IOP Conference Series: Earth and Environmental Science

PAPER • **OPEN ACCESS**

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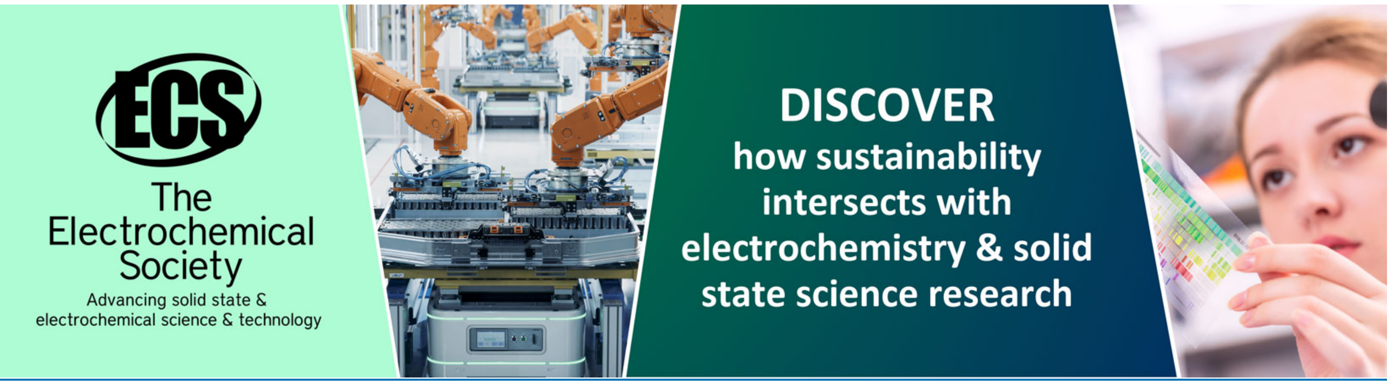
To cite this article: Minxia Cao *et al* 2017 *IOP Conf. Ser.: Earth Environ. Sci.* **61** 012138



The characteristics of dryland aggregates in mouding

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Abstract. Taking purple soil from Mouding city as the research object, the aim of this paper is to discuss the number characteristics of dryland soil aggregates. The results indicated that cumulative amounts of dryland soil aggregate obtaining from artificial screening method were obeyed the log-linear distribution, and fractal dimension of soil was ranged from 2.11 to 2.48. Moreover, the higher aggregates content was contained, the larger aggregates fractal dimension in the soil particles, which was smaller than 0.25 mm. The fractal dimension of dryland aggregates was decreased with the increasing of soil depth.

1. Introduction

Pedosphere is one of the most active and the most vitality spheres in the global ecological environment , and is the important place of material cycle and energy conversion in natural environment(Zhao, 200 1). Soil aggregate is the identification and important index of soil fertility, the size and content of soil aggregate is an important physical properties of soil(Zhang and Shao,2000). Soil aggregate is the mai n index of soil quality high or low ,and the ability to resist erosion(Zheng and Liu, 2003.Ning, et al, 20 05). Its characteristic is porous and water stability. The characteristics of specific performance in the soil porosity size are moderate, coexists the pore water and pore gas, and has a proper quantity and proportion. At present, researches of scholars mainly focus on the factors such as different fertilization conditions, different cultivation patterns and different ways of land use and different cultivated fixed number of year produced an effect on soil aggregate composition distribution and stability(Pei, et al, 2015).

In order to understand the ecological system of dryland better, linear distribution of soil aggregate and fractal dimension was observed in this study, which selected purple soil from Mouding town as the research object. As an objects mouding purple soil, this paper studied the logarithmic linear distribution and fractal dimension of soil aggregate. Aiming to further understand the dryland ecological system will provide a scientific basis for soil characteristics and ecological environment recovery.

2. Materials and methods

IOP Conf. Series: Earth and Environmental Science **61** (2017) 012138 doi:10.1088/1755-1315/61/1/012138

2.1. Study area
The study area is located in Mouding town, Chuxiong yi autonomous prefecture, Yunnan province, China. It is located in 101°19'~101°51'E and 25°09'~25°40'N, and belongs to north subtropical monsoon climate zone. The climate is mild and there is just a little, rainfall in every year. The average rainfall of annual year is 880.1 mm. The elevation of 80% county region is about 1600-1900 m. The average sunshine time of every year is 2117.9 h.

2.2. Sample collection
The soil samples are from the dryland located in Samachang Country of MouDing County, Yunnan Province, China. Then, about 1kg soil is taken in each soil horizon (0~10cm, 10~20cm and 20~30cm) of each sample point. Then, each layer soil of the ten soil sample points are mixed evenly in situ and take a quarter of mixed soil sample in three times. Finally, we got three different soil horizon samples and the soil sample of each soil horizon is about 1kg in each sampling area. Finally, the soil sample is peeled into small pieces less than 12 mm by hand along the natural soil structure. Finally, the soil is air-dried.

2.3. Analysis method
The total nitrogen contents were determined with semimicro Kjeldahl. The total phosphorus were determined by $HClO_4$-H_2SO_4. Available P was extracted by ammonium fluoride and hydrochloric acid. Soil pH value was determined by potentiometric (soil-water ratio, 1:2.5). Available N was extracted by alkali solution diffusion method. Soil aggregate analysis was determined with artificial screening method(Bao SD, 2008).

2.4. Soil aggregate fractal feature model
It was generally believed that soil aggregate structure had self-similarity. Turcotte(Turcotte, 1986) had put forword that the calculation method of soil aggregate fractal dimension was by using the relationship between the weight distribution and the average particle size: $(d_i/d_{max})^{3-d}=W(\delta<d_i)/W_0$. Among them, d_i was the two screening average particle size of between d_i and d_{i+1} , d_{max} was average diameter of biggest graded soil particles. $W(\delta<d_i)$ was less than the accumulation of d_i soil grain weight, W_0 was each graded soil weight, D was soil aggregate fractal dimension. Finally, respectively by lg $(W(\delta<d_i))/W_0)$, lg (d_i/d_{max}) for vertical and horizontal, D was calculated by the regression analysis.

3. The results and discussion

3.1. The basic physical and chemical properties of soil
The pH of dryland was approximately 5.37. Total P was 0.40g kg^{-1}. Total N was 2.71 g kg^{-1}. Effective P was 20.81 mg kg^{-1}. Effective N was 831.67 mg kg^{-1}.

3.2. Soil aggregate fractal characteristics
Under different soil depth, the results of soil aggregate analysis were showed in table 1. Being carried out Logarithmic transformation on the three soil aggregate composition, it was found that $lg(W(\delta<d_i))/W_0)$ had significant linear relationship with $lg(d_i/d_{max})$ (figure 1). According to the fitting of the logarithmic transformation, it was got the linear equation Lg(y) = aLg(x) + b, and among them, x and y were respectively $lg(W(\delta<d_i))/W_0)$ and $lg(d_i/d_{max})$. a, b, and the determination coefficient R^2 of each group of the parameters of the equation was presented in table 2. From table 2, it showed that the decision coefficient of the regression equation was greater than 0.9633, the highest could be reached 0.9981.

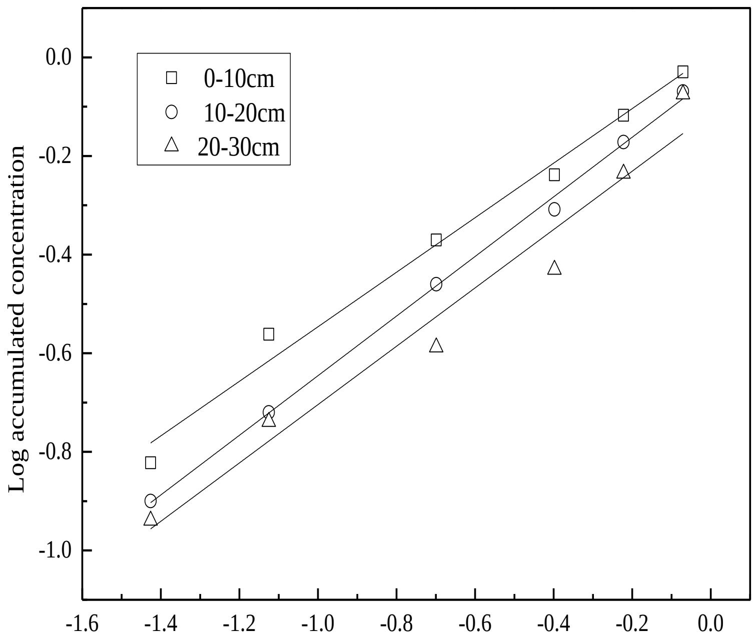

Fig.1 Log-probability plot of aggregate-size distribution

Table.1 Composition of dryland aggregates under different soil depth

Soil depth	Processing method	Composition of dry soil aggregates （%）						
		10-7 mm	7-5 mm	5-3 mm	3-1 mm	1-0.5 mm	0.5-0.25mm	<0.25mm
0-10cm	Dry	13.14	14.08	20.2	16.74	15.14	6.78	13.92
	Wet	0.00	20.2	16.8	13.6	15.2	18	16.2
10-20cm	Dry	29.4	20.72	23.72	10.82	3.42	1.32	10.6
	Wet	0.00	15.2	12.6	18.2	27.8	11.6	14.6
20-30cm	Dry	31.66	26.84	25.24	6.6	0.98	0.66	8.02
	Wet	0.00	25.2	16.8	16	14.2	12.8	15

Table.2 Logarithmic linear distribution characteristics of soil aggregate

Item	0-10cm	10-20cm	20-30cm
a	0.5531	0.6045	0.5917
b	0.0068	-0.0041	-0.1124
R2	0.988	0.9981	0.9633

Table.3 Aggregate fractal dimension

Ssmples	0-10cm	10-20cm	20-30cm
Fraetal dimension	2.48	2.26	2.11

Fractal dimension reflected the characteristics of soil aggregate composition, the effects of land use and the way of soil management. From table 3, soil aggregate fractal dimensions were different under different soil depth. The fractal dimension was arranged from 2.11 to 2.48. For 0 to 10 cm layer of the soil, aggregate content of < 0.25 mm soil was the highest (30.12%), the maximum value of fractal dimension was 2.48. For 10 to 20 cm layer of soil, aggregate content of < 0.25 mm soil was 25.2%, the fractal dimension was 2.26. For 20 to 30 cm layer of soil, aggregate content of < 0.25 mm soil was 23.02%, the fractal dimension was 2.11. The study found that the higher the clay content was, the finer quality of soil was, the higher the soil fractal dimension of particle size was(Yang PL et al, 1993). In this study, the aggregate content of < 0.25 mm soil was higher, so the fractal dimension of soil aggregate was bigger. Furthermore, the fractal texture had the similarity trends. The higher of the aggregate content of < 0.25 mm soil was, which showed that worse structural stability of soil was, the bigger of fractal dimension was.

4. Summary

(1)Theresearch area, cumulative amounts of dryland soil aggregate obtaining from artificial screening method were obeyed the log-linear distribution.
(2)fractal dimension of soil was ranged between 2.11 to 2.48. Moreover, the higher aggregates content was contained, the larger aggregates fractal dimension in the soil particles, which was smaller than 0.25 mm.
(3)The fractal dimension of dryland aggregates was decreased with the increasing of soil depth, which showed that soil structure stability was better with the increasing of soil depth.

Acknowledgements

This work was financially supported by National Natural Science Foundation (NO. 6492-20140037).

Reference

[1]Zhan X, Shao M. [Soil nitrogen and organic matter losses under water erosion][J]. Chinese Journal of Applied Ecology, 2000, 11(2):231-4(in Chinese).
[2]Zhao QG. Prosrects of siol science the 21st century[J]. Advance in Earth Sciences, 2001.
[3]Zheng ZP, Liu ZX. [Soil quality and its evaluation].[J]. Chinese Journal of Applied Ecology, 2003, 14(1):131-4(in Chinese).
[4]Ning LD, Shi H, Zhou HJ. [Quantitative characteristics of soil aggregates under different vegetations in upper reach of Minjiang River].[J]. Chinese Journal of Applied Ecology, 2005, 16(8):1405-1410(in Chinese).
[5]PEI ZJ, LIANG CH, YIN Y. [Size Hierarchy and Stability of Soil Aggregates in Solar Greenhouse Soils with Different Planted Years].[J]. Chinese Journal of Bulletin of Soil and Water Conservatio,2015, 35(6):70-74(in Chinese).
[6]Chan KY, Heenan DP, OatesA. Soil carbon fract ions and relationship to soil quality under different tillage and stubble management[J]. Soil and Tillage Research,2002,63: 133-139.
[7]Elliott E T. Aggregatest ructure and carbon, nitrogen, and phosphorus in native and cultivated soils[J]. Soil Science Society America Journal,1986,50: 627-633.
[8]Pedect E, Blevins RL. Fractal characterizations of soil aggregation and fragmentation as influenced by tillage treatment[J]. Soil Sci Soc Am J, 1997,61:896-900
[9]Kasper M, Buchan G D, Mentler A, et al. Influence of soil tillage systems on aggregate stability and the distribution of C and N in different aggregate fractions[J]. Soil & Tillage Research, 2009, 105(2):192-199.
[10]Li K, Dou S. Effects of chemical fertilizer combined corn stalk application on the quantity and infrared spectra of humic acids in soil aggregates.[J]. Journal of Jilin Agricultural University, 2009, 31(3):273-278.
[11]Kristova, P/Hopkinson, L/Rutt, et al. Quantitative analyses of powdered multi-minerallic carbonate aggregates using a portable Raman spectrometer[J]. American Mineralogist, 2015, 98(2-3):401-409.
[12]Jia J, Yu D, Zhou W, et al. Variations of soil aggregates and soil organic carbon mineralization across forest types on the northern slope of Changbai Mountain[J]. Acta Ecologica Sinica, 2015, 35(2):1-7.
[13]Zhang Z, Wei C, Xie D, et al. Effects of land use patterns on soil aggregate stability in Sichuan

Basin,China[J]. Particuology, 2008, 6(3):157-166.
[14]Zhou H, Lv Y, Yang Z, et al. Influence of conservation tillage on soil aggregates features in North China Plain[J]. Journal of Integrative Agriculture, 2007, 6(9):1099-1106.
[15]Bissonnais Y L. Aggregate stability and assessment of soil crustability and erodibility: I. Theory and methodology[J]. European Journal of Soil Science, 2016, 67(1):11–21.
[16]Jiang Y, Shao M. Effects of soil structural properties on saturated hydraulic conductivity under different land-use types[J]. Soil Research, 2014, 52(4):340-348.
[17]Nweke I A, Nnabude P C. Aggregate stability of four soils as evaluated by different indices.[J]. Journal of Experimental Biology & Agricultural Sciences, 2015, 3(3):246-252.
[18]Abdollahi L, P Schjønning, Elmholt S, et al. The effects of organic matter application and intensive tillage and traffic on soil structure formation and stability[J]. Soil & Tillage Research, 2014, 136:28-37.
[19]Bao SD. The method of analysis for soil agro-chemistry (3rd edition). [M]. Agriculture press, 2008(in Chinese).
[20]Niewczas J, Witkowska B. Index of soil aggregates stability as linear function value of transition matrix elements[J]. Soil & Tillage Research, 2003, 70(2):121-130.
[21]Turcotte DL. Fractal fragmentation. Geogr Res,1986,91(12):1921-1926.
[22]Yang PL, Luo YP, Shi YC. Fractal feature of soil particle by using mass distribution[J]. Chin Sci Bull,1993,38(20):1896-1899(in Chinese).