Working Paper

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

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Hugues Chenet, Chaire Énergie et Prospérité and University College London

Abstract:

In this paper, we argue that current finance, and the prevailing fair value accounting system, is disconnected from companies and 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 this observation, 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. 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 2°C goal in particular.

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

I. Introduction

"*Financial markets were not designed to manage the planet*"[1]: from this assertion, we can wonder how far the current financial system can contribute to the fight against climate change when its disconnection with the real economy has never been so strong. In this paper, we argue that the current 'fair value' accounting (FVA) framework has a responsibility in this disconnection, being both unable to reflect a genuine relationship between investors and corporate management, and unable to internalise the 'double materiality' (European Commission, 2019) relating firms and nature.

At the same time, the introductory report to the European Union action plan on sustainable finance (EU High Level Expert Group on Sustainable Finance, 2018) recommends to "*investigate alternative accounting approaches to fair value/mark-to-market valuation for long-term investment portfolios of equity and equity-type instruments*". As an answer to this demand, we therefore propose to explore how an alternative ecological accounting framework, the CARE (Comprehensive Accounting in Respect of Ecology) model (Rambaud & Feger, 2020; Rambaud & Richard, 2015), based on historical costs and a conception of 'natural capital' as natural liabilities/debts, can approach the links between finance issues and climate change (and more broadly ecological preservations[2]) in a more 'sustainable' way.

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 historical cost accounting (HCA) to extra-financial capitals and conceptualizes all types of capitals – financial and extra-financial one – symmetrically. One of its main features is to structure and clarify the concepts of environmental preservation, debt and costs, and consequently the targeting of sustainable financing. Thus, it proposes an operational framework for integrating the notion of ecological preservation into corporate business models and into the financial system. Consequently, such re-structuration of climate change and GHG emission issues through CARE 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 particular 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. First observation: Finance disconnected from companies

From a theoretical standpoint, finance is a means to bring money to the real economy, 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). The recent sustainable finance narrative, through its various nuances (*cf.* Table in Annex A), is calling upon this very mechanism of the financial system and adds the supplementary objective to contribute to building sustainability, that is to bring (more) money to sustainable economic activities, along with shifting out unsustainable ones (Schoenmaker & Schramade, 2018). Surprisingly, while the expectation on the societal

outcome of the financial system is growing, its underlying functioning and capacity to finance the real economy is actually not questioned by the dominant paradigm.

This is problematic, because it actually appears that the 'model' of modern finance, characterized by financialization and securitization, is no longer primarily financing companies but rather governments, and that corporate financial markets are instead used primarily to value companies and shareholders' 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. Such a move is illustrated by finance textbooks, which 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 of financial securities. Of course, even if self-financing becomes a new norm of the current capitalistic regime (Gruber & Kamin, 2016), finance is not completely disconnected from the real economy and still channels financing to companies, but this share is decreasing and a significant segment of the blooming sustainable finance field has potentially no direct impact and only a weak indirect influence on the firms themselves[4].

Thus, it appears quite strikingly that there is a missing link, literally a missing drive belt, in the process of calling upon finance in order to achieve a transformation of the economy into a sustainable one. Therefore, we propose to reframe the issue at the source/its roots, and to reconnect market finance with genuine corporate finance — in the classic sense of corporate financial management —, building on the classic basis of an analysis of the firm according to managerial principles, starting with money provided to business, considering that after all finance is about bringing money to companies[5]. Thus, the main idea is that we consider money brought in the company, in order to be used for developing or running its activities; money is then consumed, and the company must be able to reimburse it.

This perspective corresponds to a particular approach to financial accounting, as shown in Figure 1 (Richard, Bensadon, & Rambaud, 2018) – that we call 'Model 1'.

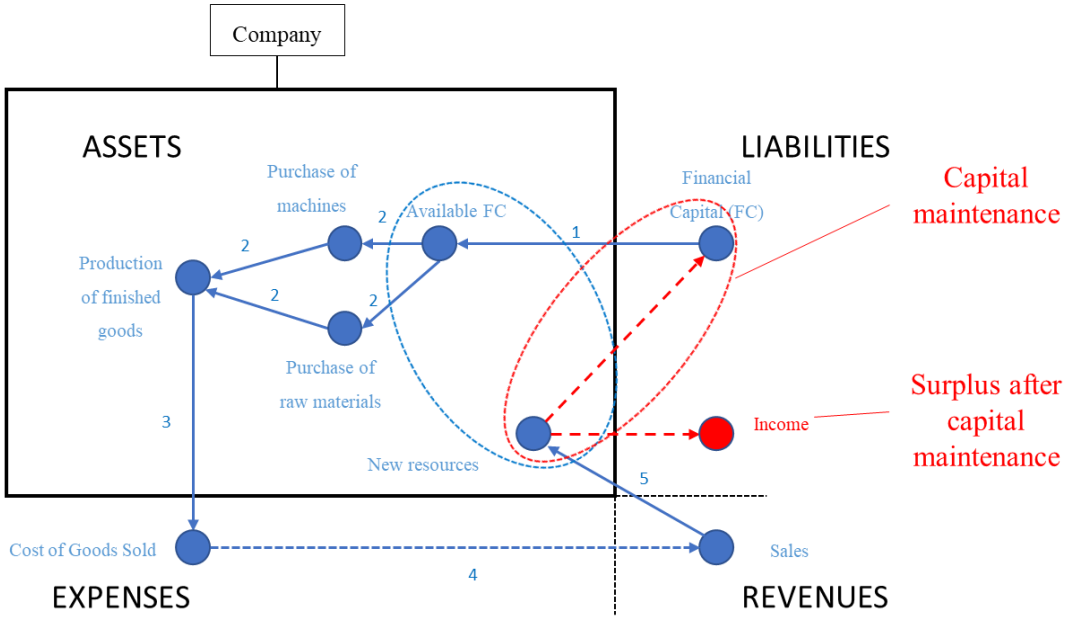

Fig. 1
The classic accounting system (Model 1)[6]:
monitoring of the flows of financial capital and reporting of its uses, its consumptions as well as the capacity to reimburse and create additional value

From this viewpoint, the fundamental mechanism of accounting starts from the direct or indirect[7] contributions of (financial) capital, that is money to be refunded[8]: 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'[9] 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. Financing activities (classic corporate finance) are mainly concerned by long-term capital. 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)). Model 1 corresponds historically to 'historical cost accounting', 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

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). It is interesting to note that the formal approach of financial analysis, which is the basis of market finance and of financial rating, indeed corresponds to the analysis of this type of accounting.

Logical as it may seem, this approach is no more what is being used on markets. Instead, 'fair value accounting' has become the norm (Richard, 2015)[10]. The very logics of financial accounting from this perspective, that we call 'Model 2', can be summarized by figure 2 (Richard et al., 2018).

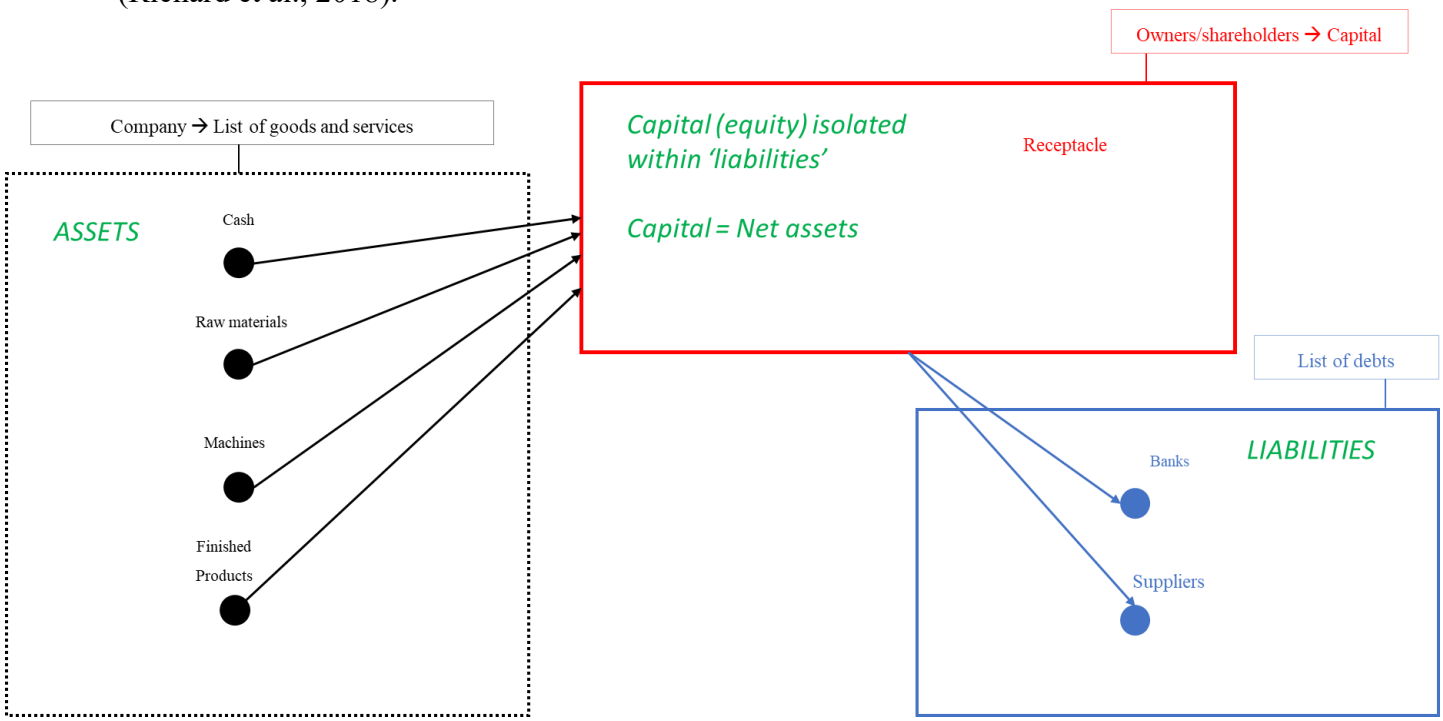

Fig. 2
The FVA accounting system (Model 2):
Inventory/reporting of values for the owners/shareholders

In Model 2, at the core of IAS/IFRS, '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[11]. 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). FVA has been developed to address the needs of short-term shareholders (Richard, 2015)

and is in genuine contradiction with long-term value creation objectives, especially if those are related to common good and general interest[12].

We therefore propose to come back to a way of thinking that considers money flows both towards and in the company, in order to have a robust monitoring and reporting tool on a basis of which we can extend the company's perimeter of interest to a broader economic system encompassing the natural environment, starting with climate change as a first example. This is along the line of the stated objectives of current initiatives such as that of the French AMF[13].

II.2. Second observation: Finance disconnected from environment

In addition to the above, we need to emphasize here that finance is, by construction of the current economic paradigm, disembedded from biophysical reality and ecological imperatives. Indeed, as mentioned in previous section, the drivers of prices 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', defined as a set of *natural assets* (Barbier, 2014; Victor, 2007), that is a set of presupposed controllable sources of productive and useful services for humans and business activities, and in particular for shareholders. This prevailing conception corresponds to an extension of Model 2 to new types of assets, natural ones (Barker, 2019). Management of these resources relies therefore on an optimisation of gains and losses of values stemming from this productivity and usefulness, including values non reflected by markets (market failures), that is environmental externalities[14] [15].

As a consequence, most of proposals of extension of corporate accounting to natural capital are based on this perspective (Barker, 2019), like in the case of the Integrated Reporting (IIRC Council, 2013)[16]. This logic is also the prevailing one 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 goal (Le Breton & Aggeri, 2019). 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, 2019).

The first issue of such a logic is that risk (CRFR) is limited to "Outside-In" (O-I) risks, that is risks from the environment to the corporate business model, whereas the reverse risks – from the corporate activities to the environment –, ('Inside-Out") (I-O) risks, are generally completely ignored by the risk narrative, as harming the environment largely comes at no direct cost for economic agents and as 'natural debts' are not internalised (Richard, 2012). The second issue of such a management of natural resources is that it is not compatible with scientific ecological requirements. For instance, such a perspective (optimisation of discounted cash-flows – even on long-term models – and internalisation of externalities) can lead to a systematic impoverishment or an overexploitation of ecosystems (Clark, 1973; Pearce, 1976). Such a vision, at the centre of Nordhaus's work, for example, also leads to significant discrepancies between economic and ecological climate management (Bichler & Nitzan, 2018). Therefore, in order to preserve the environment, the objective is to create new frameworks that incentivize

economic agents to take care of the environment and not only to protect themselves from environmental threats as well as to maximise their opportunities of value creation from natural resources. That is for instance the logic of "double materiality" tuned in by the European Commission in its Guidelines on non-financial reporting (AMF, 2020; European Commission, 2019)[17].

For all the reasons mentioned above, we need an alternative approach of taking into account, representing, measuring and assessing the economic activities as seen from the financial system, based on an accounting framework able to integrate genuinely the environmental preservation stakes and a connection with corporate activities/management. For this, we propose in the rest of the paper to 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)[18]; 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[19]. 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[20]. 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)[21]. 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[22]. 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[23];
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[24]. 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*[25]. 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.[26] 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[27] 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[28] 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 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'[29].

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).[30] 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[31]. 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.

Once a certain carbon budget is determined and accepted by convention at global scale, according to an agreed vision of the future – especially on the level of negative emissions –, it is needed to 'scale' it down 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 comes with a vision of the future, being a translation of how 'we' want to spend the remaining GHG budget. Typically, an objective could be to make it last as long as possible, restricting the allocated annual emissions, or to 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. The regional allocation process carries a strong geopolitical and diplomatic stake, while the sectoral allocation illustrates technological and industrial policy

preferences. 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. This allocation process is a huge topic in itself that requires specific research programmes, both on the underlying scientific constraints and on the political and governance aspects. For the sake of our current exploratory exercise we therefore will not go further and retain as an example the current ongoing efforts on allocation approaches such as that proposed by the Science-Based Target initiative (SBTi)[32]. Typically, based on IEA sectoral scenarios or global emission pathways, the SBTi methodology defines budgets at company level based on either a convergence of emission intensities (*e.g.* in t_CO_2/kWh) at a certain time horizon for a given sector (each company starting from its current real one, resulting to different levels of emission reduction efforts per company), or a generic rate of contraction of absolute emissions for all companies (globally or within a sector) (SBTi, 2019)[33].

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.

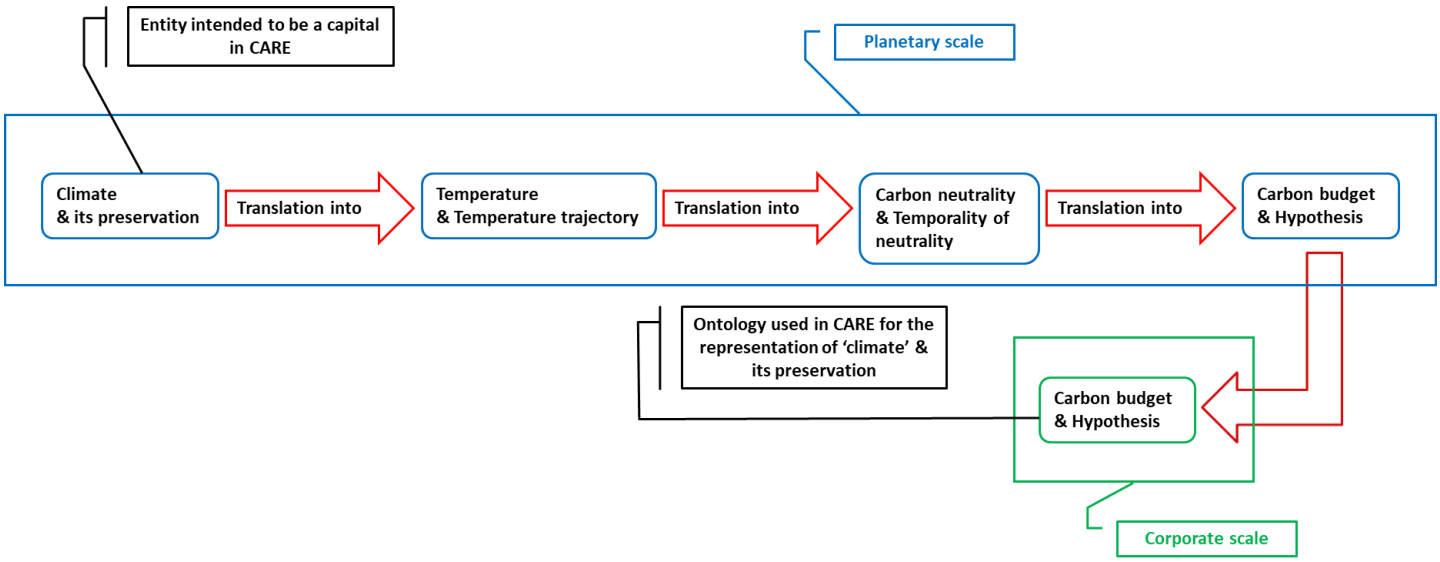

Figure 3
Ontological definition of climate in CARE

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.

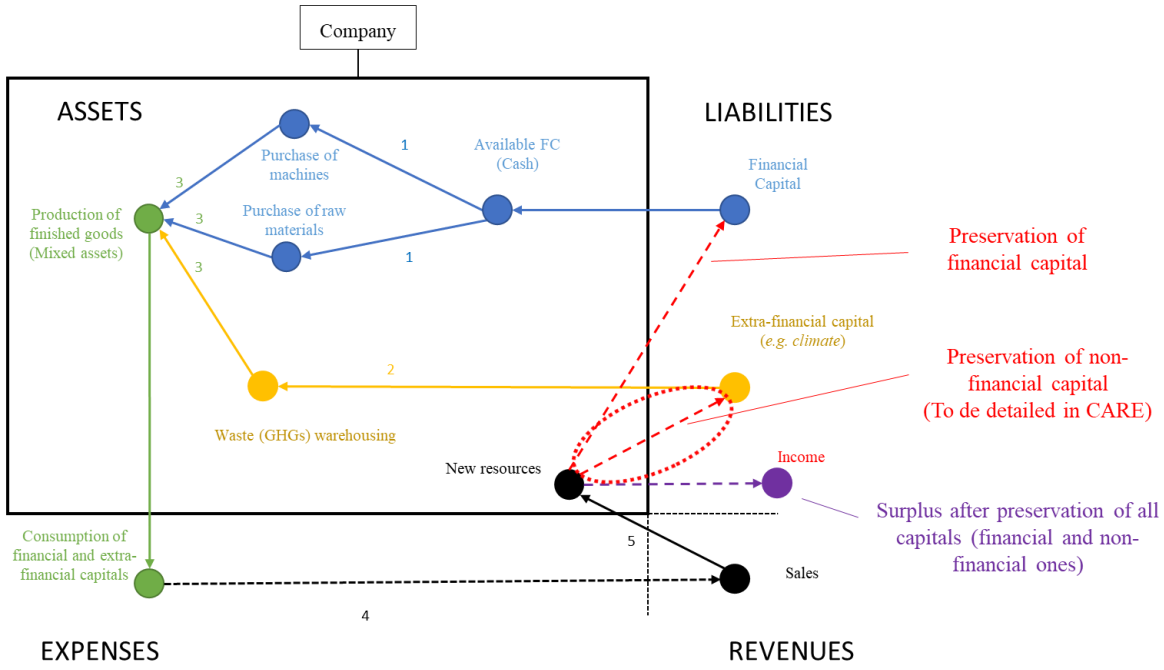

Fig. 3
Extension of Model 1 to non-financial capitals (as liabilities):
precise monitoring of several capitals (financial and non-financial) through their uses and consumptions

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[34]. The balance sheet and the income statement according to CARE for this example are given in Annex B.

Operations	Fictive Dates (dd/mm/y)	Descriptions of events[35]
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[36]' (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[37]. 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[38]. 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[39], 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[40] 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[41].

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)[42]. 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)[43].

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)[44]

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[45]), 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)[46].

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 B.

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 B, 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:

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

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 and in particular climate change, 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[47] – 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

Integrated statements according to CARE (Simplified presentation)[48]

- 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

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[1] https://www.publicbooks.org/financial-markets-were-not-designed-to-manage-the-planet/

[2] In this paper, we will focus on natural issues – and in particular, on climate change issues –, but the CARE model addresses social issues as well (Rambaud & Richard, 2017).

[3] which connects financial and extra-financial data

[4] Typically, the rise of low-carbon stock indexes *inter alia* aims the inclusion or exclusion of specific stocks in virtuous indexes, which has no direct impact on the capital of the underlying firms themselves.

[5] … and individual consumers, but this not our perspective in the paper.

[6] Fig. 1 is based on a permanent inventory and so, a classification of expenses by function.

[7] Indirect contributions correspond for instance to debts to suppliers: in that case, suppliers implicitly provide money, which is directly used to purchase their goods.

[8] 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).

[9] 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).

[10] Interestingly enough, "*Linsmeier […] FASB [Financial Accounting Standards Board] Board member, suggested that the impetus for the revolution [the shift from HCA to FVA] occurred in the 1970s when the demand for financial derivatives grew as a result of increased risk from foreign currency transactions and increased volatility in oil prices. He argues that the increased use of financial instruments resulted in a schism in what is reported under the industrial paradigm and what information is needed in the new economy*" (Shortridge & Smith, 2009).

[11] This is consistent with the aforementioned transformation of CFO from a buyer (Model 1) to a supplier (Model 2) (Vernimmen et al., 2006).

[12] 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 the introductory report to the European Union action plan on sustainable finance (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.

[13] AMF (Autorité des Marchés Financiers, French market authority) states (our translation): "*The commission [Climate and Sustainable Finance] will also provide a forum for discussion and work with the objective of participating in the effective mobilization of the financial sector in the face of climate risk and helping to make sustainable finance a practice having a significant impact on the allocation process of capital towards a sustainable economy*" (AMF, 2019).

[14] An advantage or disadvantage between economic (human) agents (Homo Oeconomicus (Nadeau, 2003)) caused by the degradation of environment, because of a particular economic activity, and that is not reflected in that activity's market value (Perman, Ma, McGilray, & Common, 2003). Along this line, following Stern, climate change is "*the greatest market failure ever seen*" (Stern, 2007).

[15] This management is "*[…] like managing a bank account, or several bank accounts […] Keep the capital intact and live off the interest. From this perspective, capital and interest include all other species that also live on earth to which we have no obligations or responsibilities*" (Victor, 2007).

[16] For the IIRC, natural capital is a "*[…] stock of value […]*" (IIRC Council, 2013) for investors (Barker & Kasim, 2016).

[17] The AMF, for instance, in order to clarify this position, considers that a large company, "*when assessing which information should be disclosed in the non-financial statement […should] consider whether the information is material from both the following perspectives:*

- *the perspective of financial materiality […which] aims at reflecting most important non-financial factors for the company's ability to remain solvent and profitable as well as create in the short, medium and long term […;]*

- *the perspective of environmental and social materiality […which] aims to report on the external impact of the company on the preservation of its eco-socio-system, beyond any consideration relating to the impact on its activity […in order to be] legitimately accountable for [its] impact on […] intrinsic value of nature*" (AMF, 2020).

[18] 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).

[19] 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).

[20] we give an example of integrated statements according to CARE in annex B.

[21] 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'.

[22] 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.

[23] In the case of financial capital, this concern is the one of the capital provider.

[24] In the case of financial capital, this ontology is simply the monetary value of capital.

[25] In the case of financial capital, this process is simply to keep money in order to be able to refund capital.

[26] The imperative to preserve a stable climate and broader environmental protection is now even included in some constitutions and fundamental laws (Mega, 2019).

[27] Current level of global warming already exceeds +1°C

[28] Climate science usually distinguishes an earlier net-zero level for CO_2, and a later one for GHG altogether.

[29] Or GHG budget, if the GHG considered are not limited to CO_2.

[30] 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

[31] 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.

[32] https://sciencebasedtargets.org/

[33] While being an interesting approach to define a clear and practical allocation, 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.

[34] 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).

[35] 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.

[36] The same term (GHG warehousing) is used to simplify the recordings here.
[37] 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.
[38] 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*.
[39] 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.
[40] 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).
[41] 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).
[42] This report calls for making a strict distinction between emission reductions and negative emissions (our translation) – "*Distinguer rigoureusement réductions d'émissionset 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).
[43] "*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).
[44] That is the value of all liabilities.
[45] It is thus possible to refine this ratio by replacing financial capital with capital employed, as in the case of ROCE.
[46] https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_NOM_DTL&StrNom=CEPA_2000&StrLanguageCode=EN&IntPcKey=&StrLayoutCode=HIERARCHIC
[47] Regulation 2020/852 of 18 June 2020 (*cf.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0852&from=EN)
[48] Adapted from (Rambaud & Feger, 2020).