Analysis of chemical parameters sourced from domestic waste in Lake Toba Region

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Abstract. Lake Toba which has a function as a water resource and ecosystem buffer area is also used as a place to dispose of various types of waste generated from agricultural activities around it, domestic waste from settlements and hotels, waste from fish feed leftovers in floating net cages, tourism waste and water transportation. Quality of water in Toba lake decreased from classify water Quality Criteria Class I to Class II based on Government Regulation No. 82 of 2001 water quality management and water pollution control. It is necessary to analyze the types of pollutants that are most dominantly produced by domestic waste so that the management efforts carried out can be right on target. This research was conducted in Lake Toba area, and used purposive sampling technique that is taking a number of 15 samples sourced from domestic waste. Samples were analyzed at the BTKLPP laboratory in North Sumatra province. The results are compared with Government Regulation No. 82 of 2001 with Class II Water Quality Criteria. The most dominant chemical parameters were Zinc followed by Free Chlorine and Flour from three characteristics of domestic waste sources are settlements areas, hotels and tourist locations. The content of heavy metals such as Zinc in the waters decreases the quality of the environment and impacts on aquatic biota. Lake Toba as a source of clean water and drinking water cause impact on public health. Sustain domestic waste management efforts need to be done so that Lake Toba are safe for living things

Keywords: chemical parameters, domestic waste, Lake Toba

1. Introduction

Lake Toba is the largest lake in Indonesia. The surface of the lake at a height of 995 meters above sea level. The Area of Lake Toba which is 1,130 Km2 with a maximum depth of Lake is 529 yards. The total Catchment area of Lake Toba approximately is 4.311,58 Km^2 [1]. The very diverse use of Lake Toba water with various community activities has an impact on water quality decrased. Lake Toba area is also used as a place to dispose of various types of waste generated from agricultural activities around it, domestic waste from settlements and hotels, waste from fish feed leftovers in floating net cages, tourism waste and water transportation [2]. The Lake Toba catchment area faces an environmental crisis characterized by widespread deforestation, drought, decline of the water level, water quality degradation, invasive species and loss of biological diversity [3].

Previous research has proven that pollution in the waters of Lake Toba has occurred which originates from both floating cages and domestic waste. The high level of human activity around the funds caused the pollution cannot be avoided. The main sources of nutrient input in waters are fertilizer runoff from agricultural land, deposition of nitrogen from the atmosphere, use of phosphate-containing detergents, soil erosion containing nutrients, and disposal of domestic and industrial waste [4]. Quality of water in Toba lake decreased from classify water Quality Chriteria Class I to Class II Government Regulation No. 82 of 2001 Water quality management and water pollution control. This study is different from previous studies which describe Lake Toba water pollution based on the characteristics of pollutant sources such as floating net cages, domestic sources and others.

This study looked at pollutants that dominate domestic waste in the Lake Toba region. This research is important because generally people living in the Lake Toba region still use Lake Toba as a source of clean water and drinking water. If this condition continues, it is feared that the accumulated effects of Zn will appear such as anemia, damage the pancreas, and decrease levels of high density lipoprotein (HDL) cholesterol [5].

Majority of people amount is 624,265 from 7 districts using Lake Toba water as a raw source of drinking water [6] in accordance with the designation based on PP No. 82 of 2001, the Regional Government of North Sumatra has set water quality standards for Lake Toba as a first class water source (Governor Regulation No. 1 of 2009). Nowadays the water quality of Lake Toba is below that standard.

Based on this, this study aims to analyze chemical parameters derived from domestic waste on the surface of Lake Toba and analyze the types of pollutants that are most dominantly produced by domestic waste so that the management efforts carried out can be right on target.

2. Research methods

This research was conducted in Lake Toba area, data collection with purposive sampling technique that is selecting samples identified as sources of domestic waste with 3 sample categories namely water samples originating in residential areas, originating from coastal tourism and settlement area, each taken 5 sample point so the total sample is 15 points. Lake water sampling method refers to SNI 06-2412-1991 which is taking lake water samples based on 10 m depth, 10-30 m [7]. After sampling, sample preservation was carried out which refers to the preservation procedure according to SNI 06-2412-1991 in the form of cooling and adding H2SO4 / HNO3 to the pH of the sample below 2. Preserved samples are taken to the laboratory for analysis. Physics and chemical parameters were examined at the BTKLPP Medan Chemical Laboratory. The results are compared with Government Regulation No. 82 of 2001 on Water Quality Management and Water Pollution Control as Class II Water Quality Criteria.

Sampling for other domestic waste sources such as office waste activities is not included because activities only during the day and locations are scattered in several places so that they cannot represent one characteristic for a sample of domestic waste sources. In Figure 1 is a map the location of sample point taken is assumed as a source of domestic waste in the waters of Lake Toba.

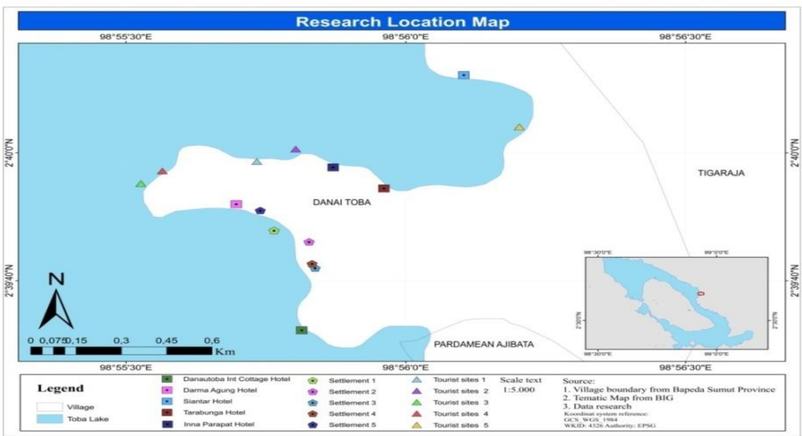

Figure 1. Map of sample point in Toba Lake

The following Table 1. is a description of the locations from three categories of domestic waste sources in Lake Toba

Table 1. Distribution of research sample points

No	Ordinat point	Description of Sample Point Location
1	N 02º 39' 46.11" E 098º 55' 49.63"	Sigalingging houses, Tiga Raja, SipanganbolonParapat
2	N 02º 39' 42.01" E 098º 55' 50.28"	Sir Ambarita houses, Tiga Raja, SipanganbolonParapat
3	N 02º 39' 42.69" E 098º 55' 49.95"	Sir Ginting houses ,Tiga Raja, SipanganbolonParapat
4	N 02º 39' 51.01" E 098º 55' 44.40"	Sir Pardosi houses, Tiga Raja SipanganbolonParapat,
5	N 02º 39' 58.66" E 098º 55' 44.04"	Sir Sitorus houses, Tiga Raja, SipanganbolonParapat
6	N 02º 40' 00.60" E 098º 55' 48.20"	Beach location 1,Tiga Raja, SipanganbolonParapat
7	N 02º 39' 55.22" E 098º 55' 31.60"	Beach location 2,Tiga Raja, SipanganbolonParapat
8	N 02º 39' 57.18" E 098º 55' 33.90"	Bung Karno Castle location 1, KelurahanTiga Raja,
9	N 02º 40' 04.08" E 098º 56' 12.17"	Bung Karno castle location 2, Tiga Raja Parapat
10	N 02º39'54.45" E 098º55'57.65"	Bahari beach 1 KelurahanParapat, KecamatanGirsangSipanganbolonParapat, KabupatenSimalungun
11	N 02º39'57.74" E 098º55'52.21"	Tarabunga hotel
12	N 02º39'32.28" E 098º55'48.84"	Inna Parapat hotel
13	N 02º39'51.99" E 098º55'41.83"	DanautobaInt.Cottage
14	N 02⁰40'12.18 "E 098º56'06.22"	DarmaAgung Hotel
15	N 02⁰40'12,18" E 098o56'06,22"	Siantar Hotel

3. Result and Discussion

3.1. Result

This research was carried out in three categories of locations that were assumed to be sources of domestic waste around the Lake Toba area. The results from 24 parameters that are examined there are 4 parameters most dominant in the waters of Lake Toba. The results obtained can be explained in the Table 2 here are the results of chemical parameter analysis from 5 sample points in the coastal resort of Lake Toba.

Table 2. Results of analysis of chemical parameters in the Tourist area of Lake Toba

No	Chemical parameter	Standards quality class II	Sample1	Sample2	Sample3	Sample4	Sample5	Unit	Averages
1	pH	6 s.d. 9	7,84	7,93	8,15	8,12	8,1	7,84-8,15	8,028
2	NO_3	0,06 mg/l	0,0008	0,0018	0,0008	0,0008	0,0054	0,0008-0,0054	0,00192
3	Chlorine	-	6,498	6,498	6,748	5,998	5,248	5,248-6,748	6,198
4	Fe	0,3mg/l	0,03502	0,00084	0,04363	0,01719	0,07162	0,00084-0,07162	0,03366
5	Mn	0,1mg/l	0,00044	0,00044	0,00044	0,00044	0,00134	0,00044-0,00134	0,00062
6	Zn	0,05 mg/l	**0,24111**	**0,23343**	**0,28562**	**0,30819**	**0,24561**	0,24111-0,30819	0,26279
7	Cd	0,01 mg/l	0,00009	0,00009	0,00009	0,00009	0,00009	0,00009	0,00009
8	Pb	0,03 mg/l	0,00022	0,00022	0,00022	0,00089	0,00022	0,00022-0,00089	0,000354
9	Hg	0,002 mg/l	0,00058	0,00076	0,00064	0,00075	0,00025	0,00025-0,00076	0,000596
10	Ar	1 mg/l	0,00024	0,00026	0,00026	0,00074	0,00026	0,00024-0,00074	0,00176
11	Br	1 mg/l	0,00029	0,00029	0,00029	0,00029	0,00029	0,00029	0.00029
12	Cu	0,02 mg/l	0,00009	0,00009	0,00009	0,00009	0,00009	0,00009	0.00009
13	Co	0,2 mg/l	0,09035	0,00003	0,18083	0,00003	0,07573	0,00003-0,18083	0.069394
14	Sn	0,05 mg/l	0,00025	0,00071	0,00025	0,00061	0,00026	0,00025-0,00071	0.000416
15	Cr Val.6	0,05 mg/l	**0,227**	0,041	**0,069**	**0,074**	0,037	0,037-0,227	0,0896
16	Free Chlorine	0,03 mg/l	**0,118**	**0,121**	**0,151**	**0,124**	**0,13**	0,111-0,151	0,1288
17	Fl	1,5 mg/l	**2,4**	**1,8**	**3,2**	**2,4**	**1,5**	0,4-4,3	2
18	P	0,2 mg/l	**0,308**	0,071	**0,57**	**0,57**	0,069	0,069-0,308	0.3176
19	Nitrate	10 mg/l	0,5	0,5	0,5	0,5	0,5	0,5	0,5
20	Sulfida	0,002 mg/l	0,002	0,002	0,002	0,002	0,002	0,002	0.002
21	DO	min 4	7,76	7,48	14,2	8,61	8,26	7,48-14,2	9.262
22	BOD	3	1,18	1,03	1,02	1,02	1,33	1,02-1,33	1.116
23	COD	25	3,687	3,218	3,187	3,187	3,694	3,187-3,694	3.3946
24	Sianida	0,02 mg/l	0,002	0,002	0,002	0,002	0,002	0,002	0.002

Based on table 3, it can be described from 24 chemical parameters that analyzed in Lake Toba beach area, the parameter results that exceed the standard threshold value are zinc with average is 0.26279 mg/L, Chromium (VI) with a average is 0.0896 mg/L, free chlorine with a average 0.1288 mg/L and the a maximum value is 0.151 mg/L, Flouride with a verage is 2 mg/L and a maximum value of 4.3 mg/L.

Table 3. Results of analysis of chemical parameters in settlement areas

No	Chemical parameter	standards quality class II	Sample1	Sample2	Sample3	Sample 4	Sample5	Unit	Averages
1	pH	6 s.d. 9	8,61	8,45	8,68	8,16	8,16	8,16-8,68	8.412
2	NO_3	0,06	0,0064	0,0062	0,0042	0,0043	0,0042	0.0042-0,0064	0,00506
3	Chlorine	-	5,248	4,249	5,498	5,998	6,498	4,249-6,498	5,4982
4	Fe	0,3	0,07181	0,08893	0,12478	**0,34748**	0,00324	0,00324-0,34748	0,127248
5	Mn	0,1	0,00044	0,00044	0,00044	0,00877	0,00044	0,00044-,00877	0,002106
6	Zn	0,05	**0,18212**	**0,21796**	**0,27411**	**0,23204**	**0,09489**	0,09489-0,27411	0,2002
7	Cd	0,01	0,00009	0,00009	0,00009	0,00009	0,00009	0,00009	0,00009
8	Pb	0,03	0,00022	0,0035	0,00022	0,00022	0,00022	0,00022-0,0035	0,000876
9	Hg	0,002	0,00076	0,00064	0,00075	0,00026	0,00024	0,00024-0,00076	0,00053
10	Ar	1	0,00026	0,00026	0,00074	0,00064	0,00061	0,00026-0,00074	0,000502
11	Br	1	0,00029	0,00029	0,00029	0,00511	0,00029	0,00029-0,00511	0,001254
12	Cu	0.02	0,00009	0,00009	0,00009	0,00009	0,00009	0,00009	0,00009
13	Co	0.2	0,00003	0,00003	0,00003	0,00003	0,00003	0,00003	0,00003
14	Sn	0.05	0,00071	0,00025	0,00061	0,00075	0,00071	0.00025-0.00075	0.000606
15	Cr Val.6	0.05	**0.056**	0.036	**0,12**	0,037	0,023	0.023-0,12	0.0544
16	Free Chlorine	0.03	**0.154**	**0.143**	**0.12**	**0.159**	**0.155**	0.12-0.159	0.146
17	Fl	1.5	0.4	1.2	**1,7**	**4.3**	**2.4**	1.5-3.2	2.26
18	P	0.2	0.012	0.021	0.03	0.054	0.03	0.03-0.054	0.0294
19	Nitrate	10	0.5	0.5	1	0.5	0.5	0.5-1	0,6
20	Sulfida	0.002	0.002	0.004	0.002	0.002	0.002	0.002-0.004	0.0024
21	DO	min 4	11,44	9,65	14,97	13,37	7,76	7,76-14,97	11,438
22	BOD	3	1,01	1.12	1,15	1,17	1,53	1,01-1,53	1,196
23	COD	25	2,805	3,111	3,194	3,25	4,25	2,805-4,25	3,322
24	Sianida	0,02	0,002	0,002	0,002	0,002	0,002	0,002	0,002

The results of laboratory analysis of settlement area of chemical parameters that exceed the standard threshold value of class II water quality are zinc with a mean of 0.2002 mg/l and a maximum value of 0.27411 mg/L, Chromium (VI) with an average of 0.0544 and a maximum value of 0.12 mg/L , Free chlorine with a mean of 0.146 mg /L and a maximum value of 0.159 mg/l, Flouride with a mean of 2.26 mg/L and a maximum value of 3.2 mg /L. Other parameters that exceed the standard threshold value in the residential area are iron parameters with a level of 0.036 mg /L at the sample point 4.

Table 4. Results of Chemical Parameter Analysis in Resort Areas

No	Chemical parameter	Standards	Sample1 mg/L	Sample2 mg/L	Sample3 mg/L	Sample 4	Sample5 mg/L	Unit	Averages
1	pH	6 s.d. 9	7,85	7,85	7,85	7,85	7,18	7,18-7,85	7,716
2	NO_3	0,06	0,0008	0,0008	0,0008	0,0008	0,0008	0,0008	0,0008
3	Chlorine	-	5,498	5,498	5,498	6,998	5,748	5,498-6,998	5,848
4	Fe	0,3	0,02695	0,02695	0,02695	0,01772	0,01212	0,01212-0,02695	0,022138
5	Mn	0,1	0,00044	0,00044	0,00044	0,00044	0,00044	0,00044	0,00044
6	Zn	0,05	**0,25217**	**0,25217**	**0,25217**	**0,20492**	**0,26767**	0,20492-0,26767	0,24582
7	Cd	0,01	0,00009	0,00009	0,00009	0,00009	0,00009	0,00009	0,00009
8	Pb	0,03	0,00313	0,00313	0,00313	0,00839	0,00022	0,00022-0,00839	0,0036
9	Hg	0,002	0,00026	0,00026	0,00026	0,00081	0,00024	0,00024-0,00081	0,000366
10	Ar	1	0,00064	0,00064	0,00064	0,00052	0,00061	0,00052-0,00064	0,00061
11	Br	1	0,00029	0,00029	0,00029	0,00029	0,00029	0,00029	0,00029
12	Cu	0,02	0,00009	0,00009	0,00009	0,00009	0,00003	0,00003-0,00009	0,000078
13	Co	0,2	0.10632	0.10635	0.10635	0.09997	0.00071	0,00071-0,10635	0,08394
14	Sn	0,05	0.00075	0.00075	0.00075	0.00061	0.00082	0,00061-0,00082	0,000736
15	Cr Val.6	0.05	0.035	0.035	0.035	**0.133**	**0.059**	0,035-0,133	0,059
16	Free Chlorine	0,03	**0.148**	**0.148**	**0.148**	**0.136**	**0.13**	0,136-0,148	0,1456
17	Fl	1,5	**1.8**	**1.8**	**1.8**	**3.4**	**3.4**	1,8-3,3	**2,42**
18	P	0,2	0.035	0.035	0.035	0.052	0.056	0,035-0,056	0,0426
19	Nitrate	10	<0.5	<0.5	<0.5	<0.5	<0.5	<0,5	<0,5
20	Sulfida	0,002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0,002
21	DO	min 4	6.59	6.59	6.59	6.15	8.12	6,15-8,12	6,808
22	BOD	3	1.48	1.48	1.48	1.28	1.77	1,28-1,77	1,498
23	COD	25	4.625	4.625	4.625	4	3.969	3,969-4,625	4,3688
24	Sianida	0,02	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0,002

Hotel location, parameters that exceed the standard threshold value are zinc with a mean of 0.24582 mg /L maximum value of 0.26767); Cr (VI) has a averages is 0.059 mg /L and a maximum value is 0.133 mg /L, free chlorine averages of 0.1456 mg /L and a maximum value of 0.148 mg /L. Flourida with average 2.42 mg/L and a maximum value is 3.3 mg /L.

3.2. Discussion
3.2.1. Zinc
The results of the chemical parameter analysis of the 3 characteristics location as a source of domestic waste obtained by zinc is the metal that dominates its presence in water. Zinc is one of the most common elements in the Earth's crust. Zinc is found in the air, soil, and water and is present in all foods. Zinc enters the air, water, and soil as a result of both natural processes and human activities. Waste streams from zinc and other metal manufacturing and zinc chemical industries, domestic waste water, and run-off from soil containing zinc can discharge Zinc into waterways. Zinc is one of the elements used as

color material in ship paint. The presence of Zn heavy metals can also be caused by the release of anti-fouling coatings on ship paints that are around the research station to the environment [8].

Zinc compounds that may be found at hazardous waste sites are zinc chloride, zinc oxide, zinc sulfate, and zinc sulfide. Most zinc are found naturally in the environment is in the form of zinc sulfide. Zinc compounds are used by the drug industry as ingredients in some common products, such as vitamin supplements, sun blocks, diaper rash ointments, deodorants, athlete's foot preparations, acne and poison ivy preparations, and antidandruff shampoos. Sludge and fertilizer also contribute to increased levels of zinc in the water [9]. Zinc is needed by our body in small amounts as an essential element. We are exposed to zinc compounds in food. Taking too much zinc into the body through food, water, or dietary supplements can also affect health. The levels of zinc that produce adverse health effects are much higher than the Recommended Dietary Allowances (RDAs) for zinc of 11 mg/day for men and 8 mg/day for women. If large doses of zinc (10–15 times higher than the RDA) are taken by mouth even for a short time, stomach cramps, nausea, and vomiting may occur. Ingesting high levels of zinc for several months may cause anemia, damage the pancreas, and decrease levels of high density lipoprotein (HDL) cholesterol [5].

The impact of domestic waste causes the concentration of high water nutrients can also affect human health and well-being by threatening aquatic ecosystem services, such as the provision of clean water for drinking and maintenance of fisheries irrigation for food, recreational opportunities and aesthetic qualities such as taste, color or smell [10].

3.2.2. Flouride

Fluoride is a common geogenic contaminant found in air, soil, fresh water, sea water, plants, rocks, minerals and lots of foods. It ranks 13th among the elements in the order of abundance in the Earth's crust. The earth’s crust contains about 900 ppm fluoride [11], but Fluoride is one of the essential nutrients needed for tooth and bone growth. Fluoride compounds can be found in a variety of household products. In toothpaste, generally contains 1 mg of fluoride as sodium mono flour phosphate. This compound is not soluble and is generally not toxic. In addition to toothpaste, fluoride compounds can also be found in other products, such as sodium fluoride in mouthwashes; sodium fluoride in vitamins and dietary supplements; ammonium bifluoride in chrome cleaning material; sodium fluoride in insecticides and rodenticides [12-13]. The average fluoride found in Lake Toba is 2.4 ppm and the WHO recommended value is 1.5 ppm

3.2.3. Free chlorine

Free Chlorine results in settlement areas is 5,4982mg/L, Tourist area is 6,198 mg/L and resort area is 5,848. Domestic waste produces free chlorine from human activities that use chlorine as a bleach, dirt cleaner and disinfectant [14]. The source of chlorine is likely to come from livestock, agricultural, human waste, especially urine, and industrial wastes around the waters of Lake Toba. In addition, chlorine can come from infiltration of septic tanks adjacent to the waters, where chlorine released by feces and urine through the process of reshaping produces organic chlorine which eventually seeps into the waters of Lake Toba. The use of pesticides also has a very large role in producing chlorine waste because pesticides that contain organic chlorine are very easily dissolved by water so that it has the potential as a source of chlorine pollutants.

Generally Chloride ions dissolve in water, Chloride ions are usually produced by electrolysis of sodium chloride dissolved in water. In a reasonable concentration, Chloride will not harm humans. If present in excessive amounts, can endanger the life of water, either directly or through the accumulation of compounds in the food chain [15]. In some studies, it turned out that people who drank water containing excess chlorine were more likely to develop cancer of the bladder, rectum or colon [15]. Whereas for pregnant women can cause birth defects with brain or spinal cord disorders, low birth weight babies, premature birth or even miscarriage. Therefore the use of Chloride is limited to human needs. In small amounts, they have no effect. In high concentrations, they cause problems with skin irritation.

3.2.4. Cromium

Chrome (VI) in the waters can come from geochemical materials that already exist in these waters. Chromium is in the form of valence 3 and valence 6. Chromium salts that enter the human body will soon be released by the body, but if the chromium levels are large enough, it will cause damage to the digestive system. Efforts that can be made to reduce heavy metal pollution are through phytoremediation naturally with water hyacinth. Water hyacinth was a moderate accumulator of Cd and Zn and could be used to treat water contaminated with low Cd and Zn concentrations [16].Another effort that can be done made domestic waste management installations. This was done in 1996 with the construction of a domestic sewage treatment plant located in the village of Jambur, Ajibata sub-district and operating in 2000. The WWTP was constructed through 2 hectare piping system. The capacity of wastewater treatment is equivalent to 3000 household connections but at the time of operation only 300 connections used it around (10%) [17]. This is due to lack of awareness, especially hotels and restaurants that prefer to dispose of wastewater directly to Lake Toba. This problem can be overcome by efforts to empower the community to reactivate the available installations, increasing public awareness to preserve the environment.

Pollution of Lake Toba is further aggravated by conditions a number of land use practices throughout the drainage basin also threaten the water quality of Lake Toba through excessive nutrient contributions. Many of the farmers use fertilizers and pesticides on their crops, some of which make their way into the lake. Nutrient-rich wastes from livestock also enter the lake through overland runoff. One of the more significant concerns throughout the watershed is the lack of wastewater management [18-19].

4. Conclution

The results showed three characteristics of domestic waste sources, the most dominant chemical parameters polluting the waters of Lake Toba were Zinc >Free Chlorine > Flour in locations of settlements areas, hotels and tourist locations in Lake Toba. Furthermore, it was followed by iron content in the settlement location and phosphate in tourism location. The content of heavy metals such as Zn in the waters decreases the quality of the environment and impacts on aquatic biota. Furthermore, the impact on public health in Lake Toba area that uses Lake Toba as a source of clean water and drinking water. Considering the low waste management practice among households, there is the need for improved policy and enhanced education on proper waste management practice among households. Sustain domestic waste management efforts need to be done so that Lake Toba are safe for living things.

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