MARCH 2023
No. 273

Author
Alexandre Rambaud
Coordination
Antoine Godin (AFD)
Annabelle Moreau Santos (AFD)

Research papers

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How can accounting reformulate the debate on natural capital and help implement its ecological approach?

Paper issued from the International Research Conference: **"Strong Sustainability: How sustainable are Net Zero trajectories?"**

AUTHOR

Alexandre Rambaud
PhD in Mathematics and Management Sciences, Senior Lecturer at AgroParisTech-CIRED.

COORDINATION

Antoine Godin (AFD)

Annabelle Moreau Santos (AFD)

Abstract
This paper shows that the mainstream usage of 'natural capital' (NC) is incompatible with an ecological approach. It argues that accounting is relevant for (re)structuring the debate around NC and implementing an alternative approach to NC that works with an ecological perspective.It first performs a 'Latourian' anthropological analysis of the mainstream notion of capital, resituated in the Modern cosmology, as well as the notion of 'ecology'. It goes on to propose an 'accounting' study of capital with the objective of suggesting an alternative vision of NC and underlines its potential. The study shows that the mainstream use of NC is incompatible with an ecological approach, even in the case of strong sustainability. Mainstream NC is associated with 'capital as a debit concept', but a credit-based approach to NC would align it better with an ecological perspective. The paper renews the critical analysis of NC and of strong/weak sustainability. It opens a potential path of research in ecological accounting based on an alternative perspective on NC. It proposes an extension of the 'classical' accounting practices in historical costs to a more ecological vision of NC, linking accounting practices understood by current corporate stakeholders to ecological requirements.
It also proposes to reorient NC to align it with ecological requirements. Therefore, this study resituates NC in a cosmological perspective and mobilises accounting theory to propose a fresh approach to the concept.

Keywords
Natural capital, Ecology, Modernity, Capitalism, Debit/Credit, Assets/Debts, Strong/Weak sustainability

Acknowledgements
The author would like to thank the Ecological Accounting Chair and the AFD.

JEL codes
Q57, Q56, M4, Q54

Original version
English

Accepted
February 2023

This paper was selected following a competitive screening process and was presented at the AFD research international research conference on strong sustainability held on December 2022.

Résumé
Cet article montre que l'usage courant du "capital naturel" (CN) est incompatible avec une approche écologique. Il soutient que la comptabilité est pertinente pour (re)structurer le débat autour du CN et mettre en œuvre une approche alternative du CN qui fonctionne dans une perspective écologique. Il effectue d'abord une analyse anthropologique "latourienne" de la notion dominante de capital, resituée dans la cosmologie moderne, ainsi que de la notion d'"écologie". Elle propose ensuite une étude "comptable" du capital dans le but de suggérer une vision alternative du CN et souligne son potentiel. L'étude montre que l'utilisation courante du CN est incompatible avec une approche écologique, même dans le cas de la soutenabilité forte. Le courant dominant du CN est associé au "capital en tant que notion liée au débit", alors qu'une approche du CN basée sur le crédit l'alignerait mieux sur une perspective écologique. Cet article renouvelle l'analyse critique du CN et de la soutenabilité forte/faible. Il ouvre une voie potentielle de recherche en comptabilité écologique basée sur une perspective alternative du CN.
Il propose une extension des pratiques comptables "classiques" en matière de coûts historiques à une vision plus écologique du CN, en reliant les pratiques comptables comprises par les parties prenantes actuelles des entreprises aux exigences écologiques.
Elle propose également de réorienter le CN pour l'aligner sur les exigences écologiques. Par conséquent, cette étude resitue le CN dans une perspective cosmologique et mobilise la théorie comptable pour proposer une nouvelle approche du concept.

Mots-clés
Capital naturel, Écologie, Modernité, Capitalisme, Débit/Crédit, Actifs/Dettes, Soutenabilité forte/Faible

Remerciements
L'auteur tient à remercier la Chaire de comptabilité écologique et l'AFD.

Codes JEL
Q57, Q56, M4, Q54

Version originale
Anglais

Accepté
Février 2023

Ce papier a été retenu suite à un processus de sélection compétitif et présenté à la conférence internationale de recherche de l'AFD sur la soutenabilité forte qui s'est tenue en décembre 2022.

Introduction

The notion of capital and the debates about its maintenance have currently become the standard basis to grasp sustainability. Indeed, at the end of the 1980s, this concept was interpreted in terms of natural capital maintenance, thanks in particular to the work of Pearce (1988; Pearce et al., 1989). From this perspective, which we can call the 'capital approach' (Ruta and Hamilton, 2007), '*sustainability requires at least a constant stock of natural capital [...]*' (Pearce, 1988), wherein natural capital is defined as '*a stock of natural assets serving economic functions*' (Pearce, 1988). Therefore, '*[...] the natural environment can be considered as a formof capital asset [...]*' (Barbier, 2014). Gray (1992, 1994) and Rubenstein (1992) then adapted the economic and macro interpretation of sustainability in terms of natural capital maintenance to organisations, thereby making a 'natural capital approach' the basis of sustainable corporate (financial) accounting. This perspective was then enlarged by the addition of other types of capital to be maintained and managed in a manner similar to that in which human and social capital are maintained and managed (Costanza et al., 2013).

The 'capital approach' is becoming increasingly common in accounting (Barker, 2019; Coulson et al., 2015; Mace, 2019) to address environmental and broader societal issues, as evidenced byinitiatives on reporting systems, such as the Integrated Reporting <IR> (International Inte-grated Reporting Council, 2013) of companies (Richens, 2015) or of international programs, such as the Natural Capital Coalition (2016), which is hosted by the Institute of Chartered Accountantsin England and Wales (ICAEW) and initiated the report *Improving nature's visibility in financial accounting* (Rambaud and Feger, 2020). This perspective allows economics, finance, and accounting to tackle (corporate) sustainability in a quite natural way; this is because these disciplines are structured around the concept of capital (from a financial viewpoint). If sustainability is seen as requiring financial and extra-financial capital management and maintenance, the extension of standard economic and accounting theories and instruments to non-financial types of capital can achieve sustainability at the social- and business-level. In this way of thinking, the manner in which we conceptualise financial capital, as well as related concepts, such as income (Hicks, 1946), is extended to extra-financial types of capital (Gray, 1992), and the manner in which these new types of capital are managed and maintained becomes the central issue whenever sustainability is of concern.

However, this perspective has been strongly criticised (Barter, 2015; Sullivan and Hannis, 2017; Victor, 2007) from the outset (Cooper, 1992; Stern, 1997). Indeed, '*there is fear [...] that people and nature become captured by economic hegemony and their intrinsic value and senseof morality is lost, often unconsciously, through symbolic violence*' (Coulson et al., 2015). Therefore, managing nature, conceptualised as natural capital, can be viewed as being '*[...] 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).

In this study, we extend this critical analysis, but from a novel angle: beyond an economic or sociological analysis, we propose, first of all, to show how the standard natural capital approach(commonly used today in economics and accounting) is, in essence, incompatible with an 'ecological approach', which we define later. Based on this analytical grid, we highlight the role of accounting in tackling this problem, reformulating it, and proposing an alternative vision of 'natural capital' that is closer to an ecological approach. More precisely, we do not challenge the 'capital approach' *per se* – particularly in accounting – that constitutes a very interesting perspective for grasping sustainability issues; however, we assert that a careful analysis of the different *performative* (Callon, 2007) concepts of 'capital' and the corresponding meanings of 'natural capital' possible is necessary (Feger et al., 2019). We argue that accounting is relevantfor this task.

Thus, in the first part, we provide a critical analysis of the standard definition of 'natural capital' through a study of the mainstream notion of capital (what we call more precisely the *capitalist*approach), resituated in its imaginary (Castoriadis, 1998) – its cosmology.

As an outcome, we provide another perspective on weak and strong sustainability (Neumayer, 2010). Moreover, we claim that this prevailing conceptualisation of natural capital is opposed to what we call an'ecological perspective'. In the second part, we use the language of accounting (and notably that of the double entry bookkeeping [DEB] principle) to reformulate the debate on capital in general, and on natural capital in particular, and we explain the fundamental difference between a capitalist and a 'classical' accounting conception of capital, with particular thanks to a historical perspective. As a consequence, we finally propose another path for conceptualising natural capital, based on these 'classical' accounting logics, and we argue that there exists a convergence between the capital approach of sustainability based on these logics and what we call an ecological perspective.

I. Capital, Capitalism, and Modernity

What is capital? Our purpose here is not to study in detail the ontology of capital, but to understand precisely what is hidden behind this central concept. In fact, it is not possible to understand this notion without analysing the concept of Modernity. Indeed, the current socioeconomic meaning of capital – the one at the heart of capitalism, in particular, and of the economic theories that dominate contemporary discourse – appeared at the beginning of the Modern period (14th–15th century) (Nitzan and Bichler, 2009; Wood, 2002). Moreover, particularly since Weber (2012), Capitalism and Modernity are clearly interrelated in one wayor another (Castoriadis, 1976; Goody, 2004; Gray, 2010; Nitzan and Bichler, 2009). If we wantto understand the concept of capital and natural capital, we need therefore to look at the questionof Modernity and its implications.

Modernity is not only a specific period, but is, in particular, an attitude (Foucault and Dekens, 2004), a cosmology (Latour, 2012a), and an imaginary (Castoriadis, 1998) that corresponds to the one prevailing in contemporary western societies (and, increasingly, in other countries). One of the most accomplished presentations and systematic analyses of this 'attitude', from an anthropological, philosophical, and sociological perspective, can be found in the work of Latour (2009, 2010, 2012a). According to him, the Modern attitude can be summed up through two processes: the work of purification and that of mediation (translation). Purification is related to the Modern dualism between Subject/Culture (along with its associated concepts) and Object/Nature (along with its associated concepts) (Castoriadis, 1998; Descola, 2013; Everett, 2004; Gallhofer, 2018; Gladwin et al., 1995), whereas mediation corresponds, roughly speaking, to the creation of mixtures (hybrids) of human and non-human entities.

More precisely, with Modernity, two levels of 'reality' appear: the real reality and the 'purified' one. The first type of reality (the 'real reality') is never outside of an ideal inside – a 'brain-in- a-vat' (Latour, 1999a) – that dominates or is dominated by this reality; this reality is neither subjective nor objective; rather, it is fundamentally a full-life experiment (Debaise, 2007), a source of surprises, and always involves a coexistence with a multitude of other entities – human or not – in a common world (Latour, 2009). This reality is a process permanently renewed by all these entities whose actions and experiments, by definition, constitute reality. In this reality, everything is a network of human and non-human entities interacting, associating, allying, and transforming each other through chains of translations and mediations. 'Translations' refer to the work by which humans and non-humans, in their actions, reactions, and behaviours in certain circumstances, modify, displace, and reflect their varied and conflicting interests (Latour, 1999a); 'mediations', by their opposition to 'intermediaries', refer to humans or non-humans (living or not) that cannot be defined with precision by their inputs and outputs (Latour, 1999a). The basis of reality is, therefore, a relational ontology (Sidorkin, 2002; Wildman, 2010), where the existence of things is defined by their relations with the other entities.

The second type of reality is an idealised one, a theoretical one (and, so, a purified one) made by and for humans. In this reality, everything is reinterpreted in terms of objectivity and subjectivity (Latour, 2014): the Modern attitude defines two ontological areas (the first one is of the Subjects and the other

is of the Objects) that are representable as a set of particular idealattributes. The area of the Subject is, by definition, the domain of the Source of the action, where 'I', the Actor, Create, thanks to my infinite Will and Freedom, this action; the area of theObject is marked by the exact opposite of this ; it is where we find the Purpose of the action, the mere Means subjected to this action. The area of the Subject corresponds to the idealised attributes of what should constitute the essence of humanity (Freedom, Ends-in-themselves, Creativity, Power, Mastery, etc.); at the exact opposite, the area of the Object represents the setof all the attributes that constitute what is not this idealised humanity (Predictability, Means, Submission, etc.). Modernity reshapes our *real* reality, based on uncertainties, surprises, non-differentiation between human and non-human entities, to obtain another purified reality, whereit is possible to perfectly delimitate what can be attributed to the area of Subjects or Objects. Moreover, all these attributes are radical and absolute ones (Latour, 2010)[1]: this means, for instance, that Subjects are supposed to be totally Free and have a perfect Power over Objects, which are mere Means and totally Predictable. Therefore, from an ontological point of view, Objects are simple Forms that are possible to Faithfully Represent through Intermediaries, which can take the form of sets of indicators, variables, and/or types of inscriptions (Latour, 1985). The sole function of Intermediaries is to transmit information in a supposedly perfect manner, and not to present the Objects themselves, but simply to replace them in – and finally to make them forget about – their management. Further, because these Objects are Means for Subjects, they are not only Faithfully Representable, but also thought of as Controllable and Predictable.

In this condition, the purification is a process that splits the *real* reality into two parts – the Objective and Subjective – and then recomposes a (fictive) Reality with this binary grammar (Proctor, 2009). This means that the Modern attitude is a way to redefine reality in mere humanterms and, so, decompose real issues, into, on the one hand, Technical and Predictable ones, and, one the other hand, Ethical and Subjective ones (further, these two types of issues are disconnected). In this work of purification (and re-composition), the 'hybrids', or the mixturesof human and non-human entities, which constitute the real world, are simply unthinkable andignored. Where there is a complex network of different types of entities that are themselves interwoven into complex interrelations, and where there is a multitude of different modes of existence (Latour, 2012b), Modernity only sees Objective and Subjective events, or Objective and Subjective issues. However, at the same time, this re-composition of our common reality allows an increase in mediations (hybridisations), without having to directly think about them and their consequences directly: as Objects are mere Means; it is possible to use them without any restrictions, except technical; because Subjects are totally Free, the fundamental question of responsibility becomes a problem of delimitation of Rights and Duties between Subjects, that is, a problem of delimitation of inter-Subjective Powers. Therefore, '*the moderns have thus,on one hand, produced self-confident spokespersons for nature who freely experiment in their laboratories without regard to given social orders ; and on the other hand, a society unafraid to accommodate new techno-scientific constructions because it is fully convinced that it shapesits own destiny*' (Blok and Jensen, 2011).

We highlight the fact that the Modern attitude is not similar to the Liberal or Capitalist one; Marxist theory, for instance, is also a Modern political theory (Castoriadis, 1998; Latour, 2012a).[2] In fact, the binary grammar of Modernity can be used in a lot of ways to recompose reality in a given way and provide particular lines of arguments.[3] Therefore, Modernity itself does not impose a choice regarding what must be considered as Objective and what should be Subjectified: '*the choice that the Moderns*

are proposing is thus not between realism and constructivism [which is a secondary choice], but between that choice itself and a practical existence [real reality] that grasps neither the terms of that choice nor its importance' (Latour, 2010).

Given these conditions, we argue, in line with a kind of 'Weberian' tradition (Weber, 2012), that Capitalism does correspond to a specific set of choices in the Modern binary grammar. As explained by Castoriadis,[4] who extended a part of the Weberian analysis (Castoriadis, 1988), Capitalism is an institution of society whose central imaginary and cosmological signification is the unlimited expansion of rational mastery (Castoriadis, 2013)[5]. If we use the terminology introduced here, Capitalism becomes a Modern system of choices to purify and recompose reality, in such a way that Objectification (related to Modern Rationality and Mastery) is always chosen, as soon as Subjects (*certain* humans) are clearly identified. This means that our common world must be purified in such a way that reality becomes as Predictable, Controllable, and Determinable as possible, in order to guarantee the increase of the Power and the Goals ofgiven Subjects.

In these conditions, it is now possible to understand what 'Capital' fundamentally is; as explained by Nitzan and Bichler (2009), whose work is partially based their on that of Castoriadis, Capital *is* Power. It means, in particular, that Capital is not something that generatesPower or is in conflict with Political Power. Capital is the symbolic representation of Power, but not just any power; it represents the Modern Power of the Subject. Therefore, we can assertthat Capital is the imprint of the area of the Subject: Subjects are, by definition, those who have the Capital and Capital defines who is a Subject in Capitalism. Maintaining Capital, as a consequence, does not mean maintaining biophysical things, for instance, but only maintainingPower, that is, the expansion of the Goals of Subjects in the future.

Thus, on the one hand, Capital defines Subjects and the relative measure of Capital allows the determination of *inter-Subjective* delimitations (Nitzan and Bichler, 2009); on the other hand, Subjects can use Objects[6]–mere Means – to increase their Goals, their Power, and, so, their Capital. The Reality of Capitalism relies on: struggles between Subjects whose stake is the levelof Capital (Power); conflicts to access this Power (which is the means to become a Subject); and unlimited Objectification of all the parts of our reality that are not associated with Subjectsto obtain unlimited sources of Power.

Therefore, the next question is: how can one operationalise this concept of Capital? This meanshow can one: measure Capital, and know precisely what can increase (or decrease) it? Hicks argues that there are two fundamental conceptions of Capital: the materialist one and the fundistone (Hicks, 1974).

1.1 Materialist and Fundist Capital

In fact, Modernity, because of its binary grammar, offers two possible ways to basically understand what a 'thing' is: it is defined either by its components (Causes), from the Inside (this is the Nominalist perspective), or by its Consequences, from the Outside (this is the Realistperspective). Therefore, Capital can be either understood through the Objects that allow the development of the Power of the Subjects, or through the consequences of the exercise of this Power. In our view, the first orientation is what Hicks (1974) calls the *materialist* conception of Capital, whereas the second perspective is what this author calls the *fundist* approach.

The notion of 'Objects', which support Capital, is operationalised, for its part, in the socioeconomic fields through the concept of (tangible or intangible) 'Assets': in materialism and fundism, as well in major Modern economic theories, Capital is defined through assets (Rambaud and Richard, 2015), that is, material or non-material 'things' whose (Predictable) Control/Mastery allows Benefits/Services for human beings (Subjects).

More precisely, from a materialist viewpoint, Capital is represented by a stock of countable Objects/Assets – '*[…] "things" of limited life which are periodically worn out or used up andreproduced […]*' (Knight, 1935); these are valued at their market value (at their '*entry value*' (Lee, 1975)).[7] This stock has no time dimension and does not depend on the structure of production; therefore, the state of this stock at a given time is the only relevant information necessary to manage it and to predict future incomes (a given state of the stock will always generate the same flow of income). These productive assets generate a profit *via* a production function.

From a fundist perspective, Capital is represented by a fund, which can regenerate itself (Pekkarinen, 1979): it is, for instance, money that generates money. A fund is dependent on time, techniques, and modes of production: funds provide services in a specific manner, and ata specific rate that is characteristic of the fund. The Objects used are simple supports for the generation of a stream of incomes. More precisely, '*the so-called "fund" of capital is not [really] a fund but an expectation, and the real thing [the Objects]that determines value is nota "fund" of capital predetermined, but an expectation of future bargaining power which determines it*' (Commons, 1924). Thus, a fund is evaluated at the discounted value of the futureservices/cash flows it generates.

These two broad distinctions make it possible to grasp the major Modern economic theories (Hicks, 1974; Knight, 1935) that all fall within one of these two orientations, refining them where necessary, or intersecting them (Kirzner, 1976).

So, to be clear, Capital is Power, and this Power can be analysed from a materialist or fundist perspective. Now, as explained, for instance, in (Nitzan and Bichler, 2009), the fundist approach corresponds to the very spirit of Capitalism. Indeed, the materialist viewpoint is not flexible enough to understand all the possibilities of Capitalism: materialism was developed by the first neoclassical economists (Hicks, 1974) at the time of the Industrial Revolutions; thus, the assimilation of the Power of Subjects on the basis of an industrial material was quite natural. Nevertheless, fundism, initially inaugurated by the Italian merchants during the 14th century (Nitzan and Bichler, 2009) and really

developed by Fisher (1906) at the beginning of the 20th century (Chambers, 1971), allows all the facets of our world to be subject to Quantification andautomatic comparability.

1.2 Capital and Nature

1.2.1. Capitalist 'Natural Capital'

What are the implications of this approach of Capital for sustainability? From a general viewpoint, it means that the 'extension' of the notion of Capital to 'natural capital' in its mainstream meaning – is certainly not related to the consideration of some natural entities 'in themselves', in their integrity and their complex networks of interactions. The emergence of the concept of Natural Capital is only the recognition that the Subject's Power can be increased or maintained thanks to non-human (Controllable) Objects (Assets), that Nature – this Modernfiction created to separate Subjects from Objects – is a 'real' source of Power *per se* and is Predictable and Objectively Representable: mainstream 'natural capital' is in fact (Natural) Capital, that is, only the 'Natural' part of the Capital-as-Power.

The concept of natural capital appeared in economics at the beginning of the 20th century (Hodgson, 2014; Missemer, 2018). Nevertheless, the original neoclassical assumptions about natural resources, especially their abundance and their increased yields due to Technical Progress make '*[…] natural resources no longer appear as an input in the aggregate production function because marginal land as representative of natural resources does not have any price*' (Farmer and Bednar-Friedl, 2010). Consequently, the issue of natural resources was almost completely neglected by most orthodox economists for much of the 20th century (Farmer and Bednar-Friedl, 2010; Stern, 1997). It was not until the emergence of environmentalawareness in the 1960s and 1970s and of Sustainable Development in the 1980s that this issuereturned to the economy. Now, as explained by Missemer, in all these economic approaches, '*[…] the natural capital concept is [always] a way of encapsulating natural items in a stock ofwealth managed by human beings. And […] "natural capital" include[s] the idea of somethinghaving a productive nature*' (Missemer, 2018). (Natural) Capital is therefore the recognition ofthe potential of natural Objects to develop this Power by their Mastery: the avatars that this notion has assumed during the 20th century are only a reflection of the evolution of Modern economic thinking on the capacity of Natural Objects to be a genuine source of Power. Therefore, Norton claims that the notion of 'natural capital' used by most of today's economistsis 'welfare-based': '*[from an] Economistic position […] all environmental values are ultimately related to impacts on the welfare of individuals and aggregations thereof*' (Norton, 2005). Additionally, welfare is a mere translation of the attributes of the Subject: (Modern) welfare is therefore directly linked to the Power and Goals of Subjects.

Hence, from this perspective, the taking into account of non-human entities is purely at the margin and remains based on the Modern assumptions about their (purified) ontology; we can adapt the remark of Latour concerning the sociology of scientific knowledge in our context: '*ifyou make a list of all the roles that things [non-human entities] […] play in [standard NaturalCapital]'s narratives, you will be struck by the fact that they don't do very much. […] They arelike hosts at a party where all the food has been brought by the [Subjects…] to stand up as tokens, but they are not there to eat and certainly not to bring their own doggy bags*' (Latour, 1999b). In fact, real non-human entities are only mere traces or

ghosts in the theory of (Natural)Capital. Further, we can extend the quotation of Latour, by saying that, from the 1970s, non- human entities have been progressively recognised as having some ticket to this '*party*' wherethe Subjects want to go: thus, the stake has become to get these ticket but, of course, without fully accepting these entities at the party. Finally, what is clear is that (Natural) Capital is not a transformation of the notion of Capital, but only the adaption of the concept of Capital to integrate Natural Objects. Instead of creating a new tool for tackling new issues related to non-human entities, (Natural) Capital is based on the concept of Capital that is at the heart of Capitalism: the only difference is the source of the Power. This is precisely why we can talk about a Natural Capitalism (Hawken et al., 2010), which is another phase in the development of Capitalism: the first prevailing sources of Power were merchandise and agriculture, followedby industry and finance; now, we have Nature itself as a source.

However, it is possible to claim that what we are talking about is only a 'weak sustainability' (Neumayer, 2010). We argue that this is not the case, and that the standard understanding of weak, strong, and even very strong sustainability (Turner, 1999) are also based on thisperspective of (Natural) Capital. This is why Norton explains that '*all Economists […] are weak-sustainability theorists*' (Norton, 2005).

The weak *versus* strong sustainability debate corresponds to the instances of allowance, or not,of a substitutability between natural capital and human-made capital. This definition can be interpreted in several ways but, in its mainstream use, it must be understood as follows: '*the stock of capital may be interpreted as the combined total stock of man-made capital assets andenvironmental assets (soil, minerals, biomass, etc.) [corresponding to weak sustainability], or,more narrowly, as the stock of environmental assets only ("natural capital") [corresponding to strong sustainability…] The narrow definition of the resource base in terms of environmentalassets only, does not dispute the importance of man-made capital in the sustainable development process, but emphasizes the* non-substitutability *of many natural-resource functions by man-made capital*' (Barbier et al., 1990). Thus, in relation to our analysis, this debate corresponds, in its mainstream use, to the recognition, or not, of substitutability between,on the one hand, (Natural) Capital, that is, Natural Objects/Assets, supports of Capital, and Human-Made Capital, that is, Human-Made Objects/Assets, classical supports of Capital, suchas machines. In fact, the Hicksian analysis of Capital (between materialism and fundism) makesit possible to understand the premises of weak and strong sustainability (Kyriakou, 2006; El Serafy, 2013).

1.2.2. Weak versus strong sustainability: relations to Fundism and Materialism

The situation is quite clear: we have *one and only one* Capital-as-Power/Welfare that we have to, at least, maintain, but we have new sources for its development. Therefore, on the one hand, from a *materialist* perspective, Capital is represented as a set of different countable Objects/Assets that constitutes the basis of this Power. The recognition of (Natural) Capital implies the *systematic* integration of Natural Objects in this set. Therefore, the materialist approach entails that Capital is interpreted as the aggregation of Natural Objects,which represent the Natural source of Capital, and of other types of Objects, such as Human- Made Objects, which generate Welfare, Utility, and, more generally, Power. On the other hand,the *fundist* approach of Capital represents it as a stream of future receipts (Hicks, 1946) or services (Fisher, 1906), rather than being based on an enumeration of Objects: the aim is not toestablish a list of all the Objects that support the Subjects' Power, but to assess directly the level of services generated by the utilisation of different types of Objects. Therefore, the fundist

perspective on (Natural) Capital considers that future receipts or services are partially provided by some Natural Objects, but it is neither relevant nor possible to determine the contribution ofa particular natural Object. What is important here is to consider that Power comes from particular combinations of different types of Objects, and that the presence of natural Objects in these combinations is of growing relevance and importance; further, it constitutes even a '*material issue*' (KPMG et al., 2012).

Therefore, fundism leads directly to very weak sustainability. In fact, from this point of view, which is defended, for instance, in El Serafy (1991, 2013), the substitutability between NaturalObjects or Human-Made Objects is not a key question. Substitutability is a fundamental presupposition that is already included in the conceptualisation of the Modern Power of Subjects: every Object in this world can be used in one way or another, and the only thing thatis relevant is the level of Welfare or Power generated. The combination of different types of Objects is seen as being analogous to a black box: only the outputs are important.

Now, from a materialist viewpoint, maintaining Capital means maintaining the ability of the countable stock of Objects/Assets, which represents Capital, to generate Power/Welfare; thus it means maintaining the aggregation of the Willingness To Pay/Willingness To Accept of consumers of each element of this stock: in the case of Natural Objects, these values correspondto the market and non-market values (Milne, 1991) that make up the Total Economic Value (Pearce et al., 1989). If we do not suppose anything else, this maintenance corresponds to a weak sustainability approach: substitutability is allowed between these Objects. However, we claim that strong sustainability is also based on the same premises, along with the addition of particular suppositions – *not about the natural Objects themselves, but about the Subjects*.

Indeed, when Daly and Farley (2004), as well as Pearce (1988), explain, for instance, that it is necessary to maintain natural capital *itself*, it is absolutely not for reasons related to the non- human entities themselves, but because of the suppositions about the structure of the productionand utility functions of consumers (Daly and Farley, 2004). Here, what is central is the problemof maintenance of production or of the consumers' level of satisfaction. The (Natural and Human-Made) Objects/Assets that compose Capital and are the variables of utility or the production function (Perman et al., 2003) are *supposed* to be complementary and not substitutable; thus, *because of* the concerns of the Subjects, we have to maintain the Natural part of Capital, that is, (Natural) Capital *itself*. The maintenance of (materialist) (Natural) Capital does not consider non-human entities; it is directly based on the same perspective on Natural Objects as the one in the fundist or weak sustainability approaches, and, more generally,on the Capitalist perspective. The only difference is the addition of the hypothesis *on the Subjects* themselves – the idea that their Power/Welfare cannot be achieved through a substitution between the Natural and Man-Made Objects/Assets within Capital. The maintenance of a critical natural capital (Turner, 1999) rests also, in general, on this perspective.What is always important is the maintenance of Power and the Welfare of Subjects; whereas Objects are supposed to be Predictable and Faithfully Representable: Objects are at worst just unavoidable constraints, or at best good opportunities to achieve this goal.

However, it would be possible to argue, for instance, that the maintenance of Objects, from a (materialist) strong sustainability perspective, can achieve, at least, a good level of sustainability and is in line with the 'ecologist demands'. According to us, this is not the case. It is also why we need to define what is an 'ecological approach'.

1.3 Ecological Perspective versus Capitalist Perspective

Ecology, understood as a science, is the global science of the relations of organisms with their surrounding external world, and which can broadly be said to include all conditions of existence(Dajoz, 2006). From this perspective, and in line with the differences between the 'real' and the'ideal' Modern reality defined earlier, Latour gives a very clear definition of 'ecologising': '"*Ecologising" means creating the procedures that make it possible to follow a network of quasi-objects whose relations of subordinations remain uncertain and which thus require a newform of political activity adapted to following them*' (Latour, 1998).

Thus, the ecological approach focuses on what we called the 'real' reality – an interweaving ofnetworks of mediations and chains of translations. At the knotting points of these chains are the'quasi-objects', or hybrids, which in fact constitute the entities proper to our reality: each entityof this world, thus, appears as a knot of intrinsically and radically uncertain (Berkes et al., 2002)relations, where the 'human' and 'non-human' become entangled without any real possibility of dissociation. As noted earlier, the very existence of *real* entities is, thus, perceived as relational ontology. In such an ontology, relations become primary and condition what the entities are (to be understood, systematically, as hybrids). Indeed, from an ecological point of view, because of the focus on interactions, no presupposition can be made *a priori* about the value or importance of a particular entity in these interrelations: the whole question of ecologylies precisely in the analysis of these relations, where '*[…] we do not know for sure what is interconnected and woven together*' (Russell et al., 2017), to understand how entities live (together) and evolve. Additionally, this particular analysis of complex interrelations needs to develop new forms of collective political activity (Castree, 2003; Latour, 1998). Latour, therefore, proposes to extend the Kantian imperative to non-humans: human and non-human entities, all quasi-objects, *symmetrically*, should never be treated as simply means, but always,also, as ends (Latour, 2009). This does not mean that non-human entities are mere ends, and so,that we re-introduce the Modern dichotomy between Means/Objects and Ends/Subjects; it means that means and ends are permanently interwoven. Therefore, this perspective is directlyopposed to the one of Environmental Ethics, including deep ecology and ecocentrism (Gladwinet al., 1995; Samkin et al., 2014), which provides an interesting example of the use of Moderngrammar to protect some non-human entities, thanks to the notion of (Objective) Intrinsic Value(Norton, 1992) – a *Subjectification* of these non-human entities – to give them the status of Moral centres, that is, of Mere (Kantian) Ends (Norton, 1991).

Therefore, in ecology, a forest, biodiversity, climate, and so on should never be distant predictable '*matters of fact*' (Latour, 2009); rather, they should always be close '*matters of concern*' (Latour, 2009): tackling sustainability by using some other perspective is only discoursing on a virtual image of sustainability in an ideal and non-existent world. This perspective is close to Norton (2005)'s dichotomy between the 'stuff-based' approach and the 'welfare-based' one: 'stuffs' can be seen as quasi-objects, hybrid things, and above all, real matters of concern that we have to enumerate (Norton, 2005). It refers

to a focus on the 'stuffs'and their networks of relations that compose our common world. These 'stuffs', such as humans, forests, climate, and so on, are neither Objects nor Subjects; they are neither Controllable Means nor Free Ends-in-Themselves. Ecology is, therefore, based on symmetricalstuff, and is concerned with following them in their networks of interrelations: what is 'capital'or 'essential' from an ecological perspective is the attention paid to these human and non-human 'stuffs' and to the preservation of certain interrelations, which are the conditions of their existence.

It is now clear, by definition, that (Natural) Capital, whether operationalised through fundism or materialism, is always incompatible with ecology: while ecology lives in, and focuses on, the real and surprising/uncertain common world, (Natural) Capital is situated in an ideal (for humans), non-existent, and ghostly/dead world.

II. Accounting and Natural Capital

Given these conditions, what is the contribution of accounting in this debate on natural capital, if any (Hines, 1991)? According to us, accounting allows a simultaneous restructuring of this question and a relevant way to define a path towards an ecological 'natural capital' approach. Indeed, as claimed by de Roover, historically, '*accounting is largely a means of classifying entries into proper pigeonholes, which are called accounts*' (De Roover, 1938). Therefore, accounting has the ability to provide qualitative classifications of concepts, and in particular ofthe notion of capital: in this way, a central issue is to highlight which 'pigeonhole' can be used for the treatment of capital in accounting. Our purpose is to show that, under these conditions, capital can be a *debit* concept (referring to the asset side) or a *credit* concept (referring to the liability side) (Anthony, 1983; Nobes, 2015; Richard and Rambaud, 2022); further, 'capital as a debit concept' is directly connected (technically and conceptually) to the Capitalist approach of capital. As a consequence, 'capital as a credit concept' offers another perspective on this notion.

2.1. An accounting perspective on capital

To this end, it is necessary to note that the notion of 'capital' predates the Modern period. Etymologically, capital comes from the Latin expressions *capitalis pars debiti* (capital/principalpart of a debt) (Böhm-Bawerk, 1890) and *caput pecuniae* ('head'/principal part of the money lent) (Cange et al., 2020; Nobes, 2015; Sweeney, 1933; Tuttle, 1903). Capital, therefore, '*[…] was that part [of a loan] which it was of vital or 'capital' importance to preserve intact, as opposed to interest which might be spent with impunity*' (Tuttle, 1903). This concept was originally understood as being opposed to the notion of interest and, thus, the returns (in the form of profits) in relation to this loan, and without reference to any notion of productivity (Ege,2014; Hudson, 2002; Wood, 2002): capital is only an administrative/legal term associated witha debt. Hence, the term 'capital' comes from a nominalisation of the adjective 'capital', wherethe thing that is capital, or paramount – and we stress this essential point – is the money to be refunded, which is a debt. What is (essential) 'capital' is not the economic agents (lender and borrower) themselves, and even less the productivity of money, but the lent 'thing' itself, and, as a consequence, the possibility of preserving it.

This perspective can be found throughout Antiquity and the Middle Ages (Braudel, 1982; Hodgson, 2014; Wood, 2002). Nevertheless, at the end of Middle Ages, and the beginning of the Renaissance, which marks the beginning of the Modern period, the notion of capital underwent a fundamental change (Braudel, 1982; Fetter, 1937; Nitzan and Bichler, 2009; Wood, 2002); for cultural/cosmological reasons, which are connected to the emergence of the Modern mindset (Wood, 2002), it became synonymous with all things intrinsically productive in 'labour and industry' (Wood, 2002). Profit was, therefore, considered included in capital as an effect (profit) in its cause (capital) (Piron, 2004). This change inaugurated the use of 'capital'in the Capitalist sense, and, therefore, marked the beginning of the materialist and fundist perspectives.

These two conceptions of capital (the Modern one, where capital is synonymous with productive things, including productive money/funds, *versus* the *classical* one, where capital is only the capital/principal part of a monetary debt) have coexisted since the Renaissance in economics and accounting (Anthony, 1983). This profound difference in the notion of capital is difficult to grasp in economics, without falling into confusion about the term. As explained earlier, accounting – because of its qualitative classifications – now offers the advantage of being able to distinguish between these two conceptions. Moreover, with the emergence of DEBat the beginning of Modernity, there was an obligation to classify capital as a debit or a credit concept.

2.1.1. Capital as a debit concept

Capital as a debit concept refers to the connection of capital to (net) assets and is close to the concept of Equity (Poitras, 2016). This perspective can be found as early as Luca Pacioli's work(Nobes, 2015), which marked the beginning of a nascent Modernity. Capital, in this way, corresponds to the 'capital account', defined as a receptacle (Littleton, 1926) ('*[…] receptaculo[…]*' (Pacioli, 1523)) of the value generated by assets for owners/shareholders, after the deduction of liabilities (different from Equity). The 'capital account' is, therefore, *defined by* the assets and is dependent on them – it is dependent on the level of value that the assets can generate.

Capital as a debit concept refers also to a particular interpretation of DEB,[8] which is connectedto the Modern cosmology. DEB is *static* reporting, an inventory (Pacioli, 1523; Poitras, 2016) of assets and debts of owners; but at a deeper level, the foundation of this perspective on DEBwas explained in Domenico Manzoni's book on double entry bookkeeping *Quaderno doppio col suo giornale […]* that was first published in 1534 and followed Luca Pacioli's work: the 'ancestors' of the asset concept (that is debit balance sheet accounts) are directly associated with '*cose morte*' or dead things, whereas credit balance sheet accounts are associated with '*cose vive*' or living things and '*creatura animata*' or creatures with a soul (Manzoni, 1554). Itis, therefore, possible to highlight the link between a certain vision of the DEB and the Moderncosmological dualism (Cooper, 1992) that is based on an opposition between Object-Assets- Debits-Cose morte and Subjects-Liabilities/Capital-Credits-Cose vive. DEB, in this way, refersto an inventory of these Objects and Subjects, centred on the 'capital account', a mere receptacle of the value generated by assets/Objects for owners/shareholders, the central Subjects of business, after deduction of the debt toward other outside Subjects (other stakeholders). This 'capital account', which is the receptacle of (net) assets, can be, therefore, directly connected to the Capitalist Capital, where Assets/Objects are its supports. This approach is also related tothe *proprietary theory* and the '*Assets & Equity-Liabilities*' view on accounting – a relationshipanalysed elsewhere (Bird, 1981).

Moreover, this accounting perspective has also been structured around the materialism and fundism (Chambers, 1978) that was present in the work of Luca Pacioli in particular. Materialism, which formed the basis of the understanding of the stock market in the US until the 1930s (Burk, 1992), corresponds to the 'entry value' accounting systems (Lee, 1975) that were present, for instance, in US accounting systems at the end of the 19th century (Previts, 1975), whereas fundism, prevalent in the US stock market after the 1930s (Burk, 1992), refers to present value accounting systems, developed from the work of Alexander (1950) and Solomons (1961). This viewpoint is also, for instance, at the core of the IAS/IFRS (Rambaud and Richard, 2015; Richard, 2015).

2.1.2. Capital as a credit concept

Now, this interpretation of capital and DEB is not the only one and did not take holdimmediately. In fact, the historical accounting tradition is (naturally) aligned with the idea of capital in the pre-Modern sense (Rambaud and Richard, 2015; Richard and Rambaud, 2022), that is, that capital is the principal part of a monetary debt, and therefore a credit concept (Nobes, 2015), disconnected from any interest or link to intrinsic productivity.[9] This way of defining capital can be found, for instance, in the first known DEB system used by a Florentinebank in 1211, where the notion of capital (*kapitale*) was used to designate the monetary debts of this bank (Lee, 1972). From this viewpoint, capital is money that a firm *has to* refund and, thus, has to maintain (Rambaud and Richard, 2015). In these conditions, the fundamental mechanism of accounting is simple: some stakeholders bring money to a firm, directly (as in the case of banks) or indirectly (e.g. in the case of a debt to suppliers, they are to be consideredas bringing money that is immediately used to purchase the goods from them). Then, this firmmust recognise a liability towards them, so as to be able to refund them, thereby preserving thecapital brought in. In this condition, the 'capital account' is only the recognition of a debt to particular stakeholders, the owners/shareholders, '*for the purposes of book-keeping treatcapital [account] as a liability – treat it just as if it were a debt payable*' (Snailum, 1926). In line with our previous remark on what is 'capital' (essential) in this notion of capital, there is adifference between the debt content, money, and the reason for this debt: what is *capital* (essential) is money itself and its preservation, whereas the reasons for this importancecorrespond to the different accounts on the liability side (the representation of the different stakeholders who have to be repaid), including the 'capital account'. More clearly, although the same term is used, there is, in particular, a difference between capital, as the money to be repaid – the 'capital thing' – and the 'capital account' – the recognition that owners/shareholders brought this 'capital thing' and need to have some guarantee of its preservation at term. This conception of the 'capital account' is, therefore, directly opposed to that existing in the contextof capital as a debit concept.

At the same time, this capital is used by the firm to obtain and create resources (that is, assets)to achieve its goals (and, in particular, the creation of profit and different goods or services). Inclassical accounting, the recognition of the resources of the firm is based on the manner in which capital is currently used, and, thus, can be consumed in the future. Assets are costs, whichcorrespond to present and future consumptions of capital (Littleton, 1929). In these conditions,an asset is not directly a thing, even in the case of a tangible asset: a cost '*[…] is the cost of anaction and not the cost of a thing at all*' (Bedford, 2014). Thus, for instance, merchandise or a machine is not directly an asset: the actions of acquiring them are the corresponding assets (Bedford, 2014; Ijiri, 1967). The DEB is structured to record this type of operation (Ijiri, 1967):what is on the credit side of the balance sheet, capital, as the principal part of monetary debts – structured through representations of the stakeholders who need the guarantee of this preservation (liability side accounts) – must be strictly maintained to be refunded. In contrast, what is on the debit side corresponds to the different *uses* of capital (Ijiri, 1967). More generally, DEB, from this perspective, is structured on the idea that the credit side delivers value and the debit side receives this value in dynamic and '*unfolding processes*' (Skaggs, 2003), where '*[…]each flow comes from somewhere and goes somewhere*' (Bezemer, 2010). This vision can be found, for instance, as early as the 16th century in the accounting German authors with expressions '*[…] wer empfangen hat ist Schuldner […] wer aus gegeben hat ist Glaübiger […]*'(Gamersfelder, 1570) (the one who received is the

debtor, the one who gave is the creditor), and was also prevalent in German or French accounting (Fuzet and Deschamps, 1926). This approach is directly connected to the *entity theory* and the '*Revenue & Expense*' view of accounting, as can be seen in the analysis by (Bird, 1981).

Therefore, in classical accounting, capital is a *credit* concept, as recalled by Nobes (2015), thatis, capital is the principal part of a monetary debt, and DEB corresponds to a recognition of thedifferent dynamic flows of capital in business activities. This perspective is, in particular, at thecore of the 19th century German accounting (called *static* accounting and based on '*exit value*')(Richard, 2005) and the Historical Cost Accounting (HCA)[10].

In contrast to the conception of capital as a debit concept, capital as a credit concept is *independent* of the activity of a firm. More precisely, capital has an existence of its own that isnot conditioned by its use inside the firm: the nature of capital is externally defined. If an investor brings 1,000 units of money to a firm, the nature of the capital owned by her is clear: it is precisely these 1,000 units, irrespective of what happens during the use of this capital by the firm. Thus, this investor and the firm know precisely what must be maintained over time.

Further, in classical accounting,

- because capital has an existence of its own—independent of the way it is used—
- because its uses are recorded (as assets) and show the degradations of capital embeddedin them, and,
- because the consumption of capital, through its uses (assets), is also recorded (as expenses),

it is possible to periodically know the deterioration of the capital itself (and to distinguish it from some changes in the very nature of capital). Maintaining capital means, therefore, guaranteeing the integrity of capital, which implies the necessity of finding specific ways to counterbalance these degradations. Thus, revenue corresponds to 'fresh blood' that is able, in particular, to maintain capital: a part of the revenue must ensure this 'maintenance', that is, thepossibility of refunding capital at term. More precisely, because expenses correspond to consumption of capital, revenues must cover these expenses, and, as a consequence, must compensate for this consumption. Hence, the residue (revenues minus expenses), which is the income, is seen as a (financially) sustainable surplus after the capital maintenance guarantee.

Table 1, which is connected to the discussion in Part II, summarises these different perspectives.

Table 1. Capital(s) and accounting systems

	(Modern) Capitalist Capital		**'Capital' as the principal of a monetary debt (Classical financial accounting)**
	Materialist Perspective	**Fundist Perspective**	
	Capital as a *debit concept*		Capital as a *credit concept*
'Capital account' financial accounting	The 'capital (Equity) account' is a representation of Capital in its Capitalist sense. 'Capital account' is a *receptacle* of values generated by assets/Objects, for the central Subjects of business (owners/shareholders) after deduction of the debt owed to other Subjects (outside the business).		The 'capital account' is a liability account like any other. Recognition of the contribution in capital by owners/shareholders, and the need to guarantee its preservation for them.
Capital and balance sheet	Capital (Equity) is defined as net assets.		The liability side of the balance sheet structures the different capital contributions and, therefore, the different obligations to guarantee that capital will be preserved at term.
Capital	Capital is the representation of the Power of the central Subjects of business (owners/shareholders). Capital is dependent on the activity of the firm.		Capital has an existence of its own (as money), defined outside of the business. Capital is independent from the activity of the firm.
Evaluation of capital	Aggregation of the market (entry values) values of each asset.	Present value of the combination of the assets.	Nominal value of money brought to business and to be repaid.
Capital maintenance	Maintenance as asset management.		Preservation of the independent existence of capital (money)
Double entry principle	Inventory/reporting for Capital-as-receptacle. Dichotomy between Assets/Objects and 'Capital and Liabilities'/Subjects.		Dynamic recording of flows of capital, recording in particular its uses and consumption.
Matter of concerns	Capital (assets) management and optimization.		Capital protection/ preservation.

2.2. Consequences for Natural Capital

Given the implications of this analysis, it is now possible to define two different paths for the conceptualization of natural capital.

The first is the Capitalist Natural Capital perspective, which we described earlier in detail, andnow associate with a *debit concept*: if natural capital, at the corporate level, is defined throughassets ('*cose morte*'), then this 'natural capital' is understood in its Capitalist sense. Therefore,as shown earlier, this type of natural capital is only concerned with the expansion of the Power/Welfare of Subjects, based on presupposed Objective Representations of Predictable Natural Objects (real *dead things*), and certainly not by ecological issues. This approach is theprevailing one today, where natural capital in accounting/reporting models is defined through natural (tangible or intangible) assets (Barker, 2019; Coulson et al., 2015; Mace, 2019; Nobes,2015).

2.2.1 Natural capital as a credit concept

2.2.1.1 Main features

The second path, which we introduce here, is an original one. Some accounting systems are aligned with it, as explained below, but the perspective should be further explored in future research. Our aim here is not to address technical, practical, and methodological issues, but to present the main ideas of this path and eventually encourage interest in the possible prospects offered. In this path, which is opposed to the standard conception of natural capital, capital is associated with the *credit concept*: 'natural capital', thus, can be seen as an extension, or moreprecisely, an *analogy* (Etzion and Ferraro, 2010) of capital as the principal part of a monetary debt, applied to 'natural things', or 'natural stuff' (Norton, 2005). 'Natural capital', in this perspective, refers to 'capital' (essential) 'natural stuffs' – where natural simply means 'non- human' (and non-'human-made') – that are used by business activities and have to be preservedover time. As a consequence, there should be as many 'natural capitals' as non-human 'stuffs'to be preserved: each 'natural capital' represents the principal part of the debts/liabilities, whosecontent is the non-human stuff concerned.

What is 'capital' (essential, crucial) from the viewpoint of this type of 'natural capital' is therefore each concerned stuff 'itself', viewed as a 'matter of concern' (Latour, 2009), and notthe Power/Welfare generated by Objects. This 'stuff-based' (Norton, 2005) notion of 'natural capital' focuses on the non-human 'stuffs' themselves, their preservations, according to the waythey are used, and, as an outcome, the specific activities to protect them, and the costs of these actions.

Besides this definition, the real issue at stake, for this re-conceptualisation of 'natural capital', is also to extend it, in the same way – that is, by using the same analogy (Etzion and Ferraro, 2010) – to the whole accounting system associated with (financial) capital as money to be repaid, what we call 'classical accounting'. Basically, the idea is quite simple: keeping the very logic of classical accounting, based on the protection and following of (financial) capital as money to be refunded, and 'adding', by analogy, these new types of 'natural capitals' in (business) accounting systems. Table 2, based on Table 1, summarises some the main features of this extension.

Table 2. Natural capital from a 'classical' accounting conception

	Classical Accounting Framework/Logics	Consequences for 'natural capital', by drawing an analogy with capital as a 'credit concept'
Capital	Capital is an entity (money) with its 'own'existence to be preserved. Capital is independent from the activity ofthe firm.	'Natural capitals' designate non-human entities with their 'own' existences to be preserved. This 'own' existence is independent from corporate activities.
Capital and balance sheet	Capital is a credit concept.	Natural capital is a credit concept.
Capital and Liabilities	Capital is the content of debts/ liabilities. Liability (credit side) accounts represent who brought capital and, above all, who needs to have the guarantee of capital preservation.	Creation of new liability accounts that should represent the (generic) reasons for the contribution of each 'natural capital' to business and, above all, for their preservation.
Capital and Assets	Capital and assets are strictly separated. Assets are uses of capital.	'Natural assets' correspond to the different and generic uses of each natural capital. A natural capital is not a mere means, but an entity to be preserved, associated with some new debts/liabilities.
Double entry principle	Dynamic recording of flows of capital that record, in particular, its uses and consumptions.	Dynamic recordings of flows of each natural capital, and their proxies/ translations, into business model, recording in particular their uses and consumptions associated to value creation.

One of the central characteristics of 'natural capitals' from this viewpoint is the recognition ofthe 'own' existence of these 'capitals', independent from business activities. More precisely, the concerned entities, such as forests, biodiversity, ecosystems, climate, soils, and so on are integrated in complex relations/interactions with firms, through their (direct and indirect) uses,but they also exist in networks of relations independent from them: they are neither mere meansnor mere ends. The concept of 'natural capitals' as a credit concept combines, therefore, the idea that non-human 'stuffs' can be, in

some extends, the means for corporate productive activities, but must be preserved on the basis of their existence outside these activities (as endsin themselves). The determination of these types of existence and the corresponding levels of preservation make necessary the generation of specific management and collective proceduresoutside business, at the social and ecosystem levels, such as the 'Accounting for the management of ecosystems' approach and model (Feger and Mermet, 2017, 2021), based on aperspective connected to the 'Comprehensive Accounting in Respect of Ecology' (CARE) model (Rambaud and Chenet, 2021; Rambaud and Richard, 2015) (see below). Moreover, this concept can be linked to the notions of ecological debt (Paredis, 2007) or debts towards presentand future generations (Sherman et al., 2002) in some ways.

Besides, this approach to 'natural capital' leads also to the creation of new accounts (Gray et al., 2014) corresponding to the way these 'natural capitals' are used and consumed in the business activity. In particular, accounts referring to 'uses' correspond to *asset accounts*. For instance, let us suppose that a soil is seen as a 'natural capital' from this perspective, and a farmuses this soil for wheat cultivation and tree culture. This situation results in the creation of assetaccounts that could be entitled 'wheat cultivation' and 'tree culture', whose content is some quantitative translations that correspond to the soil as a 'natural capital', as explained below.

In this way, DEB remains relevant to describe the different flows – of money and of other stuffto be preserved – in business activity; this allows us to follow their uses and consumptions, in particular, in the process of value creation. Moreover, double entry also makes possible the association of societal concerns, structured by liability accounts, and business concerns,structured by assets accounts.

This perspective on 'natural capital' articulates, therefore, different flows of 'capital stuffs' in firms, these flows can be translated (Latour, 2009) in terms of biophysical non-monetary values(Feger et al., 2019; Feger and Mermet, 2017) and in monetary values based on costs of actionsneeded to preserve these 'stuffs', as in the case of the CARE model (Rambaud and Richard, 2015), with these two approaches being seen as complementary.

2.2.1.2 Natural capital as 'non-human stuff to be preserved', but why natural 'capital' again?

It is possible to question whether the notion of capital should be retained, as it has very strong connotations. According to us, the 'natural capital as a credit (liability) concept' approach is, infact, a re-appropriation of a term existing long before Modernity and historically linked to other types of economies, not centred exclusively on human Welfare/Power. This makes it possible to re-inscribe this notion within a long duration and in an anthropology, while at the same time extracting the very substance of this concept, that is, what is 'capital' (essential, crucial), whatwe care about (Hache, 2011) in the economies of Anthropocene (Bebbington et al., 2019; Moore, 2017).

Besides, on using the reasoning by analogy (Etzion and Ferraro, 2010), this perspective directlyinserts an ecological vision into the classical accounting logic and practices that are well-knownto companies' stakeholders and analysts. This conception of 'natural capital' can be seen as 'hacking' the 'everyday' financial accounting, and extending its rationality to new territories and systems of accountability (Bebbington et al., 2019). This is done in terms understandable to, and meaningful for, the economic

actors; this makes the taking into account of non-human stuff more performative. Because accounting systems are framing systems (Feger et al., 2019)for firms – their operational language – it is therefore necessary to reshape this framework, butfrom the inside.

At the same time, as argued above, this particular 'natural capital' approach transforms accounting into a particular system/procedure that makes it possible to follow a network of interacting non-human entities, considered as matters of concern, in their flows, movements, and uses within business activities. In this way, we can talk about an ecologisation of accountingin the sense of Latour, making accounting one (and only one) of the '*[…] new form of politicalactivity adapted to following […]*' (Latour, 1998) the quasi-objects/stuff in the framework of firms.

There is, therefore, a fundamental hypothesis behind the conceptualisation of natural capital asa credit concept, the hypothesis that there is a strong convergence between the classical accounting logic and an ecological perspective, based on the concept of preservation/conservation of some 'stuffs', with their 'own' existence, and the adaptation of business to this preservation. Indeed, the way that classical accounting treats financial capital provides an approach to take the different entities of our common world seriously and to conceive procedures to co-exist with them, as recommended by the ecological perspective.

Finally, this articulation between concrete accounting practices and ecological ideals can createnew types of *imaginaries* (Castoriadis, 1998), operating at a junction between different actors,who have different backgrounds. As an example, in the wake of these ideas and based on the CARE model, the president of the Collège des Directeurs du Développement Durable (C3D) [11], who is also the director for sustainable development at the Bouygues group, indicated recentlyon LinkedIn that the Executive Board of this association wants to work in particular on the following project: '*Nous devons ouvrir urgemment le chantier de la refondation de la comptabilité pour y intégrer le capital naturel et humain au passif du bilan des entreprises. Comment conserver, préserver, protéger ce qui n'apparaît jamais dans les comptes! Le capitalnaturel comme le capital humain doivent être évalués à leur coût de maintien sans avoir à les actualiser, ce qui reviendrait à négocier avec la nature, ce qui n'a aucun sens*' (Bonnifet, 2020).[12]

As explained, this approach or this movement is a potential research and development programme, and we present only its main ideas; further, we underline the interest and the stakes involved. Nevertheless, this vision is in line with certain other academic currents, such as thoseof sustainable costs, full cost accounting (Bebbington et al., 2001; Sherman et al., 2002), and the sustainable cost accounting recently proposed by Murphy (2019). Above all, it is at the centre of certain current initiatives, which are gaining in importance, such as the ecosystem- centred accounting introduced by Feger and Mermet (2017) and particularly that of the CAREmodel (Rambaud and Chenet, 2021; Rambaud and Feger, 2020; Rambaud and Richard,2015),[13] whose development (Le Ravalec, Rambaud, and Blum, 2022), implementation (Taibi et al., 2020), and recognition (De Cambourg et al., 2019) is growing – notably in France. The purpose of this model is specifically to operationalise this idea of 'natural capital as a credit concept'[14] in an integrated accounting system. Thus, it re-structures the corporate income statements and balance sheets; this is done to integrate new accounts to follow, manage, and report on the different types of capitals, taken into account through the '*[…] most precise ontological investigation possible […]*' (Rambaud and Richard, 2015)[15]. As an outcome of its

conceptualisation of 'natural capitals', its principle of evaluation is based on the 'costs of preservation'; these are evaluated by budgeting for the costs (that is 'sacrifices' of revenue) necessary for the specific actions to be carried out to either prevent (ex-ante costs) or repair (ona scientific basis; ex-post costs) the damages caused to a 'natural capital' as a result of the activity of the firm concerned. These costs have to be recorded at the moment where the uses of this 'natural capital' are observed. As a consequence, the total income in CARE is a measureof the surplus generated by a firm after having fully protected the different capitals: a positive (resp. negative) income means, for instance, that the value creation of a firm is able (resp. not able) to cover the necessary costs of preservation of the concerned 'capitals'.

IV. Conclusion

Accounting systems '*[…] are never merely "local" or merely "global" but intertwined with various codes and detailed procedures which link everyday life in organisations to shared rulesof conduct defining a community and a society […]*' (Quattrone, 2009). They are at the interfacebetween practices and theories, and between the internal and external aspects of business. Underthese conditions, they are at a good position to tackle and re-question fundamental societal issues, and transform them into praxis (Castoriadis, 1998). Moreover, unlike most economic approaches, the structuration of accounting by accounts and the interrelations between them allows a deep articulation between a qualitative and a quantitative analysis. On this basis, we proposed to re-examine, from an accounting lens, the issue of 'natural capital', a controversialconcept increasingly making its presence felt in sustainability issues and in socio-environmentalaccounting.

As a first step, to clearly set out the issues at stake in the debate, we wanted to explore the underlying reasons for the incompatibility of this notion, in its standard sense, with what we have called an ecological approach. The basis of this analysis was to return to what capital is from an 'anthropological' point of view. From a Latourian study of Modernity, combined witha complementary Castoriadian perspective on Capitalism, we tried to uncover the structural problem of 'natural capital'. Indeed, this notion refers structurally to the Modern cleavage between Objects/Nature and Subjects/Culture. It corresponds to the presuppositions that non- human (and non-human made) entities are in essence pure Forms, Controllable, Predictable, and Objectively Representable by Faithful Intermediaries—some *maps that come to replace the territory* (Farinelli, 2004), the complex entities themselves— and that they are only supportsfor the development of Power and the Welfare of Subjects. To avoid a sterile debate between (standard) strong and weak sustainability, we also wanted to establish that this vision of 'naturalcapital' traverses these two approaches to sustainability with the same intensity; weak and strong sustainability are only two different operationalisations (based on fundism and materialism (Hicks, 1974)) of the same concept of Natural Capital. Then, we argued that an ecological approach could only refer to a relationalist – that is, non-dualist – vision, refocusingon the entities – the 'stuffs' (Norton, 2005) – and their uncertain interactions that make up ourcommon world, as well as on the procedures to follow these interrelations; this made it clear that the standard notion of 'natural capital' could not be compatible with an ecological vision.

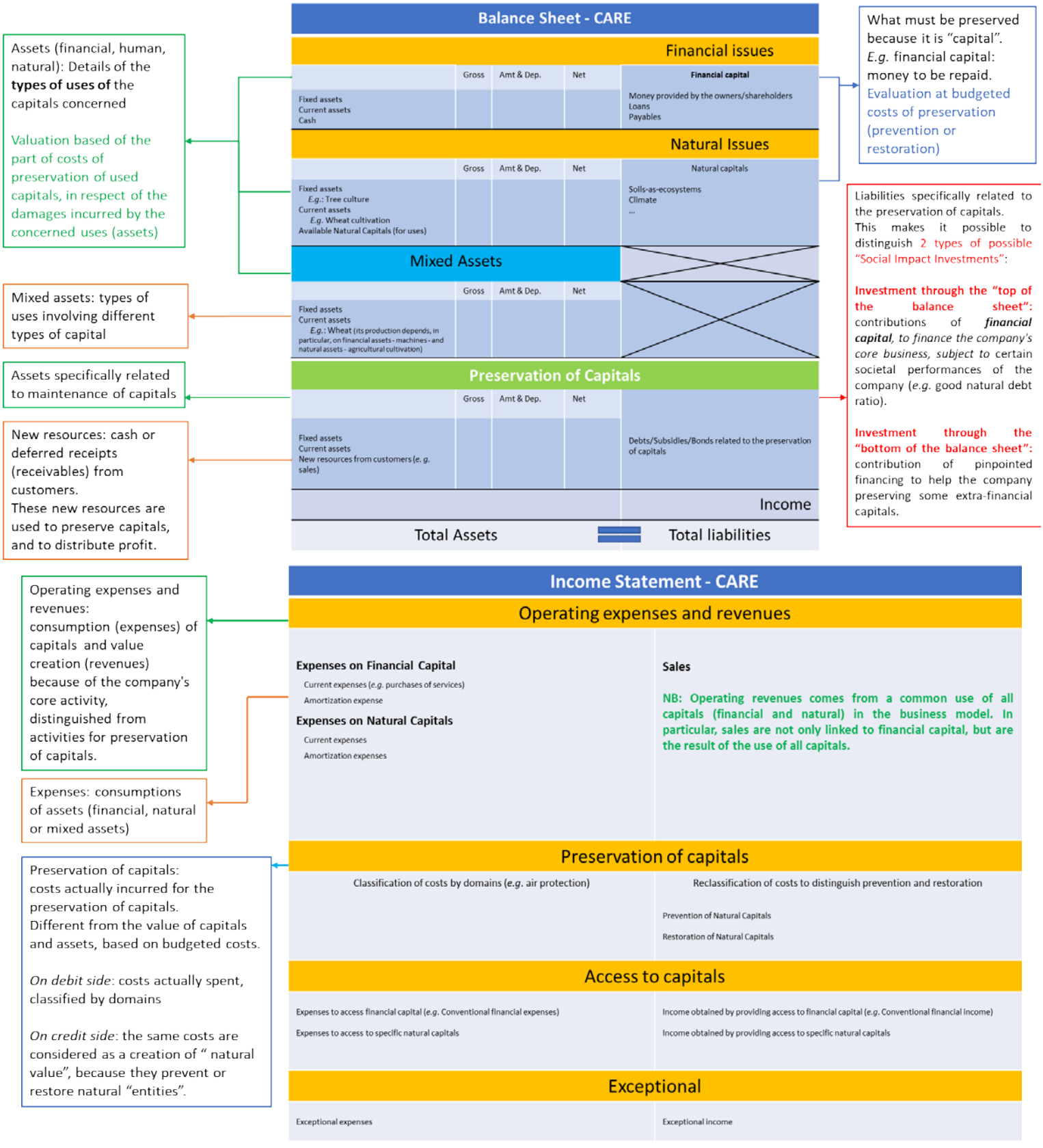
With this analysis clearly established, we proceeded, in the second stage, to re-examine these questions, by means of accounting. On the one hand, this helped us to see how the accounting framework (or even epistemology) could be relevant to reformulate these questions; on the other hand, it helped us to propose another approach to natural capital that is aligned with an ecological vision. Thus, we argued that an understanding of the notion of capital according to the concepts of 'debit and credit, and the associated accounting notions and procedures, such as the double entry principle, were a relevant point of view for addressing the division betweena standard approach to 'natural capital' – which we called (Modern) Capitalist – and a more ecological perspective. To oversimplify, 'natural capital' in its standard sense, refers to 'capitalas debit', whereas 'capital as credit' tends to move towards a more ecological approach. This led us to introduce a new understanding of the concept of 'natural capital': based on an extension, by analogy, of the structure of what we called 'classical' accounting, whose intrinsic function is to organise the protection, following, and management of the 'capital as a credit concept', we have proposed the definition of 'natural capital as a credit concept'. From this perspective, 'natural capitals' could refer to capital (essential, important) non-human stuff usedby business activities and to preserve over time.

As explained earlier, our aim here was not to go into the details of this reconceptualisation; above all, we sought to present the issues and interests for future exploration, whether in termsof academic research or corporate development. To this end, we have highlighted the extent to which this remobilisation of the term 'natural capital', from a classical accounting perspective,could be relevant in theoretical and operational terms; this could take the form of the development of, and experimentation with, new accounting models, such as CARE, that are explicitly grounded on such a conception.

Much remains to be done to take our initiative forward; however, from our point of view, the first step is to lay the groundwork for a change in the imaginary, which could be made concreteand implemented within organisations themselves. It is with this in mind that we haveendeavoured to show the relevance of accounting in this initiative.

Appendice

Integrated balance sheet and income statement according to CARE (from (Rambaud and Feger,2020))



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[1] We use a capital letter to represent the absolute, and, so, fictive, characteristics of the elements in the domains of Objects and Subjects.

[2] As a consequence of this analysis of Modernity, the differences between Marxism and Liberalism (or other Modern socioeconomic conceptions) can be interpreted as what is considered as Subjective or Objective (Latour, 2014). For instance, in Liberalism, Society is seen from a Nominalist point of view (Centore, 1997): Individuals are Subjects, whereas Society is a set of Subjects and therefore is a mere Object, controllable by Subjects. From Marxist viewpoints (and related theories), some communities, such as Classes, are partially Subjectified: a Class receives some attributes of the Subject (Power, in particular) and individuals that constitute this Class are partially Objectified (their existence is conditioned by their membership of this Class). Collectivism is also a partial Subjectification of a group (Society) and a partial Objectification of individuals. In fact, '*the fusion of the subject-object inversion with the problem of the concept of capital is the fundamental theme of Marx's œuvre*' (Hudis, 2012); this shows the importance, in the understanding of Modern socioeconomic theories, of an analysis in terms of what is Objective or Subjective.

[3] That is why we can, for instance, 'choose', in Modern thinking, to be a realist or a constructivist.

[4] Another representative, with Latour, of the French political ecology 'school'.

[5] Castoriadis (2013) specifies that this drive towards mastery is directed towards the whole of society: it is present not only in production, but also in consumption, and not only in the economy, but also in education, law, politicallife, and so on. Moreover, this drive provides itself with new means, and means of a special type—rational—to achieve it. It is no longer magic or victory in battle that are the means used, as in pre-Modern periods, but precisely Modern rationalization.

[6] We stress the fact that workers, even if they are human, can be seen as partially Objectified. This is the case from a Marxist viewpoint, as stated by Lukács: '*Marxism [...] has discovered the true identical subject-object of history: the proletariat. The worker, we recall, becomes within capitalism a thing, an object, a commodity*' (Cohen,1994).

[7] The present value of *each* asset of this stock can be also used as a *proxy* for entry value (Pigou, 1941).

[8] DEB is basically a technical tool that has different interpretations (Toms, 2009; Williams, 1978), even non- Modern ones (Aiken and Lu, 1998): we need to distinguish between DEB as '*[...a] super-historical and technicalconcept [... and as a] substantial, historical and economical concept on the basis of the recorded matters of the enterprise*' (Lane, 1977).

[9] Therefore, we challenge the idea that '*accountants traditionally use the word "capital" as an economic metaphor for financial asset and manufactured means of production, subject to financial valuation and representation*' (Coulson et al., 2015). Indeed, as still noted at the beginning of the 20th century, '*every banker andevery commercial man knows that there is only one kind of capital, and that is money. Every commercial and financial transaction is based on the truth of this proposition, every balance sheet is made out in accordance withthis well-established fact; and yet every economist bases his teaching on the hypothesis that capital is not money*'(Mitchell-Innes, 1914). The fundamental shift in capital from a credit to a debit concept, connected to an economicconception, had begun to germinate as early as the Renaissance, but really occurred, in particular, at the beginning of the 20th century, notably because of Fisher's work (Chambers, 1971).

[10] The debate on the tenuous links between HCA and the development of capitalism is, to some extent, beyond the scope of this paper. The opposition shown here between an accounting logic that we call classical', of which HCA is a part, and Capitalism refers both to a precise definition of Capitalism, at an anthropological level (Castoriadis, 2013; Nitzan and Bichler, 2009), and not simply at an economic one; above all, it refers to the fact that the notion of capital at the centre of classical accounting differs radically from capital in the Capitalist sense,as defined here. Moreover, as shown, the principle of 'accumulation' is extrinsic to capital in HCA, whereas it is intrinsic to it, particularly in fundism.

[11] French College of Directors of Sustainable Development.

[12] '*We urgently need to start work on rebuilding the accounting system to include natural and human capital on the liabilities side of companies' balance sheets. How can we conserve, preserve, and protect what never appearsin the accounts! Both natural and human capital should be valued at their maintenance cost without having to discount them, which would be like negotiating with nature, which makes no sense*' (our translation).

[13] The CARE model arose from (Richard, 2012), whereas it was first theorised in (Rambaud and Richard, 2015). The latest version of this model, as well as the concrete academic, private, and public initiatives around this research and development program are summarized in (Rambaud and Feger, 2020), (Rambaud and Chenet, 2021)and on the site of the 'CERCES' (Cercle des Comptables Sociaux et Environnementaux – Circle of Social & Environmental Accountants) (https://www.cerces.org/). There is today a growing movement in the development, implementation and recognition of CARE. This model, and the associated research project, is supported by a community, composed of academics, professionals (companies like LVMH, chartered accountants, etc.) and NGOs (such as WWF France), federated by the chair 'Ecological Accounting' (https://www.chaire-comptabilite-ecologique.fr/?lang=fr) at the research level, and by the NGO 'CERCES' at the professional and NGO level. CARE is also the subject of several French and international citations, encouraging its experimentation or exploration (see for instance (Bhattacharya et al., 2021; Notat and Senard, 2018)). About twenty experiments have been conducted so far, in large companies (including multinationals), SMEs and public organisations. In addition, a dozen research programmes are currently working on this project.

[14] CARE also takes into account human capitals in the same perspective (Rambaud and Richard, 2017).

[15] See the annex for an example of integrated statements according to CARE.

Agence française
de développement
5, rue Roland Barthes
75012 Paris I France
www.afd.fr

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Publication Director Rémy Rioux
Editor-in-Chief Thomas Melonio

Legal deposit 1st quarter 2023
ISSN 2492 - 2846

Graphic design MeMo, Juliegilles, D. Cazeils
Layout Denise Perrin, AFD
Printed by the AFD reprography service

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