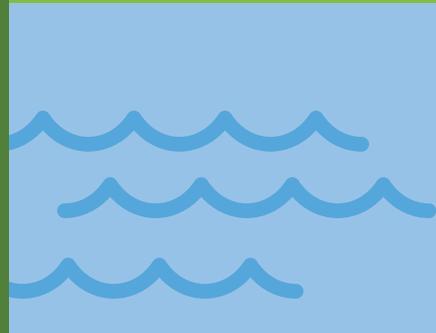


Stranded Assets: A Climate Risk Challenge



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Abbreviations

ASRIA	Association for Sustainable and Responsible Investment in Asia
CCS	Carbon capture and storage
COP	Conference of Parties
COP15	United Nations Climate Change Conference of Parties in Copenhagen
COP21	United Nations Climate Change Conference of Parties in Paris
DBF	Department of Banking and Finance (University of Zurich)
DEFRA	UK Department for Environment, Food and Rural Affairs
EIA	U.S. Energy Information Administration
ENSO	El Niño Southern Oscillation
EPA	U.S. Environmental Protection Agency
ESG	Environmental, social, and governance
ESG/RI	Environmental, social, and governance/Responsible investment
ESRB	European Systemic Risk Board
EU	European Union
FSB	Financial Stability Board
GDP	Gross domestic product
ICBC	Industrial and Commercial Bank of China
IDB	Inter-American Development Bank
IFC	International Finance Corporation
IIGCC	Institutional Investors Group on Climate Change
ILO	International Labor Organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
LAC	Latin America and the Caribbean
LNG	Liquefied natural gas
NCD	Natural Capital Declaration
NGO	Nongovernmental organization
OXWFD	Oxford World Financial Digest
PRA	Bank of England Prudential Regulation Authority
PRI	Principles for Responsible Investment

REDD+	Reducing Emissions from Deforestation and Forest Degradation
RI	Responsible investment
SFP	Sustainable Finance Programme (Oxford Smith School)
SRI	Socially responsible investment
TCFD	Task-Force on Climate-related Financial Disclosure
UNEP	United Nations Environment Programme
UNEP FI	United Nations Environment Programme Finance Initiative
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

Over the last few years, the topic of “stranded assets” resulting from environment-related risk factors has loomed larger. These factors include the effects of physical climate change as well as societal and regulatory responses to climate change. Despite the increasing prominence of these stranded assets as a topic of significant interest to academics, governments, financial institutions, and corporations, there has been little work specifically looking at this issue in Latin America and the Caribbean (LAC). This is a significant omission, given the region’s exposure to environment-related risk factors, the presence of extensive fossil fuel resources that may become “unburnable” given carbon budget constraints, and the particular challenges and opportunities facing lower-income and emerging economies in LAC.

This report includes an extensive literature review, reviews of case studies, in-depth interviews, extensive informal consultation, and a survey instrument to identify gaps in the stranded asset literature. The report builds on work undertaken in 2015 by the Inter-American Development Bank (IDB) on the issue of stranded assets. It aims to provide a deeper understanding of the issue and the existing literature about it, as well as highlight opportunities for future work, especially in LAC.

What Are Stranded Assets?

Stranded assets are defined as assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities (Caldecott, Howarth, and McSharry, 2013). Environment-related risks that can cause asset stranding include:

- Environmental challenges (e.g., climate change, natural capital degradation)
- Changing resource landscapes (e.g., shale gas abundance, phosphate scarcity)
- New government regulations (e.g., carbon pricing, air pollution regulation)
- Falling clean technology costs (e.g., solar photovoltaic, onshore wind, electric vehicles)
- Evolving social norms (e.g., fossil fuel divestment campaigns) and consumer behavior (e.g., certification schemes)
- Litigation (e.g., carbon liability) and changing statutory interpretations (e.g., fiduciary duty, disclosure requirements)

Focus on these risks has been accelerated by a wide range of support from a variety of significant international figures.¹ In addition, research on the topic of

¹ Mark Carney, the Governor of the Bank of England, became one of the most recent major figures to endorse this focus in a speech at Lloyd’s of London on September 29, 2015 (Carney, 2015). Others have included U.S. President Barack Obama; UN Secretary-General Ban Ki-moon; Jim Kim, President of the World Bank; Christiana Figueres, Executive Secretary of the United Nations Framework Convention on Climate Change; Angel Gurría, Secretary-General of the Organization for Economic Cooperation and Development; Lord Stern of Brentford; and Ben van Beurden, CEO of Shell plc.

“unburnable carbon,” which is strongly linked to the concept of stranded assets, has sparked one of the fastest-growing social movements in history – the fossil fuel free divestment campaign.

The campaign may not have a direct impact on company share value, but indirect impacts are likely to occur as a result of uncertainty and stigmatization affecting staff recruitment and retention, brand value, and the ability of stigmatized firms to influence policy (Ansar, Tilbury, and Caldecott, 2013). The divestment campaign has also contributed to an increase in support for shareholder resolutions that require greater disclosure from large listed fossil fuel companies.

Why Do Stranded Assets Matter?

Stranded assets are not just the result of climate change, and they involve sectors other than fossil fuels. Stranded assets are not considered a new phenomenon, but many interviewees expect that stranding will increase in the coming decades as a result of environmental and technological changes. Asked to rank the factors that will strand assets in the future, falling clean technology costs and physical environmental change were identified as the most likely.

Interviewees focused on the temporal aspect of stranding, noting that some assets will be stranded permanently, while others will only be temporarily affected by extreme weather or changing prices. Fossil fuels were seen as the sector most likely to be affected by stranding. However, other sectors were also highlighted as being at risk. Infrastructure (including transport, ports, and inefficient buildings), agriculture, real estate, mining, and utilities were all highlighted as being potentially affected by asset stranding.

Recent estimates suggest that 60 to 80 percent of publicly listed fossil fuel reserves must be considered “unburnable” if the world is to avoid disastrous climate change, potentially costing the fossil fuel industry \$28 trillion in revenues over the next two decades (Carbon Tracker, 2013a; Kepler Cheuvreux, 2014). This would likely be reflected in lower share prices, but could potentially lead to financial instability as a result of significant economic losses. However, if these unburnable fossil fuel reserves were to be burnt, the outcomes could be even worse, with subsequent climate change irrevocably altering the environment and affecting economic production as well as investment risk and returns (IPCC, 2014). Recent discussions of stranded assets are now moving beyond the “carbon bubble” and “unburnable carbon” and focusing more on how a wider range of environment-related political, economic, and social factors could affect asset values and stranded assets. Regardless of government policies, stranding can occur for a variety of reasons including the downward cost curve for renewables, pressure from investors, and pressure from students (Murray, 2015).

Sovereign debt could be at risk for economies that are climate-sensitive either through direct physical climate risks (such as storms or drought) or through overexposure to the fossil fuel sector (i.e. countries with large state-owned resources companies).

Investors – both asset owners and asset managers – are coming under increasing pressure to measure and disclose their exposure to stranded-asset risk. The interview process revealed that some investors have begun to explore this exposure in-depth and are taking steps to reduce their exposure. For asset managers, there is growing pressure to offer low-carbon products, including divestment and carbon footprinting tools. As a result, many fund managers are now offering equity strategies with a low-carbon tilt. However, interviewees noted that few tools were readily available to reduce stranding risk for other asset classes.

The survey also highlighted the absence of climate risk management strategies. The survey showed that 73 percent of participants did not have (or did not know) someone in their investment/financial organization responsible for ensuring that relevant climate risks had been considered. Nevertheless, survey respondents did use a variety of management tools – most notably negative and positive screening, although the non-use of tools remains high.

The survey found that only 20 percent of respondents believe there is adequate information to properly analyze corporate exposure to climate change. Providing management tools and strategies suitable for a wide range of investors of different sizes, asset class focuses, and geographies is important, but so is the ease of use of the tools.

Many financial institutions in LAC are mainly concerned with the economic growth and governance of the companies in which they are invested, and less so about environmental issues. Indigenous communities' rights and threats to a company's social license to operate are on the radar of financial institutions, and are currently considered more salient than issues such as stranded assets. Pension funds across the region tend to be more receptive to the impact of climate change and stranded assets on their portfolios given their long-term mandates. The consideration of environmental issues has gained more traction with financial industry associations across the region (e.g., the Brazilian Federation of Banks). Interviewees also pointed to the role of central banks, providing the example of the Brazilian central bank, which has a mandate to encourage all financial institutions to develop environmental, social, and governance risk management practices and processes, which it then judges in terms of whether they are fit for purpose.

The size of financial markets and the ownership of pension funds in LAC are important in determining the adoption of responsible investment principles across the investment value chain. Pension funds in LAC (particularly Chile and Peru) tend to be owned by international financial institutions, which have yet to deploy their responsible investment experience in the region even though on the global investment landscape they are considered leaders in responsible investment integration in decision-making.

The survey and interviews highlighted the ongoing shift toward greater awareness of stranded assets and broader climate consideration among financial communities internationally. However, interviewees based in Europe, the United States, and Australia showed greater urgency and appetite for integrating these issues than did interviewees in LAC, for whom issues of economic growth and governance were greater priorities.

Conclusions

Stranded assets resulting from environment-related risk factors, including the effects of physical climate change and societal and regulatory responses to climate change, have become increasingly prominent. This has been driven in large part by changes in the real economy (e.g., the falling cost of renewables), as well as by the attention generated by the Paris Agreement.

Levels of awareness and interest differ across countries and regions. Much of the early work on stranded assets originated in the United Kingdom, rapidly spreading to the United States and from there to other countries. There is currently significantly more awareness of stranded assets among financial institutions in the United States, Europe (particularly the United Kingdom, France, Netherlands, Sweden, Denmark, and Norway), China, and Australia than elsewhere.

While awareness of stranded assets among financial institutions has increased rapidly, developments in practice have not kept up. New products and tools have been launched to cater to new demand, but they are often based on carbon footprinting and related methodologies that financial institutions are increasingly questioning. There are growing calls for a new generation of data, analytical methods, and tools to help financial institutions differentiate between assets and companies that are more or less exposed to environment-related risks. Developing this next generation of analytics is critically important if financial institutions are to take account of environment-related risks that can strand assets through their decision-making.

Understanding the implications of stranded assets for successful low-carbon development is in an incipient phase. There has been some work on the need for a “just transition,” but this has been relatively high-level work that pre-dates much of the discourse on stranded assets. There is very little work looking at how to systematically identify assets that could be stranded by decarbonization in order to develop policy responses that can preempt destabilizing opposition that might result. There are significant opportunities to create tools to help policymakers understand when and where assets may become stranded, in turn enabling them to develop adequate policy and regulatory responses. There is an opportunity for pioneering work in this field in LAC.

Stranded assets could be a systemic risk to financial stability and should therefore be a topic of concern for central banks and financial regulators. There are also issues related to macro and microprudential regulation and the conduct and practices of financial institutions that make stranded assets of relevance to supervisory bodies. Much of the work in this area has been led by the Bank of England, with the Financial Stability Board and the European Systemic Risk Board also producing work. Other central banks are likely to follow suit. There could be opportunities for LAC regulators to pioneer developments in this area, particularly given that the Brazilian central bank has a progressive mandate to encourage all financial institutions to develop environmental, social, and governance risk management practices and processes.

Greater attention to framing and diffusing risks and opportunities, and to providing diverse but practical management tools, is needed to support the uptake of responses to stranded assets. This is particularly the case in LAC, where other factors such as governance and development issues vie for primacy among investment priorities, and where there are more limited opportunities for sustainable options in the smaller financial markets.

1. Introduction

1.1 Objectives

Over the last few years, the topic of “stranded assets” resulting from environment-related risk factors has loomed larger. These risk factors include physical climate change impacts as well as societal and regulatory responses to climate change. Despite the increasing prominence of stranded assets as a topic of significant interest to academics, governments, financial institutions, and corporations, there has been little work specifically looking at this issue in Latin America and the Caribbean (LAC). This is a significant omission, given the region’s exposure to environment-related risk factors, the presence of extensive fossil fuel resources that may become “unburnable” given carbon budget constraints, and the particular challenges and opportunities facing lower-income and emerging economies in LAC.

This report seeks to contribute to closing this gap in the literature. We provide an in-depth summary of existing literature, exploring the key issues relating to stranded assets through an analysis of three areas:

1. Understanding systemic climate risks: implications for the financial sector and lessons for central banks and financial regulators
2. Stranded assets and development: ensuring that low-carbon development pathways are resilient to asset stranding
3. Investor exposure to stranded assets: managing investments and portfolios exposed to environment-related risks

This report builds on work undertaken in 2015 by the Inter-American Development Bank (IDB) on the issue of stranded assets. It aims to provide a deeper understanding of the issue and the existing literature that exists, as well as highlight opportunities for future research, especially in LAC. The report also draws on results from extensive empirical interview and survey data to help identify existing and future work on stranded assets by organizations internationally. Finally, the report provides an up-to-date summary of the literature and current best practices that could help shape IDB activities in LAC.

1.2 Structure

This opening section explains the purpose, structure, and approach of the report and introduces key concepts related to stranded assets, which are defined as assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities. Section 2 is an in-depth literature review of research on stranded assets. It explores the chronological and geographical development of this research, outlining the contribution of a range of actors in the production of knowledge on stranded assets. Section 3 sets out a number of brief case studies aimed at highlighting the real-world importance and applicability of stranded assets research. Section 4 presents interviews and survey data produced by the Sustainable Finance Programme at the University of Oxford Smith School of Enterprise and the Environment (referred to here as the “Oxford Smith School”). This empirical research aims to provide ad-

ditional content on known and reported activities, identify activities that might not be known to study authors, and highlight relevant work that might be in the pipeline but is not yet in the public domain. This should provide additional insight into recent and future stranded-asset-related work that could be relevant to LAC. Section 5 puts forth conclusions.

1.3 Methodology

The research for this report was conducted between March and June 2016, building on recent interviews and survey data generated by the Oxford Smith School in 2015–2016. The topic of stranded assets is a rapidly evolving discourse and research field, and although we have endeavored to summarize all the key literature, it is not possible to create a definitive summary given the ongoing nature of the debate and research.

The literature review draws on a wide variety of sources so as to better acknowledge the range of actors involved and the diversity of research on stranded assets. Reference to academic journal articles is made, but the literature review also relies heavily on “grey literature,” including reports, speeches, government white papers, and business research notes. This diversity of sources speaks to the broad relevance of stranded assets as a concept that an array of institutions – from public and private to financial and political – are seeking to understand and research. Given the speed at which stranded assets has become an important topic, the academic literature is still relatively limited, primarily because of the comparatively long peer review and publication process for journals. Researchers have consequently opted for the publication of working papers or reports to ensure

that their research has maximum impact outside of academia in a timely manner. Grey literature has often come under scrutiny among some academics, suggesting that the lack of peer review could reduce the rigor and validity of research. However, research has shown that although published research is more likely to contain results from larger samples, methodological rigor does not appear to differ between published and grey literature (Conn et al., 2015).

To produce a systematic and thorough literature review, we divided the research focus into three themes, using the topics of systemic risk, development, and investor exposure to stranded assets to guide the literature review process. This review builds on existing literature surveys undertaken by the Oxford Smith School. Members of this research group have been studying stranded assets since 2010, and have consequently developed a wealth of knowledge on the subject from which to build this literature search. In addition, the Oxford Smith School’s Global Sustainable Finance Advisory Council plays an important role in helping to coordinate stranded assets-related work globally, so the Oxford Smith School team has strong insight into the work streams, projects, and research being undertaken by leading organizations internationally.

For each topic, we conducted primary literature searches through a range of web-based search tools, including Scopus, University of Oxford library databases (the Bodleian’s “Solo”), GoogleScholar, citation lists, and references from leading stranded asset articles. Following this initial search, we looked at websites and publications linked to key actors and organizations identified by previous research, notably governments, regulators, financial institutions, companies, think tanks, and non-governmental organi-

zations (NGOs). Several researchers were involved in this process in order to facilitate a wider scope of literature findings and reduce individual sample bias. In particular, each team member focused on identifying chronological and geographical development in research, with particular attention aimed at highlighting literature relating to stranded assets and environmental-related risks and opportunities in LAC.

One aim of the literature review is to create case studies that could aid in the dissemination of best practices in stranded-assets-related work. The project team, in collaboration with the IDB, chose the topics of the case studies based on the literature reviews and existing knowledge of the subject area. These case studies are based on a range of publicly available information and discussions with key actors. Each case study is presented in a uniform format to facilitate ease-of-use and comparability. The aim of the case studies is to focus greater attention on work that could be adapted and made relevant to LAC.

In addition to the literature review, we draw on a survey produced in 2015 by the Oxford Smith School that explores the availability of knowledge on climate issues in the investment arena internationally (Harnett, 2016). This survey was disseminated via email to members of the Oxford World Financial Digest (OXWFD), an online news outlet aimed at investment professionals. With a total 154 participants, the survey provides an international analysis of mainstream investor viewpoints: 38.7 percent of survey respondents were executives and a further 27.8 percent were investment managers. Only 4.7 percent were environmental, social, and governance/responsible investment (ESG/RI) specialists,

while 40.6 percent worked in asset management organizations. Other organizations represented included pension funds, investment banks, and financial advisory firms. The majority of responses were from the United States. Other countries represented in the survey sample included the United Kingdom, the Netherlands, Australia, and France. This survey is used to further explore the understanding (or lack thereof) surrounding stranded assets issues among investors, and the integration of the concept into investment decisions.

To complement this literature review and survey data, the project team also undertook 18 structured interviews with key individuals working on stranded assets. Stakeholders interviewed include corporations seeking finance, asset managers, asset owners, service providers (i.e., law firms, data providers), NGOs, and thought leaders (e.g., think tanks, academic institutions). The list of organizations interviewed is available in Annex 1. The organizations were contacted directly by the Oxford Smith School team. The list of questions (see Annex 2) was designed and agreed to by both the Oxford Smith School and the IDB. This structured approach to questions facilitated comparable results across multiple interviewers. Interviews were written up by project team members who conducted the interviews, and the results were analyzed collectively to create an anonymous data set. Interviews took place in person in London or via telephone. Each interview lasted between 30 minutes and an hour, and participants were asked to confirm their consent to the interview after an explanation of the project and its aims and outputs.

2. Literature Review

2.1 What Are Stranded Assets and Why Do They Matter?

The concept of “stranded assets” has attracted significant interest over the past five years as the financial community has faced increasing socio-political pressure to calculate its exposure to environment-related risk (Covington and Thamotheram 2014; Ansar, Tilbury, and Caldecott 2013). Stranded assets are defined as assets that have suffered from unanticipated or premature write-downs, devaluations, or conversion to liabilities (Caldecott, Howarth, and McSharry 2013). Environment-related risks that can strand assets include:

- Environmental challenges (e.g., climate change, natural capital degradation)
- Changing resource landscapes (e.g., shale gas abundance, phosphate scarcity)
- New government regulations (e.g., carbon pricing, air pollution regulation)
- Falling clean technology costs (e.g., solar photovoltaic, onshore wind, electric vehicles)
- Evolving social norms (e.g., fossil fuel divestment campaign) and consumer behavior (e.g., certification schemes)
- Litigation (e.g., carbon liability) and changing statutory interpretations (e.g., fiduciary duty, disclosure requirements).

Focus on these risks has been accelerated by support from a variety of significant international figures. Mark Carney, the Governor of the Bank of England and Chair of the G20 Financial Stability Board, became one of the most recent to endorse this focus

in a speech at Lloyd’s of London on September 29, 2015 (Carney, 2015). Others have included UN Secretary-General Ban Ki-moon (McGrath 2014), US President Barack Obama (Friedman 2014), Jim Kim, President of the World Bank (World Bank 2013a; World Bank 2013b), Angel Gurría, Secretary-General of the OECD (Gurría 2013), Christiana Figueres, former Executive Secretary of the UNFCCC (Christiana Figueres 2013), Lord Stern of Brentford (London School of Economics 2013), and Ben van Beurden, CEO of Shell plc (Mufson 2014).

In addition, research on the topic of “unburnable carbon,” which is strongly linked to the concept of stranded assets, has sparked one of the fastest-growing social movements in history – the fossil free divestment campaign (Ansar, Tilbury, and Caldecott 2013). The campaign may not have a direct impact on company share value, but indirect impacts are likely to occur as a result of uncertainty and stigmatization affecting staff recruitment and retention, brand value, and the ability to influence policy (Ansar, Tilbury, and Caldecott 2013). The divestment campaign has also contributed to an increase in support for shareholder resolutions requiring greater disclosure from large listed fossil fuel companies. For example, UK (and some European) institutional investors have joined together with leading NGOs to form the “Aiming for A” coalition. This focuses on in-depth engagement with the largest UK-listed extractives companies to support them in their preparations for the low-carbon transition. This work has included direct engage-

ment as well as the organization of shareholder resolutions to focus corporate attention on the creation and disclosure of “strategic resilience for 2035 and beyond” (Investor Platform for Climate Actions 2016).

Stranded assets are a regular feature of economic systems and are a phenomenon inherent in the “creative destruction” of economic growth and technological change (Caldecott and McDaniels 2014b). Stranded assets can be caused by a wide variety of factors, not just those related to climate change or the environment. For example, a 1996 IDB report identified stranded generation assets in LAC as a result of declining energy demand growth in the 1980s that was a consequence of a number of economic crises (Dussan 1996).

Recent research on stranded assets, however, has emphasized that some of the causes of asset stranding are changing and are increasingly environment-related (Caldecott and McDaniels 2014a). Such factors appear to be stranding assets across a wide range of sectors, geography, and asset classes, and this trend is accelerating (Caldecott and McDaniels 2014a). For example, the number of events and overall insured losses worldwide related to climate change has increased significantly in the last two decades (MunichRe 2014). Data gathered by the London School of Economics shows that over the past decade climate change regulations have increased rapidly: the international study of 66 countries found that in 2012 there were almost 500 climate-related regulations, compared to fewer than 40 regulations in 1997 (Nachmany et al. 2014). In addition, the world is now adding more capacity for clean power each year than coal, natural gas, and oil combined (Li-breich 2015).

In 2011, the Carbon Tracker Initiative highlighted a potential “carbon bubble” within the global economy (Carbon Tracker Initiative 2011), building on work by Krause et al. (Krause, Bach, and Koomey 1989) that suggested that fossil fuel companies could be overvalued due to future climate regulation. Recent estimates suggest that 60–80 percent of publicly listed fossil fuel reserves are “unburnable” if the world is to avoid disastrous climate change, potentially costing the fossil fuel industry \$28 trillion in revenues over the next two decades (Carbon Tracker Initiative 2013; Kepler Cheuvreux 2014). This would likely be reflected in lower share prices, but could potentially lead to financial instability as a result of significant economic losses. The Australia Institute (The Australia Institute 2014) consequently described the valuations of fossil fuel companies as “a fundamental intellectual ‘fallacy of composition’ – analogous to the traditional speculative bubble.”

However, if these unburnable fossil fuel reserves were to be burnt, the outcomes could be even worse, with subsequent climate change irrevocably altering the environment, and affecting economic production as well as investment risk and returns (IPCC 2014). This dynamic process poses risks to individuals and firms beyond the fossil fuel sector, and has been shown to have sectoral or potentially systemic implications (Caldecott and Robins 2014). The recent discussions of stranded assets are now moving beyond the carbon bubble and unburnable carbon themes and focusing on how a wider range of environment-related political, economic, and social factors could affect asset values and strand assets.

2.2 From Climate Change Impacts to Systemic Financial Risk: Implications for the Financial Sector and Lessons for Central Banks and Financial Regulators

One key area of work on stranded assets seeks to understand whether physical climate change impacts and societal responses to climate change could have financial stability implications, and if so, what the appropriate response from central banks and financial regulators would be. This section reviews the literature in this area, beginning with an examination of systemic risk and how it may cause financial instability.

Kaufman (2000) and IMF (2001) define systemic financial risk as the risk that an event will cause significant loss of economic value or be a shock that produces adverse effects for a significant part of an economic system. Mishkin (1995) provides a complementary definition as “the likelihood of a sudden, usually unexpected, event that disrupts information in financial markets, making them unable to effectively channel funds to those parties with the most productive investment opportunities.”

IMF (2001) further explains that adverse economic effects can arise through (1) payment system disruptions (causing potential failure of illiquid but solvent firms); (2) credit flow disruptions (interruption of the supply of funds to nonfinancial sector investment opportunities); and (3) asset value destruction (potential failures of financial and non-financial firms, decreases in economic activity, and declines in wealth). Financial institutions and markets can be impacted by

events that originate in the real economy, financial markets, or even within one or more financial institutions.

One of the leading initiatives to call for an assessment of whether climate change could pose a systemic risk to the financial system was the January 2012 coalition of investors, NGOs and universities, led by Climate Change Capital. This group wrote to the Bank of England to request an investigation into how exposure to polluting and environmentally damaging investments might pose a systemic risk to the UK financial system and prospects for long-term economic growth.¹ In February 2012, Governor Mervyn King responded to the letter by outlining three conditions that needed to be met to consider carbon-intensive investment as being a threat to financial stability. The conditions were:

1. That exposures of financial institutions to carbon-intensive sectors are large relative to overall assets;
2. That the impact of policy and technology is not already being priced into the market, either through lower expected returns or higher risk premiums; and
3. That any subsequent correction would not allow financial institutions to adjust their portfolios in an orderly manner.

Following this initiative, the UK Department for Environment, Food and Rural Affairs (Defra) invited the Bank of England Prudential Regulation Authority (PRA) – which is responsible

1 Bank of England – Supervisory Activities – Climate Change Adaptation Reporting (2012–2016).

for the prudential regulation and supervision of around 1,700 financial institutions in the United Kingdom³ – to submit a Climate Change Adaptation Report “focusing on the impact of climate change on the PRA’s objectives (with a focus on insurance) and the role of insurance regulation in supporting adaptation to climate change, including proposals and policies the PRA may choose to adopt, and timescales for their implementation.”⁴ In response, the Governor of the Bank of England, Mark Carney, gave a major speech at Lloyds’s of London on the topic (Carney 2015), and the Bank of England simultaneously published the PRA’s Climate Change Adaptation Report (Bank of England, 2015).

In the governor’s speech and accompanying report, the Bank of England identifies how three types of climate-related risk could potentially affect financial stability:

1. **Physical risks:** The first-order risks that arise from weather-related events, such as floods and storms. They are comprised of impacts directly resulting from such events, such as damage to property, and also those that may arise indirectly through subsequent events, such as disruption of global supply chains or resource scarcity.
2. **Transition risks:** The financial risks that could arise from the transition to a lower-carbon economy. For insurance firms, this risk factor is

mainly about the potential repricing of carbon-intensive financial assets, and the speed at which any such repricing might occur. To a lesser extent, insurers may also need to adapt to potential impacts on the liability side resulting from reductions in insurance premiums in carbon-intensive sectors.

3. **Liability risks:** Risks that could arise for insurance firms from parties that have suffered loss and damage from climate change, and then seek to recover losses from others whom they believe may have been responsible. Where such claims are successful, those parties against whom the claims are made may seek to pass on some or all of the cost to insurance firms under third-party liability contracts such as professional indemnity or directors’ and officers’ insurance.

The report finds transition risks to be relevant to financial institutions holding at least two types of financial assets (representing approximately 30 percent of global equity and fixed-income investments, as illustrated in Figure 1):

Tier 1 – Securities of firms that may be impacted directly by regulatory limits in terms of their ability to produce or use fossil fuels (e.g., coal, oil and gas, and extraction companies)

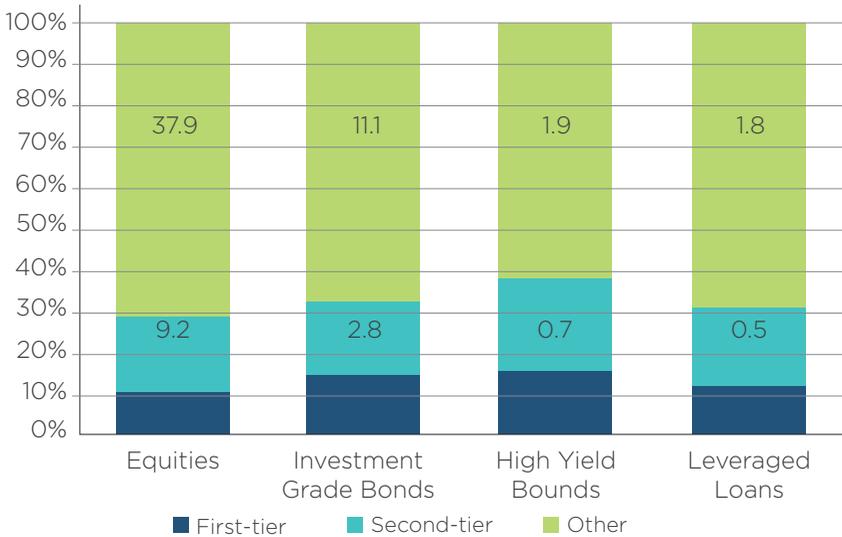
Tier 2 – Securities of firms that are energy-intensive (e.g., forestry, paper, metals and mining, etc.).

2 See Prudential Regulation Authority at <http://www.bankofengland.co.uk/pr/Pages/default.aspx>.

3 The PRA Adaptation Reporting Letter is available at <http://www.bankofengland.co.uk/pr/Pages/supervision/activities/climatechange.aspx>.

Figure 1

Value at Risk due to fossil fuel exposure across equity and fixed income assets exposed to transition risks.



Source: Bank of England (2015)

The PRA believes that while the insurance industry is relatively well equipped to deal with physical risks resulting from climate change, and that liability risks are already evident through cases related to failure to mitigate, adapt, or disclose climate related-risks, transition risks are less understood and require further and more granular examination that takes into account the speed of the low-carbon transition. The report concludes with the PRA’s commitment to focus on “promoting resilience to climate change and supporting an orderly financial sector transition to a low carbon economy ...through a combination of international collaboration, research, dialogue and supervision.” (Bank of England 2015).

Following the Bank of England PRA report, the Financial Stability Board (FSB), an international body set up in 2009 as to promote financial stability and assess the vulnerabilities of

the global financial system, proposed that G20 finance ministers and central bank governors establish an industry-led disclosure task force (modeled on the successful example of the FSB’s Enhanced Disclosure Task Force) “to undertake a coordinated assessment of what constitutes efficient and effective disclosure and design a set of recommendations for voluntary company financial disclosures of climate-related risks that are responsive to the needs of lenders, insurers, investors, and other users of disclosures” (TCFD 2016, 3). The Task Force on Climate-related Financial Disclosures (TCFD) was established in December 2015 and chaired by Michael Bloomberg, with a membership that spans private providers of capital, major issuers, accounting firms, and rating agencies. Its remit is to deliver two reports: “(i) a first report (to be delivered on March 31, 2016) that will set out the scope and high-level objectives for the proposed work, together with a set of fundamen-

tal principles of disclosure, to provide an enduring disclosure framework and guide the Task Force's Phase II recommendation; ii) a final report (to be delivered by the end of 2016) that will set out specific recommendations and guidelines for voluntary disclosure by identifying leading practices to improve consistency, accessibility, clarity, and usefulness of climate-related financial reporting" (TCFD 2016). In order to make the recommendations and guidelines meaningful and substantive, the TCFD launched a public consultation with a broad spectrum of stakeholders across academia, industry, and NGOs.

Following the Bank of England's lead, the European Systemic Risk Board (ESRB) published the report "Too Late, Too Sudden: Transition to a Low-carbon Economy and Systemic Risk" (ESRB 2016). The report identifies two channels through which a late and abrupt transition to a low-carbon economy could affect systemic financial risk: (1) the macroeconomic impact of sudden changes in energy use, and (2) the rapid revaluation of carbon-intensive assets. The report argues that a sudden low-carbon transition would result in a restricted energy supply coupled with increased energy costs, which would impair economic activity. In addition, it suggests that financial institutions could be affected by their exposure to carbon-intensive assets, which could then have financial stability implications.

The report further suggests steps that the ESRB could take to manage these risks. In the short term, the ESRB could support enhanced information collection and disclosure, which could take the shape of additional reporting requirements. In the medium term, the ESRB could perform dedicated climate stress tests of the European financial system. Potential policy options include (1) building systemic capital

buffers to protect against macroeconomic implications of an adverse climate shock to the financial system; (2) regulatory loss absorbency requirements; (3) capital surcharges based on carbon intensity of individual exposures; and (4) large exposure limits to assets prone to be at risk from the low-carbon transition.

Caldecott and McDaniels (2014a), in a paper produced to support the work of the United Nations Environment Programme (UNEP) Inquiry into the Design of a Sustainable Financial System (the "UNEP Inquiry"), find that environmental change and natural capital depletion, "could potentially pose systemic risks to financial stability, however, the processes through which this may happen are unclear and may be remote." The authors argue that although in the short term environment-related risks are unlikely to translate into systemic financial risk, there is growing evidence for the increasing materiality of environmental issues and how these could affect the stability of the global financial system. The paper develops three scenarios for how this could occur: bottom-up contagion, capital flight, and hazard globalization:

- Bottom-up contagion: This scenario argues that if mispriced environmental risks are repriced at sufficient speed and scale they could have a cascading effect and affect financial stability.
- Capital flight: Natural capital catastrophes driven by climate change result in significant negative capital outflows from an impacted country.
- Hazard globalization: Natural catastrophes and natural capital degradation resulting from climate change can significantly affect global markets and trade flows through price-based shifts, regulatory actions, or supply chain disruption.

tions (e.g., global wheat prices doubled from 2010 to 2011 in response to supply shortages brought on by shifting weather patterns). This has macroeconomic impacts, such as increases in inflation and currency volatility that can significantly impact countries dependent on imports (Sternberg 2013).

The UNEP Inquiry (2015) has suggested several ways in which central banks can promote resilience in the financial system. First, central banks can conduct or commission environmental stress tests to evaluate the impacts of plausible environmental scenarios on portfolios, institutions, and financial markets as a whole. The study also emphasizes the tools available to central banks to align their operations with sustainable development goals. These include refinancing (e.g., establishing dedicated credit lines for green investments), liquidity operations (adapting the requirements for collateral in repurchase agreements to include low-carbon assets), interest rates, balance sheet management (incorporating ESG considerations into the asset allocation process), quantitative easing (focusing on green assets in special asset purchase programs), and transparency and reporting (enhancing financial markets functioning through improved environmental risks disclosure).

In LAC, the UNEP Inquiry (2014) completed a case study entitled the “Brazilian Financial System and the Green Economy.” The case study noted that according to the Brazilian constitution, the financial system serves a public purpose by being “structured in a way to foster balanced development in Brazil” and by acting on behalf of collective interests. The resolutions of the Brazilian central bank related to environmental issues post-2008 include introducing environmental compliance and enhanced due diligence for financial institutions providing credit

to borrowers operating in the Amazon biome; establishing a program in the Brazilian Development Bank Framework to reduce greenhouse gas emissions; and introducing rules on financing climate mitigation and adaptation (see Table 1).

The report also states that in Brazil, the “lack of accurate information regarding responsibilities attributed to financial system actors – such as financial institutions, investors, certifying and regulatory agencies – associated with socio-environmental impacts of projects and initiatives in which they are involved, is certainly an inhibitor to channel capital to the Green Economy, and it is a topic that must be addressed by applicable legal instruments” (UNEP Inquiry 2014).

A similar report, commissioned by the International Finance Corporation (IFC) and written by the UNEP Inquiry, focuses on aligning sustainable development goals with financial markets in Colombia (Ramírez et al. 2015). The report includes the views of 38 heads of Colombian financial institutions, including private pension funds, private equity funds, insurance companies, commercial banks, development banks, asset managers, financial associations, government and regulatory agencies, and private standard setters.

This report finds that “the Central Bank is currently participating in policy debates about the role that international reserves could play in financing basic social programs, the infrastructure deficit, or the sustainability of the pension system. Thus, green finance is still perceived as an advanced topic for monetary policy debates and is not currently on the agenda of the Central Bank initiatives” (Ramírez et al. 2015). Nonetheless, there is wide consensus from the interviews that Colombia’s central bank understands the potential impacts environmental issues could have on the financial system.

Table 1: Brazilian Central Bank Resolutions and Circulars

Resolution / Circular	Bank Operations Impacted	Description
Resolution 3545/2008	Rural credit – environmental compliance in the Amazon	Applies to the amazon biome. Requires financial institutions to demand from credit borrowers documentation proving environmental compliance.
Resolution 3813/2009	Rural credit – sugar cane expansion	Links agro-industrial credit to the agro-ecological zoning for expansion and industrialization of sugar cane. Prohibits financing for crop expansion in the Amazon and Pantanal biomes, as well as in the Upper Paraguay River Basin, among other areas.
Resolution 3876/2010	Rural credit – labor	Prohibits rural credit granting either to individuals or business who keep workers in poor conditions, according to the List of Employers elaborated by the Ministry of Labor and Employment.
Resolution 3896/2010	Rural credit – low carbon agriculture	Establishes the Program for Reducing Greenhouse Gas Emissions (ABC Program) in the Brazilian Development Bank (BNDES) framework.
Resolution 4008/2011	Credit for mitigation and adaptation to climate change	Rules on the financing of projects aiming at climate mitigation and adaptation, backed by resources from the National Plan for Climate Change (FNMC).
Resolution 3547/2011	Internal capital adequacy assessment process – ICAAP	Requires that the institution demonstrate how it considers the risk of exposition to socio-environmental damages in its assessment process and in the calculation of capital needed for risks.
Resolution 4327/2014	Financial institutions socio-environmental responsibility	Rules on guidelines that shall be observed upon establishing and deploying socio-environmental responsibilities by Sistema Financiero Nacional (Brazilian Financial System).

Source: UNEP Inquiry (2014).

In the academic literature, several recent papers have experimented with stress tests and models that attempt to shed light on the implications of environmental risks to financial stability. Battiston et al. (2016) have examined the exposure of European financial institutions to fossil fuel production and energy-intensive sectors through their portfolios of European and U.S. equity holdings and loans. The authors find that European asset managers have

the largest direct exposure to the securities of the fossil fuel production sector and energy-intensive sectors. Banks and pension funds have significant exposure to investment funds, and hence are indirectly exposed to fossil fuels. In addition, the study provides a systemic risk assessment of climate policy shocks for the top 50 listed European Union (EU) banks by asset size. The authors conclude that while the complete write-down of the

market capitalization of the fossil fuel sector is improbable, less dramatic scenarios could still result in some highly exposed banks incurring substantial losses that could result in insolvency.

Weyzig et al. (2014) also look at the EU financial system and stranded assets. First, they estimate the equity, bond, and credit exposures of EU financial institutions to holdings in upstream fossil fuel producers. They find that the exposures to fossil fuels are approximately 5 percent of total assets for pension funds, 4 percent for insurance companies, and 1.4 percent for banks. Unlike Battiston et al. (2016), the Weyzig study focuses solely on fossil fuel exploration and production companies. It concludes that while a

carbon bubble is unlikely to threaten overall financial stability, such a shock would be harder to absorb during a period of economic fragility in Europe. However, the authors acknowledge that by focusing only on potential losses in upstream fossil fuel production, they probably underestimate the likely impact of being exposed to fossil fuels across sectors.

Prominent academics, such as Lord Stern, have also engaged in the topic of financial stability and climate change. In a 2016 presentation to the Bank for International Settlements, Stern argues that climate change is relevant to central banks because it will affect long-term economic stability and growth (Stern 2016).

2.3 Stranded Assets and Development: Ensuring Low-Carbon Development Pathways Are Resilient to Asset Stranding

The Paris Agreement aims to hold ‘the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels.’ This target has significant implications for the scale and pace of decarbonization required. Consequently, it has sent a strong signal to the global financial markets and governments about investing in technologies and policies that will facilitate a low-carbon transition (Hobley 2015).

However, the faster the pace of decarbonization, the greater the chance of transition risk induced asset stranding in different sectors, and the larger the likely economic, social, and political consequences that might need to be managed (Caldecott 2015). The

impact of such asset stranding needs to be monitored closely, particularly in developing nations where such stranded assets could destabilize efforts to improve economic growth and socioeconomic development (Caldecott 2015). The transition toward a low-carbon pathway globally needs to be managed in a way that does not disproportionately disadvantage developing countries (Swilling and Annecke 2010; International Labor Organization 2010; Stevis and Felli 2014). An important report by the World Bank on decarbonizing development argued for early action on climate change in developing countries, as “early action avoids lock-ins and is cost-effective: delays today need to be offset by faster decarbonization tomorrow, meaning higher costs and stranded assets” (Fay et al. 2015).

The implied asset stranding associated with NDCs also has implications for development pathways and the role of donor agencies. Historically some multilateral banks, donors, companies, and governments have come together to promote or support “extractives-led growth”. This has assumed that low-income countries with fossil fuel, mineral, or metal resources will be able to deploy them for economic development (Lahn and Bradley 2016). This assumption looks fatally flawed from the perspective of breaching critical environmental thresholds, such as carbon budgets.

However, little has been written on the topic of stranded assets in the context of development pathways. To date, most stranded asset research has been concentrated on developed countries and their financial markets and investors. There is surprisingly little on how to measure, monitor, and develop effective policy responses to asset stranding within developing and emerging countries while considering issues of equity and fairness. Although there is an extensive literature on the equitable distribution of the burdens of combating climate change and the equitable transition to a low-carbon world, these studies have focused overwhelmingly on consumption of fossil fuels and the emission of greenhouse gases, and not on the production and sale of fossil fuels.⁴

This section will explore the existing literature on the concept of “just transitions” in the context of Nationally Determined Contributions (NDCs) and the Paris Agreement. Following this, the section will look at the literature on fossil fuel production, agriculture and forestry, and tourism sectors that highlights the risk of stranding in natural resource dependent developing

countries. The potential for stranding human capital (in addition to physical assets) to the detriment of further development will also be examined. Finally, the section will explore the literature on the capacity of developing nations to deal with stranded assets.

2.3.1 Just Transitions and Stranded Assets

A growing literature explores the concept of “just transitions,” underlining the equity issues surrounding national decarbonization strategies. This literature identifies the need for transitions toward a low-carbon global economy, and recognizes the fact that developing and developed countries face different risks and opportunities, and have varying levels of capacity, regarding mitigation of and adaptation to environmental change. These issues are implicit in the 17 Sustainable Development Goals adopted in 2015 (United Nations 2016).

This is a salient issue for developing countries whose right to development and access to affordable energy should not be compromised by low-carbon transition goals (Swilling and Annecke 2010). The growing just transition literature points out the inequalities generated by efforts to tackle climate change, noting that the need for political trade-offs to ensure a low-carbon future can be achieved without undermining development and exacerbating inequality (Working Lives Research Institute 2008; Farrell 2012; Stevis and Felli 2014). This implies exploring the best possible outcomes for those whose livelihoods are affected by and dependent on a fossil fuel economy, and who will otherwise

4 An exception is Caney (2016) who seeks to identify and evaluate the ethical issues surrounding stranded fossil fuel assets.

lose their jobs and communities (Newell and Mulvaney 2013). Furthermore, the concept of just transition seeks to focus greater attention among policymakers on the concepts of “climate justice” and “inter-generational justice” (Moellendorf 2015; Bond and Dorsey 2010; Thomas and Twyman 2005).

The energy needs of developing countries can also be seen to clash on a national scale with efforts to create low-carbon development pathways. A recent ClimateScope report by Bloomberg New Energy Finance for a group of development agencies (including the IDB’s Multilateral Investment Fund) shows that the growth rate of wind farms and solar plants in China, India, and an array of smaller developing countries is starting to outpace that in many of the world’s richest nations, offering the potential for a more just transition (ClimateScope 2015). However, a recent IDB study estimated that total primary energy demand in LAC will be at least 80 percent higher than present-day levels by 2040, with electricity needs projected to grow by more than 91 percent (Balza, Espinasa, and Serebrisky 2016).

This report also predicted continued dependence on fossil fuels, which accounted for 74.4 percent of primary energy demand in 2013, compared to just 17.1 percent from biofuels and renewables. This highlights the potential challenges of managing low-carbon development pathways in an equitable and just manner, particularly considering that over 31 million people (7 percent of the population in LAC) live without grid-connected electricity, and 85 million (19 percent) are without clean cooking facilities (International Finance Corporation 2013).

While there may be some scope to develop new electricity grid systems and to extend existing ones in developing

countries, these could become stranded assets as NDCs are implemented. However, stranding risk will vary based on the type of energy sources used and the direct and indirect effects of climate change in each place – fossil fuel grids and some hydroelectric power are perhaps most likely to be stranded as carbon legislation and precipitation patterns change in coming decades (Carbon Tracker Initiative 2013; IPCC 2014). The mix of electricity generation technologies varies significantly by country or group of countries in LAC. The Caribbean and Central America (except Costa Rica) are reliant primarily on oil products for power generation. Mexico has a more diversified electricity generation mix, with gas playing a key role, followed by oil and coal. Hydroelectric power dominates in Brazil and the Andean countries. In the Southern Cone, hydroelectric power is also the most important source of electricity, followed by natural gas (IDB 2012).

The reallocation of resources and compensation for those individuals and communities affected by climate change and related policies could help facilitate a just transition (Caldecott et al. 2016; Newell and Mulvaney 2013). This might be more likely to occur in developed countries, where citizens tend to be able to demand higher relocation costs and stronger unions demand higher settlements for loss of earnings (Funk 2014). Rosemberg (2010) suggests that job losses are not a direct result of national climate policies, but rather are caused by a lack of social policies and by the anticipation of and investments in alternative mitigation measures. Thus, providing adequate support for sectors that are losing out in a low-carbon future and generating new employment opportunities in low-carbon sectors are critical to ensuring a just transition (Jagger, Foxon, and Gouldson 2013).

One potential solution in LAC to help keep fossil fuels in the ground while promoting sustainable development was the Yasuni-ITT Initiative launched by Ecuador in 2007. This promised to leave approximately one billion barrels of crude oil in the ground (20 percent of Ecuador's oil reserves) in one of the most intact and diverse nature reserves on the planet. The project attempted to "strand" these oil assets in order to protect biodiversity, respect the territory of indigenous peoples, combat climate change, and encourage more sustainable economic development (Sovacool and Scarpaci 2016). It was estimated that this could avoid carbon emissions of about 410 million tons of CO₂ (Vallejo et al. 2015). Under the initiative, in exchange for not developing the oilfields Ecuador would forgo half of this reserve's potential oil revenues – at the time worth \$3.6 billion – if it received the other half through international compensation based on donations placed in a trust administered by the United Nations (Caney 2016). Funds would have been placed into social and environmental development programs and the promotion of domestic renewable energy. However, the project collected only \$13 million by 2013, so drilling for oil recommenced (Martinez-Alier, Bassey, and Bond 2013). This failure was seen to be a result of a series of challenges including limited financing, intense political pressure, a national commitment to oil, and the potential for carbon leakage (Sovacool and Scarpaci 2016; Vallejo et al. 2015). In particular, it raised fears in the international community that the project could set a dangerous precedent of climate compensation claims while providing only temporary stranding. This does not mean that it is not possible to implement a scheme in which not extracting fossil fuels is compensated for. Indeed there are many policies in which "non-use" of a natural resource – or protec-

tion of an environmental service – is paid for, including Reducing Emissions from Deforestation and Forest Degradation (REDD+) programs. However, it does suggest that lessons need to be learned from the problems faced by the Yasuni-ITT Initiative (Caney 2016).

2.3.2 Natural Resource Dependency and Exposure to Stranded Assets

Many countries in LAC are dependent on a range of natural resources for a significant proportion of their export incomes, and a large proportion of citizens are employed in sectors potentially affected by climate change and stranded asset risks. This section therefore examines three sectors – the fossil fuel industry, agriculture and forestry, and tourism – that are significant employers in LAC and at risk from asset stranding.

2.3.2.1 Upstream Fossil Fuel Industry

There is a growing academic, policy, and financial literature that explores the likelihood of asset stranding within the upstream fossil fuel industry. A 2012 report by the IDB on Latin America's energy future highlighted the fact that the region is blessed with globally significant reserves of oil, and has recently benefited from increased trade with China, which is now a major player in the Latin American energy sector as both consumer and financier (IDB 2012). Latin America is home to the second largest reserves of oil outside the Middle East, and is exposed to stranding of both public and private sector assets as environmental regulations and demand for fossil fuels change internationally (IDB 2012; Caldecott 2015). NDCs under the Paris Agreement are also likely to ratchet up existing pressure on the upstream fos-

oil fuel production as climate targets are revised nationally on a five-year cycle (Mitchell and Mitchell 2016).

Stranded assets in LAC could have considerable effects on government finances given that many of the fossil fuel companies are state-owned and contribute a large portion of export income and government revenues. These effects are likely to be uneven as fossil fuel resources are unevenly distributed across the region, with oil and gas reserves concentrated in Venezuela and most coal reserves located in Colombia and Brazil (IDB 2012). For example, Colombia exported 87 percent of the 94.2 million tons of coal it produced in 2013 (EIA 2015), with the state-owned Ecopetrol accounting for 57 percent of production (Carpenter 2015). The Brazilian government still owns a majority share of Petroleo Brasileiro S.A., also known as Petrobras, the biggest oil producer in Brazil, accounting for over 72 percent of Brazil's 2014 oil production. The largest producer in Mexico, Pemex, remains under state ownership and as of 2015 controlled development rights to 83 percent of Mexico's proven oil reserves (Carpenter 2015). Latin America has adequate resources to meet its rising energy needs, but the challenge for national governments in the region is to find a balance of sources that best provides energy security, meets growing demand, is environmentally sustainable, and can be developed at a competitive cost (IDB 2012).

In 2013, the Carbon Tracker Initiative together with SITAWI, a Brazil-based ESG research provider, assessed Brazilian financial market exposure to the stranding of upstream fossil fuel assets. The report found that stranded asset risk is concentrated in Petrobras, which held 96 percent of proven oil reserves and 72 percent of proven gas reserves as of 2011 (Carbon Tracker Initiative 2013). This risk is likely to multiply given Petrobras' commitment

to develop Brazil's pre-salt reserves, which are expected to hold between 70 and 100 billion barrels of oil equivalent resources.

McGlade and Ekins (2015) used a single integrated assessment model containing estimates of the quantities, locations and costs of oil, gas, and coal reserves and resources to explore the implications of carbon budgets for fossil fuel production in different regions. In Central and South America they estimated that 42 percent of oil, 56 percent of gas, and 73 percent of coal reserves would be 'unburnable' before 2050 in a scenario where there is not widespread CCS deployment (McGlade and Ekins 2015). This compares with 35 percent of oil, 52 percent of gas, and 88 percent of coal globally, suggesting that Central and South America has slightly more unburnable oil and gas reserves than the rest of the world and relatively less unburnable coal (McGlade and Ekins 2015).

2.3.2.2 Agriculture and Forestry

Agriculture and forestry represent a key economic sector within LAC. However, countries reliant on agriculture may see sudden reductions in both the quality and quantity of yield on account of climate change as weather patterns shift (Morel et al. 2016; Rautner, Tomlinson, and Hoare 2016). Production may become increasingly idle and displaced across borders as global productivity envelopes shift polewards (IPCC 2014). Countries with the capital available to develop resilient or substitute crops, as Australia did with vineyards in former rice-growing regions during the Millennium Drought (Heberger 2011), may limit the impact of asset stranding. But others, particularly many developing countries, are likely to be adversely affected (I. Harnett, Edstrom, and Harnett 2014).

A significant share of unskilled labor, which ranges from 48 percent of total labor in Argentina to 91 percent in Nicaragua, is employed in agriculture and subsistence farming and constitutes 70 percent of the total income of poor households, according to a 2014 IDB discussion paper (Vergara et al. 2014). Caldecott et al. (2013) highlight the risk for asset stranding in these sectors internationally as environmental changes occur, noting that environment-related risk factors could cause material asset stranding throughout the global agricultural supply chain. Further, the potential challenge of stranded assets in agriculture is currently being exacerbated by an ongoing agricultural boom, which is feeding off high commodity prices and poor investment returns elsewhere in the economy and pushing farmland values to record highs in many markets, including in the United States, United Kingdom, Brazil, Central Europe, and Australia (Informa Economics 2014; Savills 2012).

Meza (2010) studied Chiapas in Mexico and found that changing climate patterns severely affected agricultural lands and infrastructure, creating unproductive “stranded” land, which led to the further deterioration of livelihoods of rural communities and increased migration to other regions. A report by New Climate Economy (2014) argued that farmers and forest-dependent people in highly diversified economies have access to sufficient resources to transition to a low-carbon future under scenarios of asset stranding, whereas a growing number of rural and agricultural communities in the emerging economies of Latin America, Eastern Europe, and Asia do not have the same support and resources to adapt to ongoing environmental changes and stranded land parcels.

Caldecott et al. (2013) explored the risk of stranding to a range of assets linked to the sector, including natural

assets (e.g., farmland water), physical assets (e.g., animals, crops, on-farm infrastructure), financial assets (e.g., farm loans, derivatives), human assets (e.g., know-how, management practices), and social assets (e.g., community networks). The paper emphasizes the need for governments, companies, and investors to understand the risks from stranded assets, arguing that such an understanding will help increase resilience to economic and environmental shocks, but also boost vital sustainable agricultural investment in developing countries, since agricultural investment has been identified as one of the most effective ways to boost the earnings of the nearly three-quarters of the population in developing countries that lives in rural areas (Conforti 2011). Governments will need to put in place policy frameworks that establish and protect property rights, invest in good public rural infrastructure, and create the conditions for well-functioning markets to facilitate such resilience to stranded asset risks (Caldecott, Howarth, and McSharry 2013).

Greater attention needs to be focused on understanding the how agriculture and forestry in vulnerable regions could be affected. Geographical differences in agriculture, forestry, and land-use should also be taken into consideration when developing strategies for low-carbon development pathways (Stone 2009). The threat of asset stranding in agriculture may require the development of new insurance policies and government interventions that can protect the interests of local communities to facilitate a just transition.

Attention should also be given to the potential transition from forestry to biofuel production land use. Barber (2010) found that in Tucuman, Argentina, demand for biofuel production led to a significant transformation of agricultural production, resulting in lower standards of health and safety

conditions and reduced (as well as substituted) rural employment. Existing biofuel production assets could also become stranded. For example, although underpinned by domestic policies, bioethanol production in Brazil could over time suffer from competition from electric vehicles displacing petrol vehicles, affecting farmers and farming communities involved in bioethanol production. This is a poorly understood potential risk for biofuel producers.

2.3.2.3 Tourism Industry

Countries dependent on nature-driven tourism are also likely to be affected by climate change, and could see service industry infrastructure stranded by physical changes. UNESCO (2009) has identified several World Heritage Sites that are critical tourist destinations but are particularly vulnerable to climate-induced environmental change, including the Chan Chan Archaeological Zone in Peru, which is exposed to increased flooding and erosion caused by the El Niño-Southern Oscillation (ENSO). Climate change is likely to strand individual tourist attractions as well as the industry in entire regions. For example, ski resorts in several countries in the Alps have been affected by changing precipitation patterns, meaning that they have had to remain closed for large parts of the season due to insufficient snow cover (UNEP 2008), while other resorts have had to import snow or create artificial snow (Agrawala 2007; Funk 2014). This will also affect other winter tourism, including glacier tourism in South America. Rabatel et al. (2013) outline how rapid glacial retreat is affecting the stability of the glaciers and altering access routes for tourists.

Of particular concern is the potential for climate change to affect demand for tourism in small Caribbean island nations, whose economies tend to be heavily reliant on tourist income and

related service industries. Some literature has begun to explore the potential effects of climate change on these industries; all reports surveyed as part of this literature search find a significant negative impact. A study by Uyarra et al. (2005) explored two Caribbean islands (Bonaire and Barbados) that rely on different tourism markets and infrastructure and are both at risk from environmental changes. The study found that more than 80 percent of tourists in each destination would be unwilling to return for the same holiday price if climate change were to negatively affect the resorts. Bonaire is chosen for its coral reefs, which are at risk of coral bleaching as a result of elevated sea surface temperatures and ocean acidification, whereas Barbados was selected as a destination for those wanting large beaches, but faces reduced beach area as a result of the rise in sea levels.

A growing number of reports explore the likelihood that climate change might have a significant impact on the Caribbean tourism economy by altering environmental features important to destination selection (Scott, Simpson, and Sim 2012; Clayton 2009; Moore 2010). However, no research has yet explored the risk of stranded assets explicitly. Looking at the stranding risk in individual island nations and resorts, or even coral reefs, could thus be of particular importance to help guide governments and investors in determining future resilience.

There is also concern that national and/or international carbon mitigation policies could impact air travel tourist flows. Carbon pricing or other market mechanisms aimed at facilitating a low-carbon economy could lead to an increase in air transport costs and foster environmental attitudes that lead tourists to change their travel patterns away from island nations and long-haul travel, putting the Caribbean at risk from asset stranding as a result of lower demand (UNEP 2008).

Developing global scenarios will be key, as asset stranding elsewhere could divert more tourists to LAC (e.g., coral bleaching in the Australian Great Barrier Reef could divert divers to the Caribbean). Similarly, further research is needed to explore the resilience and sensitivity of stranding, particularly outlining whether stranding might be temporary (e.g., in a particularly bad year of hurricanes that destroy tourism infrastructure) or permanent (irreparable destruction of beaches and/or reefs).

2.3.3 Human Capital

Physical assets are not the only type of assets that can become stranded – stranding of human capital as a result of shifting environmental and energy landscapes has occurred frequently in history and will likely occur in the coming decades as a result of physical climate change impacts and societal responses to climate change. The impact of climate change on labor markets is a growing topic in the literature (Martinez-fernandez and Hinojosa 2010; Skjeflo 2013; Paavola 2008; International Labor Organization 2010), but there has yet to be an exploration of these issues through the lens of human capital being “stranded” by a lack of mobility or means to get new jobs in different industries or regions. One exception is Caldecott et al. (2013), who briefly explore human and social stranding as a result of changing agricultural patterns. They noted that workers’ know-how and expertise developed over many years of experience and education into agricultural best practices could become stranded, alongside the stranding of social networks within agricultural communities. Both are seen as important to increasing productivity and resilience to risks and shocks.

Such knowledge and labor stranding could affect entire regions and communities as productivity envelopes of agriculture shift to different regions or as industries close. The specialization of communities could leave some particularly vulnerable. For example, the adverse impact of transition in the UK coal sector has been evident in local communities and labor dynamics. The number of people employed in UK coal mines fell from 1.2 million in 1920 to below 3,000 in 2015 (Caldecott et al. 2016). The infamous UK miners’ strike in the 1980s (known as the “Great Strike for Jobs”) is the kind of conflict that governments internationally should seek to avoid as carbon-intensive sectors are phased out, with better planning required to ensure the future of communities likely to be affected by asset stranding (Cook and Stevenson 1988). This could be achieved through voluntary relocation, education, training, and tax incentives to attract new industries to the region. However, this is likely to be even more complicated in the developing world, especially if communities that lack education and training in other skills and where low-income jobs limit opportunities to relocate and find new skilled employment. This could potentially contribute to growing urbanization globally as low-skilled migrants move to urban centers when rural livelihoods become threatened (The World Bank 2009).

In particular, stranding of fossil fuels could have a profound effect on labor dynamics and local communities in LAC. Lack of social stability and security are already closely linked with environmental degradation and unemployment. For instance, Colombian coal mines are notorious examples of “extractive enclaves,” with limited local development benefits, high health and safety risks, and displacement of indigenous communities from their farmlands (Ferguson 2005; Chomsky

and Striffler 2014). Labor strikes and unrest, such as the Cerrejón strike in Colombia in 2013 that lasted for 32 days, are common. Entire regions, and therefore entire communities, are dependent on these mines and the extractive fossil fuel industries in much of Latin America (less so in the Caribbean), so governments will need to carefully manage any transition and asset stranding to ensure that labor needs for employment are met to avoid significant unrest. However, the same issue could arise in the Caribbean if the tourist industry suffers widespread stranding, and could be intensified by a lack of diversification on small islands, and by the perhaps greater risk of a brain drain abroad from small nations, as compared to internal rural-urban migration in larger Central and South American countries (Connell and Conway 2000; Attz 2009). More research is needed to assess the resilience of communities, labor markets, and economies to potential asset stranding, including analysis of the jobs available and the training needed for those communities most affected.

As the labor movement became more involved in global environmental movement in the early 1990s, the notion of “green jobs” came to be seen as a necessary component of a just transition (Stavis and Felli 2014). Stavis and Felli (2014) explore how the promotion of green jobs and a green economy could facilitate a triple win for the economy, society, and the environment, while sustaining decent jobs and livelihoods. New job opportunities could arise from new climate policies and the stranding of carbon-intensive assets. However, this will depend on communities’ ability to adapt to new industries and develop new skills. Although some job substitution could occur relatively easily, with Rosemberg (2010) suggesting that workers in the offshore oil industry could

transition into the offshore renewable industry, not every community will be able to adapt in this way.

The International Labor Organization (2016) provides some information regarding the growth of green jobs in LAC, noting that Brazil has been at the forefront of a transition toward green jobs in the region. The Brazilian government has made green jobs a central part of its national development policy. Many green jobs have been created by extensive development of Brazil’s renewable energy sector – with many jobs in wind, solar thermal power, and solar photovoltaic power. Brazil has also invested in innovative projects such as the “My House, My Life” housing program, which facilitated the construction of 300,000 new homes equipped with solar heating systems, creating 30,000 new green jobs. In 2008, when the last assessment was carried out, 2.65 million Brazilians were employed in green jobs, accounting for 6.7 percent of the total workforce (International Labor Organization 2013b). Successful green job experiences have also been documented in other LAC countries, including Chile, Costa Rica, the Dominican Republic, Guyana, Mexico, Peru, and Trinidad and Tobago. A national assessment of the potential for creating green jobs in Mexico identified 1.8 million jobs related to the environment, representing about 5 percent of the working population in 2011 (International Labor Organization 2013a). Table 2 presents examples of the wide range of sectors offering green job opportunities. However, it remains to be seen whether these jobs will be able to replace all those that might be lost as a result of asset stranding. The ILO has developed a learning course on sustainable development and green jobs especially targeted at trade union representatives in LAC, and the course has now been replicated in Kenya and Italy (International Labor Organization 2016).

Table 2. Examples of Green Activities Providing Labor Opportunities

Green Job	Examples/Details
Sustainable agriculture	Organic farming, efficient irrigation systems
Sustainable forestry activities	International/national certifications (e.g., Forest Stewardship Certification)
Renewable electric energy	Wind, solar, hydropower, bioenergy, geothermal
Clean industry	National/international certifications such as PROFEPA's Industria Limpia (Clean Industry) in Mexico, and international ISO140001 standards
Sustainable construction	Sustainable green infrastructure (sanitation and water distribution, and renewable energy infrastructure)
Waste management	Recycling of solid urban waste
Sustainable tourism	Ecotourism and adventure tourism
Public mass transport	Urban and suburban collective transport, school and personnel transport, and railway transport
Federal government activities	Ministry of Environment and Natural Resources, sustainability programs

Source: International Labor Organization (2013b)

2.3.4 Capacity of Developing Nations to Deal with Stranded Assets and Encourage a Low-Carbon Transition

At the Copenhagen Climate Change Conference (COP15), developed countries committed to mobilize more than \$100 billion annually by 2020 in long-term climate finance from public and private sources to address the needs of developing countries (Westphal et al. 2015). However, current estimates of the costs to address climate change in developing countries alone range from \$600 billion to \$1.5 trillion per

year, showing the huge gap in potential financing, the scale of the problem in developing nations, and the capacity constraints those countries face (Montes 2012; Nakhooda 2013). Little research has explored the transnational financing required to cope with potential stranded assets (both human and physical assets), and this is a significant gap in the literature. Although some literature explores compensation for physical climate change impacts (Tol and Verheyen 2004; Adger and Barnett 2005; Kolk and Pinkse 2004), little attention has been paid to compensation or similar incentives for developing nations to strand their most polluting assets (Mitchell 2014; Caldecott et al. 2016).

2.4 Investor Exposure to Stranded Assets: Managing Investments and Portfolios Exposed to Environment-related Risks

There is growing awareness that climate change is a material issue with both short- and long-term impacts on investment returns, and that investment decisions can affect future climate change outcomes. Research from think tanks, academic institutions, governments, international development banks, and investment firms has shown that environment-related risks are poorly understood and regularly mispriced, resulting in overexposure to such stranding risks throughout financial and economic systems (Caldecott and McDaniels 2014a). Investments that depend on the natural environment, particularly those exposed to water, fossil fuels, and agriculture, are increasingly at risk from premature write-downs as regulation tightens, natural capital is impaired, clean technologies develop, and socio-political pressures increase (Caldecott and McDaniels 2014a; I. Harnett, Edstrom, and Harnett 2014). This section explores investor exposure to stranded assets and the strategies available for managing investment and portfolio exposure to these risks.

A growing literature has found that investors' fiduciary duty should encompass ESG factors to protect the long-term interests of beneficiaries and shield against corporate scandals and other large-scale losses (UK Law Commission 2014; Minter Ellison 2015; UNEP FI 2009). Consequently, the risk of stranded asset should be accounted for in investment decisions.

Legal groups such as ClientEarth and a number of NGOs have already begun designing legal actions and campaigns against companies, investors, and even governments that are failing to consider the long-term implications of stranded assets (Clark and Sharman 2015). In addition, Minter Ellison (2015) has begun exploring company directors' personal liability for corporate inaction on climate change.

There is significant evidence to suggest that investors are still mispricing these risks (Caldecott and McDaniels 2014a; UNEP Inquiry 2015). Some explanations for this include (1) existing conventions failing to account for environmental considerations, especially in terms of standard disclosures and widespread risk measurement practices based on modern portfolio theory; (2) endemic short-termism; and (3) outdated interpretations of fiduciary duty.

In its global study, Mercer (2015) calculated that adapting to a 2°C scenario should not negatively affect returns for long-term diversified investors, and should produce long-run outperformance beyond 2050. Accordingly, a business case exists for investors to act now on climate change, aid in the transition toward a low-carbon economy, and avoid exposure to potential stranded assets. Stern (2006) notes that the benefits of strong and early action will considerably outweigh the costs.

2.4.1 Managing Stranded Asset Risk in Investments

In recent years, there has been a gradual awakening of mainstream investors to the issues of climate change and carbon risk (Task Force on Climate-Related Financial Disclosures 2016; CDP 2015). As a result, new stock indexes, funds, bond ratings, and investment tools are being designed to help disclose and remove carbon risk from mainstream financial products (UNEP FI 2013; Dupré 2015). There have been some attempts to launch such products in Latin America, including a number of ESG funds and three sustainability indices – BM&F BOVESPA of the São Paulo Stock Exchange, created in 2005; the Bolsa Mexicana de Valores, launched in Mexico in 2011; and the MSCI EM Latin America ESG Index, launched in 2013. However, these attempts have been largely hindered by relatively small stock markets and the lack of sustainability reporting requirements, reducing the availability of information required to compare companies' corporate social responsibility (Vives 2012; MSCI 2016). On the other hand, there has been an increasing trend in LAC toward the issuance and receipt of funds from green bonds from local and international investors, which is explored further in Section 2.4.7.

Internationally a wide range of tools and strategies are being developed by a range of actors within the investment chain. The Institutional Investor Group on Climate Change has produced two reports on how investors can manage climate and stranded asset risk, "Financial Institutions Taking Action on Climate Change" (UNEP FI 2014) and "Climate Change Investment Solutions: A Guide for Asset Owners" (IIGCC 2015). These aim to help inves-

tors explore both the risks and opportunities from climate change and potential asset stranding within the constraints of financial market decision-making, access case studies, and explore options for buying into low-carbon opportunities without expecting lower returns. Two approaches have been highlighted by a consortium of 2 Degrees Investing Initiative, UNEP FI, and the World Resources Institute, which jointly produced an influential report in 2015 exploring the different climate strategies and metrics available to institutional investors to measure and manage stranded asset risk (Dupré 2015). The two approaches are: "carbon risk" objectives and "carbon friendliness" objectives. The metrics and strategies associated with each approach are different but not mutually exclusive:

- "Carbon risk" is the concept that the low-carbon economy may create financial risks and opportunities for portfolios.
- "Climate friendliness" has societal objectives at its center and is the concept that investors seek to contribute to greenhouse gas emission reductions and the transition to a low-carbon economy because of internal or external pressures such as mission, mandates, or fiduciary duty.

The past decade has seen growth in the tools, strategies, and investment products available to reduce carbon exposure and invest in climate friendliness so as to limit stranded asset risk within portfolios. A range of literature has become available on the benefits and challenges of each approach. For example, HSBC (2015) outlines investors' options to divest, hold, or engage in response to stranded asset exposure. Eurosif (2014) produces frequent reports on the state of socially responsible investment (SRI).

2.4.2 Calculating Exposure to Stranded Asset Risk

To account for stranded asset risk within portfolios, investors need to be able to assess changing regulatory, physical, and socioeconomic conditions in order to identify and quantify sources of risk for individual companies, sectors, geographies, and asset classes. Such calculations should include both quantitative and qualitative assessment of risk (UNEP FI 2013). One of the most popular techniques is the process of carbon footprinting investments and portfolios. This can be done by in-house analysts or by using consultants or specialist sustainability advisors such as Sustainalytics and Trucost. Measuring exposure by using carbon intensity of capital as a proxy for a range of climate-related risks that can strand assets is a step to being able to manage the exposure. In addition, there is now a growing movement to encourage asset managers to disclose portfolio-level exposure, with proponents arguing that this will increase transparency for asset owners and those selecting asset managers, and increase consideration and management of stranded assets.

France has become the first country to require institutional investors to disclose how they consider ESG issues in decision-making processes, including climate-related risks associated with carbon-intensive assets and opportunities for low-carbon and renewable energy (Smart 2015). Other governments and regulators could follow France's example toward investment disclosure standards (2 Degrees Investing 2015). Sweden is already considering such a move to require asset owners and managers to report carbon footprints (Rust 2016).

The University of Oxford has undertaken research to understand the specific water, carbon, and other environment-

related risk that could affect assets owned by companies (Caldecott, Dericks, and Mitchell 2015). This analysis can help investors identify companies at particular risk and then prompt risk management actions, such as divestment, engagement, and hedging. For example, the Oxford Smith School produced a report exploring the environment-related risks facing subcritical coal-fired power stations, which are the least efficient type of coal-fired power station (Caldecott, Dericks, and Mitchell 2015). This report studied these power stations in the major producing markets of China, the United States, Europe, India, Australia, South Africa and Indonesia. Using data points from a range of sources, the research identified which subcritical coal-fired power stations are in extremely high water stress catchments, and which of these have the most water-intensive cooling technologies. It is then possible to identify which companies and investors own these assets and determine which companies are most exposed. The Oxford Smith School has also released a similar in-depth analysis of assets throughout the thermal coal value chain globally (Caldecott et al. 2016). The report links individual assets back to company owners, facilitating an analysis of which companies have portfolios that are more or less exposed to thermal-coal-related risks.

This provides investors with the information to determine which companies are most at risk and then act accordingly. It is hoped that this “bottom up” approach can be replicated in different sectors, but it requires the development of grounded investment hypotheses as well as datasets that can allow investors to identify assets most at risk and then link this back to company ownership. Such asset- and company-level analysis will be key to helping investors better assess the stranded asset risk within their portfolios, but it is currently limited to specific sectors

and geographic locations. This will need to be scaled up in the future to ensure that investors are able to reliably assess their exposure to such risks, particularly in LAC, where little analysis has thus far been carried out.

2.4.3 Portfolio Decarbonization and Divestment

Two strategies aimed at managing and reducing exposure to stranded asset risks have gained significant momentum in the past decade: decarbonization and divestment. Decarbonization refers to a reduction in the carbon-intensity of investments and portfolios. This attempts to reduce stranded asset risk that is largely, though not exclusively, associated with exposure to high emitting fossil fuel companies. Decarbonization can be achieved through a range of investment tools, including selective divestment, screening, and investment in clean sectors.

Two decarbonization initiatives have been launched to help investors decarbonize. The Portfolio Decarbonization Coalition aims to drive greenhouse gas emission reductions by mobilizing a critical mass of institutional investors to commit to gradually decarbonizing their portfolios. This initiative helps investors work together to measure, disclose, and reduce the carbon footprints of their portfolios. Over \$100 billion had been committed to this initiative prior to the COP21 in Paris in December 2015. The Montreal Carbon Pledge was launched in September 2014 to allow investors to formalize their commitments made under the Portfolio Decarbonization Coalition with formal pledges and accountabil-

ity. The two initiatives work jointly to mobilize a large group of institutional investors to engage and/or re-allocate capital on the basis of companies' greenhouse gas emissions. It is hoped that this will provide a strong incentive for affected companies to shift from carbon-intensive to low-carbon activities so as to continue attracting investment from international institutional investors.

Divestment occurs when investors withdraw their capital – for example, by selling stock market listed shares, private equities, or debt – from firms viewed as being engaged in risky and reprehensible business (Ansar, Tilbury, and Caldecott 2013). Fossil fuel divestment is a type of decarbonization strategy and is presented by some as a response to the risk of stranded assets, and as part of investors' fiduciary duty as climate change impacts fossil fuel companies (Baron and Fischer 2015; Ansar, Tilbury, and Caldecott 2013). Campaigns for fossil fuel divestment have gained momentum due to potential future financial losses and the need for reduced carbon emissions (Flood 2015). Divestment has been supported by a number of large private wealth owners, university endowments, foundations, and public pension funds making divestment announcements.

Recent divestment announcements, such as by the Rockefeller Foundation and AXA insurance, have included both divestment from fossil fuels and the active reallocation of this capital to “green” investments (Rockefeller Foundation 2015; Clark 2015b). The Divest-Invest movement, which advocates both fossil divestment and investing in climate change solutions simultaneously, has been supported by institutions with over \$3.4 trillion in total assets (Vondrich et al. 2015).

2.4.4 Low-Carbon Indices

Passively managed funds⁵ automatically track an index or benchmark and have gained increased popularity because they offer low management fees relative to actively managed funds⁶, where investments are selected by fund managers (PRI 2011). However, many of the major indices, such as MSCI World and S&P 500, that are used in passively managed funds are overweight fossil fuels and underweight renewable energy (2 Degrees Investing Initiative 2015). As a result, an increasing number of investors are using new low-carbon indices to reduce exposure to carbon-related risks in passively managed funds. These include new “low-carbon” or “fossil-free” indices that underpin Exchange Traded Funds (ETFs), which are passive funds listed on stock exchanges.

Willis Towers Watson (2015) outline the emergence of both active and passive investors allocating capital to long-term investment strategies specifically designed to perform well in a low-carbon economy. In particular, this often involves investment in companies involved in energy efficiency, renewable energy, and clean technology. If such companies thrive in a low-carbon environment, they could provide op-

portunities for “hedging” against climate-related risk. There are numerous investment strategies across a range of asset classes – including both active and passive approaches – that offer such opportunities. For active investors, many strategies seek opportunities in renewable energy companies, green bonds, or sustainable technologies in infrastructure or transport. For passive investors there are a number of indexes that offer similar exposure to environmentally driven companies, including the following:

- **The FTSE Environmental Markets Index series**,⁷ which tracks global companies whose core business is developing and deploying environmental technologies, including renewable and alternative energy, energy efficiency, water technology, and waste and pollution control;
- **The S&P’s Global Eco Index**,⁸ which is comprised of 40 of the largest publicly traded companies in clean energy, environmental services, and water;
- **The MSCI Global Climate Index**,⁹ an equal weighted index of 100 developed market companies that are leaders in renewable energy, future fuels, clean technology, and efficiency;

5 Passive investing strategies often involve tracking a market-weighted portfolio or index. With regard to responsible investment, passive investing usually takes one of three forms (Dupré 2015):

- Tilted indices or best-in class approach, where climate-related metrics are used to reweight companies (tilting) and/or exclude worst performers (best-in class)
- A sector or industry exclusion index that, for example, excludes fossil fuels or coal
- Indices that may be “pure play,” for example by limiting inclusion to clean-tech companies or companies with climate-related revenues.

6 Active investing refers to management strategies where the manager picks specific investments to outperform the market and/or meet some other target, such as cutting portfolio carbon exposure by a set amount. Active mandate strategies can either use an approach similar to index design or a more sophisticated indicator-led selection approach (Dupré 2015).

7 See <http://www.ftse.com/products/indices/Env-Markets>.

8 See <http://us.spindices.com/indices/equity/sp-global-eco-index>.

9 See https://www.msci.com/resources/factsheets/index_fact_sheet/msci-global-climate-index.pdf.

- **MSCI Global Low Carbon Leader Indexes,**¹⁰ which aim to achieve at least 50 percent reduction in the carbon footprint by excluding companies with the highest carbon emission intensity and the largest owners of carbon reserves (per dollar of market capitalization);
- **The MSCI ACWI Low Carbon Target Index,**¹¹ a developed and emerging market index that includes exposure to Latin America. Overweighting companies with low-carbon emissions (relative to sales) and those with low potential carbon emissions (per dollar of market capitalization), the index reflects a lower carbon exposure than that of the broad market.

There are opportunities to invest in both developed and developing markets through a range of indices focused on reducing carbon exposure. However, many investors do not yet consider these indices as comparable to their mainstream equivalents. Skypala (2015) suggest that more work is needed on low-carbon indices to overcome a number of barriers to their uptake: notably, their higher costs and the fact that index construction is largely based on companies' direct emissions, with no account of indirect emissions that reduce their "green" credentials or the wider environmental impact such as that on water pollution or biodiversity loss. 2 Degrees Investing Initiative (2015) also points out that construction of the indices can have perverse and unintended effects. For example, ExxonMobil represents a higher share of the index in the MSCI's Low Carbon Leaders Index than in the MSCI World Index (Skypala 2015). Furthermore, reducing exposure to companies with high carbon emissions does not automatically translate

into exposure to green technologies, and while coal companies are largely removed from the indices, many of the low-carbon indices are still dominated by oil and gas companies. Dupré et al. (2015) argue for a combination of both carbon risk and climate friendliness in investment approaches in order to reduce stranded asset risk and actively promote a transition toward a low-carbon economy.

2.4.5 Engagement and Voting

Both passive and active managers can also engage with companies they invest in, with PRI (2011) and IIGCC (2015) arguing that voting and company engagement, both independently and collaboratively, will be key to managing exposure to stranded assets. Engagement and shareholder voting are viewed as important in the process of reducing the carbon intensity of large multinational companies, particularly those in the fossil fuel industry.

Engagement is needed not only to encourage more efficient and low-carbon practices and investment, but also to enhance transparency and disclosure. Investor engagement with investee companies on climate change has increased in recent years (PRI 2013). Investors are keen to emphasize with companies the business case for considering the financial materiality of climate change in company operations and returns, as well as their capital allocations (Louche and Hebb 2014). Such engagement could be vital in LAC – a recent CDP report found that while disclosure of environmental risks is improving, companies still

¹⁰ See <https://www.msci.com/documents/10199/1295f5c0-23c8-4d69-b339-4aee1d4e4ef8>.

¹¹ See <https://www.msci.com/documents/10199/c64f0873-5818-4304-aaf2-df19d42ae47a>

need to develop more effective climate change management, and within Latin America no company scored sufficiently to be featured in the Climate Performance Leadership Index in 2014 (CDP 2014).¹² The same report noted that Latin American corporations need to improve the monetization of financial implications and costs of management of environmental risks and opportunities. Engagement from investors could help them identify leaders in the market, and encourage greater understanding of the benefits of better governance and management.

In addition to direct engagement, there were ground-breaking shareholder resolutions filed against oil and gas giants Shell and BP in 2015. Investors demanded greater disclosure and monitoring of exposure to stranded asset risks (Clark 2015a). In the wake of the success of the Shell and BP resolutions, in which more than 90 percent of shareholders voted to support the resolutions, and following on from the widespread support for the Paris Accord in December 2015, investors have filed a record number of shareholder resolutions, largely focusing on major U.S. energy companies. The resolutions seek clarity on fossil fuel companies' plans to evolve to a post-Paris low-carbon energy landscape, and include requests that companies "stress test" their business plans against the accord's goal to reduce carbon pollution in order to limit the global temperature rise to below 2°C (Ceres 2016). Key companies targeted include ExxonMobil, Chevron, AES Corp., and Southern Co.

However, the process of filing resolutions and engaging directly with companies is both time- and resource-intensive, so many investors outsource and delegate engagement to collaborative initiatives or industry associations (Eurosif 2014; Global Sustainable Investment Alliance 2014). Groups such as the National Association of Pension Funds, ShareAction, and the Institutional Investors Group on Climate Change in the United Kingdom and Ceres in the United States facilitate stronger engagement with policymakers through a coordinated institutional investor voice.

Despite these resolutions and efforts to engage, corporate responses the topic of stranded assets have thus far ranged from ambiguous to outright denial. For example, ExxonMobil in 2014 released a statement saying "we are confident that none of our hydrocarbon reserves are now or will become 'stranded.' We believe producing these assets are essential to meeting growing energy demand worldwide, and in preventing consumers – especially those in the least developed and most vulnerable economies – from themselves becoming stranded in the global pursuit of higher living standards and greater economic opportunity" (ExxonMobil 2015).

2.4.6 Screening

Negative screening refers to the exclusion from a fund or portfolio of certain sectors, companies, or practices based on specific ESG criteria. Positive screening, in contrast, encour-

¹² The Climate Performance Leadership Index, created by CDP, rewards achievement by global corporates toward short- and long-term carbon reduction plans. The index uses data voluntarily disclosed to CDP and puts pressure on companies to directly reduce their carbon emissions. Companies must exhibit "a comprehensive approach to climate change in the four areas of governance, strategy, stakeholder communications and achievements" to be listed on the index. In 2014, 187 companies were listed on the index out of 1,971 that submitted climate change information to CDP.

ages investment in sectors, companies, or projects selected for positive ESG performance relative to industry peers. Screening has been seen as a popular choice for integrating consideration of climate change into investment decisions in a range of financial institutions, particularly among asset managers and banks, and remains the most common option for investors seeking to manage their exposure to stranded asset risk (Eurosif 2014).

Both passive and active investors are increasingly adopting negative or positive screens to reduce exposure to assets that could become stranded. For example, Local Government Super has expanded the existing negative screen methodology to exclude companies with a material exposure (more than one-third of revenues) to “high carbon sensitive” activities such as coal and tar sands mining, as well as coal-fired electricity generators. The Global Sustainable Investment Alliance (2014) found that the largest sustainable investment strategy globally is negative screening/exclusions (\$14.4 trillion), followed by ESG integration (\$12.9 trillion) and corporate engagement/shareholder action (\$7 trillion).

2.4.7 Green Bonds

The market for green bonds has grown rapidly in the past few years from \$11 billion in 2013 to \$41.8 billion in 2015 (Kidney 2016). Despite the growth in global demand for green bonds, LAC has thus far lagged behind other regions in their issuance. Only three borrowers from the region had issued green bonds as of April 2016: the Peruvian wind energy project Energía Eólica, the Brazilian food company BRF, and the Mexican development bank Nafin (West 2016).

However, LAC is beginning to benefit from external green bond issuance, with 25 percent of total green bonds issued by the World Bank targeting development in the region. These are estimated to be worth US\$3.5 billion (The World Bank 2015). The proceeds from green bonds are used to fund projects that have positive environmental and/or climate benefits.

Most green bonds issued are green “use of proceeds” or asset-linked bonds. Proceeds from these bonds are earmarked for green projects but are backed by the issuer’s entire balance sheet. Sectors that are the focus of proceeds of green bonds include energy (38.3 percent), buildings and industry (27.5 percent), transport (10.2 percent), water (9.7 percent), waste management (6.2 percent), climate adaptation (4.3 percent), and agriculture and forestry (3.9 percent) (Climate Bonds Initiative and HSBC 2015). There have also been green revenue bonds, green project bonds, and green securitized bonds that give investors flexibility regarding the type, focus, yield, and maturity of the bonds in which they invest.

The Climate Bonds Initiative, a leading international investor-focused NGO, is focused on mobilizing the global \$100 trillion bond market for climate change solutions, with the goal of encouraging the issuance of \$100 billion labeled green bonds in 2016 (Kidney 2016). A 2015 report by the Climate Bonds Initiative and HSBC (Climate Bonds Initiative and HSBC 2015) found that the wider universe of climate-aligned bonds is \$597.7 billion. The total is made up of 2,769 bonds from 407 issuers. Issuers represent a range of governmental and financial institutions, ranging from international banks (including the European Bank for Reconstruction and Development

and the World Bank) to mainstream asset managers, investment banks, renewable energy companies, and international corporations (including Apple and EDF Energy).¹³ There has been growing investor demand for green bonds in the wake of increased attention to issues of climate change and stranded asset risk, particularly by institutional investors, to the extent that demand has outstripped supply and there have been pledges to invest billions more in capital into green bonds. At the Paris COP in December 2015, asset owners, investment managers, and individual funds managing \$11.2 trillion of assets signed a statement in support of the green bond market (Climate Bonds Initiative 2015). The IDB has begun to explore the green bond market, and has approved financing to establish a regional Energy Efficiency Green Bond Program in conjunction with the Green Climate Fund (IDB 2015).

2.4.8 Sovereign Risk

Asset stranding could have significant implications on country sovereign credit ratings through direct, indirect, and systemic effects. Sovereign bonds represent over 40 percent of the global bond market and are one of the most important asset classes held by investors (UNEP FI and Global Footprint Network 2012).

Standard & Poor's (S&P) have concluded that while climate change risks to sovereign ratings of advanced economies appear on average negligible due to their capacity to adapt, the ratings of many emerging sovereigns would likely come under ad-

ditional significant pressure, with the Caribbean and Southeast Asia most at risk (Mrsnik, Kraemer, and Petrov 2015). In terms of average impact, the S&P simulations show that tropical cyclones are likely to be more damaging to long-term country risk than floods, with the most notable global climate change risk increases involving tropical cyclones in the Bahamas, Barbados, Dominican Republic, Jamaica, and Vietnam, and floods in Thailand (Mrsnik, Kraemer, and Petrov 2015). This is clear evidence of the sovereign risk to LAC, which was argued to be the most affected region globally from sovereign climate risk.

While there has been recent progress in integrating ESG into equity portfolios, methods and metrics for linking ESG materiality to other asset classes—most notably fixed-income assets—still lags behind internationally. Traditional sovereign credit risk analysis appears to inadequately reflect pressures from increasing global natural resource scarcity, environmental degradation, and vulnerability to climate change impacts (UNEP FI and Global Footprint Network 2012; Mrsnik, Kraemer, and Petrov 2015).

As such, there is a new and growing literature on how to design methodologies and tools to better understand, map, and reduce sovereign credit risks related to climate change. For example, a partnership between the Global Footprint Network and UNEP FI has developed the Environmental Risk in Sovereign Credit methodology, which focuses on the development of metrics and methods to quantify natural resource and environmental risks so that they can be incorporated into country risk assessments used by insurance companies, investors, and

¹³ For a list of labeled green bonds, see https://www.climatebonds.net/cbi/pub/data/bonds?items_per_page=100&order=field_bond_amt_issued&sort=desc.

credit rating agencies (UNEP FI and Global Footprint Network 2012). This project created country risk profiles for five countries (Brazil, France, India, Japan, and Turkey), exploring the resource balance, trade-related risk, degradation-related risk, and financial resilience of each economy. Findings from this report suggest that importers and exporters of natural resources (such as fossil fuels, timber, fish, and crops) are most exposed to the increased volatility that accompanies rising global resource scarcity and climate change, with potentially severe economic implications. In Brazil, for example, a 10 percent degradation of productive capacity on trade balances could lead to a 2 percent decline in GDP (UNEP FI and Global Footprint Network 2012).

The second stage of this research focused on the impact of food price shocks on credit ratings as a result of future climate change. It found that “higher and more volatile food prices are key transmission mechanisms through which environmental risks and constraints such as climate change, ecosystem degradation and water scarcity will impact national economies. If these impacts are significant enough, they may affect a country’s credit rating and the risk exposure of sovereign bondholders” (UNEP FI and Global Footprint 2016, 1). Brazil, Paraguay and Uruguay were three of only nine countries (of the 110 researched) that could see an increase in GDP as a result of increased food shocks. In these agricultural and crop exporting countries, economic benefits could materialize from any potential rapid rise in food commodity prices. Although African countries appear to be

the most negatively affected, several LAC countries are also at significant risk, including Nicaragua, Honduras, Jamaica, and Bolivia potentially set to lose more than 2 percent of GDP as a result of food shocks (UNEP FI and Global Footprint 2016).

In response to these threats, some investors have started to use quantitative ESG data in their analysis of country ratings and investment prospects. There are a number of ways to do this in practice. For example, UNEP FI and Global Footprint (UNEP FI and Global Footprint Network 2012) gave the examples of Bank Sarasin, which has adopted resource-based metrics such as the “ecological footprint” as a quantitative metric for assessing country-level sustainability performance, and SNS Asset Management, which applies a two-layered approach to responsible investment in government bonds, examines potential weapons violations and then ESG risks including labor rights and environmental damage. As such, a growing number of banks and investors are buying ratings or ESG data from information providers to supplement their own sovereign credit risk analysis. In addition to analysis and screening, S&P and Robeco have recently launched sovereign bond ESG indices.¹⁴ The aim of the index is to generate returns that are in line with the traditional S&P index, while achieving a structurally better ESG profile of the portfolio and reducing exposure to risk (S&P and Robeco 2015). This is an international index, including some LAC countries. Venezuela ranks 59th out of 60 countries for overall risk, and El Salvador ranks 53rd, demonstrating the importance of these risks to the LAC region.

14 The starting point for the index is the market cap weighted index. Subsequently, the country’s sustainability score in the RobecoSAM Country Sustainability Ranking and the change in this score are compared with the average score of the investment universe. The country score has a 75 percent weight and the change has a 25 percent weight. Based on the deviation from the average, the country’s weight is adjusted (S&P and Robeco 2015).

In addition to individual investors being able to offset their risks through greater awareness and reduced exposure, the literature explores ways in which central banks and governments can lower their risk. For example, Mersnik et al. (2015) call on governments to explore insurance options as extensive coverage “cushions the negative effect on the private sector, and insurance pay-outs help accelerate the restoration of damaged productive assets of the private sector.” This boosts economic growth and raises the tax

base, and could therefore “mitigate the ratings impact of natural catastrophes” (Mersnik, Kraemer, and Petrov 2015). However, insurance will not mitigate all negative outcomes, and UNEP FI and Global Footprint Network (2012) have called for more diversification away from resource-intensive economies and fossil-fuel dependence to lessen the potential impact of climate change and the low-carbon transition, as well as greater analysis of existing sovereign risk through stress tests of national economies.

3. Review of Case Studies

This section briefly summarizes some key pieces of work on stranded assets that are representative of the state of the literature on this topic and highlight opportunities to undertake research in LAC. The section will examine how work on stranded assets has developed and been applied in different institutional contexts through the use of case studies. Case studies can be used to explore and investigate contemporary phenomenon through detailed contextual analysis of a limited number of events, examples, organizations, or conditions. They are widely used in social science research to help provide real-life examples of processes and behaviors, particularly when quantitative data are lacking or insufficient to explore a phenomenon. This is the case in the context of stranded assets, whereby studies of past cases that can incorporate both quantitative and qualitative results are more likely to offer insight into best practices and opportunities for change. Case studies can also help to explain the complexities of real-life situations and institutional changes that may not be captured through quantitative modeling or survey research.

The outcomes of endeavors to apply the concept of stranded assets can thus be analyzed through case studies of existing practices and risks in a range of different institutions and settings, from academia to investment institutions and regulators. From this, best practices can be highlighted and disseminated, with a particular focus on how these examples could be applied in the context of LAC. As such, this review uses real-world examples to demonstrate the potential applicability of stranded assets in LAC, building on and extending research to date.

This section will also highlight ongoing challenges to the adoption of stranded asset discourses in these contexts, and outline the need for further research. The selected best-in-class case studies focus on four themes: transition risks, financial stability, risk and vulnerability, and ESG service/ratings providers.

Section 3.1 provides an overview of each case study, and then each case study is outlined in more detail in the sections that follow.

3.1 Overview of Case Studies

Theme	Organization / Author	Title	Date	Summary
Transition Studies	Carbon Tracker	“The U.S. Coal Crash - Evidence for Structural Change”	March 2015	Examines the drivers of the U.S. coal crash since 2011, citing the rise of cheap shale gas and increasingly stringent U.S. Environmental Protection Agency regulations making coal production less profitable. Encourages other international fossil fuel markets to develop an understanding of, and resilience to, such potential value destruction. Advises investors to request better capital discipline from coal companies and challenge high-cost projects.
	Carbon Tracker and the Association for Sustainable and Responsible Investment in Asia	“The Great Coal Cap: China’s Energy Policies and the Financial Implications for Thermal Coal”	June 2014	Report on coal restructuring in China. Informs the investment community of potential stranding of coal assets in China as the country moves away from coal and adopts a diverse power policy. The stranding of thermal coal assets will particularly affect the Shanghai, Shenzhen, and Hong Kong stock exchange markets, as well as China’s coal import demand, with potential implications for suppliers in Australia and Indonesia.
	European Systemic Risk Board	“Too Late, Too Sudden: Transition to a Low-Carbon Economy and Systemic Risk”	February 2016	Assesses the risks to financial stability posed by climate change. A late, sudden transition would likely cause reduced energy supply and increased energy costs, and financial institutions would be affected by their exposure to carbon-intensive assets, potentially causing contagion throughout the wider economy. Short- and medium-term solutions include support for enhanced information collection and disclosure, and climate stress tests of the European financial system.

Financial Systems

Bank of England Prudential Regulatory Authority	“The Impact of Climate Change on the UK Insurance Sector”	September 2015	Explores how the UK insurance sector faces multiple risks from climate change, including physical, transition, and liability risk.
United Nations Environmental Programme (UNEP) Inquiry	“The Financial System We Need: Aligning the Financial System with Sustainable Development”	October 2015	Summarizes how central banks and regulators could link climate change and broader sustainability risks with their multiple objectives, including financial stability, monetary policy, banking, insurance, pensions and securities regulations, and accounting and financial reporting standards. Central banks in developing and emerging economies appear more active than their developed country counterparts in explicitly considering national policy priorities, including financial inclusion and environmental issues as well as national economic and industrial strategies.
UNEP Inquiry	“The Brazilian Financial System and the Green Economy: Alignment with Sustainable Development”	September 2014	Analysis of the country-level risks facing Brazil. Makes a number of recommendations for developing a sustainable green economy. Includes recommendations for banks, pension funds, and the insurance industry. Recommendations include: Reduce legal uncertainty related to the socio-environmental due diligence of Brazilian financial system agents Strengthen dialogue with public authorities to improve economic tools that foster innovative sectors related to sustainable development Foster dialogue between professional associations on topics related to sustainable development
University of Zurich and Boston University (Battiston et al., 2016)	“A Climate Stress Test of the EU Financial System”	February 2016	New methodological framework to quantitatively assess the exposure of European financial institutions’ portfolios to carbon risk. The direct impact of a 100 percent loss on market capitalization in the fossil fuel sector on the European Union banking system as a whole is relatively low. However, some individual banks are overexposed to fossil fuels.

Risk and Vulnerability

Carbon Tracker	“Carbon Cost Supply Curves”	2014–2015	Series of reports that create carbon supply cost curves for global fossil fuel projects, highlighting that many make neither financial sense when stress tested against demand, price, and emissions scenarios. Investors can use this analysis to consider a range of demand scenarios, determine which price bands of production cost they think are at risk, and use this information to begin engagement with companies with high capital expenditure risk.
Carbon Tracker and SITAWI	“Unburnable Carbon: Is Brazil Avoiding the Carbon Bubble?”	June 2013	Explores the potential risk within the Brazilian economy to “unburnable carbon.” Argues for continued development of renewables to avoid further carbon lock-in, but that companies committed to fossil fuels should (1) indicate the carbon potential of their fossil fuel reserves in their annual report, (2) illustrate whether their business plan is sound under different carbon budget scenarios, and (3) consider the range of potential outcomes under a low-carbon transition for investment returns. This can be achieved through stress testing of bank and pension fund portfolios.
Inter-American Development Bank	“Vulnerability to Climate Change of Hydroelectric Production Systems in Central America and Their Adaptation Options”	January 2016	Develops methodology to determine the vulnerability of hydroelectric systems in Central America to climate change and identifies possible adaptation measures. Decreasing precipitation in most of Central America’s catchment areas, along with temperature increases in all of them, is likely to affect future hydroelectric production by influencing the amount of available water resources, potentially affecting energy supplies and prices.

Risk and Vulnerability

Natural Capital Declaration (NCD) and UNEP FI

“Towards Including Natural Resource Risks in Cost of Capital”

November 2015

Evaluates current and potential approaches for banks and asset managers to understand and assess natural capital risks, exploring (1) the business and investment case for natural capital, (2) the state of integration of natural capital in lending and investment decision-making, and (3) the capability of research providers to offer natural capital research and data services to financial institutions. The key challenges highlighted in integrating natural capital and environmental risks in investment portfolios include limited information technology budgets and personnel; lack of awareness about environmental issues; lack of suitable and contextual methodologies and datasets; vagueness of regulatory requirements regarding natural capital issues; and difficulty in relating long-term data to short-term materiality.

Oxford Smith School

“Stranded Assets and Thermal Coal: An Analysis of Environment-related Risk Exposure”

January 2016

The top 100 coal-fired utilities, top 20 thermal coal miners, and top 30 coal-to-liquids companies have been comprehensively assessed for their exposure to environment-related risks, including: water stress, air pollution concerns, climate change policy, carbon capture and storage retrofitability, future heat stress, remediation liabilities, and competition from renewables and gas. The research is designed to help investors, civil society, and company management to analyse the environmental performance of coal companies and will inform specific investor actions related to risk management, screening, voting, engagement, and divestment. The research also has clear implications for current disclosure processes, including the new Task Force on Climate-related Financial Disclosures.

Ratings and Service Providers

Carbon Delta	“Climate-Resilience of Publicly-Listed Companies”	2016
Morningstar	“ESG Fund Ratings”	2016

Carbon Delta is a boutique equity research firm that specializes in identifying and analyzing the climate change resilience of publicly traded companies. It uses a proprietary evaluation system that helps investors assess climate risks in their portfolios by identifying how much of a company’s value is possibly affected by climate change.

The Morningstar Sustainability Rating is a measure of how well the holdings in a portfolio are managing their environmental, social, and governance (ESG) risks and opportunities relative to peers. It is calculated for managed products and indexes globally using Morningstar’s portfolio holdings database and Sustainalytics ESG data.

3.2 Transition Risk Studies

Carbon Tracker Initiative

“The U.S. Coal Crash: Evidence for Structural Change” March 2015

Publication Objective	This study seeks to identify the drivers of the U.S. coal crash that has been occurring since 2011. It looks for indicators of broader structural change that could affect investors and the wider U.S. and global economy.	
Organization Background	The Carbon Tracker Initiative is an independent think tank that provides in-depth analysis of the impact of climate change on capital markets and investment in fossil fuels. It focuses on mapping risk and opportunities and the route to a low-carbon future.	
Publication Regional Focus: United States	Asset Class Covered Equities	Publication Target Sectors Thermal coal and other fossil fuel sectors, financial sector
Publication Target Audience Investors, policymakers, coal companies, and other fossil fuel companies	Risk Factors Covered Regulatory, technology, and financial risks in the thermal coal sector, competition from shale gas and renewables	Publication Available at: http://www.carbontracker.org/wp-content/uploads/2015/03/US-coal-designed-Web.pdf

This report looks into the historical trends that led to the recent weakening of coal prices and the crash of U.S. coal companies that invested in high-cost projects and acquisitions with the expectation of another upturn in the market.

Carbon Tracker Initiative's examination of corporate disclosures shows that expectations of an upswing did not materialize, but some management teams continued to bet on a bright future in the U.S. coal market. Twenty-six U.S. coal companies declared bankruptcy, but some were able to survive these market shocks due to diversification into shale gas assets. Most coal companies, including Peabody Energy, lost 80 percent of their share value, and the Dow Jones Total Market Coal Sector Index fell by 76 percent.

Two main structural drivers were highlighted as contributing to the U.S. coal crash:

1. The availability of cheap shale gas has cut the price by 80 percent since 2008. This sharp decline in gas prices made natural-gas-fired power plants more competitive than coal-fired power generation. As a result, the use of coal in electricity generation declined in absolute terms, whereas the use of natural gas increased significantly. This accelerated the retirement of old coal plants.
2. Increasingly stringent U.S. Environmental Protection Agency (EPA) regulations, especially the Mercury and Air Toxics Standards, made it difficult for the thermal coal sector to recover. EPA regulations were aimed at mitigating environmental and human health risks of coal burning, which is a critical contributor to air pollutants. As a consequence, these environmental regulations forced the utility companies to internalize the costs of coal burning, which in return restricted coal demand.

The combination of these structural factors caught the U.S. coal companies and investors unprepared. Investors who were not able to predict the U.S. coal crash suffered huge losses from bankrupted coal companies.

Although these structural factors were not driven by carbon or climate considerations, the U.S. coal sector will likely suffer further asset stranding even without a global climate deal or a federal carbon price. In sum, the U.S. coal study demonstrates that even a major developed country could facilitate decoupling of its economic activity from coal-based power. The stranding of U.S. coal assets should also be a reminder for other countries and investors to prepare for the potential value destruction in the thermal coal sector in transition to a lower-carbon energy system, which is increasingly driven by the falling costs of renewables and improved energy efficiencies.

Publication
Summary

Indication of Publication Impact	<p>This publication received good international media coverage, including in mainstream newspapers and financial news outlets. The report came out at an influential time, when climate change campaigners and green businesses were focused on the coal sector just prior to the Paris Conference. Examples of media coverage include:</p> <ul style="list-style-type: none"> • http://www.bloomberg.com/news/articles/2015-03-24/u-s-coal-fall-off-seen-foreshadowing-fossil-fuel-pain • http://www.economist.com/news/business/21647287-more-countries-turn-against-coal-producers-face-prolonged-weakness-prices-depths • http://washpost.bloomberg.com/Story?docId=1376-NLQDVP6VDKI301-38VV68LG5UKSBOOGLBPE88M0HM • http://www.theguardian.com/environment/2015/mar/24/us-coal-sector-in-terminal-decline-financial-analysts-say
Next Steps Following Publication/ Follow-up Studies	<p>Carbon Tracker Initiative published a new report on carbon asset risk in October 2015, which features the U.S. coal crash as an example of the peaking of coal demand and market dynamics that drive the energy transition to a low-carbon future (Carbon Tracker 2015a). The stranding of U.S. coal assets is also mentioned in subsequent reports, including a synthesis report on fossil fuels in November 2015 (Carbon Tracker 2015b).</p>
Citation	<p>Carbon Tracker. 2015c. The U.S. Coal Crash- Evidence for Structural Change. Carbon Tracker Initiative, London. Available at: http://www.carbontracker.org/wp-content/uploads/2015/03/US-coal-designed-Web.pdf.</p>

Carbon Tracker Initiative and ASrIA

“The Great Coal Cap: China’s Energy Policies and the Financial Implications for Thermal Coal”

June 2014

Publication Objective

Through an analysis of coal restructuring in China, this report seeks to inform the investment community about the potential stranding of coal assets in China as the country moves away from coal and adopts a diverse power policy. This report explores the extent to which China’s thermal sector is in the process of transition to greener growth, and the role of financial institutions driving this process.

Organization Background

The Carbon Tracker Initiative is an independent financial think tank that provides in-depth analysis of the impact of climate change on capital markets and investment in fossil fuels, mapping risk, opportunity, and the route to a low-carbon future. The Association for Sustainable and Responsible Investment in Asia (ASrIA) is the leading association in Asia dedicated to promoting sustainable finance across the region. ASrIA plays a critical role in facilitating Asia’s transformation to a sustainable future and encouraging participation by governments, multilateral bodies, corporates, NGOs, and financial institutions in addressing future challenges facing Asia.

Publication Regional Focus

China

Asset Class Covered

Equity

Publication Target Sectors

Thermal coal sector, financial sector

Publication Target Audience

Investment community, policymakers, company management

Risk Factors Covered

Environmental risks (air pollution, water), financial risk, competition from other resources, regulatory risk

Publication Available at:

<http://www.carbontracker.org/wp-content/uploads/2014/09/gcp1.pdf>

The main argument of the report is that China and other countries could ease the potential disruption and risks associated with stranding of thermal coal assets through diversified green power supplies, and that investors and financial institutions could be supported during the transition process. Although the timing of peak coal use ranges from 2015 to 2030, the aggressive policy ambitions of the Chinese government, and a critical volume of investment in noncoal power, could facilitate a greater level of asset stranding in the near future. The report highlights three main drivers that could expedite the peaking of China's thermal coal demand:

1. Absolute power demand in China has been slowing, affecting the demand for thermal coal. China began decoupling its economy from coal-based energy policy in 2005, as its economic growth became more dependent on less-energy-intensive sectors, such as the services sector.
2. The thermal coal sector is affected by recent environmental regulatory developments, in particular air pollution and water scarcity, which will increase the perceived risks related to high-carbon energy resources.
3. Increasing competitiveness of noncoal power resources, such as nuclear, gas, wind, and solar power, will lead to a future market downturn in the thermal coal sector.

The stranding of thermal coal assets will particularly affect the Shanghai, Shenzhen, and Hong Kong stock market exchanges, which are home to over 80 percent of non-state owned assets attributable to companies in the thermal coal sector. Among these financial markets, the Hong Kong Stock Exchange is the most vulnerable to stranding of thermal coal assets.

The report also cautions investors about the ramifications of high capital expenditures in coal, with China's coal companies investing approximately \$21 billion to find thermal coal reserves. Carbon Tracker suggests that investors take into consideration several factors, such as debt levels, geographic location, coal quality, revenue resources, and political support, in their assessment of Chinese thermal coal companies.

Finally, the report refers to the implications of the decline in China's coal import demand for international markets, most notably Australia and Indonesia as the two major suppliers of coal to China. Even as China's coal demand slows, the country continues to increase its domestic coal supply, which will adversely affect oversupplied international markets. Therefore, investors should be aware of the risks of stranding for the mining companies located in these two largest exporter countries.

Indication of Publication Impact	This report received wide international media coverage, including mainstream newspapers and financial news outlets. For examples of the media coverage, see http://www.carbontracker.org/wp-content/uploads/2014/09/China-Report-Media-Coverage-17-June-2014.pdf .
Next Steps Following Publication/ Follow-up Studies	Carbon Tracker published a follow-up study, “Carbon Supply Curves: Evaluation Financial Risk to Coal Capital Expenditures,” in September 2014. It argues that peak coal demand in China is imminent, so the investment community should be aware of the resulting oversupply in international markets and the weakening of coal prices and asset values.
Citation	Carbon Tracker and ASrIA. 2014. The Great Coal Cap: China’s Energy Policies and the Financial Implications for Thermal Coal. Carbon Tracker Initiative. London. Available at: http://www.carbontracker.org/wp-content/uploads/2014/09/gcp1.pdf

European Systemic Risk Board (ESRB)

“Too Late, Too Sudden: Transition to a Low-carbon Economy and Systemic Risk”

February 2016

Publication Objective	The publication’s aim is to illustrate, through an in-depth assessment, the channels through which climate change and the transition to a low-carbon economy could impact systemic financial stability. The report also summarizes feasible macro-prudential policy responses in light of these risks.	
Organization Background	The ESRB is responsible for the macro-prudential oversight of the financial system within the European Union in order to help prevent or mitigate systemic risks to financial stability that can result in widespread financial distress.	
Publication Regional Focus	Sectors Covered	Publication Target Sectors
Global and Europe	Multiple	Financial sector
Publication Target Audience	Risk Factors Covered	Publication Available at:
Investment and lending professionals, central bank professionals, ministers of finance, regulators	Environmental risks and link to macroeconomic risks and systemic financial risks	https://www.esrb.europa.eu/pub/pdf/asc/Reports_ASC_6_1602.pdf

The report assesses the risks to financial stability posed by climate change on the presumption that the transition to a low-carbon economy occurs late and abruptly. The report assumes that belated awareness about the importance of controlling emissions could result in an abrupt implementation of quantity constraints on the use of carbon-intensive energy sources, and the costs of the transition will be correspondingly higher.

This adverse scenario could affect systemic risk via two main channels:

1. Reduced energy supply and increased energy costs would impair macroeconomic activity;
2. Financial institutions would be affected by their exposure to carbon intensive assets.

These two channels could generate contagion in the broader financial system by interacting with other financial frictions.

Increased energy costs are expected to impair economic growth both on the supply and demand side. This report finds that energy-intensive sectors, particularly transport and manufacturing, would see their production processes disrupted as input prices increase. In the shorter term, a rapid transition could result in constrained energy supply if demand outstrips the productive capacity of renewable energy. At the same time, households' disposable income would be hit by the effect of increased energy costs on the price of consumption goods (most notably, electricity and transport).

The report finds that stranded assets are likely to result from the transition to a low-carbon economy regardless of the speed of the transition. In a gradual transition to renewable energy and replenishment of the physical capital stock, carbon-intensive technologies would gradually become unprofitable due to a combination of regulation (such as carbon taxes) and technological development (i.e., economies of scale that drive down the costs of renewable energy). In the case of a "hard landing," the sudden arrival of obsolescence caused by a rapid change in environmental policy might precipitate a more radical and not fully anticipated repricing of carbon-intensive assets, including fossil fuel reserves and other assets dependent on cheap fossil fuels. The sudden revaluation of carbon-intensive capital would also affect financial institutions with claims on firms that disproportionately own such capital or use it as an input in their production processes. Furthermore the initial shock could cause contagion throughout the financial system.

The study suggests that the ESRB could intervene on climate change risks in both the short and medium terms. In the short term, the ESRB could support enhanced information collection and disclosure, which could take the shape of additional reporting requirements. In the medium term, the ESRB could perform dedicated climate stress tests of the European financial system. The study concludes by suggesting possibilities for prudential policies that include:

1. Building systemic capital buffers to protect against macroeconomic implications of an adverse climate shock to the financial system;
2. Regulatory loss absorbency requirements;
3. Capital surcharges based on the carbon intensity of individual exposures;
4. Large exposure limits to assets prone to be at risk from the low-carbon transition.

Indication of Publication Impact	<p>As part of the European Union’s European System of Financial Supervision, the ESRB is a highly influential institution across the EU member states. In this respect, the publication has had visibility among European financial institutions. The ESRB’s website and mission is referenced on the website of the central banks of all major EU member states:</p> <p>Bank of England: http://www.bankofengland.co.uk/financialstability/Pages/esrb.aspx</p> <p>German Deutsche Bundesbank: https://www.bundesbank.de/Navigation/EN/Service/Glossary/Functions/glossary.html?lv2=129524&lv3=145666</p> <p>Banque de France: https://www.banque-france.fr/en/eurosystem-international/eurosystem/the-european-systemic-risk-board.html</p>
Next Steps Following Publication/Follow-up Studies	<p>By scoping potential ways the ESRB can contribute to the climate change and financial stability debate, the publication paves the way for further studies, particular on climate and financial stability stress testing.</p>
Citation	<p>ESRB. 2016. Too Late, Too Sudden: Transition to a Low-Carbon Economy and Systemic Risk. European Systemic Risk Board ASC Report No 6 (February). Available at: https://www.esrb.europa.eu/pub/pdf/asc/Reports_ASC_6_1602.pdf</p>

3.3 Financial System Risk Studies

Bank of England Prudential Regulating Authority

“The Impact of Climate Change on the UK Insurance Sector”

September 2015

Publication Objective This report aims “to provide a framework for considering the risks arising from climate change through the lens of the PRA’s statutory objectives in relation to insurers. The report therefore takes the form of an initial risk assessment. It explores possible responses to the risks identified but is not intended to provide a policy prescription. The report also discusses climate change-related opportunities.”

Organization Background The Prudential Regulation Authority (PRA) was created as a part of the Bank of England by the Financial Services Act (2012) and is responsible for the prudential regulation and supervision of around 1,700 banks, building societies, credit unions, insurers, and major investment firms. The PRA’s priorities are to promote the safety of the firms it regulates, focus specifically on insurance firms and protection of insurance policyholders, and facilitate effective competition.

Publication Regional Focus
Global and United Kingdom

Sectors Covered
Insurance

Publication Target Sectors
Insurance and financial sector

Publication Target Audience
Financial services and investment institutions, professionals, and policymakers

Risk Factors Covered
Physical risks of climate change, transition risks to a low-carbon economy, liability risks

Publication Available at:
<http://www.bankofengland.co.uk/pradocuments/supervision/activities/pradefra0915.pdf>

In April 2014, the PRA accepted an invitation from the UK Department for Environment, Food & Rural Affairs (DEFRA) to complete a Climate Change Adaptation Report focused on insurance. This document is the PRA's response to DEFRA and is the PRA's first report on the subject of climate change.

The paper states that “the ways in which the insurance sector, and hence the PRA's objectives, could be impacted by climate change are diverse, complex and uncertain.”

Three primary risk factors related to climate change are identified as having a significant impact on the insurance industry: physical risks, transition risks, and liability risks.

Physical risks: Risks that arise from weather-related events such as floods and storms. They involve impacts directly resulting from events such as property damage, and also indirectly through subsequent disruption of global supply chains or resource scarcity. The PRA's general view is that firms are reasonably well equipped to manage the current level of physical risks from climate change. Risks would appear to be lower where firms are:

- Considering multiple perspectives on risk, including the use of stress and scenario testing;
- Building close links within the academic community, and incorporating the latest scientific evidence into their assessment of risk, including the possibility of more sudden and severe changes in climate;
- Considering appropriate governance of climate change risks, including holding discussions at emerging risk committees, assigning senior management oversight, and exploring the merits of in-house environment committees.

Transition risks: These cover the financial risks that could arise for insurance firms from the transition to a low-carbon economy. For insurance firms, this risk factor is mainly about the potential repricing of carbon-intensive financial assets, and the speed at which any such repricing might occur. To a lesser extent, insurers may also need to adapt to potential liability impacts resulting from reductions in insurance premiums in carbon-intensive sectors.

At a high level, the PRA considers transition risk to be of most relevance to two tiers of financial assets, accounting for around 30 percent of global equity and fixed-income investments:

Tier 1: Companies that may be impacted directly by regulatory limits on their ability to produce or use fossil fuels. Producers include coal, oil, and gas extraction companies, and conventional utilities.

Tier 2: Companies that are energy-intensive may be affected indirectly via changing energy costs during the transition phase (e.g., chemicals, forestry and paper, metals and mining, construction, and industrial production firms).

Liability risks: These are risks to insurance firms arising from parties that have suffered loss and damage from climate change, and seek to recover losses from parties they believe were responsible. Where such claims are successful, those parties against which the claims are made may seek to pass on some or all of the cost to insurance firms under third-party liability contracts such as professional indemnity or directors' and officers' insurance.

Publication Summary	<p>The PRA focuses on three primary lines of argument for establishing liability, summarized as failure to mitigate, failure to adapt, and failure to disclose or comply.</p> <ul style="list-style-type: none"> • <i>Failure to mitigate:</i> Alleges that insured parties are responsible for the physical impacts of climate change, for example through emissions of greenhouse gases, and therefore can be held directly liable for loss or damage to third parties. The need to establish elements including a “duty of care” and a “causative link” would suggest this category is perhaps the most challenging area for litigation to succeed. • <i>Failure to adapt:</i> Alleges that insured parties have not sufficiently accounted for climate change risk factors in their acts, omissions, or decision-making. This could apply to a range of climate-change-related risk factors, not just those from physical risks such as storms and floods, but also those from the governance of economic or financial issues that are material to corporate risk or return. This category may be a less-difficult area for plaintiffs to achieve success given that cases may conceivably be formulated under existing statutory or common law causes of action (such as breach of directors’ duties or negligence). • <i>Failure to disclose or comply:</i> Claims allege that insured parties have not sufficiently disclosed information relevant to climate change, have done so in a misleading manner, or have otherwise not complied with climate-change-related legislation or regulation. This category may be one of the quickest to evolve, particularly as society, shareholders, and other actors call for greater transparency regarding climate change risk factors, with accompanying legislation or regulation around disclosure and reporting.
Indication of Publication Impact	<p>The report had widespread visibility among finance and investment professionals around the world, central bank senior representatives, government officials, and academic institutions, given the reputation and influence of the Bank of England in the financial world.</p> <p>The report prompted the insurance industry to further analyze how it can both hedge its insurance models against climate change and use its influence to foster climate change leadership in the financial sector. The study has also prompted other central banks and regulators to explore in depth whether the low-carbon economy transition poses risks to financial stability. See http://www.cisl.cam.ac.uk/business-action/sustainable-finance/climatewise/news/climatewise-pra-report-open-letter-2015.</p>
Next Steps Following Publication/Follow-up Studies	Not available
Citation	<p>Bank of England (Bank of England 2015) The impact of climate change on the UK insurance sector A Climate Change Adaptation Report by the Prudential Regulation Authority. Bank of England. Available at: http://www.bankofengland.co.uk/pra/Documents/supervision/activities/pradefra0915.pdf.</p>

United Nations Environment Programme (UNEP) Inquiry

“The Financial System We Need: Aligning the Financial System with Sustainable Development”

October 2015

Publication Objective

This publication presents the main findings of the UNEP Inquiry acquired across its two-year timeframe, particularly related to how sustainable development issues are incorporated across financial markets and the financial system as a whole.

Organization Background

The UNEP Inquiry into the Design of a Sustainable Financial System was established to advance policy options to improve the financial system’s effectiveness in mobilizing capital for sustainable development. The Inquiry has focused on financial and monetary policies and financial regulations, as well as standards, including disclosure requirements, credit ratings, stock exchange listing requirements, and indices. In doing so, the Inquiry has paid attention to the role that the financial system’s rule-makers can play. The Inquiry aims to support the scale-up, broadening, and exchange of policy options, advance new critical research areas, and continue its national, regional, and international engagements to embed sustainability into financial architecture.

Publication Regional Focus

Global

Asset Classes Covered

Multiple asset classes

Publication Target Sectors

Financial sector

Publication Target Audience

Central banks, financial regulators, governments, financial institutions, and credit rating agencies

Risk Factors Covered

Systemic financial risks, intangible asset risks

Publication Available at:

<http://web.unep.org/inquiry/publications>

The report provides a summary of how central banks and regulators could link climate change and broader sustainability risks with their objectives, including:

- **Financial stability:** Climate impacts may pose significant costs to the real and financial economies, creating volatility and disorderly market transitions.
- **Monetary policy:** Monetary policy operations can impact on the deployment of capital for the low-carbon economy.
- **Banking regulation and supervision:** Socio-environmental and climate factors can influence these prudential risks in banking at the asset, institutional, and market levels.
- **Insurance regulation and supervision:** Natural disasters and the physical impacts of climate change are having increasing impacts on the re/insurance industry. Insurance sector investments could also be impacted by the low-carbon transition.
- **Pension regulation and supervision:** Environmental and social issues can impact the performance of investments, so understanding these risks and sources of value may become part of fiduciary duty.
- **Securities regulation:** If companies do not appropriately disclose risks posed by environment and climate change, markets are not able to respond to them, and market failures may arise.
- **Accounting and financial reporting standards:** Sustainability issues may pose material risks and opportunities to business value through multiple channels, and traditional standards may not adequately reflect how these impact the firm.

Publication Summary

The Inquiry's findings point to central banks in developing and emerging economies as being more active than their developed country counterparts in explicitly considering national policy priorities, including financial inclusion and environmental issues as well as national economic and industrial strategies. Some commentators see these extended roles as a transitional phase that ends as other public institutions become stronger. Others point to a history of central banks targeting development objectives, and see a need to ensure alignment of central bank decision-making with a broader sustainability agenda.

Indication of Publication Impact

The information dissemination power and the high profile of the UNEP make this initiative highly impactful. While it is global in its approach, it provides enough specificity to be a very useful publication for central banks, regulators, ministries of finance, development banks, and other financial institutions.

Next Steps Following Publication/Follow-up Studies

Not available

Citation

UNEP Inquiry. 2015. The Financial System We Need: Aligning the Financial System With Sustainable Development. UNEP Inquiry into the Design of a Sustainable Financial System (October). Available at: <http://web.unep.org/inquiry/publications>.

United Nations Environment Programme (UNEP) Inquiry
“The Brazilian Financial System and the Green Economy: Alignment with Sustainable Development”
September 2014

Publication Objective The objective of this publication is to present the main findings of the UNEP Inquiry, particularly related to how sustainable development issues are incorporated across financial markets and the wider financial system. The report explores the case of Brazil, identifying restrictions and opportunities, and outlining opinions and suggestions.

Organization Background The UNEP Inquiry into the Design of a Sustainable Financial System was established to advance policy options to improve the financial system’s effectiveness in mobilizing capital for sustainable development. The Inquiry has focused on financial and monetary policies and financial regulations, as well as standards, including disclosure requirements, credit ratings, stock exchange listing requirements, and indices. In doing so, the Inquiry has paid attention to the role that the financial system’s rule-makers can play. The Inquiry aims to support the scale-up, broadening, and exchange of policy options, advance new critical research areas, and continue its national, regional, and international engagements to embed sustainability into financial architecture.

Publication Regional Focus Global and Brazil	Sectors Covered Multiple asset classes	Publication Target Sectors Financial sector
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Publication Target Audience Central banks, financial regulators, governments, financial institutions, and credit rating agencies	Risk Factors Covered Systemic financial risks, intangible asset risk	Publication Available at: http://unepinquiry.org/wp-content/uploads/2015/10/brazilianfinancialsystemgreeneconomy_febraban-gvces_april2015.pdf
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Publication Summary	<p>This report combines the analyses from primary research and two previous studies, “Current Financing for the Green Economy in Brazil” and “The Brazilian Financial Sector Institutional Context in the Transition to Sustainable Development.” From this, this report proposes an agenda for advancements in the Brazilian financial sector toward sustainable development for the 2015–2020 period. In particular, there are eight recommendations from the most strategic level to the tactical level.</p> <ol style="list-style-type: none"> 1. Global: Have global discussions on capital allocation for socio-environmental risks 2. Global: Globally standardize and monitor resources allocated to the green economy 3. Brazil: Reduce legal uncertainty related to the socio-environmental due diligence of Brazilian financial system agents 4. Brazil: Strengthen dialogue with public authorities to improve economic tools that foster innovative sectors related to sustainable development 5. Brazil: Foster dialogue between professional associations on topics related to sustainable development 6. Brazil: Tactical recommendations for banks in their credit and financing activities 7. Brazil: Tactical recommendations for pension funds and investment managers 8. Brazil: Tactical recommendations for the insurance industry
Indication of Publication Impact	<p>In addition, the report provides in-depth analysis of key themes that will need to be at the forefront of sustainable development, notably renewable energy, agriculture, and biodiversity. Recommendations for each are provided. In addition, the report explores the important role of cities in advancing sustainable development, calling for improved technology and the development of “smart cities,” as well as improved public transport, urban agriculture, and education.</p>
Next Steps Following Publication / Follow-up Studies	<p>The information dissemination power and the high profile of the UNEP make this initiative highly impactful. While the broader UNEP Inquiry has been global in its approach, this report shows clearly that the findings and insights can be easily adapted to provide useful country-specific publications for central banks, regulators, ministries of finance, development banks, and other financial institutions.</p> <p>In moving from design to delivery, the Inquiry will support the scale-up, broadening, and exchange of policy options, advance new critical research areas, and continue its national, regional, and international engagements to embed sustainability into financial architecture (UNEP Inquiry 2015).</p>
Citation	<p>UNEP Inquiry. 2014. The Brazilian Financial System and the Green Economy: Alignment with Sustainable Development. UNEP Inquiry and Center for Sustainability Studies at the Getulio Vargas Foundation. Available at: http://unepinquiry.org/wp-content/uploads/2015/10/brazilianfinancialsystemgreeneconomy_febrabangvces_april2015.pdf.</p>

University of Zurich and Boston University (Battiston et al., 2016)

“A Climate Stress Test of the EU Financial System”

February 2016

Publication Objective

The purpose of this academic paper is to provide a novel methodological framework to assess the exposure of the financial system to climate policy risks. The study extends the notion of climate policy risk scenarios in order to go beyond the fossil fuel production sector and encompass the indirect effects through key economic sectors such as energy-intensive sectors, housing, and finance.

Organization Background

The Department of Banking and Finance (DBF) at the University of Zurich (founded in 1969 as the Swiss Banking Institute) has broad expertise in its four core areas of banking, corporate finance, financial economics, and quantitative finance. The institution fosters interdisciplinary research and teaching. With 20 professors and more than 130 employees, the DBF is a leading finance group in the German-speaking part of Europe.

The Frederick S. Pardee Center for the Study of the Longer-Range Future at Boston University conducts interdisciplinary and policy-relevant research on a wide range of issues that are important contributors to improvements in the human condition. The center seeks to disseminate the collective knowledge and experience of scholars and practitioners in an effort to ensure that decisions made today lead to better outcomes tomorrow.

Publication Regional Focus

European Union

Sectors Covered

Equities, bonds, and loans

Publication Target Sectors

Cross-sectors

Publication Target Audience

Academics, asset owners, regulators, and investment professionals

Risk Factors Covered

Systemic risks, investment and counterparty risks

Publication Available at:

http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2726076

The paper provides a new methodological framework to quantitatively assess the direct and indirect exposure of European financial institutions' portfolios to carbon risk. The authors adopt a network-based approach to reveal exposures to climate-sensitive sectors and to simulate how climate policy shocks could multiply throughout the financial system.

The top-level findings of the research are:

- Investment funds are the actors with the largest equity holdings, mostly allocated to energy-intensive, finance and other sectors. They are followed by industrial companies (with a similar breakdown by sectors).
- Investment funds own the highest fraction of market capitalization, which can give them greater bargaining power, while industrial companies and other credit institutions have the highest relative portfolio exposure, which makes them more vulnerable to equity losses.
- The direct impact of a 100 percent loss on market capitalization in the fossil fuel sector on the EU banking system as a whole is relatively low, even when accounting for network amplification effects.
- Nevertheless, there are individual banks that seem to be overexposed to the sectors.

The research outlines the portfolio composition of major investment funds, together with a similar breakdown of exposure by sectors across all financial actors, with BlackRock leading among investment funds and JPMorgan Chase among banks.

The authors then run a stress test to identify the vulnerability of the banking system to climate-sensitive sectors. In addition, they provide a systemic risk assessment of the exposure of the top 50 listed EU banks by asset size to climate policy shocks by looking at the consequences of a wipe-out of equity holdings from companies in various climate-sensitive sectors. The climate-sensitive sector that contributes the most across the various scenarios is clearly the energy-intensive sector, both because of its market capitalization size and banks' equity exposure to it.

Publication Summary

Indication of Publication Impact

195 Downloads in the Social Science Research Network. Referenced in important papers such as (ESRB 2016).

Next Steps Following Publication / Follow-up Studies

Not available

Citation

Battiston, S., A. Mandel, I. Monasterolo, E. Schuetze, and G. Visentin. 2016. A Climate Stress-Test of the Financial System. Available at: <http://ssrn.com/abstract=2726076>

3.4 Risks and Vulnerability Studies

Carbon Tracker Initiative

“Carbon Cost Supply Curves Series” 2014–2015

Publication Objective The aim of this series of papers is to create supply cost curves to help investors understand their stranded asset risk exposure to fossil fuel companies with the highest capital expenditures. Carbon Tracker believes that this can help investors target their corporate engagement activities with the most-at-risk fossil fuel companies, and encourage investors to shift capital away from excess carbon risk.

Organization Background The Carbon Tracker Initiative is an independent think tank that provides in-depth analysis of the impact of climate change on capital markets and investment in fossil fuels. It focuses on mapping risk, opportunities, and the route to a low-carbon future.

Publication Regional Focus	Sectors Covered	Publication Target Sectors
Global	Equity	Fossil fuels (coal, oil, and gas)

Publication Target Audience	Risk Factors Covered	Publication Available at:
Policymakers, finance and insurance, and fossil fuel sectors	Financial risk to fossil fuel capital expenditures	Coal: http://www.carbontracker.org/report/carbon-supply-cost-curves-evaluating-financial-risk-to-coal-capital-expenditures/ Gas: http://www.carbontracker.org/report/gascostcurve Oil: http://www.carbontracker.org/report/carbon-supply-cost-curves-evaluating-financial-risk-to-oil-capital-expenditures/

This series of reports creates carbon supply cost curves for global fossil fuel projects, highlighting that many make neither financial nor carbon sense when stress tested against demand, price, and emissions scenarios. Carbon Tracker worked with Energy Transition Advisors to collate demand and supply projections from leading industry and economic sources in the form of a cost curve for oil, coal, and gas sectors. Investors can consider a range of demand scenarios and then determine which price bands of production cost they think are at risk, and can use this information to begin engagement with companies with high capital expenditure risk.

The first report in the series created cost curves for the oil sector. Key findings included:

- Listed companies have more exposure to potential high-risk future production than national oil companies, especially at the upper end of the cost curve.
- Oil majors have large interests across the cost curve, reflecting the sheer scale of their interests and the desire to be involved in any large developments, whereas smaller companies have higher percentages of their potential capital expenditure in high-cost, high-risk projects.
- Some deepwater and oil sands specialists have 100 percent of capital expenditure requiring an oil price of more than \$95.
- Some deepwater and oil sands specialists have 100 percent of capital expenditure requiring an oil price of more than \$95, highlighting their risk exposure to low-demand scenarios and falling expenditure.

Publication Summary

The paper estimated that \$1.1 trillion of capital expenditure is earmarked for high-cost oil projects needing a market price of over \$95 up to 2025. This is largely made up of deepwater, Arctic, oil sands, and other unconventionals. The report argues that investors should begin reducing their exposure to the high end of the cost curve to avoid overexposure to carbon risk.

Following the interest in the oil report, Carbon Tracker published a similar risk analysis on the global coal industry, highlighting that \$112 billion of future capital expenditure in potential thermal coal production (excluding China) is at risk of becoming stranded. This is particularly due to the headwinds in the coal sector, with increasing competition from cleaner fuels leading to lower prices and fewer profit opportunities. The paper argues that deploying additional capital expenditure is risky, especially for new mines, which typically require expensive new rail infrastructure and port facilities to get coal to market. A further analysis of the gas sector, which completes Carbon Tracker's series on "Carbon Supply Cost Curves," follows a similar approach to the oil and coal studies in identifying high-carbon, high-cost projects within the gas sector for investors. It finds that due to the long lead time, liquefied natural gas (LNG) supply is covered for a low-demand scenario for the next decade. However, beyond this time, new projects that rely on an LNG price of more than \$10/mmBtu may be stranded over the next decade. The report highlights that \$283 billion of possible LNG projects could be surplus to requirements in a low-demand scenario up to 2025. In particular, the report finds that a number of LNG plants in the United States, Canada, and Australia could fail to produce expected returns. Under the Carbon Tracker analysis, the value of unneeded LNG projects rises to \$379 billion by 2035.

Publication Summary	<p>A consistent theme within the cost curve analysis is the identification of high-carbon, high-cost options that are not consistent with a reasonable carbon budget. Coal is seen as the least consistent with a low-carbon future, but oil and gas also have significant potential for asset stranding, particularly at the high end of the cost curves among un conventionals and for LNG. The reports emphasize the argument that low-carbon scenarios and asset stranding are likely to result from changing demand as a result of a perfect storm of factors including supply costs, air quality standards, technological advances, and carbon regulation.</p>
Indication of Publication Impact	<p>These publications have garnered significant media interest internationally. Coverage in mainstream, investment, environmental, and energy publications followed each release. Carbon Tracker has engaged in a range of follow-up media statements, investment meetings, and conferences to further the impact of the work. Each report also had a launch event including summaries of the research and panel discussions on its implications for investors. The events were widely attended, pointing to the interest in and relevance of these reports. For information about impact and related press articles, see: http://www.carbontracker.org/wp-content/uploads/2014/09/Coal-Report-Media-Coverage-Stats-300914.pdf; http://www.carbontracker.org/wp-content/uploads/2014/09/il-report-coverage-080514.pdf; and http://www.carbontracker.org/wp-content/uploads/2015/07/Carbon-Tracker-Media-Coverage-16.07.pdf.</p>
Next Steps Following Publication/Follow-up Studies	<p>In November 2015, Carbon Tracker released a new report that followed up on the theme of capital expenditure and stranded asset risk. The report was entitled “The \$2 Trillion Stranded Assets Danger Zone: How Fossil Fuel Firms Risk Destroying Investor Returns.” Rather than providing cost curves for different projects, this report focused on analyzing stranded returns and capital expenditure based on the marginal production between the IEA 450 Scenario and business as usual for the coal, gas, and oil sectors up to 2035 (Carbon Tracker 2015b).</p>
Citations	<p>Carbon Tracker. 2015a. Carbon Supply Cost Curves: Evaluating Financial Risk to Gas Capital Expenditures. Carbon Tracker Initiative (July). London. Available at: http://www.carbontracker.org/report/gascost-curve</p> <p>Carbon Tracker. 2014a. Carbon Supply Cost Curves: Evaluating Financial Risk to Coal Capital Expenditures. Carbon Tracker Initiative (September). London. Available at: http://www.carbontracker.org/report/carbon-supply-cost-curves-evaluating-financial-risk-to-coal-capital-expenditures/</p> <p>Carbon Tracker. 2014b. Carbon Supply Cost Curves: Evaluating Financial Risk to Oil Capital Expenditures. Carbon Tracker Initiative (May). 2014. London. Available at: http://www.carbontracker.org/report/carbon-supply-cost-curves-evaluating-financial-risk-to-oil-capital-expenditures/</p>

Carbon Tracker Initiative and SITAWI

“Unburnable Carbon: Is Brazil Avoiding the Carbon Bubble?”

June 2013

Publication Objective

This report is aimed at assessing Brazil’s resilience to the carbon bubble, given its current energy needs and energy mix, and from a perspective of the Brazilian government exploiting the country’s proven oil and gas reserves with its major listed oil and gas companies.

Organization(s) Background

SITAWI is a civil society organization in the public interest that raises capital for positive social-environmental impacts: “We call this Finance for Good. Our role consists of four complementary programs with high synergy that contribute to the achievement of our mission and vision.”

The Carbon Tracker Initiative is an independent think tank that provides in-depth analysis of the impact of climate change on capital markets and investment in fossil fuels. It focuses on mapping risk and opportunities and on the route to a low-carbon future.

Publication Regional Focus
Brazil

Sectors Covered
Oil and gas

Publication Target Sectors
Financial sector

Publication Target Audience
Pension funds and asset management institutions

Risk Factors Covered
Stranded assets

Publication Available at:
<http://www.carbontracker.org/wp-content/uploads/2014/09/Brazil-avoiding-the-carbon-bubble-UK-FINAL.pdf>

Publication Summary	<p>The report touches on multiple angles of stranded asset risk in the Brazilian financial market. First it highlights Brazil's energy mix, the fossil fuel reserves of Brazil's listed companies, and the companies' capital expenditure plans and fossil fuel production cost curves. Next, it discusses Brazil's competitive position in the international landscape of fossil fuel reserve development. Finally, the publication illustrates the implications of aligning the investment chain with a 2°C world.</p> <p>Key findings include the fact that Brazil's current energy mix is not heavily reliant on fossil fuels. Brazil's reliance on renewable energy (which accounted for about 45.8 percent of total primary energy production in 2011) enables the country to have a balanced energy mix. However, the country's enormous potential reserves of fossil fuels, especially in the shape of its offshore pre-salt reserves, could see Brazil become more exposed to the world's carbon bubble if it bids to become a net exporter of oil to bolster its economic growth in the future. Brazilian oil and gas companies invested \$23 billion in 2012 to develop further proven reserves.</p> <p>The report makes reference to five prominent listed fossil fuel companies: Petrobras, HRT, OGX, Pacific Rubiales Energy, and Queiroz Galvao. However, it is clear that the majority of stranding risk involves the Brazilian government (which owns more than three-quarters of the pre-salt reserves off the Atlantic Coast) and Petrobras (which is 46 percent owned by the state). Petrobras has a virtual monopoly on Brazilian listed companies' oil and gas production, holding 96 percent of proven oil reserves and 72 percent of proven gas reserves.</p> <p>The report outlines that the alternative option to developing the pre-salt reserves and growing the oil and gas sectors in Brazil "is to continue focusing on renewable energy sources. The Brazilian biofuel industry is already the second largest in the world (behind the US)." However, Petrobras appears fully committed to developing the pre-salt oilfields and it is uncertain at which point some projects might become unviable in a 2°C development scenario.</p> <p>The study concludes with two recommendations:</p> <ol style="list-style-type: none"> 1. Extractive companies should indicate the carbon potential of their fossil fuel reserves in their annual reports as well as illustrate whether their business plan is sound under different carbon budget scenarios. 2. Better understanding is needed of the range of potential outcomes in the transition to a low-carbon economy. This can be achieved through stress testing of bank and pension fund portfolios.
Indication of Publication Impact	<p>The publication had traction mostly with local pension funds, mainly due to their long-term investment mandate and to their being less driven than other financial institutions by short-term decision-making.</p>
Next Steps Following Publication / Follow-up Studies	<p>Not available</p>
Citation	<p>Carbon Tracker and SITAWI. 2013. Unburnable Carbon: Is Brazil Avoiding the Carbon Bubble? London (June). Available at: http://www.carbontracker.org/report/is-brazil-avoiding-the-carbon-bubble/.</p>

Inter-American Development Bank (IDB)

**“Vulnerability to Climate Change of Hydroelectric Production Systems in Central America and Their Adaptation Options”
January 2016**

Publication Objective The goal of the study was to develop and implement a methodology to determine the vulnerability of hydroelectric systems in Central America to climate change and to identify possible adaptation measures.

Organization Background The IDB is the largest source of development financing for Latin America and the Caribbean. Established in 1959, the IDB supports Latin American and Caribbean economic development, social development, and regional integration by lending to governments and government agencies, including state corporations.

Publication Regional Focus	Asset Classes Covered	Publication Target Sectors
Central America	Hydroelectric power generation assets	Financial sector

Publication Target Audience	Risk Factors Covered
Investment decision-makers and project managers	The El Niño-South Oscillation phenomenon (ENSO), hurricanes, and temperature and precipitation extremes

Publication
Summary

The report found that 22.4 percent of Central America's primary energy matrix depended on hydroelectric plants in 2015, showing that the region's energy security is strongly dependent on the amount of hydroelectric energy that can be produced, and thus on the available water level of its rivers.

In the first phase of the study, Central America was divided into hydrological sub-basins, and in-depth analysis of each sub-basin's hydropower potential and risk from climate changes was conducted by characterizing the current and future hydrological regime and measuring the variation of its values with regard to extreme events (floods and droughts). The amount of electric energy produced was analyzed in this stage, with a potential long-term reduction found in all analyzed cases.

In the second phase of the study, the economic impact of climate change was analyzed. The impact on the electricity sector, and for each plant, was explored as a function of additional costs each national electricity system might incur to supply future energy requirements resulting from climate change. The study also analyzed the costs and benefits of possible adaptation options.

The study found that the potential impact of climate change on the hydropower system is sufficiently important to deserve consideration at the design and investment stages of new hydroelectric plants.

It is foreseen that the decrease of precipitation in most of Central American's catchment areas, along with the progressive temperature increase in all of them, would affect future hydroelectric production by influencing the amount of available resources. Due to the worsening of drought periods, the capacity of the plants would continue to decrease, while the increase in maximum flood flows for periods of highest return could possibly cause greater damage to existing infrastructure (regulation reservoirs and hydroelectric plants).

The paper also explored the economic implications of climate change on energy prices as a result of changing hydrological patterns. Although the projections varied under different scenarios, none of the scenarios for different countries showed insignificant changes. In terms of the relationship between present value and additional costs/GDP as of 2011, the most affected countries would be Honduras, Nicaragua, and El Salvador, with an average value of 11 percent (with a 4 percent discount rate). The average supply costs could increase by an average of 7 percent. As such, the impact of climate change on the hydropower system will be felt by public and private investors, as well as consumers.

Indication of
Publication
Impact

During the development of the methodology, various workshops were carried out in the countries. The sector's main actors and technicians were assembled in order to solicit opinions, refine the methodology, present the results, and train various technicians to carry out vulnerability analyses. Staff from the Ministries of Environment and/or Energy of the involved countries participated along with staff from the various regional bodies involved (IDB, 2016).

Next Steps Following Publication/Follow-up Studies	This study can be considered the first on this subject with a general focus. A recommended next step would be to design a holistic methodological approach to the vulnerability of hydrological resources in the face of climate change. This would also include all other human activities and ecosystems that depend on the water cycle in order to incorporate synergies, trade-offs and potential conflicts, and then identify priorities. Furthermore, it needs to be kept in mind that the study is based on results of constantly evolving climate change models, and its precision must continue to improve with time.
Citation	IDB. 2016. Vulnerability to Climate Change of Hydroelectric Production Systems in Central America and Their Adaptation Options. Inter-American Development Bank (January). Washington, DC.

Natural Capital Declaration (NCD)
“Towards Including Natural Resource Risks in the Cost of Capital”
November 2015

Publication Objective	This working paper evaluates current and potential approaches for banks and asset managers to understand and assess natural capital risks in portfolios. The study provides an in-depth overview of three main aspects related to natural capital: (1) the business and investment case for natural capital, (2) the state of integration of natural capital in lending and investment decision-making, and (3) the capability of research providers to offer natural capital research and data services to financial institutions.
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Organization Background	The Natural Capital Declaration was launched at the UN Conference on Sustainable Development (Rio+20) in 2012. It has been signed by CEOs of more than 40 financial institutions, and demonstrates their commitment to the integration of natural capital considerations into private sector reporting, accounting, and decision-making by 2020. To position the finance sector response, the UNEP Finance Initiative partnered with the Global Canopy Programme in 2011 to build support for the NCD. The leading Latin American business school Fundação Gerulio Vargas was a third partner in the vital early phases of the NCD, and it continues to contribute as a supporter and member of the NCD’s steering committee.
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Publication Regional Focus	Sectors Covered Across asset classes	Publication Target Sectors Financial sector
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Publication Target Audience Lending and investment institutions	Risk Factors Covered Natural capital risks (e.g., greenhouse gas emissions, water risks, biodiversity)	Publication Available at: http://www.unepfi.org/fileadmin/documents/NCD-NaturalResourceRisksScopingStudy.pdf
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Publication Summary

The paper argues that natural capital, stranded assets and, more broadly, environmental, social, and governance (ESG) risks, have the potential to impact the cash flows of companies and the markets' perception of their financial well-being, which in turn can impact the investment and lending portfolios of financial institutions. This paper suggests that these risks are yet to be incorporated into financial accounting and analysis for many reasons:

1. Current financial education and training (e.g., chartered financial analyst) does not cover intangible risk valuations and hence financial analysts mostly overlook these risks.
2. Given the geographic- and sector-specific character of natural capital risks, it is difficult to quantify them at a portfolio level.
3. The availability of natural capital datasets varies by indicators and geography. The lack of conceptual models and data robust enough to link with financial systems has been a key barrier to incorporating natural capital risks in financial models and subsequently in the lending and investment process.

This publication further offers an overview of the state of integration of natural capital into lending and investment decision-making by providing the results of a survey across 36 financial institutions. The survey included banks (67 percent), development finance institutions (11 percent), asset managers (8 percent), and insurance/reinsurance entities (5 percent). The most common implementation of natural capital considerations cited by respondents is to monitor risks at a transaction level (75 percent), reflecting the fact that most respondents were banking institutions. Twelve respondents said that they quantify/determine the materiality of natural capital risk, while 42 percent said that they already take natural capital factors into account in credit risk assessments. However, further questioning by the NCD revealed that many of these institutions were not systematically quantifying natural-capital-related credit risks.

The key challenges highlighted by survey respondents in integrating natural capital and environmental risks in their portfolios include limited information technology budgets and personnel; lack of awareness about environmental issues; lack of suitable and contextual methodologies and datasets; vagueness of regulatory requirements regarding natural capital issues; and difficulty in relating long-term data to short-term materiality.

In addition, an assessment of a shortlist of 26 research providers that offer natural capital research and data services reveals several insights. The most common indicators on which research providers and consultants focus are greenhouse gas emissions, water risks, climate risks, and air pollution. Fewer methodologies focus on indicators such as agricultural produce and over-exploitation risks, forestry and land use, and pollution. This is despite the significant contribution of land-use change to ecosystem loss and greenhouse gas emissions, and the agriculture sector's dependence on natural capital and climate security to maintain productivity. One reason for this could be that these indicators require more sophisticated analytical tools and datasets such as geographic information system tools, and traditional ESG rating providers are yet to fully incorporate these in their research processes.

Indication of Publication Impact	The study was presented during the World Natural Capital Forum 2015 in Edinburgh, as well as at other prominent events and institutions (e.g., the Green Investment Bank).
Next Steps Following Publication/Follow-up Studies	The follow-up to the present study consists of two interconnected phases that support the objectives of NCD to develop and test a methodology to map risks associated with natural capital impacts and dependencies across financial institution portfolios. In addition, the NCD is developing a methodology and guidance to embed natural capital considerations into credit risk assessment. Estimated period for implementation (subject to funding): January 2016–June 2018
Citation	Natural Capital Declaration (NCD). 2015. Towards Including Natural Resource Risks in Cost of Capital. November. Available at: http://www.unepfi.org/fileadmin/documents/NCD-NaturalResourceRisksScopingStudy.pdf

The Oxford Smith School

“Stranded Assets and Thermal Coal: An Analysis of Environment-related Risk Exposure” January 2016

Publication Objective	The principal objective of this report is to turn the latest research on environment-related risk factors facing thermal coal assets into actionable investment hypotheses for investors. By examining the fundamental drivers of environment-related risk, creating appropriate measures to differentiate the exposure of different assets to these risks, and linking this analysis to company ownership, debt issuance, and capital expenditure plans, the report aims to inform specific investor actions related to risk management, screening, voting, engagement, and divestment.
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Organization Background	The Sustainable Finance Programme (SFP) at the Oxford Smith School was established in 2012 (originally as the Stranded Assets Programme) to understand how finance and investment intersects with the environment and sustainability. The SFP seeks to understand the requirements, challenges, and opportunities associated with a reallocation of capital towards investments aligned with global environmental sustainability.
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Publication Regional Focus	Sectors Covered	Publication Target Sectors
Global	Equity and fixed income	Thermal coal miners, coal-fired utilities, coal-processing technologies companies

Publication Target Audience	Risk Factors Covered	Publication Available at:
Investors, civil society, and company management	Environment-related risks: water stress, air pollution, climate change policy, carbon capture and storage (CCS) retrofitability, heat stress, remediation liabilities, and competition from renewables and gas	http://www.smithschool.ox.ac.uk/research-programmes/stranded-assets/satc.pdf

In this report, the Oxford Smith School conducts a bottom-up asset-specific analysis of the global thermal-coal value chain. The analysis includes a range of environment-related risks faced by thermal coal companies, including water stress, air pollution, climate change policy, CCS retrofitability, future heat stress, and competition from renewables and gas. The top 100 coal-fired utilities, top 30 thermal coal miners, and top 30 coal-to-liquids companies globally are comprehensively examined for their exposure to these environmental risks. The top 100 coal-fired power utilities own 42 percent of the world's coal-fired power stations, with 73 percent of all coal-fired generating capacity.

The report gathers data on the specific assets that make up a company's portfolio for coal-fired power plants, coal mines, and coal processing plants. For each of the environment-related risk factors, the report looks into the levels of exposure and assesses how each specific asset is exposed to the factors that differentiate the level of exposure. By providing this analysis alongside company ownership, debt issuance, and capital expenditure plans, this research provides investors with actionable data that can aid them in risk management, screening, voting, engagement, and divestment.

Publication Summary

The report shows that the environment-related risks associated with the thermal-coal value chain are substantial, and include physical environmental impacts, the transition risks of policy and technology in response to environmental pressures, and legal liabilities arising from these risks. These environment-related factors could lead to stranding of coal assets. Stranding is also likely to result from regulation, with the study finding that policy actions by key countries in the thermal-coal value chain exceed the New Policies Scenario in the reduction of coal in total global primary energy demand. However, the report also finds that CCS is unlikely to play a significant role in mitigating emissions from coal-fired power stations, given a lack of political and investor appetite to scale up the technology and the availability of more cost-effective alternative mitigation strategies. Overall, the report provides a bottom-up insight into thermal coal company exposure to environment-related risks in the public domain for the first time. The report finds that only 30 percent of power stations have precise geolocational data, meaning that spatial datasets representing certain types of risk (e.g., air pollution, flood risk) are not uniformly accurate and become less useful for power stations with inaccurate geo-location data. As such, the report calls for enhanced disclosure of geographic information at an asset level to aid investors, researchers, and central banks in their risk assessment, providing support for the Task Force on Climate-related Financial Disclosures chaired by Michael Bloomberg.

Indication of Publication Impact

This report received extensive media coverage, including mainstream newspapers and financial news outlets. The report has also been influential in investment circles by providing data for assessment of the thermal coal sector. A recent decision by Norges Bank Investment Management to divest \$2.2 billion from 52 coal companies is partially based on the analysis provided by the Oxford Smith School.

Next Steps Following Publication / Follow-up Studies

A new report on Japan's thermal coal chain was to be published in the spring of 2016. This research could support disclosure regimes via a Principal of Asset-level Disclosure, and the creation of an Asset-level Data Initiative.

Citation

Caldecott, B., L. Kruitwagen, G. Dericks, D. J. Tulloch, I. Kok, and J. Mitchell. 2016. Stranded Assets and Thermal Coal: An Analysis of Environment-Related Risk Exposure. Stranded Assets Programme, SSEE, University of Oxford. Available at: <http://www.smithschool.ox.ac.uk/research-programmes/stranded-assets/satc.pdf>

3.5 Ratings and Service Providers

Carbon Delta

Company and Business Model Overview 2016

Business Objective

Portfolio optimization: Portfolio managers can use the data to assess the climate risks in their portfolios. This helps to identify a portfolio's most climate-risky positions. Active managers can show how to reduce climate-change-related risks by comparing to benchmarks.

Customized model evaluation: Companies can use the analyses to verify their climate strategy. This is useful for addressing concerns of product managers as well as investors.

Competitor and scenario analysis: Competitor comparison shows how the strategy performs in the sector. Using the model with internal company data or virtual company data derived from future business plans allows for more detailed evaluation and scenario analysis. Carbon Delta's information technology competence also facilitates the development of customized model factors for sector-specific needs.

Market research: Aggregation of the model output can provide interesting insights into whole markets. These can either be geographic- or sector-based aggregates.

Organization Background

Carbon Delta is a boutique equity research firm that specializes in identifying and analyzing the climate change resilience of publicly traded companies. It uses a proprietary evaluation system that helps investors assess climate risks in their portfolios by identifying how much of a company's value is possibly affected by climate change.

Organization Type

Boutique equity research firm

Public / Private Institution

Private sector

Organization Country of Provenance

Switzerland

Regional Focus

Global

Asset Classes Covered

Publicly traded equity

Target Sectors

Financial sector

Target Audience

Portfolio manager

Risk Factors Covered

Regulations, technology, extreme weather, climate trends, greenhouse gas limitation effects

More Information Available at:

<http://www.carbon-delta.com>

Carbon Delta uses a set of over 20 different data sources to provide insight for investment clients regarding the climate change resilience of publicly traded companies. This includes publicly available data, as well as proprietary data from various financial data providers. In addition to the financial data, different climate data sources are utilized, including extreme weather risk data and climate model trends based on Intergovernmental Panel on Climate Change (IPCC) climate pathways. In summary the data includes:

- 2,490 companies (MSCI ACWI Index)
- Geo-reference model with over 13,000 different locations
- Modeling of the whole value chain
- Extensive list of partners and supplier data
- Geographical and sector distribution of sales
- Exact production and infrastructure locations at the city level
- IPCC-based climate data based on a large set of climate models
- Exact sea-level rise information for all major coastal cities

Product Summary

For each company, Carbon Delta models the whole value chain from supply to production and distribution. Each company is analyzed via geographical and sector breakdowns of each step in the value chain. The data are then “mapped” against the “model factors.” Carbon Delta models all the relevant key factors, including:

- How changes in climate-related regulations and greenhouse gas targets impact a portfolio
- How substitutes of a technology are related to clean technology advancements
- How extreme weather poses a risk for the supply chain, production, and sales
- How climate change trends impact a portfolio
- How the greenhouse gas budget might affect companies

Carbon Delta’s model is constantly verified with various methods to ensure the most accurate estimates possible:

- Standard discounted cash flow modeling
- Expert analysis
- Company engagement
- Calibration with insurance data

Indication of Impact

- Swiss FinTech Award 2016
- Winner of 2016 SAFT challenge (one of six top climate efficiency start-ups)

The Carbon Delta team is currently working on several different projects:

- Evaluation of data providers such as FactSet, Bloomberg, Reuters, WM Daten, Interactive Data, Bureau van Dijk, and others
- Design and program work on the genetic algorithm. Genetic algorithms are search heuristics that generate solutions to optimization problems using techniques inspired by natural evolution such as inheritance, mutation, selection, and crossover
- Pre-evaluation of a list of selected companies

Next Steps

The explicit goal is to make the complex nature of assessing the future impact of climate change with the means of big-data analysis available for customers in a simple way, providing substantial help for decision-making. For more details, visit the Carbon Delta website at <http://www.carbon-delta.com>

Morningstar
ESG Fund Ratings
2016

Business Objective	The Morningstar Sustainability Rating gives investors across the globe a way to compare fund portfolios based on a standard measure of sustainability.	
Organization Background	Headquartered in Chicago, Morningstar provides investment research, ratings, and raw data on a range of investment offerings. Morningstar also offers investment management services through its registered investment advisory subsidiaries, with more than \$180 billion in assets under advisement and management as of December 31, 2015. The company has operations in 27 countries, and offers services to a range of investment actors including individual investors, financial advisers, asset managers, and retirement plan providers and sponsors. In 2016 it began publishing sustainability ratings for investment funds.	
Organization Type Investment research and investment management	Public / Private Institution Private	Organization Country of Provenance United States
Regional Focus Global	Sectors Covered Funds	Target Sectors All
Target Audience Investment managers	Risk Factors Covered Environmental, social, and governance factors	More Information: The Methodology of Ratings is available at: http://corporate1.morningstar.com/Morningstar-Sustainability-Rating-Methodology-2/

The Morningstar Sustainability Rating is a measure of how well the holdings in a portfolio are managing their environmental, social, and governance (ESG) risks and opportunities relative to their Morningstar Category peers. It is calculated for managed products and indexes globally using Morningstar's portfolio holdings database. This rating complements Morningstar's fund ratings, which look at performance and factors such as investment strategy and price, and are used by many investors globally in their decision-making. This was the first such set of ESG ratings applied to investment fund products, although MSCI has since established its own set of fund ESG ratings. Morningstar has a long history of rating fund performance, and it is introducing Sustainability Ratings into this calculation. Morningstar tracks 200,000 funds. It announced Sustainability Ratings for most funds invested in medium-sized and large companies for the first time in March 2016. However, these ESG scores have not automatically affected a fund's Morningstar rating, although analysts will now examine the ESG rating to inform their decisions about overall ratings. The Sustainability Rating is a holdings-based calculation using company-level ESG analytics from Sustainalytics, a leading provider of ESG research. Sustainalytics provides ESG scores on more than 4,500 companies globally that are evaluated within global industry peer groups. In addition, Sustainalytics tracks and categorizes ESG-related controversial incidents for more than 10,000 companies globally.

The Morningstar Sustainability Rating will be updated monthly and is derived from the Morningstar Portfolio Sustainability Score, which is calculated based on company-level ESG scores and company involvement in ESG-related controversies as follows:

Portfolio Sustainability Score = Portfolio ESG Score - Portfolio Controversy Deduction

For full details of this methodology, and a breakdown of each component score, see <http://corporate1.morningstar.com/Morningstar-Sustainability-Rating-Methodology-2/>.

Although similar, MSCI will provide a more detailed breakdown of data through its new fund sustainability scores but place less emphasis on ESG controversies. Under MSCI, each fund will receive an overall score, the Fund ESG Quality Score, a peer group percentile rank, and individual E-, S-, and G- Scores. The ESG Quality Score reflects the ability of the underlying holdings to manage medium- to long-term risks and opportunities. Clients will also have access to over 100 fund metrics to evaluate the ESG attributes of their portfolio. These attributes fall into three categories: sustainable impact, values alignment, and risks. For more information about the MSCI ratings, see https://www.msci.com/documents/10199/242721/MSCI_ESG_Fund-Metrics_Productsheet.pdf/731c6d72-3c21-4aae-8fc1-5b864b057da3.

Indication of Publication Impact	<p>The announcement by Morningstar (and MSCI) was widely covered in mainstream investment media such as the <i>Financial Times</i> (see https://next.ft.com/content/5288c842-41ce-11e5-b98b-87c7270955cf), and has been widely praised as likely to increase the consideration of ESG and sustainability factors in investment decisions.</p> <p>Fiona Reynolds, managing director at the Principles for Responsible Investment, is quoted in a <i>Financial Times</i> article as saying: “For too long, managers have been side-stepping ESG, often claiming that it was not part of their fiduciary duty. The Morningstar ratings mean managers can no longer ignore ESG issues.” However, a few commentators also expressed concerns in the article about the methodologies used in both ratings, arguing that they could simply encourage asset managers to move capital into stocks that are highly rated on ESG rather than engage with companies with lower scores in order to improve them (see https://next.ft.com/content/e8dac6ae-bb83-11e5-bf7e-8a339b6f2164).</p>
Next Steps Following Publication/Follow-up Studies	<p>Morningstar has established a growing research commitment to provide sustainable investing articles in the Morningstar magazine, available at http://corporate1.morningstar.com/Morningstar-Magazine-ESG/.</p> <p>For more information about Morningstar and to follow its work, see http://www.morningstar.co.uk/uk/.</p>

4. Interviews and Survey

This section outlines the findings and conclusions of the primary research undertaken for this report, namely interviews and surveys. In particular, we outline the current understanding of stranded assets, the availability and use of investment tools to manage stranded asset exposure, the motivation for investors and other financial actors to act on stranded assets, the information needed to help understand environmental challenges, and the ways in which these insights can apply to and inform discussions of stranded assets in LAC.

4.1 Approach and Methodology

For this report, the Oxford Smith School conducted 18 interviews with leading professionals working internationally on stranded assets. Relevant organizations and individuals were contacted directly by the project team. These individuals and organizations were identified during the literature review for their expertise on stranded asset topics. In addition, existing contacts known by the project team to have relevant expertise were also contacted. While such stratified sampling techniques are inherently biased and rely upon selective processes, they were viewed as having

the potential to yield the most interesting and insightful results, given the time and resource constraints of the project. Twenty-four organizations were contacted, with 18 responding positively to the request for an interview (a satisfactory response rate of 75 percent). Regardless, these results should be understood as part of an ongoing project: we make no claims about the universal or representative nature of our findings. We merely convey the general perspectives that we encountered as (1) regularly repeated and consistently emerging among respondents; (2) confirmed by those respondents as “popular” impressions among their comparable peers; and (3) coming from sources that we could verify as credible. Furthermore, we clearly indicate within the report where disclosed perspectives may be minority opinions, or stances that are most attributable to individuals, rather than representing wider views.

A list of interviewed organizations can be found in Annex 1. Those interviewed represented four investment organizations, eight service providers,¹⁵ two corporations, two academic institutions, and two NGOs, all of which are engaged in relevant research and practice. Individual responses have been anonymized, as agreed to by participants.

The list of structured questions (Annex 2) was designed and agreed upon by both the Oxford Smith School and

¹⁵ Service providers are defined as those servicing investors or corporates, including data providers, independent research organizations, law firms, think tanks, and consultants.

the IDB. This structured approach to questions facilitated comparable results across multiple interviewers, but the researchers also allowed open-ended conversations to garner greater insights from the different perspectives and expertise of the individual interviewee. Interviews took place in-person or by telephone, between April and June 2016.

In addition to the interviews undertaken for this report, the following section will draw upon a 2015 survey by the Oxford Smith School (E. Harnett 2016). The aim was to explore the availability of knowledge on climate issues in the investment arena internationally. This survey was disseminated by e-mail to members of the Oxford World Financial Digest (OXWFD), an online news outlet aimed at investment professionals. With a total of 154 participants, this survey provides an analysis of viewpoints of mainstream investors from around the world: 38.7 percent of survey respondents were executives and a further 27.8 percent were investment managers. Only 4.7 percent were ESG/RI specialists. Of the total, 40.6 percent worked in asset management organizations. Other organizations represented included pension funds, investment banks, and financial advisory firms. Most responses were from the United States, while other countries represented in the survey sample included the United Kingdom, the Netherlands, Australia, and France. This survey will be used in the following section to further explore the understanding (or lack thereof) of stranded asset issues among investors, and the integration of “responsible investment” into investment decisions, particularly among mainstream financial advisers and investment managers.

The following section is structured around the questions asked within the interview process. The analysis focus-

es on interview responses, but will incorporate insights from the survey undertaken as part of Harnett (2016) to provide deeper insight into the wider investment market.

4.2 Defining Stranded Assets

It was widely accepted among those interviewed that stranded assets are not just the result of climate change and that they involve sectors other than fossil fuels, but it was argued that coal and oil production have the most to lose. Stranded assets were not considered a new phenomenon, but many interviewees expect that stranding will increase in the coming decades as a result of environmental and technological changes. Interviewees from the NGO community focused on the temporal aspect of stranding, noting that some assets will be stranded permanently, whereas others will only be temporarily affected by extreme weather or changing prices. All interviewees understood the concept of stranded assets, and were able to define it (even if their definitions varied) and the likely causes of stranding. This was in sharp contrast to the survey participants, among whom only 30 percent answered that they “would feel confident in explaining [the concept] to a friend or colleague.” This suggests that while those engaged regularly in sustainable finance topics are familiar with the concept, there still remains a gap in the knowledge and understanding of mainstream investment professionals with regard to the discourse, definition, and materiality of stranded assets.

Interviewees commented that the debate on stranded assets has become widely associated with the concepts

of unburnable carbon and the carbon bubble. Interestingly, while only 30 percent of survey respondents knew about stranded assets, 42 percent were familiar with the phrase “carbon bubble.” Seven of the 18 interviewees (39 percent) suggested that “carbon bubble” or “unburnable carbon” were the concepts that they most associated with stranded assets. This is understandable, given that asset stranding of fossil fuel infrastructure is likely to result from policy changes (regulatory or corporate) that will occur if societies acknowledge that minimizing future climate change will require that some fossil fuel reserves stay in the ground. However, technological innovation, physical climate change, and long-term investment are also seen as relevant to the broader understanding of stranded assets, and this becomes clear in the following discussion of the potential causes of stranded assets.

Fossil fuels were seen by interviewees as the sector most likely to be affected by stranding. However, other sectors were also highlighted as being at risk, with equity investors viewed as the most exposed. Infrastructure (including transport, ports, and inefficient buildings), agriculture, real estate, and mining/utilities were all mentioned as being potentially affected by asset stranding. In addition, complex supply chains, forestry, healthcare, energy, and financial services were all mentioned as being at risk from stranding, demonstrating the range of sectors potentially affected by environmental changes and associated transformations. Several investors mentioned the potential for sovereign debt risk in countries whose economies are very climate-sensitive (either through direct physical climate risks, such as storms or drought, or through over-exposure to the fossil fuel sector, such as those countries with large state-owned resources companies). This shows that it is not only equity inves-

tors who are at risk from a range of environmentally driven stranding. There appears to be growing awareness that sovereign credit ratings could be affected by both physical climate changes (e.g., prolonged drought, destruction from more extreme weather, or changing agricultural productivity) as well as changing attractiveness for investments as a result of changing regulations. As such, one interviewee commented that “It seems that asset managers are searching for an optimum equilibrium point between higher yields and monitoring the risk associated with sovereign bonds which until today had either been ignored or neglected.” Despite the growing awareness of the need to account for climate change and stranded asset risk in sovereign investments, one interviewee noted that “there is currently a lack of appropriate tools for doing so, so we need more tools and methodologies.” For example, one of the organizations interviewed, BeyondRatings, has designed an online research service dedicated to assessing energy and climate risks and their impacts on sovereign ratings. Interviewees supported the design of more such tools, particularly for mainstream investors, and their integration into existing products and financial service providers.

4.3 Causes of Stranded Assets

The vast majority of interviewees accept that asset stranding will occur for a wide range of reasons. The Oxford Smith School lists the following factors as likely to cause stranded assets (Caldecott, Howarth, and McSharry 2013):

- Environmental challenges (e.g., climate change, water constraints)

- Changing resource landscapes (e.g., shale gas, phosphate availability)
- New government regulations (e.g., carbon pricing, air pollution regulation)
- Falling clean technology costs (e.g., solar photovoltaic, onshore wind)
- Evolving social norms (e.g., fossil fuel divestment) and consumer behavior (e.g., certification schemes)
- Litigation and changing statutory interpretations (e.g., changes in the application of existing laws and legislation)

Asked to rank these factors, investors tended to cite the falling costs of clean technology and environmentally driven physical challenges as most likely to cause stranded assets. Research and data providers also supported the assertion that falling clean technology costs were a likely cause, but they pointed as well to government regulations and the failure of corporate governance/management planning. One interviewee also expanded on the idea of environmental challenges as a leading cause, but argued that these would need to be large-scale and sudden: “Stranded assets are more connected to unexpected big events and distortions. Other factors that happen slowly over time (like decreasing renewables cost) give investment managers the chance to adapt their portfolios before the assets get stranded.” In addition, market forces, regulation, and sociopolitical pressure were seen by NGOs interviewed as likely drivers of stranding among. One of the NGOs interviewed, Generation Foundation (2013) has outlined four regulatory pressures that could contribute to the stranding of carbon assets:

1. Direct regulation on carbon that is led by local, provincial, national, regional supranational (e.g., the European Union), or global authorities;
2. Indirect regulation on carbon through increased pollution controls, limitations on water usage, or policies targeting health-related concerns;
3. Mandates on renewable energy adoption as well as efficiency; and
4. Impending regulation that creates uncertainty for long-lived carbon-intensive assets.

Litigation was seen by interviewees as least likely to cause stranding, followed by evolving social norms and changing resource landscapes. However, all of the interviewees noted that stranding is likely to occur as a result of a plethora of factors that are complex and interconnected. These results appeared to corroborate the survey findings, which found that, among investors, regulatory risk and physical risks were seen as the most likely climate-related factors to affect portfolio returns, with evolving social norms much less important.

4.4 Risk Exposure

Interviewees from international upstream oil and gas producers claimed that they had calculated the portfolio and asset-level stranding exposure they faced and believed that the risk was low. They had not changed their business strategy, arguing that they have robust, flexible, and resilient diversified portfolios with short payback times. Stranding assets was seen as an issue for 20-plus years in the future. The companies had engaged in scenario planning and analysis to better understand their future risks and took strategic decisions based on these exercises. In response, several oil and gas majors publish their expectations of future supply and demand, and support carbon price policies to help

dictate a more stable transition, preferring to act now and have a seat at policy discussions.

Investors (both asset owners and asset managers) are coming under increasing pressure to measure and disclose their exposure to carbon and stranded asset risk. In the interview process, some investors indicated they have begun to explore this exposure in-depth and are also taking steps to reduce their exposure. For asset managers, there is also growing pressure to offer low-carbon products, including divestment and carbon footprint tools. One fund manager said that their potential clients were placing greater weight during the process of selecting managers on the fund's provision of low-carbon products. As a result, many fund managers are now offering equity strategies with a low-carbon tilt, but interviewees noted that not many tools were readily available to reduce stranding risk for other asset classes. Thus, a number of interviewees emphasized the need for better diversification of risk management tools across sectors and asset classes, and better integration across portfolios. Currently, the tools are seen to be too narrow, and strategies seen as not allowing entire portfolios to be managed in a way that effectively manages stranded asset risk. No investor knows the actual time horizon of stranding, but there appears to be a growing conviction that there has been a change in trajectory toward low carbon. This is seen in the decline in coal and the speed of adoption of renewable technologies, which are driving a growing interest in risk management strategies, with many interviewees suggesting that demand for these products was currently outstripping supply.

This assertion was echoed by the NGO and research providers interviewed. Although they did not have the direct

exposure experienced by investors or corporations, these actors were still exploring risk management strategies in their capacity as intermediaries for both the corporate and investment clients with which they engage. NGOs commented that there has been a growing awareness of different methods for stranded asset risk management in the last two years, particularly regarding increased reporting and disclosure of these risks (especially carbon exposure and emissions).

However, there remained a sense that “there is not a single sector that takes climate change seriously enough,” as one interviewee put it, with real estate seen as the only sector that was taking it seriously on an industry-sector scale. This lack of engagement with risk management on stranded assets was seen as a result of insufficient reporting, measurement, knowledge, and commitment among industry actors in both the corporate and investment sectors.

4.5 Risk Management

The use of available risk measurement strategies was viewed as possible across different geographic locations, but the extent to which they have been adopted and considered accurate varied among interviewees. One interviewee suggested that the adoption of exposure tools, particularly in the equity markets, “depends hugely on disclosure and reporting practices, which are uneven globally due to varying degrees of legislation. Having corporate information that is comparable across geographic locations is key to developing robust tools, so this needs to improve but is difficult logistically and politically.”

Requiring accurate, comparative, and regular disclosure is particularly important for understanding exposure of complex supply chains to climate and other causes of stranding in different locations internationally. Several interviewees said that their organizations do study this, for example by overlaying future water scarcity maps onto locational data about corporate assets. Forestry funds were singled out by one interviewee as particularly good at considering such international exposure to stranding risk, whereas sovereign bond investors were highlighted as lacking sufficient tools despite the imperative to think about these risks.

Among those who do adopt risk management tools, the method of integration into decision-making varied. Most companies and investors using tools managed their implementation internally, arguing that this was the most effective way to integrate different mechanisms into their business strategy. However, particularly in the early stages of adoption, external research and analysis was seen as useful for understanding the different options available and demonstrating their relevance and use to the firm. Some investors who manage risk exposure internally also rely on external reviews, benchmarks, and bespoke analysis to aid in their work, and one interviewee said that his firm was considering “third-party tracking of progress of funds and strategies” to measure performance. Asset owners discussed using external managers in their risk management strategy. Since all of their investment capacity was outsourced, this was a natural choice. Investment managers were thus chosen based on their capacity and willingness to adopt investment strategies and tools that could measure and reduce their exposure to climate and stranded asset risk.

However, the absence of management strategies is highlighted in the survey findings, which found that 73 percent of survey participants did not have (or did not know about) someone in their investment/financial organization responsible for ensuring that relevant climate risks had been considered. Survey respondents did use a variety of management tools, most notably negative and positive screening, although the non-use of tools remains high (Figure 2).

Interviewees suggested that there were not enough management tools available, and those that were available were not of sufficient quality and rigor, particularly for calculating the risk of stranded assets. An investor thus commented that the “market is too smug in the rise of ex-fossil fuel products that facilitate investment in wind farms, but they don’t understand that this is not the only risk and that it [climate and stranded assets exposure management] needs to be integrated throughout the whole portfolio.”

One data provider lamented that “even if such tools are available they are not put into practice,” and another argued that investors tended to rely on case studies about physical risks of climate change and scenario modeling that “don’t cover all industries and sectors, time horizons, etc.” Concern over the use of models was not unique, with another interviewee saying, “The industry needs to think more carefully about the modelling and the flexibility to cater to different scenarios and carbon prices within the tools... These strategies tend to operate just in the circles of those who understand the basics of the problems, but are not suitable for those who don’t engage with the topics and the academic science on a regular basis.”

Figure 2. How Do You Incorporate Climate Change in Your Investment Process?

Answer Options	Always	Regularly	Sometimes	Never	Do Not Know/Not Applicable	Response Count
Negative screening (e.g., exclusions)	5	10	41	44	8	108
Positive screening (e.g., best-in-class)	4	18	45	34	7	108
Climate change analysis when stock-picking	3	4	43	39	16	105
Divestment or active climate-risk reduction	3	5	22	63	13	106
Shareholder voting	3	7	22	56	19	107
Direct engagement with corporations	1	4	18	60	21	104
Climate-related indices (e.g., Dow Jones Sustainability Indices, FTSE ex Fossil Fuels Indices, etc.).	1	5	18	64	18	106

Source: Harnett (2016)

This supports the survey findings, which found that only 20 percent of respondents thought that there is adequate information to properly analyze corporate exposure to climate change. Provision of management tools and strategies that are suitable for a wide range of investors (of different sizes, asset-class focus, and geographic locations) is important, but so is the ease of use of tools that are accessible to mainstream investors without deep background knowledge of sustainability and stranded asset issues. These are key factors to ensure that the necessary scale of financing can flow into the products.

There was some disagreement among interviewees as to the extent to which products should be bespoke or publicly accessible. One corporate said that “there are many tools and approaches available, but they are ‘one size fits all,’ which is not always helpful,” whereas an institutional investor commented, “external managers want to offer us bespoke strategies, but we need investment solutions that are broader and available to others and on a larger scale – there is no point in us investing wisely if no one else does, so that climate change goes on unabated.” There seems to be a need for management tools that can be easily integrat-

ed and scaled up, but also for tools to suit different organizational types and investment styles. The financial markets tend to display herd behavior (Kahneman 2011), so having stranded asset risk management tools that are widely available to investors could be key to enticing a wider range of investors and attracting a greater scale of

investment. Adoption of such mechanisms by a few large institutions would be more likely to catalyze greater interest than would their use of bespoke and expensive tools. Greater attention to the needs of investors, and the opportunity to integrate the mechanisms throughout investment portfolios, is needed.

4.6 Perspectives on Risk Management Tools, Practices, and Strategies to Identify and Reduce Exposure to Stranded Assets

This section explores the different perspectives on the availability, use, and benefits of different risk management tools, practices, and strategies aimed at identifying and reducing exposure to stranded asset risk. In particular, we explore the motivations among different institutional actors for implementing such stranded asset risk management.

4.6.1 Corporates

Long-term risk mitigation was the main reason cited by companies for their adoption of stranded asset risk management. The extent to which external versus internal factors affected decisions varied among interviewees: for some companies internal factors have been crucial, whereas for others increasing pressure from investors has led to a changed approach and the adoption of risk management tools. In this investor-driven context, “responsible investors” were more important in instigating change than mainstream institutional investors. However, on balance, corporate interviewees suggested that internal risk management processes have mainly driven the adoption of stranded asset risk management.

Over the last few years asset owners and managers have become more interested in what companies are doing in this area internationally, partially driven by changing regulations. Interviewees mentioned institutional investors in France, the United Kingdom, and the rest of the European Union as leaders in encouraging the recognition and transparency of stranded assets among companies. Among the companies, BHP Billiton and Total (the only companies seen to be acting on climate risks in their portfolios) as well as Shell (with its long-term commitment to scenario analysis) were mentioned as leaders.

Companies mentioned the Task Force on Climate-related Financial Disclosures (TCFD) as an important enabler of further development of risk management tools and practices. Interviewees suggested that its recommendations should be made mandatory, to the extent possible, in order to encourage companies to disclose better climate-related risk information and help investors make better decisions. In general, there appear to be pockets of excellent disclosure but a general lack of understanding of this issue among many companies. There needs to be recognition that the understand-

ing of these risks will evolve over time (as will business models, etc.), and that a disclosure framework needs to be comparable, consistent, and flexible enough to reflect this evolving understanding of risk. It is not just an issue for the fossil fuel sector, which is why a better understanding is also needed of how climate-related risk will affect other sectors such as infrastructure, agriculture, complex supply chains, and real estate.

4.6.2. Investment Organizations

Interviewees representing investment firms said that long-term risk mitigation, social pressure (e.g., divestment campaigns), and shareholder pressure were the main reasons why they adopted stranded asset risk management. Investment mandates, as well as these firms' understanding of the long-term risks from climate change, also motivated action on stranded asset issues. Social pressure is a useful secondary pressure and has sparked greater momentum for action on stranded asset issues in the wider market. Some endowment and foundation-based investors also approach risk management from a more values-driven basis. However, many other asset owners, and particularly asset managers, are still driven by the feeling of needing to be seen to be acting, rather than actually strongly believing in the investment case for action. Countries seen as leading in the field of responsible investment and the integration of stranded asset concerns into investment decisions are Norway, which has a very practical response to the issue; France, which is driven by a policy response to climate concerns; and China and the United States, which are driven by technological change.

Interviewees commented that NGOs, asset owners and managers, regulatory authorities (especially the Bank of England), and brokers have all been influential in catalyzing investor decisions to adopt risk management tools, practices, and strategies.

Investors discussed the need for easier-to-digest information to help their investment decisions regarding stranded asset and climate change exposure. One large institutional investor stressed the importance of communication. There is a demand for information that is presented in investment-relevant language and in distilled form so investors do not need to spend a long time digging for investment conclusions. This finding is supported by the survey, which found that only 30 percent of respondents believed that the language used in climate change communications was appropriate for the investment community. Information should be centered on investment actions rather than raw data and needs to be presented in investment cases that bring all the data together. Communication is one of the biggest barriers, alongside a lack of investment tools, to integrating stranded assets into investment decisions, according to interviewees.

4.6.3 Nongovernmental Organizations

NGOs see countries such as France, the United Kingdom (especially because of Mark Carney and the Bank of England), China (because of the emergence of carbon pricing schemes), and the United States (because of litigation) as leading in this field. One of the interviewees also pointed to Germany as showing the most consistent and successful trajectory toward a real energy transition that contributes to climate mitigation and projects posi-

tivity to the investment markets. Switzerland was also highlighted as a key example of decarbonization of the transport sector.

The NGOs interviewed also called for additional information to enhance understanding and integration of the stranded asset issue. Among their suggestions was better information on the vulnerability of nations to rapid transitions, including decarbonization scenarios and physical climate impacts. Precise scenarios for the causes and timelines of asset stranding were also highlighted as being important but limited in the current literature.

4.6.4 Data and Service Providers

Historically, the only tools available for investors to manage carbon exposure in equities were carbon footprinting and related techniques, which remain the most commonly used tools (Eurosif 2014; Global Sustainable Investment Alliance 2014; E. Harnett 2016). However, interviewees suggested that changing societies, regulations, and economic pressures made better tools necessary. A proactive stance on stranded assets has thus increasingly helped to differentiate data companies.

In the experience of data and service providers, several different organizations have been instrumental for firms' decisions to adopt risk management tools. The most important were said to be central banks, regulatory authorities, pension funds, intermediaries (e.g., rating agencies, climate groups), and investment consultants. Data providers argued that pension funds were often more receptive to the responsible investment and stranded asset agendas, given their longer investment timeframe. Banks, on the other

hand, were seen as mostly short-term oriented and as usually looking only at the governance side of their clients.

Countries that have been mentioned by data and service providers to be leading in this context are France (mainly because of Article 173, the French Energy Transition Law), Sweden, China (especially the Industrial and Commercial Bank of China's risk management tool), and the Scandinavian countries (doing the most for both governmental and financial consideration of stranded assets). Organizations leading in this context are the Environmental Agency Pension Fund, Carbon Delta, ICBC, and Allianz Global Investors. According to the interviewees, there are currently no oil, gas, or utility companies that are adequately reporting on the risks of stranded assets to their business models, although Total was argued to be the most progressive.

When asked what additional information would be helpful for organizations to adopt risk management tools, practices, and strategies, the service provider interviewees had several suggestions. One was a better overview of the cost for firms and investors, at the individual asset and corporate level, related to climate change. Even with the Stern Review and subsequent analyses, data providers argued that the cost of climate change remains unclear. However, another service provider argued "there is no lack of information but rather a lack of knowledge of existing information." Greater attention to how information is presented and disseminated to different actors was seen as more effective than just producing more data. Furthermore, the polarizing and politicized nature of the climate debate is seen as limiting the uptake of information, rather than the need for more information. Therefore, a reframing of the debate toward the materiality of climate

change and stranded assets to investment and corporate returns could be key to advancing the discourse. This view was also strongly supported by survey respondents, who commented that climate change communications were too “nebulous and nuanced,” “politicized,” “full of jargon or difficult to follow,” and full of “alarmist arguments.”

4.7 Stranded Assets and Responsible Investment in LAC

As part of the interview process, the Oxford Smith School team probed the understanding of and opportunities for asset stranding and responsible investment in LAC. Several important discussion points emerged.

First, many financial institutions in LAC are concerned mainly with the economic growth and governance issues of the companies in which they are invested and less so with environmental issues. Indigenous communities’ rights and threats to a company’s social license to operate are also on the radar of financial institutions, and are currently considered more salient than issues like stranded assets. Pension funds across the region tend to be more receptive to the impact of climate change and stranded assets on their portfolios given their long-term mandates. The consideration of environmental issues has gained more traction with financial industry associations across the region (e.g., the Brazilian Federation of Banks). Interviewees also pointed to the role of central banks, providing the example of the Brazilian central bank, which has a mandate to encourage all financial institutions to develop ESG risk

management practices and processes, which it then judges as to whether they are fit for purpose.

Second, interviewees acknowledged that the size of financial markets across LAC, as well as the ownership of pension funds, is important in determining the adoption of responsible investment principles across the investment value chain. One interviewee pointed to the opportunities for investment relating to the 2014 collaboration known as “The Alliance of Financial Markets between Chile–Peru–Colombia–Mexico” (also known as the Pacific Alliance). That alliance is approximately the same size as the Brazilian financial market (on a market capitalization basis). While the alliance and Brazil have not historically had synergies in the investment space, there were reported efforts to consolidate the relationship between Brazil and the Spanish-speaking countries of Latin America.

Pension funds in the region (particularly Chile and Peru) tend to be owned by international financial institutions, which have yet to deploy their responsible investment experience in the region, while on the global investment landscape they are considered leaders in integrating responsible investment into decision-making.

4.8 Summary of Interview and Survey Findings

This section has highlighted the ongoing shift toward greater awareness of stranded assets and broader climate consideration among financial communities internationally. However, among our interview participants, those based in Europe, the United

States, and Australia tended to have a greater urgency and appetite for integrating the issues than did interviewees in the LAC region, for whom issues of economic growth and governance were greater priorities. Although interviewees were aware of the key issues surrounding stranded assets, survey participants (who were more likely to be mainstream financial analysts and advisors) were less aware of the topic and its importance, suggesting that there is still scope for education on the topic and its relevance to the mainstream finance community.

Among those who understood the topic, though, there was a general awareness of the causes and scope of the issue, with a clear recognition among interviewees that stranded assets will occur throughout the economy, rather than be limited to the oft-talked-about upstream fossil fuel sectors, and within a range of asset classes. However, there was a sense that the current risk calculation and risk management tools were primarily focused on managing fossil fuel exposure through screening rather than catering to the risk throughout international investment portfolios.

As such, the main barriers to implementation of stranded asset mitigation strategies appear to be mostly related to knowledge and the availability of suitable management tools:

1. In terms of knowledge, there is a lack of knowledge of climate issues, particularly in the mainstream investment industry, and a need for easier-to-digest information to assist in the decision-making process. For instance, informa-

tion should be presented with the appropriate terminology based on the target audience, particularly when aimed at investors who have distinct terminology and are used to homogenous financial data sets. In addition, scenarios for timelines and causes of asset stranding are limited, and need to be scaled up and made available to mainstream analysts rather than remaining in the realm of academia.

2. Results also indicate a need for management tools that can be easily integrated and scaled up and can suit different organizational types and management styles. Current tools are narrow and do not allow for effective management of stranded assets risk in the entire portfolio. A focus on providing ex-fossil fuel indices has been successful to some extent but does not capture the complex nature of the climate issue or the multifaceted needs of different investors.

This section thus concludes that while progress has been made toward better understanding climate and stranded asset risks and integrating them into the finance community, barriers remain. Greater attention to framing and diffusing risks and opportunities, and to providing diverse but practical management tools, is required in order to continue scaling up these efforts. This is particularly the case in LAC, where other factors, including governance and development issues, vie for primacy among investment priorities, and where there are more limited opportunities for sustainable options in the smaller financial markets.

5. Conclusions

Through an extensive review of the literature and case studies, in-depth interviews, extensive informal consultation, and a survey instrument, this review has found the following:

- Stranded assets created by environment-related risk factors, including physical climate change impacts and societal and regulatory responses to climate change, have become increasingly prominent. This has been driven in large part by changes in the real economy (e.g., the falling cost of renewables), as well as by attention generated by the Paris Agreement.
- Levels of awareness and interest differ across countries and regions. Much of the early work on stranded assets originated in the United Kingdom, rapidly spreading to the United States and from there to other countries. There is currently significantly more awareness of stranded assets among financial institutions in the United States, Europe (particularly the United Kingdom, France, the Netherlands, Sweden, Denmark, and Norway), China, and Australia than elsewhere.
- In LAC, there appears to be a clear gap in the literature, less awareness, and little work on the horizon on stranded assets. This is a significant omission, given the region's exposure to environment-related risk factors, the presence of extensive fossil fuel resources that may become "unburnable" given carbon budget constraints, and the particular challenges and opportunities facing lower-income and emerging economies in LAC.
- While awareness of stranded assets among financial institutions has increased rapidly, developments in practice have not kept up. New products and tools have been launched to cater to new demand, but they are often based on carbon footprinting and related methodologies, which financial institutions are increasingly questioning. There are growing calls for a new generation of data, analytical methods, and tools to help financial institutions differentiate between assets and companies that are more or less exposed to environment-related risks. Developing this next generation of analytics is critically important if financial institutions are to take into account in their decision-making environment-related risks that can strand assets.
- Understanding the implications of stranded assets for successful low-carbon development is in an incipient phase. There has been some work on the need for a "just transition," but it has been conducted at a relatively high level and predates much of the discourse on stranded assets. There is very little work looking at how to systematically identify assets that could be stranded by decarbonization and then develop policy responses to preempt destabilizing opposition that might result. There are signifi-

cant opportunities to create tools that can help policymakers understand when and where assets may become stranded so they can develop adequate policy and regulatory responses. There is an opportunity for this to be pioneered in LAC.

- Stranded assets could be a systemic risk to financial stability and should therefore be a topic of concern for central banks and financial regulators. There are also issues related to micro-prudential regulation and the conduct and practice of financial institutions that make

stranded assets of relevance to supervisory bodies. Much of the work in this area has been led by the Bank of England, with the Financial Stability Board and the European Systemic Risk Board also producing work. Other central banks are likely to follow suit. There could be opportunities for LAC regulators to pioneer developments in this area, particularly given that the Brazilian central bank already has a highly progressive mandate to encourage all financial institutions to develop ESG risk management practices and processes.

Annex 1: List of Interviewees

Organization	Type of Organization	Organization Role	Country
Allianz Global Investment	Asset management firm	Global asset management firm, including strong risk management culture and integrated environmental, social, and governance (ESG) analysis.	United Kingdom
Beyond Ratings	ESG financial services company (service provider)	Aids the integration of climate consideration by financial services clients. Particular focus on providing analysis of sovereign carbon risk.	France
BHP Billiton	Global resources corporation	A multinational mining, metals, and petroleum extraction company engaged in the discovery, acquisition, development, and marketing of natural resources.	Australia

BP	Oil and gas corporation	One of the world's leading integrated oil and gas producing and distributing companies.	United Kingdom
Carbon Delta	Research provider	Equity research firm that specializes in identifying and analyzing the climate change resilience of publicly traded companies	Switzerland
CDP	Nongovernmental organization	NGO working as a data and research provider to improve the management of environmental risk at the corporate and city scale.	United Kingdom
Client Earth	Law firm	Law firm working to improve consideration of the environment in government and corporate law at a national and international level.	United Kingdom
Environment Agency Pension Fund	Pension fund	Pension fund for employees of the UK Environment Agency, with a strong ESG investment mandate.	United Kingdom
Generation Foundation	Advocacy and research provider	The advocacy initiative of Generation Investment Management, Generation Foundation seeks to mobilize asset owners, asset managers, companies, and other key participants in financial markets in support of the business case for sustainable capitalism	United Kingdom
Governart	Think tank	A think tank that researches responsible investment topics in Latin America and the Caribbean.	Chile

Impax Asset Management	Asset management firm	A leading investment firm that uses a proprietary investment framework to identify risks and opportunities from thematic trends, including population dynamics, resource scarcity, inadequate infrastructure, and environmental constraints.	United Kingdom
London School of Economics	Academic institution	One of the foremost social science universities in the world. It is home to the Grantham Institute on climate change and the environment.	United Kingdom
Minter Ellison	Law firm (service provider)	One of the largest corporate law firms in the Asia-Pacific region.	Australia
Sandbag	Nongovernmental organization	A not-for-profit think tank that conducts research and campaigns for environmentally effective climate policies.	United Kingdom
SITAWI	Service provider	A social and sustainable finance service provider with expertise in supporting high-impact social projects, managing philanthropic assets directly, and advising financial institutions on incorporating ESG issues into business strategy and investment analysis.	Brazil
Stanford University	Academic institution	One of the world's leading universities, and home to the influential Global Projects Center.	United States

Vigeo Chile	Environmental service provider	A European organization that focuses on assessing South American companies and organizations with regard to their practices and performance on ESG issues.	Chile
World Resources Institute	Research provider	A global research organization that spans more than 50 countries, working on topics at the intersection of environment and development.	United States

Source: Prepared by the authors.

Annex 2: List of Interview Questions

General Stranded Asset Questions

1. How do you define “stranded assets”?
2. Which concept would you most associate with stranded assets?
3. What do you consider the main causes of stranded assets?
4. Which sectors and/or asset classes do you think will be most affected by stranded assets?

7. What risk management tools, practices and/or strategies is your firm using/are firms using to identify and/or reduce exposure to stranded assets?
8. Are these tools, practices, and/or strategies adopted across asset classes?
9. Are these tools, practices, and/or strategies adopted across geographic locations?

Risk Exposure Questions

5. Has your firm or have firms in general begun examining their exposure to stranded asset risks?
6. Do you think that stranded assets will affect your own portfolio/the portfolio of many companies? If so when?

Risk Management Questions

10. Are these tools, practices, and/or strategies mostly managed internally, or by external consultants?
11. Are there enough risk management tools, practices, and/or strategies available in the market to aid in the evaluation of stranded asset risk?

12. Are you satisfied with the quality of risk management tools, practices, and/or strategies available in the market to aid in the evaluation of stranded asset risk?

Motivation Questions

13. What are the reasons for your firm/firms in general in adopting risk management tools, practices, and/or strategies to identify and/or reduce exposure to stranded assets?
14. Which organizations have been instrumental for firms' decisions to adopt risk management tools, practices, and/or strategies to identify and/or reduce exposure to stranded assets?
15. Which organizations have been instrumental in the implementation of risk management tools, practices, and/or strategies to identify and/or reduce exposure to stranded assets?
16. Which countries are leading in the implementation of risk management tools, practices, and/or strategies?
17. Which organizations are leading in the implementation of risk management tools, practices, and/or strategies?

Information Questions

18. What additional information would be helpful for those organizations adopting risk management tools, practices, and/or strategies.
19. What research have you found to be most useful in assessing climate and specifically stranded assets risks?
20. What are the most important aspects to consider when analyzing stranded asset risks for financial institutions?

LAC/ IDB Related Questions

21. What are the other ESG or financial issues that might take precedence and increased attention over stranded assets risks in LAC?
22. How can the IDB engage with the stranded assets risk debate across different countries and players in the region?

Other Questions

23. Other interesting aspects coming up not covered by our original questionnaire.

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