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MORALITY BEFORE KNOWLEDGE

Quality of artificial rain to overcome clean water crisis: A review on several parameters

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ABSTRACT

Water is the most important substance needed by living things apart from air. Long droughts have serious impacts on society and the environment resulting in a lack of clean water supply, both in terms of quality and quantity. The purpose of the article is to contribute to a better understanding of overcoming the clean water crisis by utilizing artificial rain. The method of writing this article is a literature study on several journals and previous articles to obtain data and information to review experiences that have been successfully carried out in previous studies. The parameters used are pH, DHL, Sulfate, and Ca. Based on the study data, the pH is 6-8 which is still safe for drinking water consumption and fisheries, the DHL parameter is not recommended for drinking water consumption because it contains electric charge and is not recommended for agriculture and fisheries because it has high DHL levels. Sulfate is considered safe because it has low levels. In general, the presence of sulfate does not have a significant impact on health because the nature of sulfate ions is quite stable and does not react easily. Both high and low Ca levels are still considered unsafe. Only pH and Sulfate levels are classified as safe for agriculture, fisheries, and as drinking water.

KEYWORDS: artificial rain; crisis; drought; quality; water

1. Introduction

Water is the main joint of life. It is undeniable that basic human needs and activities are dominated by almost 80% with water. Water not only meets basic human needs as drinking water, but also functions as a source of life such as industry, irrigating agricultural land, fisheries, to power plants, and so on. However, gradually water needs are not in line with the level of availability, either related to the dimensions of time and space or even the amount and quality (Akhmad and Bayuadji, 2019).

Water has a renewable and dynamic nature, which means that the main source of water in the form of rain always comes when it is in season (Kodoati and Sjarief, 2010). However, under certain conditions water is non-renewable, for example in certain geological conditions the process of groundwater travel takes thousands of years, so that if groundwater extraction is done excessively, water will run out (Kodoatie and Roestam, 2010). Rainwater can be used for the availability of sufficient clean water to prevent water crises and scarcity.

Clean water crisis is a condition of imbalance between the availability of clean water and the demand for clean water. Basically, only 2.5% of the earth consists of pure water (fresh water) (Kusumanta, 2019). The clean water crisis causes something called scarcity.

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One way to overcome the water crisis is to use artificial rain to maintain water quality and meet various needs in a sustainable manner.

Water quality is an important thing that needs to be managed. Water quality in accordance with quality standards makes meeting the need for clean water can be fulfilled (Yanti and Harudu, 2019). Water quality management is carried out from the physical parameters of water to determine odor, color, total dissolved solids (TDS), turbidity, taste, and temperature (Anuar et al., 2015).

The author chose to conduct this research because the problems raised are one of the increasingly urgent environmental issues and have a serious impact on society and the environment. Long droughts lead to a lack of clean water supply which is often caused by climate change, both in terms of quality and quantity. This has a direct impact on daily life.

By understanding the root causes and consequences of the clean water crisis caused by the long drought, the authors hope that this study can contribute to a better understanding of overcoming the clean water crisis by utilizing artificial rain. Thus, this research has a relationship in the context of environmental sustainability and community welfare.

The problem of water supply is a very urgent problem. Because the problem of water supply in the future will be more complex. This is due to the decreasing availability of water both in quantity and quality. Weather modification technology or commonly known as artificial rain is one way to anticipate reduced water reserves, especially the availability of clean water. The use of weather modification technology is carried out based on studies of aspects of water availability and the results of weather modification activities that have been carried out (Nugroho, 2001).

Artificial rain refers to a technology created to stimulate or create precipitation (rain) with the aim of overcoming the water crisis and reducing the impact of droughts that are increasingly frequent due to climate change (Puspitalova, 2023). Entering the dry month, the quality and amount of water is increasingly difficult to obtain by most residents in Indonesia. The increasingly extreme weather makes water supplies run low. It is undeniable, artificial rain will provide benefits like the function of rain in general. Artificial rain will be very beneficial, especially for areas that are experiencing a dry season.

Water is the most important substance needed by living things besides air. According to Revansyah et al. (2022) Water is a chemical molecule consisting of a combination of one oxygen atom and two hydrogen atoms forming a covalent bond. Water is one of the inseparable needs of living things in its existence.

Rapid changes at this time indicate that humans are in a transition period from a period that considers water use to be affected by scarcity of supplies (Husni &; Nuryanto, 2000).

According to Akhmad and Bayuadji (2019), water needs almost certainly have a tendency not to be in line with the level of availability, both related to the dimensions of time and space, as well as the amount and quality. For this reason, humans intervene into the pattern of water availability through the creation of water reservoirs through the construction of dams. The formation of reservoirs due to dams, it is expected that excess water in the rainy season can be stored for use in the dry/ dry season which has a relatively large level of water demand.

Climatologically, Indonesia which is located in the equatorial region, actually rainfall is quite abundant throughout the year, only the distribution is uneven. Most rainfall falls only in the rainy season. Meanwhile, water needs (especially clean water) do not know the season and even tend to increase, while water sources in the form of rainfall are relatively fixed. This resulted in many places experiencing water crises, not only in the dry season but also in the rainy season (Husni and Nuryanto, 2000)

According to the United Nations (UN) in 2019 noted that there are about 2.2 billion people or about a quarter of the world's population still lack safe drinking water. Meanwhile, 4.2 billion people lack safe sanitation services and 3 billion lack basic handwashing facilities. According to the Bappenas report, the availability of water in most areas of Java and Bali is currently classified as scarce to critical. Meanwhile, water availability in South Sumatra, West Nusa Tenggara, and South Sulawesi is projected to become scarce or critical by 2045. The scarcity of clean water also applies to drinking water.

According to the 2020-2024 RPJMN, only 6.87 percent of households have access to safe drinking water. Meanwhile, based on the 2020 National Socioeconomic Survey (Susenas) from BPS, it also shows that 90.21 percent of households have access to adequate drinking water, although the distribution is uneven (Iswara, 2021).

Many things can be done to overcome or reduce the current water crisis in Indonesia, one of which is to apply artificial rain. Artificial rain is a human effort to increase rainfall that falls naturally by changing the physical processes that occur within the cloud (Jakaria and Tohir, 2017).

Artificial rain is made by seeding clouds using materials that are hygroscopic (absorb water) so that the growth process of rain grains in the clouds will increase and will further accelerate the occurrence of rain. The cloud used to make artificial rain is a type of Cumulus (Cu) cloud that looks like a cauliflower. Once the location of the clouds is known, aircraft carrying special powder to bring down rain are flown towards the clouds. Artificial rain is usually made to help areas that are experiencing drought, or it can also be made to fill reservoirs, lakes, for clean water purposes, irrigation, power plants (PLTA), as well as anticipating forest or land fires and haze. Since this artificial rain is a weather modification, it is artificial rain can occur at any time without having to wait for the sky to cloud (Jakaria and Tohir, 2017).

2. Methods

The method used in writing this article is a literature study in several journals and previous articles to obtain data and information to review experiences that have been successfully carried out in previous research and provide a clearer understanding. Literature studies focus on searching for literature and facts about studies. Journal and article criteria are searched with the keywords "water" and "artificial rain".

3. Results and Discussion

3.1 Results of Rainwater Quality Analysis

The data used is data from the analysis of rainwater quality and reservoirs in artificial rain activities including physical and chemical parameters that have been carried out in various locations in Indonesia as in the following table:

Table 1. Observed water quality parameters

No.	Parameter
1.	Daya Hantar Listrik (DHL) Kimia
2.	pH
3.	Sulfate
4.	Calcium (Ca)

3.2 Results of Rainwater Quality Analysis During Artificial Rainfall Activities

Table 2. Comparison of parameters result

No.	Parameter	Result	Source
1.	pH	6,26-6,34	(Husni and Nuryanto, 2000)
		7	(Mashuri et al., 2021)
2.	DHL	29,13-38,55 umhos/cm	(Husni and Nuryanto, 2000)

		214,8 umhos/cm	(Riyandini, 2020)
3.	Sulfate	20 mg/L	(Mashuri et al., 2021)
		13,10 - 41,32 mg/L	(Prasetyo, 2022)
4.	Calcium (Ca)	0,67-0,79 mg/L	(Husni and Nuryanto, 2000)
		10 mg/L	(Mashuri et al., 2021)

3.2.1 pH

The pH parameter is a measure that describes the acidity of a solution. Based on the data in Table 2, there was no significant difference between the two treatments, although in general there was an upward pattern. In accordance with group A water quality standards according to PP No. 20 of 1990, water used for human consumption must have a pH between 6.5 to 8.5, but it is highly recommended around 6.5. In the two sites tested, the pH of the rainwater remained within the permissible range, even close to the recommended value. According to Swingle, as quoted in Wardoyo (1981), the pH of water for fishery purposes ranges from 5.0 to 9.0. Therefore, with a pH of about 6.4 during periods of artificial rain, the water can still support the normal life of fish.

3.2.2 Electricity

Electrical conductivity (DHL) is a measure that indicates the concentration of ions in water. Based on the data in Table 2, in general, DHL values in two different places, show a significant difference. During artificial rain treatment, there is an increase in DHL value, the amount of dissolved solids increases, which results in an increase in DHL. This phenomenon is thought to have a significant relationship with artificial rain treatment. When artificial rain is carried out, the intensity of rain increases, so the mass of water also increases.

Based on class A water quality standards according to PP No. 20 of 1990, there is no maximum limit for DHL value. However, for drinking water, it is recommended that DHL be very low or even non-existent. Therefore, although artificial rainwater can still be used as safe drinking water, because it still has the ability to conduct electricity, it should not be used for such purposes. Based on table 2 it can be concluded that artificial rainwater cannot be used as drinking water because it has high DHL levels.

According to Sylvester (1985), fish tolerance to DHL is affected by water hardness. In soft *water*, fish can live well if DHL ranges from 150 to 500 umhos/cm. Above 500 umhos/cm, fish cannot survive. However, in *hard waters*, fish can tolerate higher DHL, even up to 2000 umhos/cm. Therefore, rainwater with a DHL value of around 30 to 40 umhos/cm is still suitable for fisheries purposes.

In agriculture, salinity is an important parameter among other parameters, and indicates the amount of salt dissolved in water. Salinity is also often measured by DHL or presented as total dissolved solids (TDS, mg/l). USDA (1954). Based on the classification in table 2, artificial rainwater with a DHL value of around 29 to 215 umhos/cm can be categorized as water of poor quality for agriculture.

3.2.3 Sulphate

Sulfate is an ionic form of sulfur or sulfur that occurs naturally in water. More stable sulfates can form when reacting with other elements in water. The turbid water indicates the higher the concentration of sulfate (Mulyono, 2007). In general, the presence of sulfate does not have a significant impact on health because the nature of sulfate ions is quite stable and not easy to react, but the impact can be felt directly in terms of taste if the concentration of sulfate in water is high (Sutanto and Iryani 2011). High sulfate levels can cause an unpleasant taste and smell in water and cause corrosion in pipes (Achmad, 2004; Mauldy, 2018). The excess amount of sulfate ions in water causes the effect of washing the stomach if consumed by humans (Sulistyorini et al., 2016). Permenkes RI number 492 of 2010 stipulates that the maximum concentration of sulfate allowed for drinking water is 250 mg/L.

3.2.4 Calcium (Ca)

The standard for the content of Calcium (Ca) in drinking water in the Indonesian National Standard (SNI) number 01-0220-1987 concerning drinking water is 10 mg / L (10 ppm). Based on the data in Table 2, information can be obtained that the Ca test parameters in both treatments show a difference, generally showing an increase pattern in the two treatments during artificial rain activities. However, the Ca element obtained is relatively large, so it needs attention, because rainwater should not contain Ca elements.

Chemically the molecular structure of water is a bond of 2 hydrogen atoms and 1 oxygen atom better known by the formula H2O (dihedral), but in solid form (ice) turns into a bond of 4 hydrogen atoms and 1 oxygen atom (tetrahedral). Physically water has several unique properties: odorless, tasteless and colorless; freezing point at 0°C and boiling point at 100°C; specific heat of 539.5 calories and density = 1.00; the maximum density temperature is 4°C; and has a relatively small specific conductivity

Water that has the above properties is pure water, so that in nature water that has the properties as above almost does not occur, because water in nature is not really pure because in it there are always various materials both organic and inorganic, ranging from floating, suspended to dissolved.

3.3 Water Requirements for Fit for Consumption

WHO provides very detailed guidance in the "*Guidelines for Drinking-water Quality*", including recommended limit values for various parameters. Here are some examples of limit values recommended by WHO for some key parameters in drinking water:
In the assessment of water quality, several parameters are crucial. Microbiologically, the absence of Escherichia coli and coliform bacteria in 100 mL samples is imperative. Chemically, the concentrations of Cadmium, Mercury, Lead, Ammonium, Nitrate, and Nitrite must not exceed 0.003 mg/L, 0.001 mg/L, 0.01 mg/L, 0.5 mg/L, 50 mg/L, and 0.1 mg/L respectively. Physically, the water should not exhibit unusual smells or tastes, with Turbidity levels not exceeding 5 NTU. Radioactively, the presence of Radon should not surpass 1.000 Bq/L. Additionally, parameters such as pH (ideally between 6.5 and 8.5) and Dissolved Oxygen (at least 5 mg/L) are vital indicators of water quality. These parameters collectively serve as benchmarks for ensuring the safety and purity of water for consumption and environmental health.

3.4 Water Requirements for Agriculture

Water can be used as a source of irrigation for agriculture, the conditions for water that can be used for irrigation, if taken from the parameters in the study, namely having a temperature between 18 0 C -35 0 C, and having an acidity level of water between 6 -8.5 PH. This can affect the growth of rice in rice fields (Yusuf, 2014).

3.5 Water Requirements for Fisheries

In accordance with the Indonesian National Standard 7550:2009 (March 21, 2013), the optimal level of dissolved oxygen for tilapia is set at 7 ppm. As emphasized by Effendi (2003), waters designated for the benefit of fisheries should maintain a dissolved oxygen concentration of no less than 5 mg/L. Any imbalance in dissolved oxygen levels poses a significant risk to fish health, potentially inducing stress due to inadequate oxygen supply to the brain. Moreover, insufficient oxygen availability can lead to fatal outcomes, such as anoxia, where body tissues fail to effectively bind the dissolved oxygen in the bloodstream (Dahril et al., 2017). It's imperative to maintain adequate dissolved oxygen levels in aquatic environments to ensure the well-being and survival of fish populations, thereby sustaining the ecological balance of aquatic ecosystems.

Andrianto (2005) highlights the detrimental effects of ammonia presence in water, elucidating its impact on oxygen binding by blood grains, thereby diminishing fish appetite. Maintaining ammonia levels below 1 ppm is imperative for aquatic ecosystems, as concentrations exceeding this threshold can pose significant harm to fish and other cultivated organisms. Furthermore, Handajani and Samsundari (2005) underscore the importance of meeting specific requirements in aquaculture water management. Inadequate pond height, for instance, can induce fish shock, particularly as water temperatures escalate during the day. Such thermal stress renders fish more susceptible to diseases, emphasizing the critical role of environmental parameters in ensuring the health and well-being of aquatic species within aquaculture systems.

Maintaining optimal conditions for farmed fish is crucial for their health and productivity. The ideal temperature range for these aquatic organisms typically falls between 28°C and 32°C. Below 25°C, fish exhibit decreased movement and appetite, while temperatures below 12°C can be fatal, leading to freezing. Conversely, temperatures exceeding 35°C induce stress and respiratory difficulties due to increased oxygen consumption and decreased solubility of oxygen in water. Moreover, higher temperatures accelerate the conversion of ammonium to ammonia, which poses greater toxicity to fish. Fish species show varying degrees of resilience to temperature fluctuations, generally ranging from 22°C to 32°C, as noted by Judantari, Khairuman, and Amri (2008). Salinity levels in water, especially in freshwater environments (salinity ranging from 0 to 5 ppt), must be carefully regulated to ensure optimal fish health and maintenance, as indicated by Boyd (1982) in Ghufran et al. (2007). These chemical parameters are subject to fluctuations influenced by factors such as rainfall and evaporation in a given area, as highlighted by Handajani (2010). Furthermore, the efficiency of feed utilization is directly impacted by growth rates and the quantity of feed administered. Thus, meticulous management of these environmental and nutritional factors is essential for the successful cultivation of farmed fish.

Based on research by Khairuman (2005), it's observed that the survival rates of fish in various aquatic environments such as ponds and rice fields, particularly during maintenance at the 8-12 cm stage, typically range between 80-90%. Moreover, the survival rate at stage II in KJA stands notably high at around 70%. However, instances of seed death are noted, primarily attributed to suboptimal pond water levels. Furthermore, insights from Chotiba (2013) and Rahim et al., (2015) indicate that fish mortality within each treatment group is subject to diverse factors, among which salinity plays a significant role. Elevated salinity levels correspond to increased mortality rates among fish fry due to the strain it imposes on osmoregulation processes; when osmoregulatory demands surpass the fish's physiological capacities, fatalities occur. This underscores the multifaceted nature of factors influencing fish survival and underscores the importance of maintaining optimal environmental conditions to mitigate mortality risks.

4. Conclusions

Water pollution is considered a major problem facing freshwater and marine environments; This leads to negative impacts on human health in addition to other organisms. Freshwater ecosystems with biota living in them are considered a dangerous threat to the people who consume them. In addition, pollution or water pollution can also affect the diversity of an aquatic ecosystem due to the presence of invasive species that develop rapidly and drive out native species in the ecosystem. The public is expected not to catch let alone consume fish that are in polluted waters of factory waste, because the harmful content in these fish can enter the body and trigger damage to the human body.

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Author Contribution

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