

# 6

*by* Asmita Ahmad

---

**Submission date:** 06-Jun-2022 07:59AM (UTC+0700)

**Submission ID:** 1851065876

**File name:** dari\_2021\_IOP\_Conf.\_Ser.\_Earth\_Environ.\_Sci.\_807\_042006.pdf (1.17M)

**Word count:** 3057

**Character count:** 16421

PAPER · OPEN ACCESS

## Analysis of soil characteristics and classification from order to family category in Makale District

To cite this article: A Wulandari *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **807** 042006

6  
View the [article online](#) for updates and enhancements.



**ECS** **240th ECS Meeting**  
Oct 10-14, 2021, Orlando, Florida

**Register early and save  
up to 20% on registration costs**

Early registration deadline Sep 13

**REGISTER NOW**

## Analysis of soil characteristics and classification from order to family category in Makale District

A Wulandari<sup>1</sup>, C Lopulisa<sup>2</sup> and A Ahmad<sup>2</sup>

<sup>1</sup>Department of Soil Science, Faculty of Agriculture, Universitas Hasanuddin, Makassar, 90245, Indonesia

<sup>2</sup>Laboratory of Soil Genesis and Classification, Faculty of Agriculture, Universitas Hasanuddin, Makassar, 90245, Indonesia

E-mail: lopulisachristianto@gmail.com

**Abstract.** Makale, with hilly and mountainous areas in Tana Toraja Regency, provides high agricultural productivity so that soil as a medium for growing plants is one aspect that needs attention. Minerals influence the soil's physical and chemical properties because they are the main constituent of the soil, so that the characteristics and types of soil will vary. This study aimed to determine the type of soil based on toposequences and catena sequences from order to family category in Makale district, Tana Toraja regency, according to soil taxonomy in 2014. The method used was toposequences and catena sequences in one transect. Soil physical and chemical analysis including: soil color, texture, bulk density, C-organic, CEC, K, Na, Ca, and Mg. Analysis of soil minerals using the Fourier Transform InfraRed (FTIR) method. The results showed that the soil types found in the Makale district were Lithic Udorthents, Typic Udorthents, Typic Haplohumults, Oxic Dystrudepts, Typic Eutrudepts, and Dystric Eutrudepts. The dominant clay minerals are montmorillonite in profiles 1 and 2, kaolinite in profiles 3 and 5, chlorite and quartz in profiles 4 and 6.

### 1. Introduction

Makale is one of the districts in Tana Toraja with 3,975 ha (1.93 percent of Tana Toraja regency area). Makale has hilly and mountainous morphology. The climatic characteristics are classified as wet tropical (evenly distributed rainfall) with relatively low air temperatures. The agricultural sector in Makale district is the main aspect developed in the region because it is the source of most of the population's livelihood. Lowland rice is the largest commodity, with a productivity of 6.48 tons/ha and a harvest area of 1,263.00 ha. This signifies that there is potential for future agricultural productivity development [1].

High agricultural productivity with the mountainous region, making soil as a plant growing media, needs to be considered because it influences the development of agricultural productivity. We need to know the soil characteristics because each type of soil has a different level of fertility [2]. One of the characteristics that affect soil fertility is the type of soil minerals. Minerals affect the soil's physical and chemical properties because they are the main constituent of the soil [3]. Minerals are divided into two types, namely primary minerals from physical weathering and secondary minerals that are derived from primary minerals or through the leaching process or acceptance of elements or compounds between fellow secondary minerals [4]. Soils with a clay fraction are dominated by secondary minerals, whereas sand and silt fractions are dominated by primary minerals [5]. In general,



Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

the soil formation is dominated by secondary minerals, while primary minerals dominate the parent material. So it is necessary to classify the soil based on the specific location.

The sequence of soil formation is dominated by morphological or topographic processes (toposequences) and soil parent material (catena sequences). The two soil-forming sequences can make it easier for us to recognize various soil types and the ability to study and classify them [6]. Soil classification is a way of classifying soil based on the similarity of soil properties and characteristics, then given a name so that it is easy to remember and distinguish. Each type of soil has specific properties and characteristics, potentials, and constraints for a specific use. One of the most popular and newest soil classification system methods currently is the key to soil taxonomy developed by the USDA [7]. USDA soil classification contains various recent information, including the addition of criteria on the lower horizon of characteristics, suborders to the family category. That classification system has privilege in terms of naming, the definition of the identifier horizon, and other identifier that make it easier for us to determine the type of soil, apart from that it includes an open system, which means it is open to the development of science so there may be additional soil types in the future [8].

Based on the description, it is necessary to classify the land in Makale district from the order category to the family according to the specific location characteristics, so that it can complete information about the region so that it becomes the first step to become a guideline in preparing agricultural development plans that have great potential.

## 2. Methods

Observations, descriptions of soil profiles, and soil sampling were carried out in Makale district, Tana Toraja regency, located at the coordinates 3°06'12.0"S dan 119°51'13.0"E (figure 1). Soil analysis was carried out at the Laboratory of Chemistry and Soil Fertility, Department of Soil Science, Faculty of Agriculture, Hasanuddin University, Makassar. Analysis of clay mineral carried out at the Laboratory of Basic Chemistry, Faculty of Mathematics and Natural Science, Hasanuddin University. This research was conducted from December 2019 until March 2020.

Soil profile opening and soil sampling used the transect methods based on toposequence (topographic differences) and catena sequences (parent material differences) (figure 1 and 2).

The tools that used in this research are GPS for determining the location of a coordinate point, ArcGIS software 10.3 for making the working map, meter bar for measure the soil profile depth, the camera for documentation, Munsell Soil Color Chart for determining the color of soil, box, sample ring, loops, a geological hammer, and a set the tools of soil analysis in the laboratory. The materials used in this research are intact soil samples, disturbed soil samples, world maps of Makale District, geological maps of Tana Toraja Regency, slope maps, land use maps, Makale District climate data, list of profile fields, keys to soil taxonomy of USDA twelfth edition [8], H<sub>2</sub>O<sub>2</sub> solution for identification of organic matter and Mn in the field, HCl solution for identification of carbonate minerals in the field, and materials for soil analysis in the laboratory.

**Table 1.** Observation parameters and methods of soil analysis in the laboratory.

No	Parameter	Method
1	Texture	Hyrometer
2	Bulk density	Ring
3	pH	pH meter
4	Organic	Walkey and Black
5	Cation exchange capacity (CEC)	Titration
6	Available K, Ca, Mg, Na.	Titration
7	Soil mineral	FTIR (fourier transform infrared)

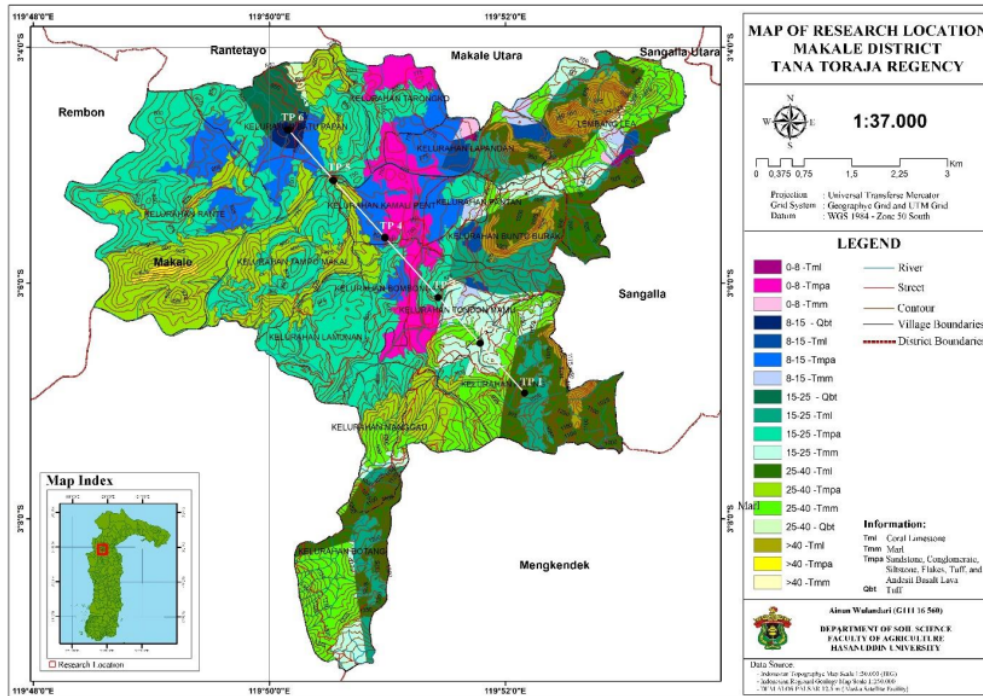


Figure 1. Profile point of research site.

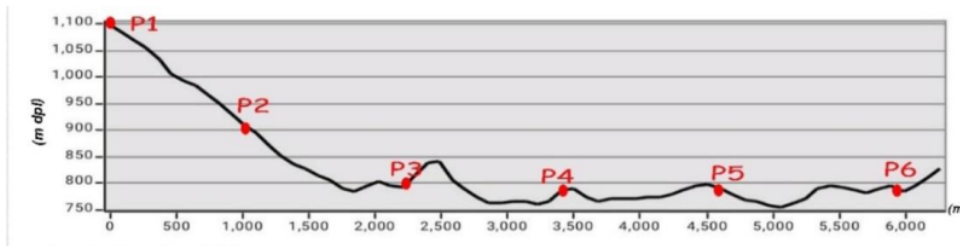
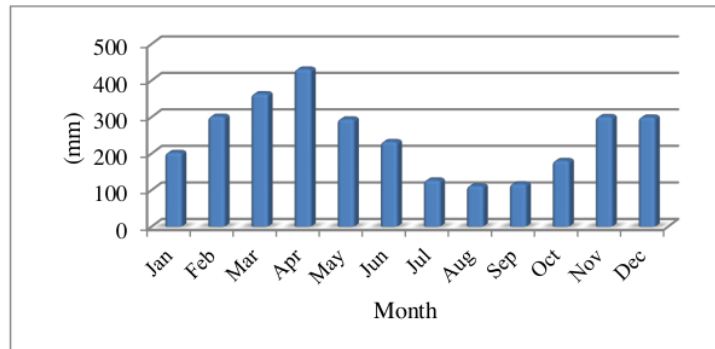


Figure 2. Cross-section of research site.

### 3. Results and discussion

Based on rainfall data in the last ten years (2010 – 2019) (Meteorology, Climatology, and Geophysics), the climate type of Makale District, according to Oldeman climate classification, is classified as type B climate with eight wet months (figure 3).



**Figure 3.** Rainfall data of Makale District.

#### 17. Soil characteristics

Based on the analysis results in the field and laboratory, the results showed that each soil profile has different characteristics, so that there are six types of soil at the research location (table 2 and 3).

**Table 2.** Soil profile characteristic.

Profiles	Coordinate	Administrative	Slope	Rock formation	Parent material
TP1	119°52'25,8" E and 03°06'50,7" S	Ariang	25-40%	Tml	Igneous rock
TP2	119°51'59,7" E and 03°06'21,6" S	Ariang	25-40%	Tmm	Marl rock
TP3	119°51'25,7" E and 03°05'57,7" S	Tondon Mamullu	15-25%	Tmpa	Claystone
TP4	119°50'57,8" E and 03°05'25,7" S	Rantetayo	0-8%	Tmpa	Interlayer of basaltic and tuff
TP5	119°50'36,3" E and 03°05'02,0" S	Tampo	15-25%	Tmpa	Meta-claystone
TP6	119°50'12,1" E and 03°04'32,4" S	Tasongko	8-15%	Qtb	Tuff

**Table 3.** Characteristics and classification of soil in Makale district.

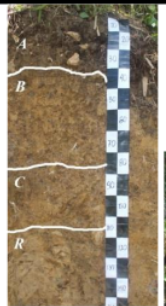


Profile TP1: Elevation 1245 m asl, soil depth 35cm, Order: Entisol with the umbric epipedon, SubOrder: Orthents, Great Group: Udorthents, SubGroup: Lithic Udorthents, Family: Mixture Lithic Udorthents  
 Horizon A 0-35 cm, brown (10 YR 4/3), the texture of clay loam, granular structure, loose, horizon boundary of clear, BD 1.13 gr/cm<sup>3</sup>, pH 5.20, CEC 16.19 cmol/kg, Base Saturation 55.1%, C-organic content 1.78%, dominant minerals: montmorillonite. Horizon R >35 cm



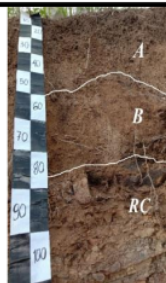
Profile TP2: Elevation 900 m asl, soil depth 25cm, horizon A 0-25 cm, olive-brown (2.5 Y 4/4), the texture of silty clay, granular to blocky structure, rather firm, horizon boundary of diffuse, BD 1.33 gr/cm<sup>3</sup>, pH 6.58, CEC 22.18 cmol/kg, Base Saturation 47.86%, C-organic content 1.84%, dominant minerals: montmorillonite. Horizon CR 25-65 cm, Horizon RC >65 cm.

Order: Entisol with the umbric epipedon, SubOrder: Orthents, Great Group: Udorthents, SubGroup: Typic Udorthents, Family: Mixture Typic Udorthents



Profile TP3: Elevation 840 m asl, soil depth 75cm. Horizon A 0-35 cm, brown (10 YR 4/3), the texture of silty clay loam, granular structure, loose, horizon boundary of clear, BD 1.06 gr/cm<sup>3</sup>, pH 5.95, CEC 18.08 cmol/kg, Base Saturation 39.26%, C-organic content 1.42%, dominant minerals: kaolinite. Horizon B 35-75, dark yellowish-brown (10 YR 4/4), the texture of clay, blocky structure, firm, horizon boundary of gradually, BD 1.61 gr/cm<sup>3</sup>, pH 5.66, CEC 24.73 cmol/kg, Base Saturation 32.95%, C-organic content 1.53%, dominant minerals: kaolinite. Horizon C 75-105 cm.

Order: Ultisols with the argillic horizon, SubOrder: Humults, Great Group: Haplohumults, SubGroup: Typic Haplohumults, Family: Mixture Typic Haplohumults



Profile TP4: Elevation 775 m asl, soil depth 75cm. Horizon A 0-50 cm, dark yellowish-brown (10 YR 4/4), the texture of clay loam, granular to blocky structure, firm, horizon boundary of real, BD 1.03 gr/cm<sup>3</sup>, pH 5.49, CEC 16.19 cmol/kg, Base Saturation 47.10%, C-organic content 1.00%, dominant mineral: chlorite. Horizon B 50-75, yellowish-brown (10 YR 5/4), the texture of loam,

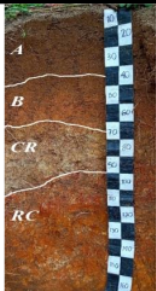
Order: Inceptisols with the ocric epipedon and cambic horizon, SubOrder: Udepts, Great Group: Dystrudepts, SubGroup: Oxic Dystrudepts, Family: Mixture Oxic Dystrudepts

granular to blocky structure, firm, horizon boundary of clear, BD 1.35 gr/cm<sup>3</sup>, pH 5.87, CEC 17.16 cmol/kg, Base Saturation 33.92%, C-organic content 1.47%, dominant minerals: quartz. Horizon RC >75 cm.



Profile TP5: Elevation 775 m asl, soil depth 80 cm. Horizon A 0-50 cm, dark yellowish-brown (10 YR 4/4), the texture of silty clay loam, granular structure, loose, horizon boundary of real, BD 1.05 gr/cm<sup>3</sup>, pH 5.43, CEC 23.41 cmol/kg, Base Saturation 27.58%, C-organic content 1.60%, dominant minerals: kaolinite. Horizon B 50-80, yellowish-brown (10 YR 5/4), the texture of clay loam, blocky structure, firm, horizon boundary of real, BD 1.54 gr/cm<sup>3</sup>, pH 5.33, CEC 19.76 cmol/kg, Base Saturation 31.00%, C-organic content 1.95%, dominant minerals: kaolinite. Horizon RC >80 cm.

Order: Inceptisols with the ocric epipedon and cambic horizon, SubOrder: Udepts, Great Group: Eutrudepts, SubGroup: Typic Eutrudepts, Family: Mixture Typic Eutrudepts



Profile TP6: Elevation 750 m asl, soil depth 65 cm. Horizon A 0-40 cm, dark yellowish-brown (10 YR 4/4), the texture of sandy clay loam, granular structure, loose, horizon boundary of clear, BD 1.34 gr/cm<sup>3</sup>, pH 4.82, CEC 27.41 cmol/kg, Base Saturation 35.08%, C-organic content 1.30%, dominant minerals: quartz. Horizon B 40-65, yellowish-brown (10 YR 5/4), the texture of clay, blocky structure, firm, horizon boundary of clear, BD 1.38 gr/cm<sup>3</sup>, pH 4.91, CEC 16.90 cmol/kg, Base Saturation 56.87%, C-organic content

Order: Inceptisols with the ocric epipedon and cambic horizon, SubOrder: Udepts, Great Group: Eutrudepts, SubGroup: Dystric Eutrudepts, Family: Mixture Dystric Eutrudepts

---

1.28%, dominant minerals:  
quartz. Horizon C1 65-90  
cm. Horizon C2 90-110 cm.  
Horizon C3 >110 cm.

---

### 3.2. The relationship of minerals to the characteristics of the soil that is formed.

Profiles 1 and 2, the dominant mineral, are clay mineral Montmorillonite, but some have been leached to kaolinite. This mineral is formed by altering other silicate minerals when conditions are suitable and can be found in young soils that have not undergone further development [4]. This mineral has the characteristics of easily expanding when wet and shrinking when dry on certain conditions in large quantities [9]. In general, high Mg content and without leaching will form Montmorillonite clay minerals [10]. One of the possible conditions in forming montmorillonite is low temperature and pressure [11]. The soil temperature is low because the soil is always moist. At profile 3 and 5, the dominant mineral is clay mineral Kaolinite. This mineral is formed from the weathering of its

Origin minerals which can also be found in sedimentary rocks. [4]. Kaolinite clay minerals are formed through a chemical change (decomposition) from primary minerals after a leaching process occurs in metal cations. If the Si element in the soil runs out of leached, it will make the soil more acidic. The existence of Kaolinite minerals indicates that they formed soil more developed or undergoing further weathering [12]. High rainfall causes the soil to undergo an intensive weathering process so that the secondary mineral formation process runs faster because the soil is always moist [13].

At profile 4, the dominant minerals are chlorite in the first layer and quartz minerals in the second layer. This mineral chlorite can be formed from alteration of mica minerals that already existed, and this mineral is usually found on soils that weathering level is still developing [14]. Whereas Quartz minerals are many found on parent material derived from igneous rocks, and their presence indicates that the soil is less fertile because this resistant mineral is difficult to release nutrients.

At profile 6, the dominant mineral is quartz. In general, only a small proportion of primary minerals are found in the soil fraction, but quartz is a resistant mineral that is not easily weathered, so that sometimes it can be found in large quantities in the soil body. This is because quartz is a very stable mineral [4]. Sedimentary rocks contain resistant primary minerals such as quartz due to weathering of pre-existing rock, and one example is tuff. According to [15] In black Vertisol which develops from carbonate sediment parent material. Illite and montmorillonite clay minerals, quartz sand and calcite minerals are commonly found.

## 4. Conclusions

Makale district, Tana Toraja regency has different soil types and characteristics depending on the topographic position and parent material:

- Entisols with montmorillonite transitioning to kaolinite are found in the ridge's topographical position with the parent material are igneous rock and marl.
- Ultisols with kaolinite minerals are found at the slope foot with the parent material is claystone.
- Inceptisol with the kaolinite, chlorite, and quartz minerals are found in the foothills position with the parent material of alternating igneous basalt in the form of volcanic sills and tuffs, meta clay, and sandy tuff.

## References

- [1] BPS 2017 *Kecamatan Makale Dalam Angka 2017* (Kabupaten Tana Toraja: Badan Pusat Statistik)
- [2] Widiatmaka, Mediranto A and Widjaja H 2015 Karakteristik, klasifikasi tanah, dan pertumbuhan tanaman jati (*Tectona grandis* linn f.) var. unggul nusantara di Ciampea, Kabupaten Bogor *Pengelolaan Sumberd. Alam dan Lingkungan*. **5** 87–9
- [3] Yusnita D, Ahmad A and Solle M S 2020 Soil classification for sustainable agriculture *IOP*

*Conf. Ser. Earth Environ. Sci.* **486** 1–6

- [4] Hanafiah K A 2014 *Dasar-Dasar Ilmu Tanah* (Jakarta: PT Raja Grafindo Persada)
- [5] Hardjowigeno S 2016 *Klasifikasi Tanah dan Pedogenesis* (Bekasi: CV Akademika Pressindo)
- [6] Hardjowigeno S 2003 *Klasifikasi Tanah dan Pedogenesis* (Jakarta: Akademika Pressindo)
- [7] Subardja D, Ritung S, Anda M, Sukarman, Suryani E and Subandiono R E 2014 *Petunjuk Teknis Klasifikasi Tanah Nasional* (Bogor: Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian, Badan Penelitian dan Pengembangan Pertanian)
- [8] Soil Survey Staff 2014 *Kunci Taksonomi Tanah* (Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian, Badan Penelitian dan Pengembangan Pertanian)
- [9] Ahmad A, Poch R M, Lopulisa C, Imran A M and Baja S 2018 Identification of soil characteristic on North Toraja landslide, Indonesia *ARPJ. Eng. Appl. Sci.* **13** 8381–5
- [10] Utami D N 2018 Dengan gerakan tanah study of clay mineral type and its implication *Alami* **2** 89–97
- [11] Borchardt G 1989 Montmorillonite and other smectite minerals *Minerals In Soil Environment* (Madison: Soil Science Society of America, Inc.)
- [12] Apriani I, Arabia T and Sufardi 2019 Identifikasi mineral tanah dengan menggunakan difraksi sinar-x pada incepticol Aceh Besar *Identification Ilm. Mhs. Pertan.* **4** 155–63
- [13] Nursyamsi D and Suprihati 2005 Sifat-sifat kimia dan mineralogi tanah serta kaitannya dengan kebutuhan pupuk untuk padi (*Oryza sativa*), jagung (*Zea mays*), dan kedelai (*Glycine max*) soil chemical and mineralogical characteristics and its relationship and soybean (*Glycine max*) *Bul. Agron.* **33** 40–7
- [14] Hardjowigeno S 1993 *Klasifikasi Tanah dan Pedogenesis* (Jakarta: Akademika Pressindo)
- [15] Juita N, Iskandar and S 2020 The role of soil minerals in red and black Vertisol in Jeneponto Regency *IOP Conf. Ser. Earth Environ. Sci.* **486**

## ORIGINALITY REPORT

17%

SIMILARITY INDEX

12%

INTERNET SOURCES

13%

PUBLICATIONS

6%

STUDENT PAPERS

## PRIMARY SOURCES

1	Submitted to Pennsylvania College of Technology Student Paper	2%
2	library.wur.nl Internet Source	2%
3	Repositorioacademico.Upc.Edu.Pe Internet Source	2%
4	ui.adsabs.harvard.edu Internet Source	1%
5	D E Safitri, A Ahmad, M Nathan. "Study of soil management in rice fields in Bantimurung District Maros Regency", IOP Conference Series: Earth and Environmental Science, 2021 Publication	1%
6	repository.unhas.ac.id Internet Source	1%
7	Musfira, M Jayadi, A Ahmad. "Application of humic substances and bottom ash compounds in improving soil quality in	1%

limestone post-mining land", IOP Conference Series: Earth and Environmental Science, 2021

Publication

8

Nirmala Juita, Iskandar, Sudarsono. "The role of soil minerals in red and black Vertisol in Jeneponto Regency", IOP Conference Series: Earth and Environmental Science, 2020

Publication

1 %

9

[jim.unsyiah.ac.id](http://jim.unsyiah.ac.id)

Internet Source

1 %

10

[openlib.org](http://openlib.org)

Internet Source

1 %

11

C Lopulisa, R Neswati, W Wahid. "Analysis of soil-forming factors and soil classification using soil taxonomy system: A case study of Baraka District, Enrekang Regency", IOP Conference Series: Earth and Environmental Science, 2020

Publication

1 %

12

Indrayani, Arfan Hasan, Andi Herius, Ahmad Mirza. "Study of geotechnical aspect base on GIS as basic design of road", MATEC Web of Conferences, 2018

Publication

<1 %

13

[docplayer.fr](http://docplayer.fr)

Internet Source

<1 %

[edepot.wur.nl](http://edepot.wur.nl)

14

Internet Source

&lt;1 %

15

A Kasno, D Setyorini, L R Widowati. "Cations ratio and its relationship with other soil nutrients of Java intensified lowland rice", IOP Conference Series: Earth and Environmental Science, 2021

Publication

&lt;1 %

16

Devianti, Fachruddin, Eva Purwati, Dewi Sartika Thamren, Agustami Sitorus. "Application of Geographic Information Systems and Sediment Routing Methods in Sediment Mapping in Krueng Jreu Sub-Watershed, Aceh Province, Indonesia", International Journal of Sustainable Development and Planning, 2021

Publication

&lt;1 %

17

M S Rusmin, C Lopulisa, R Neswati. "Modification of land requirements (soil and climate) for specific growth of pepper (*Piper nigrum* L.) in East Luwu Regency", IOP Conference Series: Earth and Environmental Science, 2021

Publication

&lt;1 %

18

P Marbun, Z Nasution, H Hanum, A Karim. "Classification of andisol soil on robusta coffee plantation in Silima Pungga - Pungga

&lt;1 %

# District", IOP Conference Series: Earth and Environmental Science, 2018

Publication

19

[www.bioflux.com.ro](http://www.bioflux.com.ro)

Internet Source

<1 %

20

Submitted to poltera

Student Paper

<1 %

Exclude quotes  On

Exclude matches  < 5 words

Exclude bibliography  On