Application of soil and water conservation techniques based on community typologies in Bonto Saile watershed, Selayar island district

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Abstract. These research purposes were to identify and to know the relationship between the application of soil and water conservation techniques with the typologies of the community in the Bonto Saile watershed Selayar district. The research was conducted from September to November 2017, which located in Benteng and Bontoharu districts. The data were collected from direct observation and interviews with respondents by using questionnaires and snowball sampling techniques. The data collected including age, level of education, level of income, number of dependents, and the area of cultivated land. The data were analyzed with the Chi-Square test ($X^2$). The research found that the methods used for soil and water conservation techniques were vegetative techniques and mechanical techniques. Vegetative techniques included the use of crop residues, use of yard, and mixed gardening. While mechanical techniques were the bench terrace and the ridge terrace. Secondly, there is no significant relationship between the typology with the application of soil and water conservation techniques.

1. Introduction

Land and water are the primary natural resources which are very influential for living things on earth, especially for humans. Both of these natural resources are increasingly limited natural resources, making this resource as high-value. The community's need for land as a place to live is increasing from year to year and not proportional to the availability of land, which will cause exploitation of land that will exceed the carrying capacity and causing degradation [1].

Degraded land will cause increasingly widespread forest damage, the expansion of critical land areas, and critical watersheds [2]. Land damage and impact of erosion in watersheds are murky river water, silting of rivers and reservoirs, leaching of soil nutrients, and declining land productivity.

The Bonto Saile watershed has an area of 1,806.06 ha, which covers two districts, Bontoharu and Benteng Districts. This watershed has a vital role in the lives of people, both upstream and downstream of the watershed [3]. Furthermore, Muhajirin (2015) [3] stated that the Bonto Saile watershed has a height between 1 to 407 meters above sea level, with the classification of land use in the form of secondary dryland forests, mixed dryland agriculture, shrubs, residential area, and secondary mangrove forests.

From a study conducted by Muhajirin (2015) [3] that land use in the form of secondary dryland forests, mixed dryland agriculture, and shrubs have a critical status. These conditions showed that proper soil and water conservation techniques are not applied. Several things can affect soil and water conservation actions in the community, such as age, level of education,
level of income, number of family members, and area of land under cultivation. Data and information about community typologies that influence the application of soil and water conservation techniques at the research site are still inadequate. In connection with that, it is necessary to conduct more in-depth research on the application of soil typology and water conservation techniques based on community typologies in the Bonto Saile watershed in the Selayar Islands, South Sulawesi.

The purpose of this research was to identify soil typology and water conservation techniques in the Bonto Saile watershed and to determine the relationship between the application of soil and water conservation techniques and community typologies. This research can be used as information material for the community. It can be used as recommendations and considerations in determining policies for local governments in order to maintain the right catchment conditions in the Bonto Saile watershed in the Selayar Island district.

2. Research methodology

2.1. Data collection method
There were two types of data collected in this research, namely primary and secondary data.

2.2. Primary data
Primary data were obtained through direct observation in the field, both through surveys and interviews with the community. Direct observation in the field was carried out with the following stages:

2.2.1. Determined the number of respondents with snowball sampling techniques. This method was carried out by interviewing people who are considered as key informants. Based on the key informants, another informant was interviewed and stopped when the answers from all the informants were almost the same.

2.2.2. Conducted field observations on the application of soil and water conservation techniques applied by the community.

2.2.3. Conducted interviews with respondents regarding the level of soil and water conservation techniques. This interview related to things that influence the level of application of soil and water conservation, such as:
- Age (respondent's age calculated starting from the year of birth until the time the research was carried out).
- Level of education (last formal education of the respondent).
- The number of dependents (all people who live or not with the respondent which covered and funded by the respondent as the head of the family).
- Level of income (Income of the respondents).
- Area of cultivated land (area of land under cultivation by the respondent).

2.3. Secondary data
Secondary data were obtained from agencies related to this research. The data included rainfall data, soil type data, population data, and other data that supported the research.

The overall qualitative data obtained were then converted into quantitative data by giving a score on each respondent's question-answer to determine variables and categories based on the indicators. The results of the scoring data obtained were analyzed with the Chi-Square Test ($X^2$) statistical analysis. Chi-Square Test ($X^2$) is used to analyze qualitative data, especially data in the form of categorical data, to determine whether there is a relationship between data collected. The variables analyzed through the Chi-Square Test ($X^2$), were the typologies of the community (age, level of education, number of dependents, level of income, and area of cultivated land).
with the application of soil and water conservation techniques. The results of the recapitulation of these data relationships revealed factors influenced the community's decision making regarding the implementation of soil and water conservation techniques. Analysis of variables, categories, and indicators related to the application of soil and water conservation techniques shown in Table 1.

**Table 1. Variables, Categories, and Indicators Related to the Application of Soil and Water Conservation Techniques**

| Variable                          | Category                  | Indicator       | Notes                             |
|-----------------------------------|---------------------------|-----------------|-----------------------------------|
| Age                               | Productive (2)            | 15 - 64 years old | Central Bureau of Statistics      |
|                                   | Less productive (1)       | >64 years old   |                                    |
| Level of Education                | High (2)                  | >average        | Primary data analysis             |
|                                   | Low (1)                   | <average        |                                    |
| Number of dependents              | High (2)                  | >5 people       | Central Bureau of Statistics      |
|                                   | Low (1)                   | <5 people       |                                    |
| Area of cultivated land           | High (2)                  | >2 hectare      | National Land Agency              |
|                                   | Low (1)                   | <2 hectare      |                                    |
| Level of income                   | High (2)                  | >average        | Primary data analysis             |
|                                   | Low (1)                   | <average        |                                    |
| Level of Soil and Water Conservation Application | High (2) | ≥15,6          |                                    |
|                                   | Low (1)                   | >15,6           |                                    |

The variables in Table 1 classified into dependent and independent variables. In this case, the dependent variable is the application of soil and water conservation techniques carried out by the community. In contrast, the independent variables are age, education, number of family members, income level, and area of cultivated land.

Descriptive results of the data obtained were analyzed using the Chi-Square test ($X^2$) statistical analysis. Chi-Square Test ($X^2$) is used to see the dependence of independent variables with the dependent variable that is a nominal or ordinal scale.

Chi-Square ($X^2$) test procedure is to tabulate one variable into categories and calculate Chi-Square statistics. For one variable, it is known as the alignment test, which compares the observed frequency ($f_0$) with the expected frequency ($f_e$). The Chi-Square test is generally formulated as follows:

$$X^2 = \sum \frac{(f_0 - f_e)^2}{f_e}$$

Notes:
- $X^2$ = chi square value
- $\Sigma$ = total number
- $f_0$ = observed frequency
- $f_e$ = expected frequency

**Hypothesis:**
- H0 = There is no real relationship between the typology and the application of soil and water conservation techniques.
- H1 = There is a real relationship between the typology and the application of soil and water conservation techniques.

"Reject the null hypothesis (H0) if the significant value of Chi-square <0.05 or the calculated Chi-square value is greater than (>) the value of the Chi-square table."

### 3. Result

#### 3.1. Application of soil and water conservation
From the interviews and observations carried out in Benteng and Bontoharu Districts, there were two soil and water conservation techniques, namely vegetative and mechanical techniques. Vegetative techniques were including the use of crop residue, use of yard, and mixed gardening. While the mechanical technique was making bench and ridge terraces.

3.2. Vegetative technique

3.2.1. The use of crop residue. According to Samiun, the use of crop residue was carried out to add soil nutrients and reduce soil erosion from rainwater directly. The residue used was coconut frond, which placed under the coconut tree (Interview in Putabangun Village, 12 September 2017).

This finding is following the study by [4] showed that the use of crop residues (mulch) was spreading evenly to protect the soil surface from erosion and placed in a pathway to control soil moisture and increase water supply for plants.

![Figure 1. Use of crop residue technique](image1)

3.2.2. Use of yard. The utilization of the yard was carried out to meet the daily needs of the household, such as water spinach and spinach. In addition, this annual crop also commonly sold to increase income for respondents.

![Figure 2. Use of yard technique](image2)

3.2.3. Mixed gardening. Mixed gardening is one of the vegetative techniques performed by planting annual plants and annual crops in the land. A mixture of annual crops with annual plants formed a canopy arrangement to protect the soil from erosion due to falling rain directly and optimizing the use of sunlight, in order to form organic matter in plants.

![Figure 3. Vegetative techniques by planting annual and seasonal plants](image3)

Figure 3 shows annual crops such as banana trees, coconut trees, cassava, and papaya tree planted by respondents.
3.2.4 Mechanical Technique. The application of soil and water conservation technique mechanically by the respondent shown in Figure 4 below.

![Figure 4](image1.png)

**Figure 4.** Mechanical technique through land management by making bench terraces.

Bench terraces were made by the community by cutting slopes and leveling the ground to reduce the speed of surface runoff and the amount of soil loss, and also to increase water infiltration.

![Figure 5](image2.png)

**Figure 5.** Mechanical technique through land management by making ridge terraces in the form of rock ridges.

Similar to bench terrace, the ridge terrace was also made by extending in the direction of contour lines or cutting slopes, which serves to reduce the rate of erosion. The results of the research found that there were several things to consider if the community wanted to apply bench and ridge terraces, such as human resources and higher costs. These would have an impact on the effectiveness both socially and economically.

3.2.5 Community Typology. The typologies of the community in this research were age, level of education, number of dependents, area of cultivated land, and level of income, which subsequently divided according to predetermined categories and indicators.

3.2.5.1 Age. The results of the research on the relationship between the respondent's age and the application of soil and water conservation techniques shown in Table 2.

| Level of Soil and Water Conservation Application | Age       | Total    |
|-----------------------------------------------|-----------|----------|
|                                               | Productive| Less Productive| People | (%) |
| Low                                           | 11        | 11       | 22     | 48.9 |
| High                                          | 14        | 9        | 23     | 51.1 |
| Total                                         | 25        | 20       | 45     | 100.0 |

Table 2 shows that there is no significant difference between respondents with productive and less productive ages in the application of soil and water conservation techniques. The data in Table 2 was then tested using the Chi-Square Test ($X^2$) to determine the level of significance between the age of respondents with the application of soil and water conservation techniques. The results of the tests performed shown in Table 3.
Table 3. Result of Chi-Square ($X^2$) Test of age and application of soil and water conservation techniques

|                         | Value | Df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|-------------------------|-------|----|----------------------|----------------------|---------------------|
| Pearson Chi-Square      | 0.538a| 1  | 0.463                |                      |                     |
| Continuity Correctionb  | 0.188 | 1  | 0.665                |                      |                     |
| Likelihood Ratio        | 0.539 | 1  | 0.463                |                      |                     |
| Fisher's Exact Test     |       |    |                      | 0.554                | 0.333               |
| Linear-by-Linear        | 0.526 | 1  | 0.468                |                      |                     |
| Association             |       |    |                      |                      |                     |
| N of Valid Cases        | 45    |    |                      |                      |                     |

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.78.
b. Computed only for a 2x2 table

In Table 3, it can be seen that the p-value is 0.463, the significance value produced is 0.463, which higher than 0.05, then the null hypothesis (H0) is accepted, means that there is no significant relationship between the age of the respondent and the level of application of soil and water conservation in the field [5]. From the observation result, family members in their productive age prefer to look for other work that provides a higher profit rather than farming. In accordance with the result of the study by Prariwi and Sudrajat (2012) [6] that age affects the performance and energy in managing agricultural land. The older farmers are assumed to have a lower level of performance and labor power compared to younger farmers.

3.2.5.2. Level of Education. The results of the relationship between the level of education and level of application of soil and water conservation techniques presented in Table 4.

Table 4. Cross-tabulation of the level of application of soil and water conservation techniques and level of education

| Level of Soil and Water Conservation Application | Level of Education | Total |
|-----------------------------------------------|--------------------|-------|
|                                               | Low | High | People | (%)  |
| Low                                           | 10  | 12   | 22     | 48.9 |
| High                                          | 10  | 13   | 23     | 51.1 |
| Total                                         | 20  | 25   | 45     | 100.0 |
Table 4 presents that high and low level of educations does not have any influenced on the application of soil and water conservation techniques. Then the results of the cross-tabulation in Table 4 tested with the Chi-Square Test ($X^2$) to determine the level of significance between the level of education with the application of soil and water conservation technique (Table 5).

| Table 5. Result of Chi-Square ($X^2$) Test of the level of education and application of soil and water conservation techniques. |
|---------------------------------------------------------------|
| **Value** | **Df** | **Asymp. Sig. (2-sided)** | **Exact Sig. (2-sided)** | **Exact Sig. (1-sided)** |
| Pearson Chi-Square | .018 | 1 | .894 |
| Continuity Correction$^b$ | .000 | 1 | 1.000 |
| Likelihood Ratio | .018 | 1 | .894 |
| Fisher's Exact Test | 1.000 | 1 | .566 |
| Linear-by-Linear Association | .017 | 1 | .895 |
| N of Valid Cases | 45 | |

- a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.78.
- b. Computed only for a 2x2 table

The significance value of the p-value in Table 5 is 0.894. Because the significance value is 0.894 > 0.05, the null hypothesis is accepted, which means that there is no real relationship between the level of education with the application of soil and water conservation techniques.

In contrast, the study by Lailis Sa'adah (2015) [7] showed that the higher the level of education, the better the application of soil and water conservation techniques, while community with a low level of education showed no effort made in the implementation of soil and water conservation.

The survey and interview results found that their formal educational background did not fully influence respondents who did soil and water conservation techniques. Still, instead, they were influenced by knowledge derived from daily life experiences or influenced by their families, neighbors, markets, or mass media.

3.2.5.3. Number of Dependents. The results of the relationship between a number of dependent on the application of soil and water conservation techniques shown in Table 6.

| Table 6. Cross-tabulation of the level of application of soil and water conservation techniques and number of dependents. |
|---------------------------------------------------------------|
| **Level of Soil and Water Conservation Application** | **Number of dependents** | **Total** |
| | **Low** | **High** | **People** | **%** |
| Low | 14 | 8 | 22 | 48.9 |
| High | 11 | 12 | 23 | 51.1 |
| Total | 25 | 20 | 45 | 100.0 |

Table 6 shows the level of application of soil and water conservation techniques with the number of dependents. There is no significant difference between low and high values. It indicates that the number of family dependents does not affect the application of soil and water conservation techniques.
The data in Table 6 then tested with the Chi-Square Test \((X^2)\) to determine the level of significance between the number of dependents and the level of application of soil and water conservation techniques (Table 7).

**Table 7. Result of Chi-Square \((X^2)\) Test of the number of dependent and application of soil and water conservation techniques**

|                | Value   | Df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|----------------|---------|----|-----------------------|----------------------|----------------------|
| Pearson Chi-Square | 1.138\(^a\)  | 1 | .286                  |                      |                      |
| Continuity Correction\(^b\) | .588    | 1 | .443                  |                      |                      |
| Likelihood Ratio    | 1.144   | 1 | .285                  |                      |                      |
| Fisher's Exact Test |         |   | .373                 | .222                 |                      |
| Linear-by-Linear Association | 1.113   | 1 | .291                  |                      |                      |
| N of Valid Cases    |         |   | 45                    |                      |                      |

\(^a\) 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.78.
\(^b\) Computed only for a 2x2 table.

In Table 7, the significance value of the p-value is 0.286. Because the significance value is \(0.286 > 0.05\), the null hypothesis is accepted, which means that there is no significant relationship between the number of dependents and the level of application of land and water conservation techniques by the community.

From the results of the observations, the number of respondents' family dependents varied, ranging from a large family to a small family. However, the number of family dependents does not have a significant influence on the respondent's decision making for the application of land and water conservation techniques. The research showed that no significant difference between respondents with a low number of dependents and high number dependents. However, a study by Daniel (2014) [8], found that the higher the number of dependents, related with higher demands for economic need, thus farmers must be careful in applying conservation techniques land and water to maintain the cost.

3.2.5.4. *Area of cultivated land.* The results of the relationship between the area of cultivated land with the application of soil and water conservation techniques shown in Table 8.

**Table 8. Cross-tabulation of the level of application of soil and water conservation techniques and area of cultivated land**

| Level of Soil and Water Conservation Application | Area of cultivated land | Total |
|-------------------------------------------------|-------------------------|-------|
|                                                 | Low | High | People | (%) |
| Low                                             | 9   | 13   | 22     | 48.9|
| High                                            | 11  | 12   | 23     | 51.1|
| Total                                           | 20  | 25   | 45     | 100.0|

In Table 8, the area of cultivated land shows no influence on the application of soil and water conservation techniques used by respondents. The research data in Table 8 then tested using the Chi-Square Test \((X^2)\) to determine the level of significance between the area of cultivated land and the level of application of soil and water conservation techniques by respondents (Table 9).
Table 9. Result of Chi-Square ($X^2$) Test of the area of cultivated land and application of soil and water conservation techniques.

|                         | Value   | Df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|-------------------------|---------|----|-----------------------|----------------------|---------------------|
| Pearson Chi-Square      | .218a   | 1  | .641                  |                      |                     |
| Continuity Correctionb | .028    | 1  | .868                  |                      |                     |
| Likelihood Ratio        | .218    | 1  | .640                  |                      |                     |
| Fisher's Exact Test     |         |    |                       | .767                 | .434                |
| Linear-by-Linear        |         |    |                       | .213                 | .644                |
| Association N of Valid Cases | 45  |    |                       |                      |                     |

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 9.78.

b. Computed only for a 2x2 table.

The significance value of the p-value in Table 9 is 0.641, which means the null hypothesis is accepted, that there is no significant relationship between the area of cultivated land and the application of soil and water conservation techniques. Soekartawi (2002) [9] argues that land area is influencing the level of community innovation in agricultural business. The wider the land is, the more inefficient the level of management because managing narrower land considered to be more efficient.

However, the research conducted not in line with the statement above because there is no real relationship between the area of cultivated land and the level of application of soil and water conservation techniques. The community tends to choose to find another job rather than having to manage the land personally, in order to provide higher income.

3.2.5.5. Level of Income. The results of the relationship between the level of income with the application of soil and water conservation techniques shown in Table 10.

Table 10. Cross-tabulation of the level of application of soil and water conservation techniques and level of income.

| Level of Soil and Water Conservation Application | Income | Total (People) | Total (%) |
|------------------------------------------------|--------|----------------|----------|
|                                                 | Low    | High           |          |
| Low                                             | 9      | 13             | 22       | 48.9    |
| High                                            | 14     | 9              | 23       | 51.1    |
| Total                                           | 23     | 22             | 45       | 100.0   |

In Table 10, the results show that there is no significant difference between high level and low level of income, which means that the level of income does not affect the application of soil and water conservation techniques at the research site. The results of the cross-tabulation between the application of soil and water conservation techniques with the next income level were tested using the Chi-Square Test ($X^2$) to determine the significance level of the two variables (Table 11).
Table 11. Result of Chi-Square (X²) Test of the level of income and application of soil and water conservation techniques.

|                                   | Value     | Df | Asymp. Sig. (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
|-----------------------------------|-----------|----|-----------------------|----------------------|----------------------|
| Pearson Chi-Square                | 1.793a    | 1  | .181                  |                      |                      |
| Continuity Correction             | 1.083     | 1  | .298                  |                      |                      |
| Likelihood Ratio                  | 1.805     | 1  | .179                  |                      |                      |
| Fisher's Exact Test               |           |    | .238                  | .149                 |                      |
| Linear-by-Linear Association      | 1.753     | 1  | .185                  |                      |                      |
| N of Valid Cases                  | 45        |    |                       |                      |                      |

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.76.
b. Computed only for a 2x2 table.

The p-value significance is 0.181. Since the significance value is lower than 0.005, then a null hypothesis is accepted, which means there is no real relationship between the level of application of soil and water conservation techniques with the level of income.

Land use and level of income level are inseparable. Each human being has their way of determining their welfare by considering natural factors and the resources they have. In this case, there is no significant relationship to the level of income and the application of soil and water conservation techniques influenced by other things such as high labor costs, lack of interest in young people to become farmers. Farmers who have a high level of education tend to make agriculture work as a side job [9].

4. Conclusion

Based on the results, it can be concluded several things as follows:
- The application of soil and water conservation techniques by respondents consisted of vegetative and mechanical techniques. Vegetative techniques include the use of crop residues, use of yard, and mixed gardening, while mechanical techniques were making bench and ridges terraces.
- The community typologies such as age, level of education, number of dependents, area of cultivated land, and level of income did not have a significant relationship with the application of soil and water conservation techniques.

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