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# Quality of the peat water and its association with public health problems in the community of the Danau Tundai area

Nawan*[1], Hopelyanza Priskila[2], Herlina Eka Shinta[3], Septi Handayani[4], Ravenalla Abdurahman[5]

[1]Departemen of Microbiology, Faculty of Medicine, Palangka Raya University, Palangka Raya, Indonesia,
[2]Faculty of Medicine, Palangka Raya University, Palangka Raya, Indonesia,
[3]Departemen of Anatomy Pathology, Faculty of Medicine, Palangka Raya University, Palangka Raya, Indonesia,
[4]Departemen of Biochemistry, Faculty of Medicine, Palangka Raya University, Palangka Raya, Indonesia,
[5]Departemen of Public Health Science, Faculty of Medicine, Palangka Raya University, Palangka Raya, Indonesia

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***Corresponding author:**
nawan@med.upr.ac.id

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## ABSTRACT

**Background:** Communities in the Danau Tundai Area, Palangka Raya City, Central Kalimantan Province, Indonesia still use peat water for their daily water needs. The use of peat water is one of the things that need to be considered because disease transmission can occur through water with poor quality and will cause health problems in the Danau Tundai community.
**Objective:** This study aimed to determine the quality of peat water in the Danau Tundai Area and to identify the association between the quality of peat water and public health problems in the Danau Tundai Area
**Methods:** Water samples taken were analyzed physically, chemically, and biologically by government water quality regulations. The primary data source in this study was a questionnaire to obtain data on peat water use and health problems among the people of Danau Tundai
**Results:** Results indicated that peat water quality of the Danau Tundai Area didn't meet the Ministry of Health standard for drinking water because the physical appearance was brown, tasted, and smells. The chemical analyses also showed that the levels of KMnO4 were 257.5 mg/L, Fe 0.66 mg/L, pH 4.02, Dissolved Oxygen (DO) 5.9 mg/L, Biological Oxygen Demand (BOD) 18.6 mg/L, and Chemical Oxygen Demand (COD) 156.9 mg/L. Those levels were higher than the cut-off points set by Ministry of Health. The public health problems that mostly experienced was itching (75.3%), stomachache (66.7%), and yellow teeth (61.3%). Simple linear regression showed a positive significant association between quality of peat water (based on individual perception) and public health problems in the Danau Tundai area ($p = 0.000$).
**Conclusion:** Peat water quality of the Danau Tundai Area didn't meet the Ministry of Health standard for drinking water, and the quality of peat water had a significant association with health problems Danau Tundai communities.

***Latar Belakang:*** *Masyarakat di kawasan Danau Tundai, Kota Palangka Raya, Provinsi Kalimantan Tengah, Indonesia masih menggunakan air gambut untuk kebutuhan air sehari-hari. Pemanfaatan air gambut merupakan salah satu hal yang perlu diperhatikan, karena penularan penyakit dapat terjadi melalui air dengan kualitas yang buruk dan dapat menimbulkan gangguan kesehatan pada masyarakat Danau Tundai.*
***Tujuan:*** *Penelitian ini bertujuan untuk mengetahui kualitas air gambut di Kawasan Danau Tundai dan mengidentifikasi hubungan antara kualitas air gambut dengan gangguan kesehatan masyarakat di Kawasan Danau Tundai*
***Metode:*** *Sampel air yang diambil dianalisis secara fisik, kimia dan biologi sesuai dengan regulasi kualitas air dari pemerintah. Sumber data primer dalam penelitian ini adalah kuesioner untuk mendapatkan data penggunaan air gambut dan gangguan kesehatan masyarakat Kawasan Danau Tundai.*

***Hasil:*** *Hasil penelitian menunjukkan bahwa kualitas air gambut di Kawasan Danau Tundai tidak memenuhi baku mutu air minum Kementerian Kesehatan karena kenampakan fisik berwarna coklat, berasa dan berbau. Hasil uji laboratorium kimiawi juga menunjukkan bahwa kadar KMnO4 adalah 257,5 mg/L, Fe 0,66 mg/L, pH 4,02, DO 5.9 mg/L, BOD 18,6 mg/L, dan COD 156,9 mg/L. Kadar senyawa-senyawa ini lebih tinggi dari standar yang ditetapkan oleh Peraturan Menteri Kesehatan. Masalah kesehatan masyarakat yang paling banyak dialami adalah gatal (75,3 %), sakit perut (66,7%), dan gigi berwarna kuning (61,3%). Uji regresi linier sederhana mendapatkan hasil pengaruh positif yang signifikan antara kualitas air gambut (berdasarkan persepsi individu) dengan masalah kesehatan masyarakat di kawasan Danau Tundai (p = 0,000).*

***Kesimpulan:*** *Kualitas air gambut di Kawasan Danau Tundai tidak memenuhi standar air minum Kementerian Kesehatan, dan kualitas air gambut memiliki hubungan yang signifikan terhadap masalah kesehatan masyarakat Danau Tundai.*

## INTRODUCTION

Water is one of the basic needs for humans to live.[1] At least 50-60% of body weight in adults consists of water. The water used must meet the requirements in terms of quality and quantity to be fit for use.[2] The sources of water used by the community may vary in certain areas that do not have access to clean water. Residents usually use the water well, rainwater, or river water, which the quality often does not meet healthy water standards according to the government's regulation.[3] So far, access to safe drinking water in Indonesia is estimated at only 6,8% of households.[4] There are 14 clean water companies spread over each district in Central Kalimantan, with 90.91% of their customers are in the household category. How-ever, not all residents of Central Kalimantan use water or have access to those companies.[5] This province has 11 major rivers and no less than 33 small rivers, the presence of these rivers being one of the characteristics of Central Kalimantan. According to that, the people of Central Kalimantan should have easy access to water, considering its geographical status with many rivers passing by. The type of water that flows in those rivers is the main prob-lem. Indonesia occupies the 4$^{th}$ highest position for peatland after Canada, Russia, and the United States.6 Central Kalimantan has a peat area of 2.66 million Hectares.[7] Therefore, most of the river water that flows in Central Kalimantan is peat water. Peat water is a dif-ferent challenge in providing easy access to clean water. Peat water has a low pH level, so it is very acidic. Peat water also has organic content, high metal, and a yellow-reddish or dark brown color.[8] Peat water hardness is also low.[9] Peat water is unfit for drinking water and sanitation. In the short and long term, poor water quality, like peat water, can lead to health problems ranging from vomiting and diarrhea, skin diseases such as dermatitis, tooth decay or loss, or even cause death because there might be heavy metals that are toxic.[10] Research conducted in Pulo Gombut, Suka Rame Baru Village, Kuala Hulu District, Labuhan Batu Utara Regency, found an association between the use of peat water and the occurrence of health problems in the community.[11]

Almost all residents in Danau Tundai use peat water as the source for their daily needs ranging from bathing, washing, and even drinking. The water does not meet the quali-ty set by the government but still in use due to financial limitations and knowledge; most people in Danau Tundai village have only received (not finished) education at the elemen-tary school level. Compared to other locations in Palangka Raya City, the residents on the riverside of Kahayan River have better access to clean water, education, and health facilities than the residents of Danau Tundai Village. According to the data provided by the local health facilities, 4 out of the top 10 diseases in Danau Tundai 2020 are related to peat water usage, such as dermatitis, gastritis, dental caries, and diarrhea. From the background above, it appears that a study is needed to determine the quality of peat water in the Danau Tundai Area and to identify the association between the quality of peat water and public health problems in the Danau Tundai Area.

## METHODS

### Study Design

This type of research is an analytic-observational study to determine the association of peat water quality (based on individual perception) with health problems in the people of the Danau Tundai area. We used water laboratory tests based on the Ministry of Health standard to determine peat water quality. The water sample, was obtained from 5 different collection points in the Danau Tundai area and the Jangahen river flow. The water sample, was

tested at the Laboratory of the Environmental Health and Disease Control Engineering Center/ Balai Besar Teknik Kesehatan Lingkungan dan Pengendalian Penyakit (BBTKLPP) in Banjarbaru, South Kalimantan. The results of the laboratory tests, was compared with the quality standard according to the Ministry of Health of the Republic of Indonesia regulations No. 492/MENKES/ PER/IV/2010 and Government Regulation of the Republic of Indonesia Number 22 Year 2021.12,13

**Population and Sample**

The population of this research was all people who use peat water for their daily needs in Danau Tundai Village. The sampling technique, was drawn up by the purposive sampling method according to the inclusion criteria on the research objectives. Samples of respondents, were taken using a questionnaire. The subject in this study was 146 residents of Danau Tundai village from a total population of 229 people. The sample size, was calculated using the Slovin formula:

$$n = \frac{N}{N.d^2+1} \quad \text{.....(1)}$$

Inclusion criteria in this study were: respondents were using Jangahen River water, can be contacted and were willing to be respondents, live in Danau Tundai village, and were male or female aged 0-75 years. For those who cannot yet understand the questionnaire or have difficulties in writing and speaking, it was possible for their family or any other living under the same roof with them to answer. The exclusion criteria in this study were: the respondent died, walk-out during the study period, was prolonged sick during data collection, or refused to be involved to the study. This research was conducted during the COVID-19 pandemic, so people who suffered from severe form of COVID-19 infection were subjects of the exclusion criteria. Written informed consent, were completed by all participant before starting in the study.

**Variables**

The independent variable in this study, was the quality of peat water, including physical, chemical, and biological quality, based on the Ministry of Health of the Republic of Indonesia regulations No. 492/MENKES/PER/IV/2010. The measurements, were performed at BBTKLPP) in Banjarbaru, South Kalimantan. The quality of the peat water was classiffied into qualified and not qualified. Meanwhile, the dependent variable in this study was the health problems complained by the people of Danau Tundai. Data, were collected with a questionnaire containing yes or no question.

**Ethics**

Ethical approval for this study, was obtained from Faculty of Medicine, University of Palangkaraya, with an ethical-approval file number: 31/UN24.9/LL 2021.

**Statistical analysis**

The data were input into a worksheet on a computer using the SPSS 26 for Windows computer software for analysis, with simple linear regression was performed to examine a linear association between one peat water quality (X) and the health problems (Y). The questionnaires, were submitted to groups with almost the same characteristics as the research sample, and the validity was measured using the Pearson product moment correlation formula. The results of r calculation, are compared to r table where df = n-2 with sig 5%. If r table <r count, then it is valid. Reliability is an index that shows the extent to which a measuring device can be trusted or relied upon. The reliability test, can be measured in the Cronbach alpha value, should the Alpha value is > 0.60, then the construct statement is reliable. The validity and reliability test of the questionnaire, was conducted on 30 respondents with characteristics that are almost the same as the characteristics of the research respondents. There are three water quality questions based on individual perceptions and ten health problems questions. r table with a significance of 5% is 0.361, and compared with r-count, the r count > r table (questions declared valid).

The reliability test of the Cronbach alpha value of water quality questions based on individual perceptions (0.923) and the Cronbach alpha value of health problems questions (0.873) > 0.60 then the construct of the statement, which is the variable dimension, is reliable.

**RESULTS**

The study data, are primarily collected from a questionnaire survey in Danau Tundai Village.

Male respondents dominated the study with 54% (81 person), as well as older adult (age 36-45) with 23.3% (35 person). Most of the respondents, are from low educational background especially the elementary school level. Based on the occupation, most respond-ents are fishermen and housewives, as seen in the Table 1.

Some quality parameters of Jangahen River had exceeded the threshold made by the Government, including pH 4.02, BOD 18.6 mg/L, COD 156.9 mg/L, DO 5.9 mg/L, Ammonia 0.16 mg/L, Iron (Fe) 0.66 mg/L, and Organic Matter (KMnO) 257.5 mg/L (Table 2).

We also obtained the public's perception of water quality and the use of peat water in daily living. Most Danau Tundai Community complained about the water used being colored by 105 people (70%), smelling by 96 people (64%), and the least complained was the water used tasted by 79 people (52.7%) (Table 3).

The questionnaire about peat water usage showed that the people of Danau Tundai village occupation, is closely related to the usage of peat water( 88.7% or 133 people). They used peat water for daily needs, with the most frequent use is to wash clothes (88% or 132 people), take a bath (82.7% or 124 person), wash the dishes (73.3% or 110 people), wash foods and fruits (64.7% or 97 people), cook (40.7% or 61 people) and the fewest use is for drinking water purpose (68.7% or 103 people) (Figure 1).

Table 1. Respondent characteristics

| Respondent Characteristics | n | % |
|---|---|---|
| Sex | | |
| Female | 69 | 46 |
| Male | 81 | 54 |
| Age | | |
| Toddler (0-4) | 6 | 4 |
| Children (5-11) | 20 | 13.3 |
| Early Teenager (12-16) | 26 | 17.3 |
| Late Teenager (17-25) | 23 | 15.3 |
| Early Adulthood (26-35) | 22 | 14.7 |
| Late Adulthood (36-45) | 35 | 23.3 |
| Early Elderly (46-55) | 11 | 7.3 |
| Late Elderly (56-65) | 5 | 3.3 |
| Seniors (> 65) | 2 | 1.3 |
| Education | | |
| Not in School | 13 | 8.7 |
| Elementary School | 65 | 43.3 |
| Junior High School | 46 | 30.7 |
| High School | 25 | 16.7 |
| Bachelor or Higher | 1 | 0.7 |
| Occupation | | |
| Not working | 12 | 8 |
| Student | 43 | 28.7 |
| Housewives | 46 | 30.7 |
| Fishermen | 47 | 31.3 |
| Traders | 1 | 0.7 |
| Teacher | 1 | 0.7 |

Table 2. Water quality test results of Jangahen river

| No | Parameter | Result | Unit of measure | Water Classification† | | | |
|---|---|---|---|---|---|---|---|
| | | | | Class 1 | Class 2 | Class 3 | Class 4 |
| 1 | Temperature | 25.3 | ℃ | | | | |
| 2 | Total Dissolved Solid | 137 | mg/L | 1000 | 1000 | 1000 | 2000 |
| 3 | Total Suspended Solid | <7 | mg/L | 40 | 50 | 100 | 400 |
| 4 | Electric Conductivity | 51.4 | µmhos/cm | | | | |
| 5 | pH | 4.02* | | 6-9 | 6-9 | 6-9 | 6-9 |
| 6 | Biological Oxygen Demand | 18.6* | mg/L | 2 | 3 | 6 | 12 |
| 7 | Chemical Oxygen Demand | 156.9* | mg/L | 10 | 25 | 40 | 80 |
| 8 | Dissolved Oxygen | 5.9* | mg/L | Min.6 | Min.4 | Min.3 | Min.1 |
| 9 | Ammonia (NH3-N) | 0.16 | mg/L | 0.1 | 0.2 | 0.5 | (-) |
| 10 | Arsenic (As) | <0.0021 | mg/L | 0.05 | 0.05 | 0.05 | 0.05 |
| 11 | Cobalt (Co) | <0.0018 | mg/L | 0.2 | 0.2 | 0.2 | 0.2 |
| 12 | Selenium (Se) | <0.002 | mg/L | 0.01 | 0.05 | 0.05 | 0.05 |
| 13 | Cadmium (Cd) | <0.0003 | mg/L | 0.01 | 0.01 | 0.01 | 0.01 |
| 14 | Copper (Cu) | <0.001 | mg/L | 0.02 | 0.02 | 0.02 | 0.2 |
| 15 | Iron (Fe) | 0.66* | mg/L | 0.33 | (-) | (-) | (-) |
| 16 | Lead (Pb) | <0.0003 | mg/L | 0.03 | 0.03 | 0.03 | 0.5 |
| 17 | Manganese (Mn) | <0.0109 | mg/L | 0.1 | (-) | (-) | (-) |
| 18 | Zinc (Zn) | <0.0025 | mg/L | 0.05 | 0.05 | 0.05 | 2 |
| 19 | Chlorine (Cl-) | 12.6 | mg/L | 300 | 300 | 300 | 600 |
| 20 | Fluorine (F) | 0.34 | mg/L | 1 | 1.5 | 1.5 | (-) |
| 21 | Calcium Carbonate (CaCO3) | 62.4 | mg/L | (-) | (-) | (-) | (-) |
| 22 | Nickel (Ni) | <0.0036 | mg/L | 0.05 | 0.05 | 0.05 | 0.1 |
| 23 | Organic Matter (KMnO4) | 257.5* | mg/L | (-) | (-) | (-) | (-) |
| 24 | Coliform | <1.8 | MPN/100 mL | 1000 | 5000 | 10000 | 10000 |
| 25 | E. coli (fecal coliform) | <1.8 | MPN/100 mL | 100 | 1000 | 2000 | 2000 |
| 26 | Total Plate Count | 100 | CFU/mL | | | | |
| 27 | Staphylococcus | - | +/- | - | - | - | - |
| 28 | Salmonella sp. | - | +/- | - | - | - | - |
| 29 | Vibrio cholerae | - | +/- | - | - | - | - |

*: Exceeded threshold.

†Water classification

Class 1: Water used for raw water for drinking and or other purposes that require the same quality of water as that use.

Class 2: Water used for recreation infrastructure/facilities, freshwater fish cultivation, animal husbandry, water for irrigating plantations and or other uses that require the same water quality.

Class 3: Water used for the cultivation of freshwater fish, livestock, water for irrigating crops, and or other uses that require the same quality of water as that use.

Class 4: Water used to irrigate crops and or other uses that require the same quality of water as that use.

Table 3. Water quality based on individual perception of the Danau Tundai Community

| Perception of water used | Yes | | No | |
|---|---|---|---|---|
| | n | % | n | % |
| Colored | 105 | 70 | 45 | 30 |
| Tasted | 79 | 52.7 | 71 | 47.3 |
| Smelling | 96 | 64 | 54 | 36 |

According to the questionnaire about the health problems complained by the people of Danau Tundai village (Table 4), the most frequent health problem in the category of skin problems was itching (75.3% or 113 people). Gastrointestinal problems include stomachache (66.7% or 100 people), and dental and oral problem, was yellowing of the teeth (61.3% or 92 people).

The people of Danau Tundai mostly tried to seek help for their health problems (68% or 102 people), while the other 32% (48 people) didn't. They mostly went to the local health facilities (110 person or 73.3%), and even if it's rare, some people went to the city by water transportation to have a doctor consult at a private clinic or public health care. Testing the hypothesis that peat water quality affects health problems in the community of Danau Tundai region, a simple linear regression needs to be done. The simple linear regression resulted in a regression equation Y= 3.160 + 1.414X, and because the regression coefficient 1.414 > 0, it can be interpreted that there is a positive influence from variable X (peat water quality) to variable Y (health problems).

## DISCUSSION

This study reported that the quality of peat water in the Tundai Area does not meet water quality standards, and the quality of peat water had a significant association with health problems

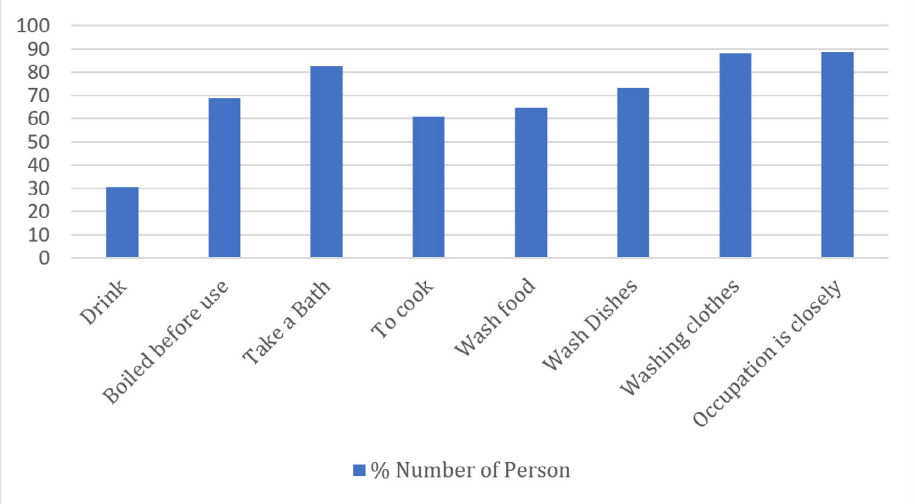


Figure 1. Utilization of peat water by the Danau Tundai Community

Table 4. Danau Tundai Communities' health problems

| Health Problems | Yes | | No | |
|---|---|---|---|---|
| | n | % | n | % |
| Skin Problems | | | | |
| Itching | 113 | 75.3 | 37 | 24.7 |
| Skin redness | 104 | 69.3 | 46 | 30.7 |
| Pain in skin | 82 | 54.7 | 68 | 45.3 |
| Burning sensation | 93 | 62.0 | 57 | 38.0 |
| Scalded skin | 89 | 59.3 | 61 | 40.7 |
| Gastrointestinal Problems | | | | |
| Stomachache | 100 | 66.7 | 50 | 33.3 |
| Watery stool more than 3 times a day | 93 | 62.0 | 57 | 38.0 |
| Burning sensation in the stomach (gastric pain) | 73 | 48.7 | 77 | 51.3 |
| Dental and Oral Problems | | | | |
| Yellowing | 92 | 61.3 | 58 | 38.7 |
| Tooth decay | 80 | 53.3 | 70 | 46.7 |

in Danau Tundai communities. Most people in Danau Tundai complained of itching, stomachache, and yellowing of the teeth. These health problems make them seek help due to their health problems.

The high amount of inorganic matter such as $KMnO_4$, Fe, As, and Mn could irritate the skin and gastrointestinal mucosa. These results are similar to a study in Pulo Gombut, Suka Rame Baru Village, Kuala Hulu District, Labuhan Batu Utara Regency, which found an association between the use of peat water and the occurrence of health problems in the community, where the main complaint is itching.[11]

Peat water used by the respondents from Danau Tundai came from the river, located right in front of the residential area. The peat water is dark brown-reddish colored water made from soil containing peat that came from decayed vegetation and organic matter[14], and peat water has a high Fe and Mn composition.[15] The high level of $KMnO_4$ will make the water turn into brown. The iron in the water can cause water to become colored, smelly, and tasteless. Besides causing a red colorization, it can also cause rust on equipment made of metal. Peat water also contains humic acid, that causes a low pH and acidic taste.[16]

Peat water in Danau Tundai serves many purposes, such as washing, bathing and for drinking consumption. The people of Danau Tundai are using peat water for drinking just by boiling the water to 100°C. In this research, the water quality test showed coliform, the E. coli level is low, and the pH level is also acidic. However, the levels of COD and Fe were high. The COD level increases as the concentration of organic material increases. It also in-creases if inorganic compounds susceptible to oxidation by the oxidant (typically dichro-mate) are present. Water with high COD typically contains high levels of decaying plant matter, human waste, or industrial effluent. The acidity of pH and temperature affects bacterial growth. Most bacteria survive in alkaline pH compared to acidic pH. The optimal pH for bacterial growth is 7-7.8 and 6.8-7.2 for aerobic and anaerobic organisms, respectively. It is consistent with the study that pH correlated with the microbiological parameters.[17]

The government's regulation states that peat water contains many chemical parame-ters above the threshold. Prolonged consumption may result in chemical buildup that is dif-ficult to metabolize in the body. These may induce health problems and diseases. The peo-ple of Danau Tundai have used peat water for many different purposes with wide variations of usage duration. Therefore, health problems among these people may also vary due to the direct effects of peat water use, such as itching, skin redness, and diarrhea. The peat water indirect effect resulted from the prolonged accumulation of chemical buildup in the body. Therefore, a body checkup is warranted to provide information should there be any damage in the liver or kidney.[18,19] This observational research reported on the direct effects on health. The most common problems (involving skin and dental) occur mainly because of the usage for bathing, gargling, and their occupation that is closely related to peat water use, such as fishermen and housewive.[20,21]

The level of $KMnO_4$ in the Jangahen River exceeded the threshold 25 times (Janga-hen River: 257.5 mg/L, threshold: 10 mg/L). Fe in Jangahen River exceeded the threshold twice (Jangahen River: 0.66 mg/L, threshold: 0.3 mg/L). The pH in Jangahen River exceed-ed the threshold and was acidic. The high amount of inorganic matter such as $KMnO_4$, Fe, As, and Mn that could irritate the skin and gastrointestinal mucosa is consistent with the top 3 health complaints, which are itching, redness, and burning sensation of the skin, and gas-trointestinal problems experienced by the respondents.[21,22,23] The high amount of organic matter could leave color in clothes or teeth. Consistently, there are some of the respondents complained about yellowing of the teeth. The acidic pH level could be dissolved with min-eral from aquifer stones and elevate the amount of metal and total dissolved solids that could cause corrosion in pipes and gastrointestinal irritation in humans.[23,24]

The limitation of this study is that the condition of peat water is affected by climate change and rainfall. High rainfall can cause flooding and change the level of water bodies. Researchers must wait until the flood recedes and the water returns to its original character-istics, then water samples are taken. Another limitation is inability to check several parame-ters because of problems with the equipment in the laboratory. Further research is needed to perform otherl water parameters such as Ba, Hg, Cl2, and Al.

## CONCLUSION

The quality of the peat water in Danau Tundai Area does not meet water quality standards, most people complained about itching, stomachache and yellowing of the teeth. It can be concluded that the peat water quality was associated with health problems complained of by the people of Danau Tundai

## CONFLICT OF INTEREST

The authors state that there is no conflict of interests for this article

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