

# ANALYSIS OF THE EFFECT OF SOIL WATER TAKING ON POTENTIAL OF SOIL WATER POLLUTION IN SEMARANG

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## ABSTRACT

*The city of Semarang is located on the beach and has a unique topography because it is divided into lowlands and highlands. To meet freshwater needs, groundwater extraction is generally carried out of confined aquifers. Related to population growth in urban coastal areas, has direct relationship with groundwater extraction to meet the needs of population activities such as industrial activities, services, and trade. The purpose of this study was to identify groundwater pollution with indicators of the content of chloride (Cl) concentrations in confined aquifers. This study uses quantitative descriptive analysis through survey techniques. In 2013, five out of seven villages experienced sea water intrusion with the highest chloride (Cl) levels of 293 mg/L in Sekayu, and in Panggung Kidul Village with the highest chloride of 2,020 mg/L was found. In this study of how intrusion on confined aquifers must be controlled using efficiency programs in water management.*

**Kata kunci:** *Population, groundwater extraction, sea water intrusion.*

## INTRODUCTION

According to Hadi (2013), the relationship between humans and the environment in the first decade of the human soul is harmony as part of the environment, so behavior is a balance with the rhythm of nature. As the human population increases with the development of technology and the need to improve, that person is no longer part of the environment, because people want to control nature. This characteristic causes damage to nature often regarded as an environmental disaster, in this case groundwater pollution.

Krugman (2009), dividing economic growth in 3 eras, namely the period from 1980 to 1990 is referred to as the era of trade which is the dominant factor of economic growth. Meanwhile in the 1990s to 2000, it

was called the information and technology era which was marked by the emergence of company-based information and communication technology. And finally in 2000 to 2020 was called the era of global warming. In this era, industries must make efforts to protect the environment from the exploration of natural resources and energy including the use of fresh water. Purwanto (2013) identifies that the use of natural resources in large quantities by ignoring environmental balance will have a negative effect and occur in a short time as an acute condition and occur continuously for a long time and will result in chronic conditions.

Groundwater extraction, especially from limited aquifers in the city of Semarang, increases with freshwater needs, which is characterized by an increase in

population. From the research it is known that the quality of groundwater in some areas in the city of Semarang has decreased, especially from the Chloride parameter which shows the number has increased. This needs to be studied whether the increase in pollution of groundwater due to sea water intrusion is related to the increase in the amount of content of chloride concentrations in groundwater due to the high demand for freshwater residents.

## **RESEARCH METHOD**

### **Location And Time Of Research**

The research was conducted in the city of Semarang, especially in several locations of drill wells in 2013.

### **Research Design**

This type of research is quantitative research using survey techniques and presented in analytical descriptions. The survey was conducted in several areas in the city of Semarang, especially in bore wells, where groundwater quality was the subject of research such as the content of the concentration of Chloride (Cl) which serves as an indicator of intrusion of the sea. Chloride concentration standards use the Minister of Health Regulation on drinking water quality standards PERMENKES. 492 / MENKES / PER / IV / 2010 [5].

### **The Scope Of Research**

The scope of this study is to measure the parameters of Chloride in groundwater from a limited aquifer managed by the Department of Energy and Mineral Resources in Central Java, Measuring the concentration of Chloride (Cl) in groundwater then comparing it with the standard quality

of Chloride to determine the condition of groundwater intrusion the sea. If the concentration of Chloride in groundwater exceeds 250 mg/L it is said that the groundwater has been contaminated by sea water.

### **Population and Samples**

The study population was wells in coastal areas of Semarang, while the method of sampling was purposive sampling of deep wells located on the ground altitude of less than 3 MSL.

### **Research Variable**

The dependent variable of this research is Chloride (Cl) in mg/L, and the independent variable is time (t) in year. Besides, there are some other variables like ground retardation factor (R), diffusion coefficient (D) and the velocity of groundwater flow (v).

### **Data Processing**

The concentration of Chloride (Cl) in mg/L in time and distance in km concentration of Chloride (Cl) data, it will be found to form a valid model to study local conditions.

## **RESULTS AND DISCUSSION**

### **General Conditions of the Research Area**

Semarang is located between 6 ° 50 'to 7 ° 10' South Latitude and 109 ° 35 'to 110 ° 50' East Longitude, bordered on the west by Kendal, in the east with Demak, in the south by Ungaran, and on north with the Java sea with a coastline of 13.6 km. This area of around 65.22% is coastal area, and the remaining around 34.88% is mountainous area with a height of 15% to 40%.



**Figure 1.** Research Area of Semarang

### Total Population

The population in the city of Semarang tends to increase along with the increase in time, in 1992, the population was as big as 1,181,394 people, then in 1994 the population became 1,228,060 people, in 2000, the population was 1,309,667 Soul, and in 2013 the population in the city of Semarang became 1,572,105 people. For more detailed data of the population from 1992 to 2013 are shown as follows:

**Table 1.**

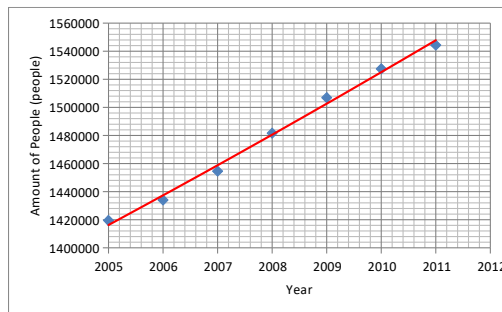
The condition of seawater intrusions in the Confined Aquifer

Well Control	Cl (mg/L) at year					
	1992	1994	1996	1998	2000	2013
Panggung Kidul	614.2	912.5	760.5	903.0	898.2	1,200.6
Tawang Mas	215.2	524.9	663.6	774.7	885.9	924.4
Simongan	17.0	27.9	27.2	23.8	17.0	22.4
Kaligawe	125.0	210.9	249.8	435.3	246.7	375.1
Sekayu	207.7	215.2	210.6	253.2	246.2	252.4
Gayamsari	172.8	153.8	164.1	152.3	137.5	164.1
Bandarharjo	193.6	201.1	321.3	375.2	431.8	367.2

Source : Survey 2013.

Table 1. presents that the salinity condition in the coastal area in Semarang identified by amount of Chloride (Cl) in Panggung Kidul aquifer had Cl more than 250 mg/L in 1992 up to 2013, Tawang Mas aquifer had Cl more than 250 mg/L in 1994 up to 2013, Simongan aquifer had Cl less than 250 mg/L to 2013, Kaligawe aquifer had Cl more than 250 mg/L after 1998, Sekayu aquifer had Cl more than 250 mg/L after 2008, Gayamsari aquifer had Cl less than 250 mg/L up to 2013, and Bandarharjo aquifer had Cl more than 250 mg/L

after 1996. Some deep well which has elevation less than 3 MSL and located in about 5 km from coastline have amount high chloride. The coastal area that is potential had seawater intrusion increasing up to 54.5 % from the whole study area i.e. 10,448.6 ha. This data describe that the groundwater management in some areas with the radius about 5 km from the coastline need the serious controll effort. Some correlated factors with the condition of seawater intrusion in Semarang such as: the increasing people population have the correlation level about 96.7%. Amount of population in Semarang per year are increasing as shown in Figure.2.



**Figure 2.** Population in Semarang

### Chloride (Cl) Concentration In Groundwater

In the condition where there is no groundwater pumping, the result showed that the distance of the Drill wells to shoreline is proportional to the velocity of groundwater flow. Thus, the farther the location of the drill wells, the lower the rate of groundwater flow is mixed with sea water in confined aquifer with the condition of not the pumping of groundwater, soil bulk density of confined aquifer are higher. The diffusion coefficient equal to  $20.3 \times 10^{-9}$  m<sup>2</sup>/sec, a velocity of groundwater flow that carries high Chloride concentrations exceeded the distance of 2.16 m/yr up to 3.35 m/yr. In the

condition of the pumping of groundwater, shows that the distance of the drill wells to coastal line is proportional to the velocity of the groundwater flow. Generally, a model of seawater intrusion is developed from advection-diffusion equations with a new variable is rate freshwater pumping.

$$\frac{\partial Cl}{\partial t} = -\frac{v_x}{R} \frac{\partial Cl}{\partial x} + \frac{D_x}{R} \frac{\partial^2 Cl}{\partial x^2} - \frac{v_z}{R} \frac{\partial Cl}{\partial z} + \frac{D_z}{R} \frac{\partial^2 Cl}{\partial z^2}$$

The dependent variable of this research is Chloride (Cl) in mg/L, and the independent variable is time (t) in year, ground retardation factor (R), diffusion coefficient (D) and the velocity of groundwater flow (v).

## CONCLUSION

1. The rate of level in seawater intrusion in confined aquifers is about 36 m to 60 m per year from the coastline.
2. In conditions of freshwater pumping, the bulk density soil on confined aquifer will be decrease and cause soil degradation.
3. Water management must to conserve groundwater troughly reduce, reuse, and recycle freshwater.

## REFERENCES

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