Aquifer characteristic and groundwater hydrochemistry around South Cipete, DKI Jakarta Province, Indonesia

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Abstract. South Cipete area is a highly populated area, where the extraction of groundwater is very intensive, so that the allocation of groundwater has decreased in term of quality and quantity. The purpose of this study is to determine the type of aquifer and groundwater hydrochemistry. Research methods are including field observations, groundwater sampling, physical properties measurement and chemical analysis of the main ions. Based on the northwest-southeast cross section of lithology log, the aquifer types are: stressed aquifers composed of silt and sandstones; semi-stressed aquifers composed of clays and conglomerates at depths of 10 m to -15 m. From the southwest-northeastern cross section, the type of aquifer is: stressed aquifer composed of sandstones with clay; free aquifer buried by backfill materials and silt soils; and semi-stressed aquifers, surrounded by silt and clay sandstones. at the depths of ± 23 m to ± 3 m. Groundwater hydrochemistry in the sample SG/02, SG/04, SG/08 the dominant cations and anions are Na⁺ with a value of 56.56%; 57.13%; 25.03% and HCO₃⁻ at 26.91%. While in sample SG/06, SG/07 the dominant cations and anions are Mg²⁺ at 25.81%; 24.52% and anions SO₄²⁻ at 32.70%; 30.96%.

1. Introduction

In aquifer systems, hydrochemical characteristics can be used to analyze the environmental process that occur in groundwater, analyze the types of rocks that predominantly affect water chemistry, groundwater fill conditions, the amount of groundwater that is in an aquifer, sources of mineralization that occur, natural and artificial contaminants [1]. The main ion content, Na⁺, Ca²⁺, Mg²⁺ and K⁺ will provide an understanding of the hydrogeological process that affect groundwater chemistry in the basin [2].

An understanding of the chemical process that affect groundwater chemistry in the Basin will understand the relationship between groundwater chemistry, geological conditions, and groundwater flow systems, and determine the characteristics and distribution of aquifers in the area [3]. Hydrochemical characteristics of groundwater can be analyzed based on the concentration of the main cations and anions to determine the hydro chemical facies. To support sustainable groundwater resources management, it is necessary to integrate the various data and make a thorough analysis to deepen understanding of the complex groundwater flow patterns and hydrogeochemical characteristics in the plain [4].

By understanding these processes, it is very important to know the factors that control groundwater quality caused by chemical aspects of groundwater [5]. Groundwater flow systems are mainly controlled
by physiographical factors (topography and climate), geological factors (lithologic structure) and anthropogenic factors [6]. Many studies have proven that hydro chemical characteristics can effectively indicate groundwater recharge (or mixing) and geochemical evolution processes [7,8].

South Cipete area is a highly populated area, where the extraction of groundwater is very intensive, so that the allocation of groundwater has decreased in term of quality and quantity. The purpose of this study is to determine the type of aquifer and groundwater hydrochemistry.

2. Material and methods
Research locations are located in South Cipete and surrounding areas, Cilandak District the Municipality of South Jakarta, DKI Jakarta Province. Geographically the research area is located at 6°15'49.10"S 106°47'19.60"T - 6°16'49.8"S 106°48'53.30"T. The research area is composed of alluvial deposits (QA) composed of clays, silt, sand, gravel, crust, and lumps. Around Holocene in age, and the alluvial (Qav) fan, fine layered tuffs, sandy tuff, alternating with conglomerate tuff. Around Plistocene in age [9].

Research methods are including field observations, groundwater sampling, physical properties measurement and chemical analysis of the main ions as well as description and correlation of drill log data. The research methodology used is the field hydrogeology method accompanied by sampling water samples for hydro chemical analysis in the laboratory. Observation and sampling were performed on five dug wells, namely SG/02, SG/04, SG/06, SG/07 and SG/08. Analysis of the main ion content (Mg\(^+\), Ca\(^+\), Na\(^+\), K\(^+\), Cl\(^-\), SO\(_4^{2-}\) and HCO\(_3^-\)) was chemistry laboratory.

3. Results and discussion
Subsurface geological conditions to determine the type of aquifer, drill log analysis is performed based on cross section A-B which is trending northwest-southeast and cross section C-D trending southwest-northeast (Figure 1).

![Figure 1. Cross section drill map [10].](image)

Based on cross section A-B can be identified, that the subsurface geology is composed of rocks in the form of silt, clay, sandstone and conglomerates. Types of aquifers that can be identified based on this lithology log are free aquifers composed of silt on the upper part boundary layer; depressed aquifers composed of silt on the upper part and sandstone the lower boundary layer; and semi-depressed aquifers are composed of clay and conglomerates in the upper layers with a depth of 10 m to -15 m (Figure 2).
In the log path of the southwest-northeastern cross section (C-D), lithology was found in the form of silt, clay, silty sand, sand and conglomerate (Figure 3). The aquifer type based on the C-D lithology log is a depressed aquifer composed by sandstones with clays as the upper and lower boundary layers. Free aquifer whose upper layers are composed by poor soil and lower layers by silt. Semi-stressed aquifer, the upper part is limited by silt sandstone with the bottom part by clays, with depth of ± 23 m to ± -3.

After chemical analysis of cations and anions by the laboratory for groundwater samples from SG/02, SG/04, SG/06, SG/07 and SG/08, researchers get elemental values in mg/l units, which are then converted to meq/l units and percentages (Table 1).
The following details the value of anion and cation elements in percentage units (Table 2). Analysis can be accepted, if the error balance of the ions (Cation & Anion) <5% [11].

$e = \frac{(rc-ra)}{rc+ra} \times 100\%$

Table 2. Percentages of cations and anions [10].

| Cations | Percentages (%) | SG/02 | SG/04 | SG/06 | SG/07 | SG/08 |
|---------|-----------------|-------|-------|-------|-------|-------|
| Ca$^{2+}$ | 27.26 | 24.38 | 18.88 | 19.77 | 9.71 |
| Mg$^{2+}$ | 21.84 | 17.53 | 22.35 | 20.88 | 10.29 |
| Na$^+$ | 33.99 | 21.23 | 14.33 | 16.14 | 16.93 |
| K$^+$ | 22.57 | 35.90 | 13.89 | 16.93 | 10.72 |

| Anions | Percentages (%) | SG/02 | SG/04 | SG/06 | SG/07 | SG/08 |
|--------|-----------------|-------|-------|-------|-------|-------|
| Cl$^-$ | 25.95 | 22.57 | 23.67 | 14.40 | 13.42 |
| SO$_4^{2-}$ | 18.19 | 12.93 | 22.35 | 26.06 | 5.22 |
| HCO$_3^-$ | 26.91 | 26.91 | 26.91 | 26.91 | 26.91 |

For percentages of cations SG/04, Ca$^{2+}$ has a value of 24.38%, Mg$^{2+}$ has a value of 17.53%, Na$^+$ has a value of 21.23%, K$^+$ has a value of 35.90%. Percentages of anions Cl$^-$ has a value of 22.57%, SO$_4^{2-}$ has a value of 18.19% and HCO$_3^-$ have a value of 26.91%. It can be concluded that for SG/04 the dominant cations and anions are Na$^+$ and HCO$_3^-$ ions, based on highest value of percentages ions cation-anion.

For percentages of cations SG/06, Ca$^{2+}$ has a value of 18.88%, Mg$^{2+}$ has a value of 25.81%, Na$^+$ has a value of 14.33%, K$^+$ has a value of 13.89%. Percentages of anions Cl$^-$ has a value of 23.67%, SO$_4^{2-}$ has a value of 32.70%, HCO$_3^-$ has a value of 26.91%. For SG/06 cations and the dominant anions are Mg$^{2+}$ and SO$_4^{2-}$ ions.

For percentages of cations SG/07, Ca$^{2+}$ has a value of 19.77%, Mg$^{2+}$ has a value of 24.52%, Na$^+$ has a value of 16.14%, K$^+$ has a value of 16.93%. Percentages of anions Cl$^-$ has a value of 14.40%, SO$_4^{2-}$ has a value of 30.96%, and HCO$_3^-$ has a value of 26.91%. For SG/07 the dominant cations and anions are Mg$^{2+}$ and SO$_4^{2-}$ ions.

For percentages of cations SG/08, Ca$^{2+}$ has a value of 9.71%, Mg$^{2+}$ has a value of 10.29%, Na$^+$ has a value of 14.31%, K$^+$ has a value of 10.72%. Percentages of anions Cl$^-$ has a value of 13.42%, SO$_4^{2-}$...
has a value of 5.22%, HCO$_3^-$ has a value of 26.91%. For SG/08 cations and the dominant anions are Na$^+$ and HCO$_3^-$ ions.

4. Conclusion
Based on the northwest-southeast cross section of lithology log, the aquifer types are: stressed aquifers composed of silt and sandstones; semi-stressed aquifers composed of clays and conglomerates at depths of 10 m to -15 m. From the southwest-northeastern cross section, the type of aquifer is: stressed aquifers composed of sandstones with clay; free aquifer buried by backfill materials and silt. Soils; and semi-stressed aquifers, surrounded by silt and clay sandstones, at the depths of ± 23 m to ± 3 m.

Groundwater hydrochemistry in the sample SG/02, SG/04 and SG/08 the dominant cations and anions are Na$^+$ + K$^+$ with a value of 56.56%; 57.13%; 25.03% and HCO$_3^-$ at 26.91%. While in sample SG/06 and SG/07 the dominant cations and anions are Mg$^{2+}$ at 25.81%; 24.52% and anions SO$_4^{2-}$ at 32.70% and 30.96%.

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