ISSN 2237-7662, Florianópolis, SC, v. 23, 1-18, e3469, 2024
https://doi.org/10.16930/2237-7662202434691
Available at http://revista.crcsc.org.br

WATER ACCOUNTING: AN OVERVIEW OF THE CORPORATE SCENARIO

SARA MEURER[1]
Federal University of Santa Catarina
https://orcid.org/0000-0001-7467-0849
sarameurer95@gmail.com

HANS MICHAEL VAN BELLEN
Federal University of Santa Catarina
https://orcid.org/0000-0002-9224-7232
hans.michael@ufsc.br

ABSTRACT

The urgent solutions required to avoid the increasingly frequent floods and droughts and many other issues regarding water access and management made water a subject that has attracted the attention of many – as they did with accounting professionals. Since businesses are among the largest consumers of freshwater worldwide, corporate engagement with water issues is required to safeguard the organization's license to operate. Corporate Water Accounting then allows companies to determine the impacts of their water use and discharges on communities and ecosystems, evaluate their water-related material risks, track the effects of changes in their water management practices, and credibly report them to their stakeholders. Therefore, this theoretical essay addresses water issues within the accounting field by recognizing three interrelated approaches that drive corporate water accounting implementation - Water Risk, Water Resources Management, and Water Reporting. We acknowledge its concepts, some useful tools, and its most concerning challenges while tracing its current state, especially in Brazil, and our future expectations for water accounting development. Furthermore, based on the theoretical contributions discussed, we point out some challenges managers face and future research opportunities. We expect more accounting professionals and researchers to engage with corporate water accounting to overcome the gaps that challenge the field's development.

Keywords: Water Accounting. Sustainability Accounting. Water Resources Management. Water Reporting. Theoretical Essay.

Edited in English.

This paper was presented at the 9th GECAMB Conference on Environmental Management and Accounting (Portuguese CSEAR Conference) on November 4, 2022, in Aveiro/Portugal (Virtual Edition).

[1] **Correspondence address:** R. Eng. Agronômico Andrei Cristian Ferreira, s/n | Dpto. de Ciências Contábeis/CSE | Trindade | 88040-900 | Florianópolis/SC | Brazil.

Received on 02/04/2024. **Revised on:** 04/27/2024. **Accepted on** 06/10/2024 by Prof. Dr. Rogério João Lunkes (Editor-in-Chief). **Published on** 06/17/2024.

1 INTRODUCTION

Ample and clean water is crucial for human health, industry, agriculture, and energy generation, but the world's freshwater systems are threatened significantly due to unsustainable management and ecosystem degradation (World Resources Institute, 2024). Besides, water and climate change are inextricably linked, from flooding, drought, waterborne illnesses, and community displacement, making water security achievement one of the most pressing challenges of our time (Russell, 2023). However, each user can perceive water value differently (United Nations, 2021), which raises concerns about reinforcing its significance for all actors. This challenges water security achievement, especially in this twenty-first century, characterized by significant changes affecting water resources (Mishra & Verbist, 2021). As a result, we must make an extra effort to reduce the impacts of vulnerable water systems and mitigate water-related hazards by managing water resources in an integrated and equitable manner (Mishra & Verbist, 2021). Since businesses are key actors in water impacts, being the largest consumers of freshwater worldwide (Ortas et al., 2019), we expect an increasing involvement in corporate water management so they can maintain their operations while guaranteeing water security for all.

Threats to water security are issues that demand a strategic and practical response from businesses to develop and implement solutions. This is particularly true for companies with significant and relatively insignificant water impacts since both may face water-related risks (The CEO Water Mandate, 2024). Thus, companies must first recognize water as a fundamental asset to their business (Lamb, 2018). Then, companies start to track their water-related business risks in order to evaluate their impacts and maintain their value chains since the financial implications of water risks are more significant than the costs of addressing them (CDP, 2021). It made the accounting profession increasingly recognize these implications associated with water risk, its measurement, and its impacts (Christ, 2014), not only through water management initiatives but also through reporting water information. By disclosing water information, companies can publicly present their water management practices, enabling stakeholders to understand and address corporate water issues more effectively (Peng et al., 2023).

Meanwhile, effective Water Accounting has arisen to allow companies to determine the impacts of their water use and discharges on communities and ecosystems, evaluate their material water-related risks, track the effects of changes in their water management practices, and credibly report their trends and impacts to key stakeholders (Morrison & Schulte, 2010; The CEO Water Mandate, 2024). Thus, it enables efficient and effective management of business-level water resources, protecting investments and limiting environmental impacts while safeguarding the organization's operating license (Burritt & Christ, 2015). However, limitations that hamper companies' ability to properly apply water accounting were recognized (e.g., nascent methods, lack of capacity among company personnel, poor water management and governance infrastructure, lack of cooperation and harmonization among key actors, and inadequate communication and engagement with relevant stakeholders) (Morrison & Schulte, 2010). While these limitations were tracked over a decade ago, the most recent water accounting frameworks have struggled to overcome those issues and avoid overlapping tools (Egan & Agyemang, 2022). This creates a demand to, besides addressing those challenges, recognize related opportunities and identify current and future paths for water accounting. However, accounting professionals and researchers appear to underestimate their role in actually advancing water resources issues while preserving the earth's capacities, business stability, and life.

Therefore, this theoretical essay addresses water issues within the accounting field by recognizing three interrelated approaches that drive corporate water accounting implementation - Water Risk, Water Resources Management, and Water Reporting. We acknowledge its concepts, tools, challenges, and opportunities while tracing our future expectations. Furthermore, based on the theoretical contributions discussed, we point out some challenges managers face and future research opportunities. Through this academic theoretical background, the questions we raised,

the current professional state of water accounting, and our perspective on its next steps, we expect more researchers and professionals to engage with the topic. This could include accountants, engineers, meteorologists, hydrologists, and others. Moreover, we hope the discussion contributes to achieving the Sustainable Development Goals (SDG) 6 – "Clean Water and Sanitation" and making a difference in the firm's relationship with the water resources.

The essay is structured into four main chapters: "Corporate Water Risk", "Water Resources Management", "Corporate Water Reporting", and "What to Expect over the Future of Water Accounting?". Finally, we close the study with "Final Reflections: Navigating The Theoretical Terrain".

2 CORPORATE WATER RISK

Water is a critical resource for businesses to maintain operational continuity and sustainable competitive advantage (Zhu et al., 2023). However, the Carbon Disclosure Project's (CDP) 2017 water report states that 60% of over 2000 reporting companies face water-related risks, with 56% expecting these risks to materialize in the next six years (CDP, 2017). Thus, water-related business risk is a growing concern worldwide, especially in sectors heavily relying on water, such as agriculture, energy production, mining, and materials (Burritt & Christ, 2018; OECD & World Water Council, 2023). According to the WWF (2018), businesses and water have a dependence and impact relationship – dependency on water since the degradation of freshwater resources can create physical risk for companies that depend on them (such as water scarcity, flood, low water quality, ecosystems degradation, basin water risks, and operational water risk); and negative impacts on water can create regulatory, reputational, and other risks. These risks can also impact a company's reputation, investor expectations, and overall performance, putting them at risk of facing penalties and financial losses (e.g., operational cost increase, loss in revenue, loss of brand value and investor's financial investments) (WWF, 2018; Zhu et al., 2023). Besides, corporate water risk strongly correlates with firm region and industry, so companies might identify and handle these water risk concerns differently.

Despite the different reactions, according to the OECD Environment Focus (2023), mitigating water risk is a condition for financial stability. Besides, there is a joint agreement that the potential financial impacts of water risks are far more significant than the costs of addressing them (CDP, 2021). One notable example is explored by Burritt and Christ (2018) in a case study on the Samarco tailings dam disaster in Brazil. The authors point out the shortfall in the knowledge of water risk involving mismanagement by Samarco Mineração S.A. The issues include too much discretion given to joint ventures in assessing water risk, the need for a specialized water risk function, and improved contingency planning for downstream communities impacted by the organization's activities.

Consequently, this disregard for water-related risk made the company responsible for the so-called "worst mining accident in Brazilian history" at the time. The Brazilian disaster scenario changed in the following years with the even worse mining "accident" at Brumadinho, with far more deaths than the Samarco case in Mariana, demonstrating the social impact linked to the mismanagement of environmental and water risks. However, failures to identify socio and environmental risks seem to be repeating in Brazil, as seen more recently in the salt mine rupture in Maceió. We are pointing it out to highlight the necessity of engaging various experts to tackle water risks better. Thus, water accounting plays an essential role in helping to identify and address those risks, providing helpful information to manage those resources, and reporting them to key stakeholders. *But are accounting professionals aware of the potential role that accounting plays in water risk management?*

To address water-related risks, they must first be correctly identified and classified. Thus, there are some common types of water risks that both companies and investors could face. While Levinson et al. (2008) and the CDP (2013) consider that there are three water-related risks

(physical risks, regulatory, and reputation), Adrio (2012) and Nikolaou et al. (2014) include a fourth risk in this list - the litigation risk. More recently, the Climate Disclosure Standards Board (CDSB, 2021) expanded this approach by adding technological and market risk. Therefore, this chapter warns about corporate impacts that may arise due to poor recognition of water risks and provides insights into identifying and recognizing such risks based on literature, as shown in Table 1.

Table 1
Types of Corporate Water Risks

Corporate water risk	Definition	Source
Physical risk	Water scarcity and flooding pose physical risks to assets, operations, and supply chains. Those physical water risks directly affect production in sectors where water is consumed or evaporated.	CDSB (2021); Levinson et al. (2008); Liu et al. (2021); OECD & World Water Council (2023)
Regulatory risk	Regulatory risks refer to the legal requirements that businesses must follow in their operations and production practices concerning water themes. To manage the consumption and discharge of certain activities, regulatory responses can involve the implementation of permits, prices, or a combination of both. Water-heavy industries with low-value production processes are most affected by regulations.	CDSB (2021); Levinson et al. (2008); Nikolaou et al. (2014).
Reputational risk	These risks include shifts in stakeholder perceptions of a company's impact on water resources, which could harm its reputation and growth prospects.	CDSB (2021); Levinson et al. (2008); Liu et al. (2021).
Litigation risk	Litigation risks refer to the consequences of lawsuits or other legal actions related to the company's impacts on water levels and water quality. It is usually dependent on the consequences of non-compliance with the Water Act or the general environmental legislation.	Adrio (2012); Liu et al. (2021); Nikolaou et al. (2014).
Technological risk	It's crucial to acknowledge the risks caused by the introduction of new technologies. These risks may have far-reaching implications and should not be overlooked.	CDSB (2021); World Economic Forum (2023).
Market risk	Market risk include changes in market preferences and the non-systematic stock market risk they suffer.	CDSB (2021); Zhu et al. (2023).

Acknowledging these risks led to the proposition of a range of water-related risk frameworks. In the accounting literature, for instance, Nikolaou et al. (2014) developed a framework to assess corporate water risks by utilizing data from their sustainability reports. A multi-theoretical framework was also proposed by Sojamo and Archer Larson (2012) and reviewed by Tello (2013), outlining the role of corporations in developing and disclosing water-risk accounting information. Moreover, a range of engaged organizations developed water risk tools to help companies identify, classify, and evaluate those risks, e.g., The WBCSD Global Water Tool, The Ceres Aqua Gauge, The Water Sustainability Tool (GEMI), Water Risk Filter (WWF). These methodologies are available to professionals interested in mitigating water risks in their company.

Once the water-related risks are recognized, they should be reflected and noted in the financial statements (CDSB, 2021). By having it in financial filings, investors could adequately identify and address water-related risks while receiving vital information about water risk in their portfolios (Adrio, 2012). This demand may result from how water scarcity or pollution risks impact corporate financial performance, as exposed by Levinson et al. (2008). The authors highlighted the financial losses due to the disruption of the production process, the higher costs related to supply chain disruption, changes in production processes, capital expenditures on water concerns, regulatory compliance, and the increased price of consuming or discharging water.

Therefore, investors exposed to these growing risks increasingly demand companies to assess, manage, and disclose water-related risks (Adrio, 2012). These stakeholders' demand is closely linked to the reputational risk mentioned previously. It is also necessary to emphasize that stakeholders go far beyond investors, including local communities, employees, and the government (regulatory risk), only to name a few. These risks must be presented transparently in financial statements and other reports, including integrated reports.

Finally, the literature on water accounting highlights a severe issue in how companies manage and disclose their water risk concerning their supply chain. As exposed by Barton (2010), in companies where water use embedded in the supply chain accounts for a significant portion of water footprint, "companies should disclose how they are evaluating suppliers on-water performance, and set related performance goals." However, the CDP (2011) exposed that water-sensitive sectors still have limitations in identifying whether their supply chains are exposed to water risks. It makes water risk mapping on the supply chain a major challenge for businesses (Ernst & Young, 2012).

3 WATER RESOURCES MANAGEMENT

Concerning water management, the involvement of businesses in water concerns is widely recognized, as they are among the largest consumers of freshwater worldwide (Ortas et al., 2019). In Brazil, economic activities (including agriculture, industry, energy production, and water services, among others) accounted for 98.3% of total water consumption in 2020, while households accounted for the remaining 1.7% (IBGE & ANA - Agência Nacional de Águas e Saneamento Básico, 2023). However, despite the large corporate consumption, managers cannot guarantee water availability and low prices. In some countries, the awareness of managing financial exposure associated with water supply risk already makes water users trade water rights on the stock market (e.g., Nasdaq Veles California Water Index). Water concerns require management improvements to appropriately deal with water risk and scarcity (Burritt & Christ, 2018). Thus, Corporate Water Management Accounting is proposed as a sub-discipline of Environmental Management Accounting designed to support corporate management decisions and improve economic and environmental water-related business outcomes (Christ & Burritt, 2017c).

Accounting gained space in water resources management literature to support corporate water management decisions. In general, previous accounting research on water management identifies the motivators and difficulties of applying water management practices (e.g. Burritt & Christ, 2017; Martínez et al., 2021; Ortas et al., 2019); develops in-depth studies on the application of water systems in companies through case studies (e.g. Burritt & Christ, 2018; Christ, 2014; Egan, 2014; Joa et al., 2014); or proposes a new or adapted water management system (e.g. Aivazidou et al., 2018; Christ & Burritt, 2017c; Nikolaou et al., 2014).

To effectively implement water management accounting in business, we might address some points to facilitate the process. Firstly, according to Christ and Burritt (2017a), the minimum requirements for a corporate water accounting system should include five elements: the level of analysis, the type of data, the timeframe adopted, the categorization and evaluation of corporate water risks, and the transdisciplinary nature of water management. Collectively, those key elements make it possible to create a framework comprising the minimum requirements for an effective corporate water accounting system and how they relate to the company's context and structure.

Secondly, Burritt and Christ (2017) state the necessity of paying attention to monetary water information. Although physical information is necessary to improve corporate water management, the financial bottom line drives management decision-making. Christ (2014) agrees with that statement by exploring water management in Australian wine supply chains. The author assumes that access to appropriate forms of physical and monetary data is vital to operating water sustainably. However, analyzing eighteen contemporary water accounting initiatives, Burritt and

Christ (2017) observed that fourteen (78%) had no monetary indicators to apply, while physical indicators were present in all of them. This discrepancy may reflect the irrelevance or neglect companies attribute to collecting accurate financial water data due to its low price, which hides its actual value. In a macroeconomic scenario, the System of Environmental and Economic Accounting for Water (SEEA-Water) framework (United Nations, 2012) offers a water statement similar to financial filings that equally attributes water accounts in both physical and monetary units. *But in a corporate scenario, do managers have enough water data to evaluate its monetary impacts properly while expressing its actual worth?* In many cases, the lack of sufficient data is the most significant factor limiting the ability of corporate water accounting to provide meaningful information on water-related impacts and risks (Morrison & Schulte, 2010), and managers should use their discretion to express the actual value of water adequately.

Thirdly, while researching water accountability, Egan (2014) highlights some findings from an Australian university. According to the author, water accountability mechanisms cannot function without measurement. However, measurement is insufficient since senior management availability and engagement are also required. An empirical investigation of listed companies in Indonesia, Wicaksono et al. (2024) indicates that the government might be an efficient player in actively pressing managers to disclose more water-related information. Therefore, it is notable that an executive engagement with water concerns, aligned with available water information to be measured, is essential to boost appropriate corporate water management.

Therefore, by overcoming its limitations, companies must strive to implement water resources management practices successfully. We must reinforce that poor water management can disrupt business, besides affecting human health and the ecosystem (Burritt et al., 2016). Various water resource management systems are being developed to avoid these negative impacts and help managers in this path of managing water sustainably. For instance, accounting scholars are developing proposals for water management frameworks, such as the ones produced by Zhang and Tang (2019). Aligned with the principle that "only what is measured can be managed," the authors propose a theoretical water management system including water accounting/management elements and procedures. It is designed to integrate water management into every corporate management aspect, with concepts similar to environmental and carbon management systems. Besides, other tools might help companies properly manage water, such as the Water Footprint Assessment, Water ISO Standard 14046, and The Australian General-Purpose Water Accounting (Gibassier, 2018).

Regardless of the strategies or frameworks chosen for each type of organization, by addressing water management effectively, the critical importance of high-quality water-related information to inform decision-making gains recognition (Chalmers et al., 2012). Thus, there's growing interest in organizational accounting of water management, spanning internal (management accounting) and external (reporting) interests (Russell, 2021).

4 CORPORATE WATER REPORTING

Corporate water reporting is essential for enterprises to convey information about water management and risks to external interests (Zhou et al., 2018). It is an effective and credible signal for companies to demonstrate their commitment to responsible business practices. The company issues water information disclosure internally and can be reviewed by investors through Corporate Social Responsibility (CSR), sustainability, and environmental-related reports. These reports can influence external observers' perceptions of the company's development prospects (Liu et al., 2021). Besides, strategies of water reporting can help companies comprehend their water risks and related cost information and profit opportunities. This understanding provides a basis for implementing effective water resource management (Zhou et al., 2018). In summary, disclosing accounting for corporate water use and impacts is essential in helping companies improve their

efforts to advance sustainable water management and meet external stakeholders' expectations (Morrison & Schulte, 2010).

The disclosure of water information is gaining recognition among practitioners, stakeholders, and researchers. Literature has identified several internal and external stakeholders showing interest in water-related disclosure. It includes investors/rating agencies, suppliers/customers, trade organizations, employees, regulators, the public and government, consumers, local communities, and non-government organizations (Burritt et al., 2016). This wide range of interested stakeholders is probably mainly because water is a shared resource in which one user's activities can harm other users' activities (Christ & Burritt, 2017c). Therefore, managers should recognize these stakeholders' demands by engaging in more water action and disclosure to fulfill their expectations (Wicaksono & Setiawan, 2022). Besides, Hazelton (2013) argues that corporate water-related disclosure constitutes a human right. For this reason, it has a "moral force" that establishes that access to its information may catalyze policy change. Thus, sharing water information with key institutional investors might be a strategic tool for implementing self-regulation when belonging to a water-intensive industry (Zhang et al., 2021).

Water information might be shared with stakeholders through a range of guidance developed by business and nongovernmental organizations progressing in guiding water reporting. For instance, companies aiming to develop their sustainability reporting through the Global Reporting Initiative (GRI) Standards (GRI, 2018) have a range of water indicators available on GRI 303 – Water and Effluents 2018. It includes water management material topics to be disclosed and other required information, besides some recommendations and guidance for reporting. Moreover, the CDP is an investor-led initiative to collect climate change, water, and forest-related corporate disclosures into a repository (CDP, 2011). In 2010, the CDP's water security questionnaire was established, and today, it consists of a valuable benchmarking measure since it provides a water scoring methodology beyond driving companies' improvements in water management. The questionnaire reflects the CEO Water Mandate narrative, with modules comprising corporate water accounting metrics, value chain engagement activities, business impacts, water risk and opportunities, facility-level water accounting, water governance, and business strategy, to name a few (CDP, 2024). More recently, the industry-based Sustainability Accounting Standards Board (SASB) Standards enable companies to disclose sustainability-related risks and opportunities, including water-related ones in industries where water is a material topic, that could impact their cash flows, access to finance, or cost of capital in the short, medium, or long term. Seventy-seven industry classifications are included in the standards, respecting the most relevant issues in each field (SASB, 2024).

Despite the various initiatives related to water reporting, most listed companies are still not required to disclose water information, making water reporting a voluntary environmental activity. Notwithstanding, despite the pandemic, we saw a 20% increase in corporate water disclosure through CDP's water security questionnaire in 2020 and a 16% increase in 2021 (CDP, 2021, 2023). A similar trend was observed in sustainability reports, with a global rise of five percentage points from 2017 to 2020 (KPMG, 2020). This increase in sustainability reporting is likely to be reflected in the reporting of water information, as companies may disclose it through various sources, such as Sustainability Reports, Financial Reports, CSR Reports, Corporate Environmental Impact Annual Reports, and other environment-related reports on the firms' official websites (Liu et al., 2021), as well as specific guidelines such as the CDP.

On the other hand, reviews indicated that the practices for reporting water were still insufficient (Egan et al., 2015; Morrison & Schulte, 2010). According to Hazelton's (2015) investigation, there are significant opportunities for improvement in water disclosure, as he revealed some poor water reporting in terms of quality and quantity. While some leading corporations take water disclosures seriously, many others provide only cursory water information. Furthermore, few organizations adequately report water risks (or opportunities), and even fewer

evaluate water issues across their supply chain. Numerous other research findings highlight inadequate disclosure quality and advocate for improved reporting on water-related matters throughout operations and supply chains (e.g. Christ & Burritt, 2017a, 2018; Russell, 2021). This reluctance to disclose water information might result from a range of inherent limitations, such as the ambiguity of key water concepts (Hewawithana et al., 2023), the lack of interest from large shareholders (Wicaksono et al., 2024) and communities (Egan et al., 2015), the concern about the authenticity of water data that may result in accusations of greenwashing (Liu et al., 2022), the necessity of embracing an effective interdisciplinary team (Christ & Burritt, 2018; Tingey-Holyoak & Pisaniello, 2019), and the disparity of water accounting frameworks available (Tingey-Holyoak & Pisaniello, 2019). *So, wouldn't accounting contribute to the standardization and reporting of water information, given its role in reporting financial and non-financial information for more accurate decision-making?* Therefore, there is a challenge in improving accounting, given the factors that hamper companies' ability to effectively measure, assess, and report their water use and impacts (Christ & Burritt, 2017c; Morrison & Schulte, 2010).

5 WHAT TO EXPECT OVER THE FUTURE OF WATER ACCOUNTING?

The growing concerns raised by the more frequent environmental disasters threatening human life have attracted the attention of many across the globe – as they did with finance and accounting professionals. In 2004, Accounting for Sustainability (A4S) was established by His Majesty King Charles III to encourage financial leaders to take action towards creating sustainable business models and a resilient economy. The organization aims to transform financial decision-making to reflect opportunities and risks posed by environmental and social issues (A4S, 2024). Despite initial resistance from the traditional economics and finance-based accounting community, social and environmental accounting research is moving from the margins of accounting literature to center stage (Parker, 2011), gaining prominence on various concerns, as it does to water. Thus, water accounting has gained increasing prominence among leaders, professionals, and society, and, as Hazelton (2013) stated, is fundamental to the most important debates occurring in the world today.

Water accounting is “the systematic process of identifying, recognizing, quantifying, reporting, assuring and publishing information about water, the rights or other claims to that water, and the obligations against that water” (Water Accounting Standards Board, 2014, p. 8). It is considered a critical factor in promoting water governance, as it aims to tackle the global water challenge. To achieve this, water accounting must incorporate concepts like "virtual water" and address the local impact on river basins by linking organizational data with local information (Gibassier, 2018). A macro perspective of water accounting can track this bigger scope, comprising governors, watersheds, and whole economies. This perspective might be the subject of a more frequent accounting agenda since accountants' contributions are in the eyes of non-government organizations, the public, and even the royalty.

We might easily identify similarities between the general accounting profession and the corporate water accounting we have addressed. Mitigating corporate risk, providing data for adequate corporate management, and reporting relevant information for accurate decision-making among stakeholders are all aspects of accounting, including water accounting. Furthermore, there is a relevant aspect that we accountants are more than used to dealing with – accounting standards. Thus, sustainability accounting standards are shaping the future of our profession. As we write, the International Sustainability Standards Board (ISSB) is working in an enormous evolution toward advancing the value of corporate sustainability reporting worldwide.

In the second half of 2023, the ISSB launched its first disclosure standards – S1 and S2. While they were its first-born initiatives, dealing with General Requirements for Disclosure of Sustainability-Related Financial Information (S1) and Climate-Related Disclosures (S2), there is a priorities agenda discussing its next steps under standardization. Water-related concerns might

not have a specific norm yet, but we can track some paths oriented by the ISSB. According to the S1, an organization may refer to and apply the CDSB Framework Application Guidance for Water-related Disclosures (IFRS, 2023). This guidance helps companies report material water-related information that ensures investors receive the information needed to drive a sustainable, resilient, and water-secure economy (CDSB, 2021). We, therefore, believe the CDSB might be an agent of great influence under the future water standards. Sustainability specialists could start paying deeper attention to this guidance to facilitate the company's engagement within a bigger adaptation period, especially if aligned with the CDP and the SASB mentioned above.

Brazil's engagement with the ISSB has gained emphasis among other jurisdictions. In 2022, the Federal Council of Accounting (*Conselho Federal de* Contabilidade - CFC) approved the creation of the Brazilian Committee for Sustainability Pronouncements (*Comitê Brasileiro de Pronunciamentos de Sustentabilidade* - CBPS), which aims to adjust and implement the ISSB standards to the Brazilian reality. Brazilian listed companies might apply the IFRS S1 and S2 (the so-called Brazilian's *Normas Brasileiras de Contabilidade para Divulgação de Informações sobre Sustentabilidade* - NBC TDS) voluntarily in 2024 and from the 2026 report, it becomes mandatory (CFC Resolution No. 1,710, 2023).

Moreover, another perspective concerns both the IFRS and the CBPS, drawing the future of water accounting – water auditing. According to Lyu et al. (2023), water auditing is a vital tool for water accounting since it identifies areas that require corrective action to direct water management and control and ensures consistent implementation of water accounting systems. Moreover, Silveira and Van Bellen (2021) state that reporting water management practices and corporate impacts may have its relevance strengthened by the water information that is assured externally. Therefore, we reinforce the necessity to provide adequate and reliable information about an entity's water risks and management to improve water accounting relevance fairly. It might be an even bigger concern for Brazilian practitioners and researchers, with the release of the Standard on Sustainability Assurance, the so-called *Normas Brasileiras de Contabilidade para Asseguração de Divulgação de Informações de Sustentabilidade* (NBC TAS), and the requirement to externally assure sustainable information by an independent auditor registered within the Brazilian Securities and Exchange Commission (CVM) (CVM Resolution No. 193, 2023).

Regarding other aspects of the future of water accounting, we hope some of the factors that challenge the field development highlighted in this essay might be overcome. For instance, the ambiguity of key concepts that could damage the global accessibility and comparability of sustainability information is a concern that caused the ISSB to propose a Sustainability Disclosure Taxonomy. Besides, using water-related monetary information will probably be more frequent with the ISSB's requirements for cross-sustainability information with its effects on the entity's financial performance and position (IFRS, 2023). Hopefully, linking water data with its economic impacts will shed light on the value of nature while increasing the debates about the multiple ways accounting can contribute to water safety.

However, accounting alone will not solve water issues. Reflecting the multidisciplinary nature of water, developing interdisciplinary and transdisciplinary research will then enhance water accounting practices and frameworks. Accountants are and will be central to water accounting, but other professionals, such as engineers, meteorologists, hydrologists, and applied scientists, are also core to the fragmented water knowledge generation (Christ & Burritt, 2018; Russell, 2021). It poses a challenge for water-sensitive smaller firms (Tingey-Holyoak & Pisaniello, 2019) that should fit water risk management and reporting to avoid getting lost in this wave of change.

Despite our hope that accountants will be able to overcome the water accounting challenges, much still needs to be done. In 2022, 53% of the companies requested to disclose water-related data through CDP refused to, including Apple Inc., Tesla Inc., and Shell (CDP, 2023). While the CDP made an optimistic statement, saying that failing to respond will

increasingly become outliers, we prefer to argue about this low adoption rate. Water accounting might sound like a recent concern, but researchers have established environmental accounting since Gray (1990), and we could easily track even later mentions. In the same way, companies seem to be deeply engaged with climate change measurement and disclosure and forgetting about how water risks and opportunities are associated. We do not intend to overcome a problem under others, but companies cannot overlook other related material environmental factors. In order to contribute towards building a more sustainable economy, companies should keep track of their impact and evaluate ways to minimize it within a multidisciplinary team. Fostering an organizational culture that cherishes creating more value for everyone is vital. By acknowledging accounting's role in achieving this run, we can help achieve this goal and create a better world for everyone. As Burritt and Christ (2015) stated, corporate water accounting enables efficient and effective management of business-level water resources, protecting investments and limiting environmental impacts, "thereby safeguarding the organization's license to operate."

6 FINAL REFLECTIONS: NAVIGATING THE THEORETICAL TERRAIN

According to Latiff and Marimuthu (2021), water resources management has emerged globally as an important research area acknowledged as a crucial factor in achieving the United Nations SDG. Despite its significance, water reporting regarding water and its risks among companies is alarmingly weak. Many companies are not effectively measuring, managing, and disclosing their water-related risks. To overcome those challenges, "water management and accounting should become a part of the core accounting curriculum to help recognize the new environment in which businesses now operate" (Burritt & Christ, 2015).

Thus, this essay addressed water issues within the accounting field by recognizing three interrelated approaches that drive corporate water accounting implementation - Water Risk, Water Resources Management, and Water Reporting. These three aspects must be considered and carefully managed for corporate water accounting to be successfully implemented among companies. Focusing on only one part of those might harm the organization, as stated by Burritt and Christ (2018). We hope this theoretical essay has clarified some relevant water accounting concepts and presented useful tools for each approach while identifying its most concerning challenges and tracing its current state, especially in Brazil, besides our future expectations for water accounting development. Given that, based on the theoretical contributions discussed, we pointed out some challenges managers face when engaging with water accounting and some research opportunities aligned to the most outstanding approaches in each case - Corporate Water Risk, Water Resources Management, and Corporate Water Reporting, as follows (Table 2).

Table 2

Challenges faced by managers and research opportunities on Water Management and Accounting

Water Risk	Water Management	Water Reporting	Challenges Faced by Managers	Research Opportunities	Theoretical Background
✓	✓		To adequately address if their supply chains are exposed to water-related risks and how to manage them.	To identify water risks in the supply chain based on the challenges the current water-risks methodologies face according to previous literature and surveys made with sustainability experts.	Barton (2010); Ernst & Young (2012)

✓		✓	To recognize their water-related risks on their financial filings to help investors to address those concerns and minimize their water risks information asymmetries in their portfolios.	To analyse the implication of the different types of water-related business risks managers are considering, on the quality of the water information reported to external stakeholders.	Adrio (2012); Levinson et al. (2008); Nikolaou et al. (2014)
	✓	✓	To apply water management systems that consider both physical and monetary water information.	To develop case studies on the application of a proposal water accounting system in water-sensitive industries that highlight physical and monetary information.	Burritt and Christ (2017); Christ (2014)
✓	✓		To have sufficient data to implement a corporate water management that provides meaningful information on water-related impacts and risks.	To analyse water management mechanisms applied in different scenarios of water risk, finding the best practices to be replicated in each water security context.	Egan (2014); Morrison and Schulte (2010)
	✓	✓	To improve water information being reported in both quality and quantity.	To improve the few pre-existing measures that evaluate the quality of water information reported.	Burritt et al. (2016); Liu et al. (2021); Morikawa et al. (2007); Zeng et al. (2020)

Although we acknowledge managers' and reporting institutions' efforts in developing sustainable solutions for water preservation, we cannot take this starting point for granted. We must emphasize that achieving water security is complex and requires action that goes far beyond water-saving techniques and reported water-related information. An interplay among different actors and a deeper and genuine change in how businesses are done is required.

In a very critical way, Gray (2010, p.57) mentions that "sustainability is both an ecological and societal concept which will only rarely, if at all, coincide with corporate or organizational boundaries." Despite becoming an active actor in water security remains deeply challenging, with some elusive answers embedded, there is still much progress to be made and positive finish lines to be reached. But there is, absolutely, a race. And we need to ensure we are in the right direction.

While accounting has sought to offer a pathway to contribute with transparency, measures, frameworks, accounts, and requirements relating to a company's water performance, accountants still require a deeper engagement with a range of disciplines to actually advance on earth's carrying capacities and respect its planetary boundaries. We close our navigation with Baker et al.'s (2023) statement. "People can create change – and must be empowered to do so. Change must be sought immediately but also thoughtfully and pragmatically."

REFERENCES

A4S. (2024). *A4S Aims*. Accounting for Sustainability. https://www.accountingforsustainability.org/en/about-us/overview.html

Adrio, B. (2012). Clearing the waters: A review of corporate water risk disclosure in SEC filings. *A Ceres Report*, *June*, 45. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Clearing+the+Waters+:+A+Review+of+Corporate+Water+Risk+Disclosure#0%5Cnhttp://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Clearing+the+waters:+A+review+of+corporate+water+risk+disclo

Aivazidou, E., Tsolakis, N., Vlachos, D., & Iakovou, E. (2018). A water footprint management framework for supply chains under green market behaviour. *Journal of Cleaner Production*, *197*, 592-606. https://doi.org/10.1016/j.jclepro.2018.06.171

Baker, M., Gray, R., & Schaltegger, S. (2023). Debating accounting and sustainability: from incompatibility to rapprochement in the pursuit of corporate sustainability. *Accounting, Auditing and Accountability Journal*, *36*(2), 591-619. https://doi.org/10.1108/AAAJ-04-2022-5773

Barton, B. (2010). Murky Maters: Corporate Reporting on Water Risk. *Governance An International Journal Of Policy And Administration*, *February*, 98. http://sites.nationalacademies.org/cs/groups/pgasite/documents/webpage/pga_057571.pdf%0Ahttp://www.ceres.org/resources/reports/corporate-reporting-on-water-risk-2010/view

Burritt, R., & Christ, K. (2015). Is it time for your business to consider water management accounting? In *Acuity*. https://www.acuitymag.com/business/time-to-consider-water-management-accounting

Burritt, R. L., & Christ, K. L. (2017). The need for monetary information within corporate water accounting. *Journal of Environmental Management*, *201*, 72-81. https://doi.org/10.1016/j.jenvman.2017.06.035

Burritt, R. L., & Christ, K. L. (2018). Water risk in mining: Analysis of the Samarco dam failure. *Journal of Cleaner Production*, *178*, 196-205. https://doi.org/10.1016/j.jclepro.2018.01.042

Burritt, R. L., Christ, K. L., & Omori, A. (2016). Drivers of corporate water-related disclosure: evidence from Japan. *Journal of Cleaner Production*, *129*, 65-74. https://doi.org/10.1016/j.jclepro.2016.04.119

CDP. (2011). *CDP Water Disclosure 2010: Global Report* (Vol. 44). https://www.cdproject.net/CDPResults/CDP-Water-Disclosure-Global-Report-2011.pdf

CDP. (2013). *Moving beyond business as usual*. https://cdn.cdp.net/cdp-production/cms/reports/documents/000/000/637/original/CDP-Global-Water- Report-2013.pdf?1470314569

CDP. (2017). *A Turning Tide: Tracking Corporate Action on Water Security. CDP Global Water Report 2017* (November). https://www.cdp.net/en/research/

CDP. (2021). *A wave of change: the role of companies in building a water-secure world*. https://6fefcbb86e61af1b2fc4-c70d8ead6ced550b4d987d7c03fcdd1d.ssl.cf3.rackcdn.com/cms/reports/documents/000/005/577/original/CDP_Water_analysis_report_2020.pdf?1614687090

CDP. (2023). Riding the wave: How the private sector is seizing opportunities to accelerate progress on water security. In *CDP Global Water Report 2022* (March). https://www.cdp.net/en/research/global-reports/global-water-report-2022

CDP. (2024). *CDP Water Security 2023 Questionnaire*. https://guidance.cdp.net/en/guidance?cid=48&ctype=theme&idtype=ThemeID&incchild=1&microsite=0&otype=Questionnaire&tags=TAG-646%2CTAG-607%2CTAG-599

CDSB. (2021). *CDSB Framework: Application guidance for water-related disclosures* (1). cdsb.net/water

CFC Resolution No. 1,710, October 25, 2023 (2023). https://www.in.gov.br/en/web/dou/-/resolucao-cfc-n-1.710-de-25-de-outubro-de-2023-520669405

Chalmers, K., Godfrey, J., & Potter, B. (2012). Discipline-Informed Approaches to Water Accounting. *Australian Accounting Review*, *22*(3), 275-285. https://doi.org/10.1111/j.1835-2561.2012.00175.x

Christ, K. L. (2014). Water management accounting and the wine supply chain: Empirical evidence from Australia. *British Accounting Review*, *46*(4), 379-396. https://doi.org/10.1016/j.bar.2014.10.003

Christ, K. L., & Burritt, R. L. (2017a). Supply chain-oriented corporate water accounting: a research agenda. *Sustainability Accounting, Management and Policy Journal*, *8*(2), 216-242. https://doi.org/10.1108/SAMPJ-05-2016-0029

Christ, K. L., & Burritt, R. L. (2017b). What Constitutes Contemporary Corporate Water Accounting? A Review from a Management Perspective. *Sustainable Development*, *25*(2), 138-149. https://doi.org/10.1002/sd.1668

Christ, K. L., & Burritt, R. L. (2017c). Water management accounting: A framework for corporate practice. *Journal of Cleaner Production*, *152*, 379-386. https://doi.org/10.1016/j.jclepro.2017.03.147

Christ, K. L., & Burritt, R. L. (2018). The role for transdisciplinarity in water accounting by business: reflections and opportunities. *Australasian Journal of Environmental Management*, *25*(3), 302–320. https://doi.org/10.1080/14486563.2018.1460631

CVM Resolution No. 193, October 20, 2023, (2023). https://conteudo.cvm.gov.br/export/sites/cvm/legislacao/resolucoes/anexos/100/resol193.pdf

Egan, M. (2014). Making water count: water accountability change within an Australian university. *Accounting, Auditing & Accountability Journal*, *27*(2), 259-282. https://doi.org/10.1108/AAAJ-07-2012-01059

Egan, M., & Agyemang, G. (2022). An exploration of developing approaches to water accounting. In *Handbook of accounting and sustainability* (pp. 279-299).

Egan, M., Frost, G., & Andreeva, Z. (2015). *Eroding corporate water reporting? A study of the Australian food, beverage and tobacco sector*. https://www.cpaaustralia.com.au/tools-and-resources/environmental-social-and-governance/future-of-corporate-reporting

Ernst & Young. (2012). Preparing for water scarcity: raising business awareness on water issues. In *EYGM Limited*. https://www.pseau.org/outils/ouvrages/ernst_young_preparing_for_water_scarcity_2012.pdf

Gibassier, D. (2018). Corporate water accounting, where do we stand? The international water accounting field and french organizations. *Advances in Environmental Accounting and Management*, *7*(July), 31-65. https://doi.org/10.1108/S1479-359820180000007002

Gray, R. (1990). The greening of accountancy: The profession after pearce. In *Chartered Association of Certified Accountants*.

Gray, R. (2010). Is accounting for sustainability actually accounting for sustainability...and how would we know? An exploration of narratives of organisations and the planet. *Accounting, Organizations and Society*, *35*(1), 47-62. https://doi.org/10.1016/j.aos.2009.04.006

GRI. (2018). *GRI 303: Water and Effluents 2018*. https://www.globalreporting.org/standards/media/1909/gri-303-water-and-effluents-2018.pdf

Hazelton, J. (2013). Accounting as a human right: the case of water information. *Accounting, Auditing & Accountability Journal*, *26*(2), 267-311. https://doi.org/10.1108/09513571311303738

Hazelton, J. (2015). Developments in Corporate Water Accounting and Accountability. In *Sustainability After Rio (Developments in Corporate Governance and Responsibility)* (8th ed, p. 27-55). Emerald Group Publishing Limited. https://doi.org/10.1108/S2043-052320150000008002

Hewawithana, D., Hazelton, J., Walkerden, G., & Tello, E. (2023). Will the revisions to GRI 303 improve corporate water reporting? The challenges of defining and operationalising "water stress". *Meditari Accountancy Research*, *31*(2), 320-343. https://doi.org/10.1108/MEDAR-12-2019-0639

IBGE, & ANA - Agência Nacional de Águas e Saneamento Básico. (2023). *Contas econômicas ambientais da água: Brasil 2018-2020* (8). https://biblioteca.ibge.gov.br/index.php/biblioteca-catalogo?view=detalhes&id=2102001

IFRS. (2023). *IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information*. https://www.ifrs.org/issued-standards/ifrs-sustainability-standards-navigator/ifrs-s1-general-requirements/#about

Joa, B., Hottenroth, H., Jungmichel, N., & Schmidt, M. (2014). Introduction of a feasible performance indicator for corporate water accounting e a case study on the cotton textile chain. *Journal of Cleaner Production*, *82*, 143-153. https://doi.org/10.1016/j.jclepro.2014.06.075

KPMG. (2020). The time has come: The KPMG Survey of Sustainability Reporting 2020. In *KPMG* (Vol. 11). https://doi.org/10.6004/jnccn.2019.0020

Latiff, N., & Marimuthu, F. (2021). Water-related sustainability reporting practices amongst South African mining and non-mining corporations. *Environmental Economics*, *12*(1), 112-123. https://doi.org/10.21511/ee.12(1).2021.10

Levinson, M., Lee, E., Chung, J., Huttner, M., Danely, C., Mcknight, C., & Langlois, A. (2008).

Watching Water: a guide to evaluating corporate risks in a thirsty world. In *J.P. Morgan, Global Equity Research* (March). https://pdf.wri.org/jpmorgan_watching_water.pdf

Liu, C., Su, K., & Zhang, M. (2021). Water disclosure and financial reporting quality for social changes: Empirical evidence from China. *Technological Forecasting and Social Change*, *166*, 120571. https://doi.org/10.1016/j.techfore.2021.120571

Liu, C., Su, K., & Zhang, M. (2022). Do boards practice what they preach on nonfinancial disclosure? Evidence from China on corporate water information disclosures. *China Accounting and Finance Review*, *25*(2), 249-289. https://doi.org/10.1108/cafr-07-2022-0080

Lamb, C. (2018). *SDG6: How corporate action is driving a water-secure future*. CDP. https://www.cdp.net/en/articles/water/sdg6-how-corporate-action-is-driving-a-water-secure-future

Lyu, F., Zhang, H., Dang, C., & Gong, X. (2023). A novel framework for water accounting and auditing for efficient management of industrial water use. *Journal of Cleaner Production*, *395*(126), 136458. https://doi.org/10.1016/j.jclepro.2023.136458

Martínez, S. S., Velázquez, E. Á., & Benítez, L. S. (2021). Environmental water accounting in sustainable companies established in mexico. *Revista Venezolana de Gerencia*, *26*(5), 614-631. https://doi.org/10.52080/rvgluz.26.e5.39

Mishra, A., & Verbist, K. (2021). *Addressing water security, climate impacts and adaptation responses in Africa, Asia, Latin America and the Caribbean: accomplishment report*. https://unesdoc.unesco.org/ark:/48223/pf0000377252.locale=en

Morikawa, M., Morrison, J., & Gleick, P. (2007). Corporate Reporting on Water: A Review of Eleven Global Industries. In *Pacific Institute for Studies in Development, Environment, and Security* (May).

Morrison, J., & Schulte, P. (2010). *Corporate Water Accounting: an analysis of the methods and tools for measuring water use and its impacts*. https://unglobalcompact.org/library/135

Nikolaou, I. E., Kourouklaris, G., & Tsalis, T. A. (2014). A framework to assist the financial community in incorporating water risks into their investment decisions. *Journal of Sustainable Finance & Investment*, *4*(2), 93-109. https://doi.org/10.1080/20430795.2013.823853

OECD Environment Focus. (2023). *Financing Water: beyond traditional economic thinking, it 's time for global action*. https://oecd-environment-focus.blog/2023/03/14/financing-water-beyond-traditional-economic-thinking-its-time-for-global-action/#comments

OECD, & World Water Council. (2023). *A new frontier: the financial materiality of water risks* (February). https://www.oecd.org/water/background-note-financial-materiality-9th-RT-on-financing-water.pdf

Ortas, E., Burritt, R. L., & Christ, K. L. (2019). The influence of macro factors on corporate water management: A multi-country quantile regression approach. *Journal of Cleaner*

Production, *226*, 1013-1021. https://doi.org/10.1016/j.jclepro.2019.04.165

Parker, L. D. (2011). Twenty-one years of social and environmental accountability research: A coming of age. *Accounting Forum*, *35*(1), 1-10. https://doi.org/10.1016/j.accfor.2010.11.001

Peng, X., Lan, Y.-C., Li, J., & Fan, H. (2023). Board gender diversity, national culture, and water disclosure of multinational corporations. *Applied Economics*, *55*(14), 1581-1602. https://doi.org/10.1080/00036846.2022.2098240

Russell, C. (2023). *How "water for all" is good for business, not just a moral imperative*. World Economic Forum. https://www.weforum.org/agenda/2023/03/how-water-for-all-is-good-for-business-not-just-a-moral-imperative/

Russell, S. (2021). Water. In *Routledge Handbook of Environmental Accounting* (p. 365-376). Routledge. https://doi.org/10.4324/9780367152369-32

SASB. (2024). *SASB Standards overview*. SASB Standards. https://sasb.org/standards/

Silveira, G. B., & Van Bellen, H. M. (2021). Disclosure corporativo da água: quais informações são asseguradas externamente? *Enfoque: Reflexão Contábil*, *40*(3), 61-78. https://doi.org/10.4025/enfoque.v40i3.52892

Sojamo, S., & Archer Larson, E. (2012). Investigating food and agribusiness corporations as global water security, management and governance agents: the case of Nestlé, Bunge and Cargill. *Water Alternatives*, *5*(3), 619-635.

Tello, E. (2013). From Risks to Shared Value? Corporate Strategies in Building a Global Water Accounting and Disclosure Regime. *Social and Environmental Accountability Journal*, *33*(2), 116-117. https://doi.org/10.1080/0969160X.2013.820414

The CEO Water Mandate. (2024). *Corporate Water Accounting*. https://ceowatermandate.org/accounting/accounting-basics/

Tingey-Holyoak, J., & Pisaniello, J. D. (2019). Water accounting knowledge pathways. *Pacific Accounting Review*, *31*(2), 258-274. https://doi.org/10.1108/PAR-01-2018-0004

United Nations. (2012). System of Environmental-Economic Accounting for Water. In *SEEA-Water*. https://unstats.un.org/unsd/envaccounting/seeaw/seeawaterwebversion.pdf

United Nations. (2021). *Sustainable Development Goals*. https://sdgs.un.org/goals

Water Accounting Standards Board. (2014). *Water Accounting Conceptual Framework for the Preparation and Presentation of General Purpose Water Accounting Reports*. http://www.bom.gov.au/water/standards/wasb/wacf.shtml

Wicaksono, A. P., & Setiawan, D. (2022). Water disclosure in the agriculture industry: Does stakeholder influence matter? *Journal of Cleaner Production*, *337*(November 2021), 130605. https://doi.org/10.1016/j.jclepro.2022.130605

Wicaksono, A. P., Setiawan, D., Anni Aryani, Y., & Hartoko, S. (2024). The effect of ownership structure on water disclosure in Indonesian companies. *Journal of Open Innovation: Technology, Market, and Complexity*, *10*(1), 100185. https://doi.org/10.1016/j.joitmc.2023.100185

World Economic Forum. (2023). *The Global Risks Report 2023 - 18th Edition*. www.weforum.org

World Resources Institute. (2024). *Secure Freshwater for All*. Our Challenge. https://www.wri.org/freshwater

Zeng, H., Zhang, T., Zhou, Z., Zhao, Y., & Chen, X. (2020). Water disclosure and firm risk: Empirical evidence from highly water-sensitive industries in China. *Business Strategy and the Environment*, *29*(1), 17-38. https://doi.org/10.1002/bse.2347

Zhang, L., & Tang, Q. (2019). Corporate water management systems and incentives to self-discipline. *Sustainability Accounting, Management and Policy Journal*, *10*(3), 592-616. https://doi.org/10.1108/SAMPJ-09-2018-0258

Zhang, L., Tang, Q., & Huang, R. H. (2021). Mind the Gap: Is Water Disclosure a Missing Component of Corporate Social Responsibility? *The British Accounting Review*, *53*(1), 100940. https://doi.org/10.1016/j.bar.2020.100940

Zhou, Z., Liu, L., Zeng, H., & Chen, X. (2018). Does water disclosure cause a rise in corporate risk-taking?—Evidence from Chinese high water-risk industries. *Journal of Cleaner Production*, *195*, 1313-1325. https://doi.org/10.1016/j.jclepro.2018.06.001

Zhu, Y., Zhang, C., Wang, T., & Miao, Y. (2023). Corporate water risk: A new research hotspot under climate change. *Sustainable Development*, *February*, 1-15. https://doi.org/10.1002/sd.2800

AUTHOR CONTRIBUTIONS

Roles	1st author	2nd author
Conceptualization	♦	
Data curation		
Formal analysis	♦	
Funding acquisition		
Investigation	♦	
Methodology	♦	
Project administration	♦	
Resources		♦
Software		
Supervision		♦
Validation		♦
Visualization	♦	
Writing – original draft	♦	
Writing – review & editing	♦	♦

CONFLICT OF INTEREST

The authors assert that there is no conflict of interest related to this submitted work.