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Are markets interested in adapting to climate? Insights from Singapore

Stella WHITTAKER

Tran Bao Phuong NGUYEN
Singapore Management University, tbpnguyen@smu.edu.sg

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White Paper

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Stella WHITTAKER
Visiting Researcher,
Centre for Climate Finance and Investment, Imperial College Business School

Dr. Tran Bao Phuong NGUYEN
Research Fellow,
Singapore Green Finance Centre
Sim Kee Boon Institute for Financial Economics, Singapore Management University

About this paper

This research has been conducted by the Singapore Green Finance Centre (SGFC), an initiative of the Centre for Climate Finance and Investment (CCFI) at Imperial College Business School and the Sim Kee Boon Institute for Financial Economics (SKBI) at Singapore Management University, backed by the Monetary Authority of Singapore (MAS) and nine leading global financial institutions. A series of interviews were conducted between September to December 2022 to learn about government and investor experiences as a participant in the delivery of climate and adaptation financing in Singapore.

This white paper offers new insights into financing climate change adaptation in cities and extends the CCFI's Adaptation Bonds report published in September 2022. The latter presents analysis and insights into the US municipal bond market to help close the adaptation financing gap. This research investigates the delivery of climate finance for climate change projects in Singapore. The research question '*To what extent can markets build for transformation in climate adaptation financing in city*?', aims to inform and promote a better understanding of financing for climate change actions today. A motivation for the study is the scale of the impacts and the economic losses the city could face without adaptation.

Delivered with the contributions of industry and government, this white paper is addressed to policymakers, regulators, and the financial industry—primarily banks, asset managers, exchanges, and marketplaces. Drawing on industry insights from leading institutions, senior officials, and policymakers regarding the common understanding of finance for adaptation in Singapore, the paper develops recommendations based on these insights. This topic is sensitive, and we respect the anonymity and discretion claimed by industry and government contributors.

This White Paper forms part of the lead author's PhD submission and the format of this case study closely follows the case of Copenhagen, for comparability reasons headings and text in both publications are aligned. (See: Whittaker, S., & Jespersen, K. (2022). Stretching or conforming? Financing urban climate change adaptation in Copenhagen. Buildings and Cities, 3(1), pp. 974–999).

Contributors

Stella Whittaker is a PhD Research fellow at Copenhagen Business School and a visiting Researcher at Imperial College Business School's Centre for Climate Finance and Investment. She holds a Master's degree in European Environmental Policy and Regulation and is specialising in climate finance for urban adaptation.

Phuong T.B. Nguyen is a Research Fellow at Sim Kee Boon Institute for Financial Economics at Singapore Management University. She holds a Ph.D. in Economics from Singapore Management University.

Michael Wilkins is Executive Director of Imperial College Business School's Centre for Climate Finance and Investment and an Executive Director of the Singapore Green Finance Centre.

Dave Fernandez is the Director of the Sim Kee Boon Institute for Financial Economics at Singapore Management University and an Executive Director of the Singapore Green Finance Centre.

Donna Ho is Assistant Director of the Singapore Green Finance Centre, Sim Kee Boon Institute for Financial Economics at Singapore Management University.

Bob Buhr is an Honorary Research Fellow at the Centre for Climate Finance and Investment Imperial College Business School specialising in research into the financing of adaptation.

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Executive Summary

We have collected the views of leading practitioners and academics in Singapore involved in funding and financing urban climate change adaptation[1] (thereon referred to as urban adaptation). Throughout this paper we discuss several vital perspectives on adaptation financing, namely responsibility for adaptation investment, the extent of government adaptation investment, private sector adaptation investment appetite and prospects for experimentation in adaptation financing. We also attempt to shed light on the existence or not of an adaptation financing gap[2] in Singapore.

Singapore has an ambitious urban adaptation approach that is widely considered a model among capital cities elsewhere. It has been successful in particular developing a whole of government approach to adaptation which sets a clear transition pathway to a climate-adapted city. Singapore has a suite of green/climate financing initiatives in play that are rarely seen, or at least reported, in other cities. Despite these achievements a motivation for the study is the scale of the impacts and the economic losses the city could face without adequate adaptation. *'As a small low-lying city-state with an open economy, Singapore is particularly vulnerable to the consequences of climate change.'* (National Climate Change Secretariat 2012:7)[3]

Singapore has investigated the cities' adaptation needs, and the Government in 2019 committed S$100 billion to adapting the city to the end of the century. This funding commitment is on top of generous funding in the previous decade of its ambitious water sensitive urban design[4] (WSUD) programme (its ABC[5] package) and activities to tackle rising sea levels. It is unclear from the data gathered from interviewees and policy documents whether the S$100 billion represents the total activity needed in the city to address the predicted scale of impacts and economic losses it could incur. Unfortunately, we were unable to access public documents clearly articulating and detailing the impacts and the need. However, the need was most likely calculated from the extensive coastal assessment studies the government conducted (but did not make public) in 2019. Further a recent Swiss Re report estimated that between 1.0- 20.2% of Singapore's GDP could be lost by the mid-century (Swiss Re Institute 2021). Transparency and clear articulation in a city of (1) the adaptation need, (2) the financing available and (3) any resulting adaptation financing gap, is a critical first step in any adaptation response but is missing for most cities and unfortunately Singapore is no exception to this.

[1] Urban adaptation measures can include both 'soft' and 'hard' infrastructure investments to address climate-induced urban flooding, coastal inundation, heatwaves, wildfires, storms, and drought. The present study focuses exclusively on adaptation measures to address urban and coastal flooding, including coastal defences, green streets, green roofs, water-retention basins, and smart drainage.

[2] The authors use the Urban Climate Change Research Network definition of the 'adaptation gap': 'Failure to adapt adequately to existing climate risks.' (Rosenzweig 2018: 775) with the 'financing gap' being 'defined and measured as the difference between the costs of, and thus the finance required, for meeting a given adaptation target and the amount of finance available to do so.' (UNEP 2016: xii).

[3] https://www.nccs.gov.sg/files/docs/default-source/default-document-library/national-climate-change-strategy.pdf.

[4] Water-sensitive urban design (WSUD) is an approach used in urban environments to manage water resource to provide both water quality and quantity outcomes. It uses natural water systems and landscapes, involves working with nature and aims for more resourceful uses of water. It is an approach widely used in cities as a response to climate induced urban flooding.

[5] Singapore's ABC (Active, Beautiful, and Clean) Waters Program is Singapore's local brand of water sensitive urban design. It was introduced in 2006 and it includes many initiatives aimed at 'institutionalising' WSUD in Singapore.

Singapore's adaptation approach has important deficiencies in terms of knowledge and partnerships. Although a sense of urgency to tackle adaptation has been widely communicated from the top down in the City State, it has not yet clearly articulated a role for the private sector and the market in adaptation. Interviewees indicated that the government do envisage a role but they have so far for instance failed to actively include private capital partners in financing adaptation infrastructure in the city. Our findings highlight that more could still be done to facilitate diverse sources of finance for adaptation measures, and that Singapore could experience problems into the future realising its ambitious goals and plans without a more diverse engagement in the solutions. This is particularly pertinent if climate impacts in the city are more severe than planned for. More diverse financing could also mean the Government will not have to use debt mechanisms or tap into state reserves to fund its ambitious adaptation program. Singapore has traditionally financed spending from tax revenue, so debt financing is a new departure for the Government. Experimentation in financing is also germane if the Singapore Government wants to include adaptation financing as a key part of its global green finance hub ambition. The benefits of building expertise (mechanisms, partnerships, business model, tools etc) in this newest area of sustainable finance would be of value not just to Singapore but to other neighbouring nations who are all grappling with the need to finance urban adaptation.

We find that there is currently an interest from the investment community in increasing their knowledge on financing adaptation and there also seems to be a willingness by some to contemplate experimentation in deal structures and payment schemes under the right conditions. The interventions discussed in this white paper provide some ideas on what could be experimented with in Singapore with the help of further intervention and regulation.

Singapore's adaptation approach is predominantly based on public finance. The absence of private sector involvement can in part be attributed to the presence of deeply entrenched barriers to private sector financing of adaptation. More far-reaching 'transformation' of the market is required to overcome current barriers to investment and enable the market to mature. The Singapore Government needs to signal to the private sector its intentions more clearly regarding the role for private capital in adaptation in the city and the region. It is worth noting that in Singapore, most infrastructure is state-owned which matters in terms of the credit rating of potential issuers but also creates ownership complications. This matters for the resolution of governance and economic complexities in relation to mobilising new private partnerships and financing deals. Attention to supply or demand issues in isolation will not suffice, rather an approach is needed that looks at the myriad of issues and the whole 'ecosystem' of finance and how different financing sources can play different roles.

COP27 in Egypt in 2022 (IISD 2022), stressed there is a need to transform the whole financial system - its structures and processes, and to engage governments, central banks, commercial banks, institutional investors, and other financial actors in the transformation. We have structured our recommendations to paint a picture of what this market 'transformation' could entail for Singapore, listing market structure changes (such as tax incentives, valuing adaptation, compliance regulation etc.) as well as market activities (such as education, co-investment, networks, instilling a sense of urgency etc.). Mixing financial instruments can also give the Singaporean Government budget flexibility - a longer term for their

investment and the opportunity to fund other priorities. The multitude of adaptation financing barriers for both investors and city governments alike however strongly signal the extremely limited prospects for boosting financing for urban adaptation without changes throughout the whole 'ecosystem' of finance.

Marina Barrage serves three purposes: a source of water supply, flood control, and a venue for lifestyle attraction. *(Source: PUB Singapore's National Water Agency)*

Introduction

Prime Minister Lee Hsien Loong of Singapore has called climate change a matter of *'life and death*,' and an existential threat to the country as important as national defence.

> *'We should treat climate change defences like we treat the Singapore Armed Forces (SAF) – with utmost seriousness. Work steadily at it, maintain a stable budget year after year, keep your eye on the target and do it over many years and several generations. That way we can afford it, and when we need it, we will have it ready. Both the SAF and climate change defences are existential for Singapore. These are life and death matters. Everything else must bend at the knee to safeguard the existence of our island nation.*' PM Lee, National Day Rally (2022:10).

The Second Minister for Finance Indranee Rajah said at the recent Singapore Sustainable Investing and Financing Conference (2022:1):

> *'We are committed as one Government to taking bold and decisive actions to tackle climate change, finance sustainable infrastructure, and catalyse the green economy. The publication of our Singapore Green Bond Framework[6] is yet another important step forward in this regard.'*

The physical risks associated with climate change for cities have been comprehensively depicted in the academic and practitioner literature (SUP Series 2022, Revi et al. 2014). Responding to these risks traditionally requires adaptation measures designed to adapt, if possible, to physical climate risks. '*These efforts need to be paid for, and an urgent question is how is that going to happen?*' (Buhr 2022:3). This research systematically analyses the current state of play and opportunities with regards to paying for urban climate change adaptation, with insights gathered from industry and government in Singapore.

There is a large and chronic underspend on adaptation in most cities. Climate change impacts are an *'incredible risk'* to many cities throughout the world, touching infrastructure, economies, and people *(*Espinosa 2018: 1). City governments are making valiant attempts to find new ways of financing the climate change adaptation needs in their cities, but these costs are so large that this is an almost impossible task for them to tackle alone. The need to adapt cities to climate change creates a significant public funding challenge and these challenges are most acute in coastal cities like Singapore. This is especially so as the difference between the funding available and the adaptation need continues to widen as climate effects worsen in their cities. One of the options open to governments is to leverage private capital to address this underspend. In addition, there is large untapped potential for private investors to ramp up their investment activities in this area, replicating and scaling the promising models that exist globally. However, many challenges exist for cities and investors alike when financing urban adaptation, invention is needed not only in technology but also in approaches to financing and investment (Whittaker

[6] 'Singapore private sector heeds call for green finance growth' (9 May 2021). Available at: https://www.straitstimes.com/business/invest/spores-private-sector-heeds-call-for-green-finance-growth

& Jespersen 2022). Without urgent investments, cities, their economies, infrastructure, and people are vulnerable to climate-induced extreme events which will be very costly indeed to all.

In the past decade a great many studies have been published focusing on urban adaptation efforts (Biesbroek & Delaney 2020). Evaluating the effectiveness of contemporary policy processes of urban adaptation has been a focus in this work (Olazabal et al. 2019). Financial and resource constraints are the most frequently highlighted and discussed barriers to urban adaptation (Moser et al. 2019). The institutional and governance implications of financing adaptation, the possible financial products and instruments for funding adaptation, and barriers to and opportunities for private sector involvement, are amongst the identified research gaps. Unfortunately, very little research is found on the financing of adaptation (Keenan *et al.* 2019). Exceptions to this finding are research examining public and private financing of coastal adaptation (Bisaro & Hinkel 2018) and adaptation financing mechanisms in the US, such as regional resilience trust funds and credit banking schemes (Cousins & Hill 2021; Keenan 2018a, 2018b; Keenan & Gumber 2019). These authors have provided valuable insights into the institutional and governance challenges of novel financing mechanisms.

This said much of the academic literature on adaptation describes an adaptation deficit or gap (Haasnoot et al. 2020). There is conversely a wealth of practitioner literature on the deficit (IPCC 2018; GCA 2019; UNEP 2016). There is a growing interest in the practitioner literature on alternative investment sources to fill the financing gap, (Climate-Kic 2020) but studies have yet to wholly cover the multi-layered challenges of pursuing private sources of capital. In general, there is a lack of specificity in terms of financing sources for adaptation generally assuming the default funder will be governments. The development of a picture of finance flows for adaptation at a city level for a leading capital market such as Singapore is therefore a worthy exercise. We seek to shed light on the research question: '*To what extent can markets build for transformation in financing climate adaptation in the city?*' We also address: (a) *What are the options to overcome investment challenges,* (b) *What are the conditions for creating a successful adaptation market in Singapore*?

Mullan & Ranger (2022) express 'climate adaptation aligned finance'[7] as more than physical climate risk stress testing of assets (ECB 2021) and climate risk disclosure (SASB 2021; WRI 2022), instead it also necessitates a more proactive investment approach. Urban adaptation often includes the construction of infrastructure and a number of sectors, such as the water sector, include adaptation infrastructure capable of generating cash flows in their own right, which is of critical interest for investors looking to invest in projects. In fact, there are a range of investment channels open to financing urban adaptation, but the research shows only traditional vehicles and predominantly public provisioning in use (Climate-Kic 2020; Bisaro et al. 2020). It is worth noting that in Singapore, most infrastructure is state-owned which matters in terms of the credit rating of potential issuers but also creates ownership complications. This

[7] 'Climate adaptation aligned finance' follows three principles (1) Physical risk management: the physical risks from climate change (such as drought or heatwaves) should be identified and managed; (2) Do No Significant Harm: the management of risks should be done in a way that does not increase the risk faced by others (e.g. by increasing downstream flood risk or damaging biodiversity); and (3) Alignment with adaptation strategies and objectives: the investment should be consistent with relevant adaptation plans or strategies, such as National Adaptation Plans (NAPs) (Mullan & Rangers 2022).

matters for the resolution of governance and economic complexities in relation to responsibility, trade-offs, equity, and accrual of benefit will be crucial to mobilising new private partnerships and financing deals. Otherwise, there can a transference of '*long term environmental risk to the broader land use planning system in cities and to non*-partners' (Taylor & Harman 2016:939). We have attempted to examine here however a broader range of potential financing activity by seeking insights from a diverse range of investors.

Underlying all the barriers found to adaptation financing is the issue that adaptation is something that is '*at least partly a public good and difficult to monetize'* (Holtedahl et al. 2022:19) where the responsibility to adapt is hotly contested. The expected role for the private sector is a key element of this research and linked to our research question. We intend to take the position of COP27 in Egypt 2022 on this issue which calls for a transformative approach to climate finance for adaptation (IISD 2022). As Mullan & Ranger (2022) propose the private sector role is threefold, to integrate physical climate risks into investment decisions, to do no significant harm and to contribute to adaptation strategies by innovating on mechanisms for financing adaptation.

For a full overview of adaptation financing and the adaptation financing gap we recommend that readers refer to the CCFI's publication on Adaptation Bonds (Buhr 2022) and treat it as a companion document to this research.

So why not invest in adaptation?

There is general consensus in the literature on the main barriers that governments face in urban adaptation (Biesbroek et al. 2014). Financial and resource constraints are the most frequently cited barriers to adaptation for city governments (Moser et al. 2019). There is also plentiful consensus on the challenges the finance sector faces investing in climate mitigation which has been extensively studied (Hafner et al. 2020). Analysis of the literature (scholarly and practitioner) in this study highlights the barriers that are common to both mitigation and adaptation investment and those applying equally to investors and governments (See Table 5). There is no doubt that urban adaptation finance is in its infancy and therefore has an even greater range of potential barriers. The additional barriers found in relation to urban adaptation investment point to the additional complexity of financing urban adaptation, when compared to financing mitigation. Underlying all the barriers is the issue that adaptation is a public good and difficult to monetize. This is a key reason for the inaction by many (Biesbroek et al 2013, Reckien & Petkova 2019). As such, adaptation harbours an even stronger dependence on market change because of these failures in the market (Helmer & Hilhorst 2006; Mazzucato & Penna 2016; Naidoo 2022; Pauw 2017). The numerous barriers for both investors and city governments alike also very strongly signal the extremely limited prospects for boosting private financing for urban adaptation without market change (Wright & Nyberg 2017).

We clearly defined adaptation activities ahead of our interviews using both the Global Centre on Adaptation, the Climate Bond Initiative definitions.[8] However, it is acknowledged that the concept is mired with definitional issues and as such investors could potentially be talking about wildly different things. There is a massive problem of unfamiliarity, and lack of knowledge of adaptation projects and urban climate-related risks. Knowledge is a key issue discussed later in this paper.

Background to urban adaptation and climate finance in Singapore

The commitment of the Singapore Government to tackling climate change as outlined in the Table 1 has been building for many decades. This response has been prompted by extreme rainfall events and flooding along with concerns over sustainable drinking water supplies all of which disrupted the city functioning. Indeed, Singapore suffered from major droughts in 2010 and 2014 and from city flooding from extreme rainfall in the late 1900s. Being a low-lying tropical island city-state, Singapore is vulnerable to the impacts of climate change, these impacts include sea level rise and storm surge, drought, extreme precipitation, and heat waves. A recent Swiss Re report estimated that even with the achievement of the Paris Agreement temperature rise target of 1.5°C between 1.0 - 4.9% of Singapore's GDP could be lost mid-century and with a 2.0°C rise this could be as large as a 20.2% loss (Swiss Re 2021).

Singapore has however succeeded in supporting its integrated water management system and adaptation programmes and many aspects of adaptation planning are now routinely integrated in all urban planning and infrastructure design in the city. This has meant city flooding and drought are now uncommon in the city. Such government support is critical, and many examples of supportive activities can be found in Singapore's approach, including seed financing, experimentation, learning networks and knowledge base development (Bhullar 2013). Its approach is a whole of Government approach which is embedded within its Green Growth Strategy 2030[9]. The Singapore Government is working hard to build knowledge and action on climate finance through experimentation.[10]

[8] According to Global Centre on Adaptation, the Climate Bond Initiative, and the European Bank, two types of climate adaptation and resilience related investment are consistently recognised:

1) Investments in assets or activities whose primary purpose is to deliver climate resilience [adaptation] benefits to the broader system ("system-level adaptation"); and

2) Investments aimed at adapting to climate change an asset or activity whose primary purpose is not addressing climate change ("asset-level adaptation" resulting in "adapted activities or assets") (GCA, 2021).

The Climate Bonds Initiative's Climate Resilience Principles (CRPs) state: 'resilience[adaptation) investments improve the ability of assets and systems to persist, adapt and/or transform in a timely, efficient, and fair manner that reduces risk, avoids maladaptation, unlocks development, and creates benefits, including for the public good, against the increasing prevalence and severity of climate-related stresses and shocks.'

[9] https://www.straitstimes.com/business/invest/spores-private-sector-heeds-call-for-green-finance-growth

[10] More detail available at: https://www.mas.gov.sg/news/media-releases/2022/mas-and-google-cloud-launch-point-carbon-zero-programme--to-catalyse-climate-fintech-solutions; https://www.mas.gov.sg/news/media-releases/2022/mas-and-sgx-group-launch-esgenome-disclosure-portal-to-streamline-sustainability-reporting-and-enhance-investor-access-to-esg-data; https://www.mas.gov.sg/news/media-releases/2021/mas-and-industry-to-pilot-digital-platforms-for-better-data-to-support-green-finance

Singapore's natural resource constraints, land availability and geopolitical situation for certain have provided an atmosphere conducive to the development of progressive climate change, climate adaptation and sustainable water management policies (Swiss Re Institute 2021). Bhullar (2013) evaluates the contribution of Singapore's water policies and practices, and the support they gave to the development of adaptation. The city exposure to climate hazards is of great national significance. During the National Day Rally in 2019, Prime Minister Lee Hsien Long projected that Singapore would need to invest at least S$100 billion over the next 100 years to protect against rising sea level.[11] The solutions proposed extend from large scale infrastructure projects (e.g., raising buildings, retaining offshore islands), to smaller scale type of infrastructure works (e.g., localised flood barriers for public assets including transportation and health infrastructure such as bus stops, metro stations and hospitals). As part of this recent public announcements the Government has stated that it expects individual ministries to pay for the smaller-scale projects from their budgets. Bigger, long-term infrastructure like sea walls and land reclamation could involve debt mechanisms or tapping into state reserves. This denotes a major departure for Singapore that has traditionally financed spending from tax revenue.

Port of Singapore. (*Source: National Climate Change Secretariat Singapore (NCCS))*

[11] 'National Day Rally 2019: $100 billion needed to protect Singapore against rising sea levels' (18 August 2019). Available at: https://www.straitstimes.com/singapore/national-day-rally-2019-100-billion-needed-to-protect-singapore-against-rising-sea-levels.

The Government's success in urban adaptation can be attributed to the presence of certain key conditions, including supportive national climate adaptation planning and water sensitive urban design (WSUD) frameworks, the involvement of the Central Bank - the Monetary Authority of Singapore (MAS) and Singapore Stock Exchange, extensive government supported academic research and climate modelling, and a plethora of well-funded green and climate-focused non-governmental organizations (NGOs) (Table 1). There are multiple collaborations between government, enabling organizations and the private sectors to improve transparency and promote a green finance ecosystem.[12]

Singapore's response to rising sea levels is impressive.
Most of Singapore is within 15 m above Singapore Height Datum and around 30 per cent of the island is less than 5m above Singapore Height Datum, (mean sea level) as such climate change is an immediate threat and unlike many other cities Singapore does not have abundant high ground to retreat to. Protection of the coastline and improving drainage is a priority of the Singapore Government. To respond to sea level rise, the minimum land reclamation level in Singapore was raised from 3 metres to 4 metres above the Singapore Height Datum in 2011. This level is adequate in addressing projected sea level rise under the Governments Second National Climate Change Study (2015). PUB and related agencies state they will continue to review the minimum reclamation levels with information from new studies available. There is also concern that sea-level rise will be even faster in the 21st century so the Government is planning for floodwaters that are higher than the current studies suggest. The Meteorological Service, Singapore's Centre for Climate Research, suggests that in a worst-case scenario factoring in effects like storm surges, floods could rise by almost 4 metres. Singapore's current efforts to defend its coastal areas from erosion include the construction of walls and stone embankments covering 70 per cent to 80 per cent of Singapore's coastline. The rest are natural areas such as beaches and mangroves.

One financing approach supported by the Government is the Singapore Green Bond Framework (2020).[13] Climate change adaptation is one category within the eight Eligible Green Expenditures for use of proceeds from the Sovereign Green Bonds. The Singapore Government will strive to fully allocate the net proceeds within two years. There were 272 sustainability, green, social or transition bonds listed in Singapore as of Sept 2022.[14] Green Bonds activity in Singapore and Hong Kong 2017 to 2021 is set out in Figure 1. The two centres have long been sparring partners for green finance supremacy. There was no breakdown available on the adaptation proportion of these issuances, but it could be expected to be much lower than mitigation focused bonds. The Singapore carbon tax announced effective 2024 will offer an additional inducement for activity. DBS bank alone targets a $50 billion sustainable finance portfolio by 2024 (they account for approximately 15% of all green and sustainability loans in 2021), leveraging sustainable finance to drive loan growth.

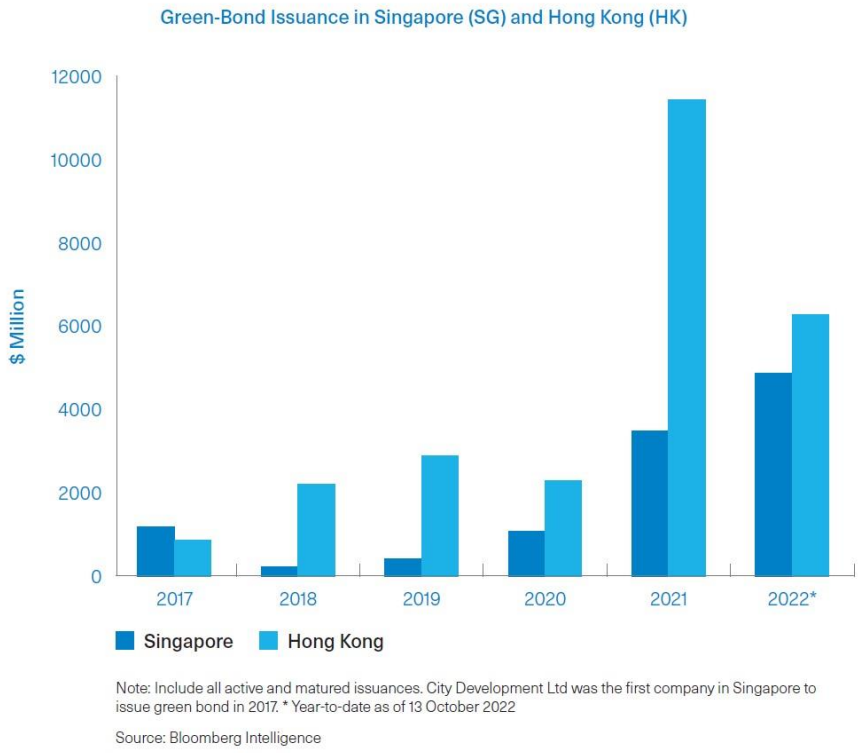
[12] The 'ecosystem' of finance refers to the all the structures and processes of the financial system and the all actors in that system, such as governments, central banks, commercial banks, institutional investors, non-professional investors and other financial actors.

[13] Singapore Green Bond Framework 2020. Available at: https://www.mof.gov.sg/policies/fiscal/greenbonds

[14] 'Singapore and Hong Kong spar for green finance supremacy in Asia' (8 December 2022). Available at https://www.straitstimes.com/business/singapore-and-hong-kong-spar-for-green-finance-supremacy-in-asia

'The Hong Kong and Singapore governments envision issuing more sovereign green bonds in the coming years to fund public green projects. Singapore strives to raise S$35 billion ($24.3 billion) by 2030, based on the Singapore Green Plan 2030. That implies an average of $4.5 billion of annual sovereign issuance by Hong Kong and $3 billion by Singapore, not a small amount compared to their respective $11 billion and $3 billion total green-bond issuance in 2021. Singapore issued its first 50-year S$2.4 billion sovereign green bond in August at 3.04%, giving a big boost to the nation's green-bond market this year. The setting up of the Green Bond Framework also lays the foundation for more issuance to come.' (Bloomberg 2022) [15]

Figure 1. The issuance of Green Bonds 2017 to 2022 (Singapore (SG) and Hong Kong (HK))



Note: Include all active and matured issuances. City Development Ltd was the first company in Singapore to issue green bond in 2017. * Year-to-date as of 13 October 2022

Source: Bloomberg Intelligence

[15] https://www.bloomberg.com/professional/blog/hk-and-singapore-vie-for-green-financing-carbon-reduction-lead/?tactic-page=600488

Table 1. Key adaptation planning and financing initiatives in Singapore (2000- 2022)

Dates	Finance Finance regulation, policy, instruments	Regulatory regime Regulation, policy, instruments	Adaptation innovations: Technology, vision, education
2000-2010		"First to the Fourth National Taps" Water Supply strategies (1960 to 2018)	ABC (Active, Beautiful, and Clean) Waters Program launched (2006)
		Minimum land reclamation level raised to 4m (2011)	Marina Barrage opening in in the Singapore River 2008
		Revision of the Code of Practice on Surface Water Drainage in Singapore to include ABC Waters in development larger than 0.2 Ha (2011)	DTSS (Deep Tunnel Sewer System) (2013)
2010-2015	S$2 billion on drainage improvement works since 2011	Climate Change National Strategy (2012) Second National Climate Change Study (2015)[16]	ABC (Active, Beautiful, and Clean) Waters Program Professional Certification (2015)
		Green Mark (2015)	National Sea Level Research Programme (NSLP) launched (2019)
		Singapore Green Plan 2020 (2012)	Project GreenPrint - a digital blockchain ESG data project to harness innovation, technology, and data to enable green finance (2020)
2019-2022	Announcement of S$100 billion Government spending plan on climate adaptation measures (2019)	PUB was appointed national coastal protection agency (2020)	Study on protecting the city-East Coast coastline from rising sea levels (2021)
	Commit additional S$190 million to enhance flood resilience (2020)	Coastal protection panel established (2021)	Risk Map Study & the Coastal-Inland Flood Model (2021)
	MAS launch of Green and Sustainability-Linked Loan Grant Scheme (GSLS) support to companies in obtaining green/sustainable financing (2020)	Singapore Green Plan 2030 (2021)	Studies to protect Jurong Island and the North-West coast – comprising Sungei Kadut and Lim Chu Kang (2022)
	Significant Infrastructure Government Loan Act (SINGA)- Singapore Green and Framework (2021)		Studies to protect Jurong Island and the North-West coast – comprising Sungei Kadut and Lim Chu Ka to be commissioned (2022)
	Singapore Government Budget public sector issuance of up to S$35 billion of green bonds by 2030 (2022)		$23.5 Million Climate Impact Science Research (CISR) Programme Launched to Support Long-Term Climate Change Adaptation Planning (2022)
	Launch of ESGenome by Singapore Stock Exchange (2022)		
	Coastal and Flood Protection Fund in S$ 5 billion (2020)		

[16] Available at: https://www.nccs.gov.sg/media/publications/singapores-second-national-climate-change-study-climate-projections-to-2100-science-report

About this research

A mixed-method approach, including an extensive review of the literature and relevant policy documents was conducted. Qualitative data was also collected from interviews (*n=22*) and from a problem-solving workshop (*n=30*) held with the interviewees and their associates. This enabled the voices of the leading practitioners and academics in the city to be collected and presented in the current case.

Table 2. Interviewees (22) and workshop participants (30)

Organisation type	Grouping and interviewee coding	Number of interview participants	Number of workshop participants	Country
Government	Government & enablers (G)	3	3	Singapore
Consultant (Engineering & Finance)	(G)	3	2	Singapore
NGO/NFP	(G)	3	3	Singapore & Global
Association	(G)	1		Singapore
Bank	Investors & enablers (IV)	4*	14*	Singapore
Institutional Investor/Pension Fund	(IV)	(3) *		Singapore
Consultant (Finance)	(IV)	1	1	Singapore & Asia
Family Trust	(IV)	1	0	Singapore
Finance – Other	(IV)	4	2	Singapore
Academic	Academics (A)	2	5	Singapore & Global

*Note to Table 2: * These interviewees are also institutional investors and not double counted in the total.*

A content analysis of policy documentation involving more than 20 years of the city's urban adaptation planning was performed. Also reviewed were the green/climate finance policy documents of Singapore investors. Together this data set afforded an understanding of how adaptation funding and financing is conceptualised in Singapore. The second dataset is from qualitative analysis of semi-structured interviews with the relevant actors (*n* = 22: government and enablers (*n* = 10), investors (*n* = 10), academics (*n* = 2)). Singapore Government representatives were approached for an interview but declined. To fill this potential gap interviews were secured from other enabling stakeholder organisations working closely with the Singapore Government and able to relay information on their approach. A third dataset is provided by a workshop held with actors who were previously interviewed (*n* = 30) in order to take a deep dive into barriers, enablers, and innovative financing products.

The question format for the 60-minute semi-structured interviews was open-ended (Longhurst 2010), based on an interview guide in accordance with the approach recommended by Guion et al. (2011) for conducting in-depth interviews. Following the script for these interviews, the authors asked interviewees to review pre-prepared lists extracted from the literature on drivers, barriers, and enablers of urban adaptation financing. For the data analysis, ATLAS.ti 7 qualitative analysis software was used to code the data systematically (ATLAS.ti™ Scientific Software Development GmbH).

We took steps to ensure that all interviewees shared a common understanding of urban adaptation. and all interviewees were selected who had a working knowledge or urban climate change adaptation infrastructure projects. This selection was facilitated through email correspondence that included a pre-circulated interview script and definitions of urban adaptation projects. The semi-structured interviews were allowed to unfold in a conversational manner offering participants the chance to explore issues in urban adaptation finance that they feel are important.

Results: Government and investor responses and interactions

Interviewees were asked to identify and discuss their key motivations for climate investment, their answers are shown in Figure 2. These included returns and impacts followed by value creation, performance, and shareholders. Interviewees were also asked to identify and discuss the top three barriers influencing access to finance for adaptation (Figure 3). All the factors/barriers identified in Figure 2 are potential impediments to the flow of finance to adaptation in Singapore; informants mentioned them all often throughout the interviews. The informants went into more detail on all these barriers in the workshop (Table 3).

Figure 2. Motivations for climate investment

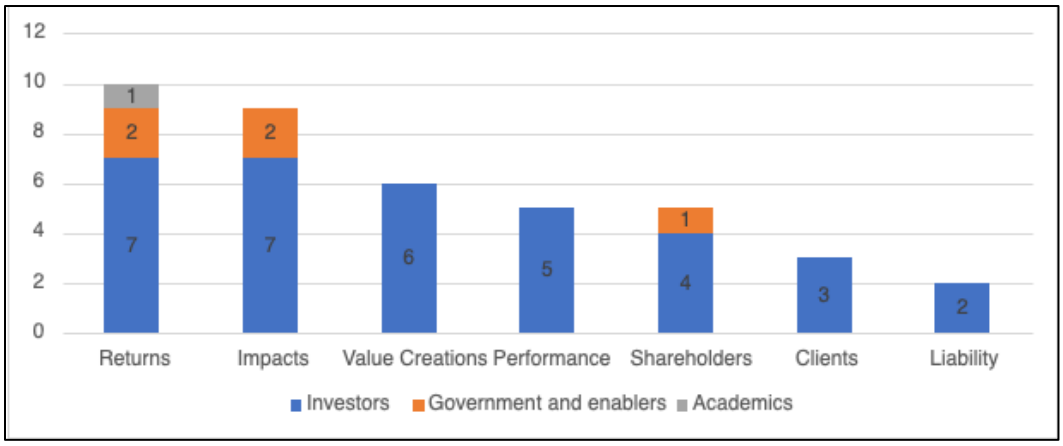


Figure 3. Barriers to adaptation investment identified by interviewees.

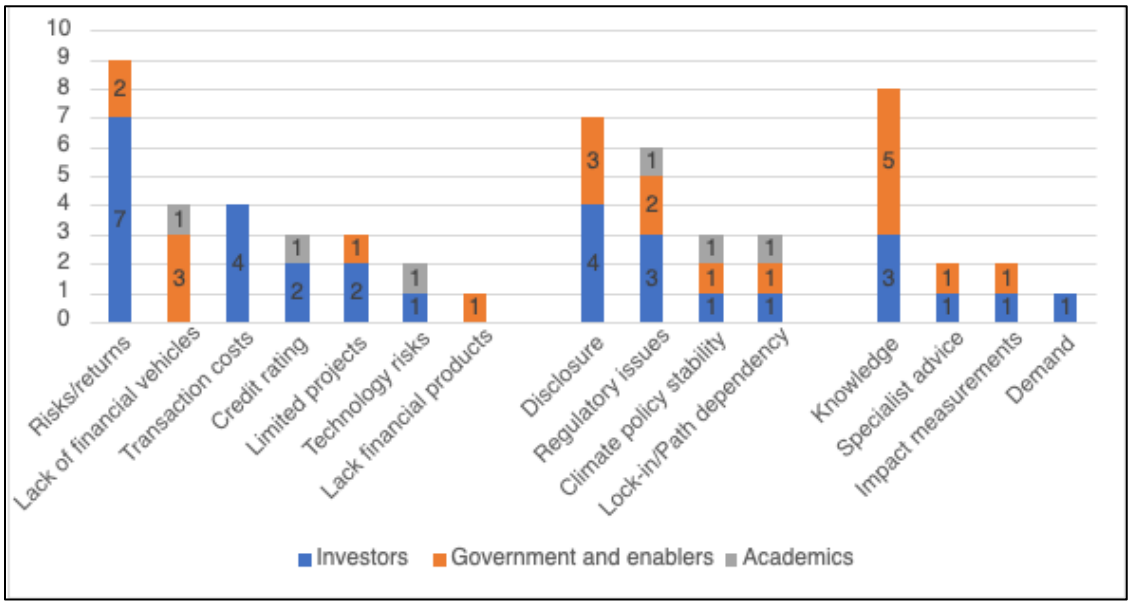
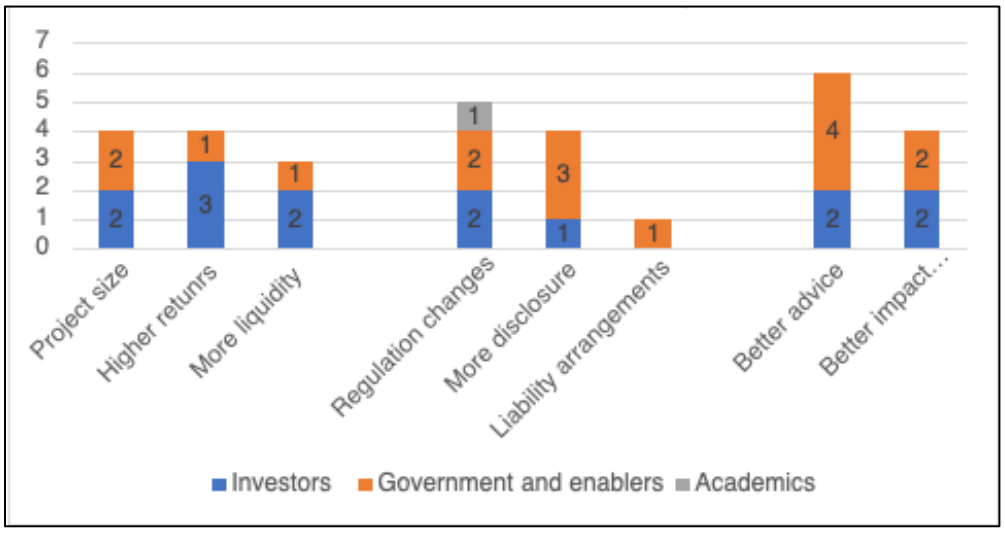


Table 3. Barriers to adaptation investment (Workshop)

Dominant factors	Actor descriptions of barriers
Regulation/Policy • Regulatory constraints	• Regulations (financial & non-financial) disenabling adaptation investment • Lack of process for adaptation investment • Lack of incentive alignment to encourage investors participation • Lack of transparency on the adaptation need, finance available & the potential adaptation finance gap
Acceptable risk/return of investment • Unacceptable risk/return • Lack of income generation • Lack of suitable financial vehicles/instruments	• No or limited income/cash flow streams for adaptation • Adaptation projects do not present an acceptable risk-return profile for investors • Absence of investment or business models for adaptation projects • Lack of collaboration between private and public fundings • Cash flow rates mismatched to impact & benefit • Lack of demand side economic policies to incentivise investment in adaptation (e.g., taxes, rebates, quotas) • Lack of investor confidence; lack of adaptation projects, no data, no transaction history & limited disclosure record • Lack of investment-ready & bankable adaption projects & project pipeline • Lack of demand and bias towards mitigation projects • Lack of investment vehicles for resilience projects
Knowledge & Heuristics • Lack of knowledge • Lack of models • Difficulties measuring impacts	• Unfamiliarity & lack of knowledge of climate change adaptation within the investor community • Expectation that adaptation is a public good and should be funded by the government • Lack of knowledge on the roles of different players and the investment requirements in adaptation projects • Lack of data (all areas) • Complexity in assessment of climate impacts
De-risking investments • Shortage of leveraged finance (supply) • Lack of track record • Lak of co-investment	• Lack of risk assessment for adaptation investment projects • Lack of research and credit/risk rating for adaptation investments • Lack of insurance products/mechanisms • Governments failing to leverage with high-risk capital to create incentives for private capital • Monopolisation of investments by public sector • Lack of track record investing in adaptation • Lack of co-investment & use of private/public partnerships
Size transformation & capital aggregation • Projects not large enough • Complex capital aggregation	• Adaptation project alone is not large enough for index requirement • Lack of scaled investment-ready & bankable adaptation projects & pipeline • Timeframes of adaptation projects are long and investment cycles are short-term

Interviewees also gave examples of what they thought needed to be change in Singapore to address these barriers (see Figure 4 and Table 4), citing further better impact measurement, regulatory changes, higher returns, increase in project size, better advice and more liquidity.

Figure 4. What needs to change in Singapore? Interviewees suggested interventions.



The barriers cited in the interviews with government differed from those cited by investor interviewees, demonstrating different priorities, concerns, and contexts. For instance, while both sets of actors agreed on the most prominent barriers (returns, disclosure, regulation, and knowledge), key differences emerged amongst the interviewees on the importance of returns and aspects of knowledge.

'*Why would a company get involved in climate adaptation unless you [face] really strong climate change risks. . There's no natural mechanism for the private sector to get involved. And so, we think you have to be a company where adaptation is all the way through the value and supply chain*.' (IV14)
'I must be absolutely honest, within our team, we haven't yet started working on adaptation just because our focus has historically been a little different.' (IV13)
'I think perceptions of green infrastructure investments are too low. That's definitely a perception that is unfounded, but it's very hard to break.' (IV08)
'I think it's [adaptation] perhaps drowning behind mitigation efforts which is politically supported.' (IV14)

Table 5 compares the top cited barriers in Singapore with the literature. Some interviewees also raised additional barriers not featured in the top three of others, namely**:** transaction costs, greenwashing risk, lack high quality assets, limited larger size projects, lack of compliance, regulation, climate change uncertainty, obstacles to SMEs, nascent market, and capacity.

Table 4. What needs to change? (Workshop attendees)

Dominant factors	Actor descriptions of interventions
Regulation/Policy	• Solidify the process for adaptation investment • Clarify the role of private sector investors in adaptation and resilience investments • Increase focus on adaptation projects in conjunction with mitigation projects • Increase awareness regarding the purpose of adaptation projects/the risks of not undertaking adaptation and resilience investments (economics, social, environment) • Communicate details on adaptation plan and investment plan to investors • Consider the possibility of adaptation bonds/tax exempt bonds
Finance	• Conduct more cost-benefit analysis on adaptation projects; demonstrate asset of an investable stream of returns from an adaptation project • Improve the credit profiles of adaptation investment projects • Identify potential risks and losses. • Provide appropriate insurance • Provide the right level of risks and returns for investors • Provide more opportunities with risk-adjusted returns. • Increase financial enablers and incentives (tax exemptions) • Utilize new sources of fundings for adaptation, i.e., carbon market, carbon credit funds • Quantify resilience benefits across different potential projects
Knowledge & Heuristics	• Conduct more research on credit ratings of adaptation investments • Improve general knowledge base on adaptation investment, especially among private investors • Provide better understanding of business models and the economics of concrete opportunities • Improve transparency of data • Create a community and joint effort in research on adaptation (climate scientists, infrastructure and finance experts, asset managers, engineers, etc.) • Clarify the long-term goal of adaptation investments • Provide unified assessment of climate impacts
Size transformation & capital aggregation	• Building more project pipelines in the right sectors • Government to create a project pipeline from a bottom-up perspective

Table 5. Top cited adaptation finance barriers (Singapore interviewees and the literature)

	Investors	Government
Top three adaptation barriers Singapore (Interviews)	1. **Risk-return** 2. **Knowledge** 3. **Data/disclosure/ESG standards/transparency** 4. **Regulatory issues** 5. **Financial vehicles/instruments/mechanisms/products** 6. **Transaction costs** 7. **Credit rating** 8. Limited projects (bankability & income streams) 9. Technology risks 10. Climate policy instability **11. Lock in path dependency** 12. Specialist advice 13. Impact measurement 14. Demand	1. Knowledge/awareness of risks & vulnerabilities* 2. Regulatory uncertainty* 3. Financial vehicles/instruments/mechanisms/products* 4. Credit rating * 5. Limited projects (bankability & income streams) * 6. Technology risks* 7. Climate policy instability* 8. Lock in path dependency* 9. Specialist advice* 10. Impact measurement*
Other adaptation barriers - literature[17]	▪ ***Fragmented system*** ▪ *Externalities & market failures* ▪ *Nascent market* ▪ *Uncertainties climatic system* ▪ ***Short termism*** ▪ *Competition of mitigation* ▪ *Carbon bias*	▪ *Funding sources* ▪ *Competing priorities* ▪ *Complexity adaptation responses* ▪ *Lack human & financial resources* ▪ *Capacity** ▪ *Lack local leadership* ▪ *Political priorities & processes* ▪ *Short termism** ▪ *Strategy conflicts* ▪ *Policy acumen* ▪ *Coordination/cooperation* ▪ *Burden of costs* ▪ *Inexperience in financing*

Source: Authors analysis of literature and Singapore responses

Notes to Table 5: * Denotes common government and investor barrier and **bold** denotes also a highly cited mitigation finance barrier

What investors and Government say and would like to see?

Commercial projects - acceptable risk/return and transaction size

Only two investors were able to cite examples of their company's investment in adaptation projects, and only one investor mentioned a distinct adaptation offering (IV03). A further three stated they were commencing the development an offering in adaptation. The lack of allocation of private capital to adaptation by banks and other investors in Singapore was emphasized by all interviewees and the reasons

[17] Review of literature for Table 5 includes Blue Orchard 2020; Boissinot et al. 2016; Hafner et al 2020, Miller & Swann 2017; Oliver et al. 2018; Pauw 2017; Root at al. 2016; Tonn et al. 2021

for this are examined in detail below. Government actors rarely referred to private capital but instead emphasised the abundance of public funding.

'The carbon market is currently one of the few markets that has had some success in creating voluntary commitment. But even that is troubling. Compared to its 'bigger brother 'compliance market, it's still a tiny amount and the real thing that is missing is compliance regulation and the way problems start with disclosure requirements and then they slowly move into stricter measures, bigger sticks, but without that [it's hard].' (IV14)

'*But I don't know what the headline figure is on the Adaptation Gap. And what does it actually mean in Singapore? What is the adaptation risk or what is adaptation that is needed? I.e., if we don't fund this and private capital doesn't fund this, then what's going to happen? What's the risk of it going wrong? I don't think that has been made clear enough. And partly I think maybe it hasn't been needed in Singapore because the Government is addressing […] barriers by making sure there're new regulations [related] to construction*.' (IV11)

In reaching decisions on investments in incumbent technologies, it is well known that acceptable risk/return is a key factor. Interviewees stated however that adaptation projects in many instances exhibit high risks and low rates of returns, meaning the investors are typically unwilling to finance them. As illustrated in Figure 3, Table 3, Table 4, and Table 5, most of the challenges cited by investors related to identifying returns, investment products, transaction costs, and lack of income stream for adaptation projects (IV02, IV02, IV08). Whilst several possible routes exist for investing in urban adaptation, most types of investment (debt, equity, novel financing vehicles and insurance) were not deemed attractive to investors and few investors mentioned use or investigation of innovative financing mechanisms. Their projects also compete with and exhibit a clear bias towards low carbon and mitigation transactions, such as renewable energy projects that now have an investment track record and an acceptable risk/return profile (G13).

'*It's strange that we have only incentives for mitigation and nothing for adaptation. And so, what we should do is we should obviously provide more grant structures for companies who actually care about adaptation, but that almost exists in our area for Singapore.'* (IV14)

'*So, as [*investment in adaptation*] starts to happen, and we reduce the return hurdle I guess that's going to be the closest thing we get to private capital. But that's going to require they stepping up to bridge the [adaptation] gap.'* (IV04)

Bird-eye view of the rejuvenated Bishan – Ang Mo Kio Park. The area features a meandering waterway flanked by park land that serves as a floodplain during wet weather and as a recreational space during dry weather. *(Source: PUB, Singapore's National Water Agency)*

Investors' attitudes regarding the responsibility for adaptation projects and who should bear this burden is a very important factor influencing whether investors in Singapore have the appetite to invest or not (IV01). For example, most investor interviewees (IV14, IV11) felt that the responsibility for such investment lies firmly with the public sector and not with private companies, with similar views expressed by government interviewees (G04, G05, G12). Many see the opportunities for adaptation investment in other Asian countries and not in Singapore (IV11). The result is almost all adaptation projects in the city are publicly funded. In addition, very few interviewees were able to give examples of best practice adaptation projects demonstrating a low level of knowledge of what constitutes adaptation by interviewees. Lack of knowledge of what constitutes climate adaptation is perhaps also a very important factor causing investors of all types to postpone or delay investment activity. It is also likely that adaptation investment is happening, but it is not tracked and disclosed as such and therefore activity is likely to be grossly underestimated. No investors interviewed have examined their activity to assess their adaptation investment.

'*It's still very basic. People don't know why it's [adaptation] important*. […] *The funds going to it are minuscule* […] *and so globally as such, Singapore also reflects that*. […] *Track record definitely is an issue because it's so new. Nobody has a track record*.' (A02)

'*Best practice [in adaptation] is very difficult to come by.'* (A01)

On August 4, 2022, the Singapore Government launched its first 50-year Inaugural Sovereign Green Bond (See Table 1), and Singapore has a Green Bond Framework (2021) which was referred to by most interviewees. It is envisaged that the finance generated can ultimately be issued or adaptation (IV12).

'*But absolutely green bonds are particularly [successful] in Singapore, given the sustainable finance and Green Bond Working Groups, which I'm part of, that has been one of the pioneering regulatory driven things that has increased capital*.' (IV02)

No interviewees were able to cite examples of Adaptation Bonds or Climate Resilience Bonds, whilst all stated that Sustainability Linked Bonds (SLB) are growing in popularity. Again no-one cited Green Bonds or SLBs allocated to adaptation.

One interviewee had a different perspective on Green Bonds:

'*I think that Green Bonds have had their heyday – it has come and gone. People realise that a Green Bond doesn't create the impact that was hoped for. It's the simplest product. It runs far too much risk of greenwashing, and it doesn't really foster change […] a lot more interest now lies in ESG linked loans and in financing structures like funds and increasingly more in providing services*.' (IV14)

Investors motivated by societal impact and value creation take a different view (IV02).

'*Philanthropic organizations, some of which are famous ones, can also be very, very visible actors. They can accelerate this sort of financing to reduce the adaptation gap. So, something to look to.'* (A01)

'Institutional clients like Sovereign Wealth Fund, as well as a lot of the family offices of ultra-high net worth people, they are having a strong focus towards climate investment, except they want to do it sensibly […] They want to have returns. But if we're able to show good returns, as well as how we are having a positive impact on environment, you'll find a lot of people willing to back those kinds of investment.' (IV06)

Opinions were aligned amongst the informants regarding the availability of finance and funding for adaptation in Singapore. Investors stated there is no issue with supply of finance but there is a demand-side problem, meaning there are no projects suitable to invest in (A01, G02, I05).

'*I don't think there's a big chance for the banks joining with the government [on adaption projects].'* (IV05)

'*But again, it's both demand of capital and supply of capital. On the demand side, the lack of project pipelines, the lack of green bonds directly for adaptation, that's not very common. And then the supply of capital we need to educate investors about the potential returns. We need to educate the investors around why this is needed and why cities need it. We are doing it. We are doing something, but there's still quite a lot to be done.'* (IV08)

Although there is an abundant supply of finance in search of projects, investors are so far either unwilling or in many instances unable to provide finance at lower than commercial thresholds for return/risk ratios. In contrast, funding for adaptation from Government is seen as plentiful by all actors. This is one of the reasons why many private actors don't see the need to get involved in financing adaptation themselves. There is a perceived and real trend for the public sector to be the default provider and the deficiency in

public funding is perhaps not so evident to them. Investors also have clear notions as to the size of projects they consider acceptable and in which they are prepared to invest, with many adaptation projects considered too small for investment. This reluctance on the part of investors relates closely to transaction costs, which can be very high for smaller projects (Figure 2 and Table 3). One interviewee stated if the issuance was small and less than US$75m this could be very expensive (IV01). Although the participants were only able to give examples of adaptation projects funded by public money, many actors displayed optimism regarding future opportunities for involving the private sector and for creating new types of adaptation projects and financing products in the future, such as private-public partnerships and blended finance (IV08, IV14, G01, G04, G12).

Before and after image of Bishan-Ang Mo Kio Park with a system of concrete canals for flood control. *Source: Chloe Schaefer, 'Bishan-Ang Mo Kio Park: From concrete canal to natural wonderland' (2014).*

Regulation

Unlike other studies (Whittaker & Jespersen 2022), many interviewees stressed that climate regulation and policy is not a major barrier affecting their access to finance for urban adaptation. By contrast other studies have found considerable concern about the flux in climate regulation and the policy risk that this creates (Blue Orchard Academy 2020; CFLI 2020; Whittaker & Jespersen 2022). Actors largely agreed that in Singapore there is an overall very stable policy framework covering adaptation. Participants' views on regulatory stability were consistent amongst government and investors alike.

'*You find [important) predictability of regulation and enforceability, with Singapore, this is something we will be very good at. If we're looking at project preparation again in Singapore, we will be very good at that.'* (IV06)

There was an acknowledgement by many that regulation is an enabler of climate financing rather than a barrier and that further regulation was probably needed. There was a suggestion by some of the need for more far-reaching regulation, such as taxes.

'I think you need the government to be a bit more proactive in creating a supply of projects, […] I'm waiting for Singapore Government to issue a green bond for that purpose.' (IV08)

Singapore aims to be a leader in green finance and MAS has a suite of initiatives which are listed in Table 1 to grow the activity, including a Green and Sustainability-Linked Loan Grant Scheme (GSLS). And whilst for now these schemes are largely focused on low carbon and mitigation projects, they could also equally cover adaptation projects.

'*So, I would say [Singapore] has gone from being a laggard in this space to being buoyant.* […] *It's a leading centre for green finance in Asia, currently competing roughly only with Japan for that title and excluding Australia. And that has been driven very much from the collective initiative that the Government and put together of private and public partnerships. And the willingness to put capital at risk here.'* (IV14)

'*The Government here has this very ambitious green agenda. They're harnessing a big ecosystem for ESG or green finance and innovation around climate tech. They're attracting venture capital and private equity investors. They're attracting a lot of scientific knowledge, R&D, university collaborations, and they're attracting a lot of philanthropy*.' (IV03)

The sentiment amongst informants was that leadership on adaptation finance would entail doing something more:

'*If Singapore really wants to be a leader, I think we would need to do a decent job in our own adaptation plans. I really think we will do a good job* […] *If you want to become big at crowding private sector funding, there isn't enough real incentive for the private sector to get involved. So, for me, it mainly public at this point*.' (IV14)

Knowledge

Whilst the interviewees exhibited a wealth of knowledge about investing in incumbent low carbon technologies, urban adaptation is an area about which actors lack sufficient knowledge to find potential projects, assess investments and make informed decisions about whether to invest or not (A01, A02, G03, G05, G12, G13, IV01, IV04, IV06, IV07, IV11).

'It's still very basic. People don't know why it's [adaptation] important. […] *The funds going to it are minuscule* […] *and so globally as such, Singapore also reflects that*.' (A02)

'So, it's in this space [adaptation], there is that perception that it's too early, the returns are too low, so this is maybe not for me. I think another one is maybe the lack of knowledge about the actual technology and the opportunity. So, it's not clear which are the winner. […] *But absolutely we need more collaboration.*' (IV02)

'*I think that data would have to be better definitely in the marketplace. So that's why I know Singapore government or MAS has been driving several initiatives to improve the data availability.'* (IV07)

For investors, knowledge barriers arise in relation climate risk, impact measurement, adaptation projects, investment models and disclosure requirements. One interviewee said they were concerned that company board members lacked adequate knowledge of climate risk and adaptation needs (IV04). Another said they had to educate clients on these topics (IV07), whilst another stated that public servants needed upskilling in adaptation projects (IV10). Knowledge barriers also loom very large amongst government interviewees, manifesting primarily in understanding, assessment, and justification of what constitutes an adaptation project and the impact of adaptation measures.

'*We actually set up a national sea level rise program*[18] […] *for the financial sector specifically you also need to grow capabilities in terms of your financial risk modelling and the implications of climate change, both the physical risks as well as transition risks into your risk models*.' (G12)

Informants (G03, G12, IV01, IV03) highlighted the need methods and processes for measuring and assessing adaptation**.** Others mentioned the need for the market to vest value in adaptation through say a resilience pricing mechanism.

Sandbags a storey high placed along the coastline from Bedok Jetty to the East Coast Lagoon *(Photo source: TheHomeGround Asia)*

[18] National Sea Level Programme (NSLP) managed by the Climate Science Research Programme Office (CSRPO) under the Centre for Climate Research Singapore (CCRS) aims to coordinate relevant climate research and modelling of the physical mechanisms of sea level rise. More detail available at: https://www.nea.gov.sg/programmes-grants/grants-and-awards/research-innovation-and-enterprise-funding-initiatives/national-sea-level-programme

Industry networks

For incumbent technologies such as low carbon initiatives, there are already well-established industry networks in Singapore that support investors in their financing of projects. These networks help to build trust, collaboration, and knowledge-sharing, thereby building confidence in experimentation and increasing the willingness to invest. Participants strongly emphasised the need for cooperation and collaboration for adaptation and described with eagerness the interagency processes that have been initiated that could be used.

'*Singapore pulled together something they called the Emerging Stronger Taskforce**.** And what they basically did, they recruited 14 of the biggest CEOs here* […with seven areas of focus] *to create jobs.*' (IV14)

The future for adaptation financing in Singapore?

There is a large volume of publicly financed adaptation activity in Singapore which has been in place over many years and adaptation is a clear top priority of the Singapore Government. Unfortunately, it was not possible to quantify this effort as detailed plans, assessments and budgets are not in the public arena. Policy stability has been achieved and investors seemed to be embracing regulations and less concerned about the many recent changes in financial directives – in sustainable finance, disclosure, and climate risk.

Awareness of urban adaptation solutions and expertise in designing new financial vehicles suited to adaptation projects however is woefully lacking and is a prominent and reoccurring barrier. It was somewhat surprising that informants were unable to refer to innovative adaptation finance mechanisms found in other cities, such as climate risk pricing, climate risk-linked bonds, climate resilience bonds, mangrove bonds, green development funds, catastrophic risk insurance, etc. (ADB 2019; Buhr 2022; Whittaker & Jespersen 2022). Learning from the small number of existing innovative adaptation finance mechanisms across the globe is imperative.

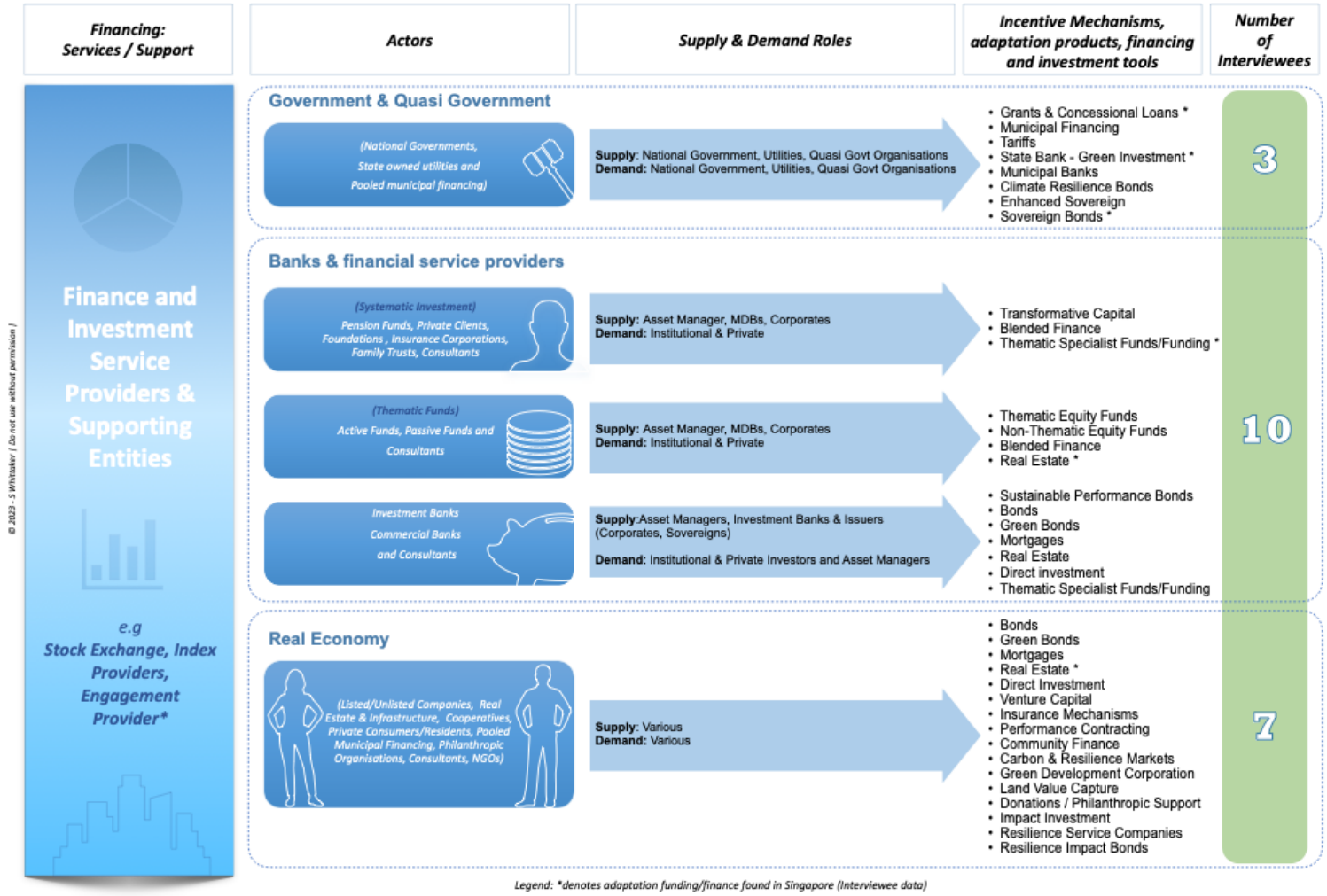
Raising finance is deeply rooted in historical and actor preferences. Explanations of the success, failure, and direction of an innovation pathway rest in these historical preferences. For example, actor and pathway dependencies ensure that almost all forms of private capital in climate finance deals with mitigation and most urban adaptation in Singapore is publicly funded, aside from some developer and philanthropic led interventions. Tracing the dominant financing routes is a key achievement of this study and enables the identification of patterns. In order to accelerate the diffusion of adaptation finance know-how there needs to be an opening up the investment actor space, thinking beyond current incumbents and creation of diversity of actors and approaches in this space. This means moving beyond government actors to involve a range of different investors and partners. However, this has been true for decades and we have not been doing well in this regard as we still have little in the way of risk transfer mechanisms from those available 10-15 years ago. Nevertheless, unravelling private capital and actors in this case can potentially guide public finance towards more transformative uses (Mazzucato & Semieniuk 2018).

a) Options for financing adaptation

We provide a snapshot in Figure 5 of the adaptation finance landscape depicting a range of potential financial market instruments according to investor types. Instruments we found in use in Singapore at present are highlighted, and these are predominantly Government funded approaches. Many of the instruments in Figure 5 are found already in mitigation markets, and some are easier than other to access, and structure and as a result could be easier to scale. Each are attractive to different investors, as each instrument (debt, equity, performance-based investment etc.) services different needs. Investors differ in their motivations and in their return requirements and risk appetite (Lloyds 2018, GARI 2022). While some, such as Family Trusts, may have below market return expectations, the majority expect financial returns and risk levels in line with market practice. In Singapore at present few of these thirty or more types of financing instruments are not yet attractive to investors and are therefore not found.

The green bond market would currently seem to offer the broadest range of possibilities, but it is not the only option. Green bonds are well known and in widespread use for mitigation but outside of the US municipal bond market, barely used for adaptation (GCA 2021; GCA 2022; Tuhkanen 2020). They are popular because they can be listed and traded, and are identical in every legal respect to vanilla bonds of the same issuer, in contrast to the bespoke nature of other types of instruments. A more nuanced approach to the reporting of what is deemed to be an adaptation activity within Green Bonds would also be highly beneficial.

Figure 5. The potential adaptation investment landscape in Singapore (2022)



Source: Adapted by the authors from Swiss Sustainable Finance (SSF) (2020)

Note: *The highlighted text are mechanisms emphasised by interviewees as in play in Singapore*

Whilst we cannot dissect the current future adaptation investment needs by sector and type of project for Singapore, it would be fair to assume that many will be infrastructure and coastal projects. Each project will be connected to the potential sources of capital (Figure 5) in different ways and require a very different involvement by the private sector. For instance, if we are talking about nature-based solutions we need to look at mechanisms in the real economy for land value capture, and if we are taking about climate-proofing critical infrastructure such as the Singapore Changi Airport, we could be looking at banks and asset managers and climate resilience or green bonds. Connecting investors, mechanisms and projects could be the subject for further detailed research.

Many interviewees mentioned that financial structuring would be required to bring more capital into adaptation investing. The most cited approach is through blended finance, and also mentioned was an investment portfolio as opposed to project-by-project approach. In Singapore blended finance and private-public-partnering approaches are being encouraged by the Monetary Authority of Singapore (MAS)[19], Infrastructure Asia and Enterprise Singapore and although infrastructure focused, they are not yet focused on adaptation infrastructure. Public or philanthropic capital in these approaches is used to leverage capital markets, however examples in climate in Singapore so far are restricted to low carbon investment. It is worth noting that in Singapore, most infrastructure is state-owned which matters in terms of the credit rating of potential issuers but also creates ownership complications. A greater level of maturity in the adaptation market would of course bring with it access to liquid and low-cost debt and equity, as well as reducing the cost and time limitations on multi-layered deals. Governance mechanism and incentives can play a role in encouraging, streamlining, and scaling the market.

b) Motivating private financing and creating the conditions for an adaptation market

So, what are the options to overcome investment challenges and what are the conditions for creating a successful adaptation market in Singapore? Figure 6 has been developed from the interviewees suggested primary interventions which are assembled according to their dominance (most cited) and transformation potential (the X axis), their interactions over time (the Y axis). It is assumed all would have the ultimate effect of increasing scale and liquidity in the market, but some could have a greater effect (Climate-Kic 2020; Geddes & Schmidt 2020; Smith & Raven 2012). Those interventions depicted in light blue are the most cited and more customary interventions, whilst those in dark blue are less common but the most

[19] The Monetary Authority of Singapore (MAS) is the central bank and integrated financial regulator of Singapore. It was established in 1971 to act as the banker to and a financial agent of the Government of Singapore.
Infrastructure Asia is a facilitation office set up by Enterprise Singapore and MAS to support Asia's social and economic growth through infrastructure development, working closely with both private and public sector organisations in Singapore and the region. Infrastructure Asia match-makes organisations that are domain experts in their respective fields with regional governments, firms, and multilateral development banks, bringing various industry stakeholders across the value chain together to explore project opportunities in Asia.
Enterprise Singapore is a government agency under the Ministry of Trade and Industry. It was formed on 1 April 2018 to support Singapore small and medium enterprises (SMEs) development through building capabilities, innovating, and internationalizing. The agency also supports the growth of Singapore as a hub for global trading and start-ups.
Convergence Blended Finance is a global network for blended finance with global membership including public, private, and philanthropic investors as well as sponsors of transactions and funds. In October 2022, MAS and Convergence Blended Finance launched a S$5 million Asia Climate Solutions Design Grant during the Transition Finance Towards Net Zero (TFNZ) Conference to mobilise capital into high impact target sectors such as early-stage climate adaptation and mitigation technology, clean energy access, sustainable transport sustainable cities and infrastructure, sustainable agriculture, and nature-based solutions.

likely to transform the 'ecosystem' of finance and grow a successful private adaptation market in Singapore. Figure 6 is constructed from similar previous work on the enablers/interventions for adaptation, nature, and low carbon markets (Holtedahl et al. 2022; Geddes & Schmidt 2020; Naidoo 2020; Whittaker & Jespersen 2022). It is envisaged that MAS would play a key role in all the market structure interventions. However, the required changes to structures and processes will need to go beyond the engagement of government and the central bank, to include commercial banks, institutional investors, and other financial actors in any transformation.

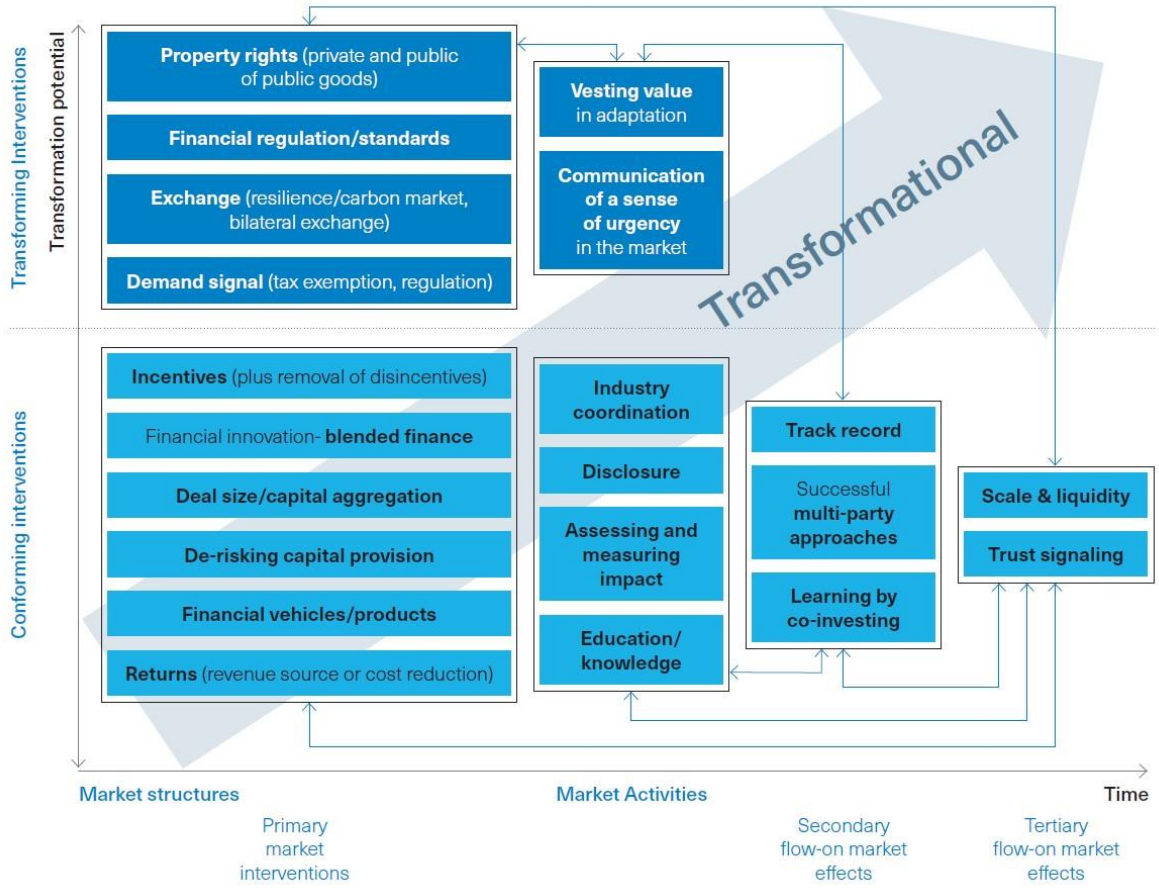
All the interventions interact and are dependent upon one another. As described in this research the private sector isn't investing in adaptation because of the fundamental reason that there is a lack of financial return or cost reduction potential, and these are further complicated by public good features and long-time horizons for projects. In addition, the government is crowding out some private investment. However, to tackle the returns hurdle for adaptation many other interventions are required.

'*If you can reduce tax burden by taking a mitigation measure – i.e., buying carbon credit, then you should also be able to contribute to adaptation in investment onshore or in your own company and have reduced tax burdens too. It's obviously not in place today and possibly not something that you could easily do. But I think if you really want to change things, you try to create the right incentives either from subsidies to innovations and technologies or reducing burdens,* […] *it's the 'free rider' problem that we have*.' (IV14)

'*When you put finances together, the question is what financing models are we using? Are we using financing models of the past and then trying to see how it works? Or do we need to be imaginative and innovative considering, the whole reason why we're doing all this*. *If we believe this is an existential threat, we definitely need a new financing model. Because the old financing models got us into this mess in the first place. So, then you need to find people who are open minded, who are willing to push the boundaries on finding better financing models that would be able to justify the need for adaptation solutions or mitigation solutions?*' (IV07)

'Singapore is in many respects the blueprint of how I think government private partnerships should work.'(IV14)

Figure 6. Potential market interventions and transformation to increase the flow of adaptation investments



Note: *The light blue boxes depict the more traditional market interventions, and the dark blue boxes are the less traditional interventions. Only those interventions most cited by interviewees are included.*
Source*: Adapted by the authors from Geddes & Schmidt (2020)*

Singapore has not yet considered the more innovative approaches which could act to transform the market, such as adaptation or resilience bonds or levies to pay for adaptation measures. Mixing financial instruments presents the Singapore Government with budget litheness. In addition, the government can look to the tools and techniques of private markets as means of enabling experimentation in adaptation. For instance, in the US in particular '*insurance techniques are being mobilized in interventions that collectivise and de-commodify risk, whether through investments in infrastructures that provide security as a public good or through programmes to reduce insurance costs'* (Collier & Cox 2021).

Conclusions

Singapore has an ambitious urban adaptation approach the elements of which are set out in Table 1, that is widely considered a model among capital cities throughout the world. It has been particularly successful in developing a whole of government approach to adaptation which set a clear transition pathway to a climate-adapted city. Singapore also has a suite of green/climate financing initiatives in play that are rarely seen, or at least reported, in other cities. The central bank (Monetary Authority Singapore (MAS)) in particular has played an instrumental and influential role, and one that is rarely observed in other countries. In addition, a 'sense of urgency' in tackling adaptation has been widely communicated from the top down in the City State. The importance of instilling a 'sense of urgency´ for investing in climate adaptation has been recently highlighted (Naidoo 2020; Whittaker & Jespersen 2022).

Despite the innovativeness of its approach, Singapore's approach is predominantly based on public finance, it has so far failed to include private capital partners in financing adaptation infrastructure. A lack of transparency on the city's climate adaptation needs, lack of knowledge of what constitutes climate adaptation, the public good nature of investments and the lack of investment opportunities are probably the most important factors which are causing investors of all types to postpone or delay investment activity. are also other key factors. The findings highlight that more could still be done to facilitate innovative financing for adaptation measures and projects. There are barriers to private sector financing of adaptation across the 'ecosystem' of finance. More far-reaching market intervention is required to overcome current barriers to investment and enable the market to mature and transform. We have structured the recommendations on potential interventions to paint a picture of what this is needed to nurture an adaptation market in Singapore, listing both market structure changes (such as tax incentives, compliance regulation etc.) as well as market activities (such as education, co-investment, instilling a sense of urgency in the market, vesting a value in adaptation and industry networks etc.).

Whilst Singapore has a particular form of governance and status being a city-nation, this should not however impact on its success in financing of adaptation by the private sector given that many of the suggested interventions involve a strong role by the state bank which could be replicated in many other nations and cities.

It is recognised that there is a need to transform the 'ecosystem' of finance - its structures and processes (IISD 2022). More ambitious views see the need for government in cities to take a 'state-market-civil society synergistic´ or 'entrepreneurial state' role in its governance of adaptation. Successful incentivisation of net zero and low carbon investment has been achieved in the last 20 years. We cannot afford to take 20 years to do the same for adaptation, but we can learn from this experience and apply it to adaptation with urgency. Without massive investments in adaptation cities, their economies, infrastructure, and people, are highly vulnerable to climate-induced extreme events which will be very costly to all. Even in a city such as Singapore with a well-developed publicly funded urban adaptation program, impacts and economic consequences could be much higher than anticipated and markets are surely needed to help avert a looming disaster.

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