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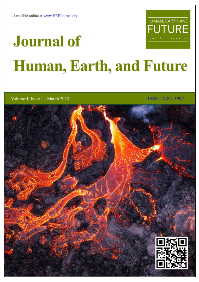

Utilization Management to Ensure Clean Water Sources in Coastal Areas

Ahmad Syarif Sukri [1*], Saripuddin M. [2], Riswal Karama [3], Nasrul [1], Romy Talanipa [1], Abdul Kadir [1], Nini Hasriani Aswad [1]

[1] *Department of Civil Engineering, Halu Oleo University, Kendari 93232, Indonesia.*

[2] *Faculty of Engineering, Islamic University of Makassar, Makassar 90245, Indonesia.*

[3] *Department of Civil Engineering, Hasanuddin University, Makassar 90245, Indonesia.*

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Abstract

Coastal communities utilize tidal water sources; existing surface water does not meet clean water standards, and communities are greatly affected by current water use. Managing existing water sources to meet the needs of the community is very difficult to obtain, so research is needed to determine the quality, quantity, and distance of water sources needed to meet the standards. This study aims to determine the quality, quantity, and distance of water sources. This study used a descriptive qualitative approach, the observation method, a survey, a questionnaire, and documentation. Good water source management will ensure that everyone has enough water. October's highest surface water potential Q = 61.96 m^3/s and April's low Q = 1.02 m^3/s, highest Q_t groundwater potential = 0.12 m^3/s, and the lowest Q_t = 0.05 m^3/s. Water availability Q = 21.15 m^3/s with a domestic demand rate Q = 0.127 m^3/s and Q = 0.021 m^3/s non-domestic. A suitable and compliant water source is located at point 5 at a distance of 9 km from the location of the coastal area, with 87% water quality and conditions Temperature, pH, NO_3, NO_2, TN, COD, BOD, and Chlo-a meet the standard value obtained at 0.2 mg/l, indicating that the condition is not contaminated and safe. Coastal water quality challenges demand research and prudent use management. Nature-based littoral zone management enhances water quality. Pollution management, sustainable water use, and community involvement safeguard coastal habitats, biodiversity, and water sources.

Keywords: Utilization Management; Clean Water; Water Sources; Coastal Areas.

1. Introduction

The intricate tapestry of coastal areas is interwoven with a vast network of water resources, serving as the lifeblood of these unique ecosystems. In the coastal areas of developing countries, water resources occupy a pivotal position, representing both a source of hope and a significant challenge on the path to sustainable development. These regions, rich in natural beauty and cultural heritage, face a myriad of complex issues that impede access to clean and sufficient water. Limited infrastructure, rapid urbanization, and inadequate sanitation systems create formidable hurdles for coastal communities, leaving them vulnerable to waterborne diseases and environmental degradation. The lack of reliable and safe water sources perpetuates a cycle of poverty, hindering economic growth and stifling the potential for social

* Corresponding author: ahmad.syarif.sukri@uho.ac.id

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progress. However, amidst these challenges lies an opportunity for transformative change. By embracing innovative approaches to water resource management, fostering cross-sector collaboration, and prioritizing the needs of marginalized communities, coastal areas in developing countries can unlock the potential of their water resources, fostering resilience, driving sustainable development, and paving the way for a brighter future for generations to come. Furthermore, the productive interactions between land and sea give rise to dynamic wetlands that act as natural filters, purifying water and mitigating the impacts of pollution. The significance of these water resources cannot be overstated, as they provide not only sustenance for diverse marine life but also a source of livelihood for countless coastal dwellers. Besides, none is more essential and fragile than the life-giving elixir of clean water. However, the very existence of these precious coastal water resources is increasingly under threat from a convergence of formidable challenges. Climate change, with its rising sea levels and intensified storms, poses a grave risk to coastal areas by altering the delicate balance of salinity, disrupting ecosystems, and encroaching upon freshwater sources. Human activities, including industrial pollution, agricultural runoff, and over-extraction of groundwater, further compound these challenges, leaving an indelible mark on the coastal environment and jeopardizing the integrity of vital water resources.

Access to clean and sufficient water resources is an ongoing global challenge, particularly in coastal areas, where the scarcity of freshwater is further compounded by increasing population growth and environmental pressures. According to the World Health Organization (WHO) and UNICEF Joint Monitoring Programme, approximately 2.2 billion people worldwide lack access to safely managed drinking water services, and around 4.2 billion lack access to safely managed sanitation facilities, contributing to the prevalence of water-related diseases and a higher risk of waterborne illnesses. Moreover, 844 million people do not have access to water that meets WHO standards, and 230 million rely on rain, pipelines, deep wells, and shallow wells for more than 30 minutes per day [1, 2]. In coastal regions, the scarcity of freshwater resources is aggravated by several factors. Firstly, coastal areas often experience saltwater intrusion into aquifers due to over-pumping of groundwater, rising sea levels caused by climate change, and coastal erosion. This phenomenon renders freshwater sources brackish or saline, making them unsuitable for consumption and agricultural use. The salinization of freshwater resources has severe implications for coastal communities that heavily rely on groundwater as a primary source of water supply. Moreover, rapid population growth and urbanization in coastal areas further strain water resources. The concentration of human settlements along coastlines increases the demand for water, overwhelming existing infrastructure and exacerbating water scarcity issues. Additionally, the expansion of industrial activities and intensive agriculture in coastal regions leads to increased water consumption and pollution, further compromising the availability and quality of water resources. Efforts to address these challenges and improve access to water resources in coastal areas require a multi-faceted approach. Integrated water resource management, including the development of efficient water storage and distribution systems, desalination technologies, and wastewater treatment facilities, is crucial for meeting the water demands of coastal communities sustainably. Furthermore, implementing climate change adaptation measures, such as coastal protection initiatives and the promotion of water-use efficiency, can help mitigate the impacts of rising sea levels and ensure the long-term availability of freshwater.

The fundamental makeup of coastal water resources extends past surface waters and into the vital underground reserves of coastal groundwater. Groundwater plays a crucial role in coastal areas, where its essence permeates the very fabric of these dynamic ecosystems. Groundwater serves as a hidden reservoir, providing a lifeline of freshwater that sustains coastal communities, supports agriculture, and nourishes delicate ecosystems. In coastal regions, the importance of groundwater is amplified by the challenges of limited surface water availability and the vulnerability of freshwater sources to saltwater intrusion. Coastal aquifers contribute significantly to the global freshwater supply, accounting for approximately 20% of global groundwater withdrawals. Coastal groundwater plays a vital role in maintaining the delicate balance of ecosystems by supplying freshwater to wetlands, estuaries, and other sensitive habitats. These ecosystems act as nurseries for diverse marine species and serve as breeding grounds for migratory birds, relying on a constant influx of freshwater to maintain their ecological integrity. Additionally, coastal groundwater provides critical support to agriculture, enabling irrigation in regions where surface water resources are scarce or unreliable. It offers resilience to farmers, allowing them to sustain agricultural production even during periods of drought or limited rainfall. However, the essence of coastal groundwater is threatened by multiple factors. Rising sea levels, resulting from climate change, increase the risk of saltwater intrusion into coastal aquifers, rendering groundwater brackish or saline. Human activities, including excessive groundwater extraction for agriculture, industry, and domestic use, further exacerbate the vulnerability of coastal aquifers. The over-pumping of groundwater creates a negative pressure gradient, causing seawater to infiltrate and contaminate freshwater resources. Hydrological models depict the flux and capacity of groundwater reservoirs [3].

Hydrodynamic characteristics of groundwater in 25 wells with groundwater network systems 80–300 m from the surface of the soil containing inorganic carbon are factors for recharging the groundwater catchment region [4]. The storage of groundwater in arid regions has a significant effect on elevation and water balance [5]. The hydrological conditions of water catchments are difficult to identify and inconsistent, particularly in sediments deeper than 200 centimeters. A system for managing environmental conditions can utilize an existing application system to manage the water balance [6]. Protecting and managing the essence of coastal groundwater requires a multifaceted approach.

Integrated coastal zone management, supported by comprehensive monitoring [7] and modeling of groundwater resources, is crucial for sustainable water resource planning. Traditional coastal populations require water for purposes of health, society, and culture [8]. A water source influences the hydraulic infrastructure, accessibility, and distribution of water in the plan area and development area [9]. The basin absorbs municipal water [10]. Dye inhibits the absorption of water [11]. Implementing measures to promote water-use efficiency, such as adopting precision irrigation techniques and reusing treated wastewater, can reduce the dependence on groundwater and alleviate the pressure on coastal aquifers. Furthermore, raising awareness and fostering community participation in groundwater conservation efforts are essential for ensuring the long-term sustainability of this invaluable resource.

The management of water sources guarantees water supply, sustainability, and community regulation. Distribution and discharge influence the management of water quality [12]. Management systems determine water use [13]. In coastal regions devoid of clean water networks, water shortages influence access, distance, season, and cost of exposure [9]. Using water use efficiency, a model regression can predict regional and neighborhood water use thresholds [14]. In arid or humid environments, water infiltration and consumption are affected by efficiency and conditions [15]. Utilization of rivers and groundwater influences water quality and quantity [3]. Coastal areas are harmed by tides, foreign water, and pure water shortages. Waves from the ocean can inundate coastal communities [16]. In urban areas, coastal zones require administration [17]. Coastal areas are protected and undeveloped, requiring regional management [18]. The coastal industry utilizes groundwater, river water, and lake water [19]. Models validate coastal flooding and surges [16]. Marine structures and ecosystems can be detrimental to coastal and estuarine ecosystems [20]. However, coastal water sources are limited and affected by foreign surface and groundwater conditions. Mass affects the surface water and conditions of a lower river [21]. At each site, piped irrigation, sanitation, and groundwater consumption vary [22]. Groundwater management should correspond to the intended area [23].

Environmental factors have an effect on water quality, capacity, groundwater depth, and foreign or effluent [24]. The volume and capacity of coastal effluent must comply with regulations [25]. Coastal communities require additional water. 18% of water is for treatment and efficiency [13]. 250 million individuals require water [26]. Progress influences the distribution of water and efficiency requirements [14]. Optimizing water jetting simplifies water supply authorizations [27]. The conservation of water safeguards the environment, increases efficiency, and reduces infrastructure damage [28]. Source, distribution, and purification reclaim fifty percent of the water [29]. Population, surface and groundwater quality, and regional factors have a significant impact on water availability [30]. It necessitates littoral water quality management. 20% of the population utilizes clean water to increase household water supplies and groundwater to prevent water shortages [31]. Clean water accounts for 15% of industrial water use [32]. The demand for pure water may exceed the available supply at water sources [33]. Numerous enterprises desalinate seawater [29]. Area influences the water requirements of meadows, forests, industries, and wetlands [27]. Coastlines impede the use of pure water. The height of the shoreline and ocean surface reveals the contours and condition of the land and coastline [34]. Coastal area monitoring determines the conditions of coastal areas, coastlines, coastal areas up to the river, and coastal ecosystems, manages and protects coastal areas, evaluates area management and construction management, operates, maintains, and rehabilitates coastal areas, and educates the public about coastal areas [18]. The AMF model accounts for coastal tree planting [35]. The rise in sea level has a significant effect on coastal areas and water availability [32]. The public's comprehension of water use in developing countries remains limited [36].

The management and utilization of clean water resources in coastal areas have received considerable attention due to their critical significance for ecological sustainability and human welfare. Despite the abundance of research on coastal water resources, there is a knowledge deficit regarding the utilization and management of these valuable resources. While research has focused on issues such as water quality, pollution control, and ecological impacts, comprehensive approaches for optimizing the use of pure water resources in coastal areas have received scant attention. There is a need for research on innovative strategies for sustainable water allocation, efficient water use practices, and integrated management frameworks that take into account the complex interactions between freshwater, saline, and human activities in coastal environments. The development and implementation of integrated coastal water resource management frameworks that incorporate multiple dimensions, such as ecological, socioeconomic, and governance factors, represents a particular research lacuna. Such frameworks should strive to strike a balance between the competing needs of water users and the long-term viability of coastal water resources. In addition, research is required to evaluate the efficacy of various water management strategies, such as water reuse, desalination technologies, and nature-based solutions, in the context of coastal regions. This would shed light on the viability, effectiveness, and environmental implications of these approaches. To resolve this issue, interdisciplinary collaborations between scientists, policymakers, and interested parties are essential.

Integrated research initiatives that combine hydrology, ecology, economics, and social sciences can contribute to a comprehensive understanding of the utilization and management of clean water resources in coastal regions. In addition, case studies and best management practices from various coastal regions can provide valuable insights and serve as a guide for the development of sustainable management strategies. This research intends to bridge those gaps so we can improve our understanding of the complex dynamics of water resources in coastal areas and devise effective management strategies to ensure the availability and equitable use of clean water resources. This will promote a harmonious coexistence between human activities and the maritime environment, contributing to the sustainable development and resilience of coastal communities. This study investigates how water quality, water quantity, and the right distance to determine the location of water sources in accordance with the quality, quantity, and use of clean water can ensure its availability for coastal communities.

2. Research Method

Figure 1 depicts the location of this qualitative descriptive study in Bombana district, Southeast Sulawesi Province, Indonesia. The Observation and Survey technique collects water samples from 100 members of a coastal community and five pure water sources. Observation, surveys, questionnaires, and documentation provide data for the instrument. The Log-Pearson III method is more accurate [37] when analyzing flood frequency. In each river segment, the discharge formula is used to calculate the river's width (b), depth (h), and velocity (V):

$$Q = V.A \text{ (m}^3\text{/s)} \quad (1)$$

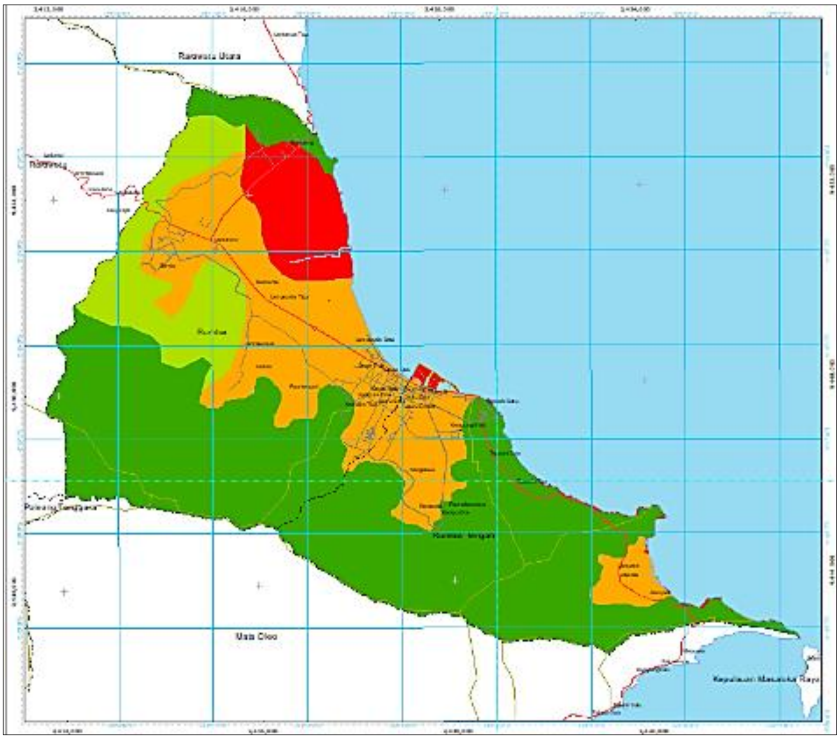

Figure 1. Study Area, Bombana district, Southeast Sulawesi Province, Indonesia.

Determination of river discharge using climate data pertinent to the study site [38], Observation of river discharge is based on the variables of river width, water depth, flow velocity, and the results of hydrological analysis [39], as well as the river's flow velocity. The behavior observed in rivers The magnitude of the river's discharge is primarily determined by hydrological analysis [40], The selection of hydrological data must demonstrate a stable cycle capable of generating a concentrated river discharge [41], and The quantity of river discharge that occurs is influenced by the season, with the maximum river water discharge occurring in winter and the minimum occurring in summer [42].

Laboratory analysis is used to analyze water quality, availability, and groundwater potential. We measure groundwater discharge using simple flow discharge analysis on groundwater wells performed with a pump system by measuring well diameter (D), water depth (h), fill time (t), and well water velocity.

$$V = h/t \text{ (m/s)} \quad (2)$$

so that good discharge

$$Q = V.\frac{1}{2}\pi D^2 \text{(m}^3\text{/s)} \quad (3)$$

The simulation model for groundwater analysis utilizes pumping, discharge, catchment area, and flow process data [43]. Ecological variables, land use, rising salinity, and river flow potential all decrease groundwater content and discharge. The area of the water catchment and the conditions of the nearby rivers determine groundwater discharge

[44], the determination of groundwater discharge is based on the area of the water catchment and the conditions of the range of the surrounding rivers [45], temperature and evapotranspiration increase groundwater discharge [46], and water balance and water mass balance influence groundwater discharge [47].

The enhancement of water quality is dependent on reference parameters [48]. Depending on water quality, water planning, administration, and control necessitate the protection and management of water sources [49]. The water quality level determines necessity and benefits [50]. Comparing availability to population establishes water requirements, while operation optimization principles define system dependability [51]. Water quality has declined due to industrialization and contamination [52].

Figure 2 depicts the location of water sampling for water balance analysis and water quality evaluations at the Faculty of Mathematics and Natural Sciences of Halu Oleo University in Southeast Sulawesi, Indonesia. Predictions of stable water quality reduce prediction errors and generate new ideas [48]. Water parameters such as pH, total dissolved solids (TDS), calcium (Ca_2^+), alkalinity (AK), magnesium (Mg_2^+), sodium (Na^+), bicarbonate (HCO_3^-), total hardness (TH), chloride (Cl^-), copper (Cu), fluoride (F^-), nitrate (NO_3^-), potassium (K^+), iron (Fe), nickel (Ni), zinc (Zn), and manganese (Mn) [24], and water quality index affects minimum water utilization by the water restriction method [53]. Laboratory evaluations serve as the standard for determining the distance from a domestic water source that is suitable for consumption. Enhanced water quality standards influence water consumption [54]. It is difficult to summarize the data to ascertain the water quality index. In this investigation, a Salinometer measured salinity and a dissolved Oxygen meter measured DO. The American Public Health Association (APHA) analyzes water samples for BOD, COD, NO_3, NO_2, NH_4, Chlo-a, and TP, while pH is determined using a pH meter and spectrometer to identify Fe, Cu, Zn, Cr, Ni, Cd, and Pb [55].

Figure 2. Water sampling location

Water Quality Index (WQI) is a comparison of changes in water quality with the number of quality parameters studied, this condition is derived from the quality rating (qi) with the formula:

$$qi = 100 \times (\frac{vi}{si}) \tag{4}$$

Description: vi is the observed data, si is the water quality standard, and qi is the same as the data standard, which is easier to determine polluted water. WQI analysis, qi quality rating used equation

$$WQI = \Sigma qi \tag{5}$$

Caption i = 1. The average water quality index (AWQI) and n is factors of the number of parameters are calculated by the following equation.

$$AWQI = \Sigma qi/n \tag{6}$$

The AWQI classification consists of 4 categories: (0.0 – 100) good, (100 – 150) medium, (150 – 200) bad, and (> 200) very bad [55].

The flowchart of the research methodology that was used to achieve the study's aims is shown in Figure 1.

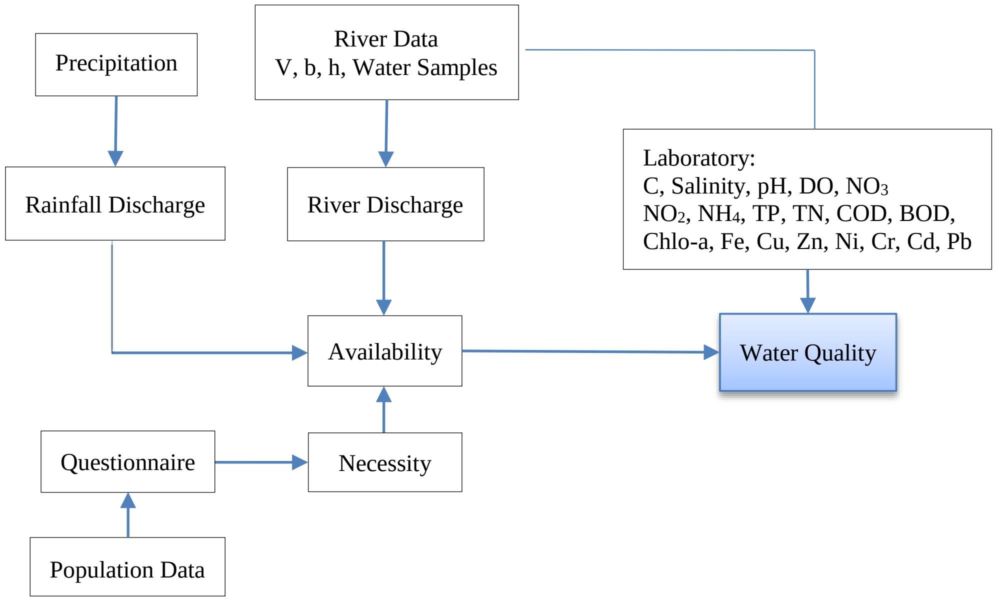

Figure 3. Flowchart of the research methodology

3. Result and Discussion

Depending on the season, surface water utilization is the prospective water source in the study area. The development of surface water with the water quality index and surface water quantity [56] is a multifaceted endeavor. The state of the water's volume will influence its potential [57]. The study area's surface water potential had the highest water availability in October (Q = 61.96 m^3/s) and the lowest in April (Q = 1.02 m^3/s), while groundwater potential had the highest Qt = 0.12 m^3/s and the lowest Qt = 0.05 m^3/s. The availability of groundwater collected from the soil constitutes a sizable water reserve that can be used as a water source [58]. Groundwater is one of the subsurface water sources for arid conditions, constituting 40 percent of the water supply [59]. Restrictions on regular water use are influenced by cultural, spiritual, and economic factors, but not always by physical access to water sources [8]. The increase in groundwater discharge is significantly affected by the surface water system and the rise in groundwater gradient in the region [60].

Domestic Q = 0.127 m^3/s and non-domestic Q = 0.021 m^3/s are the water requirements of coastal communities in this study area. According to the findings of the study, the potential of water in the raw water source area, including both surface water and groundwater, is immense; therefore, the use of water for coastal areas can be obtained from water sources that are distant but still accessible. The use of clean water in coastal locations is permissible for both domestic and industrial purposes. Providing water services to residential areas via pipelines to prevent potential water loss [56]. The flow of gravity-pattern pipes from the water source to the consumer varies based on the conditions of the water source and the hydrological pattern [61]. Improving the pipeline system requires an in-depth investigation [62]. To implement jetting in the field, pipeline systems with multiple segments require a compressor system and a control system [63]. Flow-continuous piping systems are susceptible to flow disruptions, and a system with thin pipelines can generate greater pressure [64].

Land surface conditions, land use, and precipitation influence alterations in surface water sources [65]. In clean water management systems utilizing surface water sources, weirs, gravity discharge systems, water treatment, and distribution installations for 24 hours, results were obtained. Numerous individuals continue to drink untreated surface water [11]. Monitoring the conditions of the groundwater and soil surface to determine the potential for inundation [66]. The potential of surface water sources is diminishing, so the availability of groundwater sources is essential to enhance the population's access to water [67], and there is a massive variation in groundwater conditions in a research area [68]. With the results of the study using surface water sources with an annual average availability of Q = 21.15 m^3/s and the needs of coastal communities for domestic Q = 0.127 m^3/s and non-domestic Q = 0.021 m^3/s, with the conditions of large discharge availability and water requirements that are relatively smaller than availability, it is hoped that there will be no further water use restrictions.

Figure 4 displays relative water temperature conditions that meet the 10–25 ^{o}C clean water standard not too far from the air temperature on the surface, except on the coast where the water temperature exceeds the existing standard of 28.50 ^{o}C and Simon et al. [69] state that streams with coverage in watershed temperature patterns are necessary for water development and utilization, while water temperature measurement depends on the season [70]. For water salinity, points 1 and 2 indicate saltwater conditions (30–40), point 3 indicates brackish water conditions (6–29), and points 4 and 5 indicate freshwater conditions (0–5). Human activities influence low salinity values, which indicate freshwater conditions and the quality and quantity of the flow [55]. In order for the pH of the water in the study area to meet quality standards (6–9), various pH conditions can occur under conditions of increased water volume concentration and water state [71]. Soil conditions affect dissolved oxygen in the water and can be related to aerobic respiration with soil conditions and water surface area. Soil conditions affect dissolved oxygen in the water and can be related to aerobic respiration with soil conditions and water surface area. The average levels of nitrate (NO_3) and nitrite (NO_2) at the observation points met the standard, with the exception of point 5. A nitrate NO_3 analysis of groundwater pollution is required [72], and testing of nitrate (NO_3), nitrite (NO_2), and ammonia (NH_4) levels is required to determine the required threshold [73].

This study obtained ammonia parameters (NH_4) with an average value exceeding the standard limit, which can have an effect on water quality conditions by altering color and odor and causing corrosion in copper conduit systems. The total phosphorus (TP) parameter indicates a polluted condition, and the results indicate that the area's water is polluted with the exception of point 5. The total phosphorus condition is distinct from other observational residences [74], and the total nitrogen (TN) condition of nitrogen in the field is extremely high and distinct, with the exception of points 4 and 5, which meet the maximum permissible limit of 10 mg/l and a minimum of 8 mg/l [55]. Chemical oxygen demand (COD) parameters can be used to determine water quality. For the results of the location of the research of chemical oxygen requirement (COD) parameters that meet the requirements only at points 4 and 5, as well as for biological oxygen demand (BOD), water pollution conditions with chlorophyll-a (Chlo-a) parameters, the water conditions have been polluted except at point 5, where the value obtained was 0.2 (mg/l), indicating that the condition has not been polluted.

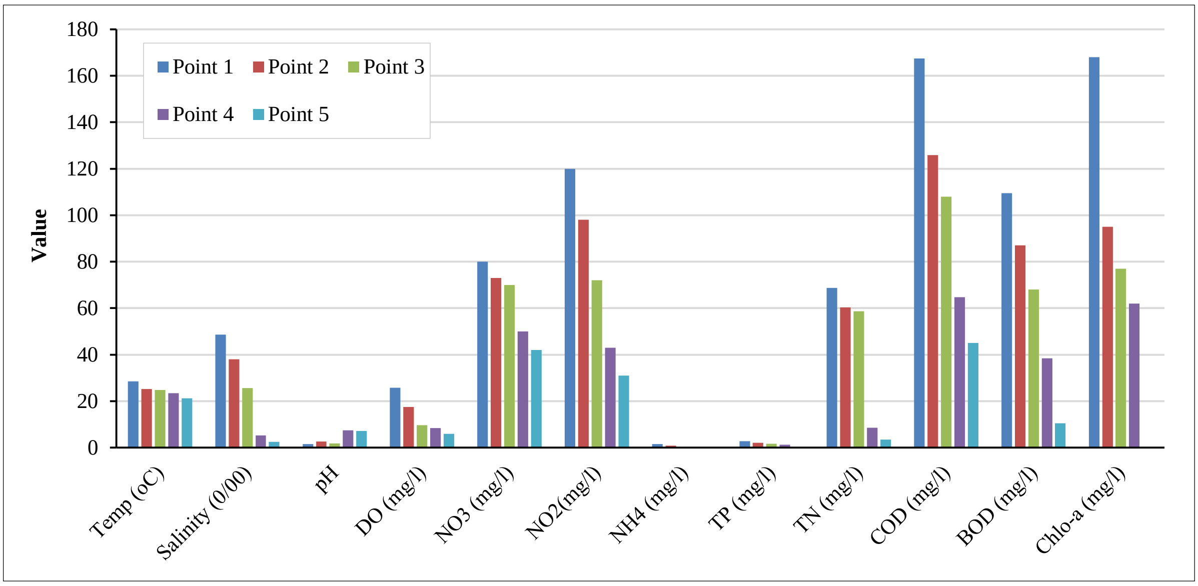

Figure 4. The average value of physicochemical parameters at each point of observation (Temp: temperature, Salinity: Salinity, pH: Potential Hydrogen, DO: dissolved oxygen, NO_3: nitrate, NO_2: nitrite, NH_4: ammonia, TP: total phosphorus, TN: total nitrogen, COD: chemical oxygen demand, BOD: biological oxygen demand, Chlo-a: chlorophyll-a).

76% of clean water usage is domestic, while 24% is non-domestic. The availability of water sources has a substantial impact on infrastructure planning [29]. Flow systems, water source phenomena, and hydrological conditions are essential for the effective management of water sources [6]. Mid-season will be significantly impacted by hydrological factors [75]. Good water source management and service systems require local, social, cultural, and economic approaches to achieve their positive values [76]. The results of our study indicated that the water quality around the coast is between 0 m and 100 m (obtained 11%-28%), 100 m - 1 km (obtained 28%-35%), 1 km - 3 km (obtained 35%-55%), 3 km - 5 km (obtained 55%-71%), 5 km - 7 km (obtained 71%-83%), and 7 km - 9 km (obtained 87%), so that the distance of adequate water sources is at a point of 9 km with water quality of 87% and a shortage rate between 5% to 13% depending on seasonal conditions, especially in periods of water scarcity [54]. Especially for water sources, water quality and retention duration have a significant effect on seasonal conditions [77]. The characteristics and purity of the water at the source will impact the source's capacity [1].

Figure 5 shows the metal concentrations of Fe, Cu, Zn, Cr, Ni, Cd, and Pb in the study area both maximally and minimum, parameters that pass the required standards, such as Fe, Zn, Ni, Cd, and Pb, while those that meet the quality standards are only copper (Cu) and chromium (Cr) factors, indicate that special management is needed if a drinking water supply facility is built in the area. The concentration of metals in the affected areas of seawater varies, with the largest concentrations of Ni, Zn, Cb, Pb, and Cu at conditions passing through the standards established by each parameter [34]. Meanwhile, Figure 6 demonstrates the water quality index and classifies the AWQI value of 117.92 into four categories: This study determined that the water quality in the study area is moderate (100 to 150) and should be treated prior to use as domestic drinking water in coastal areas. Water quality largely determines the optimal conditions for domestic drinking water [24]. Variations in water quality parameters reveal the parameter conditions of contamination sources in numerous and dispersed locations [55]. Using WQI water quality metrics requires a lengthy procedure [53]. WQI analysis provides an overview and evaluation of the suitability of water sources for human consumption and their effectiveness in preventing contamination of water [78, 79].

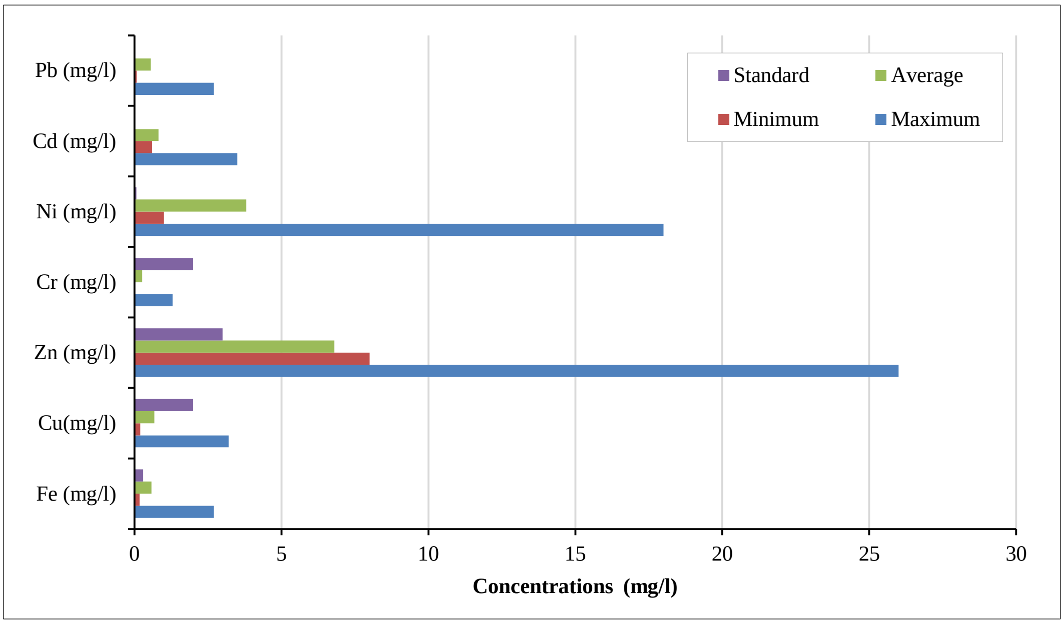

Figure 5. Maximum and minimum average values of metal concentrations (Iron (Fe), Copper (Cu), Zinc (Zn), Chromium (Cr), Nickel (Ni), Cadmium (Cd), Lead (Pb))

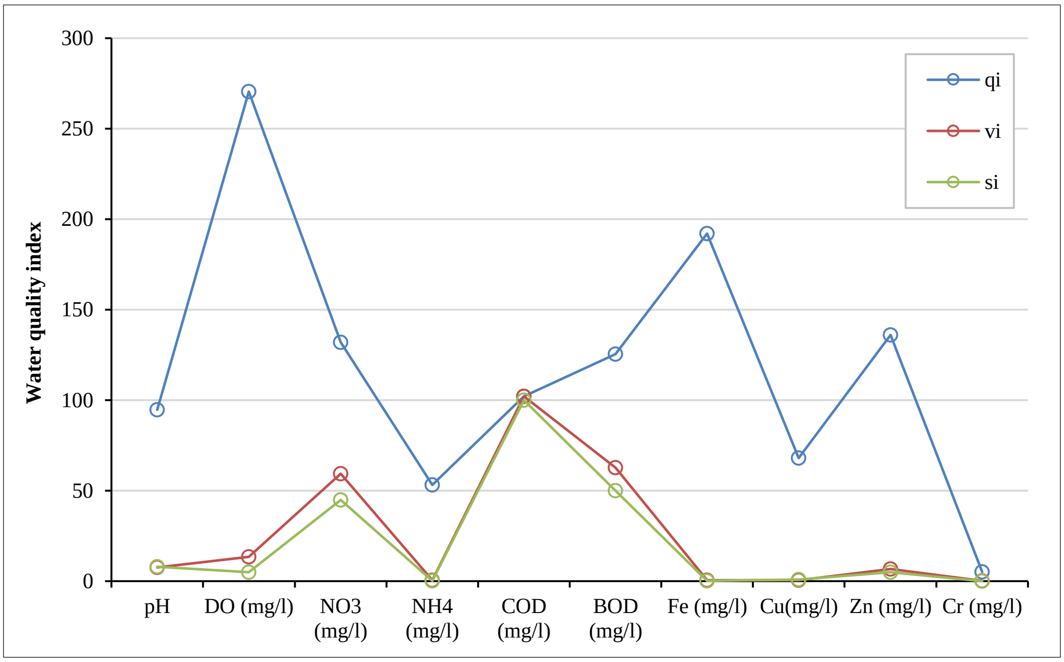

Figure 6. Water quality index and average water quality index

Due to its direct influence on the health of ecosystems, aquatic life, and human well-being, water quality in coastal regions is a pressing concern. Extensive research has illuminated the sources, distribution, and effects of water contaminants in these regions, have revealed the presence of contaminants such as nutrients, pathogens, heavy metals, and emerging pollutants, originating from various anthropogenic activities such as agriculture, industrial discharges, and urban runoff. These findings emphasize the urgent need for effective utilization management strategies to mitigate the negative effects of poor water quality on coastal ecosystems. A multifaceted strategy is required to bridge the gap between water quality research and appropriate utilization management. Integrated coastal zone management (ICZM) provides a comprehensive framework that considers ecological, social, and economic dimensions in order to accomplish sustainable development in coastal areas. By incorporating water quality considerations into ICZM plans, stakeholders can work collaboratively to maintain and improve water quality while balancing the needs of different consumers and sectors. This includes instituting measures to prevent pollution at its source, promoting water conservation, and enforcing stringent regulations and monitoring systems to ensure compliance. In coastal regions, nature-based solutions have emerged as effective instruments for enhancing water quality.

Coastal wetland types, including mangroves, saline marshes, and seagrass meadows, have natural filtration capabilities and act as buffers against pollutants, sedimentation, and nutrient runoff. Protecting and restoring these ecosystems can help preserve water quality and provide additional benefits, such as carbon sequestration and habitat preservation. Integrating coastal wetland conservation and restoration into utilization management strategies is essential for protecting water quality and enhancing the resilience of coastal ecosystems. Additionally, effective utilization management necessitates the active participation and education of local communities. Public awareness campaigns and educational programs play an essential role in promoting the responsible use of water, the reduction of waste, and the adoption of environmentally favourable practices. Knowledge of the effects of water pollution and the significance of pure water resources encourages behavioral changes and fosters a sense of stewardship toward coastal ecosystems among coastal residents. Involving communities in decision-making processes and encouraging their participation in monitoring programs can cultivate a sense of ownership and accountability, resulting in more effective utilization management practices.

4. Conclusion

Coastal communities are affected by water consumption because they use tidal water and surface water is scarce. The management of municipal water sources is complex. Complex waterways and littoral problems inhibit sustainable development. Innovative water resource management, cross-sector collaboration, and the prioritization of marginalized individuals can enhance resilience, sustainability, and the future. Therefore, this research is performed on water quality, quantity, and proximity to plan the appropriate management of its utilization. The administration of water sources ensures that everyone has plenty. The highest surface water potential is 61.96 m^3/s, and the lowest is 1.02 m^3/s. Meanwhile, the highest groundwater potential is 0.12 m^3/s, and the lowest is 0.05 m^3/s. Moreover, the annual average availability is 21.15 m^3/s, and the needs of coastal communities for domestic and non-domestic water are 0.127 m^3/s and 0.021 m^3/s, respectively, with the availability of large discharges and relatively smaller water needs. In addition, it is expected that there will be no more restrictions on water use. The appropriate water source is located at point 5 (9 km from the coastal area), with a water quality of 87% and a shortage rate between 5-13% depending on seasonal conditions. Temperature, pH, NO_3, NO_2, TN, COD, BOD, and Chlo-a meet the standard, except for the NH4 parameter, where the value obtained is 0.2 (mg/l), indicating that the water quality has not been contaminated. Surface water from river sources does not conform to standards. Community activities influence the demand for and use of coastal water. Effective water source management ensures that everyone has sufficient water. To address coastal water quality issues, research and effective utilization management must be integrated. Water quality issues are mitigated by integrated littoral zone management employing nature-based solutions and community interaction. Coastal habitats, biodiversity, and future water supplies can be preserved through pollution control, water conservation, and community involvement.

5. Declarations

5.1. Author Contributions

Conceptualization, A.S.S., S.M., R.K., and R.T.; methodology, A.S.S., N., A.K., and N.A.A.; software, A.S.S., S.M., and R.K.; validation, A.S.S., S.M., R.K., and N.; formal analysis, A.S.S.; investigation, R.T., and A.K.; resources, A.S.S., R.K., A.K., and N.A.A.; data curation, A.S.S., R.T., R.K., and N.; writing—original draft preparation, A.S.S., S.M., R.K., and A.K.; writing—review and editing, A.S.S., S.M., and N.A.A.; visualization, A.S.S., and S.M.; supervision, A.S.S. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in this study are available in the article.

5.3. Funding

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5.5. Declaration of Competing Interest

The authors declare that there is no conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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