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Submission date: 24-Oct-2020 01:28PM (UTC+0530)
Submission ID: 1425090793
File name: el_Wolo,_Anna_S._Rahmawati,_Melania_Priska,_Insar_Damopolii.docx (71.02K)
Word count: 3602
Character count: 20799

Jurnal Biologi Tropis

Original Research Paper

Study of dug well water quality in Labuan Bajo, Indonesia

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Article History
Received :
Revised :
Accepted :
Published :

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Abstract: The dug well water quality in community settlements needs assessment to ensure its quality. This initial research aimed to determine the dug well water quality in Kampung Ujung, Komodo District, Labuan Bajo City, West Manggarai Regency in September 2019. The sampling technique was purposive, namely the determination technique with specific considerations by the number of sampling points, namely two points. The test parameters include Temperature, Turbidity, pH, Smell, Total Suspended Solid (TSS), Sulfate, Total Dissolved Solid (TDS), Nitrate, Nitrite, Total Hardness, Dissolved Oxygen (DO), Nitrogen Ammonia, Total Coliforms, and E. coli. The analysis of dug well water samples physically, chemically, and biologically from two dug locations. The result showed that the parameters of TDS, Nitrate, Nitrite, E. coli, and DO exceed the Class I Water Quality Standard. The research concluded that the quality of both dug well water in the Kampung Ujung Labuan Bajo area was not suitable for use as material raw drinking water.

Keywords: Dug well, water quality, contamination, Labuan Bajo, drinking water

Introduction

Kampung Ujung is one of the areas included in the Komodo District, Labuan Bajo City, West Manggarai Regency. In recent years, the increasing population and tourism activities in Kampung Ujung have impacted environmental quality changes, particularly the aquatic environment. The development of tourism infrastructures such as Culinary Parks, Minimarkets, Hotels, and Malls can contribute to groundwater pollution (Igusman & Purwadi, 2014), exceptionally safe drinking water (Uprety et al., 2020).

Based on field monitoring results, the Kampung Ujung community's settlement pattern is center on one area, and the practice is irregular. Some of the houses are adjacent to hotels, cafes, or restaurants that are recent to build. With the increase in population and tourism activities, it will demand even greater water needs. Increased human activity, mainly due to development in the tourism sector, can result in environmental degradation, such as decreasing groundwater quality (Putu et al., 2018). Human behavior affects the quality of the environment (Mardhia & Abdullah, 2018).

Meanwhile, the water sources used daily (bathing, washing, latrines) and the Tourism Industry are sourcing from groundwater sources and water companies. Based on interviews with residents who often use dug well water, it is finding that well water cannot be used in certain seasons because it smells and tastes very salty. They dug wells in Kampung Ujung are shallow well (<20 m), cheap and easy to manufacture, causing dug wells to be widely used by the community. However, dug wells have a high risk of pollution in the form of physical and chemical, and bacteriological pollution (Kot, Baranowski, & Rybak, 2000; Latief, Wahjoedi, Sugiharto, & Suparman, 2015).

Drinkable water has rules with the requirements of established physical, chemical, and bacteriological standards. Indirectly, using drinking water that doesn't comply with quality standards, can slowly cause health problems (accumulated time), such as groundwater use for drinking needs. Shallow groundwater in dug wells

has the potential to absorb pollutants (Wardani, 2017). These pollutants come from the seepage of surface water, such as rainwater, accumulating with well water. In densely populated settlements, groundwater pollution is also caused by the lack of available land for making septic tanks, so that pollutants will flow with rainwater to water bodies (Putra, 2018).

Apart from human activities, several factors affect water quality, such as slope, geological strata, and rainfall (Aryasa, Risky, & Artaningsih, 2019). The location of Kampung Ujung is near the beach also causes seawater intrusion, besides that the activities of hotels, restaurants, and culinary parks. If organic waste disposal is not to control, it will cause the decay of organic waste in the waterways to become smelly and a den of disease (Manurung, Ivansyah, & Nurhasanah, 2017). Poor management of landfills affects water quality (Finmeta, Bunyani, & Naisanu, 2020; Luo et al., 2019).

Anticipating groundwater pollution levels need to action through regular and continuous monitoring (Istipsaroh, Laili, & Zayadi, 2016; Luo et al., 2019). The first action that must take is to collect initial data, especially data on monitored water quality. This data collection is through a water quality analysis study either in the field (in-situ) or in the laboratory (ex-situ). By monitoring water quality, it is a hope that they can detect and measure a pollutant's effect due to increased human activity and know a general picture of water quality in a place. This initial research aimed to determine the dug well water quality in Kampung Ujung, Komodo District, Labuan Bajo City, West Manggarai Regency.

Materials and Methods

This research was conducted in dug well water at two sampling locations in Kampung Ujung residents' residential area, Labuan Bajo. This research was run in September 2019. The sampling determination technique used a purposive sampling technique. Based on considering that well water is often using as drinking water, bathing, washing, the location of wells from other polluting sources, and well owners are willing to sample their wells.

The first point (I) was taken from dug wells used by about 8-10 families. Sampling was to take in the morning before residents' activities. The water sample was put in a sterile black bottle. It was also rinsed three times with the water sample.

The first well (I) was in the middle of a dense settlement and around the well. There are activities for washing dishes, bathrooms, and runoff from the housing. The well distance to the beach is about 75 meters, coordinates (-8.488537, 119.877039 / 8 ° 29'18.7 "S 119 ° 52'37.3" E).

Point 2: Dug well (II) was used for about 4-5 families. The distance from the well to the beach was about 100 meters. The distance from first well to second well was about 100 meters. Coordinates (-8.489210, 119.876487 / 8 ° 29'21.2 "S 119 ° 52'35.4" E).

The test parameters include Temperature, Turbidity, pH, Smell, Total Suspended Solid (TSS), Sulfate, Total Dissolved Solid (TDS), Nitrate, Nitrite, Total Hardness, Dissolved Oxygen (DO), Nitrogen Ammonia, Total Coliforms, and E. coli. This study emphasizes more on parameters related to safety, acceptance, and function of these waters. For water quality analysis, it can be done in two ways: directly on-site and preservation method carried out in the laboratory. Samples were stored in ice boxes which were tightly closed at 4°C +/- 2°C

Table 1. Test parameters

Parameter	Unit	Method Specifications
Temperature	°C	Thermometric
Smell		Organoleptic
Turbidity	NTU	Turbidimetry
Total Dissol Solid (TDS)	mg/L	SNI 06-6989.27-2005 Method of Gravimetric Total Dissolved Solids Level Test
Total Suspended Solid (TSS)	mg/L	SNI 06-6989.27-2005 Method of Gravimetric Total Dissolved Solids Level Test
Total Hardness	mg/L	Spectrophotometric Hach
pH		SNI 06-6989.11-2004 The method of testing the degree of acidity using a pH meter
Nitrate	mg/L	Spectrophotometric Hach
Nitrite	mg/L	Spectrophotometric Hach
Sulfate	mg/L	Spectrophotometric Hach
Dissolved Oxygen (DO)	mg/L	SNI 06-6989.14-2004 Method of Gravimetric Total Dissolved Solids Level Test
Nitrogen Ammonia	mg/L	Spectrophotometric Hach
T. Coliforms	CFU/100 mL	ALT
E. coli	CFU/100 mL	ALT

The results of the laboratory test was compared with Class I Water Quality Requirements. This consistency level meets government rules, Republic of Indonesia Regulation No. 82 of the Year 2001 on water quality protection and water emission prevention. (Permen Republik Indonesia, 2001).

Results and Discussion

Results

The results of this study reveal how the water quality of dug well in Kampung Ujung. Our research was conducted in September 2019, where the level of rainfall in the city of Labuan Bajo began to decline. The reason for choosing Kampung Ujung is because this area is one of the most visited culinary tourism destinations. Besides that, there are residential areas which are quite dense. The test results of groundwater samples (dug wells) show that several parameters exceed the government's quality standards: TDS, DO, Nitrate and Nitrite, and nitrogen ammonia parameters almost exceed the standard. The results of the study are presenting in Table 2.

Table 2. Results of shallow well water quality measurement in Kampung Ujung

No	Parameter	Unit	Test result		Method Specifications	Quality standard	Annotation
			1st Well	2nd Well			
1	Temperature	°C	29.94	29,52	Thermometric	Air Temperature ± 3	Quality standard of PERMENKES No. 32 of the year 2017 regarding Environmental Health Quality Standards and Water Health Requirements for Hygiene Purposes Sanitation, Swimming Pools, Solus per Aqua, and Public Baths
2	Smell		Odorless		Organoleptic		
3	Turbidity	NTU	0,47	0,72	Turbidimetry	25	
4	TDS	mg/L	**13115**	**1736**	SNI 06-6989.27-2005 Method of Gravimetric Total Dissolved Solids Level Test	1000	
5	TSS	mg/L	0,02	0,02	SNI 06-6989.27-2005 Method of Gravimetric Total Dissolved Solids Level Test	50	
6	Total Hardness	mg/L	0,39	0,75	Spectrophotometric Hach	500	PP No. 82 of the year 2001 concerning the management of water quality and water pollution control
7	pH		6,9	7,5	SNI 06-6989.11-2004. The method of testing the degree of acidity using a pH meter	6,5 - 8,5	
8	Nitrate	mg/L	**12**	8	Spectrophotometric Hach	10	
9	Nitrite	mg/L	0,4	**2,2**	Spectrophotometric Hach	1	
10	Sulfate	mg/L	62	54	Spectrophotometric Hach	400	
11	DO	mg/L	**3,3**	**3,9**	SNI 06-6989.14-2004 Method of Gravimetric Total Dissolved Solids Level Test	4	
12	Nitrogen Ammonia	mg/L	0,45	0,01	Spectrophotometric Hach	0,5	
13	T. Coliforms	CFU/ 100 mL	29	11	ALT	50	Quality standard PERMENKES No.32 of the year 2017
14	E. coli	CFU/ 100 mL	**7**	**7**	ALT	0	

Source: Environmental Laboratory, Environmental Service, Ende Regency Government, 2019
Note: ■ is a value that exceeds the maximum allowable threshold.

Discussion

Based on Table 2, the parameters of Total Dissolved Solids (TDS) are Dissolved materials that have a diameter range of 10-6 mm -10-3 mm (including colloids). The laboratory analysis results showed that the first sample's TDS content was 13 times more than the standard set. In the second sample, the number of TDS also exceeds the standard, namely 1736. It is almost two times the standard. TDS is one of the nine water quality criteria (Tripathi & Singal, 2019). TDS is caused by inorganic materials, which are commonly finding in areas close to water. The Kampung Ujung area is close to the sea, is one of these inorganic ions resources. Some of these ions can become main ion groups such as sodium, calcium, sulfate, bicarbonate, or secondary ion groups such as iron, potassium, carbonate, nitrate, fluoride ions. The first sample is in the medium / brackish salinity group base on the TDS concentration obtain. The second sample had a slightly salty/brackish salinity level. The high TDS is probably due to rock weathering, runoff from the soil, and anthropogenic influences / human activities in domestic waste and the tourism industry. Even though it is not toxic, the high TDS value can increase water turbidity, which implies a decrease in the photosynthesis process in water bodies. Water turbidity will also increase pathogens (Weller et al., 2020).

The second problem is oxygen (Dissolved Oxygen / DO). Generally, DO decreases with increasing salinity. The first and second samples' analysis shows that the oxygen content is less than the specified water quality standard. DO is one of the parameters for determining quality of water (Varol, 2020). Even one in five parameters is crucial (Nong, Shao, Zhong, & Liang, 2020). Apart from the salinity factor, other factors such as the movement of water bodies, photosynthetic activity, and waste also affect the concentration of oxygen. In the first sample, the amount of DO is 3.3 mg / L. The well's location is in a dense settlement. The possibility of a lack of photosynthetic activity and high anthropogenic activity (used by around 8-10 families) in the area around the well causes very little dissolved oxygen in the water sample. Whereas in the second sample, dug wells are only using by 4-5 families. The dug well area is wide enough so that the oxygen content is better than the first sample. However, it is still below standard. Decreasing DO can affect the taste of water, making water not fresh to drink.

Nitrate ($NO3^-$), Nitrite ($NO2^-$), and Ammonia ($NH4^+$) are including in the minor ion group in the water. The source of these three ions comes from the ammonification process, namely the decay of proteins from living things. Laboratory analysis results show that in the first sample, the Nitrate content exceeds the standard. It indicates the occurrence of contamination originating from human activities and animal feces. High nitrate content due to inadequate sewage treatment (Singh & Mosley, 2003). Nitrates that do not comply with WHO standards pose a risk to human digestion and are more susceptible to infant health (Adimalla, 2019).

In the second sample, the detected Nitrite levels exceeded the standard standards. The source of Nitrite also came from the tourism industry waste or domestic waste. Wastewater installation management, waste collection, and solid waste management need to be done (Luo et al., 2019). Nitrite has more toxic properties than Nitrate. Consumption of Nitrite in humans can disrupt the blood's oxygen-binding process: high Nitrite and Nitrate content cause methemoglobinemia (Kempster, Van Vliet, & Kühn, 1997). The results showed that toddlers are most vulnerable to Nitrates through drinking water in the study area (Adimalla & Wu, 2019). Although it does not exceed the standard, the presence of ammonium ion follows the water sample conditions where the dissolved oxygen value is small or below the standard. This ammonium ion level indicates organic matter contamination from domestic and industrial waste (tourism).

The following parameters used to determine the level of groundwater hygiene are the content of Total Coliform and Escherichia coli. The dug well water samples from the first and second area found that the E. coli content exceeded the specified standard. In comparison, T. coliform was still below the quality standard. E. coli is a bacterium from the T. Coli group that is harmless and is present in human feces. However, the E. Coli presence above the consistency standard indicates that human or animal waste has polluted the well water, which most likely contains pathogenic bacteria that are harmful to health. Some of these pathogens can be in groups of bacteria, viruses, protozoa, and helminths. Although the water studied is according to WHO standards, when it is consuming, it is necessary to make an agent kill microbes (Nkansah, Boadi, & Badu, 2010). Contaminants such as bacteria, viruses have contaminated water supplies (Singh & Mosley, 2003). The cause of cases of bloody diarrhea in children has been identified from contaminated well water. E. coli (Jackson et al., 1998). The highest E. coli is identification in the cattle operation area (Cooley, Quiñones, Oryang, Mandrell, & Gorski, 2014).

If there is pollution, it is necessary to manage dug well water. The health of the people who consume the dug well water is essential. Human health decreases when they drink water from un-quality and hygienic sources (Mukate, Wagh, Panaskar, Jacobs, & Sawant, 2019). There is a decrease in the quality of groundwater in the Kampung Ujung Labuan Bajo area, hence the need for collaboration between the Government and the community to regularly monitor the quality of groundwater in the Kampung Ujung area by checking in the laboratory on three parameters, namely physics, chemistry, and biology, increasing public awareness about adequate environmental sanitation starting at the household and residential level. Apart from that, the Government provides other water sources so that people do not entirely depend on dug well water, such as the addition of storage tanks for raw water.

Conclusion

Based on the results of a testing analysis of shallow well water samples in Kampung Ujung, Labuan Bajo, physically, chemically, and biological the results obtained from the locations of first and second dug wells five parameters do not meet standard standards. Parameters that do not meet the criteria are TDS, DO, Nitrate, Nitrite, and E. coli. It shows the pollution of shallow water in the Kampung Ujung area. This study concluded that the quality of the two dug wells in the Kampung Ujung Labuan Bajo area is not appropriate for use as rough material for drinking water. It is to hope that there will be further studies related to water quality monitoring using a variety of methods so that the data obtained will complement each other.

Acknowledgment

The author would like to thank the Indonesian Ministry of Tourism, the West Manggarai Regency Government, and the Center for Tourism Studies at the University of Flores for this research's financing and smoothness through the Sustainable Tourism Monitoring and Observation Program in Labuan Bajo in 2019.

Referensi

Adimalla, N. (2019). Groundwater Quality for Drinking and Irrigation Purposes and Potential Health Risks Assessment: A Case Study from Semi-Arid Region of South India. *Exposure and Health*, *11*(2), 109–123. https://doi.org/10.1007/s12403-018-0288-8

Adimalla, N., & Wu, J. (2019). Groundwater quality and associated health risks in a semi-arid region of south India: Implication to sustainable groundwater management. *Human and Ecological Risk Assessment: An International Journal*, *25*(1–2), 191–216. https://doi.org/10.1080/10807039.2018.1546550

Aryasa, I. W. T., Risky, D. P., & Artaningsih, N. P. L. J. (2019). Uji Pendahuluan Kualitas Air pada Sumber Mata Air Di Banjar Tanggahan Tengah, Desa Susut Kecamatan Susut. *Jurnal Kesehatan Terpadu*, *3*(2), 76–81. https://doi.org/10.36002/jkt.v3i2.979

Cooley, M., Quiñones, B., Oryang, D., Mandrell, R., & Gorski, L. (2014). Prevalence of shiga toxin producing Escherichia coli, Salmonella enterica, and Listeria monocytogenes at public access watershed sites in a California Central Coast agricultural region. *Frontiers in Cellular and Infection Microbiology*, *4*, 30. https://doi.org/10.3389/fcimb.2014.00030

Finmeta, A. W., Bunyani, N. A., & Naisanu, J. (2020). Keberadaan Tempat Pembuangan Akhir Berdampak pada Kualitas Air. *Jurnal Biologi Tropis*, *20*(2), 211. https://doi.org/10.29303/jbt.v20i2.1389

Igusman, I., & Purwadi, D. D. (2014). Pengaruh Sistem Sanitasi Terhadap Kualitas Air Sumur Dangkal Pada Perumahan Tipe Kecil Di Kota Mojokerto. *Rekayasa Teknik Sipil*, *3*(3), 195–204. Retrieved from https://jurnalmahasiswa.unesa.ac.id/index.php/rekayasa-teknik-sipil/article/view/9443

Istipsaroh, Laili, S., & Zayadi, H. (2016). Uji Kualitas Air Sumur Kelurahan Merjosari Kecamatan Lowokwaru Kota Malang. *Biosaintropis*, *2*(1), 19–24. Retrieved from http://biosaintropis.unisma.ac.id/index.php/biosaintropis/article/view/79/36

Jackson, S. G., Goodbrand, R. B., Johnson, R. P., Odorico, V. G., Alves, D., Rahn, K., … Khakhria, R. (1998). Escherichia coli O157[ratio]H7 diarrhoea associated with well water and infected cattle on an Ontario farm. *Epidemiology and Infection*, *120*(1), 17–20. https://doi.org/10.1017/S0950268897008479

Kempster, P. L., Van Vliet, H. R., & Kühn, A. (1997). The need for guidelines to bridge the gap between ideal drinking-water quality and that quality which is practically achievable and acceptable. *Water SA*, *23*(2), 163–167. Retrieved from http://www.wrc.org.za/wp-content/uploads/mdocs/WaterSA_1997_02_1035.PDF

Kot, B., Baranowski, R., & Rybak, A. (2000). Analysis of mine waters using X-ray fluorescence spectrometry. *Polish Journal of Environmental Studies*, *9*(5), 429–432. Retrieved from http://www.pjoes.com/Keyword-mine+water/31541

Latief, A. S., Wahjoedi, Sugiharto, & Suparman. (2015). Kajian Terhadap Debit dan Kualitas Air Sumur Bor Di Kelurahan Jabungan. *TEKNIS*, *10*(1), 156–157. https://doi.org/10.32497/teknis.v10i1.672

Luo, P., Kang, S., Apip, Zhou, M., Lyu, J., Aisyah, S., … Nover, D. (2019). Water quality trend assessment in Jakarta: A rapidly growing Asian megacity. *PLoS ONE*, *14*(7), 1–17. https://doi.org/10.1371/journal.pone.0219009

Manurung, M., Ivansyah, O., & Nurhasanah. (2017). Analisis Kualitas Air Sumur Bor di Pontianak Setelah Proses Penjernihan Dengan Metode Aerasi, Sedimentasi dan Filtrasi. *Prisma Fisika*, *5*(1), 45–50. Retrieved from https://jurnal.untan.ac.id/index.php/jpfu/article/view/19802

Mardhia, D., & Abdullah, V. (2018). Studi Analisis Kualitas Air Sungai Brangbiji Sumbawa Besar. *Jurnal Biologi Tropis*, *18*(2). https://doi.org/10.29303/jbt.v18i2.860

Mukate, S., Wagh, V., Panaskar, D., Jacobs, J. A., & Sawant, A. (2019). Development of new integrated water quality index (IWQI) model to evaluate the drinking suitability of water. *Ecological Indicators*, *101*, 348–354. https://doi.org/https://doi.org/10.1016/j.ecolind.2019.01.034

Nkansah, M. A., Boadi, N. O., & Badu, M. (2010). Assessment of the Quality of Water from Hand-Dug Wells in Ghana. *Environmental Health Insights*, *4*, EHI.S3149. https://doi.org/10.4137/EHI.S3149

Nong, X., Shao, D., Zhong, H., & Liang, J. (2020). Evaluation of water quality in the South-to-North Water Diversion Project of China using the water quality index (WQI) method. *Water Research*, *178*, 115781. https://doi.org/https://doi.org/10.1016/j.watres.2020.115781

Peraturan Pemerintah Republik Indonesia, N. 82. (2001). *Pengelolaan Kualitas Air Dan Pengendalian Pencemaran Air*. Retrieved from https://peraturan.bpk.go.id/Home/Details/53103/pp-no-82-tahun-2001

Putra, C. M. M. (2018). The Physical And Microbiological Quality Of Clean Water In Nanas Sub Village Kediri District Post Natural Phenomena Sinking Wells. *Jurnal Kesehatan Lingkungan*, *10*(4), 360–367. https://doi.org/10.20473/jkl.v10i4.2018.36-367

Putu, N., Artini, R., Putu, D., Va, R., Kadek, N., & Fujiastuti, M. (2018). Penelitian Kualitas Air Sungai Balian, Tabanan, Bali Tahun 2018. *Jurnal Kesehatan Terpadu*, *2*(1), 25–30. https://doi.org/10.36002/jkt.v2i1.443

Singh, S., & Mosley, L. M. (2003). Trace metal levels in drinking water on Viti Levu, Fiji Islands. *The South Pacific Journal of Natural and Applied Sciences*, *21*(1), 31–34. https://doi.org/10.1071/SP03006

Tripathi, M., & Singal, S. K. (2019). Use of Principal Component Analysis for parameter selection for development of a novel Water Quality Index: A case study of river Ganga India. *Ecological Indicators*, *96*, 430–436. https://doi.org/https://doi.org/10.1016/j.ecolind.2018.09.025

Uprety, S., Dangol, B., Nakarmi, P., Dhakal, I., Sherchan, S. P., Shisler, J. L., … Nguyen, T. H. (2020). Assessment of microbial risks by characterization of Escherichia coli presence to analyze the public health risks from poor water quality in Nepal. *International Journal of Hygiene and Environmental Health*, *226*, 113484. https://doi.org/https://doi.org/10.1016/j.ijheh.2020.113484

Varol, M. (2020). Use of water quality index and multivariate statistical methods for the evaluation of water quality of a stream affected by multiple stressors: A case study. *Environmental Pollution*, *266*, 115417. https://doi.org/https://doi.org/10.1016/j.envpol.2020.115417

Wardani, Y. S. (2017). Hubungan Konstruksi Sumur Gali dengan Kualitas Air Kabupaten Kebumen Tahun 2017. *Buletin Keslingmas*, *37*(3), 323–331. https://doi.org/10.31983/keslingmas.v36i3.3017

Weller, D., Brassill, N., Rock, C., Ivanek, R., Mudrak, E., Roof, S., … Wiedmann, M. (2020). Complex Interactions Between Weather, and Microbial and Physicochemical Water Quality Impact the Likelihood of Detecting Foodborne Pathogens in Agricultural Water. *Frontiers in Microbiology*, *11*, 134. https://doi.org/10.3389/fmicb.2020.00134

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