

A COMBINED MULTI-CRITERIA APPROACH OF SOIL QUALITY ANALYSIS

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The way of quantitative evaluation of soil quality through combination of two multi-criteria decision making methods is presented in this paper. Soil quality was viewed through the contents of basic parameters of fertility, radionuclides as well as of the most frequent contaminants characterised as hazardous and harmful substances. Arable soil samples were taken from thirty different locations on the territory of Čačak valley and the above mentioned groups of elements were analysed. Two specific multicriteria methods were integrated for this purpose due to a setting of the research problem. AHP (Analytic Hierarchy Process) method was used for parameter weighting while PROMETHEE (Preference Organisation Method for Enrichment Evaluation) method was used for the ranking of alternatives *i.e.* locations. Thirty criteria were embraced to rank the contents, meaning the total content and activity of each individual element being analysed. That way, quantitative indicator of soil quality was obtained for each location. Ranking showed the location of Ljubić Polje A to have the best quality soil, whereas that of Mršinci had the lowest quality soil.

Key words: soil fertility, soil contamination, soil quality, radionuclides, hazardous and harmful substances, basic parameters of fertility, AHP, PROMETHEE, quality indicators.

1. INTRODUCTION

Like air and water, soil is an integral component of our environment and, together with water, constitutes the most important natural resource. The wise use of this vital resource is essential for sustainable development and feeding the growing world population [1]. Allowing primary production in terrestrial ecosystems, soil provides about 99% of food for humanity and is a precondition for existence of life on earth. For this reason it is necessary to maintain its function and quality [2].

There are different views about the soil quality. For people active in production agriculture, it may mean highly productive land, sustaining or enhancing productivity, maximizing profits, or maintaining the soil resource for future generations. For consumers, it may mean plentiful, healthful, and inexpensive food for present and future generations. For naturalists, it may mean soil in harmony with the landscape and its surroundings, and for the environmentalist, it may mean soil functioning at its potential in an ecosystem with respect to maintenance or enhancement of biodiversity, water quality, nutrient cycling, and biomass production [3].

In this paper, under the term “quality soil”, we considered the soil of high fertility, which at the same time has low concentrations of hazardous and harmful substances, as well as the minimum radionuclide activities.

The most important characteristic of soil, from the ecological standpoint, is its fertility. Fertile soil represents the basic means for agricultural production. Fertility is the ability of soil to provide plants with necessary nourishment, water, air, heat, and other factors of life during the entire growing period, so as to achieve maximum yields [2]. Many agro chemists interpret fertility as the content of soil nutrients available to plants. Thus, a high level of fertility implies high organic matter (humus) content, high content of different forms of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) available to plants, as well as soil chemical reaction (pH) value close to neutral.

Serbian Book of Regulations on allowed content of hazardous and harmful substances in soil and irrigation water, and the analysis methods [4], states ten main elements contaminating agricultural soil and threatening its productivity and fertility. The Book of Regulations classifies them into two groups, *i.e.* hazardous (Cd, Pb, Hg, As, Cr, Ni, and F) and harmful (Cu, Zn and B). According to the International Agency for Research on Cancer (IARC), some of the elements mentioned above, including chromium, cadmium, lead and nickel, are potential cancer agents [5]. The criterion for the assessment of soil contamination with these elements are maximum allowable concentrations (MAC) allowed in soil.

The presence of radioactive elements or radionuclides can contaminate agricultural soil even to a greater extent. The activities of natural radionuclides ^{238}U , ^{226}Ra , ^{232}Th and ^{40}K *i.e.* their mutual radiation energy accounts for some 98% of the total radiation of natural radioactive elements. As for the anthropogenic radionuclides, ^{137}Cs is the most widespread and the most dangerous one for both humans and other living organisms.

The National Strategy of Sustainable Development [6] addresses the key national priorities of the Republic of Serbia, whose fulfillment will most contribute

to achieving the vision of sustainable development by 2017. The fifth section presents the objectives, priorities and measures related to the protection of the soil.

The strategic objectives of sustainable soil use include:

- Preventing further loss of soil and the conservation and improvement of its quality;
- Protection against degradation and soil use changes, and development of agricultural soil.

The National Programme of Environmental Protection [7] lists “the lack of systematic monitoring of soil quality” as one of the problems in the framework of sustainable soil use in the Republic of Serbia.

With this in mind, this paper presents an approach to evaluation of soil quality, through integration of two specific multicriteria methods – one for parameter weighting and one for the ranking of alternatives, wherein quantitative indicator was obtained for each alternative. Thus, we performed comprehensive soil quality analysis where soil quality was expressed through quantitative indicators *i.e.* we quantified soil quality.

The ranking which involved thirty criteria on thirty locations (alternatives) was done using the PROMETHEE (Preference Organization Method for Enrichment Evaluation) multi-criteria decision making method while the AHP (Analytic Hierarchy Process) method was used as an objective technique to determine criteria weights.

2. MATERIALS AND METHODS

2.1. STUDY AREA

Čačak Valley is located in western part of central Serbia. It is a narrow belt approximately 70 km long in the NW–SE direction and 5 to 18 km wide. Its surface area is over 270 km² and it lies at an elevation of 200 m to 300 m. The Kablar, Ovčar, Troglav, Stolovi, Goč, Suvobor, Vujno and Kotlenik Mountains border the basin in the SW and NE directions [8].

Study area extends from Pakovračće and Prijedor in the north west to Mrčajevci and Mršinci in the south east (Fig. 1).

Names of places and coordinates of the sampling sites examined are presented in Table 1 in [9]. The exact position of each sampling site was recorded using Global Positioning System (GPS).



Fig. 1 – Čačak Valley.

2.2. METHOD OF SAMPLING AND MEASUREMENT

Samples were collected in spring 2013. Samples of cultivating soil (1 kg) in the disordered state were taken from depths of 0 cm to 30 cm. The sample material was thoroughly mixed and homogenised to reach the size of the analytical sample.

Total content of examined hazardous and harmful substances in soils was identified by the methodology presented in [10], while the radionuclide activities were identified by the methodology presented in [9].

Contents of the basic parameters of soil fertility were determined by standard methods for soil analysis used in the laboratory of the Faculty of Agronomy in Čačak. Organic matter (humus) was determined using the Kötzmán method, while pH value in 1.0 M KCl was checked using the potentiometric method (using glass electrode pH-meter). Easily available phosphorus and potassium were determined using the Al-method according to Egner-Riehm [11], the former being identified by spectrophotometry, and the latter by flame-photometry. Total nitrogen was determined using Kjeldahl method modified by Bremner. The results are expressed in mg/100 g of air-dried soil. Samples were left to air dry for 2 to 3 weeks prior to analyses.

2.3. MULTI-CRITERIA DECISION-MAKING METHODS PROMETHEE AND AHP

For the purpose of solving the problem defined in this paper, AHP method was used for assigning relative weights of the criteria that later served for PROMETHEE rankings.

AHP method, or multi-hierarchical criteria, is especially suitable in cases with multiple criteria where they can be grouped into several functional units [12, 13, 14]. On the other hand, PROMETHEE method is particularly useful for the selection of sites, ranking of sites and prioritization of remedial actions [15]. It is based on determining the positive (Φ^+) and the negative flow (Φ^-) for each alternative towards outranking relations and in correlation with the acquired weight coefficients for each criterion [8, 9, 10]. In the case of this research, the alternatives were the investigated locations and the ranking criteria were the thirty elements examined.

Defining appropriate preference function is also necessary when implementing PROMETHEE method. The preference function defines how pairwise evaluation differences are translated into degrees of preference. It reflects the perception of the criterion scale by the decision-maker [17]. The preference functions are crucial because they define how much one object is to be preferred to others [19].

In this paper, the VPSolutions Visual PROMETHEE 1.3 software was used to apply PROMETHEE I for partial – and PROMETHEE II method for complete ranking of the alternatives. As for the AHP method, we implemented it through MS Excel [20].

2.3.1. Criteria weighting

The weighing of the criteria is known to play a major role in MCDM. It is thus essential for decision makers to be able to see to what extent changes of the weights of the criteria will impact the rankings provided by the multicriteria method [16, 17]. Regardless of whether the method of criteria evaluation is verbal, graphical or numerical, if the number of criteria is greater than 7, and there are some conflicting criteria (*e.g.* min/max), or with low contrast of importance, there is objective difficulty of gradation of their importance for the final decision [21].

The AHP method allows the classification of parameters and criteria in hierarchical levels. In AHP weight assignment, every comparison between two elements of the hierarchy is performed based on the Saaty's Rating scale (Table 1) or so-called "nine-point" scale [22], while the results of comparison between elements are written into appropriate comparison matrix.

Table 1
Saaty's Rating Scale

Intensity of Importance	Definition	Explanation
1	Equal Importance	Two activities contribute equally to the objective
2	Weak or slight	
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	
7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation
Reciprocals of above	If activity i has one of the above non-zero numbers assigned to it when compared with activity j , then j has the reciprocal value when compared with i	A reasonable assumption
1.1–1.9	If the activities are very close	May be difficult to assign the best value but when compared with other contrasting activities the size of the small numbers would not be too noticeable, yet they can still indicate the relative importance of the activities.

3. RESULTS AND DISCUSSION

It is needless to say that not all the elements exert identical polluting influence on soil nor have identical positive effects on soil from the standpoint of its fertility. Therefore they are defined by weight of each criterion. Given that there were 30 criteria in this case, we employed AHP MCDM method for defining criteria weights. A complex decision problems, such as this one, are structured into a number of hierarchical levels, assigning weight in the form of a series of comparison matrix pairs, after which they determine the normalized weight on each level. AHP decision tree for the problem of this paper is presented in Figure 2.

The aim of multi-criteria analysis (quantitative determination of soil quality) is positioned on top of the hierarchy. Criteria groups are on the second level of the hierarchy and criteria are on the third level. The last hierarchical level holds the locations within the examined area (alternatives).

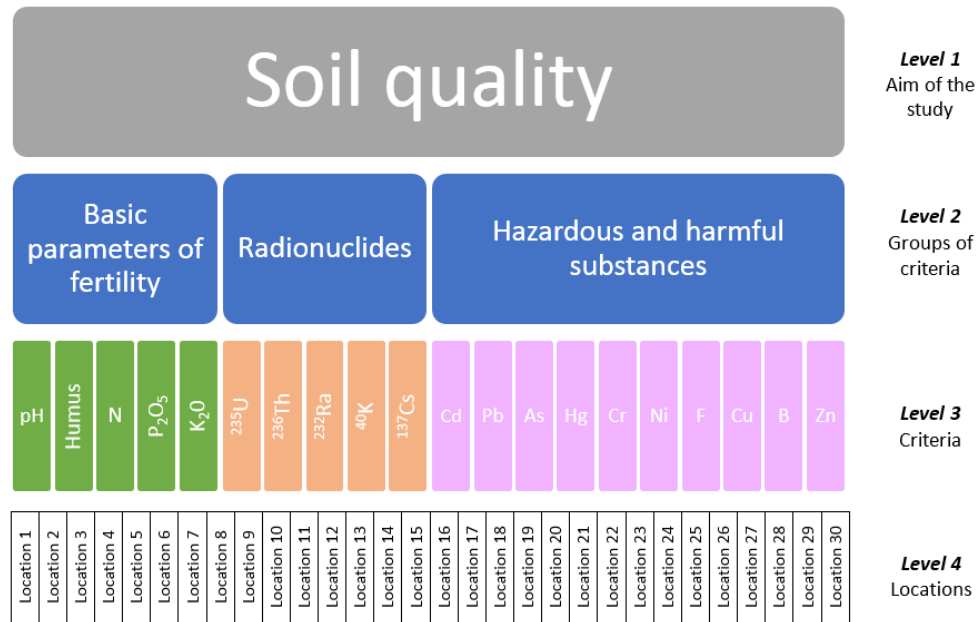


Fig. 2 – AHP decision tree.

Table 2a represents the comparison matrix for the first hierarchical level of the problem presented in Figure 2.

Table 2a

AHP comparison matrix for criteria groups

	Basic parameters of fertility	Radionuclides	Hazardous and harmful substances
Basic parameters of fertility	1	0.5	3
Radionuclides	2	1	5
Hazardous and harmful substances	0.33	0.2	1

Normalized matrix is shown in Table 2b. The values were summed by rows and displayed in the column Σ . They were then divided by the number of columns (in this case 3) and the average values, or the weights for a given group of criteria were obtained.

Table 2b

Normalized comparison matrix for criteria groups

	Basic parameters of fertility	Radionuclides	Hazardous and harmful substances	Σ	Weights
Basic parameters of fertility	0.300	0.294	0.333	0.927	0.309
Radionuclides	0.600	0.588	0.556	1.744	0.581
Hazardous and harmful substances	0.100	0.118	0.111	0.329	0.110

The same scenario was used for the second hierarchical level. Comparison matrices for the individual criteria within three criteria groups were defined. After the normalization.

Subsequently, the weights for every individual criterion of the defined decision problem were obtained and presented in Table 3. Final weights were derived by multiplying weights of criteria groups (Table 2), from the first level, by criteria weights from the second level of hierarchy. Consistency for the derived criteria weights was analyzed on both hierarchy levels by calculating the degree of consistency [23]. Considering that all of the calculated consistency indices are lower than 0.1, one can conclude the derived weights are satisfactory.

Table 4 represents the evaluation table for PROMETHEE rankings according to the values of all the criteria (analysed elements) for all alternatives (locations).

The presence of radionuclides and hazardous and harmful substances in soil is considered as a form of pollution, therefore those criteria were defined as the undesirable (min), while the presence of basic parameters of fertility are desirable (max).

Preference functions chosen for the criteria, as well as indifference and preference thresholds (Q and P) are also shown in the table. Due to the quantitative nature of all the criteria, linear functions were chosen. In addition, descriptive statistics measures are also shown at the end of the table.

The complete ranking of the alternatives (locations) is achieved by calculating the NetFlow (Φ) which represents the difference between the positive and negative flow. The greater the positive flow, the more important the alternative, while the opposite stands for the negative flow. Therefore, for the alternative to be more important from the perspective of the negative flow, it needs to be as low as possible. Table 4 shows the values of the NetFlows, as well as positive (Φ^+) and negative (Φ^-) flows of preferences, obtained from the data shown in Table 3. The locations are sorted descending according to obtained NetFlows from the location with the highest soil quality to the one with the lowest one.

Table 3

Evaluation table

Alternatives	Criteria																				
	Cd	Pb	Hg	As	Cr	Ni	F	Cu	Zn	B	²³⁸ U	²²⁶ Ra	²³² Th	⁴⁰ K	¹³⁷ Cs	pH	Humus	N	P ₂ O ₅	K ₂ O	
max/min	min	min	min	min	min	min	min	min	min	min	min	min	min	min	min	min	max	max	max	max	max
Function	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear
Q:	0.05	3.55	0.02	2.75	6.49	7.04	8.45	2.51	3.04	2.00	8.97	5.05	7.30	91.40	28.53	0.49	0.78	0.04	5.28	4.91	
P:	0.13	8.76	0.06	6.75	14.04	17.35	20.81	6.19	7.50	4.90	21.22	12.01	17.74	219.52	56.52	1.17	1.85	0.09	12.53	11.66	
Unit:	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	Bq/kg	Bq/kg	Bq/kg	Bq/kg	Bq/kg	Bq/kg	(%)	(%)	mg/100g	mg/100g	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1. Parmenac	0.21	21.77	0.20	10.30	16.32	49.31	189.34	20.83	61.47	26.77	42	24.0	27.9	351	5.6	6.20	2.21	0.11	3.48	16.8	
2. Pakovračće	0.18	22.32	0.16	6.67	16.45	23.12	213.43	19.09	67.19	34.01	55	22.3	38.3	483	30.9	5.55	3.03	0.15	9.81	28.74	
3. Rđage	0.25	24.56	0.19	7.89	18.84	33.45	185.42	22.13	63.32	29.09	36	25.9	33.8	417	33.9	5.43	3.80	0.19	13.22	27.02	
4. Bejlina	0.27	25.89	0.21	9.02	19.47	54.54	201.87	28.78	64.72	30.82	37	19.6	24.8	353	19.0	6.22	3.21	0.16	2.81	22.56	
5. Ljubić Kej	0.12	33.02	0.24	10.98	22.32	43.97	217.45	22.13	71.30	31.77	43	22.4	25.8	317	17.4	6.17	2.93	0.15	1.88	22.86	
6. Prijedor A	0.31	19.45	0.15	12.36	17.39	29.26	209.31	20.01	72.59	32.45	32	19.4	25.1	320	156.2	5.38	3.60	0.18	1.92	26.35	
7. Prijedor B	0.29	34.56	0.22	14.67	37.32	38.79	194.87	26.24	66.34	27.34	60	20	34	410	28.1	5.67	4.22	0.21	3.60	17.43	
8. Prijedor C	0.17	26.78	0.20	11.01	39.72	24.77	190.62	27.99	61.17	26.08	44	37.0	45	430	56	5.90	4.27	0.21	11.63	22.29	
9. Prijedor D	0.22	20.67	0.16	16.34	17.92	34.56	201.55	28.76	65.99	29.63	41	20	16.1	282	48.9	5.45	4.10	0.21	19.63	32.23	
10. Suvj Breg	0.15	21.02	0.17	15.35	17.30	48.78	205.20	19.90	72.03	30.67	28	21.5	20.4	296	21.6	6.40	3.80	0.19	2.86	16.65	
11. Stanići	0.11	23.34	0.23	5.58	18.78	50.06	191.29	20.13	62.23	34.02	42	26.5	38	502	61.7	6.48	4.63	0.23	22.05	38.00	
12. Mojsinje	0.34	30.47	0.25	4.47	16.64	38.29	204.38	23.45	61.72	31.99	43	22.5	39.9	500	62.0	6.60	5.67	0.28	14.81	28.63	
13. Donja Gorevnica	0.35	31.90	0.18	9.63	19.39	27.59	210.17	27.80	70.89	30.01	53	31.2	44.2	520	30.3	5.70	4.72	0.24	11.24	30.66	
14. Mračjevci A	0.16	28.87	0.21	7.24	19.69	37.66	193.49	23.78	69.44	27.34	48	22.7	35.7	446	34.2	6.93	5.68	0.28	3.47	24.65	
15. Mračjevci B	0.28	26.05	0.20	14.76	23.63	40.50	207.83	19.29	67.55	28.37	56	26.4	40	597	46.5	6.63	3.28	0.16	6.61	17.87	
16. Kukići	0.26	29.64	0.17	12.23	19.38	39.23	204.13	22.73	68.34	31.32	44	35.7	50.7	416	28.2	6.33	3.71	0.19	4.41	18.82	
17. Mršinci	0.33	33.84	0.16	10.94	30.39	48.34	218.33	25.38	64.22	33.92	63	37.4	46.6	401	34.8	4.89	2.78	0.14	0.17	20.81	
18. Zablace	0.19	25.33	0.23	12.18	31.72	31.49	201.11	21.66	61.01	26.12	60	35.7	44.7	285	5.2	6.21	4.51	0.23	12.50	26.77	
19. Vapa	0.28	22.13	0.19	9.17	19.92	25.26	193.29	19.63	70.06	28.88	48	27.9	39.8	452	23.8	6.50	3.90	0.20	17.63	26.68	
20. Tmavška Baluga	0.21	30.65	0.15	8.61	17.30	50.72	183.81	23.39	63.33	26.40	64	34.6	46.6	585	73.3	7.11	2.62	0.13	4.44	27.63	
21. Tmava	0.20	32.18	0.23	7.66	16.98	39.45	189.32	24.98	65.77	30.33	51	33.7	43.4	610	64.5	6.43	3.12	0.16	11.64	17.43	
22. Ateica	0.19	29.34	0.21	10.73	16.40	45.69	182.65	26.24	67.32	34.67	58	35.4	43.6	652	54.4	5.93	1.94	0.10	4.61	11.89	
23. Konjevići A	0.23	19.97	0.16	6.39	18.39	41.09	199.30	19.22	66.91	32.38	60	25.0	33.4	538	54.8	5.58	3.67	0.18	11.44	19.63	
24. Konjevići B	0.27	29.06	0.19	5.59	19.47	42.36	204.39	22.23	71.23	30.49	45	26.6	32.2	378	37.7	4.96	3.12	0.16	0.88	21.95	

Table 3
(continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
25. Konjevići C	0.25	31.33	0.15	12.82	22.95	36.14	208.42	26.86	63.14	27.41	47	24.7	31.1	414	33.6	6.39	2.21	0.11	16.33	24.84	
26. Konjevići D	0.28	23.40	0.20	14.44	29.65	28.34	210.01	24.01	65.85	28.18	36	24.0	28.6	328	38.4	5.96	2.82	0.14	1.86	17.83	
27. Ljubić Polje A	0.32	26.04	0.25	16.17	35.78	25.45	213.59	27.91	69.01	30.29	20	16.2	19.0	281	21.5	7.25	3.18	0.16	12.14	23.67	
28. Ljubić Polje B	0.17	30.08	0.22	5.59	33.98	30.34	216.66	24.31	71.51	29.30	60	24.1	27.8	356	34.0	5.48	3.33	0.17	11.12	19.87	
29. Prejinska Baluga A	0.21	25.66	0.18	8.40	27.93	44.92	215.26	22.15	72.66	32.16	49	27.1	34.2	435	52.4	6.54	4.23	0.21	1.26	12.97	
30. Prejinska Baluga B	0.27	22.70	0.16	7.27	26.29	41.95	194.63	27.47	61.13	30.65	48	33.7	41	658	76.7	6.55	2.36	0.12	17.33	28.48	
STATISTICS																					
Minimum	0.11	19.45	0.15	4.47	16.32	23.12	182.65	19.09	61.01	26.08	20.00	16.20	16.10	281.00	5.20	4.89	1.94	0.10	0.17	11.89	
Maximum	0.35	34.56	0.25	16.34	39.72	54.54	218.33	28.78	72.66	34.67	64.00	37.40	50.70	658.00	156.20	7.25	5.68	0.28	22.05	38.00	
Average	0.24	26.73	0.19	10.15	22.92	38.18	201.70	23.62	66.65	30.10	47.10	26.79	32.93	433.87	43.05	6.09	3.56	0.18	8.56	23.07	
Standard Dev.	0.06	4.38	0.03	3.37	6.92	8.68	10.41	3.09	3.75	2.45	10.56	5.98	9.32	109.34	28.02	0.58	0.92	0.05	6.24	5.80	

Table 4

Preference flows

No.	Location	Φ	Φ^+	Φ^-
1.	27 (Ljubić Polje A)	0.3424	0.4057	0.0633
2.	14 (Mrčajevci A)	0.2722	0.3080	0.0358
3.	10 (Suvi Breg)	0.2076	0.2624	0.0548
4.	12 (Mojsinje)	0.1981	0.2868	0.0887
5.	9 (Prijevor D)	0.1586	0.2529	0.0942
6.	4 (Beljina)	0.1562	0.2186	0.0623
7.	11 (Stančiči)	0.1425	0.2305	0.0880
8.	5 (Ljubić Kej)	0.1195	0.1992	0.0797
9.	1 (Parmenac)	0.0947	0.2023	0.1076
10.	19 (Vapa)	0.0906	0.1652	0.0745
11.	26 (Konjevići D)	0.0576	0.1567	0.0991
12.	7 (Prijevor B)	0.0569	0.1792	0.1223
13.	29 (Preljinska Baluga A)	0.0538	0.1480	0.0942
14.	25 (Konjevići C)	0.0530	0.1579	0.1049
15.	3 (Ridage)	0.0488	0.1480	0.0992
16.	2 (Pakovraće)	0.0393	0.1581	0.1188
17.	28 (Ljubić Polje B)	0.0368	0.1535	0.1167
18.	23 (Konjevići A)	-0.0102	0.1276	0.1378
19.	15 (Mrčajevci B)	-0.0335	0.1108	0.1442
20.	18 (Zablaće)	-0.0475	0.1893	0.2369
21.	6 (Prijevor A)	-0.0517	0.2071	0.2588
22.	24 (Konjevići B)	-0.0692	0.1027	0.1719
23.	13 (Donja Gorevnica)	-0.0870	0.1149	0.2019
24.	16 (Kukići)	-0.1695	0.0841	0.2535
25.	8 (Prijevor C)	-0.1699	0.1018	0.2717
26.	21 (Trnava)	-0.2091	0.0699	0.2790
27.	30 (Preljinska Baluga B)	-0.2469	0.0942	0.3411
28.	20 (Trnavska Baluga)	-0.2637	0.1171	0.3807
29.	22 (Atenica)	-0.3659	0.0316	0.3975
30.	17 (Mršinci)	-0.4049	0.0300	0.4349

The complete ranking of alternatives shows that the location with the highest soil quality was Ljubić Polje A (Location 27) with Net Flow $\Phi = 0.3424$, whereas the location with lowest soil quality was Mršinci (Location 17) with Net Flow $\Phi = -0.4049$.

Given that the above locations were already ranked in a similar way according to soil radioactivity [9], we compared these results with the results

obtained in this study. It is interesting that the location with the lowest soil radioactivity (Ljubić Polje A), is at the same time location with the best soil quality. This should not be surprising considering that the radionuclides as a criteria group within the soil quality problem had the weight of 0.581 (Table 2b). Also, the weights of radionuclides presented in [9] subjectively determined based on the radiotoxicity classification specified in ISO 2919:2004 standard [24], were in proportion with their objective weights obtained by using AHP method in this paper.

4. CONCLUSION

Apart from being the source of food and water, soil is also the source of biodiversity and the living environment of human beings. Therefore, it is necessary to regularly monitor the state of the soil in order to protect quality of life and survival of the living world itself. This statement largely relates to the cultivable soil whose fertility, as its most important characteristic, is crucially responsible for the yield which has an immediate effect on both quantity and quality of human diet. Besides fertility, soils are affected by many pollutants among which radionuclides and hazardous and harmful substances are the most common ones.

This paper proposes a comprehensive methodology of assessment and comparison of different locations according to soil quality viewed as desirable presence of basic parameters of fertility and absence of radionuclides and hazardous and harmful substances. Analyses of samples taken from 30 locations which are very similar in terms of soil type, were ranked from the most favourable to the least favourable ones from the standpoint of soil quality based on thirty criteria (elements) using the PROMETHEE method of multi-criteria analysis in combination with AHP method for objective defining of criteria weights.

The results suggest that the soil of the highest quality was in Ljubić Polje A (Location 27), while the location with lowest quality of soil was Location 17 (Mršinci).

Method of assessment and comparison of soil quality on different locations, presented in this paper, could be applied in the number of other studies where the number of criteria and criteria groups could be even greater.

It can be concluded in general that the soil in Čačak basin has slightly acidic reaction, that it is medium supplied with humus, as well as with nitrogen and phosphorus, but is well supplied with potassium. Additionally, neither radioactivity, nor the presence of hazardous and harmful substances in soil is increased relative to the region and the legislative reference values *i.e.* maximum allowable concentrations.

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