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Quality Assessment Through Land Use Change, Land Surface Temperature – An Environmental Factors Analysis

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ABSTRACT

The study of soil physico-chemical properties is an important field related to the aspect of climate change and the storage of organic carbon in soil. This field of scientific research aims to identify the impact of land management practices on the physico-chemical parameters of soil composition. This study is based on laboratory analysis and various observations of various soil physicochemical parameters, such as pH-H_2O, electrical conductivity (EC), organic matter (OM), soil organic carbon (SOC), SOC t/ha, and specific gravity (BD) g/cm^3. This study helps develop strategies to implement improved land management sustainably. The soil specific gravity averages 1.38 g/cm^3, with low variability (Std. Dev. = 0.03337), the coefficient of variation (CV) is 2.410378%, indicating a low variation about the mean, while the skewness is negative (-0.78464), while the kurtosis is positive (1.766186). Some of the differences (OM, SOC, SOC t/ha) have a high variability, while others have a lower variability (EC μS/cm, pH 1:2.5, BD g/cm^3). This may indicate that some soil characteristics are more stable, while others have a higher degree of variability.

Keywords: soil management, climate change, organic carbon.

INTRODUCTION

Land constitutes the essential basis of nature and life for humans, animals, and plants, it is the capital of a farmer (Hoxha et al., 2023). Without properly managed land, there can be no land conservation re-destination or land management (Moraru et al., 2012). Failure to maintain soil fertility will reduce yields for farmers as soil is essential for agriculture and natural vegetation. Climate regulators store organic carbon up to 75% globally (Gashi et al., 2023). In 2025, the global population is expected to grow to 8.5 billion people, with an annual increase of 77 million. However, this population growth is occurring alongside a worrying trend of land loss around the world (Sheoran et al., 2011). The world's land area is shrinking at a rate of 12 million hectares per year, according to the United Nations (Shala et al., 2023). Similarly, Kosovo is also experiencing land loss with an annual decline of 1000-5000 hectares. In 2000, the available fertile land per person was 0.22 ha, this figure was at the world level (Taszakowski et al., 2016). According to this research, by 2050, this figure is expected to decrease to 0.17 hectares per person (Możdżer et al., 2017). For this reason, there is social and political consensus on the need to manage land most sustainably (Shala et al., 2023). Plant breeding plays a key role in agricultural land management (Ahmadpour et al., 2012). Increasing yields by achieving continuous progress in plant breeding without the need to expand agricultural land to a similar extent (Shala Abazi et al., 2022). Planting and cultivation of crops and specialty crops can be a forward-looking approach to maintaining and improving soil fertility (Halecki et al., 2018). Kosovo has an area of 577,000 ha of agricultural land. The average farm size is 2.2–2.4 ha and fragmented into 6–8 plots. The area of agricultural land per capita is among the lowest in Europe at about 0.15 ha. Based on these indicators, the pressure on the ground is expected to increase (Ndaba et al., 2023). In this context, it is first required that the information on the land is adapted to this situation (Dreshaj et al., 2022). Planning and agricultural activities require more and more soil data.

MATERIALS AND METHODS

The purpose of the study is to provide a clear overview of the materials and methods that were used in this research (Dreshaj et al., 2023). The main studies were carried out in the choice of analysis methods:

a) method for choosing locations;
b) locations of research areas;
c) sampling and sampling design, and
d) summary of laboratory work, all locations for this research were chosen based on the 1974 pedological map of Kosovo.

While the random method was used for site selection, the 2006 Land Description Guidelines will be used for terrain description. Two plots that are under different land management have been researched, Bllagaje village with three plots under different land management, and Vitomericë village with three plots under different land management.

SAMPLING AND DESIGNING FOR SAMPLING

Two different forms of soil sampling were used, composite (distributed) samples were taken on the surface of the arable soil at a depth of 0–30 cm (Sandra et al., 2012). Through the manual probe, soil chemical analyses are performed for organic matter such as organic carbon, pH, carbonates, and macro elements (Tangkanakul et al., 2009). Undispersed soil samples were taken through cylinders with a volume of 100 cm^3, in the working layer of the soil where the analysis of the specific weight of the soil (soil density) will be done (Soong et al., 2004). Diagonal methods with three replications were used to prepare the composite sample of a sampling site in Table 1.

During May 2023, broken and intact soil samples were collected to determine a variety of chemical and physical soil parameters (Nsaif et al., 2024). Detached soil samples were used to estimate soil organic carbon (SOC), pH, and calcium carbonate (CaCO^3) parameters, as well as to analyze macronutrients (Li et al., 2017). On the other hand, undisturbed soil samples were used to determine soil density (BD). During the sampling process, about 500 grams were taken from each soil horizon for each soil sample taken from the selected wells (Patil et al., 2024). The samples were placed in plastic bags and carefully identified to be sent to the laboratory for chemical analysis (Ozderin 2024). Regarding the collection of continuous soil samples, one sample is taken for each soil horizon through 14 "Kopecky" rings with a volume of 100 cm^3 (Sudarno et al., 2024). After collection, the Kopecky rings were covered with aluminum foil and packed in special bags in the laboratory to preserve the original soil structure in Figure 1.

After drying, the ground samples are placed in a suitable environment for storage. This grinding and storage phase was performed to maintain the quality of the samples and ensure that they were ready for further laboratory analysis. The process of drying, grinding, and storing the samples in an open environment is of great importance for maintaining the quality of the samples, which will be

Table 1. Analyzed parameters

Parameters to be analyzed	Unit	Methods
Chemical parameters	%	WTW pH meter, SR ISO 15705;2002, SR ISO 9174–98. Nephelometer. Digital conductivity meter.
Organic matter in soil	%	(Walkley and Black, 1934)
Organic carbon in soil	%	(Walkley and Black, 1934)
pH	mg/100g	(ISO, 10390: 2005)
Macro elements	mg/100g	Plasma mass spectrometry (ICP-MS). Determined using AAES with MAES.
Physical parameters	g/cm^3	(Mehlich, 1984)

Figure 1. The process of drying the samples in the open environment

used to evaluate the chemical parameters of the soil. The samples are dried at a temperature of 105 ^{O}C until all free and hygroscopic moisture is removed from the sample in Figure 2. The Walkley-Black procedure was followed to quantify soil organic carbon. One gram of dried soil sample was mixed with 10 ml of 0.1667 M potassium dichromate and 20 ml of 36% sulfuric acid. After 30 minutes, add 250 ml of distilled water and 3–4 drops of indicator solution. 1 M ferrous sulfate was used for titration. This laboratory method, known as the "Walkley-Black" procedure, is used to estimate the amount of organic carbon in soil. The procedure was developed by Walkley-Black in 1934 and is well known for estimating soil organic carbon.

Specific gravity was determined using Kopecky metal rings and dry samples expressed in (g/cm^3) of metal rings were calculated. Kopecky metal rings were used to estimate the bulk density of a soil sample. With this method, the dried samples were placed in certain metal rings and the weight of the samples was recorded. The overall density was then calculated using the formula to divide the mass by the volume occupied by the metal rings. This method is based on the work of (Blake, 1986; De la Rosa, 2003) and is a common way to determine soil density in toxicology and plant science laboratories in Figure 3.

RESULTS AND DISCUSSION

The study presents the results of soil samples taken in the region of Peja and Istog, in the villages:

a) Vitomirice (VO1, VK2, VKI3);
b) Blagaja (BO1, BK2, BKI3);
c) Trubohoc (TO1, TK2, TKI3).

The study was carried out during the spring of 2023. The soils of this region are known as light clay-sandy soils. The physicochemical properties of soils have been compared between them in different forms of cultivation Table 2.

Physico-chemical properties of soils in organic production EC of the soil expressed in μS/cm is on

Figure 2. Sample drying process in a controlled environment (oven)

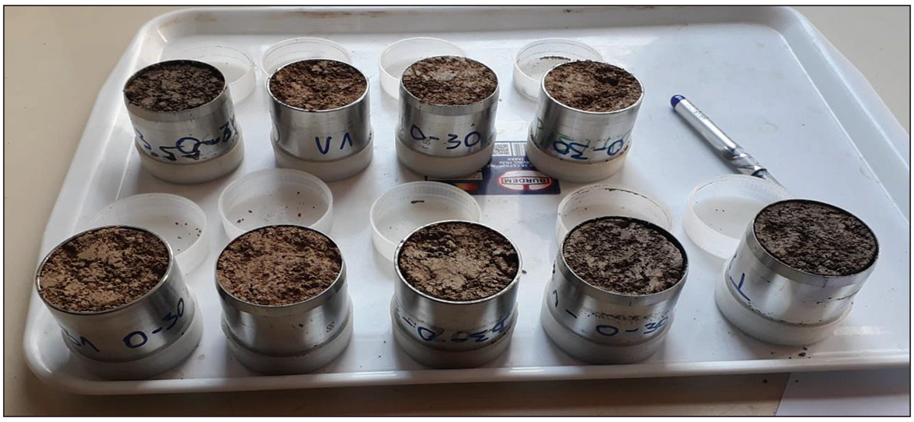

Figure 3. Procedure for determining the specific gravity of soil [BD]

Table 2. Soil characteristics under organic production

Parameters	Minimal	Maximum	Average	Std. Dev.	CV,%	Skewness	Kurtosis
EC μS/cm	289	328	306.56	13.78494	4.49672	0.252089	-1.59373
pH [1:2.5]	6.08	7.39	6.83	0.547177	8.006164	-0.50293	-1.71544
OM%	2.42	4.28	3.09	0.759239	24.57085	0.706399	-1.60183
SOC%	1.4036	2.4824	1.79	0.440359	24.57085	0.706399	-1.60183
SOC t/ha	59.36137	105.0139	74.63	19.25341	25.80005	0.709175	-1.62752
BD g/cm³	1.31	1.43	1.38	0.03337	2.410378	-0.78464	1.766186

Note: Std. Dev – standard deviation; CV – coefficient of variance; EC – electrical conductivity; OM – organic matter; SOC – soil organic carbon; BD – specific gravity of soil.

average 306.56 μS/cm, with low variability (Std. Dev. = 13.78494) and a coefficient of variation of 4.49672%. The skewness is positive (0.252089), while the kurtosis is negative (-1.59373), and the soil pH [1:2.5] averages 6.83, with a moderate variability (Std. Dev. = 0.547177). The coefficient of variation is 8.006164%, indicating a moderate variation relative to the mean, while the skewness and kurtosis are negative, respectively (-0.50293) and (-1.71544).

Soil organic matter averages 3.09%, with a high variability (Std. Dev. = 0.759239), the coefficient of variation is 24.57085%, indicating a high variation relative to the mean, while the skewness is positive (0.706399), while the kurtosis is negative. values (-1.60183). Organic carbon as an indicator of soil fertility is on average 1.79%, with a high variability (Std. Dev. = 0.440359), the coefficient of variation is 24.57085%, which shows a high variation about the average, while the skewness is positive (0.706399), while the kurtosis is negative (-1.60183). The total content of organic carbon in the soil calculated on the surface of 30 cm of soil per hectare is on average 74.63 t/ha, with high variability (Std. Dev. = 19.25341), the coefficient of variation is 25.80005%, showing a high variation compared to the mean, while the skewness is positive (0.709175), while the kurtosis is negative (-1.62752) Table 3.

Soil electrical conductivity expressed in μS/cm varies from 311 μS/cm to 374 μS/cm, with an average of 332.56 μS/cm. The level of variability is quite high with a standard deviation of 26.80427. The coefficient of variation with a value of 8.060089%, the skewness is positive (0.706074), while the kurtosis is negative (-1.6582). Soil pH values range from 6.74 to 8.07 with an average of 7.34. The level of variability is relatively low, with a standard deviation of 0.537608 and the coefficient of variation has a value of 7.321033%, while the skewness is positive (0.32352), while the kurtosis is negative (-1.71121). The content of organic matter in the soil varies from 2.18% to 3.65% with an average of 2.75%. The level of variability of OM is higher than the standard deviation of 0.619265, and the coefficient of variation is estimated to be 22.49146%, while the skewness is positive (0.648321), while the kurtosis is negative (-1.69392).

Soil organic carbon content ranges from 1.2644% to 2.117% with an average of 1.60%. The level of variability is relatively low with a standard deviation of 0.359174, and the coefficient of variation is presented at 22.49146%. The skewness value is positive (0.648321), while the kurtosis is negative (-1.69392). The total soil organic carbon content calculated on the surface of 30 cm of soil per hectare varies from 56.5232 t/ha (minimum) to 99.08353 t/ha (maximum), with an average of 73.80 t/ha. The level of variability is high with a standard deviation (Std. Dev.) of 17.96189, and the coefficient of variation is presented at 24.33788%, while the skewness is positive (0.628669), while the kurtosis is negative (-1. 70687). The specific gravity of the soil ranges from 1.49 g/cm³ to 1.59 g/cm³ with an average of 1.53 g/cm³. The level of variability is low (Std. Dev.) of 0.030952, and the coefficient of variation results in 2.017145%, while the skewness is positive (0.098349), and the kurtosis is negative (-0.3682).

Physico-chemical parameters such as EC µS/cm present a significant positive correlation only with pH with chelation 0.906203). A moderate positive correlation with organic matter content (0.311746). A moderate negative correlation with electrical conductivity (-0.05266). The percentage of soil organic carbon has a moderate positive correlation with pH (0.311746). Moderate negative correlation with electrical conductivity (-0.05266). The amount of soil organic carbon in metric tons per hectare has a strong positive correlation with organic matter content (0.996869) and a moderate positive correlation with pH (0.27347). While moderate negative correlation with electrical conductivity (-0.08577), while Earth's density has a moderate negative correlation with electrical conductivity (-0.44256). Moderate negative correlation between pH (-0.34733) and electrical conductivity (-0.44256) while moderate positive correlation with organic matter content (0.416183) and a moderate positive correlation with soil organic carbon content (0.485486) Table 4.

Another very important factor in soil management is the content of organic matter, including organic carbon and the total amount of organic carbon in the soil. In this context, the area of land with organic production shows higher values than the other two conventional ways of cultivation and land management. In this way, the study shows that the three different forms of agricultural land use have different impacts on the characteristics of the land and its management. Emphasizing the importance of choosing appropriate land use for the goals and requirements of agricultural production. Based on the results achieved during this research where differences were observed between

Table 3. Soil characteristics for conventional production

Parameters	Minimal	Maximum	Average	Std. Dev.	CV,%	Skewness	Kurtosis
EC µS/cm	311	374	332.56	26.80427	8.060089	0.706074	-1.6582
pH [1:2.5]	6.74	8.07	7.34	0.537608	7.321033	0.32352	-1.71121
OM%	2.18	3.65	2.75	0.619265	22.49146	0.648321	-1.69392
SOC%	1.2644	2.117	1.60	0.359174	22.49146	0.648321	-1.69392
SOC t/ha	56.5232	99.08353	73.80	17.96189	24.33788	0.628669	-1.70687
BD g/cm³	1.49	1.59	1.53	0.030952	2.017145	0.098349	-0.3682

Note: Std. Dev – standard deviation; CV – coefficient of variance); EC – electrical conductivity; OM – organic matter; SOC – soil organic carbon); BD – specific gravity of soil.

Table 4. Conventional intensive production

Parameters	Minimal	Maximum	Average	Std. Dev.	CV,%	Skewness	Kurtosis
EC µS/cm	293	358	320.11	26.2274	8.193218	0.518857	-1.69874
pH [1:2.5]	6.81	7.61	7.11	0.341272	4.799889	0.677085	-1.69908
OM%	1.54	2.11	1.85	0.197059	10.64542	-0.42715	-1.05748
SOC%	0.8932	1.2238	1.07	0.114294	10.64542	-0.42715	-1.05748
SOC t/ha	40.4652	53.9739	48.51	4.526006	9.330482	-0.84683	-0.29368
BD g/cm³	1.42	1.58	1.51	0.056656	3.754801	-0.47332	-1.06974

Note: Std. Dev – standard deviation; CV – coefficient of variance); EC – electrical conductivity; OM – organic matter; SOC – soil organic carbon); BD – specific gravity of soil.

different ways of cultivating the land. It is very important to implement the rotation of crops, this will affect the preservation of nutrients as well as the prevention of diseases and the degradation of agricultural land. Since three different forms of cultivation, whether organic, conventional, or intensive, have been investigated in three different locations, and based on the results achieved, we recommend maintaining the density and organic composition of the soil to increase the areas of organic soil cultivation.

The results of Table 5 show that there is a strong positive correlation (0.9428) between EC μS/cm and pH [1:2.5], and organic matter presents a strong positive correlation with soil organic carbon and soil specific gravity, respectively 0.999181 and 0.851945. This indicates that a unit in EC μS/cm tends to be associated with an increase in pH and vice versa. Due to large agricultural activities and inappropriate management, it is observed that the physico-chemical properties of the soil do not present a correlation between the properties, especially the negative presentation of the correlation between BD, OM, and SOC. In Table 5 it is observed that EC has shown higher results in plot BO1 compared to VO1 and TO1, similar results are shown for soil pH.

The level of electrical conductivity of the soil varies from 293 μS/cm to 358 μS/cm with an average of 320.11 μS/cm. The standard deviation is 26.2274, indicating a high variability between occurrence values. The coefficient of variation is 8.193218%, which indicates a relatively high variability relative to the mean. Skewness is positive (0.518857), indicating a right-sided response, while kurtosis is negative (-1.69874), indicating a relatively flat screen shape. Soil pH values range from 6.81 to 7.61 with an average of 7.11. The level of variability is relatively low with a standard deviation of 0.341272, and the coefficient of variation is 4.799889%, indicating moderate variability. Skewness is positive (0.677085), indicating a right-sided response, while kurtosis is negative (-1.69908), indicating a relatively flat pattern of occurrence. The percentage of organic matter in the soil ranges from 1.54% to 2.11% with an average of 1.85%. The level of variability is low with a standard deviation of 0.197059, and the coefficient of variation is 10.64542%, indicating moderate variability.

Skewness is negative (-0.42715), indicating a right-to-left response, while kurtosis is negative (-1.05748), indicating a relatively flat event shape. The percentage of soil organic carbon ranges from 0.8932% to 1.2238%, with an

Table 5. Soil characteristics, variability for each of its properties, agricultural and environmental soil potential

Parameters	VO1 (Vitomirice)			TO1 (Blagaja)			BO1 (Trubohoc)		
EC μS/cm	289	291	294	302	310	301	321	323	328
pH [1:2.5]	6.09	6.08	6.09	7.01	7.06	7.04	7.39	7.37	7.38
OM%	2.49	2.61	2.42	4.17	4.28	4.02	2.61	2.62	2.59
SOC%	1.44	1.51	1.40	2.42	2.48	2.33	1.51	1.52	1.50
SOC t/ha	59.36	63.13	59.80	100.14	105.01	100.03	59.50	62.46	62.20
BD g/cm³	1.37	1.39	1.42	1.38	1.41	1.43	1.31	1.37	1.38
Parameters	VK2 (Vitomirice)			TK2 (Blagaja)			BK2 (Trubohoc)		
EC μS/cm	314	311	313	315	312	317	374	369	368
pH [1:2.5]	6.77	6.74	6.75	7.24	7.21	7.22	8.07	8.04	8.05
OM%	2.18	2.21	2.26	3.64	3.65	3.57	2.41	2.43	2.43
SOC%	1.26	1.28	1.31	2.11	2.12	2.07	1.40	1.41	1.41
SOC t/ha	56.52	57.30	60.17	98.81	99.08	98.78	64.58	64.27	64.70
BD g/cm³	1.49	1.49	1.53	1.56	1.56	1.59	1.54	1.52	1.53
Parameters	VKI3 (Vitomirice)			TKI3 (Blagaja)			YKI3 (Trubohoc)		
EC μS/cm	296	293	294	311	307	312	354	356	358
pH [1:2.5]	6.91	6.92	6.89	6.87	6.82	6.81	7.61	7.57	7.59
OM%	1.91	1.90	1.87	2.11	2.06	2.01	1.71	1.55	1.54
SOC%	1.11	1.10	1.08	1.22	1.19	1.17	0.99	0.90	0.89
SOC t/ha	51.18	51.25	51.41	53.97	50.90	49.67	46.72	41.00	40.47
BD g/cm³	1.54	1.55	1.58	1.47	1.42	1.42	1.57	1.52	1.51

average of 1.07%. The level of variability is low with a standard deviation of 0.114294, and the coefficient of variation is 10.64542%, indicating moderate variability. Skewness is negative (-0.42715), indicating a response toward the left, while kurtosis is negative (-1.05748), indicating a relatively flat screen shape. The content of organic carbon in tons per hectare varies from 40.4652 t/ha to 53.9739 t/ha, with an average of 48.51 t/ha. The level of variability is low with a standard deviation of 4.526006, and the coefficient of variation is 9.330482%, indicating moderate variability. Skewness is negative (-0.84683), indicating a response towards the left side, while kurtosis is negative (-0.29368), indicating a relatively flat shape of the event. The specific gravity of the soil ranges from 1.42 g/cm³ to 1.58 g/cm³, with an average of 1.51 g/cm³. The level of variability is relatively low with a standard deviation of 0.056656, and the coefficient of variation is 3.754801%, indicating moderate variability. Skewness is negative (-0.47332), indicating a response towards the left side, while kurtosis is negative (-1.06974), indicating a relatively flat screen shape.

CONCLUSIONS

The studies carried out on agricultural lands, the analytical results have shown the assessment of the quality of the physico-chemical parameters of agricultural lands. The owners of agricultural land, whose activity affects the qualitative results of agricultural land, indicated that they are obliged to protect it from any environmental factor that leads to its destruction. Any physical person, when assessed as the cause of land damage, is obliged to rehabilitate the damaged agricultural land, returning it to its previous state. Sustainability in the natural fertility of agricultural land is essential. The necessity of preserving the physico-chemical parameters of organic matter, according to the type of agricultural land, through the circulation of agricultural crops. The conditions are created for promoting the biological activity of the soil while maintaining the normal level of physico-chemical indicators. Cultivation of agricultural land, in accordance with its relief and atmospheric conditions, not allowing damage to the arable layers of the soil and preserving the physico-chemical parameters of the studied soil.

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