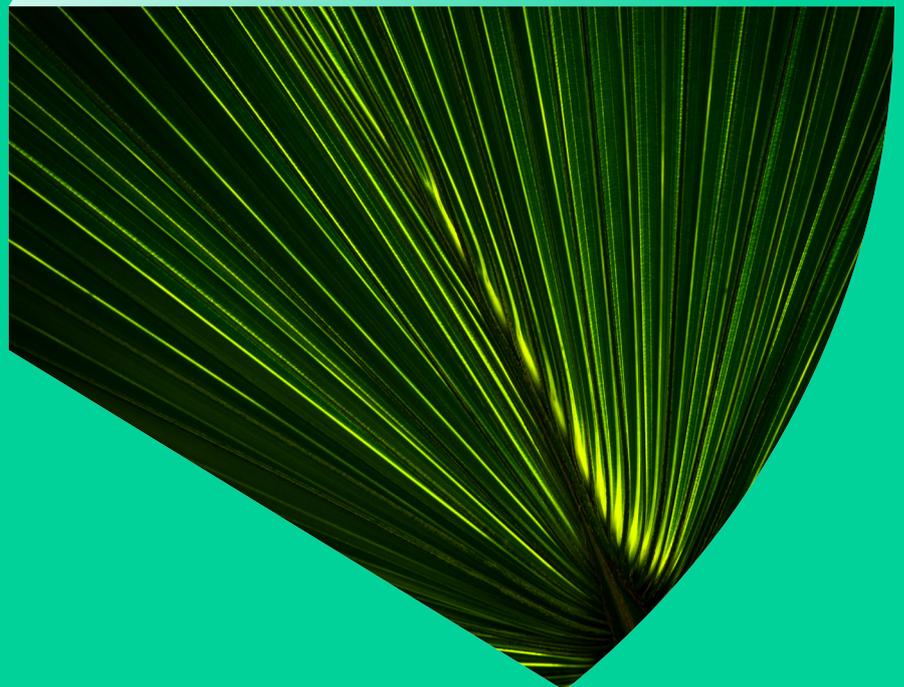


Green bonds: a mechanism for bridging the adaptation gap?

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Acronyms

ABS	Asset-backed securities
CBI	Climate Bonds Initiative
GBPs	Green Bond Principles
ICMA	International Capital Market Association
INDCs	Intended Nationally Determined Contributions
IFC	International Finance Corporation
MSMEs	Medium-sized, small and micro-enterprises
NDCs	Nationally Determined Contributions
NGFS	Network for Greening the Financial System
UNFCCC	United Nations Framework Convention on Climate Change

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1. Introduction

This paper aims to clarify the role of green bonds in financing adaptation and resilience. There is a significant need for investment in adaptation. Green bonds are often referred to as a potential contributor to filling the adaptation finance gap, specifically in terms of channelling private sector finance to adaptation. Less discussed, however, are the roles they play or could play in financing adaptation to meet those aims. Looking more closely at green bond data can help us to set more realistic expectations for the tool and identify ways to make it more useful for investing in adaptation and resilience.

The climate finance gap is internationally recognized as a critical issue for society to overcome in order to meet the future challenges presented by climate change. Estimates of the total amount of investment needed to meet this challenge vary greatly between US\$580 billion and \$6 trillion annually (Nicol et al. 2018). Estimates on adapting to the impacts of climate change in the period 2010–2050 start at \$70 billion (IPCC 2014b; IPCC 2014a).¹ Green Bonds are a debt instrument used to fund projects that meet certain environmentally friendly criteria. They have been promoted as a mechanism that can bring in private funding to support both adaptation and mitigation. According to the former UN climate chief, Christiana Figueres, annual green bond issues need to reach \$1 trillion by 2020 to meet the goals set out in the 2015 United Nations Framework Agreement of Climate Change (UNFCCC) Paris Agreement (Darby 2018). Current estimates put green bond issuance in 2019 at \$250 billion (CBI 2019c). However, as with climate finance trends overall (Buchner et al. 2017), mitigation receives about 95% of current green bond funding. There are differing views on whether green bonds have the potential to scale-up adaptation.

This working paper looks more closely at the potential for green bonds to scale-up financing for adaptation and resilience. It compares adaptation² needs against historical levels of green bond issuance to explore the potential for green bonds to meet those needs. In order to do so, Section 2 establishes a baseline for global adaptation needs and sets out private sector involvement in these areas or sectors of need. The focus is on the role of the private sector because the large gaps in adaptation and resilience financing highlight the need to scale-up private investment in these areas. Section 3 introduces green bonds as a financing tool and explores their capacity as a vehicle for private sector financing of adaptation. Section 4 analyses the data on green bond issues, and assesses the level of adaptation green bond finance and in which sectors adaptation green bonds are found. Section 5 considers the potential limitations of increasing the capacity for private sector green bonds to fill the adaptation gap. The discussion and conclusions propose some open questions for further research and are followed by policy recommendations on how to improve green bonds as an adaptation-related financing tool.

The study finds that green bonds finance adaptation, but only to a very limited extent. The challenges linked to the use of green bonds to invest in adaptation are the same as those presented by other private sector finance tools. However, these have less to do with green bonds as a mechanism, and more to do with the nature of those investments, the limits of the market and the current level of risk awareness. Efforts should be made to increase the development of projects that are appropriate for green bonds, such as revenue-generating, large-scale or poolable projects and projects that focus on hard adaptation components, but also to complement these with the necessary soft components. In addition, regions or countries with developed bond markets must act first, which would help regions with nascent or emerging green bond markets to more quickly incorporate adaptation financing into the market than has been the case to date.

If the financial sector begins to push and mechanisms for accounting for climate risk take off, green bonds could become a more commonly used mechanism. In the meantime, however, green bonds can raise awareness of climate risks among issuers and investors. The review processes associated

¹ This study only covers the specific sectors of agriculture, forestry, fisheries, infrastructure, water resources, health, coastal areas and extreme weather events (IPCC 2014b; IPCC 2014a).

² The author recognizes that there is a difference between the terms adaptation and resilience. However, as the terms are used synonymously in the field of green bonds and finance. This report mainly discusses adaptation as it is a green bonds project category, but also uses the terms employed in the various texts that are referenced.

with green bonds could enable corporations exposed to climate risk to increase their awareness of such risks. Risk awareness is likely to lead to risk management and may eventually lead to increased investment in adaptation. In order to encourage the use of green bonds under existing limitations, climate risk awareness should be increased using the green bond review processes, among other things, and guidance on including adaptation in green bonds should be improved.

2. Adaptation gap

In order to assess the extent to which green bonds can contribute to financing the adaptation gap, it is important to understand the extent of adaptation needs and the role of the private sector. The Paris Agreement sets a global goal on adaptation, which the UNFCCC defines as: “enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change...” (United Nations 2015, p.3). The global annual adaptation costs of a select group of sectors were originally estimated to be in the range of \$70 billion to \$100 billion between 2010 and 2050 (IPCC 2014b; IPCC 2014a). Later national and sector reviews indicated that the annual costs in developing countries alone could be 2–3 times that figure by 2030 (\$140–300 billion annually) and 4–5 times that by 2050 (\$280–500 billion annually) (UNEP 2016a). Total finance for adaptation needs to grow to 12–22 times current levels to meet future needs (UNEP 2016a). The public sector traditionally funds adaptation as it is within its remit to ensure long-term societal functioning, which includes adaptation to climate change. However, the investment amounts required overall are beyond what public authorities are able to finance. Furthermore, the private sector plays an important role in societal resilience. Thus, the private sector needs, and is expected, to contribute (Clark et al. 2018; CISL 2016; GARI Group 2016; Barysh et al. 2014; UNEP 2016b; Pauw, Kelin et al. 2016; OECD 2015; Bernasconi 2015).

2.1 Critical areas for adaptation investment

The changing climate requires societal adjustments and new investments globally across all sectors. Leading up to the Paris Agreement, countries submitted Intended Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCCC), which specified their post-2020 voluntary national climate targets. Of these, 85% (100 of the 119) contained an adaptation component.³ These INDCs are converted to Nationally Determined Contributions (NDCs) once countries sign the Paris Agreement, unless a country intends to formulate a new NDC.⁴ Of the 31 NDCs submitted by low income countries, close to 65% make their adaptation contribution at least partly conditional on the availability of international adaptation finance (Pauw, Cassanmagnano et al. 2016). These NDCs reflect the actions planned across all sectors or areas of the economy, but water resources, agriculture, health, ecosystems and forestry are given high priority (UNFCCC 2016). The ecosystem is not a sector in itself, but rather an area of investment.⁵ The NDCs highlighted the synergies between mitigation and adaptation in the agriculture and forestry sectors in particular, meaning that investments in these sectors would have multiple benefits. Furthermore, the International Finance Corporation (IFC), an international financial institution that is part of the World Bank Group, which focuses on private sector development in developing countries, highlights adaptation in infrastructure (including buildings), water-intensive industries and agriculture as key areas of investment in climate resilience (IFC 2016b).

The adaptation components of the INDCs submitted signal a need for investments to include both hard and soft components of adaptation. Examples of hard components include investments in concrete assets, such as technology or infrastructure. Examples of soft components include

³ The INDCs that contain adaptation components were from the following regions: Africa (46), Asia and the Pacific (26), Latin American and the Caribbean (19), Eastern Europe (7), and Western European and other states (2).

⁴ Some of these countries have not formally submitted an NDC to the UNFCCC.

⁵ Functioning ecosystems provide a foundation, and can be the source of adaptation solutions and disaster resilience, for many other sectors such as agriculture, forestry and water (Sudmeier-Rieux et al. 2019)

planning, capacity building, promoting behavioural change and conflict resolution (UNFCCC 2016). Other examples of soft components related to adaptation might be awareness raising, training on promoting changes in behaviour and practice, or research and development. The lessons from previous finance initiatives indicate that successful work on adaptation requires both types of activities. In fact, a focus purely on hard measures can lead to the creation of new risks or even result in maladaptation (ODI 2016; The Gold Standard Foundation 2017).

2.2 Global adaptation needs

Adaptation activities are needed globally to support climate resilience. Investments are especially needed in developing countries, where the impacts will be greatest and there is less adaptive capacity (Duru and Nyong 2016; UNEP 2018). Extreme heat and drought, crop failures and floods are expected in Sub-Saharan Africa, for example, and climate resilient urban transport, buildings, water supply and energy infrastructure will be crucial due to the high percentage of people who will be living in cities by 2050 (IFC 2016a). These needs are at least partially reflected in the relatively high level of inclusion as priority sectors of water and agriculture in states' NDC-related action plans or strategies. Table 1 shows the percentage of states parties to the UNFCCC in a region that have elaborated on biodiversity/ecosystems, health, water, agriculture and forestry as priority areas in their NDCs.⁶ As the focus on these sectors can be assumed to be based on the risks that these regions face, it is evident that the South Asia, sub-Saharan Africa, Latin America and the Caribbean, Middle East and North Africa, and East Asia and the Pacific regions prioritize action in these sectors more highly than Europe and Central Asia, and North America.

Table 1. Percentage of state parties to the UNFCCC in a region elaborating on priority sectors in their NDC action plans/strategies

Regions	Biodiversity/ Ecosystems	Health	Water	Agriculture	Forestry
Latin America and Caribbean	42	48	78	63	51
South Asia	62	50	75	63	63
East Asia and Pacific	22	31	40	38	38
Middle East and North Africa	35	30	50	45	15
Sub-Saharan Africa	39	46	68	81	52
Europe and Central Asia	7	11	19	15	15
North America	0	0	0	0	0

Source (Pauw, Cassanmagnano et al. 2016)

2.3 The role of the private sector in adaptation

Although responsibility for climate change adaptation is often thought to fall chiefly on the public sector, private sector funding is required due to the limits on public sector funding. Furthermore, corporations are involved in sectors that are seen as instrumental to adaptation. First, the private sector owns and operates assets and infrastructure that are at risk of being affected by the impacts of climate change (UN Global Compact et al. 2011; TCFD 2017; IFC 2016a). This affects both the company and those societies which depend on the at-risk assets. Second, the private sector develops products and services that are required for adaptation, and thus has an incentive to capitalize on the opportunities that investments in adaptation afford (Watson et al. 2015). Thinking about where these two roles for the private sector most often intersect with the key areas in need of adaptation financing outlined above, it is apparent that the private sector is integral to adaptation and resilience in the health, water, agriculture, forestry and urban

⁶ Data was only available on these five priority sectors. 'Elaborated on' signifies that an NDC has described specific actions or aims.

infrastructure sectors. It should be noted that the focus is on the climate resilience of the project, asset, service or company, rather than society more broadly. However, the assumption is that a resilient private sector will support a resilient society. In theory, climate resilient investments, or investments that take account of climate risks, are an opportunity to avoid the build-up and locking in of potential long-term risk, which happens when risk is neglected. Mitigation of future risks to business continuity and profitability will incentivize private sector organizations to enhance climate resilience.

A third role for the private sector lies with external financial investors. Private financiers, such as banks or institutional investors, invest in ways that are aligned with their risk-return profiles (UNEP 2016b; Barysh et al. 2014). Investing in adaptation and resilience can be a way to reduce the exposure of investor portfolios to climate risk (CISL 2016). Investors increasingly recognize the importance of climate risk assessments (GARI Group 2016). Investor-led initiatives, such as the Task Force on Climate-Related Disclosure, are likely to create additional pressure on companies to identify, manage and, if possible, mitigate their own climate risks. Such initiatives approach climate change adaptation by using financial risk as an entry point to justify the need for climate resilient investments. Here also, the focus is not on the resilience of society, but on the climate resilience of the investment.

3. Green Bonds

As section 2 indicates, there are large financing gaps in relation to adaptation and there is a role for the private sector in filling these gaps. To analyse the potential for green bonds to do so, it is first necessary to understand green bonds as a financial mechanism. A bond is a debt instrument through which the issuer of the bond repays the bondholder or investor the principle at a specified end date as well as interest payments throughout the term of the bond. Most bonds are fixed-income, meaning that they pay the interest back to the investor at set intervals, but interest payments can be variable. To maintain low levels of risk, investors should have confidence that the debt will be repaid from the issuer's or the project's revenue streams.

As financial instruments, most green bond are structured in the same way as typical investment grade, or low risk, bonds. The main difference between a green bond and a regular bond is that the issuer will include a "use of proceeds" clause that states that the financing will be used for green investments. This means that the issuer commits to using the funds raised by the green bond to finance or refinance assets or projects that have been determined to be green, rather than treat the funds as general working capital. Nonetheless, a typical green bond investor will not be exposed to the risks of the specific assets or projects funded by the green bond, but will instead have recourse to the issuer's entire balance sheet (CBI 2012).

A common practice for establishing that a bond is financing projects or assets that contribute to environmental sustainability is to check that they are aligned with the International Capital Market Association (ICMA) Green Bond Principles (GBPs). In some regions, what defines a bond as green is regulated (e.g. in China and India), and the European Commission is currently working on a proposal for a voluntary EU Green Bond Standard that builds on the GBPs. The GBPs set out *voluntary* guidance on the use of proceeds, processes for the evaluation and selection of eligible projects, the management of proceeds and reporting on green bonds. Issuers publish green bond frameworks detailing these ICMA components to explain to investors what types of projects and assets their green bond will fund. Labelled green bonds usually also go through a third party review process (UNDP 2019), known as a Second Opinion. There are thus additional costs of issuing a green bond compared to typical bonds that are related to planning, monitoring and reporting.

The ICMA's GBPs identify the broad environmental objectives of green projects as climate change mitigation, climate change adaptation, natural resource conservation, biodiversity conservation,

and pollution prevention and control. This report has identified additional potentially eligible categories that are often used by issuers: climate adaptation; renewable energy; energy efficiency; pollution prevention and control; environmentally sustainable management of living natural resources and land use; terrestrial and aquatic biodiversity conservation; clean transportation; sustainable water and wastewater management; eco-efficient and/or circular economy adapted products, production technologies and processes; and green buildings. Projects may fall into numerous categories and also include “related and supporting expenditures such as R&D” (ICMA 2018, p.3). The inclusion of categories and criteria in a green bond framework determines eligibility of the use of funds in a project but does not guarantee that the funds will be used for all of the specified categories.

Bonds can provide issuers with long-term bond financing at lower cost, as an alternative to costly bank loans, which is especially relevant for long-term investment such as investments in infrastructure (OECD 2015). Moreover, research suggests that green bonds provide issuers with lower capital costs compared to conventional bonds. However, these differences are quite small and a recent study finds that the yield for green bonds is on average 2 basis points (0.02%) lower than yields for comparable conventional bonds (Zerbib 2019).

3.1 Green bonds as a vehicle for private sector financing of adaptation

The potential for green bonds to act as a financing vehicle for adaptation and resilience investments has received mixed reviews. Green bonds have been touted as a promising investment opportunity (Koh et al. 2017; UNEP 2018) and an efficient vehicle for increasing investments in adaptation. The IFC promotes green bonds as a “natural solution” to the projected demand for longer-term capital for climate screened assets, both low carbon and climate resilient (IFC 2016b). Based on risk calculations accounting for climate change and adaptive capacity analysis, emerging markets are projected to provide adaptation-related green bond opportunities for investors. Relatively wealthy economies such as Singapore, Thailand, Malaysia, Brazil and Colombia are highlighted as examples (Verisk Maplecroft 2018).

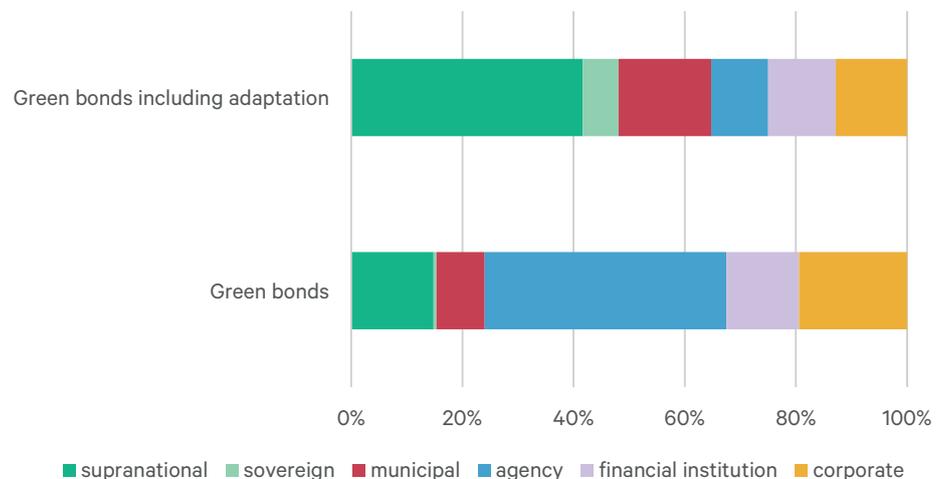
Others are more sceptical about the ability of green bonds to fund adaptation (GIZ 2017; Nicol et al. 2018; Nicol et al. 2017; Larsen et al. 2019), especially in relation to channelling much needed private sector funding to adaptation. The challenges of green bond funding for adaptation include the lack of resilience-related revenue streams, the small-scale of some adaptation projects and the overall “intangibility” of funding adaptation projects, which are similar to the challenges associated with private sector funding of adaptation more generally (Clark et al. 2018; Pillay et al. 2017). Overall, private sector finance for adaptation represents less than 1% of all climate finance (IFC 2016b). Tolliver et al. (2019) add that there is a lack of investor awareness of and investor capability with regard to adaptation investments due to short-term mindsets and a lack of sector expertise, problems that arise for any potential green bond investments with low investment volumes.

In spite of the debate on the role of green bonds in financing adaptation, green bond guidance frameworks do cover adaptation investments. The ICMA GBPs and draft EU Green Bond Standards recognize adaptation as a priority environmental objective (EU TEG on Sustainable Finance 2019). The ICMA GBPs note that adaptation activities can also be included in other categories of investment (ICMA 2018). The official guidelines on Green Bonds from China’s People’s Bank recognize adaptation as a potential project category (CBI 2019a). The Climate Bonds Initiative (CBI) has its own certification process, which rather than separating adaptation out, integrates adaptation-related criteria into relevant sector certification processes (CBI 2018b). In October 2019, the CBI also launched its Climate Resilient Principles to provide issuers and investors with clarity on how to invest in resilience (CBI 2019b). In its assessments, CICERO, a major provider of Second Opinions on green bond frameworks, assesses green bond frameworks against both climate resilience and low-carbon development principles.

3.2 Adaptation in issuers' green bond frameworks

Based on historical analysis of green bond issuances in the period March 2010 to April 2019 (Environmental Finance database 2019), 5% of all green bonds issued (162 of 3266) were categorized as adaptation. This means that 5% of all green bonds issued were linked with green bond frameworks that included adaptation as an eligible project category. In financial terms, this means that anywhere between zero and 100% of the funding can be allocated to adaptation projects. Green bonds categorized as adaptation were issued by all issuer categories, but to different extents (see Figure 1).⁷

Figure 1 Green bond frameworks with and without adaptation as an eligible project category, by issuance type, 2010 to 2019.

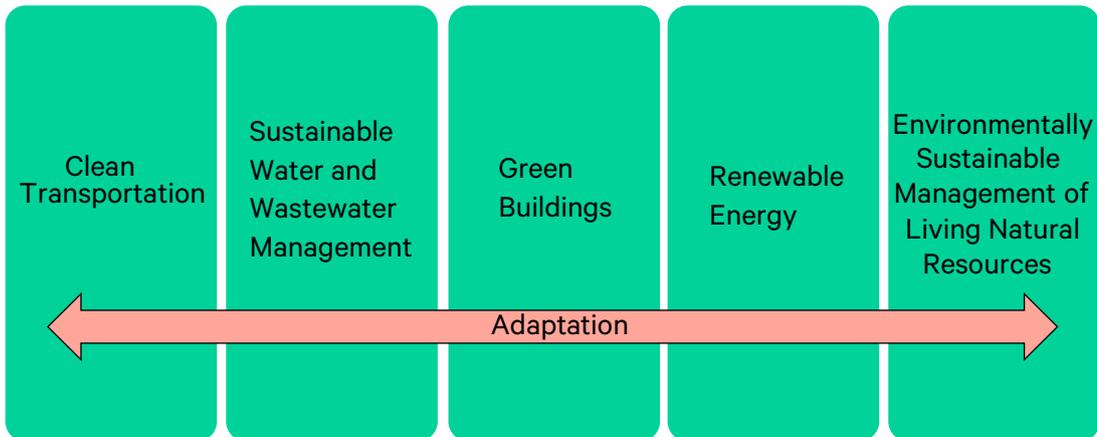


Source: Environmental Finance green bond database, 2019.

Although including adaptation as a project category in green bond frameworks is useful to enable tracking of the proportion of funding allocated to adaptation in comparison with targets (Pauw, Klein et al. 2016), it also creates some issues. This category only captures a fraction of potential adaptation funding as it only includes projects where adaptation is the main purpose. It also reinforces an incorrect perception of adaptation as a separate aspect of projects, rather than a cross-cutting and integrated aspect that should be accounted for in many projects. Separating adaptation from other linked project categories can minimize the importance of adaptation as it places it alongside other objectives rather than as integral to them. It guides neither issuers nor investors on how to account for climate adaptation in their investments or projects. For the same reason, separation also underestimates the number of bond issues that may be supporting adaptation, which could add to the perception that green bonds are not a vehicle for financing climate adaptation. The EU Taxonomy on environmentally sustainable economic activities currently under development should at least partly correct for this by including a list of indicative adaptation activities in each sector that would be valid under most circumstances, while also recognizing the context specificity of adaptation (EU TEG on Sustainable Finance 2018). Mainstreaming poses a challenge for tracking adaptation in terms of finance. However, a potential solution could be found in impact reporting or assessing whether investments have considered adaptation where relevant (Tolliver et al. 2019).

⁷ There are a variety of types of potential green bond issuer. The main categorizations of issuers do not clearly distinguish between the public and the private sector. Public issuers include municipalities, sovereign (national) and supranational organizations, while corporations are in the purely private sector category. However, two categories – agencies and financial institutions – can be either private or public, or a mix of the two (Environmental Finance 2019).

Figure 2 The cross-cutting nature of adaptation activities with other green bond project categories

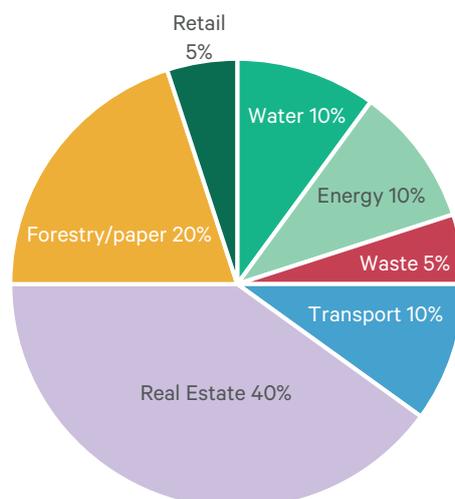


3.3 Private issuance of adaptation-related green bonds

Adaptation as a part of eligibility criteria

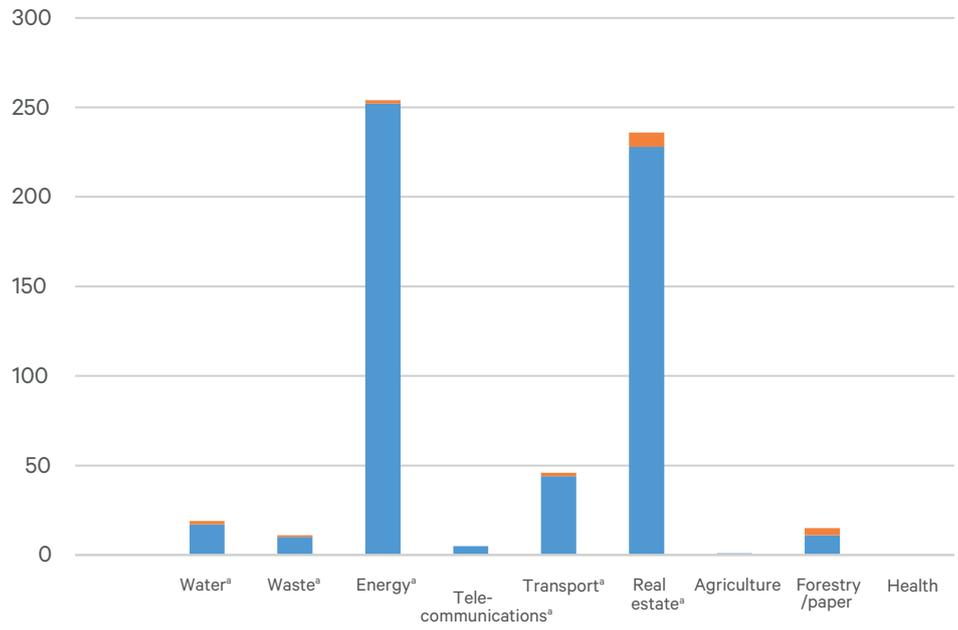
The private sector accounts for a significant proportion of adaptation-related green bond issuances (see Figure 1). Corporations issued 20 (13%) of the 162 green bonds categorized as adaptation in the period March 2010 to April 2019.⁸ Although this study is mainly focused on corporate issuances, it should be noted that 20 financial institutions, some of which are private banks, also issued green bonds categorized as adaptation (See Danske Bank 2019), but these are considered separately. Among the corporate adaptation-related green bonds, the real estate and forestry (including pulp and paper) sectors were the largest issuers (40% or 8 issuances and 20% or 4 issuances respectively). Each of the other sectors issued 10% or under, amounting to one or two issuances each (see Figure 3). Although corporate adaptation issuances make up almost one-fifth of the overall adaptation-related issuances, the share of adaptation-related issuances in green bond issuances is very small (see Figure 4).

Figure 3 Distribution of corporate green bond issuances categorized as adaptation across key sectors for adaptation, n=20 Source: Environmental Finance green bond database, 2019.



⁸ The data set includes green bonds issued between in 5 March 2010 (first issuance) and 23 April 2019, which is the day before the data was downloaded from the Environmental Finance green bond database.

Figure 4 Assessment of how key sectors issuing green bonds include adaptation as an eligible project category



Green bonds including adaptation	2	1	2	0	2	8	0	4	0
Green bonds not including adaptation	17	10	252	5	44	228	1	11	0

Notes: This assessment covers only corporate issuances.

^a denotes that it is a sub-sector of infrastructure.

Source: Environmental Finance green bond database, 2019.

The priority areas and sectors for adaptation investments were established above (see section 2.1) as water, agriculture, health, forestry and infrastructure. Infrastructure is a broad category, so it has been split into the sub-sectors water, waste, energy, telecommunications and transport, and real estate development and management. A comparison of the priority areas for adaptation investment with the sectors issuing green bonds categorized as adaptation shows that all of the infrastructure sectors apart from telecommunications have examples of issuances containing adaptation. In the infrastructure subcategories listed above, 28% of issues were based on green bond frameworks that included adaptation as an eligible project category (see Figure 4). The water sector, which is considered among the highest priority for climate adaptation investment, had two issuances, which amounted to 11% of the green bonds that included adaptation. Forestry had the highest share (27%), with four issuances. While energy and real estate had the highest number of green bond issuances, both had rather low percentages of issuances categorized as adaptation – 1% and 3%, respectively, which amounts to two issuances in the energy sector and eight issuances in the real estate sector. At the same time, real estate had the highest number of issuances categorized as adaptation. As these sectors will be greatly affected by climate change in the future, adaptation measures will be essential in future long-term investments. Furthermore, ageing infrastructure needs to be replaced in many parts of the world. Thus, the current low number of adaptation-related issuances suggests that there is potential for an increase in these key sectors.

There were no corporate green bond issuances in the agriculture nor health-related sectors, and thus also none related to adaptation (see Figure 4). Like forestry, however, agriculture will face future climate risks and investments that are not climate resilient could be considered wasted opportunities to mitigate long-term climate risks. According to Pillay et al. (2017), green bonds can fund commercial agriculture activities of a certain size as they are tangible revenue-generating commercial activities. The health sector is also vulnerable to the impacts of climate change. Adaptation-related investments can improve public health management systems and

contingency planning; early warning systems with health-related information; health monitoring programmes; and specific programmes targeted at the protection of vulnerable populations against vector-borne diseases (UNFCCC 2016).

Examples related to the corporate issuance of the type of adaptation activities included in the adaptation category in the green bond frameworks are shown in Table 2. Activities in these examples represent a change in how organizations operate based on the results of climate risk assessments, which means that future risks have been assessed. This includes investments in adequately designed infrastructure or infrastructure components, such as pumps and flood defences; the management of new conditions, such as those related to changes in stormwater; and alternative ways of handling problems such as pests.

Table 2 Sectors for which green bonds are issued and examples of adaptation-related activities included in the green bond frameworks

Sector and example	Description of activity included in the green bond framework related to adaptation
Water: Aquafin, a water and wastewater company (Belgium)	Projects related to water purification, stormwater management and adequate design of pumping stations and wastewater transport infrastructure (CICERO 2015a).
Forestry / pulp & paper: Klabin, a pulp, paper and packaging company (Latin America)	Climate vulnerability assessment-related activities and resilience enhancing activities. The latter include alternative pest control to deal with the projected acceleration of pest growth rates and forest fire risk prevention (Sustainalytics 2017c).
Energy: Latvenergo, an energy company (Latvia)	Flood protection and water management projects; highlighted as important in the Second Opinion review, given future climate change scenarios and expected regional water shortages (CICERO 2015)
Real estate: Swire Properties, a property developer and investor (Hong Kong)	The green bond framework highlighted that a comprehensive assessment during the review process should reflect initial risk assessment results, which identified water availability, heatwaves, flooding and specific extreme weather events as risks. Its green bond framework has included investments in flood defence and stormwater management systems (Sustainalytics 2018).
Private financial institution: DBS Bank (Asia)	Allows for the “(a) development, production and purchase/installation of products or technologies that enable adaptation to climate change, including information support systems such as climate observation and early warning systems; (b) construction, investment or operation of adaptation-related projects that contribute to a reduction in vulnerability to climate change”. Project-specific climate risk assessments are required of borrowers (Sustainalytics 2017a).

Environmental Finance green bonds database, 2019

In addition to the issuances by corporations, financial institutions (both public and private) can also support the allocation of private sector investments to projects that support adaptation and resilience by issuing green bonds. They have issued 13% of all green bonds, and a similar share of all green bonds with adaptation as an eligible project category (Environmental Finance 2019). DBS Bank and Danske Bank are issuers that have included adaptation on their list of eligible project categories. Both leave the eligibility criteria for that category broad (Sustainalytics 2017a; Sustainalytics 2019) (See DBS Bank in Table 2). This is probably to allow investments from multiple sectors. Interestingly, DBS Bank requires borrowers to provide climate risk assessments for funded projects (Sustainalytics 2017a).

Investments outside of the adaptation project category

Looking at private sector issuances beyond the adaptation category, other project categories could also support adaptation. These include sustainable water and wastewater management, environmentally sustainable management of living natural resources and land-use, clean transportation, waste management and green buildings, as well as some more general categories sometimes used by issuers such as sustainable development and environmental management (see Table 3).

For example, 15% of all corporate issuances were categorized as sustainable water management and 21% as green buildings. Both of these categories are important for climate resilience. Many

of the activities listed in Table 3 are similar to those listed under the adaptation category (see Table 2), such as the construction of new assets or the retrofitting of older ones. Some green bond frameworks even specifically refer to climate risks, such as decreased water consumption in climate-resilient water demand management. Projects on sustainable management of living natural resources and terrestrial and aquatic biodiversity conservation could help channel private investment into ecosystems, which is a key area for adaptation investment but not funded under the adaptation category.

Table 3. Other categories that could include adaptation-related activities

Category – project eligibility in Green Bond Framework	Example issuer	Example of eligible activities	No. of corporate green bond issuers*	% of corporate green bond issuers, N=634
Sustainable water management***	Aguas Andinas, a water company	Includes infrastructure resilience in the details of its project eligibility criteria, including the construction of new assets and the adaptation of current infrastructure to ensure water supply in case of extreme river turbidity (Aguas Andinas 2019).	92	15%
	Swire Properties	Water conservation and wastewater treatment: The green bond framework refers to climate risks related to water availability and could e.g. include greywater collection, treatment and reuse for irrigation and cleaning on-site (Sustainalytics 2018).		
	City Development Limited, a Singapore-based property developer and manager	Water consumption: the green bond framework deems expenditures that reduce the water consumption of Republic Plaza eligible for funding. In the Second Opinion review, this is linked with local water availability as a climate risk and the need for water demand management (Sustainalytics 2017b).		
Sustainable management of living natural resources***	Suzano Pulp and Paper company	Inputs and services for restoration of native forest cover on degraded land, including acquisition of seedlings, agrochemicals, fertilisers, new planting, pest management, fences, and so on, as well as studies and monitoring the restored area. ** (Sustainalytics 2016).	10	2%
Terrestrial and aquatic biodiversity conservation***	CMPC Pulp and Paper Company	Expenditures related to the restoration and conservation of existing native forests, the protection and identification of endangered flora and fauna and the preservation and restoration of High Conservation Value forests (Sustainalytics 2017b).	22	3%
Green buildings	Skanska, a construction and project development company	The project criteria do not discuss adaptation, but its green bond framework includes an example of impact reporting related to climate change adaptation (CICERO 2018).	136	21%
Other (e.g. Sustainable environment)	Latvenergo, an energy company	Supports research and development in nature conservation and biodiversity programmes (CICERO 2015).		
Other (e.g. Sustainable farmer development)	Friesland Campina, a dairy company	The green bond framework supports sustainable farmer development in Indonesia, Vietnam and Nigeria with the aim of farmer livelihood improvement and producing high quality, sustainable dairy products (Vigeo Eiris 2016).		
TOTAL				41%

*There is overlap between issuers in these categories, meaning an issuer can be in more than one category.

**Does not mention climate risk.

***Or similarly themed category.

The integrated nature of adaptation becomes clear from a closer examination of external reviews of green bond frameworks, due to the inclusion of adaptation activities in many project categories. It is also likely that there is potential for growth in the number of green bond frameworks supporting adaptation in these priority sectors. However, it should be recognized that not every type of potential investment captured in green bond frameworks can support adaptation, as some categories are not relevant and, unlike mitigation, adaptation needs are location-specific. Assessing relevance requires performing a climate risk assessment.

4. Limitations on private sector green bonds filling the adaptation gap

Despite the potential for green bonds to support adaptation, there are also barriers to scaling up private sector funding for adaptation. Green bonds may not be suitable for adaptation and resilience investments due to mismatches in geographic application or between the design of the financial instrument and the types of investments that are needed. These mismatches should be clearly accounted for when thinking about the potential for green bonds to increase private sector funding for adaptation and resilience. Another key and more general obstacle is the low level of understanding of climate risk in corporations.

4.1 Uneven geographic potential

Some of the preconditions for the development of green bond markets limit their use in developing economies. Green bond issuance requires a certain level of bond market development and stability, as well as the necessary associated regulatory and legal frameworks. To achieve this, international and national public sector actors and development banks play various roles in coordinating and increasing green bond activity (Pillay et al. 2017). This is important in countries where potential local issuers may not be aware of green bonds as an alternative to the local banking sector for raising funds (Climate-KIC 2019), but especially important in developing countries (AICCON 2018) where the green bond market may not be as developed.

Table 1 lists East Asia and the Pacific as a region where 40% of countries that are parties to the UNFCCC have submitted NDCs that have elaborated on at least one of the priority sectors for adaptation (biodiversity/ecosystems, health, water, agriculture and forestry). In terms of corporate green bond issuances with adaptation as an eligible project category, East Asia and the Pacific is responsible for 41% of issuances. The Asia-Pacific region, which partially overlaps with the East Asia and the Pacific region, has the highest regional year-on-year growth in the rate (35%) of issuance, the top performers being China, Australia, Japan and India (CBI 2018c). In addition, there is guidance on green bond issuance from China, India and the Association of Southeast Asian Nations (ASEAN), which has 10 member states. Thus, there is good potential for growth in corporate green bond issuance on adaptation.

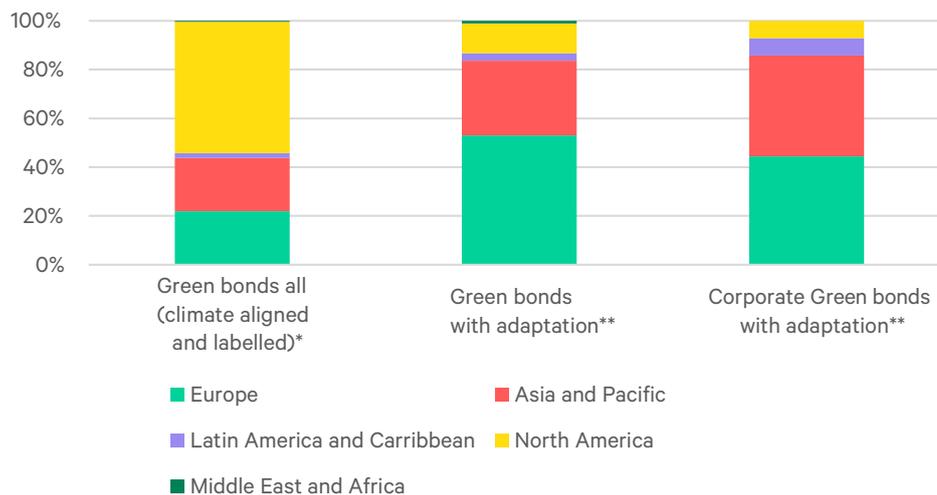
According to Table 1, 78% of the states parties to the UNFCCC in Latin American and the Caribbean have elaborated on at least one of the priority sectors for adaptation in their NDC. Of the corporate green bond issuances with adaptation as an eligible project category, 7% were from the region (Environmental Finance 2019). The number and volume of issues from Latin America and the Caribbean is still small but they include activity originating in several countries. Guidance supporting green bond issuance has been developed by the Santiago and Lima stock exchanges. Thus, there is good potential for growth in corporate green bond issuances on adaptation in this region too (CBI 2018c).

By contrast, there have been very few green bond issuances in the Middle East and Africa (CBI 2018c). Nor have there been any green bond issuances in South Asia. These regions have a clear need for investment in adaptation and mitigation. In the NDCs from sub-Saharan Africa

and the Middle East and North Africa, the proportion of states parties to the UNFCCC that have submitted an NDC elaborating on at least one of the priority sectors for adaptation is 81% and 50%, respectively. In South Asia, 75% of NDCs have a focus on adaptation (see Table 1). In the Middle East and all of Africa, green bond issuances originated from five countries: the United Arab Emirates, Morocco, Namibia, Nigeria and South Africa. About half of the issuances were from the private sector, including four from commercial banks, one from a wind energy company and one from a real estate company. These are sectors for which adaptation is likely to be highly relevant. The potential for green bonds to fund corporate adaptation, however, is currently limited by the undeveloped green bond market in these regions.

Based on the extent to which priority sectors were included in the adaptation components of the NDCs in these regions, there is a lower level of prioritization for adaptation investments in the Europe and Central Asia region and in North America (see Table 1). However, Europe and North America represent over 40% and 7%, respectively, of the corporate green bonds labelled adaptation and both regions have highly developed green bond markets.

Figure 5. Global distribution of green bonds based on issuer nationality



Sources: *CBI 2018c for data on all green bonds issued (climate aligned and labelled). Includes outstanding unlabelled bonds from fully- and strongly-aligned issuers and green bond issuance. Excludes fully-aligned US Muni issuance. **Environmental Finance database 2019 for data on green bond frameworks and corporate green bond frameworks with adaptation. Excludes supranational issuances, which account for 40% of all labelled green bond issuances with adaptation as an eligible project category.

4.2 Scale

In addition to the geographic mismatches related to the supply of and demand for corporate adaptation-related green bonds, there are also scale-related mismatches. In theory, green bonds can enable different kinds of projects and investment by a variety of issuers because the yield and recourse terms of bonds can vary to reflect different risk profiles (Nicol et al. 2018). However, the relatively high transaction costs linked to green bonds limits their usefulness for funding smaller projects (Tippmann et al. 2013). For example, while larger commercial agriculture initiatives may generate sufficient revenue streams to qualify for green bonds, smallholder farming initiatives and community level projects may be well below the size of activities considered suitable for green bond issuance (Pillay et al. 2017). Similarly, medium-sized, small and micro-enterprises (MSMEs) vulnerable to climate change risks and impacts face challenges in attracting financing even though they are crucial to societal adaptation (UNEP 2016b; UNEP 2018). Their size makes it very difficult for them to utilize green bonds. Green bonds can package several diverse projects into a single security (Lindenberg 2014) of sufficient size, which promotes the cost-efficiency of green bonds as a funding mechanism, but this limits green bonds to issuers

who have sufficiently large investment needs or the ability to pool assets. Given that in order to keep transaction costs low, most green bond issuances are over \$100 million, most adaptation activities are too small to be considered cost-efficient on their own. Some smaller deals have taken place, however, and in 2018 the average green bond issue in Latin America was \$78 million, while in Africa it was \$45 million (CBI 2018c).

To increase size, issuances can also be made up of small-scale but homogenous and standardized financial assets pooled into sufficiently sized asset-backed securities (ABS). For example, SBAB Bank's Green Bond Framework includes mortgage-backed securities pooled into ABS green bonds, which contain resilience elements such as water efficiency and flood zone screening (CICERO 2019). In addition, adaptation activities do not have to make up the sole investment of the issue. Issuers can invest in a portfolio of projects, only some of which may include adaptation elements.

4.3 Types of activities funded

A third supply and demand-related mismatch of adaptation-linked green bonds issued by the private sector concerns the types of activities they fund. As is mentioned above, for adaptation projects to be successful, soft components are required in some cases – either as the main activity or as a complementary activity. Examples of soft components include the integration of adaptation into planning and implementation, such as the climate proofing of key sectors, capacity building, enforcing behavioural change, ensuring resilience and conflict resolution (UNFCCC 2016). The draft EU Green Bond Standard explicitly broadens the scope of activities that are eligible for green financing in ways that are related to soft adaptation components by stating that: “in addition to capital expenditure, relevant Research and Development costs, as well as selected operating expenditures and working capital that increases the lifetime or the value of the eligible green assets, can be included” (EU TEG on Sustainable Finance 2019, p.26). However, traditionally such investments have been less attractive to private investment or bond issues (CBI 2018a). Investments in innovations, including the research and development (R&D) processes that lead to them, are considered higher risk and the return on investments from capacity development activities is perceived to be low.

One way to think about these challenges is to be aware of how soft components such as capacity development are needed to bring about the behaviour change required for successful adaptation projects. For example, behaviour change is often crucial to water saving in drought-prone areas, while in some cases disaster preparedness activities can result in increased financial returns for the issuer or project owner. There are examples. For instance, the City Development Limited Green Bond Framework considers efforts to limit water consumption through water demand management to be eligible for funding (Sustainalytics 2017b) and the Latvenergo Green Bond Framework treats R&D as eligible in its nature conservation and biodiversity programmes (CICERO 2015).

4.4 Low level of understanding of risk

In addition to the mismatches mentioned above, the scaling up of adaptation financing through green bonds is limited by the low level of awareness or understanding of climate risk in corporations. Low levels of understanding of climate risk limits the use of green bonds even in situations where they would be appropriate and feasible in technical terms. Climate risks comprise both physical and transition risks. Until recently, standard approaches to climate risk assessment have been absent and the level of disclosure has been low (GARI Group 2016). Although it is in a company's interest to be aware of and proactively manage future risks, there may be perceived or actual drawbacks to the voluntary public disclosure of such risks even when this forms the basis for their management (Crawford and Seidel 2013). To help create a level playing field, the Global Adaptation & Resilience Investment (GARI) Working Group, which is made up of private sector investors and other stakeholder groups, published a report that called

on: (a) industry groups to develop guidance, methodologies and industry standards on stress testing and climate risk-screening; (b) regulators to establish standards and a methodology on assessment of climate impacts; and (c) investors/financiers to price climate risk into investments, promote disclosure practices and invest in resilience (GARI Group 2016).

Since then, the Task Force on Climate-Related Disclosure (TCFD) has issued a recommendation on climate-related financial disclosures and published a scenario-based methodology for identifying climate risks and their potential impacts (TCFD 2017). Furthermore, the Central Banks and Supervisors Network for Greening the Financial System (NGFS) recently released a report reminding central banks that climate resilience falls within their mandate, due to the implications for financial risk of climate risks. It supports implementation of the TCFD recommendations and calls on financial institutions to recognize climate-related financial risks in their asset valuations by mapping and analysing risks and accounting for climate risks in monitoring and supervision activities, as well as portfolio management. In the private sector, the NGFS recommends robust and consistent disclosure on environmental risks (NGFS 2019). There is some hope that these signals from the financial sector will give the private sector the nudge required to map and disclose their risks in a way that instigates an investor response. For example, according to its green bond framework, DBS Bank requires potential borrowers to carry out climate risk assessments on their project proposals (Sustainalytics 2017a). Sjöblom et al. (2018) argue that the fiduciary duty of institutional investors should include analysing investment portfolios for climate risks.

Thus far, however, the stronger consensus around climate change has not resulted in a large increase in adaptation investments by private sector organizations. It is possible that the information costs related to mapping relevant climate risks, as a first step to investments, are still considered too high and that the long-term nature of the benefits may be an obstacle (Pillay et al. 2017). Although the World Economic Forum's multi-stakeholder community perceive climate related risks (extreme weather, climate action failure, natural disaster, biodiversity loss, and human-made environmental disasters) to be the top five longterm risks in terms of likelihood and expect risks related to extreme heatwaves, destruction of natural ecosystems, and uncontrolled fires to increase in the short-term (World Economic Forum 2020), it could be that asset managers and investors prioritize acting on transition risks, which are mostly climate mitigation-oriented, over physical climate risks (Sjöblom et al. 2018). It could also be that although investors are starting to map portfolio-related risks, they are still unclear about how to make decisions based on that information (Burgess and Rapoport 2019). While there is change taking place, it is happening at a much slower rate than is needed to meet the urgent adaptation needs established above.

5. Discussion and conclusions

Adaptation efforts are required globally, but especially in developing countries. The key needs for investment come under the areas of water, agriculture, health, forestry and infrastructure. Although there are private sector issuers from all of these key sectors involved in the green bond market, adaptation is not well represented in their bond issues. Specifically, the number of green bond issuances that represent potential adaptation activities is very low, and only the forestry, water, energy, transport and real estate sectors are represented. Private sector green bond issues in agriculture have not been labelled as adaptation, even though there is both a need and the potential for larger scale investments in agriculture.

In terms of geographical distribution, more corporate green bond issues for adaptation can be expected in Europe, Latin America and the Caribbean, and East Asia and the Pacific. These are regions with well-developed green bond markets and the guidance in place to support adaptation-related issuances. There is currently less potential for scale-up in the Middle East, Africa and South Asia. North America has a developed green bond market and issues over half of all climate-aligned and labelled green bonds. However, future research could explore the reason for the relatively low share of adaptation in public and private sector green bond issuances in this region. Canada, one of two parties to the UNFCCC in the North America region, treats health as a vulnerable sector and mentions various climate risks in its NDC (Pauw, Cassanmagnano et al. 2016)

In conclusion, green bonds have some limited potential to channel significant private sector funding into adaptation. However, despite a significant drive from the financial markets, the high rate of growth in green bond issuances overall and the increased focus on adaptation in standards and guidance, the developments needed to further scale-up private sector green bonds for adaptation activities will be too slow to significantly contribute to closing the adaptation finance gap. This is due to the limits imposed by the current low level of awareness of climate risk, which is a prerequisite for action to mitigate risk, as well as the mismatches in geography, project size and types of activities.

This does not mean that green bonds should be abandoned as a mechanism for funding adaptation. On the contrary, green bonds should continue to be pushed due to the urgent need for adaptation investments. However, how and under what conditions green bonds can be used to fund adaptation should be clarified. Efforts should be made to increase the development of projects that are appropriate for green bonds: revenue-generating large-scale or poolable projects; projects that focus on hard adaptation components but are complemented by the necessary soft components; and projects in regions or countries with developed bond markets. Similarly, as green bond markets expand to new regions, adaptation should be highlighted as an objective so that new regions can leap-frog the slow development of the adaptation-related green bond market.

6. Policy Recommendations

The recommendations set out below would promote the inclusion of adaptation in private sector green bond investments.

First, efforts are needed to increase investor and issuer awareness of climate-related risks to businesses in the key sectors in need of adaptation. The standardization of user-friendly climate risk assessment methods would help investors account for climate risk in their investment decisions. In addition, higher investor awareness might stimulate investor demand for green bonds that take account of climate risks. This demand could encourage conventional bond issuers to shift to green bonds, thereby supporting adaptation. Greater awareness of climate risks in the private sector, alongside standardized, user-friendly risk assessment methods could also enable private sector actors to identify their risks and plan ways to integrate these into decision making around investments, assets and activities. In physical locations at higher risk, higher industry standards such as building regulations that reflect requirements for resilience could create both demand and a level playing field, thereby boosting investments in the project categories required.

Second, green bond review processes should systematically highlight adaptation- and resilience-related risks wherever relevant. Reviews of green bond frameworks, such as Second Opinions, would highlight the relevance of climate risk and whether it is sufficiently accounted for in the framework. Such reviews raise awareness among both the investors and the issuers. The investor is provided with information in the review documentation. For the issuer, however, the learning opportunity takes place during the review process, when there is still an opportunity to adapt the green bond framework to strengthen adaptation components. For issuers, the review process can provide a learning opportunity to improve their thinking on adaptation and resilience issues institution-wide. Thus, in addition to being an investment tool, green bonds can be considered an awareness-raising tool. This greater awareness within the institution might spur further investment in adaptation – through either green bonds or other mechanisms more appropriate for the issuer.

Third, guidance for the private sector on how to invest in adaptation could increase the inclusion of adaptation- and resilience-type activities in green bond frameworks. There is currently a lack of guidance, save for the CBI's Climate Resilience Principles and its continuing work to integrate adaptation criteria into key sectoral Climate Bond certification standards. The lack of consensus on definitions of adaptation and resilience makes it difficult for issuers and investors to understand the potential eligibility of such investments. Furthermore, the inclusion of adaptation as a separate project category in several guidelines sustains the incorrect perception that adaptation is a separate, rather than integrated, activity. Guidance that provides definitions and tangible examples of how adaptation can be integrated into relevant sectors can help increase the inclusion of adaptation and resilience in green bond frameworks. The EU Taxonomy, which will include an indicative list of adaptation activities in each sector that would be valid under most circumstances (while recognizing the context specificity of adaptation) is one example of much-needed guidance (EU Action Plan on SF 2018). Detailed examples could have a demonstration effect and pave the way for further integration of adaptation. Guidance is also needed to clarify whether – and if so under what circumstances – soft components can be used in projects to complement hard components, and the benefits of doing so. The EU Green Bond Standard, which is under development and due to be finalized in 2022, will be aligned with the EU Taxonomy and has the potential to make clear to investors how they can invest in adaptation and resilience. This might serve as an example for green bond standards and guidance in other regions.

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