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Water accounting disclosure: a review of empirical literature

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Abstract

This paper tries to provide a timely review of the empirical literature dealing with water accounting disclosure as this topic has gained momentum following water shortage worldwide.

Reviewed papers are collected using electronic searches in numerous electronic databases (e.g., Science Direct, Emerald, Wiley-Blackwell, Springer, and Taylor & Francis). Articles dealing with water-related disclosure are generally published in sustainability and accounting journals. Keywords used to identify relevant studies include "water reporting" and "water disclosure". Our search strategy yields 37 studies published between 2011 and the middle of 2023.

The summary of reviewed papers suggests that the majority of studies were conducted in China, and identifies three streams of research.

The first stream of research that focuses on the determinants of water reporting reveals that industry water sensitivity is the most significant predictor. The second highlights the beneficial economic consequences of water reporting has a beneficial effect on investors through reduced cost of capital, on managers through reduced risk-taking and improved financial reporting quality, and on consumers through increased acceptance of recycled water. The last stream of research shows a shortage of water disclosure practices that vary considerably across sectors and countries.

Keywords: Determinants of water disclosure, economic consequences of water reporting, water reporting practices, literature review.

Article type: Literature review

1. Introduction

Over the last decade, water resources have received increased interest among diverse types of stakeholders worldwide especially in countries characterized by water shortage (Lui et al., 2022). For instance, investors, creditors, and policymakers are putting more pressures on companies to communicate water-related information in their annual reports to reduce the adverse effect of water-related business risks (Freyman et al., 2015). This is mainly due to climate change (e.g., floods and droughts in some regions of the world), rising populations, industrialization and economic growth, and weak water governance (Ben-Amar and Chelli, 2018). Accordingly, water-related business impacts have attracted a great deal of attention among business community leading to increased awareness about water disclosure and its importance to better inform stakeholders surrounding the firm (Lui et al. 2022).

"Water is a precious resource to business" (Christ and Burritt, 2017, 148). Slattery (2008) suggests that every drop counts. In their management perspective review, Christ and Burritt (2017) recognize the normative nature of water-related research and call for the empirical work on water accounting activities in real organizations. Accordingly, topics dealing with the determinants and economic consequences of water-related disclosure has been gaining momentum in accounting literature during the last decade (Ben-Amar and Chelli, 2018; Burritt et al., 2016; Botha and Middelberg, 2016; Leong et al., 2014; Salsabila and Adhariani, 2022; Wicaksono and Setiawan, 2023). Thus, it becomes interesting to summarize water-related disclosure studies.

Therefore, the objective of this study is twofold. On the one hand, this review tries to contribute to the debate over water management reporting and its economic consequences, especially, in settings characterized by water shortage following the adverse effects of climate change on water resources worldwide. It also offers guidelines for future research dealing with water disclosure. To the best of our knowledge, this is the first review that synthesizes empirical water disclosure streams of research in accounting literature.

Collected papers in this review are gathered using electronic searches in numerous electronic databases, including Science Direct, Emerald, Wiley-Blackwell, Springer, and Taylor & Francis. The identified articles are generally published in sustainability and accounting journals. We further consult the reference lists of the collected papers to identify additional relevant studies for this review. Key words used to search for relevant studies include "water reporting" and "water disclosure". Our search strategy yields 37 studies published between 2011 and the middle of 2023.

The synthesis of reviewed papers suggests that studies were mainly conducted in China. The main streams of research identified deal with the determinants, the economic consequences of water reporting and water disclosure practices. With respect to the first stream of research examining the determinants of water disclosure, several variables have been examined including gender diversity on the board, corporate characteristics (e.g., size, leverage, ownership, industry water sensitivity). Reported results show mixed evidence for gender diversity and corporate characteristics except for industry water sensitivity which represents a significant predictor of increased water reporting. The

remaining studies have explored other determinants dealing with informal institutions (culture), integrated reporting and self-regulation of water management. These empirical enquiries have shown that these factors exert a significant impact on water reporting but empirical evidence is still limited.

With respect to the second stream of research, water reporting significantly influences investors' decisions through reduced cost of capital, management's behavior through reduced risk taking and improved financial reporting quality and consumers through increased acceptance of recycled water. This stream of research can be extended to examine the impact of water reporting on other stakeholders including auditors, creditors and financial analysts.

With respect to third stream of research, water reporting practices are still in their infancy, vary considerably across sectors and countries. Despite the existence of several GRI standards that regulate water reporting (e.g., GRI 303: Water and Effluents), disclosure policy adopted by firms seems to be underdeveloped in several countries since companies still adopt the classic CSR reporting model (e.g., water consumed in operating activities) and neglect important aspects including water supply chain, water stress indicators and water efficient management governance.
The rest of this literature review is organized as follows. Section 2 displays the ways used to collect data and its main characteristics. Sections 3, 4 and 5 summarize water reporting streams of research. Section 6 presents some critics addressed to this stream of research. Finally, section 7 concludes the paper and provides future research avenues.

2. Studies included in the literature review

2.1. Scope of the review

This paper tries to synthesize studies focusing on empirical water disclosure topics using different methodological approaches including quantitative (archival or survey data) and content analysis of water disclosure. These studies deal with the determinants of water reporting, its economic consequences and the ways used to report information about water in annual reports, sustainability reports and firms' websites. It should be noted that studies dealing with water management without referring to reporting policy, qualitative and normative papers are excluded from this review[1].

2.2. Studies' collection and characteristics

Papers for this review are gathered since 2011 as this year marks the pioneering work dealing the assessment of water reporting in annual reports (Lambooy, 2011). Topics related to water reporting are generally published in journals specialized in sustainability including *Journal of Cleaner Production*, *Corporate Social Responsibility and Environmental Management*, *Sustainability Accounting, Management and Policy Journal*, *Business Strategy and Environment and sustainability.* Therefore, the initial search was conducted in these journals, and then other accounting journals, in different digital sources (e.g., Science Direct, Blackwell, Taylor and Francis, Springer, Sage, Emerald and Inderscience), are consulted to identify further published water-related papers. Key words used to identify relevant papers include "water reporting", "water disclosure" "water shortage disclosure or reporting", "water governance disclosure or reporting" and "supply chain water disclosure or reporting".

[1] Examples of these studies include Imtiaz Ferdous et al. (2019), Hazelton (2013), Hewawithana et al. (2021) and Tello et al. (2016).

Based on these key words, the initial search resulted in a preliminary sample of 283 published articles. We retain only articles published in journals focusing on accounting, finance and sustainability and water specialized journals as the scope of these reviews accepts topics linked to water reporting. By doing so, 231 articles are removed. A closer examination of the remaining articles (52) leads to the exclusion of 15 papers not linked to the scope of our review (5) or qualitative or normative studies (10) as the current survey focuses on empirical water research. This procedure has led to the identification of 37 studies published between 2011 and the beginning of 2023.

One journal has the lion's share in publishing water-related research with 7 papers (*Journal of Cleaner Production)* followed by *Sustainability Accounting, Management and Policy Journal* with 5 articles and lastly *Sustainability* with 4 published studies.

As shown in table 1, the reviewed studies were mainly conducted in China (10 papers). The remaining reviewed studies use a cross-country dataset (10) or focus on a single-country data (Australia, Peru, Italy, Indonesia, Japan, Netherlands, South Africa, UK and USA). Furthermore, the majority of water disclosure empirical studies have been published since 2019 (67 per cent (25/37)) suggesting that this stream of research has been gaining momentum during recent years. Finally, two methodologies are mainly used including empirical (archival and survey data) and content analysis approaches. With respect to empirical methodology, 19 papers have used quantitative analysis with 17 empirical studies performing multiple regressions based on archival data (e.g., Liu et al., 2022; Salsabila and Adhariani 2022; Ben-Amar and Chelli, 2018), while Structural Equation Modeling technique is performed based on survey data for the remaining two papers conducted by Hou et al. (a & b in 2020).

Finally, content analysis of annual and sustainability reports has been exclusively performed for the stream of research examining water reporting practices (18 studies) (e.g., Botha and Middelberg, 2016; Bunclark and Scott, 2022)

With regard to examined industries in the reviewed studies, most studies have examined a wide range of sectors to be able to test the impact of water-sensitive industry, while others focus on mining industry (e.g., Talbot et al. 2020), food and beverage industry (e.g., Kleinman et al., 2017), water utilities (Cantele et al., 2018) and agriculture industry (e.g., Wicaksono and Setiawan, 2022).

Table 1. Studies by countries, years, journals and streams of research

Countries	Number of studies
China	10
Cross-country	10
South Africa	4
Australia	2
USA	2
Netherlands	2
Indonesia	2
Italy	1
Japan	1
Malaysia	1
Peru	1
UK	1
Total	37
Years	**Number of studies**
2011	1
2012	0
2013	0
2014	1
2015	1
2016	3
2017	2
2018	4
2019	2
2020	6
2021	7
2022	7
2023	3
Total	37
Journals	**Number of studies**
Journal of Cleaner Production	7
Sustainability Accounting, Management and Policy Journal	5
Sustainability	4
Corporate Social Responsibility and Environmental Management	3
Meditari Accountancy Research	2
Business Strategy and the Environment	2
Environment, Development and Sustainability	2
Advances in Environmental Accounting & Management	1
Applied Economics	1
Australasian Business, Accounting and Finance Journal	1
China Accounting and Finance Review	1
Business Strategy & Development	1
Journal of Environmental Assessment Policy and Management	1
Procedia Economics and Finance	1
Sustainable Cities and Society	1
Technological Forecasting and Social Change	1
The British Accounting Review	1
Water Resources and Industry	1
Water International	1
Total	37
Streams of research	
The determinants of water disclosure	13
The economic consequences of water disclosure	6
Water reporting practices	18
Total	37

Source: Prepared by the author

3. The determinants of water accounting disclosure

3.1. Theoretical underpinnings

Classic theoretical backgrounds used to justify water reporting include stakeholder and legitimacy theories. Stakeholder theory explains the relation between stakeholders and the information they receive (Yu et al., 2020). Stakeholders generally use water disclosure by a firm to assess a firm's legitimacy. Accounting scholars (e.g., Guthrie et al., 2004; Ratanajongkol et al., 2006) distinguish between two perspectives of stakeholder theory including ethical and managerial. Both perspectives highlight the importance of sufficient amount of information reported to stakeholders. The main divergence between the two perspectives lies in the content of information disclosed (Yu et al., 2020). While the ethical stakeholder theory considers equality as a cornerstone for any information disclosed (Ratanajongkol et al., 2006), the managerial stakeholder perspective considers that disclosure content should be relevant to stakeholders' decisions (Guthrie et al., 2004).

Legitimacy theory represents the second classic theoretical background used to justify the communication of water information. This theory suggests that a company tends to legitimize its activities by trying to minimize the legitimacy gap between actual performance and social expectations of diverse stakeholders (Yu et al., 2020). Legitimacy theory suggests that organization looks for a continuous respect of norms prevailing in societies where they operate (Deegan and Blomquist, 2006). To do so, an organization tries to ensure that its activities are in line with accepted norms in business environment where they operate to send a legitimacy signal to diverse stakeholders (Deegan and Blomquist, 2006).

Aside from these classic theoretical underpinnings, other theories have been used to explain how gender diversity, non-institutional factors and corporate self-regulation concerning water management may affect water reporting. With respect to gender diversity, the upper echelons theory has been also used to justify that the presence of females may promote water-related disclosure since women are more sensitive to environmental issues this may translate into better water management activities and disclosures (Nielsen and Huse, 2010). Institutional theory has been used to justify water reporting since country-level institutions may include both formal (e.g., corporate governance infrastructure and reporting standards) and informal institutions (e.g., shared values, religiosity and national culture) (Ben-Amar and Chelli, 2018). These institutions can shape corporate reporting policy, in general, and water disclosure, in particular. Finally, self-regulation theory suggests that firms tend to undertake unilateral voluntary corporate environmental actions to avoid the adverse effects of future governmental regulations and reduce costs incurred when future environment protection laws are enacted (Zhang et al., 2021).

3. 2. Review of empirical studies

3. 2.1. Corporate characteristics including ownership structure

Burritt et al. (2016) examine the determinants of corporate water-related disclosures for a sample of 100 listed Japanese companies with different levels of water sensitivity. These drivers include size, media exposure, ownership concentration, cross-listing, water risk sensitivity and profitability. They document that size and water industry sensitivity (ownership concentration and media exposure) are positively (negatively) associated with water disclosure. By contrast, neither cross-listing nor profitability is significantly related to the same variable. Yu et al. (2020) investigate the determinants of corporate water reporting in the U.S. setting for a sample of 294 during 2016. The determinants considered in this study include profitability, leverage ratio, corporate size, ownership

concentration, industry water sensitivity and the inclusion in the capital market index (S&P 500). They document that leverage ratio, ownership concentration, industry water sensitivity and the inclusion in the capital market index (S&P 500) are positively related to corporate water reporting, while size and profitability ratio have no significant effect on the same variable. Yu (2022) investigates the relationship between state ownership, political connections (Guanxi) and water disclosure among Chinese enterprises over the period of 2010-2017. Findings show that neither higher state ownership, nor political connection is significantly associated with water disclosure. By contrast, industry water sensitivity is positively associated with water reporting and this relation becomes negative for politically connected firms, suggesting that political ties reduce managerial incentives to report water resources information.

Finally, Wicaksono and Setiawan (2022) examine the impact of several corporate characteristics on water disclosure in agriculture industry. Based on sample of 195 agriculture Chinese companies over the period of 2017-2019, they document state-ownership, foreign ownership and international operations are positively associated water disclosure practices. By contrast, leverage ratio is not significantly associated with water reporting.

3. 2. 2. Gender diversity

Liu et al., (2022) examine the association between gender diversity ((i) the number of female directors on the board; (ii) the proportion of female directors on the board and (iii) the number of independent female directors) and water disclosure for a sample of Chinese listed firms over the period of 2010-2018. They document that the three proxies for gender diversity are positively associated with water disclosure. To test for the moderating effect of industry water sensitivity, they use an interaction term between gender diversity and dummy variable industry water sensitivity (1 for highly water sensitive industries[2] and 0 other sectors). They provide evidence that this interaction term is negatively related to water disclosure implying that industry water sensitivity adversely affects the positive association between gender diversity on the board and water reporting. Similarly, Salsabila and Adhariani (2022) examine the relationship between board gender diversity, as proxied by the percentage of women on the board of directors, and corporate water reporting and test for the moderating impact of public visibility, measured by the Google Search Volume and Google Trends. Based on a sample of 51 listed companies on the Indonesian Stock Exchange over the period of 2018–2021, they provide evidence that board's gender diversity is not significantly associated with water reporting and public visibility does not moderate this relationship. They conclude that gender diversity on the board represents an "artificial" governance mechanism in the Indonesian setting.

In cross-country investigation, Peng et al. (2023) examine the association between board gender diversity and water disclosure for sample of multinational firms from China, Japan, the U.K. and the U.S.A and whether national culture moderates this relationship. They provide evidence board gender diversity is positively related to water disclosure and this beneficial impact is weakened for settings characterized by high level of masculinity and uncertainty avoidance.

[2] These industries include: (i) agriculture, forestry, livestock farming and fishery; (ii) mining; (iii) manufacturing; (iv) electricity, heat, gas and water production, and the supply industry; and (v) water conservancy, environment and public facilities management.

3. 2. 3. Informal and formal institutions

Ben-Amar and Chelli (2018) examine the impact of formal and informal institutions on voluntary water disclosure for a cross-country dataset for a sample 1,166 nonfinancial companies covered by the 2015 Carbon Disclosure Project Global Water Report. Formal institutional factor includes legal system (common versus civil law regimes), while informal institutional factors deal with uncertainty avoidance, future orientation and societal trust. For the overall sample, they document that common law legal regime and future orientation (uncertainty avoidance and societal trust) are positively (negatively) associated with water disclosure. When distinguishing between common law versus civil law sub-samples, they provide evidence that informal institutional factors have insignificant impact on water disclosure for common law countries, while future orientation (societal trust) exerts a positive (negative) impact on water reporting for civil law countries. They conclude that the effect of informal institutions on water reporting is contingent on the strength of legal system at the country.

Zhang et al., (2021) examine the determinants of water reporting by integrating factors linked to corporate self-regulation (water governance, water policy, water actions, and water performance) and test for the moderating effect of Environmental regulatory pressure dealing the intensity of water consumption and the strength of national environmental regulation. They report positive relationships between the overall self-regulation water index and its sub-indices and water reporting. This positive association is maintained for companies belonging to a water-intensive, while it becomes insignificant for companies located in countries characterized by strong environmental regulation.

Zhou et al. (2021) investigate the effect of state regulation in China, namely, China's river chief policy[3] (CRCP), on water reporting and whether state ownership, ownership concentration and regional marketization process moderate this association. The CRCP represents a dummy variable that equals 1 for years subsequent to the adoption of CRCP and 0 otherwise. Findings show a positive and significant association between CRCP and water disclosure and this association is more pronounced for state-owned firms, low equity concentration and high marketization level sub-samples.

Finally, Wicaksono and Setiawan (2023) focus on the relationship between stakeholder pressure and water disclosure in mining industry based on managerial stakeholder theory. Stakeholder pressure includes government, media, and international pressures exerted. Based on a sample comprising 263 listed Asian mining companies from 23 countries over the period of 2017-2019, they document that these stakeholder pressures are significantly associated with water disclosure practices in Asian mining sector.

3.2.4 . Market characteristics

Zhou et al. (2020) examine the relationship between product market competition and firms' water information disclosure and whether state ownership and industry competition intensity moderate this association for a sample of Chinese listed companies operating in highly water-sensitive sectors. Product market competition is proxied by two aspects dealing with industry competition

[3] China's river chief policy represents a regulation that aims at protecting water resources, preventing water pollution, improving water environment, and restoring water ecology.

intensity and enterprise market power. Findings show that the relationship between industry competition intensity and water disclosure is positive and significant and this association is more pronounced for state-owned enterprises and for mildly competitive industry.

3. 2.5. Integrated reporting

Botha et al. (2022) focus on the relationship between integrated reporting (IR) and water governance disclosure in food, beverage and tobacco industries for a sample of 49 South African companies listed on the Johannesburg Stock Exchange. The study analyzes the annual reports that were available during the period spanning from November 2018 to February 2019. They provide evidence that the 18 IR companies' water governance disclosure index (71.670 per cent) is significantly higher than the 31 non-IR group index (40.970 per cent).

4. The economic consequences of water accounting disclosure

4.1. Theoretical frameworks

Similar to other types of information disclosure (e.g., voluntary, mandatory and non-financial information), water-related disclosure may impact stakeholders' decision, especially in countries characterized by water resources' shortage, that bring huge risks to the production and operation for companies (Zhou, Zhou, Zeng, Chen, 2018). Two main theoretical frameworks have been used to justify the economic consequences of water reporting including signaling and legitimacy theories (Zhou et al., 2018). For instance, water disclosure may represent a signal of legitimacy for diverse stakeholders that firm's management is taking adequate actions and measures to use water rationally and avoid any waste. This signal of legitimacy may also assure diverse stakeholders that firm's management is following a self-regulation strategy to avoid the adverse effect of future stringent regulations that may negatively affect future cash flows leading. Accordingly, this signal of legitimacy may translate into lower estimation risk, default risk and risk taking by investors, creditors and managers, respectively.

4. 2. Review of empirical studies

4. 2.1. Investors

With respect to investors, Zhou et al. (2018) examine the empirical linkage between water disclosure and cost of capital in Chinese high-water risk firms and test for the moderating effect disclosure level and political connections. Reported results show that the negative and significant association between water reporting and cost of capital was only observed for companies characterized by high disclosure level. In addition, state-ownership influences also this relationship since water reporting is insignificantly (positively) associated with cost of capital for state-owned (non-state-owned) companies. Finally, water reporting is negatively associated with cost of capital only for firms characterized by high disclosure level and representative political connections. Zeng et al. (2020) examine the relationship between water disclosure and firm risk, as proxied by, total risk, systematic risk, and idiosyncratic risk. Using a sample of 334 Chinese listed firms during 2010–2015, they document that water reporting only reduces systematic risk. They further show that media coverage moderates this association as it becomes insignificant for negative media coverage, while non-negative media coverage strengthens the reducing impact of water reporting on systematic risk.

4. 2.2. Managers

With respect to managers, Zhou et al. (2018) investigate the association between water reporting and corporate risk-taking and whether organizational legitimacy moderates this relationship. Corporate risk taking is measured using the volatility of firm's ROA over a three-year period, while organizational legitimacy is proxied by media coverage level. Based on signaling and legitimacy theories and using a sample of 334 listed companies in Chinese high water-risk over the period of 2010-2015, they document that water disclosure is negatively related to corporate risk-taking and this negative and significant association is maintained for non-state-owned companies and those disclosing high quality information. It should be noted that the negative association between water disclosure and corporate risk-taking becomes positive and significant for companies characterized by high level of organizational legitimacy. Liu et al (2021) explore the link between water information disclosure and financial reporting quality and investigate whether financing constraints[4] mediate this association. Based on a sample of 781 listed Chinese companies during 2010–2018, they document a positive and significant association linking water information disclosure to financial reporting quality and water reporting indirectly influences financial reporting quality through financing constraints.

4. 2.3. Recycled water consumers

Recent accounting studies have examined how customers using recycled water perceive reported information about water recycling and shortage in China due to the expansion of city borders and the increased public's demand for water resources. For instance, Hou et al., (2020, a) examine the relationship between information disclosure about recycled water and its public's acceptance. Based on the responses of 616 individuals from the city of Xi'an, they document that the recycled water information disclosure increases public awareness about the necessity of water saving and has the most significant regulatory impact on consciousness and public acceptance of recycled water. In the same vein, Hou et al., (2020, b) investigate the relationship between regional water shortage information disclosure and public acceptance of recycled water. Reported results show that regional water shortage information disclosure is positively associated with public acceptance of recycled water in six regions characterized by water scarcity in China (Gansu, Shaanxi, Fujian, Hunan, Guangxi and Beijing).

5. Water disclosure practices

In this stream of research, authors assess the level of water reporting in annual reports, sustainability reports and firms' websites using content analysis technique. Theoretical framework is not generally presented and scholars generally use stakeholder or legitimacy theory to discuss their findings.

Lambooy (2011) assesses the reporting policy concerning water for sample of 20 Dutch multinational companies. She concludes that, although these companies operate in sectors and regions of the world facing significant water shortage, disclosure policy concerning corporate water performance and risk is unexpectedly weak. For example, the textual analysis of firms' annual reports reveals that only 24 per cent of multinational companies report information concerning detailed water-specific policies, standards, plans, or management systems and only 15 per cent of

[4] Financial constraints are measured using KZ index (Kaplan and Zingales, 1997). This index represents an equation integrating several indicators dealing with cash flow, long term liabilities, total dividends, cash holdings *and* Tobin's Q.

them disclosed goals to reduce waste water discharge. In the same setting, Linneman et al. (2015) rank water transparency for a sample of 75 Dutch stock-listed companies. The assessment procedure uses a disclosure checklist that focuses on three categories of items linked to *(i)* water use and pollution, *(ii)* water performance and *(iii)* water targets from the perspectives of supply chain and operations. Using a content analysis approach based on annual reports, sustainability reports and websites of companies, they provide evidence that there are large differences in water reporting between and within sectors and that companies tend to communicate more water-related information about their operations than their supply chain.

In mining industry, Leong et al. (2014) perform a content analysis on mandatory and voluntary water reporting in environmental reports published by four companies operating in the Australian setting. They provide evidence that mandatory water disclosure requirements are extensive. The voluntary reports provide information about water withdrawals, water discharges and regulatory breaches, while information concerning water sources affected by withdrawal is absent. Talbot et al. (2020) analyze also 58 reports published by mining companies. They identify four impression management strategies including strategic omission, data manipulation and two defensive strategies aiming at *(i)* minimizing the effect of mining activity on water resources and *(ii)* relativizing poor water performance by contextualizing it in its particular environment. They conclude that mining companies tend to communicate incomplete water information and reduce the importance of certain elements in order to gain legitimacy among stakeholders. More recently, Gilsbach et al. (2022) assess water reporting practices for the world's ten largest mining companies and examine whether water disclosure responds to stakeholder information requirements. They document that disclosed information on water-related regulations are in line with stakeholder interests. By contrast, disclosed information does match stakeholders' requirements with respect to the interactions of mining and water resources (e.g., corporate water strategies, mine site-level management plans and water balances). They also suggest that the existence of diverse types of expectations from stakeholders creates a difficulty to satisfy them in terms of water disclosure issues.

This topic has been extensively examined in South Africa. Botha and Middelberg (2016) evaluate the water-related in annual reports for a sample of 37 companies listed on the JSE. These companies belong to several industries including basic materials, mining, industrials and consumer goods. Findings show that reporting practices vary considerably since the mining sector (industrial sector) performed the best (worst). In the same setting, Askham et al. (2017) evaluate the quality of water risk disclosure among South African mining listed companies. By analyzing the sustainability/integrated/annual reports for 2013, they provide evidence that there is a lack of information concerning water management in the supply chain. Askham (2019) extends these works to cover water management and risk disclosures for companies belonging to food industry in South Africa. The author documents an improvement in water reporting practices over the period of investigation (2013 and 2017) since firms are committed to disclose water basic information. However, no disclosure is made concerning supply chain water management.

In Anglo-Saxon developed countries, Kleinman et al. (2017) use formal concept analysis to evaluate water reporting practices within the US food and beverage industry. The sample consists of seven firms' CSR reports. Findings show that assessments of water consumption and water withdrawal are widely used in firms' CSR reports and firms strongly emphasize on in their reporting policy on sustainable water management goals and water quality strategy. In the UK, Morris et al.

(2023) analyze the disclosure practices of 35 UK listed firms concerning water-related challenges and water sustainability strategies. They provide evidence that water reporting policy varies considerably across examined firms that still follow classic general CSR reporting with less attention paid to water as a critical component of sustainability. With respect to disclosure content, water reporting focuses on water consumption from operations and neglects other important aspects linked, for example, to supply chains and external collaborations.

In a civil law country, namely, Italy, Cantele et al. (2018) evaluate water reporting practices within 22 Italian water utilities companies based on sustainability reports. They develop a disclosure checklist of 39 indicators extracted from the SASB's (Sustainability Accounting Standard Board) sustainability accounting standard for water utility sector and GRI water standards 303 and 306. Findings show a low level of disclosure and the disclosed items generally deal with qualitative aspects that cannot be used to assess the process of water utilities performance and the effectiveness of sustainability strategies.

In emerging economies, Remali et al. (2016) analyze the extent and quality of water reporting in the annual reports of the top 10 Malaysian public listed companies and document that the level water disclosure is low among these companies. In Indonesia, Adhariani (2021) assesses the adequacy of water reporting practices against the global disclosure requirement from the Global Reporting Initiative (GRI) G4. Results show that water disclosure level is low when compared to global reporting standard. They suggest that the lack of pressures exerted by stakeholders with respect to water issues leads to a low need for companies to seek for legitimacy from water reporting. Bunclark and Scott (2022) evaluate water reporting practices in another emerging economy, namely, Peru by conducting and thematic content analysis of water information in sustainability reports for 34 companies. They find that *(i)* most corporate water reporting practices are incomplete and put more emphasis on internal firm operations, *(ii)* information on water risk does not include sufficient details to highlight company effort in sustainable water management activities and *(iii)* the main determinants of water reporting in Peru are pressures exerted by international markets, regulation and other normative issues.

In a cross-country investigation, Northey et al. (2019) assess the quality of water reporting within mining industry. Findings show that the quality of water reporting has improved considerably over time. The authors suggest that there are rooms for improvement by reporting information related to relevant water flows and disclosing non-existent flows (e.g. discharges). Tsalis et al. (2020) assess the water risk disclosures in water utilities industry. Using a content analysis of Sustainability/CSR reports, they provide evidence that there is an effective communication channel between water utilities and various stakeholder groups concerning water risk issues. Fialho et al., (2021) take the occasion of the adoption of Carbon Disclosure Project Water A-List in 2015 to analyze water reporting practices in reports available on the companies' websites from 2014 (the year before the adoption) to 2016 (the year after). They document that the number of water references has witnessed a slight increase moving from an average of 47.333 in 2014 to 48.733 in 2016 and this difference is not statistically significant. They identify three types of impression management strategies referring to justification and commitment, self-promotion, authorization. Only the difference between the average number of self-promotion references has significantly increased between 2014 and 2016 moving from 38 to 75, respectively. Botha et al., (2022) make a comparison between supply chain water information for 49 food, beverage and tobacco firms listed

on the JSE (South Africa) (16), ASX (Australia) (20) and Dow Jones Sustainability Index (DJSI) (13) exchanges. Using a content analysis to assess the level of water-related supply chain information, they find that the DJSI- and JSE-listed companies outperformed the ASX firms in their water reporting practices by achieving disclosure scores of 63%, 47% and 20%, respectively.

To sum up, this stream of research suggests that water reporting practices vary significantly across industries (mining, food, beverage and tobacco) and countries. Water disclosure policy deems to be underdeveloped in several countries since companies still follow the classic model of CSR reporting (e.g., water consumed in operating activities) and several aspects are neglected including water supply chain, water stress indicators and water efficient management governance.

6. Critical analysis

Four main critics may be addressed to the stream of research dealing with water disclosure, its determinants and economic consequences. On the one hand, water disclosure index is not exhaustive since information about reporting is only assessed in firms' annual reports and social responsibility reports (Zhou et al., 2018).

On the other hand, the use of content analysis technique to measure the extent of water reporting may introduce a bias since the researcher relies on judgment during the coding process (Hassan and Marston, 2010). In addition, self-constructed water disclosure index generally require a labor intensive data collection process leading to the employment of small sample sizes (Hassan and Marston, 2010).

Furthermore, the choice of items for water disclosure index may not fit all industries since some sectors are more water-intensive. Accordingly, the inclusion of firms from different sectors with diverse water sensitivity levels may introduce a bias into econometric analyses and results (Burritt et al., 2016; Botha et al., 2022).

Finally, Zhou et al. (2020) suggest that "water information disclosure research has just started and a quantitative index system of water information disclosure is still in the exploratory stages". This implies that water reporting is still in its infancy as a stream of research or has just emerged in settings suffering from climate change. Accordingly, the determination of definition (e.g., for water stress) and the measuring methods of a water index need improvement to reach maturity and provide more informative messages for regulators worldwide (Zhou et al., 2020).

7. Conclusion

The aim of this study is to review water accounting literature which has been gaining momentum during last decade following climate change that has caused water shortage in several settings worldwide. Based on a dataset of 37 papers published between 2011 and the middle of 2023 (see appendix), the summary of reviewed studies shows that water accounting research was mainly conducted in China. Three main streams of research are identified that deal with the determinants of water disclosure, the economic consequences of water reporting with respect to investors, managers and consumers of recycled water and water reporting practices in diverse industries and settings.

This review contributes to accounting literature as follows. With respect to researchers, it presents the main streams of research linked to water accounting, suggests future research avenues and identifies under-researched settings. With respect to policy makers, the current review suggests that regulators should define clearly the concept water stress and adopt a water disclosure standard or standardized water reporting templates that may guarantee the minimum required level of disclosure. This standard should define and specify *(i)* water stress indicators at country and firm level, *(ii)* water shortage disclosure, *(iii)* water efficient management disclosure and *(iv)* water supply chain information.

Future research should deepen the analysis with respect to water management disclosure in countries characterized by water shortage and droughts (e.g., African countries). In these countries, it is interesting to investigate how ownership type (e.g., foreign, managerial, state and institutional ownerships) or informal institutions (e.g., religiosity) may influence water reporting practices. Furthermore, it is worthy to examine how consumers perceive the use of recycled water and whether water reporting influences their perceptions. In the same vein, water management disclosure within tourism industry represents also an interesting topic since this sector is generally characterized by a high level of water wastage requiring the implementation of seawater desalination centers. Finally, accounting scholars should extend the stream of research dealing the economic consequences of water reporting with respect to other stakeholders including creditors (cost of debt), financial analysts (analyst forecast accuracy) and auditors (audit fees, audit report lag, audit opinion) within water sensitive industries.

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*Refers to studies included in the review.

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Research Ethics

Compliance with ethical standards

Conflict of interest: The author declares that she has no conflict of interest.

Disclosures and declarations

The author did not receive any fundings.

Appendix. Summary of water reporting studies

Authors	Research question	Sample	Main findings
The determinants of water reporting			
Burritt et al. (2016)	The determinants of corporate water-related disclosures in Japan	100 companies over the period 2013-2014	Corporate size and water industry sensitivity (ownership concentration and media exposure) are positively (negatively) associated with water disclosure. By contrast, neither cross-listing nor profitability is significantly related to the same variable.
Ben-Amar and Chelli (2018)	The impact of formal and informal institutions on voluntary water disclosure for a cross-country dataset	1,166 nonfinancial companies covered by the 2015 Carbon Disclosure Project Global Water Report	For the overall sample, they document that common law legal regime and future orientation (uncertainty avoidance and societal trust) are positively (negatively) associated with water disclosure. When distinguishing between common law versus civil law sub-samples, they provide evidence that informal institutional factors have insignificant impact on water disclosure for common law countries, while future orientation (societal trust) exerts a positive (negative) impact on water reporting for civil law countries.
Yu et al. (2020)	profitability, leverage ratio, corporate size, ownership concentration, industry water sensitivity and the inclusion in a capital market index (S&P 500) and water reporting in the U.S. setting	294 companies during 2016	Leverage ratio, ownership concentration, industry water sensitivity and the inclusion in a capital market index (S&P 500) are positively related to corporate water reporting, while size and profitability ratio have no significant effect on the same variable.
Zhou et al. (2020)	Product market competition and firms' water information disclosure and whether state ownership and industry competition intensity moderate this association in China	1,818 firm-year observations over the period of 2010-2015	The relationship between industry competition intensity and water disclosure is positive and significant and this association is more pronounced for state-owned enterprises and for mildly competitive industry.
Zhang et al. (2021)	Corporate self-regulation (water governance, water policy, water actions, and water performance) and water reporting and the moderating effect of Environmental regulatory pressures	1,604 firm-year observations over the period of 2010-2013	Positive relationships between the overall self-regulation water index and its sub-indices and water reporting. This positive association is maintained for companies belonging to a water-intensive, while it becomes insignificant for companies located in countries characterized by strong environmental regulation.
Zhou et al. (2021)	China's river chief policy (CRCP) and water reporting and whether state ownership, ownership concentration and regional marketization process moderate this association	2,200 firm-year observations over the period of 2010–2017.	A positive and significant association between CRCP and water disclosure and this association is more pronounced for state-owned firms, low equity concentration and high marketization level sub-samples.
Liu et al. (2022)	Gender diversity water disclosure in China	7,099 firm-year observations over the period of 2010-2018	The three proxies of gender diversity (i) the number of female directors on the board; (ii) the proportion of female directors on the board and (iii) the number of independent female directors are positively associated with water disclosure. This positive association is mitigated for companies belonging to highly water sensitive industries.
Salsabila and Adhariani (2022)	Board gender diversity and corporate water reporting and whether public visibility moderates this relationship in Indonesia	51 companies over the period of 2018–2021	Board's gender diversity is not significantly associated with water reporting and public visibility does not moderate this relationship.
Yu (2022)	Whether State ownership and political connections (Guanxi) moderate the positive association between industry water sensitivity and water disclosure in China	1,680 over the period of 2010-2017	Industry water sensitivity is positively associated with water reporting and this relation becomes negative for politically connected firms.

Wicaksono and Setiawan (2022)	The relationship between corporate characteristics (state-ownership, foreign ownership, international operations and leverage ratio) and water disclosure	195 agriculture Chinese companies over the period of 2017-2019	State-ownership, foreign ownership and international operations are positively associated water disclosure practices. By contrast, leverage ratio is not significantly associated with water reporting.

Appendix. Continued

Authors	Research question	Sample	Main findings
The determinants of water reporting			
Botha et al. (2022)	Integrated reporting and water governance disclosure in food, beverage	49 South African companies during the period spanning from November 2018	Integrated reporting companies' water governance disclosure index is significantly higher than the non-Integrated reporting
Peng et al. (2023)	Board gender diversity and water disclosure and whether national culture moderates this association	150 multinational firms from China, Japan, the U.K. and the U.S. A	Board gender diversity is positively related to water disclosure and this beneficial impact is weakened for settings characterized by high level of masculinity and uncertainty
Wicaksono and Setiawan (2023)	Stakeholder pressure and water disclosure in Asian mining industry	263 listed Asian mining companies from 23 countries over the period of	Stakeholder pressures are significantly associated with water disclosure practices in Asian mining.
The economic consequences of water reporting			
Zhou, Zhou, Zeng, Chen (2018)	The empirical linkage between water disclosure and cost of capital in Chinese high-water risk firms and test for the moderating effect of disclosure level and political connections in China	334 listed companies in the Chinese high-water sensitivity industry from 2010 to 2015	The negative and significant association between water reporting and cost of capital was only observed for companies characterized by high disclosure level. In addition, state-ownership influences also this relationship since water reporting is insignificantly (positively) associated with cost of capital for state-owned (non-state-owned) companies.
Zhou et al. (2018)	Water reporting and corporate risk-taking and whether organizational legitimacy moderates this relationship in China	334 listed companies in the Chinese high-water sensitivity industry from 2010 to 2015	Water disclosure is negatively related to corporate risk-taking and this negative association becomes positive and significant companies characterized by high level of organizational
Hou et al., (2020, a)	Information disclosure of recycled water and the public's acceptance in China	616 individuals surveyed during January 2020 from the city of Xi'an	Recycled water information disclosure increases public awareness about the necessity of water saving and has the most significant regulatory impact on consciousness and public acceptance.
Hou et al., (2020, b)	Regional water shortage information disclosure and public acceptance of recycled water in China	616 individuals surveyed during January 2020 from the city of cities of Gansu, Shaanxi, Fujian, Hunan, Guangxi and Beijing	Regional water shortage information disclosure is positively associated with positively with public acceptance of recycled water.
Zeng et al. (2020)	Water disclosure and firm risk and whether media coverage moderates this association	334 Chinese listed firms during 2010–2015	Water reporting is negatively associated with systematic risk and this association becomes insignificant under negative media coverage, while the negative association becomes stronger under non-negative media coverage.
Liu et al (2021)	Water information disclosure and financial reporting quality and whether financing constraints mediate this	781 listed Chinese companies during 2010–2018	Water information disclosure is positively associated with financial reporting quality and water reporting indirectly influences financial reporting quality through financing
Water disclosure practices			
Lambooy (2011)	An assessment of water reporting policy for Dutch multinational companies.	20 Dutch multinational companies	The reporting policy concerning corporate water performance and risk is unexpectedly weak for companies operating in sectors and regions of the world facing significant water shortage.
Leong et al. (2014)	A content analysis on mandatory and voluntary water reporting in environmental in Australian mining industry	Four companies operating within mining industry in Australia.	Mandatory water disclosure requirements are extensive. The voluntary reports provide information about water withdrawals, water discharges and regulatory breaches, while information concerning water sources affected by withdrawal is absent.
Linneman et al. (2015)	An assessment of water-related disclosure	75 Dutch stock-listed companies during 2013	Large differences in water reporting between and within sectors and more water-related information about their
Botha and Middelberg (2016)	An assessment of water-related disclosure in annual reports for South African firms	37 companies listed on the JSE	Findings show that reporting practices vary considerably across industry since the mining sector (industrial sector) performed the best (worst).

Appendix. Continued

Authors	Research question	Sample	Main findings
Water disclosure practices			
Remali et al. (2016)	An assessment of water-related disclosure in annual reports for Malaysian firms	top 10 Malaysian public listed companies	The level water disclosure is low among these companies.
Kleinman et al. (2017)	Formal concept analysis to evaluate water reporting practices within the US food and beverage industry.	7 firms' CSR reports	Firms strongly emphasize in their reporting policy on sustainable water management goals and water quality strategy.
Cantele et al. (2018)	Assessment of water reporting practices based on sustainability reports	22 Italian water utilities	Low level of disclosure and the disclosed items in generally deal with qualitative aspects which cannot be used to assess the process of water utilities performance the effectiveness of sustainability strategies
Aksham et al. (2017)	Assessment of water risk disclosure among South African mining listed companies	9 companies during 2013	There is a lack of information concerning water management in the supply chain.
Askham (2019)	Water reporting practices by South African listed food companies	14 South African listed food companies over the period of investigation (2013 and 2017)	An improvement in water reporting practices since firms are committed to disclose water basic information across the period of investigation. However, no disclosure is made concerning supply chain water management.
Northey et al. (2019)	The quality of water reporting within mining industry	359 mining company over the period 1986-2016	The quality of water reporting has improved considerably over time. The authors suggest that there are rooms for improvement by reporting information related to relevant water flows and disclosing non-existent flows (e.g. discharges).
Talbot et al. (2020)	Water reporting in the mining industry	Cross-country investigation based on 58 reports published by mining companies	Mining companies tend to communicate incomplete water information and to reduce the importance of certain elements in order to gain legitimacy among stakeholders.
Tsalis et al. (2020)	Assessment of the water risk disclosures in water utilities industry	24 CSR reports	There is an effective communication channel between water utilities and various stakeholder groups concerning water risk issues.
Fialho et al. (2021)	Water reporting practices on reports available on the companies' websites following the adoption of Carbon Disclosure Project Water A-List	15 companies listed on the water CDP A-List in 2017	The number of water references has witnessed a slight increase after the adoption of Carbon Disclosure Project Water A-List in 2015. Three types of impression management strategies referring to justification and commitment, self-promotion, authorization.
Adhariani (2021)	The adequacy of water reporting practices against the global disclosure requirement from the Global Reporting Initiative (GRI) G4 in Indonesia	463 listed companies over the of 2014 – 2016	Water disclosure level is low when compared to global reporting standard.
Botha et al., (2022)	A comparison between supply chain water information for food, beverage and tobacco listed firms from the JSE (South Africa), ASX (Australia) and Dow Jones Sustainability Index (DJSI)	49 food, beverage and tobacco listed firms	The DJSI- and JSE-listed companies outperformed the ASX firms in their water reporting practices by achieving disclosure scores of 63%, 47% and 20%, respectively.

Appendix. Continued

Authors	Research question	Sample	Main findings
Water disclosure practices			
Bunclark and Scott (2022)	Water reporting practices in Peru by conducting and thematic content analysis of water information in sustainability reports	34 companies	Findings show that *(i)* most corporate water reporting practices are incomplete and put more emphasis on internal firm operations, *(ii)* information on water risk does not include sufficient details to highlight company effort in sustainable water management activities and *(iii)* the main determinants of water reporting in Peru are pressures exerted by international markets, regulation and other normative issues.
Gilsbach et al. (2022)	Assessment of water reporting practices in mining industry	The world's ten largest mining companies	Disclosed information on water-related regulations are in line with stakeholder interests. By contrast, disclosed information does match stakeholders' requirements with respect to the interactions of mining and water resources (e.g., corporate water strategies, mine site-level management plans and water balances).
Morris et al. (2023)	Disclosure practices concerning water-related challenges and water sustainability strategies	35 UK listed firms	Firms that still follow classic general CSR reporting with less attention paid to water as a critical component of sustainability. With respect to disclosure content, water reporting focuses on water consumption from operations and neglects other important aspects linked, for example, to supply chains and external collaborations.

Source: Prepared by the author