Available online at
http://journals.usamvcluj.ro/index.php/promediu

ProEnvironment

ProEnvironment 8 (2015) 192 - 200

Original Article

Influence of Soil Climate on Elemental Translocation in Soils

DUDA[1*]Bogdan Matei, Teodor RUSU[1], David C. WEINDORF[2]

[1]*University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, 3-5 Manastur Street, 400372, Cluj-Napoca, Romania*
[2]*Department of Plant and Soil Science, Texas Tech University, Lubbock, TX, USA*

Received 20 April 2015; received and revised form 15 May 2015; accepted 20 May 2015
Available online 20 June 2015

Abstract

Soil suitability represents one of the most important conditions for effective use of agricultural lands in the Somesean Plateau, especially given its highly sloped land surface. Since conventional agricultural production systems have caused soil degradation in many countries, effective land management technologies applied to crop rotation, tillage and fertilization systems, pedoameliorative work and crop protection systems must be adapted to protect the soil and water of the area. Soil moisture and temperature play a critical role in land-atmosphere interactions. The study was conducted across eight sites on the Somesan Plateau, Romania, reflective of diverse soil types and slopes. Climate of the area is characterized by an annual average temperature of 7.8°C; average precipitation is ~700 mm y^{-1}; the rainfall regime of the Somesan Plateau has shown great variability over time manifested both by large quantities of precipitation as well as its distribution across the land surface. A total of eight HOBO micro stations were installed for measuring soil temperature, soil moisture, air temperature and precipitations in 2013. Portable X-ray fluorescence (PXRF) spectrometry is a proximal sensing technique which provides elemental data in-situ, in seconds. This study examined the potential of using PXRF for soils in the Somesan Plateau, RO by evaluating 23 soil samples representing a wide variety of soil types found in this area; the samples were taken from the locations where the microstations were installed. Even after one year of data one can determine that moisture affects the exchange of latent heat and influences the overall surface layer characteristics through changes in evaporation. There is a strong link between soil moisture and temperature. A valuable resource in Romania are the growing degree days which have the ability to increase crop productivity over time. Significant differences in air temperatures exist across the Somesan Plateau. These differences need to be acknowledged and correlated with the soil properties when choosing the planting date to utilize the full growing season of the crops.

Keywords: soil temperature, soil moisture, soil development.

1. Introduction

Soil moisture and temperature play a critical role in land-atmosphere interactions. Global soil moisture and temperature observations are useful in hydrology, climatology, agriculture, and meteorology modeling [19, 34, 36, 39, 9]. However, these factors do not universally impact soil pedogenesis.

* Corresponding author.
Fax: +40-264-596384
Tel: +40-264-593792
e-mail: duda.bogdanmatei@gmail.com

Soil moisture impacts earth surface processes in such a way that it creates an obvious synergistic relationship among the various subfields of physical geography [25]; also the dispersive and cohesive properties of soil moisture also make it an important variable in regional and microclimatic analyses, landscape denudation and change through weathering, runoff generation and partitioning, mass wasting, and sediment transport. Several studies have shown that soil moisture acts as feedback on climate in various ways [41].

Soil/atmosphere dynamics can further lengthen soil moisture time scales [7]. Continuity in soil moisture effectively translates into persistent near-surface humidity, with implications on temperature fluctuations and future precipitation events [4, 5, 6, 21, 12, 43, 14, 23, 30]. Also, it enhances the severity and persistence of floods [2, 16, 29], and determines the predictability of atmospheric surface climate anomalies [40, 8]. Therefore, when considering the impact of soil moisture and temperature on soil development in a given region, it is critical to obtain a wide range of soil climate information from different soil depths and sites.

Soil moisture plays a fundamental role in determining soil temperature by affecting the exchange of latent heat and strongly influences the overall surface layer characteristics through changes in evaporation [26, 20, 13, 18]. As such, crop production can be impacted as a results of soil temperature and moisture dynamics. In one sense, soil climate conditions impact the immediate, short-term growth needs of plants by providing moisture and suitable temperatures for growth. But longer term, these same conditions leave a lasting impact on soils; one which differentially impacts soil development from region to region. Furthermore, anthropogenic impacts such as irrigation, tillage frequency, and organic matter management have the potential to alter soil development through indirect alterations of soil thermal and moisture dynamics. For example, organic matter levels in soil are enhanced by limiting tillage. Higher organic matter levels typically result in darker soil colors which subsequently absorb more solar radiation and keep soils warmer. New technologies germane to sustainable agriculture are based upon crop rotation, reduced energy consumption, development / implementation of integrated management of plant protection, and technologies based on recoverable resources [15, 33, 10]. Similarly, repeated irrigation in soils may provide sufficient moisture to allow for eluviation/illuviation processes to occur in soils that might otherwise not have sufficient natural rainfall to facilitate such processes [10]. In this manner, soil moisture and temperature impact not only crop growth, but longer term, soil pedogenesis as well.

Soil development (pedogenesis) can be conceived as the product of temporal soil physical, chemical, biological, and hydrological processes. Such processes include soil moisture infiltration and percolation, freezing and thawing, root exploration and organic matter incorporation, soil biota population dynamics, chemical dissolution, reprecipitation, and nutrient cycling (e.g., mineralization and immobilitation). Infiltration is a complex physical process in time and space which is difficult to precisely characterize under intrinsic heterogeneous and dynamic soil conditions such as variable soil texture, compaction, moisture content, slope, thickness of the horizons, root development and soil aggregation [32]. Conversely, hydrophysical attributes influence many hydrological processes including infiltration, runoff erosion process, percolation and redistribution of pesticides leaching and migration of contaminants through the soil profile [1]. Products of soil pedogenesis can oft be observed morphologically in the form of soil structural development (e.g., stronger structural grade with depth), soil color development (e.g., redder hue with depth), and the development of diagnostic subsurface horizons/features in given parts of the profile. For instance, many old, established profiles have a regular decrease in organic carbon with depth as rooting percentage decreases deeper in the profile relative to the surface.

Similarly, accumulations of clay, $CaCO_3$, $CaSO_4$, Fe oxides, and redoximorphic conditions typically develop in soil profiles with andvanced age. All of these factors have the potential to influcence crop growth.

In the contest of geologic time scales, anthropogenic impact on soil properties is comparatively small. So small in fact that morphological recognition of changes in soil properties imparted by management impact may be difficult to discern. However, new portable, proximal sensing technologies can be used to collect both elemental as well as spectral data which detect even minute changes in soil physicochemical properties.

Specifically, visible near infrared diffuse reflectance spectroscopy (VisNIR DRS) and portable x-ray flourescence (PXRF) spectrometery offer the ability to make lab quality determination of soil properties, in-situ, in minutes. Many studies have shown the applicability of these approches to soil science [17, 42]. In fact, current research has shown that the synthesis of data from these two approaches can provide predictive models for many soil parameters with R^2>0.90 and redisual prediction deviations (RPDs) >3.0 relative to many traditional lab analyses [39].

While many studies have independently evaluted soil climate, crop growth, and soil pedogenesis, few studies have attempted to establish the linkages between them, letalone using proximal sensing spectroscopy approaches. The advent of these approaches is a key link that will allow us to move beyond comparing soil morphological features with crop productivity/performance whilst considering climatic factors. Instead, our approach will link the latter two with quantitative pedology outputs from spectroscopic sensors. Results will provide compelling evidence on the anthropogenic and natural influence of soil moisture, temperature, and land management impacts on soil pedogenesis.

As such, the objectives of this study are to: 1) collect soil temperature and moisture data from in-situ dataloggers at multiple sites, 2) collect soil samples from those sites and characterize soil physicochemical properties through traditional laboratory and spectroscopic analyses, and 3) evaluate the relationships between soil moisture, temperature, and physicochemical properties with deference to identificaiton of tranlocated elements within pedons as a function of soil climate dynamics.

We hypothesize that strong relationships between soil moisture, temperature, and soil elemental concentration will be observed.

2. Material and Method

General Occurrance and Features

The study was conducted across eight sites on the Somesan Plateu, Romania (Figure 1), reflective of diverse soil types and slopes. The Somesan Plateau is found in northwest Romania, from the foothills of the Gilau mountains (S) to the contact with the Western Hills (NW), and from the peak of Breaza (NE), to the lane formed by the Small Somes, Big Somes (E), and Almas-Agrij depression (W) [44].

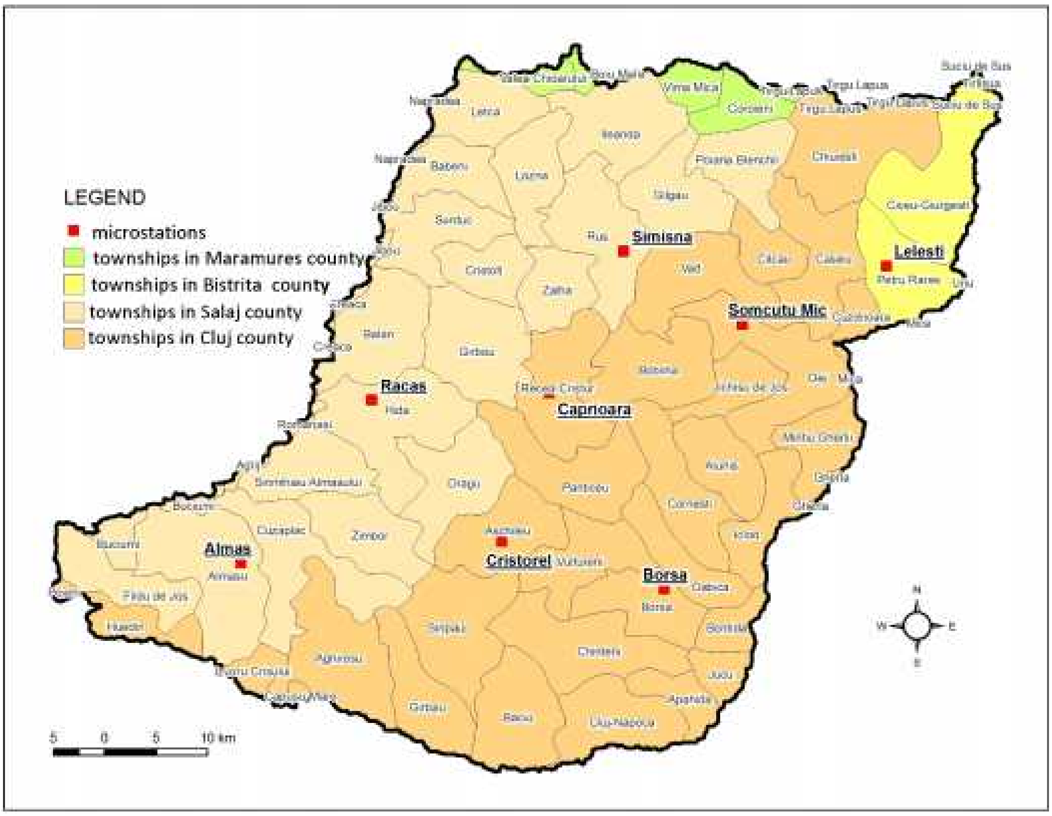

Figure 1. Sites where the station are installed in the Somesan Plateu, Romania

The landscape of the Somesan Plateau is active with intense slope processes triggering changes in the land surface across time.

The relief causes significant differences throughout the area to include varied lithological substrate. Generally, changes in topographic relief cause fundamental changes in all topo-climatic factors, soil characteristics, and vegetative cover [31].

Climate of the area is characterized by an annual average temperature of 7.8°C; the hottest and coldest months being August and January/December, respectively.

Average precipitation is ~700 mm y^{-1}; the highest and lowest amounts of precipitation being May-August and January-February, respectively.

The rainfall regime of the Somesan Plateau has shown great variability over time manifested both by large quantities of precipitation as well as its distribution across the land surface. Soils of the Somesan Plateau are mostly Luvisoils (preluvisols and luvisols), [3].

Natural conditions favor the large scale agronomic production of winter wheat (*Triticum aestivum*), maize (*Zea mays*), barley (*Hordeum vulgare* L.), rye (*Secale cereale*), oats (*Avena* *sativa*), alfalfa (*Medicago sativa*) and clover (*Trifolium pratense*); production is optimal on foothills, lowlands, and valleys. Smaller areas of cultivation feature potato (*Solanum tuberosum L.*), sunflower (*Helianthus annuus*), sugar beet (*Beta vulgaris*), and soybean (*Glycine max*).

Soil suitability represents one of the most important conditions for effective use of agricultural lands in the Somesean Plateau, especially given its highly sloped land surface.

Since conventional agricultural production systems have caused soil degradation in many countries, effective land management technologies applied to crop rotation, tillage and fertilization systems, pedoameliorative work and crop protection systems must be adapted to protect the soil and water resources of the area [24, 15].

Field Sampling and Data Loggers

A total of eight HOBO micro stations (On-set Computer Corp., Bourne, MA, USA) were installed for measuring soil temperature at 10, 30, 50 cm, soil moisture at 10 cm depth, air temperature at 1 m above ground in October, 2013. The sites were chosen such that the major soil types and slope orientations of the region would be represented in the data.

Each datalogging station featured the following sensors: three HOBO Smart Temp S-TMB-M002 temperature sensors (On-set Computer Corp., Bourne, MA, USA), one EC-5 S-SMC-M005 soil moisture sensor (Decagon Devices, Pullman, WA, USA) and a RG3-M pluviometer. The number of installed dataloggers was constrained by available financial resources.

At each site, soil samples were collected at depths of 0-20, 20-40, and 40-60 cm [35]. Brief morphological assessment was conducted in support of taxonomica classification of the soil at each location.

Collected samples were placed in sealed plastic bags and transported back to the laboratory for analysis.

Laboratory Analysis

Upon receipt in the laboratory, soil samples were dried at 105°C for 24 h, and gently ground with a mortar and pestle to pass a 2 mm sieve. Samples were evenly split into three sets; one set used for anlysis at Universitatea de Ştiinţe Agricole şi Medicină Veterinară (Cluj-Napoca, RO), the second set for analysis at Texas Tech University (Lubbock, TX, USA) and the third set for analysis at OSPA Cluj.

Soil texture was accomplished via a modified hydrometer method using a model 152H soil hydrometer. Clay determinations were made at 1440 min and sands were determined via wet sieving with a 53 µm sieve.

Loss on ignition (LOI) organic matter was determined after ashing at 400°C for 8 h [27]. Soil pH and electrical conductivity were determined on saturated pastes after 24 h of equilibration using an Accumet XL20 pH/conductivity meter (Fisher Scientific, Pittsburgh, PA, USA) [37]. Mobile K was determined from 2.5g of the soil sample. On the 2.5 sample 50 ml ethyl ammonium lactate was added and put in a shaker for 2 hours. After 2 hours it was filtered through filter paper in a Petri dish.

The filtered solution was put in flame-photometer Shrend M410 and the result was read on a graphic [11]. Mobile P was determined as the K with the difference that after the 2 hours filtered through filter paper it was put in a glass flasks. 10 ml were mixed with 6 ml ammonium molybdate and 4 ml stannous chloride.

After 10 minutes the soultion was added in a spectrophotometer Metertech Sp830 using the 715 wavelength that gave values in absorbance. The result was read on a graphic [11]. Total N content was determied from a 1g sample of soil to which was added 5 g of copper sulfate and 10 ml of concentrated sulfuric acid and put 20 min. at 420^0 C using Keldal Velp Scientific UDK129 mineralization apparatus.

The resulting solution was put in a distiller Amiro ITM with 50 ml boric acid, 50 ml distilled water and 50 ml sodium hydroxide and let 5 minutes. After that each sample was titrated with 14% sulfuric acid and nitrogen until colour red [11]. The result was read in %.

Spectroscopic Analysis

Each soil sample was scanned in duplicate with a Delta Premium portable x-ray fluorescence (PXRF)(DP-6000; Olympus, Waltham, MA, USA) spectrometer per Method 6200 [38, 42].

The instrument uses a Rh X-ray tube operated at 15 to 40 KeV in a three-beam configuration known as Soil Mode for quantifying the following elements: V, Cr, Fe, Co, Ni, Cu, Zn, Hg, As, Se, Pb, Rb, Sr, Zr, Mo, Ag, Cd, Sn, Sb, Ti, Mn, P, S, Cl, K, and Ca.

Elemental quantification was accomplished using the integrated ultra-high resolution (<165 eV) silicon drift detector. Calibration of the PXRF was accomplished using a stainless steel '316' alloy clip containing 16.130% Cr, 1.780% Mn, 68.760% Fe, 10.420% Ni, 0.200% Cu, and 2.100% Mo tightly fitted over the aperture.

Samples were scanned through the ~2 cm aperture sequentially for 30 s per beam (i.e., 90 s for one complete scan using all three beams). For all scanning, recalibration and verification with NIST standards was conducted every 20 scans. Care was taken to blow off any dust on the aperture window between sample scans. Data from the instrument was exported to MS Excel for further analysis.

3. Results and Discussions

General site location, soil type, and hillslope profile information for each site are given in Table 1. Most of the soils were classed as Preluvisols, with a few Aluviosols, Regosols, and Faeozioms present as well. Southern facing slopes were most common at elevations of 253 to 606 m amsl (Table 1). Physicochemical analysis revealed dominant soil textures of consists of clay loam, clay, and silty clay with a few other textures as well (Table 2).

Soil reaction ranged from 5.36 to 7.66, however most soils were slightly acidic to slightly alkaline (Table 2).

Soil salinity ranged from 97 to 499 µS cm^{-1}, with an average of 258 µS cm^{-1} (Table 2); very low levels of salinity.

Loss on ignition soil organic matter ranged from 1.77 to 5.01% with an average of 3.10% (Table 2), results consistent with generally dark colors observed through morphological assessment.

Table 1. Site location, elevation, taxonomic classification, and hillslope inclination for soils of the Someş Plateu, Romania.

Station no.	Locality	Altitude (m)	Soil type*	Expozition	Slope (%)
1	Cristorel, com. Așchileu	404	Preluvosol	Northern	8-10
2	Borşa	332	Typical Faeoziom	Southern	2-3
3	Leleşti, com. Ciceu-Mihăiești	606	Skeletal limestone Regosol	Western	25-26
4	Șomcutu Mic, Cluj County	271	Coluvic Aluviosol	Southern	2-3
5	Căprioara, com. Recea Cristur	416	Typical Preluvosol	Southern	4-5
6	Almaș, Sălaj County	323	Coluvic Aluviosol	Southern	8-10
7	Racaș, com. Hida	253	Typical Preluvosol	Southeastern	2-3
8	Șimișna, Sălaj County	256	Typical Preluvosol	Northeastern	7-9

*Romanian System of Soil Taxonomy [45].

Table 2. Results of physicochemical analyses of soil samples from the Someş Plateu, Romania.

Station no.	Depth	pH	EC*	SOM	Clay	Sand	Silt	Texture
	--cm--		µS cm^{-1}	----------------------------%----------------------------				
Cristorel,	0-20	5.68	201	3.47	25.2	27.4	47.2	L
20-40		5.87	97	2.88	27.1	26.4	46.3	CL
40-60		6.01	139	2.50	29.6	23.4	46.9	CL
Borșa,	0-20	6.98	293	5.01	42.4	7.7	49.7	SiC
20-40		7.04	286	3.63	42.3	6.6	50.9	SiC
40-60		7.22	499	3.46	43.2	6.8	49.8	SiC
Lelești	0-20	7.35	340	3.04	34.3	32.2	33.4	CL
20-40		7.56	443	1.83	35.5	24.0	40.4	CL
40-60		7.66	313	1.77	36.2	21.7	41.9	CL
Șomcutu Mic	0-20	6.73	201	3.80	31.1	24.2	44.5	CL
20-40		6.49	200	3.33	33.3	23.9	42.7	CL
40-60		6.35	301	2.30	35.8	22.3	41.8	CL
Căprioara	0-20	6.43	239	4.61	34.3	18.8	46.7	SiCL
20-40		6.78	298	2.70	40.0	11.7	48.2	SiC
40-60		6.86	210	3.57	35.4	15.0	49.4	SiCL
Almaș	0-20	7.38	284	1.84	36.0	45.7	18.1	SC
20-40		7.57	332	2.92	30.5	49.8	19.5	SCL
40-60		7.36	182	3.52	27.5	50.9	21.4	SCL
Racaș	0-20	5.36	236	4.12	36.3	24.5	39.0	CL
20-40		5.68	221	3.19	43.4	18.9	37.5	C
40-60		5.93	279	2.85	48.7	18.8	32.3	C
Șimișna	0-20	5.62	154	3.66	29.3	19.1	51.5	SiCL
20-40		5.70	137	2.34	29.3	19.5	51.0	SiCL
40-60		6.07	309	2.07	29.3	18.0	52.5	SiCL

*EC= Electrical conductivity; SOM= Soil organic matter; Textures: C=clay, SiC=silty clay, SC=sandy clay, SiCL=silty clay loam, SCL=sandy clay loam, L=loam.

Results of mobile P, mobile K, and N content of the soils is given in Table 3. Overall, N content varied from 0.07 to 28 % with an average of 0.17% (Table 3). Mobile P and K averaged 207 and 1786 mg kg-1, respectively (Table 3).

Table 3. Results of mobile P, mobile K, and N content of soil samples from the Someş Plateu, Romania

ID, Depth	mobile P	mobile K	N
--cm--	-------- mg kg^{-1} -------		--%--
S1, 0-20	5	96	0.177
20-40	3	82	0.142
40-60	2	106	0.121
S2, 0-20	46	1890	0.267
20-40	39	1020	0.204
40-60	20	768	0.215
S3, 0-20	77	16700	0.118
20-40	528	14300	0.082
40-60	49	1550	0.070
S4, 0-20	80	618	0.266
20-40	50	302	0.138
40-60	136	224	0.160
S5, 0-20	300	654	0.362
20-40	396	960	0.145
40-60	396	822	0.187
S6, 0-20	480	400	0.175
20-40	1216	346	0.197
40-60	1088	1088	0.045
S7, 0-20	12	212	0.281
20-40	10	272	0.180
40-60	40	228	0.161
S8, 0-20	3	74	0.202
20-40	2	74	0.136
40-60	2	82	0.097

Results of the mean of two PXRF scans for each soil sample are presented in Table 4. Determinations of each sample are presented in Table 4. Notably, Ca content varied substantively in accordance with pH levels and visual evidence of carbonates.

The trend of all the determined elements is to increase with depth .

Table 4. Elemental analysis of soil samples as determined by portable x-ray fluorescence spectrometer for soil samples from the Someş Plateu, Romania

ID,	Depth	Ca	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	As	Rb	Sr	Zr	Ba	Pb
	--cm--	-----	-----	-----	-----	-----	-----	mg kg^{-1}	-----	-----	-----	-----	-----	-----	-----	-----
S1,	0-20	4119	5034	76	103	606	27470	61	24	68	8.2	107.9	97	377	611	28.4
	20-40	4066	5086	75	110	653	27306	68	22	66	8.8	111.6	97.1	393	675	28.6
	40-60	3838	5348	80	113	683	29155	77	20	68	7.2	113.7	94.7	349	735	29.4
S2,	0-20	8131	4538	86	95	1240	34104	76	37	104	14.9	132.3	137	314	820	33.5
	20-40	7039	4428	86	80	949	34887	79	39	95	13.9	133	163	345	825	31.3
	40-60	7268	4432	81	84	1013	35723	86	40	93	13.5	136.6	157	345	881	31
S3,	0-20	17729	3436	80	72	1039	28184	70	26	91	7.8	115.5	277	272	910	22.9
	20-40	27174	3615	74	83	526	32405	80	25	92	7.8	127.2	214	289	706	22.1
	40-60	31614	4105	76	115	674	35443	97	26	95	8.9	136.8	231	270	712	25.1
S4,	0-20	4836	4467	70	107	468	29262	75	24	83	9.7	112.8	92.4	347	709	23.8
	20-40	4161	4720	79	137	497	32005	92	28	83	9.5	115.4	94	351	578	28.3
	40-60	4006	4740	77	117	484	33598	99	26	81	8.7	120.6	91.1	364	849	28.1
S5,	0-20	7495	4565	71	96	547	32157	70	26	92	6.7	121.9	98	340	781	28.7
	20-40	5165	5047	86	127	435	40341	93	32	94	9.6	135.3	95	312	844	26.1
	40-60	6457	5186	86	117	728	32113	78	31	103	8.7	123.7	105	379	698	26.6
S6,	0-20	7076	3276	59	45	405	21894	42	20	62	9.4	99.4	75.1	313	555	21.8
	20-40	13790	3046	63	49	593	23307	35	25	87	9.9	94.9	98	269	523	28.1
	40-60	18284	2659	53	32	582	18883	49	20	77	8.1	90.4	95.4	244	397	29
S7,	0-20	5414	4589	89	91	734	35689	90	32	111	6.9	132.8	96	307	937	36.9
	20-40	5483	4752	89	106	681	40395	97	38	114	7	143.6	97	276	1002	30.7
	40-60	5901	4950	101	121	615	44878	108	33	116	8.7	154.3	96	290	1153	28.7
S8,	0-20	3895	4955	76	105	516	30664	83	19	79	8.8	110.3	101	353	725	29.2
	20-40	3490	5160	76	125	613	32538	85	21	76	8.7	118.2	100	369	855	28.4
	40-60	3264	5560	81	148	581	33887	103	24	79	9.7	124.9	103	384	839	27.7

Data from the Hobo microstations was downloaded every 5-6 months. The raw data was processed using HOBOWARE Pro, version 3.7.2. (Onset Computer Corporation, USA) in order to calculate the maximum, minimum and average temperatures per day, month and year. The same principle was used to calculate the soil moisture and the air temperature. Results in Table 5 are the annual means at each station; annual means presented for the sake of brevity.

Table 5. Average annual soil temperature (10, 30, and 50 cm) and moisture content (10 cm) for soils of the Someş Plateu, Romania. Measurements were from 2013-2014.

Location	Annual average temperature			Annual average water content
	10cm	30cm	50cm	10cm
	--------------------------°C		---------------------------	-- cm^{-3} cm^{-3} --
Cristorel	12.7	12.3	12.7	14.8
Borșa	13.4	13.3	13.4	22.5
Leleşti	11.4	11.5	11.7	32.5
Șomcutu Mic	16.0	16.3	16.4	23.0
Căprioara	16.3	16.4	16.4	19.7
Almaș	14.9	14.9	14.8	25.1
Racâș	15.2	15.4	15.7	25.5
Șimișna	11.9	12.3	13.6	30.3

Establishing a strong link between soil elemental concentrations and soil climatic parameters will require multiple years of careful measurement. Somewhat surprisingly, site S3 (one of the wettest sites) showed decreases in K and N with depth, but results were mixed for P. Site S8 (also wet) showed decreases in N with depth, but K and P results were mixed. Similarly, dry site S1 showed decreases of N with depth, but mixed results for K and P. This may indicate that the mobility of N in these soils is somewhat more uniform relative to other elemental translocation. Notably, other relationships were also found. For example, the profiles with the highest temperatures at the 0-20 cm depth were also among those with the highest SOM content reflecting increased solar radiation. However, those same locations were on southern facing slopes with limited inclination.

More, the texture also influenced the humidity of soil. Site 1 which had a loamy texture was very dry compared to the sites with clay-loamy or silty-clay ones.

4. Conclusions

This study evaluated soil temperature and moisture in relation to elemental abundance and other physicochemical parameters in eight soil profiles of the Someş Plateu, Romania from 2013 to 2014.

Some trends were observed in the data, however longer term study is needed for conclusive results and as such the work presented herein should be considered preliminary data. Trends meriting further study include a detailed analisis of the relationship between soil climate on elemental translocation in soils over a period of more years.

Acknowledgement: *This paper was performed under the frame of the Partnership in priority domains - PNII, developed with the support of MEN-UEFISCDI, project no. PN-II-PT-PCCA-2013-4-0015: Expert System for Risk Monitoring in Agriculture and Adaptation of Conservative Agricultural Technologies to Climate Change.*
The authors graciously acknowledge the support of the BL Allen Endowed Chair of Pedology at Texas Tech University in conducting this research.

References

[1] Bagarello V., C.Di. Stefano, V. Ferro, M. Iovino, A. Sgroi, 2010, Physical and hydraulic characterization of a clay soil at the plot scale, Journal of Hydrology 387:54-64.

[2] Bonan G.B., L.M. Stillwell-Soller, 1998, Soil water and the persistence of floods and droughts in the Mississippi River basin, Water Resour. Res., 34, 2693-2701.

[3] Bunescu V., G. Mihai, H. Bunescu, I. Man, 2005, Ecological conditions and soils in Transylvania Plateau, Ed. AcademicPres, Cluj-Napoca.

[4] Delworth T., S. Manabe, 1988, The influence of potential evaporation on the variabilities of simulated soil wetness and climate, J. Climate, 1, 523-547.

[5] Delworth T., S. Manabe, 1989, The influence of soil wetness on near-surface atmospheric variability, J. Climate, 2,1447-1462.

[6] Delworth T., S. Manabe, 1993, Climate variability and land-surface processes, Adv. Water Resour., 16, 3-20.

[7] Dickinson R.E., 2000, How coupling of the atmosphere to ocean and land helps determine the timescales of interannual variability of climate, J. Geophys. Res., 105, 20 115-20 119.

[8] Douville H., F. Chauvin, 2000, Relevance of soil moisture for seasonal climate predictions: A preliminary study, Climate Dyn., 16, 719-736.

[9] Du J. Y., 2012, A method to improve satellite soil moisture retrievals based on Fourier analysis, Geophys. Res. Lett., 39(15): L15404, doi: 10.1029/2012GL052435.

[10] Duda B.M., T. Rusu, I. Bogdan, A.I. Pop, P.I. Moraru, R.M. Giurgiu, C.L. Coste. 2014, Considerations regarding the opportunity of conservative agriculture in the context of global warming, Res. J. Agri. Sci. 46(1):210-217.

[11] Egner H., H. Riehm, W.R. Domingo, 1960, Investigations on fiber chemical soil analysis as a basis for assessing the nutrient status of the soil, II, Chemische extraktionsmetoden zu phosphor – und kaliumbestimmung K. Lantbr. Hogsk. Annlr. 26: 199-215.

[12] Eltahir E.A.B., 1998, A soil moisture rainfall feedback mechanism 1, Theory and observations, Water Resour.Res., 34, 765-776.

[13] Fast J.D., M.D. McCorcle, 1990, A two-dimensional numerical sensitivity study of the Great Plains lowlevel, jet. Mon. Wea. Rev., 118, 151-163.

[14] Findell K.L., E.A.B. Eltahir, 1999, Analysis of the pathways relating soil moisture and subsequent rainfall in Illinois, J. Geophys. Res., 104, 31 565-31 574.

[15] Gus P., T. Rusu, I. Bogdan, 2004, Cropping, crop rotation and land management, Risoprint Ed., Cluj-Napoca.

[16] Hong S.Y., E. Kalnay, 2000, Role of sea surface temperature and soil-moisture feedback in the 1998 Oklahoma-Texas drought, Nature, 408, 842-844.

[17] Horta A., B. Malone, U. Stockmann, B. Minasny, T.F.A. Bishop, A.B. McBratney, R. Pallasser, L. Pozza. 2015, Potential of integrated field spectroscopy and spatial analysis for enhanced assessment of soil contamination: A prospective review, Geoderma 241-242:180-209.

[18] Husain S.Z., S. Bélair, S. Leroyer, 2014, Influence of soil moisture on urban microclimate and surface-layer meteorology in Oklahoma City, Journal of Applied Meteorology and Climatology, 53(1), 83-98.

[19] Jackson T.J., M.E. Hawley, P.E. O'Neill, 1987, Preplanting soil moisture using passive microwave sensors, J. Am Water Resour Assoc., 23(1): 11–19.

[20] Jacobson M.Z., 1999, Effects of soil moisture on temperatures, winds, and pollutant concentrations in Los Angeles, J. Appl. Meteor., 38, 607-616.

[21] Koster R.D., M.J. Suarez, 1995, Relative contributions of land and ocean processes to precipitation variability, J. Geophys. Res., 100, 13 775-13 790.

[22] Koster R.D., M.J. Suarez, 2001, Soil moisture memory in climate models, J. Hydrometeor., 2, 558-570.

[23] Koster R.D., M.J. Suarez, M. Heiser, 2000, Variance and predictability of precipitation at seasonl-tointerannual timescales, J. Hydrometeor., **1**, 26-46.

[24] Lăzureanu A., D. Manea, G. Cărciu, 1997, Influence of tillage and chemical fertilization on the production of maize cultivated at the Didactic Station of Timisoara, In "Alternative tillage", Cluj Napoca, Vol I, 23-30.

[25] Legates D.R., M. Rezaul, F.L. Delphis, T.L. DeLiberty, S.M. Quiring, C. Houser, F.E. Nelson, 2010, Soil moisture: A central and unifying theme in physical geography, Progress in Physical Geography, 35(1) 65–86.

[26] McCorcle M.D., 1988, Simulation of surface-moisture effects on the Great Plains low-level jet, Mon. Wea. Rev., 116, 1705-1720.

[27] Nelson D.W., L.E. Sommers, 1996, Total carbon, organic carbon and organic matter, p. 961–1010. In D.L. Sparks (ed.) Methods of soil analysis, Part 3, Chemical methods. SSSA, Madison, WI.

[28] Nicholson S., 2000, Land surface processes and Sahel climate, Rev. Geophys., 38, 117-139.

[29] Nicholson S.E., D. Leposo, J.R. Grist, 2000, On the relationship between El Nino and drought over Botswana, Journal of Climate (in press).

[30] Pal J.S., E.A.B. Eltahir, 2001, Pathways relating soil moisture conditions to future summer rainfall within a model of the land-atmosphere system, J. Climate, 14, 1227-1242.

[31] Pop G., 2012, Transylvania Depression, Ed. Cluj University Press, Cluj Napoca.

[32] Rodríguez-Vásquez A.F., A.M. Aristizábal-Castillo, J.H. Camacho-Tamayo, 2008, Variabilidad espacial de los modelos de infiltración de Philip y Kostiakov en un suelo Ándico, Engenharia Agrícola 28:64-75.

[33] Rusu T., I. Bogdan 2012, Influence of Degree Infestation with Echinochloa crus–galli Species on Crop Production in Corn, In Herbicides - Properties, Synthesis and Control of Weeds, Mohammed Naguib Abd El-Ghany Hasaneen (Ed.), InTech Ed.

[34] Saha S.K., 1995, Assessment of regional soil moisture conditions by coupling satellite sensor data with a soil-plant system heat and moisture balance model, Int J Remote Sens, 16(5): 973–980.

[35] Schoeneberger P.J., D.A. Wysocki, E.C. Benham, W.D. Broderson (eds.), 2002, Field book for describing and sampling soils, Version 2.0. Natural Resources Conserv. Serv., Natl. Soil Survey Ctr., Lincoln, NE.

[36] Shi J.C., L.M. Jiang, L.X. Zhang, K.S. Chen, J.P. Wigneron, A. Chanzy, T.J. Jackson, 2006, Physically based estimation of bare-surface soil moisture with the passive radiometers, IEEE Trans Geosci Rem Sens, 44(11): 3145–3153.

[37] Soil Survey Staff, 2004, Soil survey laboratory methods manual, USDA-NRCS. U.S. Gov. Print. Off., Washington, DC.

[38] U.S. Environmental Protection Agency, 2007, Method 6200: Field portable x-ray fluorescence spectrometry for the determination of elemental concentrations in soil and sediment, Available at www.epa.gov (verified 11 Jan. 2012). USEPA, Washington, DC.

[39] Wang L.L., J.J. Qu, 2009, Satellite remote sensing applications for surface soil moisture monitoring: a review, Front Earth Sci China, 3 (2): 237–247.

[40] Wang W.Q., A. Kumar, 1998, A GCM assessment of atmospheric seasonal predictability associated with soil moisture anomalies over North America, J. Geophys. Res., 103 (D22), 28 637-28 646.

[41] Wanru W., R.E. Dickinson, 2004, School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, Georgia.

[42] Weindorf, D.C., N. Bakr, Y. Zhu., 2014, Advances in portable x-Ray fluorescence (PXRF) for environmental, pedological, and agronomic applications, Advances in Agronomy 128:1-45. doi: http://dx.doi.org/10.1016/B978-0-12-802139-2.00001-9.

[43] Zheng X.Y., E.A.B. Eltahir, 1998, A soil moisture rainfall feedback mechanism 2, Numerical experiments, Water Resour. Res., 34, 777-785.

[44] *** Geography of Romania - Vol. III, Romanian Carpathians and Transylvania Plateau, 1987, Ph. Socialist Republic of Romania.

[45] *** Romanian Soil Taxonomy System SRTS, 2012, Ph. Estfalia, Bucharest.