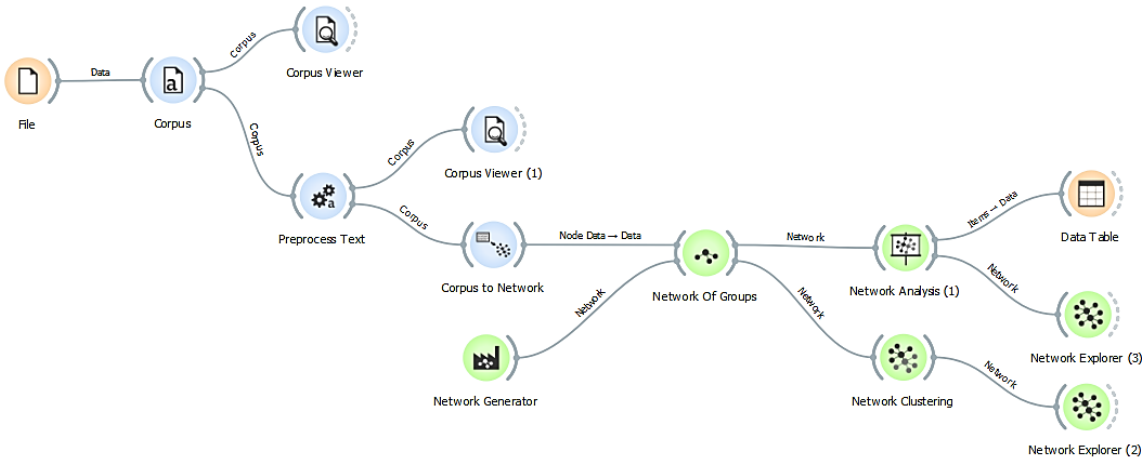
All elements and processes conducted in the Orange software that are described and defined ahead are based on information provided by the official Orange software website (Orange, 2020)

At the end of the preparation stage of the database, the document was saved as a .csv document in Microsoft Excel, later the file has been imported to Orange through a "file" widget, connected to a "corpus" widget to begin text processing. A corpus is a collection of documents, tagged with different categories [in our case different features are outlined through different columns](Orange, 2020).

4.2 Data mining round one

To obtain different types of insights on the data, two consecutive data mining rounds have been conducted, the reason for two separate processes has been to obtain as much information on the relationships among the FX2 32 *consolidated factors*. Figure 22 shows the first group of processes applied to the database.

Figure 20 – Orange 3 screenshot of the data mining round one



The following paragraphs are fast descriptions of the data mining processes, for more detailed information on how they were conducted, consult annex 23 at the end of this document.

► **Pre-process text:** This step divides the text inputted in the *"corpus"* into smaller units [*tokenization*]. In a nutshell, the text has been transformed to *lowercase,* punctuation has been eliminated, and s*top words* in English are erased [e.g., "and", "in", "an", "a", i.a.].

Figure 21 – Screenshot of Orange text preprocessing

► **Network generation: "corpus to network", "network of groups" and "network generator":** To create a network from the "*corpus*" generated during the former text preprocessing, the following add-ins were used: [1]*"corpus to network"* [resulting in 482 nodes and 577 edges], [2] "*network of groups*" to create an understandable network, in this step, the number of nodes was reduced to 32 and the number of edges to 223, and [3] *"network generator"* to produce a graphic expression of the results.

► **Network clustering vs network analysis:** The goal of the first widget is to find further clusters in the network through two different algorithms (Leung, Hui, Lio, & Crowcroft, 2009; Raghavan, Albert, & Kumara, 2007). The application of the clustering algorithms was not successful and yielded no additional groups.

The second device *"network analysis"*, performed a statistical analysis of the network, resulting in a 32-vertice network with 238 resulting relationships [edges], table 17 showcases the fifteen most important factors, ordered by the most connected [greater number of edges] to the least [i]. and therefore, is not useful for the data mining process in this report. device *"network analysis"*, performed a statistical analysis of the network, resulting in a 32-vertice network with 238 resulting relationships [edges], table 17 showcases the fifteen most important factors, ordered by the most connected [greater number of edges] to the least [i].

Table 15 – Most connected FX2 factors according to network analysis [data mining round 01]

ranking	#	Name	[i]	[ii]	[iii]	[iv]	[v]
1	F27	Enabling institutional environment & policies	25	25	16.56	0.806452	0.806452
2	F26	Behavioral resistance and transition risks	25	25	15.36	0.806452	0.806452
3	F24	Nature valuation and impact assessment	24	24	15.9167	0.774194	0.774194
4	F16	Cost effectiveness and competitiveness	23	23	16.2609	0.741935	0.741935
5	F15	Regulatory environment	23	23	16.3043	0.741935	0.741935
6	F30	Awareness of nature's importance and sense of urgency to invest	22	22	16.5455	0.709677	0.709677
7	F19	Risk management, metrics, and tools	21	21	17.0952	0.677419	0.677419
8	F29	Modelling climate change scenarios	20	20	16.95	0.645161	0.645161
9	F17	Knowledge generation and understanding	20	20	17.75	0.645161	0.645161
10	F28	Information on NBS	18	18	17.8889	0.580645	0.580645
11	F7	Long-term agenda alignment	18	18	18.3333	0.580645	0.580645
12	F32	Blended finance	17	17	16.7647	0.548387	0.548387
13	F6	Implementing community capacity	17	17	16.9412	0.548387	0.548387

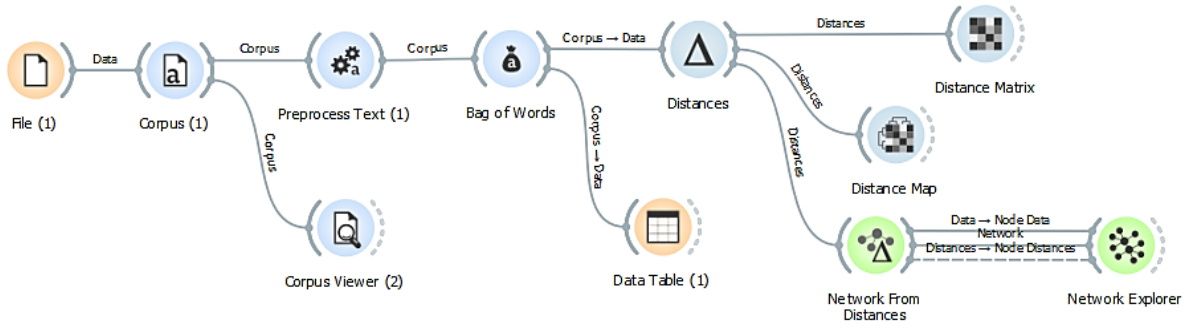
14	F31	Ecosystems' delimiting challenges and service diffuseness	16	16	18.375	0.516129	0.516129
15	F23	Political and economic landscape	16	16	18.4375	0.516129	0.516129

In conclusion, while the first round of data mining has generated a concrete list of the most linked FX2 *consolidated factors* by indicating the number of connections per node, however, it does not provide any specifics as to the names of the connecting nodes [both incoming and, or outgoing], or any of the main features of the relationships under analysis, for instance, the directionality of the connection [which factors influences what factor, i.a.] or the strength of each edge.

4.3 Data mining round two

The second part of the data mining analyzes the interpretations of the factors via distances. For this step, all the interpretation texts were concatenated [linked together in a chain] into a single 'document' representing a factor. This is slightly different from just counting the number of words in common between documents. In this case the root mean square of the difference in the number of repetitions of each word in the processed text is applied, this is done to minimize errors in the linking of fragments.

Figure 22 – Orange 3 screenshot of the data mining round two



► **Bag of words:** Unlike the first data mining cycle, the second round uses the model *"bag of words"* [BoW] after the preprocessing of the text [for more information on preprocessing consult annex 22]. The BoW transforms each sentence into numbers, also named binary vectors (Brownlee, 2017). Table 16 shows an example of this action on FX2 factor F27, the most connected node according to the former analysis.

Table 16 – Orange Bag of Words example [second data mining round]

NAME – FX2
F27 Enabling institutional environment & policies
RAW SENTENCE – interpretation **portion**

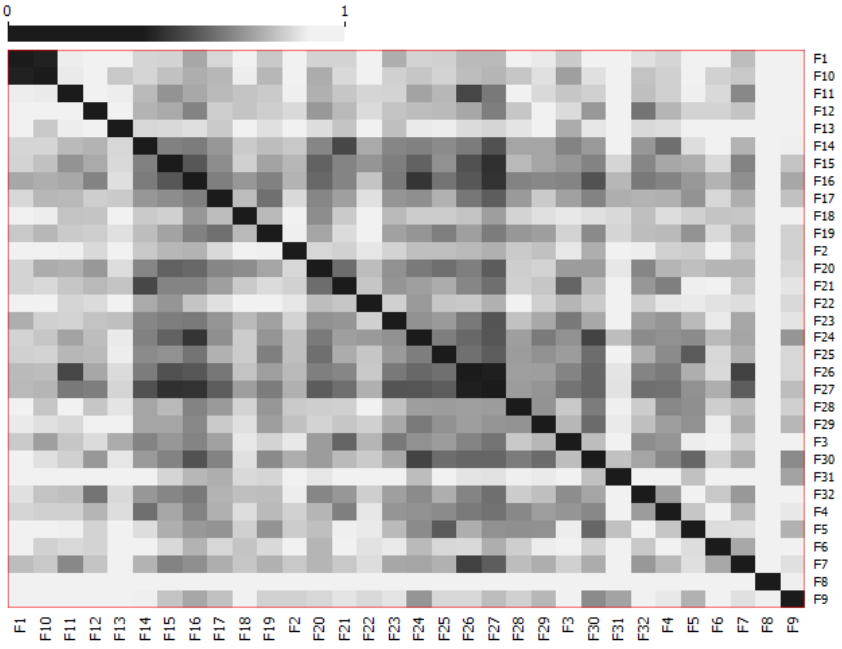
"the promotion of cross-border investment and bilateral collaboration refers to the country's visibility and predictability policy […]"

ORANGE – preprocessing [T = token]
T1= promotion, T2 and T3= cross-border, T4= investment, T5= bilateral, T6=collaboration, T7= refers, T8= country, T9=visibility, T10=predictability, T11= policy, TN= […]
ORANGE – repetitions per token
bilateral=1, collaboration=1, country=1, cross=2, border=2, investment=12, policies=5, policy=9, predictability=1, promotion=2, refers=1, visibility=1
ORANGE – Bag-of-words result
Example: [T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11] **Result: [2, 2, 2, 12, 1, 1, 1, 1, 1, 1]**

*it must be reminded that the complete interpretation of FX2 factors is composed of the individual factors' definitions included in each condensed factor, for more information consult the chapters on the filtering process.

► **Distances:** Measuring the similarity between texts is a common task in many data mining applications (Wizards, 2019), in Orange this is done with the "distance" device that measures complex similarities such as the semantic and meaning closeness between not only small words but full *"tokens"*. Figure 23 shows the graphical outcome of the distance calculations, it only includes the 15 most significant relationships. The distances resulting from the second round support the hierarchization established in the first cycle and draw "new" relationships, this data can be used to generate a BBN's in the future [for an example of the network created in Orange consult 6]. This step goes does not provide the directionality of the relationships.

Figure 23 – Orange distance map [second round]



low distance: black [stronger relationship]
high distance: white

Highest ◄ *DISTANCE* ► Lowest

Relations between FX2 factors		value
F26	F27	0.413
F15	F27	0.460
F16	F27	0.462
F16	F24	0.472
F7	F26	0.501
F15	F26	0.540
F14	F27	0.541
F16	F30	0.545
F23	F27	0.548
F24	F27	0.552
F5	F25	0.564
F20	F27	0.569
F17	F27	0.574
F25	F27	0.574
F3	F21	0.588

4.4 Conclusion

This chapter conducted two consecutive data mining processes. The first, using counting techniques, determined the presence of common words and tokens [related groups of words] among all 32 *consolidated factors*, and with that, obtained a hierarchy of the most nested elements in the network.

The second cycle of data mining explored both the word counting shared by two sources and the embedded meanings of the same 32 factors; the end-product was a matrix that ranked the relationships according to their closeness [measured with the distance operator]. Both processes confirmed the conjectures made in chapter 3, on the three most important factor clusters at the end of the literature search. The cumulative results of this chapter and their comparison with findings in former chapters are shown in Table 17.

A clear example of the coherence between the results obtained on the literature search and the data mining phases can be seen in factor F27 *Enabling institutional environment & policies*. It can be observed that in the manual establishment of interrelationships in the literature search [done using the data collector's expert opinion], the link between F27 and F15 *Regulatory environment* was highlighted as the first crucial cluster within the entire network. Later, on the first round of the text investigation, after the network analysis [consult table 17 for a complete list of results], both F27 and F15 were confirmed as part of the top ten most nested factors in the system, with 25 connections coming in and, or out of node F27 [placed in the 1° place] and with 23 connections from F15 [5° place].

Finally, as can be seen in the last phase of the second round of data mining [consult the distance matrix in figure 23], the same relationship [F27 – F15] showcases the second-lowest distance rate [0.460], which suggest a strong relationship between the elements of the regulatory environment and the institutional environment and policies too. To be able to compare the rest of the confirmed factors and links, table 19 shows the most important insights per section, the table maps the main results not the whole set of outcomes, for more detailed information consult the corresponding sections and annexes.

Nomenclature

- **Hypothesized relationships [Literature review]**

  a) F27 [SC 75] ↔ F15 [SC 79]
  b) F15 [SC 79] ↔ F27 [SC 80]
  c) F16 [SC 03] ↔ F15 [SC 57]
  d) F28 [SC 54] ↔ F17 [SC 63]
  e) F19 [SC 35] ↔ F17 [SC 63]
  f) F29 [SC 38] ↔ F24 [SC 51].

  * Also, F15, F17, F27 are detected as the most nested elements in the net, this means that they connect with more than one node, with 3, 2, and 2 links with other nodes, resp.

Node hierarchy [1st round of data mining]

1)	F27	5)	F15	9)	F17	13)	F6
2)	F26	6)	F30	10)	F28	14)	F31
3)	F24	7)	F19	11)	F7	15)	F23
4)	F16	8)	F29	12)	F32		

* Highlighted in grey are columns that are alluded to as important possible connections, because they involve a highly nested factor, this assumption is not confirmed in this step.

Relationships hierarchy [2nd round of data mining]

i)	F26 ↔ F27	v)	F7 ↔ F26	ix)	F23 ↔ F27	xiii)	F17 ↔ F27
ii)	F15 ↔ F27	vi)	F15 ↔ F26	x)	F24 → F27	xiv)	F25 ↔ F27
iii)	F16 ↔ F27	vii)	F14 ↔ F27	xi)	F5 ↔ F25	xv)	F3 ↔ F21
iv)	F16 ↔ F24	viii)	F16 ↔ F30	xii)	F20 ↔ F27		

Table 17 – Literature search and data mining collection

	F1 ▼	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F20	F21	F22	F23	F24	F25	F26	F27	F28	F29	F30	F31	F32
F1 ◄	x																										vii					
F2		x																			xv										
F3			x																						xi						
F4				x																						v						
F5					x																											
F6						13																										
F7							x																									
F8								x																								
F9									x																							
F10										x																						
F11											11																					
F12												x																				
F13													x																			
F14														x													vii					
F15															5	c										vi	a,ii					
F16																4								iv			iii			viii		
F17																	9		e								xiii	d				
F18																		x														
F19																			7													
F20																				x							xii					
F21			xv																		x											
F22																						x										
F23																							15				ix					
F24																iv								3°			x					
F25					xi																				x		xiv		f			
F26							v								vi											2°						
F27														vii	b,ii	iii	xiii			xii			ix	x	xiv	i	1,i					
F28																												10				
F29																													8			
F30																viii														6		
F31																															14	
F32																																12

Results from a Literature search 1 11 1st data mining ranking i xi 2nd data mining ranking

Table 17 offers the overview of an "average" NBS network, in other words, the universe of aspects to have in mind when assessing whether an NBS can be framed as a bankable proposal, attractive enough for PI.

The chapter confirmed the importance per item of the 32 factors of influence and was also the first step in mapping the relationships that constraint the network. Nevertheless, the previous studies did not yet provide compelling evidence on the directionality of the edges [which factors depend on another factor].

The design of effective governance strategies that enable the involvement of private capital demands an understanding of the interdependencies between the factors in the network, including a concise account of the most evident aspects to handle, but most importantly, a recognition of the hidden aspects that could have a big impact on the general landscape of the project. These hidden dynamics of a proposal have a significant part in the decision of private investors in taking part in nature-inspired solutions. The following chapter will address the direction of the relationships and the furnishing of the baseline BBN's for NBS.

CONTENTS OF THE CHAPTER

5 NBS BASELINE– BAYESIAN BELIEF NETWORK CONSTRUCTION [B-PINBS]

This chapter is divided into two sections, the first part is dedicated to [step 1] validating the data and information obtained thus far in the literature review and data mining chapters. After the elicitation of the nodes as well as the features of their relations, the second segment [step 2] constructs a validated the BBN for PI in NBS [abbreviated as B-PINbs in the forthcoming paragraphs]. Several terms are used interchangeably in this chapter, on the one hand, "variable", "node", and "factors" refer to the elements of influence, while "edge", "link", and "arc", are used to refer to the relationships between the nodes.

5.1 Software

The Bayesian Belief network models provided in the following sections and their respective iterations were constructed using the *Bayes Fusion* software GeNIe 3.0, in its academic version [for more information, consult https://www.bayesfusion.com/genie/]. The GeNIe Modeler was selected for this purpose because its graphical user interface allows interactive model building and learning (LLC, 2020), a feature that facilitates the rapid adaptation of the BBN's to the new insights arising from the different stages of this research.

5.2 The elements of a BBN

Reiterating on the description of BBN at the beginning of this report, we have established that they were selected to deal with NBS because they are efficient frameworks to model relationships between variables and capturing uncertainty (Gaag, 1996). The interrelationships between variables are graphically illustrated in the form of diagrams; the variables are displayed as nodes, and the nodes are linked through directed arcs.

Previous chapters, via in-depth literature search and analytical data mining, determined the potential variables [factors of influence] in the involvement of PI in NBS, and the suspected links between those variables

[frequently named edges]. Nevertheless, several aspects, necessary for the probabilistic analysis of the B-PINbs still need to be inspected.

5.2.1 *Directionality*

An elemental aspect, that has not yet been validated, is the representation of the interdependencies directionality (Nielsen & Jensen, 2009), in other words, the orientation of the arrow attached to an arch that reflects the direction of the causal influence (Chivatá-Cárdenas et al., 2012).

A preliminary determination of the direction of some relationships was done at the end of the literature search, where after reading and analyzing the entire database and making use of the memo notes, the data collector assigned some suspected directions to the edges, first between sub-categories, and later in between *consolidated factors* [FX2] using her expert criteria. Nonetheless, these preliminary hypotheses remain only referential.

The first outcome of this chapter is therefore a list of expert-validated dependencies and corresponding directionalities. In the initial assumptions, the researcher presumed up to 71 different arcs, each with a specific directionality. The expectation is that expert elicitation round can reduce the complexity of the network, first by cutting down the number of edges [relationships] and variables [consolidated factors], and second by corroborating or correcting the assumptions made on the directionality of the edges.

5.2.2 *Variables: conditional probabilities and states*

The second basic element of BBN is the variables. Networks always begin at a parent node, parent nodes can be connected to one or more child nodes, similarly, child nodes can be connected to several parent nodes. When a child node has no descendants, it is labeled as a “leave of the network”, while when a parent has no predecessor it is called a “root node” (Dıez & Druzdzel, 2006; J. Sigurdsson, L. Walls, & Quigley, 2001).

The probability of a value of a factor of influence [FX2] in the B-PINbs is determined by the occurrence of a change in other interrelated factors (Oniśko et al., 2001). In other words, each variable in the BBN model is an event or condition that can influence the joint probability of other nested variables.

A critical feature of a variable in BBN is that it can adopt different "states", each state denotes the degree of belief, expressed as probabilities, that a particular node will be in a particular state, given the states of its parent nodes (Chen & Pollino, 2012). While in the real world, variables have the possibility of adopting two or more discrete estates, in very simple networks, like the one intended for the NBS baseline, scenarios are assumed to be binary [only two states] for practical purposes (Newton, 2009; Pearl, 2011). Only using two states per variable also helps to ensure that the B-PINbs framework is simple and manageable enough for its use by a wide array of stakeholders including practitioners and investors. Therefore, all variables in B-PINbs are assumed binary, with their two possible states being: "absent [not happening]" or "present [happening]".

The hypothesized states of a given variable should be *mutually exclusive*, meaning that the two events cannot happen at once, and *exhaustive*, meaning all possible states should be included in the model (Jäger, 2013).

Following the work of (Chivatá-Cárdenas et al., 2012), the variable's scenarios are further discretized into a three chance categories vector [frequent, occasional, improbable], for its evaluation by experts, the layers of the likelihood of occurrence are extracted from the IPCC standards proposed by (Irwin & Mandel, 2019).

Probabilities nomenclature >	Improbable [highly unlikely]	33%
	Ocassional [likely / moderate]	66%
	Frequent [highly likely]	99%

To capture the relationships between factors [variables], conditional probabilities are extracted from experts' opinions. This data is saved in the shape of conditional probability tables [CPT], charts that map any type of interaction between factors leading to an event.

BBN's have a wide array of types of variables [objective, control variables, etc.] (Farmani, Henriksen, Savic, & Butler, 2012). To avoid a time-consuming specification of probabilistic relationships and an unreliable outcome, the conditional probability tables [CPT] are estimated to Noisy-MAX nodes (Chivatá-Cárdenas et al., 2012), that take advantage of the independence of causal interactions and provide a logarithmic reduction of the number of parameters required to specify a CPT.

Consider the example provided by (Pearl, 2011) on how to define the probability distributions and states of a hypothetical variable “wet grass”, that depends on the occurrence of the events [also variables]: [1] grass is wet by a programmed “sprinkler”, or by [2] “rain”. The meteorological service forecasts a 10% probability of rain, while there is a 5% possibility of the sprinkler malfunctioning. The illustrative node is then translated to the conditional probability chart in table 18.

Table 18 – States and probabilities of "wet grass" example

States >	*[1] Sprinkler*	*[2] Rain*
Probabilities >	P_S (functions) = 0.95	P_R (true) = 0.10
	P_S (fails) = 0.05	P_R (false) = 0.90

CPT

States >	*Sprinkler*	functions	functions	fails	fails
	Rain	true	false	true	false
Wet grass [variable] >	P_{wg} (true) =	1	1	1	0
	P_{wg} (false) =	0	0	0	1

The process of construction of the B-PINbs also follows the recommendations set by (Lytvynenko et al., 2019) that establish the following order of action as the ideal:

[1] Decide the variables to be modeled,

[2] Define the states space per each variable [binary: “happens” / “does not happen”],

[3] Model only the “expert-validated” relations between variables [construct from cause effect],

a. Start with independent root causes nodes,

b. Continue with nodes that the former influence,

c. Repeat.

[4] Determine the conditional probabilities. All the variables in the model have a finite number of states per variable, described in the corresponding CPT. Entries in the CPT are educated guesses that are also expert judgment based.

Consider table 19 that shows the former rationale applied to a “real” relationship in the B-PINbs, of an independent root cause “P28 – Information on NBS” on node “P2 – Adequate asset management expertise” [probability of F2 given F28]. Let us assume that experts confirm *that the probability of an adequate asset*

management expertise to take place [happen], given the existence [happen] of sufficient information on NBS is frequent [99%], the chance of this interaction of occurring is the described by the following CPT:

Table 19 – Example of CPT for F4 given F28.

F2 | F28		F28	
		State1: Present	*State 2: Absent*
F2	*State1: Present*	0.99	0
	State 2: Absent	0.01	1

Finally, literature experts have several recommendations in the handling of the variables in a BBN, depending on the nature of the network. Concerning the B-PINbs, up until now, the network has 32 variables, and therefore is classified as a rather large model according to (Wiegerinck, Burgers, & Kappen), since it encompasses more than 30 nodes; this could imply significant calculation challenges at larger stages (Kocabas & Dragicevic, 2006). Looking to prevent this heightened computational complexity of the B-PINbs, the researcher has followed the guidelines of (Marcot, Steventon, Sutherland, & McCann, 2006),(Marcot, Hohenlohe, et al., 2006), (Lytvynenko et al., 2019 and (Newton, 2009), to construct the network. The following recommendations are a compilation of the main considerations done in this regard:

[1] Specify as few states as necessary in each node,

[2] Indicate four or fewer "parent nodes" to ensure that CPT's are workable,

[3] Aim to produce fewer than four node-layers to avoid overcomplicating the influences of input environmental parameters.

5.3 STEP 1: Data validation method

Up to this point in the research, the handling of the data has been done internally, and on an individual basis by the researcher. As noted by (Di Zio et al., 2016) after conducting such a comprehensive data collection and categorization processes like the ones presented in this report, it is necessary to engage in a decisional procedure to determine which data gathered is acceptable and which not for future analytical steps. This section presents and develops the selected data validation methodology, designed to ensure the quality of the inputs for the construction of the B-PINbs.

5.3.1 *Selection of an elicitation methodology*

From the work of (Whittemore, Chase, & Mandle, 2001) on techniques for demonstrating validity in qualitative research, "expert checking" was selected as an adequate approach for its analytical nature. Analogous work to NBS [on risk analysis for construction projects] suggested that to capture expert judgment, interviews, and in particular, semi-structured [SSIs], are an efficient method to prevent slanted estimations and assumptions, by encoding the results (Chivatá-Cárdenas et al., 2012). The differences between structured, semi, and unstructured interviews depend on whether a script is being followed. SSIs offer a middle point because while the inquirer does follow a script, he or she does not do it strictly.

SSIs are especially useful to explore uncharted territory, where the maximum latitudes are necessary to spot and pursue useful, unexpected leads (Newcomer, Hatry, & Wholey, 2015), this research benefits from the capacity of detecting new aspects of influence and relations among factors of PI in NBS, and therefore, this is the main reason for which SSIs were selected as the validation step before the construction of the baseline framework.

The benefits of SSIs are that they offer wide coverage for a large set of vague themes since discussions can adapt to the responses provided by the interviewees (Bryman, 2016; Young et al., 2018). This flexibility of SSIs also allowed the interviewer to circle back and reiterate individual factors of influence for PI in NBS, and their corresponding relationships' features [i.e., the probability of occurrence given other related factors].

The validation and information gathering from SSIs is not a linear/consecutive process, which is also beneficial for the BBN modeling process, since as stated by (Farmani et al., 2012), utilizing an iterative process to validate a network's construction, substantially improves the credibility and consistency of the network. Nevertheless, BBN's can only keep a certain degree of flexibility as long as the network's variables are not yet parameterized (Zacharias, 2015). SSIs accomplish the required balance between flexibility and structure, which maximizes the amount of data gathering and offer the option of inputting the results into the network at different moments in time.

5.3.2 *SSIs target group*

Chapter two described the reasoning behind adopting a "broader and deeper" approach for the methodological design. It was determined that the gathering of specialized information from a multidisciplinary array of experts was the best strategy to produce a legitimate "helicopter view", critical in overcoming the fragmentation challenges that hinder the attractiveness and the allocation of private capital into NBS. The target group of the SSIs was selected being mindful of the capacity of the respondents to provide legitimate specialized, multidisciplinary responses.

As (Drew & Collazo, 2012; Frank, 2015; Krueger, Page, Hubacek, Smith, & Hiscock, 2012) denoted, there is a clear distinction between "stakeholders" and "experts". "Stakeholder" is a broad definition that does not provide information on the level of competence of the individual but refers only to his or her power to influence the processes at hand (Freeman, 2010). Contrarily, "experts" are individuals who have gained specialized, in-depth knowledge on a topic of interest, and can account for both, the good quality and applicability of the assumptions that they provide. Expert knowledge has a higher reputation than stakeholder knowledge (Zacharias, 2015). It is for this reason that, to meet the requirement for highly skilled results, experts, and not stakeholders, were selected as the target group for the elicitation of the elements of the B-PINbs. On the other hand, to ensure the transferability and multidisciplinary nature of the results, participating experts were pooled from at least one of the relevant practice clusters for this research [BCI, CES, and IVS].

In terms of the size of the population for the study, based on the advice of a BBN expert [Ibsen Chivatá Cárdernas], it was decided the smallest acceptable sample to produce robust conclusions was six experts. The selected sampling technique for this report has been key informant sampling, this is because it targets key people that are knowledgeable about the issue (St. John, Keane, Jones, & Milner-Gulland, 2014).

A background check on the experts was conducted, to extract their personal information, expertise, and practice cluster of his or her most experience. Consult annex 11 for the specific individual data per expert. To avoid incurring confidentiality breaches via deductive disclosure (Kaiser, 2009), a promise of confidentiality has been posed to the SSI participants, some personal details per interviewee have been excluded from being mentioned [i.e. name or contact, i.a]. Only the necessary information to delimit their expertise and role for this

research is maintained. A code is assigned to each one of the six interviewees, "R1" refers to respondent number 1, "R2" to respondent number two, and so on.

5.3.3 *SSIs design and preparation*

In regards to the preparation before the interviews, the protocol and questions were elaborated based on the work of (Cárdenas et al., 2012) in the definition of risk measures for large construction projects given that as we established before, the BCI is an analogous field to NBS. Table 20 provides a summary of the interviews' questions and blocks. For further details on the protocol or the semi-structured interviews' questionnaires visit annexes 7, 8, and 9.

Table 20 – Interview protocol and guide summary

#	Block	Questions
1	Review: database	No pre-designed questions
2	Match: database and experts' impressions	How accurately does the previous 'baseline' BBN model express reality? Does the model map most barriers and/or drivers for private investment in NBS? Which factor(s) capture your attention first-hand? Why do the previous factors capture your attention?
3	In-depth discussion: individual factors	From the factors selected previously [question 1.2], what chance do you think each factor has of influencing private investment is NBS? [shortly explain]
4	Closing: the potential of research	What is the added value of the proposed model for experts operating in practice? Why is the model important in the context of the demo [case] you have been mostly involved in?

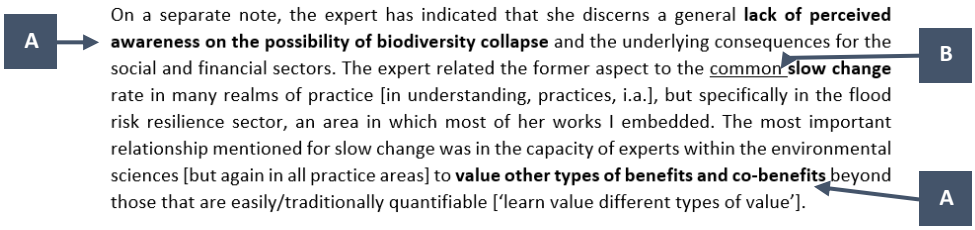
5.3.4 *Analysis procedure for SSIs results*

This sub-section includes the methods used to extract the findings from the six expert interviews. The analysis of the sessions was done following the methodological guide to use and report on SSIs furnished by (Young et al., 2018).

The first step to scrutinize the interviews was "coding" the transcripts' paragraphs, in other words, producing tags and labels for assigning units of meaning to the descriptive or inferential information compiled during an exploration (Matthew B Miles & Huberman, 1994). Codes were assigned to individual words, complete sentences, or whole paragraphs depending on how much information was necessary to clearly express or imply any of the 32 *consolidated factors*. Beyond the words themselves, the collector has made

emphasis on inputting the selected portion under the same code according to their meaning more than according to the words used by the respondents of the SSIs.

Figure 24– transcript coding strategies



The analysis was conducted on a paragraph basis. Figure 24 shows a snippet of the transcript from interview R1, to code the portion the researcher has begun changing the font format of certain segments with the following rationale: In a bold font, the researcher highlighted any reference to a consolidated factor [A]. Words hinting at the probability of the relationship occurring will be underlined [B]. Additionally, the compiler has also recorded thoughts in manual notes. All the interview transcripts have been processed in this manner to preserve the exact location in the text from where each assumption comes from.

In a second step, all the sentences labeled as well as the indications of conditional probability are compiled in a table per respondent and then transformed into meaningful parameters and variables with which the BBN baseline for NBS was later populated. Finally, results are also laid out graphically through a diagram of confirmed, contradicted, and newly raised factors for some interviews. Since diagrams only serve to create a more reader-friendly display of the obtained answers, the illustrations were only elaborated for the first two interviews. An example of the complete analysis process is described hereunder. This example uses a segment extracted from R1.

[1] The transcript reported that:

> "Among the main gaps/challenges in the implementation of NBS, the expert observes a **continuous** lack of **awareness as to the fact that costs of management of NBS, in the long run, are different from the costs of execution** [the expert has indicated that this aspect is vital for the decision or a yes/no decision of a project]. With a frequent chance of occurring, it pertains to the relationship between the availability of information for decision-makers on costs through the lifecycle of NBS and its influence on the asset management approaches used.

[2] Summarization:

The following synopsis of the original piece was inputted into the results table for R1.

"Lack of awareness on the mismatch between maintenance and operation costs of NBS in comparison to their construction costs"

[3] Inference:

In the former synopsis, the compiler has detected that:

[i] ► "[…] maintenance and operation costs of NBS in comparison to their construction costs" ***belongs*** to the consolidated factor F28 "Information on NBS" – rationale: *any cost is information on the NBS,*

and

[ii] ► "lack of awareness on the mismatch of […]" ***belongs*** to the consolidated factor F2 "Asset Management expertise" – rationale: *awareness of cost mismatches is a pointer for the degree of asset management expertise.*

Consequently, the following relationship is inferred as:

F28 [i] any information on NBS [costs] AFFECTS/DETERMINES F2 [ii] the degree asset management expertise [awareness of mismatches] or summarized F28 → F2.

Since this relationship has already been hypothesized on the BBN before R1 at the end of the literature search of this paper, this R1 segment **validates** [confirms] such relationship, the confirmation or lack of thereof is reported back to the results table. Segments from SSIs can also propose new links or contradict previous assumptions. The expert used the words "frequent chance" to describe the probability of F28 affecting F2, therefore the assigned probability assigned to this relationship is "Frequent" in the results table as well.

[4] Confirmed network relationships [matrix]:

Results have also been inputted in a matrix in Microsoft Office Excel [full version in annex 13]. In our example:

F28 is the origin [the beginning of arrow] since F28 is the one that influences F2 [head of the arrow]

Therefore, in the matrix, F28 is indicated in the horizontal axis [↔] while F2 in the vertical one [↕].

5.3.5 *SSI individual results example*

This section discloses the results of one of the SSIs [R1] in table 21. For the complete transcripts per session, respondent's information, answers tables–diagrams, and cumulative results matrix, consult annexes 10, 11, 12, and 13, respectably. The following abbreviations are used in the following results table: for *the probabilities* of the dependence being frequent [F], moderate or occasional [M], and improbable [I].

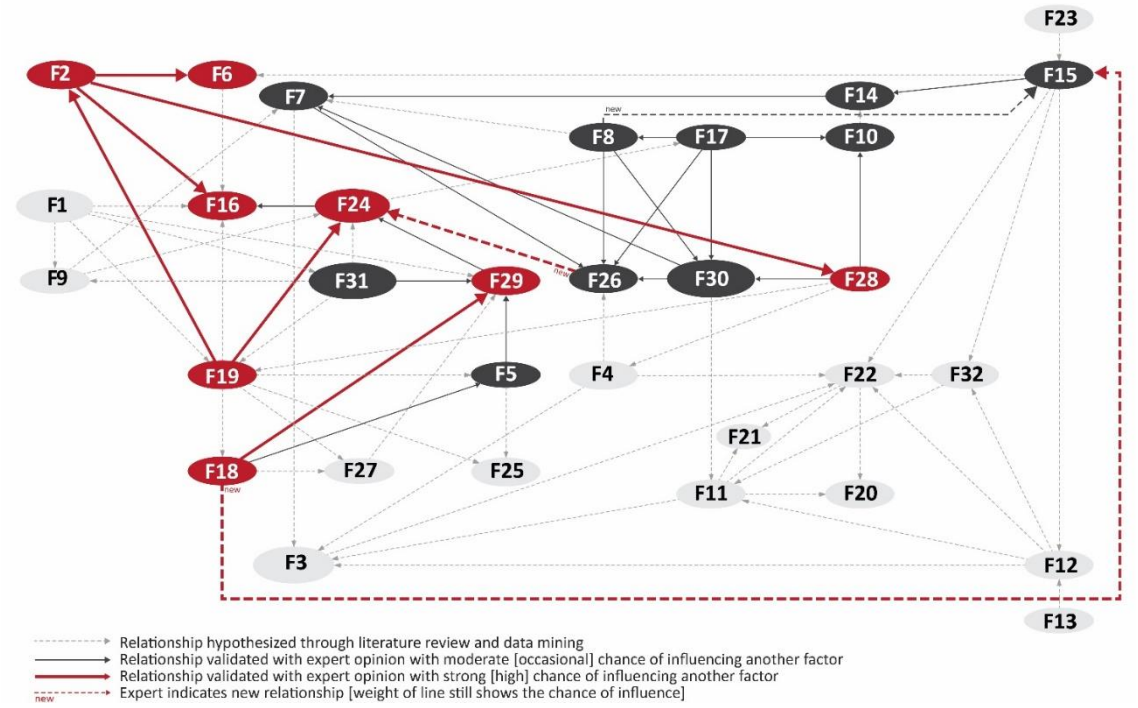
Table 21 – Interview R1 results

FRAGMENT IN INTERVIEW	[i]	**FX2 FACTORS** *[confirmed and/or proposed]*
Lack of awareness on the mismatch between maintenance and operation costs of NBS in comparison to their construction costs	F	F28 affects F2 [confirmed]
Responsibility allocation problems for asset management plans and involved parties [problem ownerships]	F	F2 -? *[Invalid [1]]*
Trust among stakeholders in the network	M	F7 -? *[Invalid [1]]*
		F5 is mapped in F29 [confirmed]
		F31 is mapped in F29 [confirmed]
Technology and system knowledge	M	F18 influences F5 [confirmed]
		F30 enables F7 [confirmed]
Multi-stakeholder approach	M	F7 determines F26 [confirmed]
Management, monitoring, and maintenance	F	F19 constraints F2 [physical] [confirmed]

		F19 defines F24 [confirmed]
		F2 defines F6 [social/network] [confirmed]
		F2 determines F16 [technical] [confirmed]
		F14 enables F7 [confirmed]
		F15 constraints F14 [confirmed]
		F7 determines F26* [confirmed]
Institutional embedding	M	*Repeated in interview*
		F29 constraints F24 [confirmed]
Business case	M	F24 defines F16 [confirmed]
Capacity building	M	Relationships between factors F8, F10, F17, F26, F28, F30 [confirmed]
Clarity on the reason to implement an NBS	F	F17-? *[Invalid [1]]*
The uniqueness of each NBS project and its influence on the creation of evaluation criteria for different purposes [technical performance evaluation, procurement processes, i.a.]	F	F18 influences F29 [confirmed] *This statement proposes a new relationship [between F18 NBS uniqueness and procurement processes within F15]*
Slow change [culture, practices, i.a.] and its influence on the capacity to value other types of gains	F	*This statement proposes a new relationship [between F26 resistance to change and F24 nature valuation]*
Limited accurate modeling capacities due to long lifecycles and the increasing exposure of NBS to extreme conditions in the future.	F	F18 limits F29 [confirmed]
Different efficiency [criteria] standard to implement NBS in comparison to the standard applied for grey infrastructure projects	M	*This statement proposes a new relationship [the influence that professional biases on performance F8, in favor of civil engineering projects, and the definition of criteria for procurement F15]*

[1] Statement that is not aligned to any specific relationship will be deemed as invalid, the details, processes, or items mentioned as important by the expert will be added to the description of each factor and are recommended to be considered as relevant for the pertaining governance strategies.

Figure 25 – R1 results [BBN diagram]



5.3.6 *Conclusions*

The list of cumulative results obtained from the SSIs is enlisted in table 22, including confirmed, and newly proposed variables by experts and their corresponding parametrizations. Also included in the table, are the main results gathered in the previous chapters. This is done to check the degree of coherence that the information validated with the experts has in comparison with the previous stages that did not make use of expert review.

The columns, from right to left, indicate, first, the research step to which this data belongs [literature search, data mining phases, or SSIs]. The second column labeled “relationship” provides information on the links between two FX2 *consolidated factors*, it includes the root factor, the direction of the dependency, and the effect variable, in that order. In some cases, the FX2 *factors* are highlighted in bold, this signaling that the variable has been detected as one of the most important [most nested] nodes during the first round of data mining [consult chapter 5 and related annexes for detailed information] , only the top 10 nodes are indicated in table 30.

The third column called “status”, expresses the condition of each of the relationships, after the validation round with the expert SSIs, and therefore is only applicable for the answers provided by experts [not for the results of the lit. review or data mining]. The label “C” means that the relationship in question was [confirmed] expected in the BBN constructed the consolidation stage at the end of the literature review chapter after the filtering processes [based on data collector assumptions and expert judgment]. The label “N” [new] means that this is the first time that this dependency between the variables is reported.

The fourth column, named “2nd expert validation” is an extension of the information provided in column three. There are two probable contents for this column, on the one hand, each “ * ” [asterisk] expresses that this relationship was mentioned by another expert during the SSIs. If the field contains the following symbols “ * * “, this will mean that in addition to the first mention in the SSIs in which the relationship was specified for the first time, two additional experts are acknowledging the existence of this edge and its directionality. Another content for this column is “[*]” [an asterisk contained by brackets], which signals that

this relationship was already forecasted as significant in the literature review or data mining round 2. Once again, only the top ten relationships in the Orange distance map in figure 26 [chapter 4] are indicated.

Column number five ("conditional probability: P") contains the parametrization previsions indicated by the experts. It has two separate sub-columns, "label" and "value", both filled with the nomenclature developed for the CPT [section 5.2.2 of this report], to express the approximation estimate that experts assigned to the probability of certain variable has of causing a given effect on a second variable [assuming independence].

If the relationship is mentioned several times during the different interviews, the highest value among all the answers is assigned in this field. Abbreviations "F", "M", and "I" refer to frequent, moderate, and improbable labels, with the assigned values of 99%, 66,% and 33%, respectively.

Denoted with a grey shade font are those rows [relationships] that were newly proposed during one of the SSIs and were not confirmed by another expert. If a future researcher were interested in including these new variables in the BBN baseline, they would need a second validation round to confirm their presence, direction, and the probability of occurrence.

Lastly, two cases of new relationships [highlighted in bright blue] are included in the BBN baseline, this is because at least one other expert indicated their importance for the network.

Also in blue is the link between F27 "*Enabling institutional environment and policies"* and F15 *"Regulatory environment",* which will be also included in the BBN, despite only having been validated by the literature review and data mining cycles, and not by experts.

As for the direction, considering the conclusions depicted in figure 17 pp. 72 of this report, F27 is suggested to determine the existence of F15 [therefore F27 →F15]. In terms of the CPT for this variable, the author of this report, based on the understanding of both *consolidated factors,* and estimated that the probability of the institutional environment impacting the regulatory setting surrounding a given NBS, is a quite frequent event [F = 0.99% for the S1 –present].

Table 22 – Compiled results [6] SSIs and previous' chapters

	Relationship			Status	2°expert validation	Conditional probability : [P]		
	FX	Dir	FX			Label [highest]	Value	
Semi-structured Interviews	F8	>	F2	New		F	0.99	
	F5	>	F29	Confirmed		M	0.66	
	F31	>	F29	Confirmed		M	0.66	
	F18	>	F5	Confirmed		M	0.66	
	F30	>	F7	Confirmed	**	M	0.66	
	F7	>	F26	Confirmed	*[*]	M	0.66	
	F19	>	F2	Confirmed		F	0.99	
	F19	>	F24	Confirmed		F	0.99	
	F2	>	F6	Confirmed		F	0.99	
	F2	>	F16	Confirmed		F	0.99	
	F14	>	F7	Confirmed	**	M	0.66	
	F15	>	F14	Confirmed	*	M	0.66	
	F29	>	F24	Confirmed		M	0.66	
	F24	>	F16	Confirmed	[*]	M	0.66	
	F18	>	F29	Confirmed	*	F	0.99	
	F18	>	F15	New		F	0.99	
	F26	>	F24	New		F	0.99	
	F8	>	F15	New		M	0.66	
	F24	>	F11	New		F	0.99	
	F30	>	F11	Confirmed	*	M	0.66	
	F17	>	F8	Confirmed	*	F	0.99	
	F17	>	F30	Confirmed		F	0.99	
	F8	>	F30	Confirmed		F	0.99	
	F28	>	F17	New		F	0.99	
	F7	>	F11	New	*	M	0.66	
	F24	>	F1	New		M	0.66	
	F30	>	F1	New		M	0.66	
	F8	>	F7	Confirmed		F	0.99	
	F8	>	F11	New		M	0.66	
	F30	>	F26	Confirmed		M	0.66	
	F30	>	F20	N	*	M	0.66	
	F17	>	F11	N		F	0.99	
	F30	>	F12	N		M	0.66	
	F30	>	F15	N		M	0.66	
	F14	>	F24	N		F	0.99	
	F14	>	F31	N		F	0.99	
	F18	>	F2	N		F	0.99	
	F26	>	F2	N		F	0.99	
	F26	>	F22	N		I	0.33	
	F26	>	F20	N		I	0.33	
	F9	>	F22	N	*	F	0.99	
	F9	>	F20	N		I	0.33	
	F23	>	F26	N		I	0.33	
	F15	>	F22	C		F	0.99	
	F9	>	F11	N	*	F	0.99	
	F16	>	F11	N		F	0.99	
	F24	>	F15	N		F	0.99	
	F14	>	F30	N		M	0.66	
	F29	>	F11	N		F	0.99	▲ seen in BBN
Lit. Review	F27	< >	F15	n/a				
	F15	< >	**F27**	n/a	[*]			
	F16	< >	**F15**	n/a		*Undetermined hierarchy*		
	F28	< >	**F17**	n/a				
	F19	< >	**F17**	n/a				
	F29	< >	**F24**	n/a				
Mining	F26	< >	F27	n/a				
	F16	< >	F27	n/a				
	F15	< >	F26	n/a		Hierarchical order↓ *[first most important]*		
	F16	< >	F30	n/a				
	F23	< >	F27	n/a				
	F24	< >	F27	n/a				

It can be observed that among the totality of variables and relationships discussed in the SSIs, 20 [twenty] relationships that were hypothesized by the researcher in previous chapters were confirmed at least once by an expert. The experts brought to light 27 [twenty-seven] newly possible relationships, making the total of examined edges amount to 61 [sixty-one]. Only 13 [thirteen] of the total edges were confirmed by more than one expert [and maximum by two separate experts]. A combination of the status of the relationship and its validation determines whether each edge will be included in the B-PINbs baseline. Relationships previously hypothesized in this research that is *confirmed* by at least on expert were automatically added to the baseline [20 edges were in this condition], on the other hand, *newly-proposed* connections required at least two experts validating their existence for them to be added to the baseline [only 3 edges were in this condition]. This leaves the B-PINbs containing 23 relationships being validated, from which 10 [ten] were described as frequent, 13 [thirteen] as moderately frequent, and non as improbable.

5.4 STEP 2: B-PINbs framework development

This section describes the expert-reviewed B-PINbs modeling process, it uses the data validated with expert judgments obtained in step 1. The basic elements that will be used to build the BBN are the [i] variables and the directed links o relationships between them, [ii] the different states of each variable, and [iii] the conditional probability tables CPT.

The baseline has more one more parent nodes than what is recommended for simple BBNs. Additionally, all states were determined to be binary and equal to also reduce computational effort.

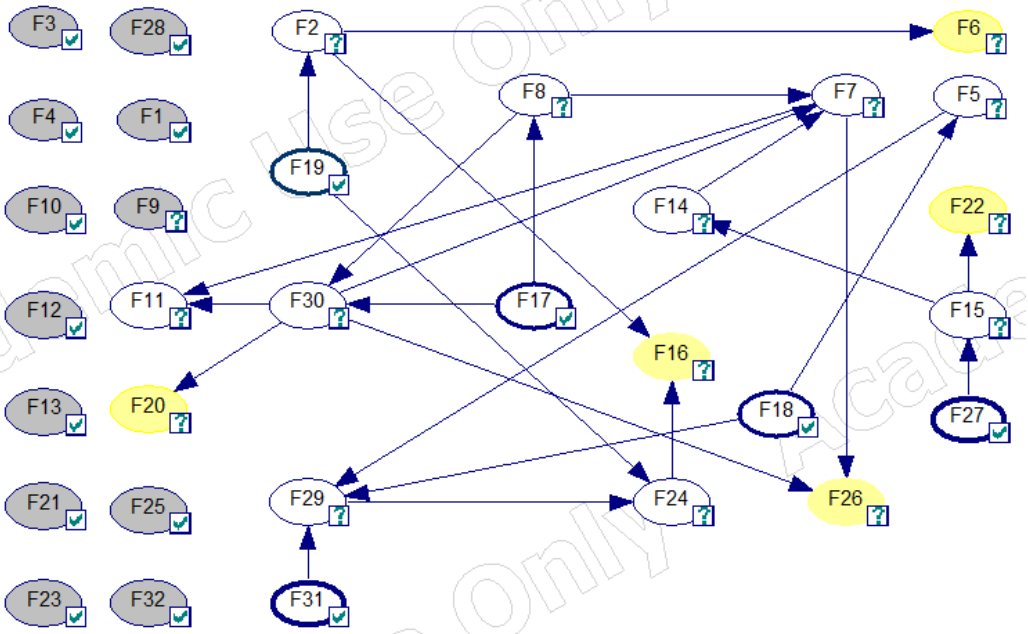
5.4.1 *The simplified B-PINbs model*

Based on the works of (Cárdenas et al., 2012; Lytvynenko et al., 2019; Pearl, 2014), the construction of the B-PINbs was made using NOISY-MAX and LEAK variables, for information on the specifics on the rationale to use these types of nodes consult annex 14.

Figure 26 shows the B-PINbs, after incorporating the SSIs cumulative results to the already known information on the BBN [consult table 22]. Indicated with a light grey filling, are FX2 consolidated factors F1, F3, F4, F9, F10, F12, F13, F21, F23, F25, F28, F32, the relationships between these factors and other nodes were

not substantially demonstrated in the SSIs [they remain isolated]. This does not imply that these aspects do not have any influence on other variables of the network, or that they should not be addressed when aiming to boost private investment in NBS, but rather, that deeper, wider studies should be conducted to explore the interactions of these aspects with the rest of the elements in the B-PINbs. Only considering those nodes and relationships that were successfully validated, we obtain a "simplified" B-PINbs baseline that only includes 20 nodes and 20 edges.

Figure 26 – Expert Validated BBN Baseline for PI in NBS [GeNIe Academic screenshot]



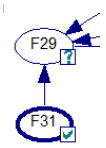
** Bear in mind that the BBN is not a model for causal relations, but a joint probability model, that represents the conditional independence assumptions in the model (Wiegerinck, Burgers, & Kappen)*

5.4.2 *Conditional probability tables population*

Recalling the recommendations for the construction of BBN's [in section 5.2.2 of this report] the construction of the B-PINbs started by inputting the probabilities of the root cause nodes [parent nodes without predecessors]. In the illustration of Network 2, the root cause nodes are highlighted with a dark bold blue border [F17, F18, F19, F27, and F31] while, shown in yellow, "the leaves" of the network are indicated [F6, F16, F20, F22, and F26].

Figure 27 shows a step-by-step example of the rationale to fill-in the CPT's of the variables F31 and F29 with the corresponding results coming from the SSIs. In short: the researcher [1] models the variables and their directed edge, [2] locates all the pertaining information to that relationship in the cumulative results table from step 1 of this chapter, [3] AND [4] with the probability value obtained in the SSIs the researcher populates the CPT in GeNIe. The same rationale displayed in fig. 27 was systematically applied to the remaining nodes until the entire B-PINbs was populated.

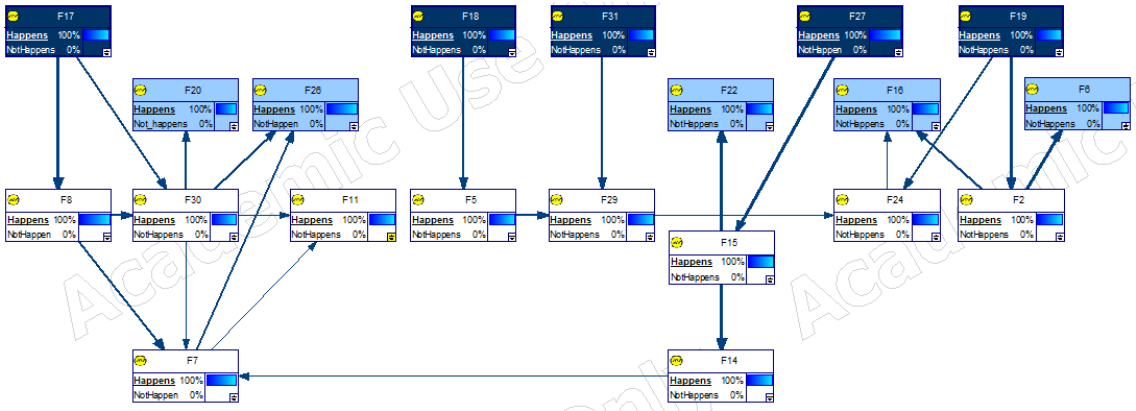
Figure 27 – Steps for parametrization of root cause node [parent]

1	*2*	*3*			*4*
GeNIe mod	*Data from SSIs*	*CPT (F29 | F31)*			*Net-parameter in GeNIe*
	- F31 > F29 - *[*] [from table 30] - [relationship] Confirmed - $P_{F29\|F31}$ = (M) [strength] - **0.66**		H	(F31) NH	[double click on node F29 to show this table]
		H	**0.66**	0	
		(F29) NH	*0.33*	1	

Parent	F5	F31	F18	LEAK
State	Happens	Happens	Happens	
Happens	0.5	0.6	0.5	0.5
NotHappens	0.5	0.4	0.5	0.5

Figure 28 showcases a screenshot of how the B-PINbs looks like after populating and arranging its variables in different layers. From top to bottom, the first level shows parent nodes in dark blue. The "leaves" variables are highlighted in a brighter shade of blue on a second layer, and finally, other more nested nodes are indicated at the bottom, in white.

Figure 28 – Bayesian belief network showing the interrelationships of factors influencing the involvement of private investment in the implementation of Nature-Based Solutions.



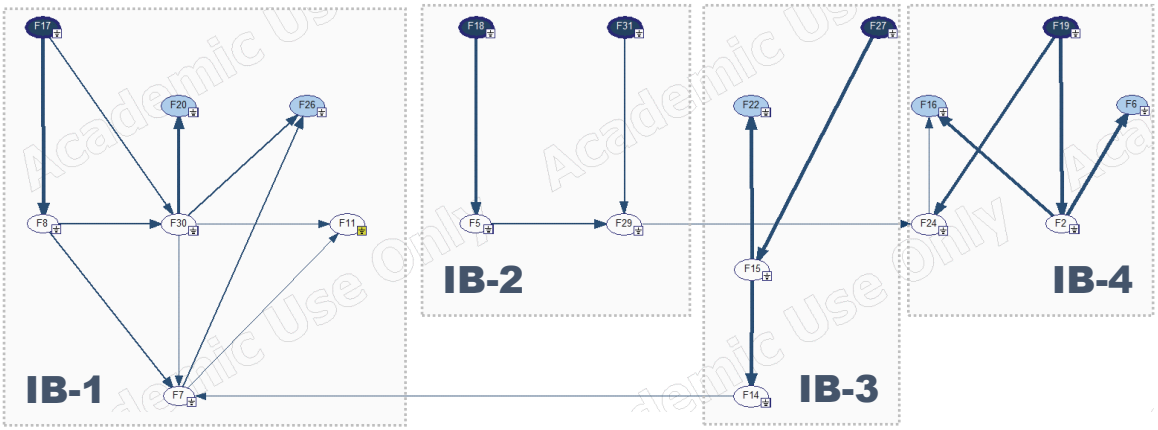
5.4.3 *B-PINbs Implementation blocks*

The different thicknesses of the arcs in the B-PINbs in figure 29 indicate the "strength of influence" or the intensity of the relationship (BayesFusion LLC, 2017), this is calculated from the CPT's of the child nodes and it is a built-in feature of the GeNIe. The thicker the edge, the stronger the connection between those variables. Consult annex 18 for the accurate numerical list of the most relevant relationships.

Analyzing the data provided before [graphical material and relationship strength table] four differentiated "bundles" of factors of influence became evident. In certain regions of the network, the nesting was much denser [variables are connected at a higher rate] and those relations were, at times, of a higher significance.

Each bundle of strongly nested variables will be referred to as an "implementation block" [IB] in this research, this is because, given their stronger interdependencies, these variables most probably will have to be addressed in a group instead of on an individual basis in any implementation and governance arrangement. Figure 29 shows the four detected IB and enlists their corresponding consolidated factors.

Figure 29 – B-PINbs implementation blocks



► IB-1		► IB-2	
F7	Long-term agenda alignment	F5	Physical risks and damages related to CC
F8	Professional biases	F18	NBS-specific features and risks
F11	Investors' capital allocation and requirements [endpoint]	F29	Modeling climate change scenarios
F17	Knowledge generation and understanding Information on NBS	F31	Ecosystems' delimiting challenges and service diffuseness

F20	Market maturity level
F26	Behavioral resistance and transition risks
F30	Awareness of nature's importance
► IB-3	
F14	Governance
F15	Regulatory environment
F22	Market size
F27	Enabling institutional environment & policies
► IB-4	
F2	Adequate asset management expertise
F6	Developing/implementing community capacity
F16	Cost-effectiveness and competitiveness
F19	Risk management, metrics, and tools
F24	Nature valuation and impact assessment

It can be observed that from the four Implementation blocks [IB-1 to IB-4], IB-3 and IB-4 stand out for their greater number of significant correlations [the former has 3 out of 3 strong relations, while the latter has 4 out of 5 links proven to be significant]. IB-1 has the largest number of nested variables [seven in total], nevertheless, the strength of those relationships is not high in comparison with other IB.

5.4.4 *Definition of endpoints [target variables]*

As was described in chapter 2, BBN's are directed acyclic graphs [DAG], in which the directions of the arcs cannot loop back into the model (Pollino & Henderson, 2010), this is because, unlike other causal methodologies, the goal of BBN's is to propagate probabilities from parent nodes to and endpoint[s], target[s] or outcome[s]. In other words, BBN's can identify the most important casual pathways and important interactions to attain specific targets or objectives.

One of the methods to do the formers is to conduct a sensitivity analysis, in preparation to do this in future chapters, it is important to identify the "endpoint" or target variables of the B-PINbs (C. Singto, L. Fleskens, J. Vos, & C. Quinn, 2020a). The first most logical target variable is F11 "investor's capital allocation". The degree of acceptance of private investors in the face of NBS [the main goal of this research] and, their level expenditure [F11 "investor's capital allocation"] mostly depends on the fulfilment of specific requirements and expectations that investors bring to the table getting involved in NBS. Therefore, the expectation is that if any of the peripheral factors to F11 experience a change, this can have a positive or negative impact on F11. To assess the degree of impact on F11 the researcher proposes to operationalize/parametrize the raw factors related to F11 [extracted from the 522-database, annex 03].

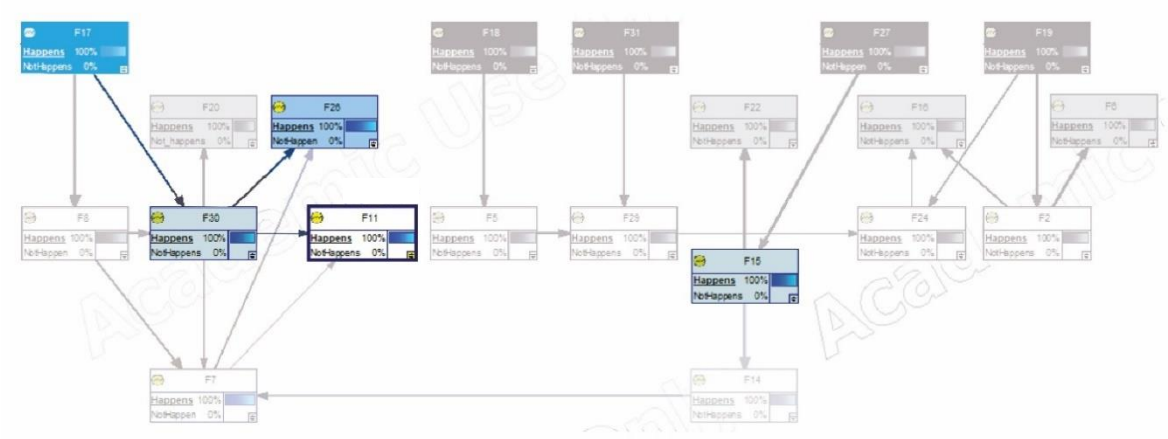
To obtain insightful conclusions in the sensitivity analysis, other FX2 factors that are less central to the main goal of this research will be included targeted as a desirable outcome. Instead of favouring variables within the same

implementation block as F11 [IB-1] for this mission, those nodes that have been historically linked throughout all phases as closely related to F11 will be set as the other target variables, the researcher has also used his expert criteria to select variables that add to the main research question in this report. Category J "investors and banks" from FX1, encompasses all the endpoints [but not exclusively], which are:

Secondary target variable

a. F26 "degree of behavioral resistance",
b. F17 "knowledge generation and understanding",
c. F26 "degree of behavioral resistance", and
d. F30 "awareness of nature's importance and sense of urgency".

For more information on the endpoints consult annex 15. Figure x shows the selected endpoints for the B-PINbs, in a GeNIe screenshot.



5.5 Conclusion

This chapter dealt with the construction of the final version of the BBN Baseline for Private Investment in Nature-Based solutions [B-PINbs]. This was done in three consecutive steps. The first section provided a fast *review* of the relevant basic elements and software to be used in the construction of the baseline framework. This section also includes some recommendations on "good practices" to build BBN.

Section two described and developed an *expert-reviewed validation round* [step 1] of the data gathered up to this point, the selected methodology was semi-structured interviews. The use of the SSIs was

twofold, to uncover new detailed information on the consolidated factors and they also served as a validation step to confirm the assumptions on relationships, their directionality, and hierarchization. Aside from a description of the design and analysis procedure for the results of the SSIs, the main highlight of this section is its outcome: a cumulative results table of all the confirmed, disproven, and newly proposed nodes, edges, and their directionality.

In summary, from the 61 [sixty-one] relationships discussed in the SSIs, 32% or 20 [twenty] edges were already hypothesized by this research and then confirmed by at least one expert. Interviewees proposed 27 potential new relationships [44% of the total of discussed edges], from which only 3 [two] were validated by more than one expert, and thus included in the B-PINbs. The baseline then only considers 23 of these "validated" edges. Most of the relationships were rated to have a moderate probability of occurring with a 66% chance [13 edges are in this condition].

Section three [step 2] begins with the visual representation of the cumulative results extracted in step 1. Consequently, it describes the process followed to fill the CPT's, to define the endpoints, and conducts a fast relationships' strength analysis with the use of GeNIe built-in features. This section concludes with a reflection on the most densely nested areas in the network [implementation blocks], and the final summarized B-PINbs, apt for its tailoring according to a real-world case. The future sections will gather information on the said NBS real case [Medina del Campo, Spain].

6 CASE STUDY: MEDINA DEL CAMPO

This chapter aims to map and analyse the presence of the baseline´s validated factors of influence in a real-world case. Secondly, since it is the first time the B-PINbs are applied to a real NBS, this chapter also tests the applicability of the baseline framework. The outcomes of Chapter 6 included the summarized B-PINbs baseline, and the definition of the endpoints in preparation to conduct a sensitivity analysis in this section.

Sensitivity analysis [SA] is a "backward reason tool" (Houben, 2010) that identifies the variables with the greatest influence on certain predetermined, baseline model endpoints (Pollino & Henderson, 2010). In other words, the goal behind SA is to define, given a "desired" outcome [value of a child node], which are the most likely conditions [values of parent nodes] to cause the said outcome. This also means that the hierarchy of the most influential nodes and relationships varies depending on the modes' states in each case study. The order of the sections in this chapter is as follows:

[1] The case is described in terms of B-PINbs variables,

[2] The B-PINbs is tailored/adapted by inputting the case's states per variable [MCGB-B-PINbs],

[3] A SA is conducted, and its results are examined.

The focus of this chapter is on the Medina del Campo groundwater body area and related ecosystems [for the selection rationale of this case, consult chapter 2, section 2.5.3 page 35]. All the pertaining information to the demo was obtained with the support and in collaboration with the Water Resources and Delta Management Department at Deltares [https://www.deltares.nl/en/] and as part of the development of the NAIAD project [consult section 2.5.3 for further details].

The presentation and evaluation of the B-PINbs through the use of a case was conducted following the guidelines for *Good practice in Bayesian network modeling* (Chen & Pollino, 2012).

6.1 General description of the MCGB

The Medina del Campo Groundwater [MCGB] site consists of a 3700 km^2 groundwater body located in the Duero River Basin, in the municipality of Medina del Campo, in the autonomous community of Castilla y León, located in the center of Spain, this region is a highly farming-oriented area. It is composed of several water bodies and stream, affecting up to 154 municipalities in total, making it important in the economic, cultural, and social national setting.

Figure 30 MCGB location

The process of implementing an NBS in the area arose from a specific triggering event. The aquifer was notified in 2010 as an over-exploited groundwater body by the Water Framework Directives 2000/60/EC and 2006/118/EC of the European Commission. This resulted in problems with the extractions necessary to maintain the current agricultural irrigation demands, which represents around 96% of the total annual extracted volume from the aquifer. The increasing demand has caused a vicious cycle of dwindling piezometric groundwater levels inducing poor water quality, a severe deterioration of aquifer-associated wetlands and streams, and finally a reduced capacity to deliver ecosystem services in the basin. This critical setting is in contrast with the increasing amount of regulation, that has become more stringent in recent years.

The biggest champion for the implementation of NBS in the area is the MCGB Duero River Basin Authority, that incorporated some nature-inspired initiative in the last 'Duero District Water Plan for the 2006-2012 period' [DWDWP], including [1] the artificial recharge to increase groundwater reserves, [2] incentivizing the use of less irrigation-intensive crops and [3] the payment and monetary incentives to boost behavioural change from farmers and the market of services provided by the MCGB (NAIAD, 2018).

The main challenges for the groundwater management of the region arise from one of two phenomena: droughts and or floods. In hierarchical order, NAIAD has indicated the following as the main threats in the MCGB (NAIAD, 2018): [1] lowering of piezometric groundwater due to excessive exploitation, [2] diffuse agricultural pollution [NO_3] and [3] high arsenic contents of lithological origin. Other problems include significant economic loses and a decreasing rural population.

6.1.1 *Diagnosis: MCGB in terms of B-PINbs variables [MCGB-B-PINbs]*

This section presents the adaptation of the B-PINbs baseline according to the Medina del Campo demo conditions. The product of this section is a parametrized network of factors of influence [to enhance] private investment in the MCGB [MCGB-B-PINbs]. The model was constructed based on the work of (C. Singto, L. Fleskens, J. Vos, & C. J. S. W. R. M. Quinn, 2020b). Table 23 displays a comprehensive exploration each factor's condition in comparison to the B-PINbs baseline.

The evidence used to diagnose each variable of the MCGB-B-PINbs was extracted from several official sources such as official deliverables, and on-site semi-structured interviews [elaborated for the NAIAD initiative both by the author of this report and other previous colleagues], in an exploration stage, before the beginning of this thesis.

Table 23 Evaluation of the MCGB in a variable basis

Variables [assessment parameters]	Condition in MCGB [quotes from interviews]	Diagnosis
IB-1		
F7 Long-term agenda alignment. Difficult mandate/objectives alignment, ownership difficulties, transparency and accountability challenge, divergences in how to achieve that overall objective, [lack of] Incentivize ambition and long-term cooperation, Effort for implementation, shifting stakeholders agenda, ambiguity in multi-actor setting, NBS complex multi-stakeholders collaboration conditions, unreliable counterparties, transparency, organizational and procedural difficulties, lack of communication, complex stakeholder environment, institutional investors lack of homogeneity, risk of fragmented approaches	Consult annex 17 – fragment 01, 09, 18, 20. *"Medina City Council is developing Local Agenda '21, [with the] environmental objective to reuse water from the water treatment plant for irrigation. Very good receptivity, problem money", "lack of trust/reliability in the Board and confederation [public authorities], it is political [corruption]", "diversity in owners", "mistrust and lack of acceptance".*	Happens [H]

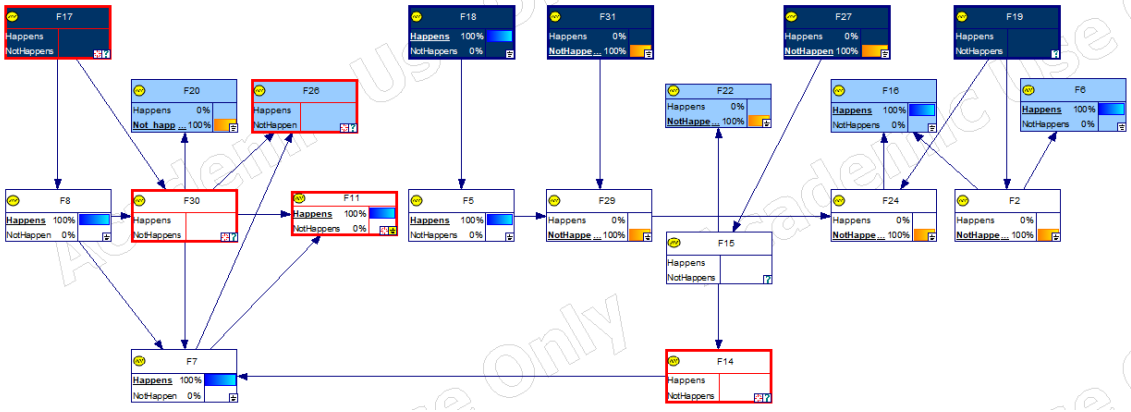
F8 Professional biases. Ecologists [professional bias], protect from nature water management approach	Consult annex 17 – fragment 14. *"[different fields biases] they trust more their own judgment than [available] tools".*	Happens [H]
F11 Investors' capital allocation and requirements. Institutional investor's [small] asset allocation to direct infra., liquidity,[investors'] focus on equity investing, spending rate, preference for NBS vs infrastructure development options in the NL, potential of mobilization, [good] exit points and strategies may be quite complex, [shortage] of capital supply for early project stages	Consult annex 17 – fragment 02, 03, 04, 07,14 *"Investment is needed … and for many years", "the problem is [the] investment", "it takes a lot of investment", "fairly strong investment", "investment is …difficult to remove/extract/mobilize".*	Endpoint
F17 Knowledge generation and understanding. NBS definitions and transparency, common understanding of NBS, their activities and products, Investors´ knowledge, experience and understanding of NBS, Data processing and presentation capacities of investors, Lack of knowledge transference between study realms	Consult annex 17 – fragment 14, 22. *"complete information to people", "training work on the optimal amount of water [to extract]", "training [is needed]".*	Endpoint
F20 Market maturity level. Market maturity, and market failures	Consult annex 17 – fragment 10, 11. *"problem with lack of value of products. Supermarkets and intermediaries who have all the [economic] benefit, [there must be a] better distribution of profits in the chain".*	Absent [NH]
F26 Behavioural resistance and transition risks. Risks of transition [innovation introduction], reluctance to change, practice and cultural shifts, Investor´s attitude, perceptions and concerns, Short-termism, Investors´ interest for reputation, Investors´ focus on the rate of return.	Consult annex 17 – fragment 10, 11. *"social and political opposition [from environmentalists for instance]", "fear of uncertainty as to whether it will work".*	Endpoint
F30 Awareness of nature's importance and sense of urgency to invest. Awareness of the need of nature [degree of individualistic behavior], Awareness/interest/sense of urgency in investing to address CC, Sense of urgency and inaction consequences awareness, Investors driven initiatives	Consult annex 17 – fragment 05, 14. *"People have environmental awareness", "awareness".*	Endpoint
IB-2		
F5 Physical risks and damages related to CC physical risks. Financial materiality of transition and physical risks, [risk] resource availability compromised by CC, [unknown] impact of climate change on the financial sector, climate change [and its risks], [rising] annual damages to GDP due to climate risk, [occurrence of] extreme weather events influence on the financial value of assets	Not mentioned during interviews. Nevertheless, the notion of the impact of CC having an increasing weight on the wellbeing of the region (Pelling et al., 2015).	Happens [H]
F18 NBS-specific features and risks. NBS unique feature, Green / NBS special risks	Consult annex 17 – fragment 15.	Happens [H]

	"the acquirer recharge is not feasible[due to its very high technical complexity,]" -the presence of particular/ unique features of this NBS.	
F29 Modeling climate change scenarios. Climate change scenarios [accuracy through time and scales, factors quantifiability challenges and sensitivity to CC Possible operationalization of societal benefits	Interviews do not directly mention this factor. Nevertheless, there are climate change scenarios and projection on the MCGB such as the one provided in deliverable 6.2 (NAIAD, 2018), nevertheless, not only is this an undergoing mission, but its accuracy through time and scales is not guaranteed.	Absent [NH]
F31 Ecosystems' delimiting challenges and service diffuseness. Challenges tied to service diffuseness and delimiting challenges	Not mentioned during interviews.	Absent [NH]
IB-3		
F14 Governance existing [non-updated] governance and risk management frameworks, government failures, better governance	Consult annex 17 – fragment 16. *"water user association [as governance measures] are key for the organization and improvement of water use" – implying that governance strategies are still under design and exploration*	Endpoint
F15 Regulatory environment Performance and its measuring, availability of adequate performance indicators for services, procurement, and bidding processes, regulatory environment [tax provisions, tariffs, enforcement], legal risks, and level of fiduciary duty	Consult annex 17 – fragment 16. *"[a proper] sanctioning regime and control strategy will take time [insinuating that it is none yet available]*	Absent [NH]
F22 Market size Scale and demand	Consult annex 17 – fragment 08. *"there would need to be a market that supports the NBS" [implies there is no market available]*	Absent [NH]
F27 Enabling institutional environment & policies. Policy and regulation risks, the existence of adequate, non-competing policies that are stable through time, adequate incentives regimes, access to subsidies and credit guarantees, enabling institutional environment	Consult annex 17 – fragment 09. "[confusion on] whether the CHD and the board are the same public body "	Absent [NH]
IB-4		
F2 Adequate asset management expertise Asset management capabilities, the informal network of asset owners, insurance sector degree of risk management and asset management, existing operating models	Consult annex 17 – fragment 17, 22. *"better resource management" [implying a lack of, "Adapt management practices to make NBS effective"]*	Absent [NH]

F6 Development/implementing community capacity. Environmental pressures on the construction sector, technological capability of the construction sector, knowledge exchange in the BCI, production network infrastructure and maintenance network, maturity of the company implementing a project, [available] technical assistance, conservative and risk avert construction sector, increasing development community	This point is mentioned in all interviews as an unknown. This is because the implementation process of the NBS in the MCGB is in its initial stages. For the SA, it will be considered that this capacity is existing but unexploited.	Happens [H]
F16 Cost-effectiveness and competitiveness Awareness of the specific needs and costs of the NBS [transition costs, upfront investment, and costs premiums], reputation of the solution against other analogous proposals, cost-effectiveness methodologies, good experiences of other investors in similar ventures [to the NBS]	Consult annex 17 – fragment 13, 17. *"high costs, but the return of those costs is worth it for the economic impact. These are long-term returns, 10-20 years [worth=effective]", "there is economic profitability in about 3,4 years".*	Happens [H]
F19 Risk management, metrics, and tools Even risk distribution of risks [perceived], availability of credible, accurate risk management metrics and environmental risk assessment tools	Consult annex 17 – fragment 19, 22. "If you put a 150eru tariff on each dealership many will unsubscribe, present water as a scarce good, payment for the right to access water. This could have risks like social unrest" [notion of risks is still vague! *"management of scarcity".*	Absent [NH]
F24 Nature valuation and impact assessment Clear financial advantages of implementing the NBS [savings], existing methodologies for nature valuation, historical forecasts accuracy on gains	Not mentioned during interviews.	Absent [NH]

After inputting the information uncovered from the case into the baseline [with the use of GeNIe 3.0], we obtain the MCGB-B-PINbs network, briefly shown in figure 31 after its parametrization.

Figure 31 – MCGB-B-PINbs



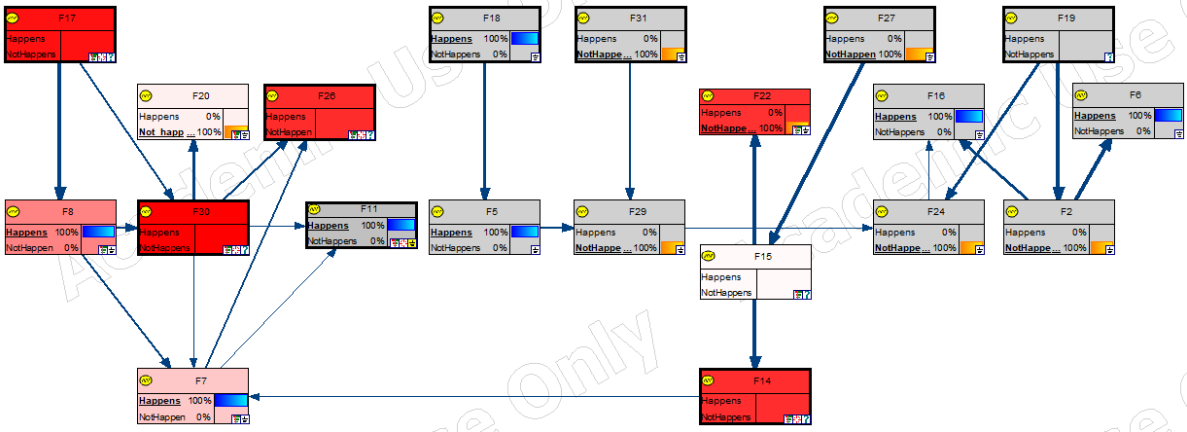
Indicated in red are those nodes that were designated as target variables [outcomes] in preparation for the sensitivity analysis conducted in the next step. Additionally, it can be observed that, through the propagation of the probabilities in the model, F11 has been forecasted as occurring given the CPT's of its peripheral nodes.

6.1.2 *Sensitivity analysis*

The sensitivity analysis [SA] enclosed in this section was conducted with the use of the built-in tool from GeNIe 3.0. As it was briefly mentioned before, SA's can be used to compare the effect of the different parent nodes on their child nodes. With this analysis, it is possible to detect the most effective way to influence the target variable via other variables (Houben, 2010).

In this case, the SA was focused on finding the variables that most influence the target variables [F11, F14, F17, F26, and F30] the resulting network is shown in Figure 32. The darker red variables show the highest impact on the target variables while paler shades of red, show variables with lower influence on the outcomes.

Figure 32 MCGB sensitivity analysis



6.2 Findings

This section provides an overview of the main results arising from the SA, it also includes some examples of how the results could be interpreted by practitioners using the PB-PINbs.

At first glance the researcher notes that the variation in the importance of the variables is too polarized, meaning that the majority of variables seem to have little to no significant influence on the target variables [the majority of nodes are highlighted in light grey]. The former phenomenon could be attributed to the fact that the variables only dispose of two states and therefore the model suffers from loss of data (Singto et al., 2020b) and a limiting discerning capacity. The researcher hypothesizes that this would be different if each one of the variables were more accurately modeled through several-layered and unique states per node.

In general terms, target variables show high sensitivity, almost exclusively to variables from IB-1 [and not to other IB's], this condition is most probably caused by the fact that the defined *endpoints* are mostly also concentrated in IB-1, this also confirms the assumptions on the IB's [drafted in Chapter 5], on how aspects within an implementation block will most probably have to be addressed simultaneously. For further information on the particular sensitivities per target node, consult annex 19 that contains a tornado diagram with the specific interactions per mode.

In terms of newly-uncovered interactions resulting from the SA, in a nutshell, the existence of a "large enough" market for NBS services [F22] as the most relevant, and the presence of fitting governance frameworks [F14] are both of vital importance in boosting the occurrence of the target nodes in the MCGB case.

The existence of governance arrangements [F14] ranks as the second non-outcome node with a high relevance. Additionally, its presence is highlighted in the SA as an aspect of moderate influence for the enhancement/hindrance of the occurrence of the long-term alignment of a common stakeholder agenda [F7 - a highly nested factor], alongside with strategies to deal with professional biases [F8] and enough awareness on nature's importance [F30].

The second batch of influential aspects for the occurrence of the outcome variables, in other words, the nodes of secondary importance for the overall set of endpoints, are the presence of professional biases [F8], long term alignment of stakeholder agenda [F7] and the degree of maturity displayed by the market [F20] [in that order]. In specific, professional biases have has a strong [but peripheral] influence on the level of awareness of nature's importance [F30] within the network and therefore also a secondary role in determining the investor's capital allocation too [F11]. On the other hand, while the alignment of the stakeholder agenda F7 definitely has a direct connection to the PI capital allocation F11, this influence is weaker than the one than

professional biases F8 have on F11 and therefore the weight of F7 on F11 is deemed as negligible as well as its role in determining behavioural resistance [F26].

Last but not least, the SA analysis also highlights the market maturity level [F20] and the regulatory environment [F15], [in that order] as incidental factors of influence.

6.2.1 *TD's and governance provisions for the MCGB*

On the other hand, exploring the results of the endpoint's tornado diagrams [TD] provided in annex 19, and the conditional probabilities and interactions that influence FX2 factor *knowledge generation and understanding of NBS information [F17]* in the MCGB, the following in-depth strategies are developed for the upscaling and management of NBS. F17 is selected as the main focus of the governance provisions because the SA highlighted it as the most influential variable in the entire network.

Figure 33 MCGB Tornado diagram of F17 [TD-17]

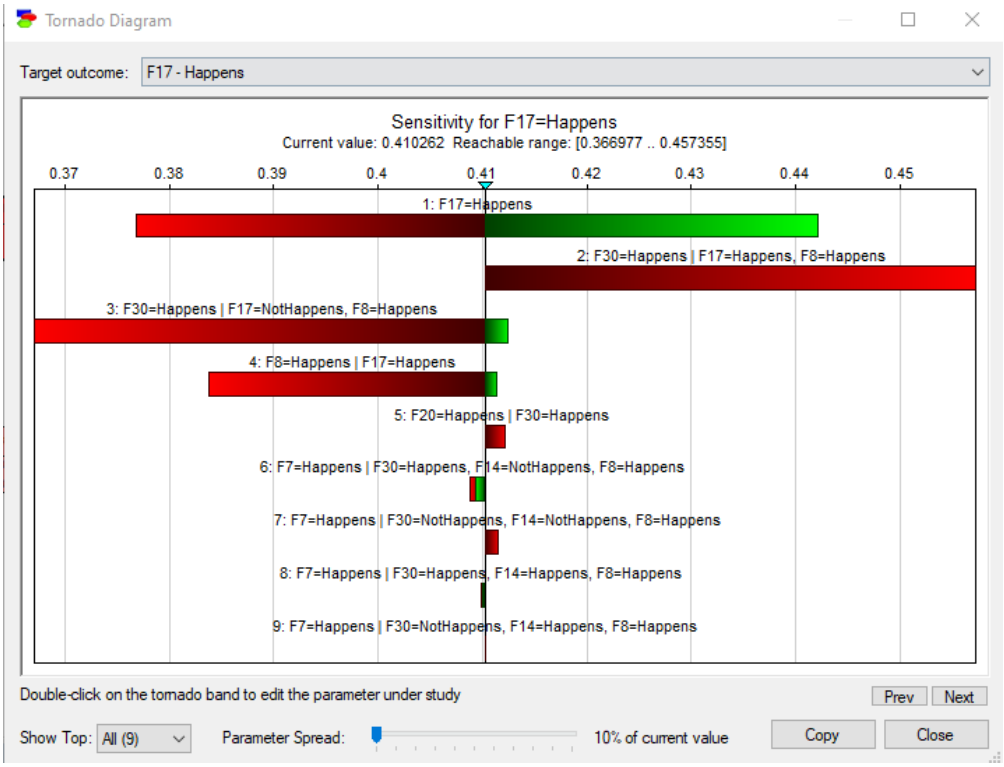


Figure 33 with TD-17 shows that the probability of F8 "professional biases" of happening given an F17 "appropriate knowledge generation and understanding" is HIGHLY [0.38] NEGATIVE [improbable], meaning

that enhancing the probability of stakeholders having enough understanding of the NBS at hand [F17] will ensure that professional biases do not take place.

Another interaction that needs to be addressed in the MCGB is the third conditional probability provided in the TD-17, which states that the probability of F30 *"awareness of nature's importance and sense of urgency to invest"* happening given that F17 "knowledge generation and understanding" does not happen and F8 "professional biases " take place, is moderately negative [0.40]. In simple words, this means that stakeholder being aware of the importance of NBS and a sense of urgency to invest in them, cannot take place if the network responsible for their implementation, is incapable of producing meaningful knowledge and does not grasp the specifics of NBS [AND] if the involved actors in the execution of the measure hold any professional biases that hinder communication, trust, and other collaboration elements.

Therefore, actions that increase the understanding of NBS, and platforms that enable the knowledge generation of the MCGB, are of utmost importance in reaching the goals related to an increase of PI in this particular NBS. It must be noted that, aside from highly technical, capacity training or performance-oriented factors, the social aspects are highlighted by this analysis as fundamental to tackle the lack of investment, in the MCGB, this means that aside from the operationalization and delimiting of the services provided by the ecosystem, exercising a constant confrontation and collaboration between opposed stakeholders is much more important and an aspect to bear in mind when designing the governance arrangement for the MCGB.

7 CONCLUSIONS, RECOMMENDATIONS AND DISCUSSION

7.1 Conclusions

When investors, policymakers, and other stakeholders, approach NBS, they are confronted with a "young" multidisciplinary, and multi-actor setting. The following sub-questions systematically address different aspects of the main research question *"What barriers and drivers enhance the involvement of private investors in the implementation of Nature-based Solutions?".*

7.1.1 *Sub question 1 [SQ-1]*

The collection of factors that influence private investment in Nature-Based Solutions, the subject of the first research sub-question, was conducted throughout chapters 3 and 4. This sub-question posed the challenge of reaching a balance between detecting as many relevant factors as possible, while also providing a manageable database for future analysis.

Given the multi-objective nature of sub-question 1, the answer was found in several different phases, some focused on gathering the actual data, and others which were aimed at creating a method and verifying the quality of the data.

As a first step, a limited, structured literature research was conducted, that identified 522 "raw" factors [barriers and drivers] to PI involvement in NBS.

To eliminate repeated or overlapping items [factor "a" was suspected to be 'part of' factor "b" i.e.], two filtering rounds were developed and applied, as a result of which the sample was reduced by 94% of its original size.

As a second response to sub-question 1, the research also aimed to identify the relationships between factors. This was attained by carrying out two data mining cycles.

The overall answer to the first sub-research question combines both findings and results in the identification of a network of 32 consolidated interrelated factors of influence for PI in NBS; each element with

a clear definition as to what it refers to, a series of underlying data points and suspected relationships with other variables.

Validation step

As a next step, a validation round was conducted to confirm the information obtained thus far. This was done via six semi-structured interviews with practitioners and experts in the field of NBS. This step had two aims. First, to verify the 32 interrelated factors [the answer to sub-question 1]. All the 32 consolidated factors were confirmed as "present" in NBS by experts.

Second, the validation also produced outputs necessary for future research steps. The direction and conditional probabilities of the relations between the identified factors were also validated. However, only 32% [20 connections] of the initial 62 hypothesized relationships were confirmed.

Three connections were pointed as potentially important by more than one expert [all related to F7 "long-term agenda alignment"] F30 – F7, F7 – F26, and F14 – F7.

7.1.2 *Sub question 2 [SQ-2]*

The second sub-question, "what factors [barriers and drivers] are critical for the decision making of PI in NBS?", yields two different answers, the importance of the factors in general terms [across NBS's] or given a specific set of circumstances.

A first filtering process reduced the number of critical factors from 32 to 20. A second step resulted in the construction of the NBS baseline model "B-PINbs", built according to Bayesian Belief Theory and adding the directionality and conditional probabilities determined by experts in the validation step. Software calculations on the strength of the relationships highlight the three strongest edges in the B-PINbs as F15 → F22, F17 → F8, and F2 → F6.

The importance of key factors was identified by applying the B-PINbs baseline to a real-world case study; the Medina del Campo Groundwater Body [MCGB] in Spain. The current state of each variable in the case was extracted from the documentation available on the measures from the NAIAD initiative. Factors F11,

F17, F26, F30, and F14 were set as the objective-variables in the sensitivity analysis that detected the most influential factors to produce a change in the target variables. The *market size* [F22], *professional biases* [F8], and ensuring the *long-term agenda alignment* [F7] were indicated as the most influential factors. Other detected important aspects were *market maturity* [F20] and the *regulation environment* [F15].

7.1.3 *Sub question 3 [SQ-3]*

Sub-question 3, *"how can knowledge extracted from the factors help overcome the hurdles of the involvement of PI in the implementation of NBS in the future?"* explores the processes of extracting insights, useful for the future enhancement of private investment in NBS. This sub-question is answered in three steps: [1] general lessons were drawn about PI in NBS from the development of the framework, [2] knowledge was obtained on PI in NBS from the application of the baseline to a particular case study, and finally, [3] knowledge was extracted from the MCGB.

Knowledge of NBS from the development of the baseline.

The B-PINbs provides a helicopter view of all relevant aspects for the enhancement of private investment in any NBS. However, an important limitation of the current B-PINbs is that is based on a structured literature review which 'only' makes use of roughly 15 articles. A bigger pool of publications could be used to develop a more comprehensive set of factors. The network shows that in NBS, factors of influence do not behave independently and that change in the state of one influences the state of others. It could very well be that a large set of factors would influence the currently identified relations between factors.

The quality of the knowledge produced from developing the B-PINbs relied on the iterative occurrence of two opposed processes: increasing the complexity and specificity of the model [to make its predictions more accurate] and maintaining the model's manageability [with simple computations], and flexibility to allow it being applied to other NBS and contexts. This report's scope was limited on both processes due to time constraints, and therefore the B-PINbs is still diffuse and its capacity to extract reliable knowledge is also severely limited. The number of organized data points, like color patches in a painting, is still insufficient to support the furnishing of a detailed description of NBS's phenomena, which can be readily improved with future

research. Nevertheless, the baseline does provide important observations such as the identification of an initial hierarchy of key factors and interactions which provide a starting point for action [extracted from the sensitivity analysis in each case]. Contrary to the common belief, the present study concludes that addressing factors within the expertise of the climate and environmental sciences [CES] such as *professional biases* [F8], *behavioral inertia* [F26] and *degree of awareness of nature's importance and sense of urgency to invest* [F30] is more important than handling the technical and financial aspects of NBS.

Figure 34—Painting a picture of NBS.

Real NBS | *increased detailed baseline. [future research]* | *the current state of the B-PINbs*

Knowledge of NBS from the application of the baseline to the case study.

The validity of the lessons extracted from applying the B-PINbs with data from the MCGB depends on the amount of information to populate the model.

The MCGB-B-PINbs case analysis was conducted in a limited time and was not as thorough, detailed, or rigorously conducted as could have been and was performed with limited case study material. The materials used were *in-situ* stakeholders' interviews and secondary case material obtained via participation in the NAIAD initiative [http://naiad2020.eu/].

The MCGB was selected as a representative case for a typical NBS, given its high compatibility with the NBS case criteria developed in chapter 2, the features of the demo are considered understandable and relevant for all concerned fields of study [BCI, CES, and IVS]. However, the more cases are used in conjunction with the B-PINbs, the stronger the confidence in the overall key factors that are provided in this study.

Nonetheless, the transferability of knowledge based on the findings to case studies that seek to apply the B-PINbs needs to take into account an important constraint. The findings are not 100% exchangeable across all NBS typologies, between NBS within the same typology, and even within the same project at different stages of the lifecycle, and thus, expert validation is important in future application of the developed method.

Knowledge on the MCGB from the application of the baseline to the case

The list of most influential factors [coming from the sensitivity analysis of the MCGB-case study], provides a preliminary order to identify potential governance measures, as well as the expected changes in the remaining variables when changing any critical aspect. This knowledge can support the development of specific measures that can enhance the involvement of PI in the MCGB.

The tornado diagram of F17 in the last chapter identified that the problem that the MCGB demo is facing is the knowledge generation and understanding of NBS, an aspect that directly impacts most of the critical aspects of PI success in NBS. The lack of common understanding [F17] increases professional biases as well as behavioral resistance to change and creates barriers for the establishment of a long-term agenda among those involved in the implementation of measures.

As mentioned before, the insights of the MCGB-B-PINbs will be different on each case and at different stages of the same project, and therefore the importance of keeping an iterative feeding–learning loop when using and improving the network.

Furthermore, they can serve as a baseline for the consideration of more generic measures that might be appropriate to consider.

7.1.4 *Main research question conclusion*

The main research question of the research was: “What barriers and drivers enhance the involvement of private investors in the implementation of Nature-based Solutions?”

Based on the findings of the previous sub-research questions we are now able to answer the main research question. The thesis describes the development of a method to detect the most important factors of

influence for private investment in the implementation of nature-based solutions. Initially, the framework yielded a list of 32 relevant connected factors. Expert validation led to a total of 20 validated aspects.

The second stage using Bayesian Belief Network theory [BBT], sketched a baseline, and using a sensitivity analysis, obtained a hierarchy on the factors of a 'typical' nature-based solution, the case selected as representative of NBS is the Medina del Campo aquifer and related ecosystems, in Spain. Three aspects stood out as the most critical for the MCGB: the size of the NBS market [F22], professional biases [F8], and long-term agenda alignment [F7]. Based on the experience of applying the baseline for the first time on a real case, this research proposed some governance recommendations to enhance PI in the MCGB.

The development of the baseline is innovative because it is among the first applications and tests of Bayesian belief theory and sensitivity analysis outside technical assessments and risks analyses of projects, and as a comprehensive tool to understand NBS. Its added value is that it unlocks information only available for highly specialized spheres [such as environmental sciences, financial engineering, or asset management] and makes it available for not-so specialized stakeholders, using a visual tool.

The B-PINbs shows connections between aspects of NBS that would not be otherwise related in literature; it includes, both, very ambiguous and specific factors across several fields of study.

Applying the B-PINbs baseline to new cases will enable practitioners and academics to learn and adapt the framework according to the new findings. The major limitation of current method is that the findings of the application of the baseline will vary from case to case, depending on the lifecycle stage of the project, and the degree of maturity of the baseline at the moment of assessment. The researcher considers that this is the first step in the development of a complete, validated, and accurate model of factors of influence for PI in NBS.

7.2 Recommendations

This section provides a compilation of the scientific and practical recommendations arising from this research [for a complete list of detailed recommendations consult annex 22]. Additionally, this section concludes with some discussion points. It is the researcher's advice to repeat the baseline's application to test

its validity and applicability in other case studies, varying the NBS typologies, but most importantly, conducting a more in-depth analysis of the demos.

It is recommended for future research to extend the steps that increase the complexity of the research [such as the literature review, data mining, and case study], and to increase the number of steps that synthesize and validate the data [such as the filtering phase and semi-structured interviews]. Additionally, it is advised to conduct an extension of the database by including a greater amount of literature sources.

It is also important to invest more attention in the customization of the baseline when applying it to new cases, including being mindful of the quality of the inputted data and the operationalization of the variables, states, and relationships. This could be done by developing a *benchmark or protocol* to delimit what is “acceptable” information to input into the B-PINbs.

Another way to improve the customization is examining all the variables of the baseline in sessions with experts and stakeholders, where they can provide knowledge on the aspects, they have the most expertise in and can reach joint-understanding and consensus on the B-PINbs.

7.3 Discussion

Climate Change and its increasing pressure on environmental systems, have set an unknown deadline for action and investment in mitigation and adaptation measures like NBS. This pressing issue makes the researcher wonder whether it is necessary to “let go” the design methodology and bring the B-PINbs outside the academic realm and treat it as a joint endeavor between scientists and practitioners. Since the usefulness of the baseline relies on the simultaneous development and the application of the B-PINbs, it is speculated that perhaps it is time to release the framework in a ”good enough” state instead of waiting for it reaching its most accurate condition.

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9 ANNEXES

9.1 Annex 01 – CONDENSED FACTORS nomenclature [FX2]

ID	Umbrella concept	Category
F1	Scale and minimal optimal size of the project	A. Investments / NBS / Project features
F2	Adequate asset management expertise	B. Asset management
F3	Level of domestic and international investment	C. Markets for natural / sustainability /green vehicles
F4	Ratings, indices, and listings	C. Markets for natural / sustainability /green vehicles
F5	Physical risks and damages related to climate change	D. Risks and metrics
F6	Developing/implementing community capacity	F. Networks
F7	Long-term agenda alignment, trust, and transparency among stakeholders	F. Networks
F8	Professional biases	F. Networks
F9	The multitude of functions and services and their challenges	G. Investment returns and benefits
F10	Information asymmetry	H. Information
F11	Investors' capital allocation features and requirements	J. Investors/banks
F12	Funding sources	L. Policy, regulation, subsidies, and incentives
F13	Historical funding strategies	L. Policy, regulation, subsidies, and incentives
F14	Governance	L. Policy, regulation, subsidies, and incentives
F15	Regulatory environment	Mixed
F16	Cost-effectiveness and competitiveness	Mixed
F17	Knowledge generation and understanding	Mixed
F18	NBS-specific features and risks	Mixed
F19	Risk management, metrics, and tools	Mixed
F20	Market maturity level	Mixed
F21	Secondary market	Mixed
F22	Market size	Mixed
F23	The political and economic landscape	Mixed
F24	Nature valuation and impact assessment	Mixed
F25	Financial risks	Mixed
F26	Degree of behavioral resistance	Mixed
F27	Enabling the institutional environment and policies for NBS	Mixed
F28	Information on NBS	Mixed
F29	Modeling climate change scenarios	Mixed
F30	Awareness of nature's importance and sense of urgency to invest	Mixed
F31	Ecosystems' delimiting challenges and service diffuseness	Mixed
F32	Blended finance	Mixed
N	excluded	n/a

9.2 Annex 02 – Literature review database sample

9.2.1 *Example of field columns by an individual factor- Source 01: G20 Green Synthesis Report*

For further details and the complete database [with 522 factors], contact the author.

#	original fragment	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
1	how to appropriately and cost-effectively internalize environmental externalities	A project that internalizes externalities is capable of monetizing on, for instance, reduced pollution, increased residential property value [externalities are consequences resulting from the execution of the project]. [pp.29] Inadequate compensation for positive externalities, and penalties for negative externalities, inadequate price signals.	environmental externalities	[cost-effectively] internalized	internalized / not internalized	NEUTRAL	F24	Nature valuation and impact assessment
2	inadequate maturity mismatch	difference between the supply of long-term funding relative and the demand for funding by long term projects. Infrastructure heavily relies on bank lending for long-term financing, banks are constrained by the short tenor of liabilities. Alignment of investor's funds and long-term policy signals. The problem is aggravated in green projects because they require larger up-front investments. [pp. 29] Sub-factors include lack of appropriate financing instruments for long term green projects.	maturity mismatch	inadequate	significant / not significant	BARRIER	F20	Market maturity level
3	Lack of clarity in green finance [activities and products]	lack of clarity of what constitutes green finance activities and products [green loans and bonds], including an inadequate definition of green finance, or too many definitions. [pp.29] Sub-factors: lack of green loan definition, lack of green bond definition, and lack of green asset definition.	green finance activities and products	unclear	clear / unclear	BARRIER	N	Excluded
4	Asymmetric information on green projects	lack of disclosure of environmental information by executing companies and/or projects, i.e., no info on the companies' environmental performance, data segregation [data collected by enviro. Regulators not shared with banking regulators and investors]. It also includes a lack of knowledge on the commercial viability of green projects by financers.	information on green projects	asymmetric	sufficient / not sufficient	BARRIER	F10	Information asymmetry
5	Inadequate financial institutions' analytical capabilities	Banks and institutional investors' general understanding of the financial implications of environmental risks, including identifying risks and quantifying them. Usually, the 'brown' project's risk is underestimated, while the green investment risks are usually overestimated. [pp.29] Sub-factors: lack of capacity to assess the impact on credit risk, and lack of capacity to assess the impact of asset valuation.	financial institutions' analytical capabilities	inadequate	adequate / inadequate	BARRIER	F17	Knowledge generation and understanding
6	No universally accepted framework for green or sustainable banking	[and green bond guidelines] to integrate environmental factors into banking operations, nevertheless there are several important initiatives. Some banks are incorporating environmental factors as 'stress testing' tools	framework for green or sustainable banking	not universally accepted [none]	sufficient / not sufficient	BARRIER	F32	Blended finance
7	limited application of sustainable banking principles	no-voluntary banking principles, due to lack of understanding of their importance, lack of consistency between risk management and green lending guidelines, lack of reporting practices [therefore low-performance forecasting]. Including i.e., disclosure practices [pp.27]	application of sustainable banking principles	limited	sufficient / not sufficient	BARRIER	F13	Historical funding strategies
8	lack of awareness on the benefits of green bonds	clear and implementable green bond criteria and requirements to label projects eligible for green bonds	awareness of the benefits of green bonds	lack of	sufficient / not sufficient	BARRIER	F26	Degree of behavioral resistance
9	lack of bond ratings, indices and, listings	[for green finance products] to pinpoint the benefits from the use of the green bond's proceeds, assess which green bonds are high quality [benchmarking]. These options have only been explored by small rating agencies, index companies, and stock exchanges	bond ratings, indices, and listings	lack of	sufficient / not sufficient	BARRIER	F4	Ratings, indices, and listings

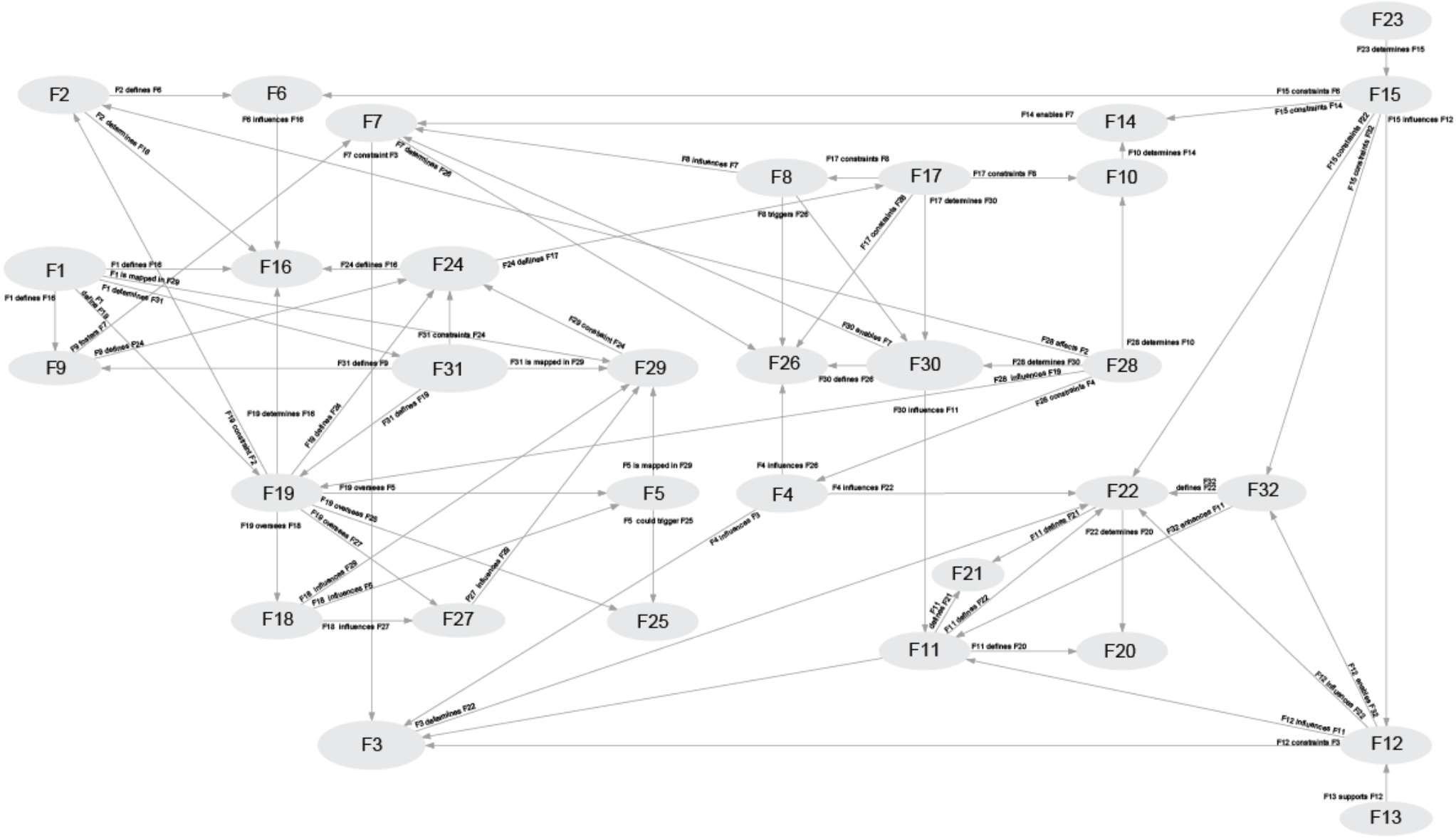
10	[limited] difficult access for international investors into local markets	differences in green bond definitions and disclosure requirements for projects across markets. Increased transaction costs i.a. There are also border issues such as capital controls, lack of FX hedging instruments, differences in trading hours, etc. constraining cross-border investments in a wide range of asset classes.	access for international investors into local markets	[limited] difficult	sufficient / not sufficient	BARRIER	F3	Level of domestic and international investment
11	lack of domestic green investors	existence of green institutional investors, with expertise labor and/or investing preferences for green assets, both important in providing sufficient demand. Includes, lack of disclosure by institutional investors on their practices for integrating environmental factors into their investment strategy, and lack of capacity to quantify the environmental costs/benefits of their investments, also many investors remain indifferent between green and brown assets.	domestic green investors	lack of	sufficient / not sufficient	BARRIER	F3	Level of domestic and international investment
12	[the existence of] positive financial performance when investors incorporate ESG principles	Correlation between ESG principles and financial performance. While correlation does not imply causation, nevertheless, 62% of meta-analyses show a positive link between those investors that incorporate environmental factors [ESG] and their financial performance. The incorporation of ESG factors varies according to the investors' profile, client priorities, investment objectives, region, and the materiality of the different factors.	financial performance when investors incorporate ESG principles	existence of	existent / non-existent	DRIVER	F16	Cost-effectiveness and competitiveness
13	[the existence of] national-level initiatives	alongside thematic initiatives such as the Global Investor Coalition on Climate Change i.a. Includes countries introducing financial policies and regulations like requiring institutional investors to provide ESG disclosures. [PP.30] Including the promotion of cross-border investment and bilateral collaboration.	national-level initiatives	existence of	existent / non-existent	DRIVER	F27	Enabling the institutional environment and policies for NBS
14	Lack of green investment strategic policy signals	refers to the country's visibility and predictability policy. Policy uncertainty translated into risk premiums, higher financing costs, and lower funding for green projects. The few signals provoke what is called the 'first mover' inertia for investors. Ultimately causes scarcity of incentives for long-term investment in green projects	green investment strategic policy signals	lack of	existent / non-existent	BARRIER	F27	Enabling the institutional environment and policies for NBS
15	lack of credible environmental risk analysis tools	lack of capacity, complexity, and the absence of adequate data [accurate, meaningful, comprehensive, and consistent]. Requires expertise that is often not found in one single institution [needs collaboration between financial, environmental, and policy specialists as well as international knowledge]. To address it, dialogue on environmental and financial risk should be enhanced, incl. facilitating knowledge exchange.	environmental risk analysis tools	credible	credible / not credible	BARRIER	F19	Risk management, metrics, and tools
16	[the existence of] impact assessment methodologies for green finance	broad economic and social impacts of green finance projects	impact assessment methodologies for green finance	existence of	existent / non-existent	NEUTRAL	F24	Nature valuation and impact assessment
17	promoted voluntary principles for green finance	by country authorities, international organizations, and the private sector	voluntary principles for green finance	promoted	promoted / not promoted	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
18	[enough] network learning capacity	analytical capacity of the network, through platforms [like the sustainable banking network, and the principles for responsible investment]. Ideally expanded over several countries and financial institutions.	network learning capacity	[enough]	sufficient / not sufficient	NEUTRAL	F17	Knowledge generation and understanding
19	local green bond markets [maturity]	data collection, knowledge sharing, and capacity building	local green bond markets	[degree of] maturity	mature / not mature	NEUTRAL	F20	Market maturity level

9.3 Annex 03 – Complete list of RAW factors [root concepts] as extracted from literature.

[1] Environmental externalities
[2] Maturity mismatch
[3] Green finance activities and products
[4] Information on green projects
[5] Financial institutions' analytical capabilities
[6] Framework for green or sustainable banking
[7] Application of sustainable banking principles
[8] Awareness of the benefits of green bonds
[9] Bond ratings, indices, and listings
[10] Access for international investors into local markets
[11] Domestic green investors
[12] Financial performance when investors incorporate ESG principles.
[13] National-level initiatives
[14] Green investment strategic policy signals
[15] Environmental risk analysis tools
[16] Impact assessment methodologies for green finance
[17] Voluntary principles for green finance
[18] Network learning capacity
[19] Local green bond markets
[20] Risk analysis tools and associated metrics
[21] Financial impacts [and risks]
[22] Technical barrier
[23] The time horizon for environmental risks to materialize.
[24] Environmental data [PAED]
[25] Understanding of environmental risks
[26] Pricing of environmental risks
[27] Management of environmental risks
[28] Service supply chain
[29] Liabilities for insurance companies
[30] Database on existing green technologies
[31] Data presentation [for the financial sector user]
[32] Pollution reduction benefits
[33] Methods to quantify the benefits and costs of green projects.
[34] Risk scenario's
[35] Confidence in macro parameters
[36] Search costs [of environmental data]
[37] Institutional capacity
[38] Green bond markets
[39] Local definitions [green bond]
[40] Disclosure requirements for green bonds
[41] Capital controls for green bonds.
[42] Common methodology to conduct blended finance.
[43] Incentives for using blending finance.
[44] Blended finance definitions
[45] Local financial markets
[46] Knowledge and capacity gaps
[47] Political uncertainty
[48] Financial uncertainty
[49] Risk/return of a project
[50] Interest rate subsidies
[51] Technical assistance
[52] Loan guarantees
[53] The company implementing the project.
[54] The company implementing the project.
[55] Interaction between lending facilities and other investment inst.
[56] Objectives alignment
[57] Ownership difficulties
[58] Transparency and accountability challenges
[59] Information on blending projects [other]
[60] Standardized [impact] indicators.
[61] [number of] stranded assets
[62] Physical risks
[63] Policy risks
[64] Liability risks
[65] Risk interactions
[66] Investment forecasts for climate-related projects
[67] Climate change scenarios
[68] Data
[69] Investment model
[70] Stakeholder's agenda
[71] Stakeholders' interest for climate-related reputation
[72] Asset owner's in-house expertise
[73] Governance and risk management frameworks
[74] Asset valuation mechanisms for factoring climate-related factors
[75] Shared industry asset-level database
[76] ESG investment rating services
[77] Banks' ability to make quantitative judgements about climate-related data.
[78] Banks position on climate-related investments
[79] Awareness of the vast scale of climate risks
[80] Investment gap
[81] Productivity
[82] Green infrastructure benefits
[83] Dependence of benefits on long-term capital mobilization
[84] Low interest-rate environment in OECD countries
[85] Weak economic growth in OECD countries
[86] Green infrastructure's investments
[87] [of green investment's] illiquidity
[88] [green investment's] policy dependence
[89] Institutional investor's asset allocation to direct infrastructure
[90] Regulatory and policy uncertainty
[91] Financing vehicles
[92] Investor's inexperience with direct investing
[93] Investor's inexperience with new technologies and assets
[94] Market and government failures
[95] High profile incidents in renewable energy investment
[96] Performance of green financial vehicles
[97] In-house asset management capabilities
[98] Green sectors cost-competitiveness
[99] Institutional investor's risk appetites
[100] Integrated domestic green investment policy framework.
[101] Incentives regime
[102] Economic landscape
[103] Feed-in tariffs
[104] Short-termism
[105] Institutional investor's tax liability
[106] [inefficient] competition policy
[107] Consequences of financial regulations
[108] Green financial vehicles issuance
[109] [existing] highly liquid vehicles
[110] Dominant infrastructure fund model of financing
[111] Transparent information and data
[112] Bidding process
[113] ALM application issues
[114] Need for scale.
[115] Deal size
[116] Political uncertainty
[117] Project pipeline and quality historical data
[118] Risk/return imbalance
[119] Duration policy support
[120] Special species or risk
[121] Capital competition.
[122] Fees to support fund structure
[123] [green investment] gain liquidity
[124] Securitization
[125] Credit and ratings issues
[126] Institutional investor's homogeneity
[127] Establishment of newer asset classes
[128] Proof of policy stability
[129] Governance
[130] Education institutional investors
[131] Contractual documents
[132] [degree of] financeability of green investments by public sources
[133] Econometric models
[134] Climate scenarios
[135] [forecasted] return opportunities for long-term investment.
[136] Expected annual return impacts.
[137] Stress testing portfolio findings
[138] Multidecade time horizon portfolios
[139] Environmental] change
[140] Awareness of climate change risks
[141] Climate risks
[142] Investor's [common] aim for returns delivery.
[143] Financial materiality of transition and physical risks
[144] Awareness that fiduciaries need to address CC.
[145] Legal action against companies for failure to mitigate, adapt or disclose cc risks.
[146] Historical data
[147] Uncertainty in forward-looking scenarios
[148] Alternative scenario model supplements
[149] Transition to a low/zero-carbon economy
[150] Spending rate
[151] National/subnational policy
[152] [risk] resource availability
[153] Risk factors pathways awareness
[154] Modelled scenarios
[155] Magnitude of results
[156] Exposure [of the portfolio] to uncertainty the further in time the analysis goes.
[157] Alarm on risk of systemic financial failure
[158] Assumption that adaptation costs are outside the investor timeframe.
[159] Social factors
[160] Healthcare sensitivity to cc
[161] Migration sensitivity to cc
[162] Liability risks
[163] Acknowledgement of un-quantifiable aspects of cc
[164] Sensitivity of infrastructure as an asset class
[165] Transition risks for real assets
[166] Time horizon mismatches across capital markets
[167] Uncertainty regarding global pathway towards a given scenario.
[168] Inability of humans to account for the effects of future risks.
[169] Cc-related peer practices
[170] [risk] potential for stranded assets
[171] Consensus on the market pricing mistakes.
[172] Infrastructure is a main driver for development.
[173] Demand for infrastructure
[174] Upfront capital costs required for sustainable infrastructure.
[175] Operating costs of sustainable infrastructure
[176] Yields in traditional asset classes.
[177] Correlations to other asset classes
[178] Cash yield
[179] Inflation protection
[180] Investment performance
[181] Popularity of low-carbon indices [reputation]
[182] Carbon data
[183] Low-carbon indices
[184] Green bonds
[185] Green bonds portion of the global bond universe
[186] Sector-level benefits for advanced planning & timely action
[187] Influence obligation of fiduciaries
[188] Number of investor initiatives
[189] Momentum cc-leadership at midsize asset owners
[190] Network[s] of asset owners
[191] Consequences of even 0.5c degree increase
[192] Cost of inaction.
[193] Risk-adjusted returns
[194] Blended finance definitions
[195] Donor interest
[196] Structured blended finance funds
[197] Evidence of blended finance
[198] Monitoring and evaluation systems
[199] Common framework of blending
[200] Development community [network]
[201] Risks and uncertainty
[202] [blended] markets
[203] Information asymmetries
[204] Market imperfections or failures [risk]
[205] Additional investment catalyzer
[206] Reputation benefits [of using development finance at a project level.
[207] Providers network benefits [of using development finance]
[208] Expertise benefits [of using development finance]
[209] Investors risk/return assumptions
[210] Foreign currency risk
[211] Blended finance funds benefits
[212] Strategic focus and exit strategy.
[213] Fragmented approaches risk
[214] Local ownership of the project
[215] Transparent and bankable pipelines
[216] Demand for investment in the developing world
[217] Development and transaction costs
[218] Funding models
[219] Regulations and policies
[220] Public budgets and tax bases
[221] Investor protection concerns
[222] Commercial viability of project
[223] Political risk
[224] Global financial regulatory risk
[225] Global economic growth impact
[226] Investors' appetite and capacity
[227] Reputation of infrastructure
[228] Private investors' features [requirements]
[229] Macroeconomic and business risks
[230] Relevant information on risks
[231] Technical risks
[232] Diversification opportunities
[233] Private investors' interest for SDG 13 - climate action
[234] Cultural change for pp co-operation
[235] Transaction period [time uncertainty/risk]
[236] Exit points and strategies.
[237] Rating agencies scores
[238] Sustainability premium
[239] Projected future global demand for infrastructure services.
[240] Transparency
[241] Scale
[242] Operating models
[243] Corruption
[244] Taxes and regulations
[245] Technical assistance
[246] Structural improvements in financial markets
[247] Impact of climate change on the financial sector
[248] Extreme weather events influence financial value of assets.
[249] Institutional investors fiduciary duty
[250] Levels of awareness about climate change in the financial sector
[251] Annual damages to GDP due to climate risk
[252] Demand for green infrastructure investments
[253] [inherent] complexity of ecosystems
[254] Levels of risk awareness
[255] Potential to capitalize on natural ecosystems' services.
[256] Cost-effectiveness of conservation payments
[257] Cost-effectiveness of green infrastructure
[258] Multitude of benefits of green infrastructure
[259] Damage reduction value of ecosystems
[260] Co-benefits of ecosystems
[261] Insurance sector expertise on risk assessment and management
[262] Modelling to assess risk mitigation capacity of green infrastructure.
[263] Stand. Global evaluation methods for investors and public bodies
[264] [interest] on institutional innovation
[265] Standards and safety regulations for the BCI sector
[266] Construction sector
[267] Protect from nature's water management approach.
[268] NBS performance engineering and measuring.
[269] Different language between NBS proposers and decision makers
[270] Need for KPI [key performance indicators]
[271] Climate-related risk management systems
[272] Ambiguity in multi-actor setting.
[273] Preference for NBS vs infrastructure development options in the NL

[274] NBS are capital-intensive.
[275] Nbs are unique
[276] Benefits [services] of NBS
[277] Benefits [services] of NBS
[278] Autonomous earning power
[279] Risk profile of NBS
[280] Perceived risks
[281] Information gaps
[282] Financial attractiveness of NBS
[283] NBS capital and operative expenses
[284] Investment levels than BAU infrastructure maintenance
[285] Long-term environmental impact on cities.
[286] Externalities
[287] Green projects' high risk
[288] Current global fiscal constraints
[289] Global infrastructure demand
[290] Upfront investments
[291] Transaction costs
[292] Private sector knowledge and experience in greening infrastructure
[293] the anti-green bias of some existing local tax provisions
[294] Policy coherence across levels of government
[295] The market for green investment projects
[296] Returns on green urban investment.
[297] Demand risks in PPP and PFI
[298] Unsolicited PPP/PFI schemes
[299] Indicators for performance-oriented contracting
[300] Outcomes and consumption patterns
[301] Government subsidies
[302] Compensation for the base cost
[303] Credit guarantees.
[304] Tax incentives
[305] risk distribution among stakeholders
[306] Access to loans and bonds
[307] Bond investment in green infrastructure
[308] Market failures
[309] Limited market size
[310] institutional and technical capacity
[311] Mitigation projects measurement of effects
[312] Relationship [co-operation]
[313] Transaction costs
[314] Awareness of the value of nature for the business community
[315] [forecasted] increase in global infrastructure spending.
[316] NBS financial advantages and sustainable competitiveness
[317] NBS support for economic development in urban areas
[318] Agricultural intensification
[319] interest and awareness of the need to maintain, and restore, the functionality of degraded ecosystems and their services.
[320] Evidence that ecosystem restoration has a key role in increasing resilience to impending risks and threats.
[321] NBS developing cost.
[322] NBS maintenance cost
[323] NBS carbon emissions
[324] NBS cost-effectiveness
[325] NBS multiple benefits
[326] Multifunctionality of NBS and benefits [other]
[327] Methodologies and conceptual frameworks for assessing the insurance value of nature.
[328] Comprehensive evidence on NBS
[329] NBS bankability
[330] NBS net effects
[331] NBS collaboration conditions
[332] NBS up-scaling capacity
[333] Business and investment models and platforms for public-private partnerships
[334] Voluntary market-based incentives for business and individuals
[335] Practical advice extraction from academic papers
[336] NBS benefits quantification
[337] NBS definition
[338] Institutional and financial frameworks
[339] Nature projects a variety of services
[340] Financial incentives
[341] Awareness of the benefits of sustainable building
[342] Organizational and procedural difficulties
[343] Risks
[344] Unforeseen costs
[345] Steering mechanisms
[346] Client understanding
[347] Regulative and enforcing regulation.
[348] Initial and transition costs
[349] Payback periods
[350] Funding
[351] Communication
[352] Reluctance to change.
[353] Knowledge and information
[354] Cost premium of sustainable projects
[355] Fear to potentially lose competitiveness.
[356] Need for positive rate of return.
[357] Cost savings in the long run of sustainable innovations
[358] [inadequate] benefits of sustainable measure allocation
[359] Institutional support
[360] Knowledge and information
[361] Aversion or risks
[362] Interest to achieve a low emissions and waste free economy.
[363] Environmental pressures on the construction sector
[364] Technological capability of the construction sector
[365] Knowledge exchange in the construction sector
[366] Technical aspects and design specifications
[367] Market
[368] Production network
[369] infrastructure and maintenance network
[370] Societal and environmental effects
[371] Stakeholder environment
[372] Management of ecosystem services
[373] Delimitation of ecosystems boundaries
[374] Ecosystem services to humans
[375] Hole of knowledge on how ecosystems ecologically [translate] to economic value.
[376] Ecosystem benefits user's [interest] on the result
[377] Ecologists fear that assigning a price to ecosystem functions will detract policy.
[378] imprecision inherent in ecosystem service valuation
[379] Failure to account for natural value in regulatory and market settings
[380] Ecosystems are dynamic systems.
[381] Unanticipated feedback and feedforward effects of ecosystems' management decisions
[382] Ecologists' ability to describe the trade-offs and synergies.
[383] Ecologists professional bias
[384] Ecosystems complex adaptive [nature]
[385] [need for] a method of economic description of ecosystems.
[386] Acquirement of ecosystem services
[387] Sense of urgency to invest in ecosystems.
[388] [interest] in engaging in the market to maximize personal gain.
[389] Applicability of the economic system to ecosystem services
[390] Availability of ecosystem services
[391] [belief] that some ecosystem services are positive externalities.
[392] Capital owners focused on maximizing individual economic gains.
[393] Majority of private owners wish to maximize economic gain.
[394] Cost of information in ecosystem service transaction.
[395] Availability of other methods of value estimation
[396] Reliability of non-market valuation methods for ecosystem services
[397] Transaction costs
[398] Free rider problem of open access of ecosystem services
[399] Risk moving between scales with limited economic data.
[400] awareness that human populations depends on the biosphere's capacity of goods and services.
[401] Market value of ecosystem services in the future
[402] "weak sustainability" premise
[403] Formation of property rights and institutional frameworks for common-pool-like resources
[404] Degradation of ecosystems and its services supply
[405] Tragedy of ecosystem services
[406] Cooperation in the creation of a property rights system
[407] Market failures
[408] Concerns that ecosystem services defy the assigning of property rights and establishment of markets.
[409] Difficulty in enforcing free riding.
[410] Markets' incentive for selfish behaviors
[411] Other kinds of property rights
[412] Anti-ecosystem bias of property law
[413] Regulation
[414] Social norms
[415] Existence of man-made substitutes to obtain the same ecosystem services.
[416] People adaptation capacity to the absence of ecosystem services
[417] Creation of winners and losers when market defect correction and policy introduction
[418] Transition problems
[419] Financial savings
[420] Sustainable actions
[421] Running costs
[422] Return on investment.
[423] Environmental protection
[424] Co2 savings
[425] Current support programs
[426] Local resources
[427] Acceptability citizens
[428] Effort for implementation
[429] Initial investment
[430] Multiplier effects
[431] Local promotion of economic development
[432] Personal impression
[433] Short-term action
[434] Potential of mobilization
[435] Local socio-cultural factors
[436] lifetime of infrastructure investments
[437] Differences in how to achieve that overall objective.
[438] Consumption patterns
[439] Development of instrument-specific methodologies for GHC accounting
[440] MDBS role in climate risk management and policies
[441] Transparency on risks and opportunities of investments
[442] Role finance plays in the global response to the climate crisis.
[443] Involvement of MDBS [multi development banks] in climate change investments
[444] Consumption patterns
[445] Assumptions underlying the cc global scenarios.
[446] Risk of stranded assets
[447] Lock-in risk
[448] Negative lists
[449] Cc-project data
[450] Financial resources, personnel, and technical expertise on client side
[451] long-term cooperation
[452] Information
[453] High costs of finding and developing bankable sustainable projects.
[454] Availability of concessional funding from international funds
[455] Climate change vulnerability of the project
[456] Transition risk
[457] Physical risk
[458] Financial voluntary and consistent' disclosure framework
[459] Risk management
[460] Investors' confidence about global outlook for the coming year
[461] Variety of concerns for investors
[462] Geopolitical uncertainty
[463] Over-regulation
[464] Key skills
[465] Climate change and environmental damage
[466] Workforce demographics
[467] Tax burden
[468] Economic growth
[469] exchange rate volatility
[470] Globalization
[471] Focus in the short-term
[472] Trust
[473] INDC implementation slowness
[474] Sensitivity to local politics
[475] Enabling environment
[476] Policies
[477] Institutions
[478] Transparency
[479] Contract enforcement
[480] Subsidies
[481] Counterparties
[482] Procurement processes
[483] Transparency and bankable pipelines
[484] Development and transaction costs
[485] Funding models
[486] Risk-adjusted returns
[487] Regulations and policies
[488] Underlying institutional performance
[489] Exchange-rate movements
[490] Proportion of project economic benefits and costs
[491] Investors' skepticism about sector and asset classes they are unfamiliar with
[492] Need to increase investment in sustainable project preparation and pipeline development.
[493] [sustainable] risk-adjusted returns competitiveness
[494] [availability] of guarantee programs for sustainable infrastructure
[495] Sustainability criteria in procurement
[496] Larger secondary market for sustainable-related securities
[497] Adaptation of financial instruments to channel investment to sustainable infrastructure and enhance liquidity.
[498] Risk-sharing instruments
[499] Sustainable infrastructure demand
[500] [continuing current] infrastructure development trends will lead to a high temperature rise.
[501] [possibility to] use combined pools of capital from different entities.
[502] [institutional investors'] strategies, preference, and regulation
[503] Requirement for liquidity
[504] correlation with other assets of similar investments
[505] Requirements
[506] Long-term cash flow of similar investments
[507] Returns for private-equity funds investing in sustainable infrastructure.
[508] Availability of unsolicited bidding
[509] Up-front capital requirement of sustainable infrastructure
[510] Payback period of sustainable infrastructure
[511] Investor's focus on equity investing.
[512] Shortage of capital supply for early project stages
[513] Investors' worry for cross-boundary investments or investment in other geographical regions.
[514] Domestic investment in sustainable-infrastructure projects [specially in middle-income countries]
[515] PPPS reduction capacity of investors 'policy risks
[516] Real rates of return on total capital for companies tied to infrastructure.
[517] Corporate leadership's resistance to short-termism
[518] Infrastructure investments' multitude of benefits
[519] Capital requirements in the back end.
[520] User's unwillingness or incapability to pay high enough charges.
[521] Fiscal risk
[522] regulations and policies

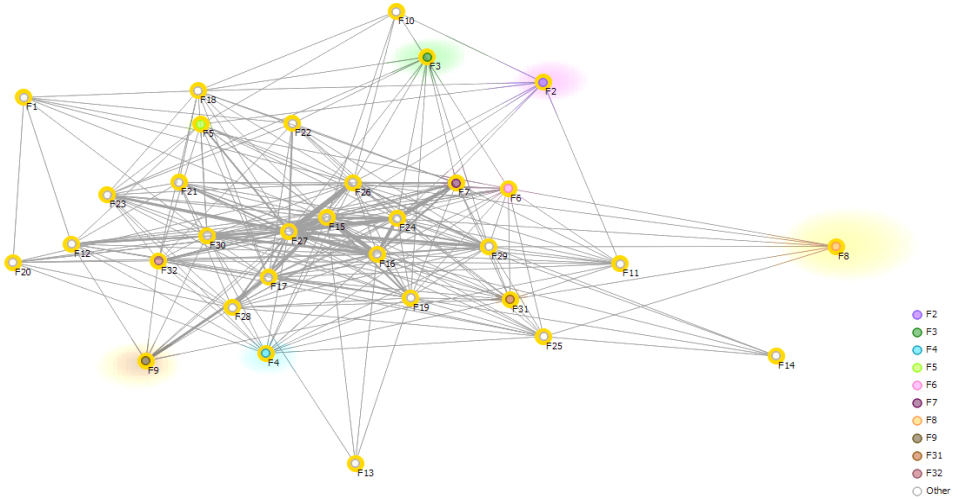
INFERRED EXPERT BBN CONNECTIONS



9.4 Annex 4 – Network analysis results per FX2 factor [Orange software]

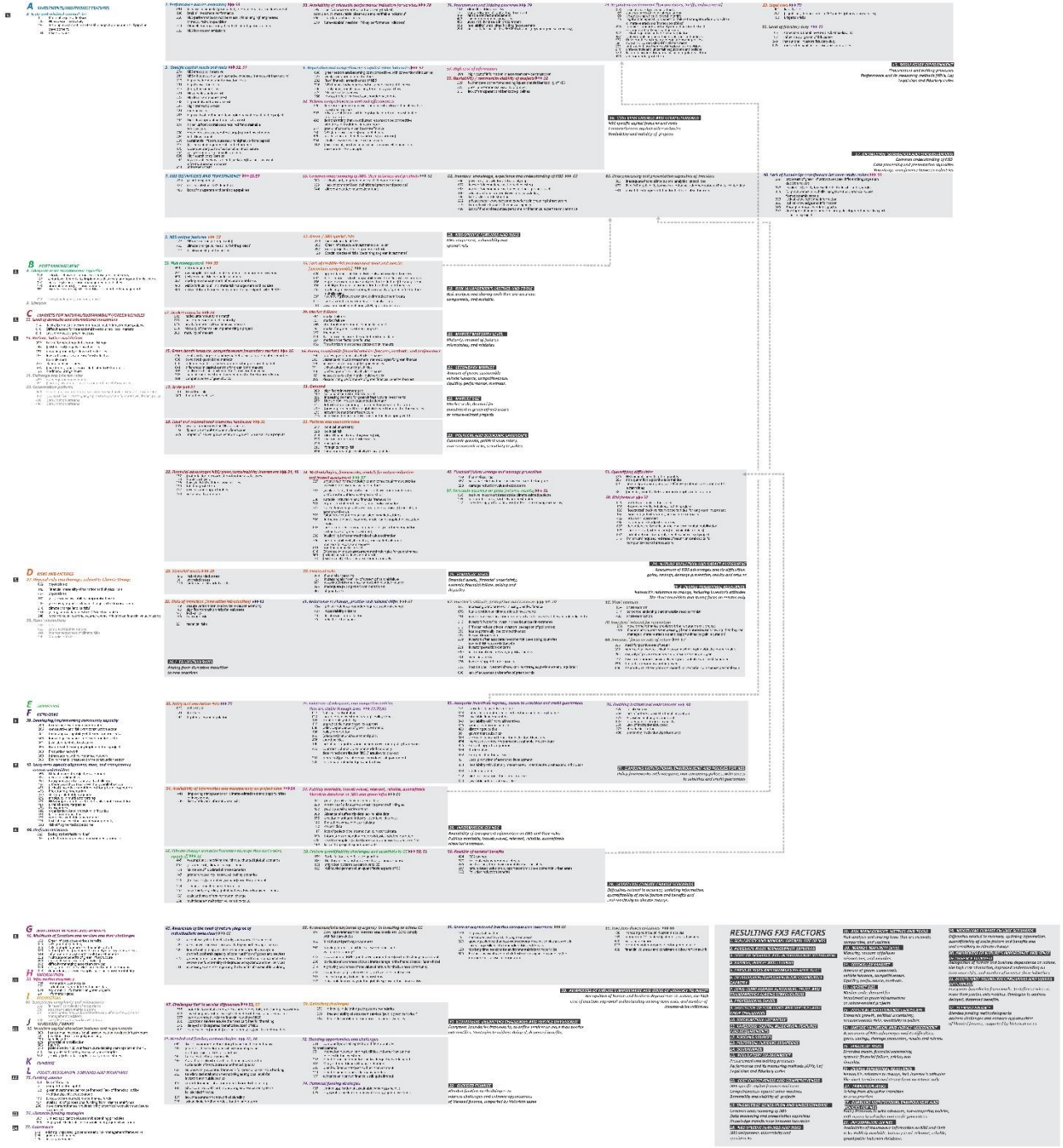
Number of nodes: 32

Number of edges: 238



FX2 factor	Degree	In-degree	Average neighbor degree	In-degree centrality	Out-degree centrality
F1	8	8	17	0.258065	0.258065
F2	8	8	17.5	0.258065	0.258065
F3	9	9	19.4444	0.290323	0.290323
F4	16	16	18.625	0.516129	0.516129
F5	13	13	18.6923	0.419355	0.419355
F6	17	17	16.9412	0.548387	0.548387
F7	18	18	18.3333	0.580645	0.580645
F8	6	6	19.3333	0.193548	0.193548
F9	8	8	19.125	0.258065	0.258065
F10	6	6	16.6667	0.193548	0.193548
F11	12	12	18.4167	0.387097	0.387097
F12	14	14	17.9286	0.451613	0.451613
F13	4	4	22.25	0.129032	0.129032
F14	5	5	20.4	0.16129	0.16129
F15	23	23	16.3043	0.741935	0.741935
F16	23	23	16.2609	0.741935	0.741935
F17	20	20	17.75	0.645161	0.645161
F18	14	14	15.8571	0.451613	0.451613
F19	21	21	17.0952	0.677419	0.677419
F20	9	9	19.7778	0.290323	0.290323
F21	13	13	19.3077	0.419355	0.419355
F22	12	12	17.5	0.387097	0.387097
F23	16	16	18.4375	0.516129	0.516129
F24	24	24	15.9167	0.774194	0.774194
F25	14	14	17.0714	0.451613	0.451613
F26	25	25	15.36	0.806452	0.806452
F27	25	25	16.56	0.806452	0.806452
F28	18	18	17.8889	0.580645	0.580645
F29	20	20	16.95	0.645161	0.645161
F30	22	22	16.5455	0.709677	0.709677
F31	16	16	18.375	0.516129	0.516129
F32	17	17	16.7647	0.548387	0.548387

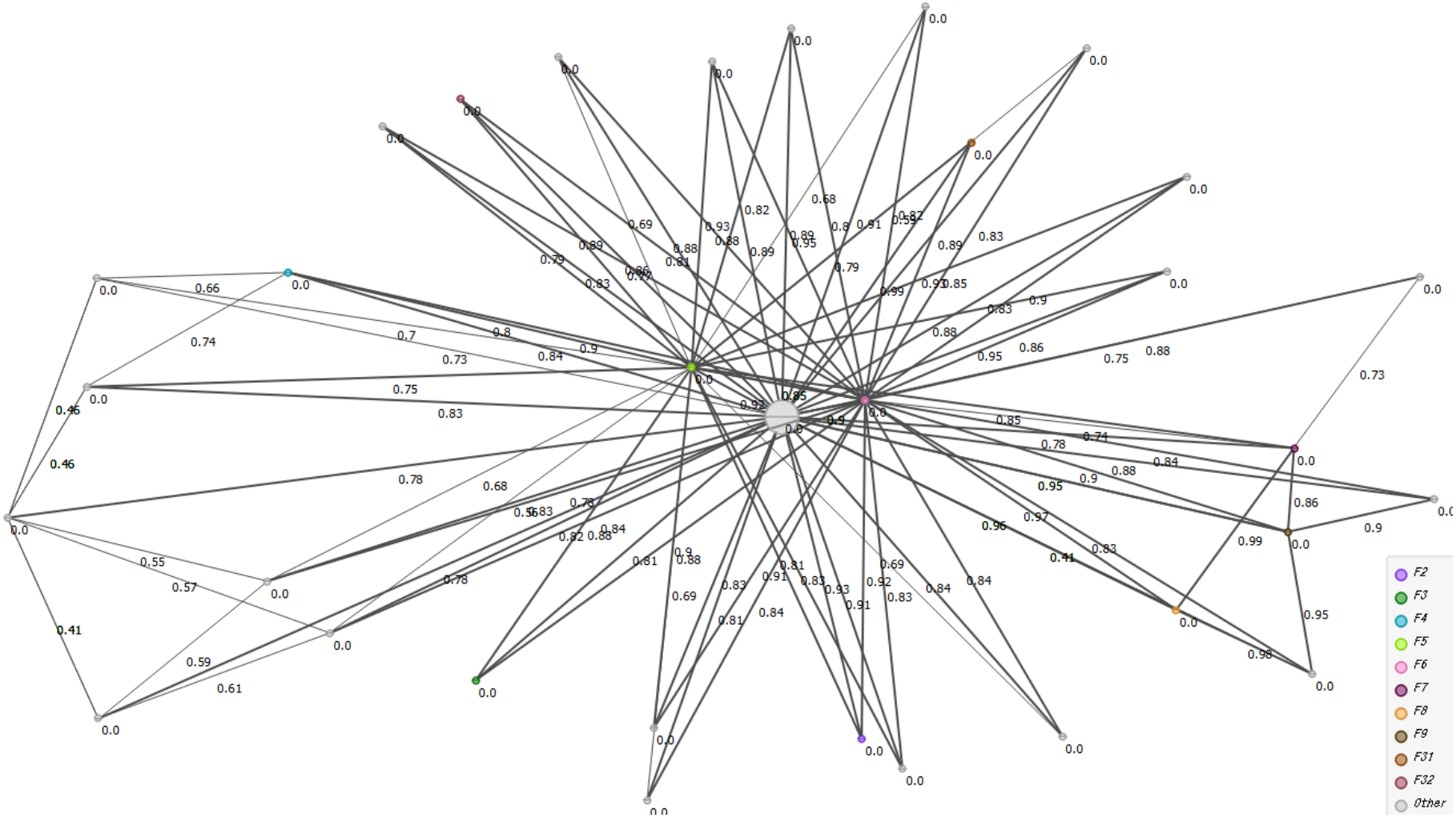
9.5 Annex 5: FX2 consolidated factors



9.6 Annex 6 – ORANGE Distance Matrix values and network

	F1	F10	F11	F12	F13	F14	F15	F16	F17	F18	F19	F2	F20	F21	F22	F23	F24	F25	F26	F27	F28	F29	F3	F30	F31	F32	F4	F5	F6	F7	F8	F9
F1		0.415	0.879	0.914	0.890	0.833	0.828	0.734	0.839	0.894	0.806	0.932	0.830	0.830	0.950	0.750	0.830	0.823	0.779	0.777	0.907	0.876	0.811	0.890	0.994	0.856	0.835	0.922	0.898	0.783	0.959	0.954
F10	0.415		0.879	0.910	0.807	0.835	0.789	0.752	0.772	0.879	0.773	0.919	0.747	0.841	0.948	0.821	0.803	0.828	0.782	0.769	0.801	0.856	0.721	0.856	0.950	0.794	0.822	0.938	0.826	0.807	0.981	0.951
F11	0.879	0.879		0.903	0.881	0.781	0.693	0.740	0.776	0.795	0.811	0.885	0.756	0.803	0.833	0.830	0.730	0.772	0.514	0.634	0.898	0.840	0.803	0.823	0.917	0.787	0.821	0.884	0.841	0.671	1.000	0.903
F12	0.914	0.910	0.903		0.902	0.762	0.745	0.657	0.820	0.800	0.817	0.843	0.705	0.776	0.846	0.794	0.781	0.780	0.738	0.646	0.801	0.891	0.847	0.704	0.923	0.621	0.766	0.829	0.829	0.798	0.983	0.920
F13	0.890	0.807	0.881	0.902		0.838	0.843	0.854	0.810	0.892	0.858	0.929	0.849	0.799	0.954	0.788	0.879	0.882	0.846	0.832	0.867	0.893	0.748	0.868	0.940	0.844	0.850	0.934	0.954	0.911	0.981	0.937
F14	0.833	0.835	0.781	0.762	0.838		0.653	0.643	0.701	0.809	0.784	0.807	0.668	0.518	0.745	0.666	0.655	0.678	0.641	0.541	0.731	0.731	0.657	0.709	0.903	0.701	0.611	0.848	0.900	0.764	0.985	0.885
F15	0.828	0.789	0.693	0.745	0.843	0.653		0.558	0.681	0.822	0.730	0.770	0.585	0.663	0.697	0.645	0.583	0.690	0.540	0.460	0.777	0.734	0.700	0.657	0.835	0.665	0.735	0.753	0.841	0.660	0.963	0.800
F16	0.734	0.752	0.740	0.657	0.854	0.643	0.558		0.650	0.700	0.655	0.764	0.594	0.662	0.798	0.639	0.472	0.623	0.556	0.462	0.658	0.668	0.663	0.545	0.773	0.634	0.659	0.703	0.762	0.686	0.943	0.737
F17	0.839	0.772	0.776	0.820	0.810	0.701	0.681	0.650		0.784	0.614	0.841	0.664	0.721	0.859	0.697	0.684	0.758	0.631	0.574	0.707	0.811	0.724	0.656	0.753	0.765	0.756	0.692	0.838	0.750	0.887	0.790
F18	0.894	0.879	0.795	0.800	0.892	0.809	0.822	0.700	0.784		0.775	0.940	0.681	0.811	0.916	0.774	0.815	0.813	0.793	0.718	0.830	0.857	0.875	0.857	0.841	0.789	0.849	0.823	0.797	0.803	0.963	0.923
F19	0.806	0.773	0.811	0.817	0.858	0.784	0.730	0.655	0.614	0.775		0.883	0.732	0.846	0.904	0.725	0.696	0.649	0.719	0.644	0.699	0.716	0.830	0.674	0.836	0.783	0.781	0.695	0.841	0.761	0.897	0.827
F2	0.932	0.919	0.885	0.843	0.929	0.807	0.770	0.764	0.841	0.940	0.883		0.840	0.826	0.869	0.831	0.787	0.787	0.773	0.756	0.812	0.789	0.874	0.751	0.935	0.882	0.828	0.814	0.920	0.807	0.985	0.827
F20	0.830	0.747	0.756	0.705	0.849	0.668	0.585	0.594	0.664	0.681	0.732	0.840		0.608	0.783	0.688	0.637	0.613	0.651	0.569	0.818	0.829	0.713	0.711	0.867	0.665	0.767	0.789	0.767	0.767	0.945	0.839
F21	0.830	0.841	0.803	0.776	0.799	0.518	0.663	0.662	0.721	0.811	0.846	0.826	0.608		0.804	0.696	0.720	0.749	0.666	0.610	0.821	0.801	0.588	0.778	0.927	0.700	0.649	0.884	0.912	0.808	0.971	0.863
F22	0.950	0.948	0.833	0.846	0.954	0.745	0.697	0.798	0.859	0.916	0.904	0.869	0.783	0.804		0.823	0.710	0.803	0.808	0.758	0.918	0.822	0.766	0.810	0.912	0.819	0.869	0.879	0.863	0.851	0.969	0.841
F23	0.750	0.821	0.830	0.794	0.788	0.666	0.645	0.639	0.697	0.774	0.725	0.831	0.688	0.696	0.823		0.691	0.709	0.636	0.548	0.792	0.741	0.633	0.740	0.924	0.721	0.696	0.779	0.878	0.735	0.910	0.866
F24	0.830	0.803	0.730	0.781	0.879	0.655	0.583	0.472	0.684	0.815	0.696	0.787	0.637	0.720	0.710	0.691		0.647	0.594	0.552	0.718	0.638	0.691	0.504	0.784	0.677	0.688	0.677	0.778	0.731	0.900	0.698
F25	0.823	0.828	0.772	0.780	0.882	0.678	0.690	0.623	0.758	0.813	0.649	0.787	0.613	0.749	0.803	0.709	0.647		0.614	0.574	0.715	0.690	0.714	0.609	0.930	0.751	0.677	0.564	0.839	0.758	0.936	0.837
F26	0.779	0.782	0.514	0.738	0.846	0.641	0.540	0.556	0.631	0.793	0.719	0.773	0.651	0.666	0.808	0.636	0.594	0.614		0.413	0.722	0.717	0.661	0.593	0.864	0.661	0.638	0.753	0.841	0.501	0.942	0.837
F27	0.777	0.769	0.634	0.646	0.832	0.541	0.460	0.462	0.574	0.718	0.644	0.756	0.569	0.610	0.758	0.548	0.552	0.574	0.413		0.714	0.697	0.622	0.592	0.861	0.612	0.621	0.691	0.752	0.571	0.931	0.785
F28	0.907	0.801	0.898	0.801	0.867	0.731	0.777	0.658	0.707	0.830	0.699	0.812	0.818	0.821	0.918	0.792	0.718	0.715	0.722	0.714		0.692	0.808	0.641	0.884	0.816	0.672	0.684	0.818	0.783	0.979	0.821
F29	0.876	0.856	0.840	0.891	0.893	0.731	0.734	0.668	0.811	0.857	0.716	0.789	0.829	0.801	0.822	0.741	0.638	0.690	0.717	0.697	0.692		0.771	0.602	0.877	0.787	0.715	0.690	0.883	0.753	0.930	0.771
F3	0.811	0.721	0.803	0.847	0.748	0.657	0.700	0.663	0.724	0.875	0.830	0.874	0.713	0.588	0.766	0.633	0.691	0.714	0.661	0.622	0.808	0.771		0.783	0.947	0.683	0.696	0.882	0.905	0.820	0.988	0.901
F30	0.890	0.856	0.823	0.704	0.868	0.709	0.657	0.545	0.656	0.857	0.674	0.751	0.711	0.778	0.810	0.740	0.504	0.609	0.593	0.592	0.641	0.602	0.783		0.791	0.733	0.671	0.592	0.825	0.747	0.893	0.676
F31	0.994	0.950	0.917	0.923	0.940	0.903	0.835	0.773	0.753	0.841	0.836	0.935	0.867	0.927	0.912	0.924	0.784	0.930	0.864	0.861	0.884	0.877	0.947	0.791		0.893	0.926	0.790	0.931	0.932	0.916	0.727
F32	0.856	0.794	0.787	0.621	0.844	0.701	0.665	0.634	0.765	0.789	0.783	0.882	0.665	0.700	0.819	0.721	0.677	0.751	0.661	0.612	0.816	0.787	0.683	0.733	0.893		0.713	0.891	0.808	0.704	0.972	0.906
F4	0.835	0.822	0.821	0.766	0.850	0.611	0.735	0.659	0.756	0.849	0.781	0.828	0.767	0.649	0.869	0.696	0.688	0.677	0.638	0.621	0.672	0.715	0.696	0.671	0.926	0.713		0.805	0.895	0.777	0.979	0.871
F5	0.922	0.938	0.884	0.829	0.934	0.848	0.753	0.703	0.692	0.823	0.695	0.814	0.789	0.884	0.879	0.779	0.677	0.564	0.753	0.691	0.684	0.690	0.882	0.592	0.790	0.891	0.805		0.851	0.855	0.922	0.760
F6	0.898	0.826	0.841	0.829	0.954	0.900	0.841	0.762	0.838	0.797	0.841	0.920	0.767	0.912	0.863	0.878	0.778	0.839	0.841	0.752	0.818	0.883	0.905	0.825	0.931	0.808	0.895	0.851		0.741	0.974	0.904
F7	0.783	0.807	0.671	0.798	0.911	0.764	0.660	0.686	0.750	0.803	0.761	0.807	0.767	0.808	0.851	0.735	0.731	0.758	0.501	0.571	0.783	0.753	0.820	0.747	0.932	0.704	0.777	0.855	0.741		0.992	0.858
F8	0.959	0.981	1.000	0.983	0.981	0.985	0.963	0.943	0.887	0.963	0.897	0.985	0.945	0.971	0.969	0.910	0.900	0.936	0.942	0.931	0.979	0.930	0.988	0.893	0.916	0.972	0.979	0.922	0.974	0.992		0.883
F9	0.954	0.951	0.903	0.920	0.937	0.885	0.800	0.737	0.790	0.923	0.827	0.827	0.839	0.863	0.841	0.866	0.698	0.837	0.837	0.785	0.821	0.771	0.901	0.676	0.727	0.906	0.871	0.760	0.904	0.858	0.883	

The resulting network was furnished with the operators "network from distances" and "network explorer"


F2
F3
F4
F5
F6
F7
F8
F9
F31
F32
Other

9.7 Annex 7 – Interview protocol

Before the interview

- Select the people for the interview.
- Send the summary and introductory poster for the research [annex x].
- Send a summary and information related to the exercise to conduct during the interview [materials in annex x].
- Inform about the timeframe necessary for the activity [30 min].

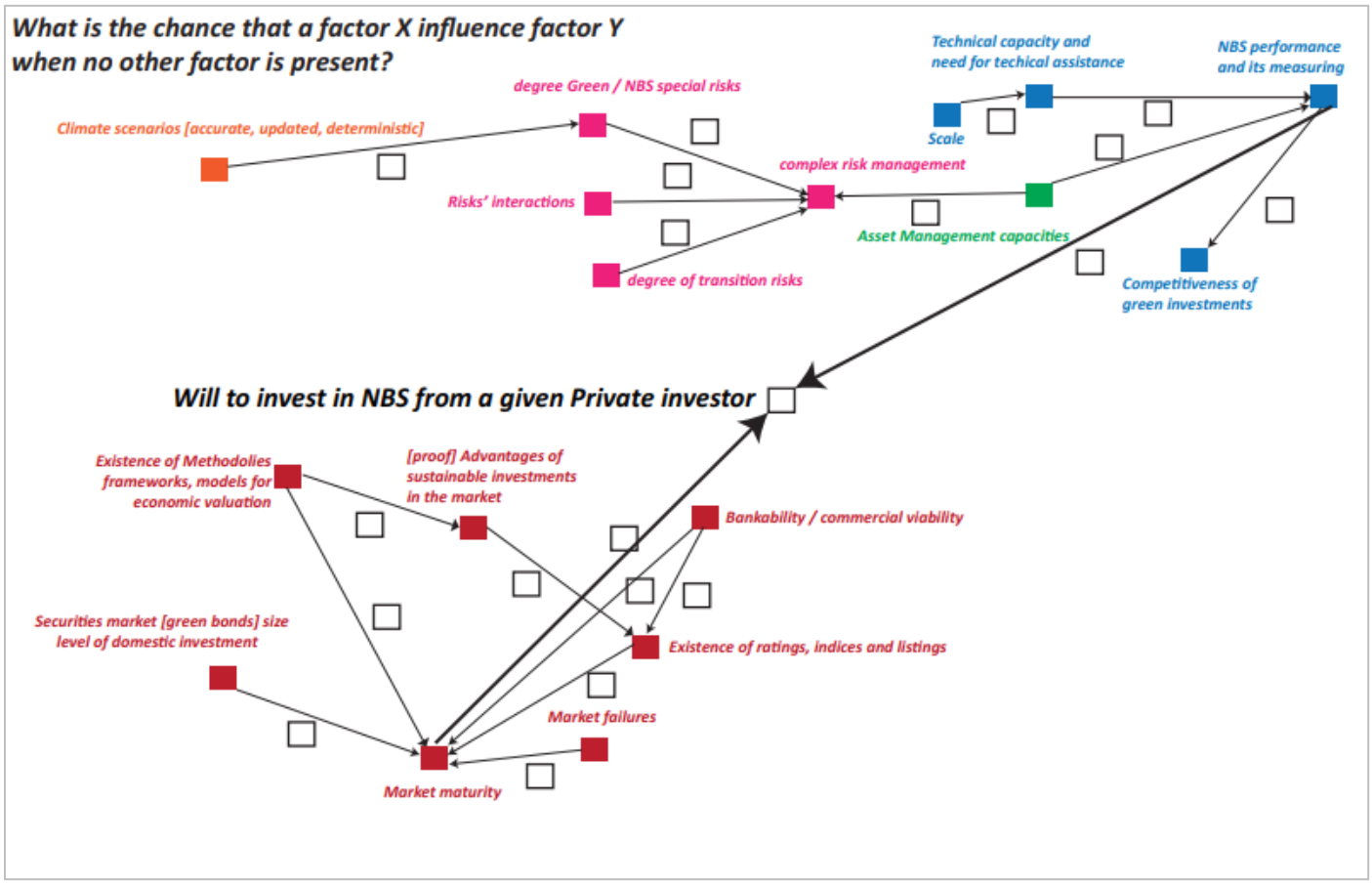
During the interview

- Introduce myself [background].
- Briefly introduce the interviewee with the research and the objective of the session:
    - The interview objective is to identify the major factors of influence for private investment in decision of implementing an NBS, confirming the relationships and the specific conditions of the variables. To avoid misunderstandings, there has been an effort to avoid highly technical and mathematical terms, therefore instead of referring to, for instance, the "probability of occurrence", the interviewer has used terms as "chance" or "likelihood", to which the experts might be more accustomed to.
- Explain the structure of the interview, that consists in four main blocks:
    [1] both the inquirer and the respondent will go through the complete set of factors of influence found in literature together, if any question arises, the interviewee is encouraged to pose them immediately. After the quick review, the interviewer has requested the expert to indicate which factors have stood as the most significant.
    [2] the interviewer has shown the expert the list of 32 consolidated factors and has verified whether they correspond with the expert's first impressions.
    [3] An in-depth conversation on each of the factors the respondent detected as crucial is initiated, the interviewer has put emphasis on gathering information on the probability distributions and the states.
    [4] Finally, the interviewee is questioned on whether he/she/they believe there is potential utility in developing such a database, decision-making tool and/ or model presented in the interview.
- All comments and answers are recorded on paper and on a tape recorder.

After the interview

- At the end of the interview the interviewer has made a summary of the conclusions and comments gathered in the session, enlisting the mentioned factors one by one.
- We have informed the interviewees of the intention of sharing all the available data and research results.

9.8 Annex 8 – Materials provided before interviews: network example and complete set of factors and subcategories.



FULL SUBCATEGORIES LISTS [showed to experts in advance of SSIs]

A INVESTMENTS/NBS/PROJECT FEATURES

1. Technical challenges and need for techical assistance

022 [existence of] technical barriers
245 provision of technical assistance
366 Technical aspects and design specifications [of the sustainable project]

2. Performance and its measuring

081 increase in [financial] productivity of green infrastructure investments
180 [stable] investment performance
268 NBS performance cannot be as easily [challenging] engineered or measured with precision
311 Difficulties in measuring the effects of mitigation projects
323 NBS low carbon emissions

3. Specific capital needs and costs

274 NBS are capital-intensive
283 NBS different capital and operative expenses [than grey infrastructure]
217 high development and transaction costs
291 high transaction costs
313 [high] transaction costs
321 NBS developing low cost
322 NBS low maintenance [cost]
348 high initial and transition costs
397 High transaction costs
421 running costs
453 high costs of finding and developing bankable sustainable projects
484 High development and transaction costs
174 higher upfront capital costs required for sustainable infrastructure
290 green infrastructure requires [large] upfront investments
429 Initial investment
509 sustainable infrastructure require higher up-front capital
519 [lesser] capital requirements in the back end
175 lower operating costs of sustainable infrastructure
354 cost premium of sustainable projects
036 High search costs [barrier]
284 Investment levels will exceed [are larger] business-as-usual infrastructure maintenance

4. Scalability and minimal optimal size

115 Minimal required deal size
332 NBS up-scaling capacity
492 Scale up investment in sustainable project preparation and pipeline development.
241 A lack of scale

5. NBS unique features

275 NBS are unique [not replicable]
455 climate change vulnerability [of the project]
214 local ownership of the project

6. Reputation and competitiveness against other industries

098 green sectors are becoming cost-competitive with conventional industries
227 weak reputation of infrastructure
282 [low] financial attractiveness of NBS
316 NBS financial advantages and sustainable competitiveness
506 similar investments have long-term steady cash flow
324 NBS cost-effectiveness
256 low cost-effectiveness of conservation payments

7. Information, transparency and definition

240 poor transparency
337 unclear, abstract NBS definition
449 lack of CC-projects quantitative data
483 lack of transparent and bankable pipelines

B ASSET MANAGEMENT

8. Adequate asset management expertise

072 lack of asset owners in-house expertise [on climate risks]
186 sector-level [benefits] to implement advanced planning and timely action
097 Increasing in-house asset management capabilities
190 informal network [s] of asset owners
261 Insurance sector expertise on risk assessment and management

9. Lifecycle

242 shaky [inadequate] operating models

10. Risk management

459 risk management
271 oversimplification of climate-related risk management systems
498 [existence of] risk-sharing instruments
027 inadequate management of environmental risks
440 MDBs [critical role] in climate risk management and policies
305 risks distributed more evenly among the participants with PPP/PFI

C MARKETS FOR NATURAL/SUSTAINABILITY/GREEN VEHICLES

11. Level of domestic and international investment

514 [lack of] domestic investment in sustainable-infrastructure projects
010 Difficult access for international investors into local markets
011 Lack of domestic green investors

12. Market maturity

002 inadequate maturity mismatch
019 local green bond markets maturity
045 poorly functioning local financial markets
054 Maturity of the market implementing a project
202 maturity of markets

13. Ratings, indices and listings

009 Lack of bond ratings, indices and, listings
448 [existence of] negative/ positive lists
181 growing popularity of low-carbon indices
183 low-carbon indices are easy / cost-effective to implement
237 Rating agencies scores
076 [investment] rating services dedicated to ESG metrics
125 credit and ratings issues

14. Exchange and interest rates

489 exchange-rate movements
084 [current] low interest-rate environment in OECD countries

15. Green bonds issuance and competitiveness [secondary market]

496 creation of a larger secondary market for sustainable-related securities
038 developed green bond markets
040 differences in disclosure requirements for green bond markets
041 differences in capital controls for green bond markets
185 small green bonds portion of the global bond universe
307 share of bond investment in green infrastructure is currently small
184 competitiveness of green bonds

16. Green, sustainable financial vehicles features, methods, and performance

108 too few green financial vehicles issuance
016 Existence of impact assessment methodologies for green finance
109 no access to existing highly liquid vehicles
091 lack of suitable financing vehicles
108 too few green financial vehicles issuance
109 no access to existing highly liquid vehicles
096 dissapointing performance of green financial vehicles [barrier]

17. Scale

114 Need for scale
309 limited market size

18. Local and international economic landscape

085 weak econmic growth in OECD countires
102 dynamic [unstable] economic landscape
225 [impact of] slower global economic growth [on sustainable projects]

19. Consumption patterns

300 Green infrastructure projects outcomes resulting in decreased consumption
377 Ecologists fear that assigning a price to ecosystem functions will detract policy
438 Consumption patterns
444 Consumption patterns

20. Market failures

094 market failures
308 market failures
246 structural improvements in financial markets
295 market for green investment projects
367 the market
171 Lack of consensus on the market pricing mistakes
204 market imperfections or failures
166 Time horizon mismatches across capital markets

21. Demand

080 significant investment gap
499 sustainable infrastructure demand
252 increasing demand for green infrastructure investments
289 Huge global infrastructure needs [demand]
315 Infrastructure spending is intended to increase in the future
239 [growing] projected future global demand for infrastructure services
173 growing demand for infrastructure
216 increasing demand for investment in the developing world

22. Advantages NBS/green/sustainability investment

177 [potential for] low correlations to other asset classes
178 Stable cash yield
176 Low yields in traditional asset classes
179 Inflation protection
232 diversification opportunities
238 sustainability premium

23. Bankability / commercial viability of projects

329 further development and testing [questionable] bankability of NBS
222 uncertain commercial viability of project
215 lack of transparent and bankable pipelines

24. Methodologies, frameworks, models for nature valuation and impact assessment

327 urgent need for methodologies and conceptual frameworks for assessing the insurance value of nature
333 [availability of] develop business and investment models and platforms for public-private partnerships
338 suitable institutional and financial frameworks
378 imprecision inherent in ecosystem service valuation
375 Hole of knowledge on how ecosystems ecologically [translate] to economical value
379 Failure to account for natural value in market settings
389 [in theory] the basic economic model can be applied to ecosystem services
035 Lack of confidence in macro parameters [i.e. future demand for a certain type of green investment]
395 [availability] of other methods of value estimation
396 lack of reliability of [alternative] non-market valuation methods for ecosystem services
021 non-linear financial impacts
016 Existence of impact assessment methodologies for green finance

D RISKS AND METRICS

25. Stranded assets

446 risk of stranded assets
061 stranded assets
170 potential for stranded assets

26. Risks of transition [innovation introduction]

149 disruptive transition to a low/zero-carbon economy
165 significant transition risks for real assets
447 lock-in risk
456 transition risk
231 technical risks

27. Physical risks and damages related to Climate Change

062 physical risks
143 Financial materiality of transition and physical risks
457 physical risk
152 [risk] resource availability compromised by CC
247 [unknown] impact of climate change on the financial sector
318 climate change [and its risks]
251 [rising] annual damages to GDP due to climate risk
248 [occurrence of] extreme weather events influence on financial value of assets

28. financial risks

048 financial uncertainty
157 Increasing alarm on risk of systemic financial failure
344 unforeseen costs
201 associated risks and uncertainty [with blended finance]
026 inadequate pricing of environmental risks
087 iliquidity risk

29. Legal risks

064 liability risks
297 [significant] demand risks in PPP and PFI [of providing services]
162 Litigation risks

30. Policy and regulation risks

063 policy risks
521 fiscal risk
244 tighter taxes and regulations

31. Political and economic risks

047 political uncertainty
223 political risk
224 global financial regulatory issues [risk]
229 macroeconomic and business risks
243 corruption
210 foreign currency risk
474 infrastructure high sensitivity to local politics

32. Green / NBS special risks

279 high risk profile of NBS
086 Green infrastructure investments are riskier
287 green projects carry a high degree of risk
120 Special species of risks [pertaining to green investments]

33. Risks' interactions

343 risks
065 complex risks interactions
141 interconnectedness of climate risks
430 Multiplier effects

34. Availability of information and transparency on project risks

441 improving transparency on climate-related risks and opportunities of investments
230 lack of relevant information on risks
213 risk of fragmented approaches

35. Lack of credible risk management tools and metrics [uncertain, comparable]

020 appropriateness of risk analysis tools and associated metrics
034 Risk scenario's lack of comparability over firms/industries/countries
156 higher exposure to uncertainty the further in time [the analysis goes]
168 Inability of humans to account for the effects of future risks
262 modelling to assess risk mitigation capacity of green infrastructure is challenging
399 risk moving between scales with limited economic data
015 Lack of credible environmental risk analysis tools
113 Asset and liability matching [ALM] application issues

E MODELLING

36. Climate change scenarios [accurace through time and scales, updated]

445 Assumptions underlying the [climate change] [global] scenarios
067 [ocurrence of] climate change scenarios
134 [existence of] updated climate scenarios
147 greater uncertainty in forward-looking scenarios
148 [trustworthy] alternative [scenario] model supplements
154 scenarios modelled are deterministic
167 uncertainty regarding global pathway towards a given scenario
139 scale and pace of environmental change
138 multidecade time horizon vulnerability to CC

37. Robust, econometric investment models

069 [lack of] no robust investment models
133 [existence of] established econometric models

38. Gains forecast accuracy [returns, results]

066 positive investment forecasts for climate-related projects
155 magnitude of results is likely underestimated
137 stress testing portfolio findings [under climate change scenarios]

39. Social factors modelling [quantifiability and sensitivity to CC]

159 Social factors are difficult to quantify
160 Healthcare sector is highly sensitive to climate change
161 migration patterns are sensitive to CC
163 Acknowledgement of un-quantifiable aspects of CC

F NETWORKS

40. Developing/implementing community capacity

200 increasing development community
266 conservative and risk avert construction sector
364 technological capability of the construction sector
365 knowledge exchange in the construction sector
051 [available] technical assistance
053 Maturity of the company implementing a project
368 Production network
369 Infrastructure and maintenance network
363 Environmental pressures on the construction sector

41. Lack of knowledge transference between study realms

269 proposers of green infrastructure speak different language than decision makers
382 [ecologists'] ability to describe the trade-offs and synergies
335 for practitioners [it is challenging] to extract practical advice from academic papers
353 lack of knowledge and information
360 lack of knowledge and information
018 Enough network learning capacity
207 development finance providers bring development network experts issues to a project

42. Reluctance to change and cultural shifts

234 private-public co-operation requires a cultural change
427 Acceptability citizens
435 local socio-cultural factors
352 reluctance to change

43. Long-term agenda alignment, trust, and transparency among stakeholders

056 Difficult mandate/objectives alignment
057 ownership difficulties
058 transparency and accountability challenges
437 differences in how to achieve that overall objective
451 [lack of] Incentivize ambition and long-term cooperation
428 Effort for implementation
070 shifting stakeholders agenda
272 ambiguity in multi-actor setting
331 NBS complex multi-stakeholders collaboration conditions
481 unreliable counterparties
478 transparency
342 organizational and procedural difficulties
351 lack of communication
371 complex stakeholder environment
126 institutional investors lack of homogeneuity

44. Awareness of the need of nature [degree of individualistic behaviour]

376 user of ecosystem benefits [only] cares about the end result
520 users unwillingness or incapability to pay high enough charges
400 limited ability to appreciate that human populations depend on the biosphere's capacity of continued flow of goods and services
319 growing interest and awareness of the need to maintain, and also to restore, the functionality of degraded ecosystems and their services
341 increasing awareness regarding the benefits of sustainable building

45. Professional biases

383 Ecologists [professional bias]
267 protect from nature water management approach

46. Sense or urgency and inaction cosequences awareness

192 High cost of inaction
191 consequences of even 0.5C degree increase
320 growing evidence that ecosystem restoration can also play a key role in increasing resilience to impending risks and threats.
023 too long time horizons for environmental risks to materialize
500 Business-as-usual scenario in infrastructure expansion could lead to a 6-degree Celsius rise in temperature

G INVESTMENT RETURNS AND BENEFITS

47. Multitude of functions and services and their challenges

082 Green infrastructure various benefits
325 NBS [multiple benefits]
326 NBS multiple functions and benefits [other]
339 Nature [projects] can provide a variety of ecosystem services
518 Infrastructure investments' multitude of benefits
258 multitude of benefits of green infrastructure
260 co-benefits of ecosystems [services]
372 difficulty managing ecosystem services
374 ecosystems provide a wide range of benefits to humans
028 dependency of service supply chain on ecosystem stability

48. Challenges tied to service diffuseness

255 potential to capitalize on services provided by [fully functioning] ecosystems
358 investing party not receiving the benefits of the sustainable measure
277 non-guaranteed and non-financial benefits of NBS
386 Ecosystem services are, for the most part, free for the taking
276 delayed and dispersed benefits [services] of NBS
391 Some services [benefits] are considered [only] positive externalities

49. Risk/returns

049 risk/return profile of the project
118 risk/return profile imbalance [of the project]
135 [forecasted] positive return opportunities for long-term investment
136 expected [industry-sector] annual return impacts
422 return on investment
486 Inadequate risk-adjusted returns
083 dependence of benefits on the long-term capital mobilisation
193 Lack of risk-adjusted returns [of sustainable projects]
033 lack of methods to quantify benefits and costs of projects
516 [minimum] required real rates of return on total capital for companies tied to infrastructure

50. Potential future savings and damage prevention

419 financial savings
357 sustainable innovations can save costs on the long run
259 damage reduction value of ecosystems

51. Possible of societal benefits

424 CO2 savings
370 Societal and environmental effects
285 positive long-term environmental impact on cities
317 nature-based solutions support economic development in urban areas
032 Pollution reduction benefits

52. Quantifying difficulties

336 NBS benefits are difficult to quantify
286 non-quantifiable positive externalities
001 how to appropriately and cost-effectively internalize environmental externalities
385 [need for] a method of economic description of ecosystems

53. Returns competitiveness and cost effectiveness

296 Returns on green urban investment are often lower than alternative investment options.
507 private-equity funds achieving significant returns in sustainable infrastructure
493 demonstrating that risk-adjusted returns can be competitive with those of traditional infrastructure
257 green infrastructure can be cost-effective
330 NBS [large investments] small net effects
490 project economic benefits and costs [proportion]
504 [similar] low correlations on other assets
012 [existence of] positive financial performance when investors incorporate ESG principles

54. Availability of adequate performance indicators for services

299 "performance-oriented contract is only [lack of] possible with measurable, observable and verifiable indicators"
060 standardized indicators
270 [unavoidable] need for KPI [key performance indicators]

H INFORMATION

55. Publicly available, industry-level, relevantm reliable historical database on NBS and green infra

024 publicly available environmental data
030 existence of a database on existing green technologies
452 publicly available information
068 Absence of sufficently detailed/ reliable data
075 creation of a shared industry asset-level database
146 limited relevance of historical data
182 carbon data
117 lack of project pipeline and quality historical data
059 Information on blending projetcs is basic and often outdated
328 need to compile a [lack of] more comprehensive evidence on NBS

56. Common understanding of NBS, their activities and products

003 Lack of clarity in green finance activities and products
039 [lack of common] local definitions [green bond products]
044 different blended finance definitions

57. Information assymetry

203 information asymmetries
111 lack of transparent information and data
004 Asymmetric information on green projects
281 information gaps

58. High cost of information

394 high cost of information in ecosystem service transaction

I ECOSYSTEMS

59. Delimiting challenges

373 difficulty in delimiting ecosystems boundaries
390 free availability of ecosystem services [public good behaviour]
398 free rider problem of open-access resources [services]

60. Ecosystems complexity and interactions

253 [Inherent] complexity of ecosystems
380 ecosystems are dynamic systems
381 unanticipated feedback and feedforward effects of ecosystems management decisions
384 Ecosystems complex adaptive [nature]

J INVESTORS / BANKS

61. Level of fiduciary duty

105 [some] institutional investor's lack of tax-liability
187 influence obligation of fiduciaries
249 Institutional investors fiduciary duty
029 unexpected liabilities for insurance companies

62. Investors´capital allocation features and requirements

089 Institutional investor's [small] asset allocation to direct infrastructure
511 [investors'] focus on equity investing
150 spending rate
434 potential of mobilisation
503 liquidity
273 preference for NBS vs infrastructure development options in the NL
236 exit points and strategies may be quite complex
512 [shortage] of capital supply for early project stages

63. Investors´ knowledge, experience and understanding of NBS

046 [investors] knowledge and capacity gaps
092 investor's inexperience with direct investing
093 investor's inexperience with new techonolgies and assets
130 education for institutional investors [knowledge]
346 lack of client understanding
292 private sector knowledge and experience in greening infrastructure
310 Limited institutional and technical capacity
450 Lack of financial resources, personnel and technical expertise on client side

64. Data processing and presentation capacities of investors

005 Inadequate financial institutions' analytical capabilities
077 Bank´s limited ability to make quantitative judgements about climate-related data
031 unsuitable data presentation for the financial sector users

65. Investors´ focus on rate of return

356 need for positive rate of return
392 some capital owners lack of focus on maximizing individual economic gains
393 majority of private owners wish to maximize economic gain
142 Investor's common aim in delivering substantial returns to stakeholders
278 limited autonomous earning power
388 assumption that everyone is engaged in the market to maximize personal gain

66. Investors driven initiatives

188 Increasing number of investor initiatives
189 momentum CC-leadership at midsize asset owners
420 Sustainable actions
017 promoted voluntary principles for green finance
458 financial voluntary and consistent' disclosure framework

67. Awareness/interest/sense of urgency in investing to adress CC

144 Growing awareness that investors need to address CC to comply with fiduciary duties
153 [Risk factors] pathways awareness
362 "striving [interest] to achieve a low emissions and waste free economy "
443 involvement of MDBs [multi development banks] in climate change investments
250 low levels of awareness about climate change in the financial sector [as a whole]
314 A growing awareness of the value of nature for the business community
233 strong focus [of private investors] on SDG 13 - climate action
387 sense of urgency to invest in ecosystems
442 critical role finance plays in the global response to the climate crisis

68. Investor´s attitude, perceptions and concerns

195 Increasing donor interest [in using blended finance]
078 banks position on climate-related investments
491 investors are sceptical about sector and asset classes that they are unfamiliar with
513 investor's [worry] to invest in cross-boundary investments
515 PPPs can reduce private investors' perception of policy risks
355 fear to potentially lose competitiveness
432 Personal impression
209 investors often associate investment in developing countries to a bad risk-return relationship
221 investor protection concerns
099 institutional investor's varying risk appetites
361 aversion or risks
226 investors' appetite and capacity
502 [institutional investors] shared/similar strategies, preference and regulation
008 lack of awareness on benefits of green bonds

69. Short-termism

104 short-termism
517 corporate leadership that can resist short-terminist
433 short-term action

70. risk awareness, perception and understanding or risks

254 low levels of risk awareness
280 elevated perceived risks
140 growing awareness of climate change risks
079 increased awareness of the potentially vast scale of climate risks
025 inadequate understanding of environmental risks

71. Investors´ interest for reputation

206 development finance providers bring reputation to a project
071 financial institutions are increasingly keen [interested] in showing that they can manage climate-related risks and opportunities [to gain reputation]

K FUNDING

72. Blended and funding methodologies

042 lack of a common methodology to conduct blended finance
439 [need for] the development of instrument-specific methodologies for GHC accounting
485 Lack of viable funding models
497 Adapt financial instruments to channel investment to sustainable infrastructure and enhance liquidity.
006 No universally accepted framework for green or sustainable banking
263 standardized evaluation methodologies at global level for investors and public bodies
110 current dominant infrastructure fund model of financing
198 [shortcoming / deficient] monitoring and evaluation systems for blended finance
199 lack of a common framework of blending
218 lack of viable funding models [for the longer term]

73. Blending opportunities and challenges

501 combined pools of capital from different entities to meet demand
55 interaction between lending facilities and other institutions involved in the investment
235 blended transaction period can last longer than anticipated
194 Many different blended finance definitions
205 blended finance catalyses additional investment
211 blended finance funds offer many benefits
197 evidence on blended finance is still quite limited

74. Funding sources

350 lack of funding
121 competition for capital
132 green investments cannot be financed [lack of financiability] by traditional public sources alone
196 [access to] structured blended finance funds
454 availability of concessional funding from international funds
208 development finance providers bring expertise in development issues to a project

75. Historical funding strategies

007 Limited application of sustainable banking principles
095 High profile incidents in renewable energy/green investmen

L POLICY, REGULATION, SUBSIDIES AND INCENTIVES

76. Existence of adequate, non competing policies that are stable through time

013 National level initiatives
014 Lack of green investment strategic policy signals
128 proof of policy stability
119 unpredictible duration policy support
088 policy dependence [of green investments]
106 policy competition
151 [adequate] national/subnational policy
476 sound policies
100 lack of an integrated domestic green investment policy framework
473 countries' voluntary plan or intended nationally determined contribution [INDC] are slow to play out
294 [degree of] policy coherence across levels of government
220 inadequate public budgets and tax bases

77. Enabling institutional environment

426 Local resources
264 lack of [interest] on institutional innovation
475 A positive enabling environment
037 inadequate institutional capacity
359 Lack of institutional support
477 effective institutions
488 underlying institutional performance

78. Governance

073 existing [unpdated] governance and risk management frameworks
094 government failures
129 better governance

79. Procurement and bidding processes

112 difficult bidding process
131 standardisation of contractual documents
479 reliable contract enforcement
482 flawed procurement processes
495 sustainability criteria in procurement
508 [availability] unsolicited bidding [procurement]
298 possibility for unsolicited PPP/PFI schemes [depending on each country]

80. Regulatory environment [tax provisions, tariffs, enforcement]

090 regulatory and policy uncertainty
107 consequences of financial regulations
103 absence/unpredictabile feed-in tariffs
145 legal action against companies for failure to mitigate, adapt or disclose climate-related risks [in their portfolios]
265 too high standards and safety regulations for the built environment and construction sector
347 lack of regulative and enforcing regulation
487 Unfavourable and uncertain regulations and policies
522 Unfavourable and uncertain regulations and policies
288 [too strict] current global fiscal constraints
293 anti-green bias of some existing local tax provisions
219 unfavourable and uncertain regulations and policies
379 Failure to account for natural value in regulatory settings
423 environmental protection

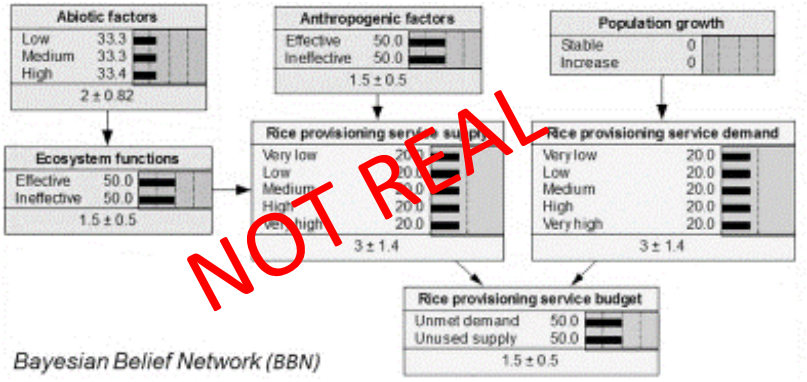
81. Adequate incentives regimes, access to subsidies and credit guarantees

101 [unsuitable] incentives regime
043 intended or unintended incentives for using blending finance
052 [available] loan guarantees
340 [availability of] Financial incentives
345 wrong steering mechanisms
480 distorting subsidies
301 government subsidies
306 access to loans and bonds [for institutional investors]
494 Increase guarantee programs for sustainable infrastructure
425 Current support programmes
304 Tax incentives
302 Compensation for base cost
431 Local promotion of economic development
334 [availability of] voluntary market-based incentives for business and individuals
303 credit guarantees
122 high fees to support fund infrastructure
050 [available] interest rate subsidies

9.9 Annex 9 – Semi-structured interview GUIDE

[provide a short description of what a private investor is]

Look at the following Bayesian Belief Network [probabilistic graphical model that explicitly captures the known conditional dependence]. The model maps the hypothesized factors that affect the involvement of private investors in the implementation of Nature-based Solutions.



From your experience in practice…

1. HOW ACCURATELY DOES THE PREVIOUS 'BASELINE' BBN MODEL EXPRESS REALITY?

[expert shares a couple of statements]

1.1 Does the model map most barriers and/or drivers for private investment in NBS?

[expert shares a couple of statements]

1.2 Which factor(s) capture your attention first-hand?

[expert shares a couple of statements]

[Interviewer leads the expert to select a sample of max. 5 factors]

1.3 Why do the previous factors capture your attention?

[expert shares a couple of statements]

1.4 From the factors selected previously [question 1.2], what chance do you think each factor has of influencing private investment in NBS? [shortly explain]

[possible answers per factor are high, medium, or low]

Consider that once more experts validate the baseline BBN, it will become more accurate. Under the assumption that the BBN becomes expert-validated

2. WHAT IS THE ADDED VALUE OF THE PROPOSED MODEL FOR EXPERTS OPERATING IN PRACTICE?

[expert shares a couple of statements]

3. LAST BUT NOT LEAST, WHY IS THE MODEL IMPORTANT IN THE CONTEXT OF THE DEMO [CASE] YOUR HAVE BEEN MOSTLY INVOLVED IN?

[expert shares a couple of statements]

End of the interview

9.10 Annex 10 – Interviews transcripts

R1

Ecologist, specialized in NBS, 12 years working in ecoshape.

Main experience related to this research:

- Dike systems and their influence on the vegetation management
- River dynamics and vegetation.
- Dealing with multiple goals, and strategies to deal with uncertainty dynamics.
- Adaptive and robust responses fixed hard construction leads to lock-in for the long run.

Among the main gaps/challenges in the implementation of NBS, the expert observes a **continuous** lack of **awareness as to the fact that costs of management of NBS, in the long run, are different from the costs of execution** [the expert has indicated that this aspect is vital for the decision or a yes/no decision of a project]. With a frequent chance of occurring, it pertains to the relationship between the availability of information for decision-makers on costs through the lifecycle of NBS and its influence on the asset management approaches used.

The expert mentioned the difficulties in the **responsibility allocation,** specifically referring to the **parties in charge of the asset management of the project.** In this line, the expert has indicated as an example the fact that very commonly [frequent] the water board [referring to the Directorate-General for Public Works and Water Management 'Rijkswaterstaat'] is seen as the responsible entity to provide safety in certain areas [alongside with the corresponding municipalities] and yet, it cannot bear with the whole responsibility for the project's asset management processes. This aspect has not been assigned to a specific relationship within the network.

Trust in RWS to provide safety for different stakeholders, has also been mentioned as an important aspect of the cooperation to enhance the implementation of NBS. Nevertheless, it has been noted that this is an aspect of lesser frequency [moderate] than the former aspects, but still worth mentioning. Trust among stakeholders has not been assigned to a specific relationship within the network.

The expert has spoken about the ecoshape project, a framework to evaluate NBS [https://www.ecoshape.org/], and the enablers [six different areas] classification within the project, as a good reference of drivers for the implementation and financing of NBS. The following aspects have been highlighted by the expert as important but no hierarchization in their occurrence has been provided, for this reason, they will all be considered as of moderate frequency [occasional]. Other factors of influence specifically addressed in the interview will be granted greater attention. Concerning the relationships impacted by each 'enabler' category, they have been retrieved from the descriptions provided in the ecoshape official website [under each category].

- **Technology and system knowledge:** functioning of the NBS itself and its services.
- **Multi-stakeholder approach:** stakeholder analysis.
- **Management, monitoring, and maintenance:** robustness vs adaptability as a management approach.
- **Institutional embedding:** written and unwritten rules of society.
- **Business case:** benefits' visualization and capitalization.
- **Capacity building:** education, training, and knowledge sharing.

The expert has put special attention to the **management** enabler category, and she has mentioned a high chance of influencing the physical, social, and technical systems of NBS.

A lack of clarity on the **'reason'** to kickstart an NBS proposal. In other words, the reason, or problem that the NBS solves is usually a contingent point of discussion ['the reason is your important risk']. This aspect has not been assigned to any relationship in the BBN. The fact that each project and NBS is **unique**, like the underlying problems they address, has also been raised as a frequent challenge for the initiation of a project, and a difficult aspect to explain to any client/investor. The 'uniqueness' of each project avoids the standardization of criteria to evaluate NBS as a whole, whether in terms of its performance or the related contracting processes.

On a separate note, the expert has indicated that she discerns a general **lack of perceived awareness on the possibility of biodiversity collapse** and the underlying consequences for the social and financial sectors. The expert related the former aspect to the common **slow change** rate in many realms of practice [in understanding, practices, i.a.], but specifically in the flood risk resilience sector, an area in which most of her works I embedded. The most important relationship mentioned for slow change was in the capacity of

experts within the environmental sciences [but again in all practice areas] to **value other types of benefits and co-benefits** beyond those that are easily/traditionally quantifiable ['learn value different types of value'].

In further explanation of the expert has asserted that the understanding that ecosystem services, although not all the time easily valuated, do have intrinsic value, and a multicriteria, comprehensive analysis could help in the mission of valuating for different multiple goals, she has re-referred the ecoshape site and the 'business case' enabler section for further information.

Moreover, the expert has indicated that from the factors and categories exposed by the research, she could see a group of constant, long-term challenges related to the **modeling of ecosystems,** on the one hand, the lifetime of NBS usually [frequently] surpasses the 10 years of duration, this timeline brings a great amount of uncertainty to the **accuracy of forecasts**. She has mentioned that the improvement of the modeling capacities is an undergoing mission, especially when understanding the behaviour of NBS under extreme conditions. The expert has indicated that one of the biggest drawbacks of the current modeling practices, is the fact that NBS are assumed to operate under controlled conditions, and therefore the models do show this same assumption, while in reality they are embedded in a very complex, uncertain climate-change setting.

Last but not least, when speaking about the category of the multitude of services provided by NBS, the expert has indicated that while it is normal [average frequency, occasional] to perceive civil projects as more reliable and efficient, in many instances, they are not the best-fit solution, in her words: 'technical solutions do not always work'. She has further explained that the goal of homologating the understanding of NBS to that understanding of civil engineering projects is valuable, nevertheless, researchers should be careful of not **holding NBS to a higher standard of efficiency to start implementing them.**

R2

Working in the Civil Engineering Faculty at the TU Delft, and Deltares in the spatial planning of NBS, and the collaboration with design studios.

Main experience related to this research:

- Willingness of residents to invest in NBS, for instance in water retention.
- Receptivity theory in receiving residents.
- Specially as a retrofit, in other words, no new investments

The expert started by stating that the **willingness to invest in NBS** as a collective [as a city], almost in all cases [frequently], directly arises from the awareness on the benefits of NBS, and the ability to show 'the city' that the problem that the NBS solves, is a shared problem. In the first section of the interview, the expert has highlighted the importance of informing 'the people' [referring to the inhabitants and other stakeholders] of the NBS.

From the network of factors displayed by the researcher, the expert has first focused on the **knowledge transference capacity and its relationship with the professional biases**, as most common [frequent] challenges for the introduction of green infrastructure and particularly in the stakeholder engagement. As an example, the expert has mentioned that the priorities, for instance, of ecologists are abruptly different to those of other actors within the network [an expert on flooding will advise to put emphasis on the ecological aspects of the decision].

In relationship with the former, the expert has confirmed the entrenched dependence of the **awareness on the importance to invest in nature** to the amount of knowledge available on NBS and the level of professional biases.

Additionally, the expert has indicated that a big problem, which is not always known to experts is the fact that ' there is too much information', in fact, many times [frequent], there is an overflow of data; the expert has stated that 'there is enough information to reject or accept anything', and that the amount of opinions on what information is relevant is fragment, condition that causes **significant interference to the proper sharing of knowledge within the network** and problems when aiming to determine which NBS is a better proposal. As an example, the expert has referenced the toolbox for climate resilient cities, he has indicated that the resources in the toolbox are supported by literature.

The expert later has spoken about a sometimes ignored [moderate] aspect of the decision-making process for a project: the emotional component of awareness. Meaning that while having a lot of information on the NBS is usually regarded as positive, 'the truth does not make believers', and that stakeholders need to feel attached to the solution in an emotional way, they need to **'trust' that the NBS is the best way to go** and solve the problem at hand, to later **decide to invest** in it.

In the topic of 'the people' associating with the project, the expert has also indicated that a **belonging or association from the stakeholders to the benefits** of the solution is usually another challenge [moderate importance], for instance overfeeding the inhabitants on the features and services of an specific project might cause them to reject it and underfeeding them with too little insight might cause them 'not to know about it' and therefore **slowing the process or scalability of the NBS in question**.

Continuing the conversation, the expert shared that the most common challenge he has observed in the implementation of NBS [in comparison to the execution of civil projects], is the **acceptance of the risk on reliability,** in other words, the degree of cognizance on the weakness of NBS to guarantee reliability [due to too-long lifecycle and deep uncertainty]. In the opinion of the expert, the implementation of hybrid solutions [green-grey projects], could be a good strategy to improve the reliability and performance of nature-based projects. Ultimately, the goal is not to ensure a certain degree of performance but to acknowledge that high reliability is not always possible or/and required.

In a related note, the expert has spoken on the 'engineering way thinking', he has mentioned that engineers and architects [two very important stakeholders for the implementation of urban NBS], are educated [this statement implies that they are always educated in this manner, thus high frequency] to believe that they are designing 'optimal' solutions for society; a mindset that incites them to trust their solutions above anything else [and strongly advocate for them], nevertheless according to the expert this is not the correct approach. Architects and engineers should start '**designing for a failing system'**, not to create anything new or hoping to increase efficiency but to focus on **minimizing damages** on overloaded ecosystems [design for failure and not for optimization]. The expert has described the former as a main component of factor F8 'professional biases' in the baseline network, he has also described its influence: '[this engineering approach] is a **barrier for the establishment of successful collaborations between multidisciplinary actors**' and thus sometimes directly hinders the rate at which NBS are implemented.

Moreover, the expert has indicated that NBS exist within an **'incomplete market'**, that confirms the status quo, and rejects innovation. He has stated: 'until 'the client' doesn't ask for it [NBS], the market does not give it', meaning that much more has to be done in the mission of understanding the inherent value of NBS and their services. For this aspect, the interviewer has questioned the expert on whether this happens occasionally or in all cases; the expert agreed with the first option [clients increasingly showcase such interest].

When questioned about the cause for the former incompleteness of the market and lack of awareness on the benefits and different types of value provided by NBS, the expert has indicated that he thinks they are **both mostly** [in occasion] **caused by 'laziness'**, he followed up by saying that there are products that are gibberish and still sell, while in the case of NBS there is no competition for value for money, need or incentive that ushes stakeholders to action.

In the search to take the conversation in a more positive direction and focus on the existence of certain drivers of NBS, the expert mentioned the **existence of a positive professional bias**, especially from experts in the landscape, urban and architectural areas, where in many cases [moderate], they actively advocate for NBS since **they have understood the value of co-benefits** such as the aesthetic value or more social gains [which usually are difficult to valuate or promote otherwise].

The interviewee has also indicated that a good NBS design needs stakeholders to rephrase, reframe the problem, and incite dialogue [which the expert has highlighted as extremely important and frequent] to arrive to an **optimal governance arrangement**. Basically, treating NBS not as a sales transaction but as a dialogue. As a sidenote to this aspect, the expert has mentioned that a successful governance strategy will be capable of handling different professional cultures and diverting interests.

R3

Main experience:

- NAIAD European Union project for Nature Insurance Value Assessment and Demonstration
- RECONNECT European Union project for risk reduction and enhancement of Nature-Based Solutions in rural and natural areas.
- Field of expertise is in civil engineering including legal aspects, behavior change, and company change.

After close examination of the baseline, the expert has indicated that the first challenge that comes into his mind as a constant [frequent] threat for the investment in NBS [F11] is specifically subfactor 269 in the unfiltered database: '**proposers of green infrastructure speak different language than decision makers**', encompassed in F17 Knowledge generation and understanding. The expert explained that the fact that the stakeholders do not have a common language or understanding on the problems at hand, **further burdens** the already considerable complexity of the network involved in the execution of NBS.

Continuing with the analysis, the expert has indicated that subfactor 371 '**complex stakeholder environment' and 057 problem 'ownership difficulties'** are two challenges that are usually intertwined and in conjunction usually [frequent] produce a lack of awareness of the real magnitude of the problem [investment gap] and the urgency with which it needs to be addressed.

As a third group of factors that were classified as common challenges are the combination of subfactor 350 '**lack of funding**' and subfactor 308 '**governmental subsidies'**, in this comment the expert has indicated that the main problem in this cluster is the fact that sometimes, for all actors involved in the implementation, but mostly for regulatory and financing institutions, it is not always **obvious that NBS are the best solution for climate problems**. The expert has further explained this by enlisting the following reasons for this phenomenon: "it is hard to finance projects", "the lack of awareness sums up to the resistance to change and not wanting to do things" and "there is a will to focus on the economic benefit and therefore a lesser focus on the public role in the financing of NBS".

The expert also quickly mentioned the presence of a professional bias hampering the financing of NBS, he did not provide further explanation on this aspect.

The interviewee maintained that one of the aspects that really stands out for him was the **lack of awareness** from the policy making entities, and how there was a **lack of transparency in the creation of NBS-related policies**. The expert mentioned that usually the problem with the policies is that they are or too stringent or too multidisciplinary and thus sometimes too broad. When asked on how common he believes this happens he related its probability of occurrence to the former aspect [NBS are not the obvious solution for CC problems] and stated that this happens in some cases, although governments are continuously improving in this aspect. To go deeper the expert has indicate that this lack of awareness is more a **lack of a better governance** [individual factor #129].

The expert continued by saying that there was also an ever-present governance-related challenge, due to the **absence of integration of the lifecycle of NBS**, maintenance people that have the knowledge on the later stages of the project and could provide a better account on the future capacity of the NBS [to provide certain services], are still not involved in the design, and most importantly in the financing phase [in other words the **decision-making is obscured by the lack of an accurate judgement/knowledge on all the life cycle stages**]. As a specific example of this condition, the expert mentioned "room for the river" project. The interviewee has also referred to this series of events as one of the types of "governmental failure" that impacts the most NBS. The last comment the expert made on the matter was that this usually cased for instance water authorities not "having money directed to maintain", meaning that usually, between their budget lines there is rarely any item for the maintenance of executed NBS.

In another theme, the expert spoke how the **maintenance of NBS is a complex problem**, on the one hand, posed by the **uniqueness of** most **of the projects [NBS]** poses challenges to the development of a standardized/general maintenance strategies, these must be tailored to each project and on the other because there is **resistance to behavioural change** from professionals in practice. As a last comment he has added that monitoring of these projects requires "patience", "iteration", "capacity learning from the network" and "knowledge creation".

To conclude the expert has shared that one of the stakeholders which can greatly boost the investment in NBS are **urban planners**, since they [as a sector] have already proven a desire to connect or involve all sorts of actors [they can perfectly operate as a bridge between different disciplines]

R4

- River morphologist [70% Deltares and 30% TU Delft Civil/Hydraulic]
- Ecoshape
- Room for the river project [RFtR]

The expert has selected to speak about his personal experiences in practice, instead of focusing on the factors. This has been his personal preference and the interviewer has agreed to listen to the examples and extract the information on the individual factors and their probability distributions later in the analysis stage.

The expert has talked about the **"market push",** and how dredging companies were the first to [this is a rare example]"create a market for themselves", competing on quality and expertise instead of economic values and their capacity of providing additional services, and therefore had an interest in **presenting themselves as "experts in NBS at a world scale**".

Consequently, the expert has indicated that **for the creation of a market** it is important to be **aware of all the "types of value" ecosystems provide**, he rephrased by saying: "understanding the intrinsic value of ecosystems". He also indicated that this is still a new [uncommon] process [still undergoing]. He has further mentioned that although the thinking revolution has already happened there is still limited examples in practice.

On another note, the interviewee has indicated that implementors [and project champions] must **understand that NBS cannot work everywhere**, and that there are cases in which grey and hybrid projects are better solutions. This aspect can be added to the node on awareness of NBS uniqueness or "correct" awareness on the importance to invest in nature, nevertheless it does not denote an existing or a new relationship and thus is not included in the analysis.

The interviewee continued the discussion [in RFtR] by explaining how a series of **disasters instigated protest** and, consequently, **change** with a search for solutions/strategies to avoid loss of life and damages. He explained that while "the government" supported a conservative approach [continuing to raise the levels of the dike], increasingly, society [protestors] asked for a different type of solution. This is the context in which room for the river took place, brough by urban planners and architects as a controversial but attractive solution. The expert indicated that this is the only way [by responding to a disaster] in which he thinks that real change can take place [game of polarization], but that this is highly improbable because there are ethical challenges in creating a "crisis" to create change and push the network to collaborate.

The discussion progressed talking about the SSRS project of RWS, the expert described this project as not very successful. While the **ambitions where quite high** [avoid CO2 levels, and considerable costs]. The NBS also promised to shelter and maintain protected species without having any real significative results. The expert indicated the "lesson that can be learned from this project" is **that willingness and financing** for a given NBS is not the only thing necessary for the NBS success in terms of productivity and even investment attractiveness. The inquirer has asked the expert how often this condition takes place and he answered that it is a quite common phenomenon [too optimistic approach] in NBS and he believes this is among the biggest **challenges for their implementation [and scaling up]**.

Finally, before concluding the interview the expert has indicated that another important aspect for the scaling up and the enhancement of private investment in NBS is the creation of "correct" performance-driven tendering criteria. With the phrase:" contractors and investors will not support the implementation of NBS **unless tendering criteria are favourable** for them, they will not get involved if they are going to lose". The researcher has questioned the expert on whether this is a common condition/constraint for the **scaling up of the NBS market**, the expert has agreed that this is a highly probably barrier for many investments.

R5

- Mobilizing funds
- Nature conservancy [expert in both scales Europe and worldwide]
- Expert on NBS public financing
- World Water Council and the preparation of business models
- Exploring targeting funds, water companies, water stewardship, or corporations as possible future investors in NBS

The expert has started mentioning that for her among the most important aspects to look for to **ensure that private investors will be interested in getting involved** in NBS is both, whether the **NBS are capital intensive** and it the **benefits are tangible.** The capital-intensive feature of NBS, according to the expert, is an important characteristic, since it hints to the fact that the projects is at least to some degree, similar to familiar investments [grey infrastructure]. The interviewer has questioned the expert on how probable it is that investors decision of getting involved is impacted by the former aspects. The expert indicated that this is highly probable and therefor the main focus in many initiatives looking to scale up NBS.

The expert indicated that the predictability of NBS is not the strongest feature of NBS, and that it adds pressure to the creation of effective regulation [the expert spoke about regulation in the UK]. It is difficult to set standards, baselines and consequent incentives and "punishments" for the projects that provide certain level of service. In other words, the expert expressed that as **long as the services provided by a given NBS cannot be forecasted accurately** [to the level of developing tangible KPI requirements], it is probable that the **regulations for environmental permits** [ad thus incentives schemes as well] will be **insufficient** [vicious circle]

In the topic of "how NBS capture value", the interviewee has suggested that **enlarging the types of outcomes that are attractive for the network** can be the first step to **incite a "paradigm shift".** In other words, to solve the ownership problems and boost collective responsibility the network must be prepared to recognized other types of outcomes. The inquirer has asked on the probability of the paradigm shift causing an increased collective response and less ownership problems, the expert has indicated that she is not quite sure about it. For the purposes of the modelling, this probability will be characterized as moderate.

R6

- Ecoengineering
- Experience with NBS of 12 years
- She has sustained different roles within Deltares, related to business development, project management, government.
- Urban NBS, including circular economy, sustainability, and urban resilience.
- Multinational NBS

The expert has started the conversation by highlighting that she believes that the **involvement of private investors**, in most cases, directly **depend**s on the **potential savings NBS produce**, whether it is in damage reduction or in the effectiveness/performance of the solution.

The expert has indicated the need for **"policy entrepreneurship",** or "champions", to **increase the level of awareness on the need for climate resilience**. This premise goes **against the professional bias**, the expert explains that these champions could play the role of integrating the sense of urgency in the network. This goes in hand with the **development of a "common language"** among stakeholders to have the same understanding in the risks and their magnitude when implementing NBS. The expert has been questioned don how probable it is that the "policy entrepreneurship" causes the effects on other factors, the interviewee has indicated that it is difficult to make approximation in this respect. For modelling purposes and given that these effects cannot be guaranteed according to what the expert indicated, the probability of occurrence has been characterized as moderate.

From this point forward the researched recognized that the repetition in the relationships [and factors] was a constant as a denoted from the tables for the last two interviews. So, to avoid redundancies, the "new" patterns are included in the transcript for the last interview R6.

The expert has shared that according to her opinion, there is a lack of platforms to exchange knowledge. Factor that hinders the learning process from best practices between study realms [so necessary to implement NBS]. In specific the expert has denoted that for instance between projects in "coastal" and "urban" landscapes there is low transferability because data cannot be transfer [scale 1:1], also data is only valid on a case-by-case basis, but most importantly, NBS are unique entities in themselves and it is hard to standardized "best practice" for the whole sector.

The former causes a lot **of emphasis on the effectiveness of the modelling tools to attract private investors**, [ergo shaping the opinions of investors in regard to a particular project] since they are the key to unlock transferability among fields of study

9.11 Annex 11 – Interviewees personal and professional information

Detailed information for each one of the six interviewees, abbreviation "R1" refers to respondent number 1, respectively R2 refers to respondent number two and so on. The order of the following table indicates the chronological order in which the interviews were conducted.

*** practice clusters nomenclature – [1] BCI, [2] CES, [3] IVS*

R1	Institution:	Deltares
	Realms of study:	1-2 [overlap]
	Summary:	River engineering, and ecology
	In-depth expertise:	NBS- Highly technical aspects: fluvial morpho-dynamics, hydrodynamics, bank protection, river training, ecological river restoration, river-bank erosion, bars meandering, braiding, bifurcations, and avulsions. Risk management and policies
	Publications:	River Width Adjustment. I: Processes and Mechanism Modelling sediment transport and morpho dynamics of gravel-bed rivers Simple physics-based predictor for the number of river bars and the transition between meandering and braiding, i.a. Numerical simulation of hydrodynamics and bank erosion in a river bend, i.a.
R2	Institution:	Deltares
	Realms of study:	2
	Summary:	Ecologist, biology [highly technical]
	In-depth expertise:	Nature-based solutions Eco hydraulic, link between experimental data and management of environmental systems, techniques for spatial mapping of vegetation in flowing waters
	Publications:	Establishing vegetated foreshores to increase dike safety along lake shores. Stream-scale Experiments on Vegetated Flows: Flow Measurement and Analysis Plants, hydraulics, and sediment dynamics, i.a.
R3	Institution:	Deltares, TU Delft
	Realms of study:	1/2
	Summary:	Urban NBS and spatial planning expert [social and governance]
	In-depth expertise:	Urban Land and Water Management and Sustainable cities, hydrology, geohydrology, and groundwater resources management
	Publications:	Adaptation Planning Support Toolbox: Measurable performance City Blueprints: 24 Indicators to Assess the Sustainability of the Urban Water Cycle Building the Netherlands Climate Proof: Urban Areas Exploring the technical and economic feasibility of using the urban water system as a sustainable energy source, i.a.
R4	Institution:	Deltares, TU Delft
	Realms of study:	1
	Summary:	Global center for adaptation, construction
	In-depth expertise:	Senior consultant in urban drainage and water management, connection between spatial planning and climate adaptation, implementation of innovative technical and sustainable solutions, stormwater drainage and infiltration, complex monitoring, urban water quality management

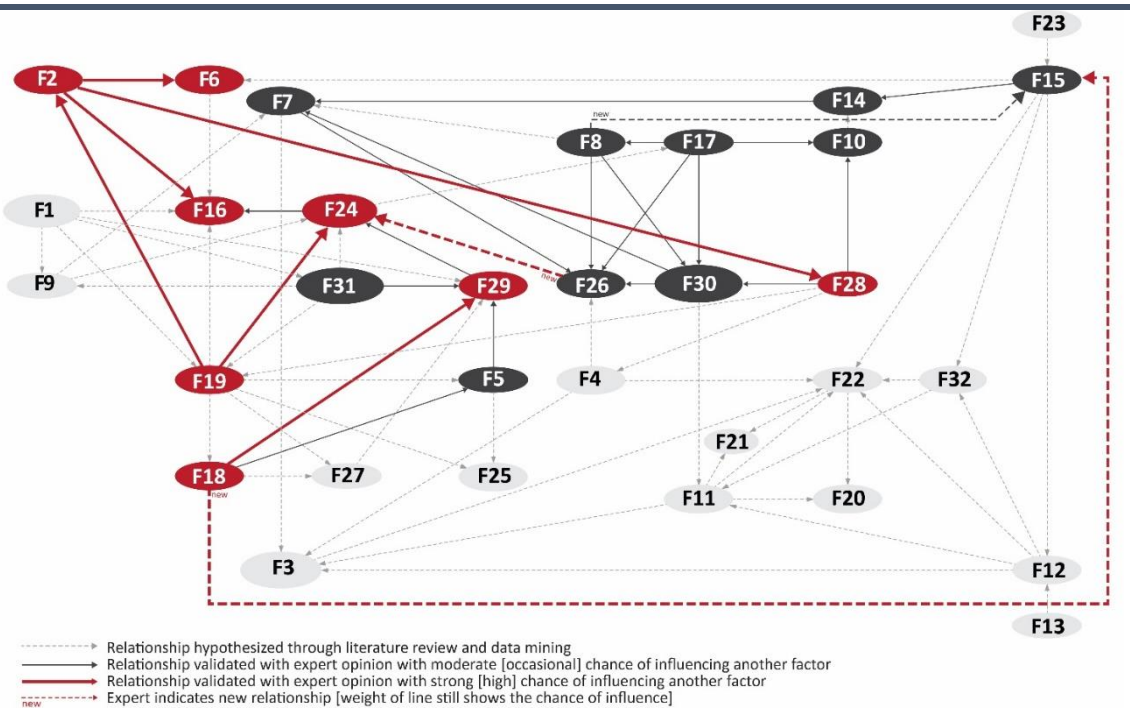
	Publications:	Risk assessment for areas prone to flooding and subsidence: a case study from Bergen, Western Norway Monitoring the impacts of floating structures on the water quality and ecology using an underwater drone Implementation of Sustainable Urban Drainage Systems to Preserve Cultural Heritage—Pilot Motte Montferland, i.a. Hydrology and water resources management in a changing world
R5	Institution:	Deltares
	Realms of study:	2
	Summary:	Ecologist, Coastal, governance and spatial planning
	In-depth expertise:	Urban Resilience, Biology, Environmental and Resource Management. Developing, testing, and implementing innovative environmentally friendly strategies and solutions, knowledge on green adaptation measures and NBS, ecosystem services, and environmental impacts.
	Publications:	Ecosystem-based marine spatial management: review of concepts, policies, tools, and critical issues Deliverable 1.1 review document on the management of marine areas with regard on concepts, objectives, frameworks, and tools to implement, monitor, and evaluate spatially managed areas, i.a.
R6	Institution:	True Nature Conservancy
	Realms of study:	1/3
	Summary:	Finance, Water security director
	In-depth expertise:	Water security , water funds, conservation, public and private funders, financing, institutional and regulatory reforms, private sector participation in the water sector
	Publications:	Taking account of the poor in water sector regulation Innovations in financing urban water and sanitation Regulation of quality of infrastructure services in developing countries, i.a.

9.12 Annex 12 – Interviews results tables [R1 to R6] and diagrams [R1 to R3]

R1

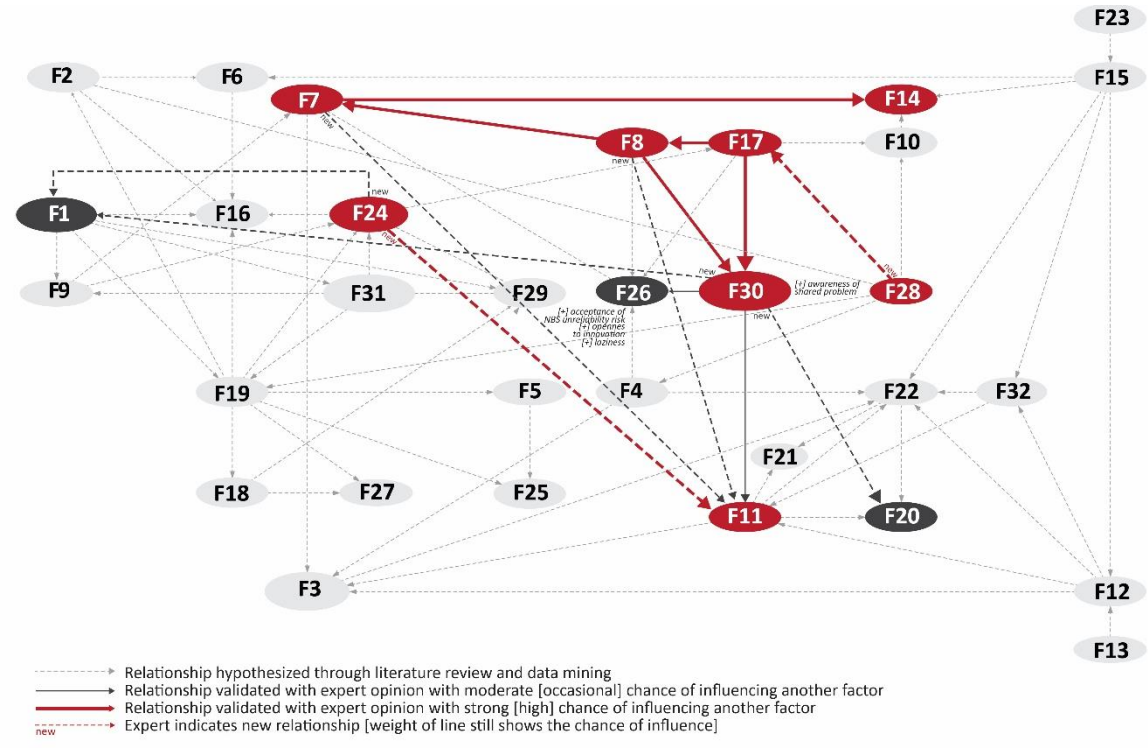
FRAGMENT IN INTERVIEW	[i]	FX2 FACTORS *[confirmed and/or proposed]*
Lack of awareness on the mismatch between maintenance and operation costs of NBS in comparison to their construction costs	F	F28 affects F2 [confirmed]
Responsibility allocation problems for asset management plans and involved parties [problem ownerships]	F	F2 -? *[Invalid [1]]*
Trust among stakeholders in the network	M	F7 -? *[Invalid [1]]*
Technology and system knowledge	M	F5 is mapped in F29 [confirmed] F31 is mapped in F29 [confirmed] F18 influences F5 [confirmed]
Multi-stakeholder approach	M	F30 enables F7 [confirmed] F7 determines F26 [confirmed]
Management, monitoring and maintenance	F	F19 constraints F2 [physical] [confirmed] F19 defines F24 [confirmed] F2 defines F6 [social/network] [confirmed] F2 determines F16 [technical] [confirmed]
Institutional embedding	M	F14 enables F7 [confirmed] F15 constraints F14 [confirmed] F7 determines F26* [confirmed] *Repeated in interview*
Business case	M	F29 constraints F24 [confirmed] F24 defines F16 [confirmed]
Capacity building	M	Relationships between factors F8, F10, F17, F26, F28, F30 [confirmed]
Clarity on the reason to implement an NBS	F	F17-? *[Invalid [1]]*
The uniqueness of each NBS project and its influence on the creation of evaluation criteria for different purposes [technical performance evaluation, procurement processes, i.a.]	F	F18 influences F29 [confirmed] *This statement proposes a new relationship [between F18 NBS uniqueness and procurement processes within F15]*
Slow change [culture, practices, i.a.] and its influence on the capacity to value other types of gains	F	*This statement proposes a new relationship [between F26 resistance to change and F24 nature valuation]*
Limited accurate modeling capacities due to long lifecycles and the increasing exposure of NBS to extreme conditions in the future.	F	F18 limits F29 [confirmed]
Different efficiency [criteria] standard to implement NBS in comparison to the standard applied for grey infrastructure projects	M	*This statement proposes a new relationship [the influence that professional biases on performance F8, in favour of civil engineering projects, and the definition of criteria for procurement F15]*

[1] Statements that are not aligned to any specific relationship will be deemed as invalid, the details, processes or items mentioned as important by the expert will be added to the description of each factor and are recommended to be considered as relevant for the pertaining governance strategies.



R2

FRAGMENT IN INTERVIEW	[i]	**FX2 FACTORS** *[confirmed and/or proposed]*
		This statement proposes a new relationship where F11 depends on F24 [F24 >F11]
		F11 depends, less frequently [moderate] on F30 [confirmed]
Willingness to invest in NBS depends on the awareness of the benefits and the capacity to frame the problem as a shared problem	F	*This statement also proposes a new factor of influence: 'awareness of the shared problem' which could be encompassed in F30 'sense of urgency to invest'*
The knowledge transference depends on the degree of professional biases and the goals alignment. The awareness of how important it is to invest in nature has the same relationships as the knowledge transference in the eyes of the expert.	F	F17 constraints F8 [confirmed] F17 determines F30 [confirmed] F8 influences F30 [confirmed]
Too much, unreliable information that causes opinions' fragmentation and significant interference in knowledge sharing	F	*This statement proposes a new relationship [between F28 - information on NBS- and its quality and the degree of knowledge transference and understanding F17]*
The investment decision depends on the trust in the solution	M	*This statement proposes a new relationship [between trust -from F7- and F11 investors capital allocation and its underlying decision]*
Scalability and successful implementation of an NBS depend on the correct level of awareness of the benefits that stakeholders have [especially referring to affected inhabitants]	M	*This statement proposes a new relationship [where F1 depends on F24 and F30]*
Acceptance of the NBS risk on reliability [which we might never manage to completely eliminate]	-	*This statement proposes a new factor of influence: 'acceptance of the risk of NBS unreliability' which could be included under F26 'Degree of behavioural resistance' as one of the pointers against resistance*
The aspect 'designing for a failing system' from the professional bias factor [focus on minimizing damages instead of increasing efficiency], has influence in the establishment of multidisciplinary collaborations	F	F8 influences F7 [confirmed]
	M	*This statement also proposes a new relationship [between F8 'degree of professional bias' and F11 'investor capital allocation on NBS']*
		F30 defines F26 [confirmed]
		This statement proposes a new factor of influence: 'openness to innovation' which could be included in F26 'behavioural resistance' or possibly constitute a new factor in itself.
Incomplete market [market maturity] depends on the degree of awareness that client showcase for NBS and their services	M	*This statement proposes a new relationship: influence of F30 'Awareness of nature's importance and sense of urgency to invest' on F20 'maturity [incompleteness] of the market'*
		This statement proposes a new factor of influence: 'laziness' which could be included in F26 'degree of behavioural resistance' as a new pointer. Given that the former is valid.
Laziness is the cause for incomplete market and lack of awareness on benefits of NBS	M	*This statement once again, confirms the newly stablished relationship between F30 [awareness] and its influence on F20 [market maturity]*
Positive professional bias F8 [professionals advocating in favour of NBS] is caused by the better understanding of co-benefits F17	M	F17 constraints F8 [confirmed]
An optimal governance arrangement depends on the problem framing, and dialogue among stakeholders	F	F14 depends on F7 [confirmed, nevertheless, the expert disagrees with the directionality of the relationship]



R3

FRAGMENT IN INTERVIEW	[i]	**FX2 FACTORS** [confirmed and/or proposed]
A lack of a common language among implementors and the great complexity of stakeholder network, both continuously hinder the investment in NBS in a great manner.	F	This statement proposes a new relationship: [lack of] F17 influences F11 F7 influences F11 [confirmed]
The complex stakeholder network in which NBS are designed, implemented, and maintained, causes problem ownership difficulties, to be specific, a lack of awareness on the correct magnitude of the problem [investment gap] and the urge to solve it	F	F30 influences F7 [confirmed, nevertheless, the expert disagrees with the directionality of the relationship] F30 influences F11 [confirmed]
The fact that many times NBS are not the obvious answer for climate problems for all actors in the network, causes a lack of interest in creating funding sources, and therefore a lack of funding, and governmental subsidies as well.	M	This statement proposes a new relationship: F30 causes a lack of F12 This statement proposes a new relationship: F30 causes a lack of F15
The lack of transparency in the creation of NBS related policies derives from the lack of better governance [also referred to as a lack of awareness] on the part of the policy making entities, causing or too stringent or too multidisciplinary [vague] frameworks	M	F15 depends on F14 [confirmed, nevertheless, the expert disagrees with the directionality of the relationship]
[example of governmental failure] Absence of integration on the lifecycle of NBS [part of governance of projects] causes a concealment/lack of knowledge or problems on the accurate costs [assessment] and features [i.e., maintainers that know specifics on the future provision of services are not integrated in the design or financing of the NBS]	F	This statement proposes a new relationship: F14 influences F24 This statement proposes a new relationship: F14 influences F31
Uniqueness of project and inertia to behavioural change create complex maintenance conditions in NBS	F	This statement proposes a new relationship: F18 create challenges for F2 This statement proposes a new relationship: F26 create challenges for F2
Urban planners have demonstrated to have a strong influence on the involvement of all sorts of actors in the financing and implementation of NBS	M	? – F11 [Invalid [1]]

R4

FRAGMENT IN INTERVIEW	[i]	**FX2 FACTORS** [confirmed and/or proposed]
		This statement proposes a new relationship: F26 enables F22
By creating a reputation of being "experts in NBS at a world scale" dredging companies created a market push	I	This statement proposes a new relationship: F26 enables F20
The creation of a market and its scaling up depends on/is driven by the awareness of different types of value [and services of NBS]	I	This statement proposes a new relationship: F9 enables F22 This statement proposes a new relationship: F9 enables F20
Generating disasters and/or "crisis" [a highly unfavorable politic or economic landscape] are effective to instigate change [there are ethical challenges in creating unfavorable conditions to motivate change]	I	This statement proposes a new relationship: F23 reduces F26
Too high expectations and understanding of NBS scope and potential [also multitude of services and attractiveness] is among the main hindrances to their scaling up	F	This statement proposes a new relationship: F9 enables F22 *
The "proper" tendering criteria design enables/allows the scaling up of the NBS markets.	F	F15 enables/constraints F22 [confirmed]

R5

FRAGMENT IN INTERVIEW	[i]	FX2 FACTORS [confirmed and/or proposed]
The fact that NBS benefits are tangible [an aspect of F9] and they are capital intensive [familiar for investors] [F16] is critical for the decision of investors to get involved in NBS	F	This statement proposes a new relationship: F9 reduces F11 This statement proposes a new relationship: F16 reduces F11
The development of efficient regulatory frameworks for NBS [incentives, tendering criteria, etc] depends on the predictability that NBS can demonstrate [through the use of KPIs o other more tangible measurements.	F	This statement proposes a new relationship: F24 enables or hinders F15
The degree of ownership problems [F7] and collective responsibility [F7] directly depends on the capacity of the network to recognize other types of value and the importance to invest in nature [F30].	M	F30 defines F7 [confirmed]

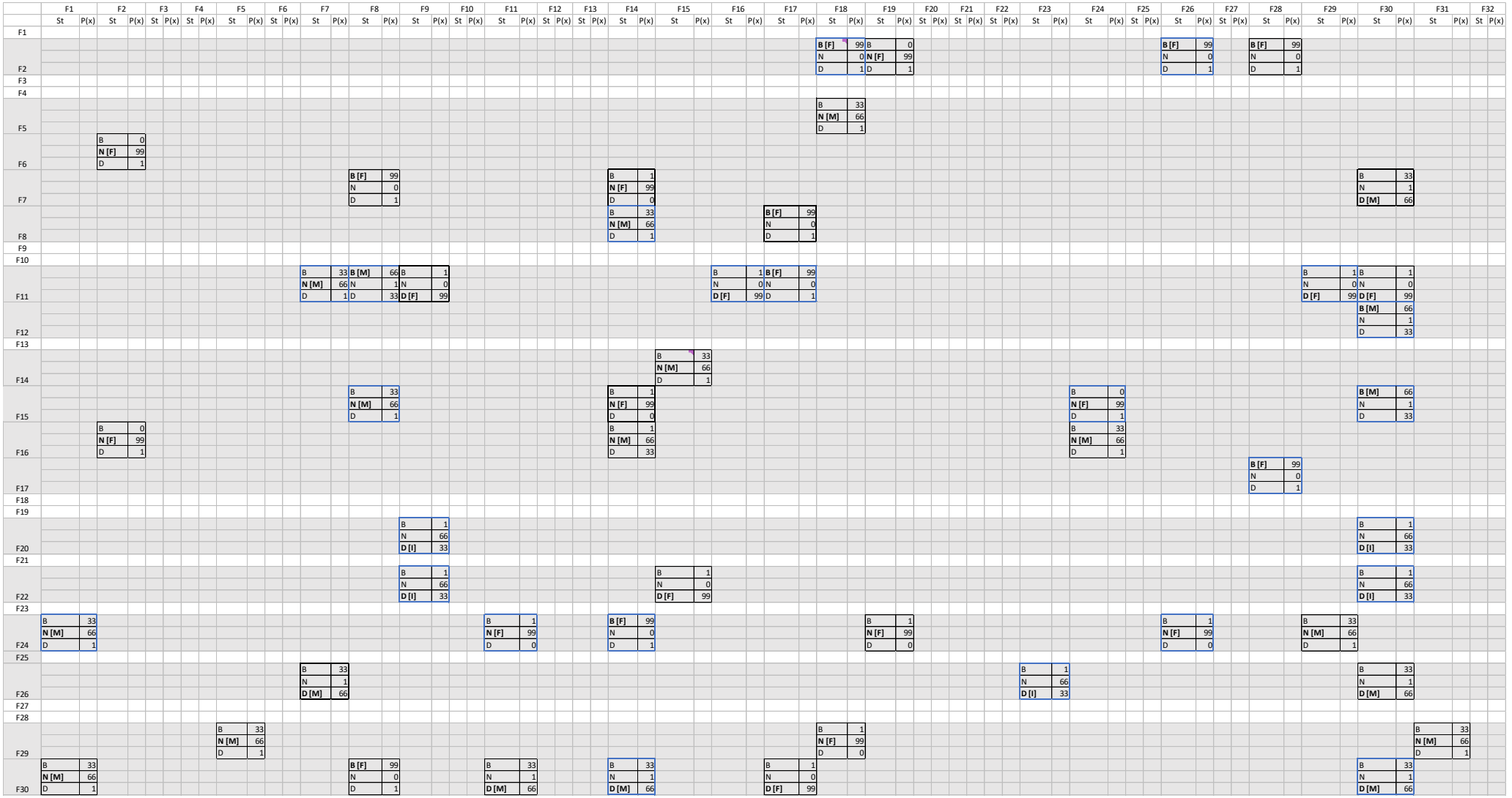
R6

FRAGMENT IN INTERVIEW	[i]	FX2 FACTORS [confirmed and/or proposed]
the involvement of private investors, in most cases, directly depends on the potential savings NBS produce	F	This statement proposes a new relationship: F9 enhances F11* two or more experts have indicated this relationship as relevant
Policy entrepreneurship [the existence of champions] drives the degree of awareness on the need for climate resilience, the development of a common language and helps tackling professional biases	M	This statement proposes a new relationship: F14 drives F30 F14 drives F7 [confirmed] F14 tackles F8
Model effectiveness shapes interest of private investors	F	This statement proposes a new relationship: F29 enhances F11

9.13 Annex 13 – Draft of confirmed, and newly proposed consolidated factors after six SSIs.

Explanation on how the matrix was populated:

- In the horizontal axe, the researcher indicated the FX2 factor that is the origin of the dependency.
- In the vertical axe, the collector indicated the FX2 that receives the effect.



of 8

9.14 Annex 14 – CPT per variable of the summarized B-PINbs [20 FX2 consolidated factors]

All Based on the works of (Cárdenas et al., 2012; Lytvynenko et al., 2019; Pearl, 2014), the construction of the B-PINbs has been made using NOISY-MAX nodes, which take advantage of independence of causal interactions and provide a logarithmic reduction of the number of parameters required to specify a conditional probability table [CPT]. The word "noisy" refers to the possibility that some "causes" at times fail to produce a given effect even when they are present (Ruytenberg, Keizer, & Oorschot, 2011). To enable a close-world assumption, "LEAK" variables are included in the definition tables from NOISY-MAX node, they represent the causes that are not modeled explicitly.

▶ F2

Parent	F19	LEAK
State	Happens	
Happens	0.99	0.5
NotHappens	0.01	0.5

▶ F5

Parent	F18	LEAK
State	Happens	
Happens	0.661	0.5
NotHappens	0.339	0.5

▶ F6

Parent	F2	LEAK
State	Happens	
Happens	0.99	0.5
NotHappens	0.01	0.5

▶ F7

Parent	F30	F14	F8	LEAK
State	Happens	Happens	Happens	
Happens	0.661	0.661	0.99	0.5
NotHappen	0.339	0.339	0.01	0.5

▶ F8

Parent	F17	LEAK
State	Happens	
Happens	0.99	0.5
NotHappen	0.01	0.5

▶ F11

Parent	F30	F7	LEAK
State	Happens	Happens	
Happens	0.661	0.661	1
NotHappens	0.339	0.339	0

▶ F14

Parent	F15	LEAK
State	Happens	
Happens	0.661	0.26086957
NotHappens	0.339	0.73913043

▶ F15

Parent	F27	LEAK
State	Happens	
Happens	0.99	0.5
NotHappens	0.01	0.5

▶ F16

Parent	F2	F24	LEAK
State	Happens	Happens	
Happens	0.99	0.661	0.5
NotHappens	0.01	0.339	0.5

▶ F17

	LEAK
Happens	0.26086957
NotHappens	0.73913043

▶ F18

	LEAK
Happens	0.26086957
NotHappens	0.73913043

▶ F19

	LEAK
Happens	1
NotHappens	0

▶ F20

Parent	F30	LEAK
State	Happens	
Happens	0.661	0.5
Not_happens	0.339	0.5

▶ F22

Parent	F15	LEAK
State	Happens	
Happens	0.99	0.5
NotHappens	0.01	0.5

▶ F24

Parent	F19	F29	LEAK
State	Happens	Happens	
Happens	0.99	0.5	0.5
NotHappens	0.01	0.5	0.5

▶ F26

Parent	F7	F30	LEAK
State	Happens	Happens	
Happens	0.661	0.661	0.5
NotHappen	0.339	0.339	0.5

▶ F27

	LEAK
Happens	0.5
NotHappen	0.5

▶ F29

Parent	F5	F31	LEAK
State	Happens	Happens	
Happens	0.661	0.661	0.5
NotHappens	0.339	0.339	0.5

▶ F30

Parent	F17	F8	LEAK
State	Happens	Happens	
Happens	0.99	0.99	0.5
NotHappens	0.01	0.01	0.5

▶ F31

	LEAK
Happens	0.26086957
NotHappens	0.73913043

9.15 Annex 15 – information on the Medina del Campo case study

This table goes through the different layers of processing so far of all the endpoints, from the raw factors from the original database, to the first and second filters, concluding in the far right their nature with respect to F11 [peripheral of direct influence]. With light Gray fond are all the aspects that are not related in any way to endpoint F11 but still belong to category "J".

Original database **factors**		FX1		FX2 **ENDPOINT**		i
No.	Name	No.	Name	No.	Name	
029	unexpected liabilities for insurance companies					
105	[some] institutional investor's lack of tax-liability					
187	Influence obligation of fiduciaries					
249	Institutional investors fiduciary duty	61	Level of fiduciary duty	F15	REGULATORY ENVIRONMENT	[very]
others		*2, 29,53, 60, 78, 79*				
089	Institutional investor's [small] asset allocation to direct infrastructure					
150	[investors'] focus on equity investing.					
236	Spending rate					
273	potential of mobilization					
434	Liquidity					
503	preference for NBS vs infrastructure development options in the NL					
511	exit points and strategies may be quite complex.					
512	[shortage] of capital supply for early project stages	62	investors' capital allocation features and requirements	F11	INVESTORS' CAPITAL ALLOCATION FEATURES AND REQUIREMENTS	Endpoint
046	[investors] knowledge and capacity gaps					
092	investor's inexperience with direct investing					
093	investor's inexperience with new technologies and assets					
130	education for institutional investors [knowledge]					
346	lack of client understanding.					
292	private sector knowledge and experience in greening infrastructure					
310	Limited institutional and technical capacity		Investors´ knowledge, experience and understanding of NBS			
450	Lack of financial resources, personnel, technical expertise on client side	63				
005	Inadequate financial institutions' analytical capabilities					
077	Bank´s limited ability to make quantitative judgements about climate-related data.		Data processing and presentation capacities of investors			
031	unsuitable data presentation for the financial sector users	64			KNOWLEDGE GENERATION AND UNDERSTANDING	Peripheral [parent node]
others		*7, 40, 55*		F17		
356	need for positive rate of return.					
392	capital owners lack of focus on maximizing individual economic gains.					
393	majority of private owners wish to maximize economic gain.					
142	Investor's common aim in delivering substantial returns to stakeholders.					
278	limited autonomous earning power.		Investors´ focus on rate of return			
388	assumption that everyone is engaged in market to maximize personal gain	65				
195	institutional investor's varying risk appetites					
078	banks position on climate-related investments					
491	investors are skeptical about sector and asset classes that they are unfamiliar with					
513	investor's [worry] to invest in cross-boundary investments.					
515	PPPs can reduce private investors' perception of policy risks.					
355	fear to potentially lose competitiveness.					
432	Personal impression					
209	investors often associate investment in developing countries					
221	investor protection concerns					
099	institutional investor's varying risk appetites					
361	aversion or risks					
226	investors' appetite and capacity					
502	[institutional investors] shared/similar strategies, preference, and regulation		Investor´s attitude, perceptions, and concerns			
008	lack of awareness on benefits of green bonds	68				
104	short-termism					
517	corporate leadership that can resist short-terminist.					
433	short-term action	69	Short-termism			
254	low levels of risk awareness					
280	elevated perceived risks					
140	growing awareness of climate change risks					
079	increased awareness of the potentially vast scale of climate risks		risk awareness, perception and understanding or risk			
025	inadequate understanding of environmental risks	70				
206	financial institutions are increasingly keen [interested] in showing that they can manage climate-related risks and opportunities [to gain reputation]		Investors´ interest for reputation			
071	development finance providers bring reputation to a project	71			DEGREE OF BEHAVIORAL RESISTANCE	Peripheral
others		*26, 41*		F26		
188	Increasing number of investor initiatives					
189	momentum CC-leadership at midsize asset owners					
420	Sustainable actions					
017	promoted voluntary principles for green finance.					
458	financial voluntary and consistent' disclosure framework	66	Investors driven initiatives			
144	Growing awareness that investors need to address CC to comply w/ fiduciary duties.					
153	[Risk factors] pathways awareness					
362	"striving [interest] to achieve a low emissions and waste free economy".					
443	involvement of MDBs [multi development banks] in climate change investments					
250	low levels of awareness about climate change in the financial sector [as a whole]					
314	A growing awareness of the value of nature for the business community					
233	strong focus [of private investors] on SDG 13 - climate action					
387	sense of urgency to invest in ecosystems.		Awareness/interest/sense of urgency in investing to address CC		AWARENESS OF NATURE'S IMPORTANCE SENSE OF URGENCY TO INVEST	Direct
442	critical role finance plays in the global response to the climate crisis	67				
others		*43, 45*		F30		

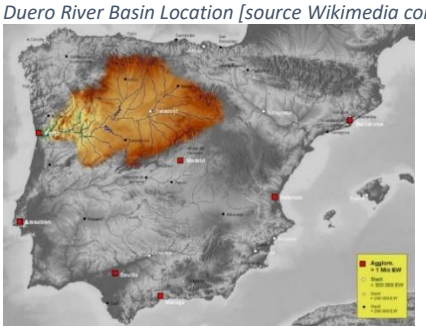
9.16 Annex 16 – Detailed information on the Medina del Campo case study

initiative from the European Commission research.

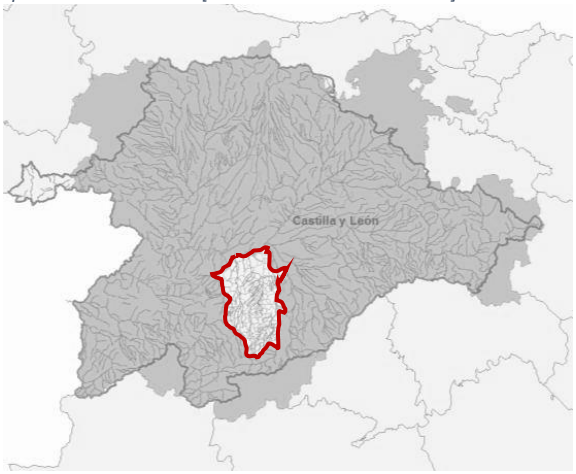
GENERAL DESCRIPTION

The Spanish case site consists of a 3700 km² groundwater body located in the Duero River Basin, in the municipality of Medina del Campo, within the autonomous community of Castilla y León, right in the centre of the country and in a highly farming-oriented area. For practical reasons, in this report, the Medina del Campo Groundwater Body will be abbreviated as MCGB [from the Spanish: Masa de agua subterránea Medina del Campo]. The aquifer mainly covers the provinces of Valladolid and Avila, while also stretching to the provinces of Zamora, Salamanca, and Segovia, in total affecting up to 154 municipalities in total]. The MCGB limits are defined as follows: North, Duero river; East, Adaja river; West: Trabancos river; South: Sierra de Gredos.

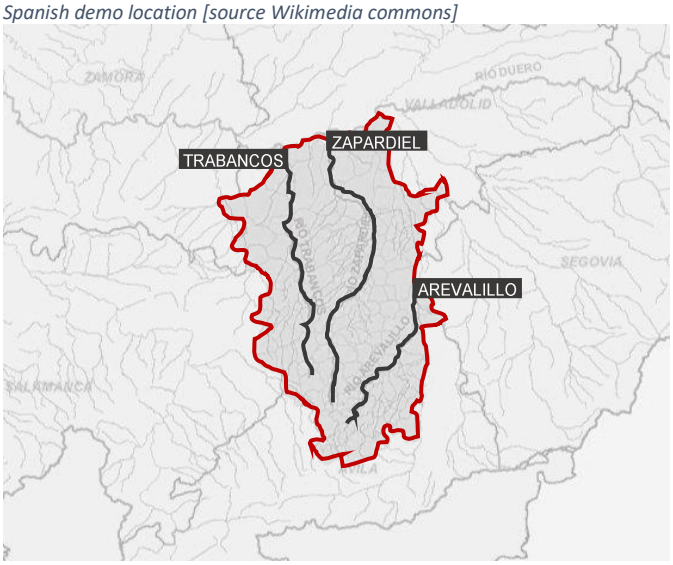
Duero River Basin Location [source Wikimedia commons]



Spanish demo location [source Wikimedia commons]



Spanish demo location [source Wikimedia commons]



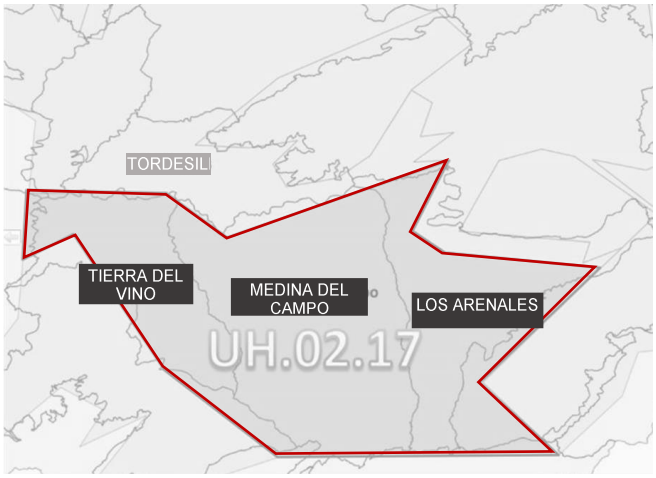
The landscape of the region is dominated by gentle undulations with cereal crops and pine forest. Another peculiar feature of the region is the former existence of seasonal streams, all currently permanently dry, such as the Zapardiel River, 'running' through the city of Medina del Campo.

The depth of the basement is variable from few meters in the south to around 600 m in the north of the MCGB.

ECOSYSTEM'S STATE

Hydrogeological features

Geographical changes throughout time, have provoked an ever-changing characterization of the MCGB in hydrogeological terms, first as part of a larger 'hydrogeological unit', currently divided into three separated groundwater bodies: Medina del Campo, Tierra del Vino, and Los Arenales



The MCGB has significant geological importance since it is associated with a set of wetlands whose relationship with the aquifer has been studied by the IGME in 2010 The study revealed that there are 26 wetlands associated with the MCGB, all of them are groundwater-related wetlands with different typologies, from permanent to temporal.

Notified in 2010 as an over-exploited groundwater body by the Water Framework Directives 2000/60/EC and 2006/118/EC of the European Commission, both in terms of qualitative and quantitative aspects, the aquifer has experienced over-exploitation mainly due to agricultural irrigation, which represents around 96% of the total annual extracted volume. The dwindling piezometric groundwater levels have caused a vicious chain reaction including poor water quality, a severe deterioration of aquifer-associated wetlands and streams, and finally a reduced capacity to deliver ecosystem services in the basin.

Among the many risks, the three main expert-detected threats in the basin are, first, the already mentioned lowering piezometric groundwater levels due to intense aquifer exploitation over the last decades [water table has fallen more than 90 meters in 4 years], diffuse agricultural pollution [NO3 contents up to 190 mg/L], and finally, an elevated arsenic content in the water [up to 240 µg/L].

Geomorphological features

Beyond the former hydrogeological features, the area is also prone to climatic and geomorphological hazards like severe floods from the Duero, Zapardiel, and Adaja Rivers to the north; these floods have caused significant damages to main cities like Medina del Campo in the past. Other important negative events to which the region is exposed to [due to its geomorphological features] are landslides and debris flows in the south, wildfires, extreme heat [+ 44 º C] or extreme cold [- 20 º C], strong winds [+ 123 $\frac{km}{h}$], among other natural phenomena.

Socio-economic impacts

The main sectors affected by both the direct and indirect impacts explained before are those reliant on drinking water supply, such as agriculture, tourism, industry, households, and transportation. The problem is especially grave for the agricultural fertilization practices that at the moment are inadequate due to the nitrate pollution in the aquifer, impacting supply wells or even completely depleting them, forcing domestic users to look for other more expensive water sources, directly impacting the economic development of the involved communities.
In terms of the socio-economic aspects, there are also important consequences of the overexploitation of the aquifer, including the increasing number of water shortages for farmers, competing redundancy of the users of groundwater supplies [region inhabitants extract for drinking water and farmers rely on the same source for crop irrigation], increasing pumping costs, abandonment of wells, construction of new [in some instances illegal] wells, and legal problems related to the right of third parties.

Environmental impacts

Significant environmental deterioration has been observed in groundwater-dependent ecosystems to the MCGB, such as wetlands, rivers, riversides, and streams, which are negatively affected by the overexploitation of the aquifer, including a significant loss of riverine vegetation and trees, except for pines groves. The overall degradation of the wetlands has also resulted in the loss of the services provided by the aquifer.

Another important environmental aftereffect is the progressive desertification of the region, which is suspected to be heightened by overexploitation, and the abandonment of agricultural land leaving it vulnerable to erosion.

Finally, the deterioration of water quality has different underlying environmental causes, such as the contamination with arsenic that has caused non-potable water streams. A second critical cause for water quality reduction is the excess of nutrients, pesticides, agricultural herbicides from agriculture activities, and important pollution from urban and industrial discharges. Finally, the mineralization and large amounts of organic matter currently present in the rivers of the region, particularly in Zapardiel and Trabancos rivers, implies highly eutrophic waters [decomposition of organic matter kills animal life by depriving it of oxygen] affecting the animal health of the rivers.

CLIMATE CHANGE EFFECTS IN THE MCGB

Climate change is closely related to the increment of extreme events in the region like frequent heatwaves, forest fires, droughts, flash floods, floods caused by rivers overflowing or breaching their banks, urban floods, and ponding through excessive rainfall. Most changes in weather behaviour have been noticed by farmers and reported during interviews with stakeholders.

In terms of temperature, under the assumption that the trends in Castilla y León will remain constant in future years [taking as a reference the period between 1961 and 1997], the mean annual temperature will have undergone an increase of about 0.2258ºC by 2025, 0.458 ºC and 0.6758ºC by 2050 and 2075, respectively. The rainfall is expected to decrease by approximately 22.75 mm by 2025, 45.5 mm, and 68.25 mm for 2050 and 2075, respectively.

These climate change-related events have also brought serious economic drawbacks, for instance, droughts affecting drinking water availability have increased the costs of water supply, therefore, causing serious problems for water users and providers [councils, water companies, and river basin authority]. Droughts are one of the most relevant challenges to society, considered as the hazard responsible for the biggest economic damages in comparison to all other sources of damage accountable for serious economic losses in agriculture for the MCGB demo. Another example of the economic impact of climate-related events is flooding, including damage to property, destruction of crops, loss of livestock, and deterioration of health conditions owing to waterborne diseases.

MCGB array of services

Besides the state of the ecosystem itself, a wide range of services rely on the well-functioning of those ecosystems, including for instance a proper plant growth, soil formation, and water filtration in the case of MCGB. Those functions that are provided directly and indirectly by ecosystems to human-wellbeing are named 'ecosystem services' (MA, 2005). In the last decades, due to several factors, the flow of services to human well-being from ecosystems is decreasing; most of the factors causing the reduction are related to the intensive human exploitation of ecosystems and un-connected management policies of natural resources. Understanding the level of performance of ecosystems services can strengthen the maintenance and preservation of natural assets and help increase participation in their implementation.

Though groundwater and, or aquifers are not included in the EU official lists of ecosystems, nor any other international ecosystems, in practice, aquifers are ecosystems that provide many and varied services to humans [direct]. In the case of the MCGB, the notorious human-oriented services are:

1. Provision of water for several uses [agriculture, which accounts for 96% of the extraction, followed by domestic-supply, and industry]
2. Provision of good quality water for uses like drinking water.
3. Support for other surface ecosystems like wetlands, springs, rivers, or forests
4. Regulation of water quality
5. Provision of social benefits like cultural, spiritual, and educational possibilities
6. Economic opportunities arising from tourism, among others.
7. Regulation of drought's effects through increased resilience of the hydrological system

On the other hand, in terms of services which are indirect to humans but primary for the best environmental conditions for the development of the region, the MCGB [shallow groundwater in unconfined aquifers], like other natural systems in semi-arid areas in the world, provides the following services:

8. Conditions for wild vegetation
9. Formation of hydric soils
10. Retention of organic matter and peat formation
11. Reduction of soil erosion (by water flows and wind)
12. Formation of permanent or seasonal wetlands
13. Generation of nursery conditions for migratory and non-migratory species

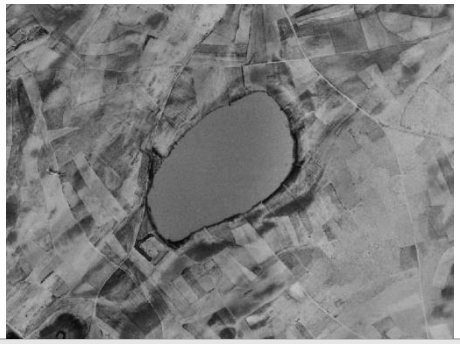
Current provision of services

In Medina del Campo a large segment of the development of the population depends on the existence of profitable agriculture; up to 19% of the useful agricultural area of the province is destined to irrigated crops. Around two thousand farmers in forty towns of the south of Valladolid obtain water from the MCGB or the adjacent Los Arenales Groundwater Body (LAGB). The overexploitation of these groundwater bodies and the proliferation of wells has caused the popularization of electric pumps - causing the water table to go deeper [between the 1970s and 2006 decrease amounted up to 30 meters from original levels], which simultaneously has increased the production costs of agrarian farms by increasing the demand for fuel, among other impacts.

Additionally, the MCGB supports a large number of wetlands and crypto wetlands. Among the most reliant natural systems, are the rivers Zapardiel and Trabancos, which have seen visible impacts due to constant environmental pressure of 35 years; while they were traditional watercourses with a stable flow throughout the year, currently, both, are permanently dry in their final 80km. In particular, in the case of the Trabancos river, it has only maintained a constant flow during three episodes over the last 15 years [twenty days in February 2001, ten days in January 2010, and eighteen days in March and April 2013].

Table Comparison between Orthophotos: American flight (1956) vs PNOA (2014)

Lavajo de la Nava




Lagunas Reales


SPECIFIC HAZARDS IN THE MCGB AND RISK MITIGATION

There is plentiful of publicly available data on the possible hazards in Spain, the most reliable and relevant data is provided from government organizations like the INE [National Statistics Institute, in Spanish: Instituto Nacional de Estadística], the CHD [Duero Hydrographic Confederation, in Spanish: Confederación Hidrográfica del Duero], and other statistical agencies.

Based on both, the previously mentioned sources and stakeholder interviews conducted in the Medina case study the main hazards identified in the region are river flooding, urban flooding for Medina del Campo city, and drought for the whole groundwater body area.

To mitigate the detected risks, the MCGB Duero River Basin Authority has implemented some measures in the 'Duero District Water Plan for the 2006-2012 period' [DWDWP], the most relevant being:

a. Artificial recharge to increase groundwater reserves, using dam water infiltrated through some river's bed.
b. Substitution of groundwater use by surface water through more advanced irrigation infrastructure.
c. Incentivize the use of less irrigation-intensive crops.
d. Increased extraction controls and improve corresponding legal conditions.
e. Alternative measures under consideration: payment schemes to reduce extractions, natural flood plain conservation, among others.

According to experts, the estimated costs to implement the previous interventions orbits around 1.6 million euros, on the other hand, the size of the monetary benefits has not yet been calculated.

CHALLENGES FOR RISK MITIGATION

The NAIAD initiative [NAture Insurance value: Assessment and Demonstration] from the European Commission research, has researched the Medina del Campo demo as well as other European examples of NBS, providing insightful information on the possible implementation of the previous mitigation measures and its consequences. The research has revealed the following main barriers, specific for the Spanish case study:

1. High level of uncertainty in modelling, design, and predicting hydrologic bodies behaviour [like the aquifer]
2. Recharge effectiveness depends on many factors [the extraction pattern after recharge, climate change, i.a]
3. Political resistance on the local level [national resistance is not expected]

Other significant chain effects that might strengthen resistance for the implementation of NBS are the following.

4. Inundated agricultural fields [due to water-table rise]

5. Salinization of wetlands [salt dissolution after recovering the groundwater discharge]
6. Increase in arsenic contents in surface water and groundwater [after infiltration of oxygen-rich water]

The insurance sector's role in risk mitigation for the MCGB

In Spain, the CCS [Spanish acronym for the - Spanish - National Insurance Consortium] is in charge of covering all-natural extreme hazards, making use of a cooperative reinsurance state program: every private insurance reserve a small percentage that feeds the CCS in order to provide the highest level of reinsurance level. This is regardless of the location of the insured properties, goods, or people. For each insurance company to claim coverage upon a case, the CCS requires a non-abstract assessment process, in order to better understand the financial risk associated to the reinsurance coverage each company provides.

STAKEHOLDERS ANALYSIS OF THE MCGB

The following table discloses the network of actors interested in the efficient performance of the MCGB and the delivery of its services. The first column shows the type of stakeholder, classified in very broad categories, the second column shows the name of the institution in both English and Spanish when available, followed by a short description in the third column when pertinent.

type of stakeholder	institution	description
National public agencies	MAPAMA [Ministry of Agriculture, Fisheries, and Food]	Department of the Government of Spain responsible for policy on agricultural, livestock and fishery resources, food industry, rural development, and human food
	CEDEX [Centro de Estudios y Experimentación de Obras Públicas]	Civil engineering research agency
	CHD [Confederación Hidrográfica del Duero]	Public law entity institutional body of basin intercommunal cooperation
Insurance and re-insurance companies	National Insurance Consortium [Consorcio Nacional de Seguro]	A compulsory Government catastrophic risk insurance in Spain
	AGROSEGURO	A national Spanish entity constituted by the combined group of Agrarian insurance companies
	Guy carpenter insurer	A leading global risk and reinsurance specialist"
Infrastructure companies	AQUALIA	Water management company, Europe's fourth-largest private water company
Financing bodies, investors, structural funds [ministry of Economy]	Triodos bank	Private bank based in the Netherlands
Regional entities	The regional government of Castilla y León	
	Province Council of Ávila	
	Department of Agriculture	
	Civil protection	
Local public entities	Municipal Council Valladolid	
	Municipal Council Medina del Campo	
	Municipal Council Horcajo de las Torres	
	Municipal Council Rágama	
	Municipal Council Pajares de Adaja	
Farmers	Union of Small Farmers and Ranchers [UPA] [Spanish: Unión de Pequeños Agricultores y Ganaderos	Association of small farmers and stockbreeders
	Farmers unión [UCCL] [Spanish: Unión de campesinos]	
	Agrarian Association of Young Farmers [ASAJA] [Spanish: Asociación Agraria de Jóvenes Agricultores]	Spanish agricultural organization, a federation of sectoral professional associations. It is dedicated to the provision of individual services, obtaining interprofessional agreements, and technological innovation.
Public and Private Companies/SMEs	Waters of the basins of Spain [ACUAES] [Spanish: Aguas de las cuencas de España]	Public Company in hydraulic infrastructures
	Environmental consultancy [CEGA] [Spanish: Consultoría, Educación y Gestión Ambiental]	Environmental consultancy, education, and management
Academic/Research	Water scientific research	
	Technological Development Centre [CIDTA] [Spanish: Centro de Investigación y Desarrollo Tecnológico del Agua]	Part of University of Salamanca
NGOs	ALHONDIGA	Cultural Association
	WWF Spain	
	SEOBirdlif	

MCGB INSTITUTIONAL SETTING

As it can be inferred in the previous section, the Medina del Campo demo has a very complex stakeholder setting, characterized by dispersing sources of power [money, authority, networks, and expertise], diverse problem perception, different hierarchy of attractive measures, various resources availability and needs [demand and supply i.e.]. Again, given the great variety and nature of actors, the hierarchization of the stakeholders as well as their objectives is a quite challenging task.

Following the framework established by [annex x FFWS], the institutional fitness of the Medina del Campo demo can be determined by analysing the various institutional layers of the demo. The first level, the broader scope of the analysis, studies the 'social embeddedness', including cultures and norms, social theory, informal rules of the game, social acceptance, and social perceptions. The second level 'Formal rules of the game' processes the property rights, regulatory frameworks, water rights, budget allocation rules, responsibilities' allocation for risk management, among others. The third level, 'transaction Costs', analyses the additional costs of taking to fruition certain governance strategy, including the cost of contracts, negotiations, reinforcement, communication, and decision making up to the risk assessment and reduction stages of the project. Finally, the fourth level of analysis, the 'baseline socioeconomic data' deals with resource allocation and specific prices and income.

Strategic Business Case: Enabling conditions of the institutional context.

Institutional layer	Incentives for investment and successful implementation	Disincentives for investment or successful implementation
Layer 1: Social Embeddedness: informal institutions, culture, norms, customs, traditions, religion. 100 to 1000 years. Social theory.	Reduction of risk perception and uncertainty in the region	Difficulty of controlling and monitoring of the Public water domain
	concessions and authorizations of water use [possible to change or transfer]	Resistance for change [resistance for NBS]
	Maintenance of the traditional main economic activity [agriculture]	
Layer 2: Institutional Environment, formal rules of the game, especially property (polity, judiciary, bureaucracy). 10 to 100 years. Economics of property rights/ positive political theory.	Complying with EU guidelines	Legal struggles to void duration of water rights [max. duration is 75 years]
	Formalization and ordering of water rights in the region [authority can extinguish the right]	
Layer 3: Governance: Play of the game, especially contracts, agreements, and negotiations. 1 to 10 years. Transaction cost economics.		
Layer 4: Individual analysis, resource allocation, and employment (prices and quantities, inflation, income, incentive alignment). Frequency: continuous. Neoclassical economics/ agency theory.		

The following table summarizes all the information provided before on the Medina del Campo Groundwater Body.

MCGB basic features summary

FULL SIZE	3700 km^2	
URBAN CLASSIFICATION	Both rural and urban, 130 municipalities with 70000 inhabitants	
MAIN STAKEHOLDERS AND END-USERS	Regional Government of Castile and León [Junta de Comunidades de Castilla-León]	
	Local councils	
	Ministry of Agriculture, Food and Environment [MAGRAMA, Spain]	
	Consortium of Insurance Compensation [Consorcio de Compensación de Seguros] [CCS]	
	Association of Groundwater Users	
EXISTING IDENTIFIED RISKS [cc extreme events]	Water drawdown [Due to intensive groundwater exploitation]	Reduction of resources available
		Increase of extraction costs
		Need for other, more expensive, water sources for agriculture
		Deterioration and loss of natural rivers, riverine vegetation, and wetlands
		Increase of arsenic release to groundwater [contamination]
	Inadequate Agricultural Fertilization Practices	Nitrate pollution in the aquifer [affecting to domestic supply wells which then will have to be abandoned]
		Need for other, more expensive, water sources for domestic use
	Loss of resilience of the aquifer and of the groundwater dependent wetlands	
	Vulnerability of human wellbeing to the effects of droughts and floods	
POSSIBLE RISKS [if measures are implemented]	Planned artificial recharge	Inundation of agricultural fields [due to water-table rise]
		Salinization of wetlands [salt dissolution]
		Increase of arsenic contents in surface water [some river reaches] and groundwater [wells]
STATE-INSURANCE LINKS	Cooperative reinsurance state program conducted by the National Insurance Consortium	
CONSIDERED ECOSYSTEM SERVICES	Provision of water for any use	
	Increase in the hydrological system resilience	
	Provision of good quality water	
	Provision of economic incomes	
	Support for groundwater dependent superficial ecosystems and their services [rivers, wetlands, and crypto wetlands	

9.17 Annex 17 – Other MCGB Interviews

[Only screenshots from the relevant pages from each interview are included in this annex]

Francisco García – farmer
AQUALIA, FCC Medina del Campo-
6-11-18

PAGE 03 /10 — **Fragment 01**

villages).	may be necessary to complete the river course. Only the surplus could be used. Pour volume 2 million m3/year. They have moved to the City Hall, because when the summer arrives the more consumption increases and less availability has of resource. Minimize the irrigation of parks and gardens,sectorize, put valves and programmers. Requires investment and a plan. Medina City Council is developing Local Agenda 21, environmental objective to reuse water from the water treatment plant for irrigation. Very good receptivity, problem money. CCE aids are coming to an end, and you have to be self-sufficient to generate.
5. Restoration of vegetation (both in agroforestry systems and forests)	YES, but as long as it is the use of native vegetation

PAGE 09 /10 — **Fragment 20**

What barriers can your implementation find?	**Economic** **Natural: economic** **Social** Acceptance by farmers: mistrust that would require education and information

José Luis Hernández -farmer
Chairman of the Board of Local Farmers, governing Medina area
13-11-18

PAGE 06 /10 — **Fragment 02**

Who should have the initiative-responsibility to implement it (central government, regional government, CHD, farmers' associations, farmers individually,...)?	The farmer, but the problem is that an investment is needed. It depends a lot on people's acitutd.
What would be the costs of implementing the measure, opportunity costs for not implementing other measures and value of the damage avoided through its implementation?	Implementation: the drip 3000 euros/ha, plants depends, is an investment to many years, which poses a risk as well. Opportunity: Avoided:
By whom and how do you think	Credits could be granted, but you'd have to control it

PAGE 07 /10 — **Fragment 03**

What barriers can your implementation find?	**Economic** The problem is investment. **Social** Lack of interest or wanting to take risks, laziness for age. **Environmental**

David Pérez **-farmer**
Regante de Fuente el Sol, zona Medina
13-11-18

PAGE 04 /10 — **Fragment 04**

2. Change of varieties and types of crops towards varieties more adapted to arid climates and with more frequent and intense droughts	Yes, if it exists. The pistachio freezes, there are no good experiences. He wouldn't dare because it takes a lot of investment. Let there be no market.
3. Promotion of agricultural practices that improve soil quality, accumulation and	Yes, tilling keeps the water more than un tilled. You're going to try direct planting

PAGE 05 /10 — **Fragment 05**

7. Restoration of flood areas	
8. Increase awareness and environmental education	NO, people have environmental awareness.
9. Effective monitoring and monitoring of	YES, re-defining what is considered illegal.

PAGE 05 /10 — **Fragment 06**

9. Effective monitoring and monitoring of illegal water extractions	YES, re-defining what is considered illegal. Mines are not illegal. Those that aren't reported anywhere, yes.
10. Regulatory measures and sanctions	Yes.

PAGE 06 /10 — **Fragment 07**

What would be the costs of implementing the measure, opportunity costs for not implementing other measures and value of the damage avoided through its implementation?	Implementation: fairly strong investment. Opportunity: Avoided: irrigated vineyards 12,000 kg without watering less than half.
By whom and how do you think	In case of board support with initial grants or aids it may

PAGE 06 /10 — **Fragment 08**

What barriers can your implementation find?	**Economic** There would have to be a market that could absorb it

PAGE 06 /10	Fragment 09
What barriers can your implementation find?	**Economic** There would have to be a market that could absorb it **Social** Lack of viability in cabinet studies Lack of reliability in the Board and Confederation. Example of the issue of mine pits These are political charges. He believes the CHD and the Board are the same.

PAGE 08 /10	Fragment 10
	Social Opposition of the Greens (NGAs). As happened with the Ebro to the Segura shipping. Social and political opposition. **Environmental** **Policies** Because every politician thinks in a different way.

Roberto Martin
Regante de Fuente el Sol, Medina area
6-11-18

PAGE 08 /10	Fragment 11
	Social Fear of uncertainty as to whether it will work **Environmental** Pistachio: that the cold can cut the cycle of the pistachio (in the Spot), varieties

Alvaro Ortega
Mayor of Horcajo de las Torres
7-11-18

PAGE 07 /10	Fragment 12
	value. They have discovered a lot of plants with applications they did not know, workshops to make brooms for erasmus. One of the problems with depopulation is the lack of value of the products. Supermarkets and intermediaries who have all the benefits. Distribution of profits in the chain.
Who should have the initiative-	The Confederacy, State.

José Luis Moyano

Mayor of Rágama, Medina area
7-11-18

PAGE 07 /10	**Fragment 13**

associations, farmers individually,)?	
What would be the costs of implementing the measure, opportunity costs for not implementing other measures and costs avoided thanks to its implementation?	Implementation: high costs, but the return of those costs is worth it for the economic impact. These are long-term returns, 10-20 years. Opportunity: Avoided:
Who pays for it and how?	It should be borne by the competent authorities: State, CCAA and EU if applicable. Farmers should also contribute to the extent that they will benefit from the measure. Farmers: through post-post cans once they saw the economic return.

PAGE 07 /10	**Fragment 14**

What other components may it take to make it effective? For example: training, information,	Complete information to people. Control more through probed counters. Cancel probe grants. Awareness. Application of usage cans. Training work on the optimal amount of water. They trust more of their judgment than tools.
What barriers can your implementation find?	**Economic** Investment of administrations that is difficult to remove **Social** Reluctance of the owners, need for parcel concentration.

Angel Gonzalez Santos
Head of Hydrological Planning, Douro Hydrographic Confederation
5-11-18

PAGE 03 /10	**Fragment 15**

1. Recharge the aquifer	Yes in general, but in the case of Medina you have to put numbers. It's difficult because we're talking about the tertiary (60m) 30m descents. It's a big volume of water. Full recharge is not feasible, but on time in some places where there is more impact with ecosystems. With interest to maintain ecosystems, not so much economic. Aquifer works with recharges and extractions. In case of overexploitation, reloading helps.

PAGE 05 /10 **Fragment 16**

9. Effective monitoring and monitoring of illegal water extractions	It helps because it allows you to have resources that are being removed. It is necessary to know how much is used, it is feasible and mandatory. This will take time. The counter order came into effect in 2010, the fat part already has. It has taken 8 years, in this area people are very sensitized to control. That there's a sanctioning regime. The good farmer knows it's useful for him. Maybe another eight years. There is capacity, because the counter is at the user's account.
10. Regulatory measures and sanctions	YES, they are being applied with a severity criterion. In general, there is no capacity to address it. If 200 files are filed, the nursery goes to the limit

PAGE 05 /10 **Fragment 16**

	Limitation of people's resources.
11. Water user associations	Yes, key. The defense, organization, improvement of water use in these areas is only possible with them. What's more, it's the most effective and fastest way to achieve: That there are instruments of control Let it be complied with and there are no sanctions.

PAGE 07 /10 **Fragment 17**

application?	
What economic benefits would it bring (I would know how much approx)? When would they materialize?	For users: they would have an exploitation stick in the face of more efficient droughts: growing crops with more value because the organization with a scarce resource, you apply it in the issues that interest you most. Better resource management. Benefits, as soon as it starts working. About 3, 4 years to roll and know how it works, so there is an economic profitability.
What other non-economic	Reduction of fertilizer application, for example to make

PAGE 07 /10 **Fragment 18**

	Social It is very difficult for those who have been functioning at their free will to fit an organized scheme. The diversity of owners makes the needs different (partial, little property and much leased). Many users, of which only some cultivate the land.

PAGE 09 /10 — **Fragment 19**

	that. If you put a fee of 150 euros on each dealership, many would unsubscribe. Raise water as a scarce good. Fee for a right. Risks, social bust. Raise fee in addition to fee.

Oscar Ramírez de Palacios (
Servicio de Infraestructuras Agrarias), ITACYL.
06/11/2018, 10:30h

PAGE 03 /10 — **Fragment 21**

1. Aquifer Recharge	No. Scale problem. Acuifero with risk of drought, would be a problem of scarcity, without drought, weather events. Recharge would be more related to the management of scarcity, not drought.

PAGE 03 /10 — **Fragment 22**

What other components may it take to make it effective? For example: training, information, etc.	Awareness from citizen, and especially farmers and ranchers. Training. Adapt your management and practices in line with this measure.

PAGE 03 /10 — **Fragment 23**

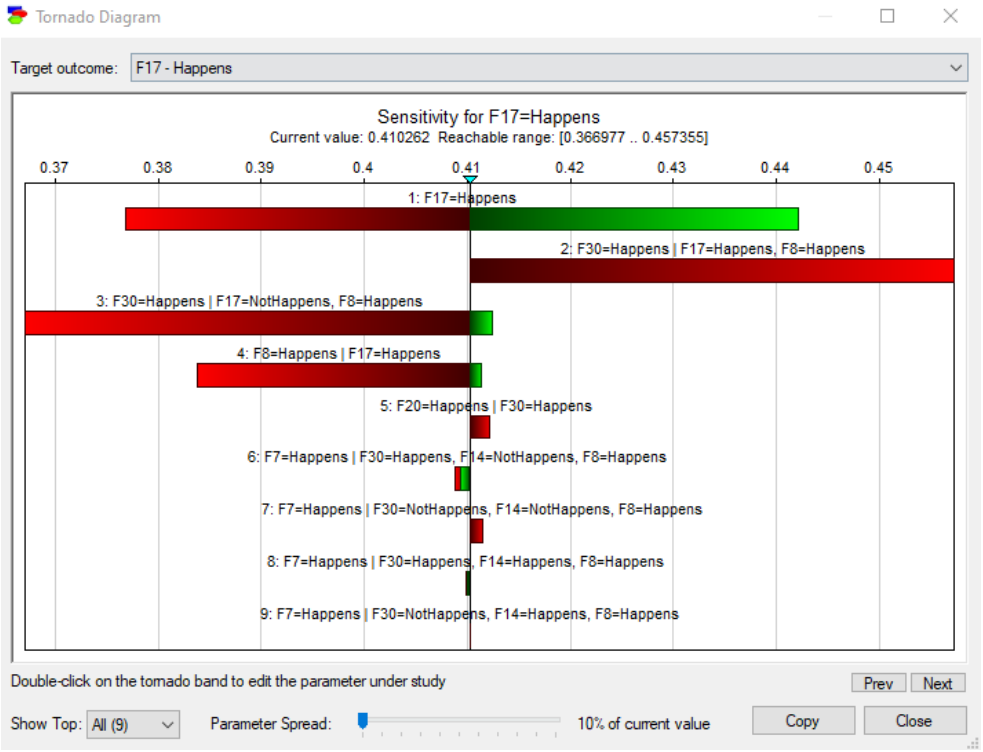
9.18 Annex 18 – B-PINbs relationships hierarchy

This table is displayed in a hierarchical order, and its values were extracted from the “strength of influence” add-in from GeNIe 3.0.

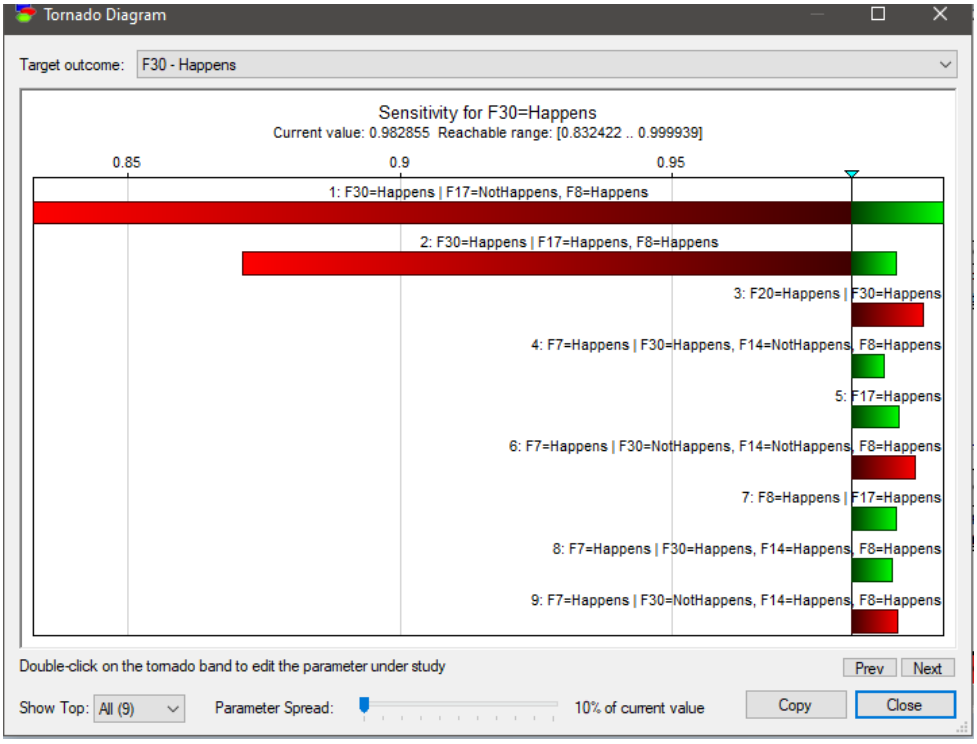
order	Parent-Child		Average	order	Parent-Child		Average
1	F15	F22	0.495	13	F8	F7	0.221874
2	F17	F8	0.495	14	F30	F26	0.22127
3	F2	F6	0.495	15	F31	F29	0.22127
4	F27	F15	0.495	16	F5	F29	0.22127
5	F19	F2	0.495	17	F7	F26	0.22127
6	F15	F14	0.488565	18	F24	F16	0.166903
7	F19	F24	0.37125	19	F29	F24	0.12625
8	F2	F16	0.331402	20	F14	F7	0.111741
9	F30	F20	0.3305	21	F30	F7	0.111741
10	F18	F5	0.3305	22	F30	F11	0
11	F17	F30	0.249975	23	F7	F11	0
12	F8	F30	0.249975				

9.19 Annex 19 – Endpoints tornado diagrams

F17

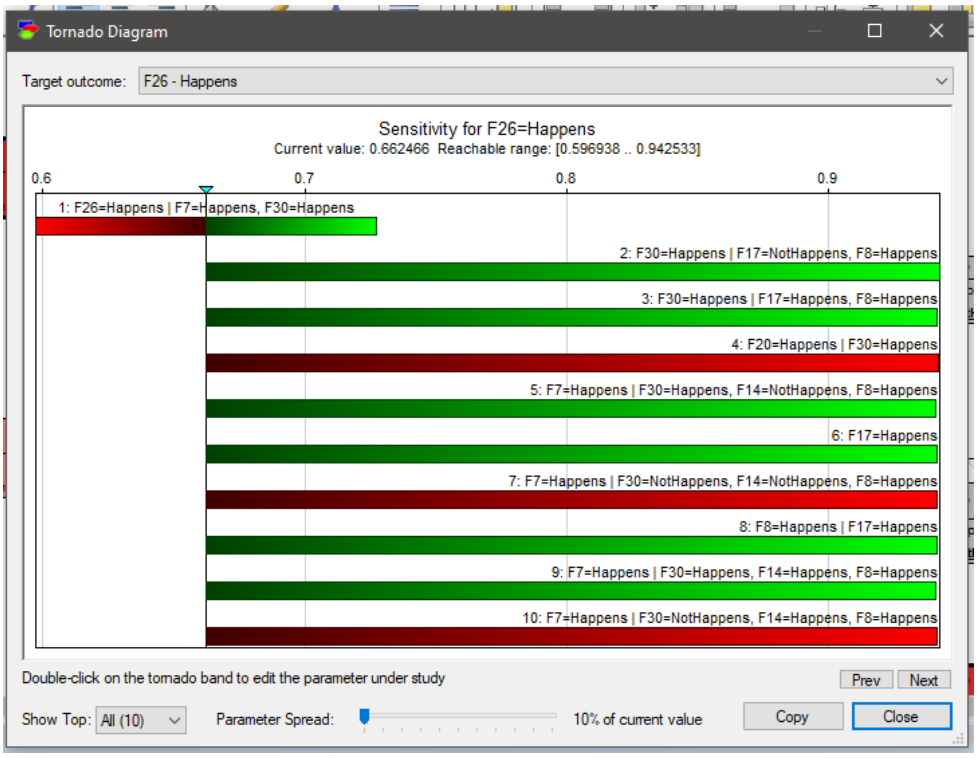


F30

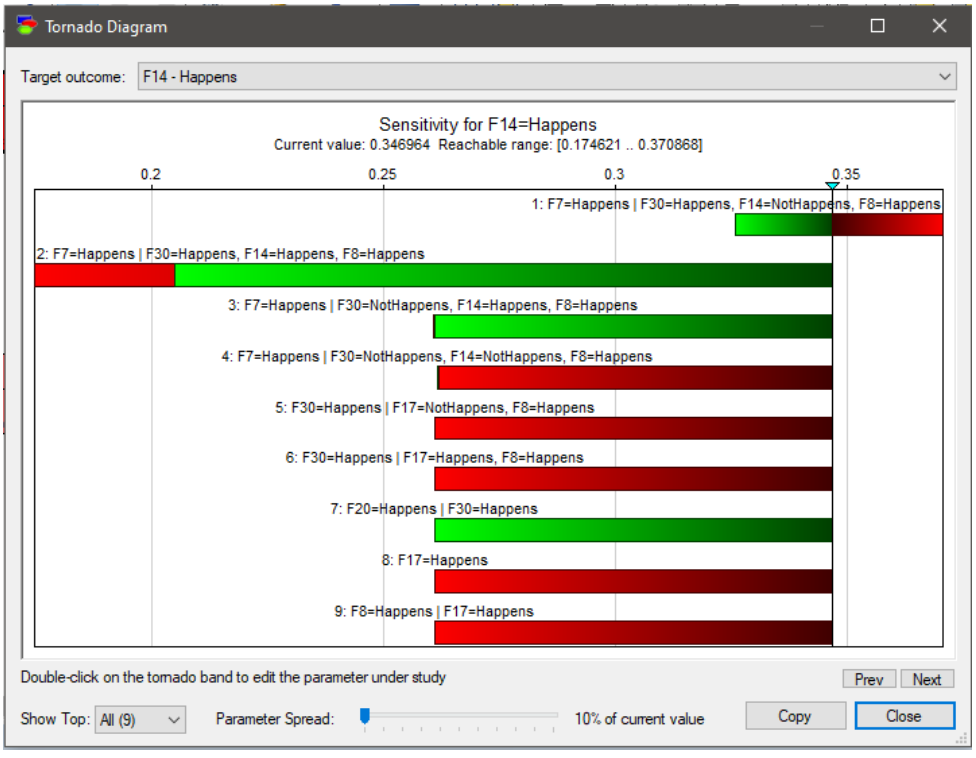


of 8

F26


Tornado Diagram
Target outcome: F26 - Happens
Sensitivity for F26=Happens
Current value: 0.662466 Reachable range: [0.596938 .. 0.942533]
0.6
0.7
0.8
0.9
1: F26=Happens | F7=Happens, F30=Happens
2: F30=Happens | F17=NotHappens, F8=Happens
3: F30=Happens | F17=Happens, F8=Happens
4: F20=Happens | F30=Happens
5: F7=Happens | F30=Happens, F14=NotHappens, F8=Happens
6: F17=Happens
7: F7=Happens | F30=NotHappens, F14=NotHappens, F8=Happens
8: F8=Happens | F17=Happens
9: F7=Happens | F30=Happens, F14=Happens, F8=Happens
10: F7=Happens | F30=NotHappens, F14=Happens, F8=Happens
Double-click on the tornado band to edit the parameter under study
Prev
Next
Show Top: All (10)
Parameter Spread:
10% of current value
Copy
Close

F24


Tornado Diagram
Target outcome: F14 - Happens
Sensitivity for F14=Happens
Current value: 0.346964 Reachable range: [0.174621 .. 0.370868]
0.2
0.25
0.3
0.35
1: F7=Happens | F30=Happens, F14=NotHappens, F8=Happens
2: F7=Happens | F30=Happens, F14=Happens, F8=Happens
3: F7=Happens | F30=NotHappens, F14=Happens, F8=Happens
4: F7=Happens | F30=NotHappens, F14=NotHappens, F8=Happens
5: F30=Happens | F17=NotHappens, F8=Happens
6: F30=Happens | F17=Happens, F8=Happens
7: F20=Happens | F30=Happens
8: F17=Happens
9: F8=Happens | F17=Happens
Double-click on the tornado band to edit the parameter under study
Prev
Next
Show Top: All (9)
Parameter Spread:
10% of current value
Copy
Close

9.20 Annex 20 – NBS applicability to this study [cross-analysis]

typologies	A Nature-Based Solution	B	C	D Service category [between brackets][4] and main functions	Comparison w/gray Infra Assets	E	F	G	H	I	Validity
01	Re/Afforestation[1]: establishment of forest areas	x	x [f]	[water supply and hydropower] storage, water supply regulation, flood control	reservoirs treatment plants water dams	x	x	x	x	x	Y
02	Riverbank Protection[1]: reestablishment of natural physical processes and physical habitats of a river system	x	x [f]	[river flood management] erosion control. co-benefits include tackling biodiversity loss	embankments Sluice gates Pump stations	/	x	x	x	x	N
03	Wetland Restoration[1]: Converting and urban dumping site into an urban wetland for stormwater runoff storage	x	x [f][d]	[river flood management] storage, water supply regulation, flood protection	Maintain services provided by wetlands	x	x	x	x	x	N
04	Wetland Construction[1]. Filter wastewater and reduce wastewater treatment	x	x [f][d]	[drought management] storage, water supply regulation, flood protection, and mgmt. of habitat and biodiversity loss	Reservoirs Treatment plants Pipe networks	x	x	x	x	x	y
05	Green Spaces[1]: Sizeable, Catchment Area [E.G., Parks]	x	x [f]	[urban stormwater management] water supply regulation, and temperature control	no analog gray infra	/	/	x	o	o	N
06	Water Harvesting[1]: infiltration basins, detention ponds[3], and aquifers [4]	x	x [f][d]	[drought management] water regulation and extreme event tackling	Reservoirs Treatment plants	x	x	x	x	x	Y
07	Riparian Buffers[1]: the vegetated area near a stream, usually forested	x	x [f]	[water supply and hydropower] temperature and flood control, moderation of extreme events, and water purification	embankment sluice gates pump stations	x	x	x	x	x	Y
08	Green Roofs[1] And Vertical Greening[3]: vegetative layers implemented on rooftops, facades and, or walls	x	x [f]	[urban stormwater management] moderation of extreme events, and co-benefits like aesthetic value	storm drains Pumps outfalls	/	/	x	o	x	N
09	Mangrove Restoration[1]	o	x [f][d]	[coastal flood management and erosion control] moderation of extreme evets	embankments groins sluice gates	o	x	x	x	x	N
10	Coastal/Salt Marshes[1]	o	x [f]	[coastal flood management and erosion control] moderation of extreme events	embankments groins sluice gates	x	x	x	x	o	N
11	Restoring Oyster Reefs[1]	x	x [f]	[coastal flood management and erosion control] moderation of extreme events	embankments groins sluice gates	x	x	x	x	o	N
12	Governance Measures[2]	/	/	increased awareness	/	x	o	/	x	x	N
13	Street Trees Areas and Boulevards[3]	x	x [f][d]	[urban stormwater management] water supply regulation, and temperature control	urban reservoirs Storm drains	/	/	x	o	/	N
14	Permeable Pavement, Concrete, Asphalt[3]	x	x [f][d]	[urban stormwater management] water/air pollution and scarcity	Hybrid	/	/	x	o	/	N
15	Biofilter[3]	x	x [f][d]	[water supply and hydropower] water purification	treatment plants	o	o	x	x	x	N
-	Others: Mounds[3]	x	x [f]	[irrigation, and drainage] Flood protection, habitat loss, biodiversity loss	dikes	/	/	x	o	o	N

9.21 Annex 21 – Categories of factors found in literature.

On the horizontal axis, eight overarching categories have been obtained; these are classes that remain constant as umbrella concepts in the work of various authors. The general categories, displayed in the horizontal axis, are knowledge management and awareness [a], global markets [b], local markets [c], policy and governance [d], social and behavioral [e], legal and regulatory [f], administrative [g], technical and implementation process [h], environmental impact and performance [i] and other types of classifications [j]. On the vertical axis, the different sources are listed following numerical order. The definitions provided intend to add an overview of the significance that each local category has in the original text, this to ensure that when counting for the number of times a general category has been mentioned throughout literature, each repetition refers to the same or similar concepts.

This analysis uses the conceptual framework and color palette of figure 3. Categories are highlighted with colors according to the practice cluster they belong to, and, therefore, hints to the actors with the best expertise to handle their underlying factors [as follows].

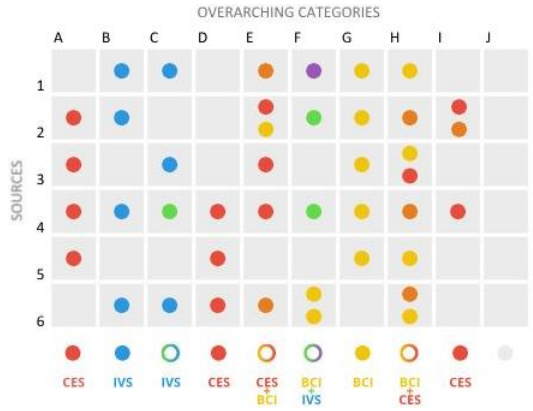
Construction Sector BCI	• [yellow]	Overlap IVS + CES	• [purple]
Overlap BCI + IVS	• [green]	Climate and enviro. sciences CES	• [magenta]
Investing sector IVS	• [blue]	Overlap CES + BCI	• [orange]

At the bottom of the table, the aggregate number of mentions per category is calculated. The goal of calculating this number is to showcase which general category is a constant concern for authors in the relevant literature. It also provides a number to hierarchize each class:

Categories ► Sources ▼	A	B	C	D	E	F	G	H	I	J	OBSERVATIONS
1	n/a	Competitive situation [a] Financial situation [b]		n/a	Customer requirements [a] Demand situation [b]	Legislative, regulation, and political situations	know-how, competence & skills	Process performance	n/a	External	1BCa – All related to the capacity to achieve unique servicecharacteristics, competitive pricing, reputation. 1BCb – Capacity to maintain or improve investment conditions, access to markets, public financial support. 1Ea – Related to the fulfillment of client expectations and provision of solutions [better performance, quality, and price flexibility]. 1Eb – Aspects related to how the value of the projects is achieved for the client, also the trends in this regard. 1F – Rules, information, and political conditions that shape access to grants or national-level support for projects. 1G – Factors related to production, technologies, management units, and organizational skills. 1H – All factors related to automation, cost reductions, avoidance of extra costs incl. sustainability. 1J – Those factors that take place outside the production unit, over which there is little influence.
2 DIMENSIONS	Unacquainted society	Global aspects	n/a	n/a	Demanding requirements from NGO's [a] Supply chain issues [b]	Legislative measures	Lack of coordination	Operation issues Performance management	Resource limitations	n/a	2A – Other stakeholders' pressure knowledge. 2B – Resource limitations, competitor's actions. 2Ea – Media, local community, labor unions' pressure. 2Eb – Customer's expectations, investor's pressure, support partners in the supply chain, competitive advantage. 2F – Government regulatory requirements, rewards and incentives, pollution, and c.c. regulation 2G – Top mgmt. vision and realization. 2H – Availability of advanced technology. 2I – Constraints related to the availability of non-renewable resources. 2HI – Cost savings in terms of reduced accidents, supplier green initiatives, corporate social responsibility, eco-literacy, emissions compliance, quantification of sustainability benefits awareness of sustainable practices
3	Information [a]	n/a	Economic	n/a	Behavioral	n/a	Organizational	Competence-related [a]	n/a	External [sub-category]	3Aa – Info. On costs and benefits, unclear info. By technology providers, the trustworthiness of the information source. 3Ab – Lack of awareness. 3C – Low capital availability, investment costs, external risks, intervention not sufficiently profitable, intervention-related risks, hidden costs.

CATEGORIES	Awareness [b]							Technology-related [b]		Internal [sub-category]	3E – Other priorities, lack of sharing the objectives, lack of interest in energy-efficiency interventions, imperfect evaluation criteria, inertia. 3G – Lack of time, divergent interests, lack of internal control, complex decision chain, low status of energy efficiency. 3Ha – Capacity to identify inefficiencies, opportunities, and difficulty in gathering external skills. 3Hb – Adequacy, and availability of technologies.
4 CATEGORIES	Information and awareness	Market	Financial	Policy	Social	Legal and Regulatory	Administrative	Technical	Environmental	n/a	4A – Availability of info., lack of awareness among authorities, perception, negative socio-economic, or environmental impacts. 4B – Split incentives, energy price distortion. 4C – High costs of design, material, and construction; hidden costs, insufficient external financial support, limited access to capital and cost incentives, economic crisis, risk, and uncertainty. 4D – Lack of long-term and consistent energy and policies, or fragmented local political commitment and support in the long term. 4E – Inertia, lack of values, and interest in common, low acceptance of new projects and technologies. 4F – Regulations for new technology, regulatory stability, non-efficient regulations, unfavorable local reg., and financial incentives. 4G – Difficulty in coordination, cooperation, and acceptance among partners public participation, institutions, the complexity of procedures and bureaucracy, public procurement, and fragmented ownership. 4H – Shortage of tested technical solutions, skilled and trained personnel, planning, defines the process. 4I – Negative effects of project intervention on the natural environment.
5 SUB-CATEGORIES	Awareness	n/a	n/a	Governance	n/a	n/a	Organization	Technical	n/a	Resources	5A – Internal local authorities' awareness, mobilization of involved officials, the burden of habits. 5D – Overlap of skills between local authorities, the priority of climate change in policies, electorate's influence, temporalities of political cycles. 5G – Motivation, ownership of actions, communication, access to data, level of expertise, admin. structure. 5H – Regulatory requirements, administrative processes' burden, state expertise, private sector as a source of innovation. 5J – State subsidies, resources at the community scale, human resources, financial resources, influence on decision-making.
6	n/a	Economic / finance		Lack of steering mechanism by the government	Underpinning knowledge	Procurement and tendering process [a] Availability of integrated methods [b]	n/a	Innovation [a] Corporation and networking [b]	n/a	n/a	6BC – Financial incentives among drivers 6D – Not indicated. 6E – Steering mechanisms, economics, a lack of client understanding. 6Fa – Knowledge and common language, the availability of methods and tools, innovation. 6Fb – Refers to procurement. 6Ha – Energy-efficient buildings as mitigation against cost in the long-term. 6Hb – Not indicated
mentions	5 mentions	5 mentions	5 mentions	3 mentions	7 mentions	5 mentions	5 mentions	9 mentions	3 mentions	n/a	

Categories distribution according to clusters of practice



9.22 Annex 22 – Sources synopsis and labelling [practice of origin labelling]

#	Name and synopsis	Main clusters [in hierarchical order]
01	Green Finance Synthesis Report Elaborated by the G20 Green Finance Study Group to scale up green financing, by deploying trillions of dollars over the coming decade. The paper defines Green Finance as the financing of investments that provide environmental benefits [reduction in air, water, and land pollution, GHG emissions, and other mitigation and adaptation to climate change co-benefits]. Mainstream challenges for climate finance mentioned in the paper, including the fact that bank lending is up to this moment constitute only a small fraction. The research covers a wide range of financial institutions and asset classes and includes both public and private finance	IVS
02	Blended finance: what it is, how it works, and how it is used. In recent years, blending has become a common development finance term to refer to the development assistance with other private or public resources to leverage additional funds from other actors. There is still confusion on its meaning and how it works, and this paper tries to add up to this knowledge gap, especially in the context of raising funds for green investment and NBS	CES
03	**Climate Change: The investment perspective** The 21st annual conference of parties [COP21] held in Paris 2015 propelled global warning toward the top of the financial services agenda. Based on the experience, this report suggests that investment opportunities arising from e.g., the energy transition will outweigh climate-related risks in the long term, and therefore could be useful as a reference in the handling and investment in NBS	IVS
04	**Institutional Investors and Green Infrastructure Investments: Selected Case Studies** Given the stretched public finances in many OECD countries, private sources of capital will be required to meet the financing requirements for new and replacement infrastructure [including the development of NBS]. This report aims to shed light on the barriers, opportunities, and risks of green infrastructure investment, to better inform government policies and decisions by institutional investors. It also contributes to the emerging literature on how climate and green-growth policies can best be designed to attract private sector investment and on the use of innovative financial instruments to overcome investment barriers	CES + IVS
05	**Investing in a Time of Climate Change** The Sequel is intended to help investors understand how climate change and underlying green investments can influence their investment performance in both the short and long term and what steps they should take to protect and position portfolio assets.	IVS
06	**Making Blended Finance Work for the Sustainable Development Goals** This paper proposes that using strategies beyond the traditional finance approaches, in specific blending, can deliver much more than capital for achieving the Sustainable Development Goals. It explores the possibility to create a pool of diverse actors from the public and private sectors, and enable that they work together to leverage strengths from each sector, which then can be applied in new ways to solve persistent development and climate change challenges	IVS + CES
07	**The next generation of infrastructure** The main premise of this paper is that sustainable projects will add trillions to the world's infrastructure costs in the future [especially due to climate change]. This report provides the reasons for which the private-sector investors must look at new ways to fill the gap.	IVS
08	**Climate value at risk of global financial assets** The main question behind this research is: What might be the impact of climate change itself on asset values? Here we show how a leading Integrated Assessment Model can be used to estimate the impact of 21st-century climate change on the present market value of global financial assets.	CES + IVS
09	**Natural Assurance Scheme: A level playing field framework for Green-Grey infrastructure development.** This report offers a conceptual framework to systematize the use of Nature-based solutions (NBS) by integrating their resilience potential into Natural Assurance Scheme (NAS), focusing on insurance value as a cornerstone for both awareness-raising and valuation.	CES
10	**Financing Green Urban Infrastructure** This document develops an overview of the main practices and challenges related to financing green sustainable cities.	IVS
11		

12	**Towards an EU Research and Innovation Policy Agenda for Nature-based Solutions & Re-naturing Cities** This report was produced by the Horizon 2020 Expert Group on "Nature-Based Solutions and Renaturing Cities", informed by the findings of an e-consultation and a stakeholder workshop. The report focuses on establishing that Nature-based solutions harness the power and sophistication of nature to turn environmental, social, and economic challenges into innovation opportunities. It thoroughly details how NBS can address a variety of societal challenges in sustainable ways, with the potential to contribute to green growth, "future-proofing" society, fostering citizen well-being, providing business opportunities, and positioning Europe as a leader in world markets	CES
13	**Introducing the suspended tree to the market through the application of strategic niche management** This research centers around the market introduction of sustainable innovations in the construction sector. The market introduction of sustainable innovations is often hindered by legal, governmental, and financial barriers, factors, and information on the instruction of sustainable projects in the BCI is a useful parallel to the development of NBS.	BCI
14	**The Law and Policy of Ecosystem Services** This research explores the problem of our economy not adequately accounting for the economic value of natural resources provided in the form of services	CES
15	**A local-level, multiple criteria decision aid for climate protection** This paper focuses on the fact that multilateral development banks (MDBs) have committed to aligning their operations with the Paris Agreement and what are the most important aspects to have in mind when aiming to fulfill this promise. The overarching aspect of this is the alignment of all future investments with the global warming limit set in Paris, is to maintain the average temperature rise to well below 2°C and pursue efforts to limit it to 1.5°C (the "Paris temperature goal")	CES
16	**Aligning Investments with The Paris Agreement Temperature Goal Challenges and Opportunities for Multilateral Development Banks** This report deals with the premise that global investments in infrastructure need to increase soon to enable social and economic development, particularly in poorer countries. It focuses on MDB and their role in this shift.	IVS
17	**Anxious optimism in a complex world** The survey asks groups of investors and insurance companies, for their opinions on growth prospects in a disruptive environment, the effects of globalization, and the threats that companies face today.	IVS
18	**Financing change: How to mobilize private-sector financing for sustainable infrastructure.** This report explores the presence of intended nationally determined contribution [INDC] over time, the challenges for their success, and all the causes and aspects connected to the existing financing gap for sustainable infrastructure.	CES

9.23 Annex 23 – Data mining processes [specifics]

ROUND ONE

Preprocess text

This step divides the text inputted in the *"corpus"* into smaller units [*tokenization*]. First, the program filtered those smaller segments through a normalization process, also called stemming, by reducing words to their stem, base, or root form, and clustering them with other words with the same stem or its detected synonyms (Lovins, 1968). Ultimately, the widget assigned each piece to a *"part-of-speech",* in other words, a category of words with similar grammatical properties (Quiles, Kūriākī, & López-Menchero, 2012). Orange allows customization in each of the process items described before, the following specifications have been thereby defined for this cycle of data preprocessing:

The text has been transformed in its entirety to *lowercase,*

Punctuation has been eliminated [including commas, exclamation signs i.a.]

Stopwords in English are erased [e.g., "and", "in", "an", "a", i.a.]

Other parameters have been left in their default values for subsequent steps.

With the help of the "*corpus viewer"* widget, the results following results from previous steps are displayed, from the total of 482 "*documents*" [segments], 8,908 *"tokens"* were detected and later classified into 2507 different *"types".* The figure shows a screenshot of the pre-processing of "*document"* no. 309, belonging to FX2 factor F9 "Multitude of functions and services". As can be seen in the figure, this step is still general and does not identify any significant patterns in the data.

Network generation: "corpus to network", "network of groups" and "network generator"

This process creates a network from the "corpus" generated during the former text preprocessing. It is composed of three main steps: The first step is to make a "corpus to network" round, which through two customizable parameters determines that [1] nodes are settled by "documents" and not by individual words [resulting in 482 nodes], and [2] that the "threshold" for the creation of a new edge [a suspected relationship] in the network is set to 5 token repetitions between both "documents" at a minimum [resulting in 577 edges]. The second step for the creation of an understandable network is to use the "network of groups" widget, in this way the software groups "documents" by a feature determined by the researcher. In this case, the clustering has been done by looking at the FX2 consolidated factor to which each segment ["document"] belongs to. For more information on the consolidated factors consult table 15. In this way, the number of nodes was reduced to 32 and the number of edges to 223.

Finally, the widget "network generator" is used to produce a preliminary exemplary understanding of the results of the processes applied to the database up to this point. The "geometric" graph type is selected for this purpose, this widget enables the creation of an undirected graph constructed by randomly placing the "nodes" in a determined metric space in future sections.

Network clustering vs network analysis

The far-right twigs of the first round of analysis as showcased in figure 22 [emanating from the "networks of groups" step] include the use of both widgets [1]"network clustering" and [2]"network analysis".

The goal of the first widget is to find further clusters in the network through two different algorithms (Leung, Hui, Lio, & Crowcroft, 2009; Raghavan, Albert, & Kumara, 2007). Unfortunately, the application of the clustering algorithms has not successfully yielded any additional groups and therefore is not useful for the data mining process in this report.

On the other hand, the device "network analysis" on the upper-end branch, perform a statistical analysis of the network, which in the case of this round, includes the following operations at the node-level, as recorded in the widgets "data table" and subsequent "network explorer":

[i] "degree" [number of edges per node]

[ii] “in-degree” [number of incoming edges in a directed graph]
[iii] “average neighbor degree” [an average of neighboring nodes]
[iv] “in-degree centrality” [ratio of incoming edges to a node in a directed graph]
[v] “out-degree centrality” [ratio of outgoing edges from a node in the directed graph]
The results of the “network analysis” of the 32-vertice network is 238 resulting relationships [edges], table 17 showcases the fifteen most important factors, ordered by the most connected [greater number of edges] to the least [i], for the detailed table consult the pertaining annex.

ROUND TWO

Bag of words

Unlike the first data mining cycle, the second round uses the model “bag of words” [BoW] after the preprocessing of the text [for more information on preprocessing consult annex 22].

The BoW is a widget that transforms each sentence into numbers, also named binary vectors. In other words, BoW counts and describes the occurrence of words within a document [or segment], and puts this information in a numerical language for the computer to understand (Brownlee, 2017).

Table 18 shows an example of this action on FX2 factor F27, the most connected node according to the former analysis. The information displayed in table 18 is extracted from the “data table” widget in Orange.

Distances

Measuring the similarity between texts [as the one in the interpretations of each one of the FX2 consolidated factors] is a common task in many applications (Wizards, 2019). One of the main qualities of Orange is that the software has friendly text distance metrics. Specifically, the device “distances” allows the measurement of complex similarities such as the semantic and meaning closeness between not only small words but full “tokens”. In terms of the parameters set for this widget:

[1] the distance has been set to be measured between rows [each one representing a separate FX2 factor], and
[2] ‘cosine distance metric, to put it simply, a mathematical calculation of orientation, an angle, which can be interpreted as the smaller the angle the higher the similarity and thus relationship between those two factors (Prabhakaran, 2020).
Figure 25 shows a graphical outcome of the “distance” calculations through the “distance map” tool, it also highlights the fifteen most significant relationships between the FX2 factors, for detailed values consult corresponding annexes x.

9.24 Annex 24 – Detailed recommendations

This section includes detailed recommendations on the application of the methodologies and, also includes suggestions for practitioners. The first section of the recommendations will be displayed in chronological order and according to the order in which the steps took place, while the second section will not follow any particular order.

METHODOLOGICAL RECOMMENDATIONS

Literature review

To begin with, a closer consideration should be made when evaluating the literature sources that fed the initial database of factors of influence. In the case of this report, to conduct a comprehensive search, both sources highly scientific realms, and practice-oriented reports were included. Future researchers should meditate on the impact of incorporating such reports coming from practice, this is because while they provide updated information, the legitimacy and validity of the conclusion they provide are not equal to those from academic sources.

Many of the stages in the present research were bound to specific timeframes, that was also the case for the literature search. The initial intention of the literature review was to analyze each "raw" factor up to the level of parametrizing it and determining whether, according to the source document, the factor in question had a mostly positive [driver] or negative influence [barrier] for the involvement of PI in NBS. This was not successfully attained due to the time-consuming nature of handling large sets of data points [522]. Perhaps if some quick operationalization parameters [or dimensions] were produced at this stage, they would have served as support for the creation of more accurate variable states in the final stages of the BBN construction.

Finally, there are opportunities for the improvement of the consolidated definitions, whether per group of factors or individual consolidated factor, a description that instead bulleting the possible included aspects, explains the context in which each variable is expected to be found and as mentioned before, including some ideas on the parameters to assess the behavior of each variable.

Filtering

Regarding the filtering processes, this report opted for a conservative approach, in the sense that all the categorization, labeling, and clustering of the data points was done physically [i.e., with the use of physical labels, stickers, memos i.a] and individually by the researcher that took the role of the compiler as well. Although this process resulted in very insightful and legitimate results, it was also time-consuming. It is therefore recommended that more efficient, technology-based approaches are used in the handling of such a large database in the future. Additionally, while at the methodological design phase, the prospect of a network of ±30 factors was considered manageable [especially considering that the original number of factors is 522] in reality, as it was revealed in later stages of the research, this is still quite a large number of variables. Applying an additional filter [FX3] could be a good alternative to further consolidate the database, nonetheless, considering how much additional time this would entail is important.

Data mining

Regarding the two separate, independent data mining rounds applied to the original database, to confirm the presence of factors in the network and their relationships [including their hierarchization]; it is the opinion of the researcher that two steps of data mining are not necessary. The second round [resulting in the distance map] alone suffices the demands set for this section. Perhaps an exploration of the relationships

finding certain prepositions such as “including”, “towards”, “between”, “under “depending on”, i.a would be a more pragmatic pathway to relationships’ detection [instead of analyzing the distance between tokens as this paper proposes].

For future studies, selecting a more “fitted” methodology or tool to establish correlations among variables could be a better alternative. Nevertheless, two critical aspects should be considered before selecting new strategies, first, that the new methodologies/tools ensure a higher degree of accuracy in the mapping of the relationships than the approach proposed in this thesis, and most importantly, that it also allows defining at least some of the directions of the correlations [before the later validation step].

In conclusion, as a general assessment of Chapters 3 and 4, while there were evident benefits to the rigorous application of the selected methodologies for literature review, filtering, and data mining processes; the invested meticulousness was not necessarily required, at least at this early stage, especially since it was known to the researcher that the conclusions of these chapters would anyway be strictly validated later by expert review.

Semi-structured interviews

Contrary to the previous expectation of the researcher [at the beginning of the thesis], the compacted database and its underlying network, were not completely analyzed or validated by the experts, some factors were not discussed or confirmed during the SSIs sessions, the author suspects that this due to several conditions, including:

- The time set for interviews [set for 30 to 45 min] was too short to cover the entirety of the BBN baseline network and its variables.
- It was mentioned in the recommendations for the filtering processes, it is possible that the scope of the baseline is still too broad and that a lesser amount of factor is more appropriate for a fast expert review round like the one intended in this paper.
- The number of interviewed experts was too limited [6], and therefore a bigger pool of respondents is necessary for future research.

After conducting this step, the researcher noticed that for participating experts, managing such an amount of information was challenging. They could not, in some cases, determine hierarchies and, or statistical information for the individual factors clearly and effectively. In many cases, the interviewed experts could not provide pin-pointed conclusions [due to being overwhelmed by the number of factors], which made the processing of an analysis per interview much more time-consuming than what was initially expected by the expert. This is because the interviewer/collector not only had to infer the numbers for the CPT but because this strategy produced significant variations on the answers since not all experts went through the same elements of the BBN. This was true even when there were only 32 consolidated factors in the network and despite providing a shortened version of the database, more graphical evidence on the network, and requesting interviewees to focus on the “big picture”, still, steering their attention to only on *consolidated factors* continued to be challenging; “the amount of information was still too much”, which caused diverse reactions from interviewees:

[1] Experts conveyed in different ways that a short interview was not enough to cover the entirety of the problem and thus could not guarantee the comprehensiveness and accuracy of their answers.

[2] To simplify the complexity of the 32-element BBN, interviewees constantly referred the inquirer to pre-existing classifications of factors developed in other literature sources. These sources were not always legitimate sources of information, but they were a natural reaction from the experts to balance the uncertainty sensation they experienced during the interviews.

[3] Finally, some experts felt more comfortable focusing on individual raw factors [from the original database] and had a hard time exploring high-level interactions of consolidated variables. For these

cases, the inquirer had to intervene several times to focus the conversation on the consolidated factors [32] and not individual items of the database [522].

In conclusion, three recommendations stand out for the execution of SSIs, based on the experiences of this research: prioritize a higher compacting of the network, conduct more interviews, and ensure a longer duration per session. These measures must be taken being mindful of the additional time and effort they imply for the study.

BBN construction

The use of BBN as support for decision-making and diagnosis of environmental models is still a mission under development, more so, if speaking of non-technical themes, as is the case in the present study. There is a limited amount of literature on the "proper" principles to construct and validate non-technical BBN like the B-PINbs baseline, and therefore the author has heavily relied on snippets from several sources as a guide. In this line of thought, the researcher has also found it useful to consult quality protocols for evidence and population of BBN's (Jørgensen & Bendoricchio, 2001; Pollino & Henderson, 2010), and to continuously assess the level of rigor and credibility of the inputs and outputs of the network. In the case of the B-PINbs, the baseline ranks as a medium quality BBN, this is because:

- In terms of the calibration and statistical fit, the data is only moderately calibrated.
- While there is a legitimate validation process that is done using an independent data set, the validation cannot be considered comprehensive given the sheer amount of data points. To improve the quality of the model, a wider elicitation process must take place, or the database must be efficiently reduced to a smaller set.
- The database sampling is large in number but does not account for various sites or timeframes. Therefore, the B-PINbs serves as an "accepted design framework" and not as a best practice framework for private investment in NBS. To increase the status of the framework to a "best practice" example, the elicitation step must be more stringent and with a wider pool of experts and account for different moments of the project.
- Finally, while the pool of experts is varied, the degree of consensus in their answers is not precisely high, but rather, the baseline showcases a partial consensus, to be tested later by-future research and by the growing application of the framework by practitioners' in the real world.

Additionally, to produce a more meaningful, dynamic model that is capable of uncovering hidden relationships and effects of the adjustment of one or more variables, it is necessary to expand the specification of the model. In other words, a more in-depth analysis of the variables for the construction of the B-PINbs, including a larger discretization of the conditional probabilities in, for instance, five levels instead of the three proposed for in this research [frequent, occasional, and improbable], a wider array of states per variable instead of the simplified binary strategy used for this report and the use of different types of variables in the model [decision, chance, value, i.a.]. A model with these features will not only result in more differentiated and insightful results but will be a closer, more accurate model of the real-world conditions that private investment faces when considering involvement in the implementation of any NBS.

Furthermore, given the fact that, particularly, biodiversity and resource management [biotic] systems change over time, more attention should be placed on the temporal analysis of the interactions of the system under analysis, since as noted by (McCann, Marcot, & Ellis, 2006), BBN is not optimal for temporal dynamics analysis tool. This implies that to properly understand NBS by using B-PINbs will most probably require an exhausting process, of replicating the entire BBN structure each time any significant interaction is assumed to have experienced a substantial change, this includes once again establishing the nodes, confirming the relevance of the relationships, so on and so forth.

Depending on the rate at which the B-PINbs methodology is tested in different settings, it could result in an increasingly detailed, legitimate methodology that offers the operationalization of certain performance indicators, to ultimately assess the efficiency of NBS.

General recommendations

It is important to remember that the problem at hand is deeply rooted in practice and basing the solution solely in academic sources and analyzing it only through scientifically "guarded" methodologies, could produce a limited overview of the problem and its solutions, not even addressing the highly fragmented status of the problem. Future research has an almost contradictory mission, to include and bolster a larger data collection, validation, and inputting methods for knowledge coming from practitioners and private investors, while also providing more efficient strategies to reduce the complexity of the modeling outcomes.

RECOMMENDATIONS FOR PRACTITIONERS

Among the main recommendations for those NBS-experts rooted in practice, the advice is getting involved in the testing and development of frameworks like the B-PINbs, which offers a comprehensive, scientific-based foundation to the implementation of NBS. It is also the case for this research that the framework relies on iteration to increase its accuracy, in terms of how the BBN model[s] mimics the real world's conditions, and on how efficiently will the model predict the interactions between nodes. Therefore, in a nutshell, the importance of involving practitioners is clearly outlined by the demand for more information on how different aspects of NBS operate in reality.

Specifically, practitioners are crucial in the operationalization of some of the baseline variables, this is because they have contact first- hand with real cases in a more constant manner, and in the case of some variables, they might be the only source of knowledge in that particular aspect.

While the approximations made by practitioners, might rely on a sense of intuition built over the years, and in that sense might be less reliable, inputting their pragmatic knowledge in ongoing governance arrangements and the baseline [B-PINbs] is transcendental because beyond causing significant benefits, not individual benefits, it will greatly advance the knowledge generation and learning of the entire NBS field of study.

A final reflection. It is of public knowledge that Climate Change and its increasing pressure on environmental systems, have set an indefinite deadline for action [and therefore investment] in mitigation and adaptation measures such as NBS. Not one actor, in the academic world or practice, is capable of accurately forecasting where this time limit is set. Nevertheless, one thinking is clear, action must be taken before significant, irreversible systemic effects start developing and cause additional greater challenges.

The author recommends expanding the sense of urgency and understanding of the consequence of CC among all the stakeholders of the network, this common ground could be the steppingstone to start collaboration among experts in academia and in-practice professionals, to ponder on how much time is sensible to hold frameworks like the B-PINbs and their development within the scientific and academic realms before allowing the "free" input of practitioners [its use in practice]. A consensus should be attained on whether any methodology focused on such cutting-edge assets like NBS, including the one proposed in this report, will be able to prove enough methodological rigor "in time".

The real question here is, is it time to develop a tolerance for the utilization of “acceptable” [good enough] frameworks like the B-PINbs? Is it time to implement them even before their acceptance according to the utmost rigorous standards in academia.

9.25 Annex 25 – Definitions in the academic discourse

The term infrastructure usually pertains explicitly to grey infra utilities such as roads, ports, railways, water pipes, i.a (AGIC, 2009; Mutanu Munyasya & Chileshe, 2018). When coupling it as "sustainable infrastructure", we refer to the creation of all assets, actions, and initiatives that meet the current needs of society without compromising the ability for future generations to meet their own (United-Nations, 1987). In other words, the definition of infrastructure alone is quite limited since it almost exclusively refers to "grey" physical resources. Therefore, it is closely related to the traditional conception of asset management. Once the sustainability label is added, the character of the definition shifts towards the utility and the long-term consequences of the said measures, regardless of whether the provided services stem from a tangible or intangible solution.

The concept calibrating the level of analysis in this report is "Nature-Based Solution", a concept rooted in climate change mitigation and adaptation spheres (Kabisch et al., 2017); the term is well-suited and originated from policy-oriented realms. A widely accepted definition is the one stated by (Nathalie Seddon, 2019, p. 377) that defines NBS as ecosystem-inspired assets that deal with climate change, water security, disaster risk, among other services. Additionally, given the wide arrange of stakeholders using the definition, it is not strange to find slight variations according to each realm of studies; for example, both the EU and the IUCN's definitions showcase small differences in terms of connotations, according to their areas of expertise and agency. The European Union takes an opened-up approach by including within the characterization anything [assets, measures, actions, strategies, i.a.] that provide environmental, social, and economic benefits as a Nature-Based Solution (EU-Commission, 2016). On the contrary, the IUCN focuses and highlights the importance of the lifecycle by considering as an NBS any action to protect, manage, or restore natural or modified ecosystems (E. Cohen-Shacham et al., 2016).

To summarize, in comparison with the concepts of sustainable infrastructure and green infrastructure, the definition of Nature-Based Solution includes both traditional physical projects [with a defined lifecycle] as well as intangible actions like "preservation and protection of forest areas" (EU-Commission, 2015b). In comparison with other theoretical approaches, the conception of NBS entails a strong understanding of the multi-functionality of natural assets and the importance of conserving them (Maes & Jacobs, 2017). Not to be confused with ecosystem-based adaptation measures, an umbrella word that refers to the general use of biodiversity to help people adapt to the adverse effects of climate change at different broader scales (Brink et al., 2016; CBD 2009).

Lastly, the concept of Green infrastructure has an urbanistic origin; it emanates from the concern that urban sprawl in the '90s included a disproportionately low amount of green spaces within cities (Benedict & McMahon, 2012). Therefore, it is firmly rooted in both landscape architecture and landscape ecology (Fletcher et al., 2015); nevertheless, as the former two definitions, it also includes human wellbeing and other abstract concepts (Mell, 2009; Pauleit et al., 2017). Since GI has a close link with architecture, this conception is closer to the operational discourse usual in the BCI sector; also, for this reason, this characterization could be useful when looking to reach a consensus among those industries and academia used to this terminology (Pauleit et al., 2017). To conclude, GI is invariably linked to planning and developing on the ground, and thus, it is more oriented toward the physicality of the projects.

Through a colored pallet, figure 1 shows the practice clusters or industries that most commonly use each term; on the one hand, the yellow indicator refers to the BCI or building and construction industry, while the magenta figure refers to the Climate and Environmental Sciences realms. It is worth mentioning that a third cluster is analyzed in this research, the investment sector, which, while already going through the adoption of new sustainability jargon, is still in the first stages of this transformation and therefore there are no terms that are more closely to this last cluster.

9.26 Annex 26 – BCI vs CES understanding of transformation processes and SID.

To compare the difference in how experts within the BCI understand change and how the same is understood from the CES, table 2 cross-references the stages of the implementation of SID principles in the construction sector with different theories on the nature of transformation processes.

The first column, through a broader lens, showcases the different change responses according to systemic change theory [i](Jenal, 2019; Nippard, Hitchins, & Elliott, 2014), the second column indicates the possible adaptive responses to promote SID according to adaptive theory [ii](Béné et al., 2014). Column three describes the change process analyzed through risk management theories [iii] (Rose, 2013). Finally, at the bottom of each separate stage, the evidence of the transformation process within the BCI is provided [iv]; these indications at the bottom qualitatively describe the basic pointers of the overall maturity of the SID process. The first two columns correspond to theories common for the cluster of climate and environmental sciences, while the third column views risk management theory, commonly used in the construction and building industry.

Table 24 — Sustainable Infrastructure Development [SID] transformation stages

First Stage

Systemic change theory [i]		*Adaptive theory [ii]*	*Risk mgmt. theory [iii]*
Name	Response	Name [incl. Description]	Response
Institutionalized beliefs and fixed predominant attitudes	Respond: supporting existing functions and rules	Resistance: investment in existing systems, the main goal is to protect business-as-usual, examples in civil projects is investing in maintaining existing assets and establishing insurance for those at risk	Avoid: evade as many modifications as possible
Adaptation evidence in the CBI [iv]			
Implementing a limited number of modifications to existing assets and practices, i.e., without substantial change on policies or physical features like materials permitted			

Second Stage

Systemic change theory [i]		*Adaptive theory [ii]*	*Risk mgmt. theory [iii]*
Name	Response	Name [incl. Description]	Response
Transformational change	Adapt: initial investments in poor change	Incremental Adjustment: Marginal changes on infrastructure, institutions push new practices to foster flexibility without threatening the integrity of the system. Committed to functional persistence, does not allow for challenging underlying values.	Mitigate
Adaptation evidence in the CBI [iv]			
Adapt practices, oriented to reduce the probability or impact of the damages that physical assets produce on ecosystems, by imposing more stringent regulations [i.e., footprint, or performance]			

Third Stage

Systemic change theory [i]		*Adaptive theory [ii]*	*Risk mgmt. theory [iii]*
Stage	Response	Stage [incl. description]	Response
Transformational change	Adopt: stakeholders have a viable concrete plan to continue in the future	Transformation: fundamental, systematic change to the functioning of systems, in the BCI, it means a shift on priorities [to ESG values], or the characterization of new outcome units [NBS, green infra-assets], new policies that address deep-rooted causes of risk. *Beware, this might create unexpected secondary costs until the system stabilizes.*	Accept, create active contingency plans to bear with risks
Adaptation evidence in the CBI [iv]			
Adopt new practices and products, fundamentally changing the way outcomes are produced by creating new types of assets [like NBS] or inducing behavioral change by incorporating diffused performance indicators for instance			

Fourth Stage *[undergoing]*

Systemic change theory [i]		*Adaptive theory [ii]*	*Risk mgmt. theory [iii]*
Stage	Response	Stage [incl. description]	Response

Scale-up	Expand	*Undergoing*	Transfer: relocate risks and, or responsibilities to [new] third parties
Adaptation evidence in the CBI [iv]			
Undergoing			

** This table was developed by analyzing the work of [I and iv](Nippard et al., 2014), [ii] (Béné et al., 2014), and finally [iii](Rose, 2013)*

In conclusion, to accelerate the sustainability transition in an inflexible sector such as the BCI, it is crucial to expand the understanding of the ongoing transformation process, including its challenges and enablers for the attainment of the different stages. The traces of transformational change have been observable for a while, including plans at a global scale such as the Paris Agreement, the Infrastructure 2030 OECD report [OECD,2007], and the G20 Infrastructure Initiatives Hub [Global Infrastructure Hub, 2018]. In the European context, for example, initiatives like the Private Infrastructure Development Group ("PIDG") and the one analyzed in this Report, the horizon 2020 NAIAD initiative, are mature transformation responses.

Table 2 also contains evidence of the fourth stage of the sustainable infrastructure development [SID] being already under progress in the construction industry, including the "scaling-up" and mainstreaming of sustainable actions according to systemic change theory, and the "transferring" of responsibilities and risks to third parties of such actions, according to the risk management theory.

9.27 Annex 27 – Research approach from the objective perspectives

Descriptive research focuses on statically describing a situation, problem, or phenomenon, and what is critical concerning the issue under study. As (Lans & van der Voordt, 2002, p. 53) delineates, this type of research is restricted to the factual registration of the problem at hand. It is particularly compatible, with three different advisable methodological approaches: in-depth case studies that offer deeper insights into the core problems but might incur inaccuracies due to generalizations when outlining conclusions out of single cases, secondly, systematic methodological approaches, in which the focus is the creation of knowledge on a given structure and building hypotheses on it, and finally a mid-point between strategies. Both the keyword literature review and the case-study methodology in this research are oriented to create a picture of the influencing factors on private investment in NBS, and therefore are more descriptive. For more information on the specifics of each methodological step consult section 3.6.

Correlational studies, on the other hand, deal with establishing whether there is a relationship or dependency among two or more aspects of a problem and aims to paint a systematic picture of the problem variables (Stangor, 2011, p. 16). Among the strengths of correlational research is that, at first glance, it is easy to determine the existence of associations between two or more variables, a feature especially attractive when interested in, i.e., dynamic studies such as those handling behavior/change patterns. Nevertheless, this research type struggles to provide proof for causation, correlation, or influence among factors and rarely leads to accurate scientific statements or precise information on the cases (Stangor, 2011; Tillbrook, 2014).

The data mining, expert semi-structured interviews for validation, and the different BBN's modeling are all concerned with the establishment of relationships and criticality of the variables [factors of influence].

Explanatory research handles the "why?" and "how?" questions of the relationships between study variables (Kumar, 2019), according to (Baskerville & Pries-Heje, 2010, p. 274) the primary goal of explanatory design methods is to delineate the "requirements" that must be met by a system or system component [variable] to satisfy a determined [suspected] condition. It must be mentioned that this approach is best embedded within softer sociological approaches to scholarly research (Baskerville & Pries-Heje, 2010, p. 281), a feature that is seen as a weakness or strength, depending on the academic community that employs it. Exploratory research is suitable when the objective of the research is to examine an aspect that is vaguely known (Kumar, 2019), this approach fits empirical sciences in which the strict proof or disproof of the conditions is not possible and, or not desirable, and in which the experience and qualitative knowledge acquisition enjoys higher importance (Popper, 2002, p. 28). The choice of the underlying methodologies is not random; in terms of case study methodology, the case must be chosen following the logic of analyzing the informative, most insightful example of the relationship between any given variables (Reiter, 2013, p. 8).

9.28 Annex 28 – Investors' profiles

To detect the threats and enhancers for private investment in the execution of NBS, it is necessary to outline the evaluation criteria and rationale of the character deciding on the PI the involvement. While in traditional infrastructure, it is already known that private investors have a cautious attitude towards traditional infrastructure investment (Committee, 2013), the same and a more restrained posture can be expected from investors when dealing with green infrastructure.

According to (Rothballer & Kaserer, 2012), the constrained attitude of investors towards infrastructure development is caused by three main conditions. The fact that most of the decisions are taken under high uncertainty, that in comparison to other industries, product testing is not possible, and lastly, that due to the large scale of projects, the risk perception is greatly affected. These hurdles remain valid for NBS.

The risk perception, as well as priorities for each investor, shift according to the source of the capital at stake. According to (Alfen & Weber, 2010), historically, there are two primary sources of revenue in the realm of private infrastructure investment that investors look for: first, complete or partial user payments for services provided by the NBS, and secondly, budget funds paid by the public-sector principal as a regular fee [through Public-Private Partnerships – PPP].

(Della Croce & Yermo, 2013) provides a much more comprehensive classification that classifies the investors according to their priorities. The classification distinguishes from "Pure Financial Investors" [also referred to as Institutional investors in literature], like those motivated by the return on equity and risk profile of projects, and the "strategic investors", like those that also look for other forms of value [including ESG principles]; some examples include endowments, foundations, and in the specific case of NBS, water stewardships. The alignment of investors' priorities with the "most critical" factors will be analyzed in the governance arrangements chapter, in other words, whether the factors are more prone to affect an institutional or a strategic investor will be indicated while furnishing the observations in chapter 8

9.29 Annex 29 –

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
2	**1 G20 Green Synthesis Report** Green Finance Study Group. "G20 green finance synthesis report." September. http://unepinquiry. org/wp-content/uploads/2016/09/Synthesis_Report_Full_EN. pdf (2016).	Elaborated by the G20 Green Finance Study Group to scale up green financing , by deploying trillions of dollars over the coming decade. The paper defines Green Finance as the financing investments that provide environmental benefits [reduction in air, water and land pollution, GHG emissions and other mitigation and adaptation to climate change co-benefits]. Challenges to CF, include the fact that back lending, explicitly classified as green is only a small fraction. The research covers a wide range of financial institutions and asset classes, and includes both public and private finance.	1	how to appropriately and cost-effectively internalize environmental externalities	A project that internalizes externalities is capable of monetizing on, for instance, reduced pollution, increased residential property value [externalities are consequences resulting from the execution of the project]. [pp.29] Inadequate compensation for positive externalities, and penalties for negative externalities, inadequate price signals.	environmental externalities	[cost-effectively] internalized	internalized / not internalized	NEUTRAL	F24	Nature valuation and impact assessment
3			2	inadequate maturity mismatch	difference between supply of long-term funding relative and the demand for funding by long term projects. Infrastructure heavily relies in bank lending for long-term financing, banks are constrained by short tenor of liabilities. Alignment of investor's funds and long-term policy signals. Problem is aggravated in green projects because they require larger up-front investments. [pp. 29] Sub-factors include: lack of appropriate financing instruments for long term green projects.	maturity mismatch	inadequate	significant / not significant	BARRIER	F20	Market maturity level
4			3	Lack of clarity in green finance [activities and products]	lack of clarity of what constitutes green finance activities and products [green loans and bonds], including inadequate definition of green finance, or too many definitions. [pp.29] Sub-factors: lack of green loan definition, lack of green bond definition, and lack of green asset definition.	green finance activities and products	unclear	clear / unclear	BARRIER	N	excluded
5			4	Asymmetric information on green projects	lack of disclosure of environmental information by executing companies and/or projects, i.e. no info on the companies' environmental performance, data segregation [data collected by enviro. Regulators not shared with banking regulators and investors]. It also includes the lack of knowledge on the commercial viability of green projects by financers.	information on green projects	asymmetric	sufficient / not sufficient	BARRIER	F10	Information asymmetry
6			5	Inadequate financial institutions' analytical capabilities	Banks and institutional investors general understanding of the financial implications of environmental risks, including identifying risks and quantifying them. Usually 'brown' project's risk are underestimated, while the green investment risks are usually overestimated. [pp.29] Sub-factors: lack of capacity to assess impact on credit risk, and lack of capacity to assess impact of asset valuation.	financial institutions' analytical capabilities	inadequate	adequate / inadequate	BARRIER	F17	Knowledge generation and understanding
7			6	No universally accepted framework for green or sustainable banking	[and green bond guidelines] to integrate environmental factors into banking operations, nevertheless there are several important initiatives. Some banks are incorporating environmental factors as 'stress testing' tools	framework for green or sustainable banking	no universally accepted [none]	sufficient / not sufficient	BARRIER	F32	Blended finance
8			7	limited application of sustainable banking principles	no-voluntary banking principles, due to lack of understanding of their importance, lack of consistency between risk management and green lending guidelines, lack or reporting practices [therefore low performance forecasting]. Including i.e. disclosure practices [pp.27]	application of sustainable banking principles	limited	sufficient / not sufficient	BARRIER	F13	Historical funding strategies
9			8	lack of awareness on benefits of green bonds	clear and implementable green bond criteria and requirements to label projects eligible for green bonds	awareness on benefits of green bonds	lack of	sufficient / not sufficient	BARRIER	F26	Degree of behavioural resistance
10			9	lack of bond ratings, indices and, listings	[for green finance products] to pinpoint the benefits from the use of the green bond's proceeds, assess which green bonds are high quality [benchmarking]. These options have only been explored by small rating agencies, index companies and stock exchanges	bond ratings, indices, and listings	lack of	sufficient / not sufficient	BARRIER	F4	Ratings, indices and listings
11			10	[limited] difficult access for international investors into local markets	differences in green bond definitions and disclosure requirements for projects across markets. Increased transactions costs i.a. There are also boarder issues such as capital controls, lack of FX hedging instruments, difference sin trading hours, etc. constraining cross-border investments in a wide range of asset classes.	access for international investors into local markets	[limited] difficult	sufficient / not sufficient	BARRIER	F3	Level of domestic and international investment
12			11	lack of domestic green investors	existence f green institutional investors, with expertise labour and/or investing preferences for green assets, both important in providing sufficient demand. Includes, lack of disclosure by institutional investors on their practices for integrating environmental factors into their investment strategy, and lack of capacity to quantify the environmental costs/benefits of there investments, also many investors remain indifferent between green and brown assets.	domestic green investors	lack of	sufficient / not sufficient	BARRIER	F3	Level of domestic and international investment
13			12	[existence of] positive financial performance when investors incorporate ESG principles	Correlation between ESG principles and financial performance. While correlation does not imply causation, nevertheless, 62% of meta-analyses show positive link between those investors that incorporate environmental factors [ESG] and their financial performance. Incorporation of ESG factors varies according to the investors profile, client priorities, investment objectives, region, and the materiality of the different factors.	financial performance when investors incorporate ESG principles	existence of	existent / non-existent	DRIVER	F16	Cost effectiveness and competitiveness
14			13	[existence of] national level initiatives	alongside with thematic initiatives such as the Global Investor Coalition on Climate Change i.a. Includes countries introducing financial policies and regulations like requiring institutional investors to provide ESG disclosures. [PP.30] Including the promotion of cross-border investment and bilateral collaboration.	national level initiatives	existence of	existent / non-existent	DRIVER	F27	Enabling institutional environment and policies for NBS
15			14	Lack of green investment strategic policy signals	refers to the country's visibility and predictability policy. Policy uncertainty translated into risk premiums, higher financing costs and lower funding for green projects. The few signals provokes what is called the 'first mover' inertia for investors. Ultimately causes scarcity of incentives for long-term investment in green projects	green investment strategic strategic policy signals	lack of	existent / non-existent	BARRIER	F27	Enabling institutional environment and policies for NBS
16			15	lack of credible environmental risk analysis tools	lack of capacity, complexity and the absence of adequate data [accurate, meaningful, comprehensive and consistent]. Requires expertise that is often not found in one single institution [needs collaboration between financial, environmental and policy specialist as well as international knowledge]. To address it, dialogue on environmental and financial risk should be enhanced, incl. facilitating knowledge exchange.	environmental risk analysis tools	credible	credible / not credible	BARRIER	F19	Risk management, metrics and tools
17			16	[existence of] impact assessment methodologies for green finance	broad economic and social impacts of green finance projects	impact assessment methodologies for green finance	existence of	existent / non-existent	NEUTRAL	F24	Nature valuation and impact assessment
18			17	promoted voluntary principles for green finance	by country authorities, international organizations and the private sector	voluntary principles for green finance	promoted	promoted / not promoted	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
19			18	[enough] network learning capacity	analytical capacity of the network, through platforms [like the sustainable banking network, and the principles for responsible investment]. Ideally expanded over several countries and financial institutions.	network learning capacity	[enough]	sufficient / not sufficient	NEUTRAL	F17	Knowledge generation and understanding

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
20			19	local green bond markets [maturity]	data collection, knowledge sharing an capacity building	local green bond markets	[degree of] maturity	mature / not mature	NEUTRAL	F20	Market maturity level
21	**2 G20 Green Synthesis Report** Green Finance Study Group. "G20 green finance synthesis report." September. http://unepinquiry. org/we-content/uploads/2017/09/Synthesis_Report_Full_EN. pdf (2017).	Updated version [2017]	20	appropriateness of risk analysis tools and associated metrics	depending on risk types [e.g. market, credit, business], financial risks to which institutions are expose [e.g. physical or transition risks], size of direct or indirect exposure to specific environmental risks, country and, or sector factors.	risk analysis tools and associated metrics	appropriateness	sufficient / not sufficient	DRIVER	F19	Risk management, metrics and tools
22			21	non-linear financial impacts	environmental factors and risks might cause disruptive and pose new risk management challenges	financial impacts [and risks]	non-linear	linear / non-linear	BARRIER	F24	Nature valuation and impact assessment
23			22	[existence of] technical barriers	including, for instance, availability and accessibility of ERA [environmental risk analysis] methodologies and relevant environmental data	technical barrier	existence of	existent / non-existent	BARRIER	N	excluded
24			23	too long time horizons for environmental risks to materialize	financial institutions might not realize that some environmental risks can develop within their normal time horizon. Lack of incentive to act because risks crystallize too far away in time. Financial firms mis appreciate short- and long-term environmental related financial risks.	time horizon for environmental risks to materialize	too long	too long/normal	BARRIER	F30	Awareness of nature's importance and sense of urgency to invest
25			24	publicly available environmental data [PAED]	Useful for financial analysis. Historical physical trends, forecasts and forward-looking scenarios, costs of pollution and benefits of remediation. Reported by non-corporate entities, such as government agencies, international organizations and science institutes. Examples of PAED include: physical asset data, projections of water stress and other exosystemic pressures, projections of natural disaster probabilities, data on solar and wind resources, forecasts of energy demand shift, i.a.	environmental data [PAED]	publicly available	publicly available / not publicly available	DRIVER	F28	Information on NBS
26			25	inadequate understanding of environmental risks	from the part of investors, lenders and insurers, and due to the lack of access to proper environmental information and or knowledge	understanding of environmental risks	inadequate	adequate / inadequate	BARRIER	N	excluded
27			26	inadequate pricing of environmental risks	from the part of investors, lenders and insurers, and due to the lack of access to proper environmental information and or knowledge	pricing of environmental risks	inadequate	adequate / inadequate	BARRIER	F25	Financial risks
28			27	inadequate management of environmental risks	from the part of investors, lenders and insurers, and due to the lack of access to proper environmental information and or knowledge	management of environmental risks	inadequate	adequate / inadequate	BARRIER	F19	Risk management, metrics and tools
29			28	dependency of service supply chain on ecosystem stability	Ecosystem stability is dependent on the increasing pressure due to climate change and other environmental problems. Industries that heavily really on the supply f ecosystems services include, agriculture, fishing and forestry, i.a. Ecosystem collapsing could lead to supply chain disruptions, thus resulting in scarcity of natural resources, and corresponding increase of price volatily. Data on the health of ecosystems and the quality of their resulting services, as well as ecosystem stress are essential to overcome this barrier.	service supply chain	dependency [on ecosystem stability]	dependent / independent	BARRIER	F9	Multitude of functions and services and their challenges
30			29	unexpected liabilities for insurance companies	resulting from the physical events	liabilities for insurance companies	unexpected	expected/unexpected	BARRIER	F15	Regulatory environment
31			30	existence of a database on existing green technologies	green/clean technologies ready to apply in different countries.	database on existing green technologies	existence of	existent / non-existent	DRIVER	F28	Information on NBS
32			31	unsuitable data presentation for the financial sector users	for instance, some meteorological data and forecasts are written in units that are not commonly understood by financial actors [units, not standardized or comparable]	data presentation [for the financial sector user]	unsuitable	suitable / unsuitable	BARRIER	F17	Knowledge generation and understanding
33			32	Pollution reduction benefits	[Also referred as environmental remediation] Quantifying the benefits of the pollution [air, water and land] reduction are a cardinal aspect when assessing a green investment and its demand. These benefits can be categorized in physical terms or as an estimate of the social and economic costs of pollution	pollution reduction benefits	N/A	N/A	NEUTRAL	F29	Modelling climate change scenarios
34			33	lack of methods to quantify benefits and costs of projects	Lack of a widespread methods for quantifying environmental benefits/costs of projects, this is also hugely complex, and vary depending on sectors and geographical regions.	methods to quantify benefits and costs of green projects	lack of	existent / non-existent	BARRIER	F24	Nature valuation and impact assessment
35			34	Risk scenario's lack of comparability over firms/industries/countries	Risk analysis assumptions are made individually by firms and on ad hoc basis, leading to communication problems. Many macro-parameters such as future demand for green projects and potential technological breakthroughs are highly uncertain, and might feature in the scenario analysis.	risk scenario's	lack of comparability over firms/industries/countries	comparable/not comparable	BARRIER	F19	Risk management, metrics and tools
36			35	Lack of confidence in macro parameters [i.e. future demand for a certain type of green investment]	Lack of confidence in the assumptions for analysis, even so when the financial institutions have already conducted their own analysis of environmental risks and green investment opportunities [this is due to exposure to microparameters]	confidence in macroprameters	lack of	reliable / unreliable	BARRIER	F24	Nature valuation and impact assessment
37			36	High search costs	High cost for financial institutions to obtain environmental data [risks and opportunities] bases and to translate it to meaningful information in terms of assets and firms. Including a lack of an effective integrated public approach in collecting, consolidated and disseminating the relevant information. This high costs might also arise from the fact that risk management is time consuming	search costs [of environmental data]	high	high / acceptable	BARRIER	F16	Cost effectiveness and competitiveness
38			37	inadequate institutional capacity	In developing countries causes a low availability of publicly available environmental data. Characterized by lack of adequate resources, lack of investment in technologies, platforms, training and knowledge exchange	institutional capacity	inadequate	adequate / inadequate	BARRIER	F27	Enabling institutional environment and policies for NBS
39			38	developed green bond markets	to compensate for the limited availability of long-term bank loans and offer a source of long term green finance, in addition to lending and equity finance. Specially important in countries where demand for green infrastructure is high and the banks capacity limited.	green bond markets	developed	developed/undeveloped	NEUTRAL	F21	Secondary market
40			39	differences in local definitions [green bond]	vital to promote international collaboration and facilitate cross-border investment in Green Bonds.	local definitions [green bond]	differences	significant / not significant	BARRIER	N	excluded
41			40	differences in disclosure requirements for green bond markets	vital to promote international collaboration and facilitate cross-border investment in Green Bonds.	disclosure requirements for green bonds	differences	significant / not significant	BARRIER	F21	Secondary market
42			41	differences in capital controls for green bond markets	vital to promote international collaboration and facilitate cross-border investment in Green Bonds.	capital controls for green bonds	differences	significant / not significant	BARRIER	F21	Secondary market
43			42	lack of a common methodology to conduct blended finance	it is possible to account official development assistance [concessional public money] twice [double-counting], meaning, to report expenditure as ODA money, which is not spent in a concessional way.	common methodology to conduct blended finance	lack of	existent / non-existent	BARRIER	F32	Blended finance
44			43	intended or unintended incentives for using blending finance	increased mobilized finance, also blending projects are easier to align with donor{s political and economic priorities	incentives for using blending finance	unintended or intended	unintended/intended	NEUTRAL	F27	Enabling institutional environment and policies for NBS

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
45			44	different blended finance definitions	there is no official definition of blending [approved by the OECD], the distinction between public-public and public-private blending is subject of a lot of debate	blended finance definitions	different	matching / unmatching	BARRIER	N	excluded
46			45	poorly functioning local financial markets	Poorly functioning local financial markets (e.g., lack of capital, expertise in certain areas, etc.) this usually tends to increase the costs of finance, which leads to an increase in project costs that can erode potential returns (e.g. poor regulatory environment, exchange-rate fluctuations, long time frame for achieving returns, etc.).	local financial markets	poorly functioning	functioning/not-functioning	BARRIER	F20	Market maturity level
47			46	[investors] knowledge and capacity gaps	poor understanding of developing countries' markets and local risks	knowledge and capacity gaps	N/A	significant / not significant	BARRIER	F17	Knowledge generation and understanding
48			47	political uncertainty	poor regulatory environment	political uncertainty	N/A	significant / not significant	BARRIER	F23	Political and economic landscape
49			48	financial uncertainty	exchange-rate fluctuations, long time frame for achieving returns, etc.	financial uncertainty	N/A	significant / not significant	BARRIER	F25	Financial risks
50			49	risk/return profile of the project	includes other factors influence on the decision making of investors. For example political uncertainty increases the risks of a determined project, thus its implementation becomes less likely in the absence of large returns	risk/return of project	N/A	risky/not risky [project]	NEUTRAL	F24	Nature valuation and impact assessment
51	**3 Blended Finance: What it is, how it works and how it is used**	In recent years, blending has become a common development finance term to refer to the development assistance with other private or public resources in order to leverage additional funds from other actors. There is still confusion on its meaning and ow it works and this papers tries to add up on this knowledge gap	50	[available] interest rate subsidies	investment grants to cover specific costs and activities, usually part of a larger package and used mostly to purchase or upgrade existing fixed capital. They can help lower the costs of finance resulting from underdeveloped local financial markets	interest rate subsidies	[available]	existent / non-existent	DRIVER	F27	Enabling institutional environment and policies for NBS
52			51	[available] technical assistance	specially beneficial in new projects or in uncharted territories, it could also improve the quality f the project, for example, in terms of impact studies, increasing likelihood of success	technical assistance	[available]	existent / non-existent	DRIVER	F6	Developing / implementing community capacity
53			52	[available] loan guarantees	provided by the public sector, to protect investors against losses and/or improve the financing costs [government guarantees reduce borrowing costs], e.g. if private investors still think that the risk is too high, the public sector provides a guarantee payment	loan guarantees	[available]	existent / non-existent	DRIVER	F27	Enabling institutional environment and policies for NBS
54	Pereira, Javier. "Blended Finance: What it is, how it works and how it is used." (2017).		53	Maturity of the company implementing a project	specific to the company's capacity	company implementing the project	maturity of	mature / not mature	NEUTRAL	F6	Developing / implementing community capacity
55			54	Maturity of the market implementing a project	N/A	company implementing the project	maturity of	mature / not mature	NEUTRAL	F20	Market maturity level
56			55	interaction between lending facilities and other institutions involved in the investment	return [even when it is not expected by certain institutions], may be affected by the self-sustainability or profitability requirements of other institutions involved in the process [these requirements might shift the priorities when deciding on an investment]	interaction between lending facilities and other institutions involve din the investment	N/A	existent / non-existent	NEUTRAL	F32	Blended finance
57			56	Difficult mandate/objectives alignment	while some investors have committed capital to implement certain development principles other institutions or actors have different mandates or a business model, all which might be difficult to align. Tensions between institutions and project managers	objectives alignment	difficult [challenging]	challenging / not-challenging	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
58			57	ownership difficulties	it is difficult to allocate responsibilities, select priorities and risks due to the multiple funding managed by multiple entities, non with overall representation. institutions could not guarantee the ownership of development projects, because of a bias in favour of donors' economic interests and businesses	ownership difficulties	N/A	existent / non-existent	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
59			58	transparency and accountability challenges	difficulties for different stakeholders to exert the right t hold project funders accountable for the delivery of a certain service	transparency and accountability challenges	N/A	significant / not significant	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
60			59	Information on blending projects Is basic and often outdated	information publicly available in databases is restricted to a few essential facts and sometimes no actual documents are available	information on blending projects [other]	basic and outdated	outdated / not-outdated	BARRIER	F28	Information on NBS
61			60	standardized indicators	Factors focused on the delivery of project outputs, therefor is difficult to assess impact without conducting detailed evaluations. Indicators are generally sector specific. Main drawback is that it makes it very difficult to make broader development assessments	standardized [impact] indicators	N/A	existent / non-existent	NEUTRAL	F15	Regulatory environment
62			61	stranded assets	Potential consequence of climate risk. Stranding is the only part of a complex range of climate risks each of which creates its own opportunities. The risks posed by "stranded assets" — assets that unexpectedly lose value as a result of climate change. The value of global financial assets at risk from climate change has been estimated at US$2.5t by the London School of Economics.	[number of] stranded assets	N/A	significant / not significant	BARRIER	F25	Financial risks
63			62	physical risks	damage to land or infrastructure or the project, owing to physical effects of climate change factors, such as heat waves, drought, sea levels, ocean acidification, storms or flooding. There are also secondary risks, which re knock-off effects of physical risks, such as failing crop yields, resource shortages, supply chain disruption, as well as migration, political instability or conflict. Many of these risks are considered self-reinforcine	physical risks	N/A	significant / not significant	BARRIER	F5	Physical risks and damages related to climate change
64			63	policy risks	financial impairment arising form local, national, or international policy responses to climate change, such as carbon pricing or levies, emission caps or subsidy withdrawal	policy risks	N/A	significant / not significant	BARRIER	F27	Enabling institutional environment and policies for NBS
65			64	liability risks	financial liabilities including insurance claims and legal damages, arising under the law of contract, tort or negligence	liability risks	N/A	significant / not significant	BARRIER	F15	Regulatory environment
66			65	complex risks interactions	example: when a physical risks leads to migration, causing economic instability or underinvestment, contributing to the stranding of the core asset	risk interactions	complex	complex / not complex	BARRIER	N	excluded
67			66	positive investment forecasts for climate-related projects	research suggest that economic benefits of investment will outweigh the costs of inaction. Citigroup expects investment in climate change mitigation to generate attractive and growing yields	investment forecasts for climate-related projects	positive	positive / negative	DRIVER	F24	Nature valuation and impact assessment
68			67	[occurrence of] climate change scenarios	post industrial temperature rises, properly defined by both probabilities and temperatures. IPCCs latest scenarios are: RCP 2.6 [severe mitigation] trying to limit temperature increase to 2 degree, RCP 4.5 an intermediate scenario, RCP 6 a higher greenhouse gas emission version of last scenario. RCP 8.5 a high greenhouse gas emission or inaction scenario. The occurrence of a determined scenario bring difference external risks specially severe physical consequences that could greatly affect the performance of projects	climate change scenarios	N/A	positive / negative	NEUTRAL	F29	Modelling climate change scenarios
69	**4**		68	Absence of sufficiently detailed/ reliable data	difficult for financial institution to make precise judgements about climate risks or climate-related investment opportunities.	data	absence of	existent / non-existent	BARRIER	F28	Information on NBS
70	**Climate Change:**	The 21st annual conference of	69	[lack of] no robust investment models	available models [like -social cost of carbon SC-CO] has serious limitations and do nor support individual investment decisions	investment models	lack of	existent / non-existent	BARRIER	F24	Nature valuation and impact assessment

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71	**The investment perspective** Brikin, Alex, et al. "Climate Change: The Investment Perspective." Ey.com/Fssustainability, Ernst & Young, 2016, assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/banking-and-capital-markets/ey-climate-change-and-investment.pdf.	parties [COP21] held in Paris 2015 has propelled global warning toward the top of the financial services agenda. Research suggest tat investment opportunities arising from e.g. the energy transition will actually outweigh climate-related risks in the long term	70	shifting stakeholders agenda	including government, regulators, beneficiaries and media, i.a. Even so, actors in the investment values chain need to address climate risks sooner rather than later.	stakeholders agenda	shifting	stable/non-stable	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
72			71	financial institutions are increasingly keen [interested] in showing that they can manage climate-related risks and opportunities [reputation]	Insurers, pension funds, and other asset owners want to show regulators, their own investors and the public. 36 % of institutional investors divested assets during 2015 to ESG factors, 27% plan to monitor climate-related projects in the future. 97 out of 500 largest asset owners are taking tangible action for climate risks compared to 77. Institutional investors are increasingly willing to provide direct finance for renewable assets.	stakeholders interest for climate-related reputation	increasing	existent / non-existent	DRIVER	F26	Degree of behavioural resistance
73			72	lack of asset owners in-house expertise [on climate risks]	necessary to develop an informed view about climate change scenarios. As one UK pension fund trustee said it ' we just don't have the ability to critically evaluate the decisions of asset managers in this area'. Only 24% of institutions frequently factor ESG considerations into their investment decisions.4	asset owners in-house expertise	lack of	sufficient / not sufficient	BARRIER	F2	Adequate asset management expertise
74			73	existing [updated] governance and risk management frameworks	they do not account climate-related risks and opportunities. It is necessary to develop a statement of investment principles on climate change	governance and risk management frameworks	un-updated	updated/un-updated	BARRIER	F14	Governance
75			74	As yet, there are no [lack of] proven quantitative mechanisms for factoring climate-related factors into asset valuations.	While active portfolio managers may be used to judging intangible factors, many might prefer a semi-quantitative approaches.	asset valuation mechanisms for factoring climate-related factors	lack of	existent / non-existent	BARRIER		#N/A
76			75	creation of a shared industry asset-level database	to enhance the collaboration within the industry, actors such as policymakers, regulators, industry bodies, and other groupings to compare notes and speak about the climate-related issues	shared industry asset-level database	lack ok	existent / non-existent	BARRIER	F28	Information on NBS
77			76	[investment] rating services dedicated to ESG metrics	Consultant, advisors and rating agencies factors influence on the investment value chain. Including for instance carbon emissions, as Herve Guez of Mirova stated: an ESG equivalent of Moody's, Flitch or S&P will take time to emerge, but would create a huge amount of value across the investment universe	ESG investment rating services	lack of	existent / non-existent	BARRIER	F4	Ratings, indices and listings
78			77	Bank´s limited ability to make quantitative judgements about climate-related data	specially in terms of long-term nature lending commitments and the consequent risk of exposure to unpredictable policy shifts. At a micro level, banks also need to ensure that they are taking note of specific risks to assets or borrowers from local changes, like local policy changes	banks ability to make quantitative judgements about climate-related data	limited	sufficient / not sufficient	BARRIER	F17	Knowledge generation and understanding
79			78	banks position on climate-related investments	banks play a variety of roles in the investment value chain both as providers of finance and as facilitators of investment. Investment banks' research teams are also the most likely source of credible valuation techniques for investors, asset managers and others. Banks can help shape the finance industry's response to climate change more than any other institutions, by for instance, developing green bond markets, new investment route and financial vehicles.	banks position on climate-related investments	N/A	positive / negative	NEUTRAL	F26	Degree of behavioural resistance
80			79	increased awareness of the potentially vast scale of climate risks	few financial institutions would claim that they have mastered climate related issues, nor that they fully understand the systemic risks they pose to the stability of the financial system	awareness of the vast scale of climate risks	increased	existent / non-existent	BARRIER	N	excluded
81			80	significant investment gap	around USD 1 trillion per year [estimates as necessary between 2012 and 2030]. Awareness on the amount required might support an increased private involvement in financing green infrastructure, or might cause hesitation among investors.	investment gap	significant	significant / not significant	DRIVER	F22	Market size
82			81	increase in [financial] productivity of green infrastructure investments	related to green infrastructure investments	productivity	increase	significant / not significant	DRIVER	F15	Regulatory environment
83			82	Green infrastructure various benefits	including benefits for human health, the environment, security and economy. Examples would include fuel savings of EUR 170-320 billion a year, and monetised benefits of up to EUR 88 billion per year by 2050. Additionally, the achievement of these benefits is contingent to the mobilisation of more long-term capital	green infrastructure benefits	N/A	significant / not significant	DRIVER	F9	Multitude of functions and services and their challenges
84			83	dependence of benefits on the long-term capital mobilisation	the achievement of these benefits is contingent on the mobilisation of more long-term capital from institutional investors.	dependence of benefits on long-term capital mobilisation	N/A	strong / weak	NEUTRAL	F24	Nature valuation and impact assessment
85			84	[current] low interest-rate environment in OECD countries	Institutional investors have been seen as sources of long-term capital with investment portfolios built around bonds and equities [asset classes] and long]term horizons linked to the nature of their liabilities [such as pension funds for instance. the low interest environment is leading institutional investors to look for tangible asset classes that can deliver diversification benefits and steady, preferably inflation-linked, income streams with low correlations to the returns of other investments.	low interest-rate environment in OECD countries	N/A	existent / non-existent	DRIVER	N	excluded
86			85	weak economic growth in OECD countries	leading institutional investors look for tangible asset classes that can deliver diversification benefits and steady, preferably inflation-linked, income streams with low correlations to the returns of other investments.	weak economic growth in OECD countries	N/A	existent / non-existent	BARRIER	F23	Political and economic landscape
87			86	Green infrastructure investments are riskier	N/A	green infrastructure's investments	riskier	riskier / tolerable risk	BARRIER	F18	NBS-specific features and risks
88			87	illiquidity risk [of green investments]	[Direct investing challenge] green infrastructure investment tends to suffer from illiquidity. Short term investment horizon and need for liquidity [institutional investment risk]; broader reluctance of investors to take a long-term view in financing the relatively illiquid assets associated with infrastructure development.	[of green investment's] illiquidity	N/A	liquidity / illiquidity	BARRIER	F25	Financial risks
89			88	policy dependence [of green investments]	perceived by developers and financial investors as the main risk	[green investment's] policy dependence	N/A	strong / weak	BARRIER	F27	Enabling institutional environment and policies for NBS
90			89	Institutional investor's small asset allocation to direct infrastructure	less than 1% for OECD pension funds, this percentage is even more limited for 'green# investment component. This is due to regulatory and policy uncertainty, lack of suitable financing vehicles, investor's inexperience with direct investing and new technologies and assets, as well as market and government failures [all factors in themselves]	Institutional investor's asset allocation to direct infrastructure	small	significant / not significant	BARRIER	F11	Investors' capital allocation features and requirements
91			90	regulatory and policy uncertainty	influencing institutional investor's asset allocation	regulatory and policy uncertainty	n/a	significant / not significant	BARRIER	F15	Regulatory environment
92			91	lack of suitable financing vehicles	influencing institutional investor's asset allocation	financing vehicles	lack of	existent / non-existent	BARRIER	F21	Secondary market

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
93			92	investor's inexperience with direct investing	influencing institutional investor's asset allocation, only knowledgeable with bonds and equities	investor's inexperience with direct investing	N/A	experienced / inexperienced	BARRIER	F17	Knowledge generation and understanding
94			93	investor's inexperience with new technologies and assets	influencing institutional investor's asset allocation	investor's inexperience with new technologies and assets	N/A	experienced / inexperienced	BARRIER	F17	Knowledge generation and understanding
95			94	market and government failures	influencing institutional investor's asset allocation. Perceived by developers and financial investors as the main risk	market and government failures	N/A	existent / non-existent	BARRIER	F14	Governance
96			95	High profile incidents in renewable energy/green investment	They have brough doubts on whether institutional investors should increase their allocations to these sectors. Collapse and defaults of significant number of wind turbine manufacturing firms due to unexpected price declines amid intense international competition. Notably around equity investments in solar power manufacturing, corporate and asset-backed bond investments in wind farms and early-stage venture capital investments)	High profile incidents in renewable energy investment	High profile incidents in renewable energy/green investment	existent / non-existent	BARRIER	F13	Historical funding strategies
97			96	disappointing performance of green financial vehicles	such as the Breeze Bonds	performance of green financial vehicles	disappointing	satisfactory / non-satisfactory	BARRIER	F21	Secondary market
98			97	Increasing in-house asset management capabilities	for major direct investments in renewable energy infrastructure. Efforts done by a number of pension funds, and insurance companies from OECD and emerging and developing economies as well as notable actors in the private sector such as Berkshire Hathaway and Google. Institutional investors with long-term horizons are attempting to bypass traditional financial intermediaries by "in-sourcing" asset management	in-house asset management capabilities	increasing	significant / not significant	DRIVER	F2	Adequate asset management expertise
99			98	green sectors are becoming cost-competitive in comparison with conventional industries	that is the case of renewables against conventional electricity generation. This is also accounted for an appropriate policy framework	green sectors cost-competitiveness	increasing	significant / not significant	DRIVER	F16	Cost effectiveness and competitiveness
100			99	institutional investor's varying risk appetites	including different investment preferences, and constraints. Investors with fiduciary responsibilities will not make an investment just because it is green—their primary concern is its (risk-adjusted) financial performance. Pension funds and insurers have to invest in accordance with the "prudent person principle". Assets have to be invested in the best interest of members and beneficiaries and policyholders and in such a manner as to ensure their security, profitability, liquidity and quality	institutional investor's risk appetites	varying [multitude]	N/A [different investor's profiles]	BARRIER	F26	Degree of behavioural resistance
101		Given the stretched public finances in many OECD countries, private sources of capital will be required to meet the financing requirements for new and replacement infrastructure. This report aims to shed light on the barriers to, and opportunities and risks of green infrastructure investment, to better inform government policies and decisions by institutional investors. It also contributes to an emerging literature on how climate and green-growth policies can best be designed to attract private sector investment and on the use of innovative financial instruments to overcome investment barriers	100	lack of an integrated domestic green investment policy framework	N/A	integrated domestic green investment policy framework	lack of	existent / non-existent	BARRIER	F27	Enabling institutional environment and policies for NBS
102			101	[unsuitable] incentives regime	incentives regimes [subsidies] do not account for environmental externalities through carbon pricing or other efficient and effective support policies which are targeted, tailored and time-limited	incentives regime	unsuitable	suitable / unsuitable	BARRIER	F27	Enabling institutional environment and policies for NBS
103			102	dynamic [unstable] economic landscape	green investments [like renewable energy] costs have fallen faster than policy markers anticipated and which has lead in some cases to retroactive policy changes to control the costs and has at the same time damaged the confidence in this type of markets	economic landscape	dynamic [unstable]	stable/non-stable	BARRIER	F23	Political and economic landscape
104			103	absence / unpredictable feed-in tariffs	or other support programmes to help immature technologies achieve competitiveness with incumbent technologies	feed-in tariffs	absence	existent / non-existent	BARRIER	F15	Regulatory environment
105			104	short-termism	financial markets reward short-term, over longer-term investment in terms of accounting and reporting. Policies that reward longer-terms with no economic cos or even economic benefit may stimulate investment	short-termism	existence of	existent / non-existent	BARRIER	F26	Degree of behavioural resistance
106			105	[some] institutional investor's lack of tax-liability	tax-exempt pension funds, and sovereign wealth funds, or other foreign entities cannot benefit from tax credits [if these incentives are even in place]	institutional investor's tax liability	lack of	existent / non-existent	BARRIER	F15	Regulatory environment
107	**5 INSTITUTIONAL INVESTORS AND GREEN INFRASTRUCTURE INVETSMENTS: selected case studies** Kaminker, Christopher, et al. "Institutional investors and green infrastructure investments: selected case studies." (2013).		106	simultaneous green investment ownership prohibitions / [inefficient] competition policy	some competition policies restrict [or unbundle] the simultaneous ownership of for instance transmission lines and electricity generations, then it forces investors to choose between owning assets or generating assets	[inefficient] competition policy	N/A	existent / non-existent	BARRIER	F27	Enabling institutional environment and policies for NBS
108			107	consequences of financial regulations	unintended consequences on the availability of long-term capital	consequences of financial regulations	N/A	significant / not significant	BARRIER	F15	Regulatory environment
109			108	too few green financial vehicles issuance	emerging green bond and asset backed securities markets face the challenge of too few issuances to meet the investment grade requirements of institutional investors.	green financial vehicles issuance	too few	significant / not significant	BARRIER	F21	Secondary market
110			109	no access to existing highly liquid vehicles	project/investment has no access to highly liquid vehicles such as Master Limited Partnerships and Real Estate Investment Trusts	[existing] highly liquid vehicles	no access to	[projects'] access - no-access	BARRIER	F21	Secondary market
111			110	current dominant infrastructure fund model of financing	[inflexible] stuffiest liquidity, a disconnect to specific projects, high fees and excessive leverage	dominant infrastructure fund model of financing	N/A	existent / non-existent	BARRIER	F32	Blended finance
112			111	lack of transparent information and data	Fundamental for any well-functioning market, this information can act as a 'entry' signal to investors. This is fundamental for stimulating investment conditions and building confidence in new technologies, markets and financial products	transparent information and data	lack of	existent / non-existent	BARRIER	F10	Information asymmetry
113			112	difficult bidding process	[Direct investing challenge] Especially due to timing challenges, lack of investor best practice and expertise	bidding process	difficult	challenging / not-challenging	BARRIER	F15	Regulatory environment
114			113	Asset and liability matching [ALM] application issues	[Direct investing challenge] diversification and exposure limits [risk faced by banks due to mismatch due to liquidity or changes in interest rates]	ALM application issues	N/A	existent / non-existent	BARRIER	F19	Risk management, metrics and tools
115			114	Need for scale	[Direct investing challenge] > 50Bn Assets under management and deal flow to maintain costly team	need for scale	N/A	existent / non-existent	BARRIER	F22	Market size
116			115	Minimal deal size	[Direct investing challenge] Min [project] size of $100M deal size; expensive and time consuming due diligence; higher transaction costs [too big investment, too big risk for some investors]	deal size	minimal	challenging / not-challenging [for investor]	BARRIER	F1	Scale and minimal optimal size of the project
117			116	Political uncertainty	[regulatory and policy issues]	political uncertainty	N/A	existent / non-existent	BARRIER	N	excluded
118			117	lack of project pipeline and quality historical data	[issues with infrastructure investments] compounded by exit of banks [Basel III / deleveraging] and little historical pricing data or indices for investment such as private placement debt	project pipeline and quality historical data	lack of	existent / non-existent	BARRIER	F28	Information on NBS
119			118	risk/return profile imbalance [of the project]	[issues particular to green investments] market failures: insufficient carbon pricing and incentives; presence of fossil fuel subsidies	risk/return imbalance	N/A	existent / non-existent	BARRIER	F24	Nature valuation and impact assessment
120			119	unpredictable duration policy support	[issues particular to green investments] fragmented, complex and short duration of policy support: retroactive support cuts, switching incentives, use of tax credits popular with insurers can discourage tax exemption pension funds,	duration policy support	unpredictable	predictable/not-predictable	BARRIER	F27	Enabling institutional environment and policies for NBS

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
121			120	Special species of risks	[issues particular to green investments] e.g. technology and volumetric require expertise and resources	special species or risk	N/A	significant / not significant	BARRIER	F18	NBS-specific features and risks
122			121	capital competition	[issues particular to green investments] competition for capital with other traditional infrastructure assets	capital competition	N/A	existent / non-existent	BARRIER	F12	Funding sources
123			122	high fees to support fund structure	[lack of suitable investment vehicles]	fees to support fund structure	high	high / acceptable	BARRIER	F27	Enabling institutional environment and policies for NBS
124			123	[for green investments it is] difficult to [gain] liquidity	without asset disconnect, churn and leverage in fund. Liquidity trade-off with connection to underlying asset and associated benefits [it is not easy to obtain liquidity without proving the asset performance or underlying services]	[green investment] gain liquidity	difficult to	difficult / not-difficult	BARRIER	N	excluded
125			124	challenges with securitisation	[lack of suitable investment vehicles]	securitisation	challenging [difficult]	difficult / not-difficult	BARRIER	N	excluded
126			125	credit and ratings issues	historical lack of ratings data and expensive process; absence of monoline insurers since financial crisis	credit and ratings issues	N/A	significant / not significant	BARRIER	F4	Ratings, indices and listings
127			126	institutional investors lack of homogeneity	they cannot be viewed as a homogeneous group with identical characteristics and investment approaches. The geography of institutional investors is incredibly diverse [from small university endowments to global life insurers and pension-funds managers with AUM in the hundred of billions of dollars]	institutional investor's homogeneity	lack of	homogeneous / not homogeneous	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
128			127	Issues in the establishment of new asset classes	introducing newer asset classes and establishing track record and benchmarks takes time to institutionalise	establishment of newer asset classes	issues with [difficulties]	difficult / not-difficult	BARRIER	N	excluded
129			128	proof of policy stability	[scaling-up investment channels] that provides investors with clear and long-term policy frameworks	proof of policy stability	N/A	existent / non-existent	DRIVER	F27	Enabling institutional environment and policies for NBS
130			129	better governance	to enable institutional investors to use a longer term investment horizon. Government can take seven key actions to address the barriers and facilitate institutional investor's investments in green infra projects: [1] ensure stable integrated policy environment; [2] address market failures; [3]provide a national infrastructure road map; [4] facilitate the development of appropriate green financing vehicles; [5] reduce transaction costs for green investment; [6] promote public-private dialogue on green investments; [6]promote market transparency and improve data on infrastructure investment	governance	better	[good] sufficient / not sufficient	DRIVER	F14	Governance
131			130	education for institutional investors	help institutional investors: a] understand the different channels available as described in the report [indirect, semi-direct, direct] and their associated risks, b] build the necessary capabilities to manager the risks associated with these investments and the better standardization of contractual documents and project evaluation procedures [next factor]	education institutional investors	N/A	existent / non-existent	DRIVER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
132			131	standardisation of contractual documents	including project evaluations procedures	contractual documents	standardised	standardised / not standardised	DRIVER	F15	Regulatory environment
133			132	green investments cannot be financed [lack of financeability] by traditional public sources alone	The financial crisis and global deleveraging has exacerbated the situation, further reducing the scope for public investment in infra within government budgets. This has lead to the awareness of a significant investment gap and the need for greater recourse to private-sector finance in the OECD	[degree of] financiabilty of green investments by public sources	lack of	publicly financeable / not publicly financeable	DRIVER	F12	Funding sources
134			133	[existence of] established econometric models	such models are based primarily on empirical evidence rather than assumptions regarding optimization; this information on transition risk impacts, may result in a more positive overview on climate-related investments	econometric models	established	existent / non-existent	DRIVER	F24	Nature valuation and impact assessment
135			134	[existence of] updated climate scenarios	By the Cambridge Econometrics, There are three considered scenarios, 2C, 3C, and 4C temperature increases, with evolved pathways and magnitude	climate scenarios	updated	existent / non-existent	DRIVER	F29	Modelling climate change scenarios
136			135	[forecasted] positive return opportunities for long-term investment	In certain scenarios, return opportunities are positive according to the climate change scenario for which each investor has gauged their portfolios to. The 2C scenario, for instance is clearly the most beneficial. The opportunity returns oscillate between 0.10% [per annum] p.a. and 0.30% p.a. for 2030 in the 2C scenario.	[forecasted] return opportunities for long-term investment	positive	positive / negative	DRIVER	F24	Nature valuation and impact assessment
137			136	expected [industry-sector] annual return impacts	[forecasted] expected annual return impacts remain most visible at the industry-sector level. Asset class return sometimes vary greatly by scenario. For infrastructure [s2C- %p.a.to 2030 = +2.0, s2C- %p.a.to 2050 = +1.0], sustainable themed infrastructure [s2C- %p.a.to 2030 = +3.0, s2C- %p.a.to 2050 = +1.6] and finale all the world real estate [s2C- %p.a.to 2030 = 0.0, s2C- %p.a.to 2050 = -0.2], In 3°C and 4°C scenarios, all sectors, apart from renewables, have negative return impacts, to 2030, 2050 and 2100, with return impacts varying between 0.1% p.a. and 7.7% p.a.	expected annual return impacts	N/A	positive / negative	DRIVER	F24	Nature valuation and impact assessment
138			137	stress testing portfolio findings [under climate change scenarios]	The findings of portfolio stress support the argument for investor action on climate change. Portfolio stress entails to scan for changes in scenario probability, market awareness and physical damage impacts. The former can help investors to consider that longer-term return impacts as small on an annual basis and increase the investor's interest on more meaningful [ESG principles for example] and shorter-term market.	stress testing portfolio findings	N/A	positive / negative	DRIVER	F24	Nature valuation and impact assessment
139			138	multidecade time horizon [portfolios] vulnerability to CC	multidecade time horizon [portfolios], often 50 years of more, with exposure across the global economy. For them it is essential to address the potential impacts of low-carbon transition and physical damages associated with climate change, to prepare their portfolios for the future. The multidecade time horizon then 'forces' investors to address climate change, in other words, it creates an exposure of the portfolio to climate change [vulnerable to CC]. In a multidecade analysis the annual investment impacts are smalls in absolute terms	multidecade time horizon portfolios	vulnerability [to climate change]	vulnerable / not vulnerable	DRIVER	F29	Modelling climate change scenarios
140			139	scale and pace of [environmental] change	scale and pace of [environmental] change poses serious concerns [threat] for human adaptation, given our dependency [consumption patterns] for water or food, as well as severe exposure of our built environment [infrastructure] to severe environmental damage	[environmental] change	scale / pace [significance]	significant / not significant	DRIVER	F29	Modelling climate change scenarios

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
141			140	growing awareness of climate change risks	Among business and government leaders. The awareness is reflected for instance in the World Economic Forum - global risks report. There are important shifts in the Top Five Global Risks in Terms of Likelihood and impact [2019], environmental risks dominate: extreme weather, climate change mitigation and adaptation failure, natural catastrophes and water crises. Three out of five factors in 2019 are environmental or related, while in 2009 none [out of the 6] were climate or water related	awareness of climate change risks	growing	sufficient / not sufficient	DRIVER	N	excluded
142			141	interconnectedness of climate risks	For instance, survey participants believe weak climate change mitigation exposes business and government to extreme weather, natural catastrophes and water crises. This interconnectedness of these issues will be increasingly important for anticipating and preparing portfolios and investors.	climate risks	interconnectedness of	interconnected / independent	DRIVER	N	excluded
143			142	Investor's [common] aim [in delivering substantial returns to stakeholders]	Investors with varying objectives and portfolio allocations are all, regardless of their differences in nature, interested in delivering substantial returns for members, beneficiaries and stakeholders.	Investor's [common] aim for returns delivery	N/A	existent / non-existent	DRIVER	F26	Degree of behavioural resistance
144			143	Financial materiality of transition and physical risks	Financial implications of physical and transition risks, the latter are those risk arising from technology and policy changes in the look for energy transition and embracement of climate change mitigation principles. evidenced in the 2015 Report and the Sequel and supported in reports by The Bank of England, the G20 Financial Stability Board and The Economist Intelligence Unit. In pp 21, this risk is referred as to [possible] impact of natural catastrophes.	Financial materiality of transition and physical risks	N/A	significant / not significant	DRIVER	F5	Physical risks and damages related to climate change
145			144	Growing awareness that investors need to address CC to comply with fiduciary duties	Awareness that many investors will have to address climate-related factors to comply with their fiduciary duties [CC factors must be addressed by fiduciaries]. In many cases, climate change has the potential to impact on long-term investment performance	awareness that fiduciaries need to address CC	growing	sufficient / not sufficient	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
146			145	legal action against companies for failure to mitigate, adapt or disclose climate-related risks [in their portfolios]	Many countries have established policy that forces investors consider the financial materiality of the risks, therefore, legal action against those companies that fail to consider climate-change-related risks, mainly pension funds, but also governments. Specific risks may be susceptible to legal challenges in the future.	legal action against companies for failure to mitigate, adapt or disclose climate-related risks	N/A	existent / non-existent	DRIVER	F15	Regulatory environment
147			146	limited relevance of historical data	for modelling climate-change-related impacts	historical data	limited relevance	relevant / not relevant	BARRIER	F28	Information on NBS
148			147	greater uncertainty in forward-looking scenarios	in comparison to other traditional scenarios, that rely on historical data, this makes investors reliance on this technique for decision making difficult [since its accuracy is not safe proof]. This factor arises from the bad quality of data [former factor]. Also referred as to multi-level uncertainty, due to the shortcomings of the model construct, the assumptions, and the different time horizon over which the analysis is performed.	uncertainty in forward-looking scenarios	greater	certain / uncertain	BARRIER	F29	Modelling climate change scenarios
149			148	[trustworthy] alternative [scenario] model supplements	to traditional investor asset-allocation processes which strongly historical data to model, and the expected risk and return of different asset classes within portfolios. Mercer climate scenario model is an example, enables investors to anticipate physical damages of climate change and low-carbon economy. Goal is to provide clarity for investors on the priority of actions.	alternative scenario model supplements	N/A	existent / non-existent	DRIVER	F29	Modelling climate change scenarios
150			149	disruptive transition to a low/zero-carbon economy	caused by long waiting periods and delays from policymakers and investors. To take action, which at the same time reduces the likelihood that the 2C or below scenario is attained, and causes abrupt actions to 'catch up' later on [when it is too late, or to expensive to act]. The possibility of a disruptive transition should motivate investors to act swiftly, in other words, create greatest efforts to reduce emissions sooner than later.	transition to a low/zero-carbon economy	disruptive	disruptive / not-disruptive	DRIVER	F27	Enabling institutional environment and policies for NBS
151			150	spending rate	rate of investment to catalyse the transition [motivate other investors to join in the transition]	spending rate	N/A	sufficient / not sufficient	DRIVER	F11	Investors' capital allocation features and requirements
152			151	[adequate] national/subnational policy	aiming to reduce the risk of further human-induced climate change. This includes targets, legislations and regulations	national/subnational policy	adequate	adequate / inadequate	NEUTRAL	F27	Enabling institutional environment and policies for NBS
153			152	[risk] resource availability compromised by CC	[risk/threat] long-term pattern changes for instance in precipitation might impact the future availability of resources like water and thus other assets in an investor's portfolio, therefore this risk can be [or not] significant in the decision making process of investors	[risk] resource availability	compromised by CC	significant / not significant	DRIVER	F5	Physical risks and damages related to climate change
154			153	[Risk factors] pathways awareness	[figure 5 in pp. 22]it is important to highlight that the importance of S [spending] and T [transition] factors, only resides in the first two scenarios [2C and 3C], and therefore their importance as catalyst to avoid the other two significant risks [impact of natural catastrophes and resource availability]. Bear in mind that different sectors will respond differently. This information could convince investors on the importance of attaining the 2C [max the 3C].	Risk factors pathways awareness	N/A	existent / non-existent	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
155			154	scenarios modelled are deterministic	necessary given the gaps in scientific research and our current understanding of climate change, not to mention the complexity of conducting investment analysis 80 years into the future, nevertheless, this means that interactions are likely much more complex than we can ever model	modelled scenarios	deterministic	deterministic / stochastic	NEUTRAL	F29	Modelling climate change scenarios
156			155	magnitude of results is likely underestimated	quantitative magnitude like the expected physical damages for instance might be under-estimated [meaning that it will raise the expectations of investors in the short run, in the long term it can cause reputation problems]	magnitude of results	underestimated [inaccurate]	inaccurate / accurate	BARRIER	F24	Nature valuation and impact assessment
157	6		156	higher exposure to uncertainty the further in time [the analysis goes]	longer-term the investment decision making is subject to higher uncertainty, in other words, longer-term investment have a higher exposure to inaccuracies in analysis the further in time their time horizons expands	exposure [of the portfolio] to uncertainty the further in time the analysis goes	higher	high / acceptable	BARRIER	F19	Risk management, metrics and tools

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
158	**Investing in a Time of Climate Change: The sequel 2019** Mercer, L. L. C. "Investing in a time of climate change. The sequel 2019" London, UK: Mercer International Finance Corporation and the UK Department for International Development (2019).	The Sequel is intended to help investors understand how climate change can influence their investment performance in both the short and long term and what steps they should take to protect and position portfolio assets.	157	Increasing alarm on risk of systemic financial failure	This in the case that climate change is not addressed by investors [increasing sense of urgency]. Regulators responsible for financial stability are increasingly raising the alarm of possibility financial systemic failure. The 4C world has been described by leading insurers as 'uninsurable'	alarm on risk of systemic financial failure	increasing	sufficient / not sufficient	DRIVER	F25	Financial risks
159			158	assumption [belief] that adaptation costs are outside the typical investor timeframe	Tu current focus in in mitigation, integrated assessment models [IAMs] usually assume that adaptation costs come later and outside the typical investor timeframe, a barrier for adaptation investments	assumption that adaptation costs are outside the typical investor timeframe	N/A	existent / non-existent	BARRIER	N	excluded
160			159	Social factors are difficult to quantify	and could be exacerbated by a multitude of other factors [as explained in upcoming factors]	social factors	difficult to quantity	quantifiable / non-quantifiable	BARRIER	F29	Modelling climate change scenarios
161			160	Healthcare sector is highly sensitive to climate change	Population [and workforce] health might be highly affected by CC, many infectious diseases are highly sensitive to climate conditions, extending transmission seasons and geographical extension. In the same line, heat stress might create unbearable conditions in some regions. This factor is relevant if the investors portfolio highly depends on the degree of optimal health of population/workforce, A high sensitivity might motivate investors to get involved in green investments.	healthcare sensitivity to CC	high	high / acceptable	DRIVER	F29	Modelling climate change scenarios
162			161	migration patterns are sensitive to CC	Energy, food or water shortages lead to social and economic impacts and political implications or conflict and thus imply an underlying risk of forced or unsafe migration. A high sensitivity might motivate investors to get involved in CC-related investments.	migration sensitivity to CC	N/A	high / acceptable	DRIVER	F29	Modelling climate change scenarios
163			162	Litigation risks	Specially emerging from the failure to mitigate, adapt or disclose, it s principally targeted at companies. They are usually not considered/captured in the modelling. Avoidance of this risk might motivate investors to get involved in CC-related investment	liability risks	N/A	high / acceptable	DRIVER	F15	Regulatory environment
164			163	Acknowledgement of un-quantifiable aspects of CC	[from the part of investors] vital for shaping a criteria-based thinking process and to prepare portfolio to multiple eventualities, rather than relying on a single scenario as the most likely correct. How comfortable are investors, or how sensitive their portfolio are to the un-quantifiability for certain CC-related factors might be relevant when deciding to invest in mitigation or adaptation measures	Acknowledgement of un-quantifiable aspects of CC	N/A	existent / non-existent	NEUTRAL	F29	Modelling climate change scenarios
165			164	[polarized] sensitivity of infrastructure as an asset class	[according to figure 14] Infrastructure shows the most polarized [positive and negative] sensitivities across all types of asset classes: in terms of the transition risk under a 2C scenario, infra shows the most positive degree of sensibility [most probable to raise positive return or avoid damages], while it also shows the most negative sensitivity, in terms of the risk of impact of natural catastrophes, probably linked to the physical vulnerability of assets to extreme events and resource availability. Both the prospect of very positive outcomes and the threat of loss for investors involved in infrastructure might motivate those actors to get involved in CC-related projects	sensitivity of infrastructure as an asset class	N/A	high / acceptable	DRIVER	N	excluded
166			165	significant transition risks for real assets	Real estate, infrastructure, agriculture and timberland are real assets. Specially the first two, will be exposed to stringent climate change risk factors, that are likely to reduce the value of those assets that fail to adapt, or that are not advance enough. However policy is also expected to be a catalyst for a net positive development	transition risks for real assets	significant	significant / not significant	NEUTRAL	F27	Enabling institutional environment and policies for NBS
167			166	Time horizon mismatches across capital markets	[market lack of CC pricing] pose especial challenges for long-term asset owners. This factor will pose a threat or an opportunity depending on the different investor's profile	Time horizon mismatches across capital markets	N/A	significant / not significant	NEUTRAL	F20	Market maturity level
168			167	uncertainty regarding global pathway towards a given scenario	and resulting confusion on whether some risks are likely to manifest and their magnitude	uncertainty regarding global pathway towards a given scenario	N/A	high / acceptable	BARRIER	F29	Modelling climate change scenarios
169			168	Inability of humans to account for the effects of future risks	especially in regards to those large and infrequent risks. This assumption derives from behavioural economics [i.e. prospect theory]	Inability of humans to account for the effects of future risks	N/A	existent / non-existent	BARRIER	F19	Risk management, metrics and tools
170			169	[few] CC-related peer practices	To date, there is a low proportion of institutional investors adopting CC risk management strategies. Since peer practices are a key input for many investor's decision the lack of involvement of others might avoid investors involvement in CC-related projects.	CC-related peer practices	few	sufficient / not sufficient	BARRIER	N	excluded
171			170	potential for stranded assets	possibility that a proportion of existing assets will never be used or damaged by the transition of portfolios are not adjusted to climate change	[risk] potential for stranded assets	N/A	significant / not significant	DRIVER	F25	Financial risks
172			171	Lack of consensus on the market pricing mistakes	lack of consensus on the extent to which markets are mistakenly [usually under pricing] the risks like climate change in valuations today	consensus on the market pricing mistakes	lack of	existent / non-existent	BARRIER	F20	Market maturity level
173			172	infrastructure [including green] is a main driver for development	Therefore there's a permanent demand for it [infrastructure]. Investment in infrastructure is widely recognized as crucial to promoting economic growth and social stability through the delivery of essential services and assets. As the global population grows and urbanizes, the demand for infrastructure grows with it. From 2015 to 2030, the global requirement for new infrastructure assets will be US$90 trillion [source: new climate economy]	infrastructure is a main driver for development	N/A	relevant / not relevant [for investor]	DRIVER	N	excluded
174			173	growing demand for infrastructure	As the global population and urbanization grows, the demand for infrastructure too. Estimations preview a global requirement from 2015 to 2030, of new infra assets amounting to around US$90 trillion. To attain the year average of US$6 trillion necessary to comply with the former goal, there is a significant gap of almost half of the amount [current annual investment ranges from US$2.5 to US$3.5 trillion a year]	demand for infrastructure	growing	fulfilled / not fulfilled [demand]	NEUTRAL	F22	Market size
175			174	higher upfront capital costs required for sustainable infrastructure	higher upfront capital costs by roughly 5%	upfront capital costs required for sustainable infrastructure	higher	relevant / not relevant	BARRIER	F16	Cost effectiveness and competitiveness
176			175	lower operating costs of sustainable infrastructure	over the life of the investment while also reducing risks and negative externalities and therefore making it more resilient and likely to have a longer life	operating costs of sustainable infrastructure	lower	competitive / not competitive	DRIVER	F16	Cost effectiveness and competitiveness
177			176	Low yields in traditional asset classes	One of the factors driving investor interest in infrastructure [together, are reinforcing developments]. The greater the difference in yields between sustainable projects and traditional assets the bigger cost of opportunity and thus attractiveness in investing in green infra	yields in traditional asset classes	low [not competitive]	competitive / not competitive	DRIVER	F24	Nature valuation and impact assessment

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
178			177	[potential for] low correlations to other asset classes	One of the factors driving investor interest in infrastructure [together, are reinforcing developments]. Better for portfolio diversification.	correlations to other asset classes	low [competitive]	competitive / not competitive	DRIVER	F24	Nature valuation and impact assessment
179			178	Stable cash yield	One of the factors driving investor interest in infrastructure [together, are reinforcing developments]	cash yield	stable [competitive]	competitive / not competitive	DRIVER	F24	Nature valuation and impact assessment
180			179	Inflation protection	One of the factors driving investor interest in infrastructure [together, are reinforcing developments]. Assets that might be protected against inflation might be considered more competitive/attractive for investors	inflation protection	N/A	competitive / not competitive	DRIVER	F24	Nature valuation and impact assessment
181			180	[stable] investment performance	One of the factors driving investor interest in infrastructure [together, are reinforcing developments]. Adaptation and mitigation measures [sustainable infrastructure projects] might offer [stable] performance throughout the whole economic cycle. One of the factors driving investor interest in infrastructure	investment performance	stable [competitive]	competitive / not competitive	DRIVER	F15	Regulatory environment
182			181	growing popularity of low-carbon indices	for index investment strategies, which support the investment in sustainable infrastructure. Some investors describe the low-carbon tilt as a "free hedge" against climate change transition risk. The following factors shape the popularity of low carbon indices	popularity of low-carbon indices [reputation]	growing [relevant]	relevant / not relevant	DRIVER	F4	Ratings, indices and listings
183			182	carbon data	[relevant for the popularity of low-carbon indices] While knowingly flawed in scope and consistency, on the other hand, readily available, widely used and reasonable accurate	carbon data	availability	relevant / not relevant	DRIVER	F28	Information on NBS
184			183	low-carbon indices are easy / cost-effective to implement	and are a good replacement for market-cap-weighted index exposures	low-carbon indices	easy / cost-effective [relevant]	competitive / not competitive	DRIVER	F4	Ratings, indices and listings
185			184	competitiveness of green bonds	they have demonstrably similar performance to standard bonds, with similar credit quality and durations, for this reason, many "environmentally neutral" fixed income investors already own green bonds simply by virtue of their risk/return characteristics. There is even a 'greenium' in other words benefits and protection to climate risks	green bonds	competitiveness	competitive / not competitive	DRIVER	F21	Secondary market
186			185	small green bonds portion of the global bond universe	issuance continues to increase every year, reducing liquidity concerns which have surrounded early investments in this space	green bonds portion of the global bond universe	small	competitive / not competitive	BARRIER	F21	Secondary market
187			186	sector-level [benefits] to implement advanced planning and timely action	Among the benefits are: technological maturation, lower cost of industrial decarbonization, and ensure synchronicity between the industry energy transition and changes in energy supply	sector-level benefits for advanced planning and timely action	N/A	significant / not significant	DRIVER	F2	Adequate asset management expertise
188			187	influence obligation of fiduciaries	Fiduciaries, motivated by their beneficiaries and clients have an arguable obligation to use their portfolios and influence to help guide us towards a more economically secure outcome [2C scenario]	influence obligation of fiduciaries	N/A	relevant / not relevant	DRIVER	F15	Regulatory environment
189			188	Increasing number of investor initiatives	50+ investor initiatives have been established seeking to compel and support investor activity on climate change, whether they are focused on integration, stewardship, sustainability-theme investment or screening	number of investor initiatives	increasing	significant / not significant	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
190			189	momentum CC-leadership at midsize asset owners	although leadership on climate change is most often displayed by the largest investors [perhaps because they can better handle risks]	momentum CC-leadership at midsize asset owners	N/A	existent / non-existent	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
191			190	informal network [s] of asset owners	collaboration has critical role for investor action in regards to climate change, although informal networks are a catalyst, a more formal network could be a better catalyst for CC transition	network[s] of asset owners	informal	formal / informal	DRIVER	F2	Adequate asset management expertise
192			191	consequences of even 0.5C degree increase	Specially the physical damages expected with 0.5C degree warming is a clear motivation for that transformation	consequences of even 0.5C degree increase	N/A	significant / not significant	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
193			192	High cost of inaction	A 4°C scenario to 2050 sees infrastructure and property down 0.4% p.a. and 0.2% p.a., respectively, developed market equities are down 0.1% p.a. and emerging markets are down 0.3% p.a. In a 4°C scenario.	cost of inaction	high	significant / not significant	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
194			193	Lack of risk-adjusted returns [of sustainable projects]		risk-adjusted returns	Lack of	existent / non-existent	BARRIER	F24	Nature valuation and impact assessment
195			194	Many different blended finance definitions	Including ambiguity, and lack of effectiveness, lack of matched definitions and common understanding	blended finance definitions	many different	matching / unmatching	BARRIER	F32	Blended finance
196			195	Increasing donor interest [in using blended finance]	Between 2000 and 2016 donor governments' that pool public financing for blending and the number of new European facilities grew according to the OECD and the EDFI	donor interest	increasing	sufficient / not sufficient	DRIVER	F26	Degree of behavioural resistance
197			196	[access to] structured blended finance funds	[They are innovative ways of mobilising capital] structured blended finance funds provide risk cushions, governments use concessional finance to cushion and thus attract commercial finance	structured blended finance funds	N/A	accessible / not accessible [op. existent]	DRIVER	F12	Funding sources
198			197	evidence on blended finance is still quite limited	despite the various efforts to map the blending landscape, there is no single, consistent and comparable estimate of the blended finance market that covers the entirety of flows. Main short=comings in the evidence base result in lack of consistent blended market estimates, inaccurate assessment of effectiveness of blended finance, i.a. Stand-alone surveys provide useful but limited market info	evidence of blended finance	[is quite] limited	sufficient / not sufficient	BARRIER	F32	Blended finance
199			198	[shortcoming / deficient] monitoring and evaluation systems for blended finance	for blended finance, this contributes to the gaps in evidence and has implications for the engagement capacity of blended finance. Developing this systems is quite challenging because they must satisfy the needs of a wide array of stakeholders.	monitoring and evaluation systems	[deficient]	sufficient / not sufficient	BARRIER	F32	Blended finance
200			199	lack of a common framework of blending	including a common understanding on blending, both will support cohesive action. At the moment is a quite large variation in understanding [definitions] and a lack of policy coherence and standards	common framework of blending	lack of	existent / non-existent	BARRIER	F32	Blended finance
201			200	increasing development community	this community, increasingly using blended finance might also give certainty to commercial capital to get more involved in the development of ESG principles. This variety of actors has also increased the number of financial instruments and structures as innovative ways of attracting commercial investors	development community [network]	increasing	relevant / not relevant	DRIVER	F6	Developing / implementing community capacity
202			201	associated risks and uncertainty [with blended finance]	[other common challenges for commercial capital involvement in important public projects, with good dimensions, and good business models] Specially with blended projects / Investments in development countries	risks and uncertainty	associated [with the source of finance]	significant / not significant	BARRIER	F25	Financial risks
203			202	maturity of markets	[other common challenges for commercial capital involvement in important public projects, with good dimensions, and good business models]	[blended] markets	maturity of	mature / not mature	BARRIER	F20	Market maturity level
204			203	information asymmetries	[other common challenges for commercial capital involvement in important public projects, with good dimensions, and good business models]	information asymmetries	N/A	significant / not significant	BARRIER	F10	Information asymmetry

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
205	**7 Making Blended Finance Work for the Sustainable Development Goals** OECD (2018), Making Blended Finance Work for the Sustainable Development Goals, OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264288768-en [SIG]	Going beyond finance, blending can deliver much more than capital for achieving the Sustainable Development Goals; diverse actors from the public and private sector working together leverages strengths from each sector that can be applied in new ways to solve persistent development challenges	204	market imperfections or failures	[other common challenges for commercial capital involvement in important public projects, with good dimensions, and good business models]	market imperfections or failures [risk]	N/A	significant / not significant	BARRIER	F20	Market maturity level
206			205	blended finance catalyses additional investment	Since blended finance focuses in the purpose instead of the source of financing, there is some degree of causality between the diverse sources which should result in additional finance being mobilised	additional investment catalyser	N/A	significant / not significant [potential]	DRIVER	F32	Blended finance
207			206	development finance providers bring reputation to a project	the good reputation could translate to financial value	reputation benefits [of using development finance at a project level]	N/A	significant / not significant [potential]	DRIVER	F26	Degree of behavioural resistance
208			207	development finance providers bring network in development issues to a project	A good network and collaboration practices could translate to financial value	providers network benefits [of using development finance]	[good]	significant / not significant	DRIVER	F17	Knowledge generation and understanding
209			208	development finance providers bring expertise in development issues to a project	Adequate expertise could translate to savings in terms of les mistakes and effective implementation of blended finance	expertise benefits [of using development finance]	N/A	significant / not significant	DRIVER	F12	Funding sources
210			209	investors often associate investment in developing countries to a bad risk-return relationship	This perception is exacerbated in emerging markets	investors risk/return assumptions	N/A	existent / non-existent	BARRIER	F26	Degree of behavioural resistance
211			210	foreign currency risk	due to the nature of the investment, specially those cross-border investments. This also relates to the risk of the country itself, which might have a poor credit ratings. Providing financing in local currency and seeking opportunities for participation from local financial investors. Doing this helps to mitigate the risk of exposure to currency fluctuations. This include what is referred to as 'foreign exchange volatility' for cross-boundary collaborations in pp. 43	foreign currency risk	N/A	significant / not significant	BARRIER	F23	Political and economic landscape
212			211	blended finance funds offer many benefits	they have capacity to attract additional commercial finance because they offer, acceptable return rates, an investment grade profile due to low volatility, significant vehicle sizes and potentially higher liquidity of their assets. In some cases they may offer development and commercial investors the same exposure to risks and returns	blended finance funds benefits	N/A	significant / not significant	DRIVER	F32	Blended finance
213			212	clear strategic focus and exit strategy	There is a tendency for blended finance to go towards sectors for which the business case is clearer and the potential for commercial gains more apparent	strategic focus and exit strategy	clear	clear / unclear	NEUTRAL	N	excluded
214			213	risk of fragmented approaches	due to the increasing number of blended finance facilities being set up, this also means additional layers of intermediation, which have implications for the complexity of intervention, monitoring and evaluations of impact and results. For commercial investors the former conditions also mean a big array of modalities, terms and conditions to fulfil	fragmented approaches risk	N/A	significant / not significant	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
215			214	local ownership of the project	local ownership and sustainability for the long run. This relates to deploying blended finance in a way that is consistent with the goal of, and where possible reinforces, the evolution of local financial markets.	local ownership of the project	N/A	clear / unclear	NEUTRAL	F18	NBS-specific features and risks
216			215	lack of transparent and bankable pipelines	magnitude and concessionally of development finance being channelled towards blended approaches and what is being mobilised as a result. Much of what is known comes from based on standalone surveys, that focus on the facility or fund executing them. project databases, either publicly supported or commercial, are another source of data that can provide proxy estimates of blending. But they vary in their breadth, coverage and comparability. Also. lack of transparency on the commercial dimensions of blended finance.	transparent and bankable pipelines	lack of	existent / non-existent	BARRIER	F16	Cost effectiveness and competitiveness
217			216	increasing demand for investment in the developing world	which should warrant increased investor attention, especially given the high level of global savings and the relatively small returns many investors are accepting in advanced economies. There is also the assumption that developing countries might offer better returns	demand for investment in the developing world	increasing	significant / not significant	DRIVER	F22	Market size
218			217	high development and transaction costs	[specially pertaining to infrastructure]	development and transaction costs	high	high / acceptable	BARRIER	F16	Cost effectiveness and competitiveness
219			218	lack of viable funding models [for the longer term]	[specially pertaining to infrastructure]	funding models	lack of	existent / non-existent	BARRIER	F32	Blended finance
220			219	unfavourable and uncertain regulations and policies	[specially pertaining to infrastructure] Regulatory and institutional reforms are needed to make infrastructure more attractive to private investors	regulations and policies	uncertain	certain / uncertain	BARRIER	F15	Regulatory environment
221			220	inadequate public budgets and tax bases	[specially pertaining to private investment in infrastructure]	public budgets and tax bases	inadequate	adequate / inadequate	BARRIER	F27	Enabling institutional environment and policies for NBS
222			221	investor protection concerns	[specially pertaining to private investment in infrastructure]	investor protection concerns	N/A	significant / not significant	BARRIER	F26	Degree of behavioural resistance
223			222	uncertain commercial viability of project	[specially pertaining to private investment in infrastructure]	commercial viability of project	uncertain	certain / uncertain	BARRIER	F16	Cost effectiveness and competitiveness
224			223	political risk	[pp. 43 specially pertaining to private investment in infrastructure] pp. 81 associated to uncertainties in the enabling environment of a country, in general investors are attracted to stable conditions. They are subjective and rather hard to quantify, examples are: change sin regulation affecting specific sectors, institutional risks related to the enforceability of the contract, currency inconvertibility and transfer restrictions, expropriation, defaults related to wars, terrorism and civil disturbance	political risk	N/A	significant / not significant	BARRIER	F23	Political and economic landscape
225			224	global financial regulatory issues [risk]	challenge for catalysing investment, for instance in the last decade decade capital requirements for insurance companies and required investment limits on certain asset classes have heightened, affecting some pension funds. Banks also have been more risk-constrained as they implement Basel III guidelines	global financial regulatory risk	N/A	significant / not significant	BARRIER	F23	Political and economic landscape
226			225	[impact of] slower global economic growth [on sustainable projects]	[for the public entities] global environment has become less favourable in recent years for many developing countries as the result of slower global economic growth, challenging macroeconomic conditions, low commodity prices, slowing growth in trade, capital flow volatility and humanitarian crises	global economic growth impact	slower	significant / not significant	BARRIER	F23	Political and economic landscape

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227			226	investors' appetite and capacity	affected by risk on top of project, but specially by regulatory challenges, in the case of infrastructure, the lack of recognition of infrastructure as an asset class hinders investors, specially institutional investors, from properly understanding its role within a portfolio even if the individual risks of the project have been managed down to acceptable parameters. In itself this factor is not negative or positive, the comparison with the conditions of the investment against the expectation [appetite] will become favourable or not]	investors' appetite and capacity	N/A	positive / negative	NEUTRAL	F26	Degree of behavioural resistance
228			227	weak reputation of infrastructure	as mentioned in former factor [highly related], infrastructure is not yet recognized as an asset class	reputation of infrastructure	weak [bad]	positive / negative	BARRIER	F16	Cost effectiveness and competitiveness
229			228	private investors' features [requirements]	Many different commercial private actors, ranging from institutional investors, to banks and corporations, increasingly get involved in blending and development projects. The challenge is that they are not monolithic even among each category of investor. Institutional investors such as pension funds, insurance companies, investment funds, endowments or sovereign wealth funds collectively manage a significant amount of capital, which makes them highly influential around allocation of capital and investment, they have a long-term outlook due to the nature of their liabilities and make strategic allocation decision usually through a diversified set pf financial instruments	private investors' features [requirements]	N/A	matching / unmatching [with average of project's conditions]	BARRIER	N	excluded
230			229	macroeconomic and business risks	decisive determinants of investors' willingness to invest in a company, project or portfolio of projects. Examples of these risks are: credit risk [probability of default of the counterparty in the transaction], liquidity, market risk [specially relevant in the shape of equity risk],	macroeconomic and business risks	N/A	significant / not significant	BARRIER	F23	Political and economic landscape
231			230	lack of relevant information on risks	impacts the perception and assessment of other risks greatly, like market and credit risks	relevant information on risks	lack of	existent / non-existent	BARRIER	F28	Information on NBS
232			231	technical risks	associated particularly with infrastructure projects, they are decisive, the emanate from the underlying asset subject to construction and operation risks, i.a. Other prominent examples are: construction delays, and cost overruns.	technical risks	N/A	significant / not significant	BARRIER	F27	Enabling institutional environment and policies for NBS
233			232	diversification opportunities	investing in a fund or other blending mechanisms offers private investors a number of benefits, such as mitigating portfolio risk via diversification and the possibility to pilot and learn from innovative approaches in a contained environment.	diversification opportunities	N/A	significant / not significant	BARRIER	F24	Nature valuation and impact assessment
234			233	strong focus [of private investors] on SDG 13 - climate action	surveys found a significant level of activity among blended finance facilities and funds related to climate, with 78% of the 69 respondents targeting climate change mitigation and 49% targeting climate change adaptation	private investors' interest for SDG 13 - climate action	strong	significant / not significant	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
235			234	private-public co-operation requires a cultural change	Partnerships of private and public actors, are not necessarily a natural fit. Established roles and mandates differ, as do working modalities. These differences are exemplified by the private sector's need for standardised processes and documentation, low entry and exit barriers, and efficient time management practices to maximise cost/benefit ratios. Additional challenges related to bringing together local governments and the private sector include a lack of experience. Also referred as to lack of alignment and harmonisation [pp.136]	cultural change for PP co-operation	N/A	adequate / inadequate [degree of change]	BARRIER	F26	Degree of behavioural resistance
236			235	blended transaction period can last longer than anticipated	Blended finance should be a temporary measure if more private commercial investors want to be attracted	transaction period [time uncertainty/risk]	longer than anticipated	significant / not significant	BARRIER	F32	Blended finance
237			236	exit points and strategies may be quite complex	N/A	exit points and strategies	quite complex	complex / not complex	BARRIER	F11	Investors' capital allocation features and requirements
238			237	Rating agencies scores	Country's sub-investment grade and sovereign rating. Rating agencies play a significant role for institutional investors to ensure investment quality. Many institutional investors will not invest in financial products that are assigned a credit rating below investment grade (BBB- by Standard & Poor's and Fitch and Baa3 by Moody's). Options might include the existence of other examples [projects] which have managed to hedge against this condition	Rating agencies scores	N/A	acceptable / not acceptable	BARRIER	F4	Ratings, indices and listings
239	**8 The next generation of infrastructure** Bielenberg, A., et al. (2016). "The next generation of infrastructure." McKinsey&Company - Sustainability & Resource Productivity	Sustainable projects will add trillions to the world's infrastructure costs. Our report finds that private-sector investors must look at new ways to fill the gap.	238	sustainability premium	Sustainable projects are typically more expensive than traditional ones. projections show that this sustainability "premium" could add $14 trillion to overall infrastructure costs between 2015 and 2030. It is estimated that an additional 6 percent in up-front capital will be required to raise the level of the new infrastructure to the sustainability standards achieved.	sustainability premium	N/A	existent / non-existent	BARRIER	F24	Nature valuation and impact assessment
240			239	[growing] projected future global demand for infrastructure services	Much of the sustainable-infrastructure funding gap is likely to occur in middle-income nations, whose continued development and increasing prosperity are vital to global growth prospects and business opportunities. he vast scale of what's needed, combined with fiscal constraints in the public sector, suggests that private-sector financing will be crucial.	projected future global demand for infrastructure services	growing	significant / not significant	DRIVER	F22	Market size
241			240	poor transparency	Poor transparency in terms of pipelines and strategic plans. Only half of the G-20 nations publish their infrastructure project pipelines, so it is difficult for investors to learn which projects are available and to assess whether they are "bankable."	transparency	poor	sufficient / not sufficient	BARRIER	F17	Knowledge generation and understanding
242			241	A lack of scale	Often, economies of scale are not sufficient for larger investments[projects are not scalable]	scale	a lack of	sufficient / not sufficient	BARRIER	F1	Scale and minimal optimal size of the project
243			242	shaky [inadequate] operating models	[provision of services] In sub-Saharan Africa, for instance, 70 percent of the water utilities provide is wasted by leakage, unmetered, or stolen	operating models	shaky	adequate / inadequate	BARRIER		#N/A
244			243	corruption	Notwithstanding the attractions of infrastructure investments, corruption often makes adjusting their return-to-risk ratios particularly difficult.	corruption	N/A	existent / non-existent	BARRIER	F23	Political and economic landscape
245			244	tighter taxes and regulations	Tighter global banking regulations, such as Basel III, have the unintended effect of reducing the interest of big global institutions in longer-term cross border infrastructure investments. Uncertain local tax regimes often raise the bar for investments by increasing the risk that returns will take a hit	taxes and regulations	tighter	too tight / acceptable	BARRIER	F27	Enabling institutional environment and policies for NBS

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246			245	provision of technical assistance	Bodies such as the International Finance Corporation could provide technical assistance to nations by helping them to prioritize projects and demonstrating the feasibility of returns to investors. (For example, they could counsel government officials on the relative risks and returns of new roadways as opposed to rapid-transit systems.)	technical assistance	provision of [availability]	available / not available	DRIVER	N	excluded
247			246	structural improvements in financial markets	They encourage greater private participation. The wider syndication of infrastructure loans by development banks, for instance, would significantly broaden the capital base. Establishing a secondary market for sustainable infrastructure–related securities would provide for the greater recycling of development capital, and more innovative financial instruments could give investors greater flexibility.	Structural improvements in financial markets	N/A	sufficient / not sufficient	DRIVER	F20	Market maturity level
248	9 'Climate value at risk' of global financial assets	What might be the impact of climate change itself on asset values? Here we show how a leading Integrated Assessment Model can be used to estimate the impact of 21st century climate change on the present market value of global financial assets.	247	[unknown] impact of climate change on the financial sector	he impact of climate change on the financial sector has been little researched to date. Yet, if the economic impacts of climate change are as large as some studies have suggested, then, the impact of climate change on financial assets could also be significant.	impact of climate change on the financial sector	unknown	known / unknown	BARRIER	F5	Physical risks and damages related to climate change
249			248	[occurrence of] extreme weather events influence on financial value of assets	CC and extreme weather events can destroy o accelerate the depreciation of capital assets, or reduce the outputs [services] achievable given inputs, in other words, a change n the return on capital assets, in the productivity of knowledge, and/or labour productivity and thus wages.	extreme weather events influence on financial value of assets	occurrence of	significant / not significant	BARRIER	F5	Physical risks and damages related to climate change
250	Dietz, Bowen, Dixon & Gradwell, Climate value at risk of global financial assets, Nature Climate Change, April 2016		249	Institutional investors fiduciary duty	knowing the impact that CC can have on long-term investments, obliges some institutional investors [specially some pension funds] to advocate for emissions reductions, and other green goals [they have a fiduciary duty towards the affected fund beneficiaries]	Institutional investors fiduciary duty	N/A	existent / non-existent	DRIVER	F15	Regulatory environment
251			250	low levels of awareness about climate change in the financial sector [as a whole]	financial regulators need to ensure that financial institutions such as banks are resilient to shocks, hence their growing interest in the possibility of a climate-generated shock	levels of awareness about climate change in the financial sector	low	sufficient / not sufficient	BARRIER	F30	Awareness of nature's importance and sense of urgency to invest
252	10 Natural Assurance Scheme: A level playing field	conceptual framework to systematize the use of Nature-[illegible]	251	[rising] annual damages to GDP due to climate risk	rise of 77% by 2030 according to IPCC	annual damages to GDP due to climate risk	rising	high / acceptable	BARRIER	F5	Physical risks and damages related to climate change
253			252	increasing demand for green infrastructure investments	the demand for the volume and new uses of green infrastructure is growing, and this only to maintain the current level of ecosystem services under present trends	demand for green infrastructure investments	increasing	significant / not significant	DRIVER	F22	Market size
254			253	[Inherent] complexity of ecosystems	Dynamics of natural systems are highly complex and some impacts of environmental change are irreversible and the replacement of natural capital is often impossible, therefore it is unlikely that scaling existing measures will be enough. This complexity also posses challenges in translating the concept of natural resilience into policy and its uptake into Disaster risk reduction (DRR) planning	[Inherent] complexity of ecosystems	N/A	existent / non-existent	BARRIER	N	excluded
255			254	low levels of risk awareness	on the possible impacts of losses of natural capital and the potential of Nature Based Solution (NBS) to mitigate them.	levels of risk awareness	low	sufficient / not sufficient	BARRIER	N	excluded
256			255	potential to capitalize on services provided by [fully functioning] ecosystems	ecosystems as a natural assurance system composed of green infrastructure, thus generating provable	potential to capitalize on natural ecosystems' services	N/A	potential to capitalize on services provided by natural ecosystems	DRIVER	F31	Ecosystems' delimiting challenges and service diffuseness
257			256	low cost-effectiveness of conservation payments	programs and subsidies [e.g. agro-environmental subsidies] and the comparatively high potential of ecosystem service thinking	cost-effectiveness of conservation payments	low	sufficient / not sufficient	BARRIER	F16	Cost effectiveness and competitiveness
258			257	green infrastructure can be cost-effective	when managing climatic impacts. The river restoration community, was one of the first to realize and act on the fact that the natural structure of rivers and streams greatly attenuates the risks humanity faces due to climate change and other anthropogenic impacts.	cost-effectiveness of green infrastructure	N/A	significant / not significant	DRIVER	F16	Cost effectiveness and competitiveness
259			258	multitude of benefits of green infrastructure	financial benefits. climate change, adaptation, mitigation benefits, and the attainment of policy objectives i.e. of the European Union. One of the most difficult challenges of the multitude of services is to quantify them.	multitude of benefits of green infrastructure	N/A	quantifiable / non-quantifiable	DRIVER	F9	Multitude of functions and services and their challenges
260			259	damage reduction value of ecosystems	and hence reduction in the price for insurance, i.e. the premium, although important in itself, alone may be too limited to act as an sole incentive to their preservation in many cases	damage reduction value of ecosystems	N/A	significant / not significant	DRIVER	F24	Nature valuation and impact assessment
261			260	co-benefits of ecosystems [services]	such as hatchery of fish in the case of mangroves, might act as an incentive for the private investment	co-benefits of ecosystems	N/A	significant / not significant	DRIVER	F9	Multitude of functions and services and their challenges
262			261	Insurance sector expertise on risk assessment and management	This central position is particularly highlighted by the database of past disaster which is crucial for model calibration. Similar datasets at the global level have been collected by CCR, MunichRe and Swiss Re, These databases usually cannot be shared for reasons of confidentiality.	Insurance sector expertise on risk assessment and management	N/A	existent / non-existent	DRIVER	F2	Adequate asset management expertise
263			262	modelling to assess risk mitigation capacity of green infrastructure is challenging	[highly engineered systems] it requires vast technical knowledge and it also has scale problems, modelling all of these at policy-relevant scales is challenging based on field data alone and must be supported by remote sensing and Geographical Information Systems (GIS). The information produced for modelling aside from challenging to forecast it is difficult to translate for financial actors	modelling to assess risk mitigation capacity of green infrastructure	challenging [difficult]	challenging / not-challenging	BARRIER	F19	Risk management, metrics and tools
264			263	standardized evaluation methodologies at global level for investors and public bodies	[standardize assessment methodology] Robust and transferable [ex-ante] evaluation methods for investors and public bodies. related to former factor, methods used to convince investors and public bodies on the potential reliability and economic relevance of NBS	standardized evaluation methodologies at global level for investors and public bodies	standardized, robust, transferable and ex-ante [adequate]	adequate / inadequate	NEUTRAL	F32	Blended finance
265			264	lack of [interest] on institutional innovation	For instance, on urban green infrastructure, the existing path dependency in spatial planners decision making as well as them not being particularly keen on institutional innovation constitutes an obstacle to the development of GI. The EU has launched some initiatives to raise awareness of decision-makers on the full potential of NBS, but inertia of these mostly national institutions to expand and accept the new knowledge and build the capacity also presents a unique challenge	[interest] on institutional innovation	lack of	existent / non-existent	BARRIER	F27	Enabling institutional environment and policies for NBS
266			265	too high standards and safety regulations for the built environment and construction sector	primarily to prevent death and injury from accidents and disasters,	standards and safety regulations for the built environment and construction sector	too high	high / acceptable	BARRIER	F15	Regulatory environment

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267	framework for Green-Grey infra development	based solutions (NBS) by integrating their resilience potential into Natural Assurance Scheme (NAS), focusing on insurance value as corner	266	conservative and risk avert construction sector	where innovations take a very long process to be implemented and mainstreamed. Given also procurement and financing rules and corresponding economic incentives, only proven technologies are used in real scale projects so as to limit construction risks to a minimum. traditionally been slow at technological development and has undergone no major disruptive changes	construction sector	conservative and risk avert	risk avert / risk acceptant	BARRIER	F6	Developing / implementing community capacity
268	Denjean B, Altamirano MA, Graveline N, et al. Natural Assurance Scheme: A level playing field framework for Green-Grey infrastructure development. Environ Res. 2017;159:24-38. doi:10.1016/j.envres.2017.07.006	stone for both awareness-raising and valuation.	267	protect from nature water management approach	working against nature, with individuals with backgrounds as civil engineers, whose training is in line with risk reduction, safety and accuracy, similar to the construction sector	protect from nature' water management approach	N/A	existent / non-existent	BARRIER	F8	Professional biases
269			268	NBS performance cannot be as easily [challenging] engineered or measured with precision	In contrast with grey infrastructure, NBS performance cannot be as easily engineered or measured with as much precision and is expected to have a rather cyclical nature.	NBS performance engineering and measuring	challenging	challenging / not challenging	BARRIER	F15	Regulatory environment
270			269	proposers of green infrastructure speak different language than decision makers	proposers are often ecologists and biologists that have been trained within a very different scientific paradigm and speak a 'different language' than the key decision makers, who are often civil and financial engineers at the service of public authorities, contractors and financing institutions. Decision-makers expect hard data and figures [about lifecycle costs and total costs of ownership] which might not be easily generated within pilot studies. This limits the scalability of tis projects. In pp 13 is referred to as lack of permeability [in interdisciplinary exchanges]	different language between NBS proposers and decision makers	N/A	existent / non-existent	BARRIER	F17	Knowledge generation and understanding
271			270	[unavoidable] need for KPI [key performance indicators]	BS to be up scaled and become mainstreamed; they need to be procured following the same public procurement rules and contracting frameworks as regular infrastructure. Including KPI and functional requirements on which to base payments to private contractors implementing NBS	Need for KPI [key performance indicators]	[unavoidable]	avoidable / not avoidable	BARRIER	F15	Regulatory environment
272			271	oversimplification of climate-related risk management systems	Negligence with uncertainty and complexity. The densely interconnected networks in which decision-actors operate, which span between and across ecological, economic and socio-political domains can create complexities and challenges the need to be considered	climate-related risk management systems	oversimplified	accurate / not accurate	BARRIER	F19	Risk management, metrics and tools
273			272	ambiguity in multi-actor setting	[mis-alignment of interest frames] Action choices are not neutral, but commensurate with the perspectives and frames held by the actors making the decisions [and their interdependency to other actors]. The problem is when these frames do not overlap or are incompatible. Although this disparity might foster innovation and creative solutions, it can also be the source of discrepancies and conflict	ambiguity in multi-actor setting	N/A	significant / not significant	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
274			273	preference for NBS vs infrastructure development options in the NL	[demonstrated in the NL] based on the positive correlation between knowledge on the NBS adaptive capacity and societal preference for NBS vs infrastructure development options, consider that the scale of acceptability issues might be unknown and culturally dependent, but still related to the impact, and efficiency of NBS	preference for NBS vs infrastructure development options in the NL	N/A	existent / non-existent	DRIVER	F11	Investors' capital allocation features and requirements
275			274	NBS are capital-intensive	[NBS unique risks]	NBS are capital-intensive	N/A	high / acceptable	BARRIER	F16	Cost effectiveness and competitiveness
276			275	NBS are unique [not replicable]	[NBS unique risks] not replicable in entirety of partially, scalability challenge	NBS are unique	not replicable	replicable / not replicable	BARRIER	F18	NBS-specific features and risks
277			276	delayed and dispersed benefits [services] of NBS	[NBS unique risks]	benefits [services] of NBS	dispersed	dispersed / not dispersed	BARRIER	F31	Ecosystems' delimiting challenges and service diffuseness
278			277	non-guaranteed and non-financial benefits of NBS	[NBS unique risks]	benefits [services] of NBS	non-financial	financial / not financial	BARRIER	F31	Ecosystems' delimiting challenges and service diffuseness
279			278	limited autonomous earning power	[NBS unique risks]	autonomous earning power	limited	limited / not limited	BARRIER	F26	Degree of behavioural resistance
280			279	high risk profile of NBS	[NBS unique risks]	risk profile of NBS	high	high / acceptable	BARRIER	F18	NBS-specific features and risks
281			280	elevated perceived risks	sub-factor from former challenge 'high risk profile of NBS'	perceived risks	elevated	adequate / inadequate [elevated]	BARRIER	N	excluded
282			281	information gaps	sub-factor from former challenge 'high risk profile of NBS' , this subfactor is due to newness of the technology	information gaps	N/A	significant / not significant	BARRIER	F10	Information asymmetry
283			282	[low] financial attractiveness of NBS	caused by all unique risks and underlying factors [above]	financial attractiveness of NBS	low	sufficient / not sufficient	BARRIER	F16	Cost effectiveness and competitiveness
284			283	NBS different capital and operative expenses [than grey infrastructure]	[important for the expectation management of implementations, beneficiaries and investors] Differences are problematic for standard project finance loans. NBS may require similar capital expenses but spread over a longer term as they take longer to "build" than grey solutions, but are expected to require in the long term lower costs for their maintenance and operation.	NBS capital and operative expenses	different [than]	significant / not significant	BARRIER	F16	Cost effectiveness and competitiveness
285			284	Investment levels will exceed [are larger] business-as-usual infrastructure maintenance	Cities will require high levels of investment in the years to come in order to finance these changes [greening of infrastructure]. These investments are concentrated over a relatively short period of time [to attain climate change goals] making it harder to resolve the issue of financing these investments	investment levels than BAU infrastructure maintenance	larger	too large / acceptable	BARRIER	F16	Cost effectiveness and competitiveness
286			285	positive long-term environmental impact on cities	N/A	long-term environmental impact on cities.	positive	significant / not significant	DRIVER	F29	Modelling climate change scenarios
287			286	non-quantifiable positive externalities	often justified through a collective social benefit that cannot be readily quantified in economic terms. Infrastructure aimed at reducing greenhouse gases exemplifies this characteristic. They produce effects over the very long term, which makes it hard to advance conventional economic arguments regarding the financing of investments	externalities	non-quantifiable	quantifiable / non-quantifiable	BARRIER	F24	Nature valuation and impact assessment
288			287	green projects carry a high degree of risk	especially related to uncertainty of the regulatory and economic environment (energy prices, cost of carbon dioxide, etc.). Risk profiles vary for different technologies and their stages of development; the technology development stage determines which type of financing is most appropriate, green projects with high capital intensity and high technology risk will be most difficult to finance	green projects' high risk	N/A	high / acceptable	BARRIER	F18	NBS-specific features and risks
289			288	[too strict] current global fiscal constraints	Resources are scarce, and public authorities in all levels of government must do more with less. Since 2010, however, most OECD countries have attempted to curb public debt by reducing public expenditure. As a result, many cities around the world have been faced with local budget cuts due to reduced intergovernmental transfers and lower tax bases	current global fiscal constraints	too strict	adequate / inadequate	BARRIER	F15	Regulatory environment

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
290	**11 Financing Green Urban Infrastructure** Merk, O., Saussier, S., Staropoli, C., Slack, E., Kim, J-H (2012), ―Financing Green Urban Infrastructure‖, OECD Regional Development Working Papers 2012/10, OECD Publishing; http://dc.doi.org/10.1787/5k92p0c6j6r0-en	overview of practices and challenges related to financing green sustainable cities.	289	Huge global infrastructure needs [demand]	According to OECD (2007), improving the world's infrastructure will require an estimated USD 35-40 trillion – i.e. USD 2 trillion dollars per year, or 2.5% of global GDP.	global infrastructure demand	huge	significant / not significant	DRIVER	F22	Market size
291			290	green infrastructure requires [large] upfront investments	that may show benefits only in the long run and incur risks related to uncertainty over regulatory, economic and technological developments (e.g. energy prices and the cost of carbon dioxide emissions)	upfront investments	large	significant / not significant	BARRIER	F16	Cost effectiveness and competitiveness
292			291	high transaction costs	N/A	transaction costs	high	significant / not significant	BARRIER	F16	Cost effectiveness and competitiveness
293			292	private sector knowledge and experience in greening infrastructure	N/A	private sector knowledge and experience in greening infrastructure	N/A	significant / not significant	DRIVER	F17	Knowledge generation and understanding
294			293	anti-green bias of some existing local tax provisions	perverse incentives created by many environmentally harmful subsidies	anti-green bias of some existing local tax provisions	N/A	existent / non-existent	BARRIER	F15	Regulatory environment
295			294	[degree of] policy coherence across levels of government	Ensure coherence and consistency between national and local policies. Particularly important for establishing price signals for non-localised environmental externalities. [pp 24] Remove national obstacles to local incentives, national regulations may in some cases constrain local governments' ability to act.	policy coherence across levels of government	degree of	sufficient / not sufficient	NEUTRAL	F27	Enabling institutional environment and policies for NBS
296			295	market for green investment projects	With appropriate projects and size. n deciding on their investment portfolio, each private investor considers the trade-off between projected return on investment and risk. To gain the interest of private investors, urban green infrastructure projects need to be marketable and promising with regard to returns and risk: high potential yields or limited risk, or both.	market for green investment projects	N/A	adequate / inadequate	NEUTRAL	F20	Market maturity level
297			296	Returns on green urban investment are often lower than alternative investment options.	dirty infrastructure is favoured since negative externalities are not always taken into account for i.e. taxes. [IMPORTANT] Even if the returns of investment could be high, the benefits might spill over to other actors leading to under-investment from a societal point of view. Policy must take this spill over into account.	Returns on green urban investment	lower than [alternative investment options]	sufficient / not sufficient	BARRIER	F16	Cost effectiveness and competitiveness
298			297	[significant] demand risks in PPP and PFI [of providing services]	[traditional procurement strategies to implement infrastructure] In concessions, payments are made by users or are substantially connected to the number of users (e.g. shadow tolls), the private operator bears the demand risks because revenues are directly and substantially connected to the consumption level. In contrast, payment for PFIs is based on making the infrastructure available and is usually affected by the capabilities of the operator to meet performance targets. The demand risk is more extensively transferred in concessions than in PFIs	demand risks in PPP and PFI	significant	significant / not significant	BARRIER	F15	Regulatory environment
299			298	possibility for unsolicited PPP/PFI schemes [depending on each country]	could incentivize the private sector to identify a potential green project and request designation of the project as a PPP from the competent authority.	unsolicited PPP/PFI schemes	possibility for	available / not available	DRIVER	F15	Regulatory environment
300			299	performance-oriented contract is only [lack of] possible with measurable, observable and verifiable indicators	The more difficult the control, the more likely ex post conflicts concerning efficiency targets, observed performances and responsibilities will occur. These conflicts are costly and affect the efficiency of PFI.	indicators for performance-oriented contracting	lack of	existent / non-existent	BARRIER	F15	Regulatory environment
301			300	Green infrastructure projects outcomes resulting in decreased consumption [incompatible outcomes and consumption patterns]	Green PPPs might face challenges if their objectives result in decreased consumption. Such objectives appear incompatible with concession contracts, in which the gains of the private operator is positively linked to the level of consumption, When private operators' payment is based on the amount of water consumed, conserving natural resources (i.e. reducing the quantity of distributed water) conflicts with increasing earnings	outcomes and consumption patterns	incompatible [contradictory]	compatible / incompatible	BARRIER	N	excluded
302			301	government subsidies	Government may grant a construction subsidy to the concessionaire, if it is required to maintain the user fee at an affordable level.	government subsidies	[available]	available / not available	DRIVER	F27	Enabling institutional environment and policies for NBS
303			302	Compensation for base cost	the government assumes a portion of investment risk. This risk is limited to what the government's costs would have been in the case of a public-financed project	Compensation for base cost	[available]	available / not available	DRIVER	F27	Enabling institutional environment and policies for NBS
304			303	credit guarantees	credit guarantees to concessionaires who want to obtain loans from financial institutions for PPP projects. I.e. in Korea, when the project guaranteed by the ICGF defaults, the ICGF subrogates on behalf of the project company.	credit guarantees	[available]	available / not available	DRIVER	F27	Enabling institutional environment and policies for NBS
305			304	Tax incentives	To facilitate infrastructure financing, the government provides tax incentives. An example is tax increment financing (TIF) is an economic development tool used to encourage the redevelopment of areas in need of revitalisation and brownfield remediation [city greening]	Tax incentives	[available]	available / not available	DRIVER	F27	Enabling institutional environment and policies for NBS
306			305	risks distributed more evenly among the participants with PPP/PFI	PPP diversifies business risks and stakeholders by promoting joint public-private activities	risk distribution among stakeholders	[even]	even / uneven	DRIVER	F19	Risk management, metrics and tools
307			306	access to loans and bonds [for institutional investors]	This could help to mobilise finance for green urban investment. Bonds provide institutional investors, such as pension funds, stable yields and limited risks. states' fiscal rules may ban local governments from borrowing or issuing bonds; while others constrain the size of municipal budget deficits or debt levels	access to loans and bonds	larger	sufficient / not sufficient	DRIVER	F27	Enabling institutional environment and policies for NBS
308			307	share of bond investment in green infrastructure is currently small	and even smaller for green urban infrastructure. Institutional investors in OECD member countries seek long-term investments with steady yields and limited risks; their portfolios are thus dominated by bonds	bond investment in green infrastructure	small	sufficient / not sufficient	BARRIER	F21	Secondary market
309			308	market failures	Green infrastructure banks could help solve them	market failures	N/A	significant / not significant	BARRIER	F20	Market maturity level
310			309	limited market size	Green infrastructure banks could help solve them	limited market size	N/A	significant / not significant	BARRIER	F22	Market size
311			310	Limited institutional and technical capacity	N/A	institutional and technical capacity	limited	sufficient / not sufficient	BARRIER	F17	Knowledge generation and understanding
312			311	Difficulties in measuring the effects of mitigation projects	with existing methodologies and lack of standardised methodologies	mitigation projects measurement of effects	difficult	challenging / not challenging	BARRIER	F15	Regulatory environment
313			312	The long duration of the relationship[s]	involving co-operation between the public and private partners on different aspects of a green project (to be implemented) or a service (to be managed)	relationship [co-operation]	long duration	too long / normal	BARRIER	N	excluded

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1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
314			313	[high] transaction costs	PPs require the implementation of a long-term partnership that results in transaction costs – ex ante and ex post contracting costs, including, costs for feasibility studies and diagnostics, choosing partners, writing the contract, enforcing the contract, and dealing with maladaptation and renegotiation (or amendments) to the contracts. Contract length is a crucial feature for PPP efficiency and thus in the calculation of transaction costs	transaction costs	high	significant / not significant	BARRIER	F16	Cost effectiveness and competitiveness
315	**12 Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities. Bauduceau, Nicolas, et al.** "Towards an EU Research and Innovation Policy Agenda for Nature-based Solutions & Re-naturing Cities: Final Report of the Horizon 2020 Expert Group on'Nature-based Solutions and Re-naturing Cities'." (2015).	This report was produced by the Horizon 2020 Expert Group on 'Nature-Based Solutions and ReNaturing Cities', informed by the findings of an e-consultation and a stakeholder workshop. Nature-based solutions harness the power and sophistication of nature to turn environmental, social and economic challenges into innovation opportunities. They can address a variety of societal challenges in sustainable ways, with the potential to contribute to green growth, 'future-proofing' society, fostering citizen well-being, providing business opportunities and positioning Europe as a leader in world markets	314	A growing awareness of the value of nature for the business community	here is a growing interest and awareness within the business community2 of the value of managing and maintaining biodiversity and ecosystem services	awareness of the value of nature for the business community	growing	sufficient / not sufficient	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
316			315	Infrastructure spending is intended to increase in the future	[business has an opportunity] Infrastructure spending amounts to about 3.8% of global GDP, equivalent to US$2.6 trillion in 2013, and could grow to US$3.4 trillion per year through 2030 [market]	[forecasted] increase in global infrastructure spending	N/A	significant / not significant	DRIVER	F22	Market size
317			316	NBS financial advantages and sustainable competitiveness	reduction in initial capital expenses and on-going operational expenses and they have been used strategically to recapitalise ageing resources. Nature-based solutions also offer more opportunities than 'grey' infrastructure, as they not only increase the resilience of society to external economic and environmental stresses, but contribute positively to human health and well-being, i.e. green space availability can be related to people's perceived happiness and general health	NBS financial advantages and sustainable competitiveness	N/A	significant / not significant	DRIVER	F16	Cost effectiveness and competitiveness
318			317	nature-based solutions support economic development in urban areas	economic development is highly dependent on the amount and quality of natural resources available, such as water for sanitation, drinking and manufacturing [services provided by NBS]. build on the circular economy and increased reliance on local resources, leading to greater efficiency in the use of energy and materials	NBS support for economic development in urban areas	N/A	existent / non-existent	DRIVER	F29	Modelling climate change scenarios
319			318	climate change [and its risks]	Key drivers of ecosystem loss and degradation: agricultural intensification, grey infrastructure expansion, pollution of brownfield sites, hydrological modifications to water bodies, and the intensification of forestry practices. They affect the ecosystem's ability to function, deliver ecosystem services and meet other challenges like such as water purification, soil erosion protection, flood damage control, carbon sequestration and the provision of liveable places and recreational opportunities	agricultural intensification	N/A	significant / not significant	BARRIER	F5	Physical risks and damages related to climate change
320			319	growing interest and awareness of the need to maintain, and also to restore, the functionality of degraded ecosystems and their services	It is seen as an essential ingredient within future business investments for generating revenue and by society wishing to improve the attractiveness of landscapes and cities, which would generate investment and other economic benefits, as well as contributing to human health and well-being.	interest and awareness of the need to maintain, and restore, the functionality of degraded ecosystems and their services	growing	sufficient / not sufficient	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
321			320	growing evidence that ecosystem restoration can also play a key role in increasing resilience to impending risks and threats.	Such actions not only contribute to the stabilisation of ecosystems, but also can generate benefits exceeding investment costs in the long term. Restoring and enhancing such habitats can also provide wider benefits, for example, boosting local tourism including related economic activities), providing employment and education opportunities and augmenting biodiversity conservation.	evidence that ecosystem restoration has a key role in increasing resilience to impending risks and threats.	growing	sufficient / not sufficient	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
322			321	NBS developing low cost	factors of investment in CCAM -climate change and adaptation- NBS that enhance cost-effectiveness	NBS developing cost	low [competitive]	competitive / not competitive	DRIVER	F16	Cost effectiveness and competitiveness
323			322	NBS low maintenance [cost]	factors of investment in CCAM -climate change and adaptation- NBS that enhance cost-effectiveness	NBS maintenance cost	low [competitive]	competitive / not competitive	DRIVER	F16	Cost effectiveness and competitiveness
324			323	NBS low carbon emissions	factors of investment in CCAM -climate change and adaptation- NBS that enhance cost-effectiveness	NBS carbon emissions	low [competitive]	competitive / not competitive	DRIVER	F15	Regulatory environment
325			324	NBS cost-effectiveness	enhanced by former factors. NBS, in the long run they can be more cost-effective, and represent an effective, resource-efficient and flexible approach to sustainable and inclusive economic growth	NBS cost-effectiveness	N/A	sufficient / not sufficient	DRIVER	F16	Cost effectiveness and competitiveness
326			325	NBS [multiple benefits]	NBS offer synergies in reducing multiple risks, such as CC-risks exposure and economic losses, they can protect against natural and technological hazards, including drought, extreme temperatures, floods, industrial and transport accidents, landslides and avalanches, storms, volcanoes and wildfires, The implementation of nature-based solutions offers major opportunities to reduce the frequency and/or intensity of different types of hazards	NBS multiple benefits	N/A	significant / not significant	DRIVER	F9	Multitude of functions and services and their challenges
327			326	NBS multiple functions and benefits [other]	pollution reduction, carbon storage, biodiversity conservation and the provision of recreational activities and economic opportunities	multifunctionality of NBS and benefits [other]	N/A	significant / not significant	DRIVER	F9	Multitude of functions and services and their challenges
328			327	urgent need for methodologies and conceptual frameworks for assessing the insurance value of nature	urgent need to scientifically explore methodologies and conceptual frameworks for assessing the insurance value of nature to integrate this into the disaster risk management agenda [implies there is a lack of methodologies to assess insurance value of ecosystems and therefore NBS]	methodologies and conceptual frameworks for assessing the insurance value of nature	urgent need [lack of]	existent / non-existent	BARRIER	F24	Nature valuation and impact assessment
329			328	need to compile a [lack of] more comprehensive evidence on NBS	base on the social, economic and environmental effectiveness of possible nature-based solutions, including a comparison with more traditional solutions	comprehensive evidence on NBS	lack of	sufficient / not sufficient	BARRIER	F28	Information on NBS
330			329	further development and testing [questionable] bankability of NBS	need further development and testing to establish how NBS can be turned into bankable opportunities, scaled up to leverage private capital flows, or transferred to other locations or actions.	NBS bankability	questionable	questionable / unquestionable	BARRIER	F16	Cost effectiveness and competitiveness
331			330	NBS [large investments] small net effects	limits to nature-based solutions: beyond certain boundaries of environmental change (e.g. in precipitation and temperature) where even large investments may result in small net effects	NBS net effects	small	sufficient / not sufficient	BARRIER	F16	Cost effectiveness and competitiveness
332			331	NBS complex multi-stakeholders collaboration conditions	working across different professions and disciplines, sectors, institutions, governments and national borders. These diverse actors include practitioners, researchers, citizens, grass-root activists, policy-makers, think-tanks, companies involved in the design, creation and maintenance of nature etc	NBS collaboration conditions	complex, multi-stakeholders	complex / not complex	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
333			332	NBS up-scaling capacity	N/A	NBS up-scaling capacity	N/A	existent / non-existent	NEUTRAL	F1	Scale and minimal optimal size of the project
334			333	[availability of] develop business and investment models and platforms for public-private partnerships	Identify mechanisms to encourage and/or support actors (companies and financial institutions – banks, pension funds) to invest in and restore/re-nature degraded ecosystems and also create supporting and adequate legislative and institutional structures to enable investments in ecosystem restoration.	business and investment models and platforms for public-private partnerships	availability	available / not available	DRIVER	F24	Nature valuation and impact assessment
335			334	[availability of] voluntary market-based incentives for business and individuals	Identify mechanisms to encourage and/or support actors (companies and financial institutions – banks, pension funds) to invest in and restore/re-nature degraded ecosystems and also create supporting and adequate legislative and institutional structures to enable investments in ecosystem restoration.	voluntary market-based incentives for business and individuals	availability	available / not available	DRIVER	F27	Enabling institutional environment and policies for NBS
336			335	for practitioners [it is challenging] to extract practical advice from academic papers	[knowledge creation] for a range of reasons, including most being behind paywalls, shortage of time	practical advice extraction from academic papers	challenging [difficult]	difficult / not-difficult	BARRIER	F17	Knowledge generation and understanding
337			336	NBS benefits are difficult to quantify	economic, social and environmental benefits are [rarely] quantified, especially the social and environmental benefits where monetary evaluation is not always applied or traditional economic approaches are not appropriate	NBS benefits quantification	difficult	difficult / not-difficult	BARRIER	F24	Nature valuation and impact assessment
338			337	unclear, abstract NBS definition	NBS are still perceived as concepts, the definition, as well as the relationship with other (related) concepts (e.g.: ecosystem services, green infrastructure) and initiatives (e.g.: Millennium Ecosystems Assessment) need further clarification. A clear operational framework is needed.	NBS definition	unclear	clear / unclear	BARRIER	F17	Knowledge generation and understanding
339			338	suitable institutional and financial frameworks	into governance practices including decision-making processes, constraints and opportunities related to institutional and regulatory frameworks, as well as the development of new financial instruments are all necessary to create a market for Nature-Based Solutions.	institutional and financial frameworks	suitable	suitable / unsuitable	DRIVER	F24	Nature valuation and impact assessment
340	13 Introducing the suspended tree to the market through the application of strategic niche management [sustainable innovations during their market introduction]	This research centres around the market introduction of sustainable innovations in the construction sector. The market introduction of sustainable innovations such as the ST is often hindered by legal, governmental and financial barriers	339	Nature [projects] can provide a variety of ecosystem services	that improve the overall liveability of the city environment	nature projects variety of services	N/A	significant	DRIVER	F9	Multitude of functions and services and their challenges
341			340	[availability of] Financial incentives	financial improvements in the legislation to stimulate the implementation of more sustainable innovations. Such as Governments creating tax reductions as incentive for companies to stimulate sustainable construction	financial incentives	availability	available / not available	DRIVER	F27	Enabling institutional environment and policies for NBS
342			341	increasing awareness regarding the benefits of sustainable building	increase client's awareness. [pp. 30] Main barrier to the implementation, lack of public perception of need	awareness on the benefits of sustainable building	increasing	sufficient / not sufficient	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
343			342	organizational and procedural difficulties	when adopting new sustainability technologies and practices	organizational and procedural difficulties	N/A	significant / not significant	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
344			343	risks	Due to the often disruptive nature of sustainable technologies, they require process changes	risks	N/A	significant / not significant	BARRIER	N	excluded
345			344	unforeseen costs	Due to the often disruptive nature of sustainable technologies, they require process changes. [pp. 31] capital costs concerns	unforeseen costs	N/A	significant / not significant	BARRIER	F16	Cost effectiveness and competitiveness
346			345	wrong steering mechanisms	[legal / governmental barriers]	steering mechanisms	wrong	adequate / inadequate	BARRIER	F27	Enabling institutional environment and policies for NBS
347			346	lack of client understanding	including the perception of stakeholders that building green is expensive [knowledge barriers]	client understanding	lack of	sufficient / not sufficient	BARRIER	F17	Knowledge generation and understanding
348			347	lack of regulative and enforcing regulation	lack of planning policy, and lack of legislation , [pp. 32] inappropriate or lack of legislations, Sustainable innovation being restricted or prohibited by the regulators, Lack of planning policy	regulative and enforcing regulation	lack of	sufficient / not sufficient	BARRIER	F15	Regulatory environment
349			348	high initial and transition costs	[financial barrier]	initial and transition costs	high	high / acceptable	BARRIER	F16	Cost effectiveness and competitiveness
350			349	long payback periods	[financial barrier]	payback periods	long	long / acceptable	BARRIER	N	excluded
351			350	lack of funding	[financial barrier]	funding	lack of	sufficient / not sufficient	BARRIER	F12	Funding sources
352			351	lack of communication	N/A	communication	lack of	sufficient / not sufficient	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
353			352	reluctance to change	tendency to maintain current days' practices	reluctance to change	N/A	significant / not significant	BARRIER	F26	Degree of behavioural resistance
354			353	lack of knowledge and information	specially the subcontractors' limited knowledge and skills	knowledge and information	lack of	sufficient / not sufficient	BARRIER	F17	Knowledge generation and understanding
355			354	cost premium of sustainable projects	Affordability of sustainable construction [financial barrier]	cost premium of sustainable projects	N/A	existent / non-existent	BARRIER	F16	Cost effectiveness and competitiveness
356			355	fear to potentially lose competitiveness	N/A	fear to potentially lose competitiveness	N/A	significant / not significant	BARRIER	F26	Degree of behavioural resistance
357			356	need for positive rate of return	[pp. 32] Lack of financial incentive for sustainable construction	need for positive rate of return	N/A	significant / not significant	BARRIER	F26	Degree of behavioural resistance
358			357	sustainable innovations can save costs on the long run	N/A	cost savings in the long run of sustainable innovations	N/A	significant / not significant	DRIVER	F24	Nature valuation and impact assessment
359			358	investing party not receiving the benefits of the sustainable measure	benefits of sustainable measure allocation not with investing party [financial barrier]	[inadequate] benefits of sustainable measure allocation	N/A	adequate / inadequate	BARRIER	F31	Ecosystems' delimiting challenges and service diffuseness
360			359	Lack of institutional support	[legal / governmental barriers]	institutional support	lack of	sufficient / not sufficient	BARRIER	F27	Enabling institutional environment and policies for NBS
361			360	lack of knowledge and information	[knowledge barriers]	knowledge and information	lack of	sufficient / not sufficient	BARRIER	F17	Knowledge generation and understanding
362			361	aversion or risks	N/A	aversion or risks	N/A	significant / not significant	BARRIER	F26	Degree of behavioural resistance
363	Introducing the suspended tree to the market through the application of strategic niche management [sustainable innovations during their market introduction		362	striving [interest] to achieve a low emissions and waste free economy	No explanation why. Sustainability itself is nowadays the main driver for innovations in general, incentivized by the pressure on the planet from the current economic system. traditional companies will collapse and innovative sustainable solutions are required	interest to achieve a low emissions and waste free economy	N/A	significant / not significant	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
364			363	Environmental pressures on the construction sector	[driver for innovation for the construction industry] stimulation or forcing of institutions or organizations to increase their innovativeness due to pressure exerted by other institutions or organizations. Governmental guarantees, market pull, clients with innovative demands, regulations and subsidies stimulating innovation are examples of "environmental pressures"	Environmental pressures on the construction sector	N/A	significant / not significant	DRIVER	F6	Developing / implementing community capacity
365			364	technological capability of the construction sector	N/A	technological capability of the construction sector	N/A	sufficient / not sufficient	DRIVER	F6	Developing / implementing community capacity
366			365	knowledge exchange in the construction sector	N/A	knowledge exchange in the construction sector	N/A	adequate / inadequate	DRIVER	F6	Developing / implementing community capacity
367			366	Technical aspects and design specifications [of the sustainable project]	What are the limitations? Which adjustments are required?	Technical aspects and design specifications	N/A	complex / not complex	NEUTRAL	N	excluded
368			367	the market	Who are the users of the new technology? What are their needs and requirements? How to marked the technology in an economically sound manner?	market	N/A	mature / not mature	NEUTRAL	F20	Market maturity level

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
369			368	Production network	Which party should produce and market the new technology?	Production network	N/A	mature / not mature	NEUTRAL	F6	Developing / implementing community capacity
370			369	Infrastructure and maintenance network	Which additional infrastructure, technologies, capabilities need to be developed? Who is responsible for the maintenance of the new technology? Who is responsible for the recycling/waste of the new technology?	Infrastructure and maintenance network	N/A	mature / not mature	NEUTRAL	F6	Developing / implementing community capacity
371			370	Societal and environmental effects	What effect will the new technology have on the environment and society as a whole?	Societal and environmental effects	N/A	mature / not mature	NEUTRAL	F29	Modelling climate change scenarios
372			371	complex stakeholder environment	varying, aims, focus, scope, time frames and stages of involvement	stakeholder environment	complex	complex / not complex	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
373			372	difficulty managing ecosystem services	due to the dynamic interactions of ecosystem processes, functions, and structural components. Those interactions can generate feedback and feedforward loops between agents, through which the action of any one agent could affect many others, including the original actor, ultimately producing emergent behaviour, although there are some ecosystems that are less complex that others the author seems to imply that this factor is a constant.	management of ecosystem services	difficult	difficult / not-difficult	BARRIER	F9	Multitude of functions and services and their challenges
374			373	difficulty in delimiting ecosystems boundaries	Wherever we might draw the physical "boundary" of an ecosystem for political, research, or other purposes, inputs of energy (e.g., sunlight) and materials (e.g., water) from outside its bounds will affect internal processes, and outputs of energy (e.g., increased water temperature) and materials (e.g., decomposition waste) will be returned to the producing ecosystem or become inputs delivered for use in other ecosystems. Some commentators have gone so far as to argue that any effort to forge ecosystem-based policies is premature because we do not know enough about the biological and physical boundaries of ecosystems and thus cannot possibly develop effective policy	delimitation of ecosystems boundaries	difficult	difficult / not-difficult	BARRIER	F31	Ecosystems' delimiting challenges and service diffuseness
375			374	ecosystems provide a wide range of benefits to humans	(1) non-use and other indirect existence benefits; (2) direct aesthetic and recreational use benefits; and (3) direct commodity consumption benefits. In pp 42 the source provides a list of major ecosystem services.	ecosystem services to humans	wide range of	sufficient / not sufficient	DRIVER	F9	Multitude of functions and services and their challenges
376			375	Hole of knowledge on how ecosystems ecologically [translate] to economical value	Science of ecology has ignored the exploration of human service values until recently. Similarly, economics as a discipline focuses on pricing in markets, but without information from ecologists about the delivery to humans of ecosystem services. Researchers in both fields, however, have begun to bridge the gap. Classification of services in page 44. The way in which ecosystem processes produce services may not be fully understood	Hole of knowledge on how ecosystems ecologically [translate] to economical value	N/A	adequate / inadequate	BARRIER	F24	Nature valuation and impact assessment
377			376	user of ecosystem benefits [only] cares about the end result	it is easy for people to describe a value for the end result: the image, the scene, the hiking trail, the timber—just as a homebuyer cares about the finished house, not the many service providers who built it or its parts	ecosystem benefits user's [interest] on the end result	N/A	sufficient / not sufficient	BARRIER	F30	Awareness of nature's importance and sense of urgency to invest
378			377	Ecologists fear that assigning a price to ecosystem functions will detract policy	fear [from the ecology sector] that efforts to assign price or price-like values to ecosystem functions will detract from other policy grounds for ecosystem protection (services that easily quantifiable will be mor eprotected than other that are not, which might not be environmentally sustainable in the long run)	Ecologists fear that assigning a price to ecosystem functions will detract policy	N/A	significant / not significant	BARRIER	N	excluded
379			378	imprecision inherent in ecosystem service valuation	The services we use, therefore, cannot easily be selected for rate, location, combination, and other qualities	imprecision inherent in ecosystem service valuation	N/A	significant / not significant	BARRIER	F24	Nature valuation and impact assessment
380			379	Failure to account for natural value in regulatory and market settings	he playing field is not level; rather, it is tilted sharply in favour of economic development. To put it bluntly, it can't possibly help the cause of sustainable ecosystems to have ecologists sit on the side-lines of this endeavour, unwilling to engage in research on ecosystem service values	Failure to account for natural value in regulatory and market settings	N/A	existent / non-existent	BARRIER	F15	Regulatory environment
381			380	ecosystems are dynamic systems	we know that ecosystems are open dynamic systems, meaning that to alter ecosystem services provided from one defined ecosystem, we may need to alter processes of another ecosystem, but that doing so may affect process flows in yet another ecosystem	ecosystems are dynamic systems	N/A	complex / not complex	DRIVER	N	excluded
382			381	unanticipated feedback and feedforward effects of ecosystems' management decisions	Such cascade effects, which may amplify some services and degrade others throughout the interconnected chain of ecosystems. Managing for one ecosystem service, in other words, has inevitable trade-off impacts [possibly negative] for other ecosystem services. This situation inevitably leads to a difficult question, which service to favour when enhancing one diminishes or enhances another	unanticipated feedback and feedforward effects of ecosystems' management decisions	N/A	significant / not significant	BARRIER	N	excluded
383			382	[ecologists'] ability to describe the trade-offs and synergies	between the indirectly-used ecosystem provisioning services that support ecosystem structure and the directly-used ecosystem regulating service benefits that are supported by ecosystem structure, and to efficiently communicate them to less knowledgeable actors	ecologists' ability to describe the trade-offs and synergies	N/A	sufficient / not sufficient	NEUTRAL	F17	Knowledge generation and understanding
384			383	Ecologists [professional bias]	Ecologists must accept that good ecological analysis in the conventional sense will not suffice to reveal this full dimension of ecosystem services to human populations	Ecologists professional bias	N/A	existent / non-existent	BARRIER	F8	Professional biases
385			384	Ecosystems complex adaptive [nature]	Ecosystems have trajectories that play out over time, like any complex adaptive system, at any point in time there is an array of alternative future trajectories. Which path the ecosystem takes, and how far that path diverges from the previous trajectory, will depend largely on the degree of sensitivity the ecosystem exhibits to changes in conditions [butterfly effect]	Ecosystems complex adaptive [nature]	N/A	significant / not significant	BARRIER	N	excluded
386			385	[need for] a method of economic description of ecosystems	One reliable economic metric—some would say the most relevant measure of economic value—is market price. With knowledge on the good economic sense to provide a compensation and strike bargain [example of pollination services provided by nearby forests] Research providing direct knowledge of the economic benefit value of an ecosystem service is a powerful tool which may prompt natural capital resource owners to initiate negotiated transactions	[need for] a method of economic description of ecosystems	N/A	adequate / inadequate	DRIVER	F24	Nature valuation and impact assessment

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
387	**14 The Law and Policy of Ecosystem Services** Ruhl, John B., Steven E. Kraft, and Christopher L. Lant. The law and policy of ecosystem services. Island Press, 2013.	our economy does not adequately account for the economic value natural resources provide in the form of services	386	Ecosystem services are, for the most part, free for the taking	One does not have to purchase photosynthesis or the radiation screening effects of the ozone layer, and therefore no market price data are available for them.	acquirement of ecosystem services	free	costless / paid	BARRIER	F31	Ecosystems' delimiting challenges and service diffuseness
388			387	sense of urgency to invest in ecosystems	[notion that ecosystem services are economically valuable] We know that without ecosystem services, we all die. Or, more realistically, with widespread degradation of ecosystem services eventually53 some people would die and many others would be substantially worse off. The real question, therefore, is not whether we know that ecosystems are economically valuable, but whether we know how valuable they are compared toother goods and services	sense of urgency to invest in ecosystems	N/A	existent / non-existent	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
389			388	assumption that everyone is engaged in the market to maximize personal gain	[challenge arising from ecosystem services being free] assumption in economic theory, gain of profits by supplying goods and services or gain of satisfaction by paying for them, the strength of this reason to engage in investment for instance, directly influences the probability of involvement of investors	[interest] in engaging in the market to maximize personal gain	N/A	significant / not significant	NEUTRAL	F26	Degree of behavioural resistance
390			389	[in theory] the basic economic model can be applied to ecosystem services	to avoid inefficient resource allocations. n application, however, this model faces numerous obstacles to its fruition in the context of ecosystem services [following factors]	applicability of the economic system to ecosystem services	in theory	in theory / in practice	BARRIER	F24	Nature valuation and impact assessment
391			390	free availability of ecosystem services [public good behaviour]	they are the result of ecosystem processes that operate in open complex ecosystem settings and which deliver services to humans though a myriad of different landscape settings, Even when we know exactly how an ecosystem service is provided and precisely where its natural capital source is located physically, it can be quite difficult to allocate it through the market's "invisible hand" mechanism, would anyone sell or buy photosynthesis? even when someone can control the provision of an ecosystem service, such as the owner of land on which is located a wetland area that provides downstream flood control benefits, whom would the person charge for the service, and how?	availability of ecosystem services	free	free / paid	BARRIER	F31	Ecosystems' delimiting challenges and service diffuseness
392			391	Some services [benefits] are considered [only] positive externalities	An externality is any cost or benefit of production of a good or service that is not borne or enjoyed by the producer. Cost is not borne internally by the producer, the producer does not need to recover it in the market. Resource owners seeking to maximize gain do not take them into account when deciding how to use the resource	[belief] that some ecosystem services are positive externalities	N/A	existent / non-existent	BARRIER	F31	Ecosystems' delimiting challenges and service diffuseness
393			392	some capital owners lack of focus on maximizing individual economic gains	Public entities may pursue policies such as maximizing ecosystem service provision; private entities [land trust] have other goals [ESG principles]	capital owners focused on maximizing individual economic gains	lack of	existent / non-existent	DRIVER	F26	Degree of behavioural resistance
394			393	majority of private owners wish to maximize economic gain	N/A	majority of private owners wish to maximize economic gain	N/A	significant / not significant	BARRIER	F26	Degree of behavioural resistance
395			394	high cost of information in ecosystem service transaction	it would require a tremendous investment of time and resources to generate this kind of direct information about economic value for all ecosystem services in all their delivery settings Additionally the info s unlikely to provide generalized information about the value of wild pollinators for instance [individually applicable]	cost of information in ecosystem service transaction	high	high / acceptable	BARRIER	F16	Cost effectiveness and competitiveness
396			395	[availability] of other methods of value estimation	the avoided cost and replacement cost methods, revealed preference (also known as inferential valuation) methods such as travel costs and hedonic pricing, and stated preference methods such as contingent valuation. There may also be non-economic indicators, such as certain ecological attributes, that could act as surrogates for economic value.	availability of other methods of value estimation	N/A	efficient / not efficient	DRIVER	F24	Nature valuation and impact assessment
397			396	lack of reliability of [alternative] non-market valuation methods for ecosystem services	while the non-market valuation techniques may alleviate the problem of information costs for some cases, they do not take the place of market-based prices as a metric of economic value	reliability of non-market valuation methods for ecosystem services	lack of	sufficient / not sufficient	BARRIER	F24	Nature valuation and impact assessment
398			397	High transaction costs	costs of consummating a transaction such as the purchase of wild pollination may be so high as to offset the efficiency gains so much as to make the transaction not worthwhile to the interested parties. For example, what would happen were the forest area supplying the wild pollination owned not by a single person but by several dozen people in separate parcels. This would complicate the coffee plantation owner's ability to negotiate as each owner would have to be located and separate negotiations may need to be held.	transaction costs	high	high / acceptable	BARRIER	F16	Cost effectiveness and competitiveness
399			398	free rider problem of open-access resources [services]	when resource users interact without the benefit of effective rules limiting access and defining rights and duties, substantial free-riding in two forms is likely: overuse without concern for the negative effects on others, and a lack of contributed resources for maintaining and improving the [resource] itself.	free rider problem of open-access of ecosystem services	N/A	significant / not significant	BARRIER	F31	Ecosystems' delimiting challenges and service diffuseness
400			399	risk moving between scales with limited economic data	Just as with geography, therefore, spatial and temporal scales complicate the description of economic phenomena, with ecosystem services being no exception	risk moving between scales with limited economic data	N/A	significant / not significant	BARRIER	F19	Risk management, metrics and tools
401			400	limited ability to appreciate [awareness] that human populations depends on the biosphere's capacity of continued flow of goods and services	Limited ability to appreciate that the fate of human populations depends on the biosphere's capacity to provide a continued flow of goods and services. Economic theory may provide powerful explanations for why people do not invest in or conserve natural capital resources for ecosystem services provisioning, but it has no answers for what we will do if the services run dry	awareness that human populations depends on the biosphere's capacity of goods and services	limited	limited / not limited	BARRIER	F30	Awareness of nature's importance and sense of urgency to invest
402			401	market value of ecosystem services may not be stable very long into the future	the market value of an ecosystem service at any one moment, and of the natural capital from which it is provided, may not be stable very long into the future. By the time service86 beneficiaries appreciate that the scarcity of natural capital has turned ecosystems from water into diamonds, it may be too late to restore the stock of natural capital in time to turn the services spigot back on.	market value of ecosystem services in the future	unstable	stable/non-stable	BARRIER	N	excluded
403			402	"weak sustainability" premise	The concern of many ecological economists, however, is when assumptions include the so-called "weak sustainability" premise that technological capital can provide perfect substitutes for natural capital	"weak sustainability" premise	N/A	existent / non-existent	BARRIER	N	excluded

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404			403	Formation of property rights and institutional frameworks for common-pool-like resources	to avoid the tragedy of the commons and to provide the means for enforcing excludability within the common-pool resource group. [pp118] a property rights system is the one that legitimately lays claim to being the owner of land or other goods and services, including [1] set of interested that claiming property grants, [2] a system to enforce those interests against other who might contest them, and 3] means of divesting interests, to sell or transfer to others. [pp132] assigning absolute rights in natural capital and ecosystem services is no quick answer to the problem	Formation of property rights and institutional frameworks for common-pool-like resources	N/A	adequate / inadequate	NEUTRAL	N	excluded
405			404	Degradation of ecosystems ant its services supply is likely not to be fully reversible	By the time scarcity alone focuses economic investment on ecosystem services, we may not have sufficient natural capital resources available to provide the services in the quantities demanded, and we may not be able to create enough either.	Degradation of ecosystems and its services supply	not fully reversible	reversible / not reversible	DRIVER	N	excluded
406			405	tragedy of ecosystem services	[only a fool in open-access property rights would voluntarily cede from economical behaviour that enables resource depleting behaviour],its existence depends on three conditions, the property rights, prescriptive state regulation and social norms	tragedy of ecosystem services	N/A	existent / non-existent	NEUTRAL	N	excluded
407			406	need for cooperation [among all those involved] in the creation of a property rights system [for ecosystem services]	If everyone who might contest the right to a particular good or service in question does not agree to abide by the property system, those who refuse might try to exert force to take the bounty. In such a complex networks as the ones ecosystems pose, attaining a high degree of cooperation is challenging to attain.	cooperation in the creation of a property rights system	need for	significant / not significant	NEUTRAL	N	excluded
408			407	market failures	markets don't function smoothly when property rights, assuming the state is enforcing them, are either unclearly defined or unwisely defined. ho would pay for a right if there were no reasonable expectation that anyone else will recognize the right or that the state will enforce it?	market failures	N/A	existent / non-existent	BARRIER	N	excluded
409			408	concerns that the nature of ecosystem services defies assigning property rights and thus no markets for them are possible	pointing to these preliminary concerns, some commentators quickly go so far as to suggest that the challenge is insurmountable, that the very nature of ecosystem services defies assigning property rights, and thus no markets in ecosystem services are possible	concerns that ecosystem services defy the assigning of property rights and establishment of markets	N/A	significant / not significant	BARRIER	N	excluded
410			409	Difficulty in enforcing free-riding	difficult for the state to enforce injunctive or compensatory remedies against property owners who "steal" services	Difficulty in enforcing free-riding	N/A	significant / not significant	BARRIER	N	excluded
411			410	the market works best when everyone acts selfishly	[contradiction for natural capital user on their self-interests with a duty to act reasonably toward each other] due to the nature of ecosystem services	Markets' incentive for selfish behaviours	N/A	significant / not significant	BARRIER	N	excluded
412			411	other kinds of property rights	that harmonize private individual interests and public welfare. Including [pp135] group ownership [co-tenancy, partnerships, corporations, and family owned property],	other kinds of property rights	N/A	available / not available	DRIVER	N	excluded
413			412	The Anti-Ecosystem Bias of [American] Property Law	property law is anything but unclear about a landowner's discretion over the fate of natural capital and ecosystem services. One of the main components of that bias is the neutrality paradigm, that assumes that law neither encourages nor discourages property owners from destroying natural capital. Contemporary common law of property has remained stuck in its nineteenth century anti-wilderness bias	Anti-Ecosystem Bias of Property Law	N/A	significant / not significant	NEUTRAL	N	excluded
414			413	[effective] regulation	To deal with the tragedy of the commons. Mutual coercion, mutually agreed upon by the majority of the people affected.". [pp182] There is different approaches for regulation, an important distinction is the difference between government acting to manage its share of a mixed ownership regime versus government regulating when it has no ownership share in the resource. [pp 195 - 202] assessment of regulations scale	regulation	effective	efficient / not efficient	NEUTRAL	N	excluded
415			414	well-developed social norms	regimes for managing natural capital and ecosystem services in ideal settings such as watersheds, where the management boundaries are clear and the relevant management community is often close-knit	social norms	well-developed	adequate / inadequate	DRIVER	N	excluded
416			415	Existence of man-made substitutes to obtain the same ecosystem services	Are there man-made substitutes that exist or could be developed?	Existence of man-made substitutes to obtain the same ecosystem services	N/A	existent / non-existent	BARRIER	N	excluded
417			416	People adaptation capacity to the absence of ecosystem services	How can and do people adapt to not having certain ecosystem services?	People adaptation capacity to the absence of ecosystem services	N/A	significant / not significant	BARRIER	N	excluded
418			417	winners and losers anytime a market defect is corrected or a public policy alters the economic landscape	[market defects are corrected through improved property rights and information], a cost-benefit analysis of the new et of conditions will demonstrate an overall rise in social welfare but also distributional effects on winners or losers.	creation of winners and losers when market defect correction and policy introduction	N/A	significant / not significant	BARRIER	N	excluded
419			418	transition problems	difficulties moving from the current position [in terms of policy and property rights] to the new position when a powerful set of interests believe their new circumstances will be substantially less advantageous than the status quo	transition problems	N/A	significant / not significant	BARRIER	N	excluded
420			419	financial savings	[cluster: financial motivated criteria] The criteria "initial investment", "financial savings", "running costs" and "return on investment" correlate.	financial savings	N/A	significant / not significant	NEUTRAL	F24	Nature valuation and impact assessment
421			420	Sustainable actions	[cluster: ecological criteria] CO2 savings", "sustainable actions" and "environmental protection" can be summarised as ecological dimensions	Sustainable actions	N/A	significant / not significant	NEUTRAL	F30	Awareness of nature's importance and sense of urgency to invest
422			421	running costs	[cluster: financial motivated criteria] The criteria "initial investment", "financial savings", "running costs" and "return on investment" correlate.	running costs	N/A	significant / not significant	NEUTRAL	F16	Cost effectiveness and competitiveness
423			422	return on investment	[cluster: financial motivated criteria] The criteria "initial investment", "financial savings", "running costs" and "return on investment" correlate.	return on investment	N/A	significant / not significant	NEUTRAL	F24	Nature valuation and impact assessment
424			423	environmental protection	[cluster: ecological criteria] CO2 savings", "sustainable actions" and "environmental protection" can be summarised as ecological dimensions	environmental protection	N/A	significant / not significant	NEUTRAL	F15	Regulatory environment
425			424	CO2 savings	[cluster: ecological criteria] CO2 savings", "sustainable actions" and "environmental protection" can be summarised as ecological dimensions	CO2 savings	N/A	significant / not significant	NEUTRAL	F29	Modelling climate change scenarios
426			425	Current support programmes	[cluster: inner and outer driver] "current support programmes" and "personal impression" correlate	Current support programmes	N/A	existent / non-existent	NEUTRAL	F27	Enabling institutional environment and policies for NBS

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
427	15 A local-level, multiple criteria decision aid for climate protection Markl-Hummel, Lioba, and Jutta Geldermann. "A local-level, multiple criteria decision aid for climate protection." EURO Journal on Decision Processes 2.1-2 (2014): 121-152.	Multilateral development banks (MDBs) have committed to aligning their operations with the Paris Agreement. A crucial aspect of this is the alignment of all future investments with the global warming limit set in Paris, namely to limit average temperature rise to well below 2°C and pursue efforts to limit it to 1.5°C (the "Paris temperature goal")	426	Local resources	N/A	Local resources	N/A	available / not available	NEUTRAL	F27	Enabling institutional environment and policies for NBS
428			427	Acceptability citizens	[cluster: local context] The criteria ''acceptability citizens'', ''potential of mobilisation'', ''effort for implementation'', ''short-term action'', ''local promotion of economic development'' and ''local socio-cultural factors'' refer to the importance of the local context.	Acceptability citizens	N/A	sufficient / not sufficient	NEUTRAL	F26	Degree of behavioural resistance
429			428	Effort for implementation	[cluster: local context] The criteria ''acceptability citizens'', ''potential of mobilisation'', ''effort for implementation'', ''short-term action'', ''local promotion of economic development'' and ''local socio-cultural factors'' refer to the importance of the local context.	Effort for implementation	N/A	significant / not significant	NEUTRAL	F7	Long-term agenda alignment, trust, and transparency among stakeholders
430			429	Initial investment	[cluster: financial motivated criteria] The criteria ''initial investment'', ''financial savings'', ''running costs'' and ''return on investment'' correlate.	Initial investment	N/A	high / acceptable	NEUTRAL	F16	Cost effectiveness and competitiveness
431			430	Multiplier effects	N/A	Multiplier effects	N/A	significant / not significant	NEUTRAL	N	excluded
432			431	Local promotion of economic development	[cluster: local context] The criteria ''acceptability citizens'', ''potential of mobilisation'', ''effort for implementation'', ''short-term action'', ''local promotion of economic development'' and ''local socio-cultural factors'' refer to the importance of the local context.	Local promotion of economic development	N/A	significant / not significant	NEUTRAL	F27	Enabling institutional environment and policies for NBS
433			432	Personal impression	[cluster: inner and outer driver] ''current support programmes'' and ''personal impression'' correlate	Personal impression	N/A	positive / negative	NEUTRAL	F26	Degree of behavioural resistance
434			433	short-term action	[cluster: local context] The criteria ''acceptability citizens'', ''potential of mobilisation'', ''effort for implementation'', ''short-term action'', ''local promotion of economic development'' and ''local socio-cultural factors'' refer to the importance of the local context.	short-term action	N/A	short-term / long-term	NEUTRAL	F26	Degree of behavioural resistance
435			434	potential of mobilisation	[cluster: local context] The criteria ''acceptability citizens'', ''potential of mobilisation'', ''effort for implementation'', ''short-term action'', ''local promotion of economic development'' and ''local socio-cultural factors'' refer to the importance of the local context.	potential of mobilisation	N/A	sufficient / not sufficient	NEUTRAL	F11	Investors' capital allocation features and requirements
436			435	local socio-cultural factors	[cluster: local context] The criteria ''acceptability citizens'', ''potential of mobilisation'', ''effort for implementation'', ''short-term action'', ''local promotion of economic development'' and ''local socio-cultural factors'' refer to the importance of the local context.	local socio-cultural factors	N/A	significant / not significant	NEUTRAL	F26	Degree of behavioural resistance
437	16 MDB working paper Germanwatch & NewClimate Institute (2018). Aligning investments with the Paris Agreement Temperature Goal – Challenges and Opportunities for Multilateral Development Banks. Cologne/Bonn/Berlin	Global investments in infrastructure need to increase in the near future to enable social and economic development, particularly in poorer countries.	436	long lifetime of infrastructure investments	decisions taken today will have a decisive impact on long-term emission trends	lifetime of infrastructure investments	long	too long / normal	BARRIER	N	excluded
438			437	differences in how to achieve that overall objective	N/A	differences in how to achieve that overall objective	N/A	significant / not significant	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
439			438	Consumption patterns	have a substantial impact on how costly the transition will be	Consumption patterns	N/A	adequate / inadequate	NEUTRAL	N	excluded
440			439	[need for] the development of instrument-specific methodologies for GHC accounting	These methodologies are not yet available to measure the GHC of the intended projects. GHC should be publicly disclosed. Emissions standards and shadow carbon pricing are useful to ensure Paris-alignment of investments	development of instrument-specific methodologies for GHC accounting	lack of [need of]	available / not available	BARRIER	F32	Blended finance
441			440	MDBs [critical role] in climate risk management and policies	multi development banks should accompany their clients in setting up and strengthening climate risk management systems and aligning policies, procedures and regulations. Client reporting on climate risks using standardized indicators should become mandatory.	MDBs role in climate risk management and policies	critical	critical / not critical	NEUTRAL	F19	Risk management, metrics and tools
442			441	improving transparency on climate-related risks and opportunities of investments	Forward-looking disclosure of climate-related risks and opportunities, can also be an important driver toward better understanding and management of those risks. [not yet present] [pp90] Whether a PPF is involved in project preparation or also responsible for strengthening domestic institutional capacity	transparency on risks and opportunities of investments	[improving] lack of [still]	sufficient / not sufficient	DRIVER	F28	Information on NBS
443			442	critical role finance plays in the global response to the climate crisis	The international community has explicitly recognized the critical role finance plays in the global response to the climate crisis.	role finance plays in the global response to the climate crisis	critical	critical / not critical	NEUTRAL	F30	Awareness of nature's importance and sense of urgency to invest
444			443	involvement of MDBs [multi development banks] in climate change investments	MDBs are often lead investors that bring in other, private investors, to invest alongside them, thus leveraging significant amounts of private capital. The banks can also set standards, in terms of the kind of projects they invest in or the safeguards and standards they apply - that will often be replicated by other financial institutions.	involvement of MDBs [multi development banks] in climate change investments	N/A	existent / non-existent	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
445			444	Consumption patterns	[demand and supply] consumption patterns will have a massive impact on how costly the transition will be	Consumption patterns	N/A	significant / not significant	NEUTRAL	N	excluded
446			445	Assumptions underlying the [climate change] [global] scenarios	vary considerably and are reflected in diverting outcomes [and assessment tools],	Assumptions underlying the CC global scenarios	N/A	accurate / not accurate	BARRIER	F29	Modelling climate change scenarios
447			446	risk of stranded assets	Stranded assets refer to resources that are no longer able to produce an economic return prior to the end of their economic or physical lifetime due to changes associated with a transition	risk of stranded assets	N/A	significant / not significant	BARRIER	F25	Financial risks
448			447	lock-in risk	investment decisions that create system inertia and barriers to the introduction of low carbon alternatives despite economic or environmental advantages. It is mainly relevant for assets with a long lifetime where such investments prevent a policy change to enable more advantageous technologies to enter the system later on	lock-in risk	N/A	lock-in risk	BARRIER	F27	Enabling institutional environment and policies for NBS
449			448	[existence of] negative/ positive lists	Negative lists define projects and technologies which banks choose not to finance and are therefore very straightforward to implement and monitor. [pp94] global emphasis on reporting not only positive investments in climate-related activities, but also the risks that investments face from the changing climate, informed by forward-looking climate-related scenarios	negative lists	existence of	existent / non-existent	NEUTRAL	F4	Ratings, indices and listings
450			449	lack of CC-projects quantitative data	The lack of data also prohibits a thorough assessment of the quantitative role of FI [financial intermediaries] lending for climate finance [projects]	CC-project data	lack of	existent / non-existent	BARRIER	F28	Information on NBS
451			450	Lack of financial resources, personnel and technical expertise on client side	Need for additional TA and grants to support clients in setting up/strengthening climate impact management systems, aligning policies and procedures, monitoring and reporting on impacts	financial resources, personnel and technical expertise on client side	lack of	sufficient / not sufficient	BARRIER	F17	Knowledge generation and understanding
452			451	[lack of] Incentivize ambition and long-term cooperation	Incentivize ambition raising in prospect of future to attain CC	long-term cooperation	lack of	sufficient / not sufficient	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
453			452	publicly available information	N/A	information	[lack of]	existent / non-existent	BARRIER	F28	Information on NBS

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454			453	high costs of finding and developing bankable sustainable projects	Project costs could increase due to consideration of Paris alignment	high costs of finding and developing bankable sustainable projects	N/A	high / acceptable	BARRIER	F16	Cost effectiveness and competitiveness
455			454	availability of concessional funding from international funds	leveraging more capital from other financial institutions or from the private sector, are important tools to encourage the client's decision to integrate climate considerations into projects	availability of concessional funding from international funds	N/A	available / not available	DRIVER	F12	Funding sources
456			455	climate change vulnerability [of the project]	N/A	climate change vulnerability of the project	N/A	vulnerable / not vulnerable	BARRIER	F18	NBS-specific features and risks
457			456	transition risk	the financial risks which could result from the process of adjustment towards a lower-carbon economy, i.e. policy risks, legal, risks, technology risks, market risks, and reputational risks	transition risk	N/A	significant / not significant	BARRIER	F27	Enabling institutional environment and policies for NBS
458			457	physical risk	he impact on insurance liabilities and the value of financial assets that may arise from climate and weather-related events, differentiated by acute risks and chronic risks	physical risk	N/A	significant / not significant	BARRIER	F5	Physical risks and damages related to climate change
459			458	financial voluntary and consistent' disclosure framework	that comprises four key dimensions: governance, strategy, risk management, and metrics and targets. The framework is supposed to be implemented by all organizations with public debt, and also by asset managers and asset owners. The framework provides supplemental guidance for the financial sector and for those non-financial sectors likely to be especially affected by climate change	financial voluntary and consistent' disclosure framework	N/A	efficient / not efficient	DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
460			459	risk management	process used by executive to identify, assess and manage climate-related risks	risk management	N/A	adequate / inadequate	DRIVER	F19	Risk management, metrics and tools
461	17 2018 Global Investor Survey: Anxious optimism in a complex world	We asked the two groups for their opinions on growth prospects in a disruptive environment, the effects of globalisation and the threats that companies face today.	460	Investors and CEOs are more confident about global outlook than they were last year	answer to a survey with the following question: Do you believe global economic growth will improve, stay the same or decline over the next months. Answers from investors particularly, range from 54% improve, 33% stay and 11% worsen. In comparison with last years values [45%, 34% and 19% respectively]	investors' confidence about global outlook for the coming year	[increased]	sufficient / not sufficient	DRIVER	N	excluded
462			461	variety of concerns for investors	to answer the question for investors: how concerned are you, if at all, about the following potential business, economic, policy, social and environmental threats to [your] company growth prospects?	variety of concerns for investors	N/A	significant / not significant	BARRIER	N	excluded
463			462	geopolitical uncertainty	investors' concern	geopolitical uncertainty	N/A	significant / not significant	BARRIER	N	excluded
464			463	over-regulation	investors' concern	over-regulation	N/A	high / acceptable	BARRIER	N	excluded
465			464	availability of key skills	of inverstors [of executing parties in terms of the investments]	key skills	availability of	available / not available	NEUTRAL	N	excluded
466			465	climate change and environmental damage	investors concern [avoiding]	climate change and environmental damage	N/A	significant / not significant	DRIVER	N	excluded
467			466	changing workforce demographics	investors' concern	workforce demographics	changing	significant / not significant	BARRIER	N	excluded
468			467	increasing tax burden	investors' concern	tax burden	increasing	high / acceptable	BARRIER	N	excluded
469			468	uncertain economic growth	investors' concern	economic growth	uncertain	certain / uncertain	BARRIER	N	excluded
470			469	exchange rate volatility	investors' concern	exchange rate volatility	N/A	significant / not significant	BARRIER	N	excluded
471			470	globalisation	investment professionals think that globalisation has helped some aspects of doing business: the ease of moving capital, people, goods and information and enabling universal connectivity, while also having negative effects such as: averting climate change and resource scarcity and closing the gap between the rich and poor. This is unchanged from last year	globalisation	N/A	significant / not significant	NEUTRAL	N	excluded
472			471	focus in the short-term	Increasing pressure to deliver business results under shorter timelines	focus in the short-term	N/A	short-term / long-term	BARRIER	N	excluded
473			472	lack of trust	between workforce and organisations leadership, from customers and between companies and governments	trust	lack of	existent / non-existent	BARRIER	N	excluded
474			473	countries' voluntary plan or intended nationally determined contribution [INDC] are slow to play out	take a long time to become relevant	INDC implementation slowness	N/A	slow / fast	BARRIER	N	excluded
475			474	infrastructure high sensitivity to local politics	Because infrastructure has strong public-good characteristics, typically requires large-scale capital mobilization	sensitivity to local politics	high	high / acceptable	BARRIER	F23	Political and economic landscape
476			475	A positive enabling environment	one characterized by sound policies, effective institutions, transparency, reliable contract enforcement, and other sector-specific factors, which makes it easier to mobilize private finance.	enabling environment	positive	positive / negative	DRIVER	F27	Enabling institutional environment and policies for NBS
477			476	sound policies	[vital for a positive enabling environment for private investment]	policies	sound [adequate]	adequate / inadequate	DRIVER	F27	Enabling institutional environment and policies
478			477	effective institutions	[vital for a positive enabling environment for private investment]	institutions	effective	effective / not effective	DRIVER	F27	Enabling institutional environment and policies
479			478	transparency	[vital for a positive enabling environment for private investment]	transparency	N/A	existent / non-existent	DRIVER	F7	Long-term agenda alignment, trust, and
480			479	reliable contract enforcement	[vital for a positive enabling environment for private investment]	contract enforcement	reliable	reliable / unreliable	DRIVER	F15	Regulatory environment
481			480	distorting subsidies	[cause for a poor environment for private investment] can raise the cost of private finance to the point where infrastructure projects are no longer economically viable	subsidies	distorting [inadequate]	adequate / inadequate	BARRIER	F27	Enabling institutional environment and policies for NBS
482			481	unreliable counterparties	[cause for a poor environment for private investment] can raise the cost of private finance to the point where infrastructure projects are no longer economically viable	counterparties	unreliable	reliable / unreliable	BARRIER	F7	Long-term agenda alignment, trust, and transparency among stakeholders
483			482	flawed procurement processes	[cause for a poor environment for private investment] can raise the cost of private finance to the point where infrastructure projects are no longer economically viable	procurement processes	flawed [inadequate]	adequate / inadequate	BARRIER	F15	Regulatory environment
484			483	lack of transparent and bankable pipelines	N/A	transparency and bankable pipelines	lack of	existent / non-existent	BARRIER	F17	Knowledge generation and understanding
485			484	High development and transaction costs	projects do not naturally generate the economies of scale that can keep costs down. To tackle increase syndication of loans that finance sustainable infrastructure projects and, adapt financial instruments to sustainable infrastructure and increase liquidity	development and transaction costs	High	high / acceptable	BARRIER	F16	Cost effectiveness and competitiveness
486			485	Lack of viable funding models	resources [i.e. water] are leaked, unmetered, or stolen; therefore not enough revenue is generated to maintain or expand the system	funding models	lack of	existent / non-existent	BARRIER	F32	Blended finance
487			486	Inadequate risk-adjusted returns	Investors may be willing to take on sustainable infrastructure but want higher returns to compensate them for the perceived risks. Infrastructure projects are also notoriously prone to corruption, creating significant additional risks	risk-adjusted returns	inadequate	adequate / inadequate	BARRIER	F24	Nature valuation and impact assessment
488			487	Unfavourable and uncertain regulations and policies	Basel III and Solvency II regulations could have the effect of reducing investment in infrastructure at the global level; uncertain tax policies can do the same at the national level	regulations and policies	uncertain	certain / uncertain	BARRIER	F15	Regulatory environment
489			488	underlying institutional performance	especially around procurement practices, will boost confidence for investors	underlying institutional performance	N/A	sufficient / not sufficient	DRIVER	F27	Enabling institutional environment and policies for NBS
490			489	exchange-rate movements	particularly important in regard to cross border finance	exchange-rate movements	N/A	significant / not significant	NEUTRAL	N	excluded

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
491	18 Financing change: How to mobilize private-sector financing for sustainable infrastructure Bielenberg, Aaron, et al. "Financing change: How to mobilize private-sector financing for sustainable infrastructure." McKinsey Center for Business and Environment (2016).		490	project economic benefits and costs [proportion]	every project needs to fulfil a social need with economic benefits that are greater than the project costs. If these conditions are not met (at least to a first approximation), no amount of fine-tuning the design of financial instruments will make a difference in changing the risk perceptions of private investors.	proportion of project economic benefits and costs	N/A	bankable / not bankable	NEUTRAL	F16	Cost effectiveness and competitiveness
492			491	investors are sceptical about sector and asset classes that they are unfamiliar with	where they perceive high political risks or project failure	Investors' scepticism about sector and asset classes they are unfamiliar with	N/A	significant / not significant	BARRIER	F26	Degree of behavioural resistance
493			492	Scale up investment in sustainable project preparation and pipeline development.	focus investment on project-preparation facilities and technical assistance to increase the "bankability" of project pipelines (meaning those that have an attractive economic profile). This is the highest-risk phase of the project life cycle; it is critical to get right.	need to increase investment in sustainable project preparation and pipeline development	N/A	significant / not significant	NEUTRAL	F1	Scale and minimal optimal size of the project
494			493	demonstrating that risk-adjusted returns can be competitive with those of traditional infrastructure	to attract private-sector financing	[sustainable] risk-adjusted returns competitiveness	N/A	significant / not significant	DRIVER	F16	Cost effectiveness and competitiveness
495			494	Increase guarantee programs for sustainable infrastructure	Improve the capital markets for sustainable infrastructure by encouraging the use of guarantees [expanding access to guarantees], this could help overcome the policy-sensitivity of these investments, reducing risks for private investors	[availability] of guarantee programs for sustainable infrastructure	N/A	available / not available	DRIVER	F27	Enabling institutional environment and policies for NBS
496			495	sustainability criteria in procurement	Encourage the use of sustainability criteria in procurement. Governments should strengthen sustainability criteria in both public procurement processes and public-private partnerships.	sustainability criteria in procurement	N/A	existent / non-existent	DRIVER	F15	Regulatory environment
497			496	creation of a larger secondary market for sustainable-related securities	Increase syndication of loans that finance sustainable-infrastructure projects. This would increase institutional-investor familiarity with the asset class, reduce transaction costs, and allow the recycling of development capital.	larger secondary market for sustainable-related securities	N/A	existent / non-existent	DRIVER	F21	Secondary market
498			497	Adapt financial instruments to channel investment to sustainable infrastructure and enhance liquidity.	"Yieldcos" or "green bonds" have characteristics similar to traditional investment instruments, but with an emphasis on sustainability. Increasing use of these instruments could unlock investment from previously restricted investors, lower transaction costs, and reduce barriers to entry	adaptation of financial instruments to channel investment to sustainable infrastructure and enhance liquidity	N/A	adapted / not adapted	DRIVER	F32	Blended finance
499			498	[existence of] risk-sharing instruments	muscular set of nudges and risk-sharing instruments are required: they can shift perceptions and get capital to flow	risk-sharing instruments	existence of	existent / non-existent	DRIVER	F19	Risk management, metrics and tools
500			499	sustainable infrastructure demand	The productivity of infrastructure development and the model by which infrastructure services are delivered also affect demand	sustainable infrastructure demand	N/A	sufficient / not sufficient	NEUTRAL	F22	Market size
501			500	Business-as-usual scenario in infrastructure expansion could lead to a 6-degree Celsius rise in temperature	[high sense of urgency to change current trends] The business-as-usual scenario assumes infrastructure expansion that keeps pace with growth that could lead to a 6-degree Celsius rise in temperatures above preindustrial levels	[continuing current] infrastructure development trends will lead to a high temperature rise	N/A		DRIVER	F30	Awareness of nature's importance and sense of urgency to invest
502			501	combined pools of capital from different entities to meet demand	Institutional investors can be divided into eight groups based on motivation, risk profile, and regulatory status: [1] banks, [2] investment companies, [3] insurance companies and private pensions, [4] public pensions and superannuation plans, [5] sovereign-wealth funds, [6] infrastructure operators and developers, [7] infrastructure and private funds, [8] endowments and foundations. [pp19] Combining different pools of capital can lower the weighted average cost of capital (WACC) for projects by trading more expensive capital in riskier stages (construction) for less expensive capital in stages with steady cash flows (operations)	[possibility to] use combined pools of capital from different entities	N/A	possible / not possible	DRIVER	F32	Blended finance
503			502	[institutional investors] shared/similar strategies, preference and regulation	Investment companies, insurance companies, and pension funds share similar strategies and preferences, and are subject to similar levels of regulation; together, they represent more than 31 percent of global assets under management	[institutional investors'] strategies, preference and regulation	shared / similar	significant / not significant	DRIVER	F26	Degree of behavioural resistance
504			503	requirement for liquidity	of business models to meet ongoing customer obligations	requirement for liquidity	N/A	significant / not significant	BARRIER	F11	Investors' capital allocation features and requirements
505			504	[similar] low correlations on other assets	renewable energy investments can be inflation linked and provide long-term steady cash flow [positive for portfolio diversification purposes]. For example, 4 danish pension funds, the Canadian institutional-fund manager and Allianz, a German insurer made significant investments in projects for their 'horizon of at least 25 years . . . and these yields are also totally uncorrelated with the ups and downs of the financial markets.	correlation with other assets of similar investments	low	low / high	DRIVER	F16	Cost effectiveness and competitiveness
506			505	[recent] restrictive requirements	under Basel III.	requirements	restrictive	restrictive / permissive	BARRIER	N	excluded
507			506	similar investments have long-term steady cash flow	renewable energy investments can be used as a reference	long-term cash flow of similar investments	steady	steady / not steady	DRIVER	F16	Cost effectiveness and competitiveness
508			507	private-equity funds achieving significant returns in sustainable infrastructure	private-equity and infrastructure funds invest heavily in unlisted assets, creating successful experiences [high returns] of private investors in this type of investments	returns for private-equity funds investing in sustainable infrastructure	significant	significant / not significant	DRIVER	F16	Cost effectiveness and competitiveness
509			508	[availability] unsolicited bidding [procurement]	sustainable-infrastructure projects to governments via unsolicited bids can differentiate their proposals and help governments meet dual objectives	availability of unsolicited bidding	N/A	available / not available	DRIVER	F15	Regulatory environment
510			509	sustainable infrastructure require higher up-front capital	[p33] For example, an analysis of the economics of new green districts within cities found that construction generally cost 8 to 10 percent more.	up-front capital requirement of sustainable infrastructure	higher	high / acceptable	BARRIER	F16	Cost effectiveness and competitiveness
511			510	sustainable infrastructure require higher up-front capital and take long to pay back	for sustainable-infrastructure projects payback often comes later than in traditional projects	payback period of sustainable infrastructure	long	long / acceptable	BARRIER	N	excluded
512			511	[investors'] focus on equity investing	likely due to the fact that infrastructure debt has traditionally been the focus of a small group of major international commercial banks	investor's focus on equity investing	N/A	existent / non-existent	BARRIER	F11	Investors' capital allocation features and requirements
513			512	[shortage] of capital supply for early project stages	where there is often a lack of contractual or regulatory certainty	shortage of capital supply for early project stages	N/A	significant / not significant	BARRIER	F11	Investors' capital allocation features and requirements
514			513	investor's [worry] to invest in cross-boundary investments	[investment in other geographical areas] investors worry that they do not understand the physical environment, government policies, or overall business climate outside their home region. Also geographic distance increases, project management and delivery become more complex.	investor's worry for cross-boundary investments or investment in other geographical regions	N/A	significant / not significant	BARRIER	F26	Degree of behavioural resistance

	A	B	C	D	F	G	I	J	K	M	N
1	source	summary	numbering	original excerpt	interpretation	root concept [subject/noun]	attribute [adjective]	[attribute] binary assessment	connotation in paper	FX2 factor	Name
515			514	[lack of] domestic investment in sustainable-infrastructure projects	Domestic investment is critical for closing the sustainable-infrastructure gap. Domestic investment often has lower transaction costs because investors are more familiar with the country context and can avoid currency risk. Most demand for infrastructure from 2015 to 2030 will come from middle-income countries, so it is specially important to boost domestic participation tailored for investors in middle and lower income countries [80% of AUM, assets under management in these countries are managed by SWFs, banks , pensions and insurance companies]	domestic investment in sustainable-infrastructure projects [specially in middle-income countries]	lack of	sufficient / not sufficient	BARRIER	F3	Level of domestic and international investment
516			515	PPPs can reduce private investors' perception of policy risks	Since public investment signals genuine government commitment to the project. PPPs constitute 22% of overall flows in infrastructure for middle-income countries	PPPs reduction capacity of investors 'policy risks	N/A	significant / not significant	BARRIER	F26	Degree of behavioural resistance
517			516	[minimum] required real rates of return on total capital for companies tied to infrastructure	On average, companies whose businesses are tied to infrastructure assets require real rates of return on total capital employed of 5 to 10 percent for new investments: 5 to 6 percent for power and water utilities, 7 to 8 percent for energy companies, and 9 to 10 percent for engineering and construction companies.	real rates of return on total capital for companies tied to infrastructure	required	restrictive / permissive	BARRIER	F24	Nature valuation and impact assessment
518			517	corporate leadership that can resist short-terminist	to take a full life-cycle view, for example, by considering climate-related risks	corporate leadership's resistance to short-terminism	N/A	short-term / long-term	DRIVER	F26	Degree of behavioural resistance
519			518	Infrastructure investments' multitude of benefits	Infrastructure investments offer diversification, liability hedging, long-term horizons, fixed income, and stability. Sustainable-infrastructure, in addition, are characterized by faster construction and lower operation costs	Infrastructure investments' multitude of benefits	N/A	sufficient / not sufficient	DRIVER	F9	Multitude of functions and services and their challenges
520			519	[lesser] capital requirements in the back end	Even without factoring in environmental benefits, project costs were paid back within three to five years because of lower operating costs [back end]	capital requirements in the back end	lesser	significant / not significant	DRIVER	F16	Cost effectiveness and competitiveness
521			520	users unwillingness or incapability to pay high enough charges	enough to allow full cost recovery plus a return on investment. For example, in some sub-Saharan African countries, up to 70 percent of water does not result in revenue because it is leaked, unmetered, or stolen	users unwillingness or incapability to pay high enough charges	N/A	existent / non-existent	BARRIER	F30	Awareness of nature's importance and sense of urgency to invest
522			521	fiscal risk	specially in highly subsidized infrastructure like water infrastructure	fiscal risk	N/A	significant / not significant	BARRIER	F27	Enabling institutional environment and policies for NBS
523			522	Unfavourable and uncertain regulations and policies	Regulations on investment limits, capital adequacy, reserve requirements, the valuation of assets and liabilities, and limits on foreign investment can discourage investors from making longer-term and cross-border investments. I.e. Basel III discourages mismatches in the maturity of assets and liabilities, which makes it harder for banks to issue long-term debt	regulations and policies	unfavourable	favourable / unfavourable	BARRIER	F15	Regulatory environment
524											
525			ID	Umbrella concept	Category						
526			F1	Scale and minimal optimal size of the project	A. Investments / NBS / Project features			Excluded factors [after second filter]		72	
527			F2	Adequate asset management expertise	B. Asset management						
528			F3	Level of domestic and international investment	C. Markets for natural / sustainability /green vehicles						
529			F4	Ratings, indices and listings	C. Markets for natural / sustainability /green vehicles						
530			F5	Physical risks and damages related to climate change	D. Risks and metrics						
531			F6	Developing / implementing community capacity	F. Networks						
532			F7	Long-term agenda alignment, trust, and transparency among stakeholders	F. Networks						
533			F8	Professional biases	F. Networks						
534			F9	Multitude of functions and services and their challenges	G. Investment returns and benefits						
535			F10	Information asymmetry	H. Information						
536			F11	Investors' capital allocation features and requirements	J. Investors / banks						
537			F12	Funding sources	L. Policy, regulation, subsidies and incentives						
538			F13	Historical funding strategies	L. Policy, regulation, subsidies and incentives						
539			F14	Governance	L. Policy, regulation, subsidies and incentives						
540			F15	Regulatory environment	Mixed						
541			F16	Cost effectiveness and competitiveness	Mixed						
542			F17	Knowledge generation and understanding	Mixed						
543			F18	NBS-specific features and risks	Mixed						
544			F19	Risk management, metrics and tools	Mixed						
545			F20	Market maturity level	Mixed						
546			F21	Secondary market	Mixed						
547			F22	Market size	Mixed						
548			F23	Political and economic landscape	Mixed						
549			F24	Nature valuation and impact assessment	Mixed						
550			F25	Financial risks	Mixed						
551			F26	Degree of behavioural resistance	Mixed						
552			F27	Enabling institutional environment and policies for NBS	Mixed						
553			F28	Information on NBS	Mixed						
554			F29	Modelling climate change scenarios	Mixed						
555			F30	Awareness of nature's importance and sense of urgency to invest	Mixed						
556			F31	Ecosystems' delimiting challenges and service diffuseness	Mixed						
557			F32	Blended finance	Mixed						
558			N	excluded	n/a						
559											