How to re-conceptualise and re-integrate climate-related finance into society through ecological accounting?

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Abstract:

In this paper, we argue that the current mainstream sustainable finance approach, because of its embeddedness in the neoclassical paradigm, is disconnected from strong sustainability requirements, making it difficult to develop a climate finance system that is operational and aligned with the challenges of climate preservation. Based on these observations and from a critical analysis of this paradigm, and its implication for accounting, we propose to reframe sustainable finance on the basis of a more 'traditional' approach to finance, starting by restructuring accounting on this foundation, as a support accompanying the development of finance and its connexion with firms. Therefore, we propose an exploratory and theoretical study which introduces how and why a particular and innovative ecological accounting approach, the CARE model, currently called upon by a growing number of practitioners and researchers, is a relevant framework to re-conceptualise the issue of climate finance on this basis. From a theoretical point of view, CARE offers a suitable language for structuring the issues of ecological costs, debts and conservation and associated financing. From a practical point of view, it offers a methodological support that can be used to address these issues, from an accounting and management point of view as well as from an investor's point of view, ensuring compliance with the Paris Agreements 'well below 2°C' goal in particular.

Keywords:
Climate finance, sustainable finance, natural capital, historical cost accounting, corporate finance, ecological accounting

I. Introduction

Sustainable finance, as a new and broader approach to finance integrating environmental, social and governance issues, is becoming increasingly important nowadays,[1] particularly in the sub-fields of 'green' and 'climate finance' (*cf.* Annex A). However, some actors claim that "*Financial markets were not designed to manage the planet*".[2] From this assertion, we can wonder how far the current financial system can be sustainable and can contribute to the fight against climate change.

In this paper, we argue that, in fact, today's mainstream sustainable finance, and the accompanying accounting systems, are based on a particular paradigm/model (a neoclassical one); then, through a bio-economic analysis, we show that it raises serious questions about its ability to be aligned with strong ecological requirements (including climate issues). Therefore, we analyse this paradigm, associated with 'fair value accounting' (FVA), and show that this model is by no means the only one: we discuss the distinctions between this paradigm and what we call 'traditional finance' (Spremann, 2010), which is related to 'historical cost accounting' (HCA). From this analysis, we propose to reframe sustainable finance on the basis of this other paradigm (the 'traditional' one), starting with restructuring accounting systems. In this, we follow the current demands to re-embedding sustainable finance in integrated accounting systems capable of accompanying it (EU High Level Expert Group on Sustainable Finance, 2018; Fullwiler, 2016). This accounting redirection corresponds in many respects to what the CARE (Comprehensive Accounting in Respect of Ecology) model proposes, as defined by Rambaud and Richard (2015).

Indeed, CARE is an integrated[3] and 'strong sustainability' accounting model that is currently called upon by a growing number of practitioners and researchers. It extends HCA to extra-financial capitals and conceptualizes all types of capitals – financial and extra-financial – symmetrically. One of its main features is to structure and clarify the concepts of environmental preservation, debt, and costs, thereby fitting what sustainable finance is supposed to target. Thus, it proposes an operational framework for integrating the notion of ecological preservation into corporate business models and into the financial system.

We therefore explore how to implement CARE for the specific case of climate and how such re-structuration of climate change and Greenhouse Gases (GHG) emission issues through the CARE model open new avenues to reshape climate finance on sound bases. For this purpose, we firstly develop the paper on the necessity to precisely define what is a 'capital-climate', in the sense of CARE, and we present, to this end, the prerequisite concepts, models and underlying assumptions. Then, we focus on the insertion of this specific capital in business models and on the different types of costs that need to be associated to its uses (through GHG emissions) and its preservation, in order to define a proper climate accounting framework that companies can implement. Finally, we discuss some implications for 'sustainable financing' in relation to climate change.

II. Sustainable finance issues

II.1. Today's mainstream sustainable finance

From its origins within the framework of investment ethics at the beginning of the 20th century (Revelli, 2013) to the present day, sustainable finance has diversified and now refers to numerous strategies and interpretations (Liang & Renneboog, 2021). These are mainly (Liang & Renneboog, 2021; Revelli, 2015): negative screening; impact finance, which is still underdeveloped (Alijani & Karyotis, 2019); and above all, ESG strategies, which are divided into approaches of shareholder engagement (ESG activism), best-in-class, best-in-universe, best effort and transversal.

It is important to note that ESG strategies are derived from the concept of the Triple Bottom Line (TBL) (Liang & Renneboog, 2021; Revelli, 2013), introduced in the 1990s, notably by Elkington (1997). TBL is an accounting system developed to adapt the 'capital approach' of sustainable development (SD) to companies and to base the extra-financial performance of companies on the concept of eco-efficiency (Rambaud & Richard, 2015) and *not on eco-effectiveness* (Elkington, 1997). The ESG 'transversal' strategy is moreover seen as being fully aligned with the TBL (Liang & Renneboog, 2021). The 'capital approach' of SD (Ruta & Hamilton, 2007) emerged at the end of the 1980s: sustainability was interpreted in terms of financial, human and natural capital maintenance, thanks in particular to the work of Pearce (Pearce, 1988; Pearce, Markandya, & Barbier, 1989; Pearce & Turner, 1990), where natural capital is defined as "*a stock of natural assets serving economic functions*" (Pearce, 1988). Furthermore, at this stage, it is interesting to note that Elkington himself, in a retrospective analysis of the relevance of TBL to sustainability issues, acknowledged that this tool posed serious problems in terms of sustainability: "*It [TBL] was supposed to provoke deeper thinking about capitalism and its future, but many early adopters understood the concept as a balancing act, adopting a trade-off mentality [based on eco-efficiency]. [...] Such experimentation is clearly vital […]. But the bewildering range of options now on offer can provide business with an alibi for inaction. Worse, we have conspicuously failed to benchmark progress across these options, on the basis of their real-world impact and performance*" (Elkington, 2018).

In this proliferation of strategies and interpretations, however, it is possible to identify some common features. Thus, for Fullwiler, sustainable finance recognises: "*(a) more values; (b) more type of returns; (c) ESG as a risk class; (d) financial innovations that encourage greater sustainability; (e) the accompanying financial and non-financial accounting to these first four; (f) that finance, economics, and markets are socially and environmentally embedded creations for social provisioning; (g) risks to impact or non-financial returns, non-financial correlations, and potential for diversifications on non-financial grounds and (h) time's effect on financial analysis needs to be socially and environmentally embedded*" (Fullwiler, 2016). Schoenmaker et al. (Schoenmaker, 2017; Schoenmaker & Schramade, 2018) propose to structure sustainable finance in three main stages: "*sustainable finance 1.0 […] Profit maximisation, while avoiding 'sin' stocks […] sustainable finance 2.0 […] internalisation ox externalities to avoid risk […] sustainable 3.0 […] contributing to sustainable development, while observing financial viability*" (Schoenmaker, 2017).

Let us first draw attention to an important point in the context of this paper, corresponding to Fullwiler's point (e): the need for accounting systems to accompany sustainable finance. Thus, the introductory report to the European Union action plan on sustainable finance (EU High Level Expert Group on Sustainable Finance, 2018) acknowledges that the integration of sustainability issues into accounting is "*crucial*", that without this, investors, lenders and managers cannot make "*appropriate decisions*" (and thus sustainable finance cannot be properly structured) and that the long-term ambition is to achieve accounting convergence between financial and non-financial issues.

Secondly, the notions of risk and maximisation of returns are a fundamental feature of most sustainable finance approaches. This vision can be found in several official definitions (see Annex A). This corresponds to Fullwiler's points (b), (c) and (g). These notions appear as soon as Schoenmaker calls sustainable finance 1.0: "*[...] the main purpose [of SF 1.0] is to reduce costs and business risks, to improve reputation and attractiveness for new or existing human talent, to respond to new customer demands and segments, and thereby to increase profits, market positions, competitiveness and shareholder value in the short term. Business success is still evaluated from a purely economic point of view and remains focused on serving the business itself and its economic goal*" (Schoenmaker, 2017). Investment decision making in this framework therefore corresponds to a cost-benefit analysis (CBA) incorporating other types of risks and opportunities related to societal issues (Fatemi & Fooladi, 2013). In this context, many ESG investors perceive their business more as a 'sound' business practice, limiting risks, than as an activist approach leading to societal transformation (van Duuren, Plantinga, & Scholtens, 2016). Moreover, SF 1.0 refers to the notion of 'single materiality', also called financial materiality or Outside-In materiality, that is the fact that the only relevant information to be considered is that concerning the positive or negative impacts of the social and natural environment on the activities of a company and thus on an investment. From an accounting point of view related to this type of sustainable finance, this single materiality orientation is the one adopted by the Task Force on Climate-related Financial Disclosures (TCFD)[4], the Integrated Reporting Systems <IR> (Barker & Kasim, 2016), and recently by the IAS/IFRS standards to integrate extra-financial issues and attempt to standardise ESG.[5] This is also the approach of the Greenhouse Gas Protocol (GHGP) tool and the Carbon Disclosure Project (CDP), whose role is to report downside risks about GHG in investments (so for investors, in a mere financial logic (Le Breton, 2017)), and not to guarantee an incentive to invest in portfolios aligned with the Paris Agreement <<2°C[6] goal (Le Breton & Aggeri, 2019).

Thirdly, Schoenmaker explains that "*in Sustainable Finance 2.0, financial institutions explicitly incorporate the negative social and environmental externalities into their decision-making*" (Schoenmaker, 2017). This vision of sustainable finance corresponds in particular to point (a) of Fullwiler (2016). But here these 'societal' values are of a specific kind; indeed, part of sustainable finance, beyond level 1.0, seeks to integrate the negative impacts of investments on the social and natural environment, thus going beyond the single materiality approach, but, already, only to "*[...] reduce the risk that financial investments become unviable*" (Schoenmaker, 2017) and in a very particular sense (Gregory, Stead, & Stead, 2020). Indeed, an externality occurs when the production or consumption decisions of one economic (human) agent affect (negatively or positively) another economic agent's well-being (or profit) and this disadvantage or advantage is not reflected in market prices (Perman, Ma, McGilvray, & Common, 2003) – along this line, following Stern, climate change is "*the greatest market failure ever seen*" (Stern, 2007). Externality is not synonymous with 'impact' and is part of a neoclassical – that is utilitarian and anthropocentric – economic thinking. In fact, there are externalities only if there is no compensation on a real or fictitious market. Moreover, the natural environment exists in this vision only through the prism of human well-being. The notion of externality excludes, for example, any reference to a deontological approach to environmental management (Passmore, 1980), to the notion of intrinsic value of the environment (on which biocentrism or ecocentrism are based) (Naess, 1989; Rolston III, 2007) or to ecological relationalism (Latour, 2009; Norton, 2005).

The third level of SF "*[...] moves from risk to opportunity*" (Schoenmaker, 2017). These opportunities correspond to the incorporation not only of negative (*cf.* SF 2.0) but also positive

(Gregory et al., 2020) externalities[7], thus remaining within the framework of neoclassical economics as previously indicated. At the accounting level, these visions are integrated in the notion of Environmental P&L, experimented by Kering (Richard, 2012) or Novo Nordisk (Høst-madsen et al., 2014), which extends the income statement to positive and negative externalities.

These approaches, which encompass most of today's sustainable finance, ultimately base decision making on CBA, potentially including negative (SF 2.0) and positive (SF 3.0) externalities (Lagoarde-Segot, 2019; Schoenmaker, 2017). Under these conditions, even if some actors consider that today's sustainable finance goes beyond a neoclassical framework (Schoenmaker & Schramade, 2018), objectively, it is still a question of maximising shareholders' value (Fatemi & Fooladi, 2013), possibly by incorporating the pricing of externalities, thus scrupulously respecting neoclassical theory and its extension to socio-environmental issues (Barbier, Markandya, & Pearce, 1990): "*the sustainability principle shifts the investment objective from the accumulation of money to the accumulation of value*" (Lagoarde-Segot, 2019). In the context of climate issues, of particular interest to us in this paper, that is the reason why there is such a focus on investors' disclosure of climate-related financial risks (CRFR) that is expected to maximise shareholders value and to fix such market mispricing (Ameli, Drummond, Bisaro, Grubb, & Chenet, 2019; Chenet, Ryan-Collins, & van Lerven, 2021)

II.2. Implications for resource management

All these approaches therefore lead to environmental management on a cost-benefit or risk/opportunity analysis basis – which is an extension of CBA by taking into account the probabilistic uncertainty (Wijnmalen, 2007). So the drivers of prices (including externalities) and risks are currently assumed to be the main mechanisms to reorient the financial system towards a sustainable economy (Chenet, 2019; Chenet, Zamarioli, Kretschmer, & Narvaez, 2019; Christophers, 2017; Thomä & Chenet, 2017). From this perspective, natural resources are considered as 'natural capital', in the sense of the capital approach of SD, defined therefore as a set of natural assets (Barbier, 2014), that is a set of presupposed controllable sources of productive and useful services for humans and business activities, and in particular for shareholders in the case of finance. And so, management of these resources relies on an optimisation of gains and losses of values stemming from these productivity and utility, including values non reflected by markets (market failures), that is externalities.

This approach of nature as a set of natural assets and environmental management based on CBA raises many philosophical issues (Barter, 2015; Spash, 1997; Sullivan, 2014; Victor, 2007). But, above all – and that is our point here –, several bio-economic models show that there are mathematically and logically very strong limits to the use of CBA in environmental management. For example, in the context of dynamic management of plant or animal populations, the optimal management scenario obtained by CBA leads to an optimal population level that must respect an extension of the 'Golden Rule of capital accumulation' – affirming that the optimal capital stock is reached when its marginal productivity is equal to the discount/interest rate – to natural capital (Clark, 2010). As recalled by Clark, "*although probably entirely unknown to most resource managers [and, we add, to most asset managers in sustainable finance], this rule turns out to be central to the economics of renewable resources*" (Clark, 2010). However, the optimal natural capital stock can be zero, which corresponds to a mere *extinction* of the population concerned (Mitra & Roy, 2006). Clark (1973) shows this, for example, in the case of whales. This result has been extended to several

other population types (Clark, 2010) and even to soil management (Hediger, 2003) or climate management: such a vision, at the centre of Nordhaus' work, for example, also leads to significant discrepancies between economic and ecological climate management (Bichler & Nitzan, 2018). These issues also refer to Fulwiller's point (h). These outcomes, which are incompatible with ecological requirements, resist the integration of negative and positive externalities in CBA. A central model, Pearce model (Pearce, 1976), shows that such management inevitably leads to overcoming the resilience of ecosystems, thereby systematically impoverishing them. This particular result, which has important consequences, has been regularly discussed, notably by Godard (2004), who has re-examined the 'strategies' proposed in an attempt to escape the 'trap' ("*piège*" (Godard, 2004)) of Pearce model: his conclusions establish that the principle of Pearce model cannot really be avoided and that a revision is therefore necessary with regard to the status of the theory of external effects (externalities) in the field of the environment. The optimum of internalisation of external effects certainly alleviates the pressure on the environment – and in this sense marks an undeniable practical progress compared to the absence of any consideration – but it participates, by construction, in the process by which an economic system degrades and exhausts its environment until the final outcome (our translation)[8] (Godard, 2004).

These findings show that there are serious doubts about the ability of current sustainable finance to align itself with scientifically based ecological requirements at a moment in time where the limits of the planet are reached. Therefore, how to overcome these problems and define the contours of a more 'ecological' finance, especially in the case of climate? To do this, we need to return to the sources of what constitutes finance – and its link to corporate finance and accounting – and of what has led to *this* particular type of understanding of so-called 'sustainable finance' (and associated forms of accounting systems), to assess if other ways for sustainable finance are possible.

II.3. The two paradigms of finance and financial accounting

Spremann (2010) actually defines two fundamental paradigms of finance, which he calls 'Old' (or 'Traditional') and 'New' (or 'Neoclassical'). The first one was already present since the Italian merchants of the Renaissance, and remains still valid and used by practitioners and entrepreneurs today (despite its name 'old');[9] the second one emerged from the 1960s onwards (Sun, Louche, & Pérez, 2011; Weinstein, 2010).

The first paradigm is based on a central question – "*Where can I [as an entrepreneur] find funds? Who will supply them and on what terms?*" (Spremann, 2010) – and on several principles in relation: "*Traditional financial theory does not assume the existence of a capital market [working smoothly]. Each and every financial contract is unique*" (Spremann, 2010). Traditional finance is therefore a mere means to bring money (funds) to the real economy (firms), as a tool that primarily allocates excess household savings to companies against a financial reward. Financial markets are expected to fluidify and optimise this allocation process for the benefit of society (Shiller, 2013; Zingales, 2015). According to this approach, the aims of a company and investments are multiple and not focused on maximizing dividends: "*[…] these aims could indeed be described in terms of ROE [Return On Equity], [while] others object that long-term profits are far more important. Still others argue that companies should apply themselves first and foremost to safeguarding their substance"* (Spremann, 2010).

The neoclassical paradigm is based on this idea: "*Assume a capital market [Equity market] that is working smoothly. Then explain every phenomenon in the finance industry in terms of how it*

would be valued in such a perfect market" (Spremann, 2010). Thus, from this perspective, finance is no longer primarily focused on corporate financing and corporate financial markets are instead used primarily to assess shareholders' values and risks (Artus and Boone, 2017; Buchanan, 2017; Jachnik *et al.*, 2019; Spanò, 2019). In that sense, shareholders are the foremost economic agents — notably short-term oriented — to satisfy (Dallas, 2011). This prioritizes liquidity of exchanges over new flows of money to companies, and secondary market transactions indeed constitute the bulk of financial market activity compared to primary market issuance. In this framework, "*corporate efficiency is redefined as the ability to maximize dividends and keep stock prices high*" (Van Der Zwan, 2014).

Such a move naturally also corresponds to an evolution of corporate finance: textbooks, nowadays generally define corporate finance as primarily maximizing shareholder value, while acknowledging that the initial/fundamental function of the financial manager of a company is to be "*responsible for the company's financial procurement […] [by minimizing] the price of the commodity to be purchased, i.e., the cost of the funds he raises*" (Vernimmen, Quiry, Le Fur, Dallocchio, & Salvi, 2006), thus changing his role from a buyer of financial resources to a seller (Vernimmen et al., 2006) of financial securities.

In the same way, at the same period, financial accounting also evolved from one paradigm to another (Richard, 2015; Shortridge & Smith, 2009; Wells, 1976), from a model, where the central issue was "*What did the management do with the funds entrusted to it?*" (Rashad Abdel-Khalik, 2011) to another one, centred on the following question: "*What does the management expect to get in return?*" (Rashad Abdel-Khalik, 2011). The first paradigm – that Shortridge and Smith (2009) call 'industrial' in the field of accounting – corresponds to HCA, an accounting approach genuinely structured to show "*[…] 'accountability' in terms of informing investors about the management's initial deployment of funds*" (Rashad Abdel-Khalik, 2011) and to manage companies, with a focus on its activities – and managers – rather than on its shareholders or other counterparts (Richard, 2015): with HCA, "*[shareholders] have reached a sort of compromise with owner-managers who still hold enough influence to ensure the conservation of the financial capital*" (Richard, 2015). HCA is "*[…] rules-based, and [is] focused on transactions and allocations"* (Shortridge & Smith, 2009), as traditional finance is. The neoclassical paradigm refers to FVA, which has been developed to address the needs of 'short-term' shareholders (Richard, 2015) and is market-centred: FVA "*[…] focuses on economic events*" (Shortridge & Smith, 2009), where fair values "*[…] are only expectations the realization of which is conditional on many factors that are largely market determined and are outside management control*" (Rashad Abdel-Khalik, 2011).

Moreover, behind these two paradigms lie also two different visions of the notion of 'capital' (Richard & Rambaud, 2020). These two paradigms, for finance and financial accounting, can be schematised in this way: we call the 'traditional' (resp. 'neoclassical') one, 'model 1' (resp. 'model 2'), described in figure 1 (resp. figure 2) (Richard & Rambaud, 2020). Annex B sums up the main features of these two paradigms/models.

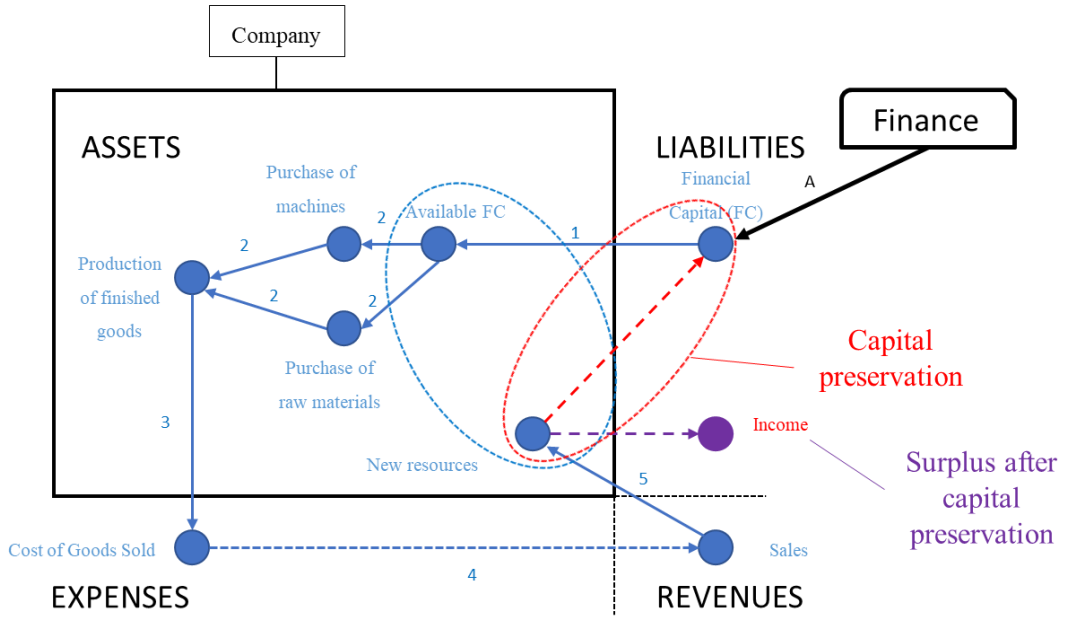

Fig. 1
The traditional finance and accounting system (Model 1)[10]:
monitoring of the flows of financial capital, as 'money to be refunded', and reporting of its uses, its consumptions as well as the capacity to reimburse it (preserve it) and create additional value

From this viewpoint, the fundamental mechanism of finance and accounting starts from the direct or indirect[11] contributions of (financial) capital, defined as 'money to be refunded'[12]: liabilities structure and organize these different contributions and so the different types of debts. There is thus a kind of collective pooling of capital. The 'capital'[13] account corresponds only to capital initially contributed by the owners/shareholders, while 'equity' refers to all capital contributed and thus owed, in one way or another, to the owners/shareholders: 'equity' is therefore a debt to the owners/shareholders. Finance refers to financing activities which allocate financial capital (long-term capital) to firms (arrow A in Fig. 1). Capital, whatever its origin, is then made available (arrow 1 in Fig. 1) and used (arrows 2): the different uses of capital constitute the assets (Ijiri, 1967) – an asset, from this perspective is therefore a particular use of capital and not a good or a service. So, this model distinguishes between money to be repaid (capital) – the sources of the company's responsibilities – and the money used for the company's activity – the sources of corporate productivity. It should be noted that the double-entry system according to this model can be represented by a system of arrows pointing from credit to debit: accounting, according to Model 1, aims to follow the flows of capital in business activities. Then expenses are capital consumptions (arrow 3), due to the uses of capital, that is the parts of assets really used for value creation. Finally, sales, that occur due to expenses (arrow 4), create new resources (arrow 5), which increase cash or receivables, and which make it possible to repay, if necessary, the capital contributed and to generate a possible surplus, the income, which appears as a residual profit after capital maintenance. In this system, capital is an entity independent of the company's activity: money provided to the company does not change in nature/value whatever its uses. The company appears as an entity also independent of the capital and its contributors, notably the owners/shareholders: it can be seen as a collective organisation, with its own substance (what is called the 'entity theory' (Müller, 2014) and is consistent with the stabilization of firm substance in 'traditional finance' as explained above).

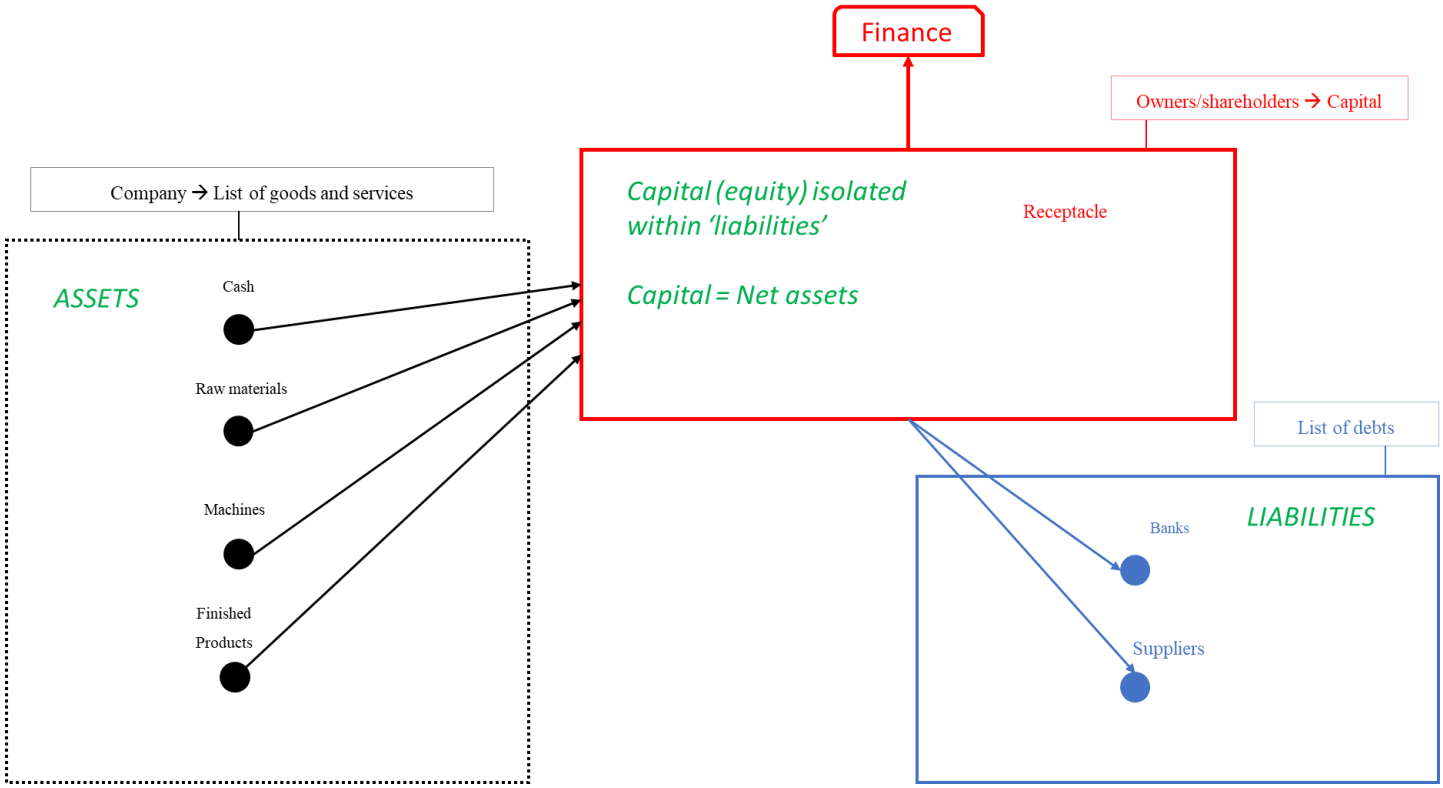

Fig. 2
The neoclassical finance and accounting system (Model 2):
Inventory/reporting of values for the owners/shareholders

In Model 2, at the core of IAS/IFRS for instance, 'capital' is no more a monetary debt: it is an isolated accounting entity which corresponds to a receptacle of *values* – the flow of services/cash generated by 'things' (resources) under control – for the owners/shareholders, taking into account that the owners/shareholders 'themselves' have debts to third parties. In this model, assets are not uses of capital but 'concrete' goods, services or contracts, generating cash flows for owners/shareholders. The function of financial accounting here is to provide an accurate listing/reporting, for the latter, of the various productive 'things' they can rely on as well as of 'their' debts. This system is therefore focused on owner/shareholder value. We also note that, according to Model 2, the direction of the arrows of the double-entry system is oriented from debit to credit, contrary to Model 1: This accounting system starts from assets, basis of value, and not from liabilities. Under these conditions, 'capital', in Model 2, is directly dependent on business activity: the way assets are managed changes the cash flows generated by them and thus the capital. Moreover, the company is no longer an autonomous entity but is understood here as a system for optimising asset management on behalf of the owner/shareholders (Müller, 2014). Corporate finance is based on sales of 'equity' (capital in the sense of Model 2) and finance is focused on the assessment of equity.

As explained before, the main point is that today's mainstream sustainable finance is developed from 'model 2'/neoclassical thinking, extended to social and environmental issues (Richard & Rambaud, 2020). Natural capital, as used by this type of sustainable finance, is indeed an extension of 'capital' in the sense of model 2, extended to new classes of assets, *natural assets* (*cf.* part 1); its evaluation is based on an extension of FVA to these assets, by an assessment of new classes of risks, opportunities and values, that markets should provide (from a neoclassical viewpoint), that is externalities. Finally, as shown before, decision-making and resource

management are based on a maximisation of shareholders' value, extended to these new assets and their whole pricing.

We have thus established that 1) current sustainable finance, mainly based on model 2, leads to serious questions about its capacity to be aligned with scientific ecological requirements – moreover, FVA raises more and more questions about long-term value creation objectives, especially if those are related to common good and general interest[14]; 2) finance, and its link with accounting, does not only come from the neoclassical paradigm and model 2. Is it therefore possible to base sustainable finance on an extension of model 1 and, under these conditions, what would be this extension and its operationalisation. As underlined above, in order to accompany the development of sustainable finance, it is necessary to focus on the deployment of an adequate accounting system. We therefore propose this starting point: in the rest of the paper, we will use the CARE framework (Rambaud & Feger, 2020; Rambaud & Richard, 2015), which was specifically developed to address these issues. We thus present its main features, which we consider to be relevant to financing issues and more particularly to reconceptualizing climate finance.

III. The CARE model

The basis of the CARE model comes from (Richard, 2012) while its first theorization was given in (Rambaud & Richard, 2015)[15]; a recent and updated overview of this model can be found in (Rambaud & Feger, 2020). There is today a growing movement in the development, implementation and recognition of CARE, notably in France[16]. Concretely, this model is a whole integrated accounting model, structured by integrated general ledger (with new types of accounts), balance sheet, income statement and annex[17]. Conceptually, it corresponds to an extension of Model 1 to 'extra-financial' capitals and their 'preservation costs' (which extend therefore historical costs to extra-financial issues), where these new types of capitals correspond to new types of liabilities/debts – in line with the concept of capital of Model 1 – and not to new types of assets. CARE relies on the idea that there is a convergence between the conception of strong sustainability defined as the need to preserve/protect particular natural and human 'entities' (Rambaud & Richard, 2015) and the fact that classic financial accounting system (Model 1) is completely based on the preservation/protection of a particular entity, money. Thus, CARE extends the whole system of financial capital protection and monitoring to other non-financial 'capital' (that is 'crucial/important') entities, called therefore 'extra-financial capitals' in CARE. As, "*[…,] in its broadest sense [,…accounting is] the preparation and the framing of information (qualitative and quantitative) to assist specific organizing and decision-making processes*" (Feger et al., 2019), the goal of CARE is to provide a *methodological framing* of sustainability issues and a particular *language* to connect financial and extra-financial issues. So, our purpose here is to introduce, in an exploratory way, the usefulness of using this language for climate finance and its links with business. For this purpose, we will use a simple schematic example to follow and understand the logic of the model.

III.1. Climate as a 'capital'/liability

III.1.a. Definition of a capital in CARE

According to CARE, a 'capital' is a 'thing', material or not, offering potential uses in a business model, and recognized as having to be preserved over a certain predetermined period (Rambaud, 2015)[18]. Thus CARE conceives human beings (in particular, employees) and

environmental 'entities' (or at least some of them), used, directly or indirectly, by a firm, as 'capitals', according to the above definition, and not as assets (that is as mere means). From this perspective, it is possible to conceive the uses made of human beings and environmental entities as a 'loan' that the firm has to 'refund', a kind of 'social and environmental debt': thus the maintenance of human beings (employees) and environmental entities, used by a firm, becomes a basis for the company's activity, in accordance with the logic of Model 1 (for financial capital). So, it may appear a lot of new extra-financial capitals, as many as 'capital'/principal/paramount entities to be preserved[19]. Furthermore, this perspective implies special attention to the way entities (human or non-human) used by a firm can be seen as 'capital', and so the operationalisation of this notion. In fact, three characteristics are necessary to determine if an entity can be a 'capital':

1. *a concern about the preservation of the considered entity*: a 'thing' is a 'capital' only if there is such a concern[20];
2. *a clear ontology of this entity*. This ontology, explaining the nature of the existence of the concerned entity and the (quantitative and qualitative) levels of conservation, makes it possible to establish and monitor its preservation[21]. This ontology must be detailed in the annex of CARE. For instance, this ontology can be structured by particular set of indicators.
3. *a real process to preserve this entity, according to its ontology*[22]. More precisely, there must be possible planning for a succession of preservation activities, leading to a conservation as is of the concerned entity. A preservation activity is defined as an activity whose primary function is to guarantee either *ex-ante* or *ex-post* preservation of a given entity, where *ex-ante* preservation corresponds to prevention of an impact on this entity and ex-post preservation corresponds to repair/restoration activities of this entity. We draw attention to the fact that preservation activities must be carefully distinguished from avoidance activities, as explained in Part III.2.c.

CARE transforms social and environmental issues in terms of entities degraded during business activity and to be preserved, through three questions: (1) 'What do we care about (Hache, 2011) (what 'things' are matters of concerns)?', (2) 'What is the nature and the description of these 'things', matters of concerns?' and (3) 'Does it exist a real way to preserve them?'. In particular, "*this model is […] based on a vision in terms of "stocks", where flows are variations of stocks, and not in terms of "flows" – this perspective avoids in particular the shifting baseline syndrome (Pauly, 1995)*" (Rambaud & Feger, 2020).

III.1.b. Implications for climate issues

Can climate be defined as a 'capital' in the sense of CARE? In the following, we examine the three conditions aforementioned in the case of climate.

First of all, building on the Kyoto Protocol (1997), the Paris Agreement (PA) (2015) made 'universally' clear that the Earth's climate is something to preserve as close as possible to its pre-industrial average state.[23] Climate preservation is therefore a source of concerns.

Then, we need to define properly what we consider as a 'stable climate', and on which analytical basis we can determine its conservation from a company perspective, thus defining the ontology of climate. Climate is a complex multidimensional system, but international discussions in the frame of climate negotiations introduced global mean temperature as a simplified unique proxy to overview the primary effect of climate change. Hence, with the PA, *"well below +2°C"* became the internationally agreed target for limiting climate change, *"pursuing efforts to limit the temperature increase to +1.5°C"* (United Nations, 2015). Importantly, +1.5°C, and not

+1°C or below, constitutes the ultimate target as the PA acknowledges that destabilisation is already ongoing[24] and irreversible within manageable timescales (a few centuries) (Masson-Delmotte et al., 2018). We therefore use this commonly agreed target as our reference for climate stability, which by its statute seems a realistic and acceptable framework. Therefore, global average temperature and its trajectory over time constitute the agreed ontology of 'climate' at the planetary scale.

But temperature as a proxy for climate change is not practicable directly. Nevertheless, global warming being a result of the increased greenhouse effect coming from anthropogenic activity, as human-induced GHG emissions are recognized the main cause of global warming (IPCC, 2014), it is usual to consider climate, and its preservation, directly through a level of GHG emissions that is compatible with the agreed climate target, instead of dealing with temperatures.

GHG neutrality, *i.e.* achieving global net-zero GHG emissions (Millar, Hepburn, Beddington, & Allen, 2018), is actually the only way to stabilise the climate. The level of stabilised warming is, according to this approach, a function of *when* net-zero is reached (typically, reaching net-zero CO_2[25] in 2050, 2070, 2100 can stabilise warming at respectively +1.5°C, +2°C, +3°C, *etc.*). Thus, whatever our climate ambition we will need to reach net-zero at one point in time if we do not want climate to warm forever. Concretely, requiring all companies to be neutral as of now would be good for stabilising climate at a rather low degree of warming (somewhere between +1°C and +1.5°C), but is quite unrealistic, owing to the fact that the world economy still relies essentially on fossil fuels. Following the Intergovernmental Panel on Climate Change (IPCC), the +1.5°C climate target still allows to emit a certain quantity of GHG in the atmosphere before having to be net-zero. This quantity defines the 'carbon budget'.[26]

While carbon budget is a quite simple concept, it is actually very complex to calculate and is strongly model- and hypothesis-dependent. Among the many difficulties, one may note first that the definition itself is not unique, as the limit for temperature increase is not defined relatively to a clear reference, neither in time (when exactly is 'pre-industrial') nor in space (which definition/methodology for mean temperature is taken).[27] Moreover, the carbon budget depends on which type of socioeconomic pathway one has in mind. Whether we will rely on massive negative emission technologies or not totally changes our capacity to emit GHG in the near future.[28] The more capacity to capture/compensate emissions in the future, the more degree of freedom we have to emit now and to slowly reduce our GHG emission pattern, rather than abruptly. There is no single pathway to a certain climate target. For instance, the IPCC works with a set of 222 scenarios that are consistent with a 1.5°C or 2°C climate target (Masson-Delmotte et al., 2018).

Once a certain carbon budget is determined and accepted by convention[29] at global scale, according to an agreed vision of the future – especially on the level of negative emissions –, our accounting exercise makes it necessary to 'scale' down that budget to the company (or any other accounting) level. This downscaling can be seen as an allocation exercise, sharing the global budget among each emitting entity. Different levels of allocation can be determined, by region, by sector, by companies. Our accounting entity being the company, it is necessary in our case to determine an allocation key relevant to the company level, which does not preclude to use prior allocation method by region and sector. The allocation process itself is also highly based on conventions and comes with a specific vision of the future – as the scenario choice itself –, being a translation of how 'we' want to spend the remaining GHG budget. Typically, an objective could be to make it last as long-lasting as possible, by a severe restriction of the

allocated annual emissions, or to focus on the support specific technologies while hampering others. Budget allocation is therefore a choice between a large number of options (theoretically infinite), and not characterised by a unique solution dictated by deterministic science.

It is key to comprehend that the specification of the accounting framework is by essence of conventional nature, and results from normative choices. Such choices are characteristics of traditional accounting systems (Demeestère, 2005; Feger et al., 2019; Rambaud & Richard, 2015) in general and must be reached by a robust, reliable (Shortridge & Smith, 2009) and ideally collaborative process. Facing an infinity of options is not an obstacle *per se*, as long as a robust decision process is proposed to pick up what is considered as the best option. It is indeed a convention, not an objective technical result. Therefore, such a feature has strong consequences on the meaning, significance and acceptability of the chosen accounting framework. This emphasises the importance of the deliberative process needed to converge to a shared vision (Callon, Lascoumes, & Barthe, 2009). It is important to stress that current accounting norms or management accounting systems[30] result from similar conventional processes and are highly conventional/subjective/political too, while being finally accepted by stakeholders after an inevitable phase of debates and controversies (Richard, Bensadon, & Rambaud, 2018).

Different dimensions have to be taken into account in the allocation process. The regional allocation process carries a strong geopolitical and diplomatic stake, which can take an ethical and historical equity dimension (*e.g.* right to development) or a pure economic (*e.g.* cost optimization) consideration (*e.g.* (Bjørn, Lloyd, & Matthews, 2021)), while the sectoral allocation illustrates technological and industrial policy preferences, which are by definition very divergent among countries and even intra countries. Then, the granular allocation process at company level faces other challenges, related to the planned vision of the number and size of companies operating in a given region/sector over time.

As we can see, this allocation process is a huge challenge in itself that requires specific research programmes, both on the underlying scientific constraints and on the political and governance aspects. This allocation step is impossible to override, which is intimately entangled with a societal vision of 'the future we want', either at local or global scale. From an accounting perspective, the regional consistency among frameworks and references is important but it is conceivable to envisage different references coexisting, each being locally consistent with its own decarbonation pathway, as long as the same target is shared (*e.g.* 1.5°C) and each individual pathway is independent from the other (possible in theory but currently highly debatable in a globalized interconnected world).

For the sake of our exploratory exercise, we will therefore not go further in this paper in terms of proposing a specific allocation approach. As an illustrative example, let us just briefly describe one of the possible concepts on the basis of the current ongoing efforts on allocation approaches such as that proposed by the Science-Based Target initiative (SBTi).[31] The SBTi framework and proposed methodologies have already been analysed in depth elsewhere (cf. (Bjørn et al., 2021) and references therein). Typically, based on International Energy Agency (IEA) sectoral scenarios or global emission pathways, the SBTi methodologies define budgets at company level based on two main possible approaches (SBTi, 2019). A first approach relies on a convergence of emission intensities (*e.g.* in t_CO_2/kWh for electric power) at a certain time horizon for a given sector. Each company starting from its current real emission intensity, this leads to different levels of emission reduction efforts per company, and at the end of the period all companies in consideration would then have the same emission characteristics. Such

an approach can be taken at global scale or adjusted *e.g.* by region. An alternative approach consists in a generic rate of contraction of absolute emissions for all companies (globally or within a sector) (SBTi, 2019). Here, whatever the current state of companies' GHG emissions, their efforts in terms of reduction rate would be the same but each company would keep a specific feature. While these examples constitute interesting approaches to define clear and practical allocation tools, it is impossible to guarantee that the sum of allocations in the end fits into the global budget, as such an allocation relies on a pure top-down process and there is no bottom-up feedback to continuously adjust the micro allocation at company level while constraining the global budget. Such a process would be feasible with a physically limited resource that could be physically shared among a specific number of participants but is clearly unrealistic in our case.

Therefore, climate and its preservation can be represented at corporate level as a carbon budget, which must be detailed in the annex of CARE; in particular, the particular choices of hypothesis and models used to obtain it are required as a precise, robust and explicit description of the ontology of climate. We saw above that many theoretical, practical, ethical and political obstacles are standing on our way, which means that the implementation of such a novel and genuine accounting framework is by no means an immediate turnkey solution but should rather be approached as part of the fundamental societal debates that need to be undertaken to define our desirable futures. While clearly illustrating the difficulty of such an endeavour, this should not undermine the objective of developing an ambitious accounting framework, but rather be taken as an imperative step to undertake to meet the challenge of the indispensable renovation of accounting in the face of the environmental and climate challenge.

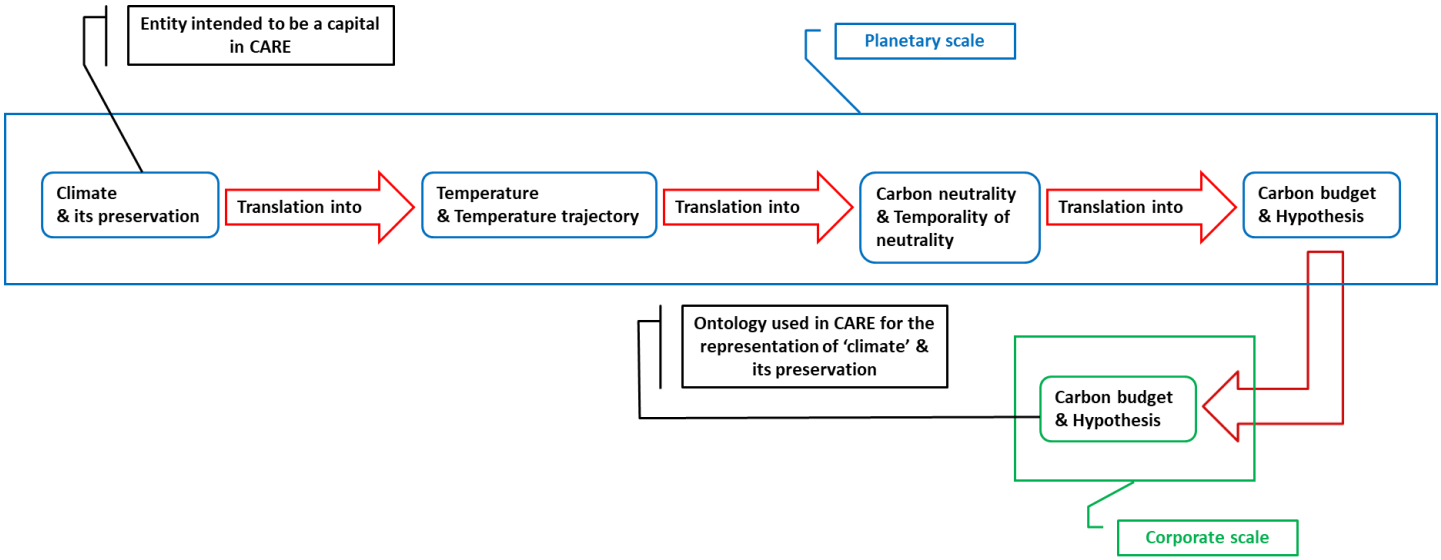

Figure 3
Ontological definition of climate in CARE

Finally, the last step to determine whether climate can be a capital in the sense of CARE is the possibility to have real processes to preserve it. Here, these processes exist and correspond to technics of carbon sequestration (Dugast & Carbone 4, 2020; Hepburn et al., 2019; Van Effenterre & Rocle, 2009). We can distinguish between *ex-ante* and *ex-post* preservation. In the case of climate, *ex-ante* preservation (prevention) corresponds to the capture of GHG emissions, due to the corporate operating activities, before they go into the atmosphere and

impact the climate. More concretely, Carbon Capture and Storage (CCS) (Hepburn et al., 2019) systems are typical *ex-ante* preservation activities for climate. *Ex-post* preservation corresponds to the absorption of GHGs present in the atmosphere, in a proportion equal to the company's emissions released into the atmosphere, thus impacting the climate. This refers to the creation of carbon sinks to 'compensate' GHG emissions. We insist here on the need for credibility in biophysical, societal and scientific terms for preservation activities (Rambaud & Richard, 2015): for instance, carbon sinks or CCS systems can be considered in CARE as such activities only on the basis of such scientific reliability and social/collective acceptance.

From this analysis, it is possible to consider climate as a particular capital according to the definition of CARE.

III.2. 'Capital-climate' in CARE

III.2.a. Insertion of extra-financial capitals in business model

Using this notion of 'capital', figure 3 sums up the CARE model over one accounting period (year N here) and in the simplified case of only one non-financial capital – here the 'capital-climate'. This figure shows that CARE is a direct extension of Model 1. In addition, it also highlights the distinction, central to CARE, between preservation activities, shown in the figure, and others, which are operating activities.

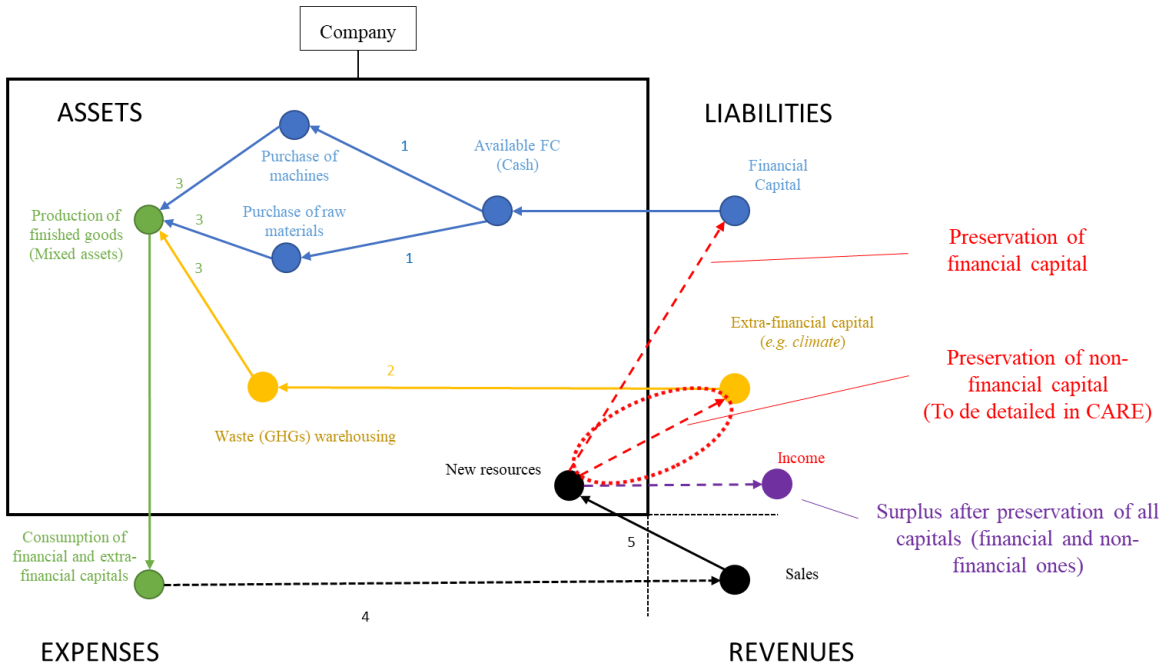

Fig. 3
Extension of Model 1 to non-financial capitals (as liabilities):
precise monitoring of several capitals (financial and non-financial) through their uses and consumptions

The 'capital-climate' is represented by a carbon budget, as described in previous part; we suppose for instance a carbon budget of 10kt for year N. To follow the operations in CARE, we will use, as explained, a simplified and schematic example – connected to Fig. 3 – that

highlights the important features of CARE that are relevant to this paper[32]. The balance sheet and the income statement according to CARE for this example are given in Annex C.

Operations	Fictive Dates (dd/mm/y)	Descriptions of events[33]
A	02/01/N	Creation of the company with financial capital provided by the owners for 5M€ and by banks for 3M€, deposited in the bank account of the company
B	02/01/N	Purchase of raw materials, for 1M€, and of a machine, for 3M€
C	01/02/N	Emission of 6kt of GHGs (due to the year's production and thus to the consumption of the machine and raw materials)
D	01/03/N	Purchase of a GHG CCS system for 4M€ (used for 10 years)
E	01/04/N	Emission of 7kt of GHG, of which 2kt are captured by the device purchased on 01/03/N
F	02/05/N	Cash sale of all finished goods, for 3M€
G	01/06/N	Purchase of a machine, for 1M€, that emits less GHG, to replace the old equipment. This machine is used for 20 years

Table 1
Simplified example (in the case of the capital-climate)

Financial and non-financial capitals are used (and then negatively impacted) by busines activities: the different uses of these capitals are defined as assets, in accordance with Model 1. Thus, for instance, financial capital is used to purchase a machine and raw materials (Operation B), a CCS device (Operation D) and another machine (Operation G) (Arrows 1 in Fig. 3). In the case of the capital-climate, its most common use is to receive GHG emissions and therefore to store up them. So, its use can be called 'GHG warehousing'. As in the case of Model 1, the corporate activities do not stem directly from capitals but from the different uses of capitals. In the example, this principle corresponds to the recognition that the business model is based not directly on climate, which is the 'thing' to be preserved, but on the services generated by it through its uses (here a service of reception of GHG emissions possible thanks to the use of the climate to store up particular waste – GHG). Hence, liabilities refer to external issues (corporate responsibility), while assets refer to internal issues (best possible uses of services generated by capitals for the company's activity). The double-entry system allows to link these two stakes, without confusing them.

In Operation C, GHG emissions do not exceed the carbon budget: climate accumulates/stores up less emissions than what is considered to have a negative impact on it (climate). Consequently, capital-climate is not really used in Operation C and CARE does not record any specific entry. In the case of Operation E, the situation is clearly different: accumulated GHG emissions exceed the carbon budget and so, the capital-climate is impacted and used. It also means that Operation E generates a 'climate debt', the obligation to preserve the 'capital-climate' in the end, because of a specific use of it in the business operating activities.

The question is therefore to know what is the level of use of capital-climate. One way to calculate is to add the total emissions (in Operations C and E, that is 13kt), remove the absorbed emissions (in Operation E, that is 2kt) and deduct the carbon budget (10kt for year N) from this result (13kt – 2kt – 10kt = 1kt). From this perspective, the impact on capital-climate would be 1kt. Nevertheless, to clarify operating and preservation activities, it is necessary to distinguish what the company's business model has as its intrinsic impact (its level of intrinsic impact on extra-financial capitals) from specific activities whose primary function is to repair or prevent these impacts. Therefore, the CCS device is dedicated to an activity of preservation (here in terms of prevention, as explained in previous part) of the capital-climate. Under these conditions, the intrinsic impact on the capital-climate of business model is here 13kt – 10kt = 3kt, whereas Operation D is a specific activity of preservation (and therefore, is not an operating activity). So, CARE recognizes that, in Operation E, capital-climate is provided to business to be used as 'GHG warehousing' and consequently that there is a 'climate debt' for 3kt. It is therefore recorded in this way, which correspond to arrow 2 in Fig. 3.

Accounting entries n°1	Biophysical entries	01/04/N (Operation E)
Nature of the flow	Capital-climate (representation of the 'part' of capital-climate used, in biophysical units)	
Credit	'Climate debt' (Liability)	3kt
Debit	'GHG warehousing' (Asset)	3kt

Then, the different capitals (financial and non-financial ones) are consumed because of their uses: a consumption is an expense in CARE. A consumption is not a use/degradation of a given capital, that is an asset; it corresponds, because of the accounting matching principle, to the part of an asset that really participates to the value creation of the business model during the given accounting period (here, year N). For instance, as GHG are emitted (Operations C and E) because of the production of year N (and thus, not for production of next year), the asset 'GHG warehousing' is entirely consumed in the business operating activities of year N. The related accounting recording is:

Accounting entries n°2	Biophysical entries	01/04/N (Operation E) – Just after entries n°1
Nature of the flow	Capital-climate (representation of the 'part' of capital-climate used and consumed, in biophysical units)	
Credit	'GHG warehousing' (Asset)	3kt
Debit	'GHG warehousing[34]' (Expenses)	3kt

Certain assets may be consumed, in the *normal* course of business, over less than or more than one accounting period. In the first case, these will be 'current assets' (and the corresponding charges will be 'current expenses') and in the second case, 'fixed assets' (and the corresponding charges will be 'amortization expenses') (Rambaud & Feger, 2020; Rambaud & Richard, 2015, 2017).

Thanks to the consumptions of financial and non-financial capitals, it is possible to produce finished goods, which are therefore 'mixed assets', that is uses of several different capitals (arrows 3 in Fig. 3). These expenses generate sales (Arrow 4 in Fig. 3), which are joint value creations through the uses and consumptions of capitals, and so new resources for business (Arrow 5 in Fig. 3). Now, these new resources are recorded in a dedicated account in CARE, in order to clearly distinguish them from 'financial capital made available, *i.e.* cash'. Indeed, the primary function of these new resources is to guarantee the possible preservation of all the different capitals, and, eventually, to make an *ex-post*, residual, profit, whereas cash (as 'Available financial capital') is intended for operating activities. Besides, the income, in CARE, is a surplus beyond the preservation of all the different types of capitals which contributed to the company[35]. More precisely, the recording of sales is the following one:

Accounting entries n°3	Monetary entries	02/05/N (Operation F)
Nature of the flow	Money (from clients)	
Credit	'Sales' (Revenues – For operating activities)	3M€
Debit	'Cash (New resources)' (Asset – For preservation activities)	3M€

III.2.b. Monetary proxies for extra-financial capitals

From this analysis of business activities including extra-financial capitals, in order to connect all the different information, CARE then uses a monetary proxy for representing these capitals in accounting[36]. It is possible to prove (Rambaud, 2015) that the monetary assessment of capitals, according to CARE, must be based on their *costs of preservation*. More precisely, this assessment of a given capital is the sum of all the (non-discounted) costs of preservation activities, according to its particular ontology (point 2 of capital definition), through a real process of preservation (point 3). These amounts are calculated *ex-ante*, at the time of the use of the concerned capital[37], by means of a (pragmatic) spending plan. As an outcome, the assessment of an asset – so a particular use of capital(s) – is equal to the part of the costs of preservation of the used capital(s), due to this particular use.

For instance, as explained, Operation C does not correspond to a degradation/use of the capital-climate; so, there is no need to preserve the capital-climate because of this event and there is therefore no monetary assessment associated to this event. Operation E, on the other hand, involves a climate debt and a use of capital-climate for a biophysical value of 3kt. At that very moment (01/04/N), CARE recognizes the necessity to plan a succession of preservation activities, leading to the *real* and *controllable* preservation of capital-climate and thus the elimination of climate debt. This plan (preservation plan) is not unique and we can pragmatically choose the most convenient and least expensive one, on the express condition that this plan leads to proven preservation of the capital-climate. Here, for instance, as the firms purchased a CCS device, we can include this device in the preservation plan. By doing so, it remains only 1kt (3kt – 2kt) to be removed from atmosphere. This can be done through *ex-ante* or *ex-post* preservation activities.

Now, as shown in the different events of the example, no preservation activities are actually planned by the company to eliminate this volume of GHGs. We therefore need to distinguish between *actual* and *necessary* preservation activities: necessary activities are those that should

be carried out to ensure the effective preservation of extra-financial capitals (here, the elimination of climate debt); actual activities are those that the company actually carries out to preserve its extra-financial capitals. Consequently, the monetary assessment of extra-financial capitals is based on the costs of *necessary* preservation activities; actual preservation costs are recorded in a specific way in CARE presented below. In this example, we therefore need to add a necessary preservation activity to guarantee the elimination of 1kt of GHG, even the firm will not carry out it. Let us suppose that this preservation activity is an *ex-post* one, based on the (potential) purchase of a carbon sink, at a planned date T during year N+1.

The next step is to assess the costs of the different preservation activities of the preservation plan. In the case of climate, these costs are much discussed and give rise to significant variations between authors and methods (Barnard, 2016; Hepburn et al., 2019; Quinet et al., 2019; Rubin, Davison, & Herzog, 2015; Van Effenterre & Rocle, 2009). Moreover, the credibility of these preservation activities[38] can lead to an increase of their costs. A precise discussion about these costs goes beyond the scope of this paper. Let us suppose for instance that the purchase cost of the aforementioned carbon sink is 200,000€ (so 200€ per ton of GHG). Therefore, the total preservation cost of the capital-climate is equal to 400,000€ (that is the amortization expense of the CCS device) + 200,000€, so 600,000€. The climate debt is thus assessed at 600,000€. As this capital is only used for 'GHG warehousing', the monetary assessment of this asset is also 600,000€. We can sum up the process of assessment of the capital-climate in the following table.

	01/03/N	Time T (year N+1)	Monetary proxy of capital-climate	Monetary proxy of the asset 'GHG warehousing'
Preservation plan	CCS device	Carbon sink		
Spending plan	Amortization of this device 400,000€	200,000€	600,000€ (Total cost of the spending plan)	600,000€

Table 2
Preservation and spending plans (example)

From this analysis, the accounting recording of Operation E, given from a biophysical viewpoint above, can be extended to a monetary representation in this way. We also include additional information on these accounting entries that we have introduced.

Accounting entries n°4	Monetary entries	01/04/N (Operation E) – Monetary entries which translate (Callon, 1986; Latour, 2009) biophysical entries of entries n°1

Nature of the flow	Capital-climate / Use of a monetary proxy	
Credit	'Climate debt' (Liability – On capital-climate – For operating activities)	600k€
Debit	'GHG warehousing' (Asset – Current asset – For operating activities)	600k€

Accounting entries n°5	Monetary entries	01/04/N (Operation E) – Just after entries n°4 – Monetary entries which translate (Callon, 1986; Latour, 2009) biophysical entries of entries n°2

Nature of the flow	Capital-climate / Use of a monetary proxy	
Credit	'GHG warehousing' (Asset – Current asset – For operating activities)	600k€
Debit	GHG warehousing' (Current Expenses – Capital-climate consumption – For operating activities)	600k€

III.2.c. Avoidance costs and natural debts ratio

We draw attention to a central point in CARE: the preservation costs, and thus the assessment of capital-climate (and climate debt), is not based on the costs of Operation G. The purchase costs of a 'greener' machine are not preservation costs but avoidance costs (in the language of CARE). More precisely, avoidance costs are operating costs whose primary function is related to business productivity/profitability, but which lead to reducing the negative impact on certain capitals, and so to reducing the preservation costs of these capitals[39].

This distinction corresponds to a differentiation between preservation activities, which have no impact on the company's business model – and in particular on its level of impact on the environment – and avoidance activities, aimed at modifying this business model to make it less environmentally damaging. In particular, this distinction is considered to be of prime importance in the report 'Net Zero Initiative (NZI)' of the consulting firm Carbone 4 (Dugast & Carbone 4, 2020)[40]. According to this report, this confusion may already have hampered climate action by creating overconfidence in negative-emission technologies, thus undermining measures to reduce emissions at source (our translation)[41].

Avoidance costs are uses and consumptions of financial capital (and not of extra-financial capitals), but they must be isolated from other uses and consumptions of financial capital. Therefore, in CARE, they are recorded in this way (Rambaud & Feger, 2020):

Accounting entries n°6	Monetary entries	01/06/N (Operation G)

Nature of the flow	Financial capital	
Credit	'Cash' (Asset on financial capital – For operating activities)	1M€
Debit	'Machine – Fixed asset for natural debts reduction' (Asset on financial capital – For operating activities)	1M€

The notion of natural debts ratio (NDR), used in this recording, can be defined in this way:
Monetary assessment of all natural capitals (NC) / Monetary assessment of all capitals (C)[42]

This ratio is therefore an integrated analysis ratio, which extends financial analysis to extra-financial capitals. More precisely, it is a ratio between two parts of liabilities; therefore, it is a

solvency ratio. It assesses the corporate level of indebtedness to the environment. Its operating mechanism is as follows (for the sake of simplification, we suppose that there is only two capitals, financial capital and the capital-climate – so NC is equal to the capital-climate and C is equal to NC plus the financial capital (FC)). First of all, if the company emits more GHGs, without changing its financial capital, then the company generates more climate debt and the costs of preservation increase. Consequently, NDR increases. Now, let us transform this ratio:

$$NDR = \frac{NC}{C} = \frac{NC}{FC+NC} = \frac{1}{1+\frac{FC}{NC}} \text{ (Equation 1)}$$

If avoidance costs increase (at time T0), then the financial capital increases (assuming that cash is fully used[43]), but at the same time, as the company will emit less GHG, the preservation costs will decrease over time (at time T1). From equation 1, we notice that:

- At time T0, the increase of FC, at constant value of NC, leads to a decrease of NDR
- At time T1, the decrease of NC, at constant value of FC, also leads to a decrease of NDR

Thus, avoidance costs lead to a decrease of this ratio, hence the accounting classification of these costs in the aforementioned accounting entries.

III.2.d. Actual preservation costs

Let us now turn our attention to the treatment of the actual preservation costs. The recording of these costs is broken down into two parts:

a. the recognition of costs actually incurred to protect certain entities of a given nature;
b. the recognition that these costs, by their function, whether in terms of prevention or restoration, create a kind of societal value that reduces the natural debt.

Point a) corresponds to the recording of particular expenses, dedicated to preservation activities, and classified by nature of the entities protected. Point b) is related to the recording of particular revenues, dedicated to preservation activities, and classified by types of preservation activities (prevention or restoration/reparation). This double classification (by natures and by types of activities of protection) is aligned with the official European Classification of Environmental Protection Activities and Expenditure (CEPA)[44].

In our simplified case, the only actual preservation costs are those of Operation D: this preservation activity is a prevention one, for protection of air and climate (to use the CEPA). Moreover, on 01/03/N, as the capital-climate is not used/degraded, there is no need for preservation activities, these ones occur only on 01/04/N. Therefore, on 01/03/N, CARE only indicates that the actual preservation costs are 'stored', awaiting consumption for preservation activities: consequently, CARE records a specific asset dedicated to preservation activities. Here are the accounting records corresponding to the actual costs of preservation.

Accounting entries n°7	Monetary entries	01/03/N (Operation D)
Nature of the flow	Financial capital	
Credit	'Cash' (Asset on financial capital – For operating activities)	4M€
Debit	'CCS device – Fixed asset' (Preservation activities)	4M€

Accounting entries n°8	Monetary entries	01/04/N (Operation E) – Just after entries n°5
Nature of the flow	Financial capital	
Credit	‘Amortization of CCS device’ (Preservation activities)	400k€
Debit	‘Air and climate protection’ (Expenses – Preservation activities)	400k€

Accounting entries n°9	Monetary entries	01/04/N (Operation E) – Just after entries n°8
Nature of the flow	Capital-climate / Use of a monetary proxy (the preservation activity creates an ‘environmental value’ that is ‘giving back’ to climate what was ‘used from it’)	
Credit	‘Prevention activities’ (Revenues – Preservation activities)	400k€
Debit	‘Climate debt’ (Liability – On capital-climate – For operating activities)	400k€

In the end, as the actual preservation costs (400k€) are smaller than the necessary preservation costs (600k€), the company retains a climate debt (of 200k€) – *cf.* also Annex C.

III.2.e. Implications for ‘climate financing’

The implications of this particular structuration of accounting and therefore of accounting information for corporate finance/financing and market finance are multiple. Here we outline some of the main aspects of this possible restructuring of sustainable finance, particularly in the case of climate change.

First of all, in line with our introductive analysis, the precise and adapted structuring of the various environmental costs, on a preservation basis, makes it possible to inform “*[…] investors about the management’s initial deployment of funds*”, as in the case of HCA, while guaranteeing a clear environmental preservation. From the viewpoint of CARE, in line with the HCA approach of accounting (Rashad Abdel-Khalik, 2011; Shortridge & Smith, 2009), accounting is viewed, not as a mere objective, faithful, functionalist (Riahi-Belkaoui, 2004) representation of quantitative economic values (Rashad Abdel-Khalik, 2011), whose purpose would be to perfectly replace – like a map could (falsely) replace a territory (Farinelli, 2004) – corporate management for the benefit of optimized shareholder management, but as a meaningful space (Latour, 1985), where numbers are pragmatically (Demeestère, 2005) recorded in “*[…] accordance with some prespecified rules*” (Rashad Abdel-Khalik, 2011). The goal of CARE is therefore not to turn accounting into a mere ‘rubber stamp’ for recording economic gains and losses, to show precisely what the company is worth to the shareholders; its goal is to increase the informational value (like separation between operating and preservation activities, allocation of particular costs, *etc.*) of this meaningful space to enable managers, attentive shareholders and stakeholders to make better informed decisions, on the basis of prespecified rules, that is preservation of socio-eco-systems.

Moreover, if we go back to accounting entries n°7, we can notice that the CCS device, dedicated to preservation activities, is paid for out of the company’s cash. But this cash should be used

for operating activities. In that case, these 4M€ are not productive and do not participate to normal value creation. However, they are used to reimburse what has been negatively impacted by the company's productive activity. The central question is whether it would not be more appropriate to use cash for a productive activity, so as to obtain significant sales, capable not only of directly covering the cost of this device but also of generating a margin. So, more concretely, let us suppose the company has obtained specific financing (in the amount of 4M€) to help it preserve the capital-climate and has used its cash for operating activities (at a positive operating margin). Then, in the end, it could both repay preservation funding and generate a margin. Consequently, the clear distinction between operating and preservation activities leads to the necessity to also distinguish between financing of operating activities and of preservation activities. As shown in balance sheet and income statement given in Annex C, this distinction is clarified in CARE.

In fact, in a natural way, by structuring liabilities in line with that of assets, CARE makes it possible to distinguish not only 'preservation financing' (financing of preservation activities) from 'operating financing' (financing of operating activities), but also within the latter, between 'normal' operating financing and operating financing dedicated to the coverage of 'avoidance costs' (*cf*. Operation G). These different types of financing have the following features:

<table>
<tr><td colspan="2">Operating financing

Classification in CARE (Cf. Annex C): Liabilities / Contribution of funds dedicated to operating activities (Top of balance sheet)</td><td>Preservation financing

Classification in CARE: Liabilities / Contribution of funds dedicated to the preservation activities (Bottom of balance sheet)</td></tr>
<tr><td>Financing of avoidance costs
Classification in CARE: Contribution of funds for natural debts reduction</td><td>'Normal' financing
Classification in CARE: Contribution of funds for 'other' operating activities</td><td></td></tr>
<tr><td>Ecological transition financing, that is financing for an evolution of the business model so that it has less environmental impact.</td><td></td><td>Financing of preservation activities, present and past
→ Possible specific financing for reducing natural debts</td></tr>
</table>

This classification makes it possible to better target investments, in order to improve the financing of 'sustainable' activities and to guarantee their better employment by companies.

Finally, the last implication of CARE for sustainable finance/financing is the possibility to develop a real integrated analysis. The notion of NDR is an example of a part of such analysis. The principle of such an analysis, connecting financial and extra-financial data, is to show global performances, which can help investors, in particular, in their investment decisions.

IV. Conclusion

In this paper, after highlighting the significant deadlocks of financial and accounting systems in their current development, with regard to environmental issues, we focused on the CARE accounting model as a response to these limitations. We have used it as a framing system, a specific language adapted to connect financial issues and ecological preservation and business management issues, through an applied exploration of the case of climate change challenge.

This led us, first, to clearly define an operational representation of the climate and its preservation, through the notion of *carbon budg*et. We underlined the dependence of such a carbon budget to a number of important underlying hypotheses and models which are necessary to detail in the CARE model. Next, we highlighted and distinguished two main types of company activities: *preservation activities and operating activities*. On the operating side, we emphasized that the climate is incorporated into the business model by the fact that it is used, and thus degraded, in order to *warehouse GHGs*. Consequently, this use generates a *climate debt*, which we have been able to structure thanks to the notion of preservation activities: the climate debt, which already appears as a biophysical reality, is thus translated into monetary terms by the spending plan associated with a plan for *necessary* preservation activities. We were therefore also able to differentiate between two other types of costs: *avoidance* costs and *actual* preservation costs, which are thus treated differently in CARE. In particular, the concept of avoidance cost leads to the definition of an *integrated analysis ratio*, the Natural Debt Ratio, capable of estimating *natural solvency* (and specifically climate solvency). On the other hand, the notion of actual preservation costs makes it possible to understand in detail the actual actions undertaken by the company to reduce its natural debt (and so, its climate debt), highlighting that, in this case, the company bears a cost, associated with particular environmental areas (like climate, soil , biodiversity, *etc*.), but that it also creates a *societal value*, associated with this debt reduction. Finally, we have presented the consequences of this approach, this framing and structuring, in order to better understand corporate global performances (starting with climate solvency) and to better target financing in relation to sustainability.

This paper constitutes an exploratory study, limited to introducing the issues of CARE's use in the case of climate finance. Under these conditions, several aspects of the shift in scale between planetary and corporate carbon budgets have not been developed. Similarly, the specific treatment of GHG scopes 1, 2 and 3 and the supply chain (GHG emissions from suppliers and customers) was also not addressed. These points will be the subject of further work and developments. Another limitation of this paper is obviously its theoretical nature, which does not allow us in the present paper to go into the details of the model implementation. The choice thus made here was to focus on the general structure rather than trying to present a particular case.

At a time when the European regulation on the taxonomy of sustainable activities[45] – and in particular in the case of climate change mitigation –, has just been adopted, obliging from now on large companies to better structure their activities and associated expenditures, and investors to be more aware of the impact of their investments, our aim was to show how CARE and its concepts offer a clarified and promising approach to accompany this emerging structuring movement.

Annex A

Different definitions and meanings of 'sustainable finance' (BAFU, 2020; BNP Paribas, 2020; HSBC, 2020; ICMA, 2020; MAS, 2020)

Source	Definition/meanings of "sustainable finance"
UN / UNEP / UNEP FI	"Although the terms are not always used consistently, in general a distinction can be drawn between approaches to sustainable finance that take a broad environmental, social, economic and governance approach, and those that take a narrower, 'green finance' one concerned only with environmental issues. Even more narrowly focused are those targeted only on climate change mitigation and/ or adapting to climate change impacts"
EU	"the process of taking due account of environmental and social considerations in investment decision-making, leading to increased investments in longer-term and sustainable activities" "In the EU's policy context sustainable finance is understood as finance to support economic growth while reducing pressures on the environment and taking into account social and governance aspects. Sustainable finance also encompasses transparency on risks related to ESG factors that may impact the financial system, and the mitigation of such risks through the appropriate governance of financial and corporate actors."
G20	"Sustainable finance can be broadly understood as financing as well as related institutional and market arrangements that contribute to the achievement of strong, sustainable, balanced and inclusive growth, through supporting directly and indirectly the framework of the Sustainable Development Goals (SDGs). A proper framework for sustainable finance development may also improve the stability and efficiency of the financial markets by adequately addressing risks as well as market failures such as externalities."
ICMA	"Sustainable Finance incorporates climate, green and social finance while also adding wider considerations concerning the longer-term economic sustainability of the organisations that are being funded, as well as the role and stability of the overall financial system in which they operate."
HSBC	"We define sustainable finance as any form of financial service which integrates environmental, social and governance (ESG) criteria into business or investment decisions." "Sustainable finance covers both the financing and the investment activities needed to support the UN Sustainable Development Goals (SDGs), and in particular action to combat climate change."
BNPP	"Sustainable finance is anchored in a long-term ethical vision of financial investing. It seeks to reconcile economic performance with positive social and environmental impact, by funding companies that actively contribute to sustainable development."
MAS	"Sustainable finance is the practice of integrating environmental, social and governance (ESG) criteria into financial services to bring about sustainable development outcomes, including mitigating and adapting to the adverse effects of climate change."
BAFU	"A financial system is defined as sustainable if its finance and investment decisions promote economic activities that take the scarcity of limited natural resources and the regeneration capacity of renewable resources into consideration. To increase sustainability and exploit the associated business opportunities, financial actors must take sustainability factors into account in their financial and investment decisions as a matter of course."

Annex B

The two paradigms/models of finance and financial accounting

	Model 1	**Model 2**
Capital	Money to be repaid	Receptacle of values, generated by assets
Assets	Uses of capital	Productive and useful (material or immaterial) resources, which generate controllable flows of services, cash, *etc.*
Financial accounting system	Historical cost accounting	Fair value accounting
Purpose of financial accounting	What did the management do with the funds (capital) entrusted to it?	What does the management expect to get in return?
Purposes of business	ROE Long-term profits Companies should apply themselves first and foremost to safeguarding their substance	Maximizing dividends Keeping stock prices high
Main business actors	Managers	Shareholders
Paradigm of finance	Traditional	Neoclassical
Purpose of finance	Means to allocate excess household savings (funds) to companies against a financial reward (not necessarily maximised - *cf.* above)	Assessment of shareholders' value and risks Liquidity of exchanges over new flows of money to companies Secondary market transactions constitute the bulk of financial market activity compared to primary market issuance.
Purpose of corporate finance	Buying funds, by minimizing the price of the commodity to be purchased, that is the cost of the funds raised	Maximizing shareholders' value
CFO	Buyer of capital	Seller of financial securities
Natural capital	(Based on CARE) Each natural entity recognized as a capital entity, to be preserved	Part of 'capital', composed by natural assets (that is productive and useful natural resources)
Resource management	(Based on CARE) Based on scientific and collective determination of ecological level if preservation	Based on CBA
Assessment of natural capital	(Based on CARE) Preservation costs	Fair value of natural assets + negative and positive externalities

Annex C

Integrated statements according to CARE (Simplified presentation)[46]

- Treatment of the example: Balance sheet at 01/06/N and Income statement from 02/01/N to 01/06/N
- Highlighting the different types of possible financing (Liability structure)
- Focus on natural and financial issues

Balance Sheet - CARE

Operating assets & liabilities

Financial issues

	Gross	Amt & Dep.	Net	Financial capital
Assets for natural debt reduction				Liabilities for natural debt reduction
Fixed assets				Money provided by the owners/shareholders
Machine (Operation G)	**1M€**	**0**	**1M€**	Loans
Current assets				Payables
Other assets				Other liabilities
Fixed assets				**Money provided by the owners/shareholders 5M€**
Machine (Operation B)	**3M€**	**300k€**	**2,700k€**	**Loans 3M€**
Current assets				Payables
Cash				

Natural Issues

	Gross	Amt & Dep.	Net	Natural capitals
Fixed assets				Soils-as-ecosystems
Current assets				**Climate 200k€ (=600k€ - 400k€)**
Available natural capitals (for uses)				...

Mixed Assets

	Gross	Amt & Dep.	Net	
Fixed assets				
Current assets				

Preservation of Capitals

	Gross	Amt & Dep.	Net	
Fixed assets				Liabilities (Debts/Subsidies/Bonds/etc.) related to the preservation of capitals
CCS device	**4M€**	**400k€**	**3,600k€**	
Current assets				
New resources from customers (*e. g.* sales)			**2M€ (=3M€ - 1M€) (Operation F & G)**	

Income 1,100k€

Total Assets = Total liabilities

Income Statement - CARE

Operating expenses and revenues

Expenses on Financial Capital		**Sales**	**3M€**
Current expenses			
Purchases expenses	**1M€ (Operation B)**		
Amortization expenses	**300k€**		
Expenses on Natural Capitals			
Current expenses			
GHG warehousing	**600k€**		
Amortization expenses			

Preservation of capitals

Air & Climate preservation	**400k€**	**Prevention of Natural Capitals**	**400k€**
Water preservation			
Etc.		Restoration of Natural Capitals	

References

Abel, J.-D., & Blanc, M. (2017). *Aiming for a sustainable bioeconomy*. Retrieved from Conseil Economique, Social et Environnemental website: https://www.lecese.fr/en/publications/aiming-sustainable-bioeconomy

Alijani, S., & Karyotis, C. (2019). Coping with impact investing antagonistic objectives: A multistakeholder approach. *Research in International Business and Finance*, *47*, 10–17.

Altukhova, Y. (2013). *Comptabilité agricole et développement durable: Etude comparative de la Russie et de la France*. Université Paris-Dauphine.

Ameli, N., Drummond, P., Bisaro, A., Grubb, M., & Chenet, H. (2019). Climate finance and disclosure for institutional investors: why transparency is not enough. *Climatic Change*, *160*(4), 565–589.

Artus, P., & Boone, L. (2017). Le rôle des marchés financiers pour financer les entreprises. *Séance Du Conseil Scientifique de l'AMF Du 5 Décembre 2017 Consacrée Au Rôle Des Marchés Dans Le Financement de l'économie et Aux Biais Comportementaux Des Analystes Financiers*. Paris: Autorité des Marchés Financiers (AMF).

BAFU. (2020). Sustainable Finance.

Barbier, E. ., Markandya, A., & Pearce, D. . (1990). Environmental sustainability and cost-benefit analysis. *Environment and Planning A*, *22*, 1259–1266.

Barbier, E. B. (2014). Ecosystems as assets. In G. Atkinson, S. Dietz, E. Neumayer, & M. Agarwala (Eds.), *Handbook of Sustainable Development* (pp. 72–90). Edward Elgar Publishing Ltd.

Barker, R., & Kasim, T. (2016). Integrated Reporting: Precursor of a Paradigm Shift in Corporate Reporting? In C. Mio (Ed.), *Integrated Reporting* (pp. 81–108). London: Palgrave Macmillan UK.

Barnard, M. (2016). Carbon Capture Is Expensive Because Physics. Retrieved from CleanTechnica.com website: https://cleantechnica.com/2016/01/19/carbon-capture-expensive-physics/

Barter, N. (2015). Natural capital: Dollars and cents/dollars and sense. *Sustainability Accounting, Management and Policy Journal*, *6*(3), 366–373.

Bichler, S., & Nitzan, J. (2018). The Nordhaus Racket: How to use capitalization to minimize the cost of climate change and win a 'Nobel' for 'sustainable growth.' Retrieved from Real-World Economics Review Blog website: http://bnarchives.yorku.ca/562/2/20181105_bn_the_nordhaus_racket_rwerb.htm

Bjørn, A., Lloyd, S., & Matthews, D. (2021). From the Paris Agreement to corporate climate commitments: Evaluation of seven methods for setting “science-based” emission targets. *Environmental Research Letters*. https://doi.org/10.1088/1748-9326/abe57b

BNP Paribas. (2020). What do we mean by “sustainable finance”?

Bouquin, H. (2010). *Le contrôle de gestion*. Presses Universitaires de France - PUF.

Buchanan, B. G. (2017). The way we live now: Financialization and securitization. *Research in International Business and Finance*, *39*, 663–677.

Callon, M. (1986). Eléments pour une sociologie de la traduction. *L’Année Sociologique*, *36*(31), 169–208.

Callon, M., Lascoumes, P., & Barthe, Y. (2009). *Acting in An Uncertain World: An Essay on Technical Democracy*. Cambridge, Massachusetts: MIT Press.

Cange, D., Bénédictins, Carpentier, P., Henschel, L., & Favre, L. (2020). Capitale. In *Glossarium mediae et infimae latinitatis*. Retrieved from http://ducange.enc.sorbonne.fr

Chenet, H. (2019). *Climate change and financial risk*.

Chenet, H., Ryan-Collins, J., & van Lerven, F. (2021). Finance, climate-change and radical uncertainty: Towards a precautionary approach to financial policy. *Ecological Economics*, *In press*.

Chenet, H., Zamarioli, L., Kretschmer, B., & Narvaez, R. (2019). *From transformational climate finance to transforming the financial system for climate*.

Christophers, B. (2017). Climate Change and Financial Instability: Risk Disclosure and the Problematics of Neoliberal Governance. *Annals of the American Association of Geographers*, *107*(5), 1108–1127.

Clark, C. W. (1973). The economics of overexploitation. *Science*, *181*, 630–634.

Clark, C. W. (2010). *Mathematical bioeconomics*. Wiley.

Dallas, L. (2011). Short-Termism, the Financial Crisis, and Corporate Governance. *Journal of Corporation Law*, *37*, 264.

De Cambourg, P., Gardes, C., & Viard, V. (2019). *Ensuring the relevance and reliability of non-financial corporate information: an ambition and a competitive advantage for a sustainable Europe*. Ministère de l’Economie et des Finances.

Demeestère, R. (2005). Pour une vue pragmatique de la comptabilité. *Revue Française de Gestion*, *31*(157), 103–114.

Dugast, C., & Carbone 4. (2020). *Net zero initiative*. Retrieved from http://www.carbone4.com/wp-content/uploads/2020/04/Carbone-4-Referentiel-NZI-avril-2020.pdf

Elkington, J. (1997). *Cannibals with forks:the Triple Bottom line of the 21st Century Business*. Oxford: Capstone.

Elkington, J. (2018). 25 Years Ago I Coined the Phrase "Triple Bottom Line." Here's Why It's Time to Rethink It. *Harvard Business Review*, *25*.

EU High Level Expert Group on Sustainable Finance. (2018). *Financing a sustainable European economy*. Retrieved from https://ec.europa.eu/info/sites/info/files/180131-sustainable-finance-final-report_en.pdf

Farinelli, F. (2004). Map and Territory. Retrieved from http://www.amaze.it/AMAZE/node/41

Fatemi, A. M., & Fooladi, I. J. (2013). Sustainable finance: A new paradigm. *Global Finance Journal*, *24*(2), 101–113. https://doi.org/10.1016/j.gfj.2013.07.006

Feger, C., Mermet, L., Vira, B., Addison, P. F. E., Barker, R., Birkin, F., … Sutherland, W. J. (2019). Four priorities for new links between conservation science and accounting research. *Conservation Biology*, *33*(4).

Fragnière, A. (2015). *La compensation carbone : illusion ou solution ?* Presses Universitaires de France.

Fullwiler, S. (2016). Sustaiable finance: Building a more general theory of finance. In O. M. Lehner (Ed.), *Handbook of Social and Sustainable Finance* (pp. 17–34). Retrieved from https://books.google.fr/books?id=j3V9DAAAQBAJ&dq=%22sustainable+finance%22+%22cost-benefit%22&lr=&hl=fr&source=gbs_navlinks_s

Godard, O. (2004). La pensée économique face à la question de l'environnement. *Cahiers Du Laboratoire d'économétrie de l'Ecole Polytechnique*, *25*.

Gregory, R. P., Stead, J. G., & Stead, E. (2020). The global pricing of environmental, social, and governance (ESG) criteria. *Journal of Sustainable Finance and Investment*. https://doi.org/10.1080/20430795.2020.1731786

Hache, E. (2011). *Ce à quoi nous tenons*. La Découverte.

Hediger, W. (2003). Sustainable farm income in the presence of soil erosion: An agricultural Hartwick rule. *Ecological Economics*, *45*(2), 221–236.

Hepburn, C., Adlen, E., Beddington, J., Carter, E. A., Fuss, S., Mac Dowell, N., … Williams, C. K. (2019). The technological and economic prospects for CO2 utilization and removal. *Nature*, *575*(7781), 87–97.

Høst-madsen, N. K., Damgaaard, C. K., Szeler, A., Jørgensen, R., McManamon, D., Bullock, S., … Schmidt, J. (2014). *Methodology report for Novo Nordisk's environmental profit and loss account*.

HSBC. (2020). Sustainable Finance.

ICMA. (2020). *Sustainable Finance — High-level definitions*.

Ijiri, Y. (1967). *The Foundations of Accounting Measurement*. Englewood Cliffs: Prentice-Hall.

IPCC. (2014). Summary for Policymakers. In Intergovernmental Panel on Climate Change (Ed.), *Climate Change 2013 - The Physical Science Basis* (pp. 1–30). Cambridge: Cambridge University Press.

Jachnik, R., Mirabile, M., & Dobrinevski, A. (2019). Tracking finance flows towards assessing their consistency with climate objectives: Proposed scope, knowns and unknowns. In *OECD Environment Working Papers*.

Lagoarde-Segot, T. (2019). Sustainable finance. A critical realist perspective. *Research in International Business and Finance*, *47*, 1–9.

Latour, B. (1985). Les" vues" de l'esprit: Une introduction à l'anthropologie des sciences et des techniques. *Culture et Technique*, *14*, 4–30.

Latour, B. (2009). *Politics of Nature: How to Bring the Sciences into Democracy*. Cambridge, Massachusetts: Harvard University Press.

Le Breton, M. (2017). *Performativité de la comptabilité carbone : de la construction des règles aux dispositifs de management du carbone*. Mines ParisTech.

Le Breton, M., & Aggeri, F. (2019). The emergence of carbon accounting: How instruments and dispositifs interact in new practice creation. *Sustainability Accounting, Management and Policy Journal*, *11*(3), 505–522.

Liang, H., & Renneboog, L. (2021). Corporate Social Responsibility and Sustainable Finance. Retrieved February 12, 2021, from Oxford Research Encyclopedia of Economics and Finance website: https://papers.ssrn.com/sol3/Papers.cfm?abstract_id=3698631

MAS. (2020). Sustainable Finance.

Masson-Delmotte, V., Zhai, P., Pörtner, H.-O., Roberts, D., Skea, J., Shukla, P. R., … Waterfield, T. (2018). Global warming of 1.5°C — An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change. In *Report of the Intergovernmental Panel on Climate Change*.

Mega, E. R. (2019). Cuba acknowledges climate change threats in its constitution. *Nature*, *567*(7747), 155–155.

Millar, R. J., Hepburn, C., Beddington, J., & Allen, M. R. (2018). Principles to guide

investment towards a stable climate. *Nature Climate Change*, *8*(1), 2–4.

Mitra, T., & Roy, S. (2006). Optimal exploitation of renewable resources under uncertainty and the extinction of species. *Economic Theory*, *28*(1), 1–23. https://doi.org/10.1007/s00199-005-0618-5

Müller, J. (2014). An accounting revolution? The financialisation of standard setting. *Critical Perspectives on Accounting*, *25*, 539–557.

Naess, A. (1989). *Ecology, Community and Lifestyle: Outline of an Ecosophy*. Cambridge University Press.

Nobes, C. (2015). Accounting for capital: the evolution of an idea. *Accounting and Business Research*, *45*, 413–441.

Norton, B. G. (2005). *Sustainability*. Chicago: The University of Chicago Press.

Notat, N., & Senard, J.-D. (2018). *L'entreprise, objet d'intérêt collectif*. Retrieved from Ministères de la Transition Ecologique et Solidaire, de la Justice, de l'Economie et des Finances, du Travail website: https://minefi.hosting.augure.com/Augure_Minefi/r/ContenuEnLigne/Download?id=FAA5CFBA-6EF5-4FDF-82D8-B46443BDB61B&filename=entreprise_objet_interet_collectif.pdf

Pasquier, J. (2018). *What levers exist to increase the french agriculture and agrifood sectors' competitiveness ?* Retrieved from Conseil Economique, Social et Environnemental website: https://www.lecese.fr/en/publications/what-levers-exist-increase-french-agriculture-and-agrifood-sectors-competitiveness

Passmore, J. (1980). *Man's Responsibility for Nature. Ecological problems and western traditions.* (2th ed.). Duckworth.

Pauly, D. (1995). Anecdotes and the shifting baseline syndrome of fisheries. *Trends in Ecology & Evolution (Personal Edition)*, *10*(10), 430.

Pearce, D. (1976). The limits of Cost Benefit analysis as a guide to environmental policy. *Kyklos*, *29*, 97–112.

Pearce, D. (1988). Economics, equity and sustainable development. *Futures*, *20*, 598–605.

Pearce, D., Markandya, A., & Barbier, E. B. (1989). *Blueprint for a green economy*. London: Earthscan.

Pearce, D., & Turner, R. K. (1990). *Economics of Natural Resources and the Environment*. London: Harvester Wheatsheaf.

Perman, R., Ma, Y., McGilvray, J., & Common, M. (2003). *Natural resource and environmental economics* (3rd ed.). Pearson Education.

Quinet, A., Bueb, J., Le Hir, B., Mesqui, B., Pommeret, A., & Combaud, M. (2019). *La valeur de l'action pour le climat*. Retrieved from France Stratégie website: https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs-2019-rapport-la-valeur-de-laction-pour-le-climat_0.pdf

Rambaud, A. (2015). *La valeur de l'existence en comptabilité : pourquoi et comment l'entreprise peut (p)rendre en compte des entités environnementales pour « elles-mêmes » ?* Université Paris-Dauphine.

Rambaud, A., & Feger, C. (2020). Method 3 - Comprehensive Accounting with Respect to Ecology (CARE) Model. In *Improving nature's visibility in financial accounting*. Retrieved from https://www.chaire-comptabilite-ecologique.fr/Natural-capital-visibility-in-financial-accounting-Method-3-Extended-Version?lang=fr

Rambaud, A., & Richard, J. (2015). The "Triple Depreciation Line" instead of the "Triple Bottom Line": Towards a genuine integrated reporting. *Critical Perspectives on Accounting*, *33*, 92–116.

Rambaud, A., & Richard, J. (2017). The "Triple Depreciation Line" Accounting Model and its application to the Human Capital. In S. Alijani & C. Karyotis (Eds.), *Finance and Economy for Society: Integrating Sustainability* (pp. 225–251). Emerald Group Publishing.

Rashad Abdel-Khalik, A. (2011). Fair Value Accounting and Stewardship. *Accounting Perspectives*, *9*(4), 253–269.

Revelli, C. (2013). L'investissement socialement responsable. *Revue Française de Gestion*, *236*, 79–92.

Revelli, C. (2015). Analyse critique de l'investissement socialement responsable (ISR): méta-débat et perspectives d'évolution. In B. Paranque & R. Perez (Eds.), *La finance autrement? Réflexions critiques sur la finance moderne* (pp. 131–160). Presses Universitaires du Septentrion.

Riahi-Belkaoui, A. (2004). *Accounting Theory*. Singapore: South-Western CENGAGE Learning.

Ricard, J.-P., & Ricard, S. (1724). *L'art de bien tenir des livres de comptes en parties doubles à l'italienne*. David Paul Marret.

Richard, J. (2012). *Comptabilité et Développement Durable*. Paris: Economica.

Richard, J. (2015). The dangerous dynamics of modern capitalism: From static to IFRS' futuristic accounting. *Critical Perspectives on Accounting*, *30*, 9–34.

Richard, J., Bensadon, D., & Rambaud, A. (2018). *Comptabilité financière* (11e ed.). Dunod.

Richard, J., & Rambaud, A. (2020). *Révolution comptable : Pour une entreprise écologique et sociale*. Editions de l'Atelier.

Rolston III, H. (2007). La Valeur dans la Nature et la Nature de la Valeur. In H.-S. Afeissa (Ed.), *Ethique de l'environnement* (pp. 153–186). Vrin.

Rubin, E. S., Davison, J. E., & Herzog, H. J. (2015). The cost of CO2 capture and storage. *International Journal of Greenhouse Gas Control*, *40*, 378–400.

SBTi. (2019). *Foundations of Science-based Target Setting*.

Schoenmaker, D. (2017). *From Risk to Opportunity: A Framework for Sustainable Finance*. Rotterdam School of Management, Erasmus University.

Schoenmaker, D., & Schramade, W. (2018). *Principles of Sustainable Finance*. Oxford: Oxford University Press.

Shiller, R. J. (2013). *Finance and the good society. Princeton University Press.* Princeton University Press.

Shortridge, R. T., & Smith, P. A. (2009). Understanding the changes in accounting thought. *Research in Accounting Regulation*, *21*(1), 11–18.

Spanò, M. (2019). Measuring finance for the economy and finance for finance. In L.-P. Rochon & V. Monvoisin (Eds.), *Finance, Growth and Inequality*. Edward Elgar Publishing.

Spash, C. (1997). Ethics and Environmental Attitudes With Implications for Economic Valuation. *Journal of Environmental Management*, *50*(4), 403–416. https://doi.org/10.1006/jema.1997.0017

Spremann, K. (2010). Old and New Financial Paradigms. In G. Eilenberger, S. Haghani, A. Kötzle, K. Reding, & K. Spremann (Eds.), *Current Challenges for Corporate Finance: A Strategic Perspective* (pp. 7–26). https://doi.org/10.1007/978-3-642-04113-6_2

Stern, N. (2007). The economics of climate change: The stern review. In *The Economics of Climate Change: The Stern Review*.

Sullivan, S. (2014). *The natural capital myth; or will accounting save the world?*

Sun, W., Louche, C., & Pérez, R. (2011). Finance and Sustainability: Exploring the reality we are making. In W. Sun, C. Louche, & R. Pérez (Eds.), *Finance and Sustainability: Towards a New Paradigm? A Post-Crisis Agenda* (pp. 3–15). Bingley: Emerald Group Publishing.

Sweeney, H. W. (1933). Capital. *The Accounting Review*, *8*(185–199), 254–264.

Taibi, S. (2019). *Soutenabilité forte : du concept à l'opérationnalisation. : cas d'une entreprise stratégiquement militante*. Université de Nantes.

Thomä, J., & Chenet, H. (2017). Transition risks and market failure: a theoretical discourse on why financial models and economic agents may misprice risk related to the transition to a low-carbon economy. *Journal of Sustainable Finance and Investment*, *7*, 82–98.

Tuttle, C. A. (1903). The real capital concept. *The Quarterly Journal of Economics*, *18*, 54–96.

United Nations. (2015). *Convention on Climate Change: Climate Agreement of Paris.* 1–27.

Van Der Zwan, N. (2014). Making sense of financialization. *Socio-Economic Review*, *12*, 99–129. https://doi.org/10.1093/ser/mwt020

van Duuren, E., Plantinga, A., & Scholtens, B. (2016). ESG Integration and the Investment Management Process: Fundamental Investing Reinvented. *Journal of Business Ethics*, *138*(3), 525–533. https://doi.org/10.1007/s10551-015-2610-8

Van Effenterre, C., & Rocle, R. (2009). La séquestration du carbone, solution miracle ? *Regards Croisés Sur l'économie*, *6*(162–164), 27–40.

Vernimmen, P., Quiry, P., Le Fur, Y., Dallocchio, M., & Salvi, A. (2006). *Corporate Finance: Theory & Practice*. John Wiley & Sons.

Victor, P. A. (2007). Nature as Capital: Concerns and Considerations. In J. Leonard, C. Ragan, & F. St-Hilaire (Eds.), *A Canadian Priorities Agenda: Policy choices to improve economic and social well-being* (pp. 171–178). IRPP.

Weinstein, O. (2010). *Pouvoir, finance et connaissance*. Retrieved from https://www-cairn-info-s.proxy.bu.dauphine.fr/pouvoir-finance-et-connaissance--9782707156303.htm

Wells, M. C. (1976). A Revolution in Accounting Thought? *The Accounting Review*, *51*(3), 471–482. Retrieved from https://www.jstor.org/stable/245459?seq=1

Wijnmalen, D. J. D. (2007). Analysis of benefits, opportunities, costs, and risks (BOCR) with the AHP–ANP: A critical validation. *Mathematical and Computer Modelling*, *46*, 892–905.

Wood, D. (2002). *Medieval Economic Thought*. Cambridge University Press.

WWF France, & AXA. (2019). *Into the Wild: integrating nature into investment strategies*. Retrieved from https://d2ouvy59p0dg6k.cloudfront.net/downloads/report_wwf_france___axa_into_the_wild_may_2019__dv_1.pdf

Zingales, L. (2015). Presidential Address: Does Finance Benefit Society? *The Journal of Finance*, *70*(4), 1327–1363.

[1] https://ifamagazine.com/article/the-irresistible-growth-of-esg-investing/
[2] https://www.publicbooks.org/financial-markets-were-not-designed-to-manage-the-planet/
[3] which connects financial and extra-financial data.
[4] https://www.esginvestor.net/tcfd-view-of-materiality-no-longer-adequate-unep-fi-chief/
[5] https://www.ifrs.org/news-and-events/2021/02/trustees-announce-next-steps-in-response-to-broad-demand-for-global-sustainability-standards/
[6] <<2°C: "well below 2°C", as featured in the Paris Agreement overarching goals.
[7] As recalled in the French Impact's recent forum, entitled "*Il faut « donner une valeur aux impacts écologiques et sociaux de l'entreprise"*. *Cf.* https://www.lemonde.fr/idees/article/2021/02/09/il-faut-donner-une-valeur-aux-impacts-ecologiques-et-sociaux-de-l-entreprise_6069286_3232.html
[8] "*une révision s'impose quant au statut de la théorie des effets externes [externalités] dans le domaine de l'environnement. L'optimum d'internalisation des effets externes atténue certes la pression exercée sur l'environnement - et en ce sens marque un progrès pratique indéniable par rapport à l'absence de toute prise en compte -, mais elle participe, par construction, du processus par lequel un système économique dégrade et épuise son environnement jusqu'à l'issue finale*" (Godard, 2004).
[9] "*To this day, this school of thought continues to influence the way people – especially practitioners – think about finance. Many entrepreneurs too are still guided by terms fashioned [by Old finance paradigm]*" (Spremann, 2010).
[10] Fig. 1 is based on a permanent inventory and so, a classification of expenses by function.
[11] Indirect contributions correspond for instance to debts to suppliers: in that case, suppliers implicitly provide money, which is directly used to purchase their goods.
[12] Historically, the term 'capital' comes from the Latin expressions "*caput pecuniae*" ('head'/principal part of money – lent –) (Cange, Bénédictins, Carpentier, Henschel, & Favre, 2020; Nobes, 2015; Sweeney, 1933; Tuttle, 1903): it was thus the main part of a debt in money, regardless of any interest. Capital, until the late Middle Ages/early Renaissance, was thus purely money, without reference to any notion of productivity, and was dissociated from any addition (interest) increasing the value of the initial loan (Wood, 2002).
[13] The use of the word 'capital' to denominate this account must be strictly distinguished from capital as monetary debt. The 'capital' account, introduced at the end of the Middle Ages (Nobes, 2015), literally means what is 'capital' for the owner (Ricard & Ricard, 1724).
[14] For instance, the French report "L'entreprise, objet d'intérêt collectif" (The company, an object of collective interest) (Notat & Senard, 2018) – preamble to the recent French evolution of Company Law and other laws related to firms – states that, from the perspective of IASB, financial accounting has only to take into account the private interest of owners/shareholders. Moreover, in (EU High Level Expert Group on Sustainable Finance, 2018), the authors indicate that IFRS 9 "*[…] is seen as having negative impact on long-term finance, including both investment and lending […]*"; as an outcome, they ask for an investigation for "*[…] alternative accounting approaches to fair value/mark-to-market valuation for long-term investment portfolios of equity and equity-type instruments*". This paper can be seen as a kind of (partial) answer to this demand.
[15] While its foundations and principles did not change since (Richard, 2012), its name has changed, from "Comptabilité Adaptée au Renouvellement de l'Environnement" (Richard, 2012) to "Comprehensive Accounting in Respect of Ecology" (Rambaud & Feger, 2020) (through the denomination "Triple Depreciation Line" (Rambaud & Richard, 2015)), and, more importantly, its structure and methodologies have been refined (and are still in the process of being worked on).
[16] At corporate and professional level, several experiments of this accounting system have been implemented since 2012. In particular, the R&D section of a French consulting firm is dedicated to CARE. As an example, the principles of this accounting model are used by a NGO which works with farms to promote agro-ecology and a collective operation centred on this model has begun, in 2019, in the south of France in partnership with ADEME and the French "Institut National de l'Economie Circulaire", involving ten firms (in different sectors – industrial, distribution, *etc.* – and ranging from SMEs to multinationals), with the support of the French Ministry of Environment. At an academic level, a research program around CARE is emerging, including PhD thesis – past (Altukhova, 2013; Rambaud, 2015; Taibi, 2019) and in progress –, experimentations (in French multinationals and in the agri-food and retail sector), and research chairs, in particular one entitled "Comptabilité écologique" (AgroParisTech, Paris-Dauphine University, University of Reims-Champagne-Ardenne), which studies and develops this accounting system in particular. At the institutional level, CARE is included in several reports (De Cambourg, Gardes, & Viard, 2019; Notat & Senard, 2018; WWF France & AXA, 2019) and is the subject of some recommendations, notably from the French Economic, Social and Environmental Council (Abel & Blanc, 2017; Pasquier, 2018).
[17] we give an example of integrated statements according to CARE in annex C.

[18] This definition of 'capital' clearly encompasses the notion of 'financial capital' according to Model 1, that is as 'money to be repaid': the considered 'thing', in this case, is simply 'money'.
[19] In order to simplify their reporting and to respect business confidentially, CARE gathers these different capitals into three categories: financial capital, natural capitals and human capitals.
[20] In the case of financial capital, this concern is the one of the capital provider.
[21] In the case of financial capital, this ontology is simply the monetary value of capital.
[22] In the case of financial capital, this process is simply to keep money in order to be able to refund capital.
[23] The imperative to preserve a stable climate and broader environmental protection is now even included in some constitutions and fundamental laws (Mega, 2019).
[24] Current level of global warming already exceeds +1°C.
[25] Climate science usually distinguishes an earlier net-zero level for CO_2, and a later one for GHG altogether.
[26] Or GHG budget, if the GHG considered are not limited to CO_2.
[27] *Cf.* Carbon Brief for a detailed explanation of the various difficulties in defining carbon budget https://www.carbonbrief.org/analysis-why-the-ipcc-1-5c-report-expanded-the-carbon-budget
[28] Beyond neutrality, net negative emissions (absorbing more emissions than what we emit) can also contribute to reach a certain stabilisation level, 'compensating' to a certain extent, past emissions in excess. Many +1.5°C compatible emission pathways rely on global emissions that are massively negative after 2050 or 2070, questioning the realism of underlying scenarios. Technical items such as the detailed mechanisms of the climate response to different emission trajectories, the credibility of socioeconomic (including policy and technology) hypotheses on the various realisations of the future, and the precise definitions of what can be considered as a permanent capture and storage of GHG are quite far beyond the scope of this paper.
[29] It is important to stress that beyond the robustness of the different scenarios validated by science, the choice of which scenario to be follow (*i.e.* to be taken as a roadmap/strategy) will not be dictated by science but will eventually result from a political choice, whether democratic or not. Hence the importance of this notion of 'convention'.
[30] Like in the case of indirect costs allocation (Bouquin, 2010).
[31] https://sciencebasedtargets.org/
[32] In order to avoid too many arrows in Fig. 3, but to clarify the different steps in CARE's accounting records, Fig. 3 is based on a permanent inventory and a classification of expenses by function (leading to the recognition of *e.g.* a single expense – costs of goods sold) whereas the accounting records in the following will be based on a classification of expenses by nature (to highlight the different expenses).
[33] To simplify, we assume that only the following events are observed. In particular, the owner is the only one doing the work (*i.e.* there are no employees). In addition, we assume that the use of a CCS system can be summarized by a purchase of a particular CCS device, treated as a fixed asset.
[34] The same term (GHG warehousing) is used to simplify the recordings here.
[35] A positive (resp. negative) income means that business model generates (resp. does not generate) enough revenues to cover the consumptions of all the different capitals.
[36] It is not really a 'monetary valuation of capitals' which is integrated in CARE : the purpose of monetary values is not to 'replace' the extra-financial capitals themselves (and so to manage monetary values instead of biophysical entities) but to insert a particular 'reality' into the accounting system : the fact that degradation of extra-financial capitals, because of the business operating activities, generates debts and should be *costly*.
[37] The trigger event for the calculation of this budget of costs of preservation is precisely the use (and so the degradation) of the concerned capital.
[38] For instance, in the case of trees planted as carbon sinks, the aim is to guarantee the credibility of the measurement of the carbon actually absorbed by these trees and to secure their management – so that the re-emission of carbon through their felling or death is controlled (Fragnière, 2015).
[39] This distinction between costs of preservation and avoidance costs are in line with a recommendation from the French accounting standard-setter (Recommendation n°2003-r02), which states: "*Expenditure which may have a positive impact on the environment, but which is primarily intended to satisfy other needs, such as improving profitability, hygiene and safety at work or ensuring the safe use of products manufactured by the company or production efficiency, must be excluded[from environmental expenditure]*". "*Echoing this recommendation, the primary intention of the cost (profitability or environmental preservation) is thus decisive in classifying costs in CARE*" (Rambaud & Feger, 2020).
[40] This report calls for making a strict distinction between emission reductions and negative emissions (our translation) – "*Distinguer rigoureusement réductions d'émissions et émissions negatives*" (Dugast & Carbone 4, 2020) – where emission reductions correspond to an evolution of the business activities and negative emissions, to the creation of carbon sinks (so to preservation activities).

[41] "*Cette confusion a peut-être déjà entravé l'action en faveur du climat en suscitant une confiance excessive dans les technologies à émissions négatives, nuisant ainsi aux mesures de réduction des émissions à la source*" (Dugast & Carbone 4, 2020).
[42] That is the value of all liabilities.
[43] It is thus possible to refine this ratio by replacing financial capital with capital employed, as in the case of ROCE.
[44]https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=CEPA_2000&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC
[45] Regulation 2020/852 of 18 June 2020 (*cf.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0852&from=EN)
[46] Adapted from (Rambaud & Feger, 2020).