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Dynamic Capabilities and Climate Resilience Innovation: An Exploratory Analysis

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Abstract:

Climate adaptation and resilience are increasingly important dimensions of corporate sustainability and R&D strategies, yet management and economics research remains largely focused on climate mitigation and decarbonisation. Despite growing evidence that firms are exposed to escalating climate risks, limited attention has been paid to the capabilities that enable business model innovation for climate adaptation and resilience. This study develops an exploratory approach to identify firm-level capabilities for climate resilience by integrating insights from business model innovation, corporate resilience, and climate adaptation literature. Building on validated cases, this paper examines how micro-foundations of dynamic capabilities shape firms' ability to anticipate, absorb, adapt to, and transform in response to climate change. The paper adopts a multiple case study methodology focused on three France-based firms in logistics and transportation: CMA CGM, Getlink, and Sogaris. Initial evidence suggests that climate resilience capabilities are emerging at the corporate level but remain unevenly developed across functions and value chains. Sensing and seizing capabilities appear more established, while reconfiguration and innovation capabilities remain more limited. The study highlights a relevant gap in the literature and points to the need for further theory-building and empirical validation at the intersection between firm-level dynamic capabilities and system-level climate resilience transformations. This working paper presents an exploratory analysis based on an initial set of five interviews and three illustrative case studies. The proposed framework should therefore be interpreted as an initial conceptual and empirical contribution that will be further refined and validated through additional data collection and comparative case studies.

Keywords: climate adaptation and resilience, dynamic capabilities, business models, innovation, firms.

JEL codes: *D81, Q54, Q55, Q56, O32, O39.*

1. Introduction

The effects of climate change are ever present in today's economy and society. While corporate decarbonisation and net zero strategies are widespread in industry and a great deal of effort is devoted to tracking progress to achieve net zero emissions, climate adaptation and resilience have received significant less attention in management and innovation studies.

The study of climate resilience innovation in firms is in an emerging state as a field of academic enquiry with many gaps and disconnections between management and climate sciences (c.f. Villano et al., 2026; Wang et al., 2025). A search on academic databases (Web of Science - WoS and Scopus) results in very limited number of specialist publications in the last 20 years[1] (published in business and management journals). On Scopus, searching "climate resilience" with additional keywords related to firms (i.e. "business*" OR "firm*") brings no results, whereas on WoS it identifies 36 documents (excluding articles in press). Overall, available literature is oriented to climate-risks exposure (including financial risks), value/supply chain resilience, disclosure, finance, artificial intelligence, CSR, ESG

[1] TITLE-ABS-KEY ("climate resilience") AND (LIMIT-TO (SUBJAREA , "ECON") OR LIMIT-TO (SUBJAREA , "BUSI")) AND (LIMIT-TO (DOCTYPE , "ar"))

mechanisms and the effects on governance, while it remains thinner on the firm-level capability-building processes that enable climate resilience innovation, the incorporation of climate adaptation solutions, and business-model reconfiguration. As demonstrated in this paper, hardly any study has explained the internal capabilities through which firms translate climate-risk awareness into anticipatory, absorptive, adaptive and transformative responses to climate change. To address this pressing gap in the academic literature, this paper reviews different contributions emerging evidence at the intersection of business management, organisational resilience and climate sciences. More concretely, this study explores the application of dynamic capabilities to business model innovation for climate adaptation and resilience as building blocks of a firm-level framework.

Despite initial progress in the study of corporate climate resilience at the firm-level, many gaps remain unsolved. The key research question guiding this study is to know *how can a company strengthen the climate resilience of its business model(s)?* To solve this question, an exploratory study based on desk research, interviews, and mini-qualitative case studies analysing three large firms headquartered in France is conducted: CMG CGM, GetLink and Sogaris. Data triangulation was used to identify a combination of climate risks, firm-level dynamic capabilities, adaptation solutions, and territorial/system-level climate adaptation and resilience capacities. The initial results of this paper constitute preparatory work to develop a full operationalisation of the dynamic capabilities approach applied to climate resilience allowing firms to be more adaptive to new market and socio-ecological and geophysical conditions imposed by a changed climate.

As an initial exploratory study, the proposed framework and findings are based on five interviews and three illustrative case studies and are intended to inform subsequent theory development and broader empirical validation.

The remainder of the paper is distributed providing in section 2 background to the study and key definitions stemming from climate science and innovation studies, section 3 a focus on dynamic capabilities for climate resilience innovation, section 4 presents the methodology for conducting mini-case studies, section 5 discuss results, and the final part presents initial conclusions, limitations, and next steps needed to further investigate this topic.

2. Key concepts and an operational definition of climate resilience innovation.

Innovation, adaptation and resilience are popular terms in scientific and grey literature. **Innovation** is a broad term that can be used to describe novel solutions that solve wicked problems – including climate change (Nooteboom & Stam, 2008). In economics, the OECD and Eurostat (2018) defines **business innovation** is a *new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes, and that has been introduced to the market or brought into use by a firm*. In management literature, business innovation is also seen as an activity, involving a process of idea generation, the development of prototypes, testing, scalability and the use of novel solutions in real market conditions (Díaz López, 2023). **Business model innovation** refers to new or improved forms to *articulate the logic, the data, and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value* (Teece, 2010, p. 179). The Business model Canvas by Osterwalder and Pigneur (2010) is a widely use representation of a business model, composed of a supply chain (assets, partners, activities), a customer interface (segments, relations and channels), a financial model (cost structure, revenue streams) and a core value proposition (value offerings). Such components that can be further be operationalised into a *value proposition*, a *value architecture*, and a set of *contributions* (Lehman-Ortega, Musikas, et. al. 2025).

According to the sixth assessment report of the IPCC (2022), **adaptation to climate change** in human systems refers to *the process of adjustment to actual or expected climate and its effects, to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.* The IPCC report also defines **climate resilience** as *the capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their*

essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation (Arctic Council, 2016).

Building on the notions provided above, **climate resilience innovation** is defined in this paper as new or significantly improved technologies, products, services and business models used to anticipate climate risks e.g. increasing preparedness), to absorb the effects of extreme weather events (e.g. reducing vulnerability), to adapt to a new climate conditions (e.g. better protection to exposure), to increases to the scope and degree of system-wide transformations (in socio-economic, socio-ecological, and/or socio-technical systems) and to positive changes to infrastructure or habitat that result from climate impacts. In turn, **climate resilience business models** can be considered a special archetype of sustainability-oriented business models (c.f. Bocken et al., 2014; Díaz López et al., 2019). They can be defined as new or improved forms to support value creating and value capturing activities and routines derived from the use of innovations oriented to climate adaptation solutions (including products and services) and from climate resilience strategies (c.f. Larosa & Mysiak, 2020) (e.g. climate services, smart and resilient agriculture, climate proofing for buildings and infrastructure, etc).

3. Towards a framework of dynamic capabilities for firm-level climate resilience innovation

This section introduces three building blocks of an emerging framework to understand corporate climate adaptation and resilience linked to business model innovation in firms: the dynamic capabilities approach, organisational resilience, and climate adaptation and resilience. The choice to incorporate 'climate science' concepts has been noted by Howard-Grenville et al. (2014) and Benischke et al. (2025). In this section, salient insights from climate risks management, transformative climate resilience and territorial climate adaptation dynamics are highlighted.

3.1 Firm-level dynamic capabilities.

Despite some known limitations and its limited use in climate change corporate studies (Daddi et al., 2018), looking at literature of dynamic capabilities and their crossovers with climate adaptation and corporate resilience is an adequate building block for this study. The assumption is made that at the heart of climate resilience innovations, dynamic capabilities can provide firms with the ability to *integrate, build, and reconfigure internal and external competences to address rapidly changing environments* (Teece & Pisano, 1994), such as those imposed by a rapid and constant climate.

Teece & Pisano (1997) introduced the framework of *dynamic capabilities* to improve the understanding of the evolution and ability of firms to cope and adapt to new business conditions. Firm-specific *capabilities* can take the form of *organisational* or *technological* – among many additional sub-categories. The development and use of *dynamic capabilities* can enable the firm to adapt to different environments (like new environmental regulations or external climate impact shocks, for example) and re-configure, integrate or change those internal and external organisational skills, methodologies and tools, learning, problem solving methods, manager's willingness, corporate values, management systems, resources (i.e. technical systems) and functional 'core' competences of firms. The dynamic capabilities perspective of the firm calls for the use of 'difficult to imitate' sources of firm-specific competitive advantage. Business model innovation are indeed enabled by dynamic capabilities (Teece, 2010, 2018), relying on the ability of the firm to 'evolve', 'renew' and adapt' – what Teece (2007) identifies as the core capabilities of **sensing** (and shaping)**, seizing** (opportunities), and (managing threats and) **reconfiguring**. Following Teece (2007), many economics and management authors have adopted the categories of micro-foundations of dynamic capabilities of sensing, seizing and reconfiguring. Across management and economic studies, the term "capabilities" or "dynamic capabilities" often refer to similar constructs: identifiable and specific processes with the key characteristic of being "conceptualized in the context of collective organizational problem solving", "cannot be separated from acting or practicing", and they "represent a reliable pattern" (Schreyögg & Kliesch-Eberl, 2007).

The following section is organised in three parts. We first introduce a handful of pioneer studies that analysed firm strategies in view of climate change adaptation. This is followed by more recent reviews summarising management literature interested on climate risks in business. The core of the section focuses on literature

using the dynamic capabilities framework to understand climate adaptation responses and organisational resilience.

3.2 Corporate resilience, climate change adaptation and risk management.

A wave of exploratory studies stemming from research focusing on organisational change and climate adaptation emerged since the mid-2000s. Initial exploratory work has been conducted focusing on adaptation responses to climate change in water and energy sectors (Berkhout, 2012; Berkhout et al., 2006). Berkhout and co-authors studied organizational processes of perception, evaluation, enactment and feedback and resulting adaptation strategies: do nothing, assess, reduce or share risks, and diversity. Additional conceptual work has discussed the intersection between climate resilience and organizational change, highlighting the role that rapid climate events, or 'massive discontinuous change' affecting the scale, scope and systemic uncertainty associated to climate change disruptive changes (Linnenluecke, 2017; Linnenluecke & Griffiths, 2012; Linnenluecke et al., 2013). While predominantly theoretical, these pioneer studies shed light on the relation between firms and their economic and socio-ecological systems where they operate. They also highlighted the role that strategy plays in identifying adequate adaptation solutions and the risk of maladaptation. They have also posted evident limitations of the traditional sustainability management focus on prevention and the risk management bias towards regulatory compliance and risk transfer (e.g. via insurance and the estimation of affordable damage) could prevent firms to develop effective responses and are unable to sufficiently learn to adapt to fast, radical, and discontinuous change caused by climate impacts, already warning of the eventual insurability of assets and the challenge to truly achieve organisational-wide resilience.

More recently, scholars have developed an interest in methodological approaches and empirical validations linking climate adaptation and resilience with organisational change and sustainability transitions (Huiskamp et al., 2022; Singh & Goyal, 2023), circular economy and resilience (Kennedy & Linnenluecke, 2022; Perramon et al., 2024) and R&D and innovation (Ali & Kamraju, 2025; Hyun & Kim, 2026). In addition, management studies focusing on organisational resilience have produced systematic literature reviews, highlighting conceptual and methodological challenges of a risk-focused approach to emerging wicked challenges (c.f. Hillmann & Guenther, 2021; Joussen et al., 2025; Villano et al., 2026). Management and economics literature have also analysed climate risks and corresponding adaptation strategies (Kouloukoui et al., 2025; Li, 2025; Weinhofer & Busch, 2013).

Focusing on risks management, Wang et al. (2025) summarised critical physical and transition risks and their potential impact for business (following on from the Task Force on Climate-Related Financial Disclosures TCFD risk classification[2]). **Physical risks** with short term impacts include heatwaves, floods, droughts and cyclones, resulting in damages to e.g. infrastructure, disruption of production, increased competition for (clean water resources), and power cuts. Under the same category, long term risks included global warming and rising sea levels (melting of glaciers, expanding seas). Potential impacts under this category include coastal floodings, saltwater intrusion and land erosion, among others. Shifting to **transition risks**, specific categories included policies and laws, skills, market, and reputational issues, resulting in potential legal risks and litigations, increased transition costs, higher raw material costs, and negative consumer reactions. Rhein et al. (2026) provides an overview on the relationship between climate risks, (business) actors, and factors enabling climate resilience opportunities. The most prominent finding Rhein and colleagues is the imbalance of firms' perception between which are the climate risks against their opportunities. The risks are acknowledged highlighting the importance of monitoring and accountability focused climate resilience variables.

[2] The TCDF is no longer operational, as it can be read in their website (). Nonetheless, their classification of risks has been influential in many policies and regulations, including the European CSDR requirements of disclosure of the financial impact of climate risks of corporations with above 1,000 employees and 450 million EUR in annual revenue. See: https://finance.ec.europa.eu/financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en

The study of (Huiskamp et al., 2022) departed from the premise that climate resilience depends on the ability of firms to anticipate, withstand, and adapt to climate-related disruptions while preserving operational and financial stability. Huiskamp et al. (2022) acknowledged and underlined how much firms are struggling to apply "climate change scenario analysis" and there was poor information among firms about climate resilience (Demaria & Rigot, 2020). These scholars propose a climate resilience cycle for firms (Figure 2), composed of two well-defined periods of *stability* and *change*. In this study, the concept of climate resilience is framed as "bouncing back" where in a business context it refers to a financial performance under different climate conditions and develop the ability to survive in the aforementioned resilience categories. They used the TCFD categories of physical and transition risks to test a scenario analysis procedure and cycle to provide an adoption of climate strategies encouraged by emerging disclosure requirements. They argued that the greatest value for firms lies in the organisational learning they enable, to understand how climate resilience can be strengthened across the value chain and translating these responses into the company's broader strategic direction. Huiskamp et al. (2022) concluded that three key dynamic capabilities influence climate resilience innovation in business: (i) *sensing climate risks & opportunities*, (ii) *coping with climate change impacts and hazards*, and (iii) *reconfiguring an existing business model*.

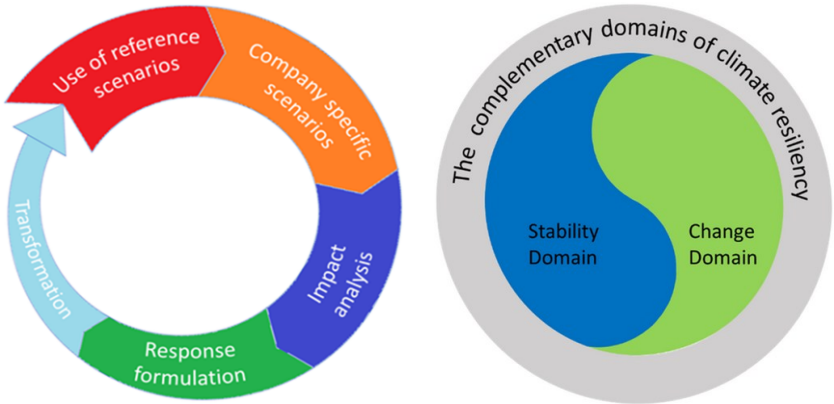

Figure 1 Huiskamp et. al. 2022 climate resilience cycle

In turn, Joussen et al. (2025) reviewed over 80 scientific articles specifically using dynamic capabilities to address organisational resilience across different sectors and industries exposed to volatile, uncertain, complex, and ambiguous (VUCA) environments (e.g. tourism, agriculture, insurance, etc). While not specifically addressing adaptation to climate change and climate resilience, these authors identified six categories of dynamic capabilities enabling resilience in firms. Also building on Teece (2007), Joussen and co-authors suggested a theoretical framework organised along three broad categories: (i) **sense**, where the dimensions of *engage* and *anticipate* identified, (ii) **seize**, characterised by capabilities of *coping*, and (iii) **reconfigure,** including the micro-dynamic capabilities of *transforming*, *sustaining* and *growing*.

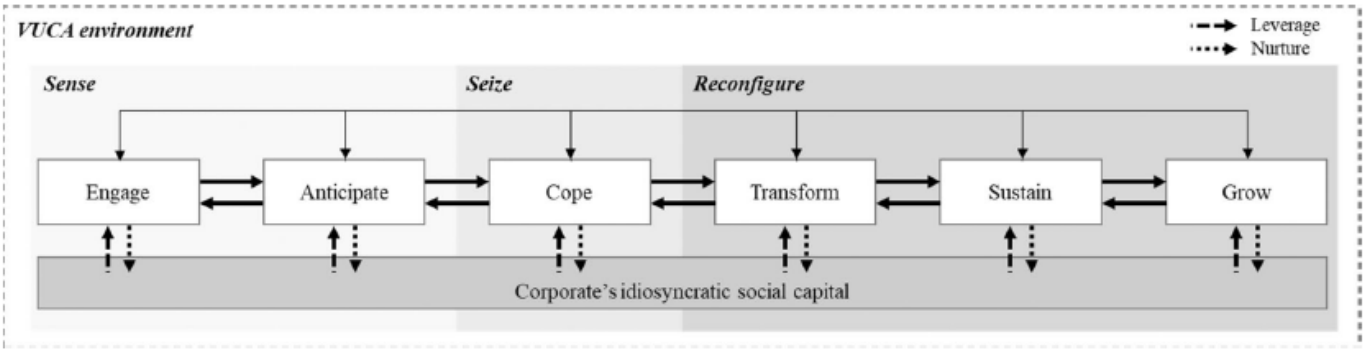

Figure 2 Joussen et.al. (2025) integrated theoretical framework of dynamic capabilities for corporate resilience

Joussen and colleagues further provided strategies and examples of each of the micro-dynamics of dynamic capabilities introduced in Figure 2 above. **Engage** capabilities are described as "*active networking involving engagement and partnering activities"* and uses the examples of strategic alliances, consortia and local

partnerships. **Anticipate** capabilities are "*actions taken to foresee and prepare for future events*", including risks assessments, adoption of early warning systems, and contingency and emergency plans. **Cope** capabilities are "*strategies to manage and overcome [materialised] crises*", including the implementation of emergency response plans and crisis protocols. **Transform** capabilities are described as "*processes that lead to significant change and/or resource reconfigurations*", including the implementation of new technologies and reorganization of business structures. **Sustain** capabilities are "*efforts to maintain and uphold operational and resource flows*" including sustainability practices and predictive maintenance. Finally, **grow** capabilities are described as "*initiatives aimed at expansion and growth throughout crises*", such as expansion into new markets, innovation throughout crises and first mover advantages.

3.3. Climate risks and system-level climate adaptation and resilience

The IPCC (2022) notes that prioritisation of climate risks reduction, enhancing resilience, and building a business case for climate adaptation is an area where a large amount of human, financial, and technological resources are required. Many large companies are reported to publicly disclose financial implications from their climate risks (e.g. following the guidelines of the TCFD because of reporting obligations of the European CSDR). Climate risks are forcing (large and diversified) companies to relocate facilities to other areas and/or to modify corporate investment decisions favouring lower risk to their employees, operations and supply chains (from floods, fires, etc.) – adding strong financial pressures and destabilising supply chains (Neise & Revilla Diez, 2019; New et al., 2022; Ren et al., 2025).

In climate sciences, there is a growing attention to better understanding **climate risks**, their methods of assessment, their cascading and compound effects across sectors and systems and management practices to better respond to their effects and impacts (Higuera Roa et al., 2025; Simpson et al., 2021). The IPCC defines risks *as the potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems*. It further considers the risks of climate change impacts as those resulting from changing interactions among climate-related (existing and future) **hazards** and the levels of **exposure** and **vulnerability** of affected human and ecological systems (including systems, sectors and various governance levels). From this perspective, risks can appear because of potential impacts of climate change and from human responses to a changed climate (Begum et al., 2022). Modern climate scholars have posited that climate risks are dynamic and now consider '**responses**' to climate change (mitigation and adaptation) a fourth factor or dimension of the management of climate risks (see the 'risk-propeller' Figures below).

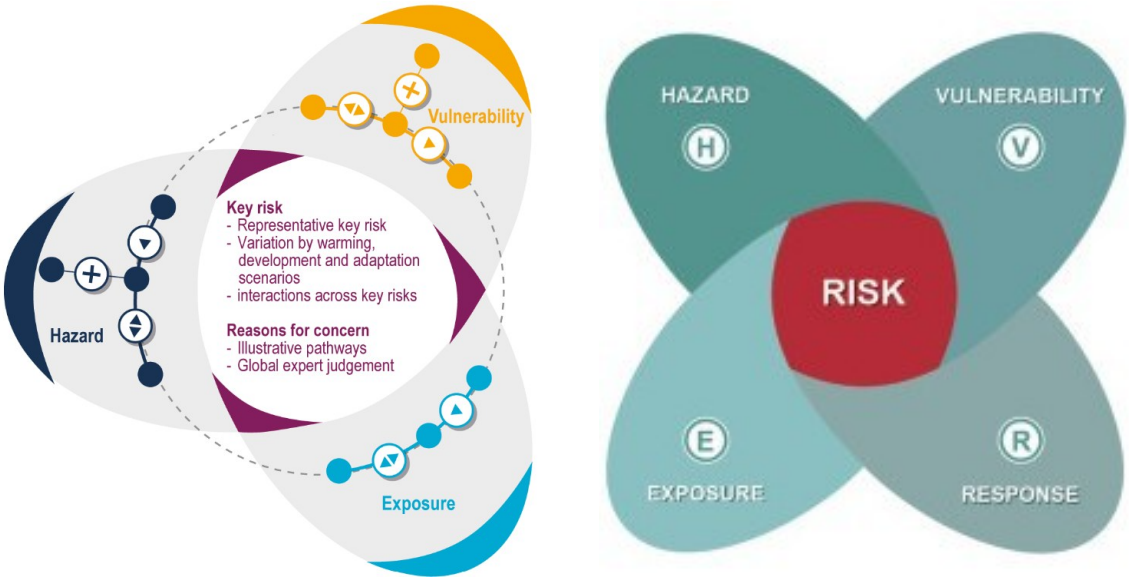

Figure 3 . Sources: Left figure Bogum et al (2022), right figure Simpson et al (2021)

This robust and dynamic view of climate risks is in stark contrast to the oversimplified notion of risks in the TCFD framework, where the physical risks tend to be seen as static and predictable and often leading to

prioritisation of risks based in incomplete information. This is because the impacts of materialised climate risks can occur in a bundled (multi-risks), aggregated, cascading, compound, correlated and interactive manner. Moreover, their different dynamic interactions among sectors and systems can amplify or reduce climate change risks because of climatic and non-climatic factors, leading to a surpass to the limits of adaptation and result in significant losses and damages (Higuera Roa et al., 2025; Simpson et al., 2021).

The final building block for our framework is an adequate interpretation of the term resilience at the system-level, which in climate science is used to describe the *"ability to resist, recover from, of adapt to the effects of a shock or a change"* (Béné et al., 2012). When applied to climate change, the response of the resilient system combines processes and measures to anticipate, absorb, accommodate and recover in a timely and efficient manner (Mitchell & Harris, 2012). In climate adaptation studies, it is widely recognised that the ability of systems to deal with shocks and stresses rests on four interlinked and mutually reinforcing **capacities**: **anticipatory, absorptive, adaptive, and transformational** (Béné et al., 2012; IPCC, 2022; Ziervogel et al., 2016). The IPCC report stresses the relevance of **anticipatory capacities**, or *the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences* (MA, 2005). Recent focus since the IPCC AR6 report is devoted to t*ransformational adaptation (and capacities), defined as a process of adaptation that changes the fundamental attributes of a system in anticipation of climate change and its impacts (UNFCCC, 2024; Wang et al., 2025)* A representation of the capacity of systems to respond to climate hazards is shown in Figure 3, where the upper ride quadrant of the illustration shows the existence of transformative capacities in periods of high disturbance and change over extended periods of time. In contrast, the lower end of the figure shows a trajectory of prevention and anticipation of climate risks in periods of relative stability (Manca et al., 2017).

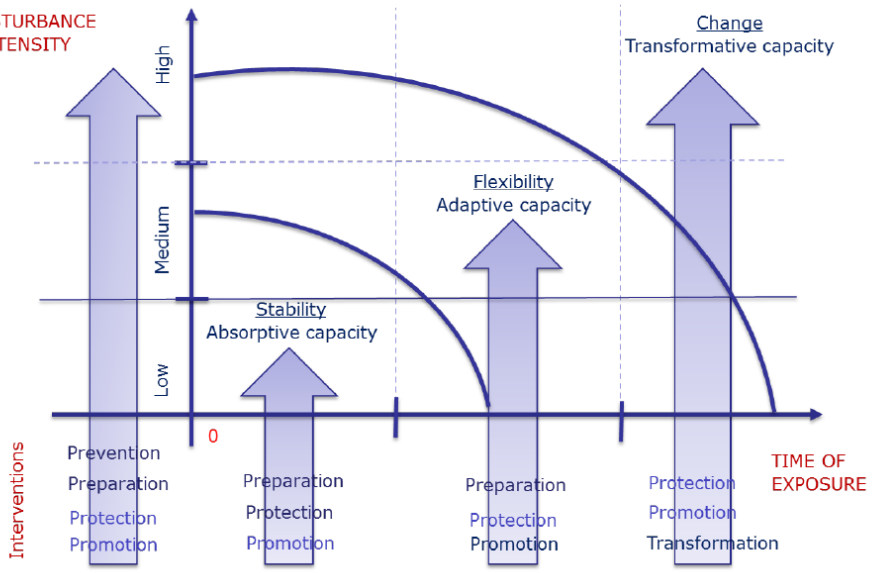

Figure 4 Climate resilience capacities. Source: Manca et al (2017)

Manca et al. (2017) noted that the concept of resilience is embedded in systems thinking, where disturbances or shocks hit the systems and it must develop the capacity to recover and bounce back (building on Béné et al., 2012). The figure 3 above shows two axes depicting different capacities of systems to sustain a climate resilience performance. Before a climate hazard materialises, the system can use **anticipatory capacities** to deal with future shocks. When the times of exposure and intensity are moderate, **absorptive capacities** can be translated into mechanisms of stability and resistance, with agents absorbing the impact of shocks but without necessarily changing their behaviour. At higher exposure and intensity, the ***adaptive capacity*** of the systems manifests providing an ability to deliverability implement incremental changes to mitigate the adverse effects of the disturbance. This flexibility and adaptation allow agents to continue being functional without major distress and disturbances, by being able to adjust to potential damages and to take advantage of opportunities offered by adaptation solutions. Finally, at extreme cases

of intensity and persistence of disturbances, the degree and scope of required change is too large so that the system gets significantly modified. This is where **transformative capacities** allow agents to change the fundamental attributes of a system and to engineer changes to ensure better conditions given imposing constraints. According to these authors, learning prom past disturbances is an opportunity to handle better future crisis and to maximise societal wellbeing.

Because of the relevance of system-level capacities to the way firms adapt and become more resilience at the corporate, facility and plat level, in this study we attempt to identify the presence of the four distinctive system-level capabilities emerging from territorial and socio-ecological climate adaptation and resilience. Moving forward towards an empirical testing, this paper uses the TCFD categorisation of climate risks, the categories of dynamic capabilities for organisational resilience of Joussen et. al. (2024), the perception of periods of stability and change of Huiskamp et al. (2021) and attempt to identify adaptation solutions and system-level / territorial climate adaptation capacities (anticipate, absorb, adapt, transform) of Manca et al (2017).

4. Methodology

For this study, a qualitative approach based on targeted case studies was used following the suggestions of Hillmann and Guenther (2021) The selection of French companies responded to a combination of the legal framework of the European Union's CSDR requiring the identification of climate risks (IRO method) and country-level policies and support tools for firm-level climate adaptation assessments (PNAC-3, environmental code, ADEME climate adaptation ACT method,). In addition, the criteria included: companies headquartered in France and being a group or a company controlling different brands/ sites with different governance models (large multinational with global or regional presence, family owned, public mission). The availability of a corporate climate strategy or an ESG/Sustainability department was an important element for the inclusion of cases. As a result of the criteria above, three French case studies from the logistics and transportation sector were selected to identify emerging patterns of the existence of dynamic capabilities for climate resilience innovation: **CMA CGM**, **Getlink** (formerly Eurotunnel) and **Sogaris** (see Table 1 in the Annex). The selected cases reflect different types of company models, responding to Joussen et. al. (2024)'s recommendation to conduct research in companies of different size, governance, legal form, geographical scope. They are also relevant to understand different territorial climate adaptation dynamics and strategic planning capabilities (c.f. Hennes et al., 2024; Manca et al., 2017).

Table 1 Overview of companies included in the study

Company / Criteria	CMA-CGM	Getlink	Sogaris
Type	Large multinational; family-owned business.	Large corporation.	Public mission company (semi-public company).
Year of creation	1978	1986	1960
No. employees	183,625 (very large)	3,892 (large)	73 (SME)
Countries	177 countries worldwide	Binational (France-UK)	France
Governance	Private (SA à conseil d'administration)	Private (European society)	Private, with public capital
Annual results 2025 (EBITDA)	10.57 billion	859 million (96% decarbonized EBITDA)	39.10 million
Companies/ brands/ sites	ANL, APL, CNC, Mercosul Line, Comanav, CMA Ships, CMA CGM Air Cargo, CMA Terminals & Terminal Link, CEVA Logistics, CMA media.	Eurolink, Eleclink, Europorte Getlink custom services, CIFFCO	13 sites across the Grand Paris region.
Labels, rankings, and standards	SBF120, SBTi, CDP "A-", Ecovadis 80/100, ISO 14 001	SBF120, SBTi, CDP "A-", MSCI "AA'", ISS-ESG "B-", Sustainalytics ESG Risk Rating "Low", FTSE4Good, Euronext Low Carbon 100 index, ISO 14 001* (*refers to 2025 100% target)	Paris Action Climate Biodiversity Pact "Gold", ISO 14 001

Literature review of grey documents focused on company websites, corporate reports (integrated, non-financial, CSR), specialised platforms (EFRAG, TCFD, MSCI, SBTi), and industry magazines. The purpose was to identify critical physical and transition risks and three core elements of each firm's business model: *value*

proposition, value architecture and contributions. In addition, two rounds of semi-directed interviews were conducted with five senior and middle management executives in corporate sustainability functions in the three companies (six blocks of interviews in total with a total duration of 18 hours). The list of interviewees included the sustainability and the decarbonisation managers of CMA CGM, the group environment director of Getlink, and a member of the board of directors of Sogaris. A key objective of the interviews was to confirm the approach to (i) climate risks (hazards), (ii) to identify the implementation of specific climate adaptation solutions, and (iii) to capture specific firm-level capabilities and system-level capacities. Where possible, salient limitations and complementarities of existing strategic choices at the level of the firm that may be creating or hampering enabling conditions were also discussed.

In terms of implementation strategy, each of the interviews was rolled out in two blocks of questions. The first part of the interview focused on the company's climate resilience strategy (with a focus on) and how the company responds to physical and transition climate risks. The second part of each interview focused on adaptation measures and solutions and in the existence of bottlenecks and/or enabling conditions. The interviews were conducted in French and digitally recorded in Microsoft Teams, powered by Copilot to generate automated transcripts. The latter text was processed through Harvey AI (2025) for completeness and clarity checks. The tool Deepl.pro was manually used to check for consistency between the French and English translations.

The following section presents the main findings from the three (mini-)case studies. For each company, a general description is presented, followed by key features of their business model, evidence about climate risks, climate adaptation solutions implemented. Where appropriate, salient dynamic capabilities used and/or during development are identified (*management-oriented* and climate-science oriented). Annex 1 includes a summary Table with the key findings.

5. Initial case evidence and discussion

CMA-CGM is a large global maritime transport operator with 55,5 billion of turnover in 2024 and presence in over 170 countries. It exclusively operates in the freight domain (including its subsidiary CEVA, a third-party logistics provider and transport operator). It holds an 'A-' label score of the Carbon Disclosure Project (CDP) it is ranked in the top 19% of its industry in the climate category.[3] Its *business model* is characterised by a *value proposition* dedicated to the maritime transport service of goods on container ships. Its main clients are large industrial companies and intermediaries in logistic chains. With proprietary fuel-powered vessels, its *value architecture* is based on owning ships and ports operating in es regular routes around the world, with a high number of rotations, and adapts its offer to all types of containers: dry, refrigerated, containing dangerous products, etc.[4] CMA-CGM's competitive advantage therefore comes from its expertise in ships, from construction to operation. In terms of key *contributions*, their profits are mainly based on the volume of goods transported, variable costs (fuel, access to ports, etc.) and long-term contracts. Low carbon emissions vessels and operations have been explicitly mentioned by the company as part of its key environmental contributions.

Key *climate risks* are briefly described in the company's non-financial (ESG) report, mostly focusing on preparations for the introduction of the European Union (EU)'s CSRD. In this source, *physical risks* identified included hazards related to *hydric stress, heat waves, tornadoes*, and *floods*. The company reports that a third of their locations have been analysed for *financial risks* derived from climate impacts. In contrast, *transition risks* are plentiful in their ESG report, including upcoming regulations from the International Maritime Organisation and the EU.

In terms of *adaptation solutions* and *firm-level dynamic capabilities* identified, *anticipatory adaptation solutions* were identified at the facility/site level. This include *local climate adaptation strategies* that contain specific measures such as retrofitting of port infrastructures to be more resistant to extreme climate events

[3] https://www.cdp.net/en/data/scores
[4] https://www.cma-cgm.fr/ebusiness/tarifs/charge-finder

and elevation of sensitive equipment to minimise damage from flooding (*anticipatory capabilities*). However, at the corporate level interviews reported that the completion of climate risks is still an ongoing process. This task follows the approach of climate impacts, risks, and opportunities (IRO) and in some parts supported by external consultants. Most reported measures are intended to deal with transition risks (with a strong focus on GHG emission reduction), including investments in fleet decarbonisation technologies (biofuel mixes, rigid sails). It also included market intelligence measures to offer carbon-free solutions (e.g. the product ACT with CMA-CGM+) and carbon offsetting services, in close collaborations with clients and other stakeholders (*engage and* somewhat *reconfigure capabilities*). The use of multiple scenario analysis and the creation of a corporate innovation centre in Marseille (TANGRAM) includes part of the emerging *capabilities to innovate*.

GetLink is a regional France-United Kingdom rail infrastructure operator with 1,6 billion euros of turnover in 2024.[5] Completely freight transport oriented, it was one of the first companies in the French Stock Market (SBF120 index) to introduce a climate action plan and it is also holder of an "A-" label score in the CDP.[6] Its *business model* includes a *value proposition* focusing on (i) providing access to the Channel Tunnel for passenger high-speed and goods rail freight trains and charging a toll, and (ii) the 'LeShuttle' train service for lorries and cars travelling between the two ends of the tunnel (Calais and Folkstone). Getlink's customers are railway companies (Eurostar), freight carriers and road hauliers (B2B), and private individuals (B2C). In terms of *value architecture*, this firm relies on the tunnel and ancillary infrastructure (e.g. logistics zones) and highly skilled maintenance staff and operators. Finally, Getlink's *contributions* focus on a profit equation where revenue is positively related to the amount of traffic. Because most of the company's costs are fixed (infrastructure repayments), it is essential to reach the break-even point. Because rail is a low carbon transport (with 54% of renewable and clean energy, including nuclear), this is a model where climate and social contributions are directly linked to its profit model.

GetLink's identified *physical and transition risks* with the help of external consultants. A taskforce ((risk and compliance, infrastructure and engineering, CSR, human resources and purchasing) studied climate scenarios to identify acute risks (heat peaks, bad weather and flooding, storms, etc.) and chronic risks (higher levels of humidity, etc.). More specifically, the IRO analysis lead to the identification of financial impacts and probability of occurrence from two critical *physical climate hazards*: (i) *extreme heat* affecting particularly employees and customers (with moderate impacts on infrastructure), and (ii) *flooding* of the Calais terminal catchment area, threatening infrastructure located on a polder below sea level and where water is systematically managed by drains, basins and pumps. In terms of *transition risks*, the company developed a transition scenario of +2°C and a business-as-usual scenario of +4°C. The resulting risks identified included changes to the price of low-carbon electricity, changes in the technical characteristics of customer vehicles, and price changes of low carbon/ carbon-free energy. A "decarbonised margin" indicator has been developed to visualise the resistance of the business model in the face of a high carbon pricing scenario. Future opportunities to strengthen its business model include the acceptability of new vehicles (LNG, hydrogen) in the tunnel, requiring investment (around €1 million) to adapt safety.[7]

In relation to *adaptation solutions* and firm-level *dynamic capabilities* at Getlink, this category included investments to adapt infrastructures to physical risks and taking this parameter into account in investment decisions, developing a solar PV park on a Getlink site to reduce vulnerability to fluctuations in the price of carbon-free energy. A second adaptation solution focuses on adapting the tunnel's safety standards to allow the transit of hydrogen/LNG trucks. However, interviews revealed that this project responded more to a competitiveness need, in tandem to the ROI recommendations above (*anticipatory capabilities*). Additional capabilities identified include creating strong partnerships and collaborations of new technological assets and risk management and a close attention to client's feedback and joint activities (*engage capabilities*) and

[5] In this case study, only the Eurotunnel business unit was considered with specific mentions to the 'LeShuttle' service, were appropriate..
[6] IDEM.
[7] Currently it's only possible for electric and hybrid personal cars in LeShuttle. https://www.getlinkgroup.com/en/strategy-and-sustainability/csr/societal-strategy/

the incorporation of resilience in the company's dual materiality matrix and risk register and the assessment of risks in terms of probability, financial impact and speed of occurrence for all investment decisions (*reconfigure capabilities*). Emerging *innovate capabilities* could also be identified through different collaborative projects with universities and technical partners, such as those aimed at improving predictive maintenance systems using artificial intelligence and big data.

Sogaris is a publicly owned domestic logistics centre operator with 88,2M€ turnover in 2024. It has a public mission is to develop sustainable urban logistics; it mentions resilience into its objectives and has developed an ambitious climate plan focused on decarbonisation, biodiversity and social inclusion. Its business model focuses on a *value proposition* where Sogaris has a multi-functional approach to assets. Firstly, it acts as a property company, i.e. it acquires, develops and manages logistics real estate and rents it out to professional customers (large-scale distribution, logistics, mail, etc.), deriving most of its income from rental activity. It also plays an active role in the design and conception of buildings adapted to the dense urban environment and in the implementation of innovative solutions. In terms of *value architecture*, Sogaris relies on relies heavily on its assets, the logistics parks and hotels, as well as its local areas. Its approach is strongly based on innovation and collaboration with ecosystem players. In terms of *contributions*, Sogaris' profit equation is essentially based on the rents it collects and the occupancy rate of its surface areas, which exceeded 90% in 2023. Sogaris' services are part of a drive to make urban logistics more carbon-free, particularly last-mile logistics.

Sogaris' *climate risks* are not reported in their climate plan or in the universal registration document. Interviews did not provide this information, but there are recent studies providing critical climate risks in the Ile-de-France region where Sogaris operates (Grand Paris region). According to Cordeau et al. (2022), critical *climate hazards* affecting infrastructure and logistics around the greater Paris region include *heat waves* and *heat island effects* affecting thermal comfort of buildings and providing excess heat to infrastructure, *contraction and expansion of (clay) soils*, *floodings* and *droughts*.[8] Key *transition risks* are material in nature and mostly related to local and regional regulations. The introduction in France of the Zero Net Artificialisation (ZAN) policy is forcing logistics centres to be more efficient in their use of space. In addition, Emission Mobility Zones (ZFE-m) in most major French cities forces hauliers to stop at the city gates and finding a relay for the last few kilometres or they are forced to own a fleet of low-carbon vehicles for last-mile delivery.

In terms of *adaptation solutions* and firm level *dynamic capabilities*, Sogaris has implemented different foresight and forward-looking techniques for decision making (*anticipatory capabilities*), engages with customers and shareholders assessing their carbon maturity and proposing new solutions (*engage capabilities*) and constantly redefines its purpose in urban logistics (*reconfigure capabilities*). Sogaris has also implemented experimentation approaches in new urban centres developments. This has included nature based and low carbon solutions such as the use of wooden micro-hubs in collaboration with the small company Moonarchitectures, using eco-design and locally sourced materials. Another example is the 'Chapelle International logistics hotel' in Paris delivering logistics-related activities for different modes of transport, provides local services (urban farms, sports facilities, restaurants) and generates district heating using a large-scale data centre. The company has also experimented with new techniques for the reclamation of wasteland (*innovate capabilities*). More recently, the city of Paris has set up new legal requirements for the implementation bio-climatic design in new developments, which will unavoidably impact Sogaris' portfolio of new projects.[9]

The different initial findings above point to the emergence of a diverse set of firm-level climate resilience capabilities in response to specific climate risks, regulatory and reporting requirements, stakeholder and

[8] In Ile-de-France, it is estimated that 48% of the territory is constituted by clay soil. Since 2020 the French construction and building code (article R112-10) requires technical studies of geo-risks and compliance with strict technical requirements including adaptation solutions in the construction of new houses and buildings to avoid risks from contraction and expansion of soils.
[9] See: https://www.adaptation-changement-climatique.gouv.fr/actualites/veille/paris-lance-nouveau-plan-local-durbanisme-bioclimatique (in French).

shareholder preferences, and an overall shift in market dynamics. Nonetheless, these seem to be in a very emerging nature and building on specific elements from either *anticipatory* and *emerging* capabilities (sensing) and somewhat extended to *coping*- capabilities (seizing). The two types of sensing capabilities seem to be distinct but complementary, the former at firm-level and the latter at industry-level and/or value chain level. Anticipatory capabilities seem to exist to anticipate climate hazards (focusing largely on climate hazards). Nonetheless, it is unclear if the integration of advance management of climate risks really includes criteria of exposure, vulnerability, cascading and compounding effects and transformational adaptation. It may be possible that the general management strategy may be a missing a strong link to 'climate science' capacities to really foster processes of innovation and change for climate resilience. In this way, the evidence identified of capabilities for reconfigure and innovate seem to be less mature and relying on standard adaptation solutions (e.g. increased the elevation of equipment) and the incorporation of new technologies – sometimes strongly linked to decarbonisation and somewhat providing co-benefits to adaptation (e.g. the solar PV project of Getlink or the wooden hubs of Sogaris). From an empirical perspective, it may be possible to suggest that the emergence of stability-enhancing capabilities and change fostering capabilities may be mutually reinforcing – but the level of maturity of those capabilities does not allow their full identification. The following section provides some initial conclusions, limitations and next steps of our research.

6. Conclusions and next steps

This paper responds to a specific gap in management and economics of innovation literature that overlooks firm-level dynamic capabilities for climate resilience innovation and associated business models. Our findings constitute initial building blocks for integrating (i) climate risks into strategic management processes at the firm level and (ii) ecosystem-wide engagement and collaborations may represent critical enabling conditions for business model innovation for climate adaptation and resilience. Conceptually, the concept of resilience in climate sciences and in business and economics seem to be related, but there are fundamental differences in scope, depth and orientation (priority areas of responses to climate risks). A salient finding is related to the observation that firms present different levels of maturity of their existing firm-level capabilities. Matching them to the corresponding system-level capacities for climate adaptation and resilience (and their business models) would require identifying the degree of complementary and synergistic potential at different levels of scale and exposure to a robust and dynamic interpretation of climate risks (see figure 5 below).

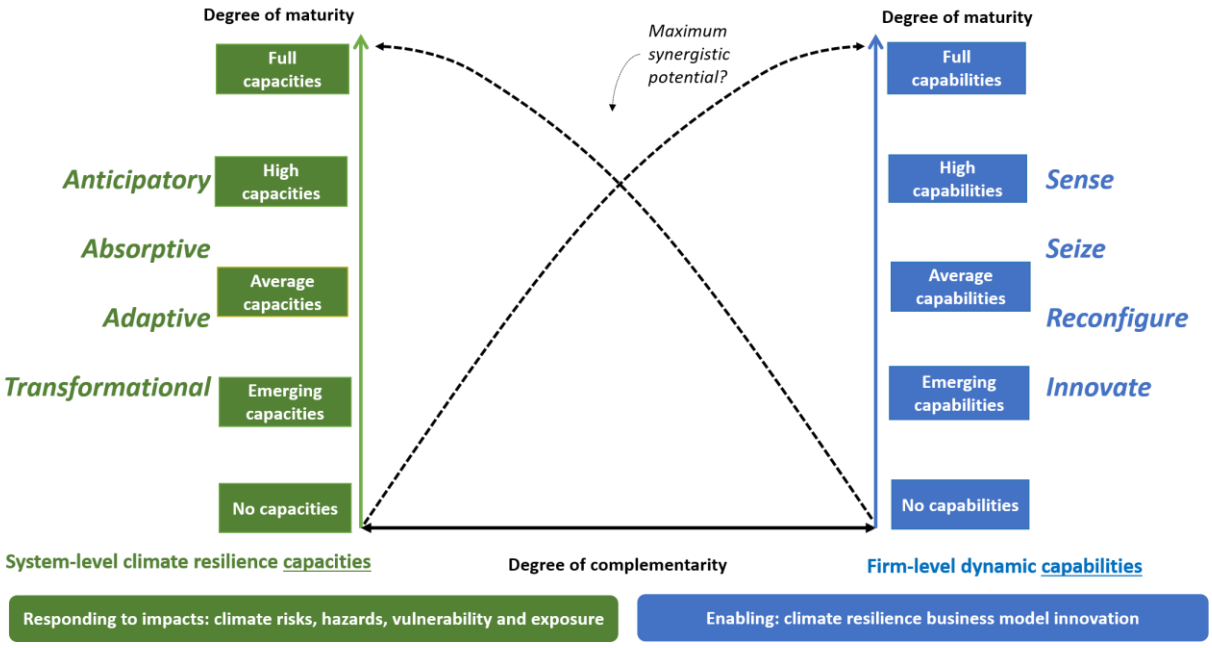

Figure 5. ***"CLIMB Framework"***
C*limate-Linked* ***I****ntegrated* ***M****aturity for* ***B****usiness Resilience to assess the maturity and complementarity between firm-level capabilities and system-level capacities.* ***Source****. Own elaboration.*

While emerging frameworks studying firm-level dynamic capabilities for corporate resilience have emerged focusing on variations of sensing, seizing, and reconfiguring (Teece, 2007), in our study we unsuccessfully attempted to trace cross-linkages with four distinctive system-level capacities emerging from climate adaptation and resilience (Manca et al., 2017). From our initial findings, it seems evident that the dynamic capabilities framework is insufficiently equipped to identify system-level capacities to anticipate, absorb, adapt and transform firms in view of climate impacts. This tension has been noted by Villano et al (2026) observing that firm and value chain level (economics and management) vs socio-ecological systemic level (climate sciences) different in scope and multi-level dimensioning of climate risks, adaptation planning and multilevel governance (Villano et al., 2026). More critically, the notions of physical and transition risks can only partially help companies to systematically assess exposure, as required by disclosure requirements and upcoming regulations (such as the European CSDR). However, compound and cascading risks are insufficiently addressed, and the different risk factors linked to exposure, hazards, vulnerability and responses often oversimplified (Higuera Roa et al., 2025).

This exploratory study is simply a first step in our research enquiry that requires additional theory building and empirical validation. Empirically, our imminent work shall focus on conducting additional case studies in different economic sectors with high vulnerability and exposure to climate risks and where climate adaptation solutions are less evident, particularly for buildings and construction and manufacturing. In addition, an attempt will be made to develop a more robust analytical and operational framework that allows the identification of the degree of maturity of capabilities, resources and competences across firms of different size and sector of operation.

Our meta-theoretical tasks require exploring different possible pathways. For instance, firm-level resilience requires a better understanding of recombination capabilities influencing radical innovation and high impact firm-level transformations, including R&D capabilities will also be analysed (Hyun & Kim, 2026), aiming at a better understanding of the 'innovate' capabilities identified in this initial set of case studies. At the system level, insights from systems innovation and transitions literature can bridge this conceptual gap between firm-level capabilities for innovation and change and system-wide innovation-based transformations (c.f. Coenen and Diaz Lopez, 2010). However, the real challenge will be to attempting to challenge and improve some of the foundations of the application of the dynamic capabilities of the firm for organisational-level resilience. Howard- Grenville and Lahneman (2021) and Williams et al. (2021) have long argued for the integration of concepts derived from ecology and environmental sciences into management theory. For this reason, additional focus on specific aspects of complex and dynamic climate risks and multiple dividends can be explored (Higuera Roa et al., 2025). This can aim at better informing firm-level (corporate) climate adaptation and resilience planning (Hennes et al., 2024), at the time it connects it to strategy development and innovation across different scales (Benischke et al., 2025). To improve the connection of our maturity framework with system-level climate adaption, we might be able to incorporate certain elements of the multiple dividends framework of climate risks management (Hochrainer-Stigler et al., 2025), dynamics of system transitions for sustainability (Hebinck et al., 2022), and multiple-criteria decision making in system-level socio-ecological transformations for climate resilience (Dentoni et al., 2026).

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Table 2 Summary of critical climate risks, adaptation solutions and dynamic capabilities in the three case studies. Source. Own elaboration.

Company name	Resilience Strategy and Climate Risk				
	Climate Risk	Sense	Seize	Reconfigure	Innovate
		Anticipate	***Engage***	***Transform***	
CMA-CGM	**Physical risks:** floods, tornadoes and heat waves. **Transition risks:** ESG strategy focus, EU and IMO regulations increasing carbon-emission costs, and customer demand for decarbonized transport.	• Initial identification of climate IROs at corporate level, both physical and transition risks. • Definition of local adaptation strategies for assets. **Enabler:** Risk management department.	• Engagement with clients to understand ESG criteria • Dialogue with public institutions (lobbying and advocacy) to anticipate and propose regulations; • Engagement with stakeholders to imagine the future of transport (New Energies coalition). • Strategic alliances with Universities, competitors (Maersk), and other stakeholders (PULSE fund). **Enabler:** Heavy investment in corporate relationship functions; collaboration at every level, from R&D to product design and asset adaptation.	• Product adaptation to customers using functional teams and other 'lean' methods. • Asset adaptation added to decarbonization trajectories. **Enabler:** Integration of "engage" insights into the business model.	• Multiple scenario analysis used to choose strategic directions. • TANGRAM innovation centre and different foresight and entrepreneurship programmes. **Enabler:** Investment in R&D.
Getlink	**Physical risk:** extreme heat and flooding of infrastructure. **Transition risks:** traffic changes, changes in vehicle characteristics, and carbon-free energy price changes.	• Detailed identification of climate-related impacts, risks and opportunities (materiality matrix and risk register), supported by tailored consultancy work and scenario analysis. • Financial measurement of climate IROs and development of mitigation and emergency plans for climate hazards. **Enabler:** Sustained support to ESG department, which were given enough resources to call a consultancy firm, and elaborate recommendations.	• Collection of feedback from stakeholders to improve the understanding and management of climate-related risks. **Enabler:** Sustained support to ESG department.	• Integration of risk-analysis feedback into new investment decisions, so that future infrastructure and business choices reflect climate-risk considerations. • CSR department is a risk owner and a source of new risk identification across teams and departments. **Enabler:** Sustained support to ESG department.	• Research projects in consortia and existence of University Chair • Partnership with French University and Railnova to improve predictive maintenance systems using big data. **Enabler:** Group's strategic planning.
Sogaris	**Transition risks** linked to urban logistics: optimization of urban space use, adaptation to new types of urban vehicles, and cost of decarbonized energy.	• Imagining the future of the logistics industry and positioning Sogaris within that future. **Enabler:** Shareholder activism and strategic direction.	• Engagement with local stakeholders. • Creation of Sogaris Capital Innovation for investments in innovative companies. • Strategic alliances with Universities and private actors (La Post Immobilier) **Enabler:** Shareholder activism and strategic direction.	• Constant redefinition of Sogaris' role in urban logistics and reorganization of its activities. • Vertical logistics warehousing to optimise use of land, operational risks, and energy efficiency.	• Test-and-learn methods to experiment with low carbon and nature-based construction solutions.

Company name	Resilience Strategy and Climate Risk				
	Climate Risk	Sense	Seize	Reconfigure	Innovate
		Anticipate	*Engage*	*Transform*	
				Enabler: Shareholder activism and strategic direction.	**Enabler:** Shareholder activism and strategic direction.