

Does water accounting support sustainable water management? A review,

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5 Does water accounting support sustainable water management? A review

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Abstract. The business risks experienced by clean water companies include losses and decreased loyalty of water users. This risk occurs due to the absence of accountability, reliability, and transparency in sustainable clean water management. It can be overcome by implementing water accounting. This narrative review explains a sustainable water management model using a water accounting approach. The narrative review method consists of compilation, tabulation, comparison of research results, and summarizing. The literature review study collected articles from accredited journal sites (*Sinta, Emerald, Science Direct*). After searching for research keywords criteria, 29 articles were taken as samples. The results show that water accounting, in addition to reducing business risk for clean water service providers, also supports sustainable water management. Water accounting components such as gross inflow, net inflow, available water, water depletion, and outflow provide transparent and accountable information. The components of water accounting can analyze water use, scarcity, and productivity to predict the need for clean water because the amount of water discharge produced and used in one day can be known with certainty. Management and community commitment are needed to realize sustainable groundwater use conservation to ensure that the community enjoys the long-term supply of clean water.

1. Introduction

Water is an essential need and cannot be separated from the life of living things on the surface of the Earth [1]. On the surface of the Earth, 70% of the composition is water, which means that clean water should not depend on clean water management companies [2]. From year to year, Indonesia experiences an increase in population and development, so the need for clean water has increased [3]. The increasing availability of clean water does not offset the rise in population and growth. A platform for collaboration between ministries was established as mandated by the Presidential decree of the Republic of Indonesia Number 185 of 2014 regarding provisions to accelerate the provision of clean water supply to achieve the availability of clean water for all. Therefore, provinces and districts reaffirm their commitment to achieving targets by strengthening and enabling environmental policies through the implementation of regional policies, budgets, and objectives [4].

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A poor clean water management model will harm the chain of water availability in the future [5]. Then, water accounting is needed for clean water management to reduce negative impacts [6]. Water accounting is the identification, recording, and communication of information related to water resources



to allow companies to manage water responsibly and openly [7]. The components of water accounting are gross inflow, net inflow, available water, water depletion, and outflow. The management of water flowing and distribution to the community can be seen from these components [8]. It means that it can integrate various aspects ranging from inputs, outputs, and impacts on the environment so that there is no scarcity of clean water availability [9]. Thus, clean water management can be effective and efficient and create water management continuity [10].

The study results also explained that water accounting provides information for managers to assess business risks in the management of clean water [6], thus facilitating decision making [11]. Clean water management companies can identify, reduce business risks, and predict water availability [10]. For example, 12 states in the western United States, such as California, Arizona, Colorado, Idaho, Kansas, Nebraska, Nevada, New Mexico, Oregon, Texas, Utah, and Washington, implemented water accounting to achieve clean water management that is transparent, reliable, accountable, quality and provides guarantees of water availability and community loyalty [11].

The problem of water availability also penetrates rural areas near water sources. It means that the community has not been able to utilize water sources and has not managed them properly. When the water source is used optimally, there will be no water shortage, even in the dry season. Even in some places in large cities, clean water sources managed by Local Water Companies (*PDAMs/ Perusahaan Daerah Air Minum*) have been polluted by industrial waste and domestic waste [12], so the burden of clean water management is increasing [13]. The water will be treated through complex stages to become clean water ready to be consumed for daily needs. The management of clean water is a priority to be completed [5]. The results showed that in 2019 *PDAM Tirta Pakuan Bogor* experienced an increase in demand for clean water needs reaching 2066 liters /second [1], similar to the clean water management in Konawe Regency, southeast Sulawesi Province also responded to the same [14], [15].

The demand for clean water is continuously increasing, but it is not offset by the increasing availability of water sources [16]. The water demand in Indonesia in 2016 increased by 0.3937 liters / second and is predicted in 2036 to be 0.5654 liters / second [17], so good water management is needed to achieve sustainable water management. Therefore, this article explains in detail the support of water accounting in creating sustainable water management around us.

2. Methodology

The narrative review method consists of compilation, tabulation, comparing research results, and summarizing. The literature review study collected the articles from accredited journal sites (*Sinta, Emerald, Science Direct*). The journal articles used are open access, full text journal, publication date in the past ten years, May 2012-May 2022, relevant to the research topic, and indexed journal. Since August 2021 until June 2022, the authors searched for reputable international journal articles using the keyword 'water accounting' and obtained up to 17 titles (17 titles), 'water management' obtained two titles (2 titles), and 'sustainable environment' obtained one title (1 title). Meanwhile, articles in national journals using the keyword "water management" obtained six titles (6 titles), and "sustainable environment" obtained three titles (3 titles). In addition to the relevant articles, the search proceeds by reviewing relevant literature and books. This study examines water management and a sustainable environment. However, to the best of the researcher's knowledge, the water accounting approach in the management of sustainable water resources has not been widely used. Usually, they did not use a water accounting approach; on the other hand, in water accounting research, they are concerned with financial reporting and examination or auditing [18].

3. Result and Discussion

3.1. Business Risks of Clean Water Management

Risk is defined as the chance of loss, and the risk is the possibility of loss, uncertainty, the dispersion of actual from expected, and risk is the probability of any outcome different from the one expected [10]. Research [9] explained that risk is classified as speculative and pure risk, which can come from within

or outside of the company. The high growth of the population, either naturally or implicitly migratory, adds to the increasing pace of the water crisis and ineffective management of clean water [19]. In research [11] in Australia, clean water management has not been implemented effectively, with the finding that there is no explicit calculation of water availability in the present and future. Sustainable clean water management by applying water accounting will anticipate water shortages during the dry season [19]. In the future, the water crisis will make clean water management stop distributing clean water and become a significant challenge in dry areas [10].

The accounting of water for clean water management will minimize business risks [10], as in the western United States, which often experiences drought even though they have applied the accounting of water to clean water management [20]. There are several models of clean water management to overcome the water deficit; According to the combined model, where the result is that the availability of groundwater in 2050 is predicted to be $0.89 \times 10^6 \text{ m}^3$ and does not experience a groundwater deficit, and the moratorium model on groundwater use, the result is that since 2020 the availability of water is predicted to increase. In 2025 it has reached stability [11].

3.2. Components of Water Accounting

Water accounting can be used to analyze clean water management [19]. Water accounting is identifying, recording, and communicating information related to water resources, enabling companies to carry out water management more responsibly [21]. This identification allows for analysis of water use, scarcity, and productivity [18]. Here are the components of water accounting commonly used in research [4].

- Gross inflow is the total discharge of water entering the system consisting of precipitation, surface water, and subsurface water.
- Net inflow is the gross inflow plus storage changes. If there is a reduction in storage, the net inflow is more significant than the gross inflow. If there is an increase in storage, the net inflow is smaller than the gross inflow. If there is no addition to storage, then net inflow = gross inflow.
- Available water is available water that can be utilized, is the difference between net inflow and committed water
- Water depletion is the use of water that will eventually reduce the availability of water (available) for other uses. Water depletion can be categorized as process depletion and nonprocess depletion. Process depletion uses water to produce specific products, for example, water for evapotranspiration, drinking water needs, and industry. Nonprocess depletion is the use of water other than process depletion, for example, evaporation from the free water level and or from the surface of the soil that is not cultivated and deep percolation.
- Outflow is a certain amount of water that comes out of the system. Outflows can be grouped into committed water and uncommitted water. Committed water is part of the outflow agreed to be used or given to users at the bottom of the system. It is to be utilized by irrigation areas downstream, used for ecosystem purposes, for example, as a minimum discharge that must be left to the digger of the river flow and or for the needs of downstream fisheries, or as part of the debit to prevent seawater intrusion. Uncommitted water is a million water that comes out of the system as excess from the user.

3.3. Application of Water Accounting

Water accounting is the systematic quantitative assessment of the status and trends in water supply, demand, distribution, accessibility, and use in specified domains, producing information that informs water science, management, and governance to support the results of sustainable development for society and the environment [22], [23]. The benefits of water accounting itself (1) can improve understanding of costs in terms of water for sustainable development, (2) can help identify water problems across sectors, and (3) increase transparency over water allocation. Water accounting is a system companies use to measure and calculate their water use and cover issues related to water quantity and storage, water quality, and impacts of use [4].

Although water accounting has many benefits when implemented, the application has several obstacles because most developing countries still have difficulty managing water resources in clean water management companies [6]. In terms of water sources, water accounting has an undetermined amount and quality from time to time. Furthermore, the absence of hydrometric infrastructure (e.g., measuring devices) in the management of clean water will result in the absence of a calculation of the quantity of water in the water sources in the present and future [24]. It makes the clean water management carried out by the company very vital.

3.4. Sustainable Water Management Model

Water management models can positively impact clean water management in the present and future, especially at water sources [25]. The following is a model of sustainable water management [26].

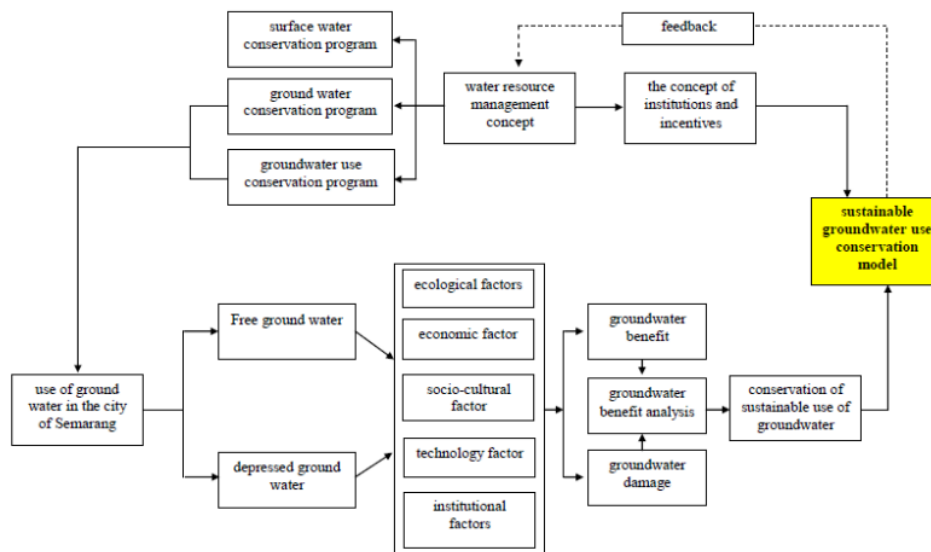


Figure 1. Sustainable Water Management

The model explains that groundwater use in Semarang City can be done by conducting surface water conservation programs, groundwater conservation, and groundwater utilization conservation. In its implementation, it is influenced by ecological factors, economic factors, sociocultural factors, technological factors, and institutional factors. These five factors greatly determine the conservation of sustainable groundwater utilization by analyzing water use and groundwater damage. The concept of water resource management will provide feedback from the user community. Therefore, it requires the commitment of managers and communities to strengthen institutions and appropriate incentives [27]. All these actions will achieve the conservation of sustainable groundwater use so that it can overcome the scarcity of water availability in the future [28]. Clean water management by implementing water accounting must pay attention to several aspects [29] to support sustainable clean water management. The aspects in question are as follows.

- Aspects of community participation include the need to increase the provision of clean water, perceptions of the relationship between benefits and increased provision of clean water, a sense of responsibility and ownership, culture, habits, and beliefs related to clean water.

- Technical aspects include current and future water needs, clean water treatment, technical standards, organizational procedures, and water quality management.
- Environmental aspects include the quality and quantity of water sources and the protection of water sources.
- Financial aspects include cost–revenue analysis, ability and willingness to pay, and tariff structure.
- Institutional aspects, namely strategies at the national level and policies/legal foundations

4. Conclusion

Each year, population growth and development have increased, which will impact the demand for clean water. In the dry season, many regions in Indonesia experience scarcity of clean water availability due to poor clean water management. Clean water management companies play a crucial role in maintaining the availability of clean water needed by the community. Applying water accounting to clean water management companies can solve this problem. Water accounting can identify business risks and calculate future water use and availability. Companies can manage water in a transparent and accountable manner. Business risks that are often experienced are losses and loss of customer trust. Implementing water accounting can minimize these risks. In water accounting, the amount of water discharge produced and used in one day can be known with certainty, so it will bring many benefits. Therefore, community involvement in clean water management is needed.

Many communities lack water, especially during the dry season. It is necessary to increase community involvement to maintain water sources so that natural sustainability is maintained. Community involvement begins with the implementation of surface water conservation programs, groundwater conservation programs, and groundwater utilization programs. Water resource management focuses on ecological, economic, sociocultural, technological, and institutional factors. If all these factors are considered, there will be a sustainable management of water resources and the environment. Finally, the community can enjoy the water supply in the long term.

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