The Application of FGD to Support Concept of Policy for Sustainable Groundwater Management in Kupang City, East Nusa Tenggara, Indonesia

[1]Aplonia Bani, [2]Suprihatinsuprihatin, [3]Satyanto Krido Saptomo, [4]Regan Kaswanto

[1]Postgraduate Student of Natural Resources and Environmental Management Science, Graduate School, IPB University, IPB Darmaga Campus, Bogor, 16680, Indonesia
[2,3]Department of Agroindustrial Technology, Faculty of Agricultural Engineering and Technology, IPB University, IPB Darmaga Campus, Bogor, 16680, Indonesia
[4]Department of Landscape Architecture, Faculty of Agriculture, IPB University, IPB Darmaga Campus, Bogor, 16680, Indonesia

Abstract- This study aims to design sustainable groundwater management policies in the City of Kupang, East Nusa Tenggara, to realize integrated water resource management at all levels. Stakeholder perceptions of the model's design are planned for several issues: the conservation program, utilization, and control of destructive power. The method used in this study was Focus Group Discussion (FGD). The data were analysed using qualitative data analysis with NVivo 12 QSR International software. The results showed that there were several problems, including the limited availability of water resources, increasing water demand, changing the function of watershed area, not optimal utilization of areas as water storage containers (dams, ponds), and the problem of tidal waves that damage coastal areas (abrasion beaches). However, stakeholders felt that the source of risk can be overcome with management that binds all parties and integrates into a sustainable policy model. Stakeholders also believe that this can contribute to preparing a water resources management plan based on soil and water conservation in the Kupang City area.

Keywords: groundwater, sustainable, policy, management

I. INTRODUCTION

Rapid economic growth and social development have led to an increase in the demand for water resources. Requires well-informed management for efficient groundwater management. Groundwater management, in a broad sense, is all efforts that include inventorying, regulation of utilization, permits, control, and supervision in the framework of groundwater conservation [1]. According to the regional regulation of East Nusa Tenggara Province Number 11 of 2018, groundwater management includes programs for conservation, utilization, and control of destructive forces. Conservation activities are carried out through efforts to protect and maintain the existence, condition, and environment of groundwater to maintain the sustainability and continuity of functions, availability in sufficient quantity, and quality to meet the needs of living things. Utilization activities include stewardship, provision, utilization, development, and exploitation of groundwater and further control of destructive potential by restoring the condition and environment of groundwater in critical zones and damaged zones which include: prohibiting the extraction of new groundwater and gradually reducing withdrawal in critical zones, prohibit taking in damaged zones, enforce spatial rules regarding natural recharge areas and create artificial recharge.

The clean water sources used by the people of Kupang City are currently 13 springs and 12 drilled wells with a flow capacity of 296.26 L/s. PDAM Kupang's clean water services are divided into eight zones, namely zone I, with 4,752 service connections, consisting of home, commercial, social, and government agency connections. The source of water used came from springs and drilled wells which are directly distributed to PDAM customers without going through a treatment system. Zone II has 4,534 units, with the water sources coming from Sago Springs, Oepura Springs, and Baumata Springs. Zone III 1,918 units, sourced from Jerky Springs, Oeba Springs, Sago Springs, and Oepura. Sago Springs and Oepura Springs. Zone IV 4,195 units of Baumata Springs, Bonem Springs, Kelapa Lima Drilling Wells, SMKK Drilling Wells, RSS LP Drilling Wells, Pramuka Drilling Wells. Zone V 1,506 units, originating from the Alak Bore Well, Namosain Bore Well, and Oenesu Spring. Zone VI 1,199 units, originating from Kolhua Springs. Zone VII has 3,154 units; Zone VIII has 1,541 units [2].

The availability of water resources in an area must meet the expected water needs so that there is a balance between the two. Determination of excess availability by water demand can be expressed through the status of environmental carrying capacity [3]. The four main sectors of water use (industry, society, environment, and agriculture) [4]. Carrying capacity analysis is carried out to determine the status of water resources and their ability to support population growth and their economic activities in a sustainable manner. In RI Law Number I7 of 2019 Concerning Water Resources, Article 45, Letter A, Point 2, what is meant by "large amounts of water" for groundwater is if groundwater is taken from a drilled well with a diameter of more than two inches, more than five centimeters, or more than 25 m3 per month per head of the family.

Based on Minister of Energy and Mineral Resources Regulation No. 2 of 2017 concerning groundwater basins in Indonesia, Article 2, Paragraph 3, explains that "Groundwater management is based on groundwater basins." It is expected that government agencies and agencies in the management and control of water resources will use groundwater management systems based on groundwater basins. The concept of sustainability is a concept that must be applied in an environment that is experiencing many changes [5]. According to [6], easier access to clean water sources affects community water use and fulfillment patterns.

Groundwater value is driven by several factors, including supply and demand, as well as institutional and policy factors. The easier access to clean water sources affects the pattern of use and fulfillment of community water. Groundwater value is driven by several factors, including supply and demand and institutional and policy factors [7]. In other semi-arid areas, groundwater evaluation datasets based on climate scenarios and institutional options show that a persistent imbalance between groundwater extraction and recharge causes groundwater depletion, so management plans (artificial recharge, desalination of seawater to fresh water, and reuse of wastewater) have been adopted to restore the groundwater imbalance [8]. In addition, according to [9] the integrated management of surface water and groundwater is carried out through harvesting rainwater and recharging groundwater aquifers to utilize rainwater in protecting the area from the risk of flooding and storing water to overcome water scarcity. This study aims to design sustainable groundwater management policies in the Kupang City, East Nusa Tenggara, to realize interagted water resources management at all levels.

II. RESEARCH METHODS

This research was conducted using qualitative research methods to obtain information for answering research objectives through open questions and answers between the interviewer and the respondent. This method has the main characteristic of using interaction data from discussions among the participants. Data was collected through focus group discussions (FGD). This method's main strength is that it provides deeper, more informative, and more valuable data than other methods. [10].

This FGD was held on March 25, 2021, and was attended by 14 respondents, including the Director of Planning and Supervision of Watershed Management, Nusa Tenggara II River Basin Center (BWS), Head of Watershed and Protected Forest Management Center Benain Noelmina, Development Planning Agency, Research and Regional Development of East Nusa Tenggara Province, Chair of the East Nusa Tenggara Province Watershed Forum, Kupang City Development Acceleration Team, Kupang City DPRD Commission III, NGOs (Non-Governmental Organizations), Environmental Practitioners, Provincial Level Environmentalist Groups, City and District of Kupang, Legal Practitioners, and Academics. During the FGD, respondents were free to express their opinions regarding policies for sustainable groundwater management in the City of Kupang, East Nusa Tenggara. Furthermore, the data were analyzed using qualitative analysis, which consisted of three stages, namely: data reduction, data display, and drawing conclusions [11]. The first stage in this study's data reduction process is identifying each direct quote's key points. Then using, the NVivo12 QSR International software to analyze the coding to make the analysis process more efficient. Coding is a form of analysis for assigning code placement using letters or numbers or a combination of both that represent data components so that the number of qualitative data is reduced to smaller pieces in texts related to behaviour, events, meanings, strategies, relationships, constraints and consequences with a shorter term; then the data is entered in the metadata sequentially according to the case [10].

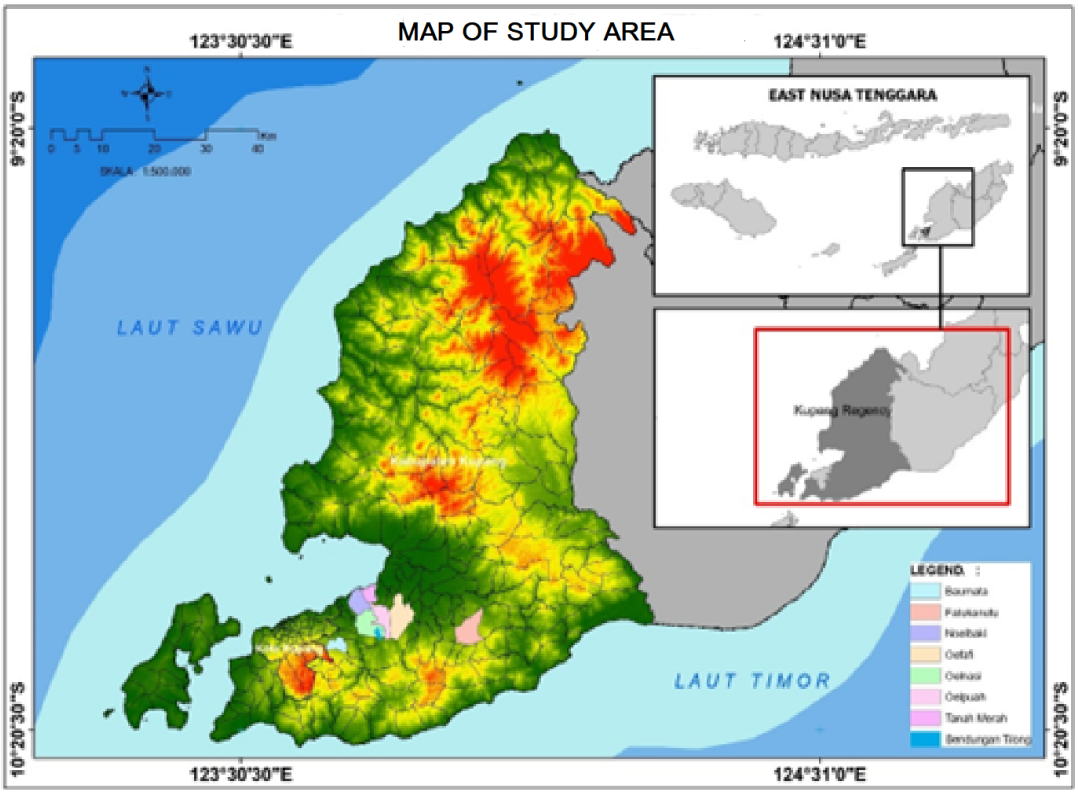

Figure 1. Map of Study Area

III. RESULTS

A total of 14 respondents participated in this study. From the FGD, it was found that all respondents had a positive perception of this research and indicated their willingness to support policies for the sustainable management of groundwater in Kupang City, East Nusa Tenggara.

"...Forest ecosystems dominate the focus of watershed management in the upstream watershed and are the main determinant of the hue of the watershed management area according to the landscape (an aspect of topographical configuration). Watershed-based forest governance format The forest functions as a water tower; the forest is an expression of a landscape "masterpiece" and has multidimensional influence in the watershed management space, including disaster risk reduction through watershed-based forest governance schemes. Program compatibility between economic growth and natural resource conservation…"
(Director of Planning and Supervision of Watershed Management)

"...problems in the Kupang City, namely several factors that can affect the availability of water to meet various needs in the Kupang City including limited availability of water resources, increased demand for water, conversion of watershed area and not yet optimal utilization of the area as a container for water storage (dams, ponds) and the problem of tidal waves that damage coastal areas (coastal abrasion) so that a "Management Frame" is needed that binds all parties. Comprehensive and integrated management of water resources based on river areas. Why? Due to: the nature of water flowing dynamically from certain places to lower places (can be across districts/cities, across provinces, or even across countries), the availability of water follows the hydrological cycle; some watersheds are naturally rich in water, and some watersheds are always short of water, everyone has the right to get water for their survival, preventing conflicts from arising; while at the same time placing water as a unifying element between regions as well as the principle of management efficiency and effectiveness…."
(Nusa Tenggara River Basin Center (BWS) II)

"…Groundwater conservation is intended to restore, maintain, and improve the function of ecosystems (forests and land) so that their carrying capacity, productivity and role in supporting life support systems are maintained…"
(Head of Benain Noelmina River Basin and Protected Forest Management Center)

"…The decline in the carrying capacity and function of ecosystem services in the watershed is characterized by a decrease in the quantity of water due to reduced water catchment areas, reduced vegetation cover and conversion of productive land functions, not optimal control of spatial use and supervision of spatial planning in realizing environmental sustainability. , increased disaster risk due to improper disaster prevention and preparedness, increased damage to natural resources, forest ecosystems and biodiversity…."
(Development Planning, Research and Development Agency for East Nusa Tenggara Province)

…"Water and soil conservation (KTA) as a water resource management solution in upstream-downstream ecosystems implemented through the "grand design" of watershed management…."
(Chairman of East Nusa Tenggara Province Watershed Forum)

"…Regulatory changes related to the Draft Regional Regulations for preparing soil and water conservation policies and stakeholder constraints…"
(Regional Elderly Commission)

"…That the Biknoi weir is one of the watersheds in Bakunase II Village, where this weir is an asset of the Government of the City of Kupang that needs to be maintained. The Kupang City government has recruited us under the Kupang City Public Works Service. In 2020 our status changed, and we were transferred to PDAM Kupang City, but until now, the government has not facilitated an appointment decree to become staff at PDAM Kupang City; therefore, please explain our status?..."
(Chief Guard of the Biknoi Weir)

"…The Kupang Regency area, which is included in the watershed area, has constraints related to forests. Therefore, it is necessary to carry out conservation for tree planting in connection with this. Planning for it to be budgeted for in the APBD discussion is necessary. For this reason, please explain what types of trees need to be planted in our area. Apart from that, community leaders/traditional leaders who have water sources, there must regulations that arrange it so that many people can use the water. Effectively religious leaders have enormous influence in providing land in the upstream area so that water availability is sufficient for use by the general public. Recommendations from the watershed forum concerning this FGD can accommodate common interests so that water management can be put to good use…."
(Head of Kupang District Public Works Office)

"…There must be planning in the budget for conserving trees around the watershed. It is hoped that all programs must be included in the planning document. The fiscal capacity is related to the budget; apart from that, it requires serious attention from the central government for watersheds. There must be budget support, depending on the policy from political to technical planning, related to regulations can be considered related to soil and water conservation, then ask for support from the watershed forum and the ministry for watershed management planning because the regional government needs recommendations to strengthen planning regulations later…."
(Head of Regional Revenue Agency of Kupang Regency)

"...That the topic of the FGD was too broad because there were no meeting points for the problems but the knowledge was very good. The city of Kupang must be in a special zone to identify watershed conservation areas because so far the water source has come from other areas, in this case outside the city of Kupang, therefore the city of Kupang must have environmental services…"
(Rudi Molo)

"…The first thing to pay attention to is potential. The potential that exists is how big the number of watersheds is in the city of Kupang and cross-watersheds, where some are in the city of Kupang, and some are outside the city of Kupang. The second thing is the problem that is within the watershed itself. In terms of which Government authority is related to watershed management…."
(Nusa Tenggara River Regional Office II)

"…It is hoped that the handling of watershed problems will focus on its management. For example, what kind of utilization, its potential, and watershed management must be considered for conservation to improve the water supply? What legitimizes conflicts of interest that occur in society? For example, from a religious perspective, it makes a guideline that must collaborate to be legitimized. Implementation of regulations affects order. For example, Permendagri 90 of 2019 greatly influences planning products. For example, the problem of watershed management was originally a forestry affair but turned out to be an environmental one. So this affects planning related to budgeting.
(Development Planning, Research and Development Agency for East Nusa Tenggara Province)

"…The agency has paid attention to the problem of the beach or the reflection on the coast. It's just that the balance of priority scales still constrains it. Regarding how to manage watersheds, it does not mean that there is a sectoral ego in implementing it, but it is possible that all fields have not been the focus. The ministry is already in the process but still sees the function of the watershed itself from the upstream, middle, and downstream so it still needs affirmation and supervision from the community…."
(CENTRAL WATERSHED

IV. DISCUSSION

The results of this FGD are the obligation to carry out the mandate of law number 37/2014 concerning soil and water conservation, law number 17/2019 concerning water resources, and government regulation number 37/2012 concerning watershed management by taking into account the authority regulated in the law number 23/2014 concerning regional government. Philosophically, soil and water conservation actions aim to balance the climatological balance of water so that it can always be ensured that stored groundwater can be distributed throughout the year to the residents of Kupang City. The main attention must be paid to the water balance in the water table or unconfined aquifer zone because confined water must be maintained to become an integral part of the geological stability of the city of Kupang. Follow-up plan recommendations based on the FGD results from various aspects, namely general aspects of water resource, watershed conditions and management, governmental soil and water conservation program, as well as upstream and downstream stakeholders in the Kupang watershed.

General aspects of water resources

Water scarcity is currently one of the most important challenges to human health and environmental integrity in most regions of the world [12], especially in Kupang City, East Nusa Tenggara, with the uneven distribution of rainfall and temperature, especially the imbalance between supply and demand. Water and a decrease in reserve discharge during the long dry season, reduced green open space due to land conversion, conservation efforts in the upstream part that have not been maximized, the role of the community in preserving open spaces and forests upstream, and the problem of tidal waves that damage downstream/coastal ecosystems in the form of beach abrasion.

Table 1. A group of issues regarding aspects of water resources in general

Potential	Problem	Solutions
The rainfall intensity during the dry season is quite high for 3–4 months. Groundwater reserves are sufficient both in the shallow aquifer layer and in the deep aquifer layer. There is a forest area in the upper watershed.	Decreased reserve discharge during long dry spells Reduced green open space due to land conversion Not maximal conservation efforts in the upstream section The role of the community has yet to be maximized in conserving open spaces and forests upstream. The problem of tidal waves that damage downstream/coastal ecosystems in the form of beach abrasion	An accurate and open database for the public's interest must be created. Construction/development of soil and water conservation building systems such as reservoirs/dams The efficiency of groundwater utilization Upstream watershed conservation in a sustainable manner Effective and efficient management of water distribution includes constructing, rehabilitating, and improving water distribution networks.

Watershed conditions and management

The damage to watersheds is increasing; besides being due to changes in land cover, watershed management factors are also a trigger for this. It is necessary to manage water resources, spatial planning, and the role of government stakeholders in managing and implementing policies [13]. Various problems faced in the semi-arid area of Kupang City, namely: the restoration of the status of six watersheds with a total area of 1,545 ha of critical land, 7,121 ha of slightly critical land, and 1,029 ha of critical land, conservation of forest land, fields, pastures, mixed gardens, paddy fields became settlements in the last eight years 2,434 ha, with axial soil type and has a steep topography, slash and burn farming practices, extensive livestock rearing practices, decreasing forest stand area, sea water abrasion, land use that is not applying the principles of soil and water conservation, coordination between institutions that are not yet synergized, community legal awareness still needs to be improved, financial support is still low, control of water sources by traditional leaders, there are no regulations for digging drilled wells, there are several companies that use water, river banks has been converted into a residential area and the quality of drinking water is relatively low due to the excessive use of agricultural chemicals in the rice fields.

Table 2. A group of issues watershed condition and management

Potential	Problem	Solutions
The status of the six watersheds is maintained.	Status of 6 watershed restored	Involve the community in planting to support the RHL and green and clean programs.
The critical land area of 5,564Ha	Potentially critical land is 1,545 ha, slightly critical land is 7,121 ha, and 1,029 ha is critical.	Improving coordination and synergy between institutions in preparing KTA programs in the watershed
The potential area of forest resources is 448Ha	Conservation of forest land, fields, grazing fields, mixed gardens, and rice fields into settlements in the last eight years 2,434Ha	Development of reforestation and afforestation programs
Availability of ponds	The nature of the rain is sheer.	Increase synergy and coordination between institutions in the form of cooperation.
One permanent nursery unit of Watershed Benain Noelmina produces 1 million saplings per year.	Shaft soil type	The CSR of water-using companies is directed toward protecting water conservation areas.
Rainfall 1200mm/year	The topography of the area is steep.	Improvement of water harvesting program to the community
There are 463,351 human resources.	Slash-and-burn farming practice	Socialization of household wastewater recycling Socialization of the application of conservation agriculture in dry land
The level of community education is relatively high.	Extensive livestock-raising practices	Regulation of the use of water in springs on customary land
There are 245 farmer groups.	The area of forest stands is decreasing.	Regulation and socialization of environmentally friendly agriculture
There are statutory regulations, regional regulations, and technical instructions.	Sea water abrasion	Development of reforestation and afforestation programs
Availability of Watershed city government organizations/institutions, NGOs, and Watershed forums	Land use that does not apply soil and water conservation principles	
Realization of the mangrove planting program	Inter-institutional coordination that has not been synergized	
Realization of RHL programs/activities	Public legal awareness still needs to improve.	
	Still low funding support	

Realization of the Kupang Green and Clean program	Mastery of water sources by traditional leaders There are no regulations for digging drilled wells There are several companies utilizing water The riverbank has been converted into a residential area The quality of drinking water is relatively low due to the excessive use of agrochemicals in rice fields	

Integration of soil and water conservation programs into the programs of the province East Nusa Tenggara

Local knowledge and practices of soil and water conservation are essential to designing and implementing a cost-effective and sustainable erosion control program, thereby mitigating the adverse impacts of the soil erosion challenge and knowledge of erosion management [14]. Although several soil and water conservation technologies have been developed and promoted, accelerated soil erosion is a major constraint in many parts of the plateau. Besides implementing many of the recommended measures, the social and economic factors influencing the adoption of soil and water conservation are minimal, and soil erosion continues to be a problem [15]. The problem that occurs in the city of Kupang is how groundwater conservation in the city or district of Kupang is included in the program criteria and indicators for the Province of East Nusa Tenggara based on the program nomenclature mapping listed in Permendagri No. 20/2019 for the alignment of city/regency programs with provincial programs on six priorities: disaster resilience, climate change adaptation, and environmental management.

Table 3. A group of issues concerns integrating soil and water conversation programs into the Province's East Nusa Tenggara programs.

Potential	Problem	Solutions
What programs are available in the Province	How is the KTA for the city or district of Kupang included in the criteria and indicators for the Nusa Province program?	How is the coordination
Forestry	East Southeast Program nomenclature mapping listed in Pemendagri No. 20/2019	Integration into City/Regency/Province development issues
Environment	Alignment of city/regency programs with provincial programs on priority 6, namely: disaster resilience, climate change adaptation, and environmental management	Collaborative programs and activities
disaster		Collaboration locus of programs/activities Stakeholder collaboration
Public Works		Coordinate between the public and private governments:
Spatial		1. The government makes provincial facilitation of cross-regency/city. Watersheds with a focus on soil and water conservation through an MoU on compensation for environmental services between regions 2. The community forms a watershed care and management group that includes academia, the private sector, and the community 3. The private sector is obligated to pay compensation for environmental services

Upstream and downstream stakeholders in the Kupang watershed

Watershed management is essential for a sustainable clean water supply to urban centres, especially in developing countries where large-scale infrastructure projects are costly [15]. Some problems in Kupang include the water catchment area being overgrown with trees, the upstream decreasing, and the upstream becoming increasingly degraded. In addition, several upstream watersheds

are in Kupang Regency, so there is a need for inter-regional coordination to manage surface water and groundwater in the groundwater basin. In addition, in the middle and downstream, waste and pollutants are discharged into river bodies, as evidenced by the high content of E. coli in the quality of groundwater in Kupang City and the use of space not covered by the Kupang City spatial plan.

Table 4. A group of upstream and downstream stakeholders relations issues group in the Kupang watershed

Potential	Problem	Solutions
The upstream ecosystem is a water provider.	The area of the catchment area covered by trees upstream is decreasing, and the upstream is degrading.	Forest rehabilitation in the upstream region
Middle and downstream ecosystems are the beneficiaries of water services.	Some of the upstream watersheds are located in Kupang Regency, and there needs to be coordination between regions to manage surface water and groundwater in groundwater basins.	The center and provinces can carry out inter-regional coordination.
	In the middle and downstream parts, waste and pollutants are disposed into the river's body, as evidenced by the high content of E. coli in the quality of groundwater in Kupang City.	There need to be incentives and disincentives for water utilization.
	Utilization of space that is not by the urban spatial plan of Kupang	It is necessary to develop compensation for environmental services as mandated in PP No. 46 of 2017 concerning environmental and economic instruments It is necessary to enforce the implementation of spatial planning sustainably.

V. CONCLUSION

The results showed that there were several problems, including the limited availability of water resources, increasing water demand, the conversion of watershed area, the not optimal utilization of areas as water storage containers (dams, ponds), and the problem of tidal waves that damage coastal areas (beach abrasion). However, stakeholders feel that management can overcome the source of risk by binding all parties as a whole and integrating a sustainable policy model. Stakeholders also believe that this can contribute to preparing a water resources management plan based on soil and water conservation in the Kupang City area.

REFERENCES:

[1] A. R. Wicaksono, T. T. Putranto, dan R. Setyawan, "Pemodelan Hidrogeologi Cekungan Airtanah Samarinda-Bontang Segmen Penajam Dalam Upaya Konservasi Airtanah Berbasis Cekungan, Kabupaten Penajam Paser Utara, Provinsi Kalimantan Timur," Jurnal Geosains dan Teknologi, vol. 2, no. 1, 2019, doi: 10.14710/jgt.2.1.2019.13-23.

[2] R. Theodolfi dan F. W. Waangsir, "ANALISIS KEBUTUHAN AIR BERSIH KOTA KUPANG MENURUT KETERSEDIAAN SUMBER AIR BERSIH DAN ZONA PELAYANAN," Jurnal Media Kesehatan Masyarakat Indonesia, vol. 10, no. 2, 2014.

[3] N. Setyaningrum, "Analisis Ketersediaan Dan Kebutuhan Air Untuk Daya Dukung Lingkungan," Seminar Nasional Geomatika, vol. 2, hlm. 155, 2018, doi: 10.24895/sng.2017.2-0.408.

[4] Z. Jia, Y. Cai, Y. Chen, dan W. Zeng, "Regionalization of water environmental carrying capacity for supporting the sustainable water resources management and development in China," Resour Conserv Recycl, vol. 134, hlm. 282–293, 2018, doi: https://doi.org/10.1016/j.resconrec.2018.03.030.

[5] C. Wu, L. Zhou, J. Jin, S. Ning, Z. Zhang, dan L. Bai, "Regional water resource carrying capacity evaluation based on multi-dimensional precondition cloud and risk matrix coupling model," Science of the Total Environment, vol. 710, 2020, doi: 10.1016/j.scitotenv.2019.136324.

[6] J. J. Messakh dan D. A. Punuf, "Study on the accessibility of water sources to meet the water needs of rural communities in semi-arid regions of Indonesia," dalam IOP Conference Series: Earth and Environmental Science, 2020. doi: 10.1088/1755-1315/426/1/012043.

[7] M. E. Qureshi, A. Reeson, P. Reinelt, N. Brozović, dan S. Whitten, "Factors determining the economic value of groundwater," Hydrogeol J, vol. 20, no. 5, 2012, doi: 10.1007/s10040-012-0867-x.

[8] M. Hssaisoune, L. Bouchaou, A. Sifeddine, I. Bouimetarhan, dan A. Chehbouni, "Moroccan groundwater resources and evolution with global climate changes," Geosciences (Switzerland), vol. 10, no. 2, Feb 2020, doi: 10.3390/geosciences10020081.
[9] I. Fathy, A. Ahmed, dan H. F. Abd-Elhamid, "Integrated management of surface water and groundwater to mitigate flood risks and water scarcity in arid and semi-arid regions," J Flood Risk Manag, vol. 14, no. 3, 2021, doi: 10.1111/jfr3.12720.
[10] M. B. Miles dan A. M. Huberman, Miles, M. B., & Huberman, A. M. (1994). Qualitative data analysis: An expanded sourcebook, vol. 30, no. 25. 2016.
[11] M. Miles dan A. Huberman, "Miles and Huberman," Qualitative Data Analysis: An expanded sourcebook. 2014.
[12] H. Filali, N. Barsan, D. Souguir, V. Nedeff, C. Tomozei, dan M. Hachicha, "Greywater as an Alternative Solution for a Sustainable Management of Water Resources—A Review," Sustainability (Switzerland), vol. 14, no. 2. 2022. doi: 10.3390/su14020665.
[13] R. Mulyawan, E. D. Wahjunie, I. Ichwandi, dan S. D. Tarigan, "Kajian Peran Stakeholder Pada Implementasi Kebijakan Pengelolaan DAS Terpadu, Studi Kasus DAS Krueng Aceh," Jurnal Ilmu Lingkungan, vol. 20, no. 2, 2022, doi: 10.14710/jil.20.2.198-209.
[14] G. B. Chuma dkk., "Farmers' knowledge and Practices of Soil Conservation Techniques in Smallholder Farming Systems of Northern Kabare, East of D.R. Congo," Environmental Challenges, vol. 7, 2022, doi: 10.1016/j.envc.2022.100516.
[15] A. J. Tenge, J. De Graaff, dan J. P. Hella, "Social and economic factors affecting the adoption of soil and water conservation in West Usambara highlands, Tanzania," Land Degrad Dev, vol. 15, no. 2, 2004, doi: 10.1002/ldr.606.