# Heavy Metals Contamination Of $Cr^{6+}$ And Cd In The Ground Water In Nickel Laterite Mining Area In Tapunggaya Konawe Utara

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***Abstract*— This research was conducted at Tapunggaya in Molawe subdistrict in North Konawe Regency in South East Sulawesi, near activity of mining Laterite Nickel. This research aims to know the impact of the activity of mining nickel laterite on the quality of groundwater. The methods used to analyze concentrations of Cr6+, and Cd was direct observation and AAS which was a method of index pollution in the determination of the quality of groundwater. The activity of nickel mining did not show the significant impact to surrounded groundwater. There was nickel in the area of research through the standard of groundwater quality because the bedrock is ultramafic rocks. It was peridotite and garnierite filling veins among body rocks. According to the estimations of index pollution, the quality of groundwater was low pollution. Quality of groundwater was divided into three contaminant levels. Quality of groundwater includes two contaminant levels consisting of filling quality standard, and low contamination. The filled standard quality groundwater was at 2nd and 3rd stations. The low contaminations were at 1st, 4th, 5th, 6th, and 7th stations.***

***Keywords*—Heavy metals, groundwater, nickel laterite, Index pollution**

## I. Introduction

Mining activities generally carried out in forest areas can cause overall environmental damage in the form of water, soil and, air pollution. This is justified by [1] which states that environmental pollution is a condition that occurs due to changes in environmental conditions i.e., soil, air, and water. That is unfavorable for human, animal, and plant life caused by the presence of foreign objects such as garbage, industrial waste, oil, heavy metals which are harmful to human activities and make the environment does not work as before. Natural resources exploitation such as the mining industry is one of the financially profitable industries for the country's economy because it has a high selling power in the global market. However, any of these natural resources exploitation can have an impact on the environment, both physically and socially [2].

North Konawe District is part of the Soroako National Strategic Area (KSN) and surrounding areas, which it was proclaimed as a region with nickel mining commodities. Tapunggaya area is one of the areas near the post-mining location conducted by several companies located in the area. This research's purpose is to conduct groundwater quality analysis on settlement around nickel laterite mining area in Tapunggaya.

## II. BASIC THEORY

Environmental geology is essentially an applied geology science that it was aimed at making use of natural and energy resources efficiently and effectively to meet the human life's needs in the present and future by reducing the environmental impact it generates as much as possible. Thus it can be said that the earth as an object is influenced by the environment, including in it is human as one of the elements that influence it [3]. In essence, the relationship between geology and the environment can not be separated, reckoning the environmental problems that arise as a result of the natural resources exploitation and other human activities is the geology's subject and object [3]. Groundwater is a hydrological cycle part that takes place in nature and is present in underground rocks including the groundwater's availability, distribution, and movement with an emphasis on its relation to the region's geological conditions [4].

Heavy metal is a term commonly used for heavy metal and metalloid groups whose density is greater than 5g / $cm^3$ [5]. Heavy metal in the water is present in soluble and suspended form (bonded to suspended solids). Heavy metals in waters, especially at the creek, have a conservative and non-conservative nature. Heavy metal's elements are usually closely related to the pollution and toxicity problem. Based on the physical and chemical properties, the level or the toxicity of heavy metals to aquatic animals can be sequenced (from high to low) as follows: mercury (Hg), cadmium (Cd), zinc (Zn), lead (Pb), cadmium (Cd), nickel

(Ni), and cobalt (Co) [6]. Heavy metal pollution to the environment occurs due to a process closely related to the metal used in human activities, and intentionally or unintentionally discharges various heavy metal-containing wastes into the environment [7].

Pursuant to PP RI Number 82 the year 2001 stated that the Water Quality Standard is the limits or levels of living things, substances, energy or other components that exist or must exist and/or any kind of pollutant elements with grace existence in water at certain water sources in accordance with its designation. According to this rule, the intended water is all water contained in and/or from a water source, and located above the ground, excluding seawater and underground water.

## III. RESEARCH LOCATIONS

The sampling was conducted in residential areas around nickel mining with 7 observation stations of groundwater samples at residents' wells. The sample analysis was conducted at Forensic Microbiology Laboratory Faculty of Mathematics and Natural Sciences of Halu Oleo University.

Figure 1. Location Map and Points of Water Sampling Station

This research is descriptive research using survey method. This research tries to find out the groundwater condition in the residential area around the mining area which is finally analyzed based on the safe result of groundwater utilization in order to avoid adverse environmental impact in the end. In this study, the survey conducted is a field survey that aims to take samples of residents' well water at some sample points.

## IV. RESULTS AND DISCUSSION

The results of groundwater quality measurement analysis in post nickel mining area of Tapunggaya can be seen in table 1.

**Table 1**. Analysis of groundwater samples

| Station | Parameter | | |
|---|---|---|---|
| | pH | Chromium Hexavalent ($Cr^{6+}$) (mg/L) | Cadmium (Cd) (mg/L) |
| 1 | 7.3 | 0.1 | 0.0014 |
| 2 | 8.2 | 0.014 | 0.002 |
| 3 | 7.9 | 0.029 | 0.002 |
| 4 | 8.1 | 0.057 | 0.002 |
| 5 | 8.2 | 0.085 | 0.014 |
| 6 | 7.8 | 0.085 | 0.002 |
| 7 | 8.1 | 0.114 | 0.002 |
| **Average** | **7.9** | **0.069** | **0.0015** |
| **Standards Quality** | **6-9** | **0.05** | **0.01** |

Sources : Primary data research, 2017

### A. *Chemical Parameters of Groundwater in Research Area*

a) Level of Acidity (pH)

Based on the data processing results, it can be made graph comparison between observation stations and the results of laboratory analysis as in figure 2.

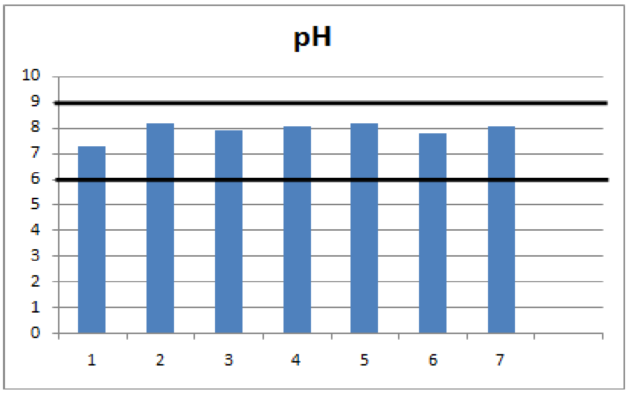


Figure 2. Comparison station location with pH index

Acidity (pH) is the acid or base state intensity in water. pH is said to be normal if it is ranged from 6-9 (Government Regulation No.82 of 2001). [8] argue that pH is closely related to carbon dioxide and alkalinity. At pH <5, alkalinity can reach zero. The higher the pH value, the higher the alkalinity value and the lower the free carbon dioxide levels. The acidic solution (low pH) is corrosive. pH also affects the chemical compound toxicity. Ammonium compounds that can be ionized are found in waters with low pH. Most aquatic biotas are sensitive to pH changes and favor a pH value of about 7-8.5. The pH value greatly affects the aquatic biochemical processes, e.g. the nitrification process will end if the pH is low. Metal toxicity shows an increase in low pH [8].

The pH measurements of the water does not affect the health but water with a pH of less than 6 will cause metal (water pipe) corrosion, dissolving the elements of lead, cadmium, copper, and vice versa if the pH is more than 9, it can form the precipitate (crust) on a water pipe which can then be toxic [9]. The pH measurements were done directly *in situ* using latmus paper, where the results of the acidity (pH) measurements in the water samples were still normal (pH 6-9). This is indicated by the change of color of blue litmus paper to blue, and there is no change of color on red litmus paper. Based on Government Regulation No. 82/2001, the acidity level throughout the stations meets the specified quality standards.

b) Chromium Hexavalen ($Cr^{6+}$)

Based on the data processing results, it can be made a comparison graph between observation stations and the laboratory analysis results as in Figure 3.

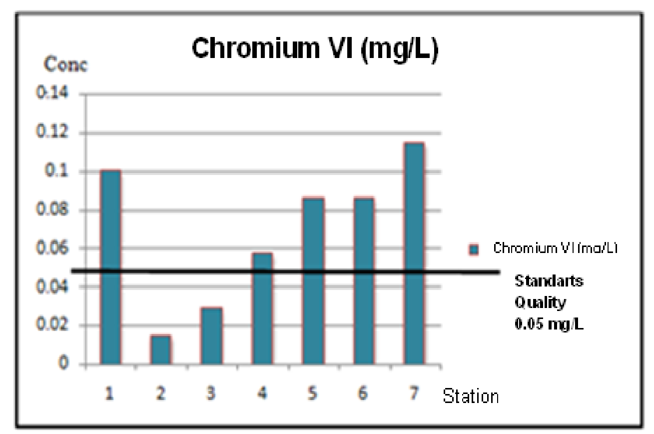


Figure 3. Comparison station location with $Cr^{6+}$ index

The laboratory analysis result on heavy metal chromium hexavalent shows a contamination of groundwater at station 1, station 4, station 5, station, 6 and station 7. The highest concentration is at station 7 that is 0.1143 mg / L and the lowest concentration is at station 2 that is 0.0286 mg / L. The concentration of chromium in groundwater when referring to the quality standard of Government Regulation No. 82 of 2001 is 0.05 mg / L, this means that hexavalent chromium parameters still meet the quality standard requirements for the designation of class I, class II, class II, and class IV. Chromium (Cr) is a rare element found in natural waters. Chromium is never found in nature as a pure metal. Chromium natural sources are very few, namely chromite (FeCr2O4) and chromic oxide (Cr2O3) [8]. Chromium salts are used in the steel industry, paints, dyes, explosives, textiles, paper, ceramics, glass, photography, as corrosion inhibitors, and as a drilling mud mixture. The maximum permissible chromium level for the benefit of drinking water is 0.05 mg/liter [8]. Chromium levels in freshwater waters are usually less than 0.001 mg/liter and around 0.00005 mg/liter in ocean waters.

c) Cadmium (Cd)

Based on the data processing results, it can be made a comparison graph between observation stations and the laboratory analysis results as in figure 4.

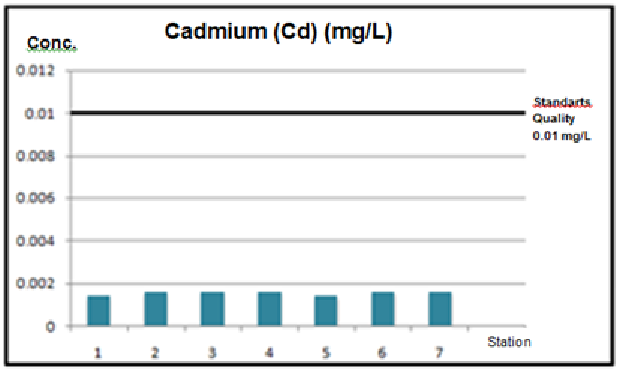


Figure 4. Comparison station location with Cd index

From the analysis results obtained, cadmium concentration shows no samples of water contaminated by this heavy metal. The analysis results of all water samples are below the maximum threshold allowed by Government Regulation No. 82 of 2001 which is 0.01 mg / L and meet the quality standards for the designation of class I, class II, class II, and class IV. With Hg, Pb, and V, cadmium (Cd) is a metal whose role for plants and other living things until now has not been clearly identified. In water, cadmium (Cd) is present in very small quantities (microorganisms) and is insoluble in water. The cadmium content of the earth's crust is about 0.2 mg/kg [8]. Cadmium natural sources are greenockite (CdS), hawleyite, sphalerite, and otavite [8]. Cd toxicity can damage the physiological, respiratory, circulatory, and cardiovascular systems, the reproductive system, the nervous system, it can even lead to bone fragility, kidney damage, and decreased pulmonary function in the body [10].

### *B. Evaluation of Groundwater Pollution Level*

Viewed from the quantity (amount) of groundwater, the research area is not difficult to obtain groundwater, this is due to topography where the research area is located at an altitude ranging from 12.5 to 25 mdpl with a depth of wells ranging from 3-10 meters. Generally, groundwater in igneous and metamorphic rocks contains little-dissolved solids since many of these contain silicate compounds that are resistant, except in dry areas where many substances are dissolved through the evaporation process. A region's lithology condition affects the quality and quantity of groundwater in the area. The research area's lithology is an ultrabasic rock with peridotite type, where this rock contains nickel element equal to 0,2%. The nickel element is present in the mineral crystals of olivine and pyroxene as the substitution of Fe and Mg atoms.

The analysis of groundwater contamination level was conducted using Pollution Index (IP) method based on Decree of State Minister of Environment No. 115 of 2003 on Guidelines on the Determination of Water Quality Status. The Pollution Index is used to determine the level of pollution relative to the permitted water quality parameters [11]. Evaluation of pollution index calculation of all observation locations is shown in table 2 below.

**Table 2.** Evaluation value of pollution index and water quality status

| Station | Evaluation value | Water Quality Status |
|---|---|---|
| 1 | 2.45 | Lightly Contaminated |
| 2 | 0.84 | Comply of quality standard |
| 3 | 0.86 | Comply of quality standard |
| 4 | 1.19 | Lightly Contaminated |
| 5 | 1.39 | Lightly Contaminated |
| 6 | 2.69 | Lightly Contaminated |
| 7 | 1.22 | Lightly Contaminated |

Sources : Estimation of the result, 2017

From the pollution percentage analysis based on the evaluation value of Pollution Index and Water Quality Status as stated in table 2, the average water quality status of all stations is lightly polluted, where the average evaluation score is 1.52 (1.0 <PIj ≤ 5.0). At station 1, the level of acidity (pH) still meets the quality standard of Government Regulation No. 82 of 2001. Based on the calculation of the pollution index, the status of water quality at this station is at 2.45 which means that groundwater at this point is classified as lightly polluted (1.0 <PIj ≤ 5.0). At the station 2, the level of acidity (pH) meets the quality standard of Government Regulation No. 82 of 2001. Based on the calculation of pollution index, the status of water quality at this station is 0.84 which means that groundwater at this point still meets the water quality standard (0 <PIj ≤ 1.0) For station 3, the acidity (pH) meets the quality standard pursuant to Government Regulation Number 82 the Year 2001. Based on the calculation of the pollution index, water quality status at this station is 0.86 which means that groundwater at this point meets the quality standard (0 <PIj ≤ 1.0). The sampling location 4 has the acidity (pH) that meets the quality standard based on Government Regulation No. 82/2001.

Based on the pollution index calculation, the status of water quality at this station is at 1.19 which means that groundwater at this point is classified as lightly polluted (1, 0 <PIj ≤ 5.0). The sampling location 5 has acidity level (pH) which still meets the quality standard based on Government Regulation Number 82 the Year 2001. Based on the calculation of the pollution index, the status of water quality at this station is at number 1.39 which means that groundwater at this point is classified as lightly contaminated 1.0 <PIj ≤ 5.0). The sampling location 6 has acidity (pH) that meets the quality standard based on Government Regulation Number 82 the Year 2001. Based on the calculation of pollution index, the status of water quality at this station is at 2.69 which means that groundwater at this point is classified as lightly polluted (1, 0 <PIj ≤ 5.0). The sampling location 7 has an acidity level (pH) that meets the water quality standard based on Government Regulation No. 82 of 2001. Based on the calculation of the pollution index, the status of water quality at this station is at 1.22 which means that groundwater at this point is classified as polluted light (1.0 <PIj ≤ 5.0).

## V. CONCLUSION

Based on the results and research analysis, the following conclusions can be drawn:

1. The effect of nickel mining on groundwater in the area around the nickel mining area does not indicate any significant effect, the presence of Cr6+ which passes the water quality standard is caused by the peridotite ultramafic rock, and supported by the presence of chromium minerals (Cr2O3) in the saprolite zones in the laterite zonation.

2. Based on the calculation of the pollution index, groundwater quality is classified as lightly contaminated. Groundwater quality of this area is divided into 2 levels of contamination that meet the standard of quality and is contaminated lightly. Groundwater that meets the water quality standard is located at station 2 and station 3. The lightly contaminated classified groundwater is located at station 1, station 4, station 5, station 6, and station 7.

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