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IMPACT OF POWER VALUE IN IDW INTERPOLATION METHOD ON ACCURACY OF THE SOIL ORGANIC MATTER (SOM) MAPPING

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Abstract

Inverse Distance Weight (IDW) is one of the most popular interpolation methods in GIS analyses as well as for the predicted map, including soil organic matter mapping. For this method, the most important factor can be influence to the accuracy of map is power value. Our research base on the input data are 125 points and checked data are 25 points were conducted in hilly area in central Vietnam indicated that for IDW interpolation method to create soil organic matter map, the best choice of power value of 2. The result contribute to confirm the value from other studies as well as the manufacturer recommends is practical and can be applied in the field of soil mapping. This result is obtained from the comparison the accuracy of the map when applied six power values, including 1.0, 1.5, 2.0, 2.5, 3.0, 3.5 respectively.
Keywords: Inverse Distance Weight, spatial interpolation, soil mapping

INTRODUCTION

Soil quality map, especially Soil Organic Matter (SOM) content in soil is one of most important documents to provide the necessary information for land users as well as land use planning. Unfortunately, SOM mapping also is costly and take a lot of time, because the scientists have to do a lot of experiment in the field with the dense soil sample. In fact, researchers always need the supporting from interpolated technology for SOM mapping.

There are a lot of spatial interpolation methods were applied for diagnosis the unknown value by GIS software, for example, in ArcGIS we have Kriging, Spline or Inverse Distance Weighting. The characteristics of input database will decided what the interpolated method will be applied. Interpolated results depending on the method, even in the same method, if we chose different parameters then the results are different.

IDW is simple method and was used widely on the many fields. The result of IDW interpolation method processing may be influent by 2 factors. First is the distance between known points to unknown point, second is proportional to the inverse distance raised to the power value (p value).

About the distance problem, we can reduce the error by sampling selection, however, for p value we have to test and select the optimal value. Therefore, the aim of this paper is identity the best value of P for SOM mapping by IDW method in ArcGIS.

RESEARCH SITE AND METHODS

1. Research area

A Luoi (16^o30 N, 107^o00 E and 16^o00 N, 107^o30 E) is located at western of Thua Thien Hue province, central of Vietnam with main terrain is hilly area and high mountain. Research area is the agricultural and forest land of A Luoi with 55,160 hectares. There are 13 land use type belongs to this area in which forestry occupied major part and 6 soil types belonging to the Acrisols group.

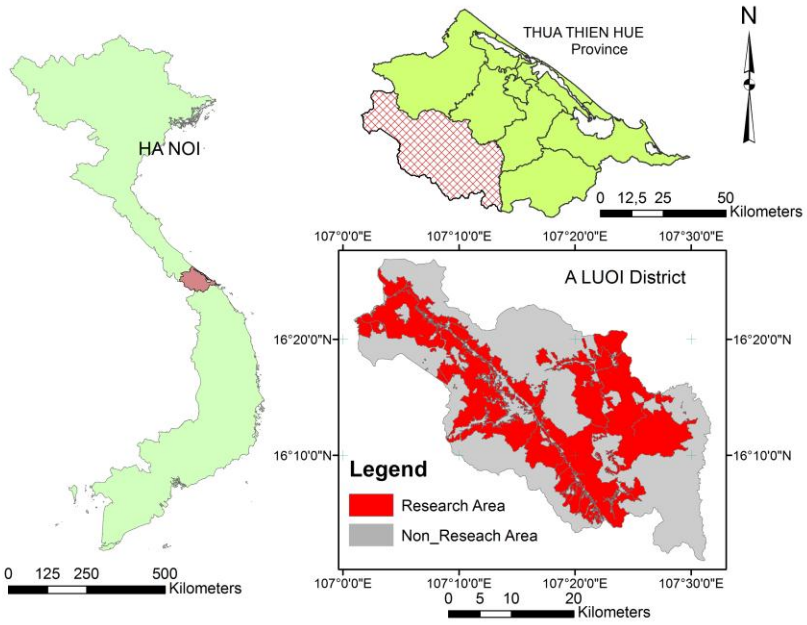

Fig 1: *Research Area belongs to A Luoi district*

2. Methods

Soil sample and soil analysis

There are 155 soil sample were taken to analyses in Laboratory of Soil science Department, Hue university of Agriculture and Forestry from December 2015 to February 2016. Analysis points are chosen based on the unit map from land use type, slope of terrain, soil texture and soil type. Among them, 125 points were used for interpolated processing and remaining 30 points were used to check the accuracy of interpolation value. Positions of checked point are spread evenly with thin the sampling area.

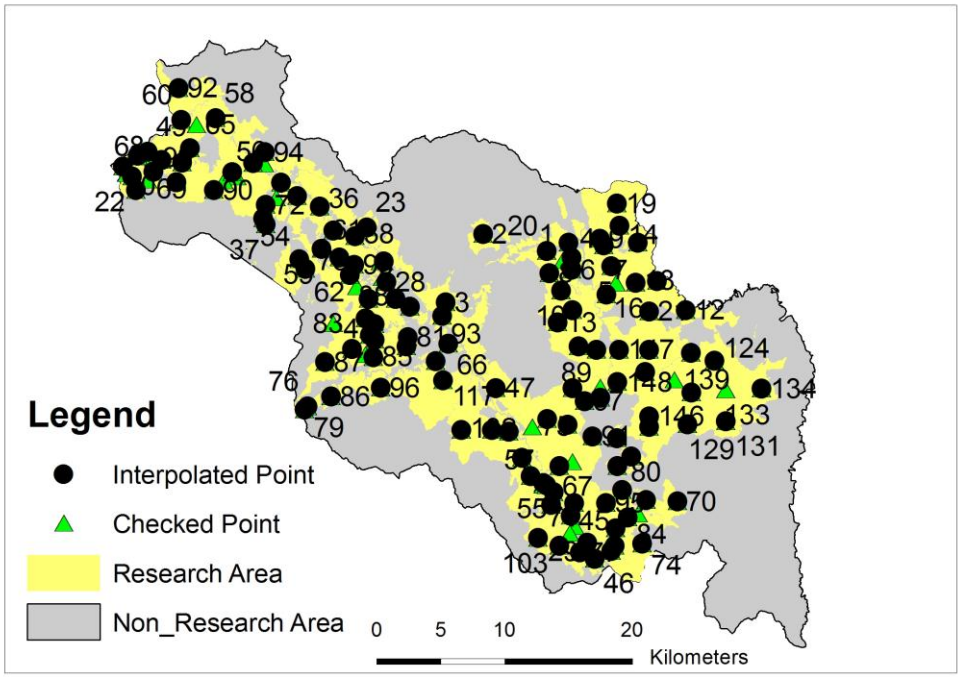

Fig 2: Location of analyzed point (125 points) and checked point (30 points)

The method to identify the Soil Organic Carbon (SOC) is Walkley-Black (1934). Estimates of SOC are used to assess the SOM by a convert factor.

Inverse Distance Weighting

Inverse distance weighted (IDW) interpolation explicitly makes the assumption that things that are close to one another are more alike than those that are farther apart. Each value of point will be identified by IDW as equation followings:

$$w(x,y) = \sum_{i=1}^{N} \lambda_i w_i, \ \lambda_i = \frac{\left(\frac{1}{d_i}\right)^P}{\sum_{k=1}^{N}\left(\frac{1}{d_k}\right)^P}$$

where w(x,y) is the predicted value at location (x,y), N is the number of nearest known points surrounding (x,y), l_i are the weights assigned to each known point value w_i at location (x_i,y_i), d_i are the Euclidean distances between each (x_i,y_i) and (x,y), and P is the exponent, which influences the weighting of w_i on w. In this research, we setup the parameter for IDW interpolation as bellows: power value of 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 respectively, N of 12.

Accuracy assessment

The SOM content of 30 soil samples were given by field observations (colume 2nd) and 6 caculations with different p value (colume 3th to 8th). We want to find out which p value gives the most accurate result.

Table 1: Soil Organic Matter of checked point with different p value

Point	Observation	P=1	P=1.5	P=2	P=2.5	P=3	P=3.5
1	3.62	2.21	2.30	2.37	2.42	2.46	2.48
16	1.99	2.42	2.52	2.60	2.65	2.68	2.68
24	3.53	2.23	2.13	2.04	1.98	1.94	1.91
26	2.62	2.58	2.39	2.19	2.04	1.94	1.88
27	3.08	2.76	2.82	2.88	2.92	2.95	2.96
29	1.64	2.27	2.25	2.22	2.18	2.15	2.12
32	3.17	3.02	3.20	3.31	3.36	3.38	3.39
35	1.54	2.71	2.74	2.78	2.82	2.86	2.88
41	1.99	2.98	3.26	3.55	3.84	4.08	4.28
42	1.64	2.41	2.35	2.26	2.15	2.05	1.96
56	0.91	1.75	1.58	1.43	1.33	1.28	1.25
57	3.17	2.33	2.38	2.38	2.36	2.35	2.33
61	0.91	1.64	1.16	0.98	0.93	0.91	0.91
64	0.91	2.51	2.58	2.63	2.66	2.68	2.69
65	1.54	1.70	1.64	1.59	1.55	1.51	1.49
69	3.64	2.22	2.35	2.48	2.60	2.70	2.78
75	2.00	1.83	1.81	1.81	1.81	1.82	1.83
78	3.14	2.83	2.97	3.12	3.27	3.41	3.54
99	2.61	1.91	1.86	1.79	1.73	1.68	1.64
100	2.47	2.04	2.05	2.06	2.08	2.10	2.11
109	2.29	2.17	2.23	2.25	2.25	2.25	2.24
111	1.59	1.79	1.69	1.59	1.52	1.47	1.43
118	2.04	2.47	2.26	2.07	1.94	1.86	1.82
119	1.86	1.88	1.88	1.88	1.89	1.89	1.90
126	2.16	2.19	2.20	2.21	2.21	2.22	2.23
133	2.27	2.23	2.23	2.24	2.24	2.25	2.25
139	2.17	2.16	2.15	2.15	2.15	2.15	2.15
144	2.64	2.61	2.66	2.72	2.77	2.82	2.86
154	2.37	2.35	2.38	2.37	2.35	2.32	2.30
155	1.94	2.31	2.30	2.29	2.28	2.27	2.26

In this study we use SPSS software to assess the t-test as paired two samples for mean with assumptions following:

H_0: $\mu_{observation} = \mu_{p1.0} = \mu_{p1.5} = \mu_{p2.0} = \mu_{p2.5} = \mu_{p3.0} = \mu_{p3.5}$

H_1: The means are not all equal

The confidence level is 95%

If the Sig (2-tailed) > 0.05 means that we accept H0, opposite, H1 will be accepted. In paired test, the smallest of t value (the absolute value of accreditation) and the biggest of Sig (2-tailed) are the most accuracy of p value.

RESULT

Soil Organic Matter maps

By the IDW method with 6 of power values as above, SOM content of A Luoi district change from 0.72% to 6.79% of soil weight. Among them, the highest points are agricultural (paddy rice and cassava land use type) located at Hong Trung, Hong Bac, Hong Thuy communes. In the opposite situation, forests as well as unused land types have low SOM.

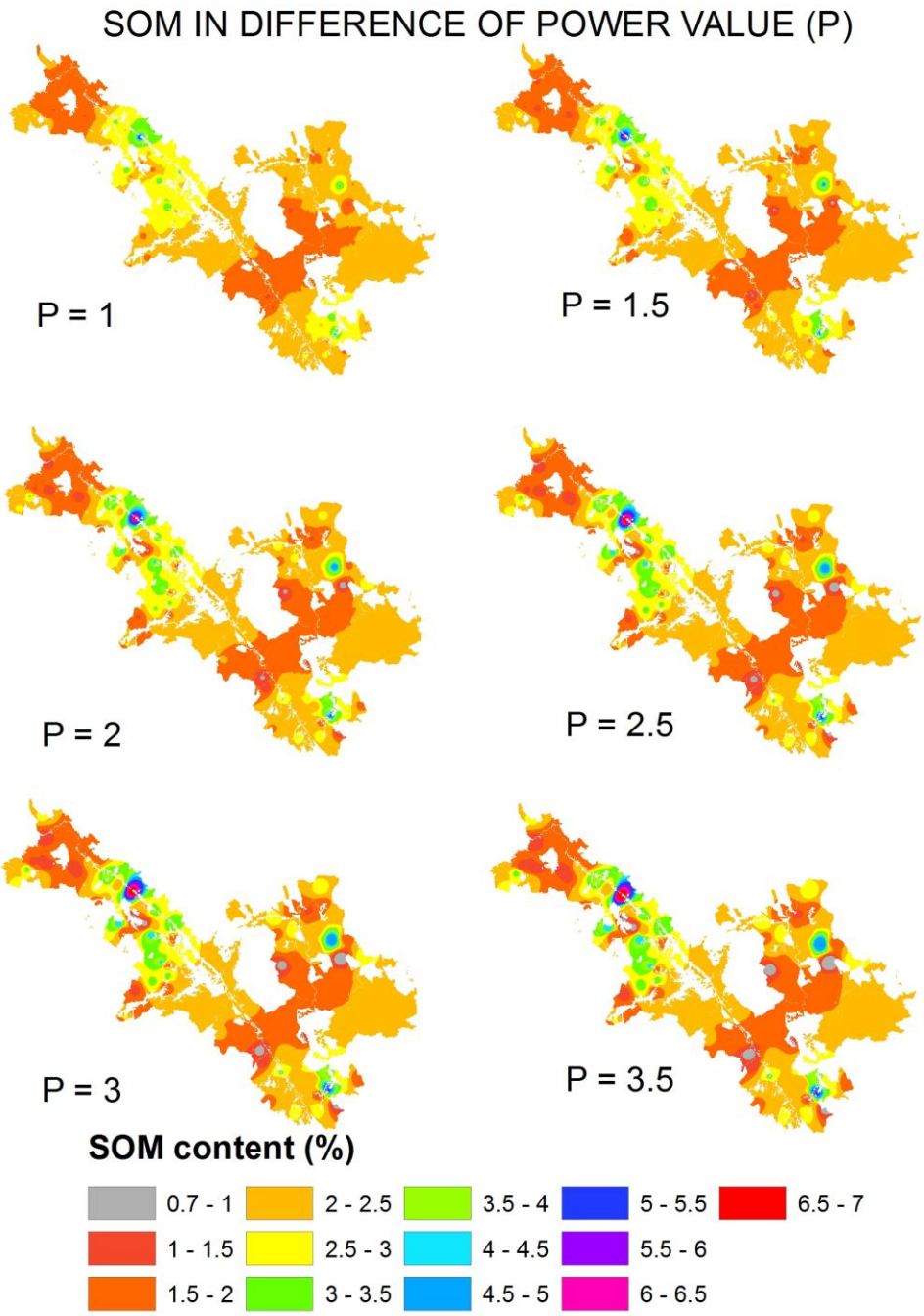

Fig 3: Soil Organic Matter map

t-test

Scatter chart of the SOM of 30 soil samples caculated by differnt p value can be displayed as follows:

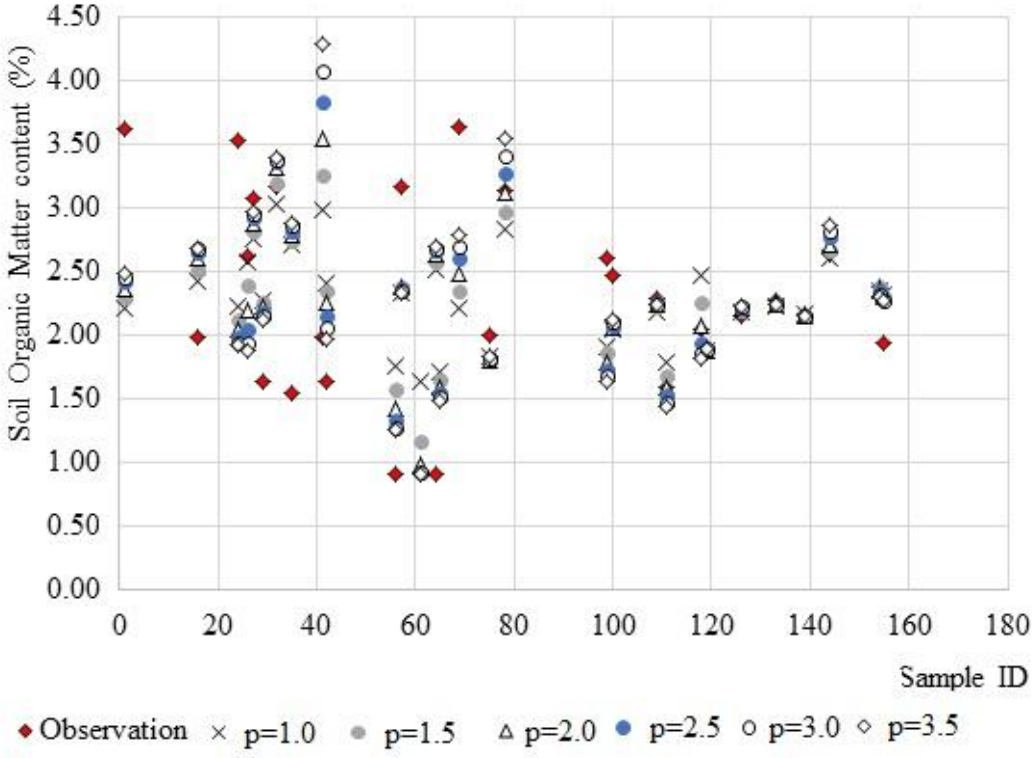

Fig 4: Soil Organic Matter content value of 30 checked points chart

Table 2: Summary of t-test by SPSS analysis

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Obeservation – p=1.0	-0.036	0.720	0.131	-0.305	0.233	-0.273	29	0.787
Pair 2	Obeservation – p=1.5	-0.029	0.710	0.130	-0.294	0.236	-0.225	29	0.823
Pair 3	Obeservation – p=2.0	-0.027	0.726	0.133	-0.298	0.244	-0.203	29	0.841
Pair 4	Obeservation – p=2.5	-0.029	0.751	0.137	-0.309	0.252	-0.209	29	0.836
Pair 5	Obeservation – p=3.0	-0.033	0.778	0.142	-0.323	0.257	-0.232	29	0.819
Pair 6	Obeservation – p=3.5	-0.038	0.801	0.146	-0.337	0.261	-0.260	29	0.797

The data from table 2 indicates that all of p values have Sig. (2 tailed) > 0.05, mean that IDW with p value from 1.0 to 3.5 is not too much different significant. We accepted H_0 at confidence level 95%.

Among Sig (2 tailed) values shows that the SOM from IDW with p value of 2 is closest with the observation value, mean that for SOM mapping, p value of 2 is best choice for IDW interpolation.

CONCLUSION

Many studies show that the IDW method is not high precision as other methods, in this study, we did not mention the comparison between the methods, but the results showed that the method completely IDW can use interpolation for SOM mapping.

Besides factors such as distance and the nearest point, the p value has a direct influence on the result of interpolation when SOM map. When using IDW interpolation method with the same values of other factors, the p value of 2 is the highest accuracy. This p-value is the value ArcGIS software recommended and become as a default value.

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