Analysis of The Season Effect on The Shallow Ground Water Parameters using Multivariate Statistics

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Abstract. Problems related to water resources are still a major concern in some regions in the tropical climate. The effect of seasonal changes on the physical parameters of water quality is quite clearly visible. This certainly can pose a serious risk if it takes place in the long term towards human health and the environment without conducting intensive studies. The approach of this study is to draw the relationship between seasonal changes and physical parameters of water quality in 185 points spread across 11 sub-districts. Water parameter data was analyzed using multivariate statistics. Based on multivariate analysis in the dry season, the regression equation $Y = 343.482 X_1 + 0.039 X_2 - 0.016 X_3 + 12.961 X_4 + 124.773 X_5 - 815.208$ and rainy season $Y = 273.119 X_1 + 0.025 X_2 + 0.336 X_3 + 15.731 X_4 + 39.731 X_5 - 745.119$ (X1 salinity, X2 resistivity, X3 depth, X4 TDS, and X5 temperature, with bound parameters or Y is conductivity). Based on the health standards of the Indonesia Health Ministry concluded that regions showed the zone of extreme changes is close to the coast.

Keywords: Season, Water Quality Parameters, Multivariate.

Introduction
Source of clean water is a water supply system that can be in the form of sea water, river water, lakes, and the most frequently encountered in the community is well water, both dug wells and boreholes. Climate change can affect the quality and quantity of groundwater, by calculating seasonal averages and annual groundwater levels we can calculate the quality and quality of groundwater depending on one component, namely the distribution of rainfall and melting snow.

The effect of the season on water quality parameters, during the rainy season the salinity will decrease, because the empty ground water will be replenished, and encourage sea water intrusion out of the groundwater zone, while in the dry season the salinity will rise again. The change in salinity parameters, the elements of other physical water parameters will also change, such as TDS, resistivity, conductivity. Seeing conditions like this, it is very clear in this case indicating an indication of the influence of the season on well water. Conductivity depends on water temperature and salinity / TDS. Water flow and changes in water level can also contribute to conductivity through its impact on salinity. Water temperature can cause fluctuating conductivity levels every day. The water level in the well can have different conductivity values at different depths.

Measurements were made at 185 sample points / wells, with random sampling methods, and samples were considered the same in one area. In this study the authors conducted a linear regression analysis, non linear, Correlation and multiple regression analysis and conducted the T test and F test using...
Statistic Analysis
Analysis is used to see trends in the pattern of distribution of a data set. Based on this statistical analysis can be explained the relationship / correlation and trend / trend data so that an assessment method can be determined in accordance with the pattern of data distribution that is owned. The statistical analysis that is commonly used is:

1.1. Simple Linear Regression Analysis
Linear regression analysis is a linear relationship between one independent variable (x) and the dependent variable (y). This analysis is to determine the direction of the relationship between independent variables with the dependent variable whether positive or negative and to predict the value of the dependent variable if the value of the independent variable increases or decreases. Data used is usually interval or ratio scale.\[^1\][^2][^3]

The simple linear regression formula is:

\[
Y' = a + bX
\]  \hspace{1cm} (1)

Description:

Y’ = dependent variable (predicted value)
X = independent variable
a = constant (Y value if X = 0)
b = regression coefficient (value of increase or decrease)

The values of a and b can be calculated as follows:

\[
a = \frac{(\Sigma y)(\Sigma x^2) - (\Sigma x)(\Sigma xy)}{n\Sigma x^2 - (\Sigma x)^2} \hspace{1cm} (2)
\]

\[
b = \frac{\Sigma xy - (\Sigma x)(\Sigma y)}{n \Sigma x^2 - (\Sigma x)^2} \hspace{1cm} (3)
\]

1.2. Multiple Linear Regression Analysis
Linear regression analysis is a linear relationship between two or more independent variables (x1, x2, x3, ..., xn) with the dependent variable (y). This analysis is to determine the direction of the relationship between the independent variable and the dependent variable whether each independent variable is positively or negatively related to predict the value of the dependent variable if the value of the independent variable increases or decreases. Data used is usually interval or ratio scale.\[^1\][^2][^3][^4]

The multiple linear regression equation is as follows:

\[
Y' = a + b_1X_1 + b_2X_2 + \ldots + b_nX_n \hspace{1cm} (4)
\]

Description:

Y’ = dependent variable (predicted value)
X1 and X2 = independent variable
a = constant (Y value if x1, x2... xn = 0)
b = regression coefficient (value of increase or decrease)

1.3. T Test
This test is used to determine whether in the independent variable model (x1, x2, ... xn) partially has a significant effect on the dependent variable (y).\[^1\]

The t-count formula in the regression analysis is:

\[
T_{test} = \frac{b_i}{S_{bi}} \hspace{1cm} (5)
\]

Description:

b = Variable regression coefficient i
Sb = standard error i

Or can be searched by the formula as follows:

$$T_{Test} = \sqrt{n-k-1} \sqrt{1-r^2}$$

(6)

Description:

- $r$ = description of simple correlation
- $n$ = number of data or case

1.4. F Test

This test is used to determine whether the independent variables ($x_1, x_2, ... x_n$) together have a significant effect on the dependent variable ($y$), or to find out whether the regression model can be used to predict the dependent variable or not. Significant means that the relationship that occurs can apply to the population (can be generalized).[^2]

$$F_{Test} = \frac{R^2/k}{(1-R^2)/(n-k-1)}$$

(7)

Description:

- $R^2$ = coefficient of determination
- $n$ = number of data or case
- $k$ = number of independent variables

Research Method

Data collection is located in Padang City, with its administration in 11 sub-districts of Padang City, data was taken as many as 185 measurement points, in 2 (two) data collection times, namely during dry season and during rainy season at the same location. Each parameter is being compared (salinity, conductivity, TDS, Resistivity, temperature and temperature) during the dry and rainy seasons. The coefficient correlation between the parameters has aim to see how much the variables are related, whether during dry or rainy season. The value of the t-test and the f-test between the variables examined, to answer the hypothesis rejected or accepted.

Results and Discussion

1.5. Dry Season

The results of statistics analysis in dry season can be seen in Table 1, Table 2, and Table 3. The equation that describes relationship the independence variable (conductivity) and independence variables (salinity, resistivity, TDS, water temperature, and depth) is:

$$Y = 343.482 X_1 + 0.039 X_2 - 0.016 X_3 + 12.961 X_4 + 124.773 X_5 - 815.208$$

Description: ($Y$ (Conductivity), $X_1$ (Salinity), $X_2$ (Resistivity), $X_3$ (TDS), $X_4$ (Water Temperature), $X_5$ (Water depth))

The specific result equation is shown in Table 1.
Table 1. Coefficient analysis in dry season

\[
\begin{array}{cccccc}
\text{Model} & \text{Unstandardized Coefficients} & \text{Standardized Coefficients} & t & \text{Sig.} \\
\text{1 (Constant)} & -815.208 & 575.155 & -1.417 & .158 \\
\text{Resistivitas} & 0.009 & 0.729 & 4.551 & .000 \\
\text{Kedalaman} & -124.773 & 74.872 & -0.024 & 1.666 & .097 \\
\text{TDS} & 0.016 & 0.803 & -0.012 & -0.412 & .681 \\
\text{Salinitas} & 343.482 & 96.584 & 1.019 & 34.471 & .000 \\
\text{Temperatur} & 12.961 & 19.190 & 0.109 & .654 & .514 \\
\end{array}
\]

\textit{Note:} Dependent Variable: Kondalivitas

Table 2. T Test during Dry Season.

| Variabel   | Dependent | Independent | T value | Conclusion              | Significant |
|------------|-----------|-------------|---------|-------------------------|-------------|
| Conductivity |           |             |         |                         |             |
| Salinity   | ✓         |             | 34.471  | H0 rejected H1 accepted | 0           |
| Resistivity| ✓         |             | 4.551   | H0 rejected H1 accepted | 0           |
| TDS        | ✓         |             | -0.412  | H0 accepted H1 rejected | 0.681       |
| Temperatur | ✓         |             | 0.654   | H0 accepted H1 rejected | 0.514       |
| Depth      | ✓         |             | 1.666   | H0 accepted H1 rejected | 0.097       |

Ttest of salinity is bigger than Ttable (34.471 > 1.973) and Ttest of resistivity is bigger than Ttable (4.551 > 1.973) then H0 is rejected, meaning that partially there is a significant influence between salinity and resistivity with conductivity. So, it can be concluded that partially salinity and resistivity have a positive effect on the conductivity value during the dry season. For Ttest of TDS is smaller than Ttable (-0.412 < 1.973), Ttest of temperature is smaller than Ttable (0.654 < 1.973), and Ttest of depth is smaller than Ttable (1.666 < 1.973) then H0 is accepted. This meaning that there is no significant influence between TDS, temperature and depth of conductivity. So it can be concluded that partially TDS has a negative effect on the value of conductivity, and partially temperature and depth, have a positive effect on conductivity even though the correlation is very weak during the dry season.

Table 3. F Test during Dry Season.

| Variabel   | Terikat | Bebas | F value | Conclusion              |
|------------|---------|-------|---------|-------------------------|
| Conductivity | ✓       |       | 934.938 | H0 rejected H1 accepted |
| Salinity   | ✓       |       | 934.938 | H0 rejected H1 accepted |
| Resistivity| ✓       |       | 934.938 | H0 rejected H1 accepted |
| TDS        | ✓       |       | 934.938 | H0 rejected H1 accepted |
| Temperatur | ✓       |       | 934.938 | H0 rejected H1 accepted |
| Depth      | ✓       |       | 934.938 | H0 rejected H1 accepted |

The conclusions from Table 3, Ftest is 934.94 while for Ftable is 2.265. Because of Ftest is larger than Ftable (934.94 > 2.265) then H0 is rejected, it is mean that there is a significant influence between...
salinity, resistivity, TDS, water temperature, and water depth to conductivity. So from this case it can be concluded that salinity, resistivity, TDS, water temperature, and water depth together have the same effect on conductivity during the dry season.

1.6. Rainy Season

The results of statistics analysis in rainy season can be seen in Table 4, Table 5, and Table 6. The equation that describes relationship the independence variable (conductivity) and independence variables (salinity, resistivity, TDS, water temperature, and depth) is:

\[ Y = 273.119 X_1 + 0.025 X_2 + 0.336 X_3 + 15.731 X_4 + 39.731 X_5 - 745.119 \]

**Description:** (\( Y \) (Conductivity), \( X_1 \) (Salinity), \( X_2 \) (Resistivity), \( X_3 \) (TDS), \( X_4 \) (Water Temperature), \( X_5 \) (Water depth))

The specific result equation is shown in Table 4.

**Table 4. Coefficient analysis in rainy season**

| Model | Unstandardized Coefficients | Standardized Coefficients |
|-------|-----------------------------|---------------------------|
|       | B   | Std. Error | Beta | t   | Sig |
| 1     | -745.119 | 494.618 | 0.1506 | 1.34 |
| Salinity | 273.167 | 6.755 | 0.4043 | 0.00 |
| Resistivity | 0.25 | 0.05 | 0.056 | 4.732 | 0.00 |
| TDS | 3.66 | 0.41 | 0.182 | 8.000 | 0.00 |
| Kedalanan | 18.48 | 4.205 | 0.10 | 0.02 | 0.36 |
| Temperatur | -18.71 | 17.254 | 0.10 | 0.91 | 0.36 |

a. Dependent Variable: Konduktivitas

**Table 5. T Test during Rainy Season**

| Variabel | Dependent | Independent | T Test | Conclusion | Significant |
|----------|-----------|-------------|--------|------------|-------------|
| Conductivity | ✔️ | ✔️ | 40.37 | 1.973 | H0 accepted H1 rejected | 0.364 |
| Salinity | ✔️ | ✔️ | 4.752 | 1.973 | H0 accepted H1 rejected | 0.00 |
| Resistivity | ✔️ | ✔️ | 8.9 | 1.973 | H0 rejected H1 accepted | 0.364 |
| TDS | ✔️ | ✔️ | 0.902 | 1.973 | H0 accepted H1 rejected | 0.364 |
| Temperatur | ✔️ | ✔️ | 0.91 | 1.973 | H0 accepted H1 rejected | 0.364 |

T-test of salinity is bigger than Ttable (40.37 > 1.973), T-test of resistivity is bigger than Ttable (4.752 > 1.973) T-test of TDS is bigger than Ttable (8.9 > 1.973) then H0 is rejected. Meaning that there is a significant influence between salinity, resistivity, TDS with conductivity. So it can be concluded that partially salinity, resistivity and TDS have a positive effect on the value of conductivity during the rainy season.

For T-test of temperature is smaller than T table (0.902 <1.973), and T-test of depth is smaller than Ttable (0.91 < 1.973) then H0 is accepted. It is mean that partially there is no significant effect between temperature and depth on conductivity. So it can be concluded that partially the temperature and depth have no effect and the correlation is positive for the conductivity value, even though the correlation is very weak during the rainy season.
### Table 6. F Test during Rainy Season.

| Variabel | Terikat | Bebas | F value | Conclusion |
|----------|---------|-------|---------|------------|
| Conductivity | ✓ | | 0.0017 | 2.265 | H0 accepted H1 rejected |
| Salinity | ✓ | | 0.0017 | 2.265 | H0 accepted H1 rejected |
| Resistivity | ✓ | | 0.0017 | 2.265 | H0 accepted H1 rejected |
| TDS | ✓ | | 0.0017 | 2.265 | H0 accepted H1 rejected |
| Temperature | ✓ | | 0.0017 | 2.265 | H0 accepted H1 rejected |
| Depth | ✓ | | 0.0017 | 2.265 | H0 accepted H1 rejected |

The conclusions from Table 6, Ftest is 0.0017 while for Ftable is 2.265. Because of Ftest is smaller than Ftable (0.0017 < 2.265) then H0 is accepted, it is mean that there is no significant influence between salinity, resistivity, TDS, water temperature, and water depth to conductivity. So from this case it can be concluded that the salinity, resistivity, TDS, water temperature, and water depth together do not affect conductivity during the rainy season.

### Conclusions

- The equation of conductivity parameter as dependence variable and salinity, resistivity, TDS, temperature, depth as independence variable in dry and rainy seasons chronologically:
  - Y = $343.482 X_1 + 0.039 X_2 - 0.016 X_3 + 12.961 X_4 + 124.773 X_5 - 815.208$ (dry season)
  - Y = $273.119 X_1 + 0.025 X_2 + 0.336 X_3 + 15.731 X_4 + 39.731 X_5 - 745.119$ (rainy season)
- Ttest in dry season, salinity and resistivity have a positive effect on the conductivity beside that TDS has a negative effect on the value of conductivity, and partially temperature and depth, have a positive effect on conductivity even though the correlation is very weak.
- Ftest in dry season, there is a significant influence between salinity, resistivity, TDS, water temperature, and water depth to conductivity. So from this case it can be concluded that salinity, resistivity, TDS, water temperature, and water depth together have the same effect on conductivity.
- Ttest in rainy season, salinity, resistivity and TDS have a positive effect on the value of conductivity during the rainy season. Beside that temperature and depth have no effect and the correlation is positive for the conductivity.
- Ftest in rainy season, there is no significant influence between salinity, resistivity, TDS, water temperature, and water depth to conductivity. So from this case it can be concluded that the salinity, resistivity, TDS, water temperature, and water depth together do not affect conductivity during the rainy season.

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