Accounting and Accountability Tools and Practices for Environmental Issues: A Narrative Historical Academic Debate

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1 Introduction

Since the early 90s, the pathway of sustainability has affected public and private organizations' accountability. Until that time, the accountability issue was largely addressed through the provision of fair accounts internally, as a result of correct uses of managerial accounting tools and procedure and externally, as a result of a correct use of GAAP for the preparation of financial statements and related disclosure. However, the concept of accountability is rapidly changed since the early 90s as a natural aftermath of the growing relevance of other important issues linked to social and environmental variables and facts (financial troubles in developed countries, growing pollution, big corruption scandals, climate changes, etc.). In response, both academics and practitioners strove their efforts to new models, concepts, and techniques for addressing the enlarged accountability needs for society. While at the beginning of 90s main issues were represented by searching which existing tools or models could be proposed for addressing these new accountability needs, the passage of time (and especially with the advent of the twenty-first century) has revealed the need of new and integrated frameworks determining a sort of accountability process re-engineering. The aim of this chapter is using a narrative and chronological approach, to retrace this never-ending journey with a focus on selected environmental issues and to point out the main contributions provided overtime by the academic debate. To this end, it seems possible to chronologically review the debate dividing the time span into four main periods:

1. the early debate occurred in the 90s regarding accounting for sustainability and preliminary issues for environmental accounting purposes;

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2. the "meta" debate observed in the late 90s and early 2000s aimed at criticizing and refining models and tools proposed during the early one;
3. the environmental debate, which became the absolute protagonist in the light of many alarms launched throughout the world in the late of 10s in response to natural disaster and climate extreme events;
4. the recent debate regarding the awareness of an integrated approach and the need of integrated reports. To this regard, we will see that main issues, which historically affect accounting themes, such as harmonization, standardization, compulsoriness, or voluntariness seem to be so far the heart and the solution of the problem.

This chapter has a twofold aim: on the one hand, it would fix milestones achieved in the landscape of environmental accounting; on the other hand, it highlights the need to change the mindset in facing on the issue fostering further efforts aimed at improving accounting for sustainability (A4S) as a whole. As a matter of fact, merging innovative approach in the fields of accounting, economics, and law could represent the best effective way to point out fair and shared models useful for both academics and practitioners. The great call represented by United Nations Sustainable Development Goals (UN SDGs) rows exactly in this direction: finding large consensus to heal the world.

Consequently, this paper is organized in four sections aimed at exploring each period individuated and the related debate. Final remarks conclude the paper summing up evidences achieved and formulating suggestions for further researches.

2 The Early Debate

In order to account for sustainability, Gray (1992) suggests that sustainable cost analysis should be used as a shadow of price-driven accounting information. Indeed, a parallel accounting system should be derived in order to provide calculations of what it would cost at the end of the accounting period to return the biosphere to the point it was at the beginning of the accounting period (Gray 1992). The figures produced by this shadow accounting system should be deducted from computed accounting profit and be expended in the restoration of the biosphere (Gray 1992). At this early stage, Johnson (1993) identifies three main challenges for accountants engaged in environmental reporting and accounting:

1. How should environmental outlays be depicted when they are made? Here, the main issues are whether to capitalize or expense them, as well as how to assign them to accounting periods;
2. When, and if, events or conditions that may require future environmental outlays should be recognized as liabilities?
3. How should expected environmental outlays be measured?

The author specifies that recognized items could require additional disclosures to provide more information. Milne (1996) suggests that two decision-making tools

can be introduced to integrate environmental concerns into accounting. They are environmental impact analyses and extended cost-benefit analyses. Both of these methodologies strive to account for social and environmental externalities: they capture information on those impacts beyond the entity that creates them. The main difference between these tools is that environmental impact analyses represent environmental factors in the form of a descriptive analysis, with information expressed in non-monetary amounts. While, extended cost-benefit analysis seeks to quantify, under the financial standpoint, all known impacts. Birkin (1996) brings attention to life cycle analysis: a methodology, which can be used as an integrating and comprehensive tool in order to account for the ecosystem. Solomon (2000) asks himself whether corporate environmental reporting could shadow financial reporting. In particular, he addresses the need to standardize corporate environmental reporting through a formal framework, in order to ensure credibility and effective communication. According to the author, the easiest way to do so is to use the existing financial reporting conceptual framework as a basis for a corporate environmental reporting conceptual framework. Solomon (2000) tests his hypothesis disseminating a survey in the UK, with the aim to verify whether there is consensus on some perceived commonalities between the UK financial reporting conceptual framework and a potential corporate environmental reporting conceptual framework. The table below provides Solomon (2000)s findings (Table 1).

What emerges from Solomon (2000) findings is that a conceptual framework for corporate environmental reporting could shadow the existing conceptual framework for financial reporting, except for the users of disclosed information and the issues of recognition and measurement. Indeed, the users of corporate environmental information are a broader group than shareholders, and recognition and measurement issues are strictly related to the items being recognized and measured. Looking into the organizations, in the view of Atkinson (2000), one of the keys to understanding corporate sustainability is full cost accounting aimed at valuing pollution in corporate green accounts. The author cites the definition according to which full cost accounting means *"accounting for a corporate entity's internal and external costs generated as a result of its economic activity"* (Atkinson 2000, p. 436). External costs are described as costs imposed by organizations as a consequence of their economic activity on third parties. For instance, pollution is an external cost, which imposes costs on others, through detrimental effects on health and environmental quality. This is an external cost because firms do not take into consideration this outcome when deciding the amount of pollution they should emit. Full cost accounting for external costs includes the monitoring of physical indicators and makes it possible to estimate those costs in monetary terms. Then, it is possible to adjust firms' incurred income by the amount corresponding to externalities directly associated with the production of their income. Theoretically, that amount should be used to compensate the externalities produced. Monetary evaluation of environmental impacts means *"the value in dollar terms of the stream of benefits that society derives from the environment"* (Atkinson 2000). The author argues that measuring changes in this stream can provide that link between human well-being and the environment, which is sought in sustainability debates. In fact, the value of pollution damage consists of

Table 1 Potential corporate environmental reporting conceptual framework

Items	Features of corporate environmental reporting conceptual framework	Similarities to financial reporting conceptual framework
Users of information	Shareholders are important, but they are not the primary users. The most relevant information' users are employees, legislators, and local communities	No
Qualitative characteristics	The greatest emphasis is on understandability, relevance, reliability, faithful representation, freedom from error, and a true and fair view	Yes
Recognition and measurement	The elements to be recognized are natural resources: air, land, water, and sound. They are treated as assets, while their pollution is a liability	No
Verification	Independent verification will increase credibility	Yes, at least in terms of actions undertaken
Bearing the cost of disclosure	The cost of disclosure has to be beard by firms	Yes
Timing and communication of information	Information has to be disclosed via the annual report	Yes, but also elsewhere

Source Author elaboration from Solomon (2000)

a price multiplied by a quantity. The price should reflect the marginal willingness to pay: the amount of income an individual is willing to give up in return for a small improvement in environmental quality. While quantity is total emissions attributable to an individual organization. The aftermaths of this preliminary debate have been consisted in deepening the use of accounting sustainable tools by academics integrating the existing knowledge with new approaches and a certain spirit of criticism in suggesting to move from accounting to accountability initiatives and instruments.

3 Meta Debate

Bebbington et al. (2007) criticize cost-benefit analysis and suggest sustainability assessment models should be adopted to support sustainable development initiatives. They identify five principal categories of concern about cost-benefit analysis:

1. Over-reliance on monetization. The monetization of non-economic values involved in sustainable development risks underestimating values themselves; moreover, choices risk being determined exclusively by market values;
2. Subjectivity of calculations. Cost-benefit analysis faces a number of measurement and valuations difficulties, such as: the dependency of economic values on property rights' allocation; the impact of wealth and income distribution on willingness to pay; information asymmetries and scientific uncertainty. Moreover, the results of contingent valuation methods depend on the selected population. Furthermore, cost-benefit analysis computations entail cost and benefit estimates, as well as judgments about the proper discount rate. These uncertainties in the monetization process can lead to opportunistic interpretations;
3. Politics of cost-benefit analysis. Cost-benefit analysis is assumed to be a-political in nature. However, this can hide value choices and the political nature of actions, jeopardizing democratic processes. Decision-makers can filter information stakeholders receive and take opportunistic advantage of cost-benefit analysis calculations' uncertainties;
4. Distributional issues. Cost-benefit analysis focuses on monetary totals, disregarding how costs and benefits are allocated among different groups;
5. Reliance on experts. Cost-benefit analysis is an expert-driven process, inaccessible to non-specialist audience. Results are often presented in a technical language or via summary statistics, without providing explanations. Alleged scientific objectivity is conveyed, with people accepting results on faith.

Sustainability assessment models are presented by the authors as an alternative to cost-benefit analysis. A sustainability assessment model can be defined as a full cost accounting approach to make external costs more central to organizational decision-making. The development of a sustainability assessment model follows a four-step process: (1) definition of the entity for which the account has to be developed; (2) determination of analysis's boundaries; (3) quantification of physical flows related to aspects of interest; (4) translation of information into monetary terms. The application of this methodology results in a project-specific sustainability assessment model, which shows changes in economic, environmental, and social capital categories resulting from the project. Below we summarize the main differences between cost-benefit analysis and sustainability assessment models (SAMs) signaled by the authors (Bebbington et al. 2007):

1. Monetization. SAMs combine monetary and non-monetary indicators and it allows dialog among stakeholders with different ideological orientations;
2. Subjectivity of calculations. SAMs explicitly recognize subjectivity;
3. Politics of SAMs. SAMs explicitly acknowledge the political nature of decision-making processes. SAMs do not adopt a predefined approach to sustainable development since different stakeholders' perspectives can emerge during the decision-making process. Indeed, if the engagement is not plural enough, there is the risk that SAMs will be dominated by a narrow range of interests;
4. Distributional issues. SAMs explicitly express impacts on economic, environmental, and social capital;

5. Reliance on experts. The design of SAMs explicitly involves all relevant stakeholders, in order to consider a plurality of perspectives.

Full cost—environmental—accounting has been conceived as a valuable approach also in more recent years. According to Cuckston (2013), it can be seen as a way of representing the interactions between organizations and the natural world. In particular, it tries to assess, financially, the value that the organization has extracted from nature. A way to pragmatically affect corporate financial accounting calculations of profit and loss will be a tax system based on full cost environmental accounting. Specifically, governments should impose a tax on corporation's equivalent to the cost of restoring the damage done by corporations on the environment. Bebbington and Larrinaga (2014) ascertain that, among various accounting techniques that have tried to better expose social, environmental, and economic externalities, full cost accounting has been seen as the most promising since it moves beyond the entity to find externalities. As a matter of fact, contrary to full cost accounting, financial accounting ignores social and environmental impacts, by contributing to a bounded organization, which ignores its overall nature. Specifically, the idea at the basis of full cost accounting is that in order to identify more sustainable ways for producing goods and services, it is necessary to consider the sustainability of current activities, by assigning a value to the use of otherwise free environmental and social services. Linnenluecke et al. (2015) describe full cost accounting as accounting for the amount of money a firm would have to spend to return the environment back to the state where it was at the beginning of the accounting period. External costs are central to full cost accounting and the interlinks between sustainable development issues and the entity are addressed under this approach. Discussing quality in full cost accounting, Bebbington and Larrinaga (2014) state it has to be measured by the level of stakeholder's engagement in the construction of an account. This leads to several challenges to be tackled, such as: (a) the representativeness of participant; (b) inclusiveness; (c) how to obtain a fair deliberation or the access to resources to participate. In addition to full cost accounting, Linnenluecke et al. (2015) recall the other two methods for accounting for environmental impacts. They are input/output accounting—it analyzes the physical flow of inputs such as materials, energy, waste, and outputs such as carbon emissions or waste, and natural capital accounting such as habitat or biodiversity costs usually not included into pricing decisions. Unerman and Chapman (2014) add that conventional accounting practices disregard or judge as immaterial the long-term economic risks arising from social and environmental impacts of firm's activities. Along the lines of Unerman and Chapman (2014), Linnenluecke and Birt and Griffiths (2015) state that finance and accounting systems focus on short-term outcomes and the management of short-term costing, reporting, and disclosure, rather than on longer-term climate risks. However, since the impacts of climate change become more visible, they will need to be reflected in the costing, reporting, and disclosure of impacts, vulnerabilities, and adaptive capacity (Linnenluecke et al. 2015). The CDSB Climate Change Reporting Framework can be considered as an attempt to integrate climate change-related information into mainstream company reporting (Linnenluecke et al. 2015). Previously, Llena et al. (2007)

studied environmental reporting practices in the annual report of large companies operating in Spain. They verified the impact of the implementation of a compulsory accounting standard (in 2002) on environmental reporting behaviors. Authors' findings can be classified according to four categories:

1. Type of environmental information provided. On the one hand, narrative information about environmental performance is common for the majority of the companies; on the other hand, quantitative information is less frequent. The introduction of a compulsory accounting standard has led to a significant increase in the provision of financial data and in the number of environmental items disclosed via narrative and qualitative information;
2. Sections of the annual report devoted to environmental information. Firms publish their environmental information in the general corporate information included in the annual reports. The adoption of a compulsory accounting standard has caused an increase in the environmental data published in the notes to the annual accounts. Moreover, it is possible to register an increase in the number of companies providing an environmental report and the majority of the companies have devoted a section of corporate website to the environment. Finally, there has been an increase in the number of firms disclosing environmental information within compulsory information subject to audit procedures;
3. Organizations' environmental policies. The introduction of a compulsory accounting standard has triggered the increase of (1) the implementation of environmental audit, (2) the adoption of an ecological policy, and (3) the external environmental commitments with governmental agencies or business organizations;
4. Environmental disclosure in the annual accounts. All the environmental information provided in the annual reports is located in the notes; only few companies have included environmental items in the balance sheet or income statement. The introduction of a compulsory environmental standard has resulted in an increased disclosure of information on environmental provisions, investments, and expenses.

Llena et al. (2007) summarize that the implementation of a compulsory accounting standard has increased the publication of environmental information in the annual reports, especially in the (financial) data provided in the notes to the accounts and in the corporate general information section. de Villiers and van Staden (2011a) broaden the scope of the analysis considering not only environmental disclosure in firms' annual reports but also on their websites. Firms use both media to disclose environmental information, but annual reports are more credible than websites, because of regulation and audit. Moreover, these two different media serve different purposes and audiences. The table below summarizes the main findings of de Villiers and van Staden's (2011b) study on S&P 500 and the largest 3000 US publicly traded firms by market capitalization; it shows that managers' voluntary disclosure decisions are influenced by their firms' environmental performance (Table 2).

Table 2 Where firms disclose environmental information

Annual reports	Bad reputation firms report more environmental information in their annual reports. Indeed, managers provide investors with additional environmental disclosure in their annual reports in order to reduce information asymmetry and the cost of capital
Websites	Firms experiencing an environmental crisis disclose more environmental information on their websites. In fact, managers use corporate websites to provide activists, regulators, politicians, and the general public with information in order to reduce the political costs related to the crisis, by showing that the situation is adequately managed and neither consumer action nor regulation is required

Source Authors elaboration from de Villiers and van Staden (2011b)

4 The Growing Relevance of Environmental Issues in the Global Landscape of A4S

The worries about climate change phenomena as a whole, the increasing attention posed by social media all around the world, issues of carbon accounting, and the rise and rise of greenhouse gas (GHG) protocol have brought the debate on this mainstream also among academics. In 2008, Kolk, Levy, and Pinske focused specifically on the development of reporting mechanisms for GHGs. The authors argue that an ambitious project of commensuration should be at the basis of the institutionalization of standardized information disclosure. Commensuration is the transformation of qualitative relationships into quantities on a common metric. In general, a process of commensuration is characterized by three dimensions: technical, value, and cognitive dimensions, which can be applied to climate change as well. First of all, as financial reporting translates firms' activities into a common monetary metric, so carbon reporting, from a technical perspective, aims at rendering organizational operations involving multiple gases and impacts in terms of a common carbon metric: tonnes of carbon dioxide equivalent—tCO_2. Secondly, value commensuration is the attachment of a price to GHGs reductions; finally, from a cognitive perspective, it is necessary to develop a common understanding of the meaning of pollution, the identity of the polluter, and the emissions a firm is responsible for Kolk et al. (2008) believe the key to achieve commensuration in carbon accounting is the use of a widely accepted methodology to transform all polluting activities into corresponding emissions. For instance, the GHG Protocol can be adopted to track and register firms' GHG emissions. Under this protocol, emissions are distinguished between direct and indirect ones. Direct emissions come from sources that a firm owns or controls, while indirect ones come from sources where the point of release is either upstream or downstream in the supply chain. Moreover, there are indirect GHG emissions, which cannot be classified according to the above-mentioned dichotomy. They are, for instance, business travel, external distribution, use and disposal of products, others (Matisoff et al. 2013). The authors highlight the difficulties emerging from

this process since carbon market is not a naturally existing entity. Indeed, the commodification of carbon requires a legal and bureaucratic infrastructure to: (a) define and measure carbon units for various activities and gases; (b) allocate and adjudicate property rights; (c) establish rules for trading across national boundaries, and (d) different carbon jurisdictions. Moreover, reporting systems should consider not only technical issues such as which technologies and activities count toward emissions and reductions but also political ones in terms of emissions' allocation to actors and activities in the value chain. Bebbington and Larrinaga (2008) study carbon trading's financial implications for companies. In particular, short-term financial implications arise from the cost of allocated or purchased allowances. In their risk-based approach to global climate change, the authors believe financial and non-financial information, such as GHGs emissions, is necessary to provide insights on the risks associated with global climate change. They argue the GHG Protocol can be the starting point of a standard for the measurement of GHG emissions and it can be adopted as a benchmark of corporate performance in this area. Since its first publication in 2001, this protocol has been incorporated into several voluntary and governmental reporting guidelines such as the GRI (Ascui and Lovell 2011). Linnenluecke et al. (2015) define the GHG Protocol Corporate Standard as a mitigation accounting standard, which provides guidance for organization preparing a GHG emissions inventory. In line with Bebbington and Larrinaga-González (2008), Ascui and Lovell (2011) highlight that companies operating in carbon markets have new liabilities, assets, and financial flows to account for in their financial reports. Rathee and Kapil (2015) reiterate that, because of firms' participation in climate trading, new balance sheet items and/or cash flow and income statement events can emerge. Specifically, climate trading-related new financial activities may affect either the annual net income or net balance sheet value, which can change the firm's debt valuation and affect the price of corporate equity securities. The recognition of these items in financial accounting makes visible the real impact of CO_2 emissions on companies' profit (Cuckston 2013). Thus, accountants are engaged in reporting these assets and liabilities in corporate financial reports (Ascui and Lovell 2011). On the same wavelength, Linnenluecke et al. (2015) register an increase in corporate development of informational infrastructure for assessing, measuring, reporting and managing GHG emissions. Moreover, companies are building GHG accounting capabilities to establish emission baselines, measure actual emissions, and budget for future purchase or sale of emissions credits. However, in the absence of an official international guidance on how to account financially for carbon allowances or credits (Lovell and MacKenzie 2011), several accounting practices have emerged to account for emissions rights and obligations (Ascui and Lovell 2011). It is the multinational scope of carbon trading schemes that would require financial carbon accounting's convergence on a global basis. The authors argue that if carbon accounting fails to provide comparable information on corporate emissions, impacts, and responses and to recognize and reward negative emissions, society will lose the valuable chance to avoid or reduce the damage caused by climate change. Andrew and Cortese (2011) recognize that a variety of voluntary and mandatory regulatory regimes has emerged to encourage climate change in standardized reporting and disclosure practices. For instance, the

GHG Protocol promoted by the CDP. This methodological guidance reflects a desire for a greater level of data uniformity and comparability. Drawing parallels between financial and GHG accounting and reporting, generally accepted GHG accounting principles are necessary to ensure that the information provided represents a faithful, true, and fair account of firms' GHG emissions (Andrew and Cortese 2011). According to Bowen and Wittneben (2011), a fully functioning carbon accounting system should be based on measurement that is (1) materially accurate: actual atmospheric emissions have to be reflected; (2) consistent over space and time, by using calibrated equipment, agreed procedures, and verification; and (3) able to incorporate data uncertainty to allow for valid data interpretation. Indeed, all the initiatives dealing with climate change require the measurement, collection, and comparison of carbon dioxide (CO_2) emissions data. Also, the authors argue that carbon accounting systems have to evolve on three levels: (a) scientific knowledge: how to recognize and count carbon emissions; (b) accounting effort to collect and record this information; (c) policy field of developing accountability systems that use and compare this data. Finally, they question the practice of reporting carbon performance in a separate corporate environmental, sustainability, or social report. On the one hand, this signals firms' awareness of the need to tackle climate change; on the other, these reports represent merely symbolic responses by firms, rather than substantive mitigation actions. A solution to this issue may be represented by Evangelinos, Nikolaou, and Filho's (2015) proposal. They believe information on the corporate response to climate change should be measured (a) in financial terms, being recorded into formal financial statements—balance sheet and income statement—and in (b) non-financial terms, being recorded into balance sheet. Bui and de Villiers (2017) distinguish between (a) short-term, past-oriented physical and monetarized accounts and ad-hoc collection, reporting, and use of carbon information and (b) long-term, future-oriented physical and monetarized accounts and recurring collection and use of carbon information in decision-making. The approach sub (a) characterizes reactive strategies toward climate change, while the approach sub (b) is typical of more proactive ones. Lovell and MacKenzie (2011) already recognized that, since carbon accountancy rules have a great influence on companies' profits and liabilities, there is an unsurprising conflict in the field of accountancy rules and standards. However, it is crucial to settle this conflict and make carbon accounting easier, by eliminating the current necessity of following a variety of national, international, and corporate guidelines. Indeed, the lack of international carbon accounting and reporting standards jeopardizes data sets comparison Stechemesser and Guenther (2012). In addition, Matisoff et al. (2013), in their study based on the contribution of the CDP to environmental reporting's transparency, state that the inconsistency of measurement techniques and standards make the assessment of environmental reporting difficult. They also believe the heterogeneity of reporting signals that carbon commensuration is not just a technical issue, but it has also social and political implications. One of the benefits of greater clarity in carbon accounting will be the fairer comparison of companies with their competitors (Lovell and MacKenzie 2011). In line with Bebbington and Larrinaga (2008) and Ascui and Lovell (2011), Stechemesser and Guenther (2012) clarify that, because of emissions trading, CO_2 allowances have

to be included in annual financial statements. In particular, they highlight how carbon accounting involves both the valuation of assets—granted pollution rights—and the assessment of liabilities, since organizations have to purchase further permits to compensate for their emissions. In addition, Bui and de Villiers (2017) clarify that monetarized data include costs, revenue from selling carbon credits and estimated cost savings from new investments. In fact, despite carbon accounting tends to be connected with physical information, monetary assessment is also crucial for climate change information (Stechemesser and Guenther 2012). Moreover, Stechemesser and Guenther (2012) state the necessity to standardize GHG reporting as well as to audit the GHG emissions; indeed, this will enhance the credibility of disclosed information. This is reiterated by Linnenluecke et al. (2015), according to whom, the assurance of carbon emissions information increases the quality of disclosed information. Despite the need to standardize and provide guidance for the treatment of climate instruments in financial statements has been expressed since 2011, in 2015 Rathee and Kapil had to certify the absence of a formal accounting policy in countries across Europe, America, and Asia. This leads to great disparities in reporting, measurement, and disclosures by firms on climate instruments. Rathee and Kapil (2015) also argue that the consequent lack of credible information on climate-related economic activities creates difficulties for financial analysis, investment research, and comparability among firms willing to rise private capital. Moreover, the absence of common guidelines for climate accounting across countries and industries can constitute an obstacle toward the achievement of effective results to control carbon emissions (Rathee and Kapil 2015). However, it has to be considered that incorporating carbon accounting information in corporate financial reports is not the only way this information can be collected and presented.

5 Unresolved Questions: How to Account for Climate Changes? Toward Partially Mandatory Integrated Reports

There are radical alternatives such as online map-based formats to present site-specific emissions, allocations, and offsets data (Stechemesser and Guenther 2012). As regards, authors signal that the application of software for monitoring and reporting aims leads to lower costs, improved verification, and higher transparency. Birnik (2013) states that, in addition to the GHG Protocol, other standards can be adopted in the preparation, validation, and reporting of GHG inventories, such as the Climate Registry, ISO 14064, and the CDP. GHG inventories help managers quantify a company's climate impact, by knowing how much is emitted and from what sources. The table below provides Birnik's (2013) standards' collection (Table 3).

The author recognizes that the above-mentioned standards may lead to silo-based reporting structure. A way to avoid this risk is the development of integrated reporting practices, in order to present a comprehensive view of a firm's performance in a

Table 3 Standards for the computation and reporting of corporate GHG inventories

GHG protocol	– It does not require an organization to report GHG information externally – It provides guidelines for: (a) the setting of organizational and operational boundaries for GHG inventories (b) consolidating inventories across multiple organizational levels (c) choosing a base year for emissions reporting; (d) setting GHG reduction targets – It does not provide technical details on how to compute GHG inventories
Climate registry's general reporting protocol	– It provides a more hands-on guide to the computation of a corporate GHG inventory than the GHG protocol – Contrary to GHG Protocol's global approach, it focuses only on North America – It keeps a verified registry of completed voluntary GHG inventories
ISO 14064	– It focuses on measuring, quantifying, and reducing GHGs – The first two components focus on the quantification, monitoring, and reporting of GHGs at organizational and project levels – The third component involves the validation and verification of greenhouse assertions. This component can be used to validate and verify GHG inventories computed under the GHG Protocol
CDP	– It does not prescribe how GHG inventories should be computed, but it requires that submitted reports be verified by third parties

Source Authors elaboration from Birnik (2013)

single reporting document. The main advantage of integrated reporting is that it considers sustainability as a constitutive part of firm's operations, rather than a separate topic to be addressed in an additional sustainability report (Birnik 2013). According to the author, adopting integrated reporting signals internally that sustainability and climate change are integral concerns for the company as a whole. Hahn and Kühnen (2013) reiterate that integrated reporting combines sustainability information together with financial information in a single report to convey a holistic picture of value creation over time. In this field, the GRI guidelines provide principles and standard disclosures, which firms can adopt to report their economic, environmental, and social performance and impacts (Linnenluecke et al. 2015). In fact, GRI can be considered the most comprehensive framework for sustainability reporting (Arena et al. 2015). Moreover, Hahn and Kühnen (2013) signal voluntary initiatives may be insufficient in achieving corporate accountability. In addition, companies' self-governance is inadequate because of a scarce level of transparency, incomplete

and irrelevant information for stakeholders, and a lack of comparability of sustainability reports. Thus, a basic legal framework is necessary in order to promote a level of sophistication similar to mandatory financial reporting systems. On the one hand, Matisoff et al. (2013) add that mandatory disclosure programs will allow for more uniformity and standardization, enhancing comparability over time and across firms. On the other hand, it can be argued that by adhering to voluntary reporting and disclosure firms can distinguish themselves from competitors and gain recognition for going beyond compliance. Schaltegger et al. (2017) warn against the risk of limiting accounting and reporting innovations through rigid standardization. Evangelinos et al. (2015) enter the debate about voluntary versus mandatory reporting specifying that currently the majority of accounting methods record information on climate change on a voluntary basis. According to the authors, the informal nature of such accounting standards and the variable type of financial and non-financial information make the use of such models untrustworthy and complex. In line with Stechemesser and Guenther's (2012) discourse about the need to audit GHG emissions, Hahn and Kühnen (2013) signal the need of independent assurance to improve the sustainability reporting quality. Also, it has been found that perceived credibility increases when a sustainability report is assured by professional accountants. Bebbington and Thomson (2013) enter the debate about the relationship between traditional accounting and sustainability accounting arguing that DuPont analysis, a valuable management accounting tool, can be adapted to provide an integrated assessment of corporate environmental and economic performance. In particular, eco-efficiency can be disaggregated into its value components and drivers in order to provide guidance on the use of environmental and economic resources (Bebbington and Thomson 2013). This example shows that the challenge to be addressed is the development of pragmatic accounting tools for integrating sustainability targets with performance management. Siddiqui (2013)s analysis, despite devoted to the public sector in developing countries, may provide a further example of practices which can be developed by the private sector. Indeed, he argues that an inventory of natural assets using proper biodiversity accounting techniques is more objective than descriptive environmental disclosures that cannot be easily verified. The production of a pre-disaster inventory of those natural assets companies are accountable for can be conceived as an objective basis for responding to stakeholders' demand for clarity in the assessments of the impacts from natural disasters and climate change (Siddiqui 2013). One of the methods aiming at estimating the economic value of environmental assets is the restoration cost method. It is based on the economic benefits derived from an environmental attribute lost due to a natural disaster. According to Unerman and Chapman (2014), firms have to cover three steps in order to turn social and environmental reporting into a generally accepted practice within their organizations. This path is shown in Fig. 1.

Arena, Conte, and Melacini (2015) study how environmental accounting instruments can be linked to corporate reward systems for motivating firm's employees to adopt more environmentally friendly behaviors. Specifically, the environmental accounting instrument they consider is the environmental profit and loss account, which complements the traditional profit and loss account by including figurative

STEP 1	STEP 2	STEP 3
Before any systematic external sustainability reporting, a shared understanding about corporation's social and environmental responsibilities has to be developed	Practices and processes used to produce annual sustainability reports have to be continuously enhanced	Sustainability reporting processes and systems have to be formalized, including the roles of staff and departments involved in these processes

Fig. 1 How to embed social and environmental reporting into organizational general accepted practices. *Source* Personal elaboration from Unerman and Chapman (2014)

revenues and costs related to the environmental impact of business activities. This helps employees consider corporate environmental performance as part of their daily activities. For instance, the environmental impacts associated to GHG emissions can be transformed into monetary values by adopting the social cost of carbon (SCC) methodology. The SCC represents the damage caused by one additional ton of CO_2 or equivalent substances.

6 Final Remarks

In this chapter, I reviewed academic discourses about measurement, accounting, and reporting of sustainability-related data and information, with a particular focus on several environmental issues (carbon accounting, GHG emissions, and climate changes). This is a recurring theme among scholars and it is reiterated by Bebbington and Unerman (2018) who state that the technologies of accounting, target setting, and reporting are required in the context of the UN SDGs. Schaltegger et al. (2017) clarify why measurement systems and accounting are important for sustainable development. They argue that decision-makers and stakeholders can only act in favor of sustainability if they are well informed about unwelcome environmental and social impacts and if they can compare different investment and operational options on the basis of their sustainability impacts. Despite academic consensus about the necessity to account for social and environmental externalities by using both physical and monetary measures, scholars complain about the lack of standardization and international guidance. This is especially the case when considering carbon-trading implications for financial reporting. Efforts toward a more shared agreement on how to pursue objectives are therefore strongly encouraged. Fixing rules is something desirable but at the same time, fixing identical standards for all does not seem desirable, if we acknowledge that the higher is the distance from measuring something through the

monetary lenses, the lower is the success in searching shared and harmonized standards. To this regard, it seems to be fair moving on using supranational legislative power (such as the last EU directive 95/2014) in order to pursue soft alignments across jurisdictions. This way pushes to higher accountability for sustainability.

From academics and practitioners, one would expect new empirical evidence, new framework, or proposal for enriching available arrows for sustainability under the awareness that one size does not fit all but "similar languages" are needed.

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