



HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE  
SCIENCES  
ENVIRONMENTAL SCIENCES DOCTORAL SCHOOL

## **Effect of water cover on soil properties**

PhD DISSERTATION THESIS BOOK

SEBŐK ANDRÁS

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## **Background and objectives of the work**

The aim of this paper is to explore the effects of more permanent water cover on soil conditions. In this thesis, I will look at typical soil types in Hungary to get an overall picture of the effects of waterlogging on soil physical and chemical parameters.

In my thesis I will seek answers to the following objectives:

- What physical changes in the structure and measurable parameters of the soils under study are caused by water cover for different soils.

To achieve this, it is necessary to investigate possible changes in grain size and aggregate stability. These affect the pores formed, the resistance of the soil and the shape of the larger aggregates. The size range shifts observed in the tests may confirm aggregate fragmentation or build-up.

- Monitoring chemical changes in soils, in particular changes in solubility due to prolonged waterlogging.

The main objective is to monitor the dynamic changes on the surface of the particles and constituents of the soils. Changes in physical parameters may be associated with changes in sorption properties, while changes in the structure of the material may affect its solubility or fixation. Concentration changes observed during dissolution studies help to understand whether the processes are influenced by dissolution or incorporation.

- Changes in organic matter quality of the soil types studied and their possible consequences for soils.

In addition to the chemical parameters, the organic matter of the soils studied deserves particular attention. Its quality and quantity can provide answers to the causes of certain chemical or physical transformations. Organic matter is also an important sorption medium, which is of particular importance from both an environmental and an agricultural point of view, and it is therefore this fraction that I intend to examine in greater detail. Both quantitative and qualitative

analyses should be carried out to determine how the initial organic matter content of soils changes with longer periods of waterlogging.

## Materials and methods

An important aspect in the selection of soil samples for the study was the use of soil types that are representative of the typical soil types that have been created under Hungarian conditions. For this purpose, the soil samples according to the criteria defined in the TAMOP-4.2.1/B-09/1/KONV-2010-0003 research appeared to be the most suitable choice. The reason for this is that this research will develop a reference database of soils under Hungarian conditions, covering the widest possible range of soil properties. Thus, the soils used here are suitable for a wide range of typical types of Hungarian conditions. Table 1 shows the main classifications of the soils used.

Table 1: Soil classifications and abbreviations of the soils used in the research.

Soil sample	WRB classification
Karcag -KR	Vertic Stagnic Solonetz (Clavic)
Kápolnásnyék - KP	Vermic Calcic Chernozem (Anthric, Siltic)
Keszthely – KA	Hortic Terric Cambisol (Dystric Siltic)
Keszthely - KB	Hortic Terric Cambisol (Dystric Siltic)
Kisújszállás - KI	Gleyic Vertisol (Clavic)
Magyarszombatfa - MA	Vertic Gleyic Luvisol (Magniferric, Siltic)
Paks - PA	Calcisol
Salföld – SA	Arenosol
Várvölgy – VA	Cutanic Luvisol (Siltic)
Várvölgy - VB	Cutanic Luvisol (Siltic)

## Chemical extraction methods

The research focused on the effect of water cover and the resulting changes in soils. Due to the highly variable environmental conditions, in situ studies are difficult and their comparability is questionable. To solve this problem, I decided to develop laboratory conditions. All soil samples were ground and then milled to a particle size below 1 mm. I weighed the same amount (50 g) of the selected soils into centrifuge tubes, then poured 60% of the binding value (Arany binding value, or plasticity index) of each soil from distilled water and homogenised. The prepared centrifuge tubes were sealed and stored in a temperature-controlled (20 °C), light-free room. The centrifuge tubes were opened after 30, 60 and 90 days (samples of months 1, 2 and 3) and the contents were dried in a drying oven at 60°C to air-dry condition to stop the chemical reactions by extracting the water.

Depending on the subsequent results, I repeated the same procedure for two chosen soils, but in this case the centrifuge tubes were opened every 3 days and then preserved by drying for a period of 30 days.

Two types of extracts were prepared from the matured samples. This corresponds to the procedure according to the Hungarian standard (MSZ 21470-50 (1998)), which is very similar in purpose to the internationally used BCR (Community Bureau of Reference) extraction.

I followed the procedure of the standard MSZ 21470-50 (1998) with two modifications: 0.01 M CaCl<sub>2</sub> solution was used instead of the 0.5 M ammonium acetate solution recommended for the second step. The reason for this is that, according to the recommendations of several countries (Netherlands, France) and several authors, this extraction method is more suitable for the detection of species bound to organic matter and does not require a pH buffered medium. Another advantage is that it allows measurements with more sensitive instruments for organic matter (in this case the MP-AES instrument). The concentrations to be used may vary between authors, so I have taken as a guideline the 0.01 M CaCl<sub>2</sub> solution published by researchers at the University of Debrecen, which is supported by the work of different authors for a general study of the element content that can be mobilised.

Another change is the amount of nitric acid used. The shaking technique with 0.43 M HNO<sub>3</sub> (Westerhoff) is, according to international publications, at

least as effective as the destructive extraction prescribed by the Hungarian standard.

From this procedure, the water-mobile, easily soluble and the poorly soluble fractions were not investigated (assuming that the water-soluble fraction has already been removed from the soils by regular precipitation). The easily soluble fraction was extracted using a 0.01 M CaCl<sub>2</sub> solution, while the difficult to mobilise fraction was extracted using a 0.43 M HNO<sub>3</sub> solution: 20 ml of extractant (1:10 ratio) was poured onto 2 g of soil and shaken in a shaker for 2 hours (60 rpm). The resulting suspension was centrifuged (10 min, 5000 rpm) and the supernatant fraction was filtered through 0,45 µm filter paper. The resulting purified liquid was measured on an Agilent MP-AES for the determination of elemental content.

The pH was measured from a 1:2.5 soil suspension according to the method described by István Buzás (1988). The pH values were also measured in a suspension of KCl solution (1 M) and distilled water. This was done by allowing to stand for 24 h and then measuring the shaken suspension on a Laboratory Digital pH meter OP-211/2 Radelkis pH meter (electrode: OP 0808 P glass electrode, checking the calibration after every 20 samples). Conductivity was measured from the distilled aqueous extracts using a Jenway 4510 Conductivity Meter.

### **Physical parameter measurements**

I measured the basic properties of these soil samples using the following methods:

Particle size distribution was carried out using two methods. The particle size distribution according to physical textures (three fractions, sand, dust, clay) was carried out using the pipette method according to MSZ-08.0205-78. The MSZ method separates the coarse sand fraction above 0.25 mm by sieving. For the other two fractions, the settling velocity of the particles and the pipetting times and depths were determined according to the MSZ standard on the basis of the densities determined by the volumetric method for soil/sediment samples. The mechanical composition tests were carried out at room temperature (23°C).

The grain size distribution data (mechanical composition data) shown in the results section were measured by using a Malvern Mastersizer 3000. A small quantity (1-5 g, depending on the instrument setting, to obtain a suitable obscuration value) of the soil sample, mixed in air-dry condition with a dispersant (a mixture of Na-hexametaphosphate [33 g] and Na-carbonate [7 g] dissolved in 1 litre of distilled water, Calgon solution), was transferred to the sample preparation unit (Hydro V), where a total of 25 cm<sup>3</sup> of Calgon solution was added to the deionised water. A 240 s ultrasonic treatment is then carried out and the instrument is then adjusted to obtain an obscuration value within the measuring range (5-20 %). The instrument then takes a sample and measures the light scattering (laser diffraction) in five repetitions to calculate the particle size distribution of the sample (per range, in percent). The Mastersizer particle size analyser has a measuring range of 0.02-2000 µm.

The aggregate stability was measured on the same Malvern instrument in a very similar way. The same amount of soil as in the particle size test was placed in the sample preparation unit. In contrast to the particle size distribution measurement, neither chemical nor ultrasonic dispersion was used here, as the aim was to measure the natural variation of the sample. The Malvern device mixed the sample with deionised water, taking measurements every minute from the end of the first minute to the end of the tenth minute. These measurements were processed for the aggregate stability values.

For the characterisation of the soils, other data were obtained using the following methods: carbonate content using the Scheibler method, organic matter content using the Tyurin method, and the Arany Index ( $K_A$  or plasticity index) value also according to the soil test method

### **Organic matter quality measurement**

For organic matter quality, soil extracts were prepared according to the modified Stevenson (1982) method (0.5 M NaOH and 0.1 M Na<sub>4</sub>P<sub>2</sub>O<sub>7</sub>). To each soil sample (5.0 g) 20 ml of extracting agent was added, the samples were shaken for four hours and finally filtered. The prepared extracts were diluted with the solvent as required (the pH of each sample was measured, making sure that it was above 11, because precipitation may occur in samples below pH 11).



Full spectral analysis was performed with a Horiba spectrophotometer in the 400-800 nm range at 1 nm resolution. The exponential curves were fitted to the measured data using Microcal Origin 6.0 (Microcal Software Inc. 1991-1999) (EFA method). The absorbance values measured at two wavelengths of interest were used to determine the E4/6 values. I divided the value measured at 465 nm by the absorbance value measured at 665 nm, which gives the E4/6 value.

If the sample is low in high molecular weight carbon chains, the determination is potentially subject to error. This source of error lies in the method of measuring E4/E6, as the values measured at 665 nm are usually very small, close to the lower range of the photometer for soils with low organic matter content, and therefore the measurement error has a significant impact on the measured value, detectable in percentage. For this reason, I have tried to calculate organic matter quality based on the molecular size distribution of the whole spectrum, in parallel with the conventional E4/E6 values. The light absorbance values measured in this way give a spectral range defined by an exponential curve.

For comparability, the values of the exponential curve obtained in this way can be used to derive the value given by the original E4/E6 method. Thus, the original E4/E6 value (i.e. the organic matter quality ratio) can be obtained from the t value of the exponential curve. In my measurements I have plotted both the original and the derived values for comparability.

### **Sedimentation test**

The stability of the colloidal systems can also be determined by anions and cations, which can promote or inhibit the formation or disintegration of aggregates. To determine this, I designed a series of experiments (part of a Norwegian study) to test aggregation (and sedimentation) efficiency with different cation-anion pairs. The experiment involved mixing a fixed amount of soil (2.0 grams) in one litre of distilled water. The soil used was a Norwegian soil sample (Skuterud experimental area, near the town of Ås, south-eastern Norway (DMS, latitude N 59° 40' 12.652", longitude E 10° 50' 15.904", elevation 119 m MASL), collected in the SoilSpace Project (NFR Project #240663, Norway). The

tests show that the soil is very similar to the soil of Kisújszállás-A (WRB classification: Gleyic Stagnosol), with an organic matter content of 0.17%.

For each experiment, distilled water mixed with the selected ion was added to 5 glass cylinders, into which the measured soil sample was poured. The experiments were set at cation concentrations of 0, 10, 20, 40, 80 mg/l. After mixing, pictures were taken of the five columns, which were back-illuminated, and then every 10 minutes during a three-hour settling period, one picture was taken (Fujifilm FinePix S8600 camera in manual mode, 4608 x 2592 pixels setting (16:9, L, fine quality), shutter speed 60, and aperture F2.9). The significance of this is that the basic idea is that the colour change observed in the glass cylinder indicates the efficiency of the settling (in parallel with the turbidity measurement). The coagulation capacity, which affects aggregate stability, can be inferred from the grain size, which determines the sedimentation rate and can be calculated from Stokes' law (larger grains settle faster, so the soil suspension clears faster). So, more efficient coagulation means faster settling and a lighter glass cylinder.

The photographs were analysed automatically using a program written for this purpose. The program performs the analysis on the vertical, middle third of the glass column (35 pixels wide), where it averages the RGB colour depth value line by line. Averaging these values column by column (400 rows of values, excluding the notches in the glass cylinder) gives a typical colour depth. For each column, for each photograph, there will be one such averaged data (0-180 minutes per ten minutes, so 19 photographs, 19 data/column). I fitted the resulting series of points to an exponential function, whose parameter  $t$  (when multiplied by  $\ln 2$ ) gives the half-life of the fitted function for a given column, i.e. the time it takes for the darkness (brightness, i.e. the degree of opacity) of the pixels to halve. I have included these values in the results section.

The pH values were measured at minutes 0 and 180 in each column using a portable Meinsberg TM40 pH meter.

## Results and discussion

In the results chapter, I analyse the soil types studied separately. This helps me to put the different behaviour of each soil in context and to confirm the explanations with the test results. However, a brief summary of each test type is necessary to present the new scientific results and is discussed at the end of the chapter.

### General characteristics of the studied areas

Based on the general soil properties (Table 2), it can be said that the different parameters of the investigated soil types distinguish the samples well from each other - for example, the high carbonate content of Kápolnásnyék (almost 10%), the high clay content of Karcag and Kisújszállás samples, or the acidic (pH 5.7) soil of Magyarszombatfa. For ease of reference, I will briefly summarise these characteristics in the description of the samples.

Table 2: Soil properties of the soils tested (abbreviations of the samples correspond to those listed in the Materials and Methods section)

Sample name	Genetical layer and depth (cm)	Clay + Iron hidrate (<0.002 mm) (%)	Silt (0.002-0.05 mm) (%)	Sand (0.05-2 mm) (%)	Organic matter (%)	Ca-CO <sub>3</sub> (%)	Arany-plasticity index	pH (H <sub>2</sub> O)
KR	B 5 - 30	51.09	45.90	0.88	2.00	0.13	90	6.9
KP	A 0 - 30	27.60	51.68	7.50	3.70	9.52	46	7.8
KA	A 0 - 30	21.09	33.13	44.28	1.45	0.05	30	7.0
KB	B 30 - 50	22.90	33.87	42.29	0.93	0.00	36	6.8
KI	A 0 - 30	53.88	41.19	1.05	3.89	0.00	74	7.5
MA	B 20 - 50	38.96	25.93	34.61	0.49	0.00	59	5.7
PA	*	16.89	24.25	58.85	0.63	28.04	38	8.2
SA	*	1.31	0.05	98.64	0.00	0.02	29	7.4
VA	A 0 - 20	15.27	29.35	54.05	1.33	0.00	29	6.6

VB	B 20 - 50	22.30	26.56	50.49	0.65	0.00	38	6.6
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\*Paks, Salföld: carbonate and sand, used as reference materials

## **Coagulation measurements**

As a result of the changes in soil structure identified so far, the susceptibility of soils to erosion is increasing. As the average rainfall intensity increases due to climatic changes in recent decades, water-induced erosion is more prevalent. This has led to the need to install and use sedimentation equipment in order to preserve our soils.

The study of coagulation was carried out at the NIBIO research centre in As, Norway, as part of the Erasmus programme. The reason for this is that in Norway, in recent years, there has been an increasing emphasis on mitigating the damage caused by erosion and reducing soil loss through erosion, soil retention and soil reuse. The efficiency of the sedimentation ponds built for this purpose is not sufficient in the case of high rainfall and a call for tenders has been launched to increase this. Using the correlations I have measured, I have proposed the coagulation of particles (which accelerates the rate of sedimentation), thus making it necessary to determine precisely the effects of different anions and cations on soils. I have described the theoretical and practical background of this research in the literature review and the material and methods sections, and will now focus on the results.

During the procedure, photographs of the settled soil were taken every ten minutes, and the data points, which were then resolved by the background correction already described, were plotted and compared. For such a series of functions, it is clearly observed that the settling (lightening) follows a definite exponential function for each of the  $t$  concentrations. For example, after 3 hours, the control (no added chemical) solution achieved a settling efficiency of around 40%, compared to a minimum chemical addition (10 mg/l Mg) which improved the settling efficiency to 55%, and higher concentrations to almost 90%. Of course, this alone does not give sufficient information - the endpoint does not reveal information about the dynamics. Thus, by examining the parameters of the fitted functions, the half-life can be determined according to the following function:

$$y=y_0+A_1e^{(-x/t_1)}$$

where  $y$  is the measured value,  $y_0$  is the amount of displacement with respect to the  $x$ -axis (corrected to 0 as described in the material and method section),  $A_1$  is the amplitude,  $t_1$  is the time constant. The half-life  $(t_{1/2})= t_1 \cdot \ln 2$

By analysing the half-lives, it can be seen that the rate at which the soil settles out of suspension increases by almost doubled as a result of the increased chemical concentration. The effect of the applied concentrations on the half-life follows an exponential curve, which confirms that the amount of ions applied affects the rate of settling.

This led to the measurement of all cation and anion pairs. Calcium and magnesium were given priority because, as divalent cations, they have a more effective coagulation effect than any monovalent anion (e.g. sodium, potassium) and do not pose the same environmental burden as iron or aluminium when dissolved in water.

Looking at the results, it can be stated that the experimental set-up is suitable for replicating the experiments, and the results obtained have low standard deviations. With the exception of the concentration of 20 mg/l, the results obtained are close to each other, with no significant variation due to anions. However, at the 20 mg/l concentration, sulphate ions reduce the efficiency of coagulation.

The results obtained indicate that even at relatively high concentrations (80 mg/l), monovalent cations (sodium) do not have a significant effect on the sedimentation of the particles, and in fact, with hydroxide anion pairs, they have a pronounced inhibitory effect. Calcium and magnesium ions show the same tendency as mentioned above - at higher concentrations they are more effective, while at concentrations of 20 mg/l their effectiveness varies, depending on the anion pair. Iron and aluminium have a strong effect even at low concentrations of 10 mg/l, and it is not by chance that this type of coagulant is used in industrial solutions. In all cases, concentrations of 40 mg/l and 80 mg/l were more effective than lower concentrations.

Finally, I measured the pH values at the beginning (0 min) and at the end (180 min) of the experiment. It is interesting to note that for iron and aluminium, they are at a markedly acidic pH (5 and 4, respectively) at the beginning and do not change significantly in pH throughout the experiment. In the case of sodium and calcium, the strong alkaline environment (around pH 11) caused by hydroxide ions may explain why the sedimentation was so poor for sodium. For calcium, magnesium cations cause a slightly acidic or alkaline environment initially depending on the anion, which in all cases settles to a neutral pH of around 7 during the 3-hour experiment. This may be due to adhesion to the surface of the soil particles.

## **Conclusions and recommendations**

Based on the data examined, I separate the results into five major groups. While in the previous chapter it was appropriate to start with the grain size, in this chapter I reverse the order because of the overbuilding of the different chapters. Accordingly, I will start with the results of the coagulation studies.

### **Coagulation studies**

The results obtained show that the Schulze-Hardy law is fully valid in the soil medium, i.e. the effect on sedimentation increases in proportion to the charge of the cations. This means, practically, that ions with three charges contribute significantly to aggregation. By comparison, the two-charged ions also have such properties, only for the singly positively charged cations (e.g. sodium, potassium) no difference in magnitude is detected compared to untreated soils used as controls.

For the anions, in this case sulphate ions and chloride ions, as common anion pairs occurring in nature, there was no statistically significant difference, although chloride ions were shown to be more effective. In contrast, hydroxide ions had a clear negative effect on aggregation propensity.

Thus, if the calcium or magnesium content of the environment is high, it is expected that the tendency to aggregate will be strong, with the soil constituents not easily breaking down, the reason for which is clearly due to the chemical content. This effect is particularly strong for the colloidal domain, as the Kápolnásnyék sample showed. The same cannot be said for sodium, which is a monovalent cation and, according to my measurements, does not have a significant positive effect on the aggregation of the grains.

## **Extraction measurements**

In general, the chemical studies show that the solubility of iron and manganese compounds increases with reductive treatments, while the solubility of calcium and magnesium decreases. This is of course not the case for the sample from Magyarszombatfa, which was already present in a reductive environment, so the effect of the treatments is negligible.

It is interesting to compare the observed results with the grain sizes. As the grain size shifts towards the larger size range, the amount of soluble ions tends to increase. This is mainly due to a change in the active surface area (adsorption surface): an increase in grain size is associated with a decrease in the amount of active surface area per unit mass, which significantly affects the chemical solubility of the elemental content of soils. In other words, as observed for surface adsorption, a smaller active surface area means less bound material.

Mild solvents ( $\text{CaCl}_2$ , distilled water) do not leach measurable amounts of the test substance from samples exposed to natural influences (unless there is some extreme effect), so such studies have not been successful in tracking changes.

## **Studies of organic matter**

There was no change in the organic matter content of the soils compared to the baseline, only the Keszthely sample showed a decrease. However, for all soils, the simulation of the water cover caused a change in the qualitative distribution of humic substances, i.e. in the molecular sizes. This trend is particularly notable (and traceable) when the full spectral range is analysed, not just the two wavelengths defined by the original E4/E6 methods.

In terms of humus quality, there are two trends: for the A level samples, the long-term effect (by the end of month 3) is that the humus quality shifts towards higher molecular weight material considered to be of higher quality, while for the deeper layers the opposite is true, with a dominance of organic material of smaller size range. There are two exceptions to this: level B in the Várvolgy sample shows an improvement typical of level A, which is possible due



to soil mixing (ploughed layer), while the Kisújszállás sample shows a deterioration, although it is level A. The probable reason for these changes is that the microbial life of the soils utilises the low molecular weight carbon chains, but this effect is reduced in the deeper layers. There, the natural decomposition and degradation of organic matter is the decisive process. In the exception soils, this process is altered by soil rotation, and in the case of the sample from the small town of Svalbard, the natural decomposition of large quantities of humic matter counteracts the effect of soil microbial life on the smaller molecules.

### **Analysis of grain size distribution**

Based on the previous chapters, three major trends in grain size distributions can be identified. The first is that there is no significant change as a result of the treatments. This is either the case for soils that are structurally strong (containing mineral grains), resistant, with highly stable microaggregates (Paks, Salföld), or for the Hungarian lowland sample, which is inherently reductive (long water covered).

The other trend is when the 100 micron size range starts to break down into smaller sizes as a result of treatments. This is typically the case in Karcag soil, where the silt fraction breaks down as a result of water cover.

The third group includes soils (Keszthely, Kápolnásnyék, Kisújszállás, Várölggy) where aggregation occurs in the 100 micron range, while the smaller and larger ranges show a quantitative decrease (the larger range disintegrates and the smaller range aggregates). This is due to the appearance of cations, as detailed in the leaching tests and coagulation tests, which cause the smaller particles to aggregate.

### **Analysis of aggregate stability**

For aggregate stability values, the fact that the tests were all performed in a distilled aqueous environment should not be ignored. This can easily cause the phenomenon that some of the ions bound on the surface of the particles and aggregates are precipitated and dissolved in equilibrium. Thus the force holding the grains together is reduced and some aggregates may disintegrate. This is due to the fact that in each of the soils tested, the ten-minute measurement process

tended towards aggregate fragmentation (except in the case of Magyarszombatfa, which is inherently from a reductive environment). In almost all the other soils tested, the rate of change was reduced.

Whether the small or large grain size ranges were investigated, the change in grain size caused by several months of chemical transformations in a reductive environment represents a stabilisation process, with a fixation in the range around 100 microns, and a refusal of the majority of the grains to change quantitatively. The slight change could be due to a change in state caused by distilled water. A typical quantitative increase is observed in the smaller, colloidal range, which can be explained in the same way by aggregate splitting caused by leaching ions. Aggregates are also influenced by the amount of organic matter, especially high organic matter content and higher molecular weight organic matter, which contributes to the formation and persistence of aggregates.

## **New scientific results**

I., Long-term water cover changes the chemical composition. Based on the results of my particle size studies, one possible reason for this is that the active adsorption surface area for a given ion changes as the particle size range changes. Exceptions to this are iron and manganese, which become soluble by reduction, and calcium and aluminium, which are involved as aggregating agents. The amount of these may differ from the effect of concentration changes generated by changes in particle size.

II., The effect of increasing cation concentration on the sedimentation rate can be described by first-order kinetics. It can be concluded that the change in the rate constant of sedimentation is proportional to the concentration of the metal ion. This suggests that the change in metal ion concentration changes the sedimentation rate less and less for increasing concentration values.

III., Long-term water cover affects the quality, if not the quantity, of organic matter. In the more organic matter-rich and deeper layers, the decomposition of humic matter results in the formation of lower molecular weight material, while near the surface the concentration of these low molecular weight organic matter decreases. Presumably, microbes are able to utilise these more easily, which is the reason for the decrease.

IV., In the grain size, unless they are particularly resistant mineral grains, a disintegration process is invariably initiated by long-term water cover. The grains aggregate with the cations present and stabilise in the size range around 100 microns.

V., The aggregate stability is stabilized by long-term water cover, as the formed grains of around 100 microns become resistant to disintegration due to the released (coagulating) substances.

## PUBLICATIONS

### 1. Full-text, peer-reviewed scientific publications in scientific journals (accepted for publication)

#### 1.1. In a foreign language journal with impact factor (according to WEB OF SCIENCE):

Czinkota I, Filep T, Rétháti G, Tolner L, Gulyás M, Sebők A, (2021): Derivation and application of a generalised exchange-adsorption isotherm for the adsorption of hydrophobic compounds on soils. Soil and Water Research, 16 : 2 pp. 67-73. , 7 p. Scopus: Q3, DOI: 10.17221/69/2020-SWR, (IF: 0,53 in 2021) **(18 pont)**

Sebők A, Labancz V, Czinkota I, Nemes A (2020): The effect of various metal-salts on the sedimentation of soil in a water-based suspension. PLOS One, Vol. 15 (1), 15 pp. ISSN: 1932-6203, Scopus: D1, <https://doi.org/10.1371/journal.pone.0227338> (IF 0,57 in 2020) **(18 pont)**

Kalmár, J., Füleky, Gy., Kuti, L. és Sebők, A (2017): Iron rich embeddings in east hungarian eolian sand accumulation, Tamáspuszta area: genetic and environmental considerations, Carpathian Journal of Earth and Environmental Sciences, Vol. 12/1, pp. 109-120. ISSN: 1842-4090 (IF 0,671 in 2017) **(18 pont)**

#### 1.1.1. Hungarian edition

- article

Sebők A, Razane A, Takács A (2022): Kalcium hatása a talaj üledékképződésére – mérési módszer. Journal of Central European Green Innovation, Vol. 10, Suppl. 1. pp 44-54. ISSN: 2064-3004 **(5 pont)**

Grósz J, Sebők A, Nagy N, Kovács A, Waltner I (2019): Analysis results of in situ water and sediment quality of Újpest backwater. Tájökológiai Lapok, Vol. 17 (2), pp 179-192. ISSN: 1589-4673 **(7 pont)**

Sebők, A., Czinkota, I., Nyiri, B., Bosnyákovics, G., Gulyás, M., Dálnoki, A. B. (2018): A talaj szervesanyag minőségének vizsgálata UV-VIS spektrumban – az Exponenciális Illesztés Módszere (EFA) – Növénytermelés, Vol. 67 (4), 1-14 ISSN: 0546-8191 **(5 pont)**

Czinkota, I., Szanyi, J., Kovács, B., Sebők, A., Hajdok, I. és Papp, M. (2015): The Effect of Thermal Water Aeration and Water-rock Interaction — Central European Geology, Vol. 58/4, pp. 306-320 ISSN: 1788-2281 **(7 pont)**

Fügedi, U., Kuti, L., Tolmács, D., Szentpétery, I., Kerék, B., Dobos, T., Sebők, A., Szeiler, R. (2014): Regional Patterns of the Accumulation of Toxic and Nutritious Elements in Hungary — Central European Geology, Vol. 57/3, pp. 231-251. ISSN: 1788-2281 **(7 pont)**

Zsámbok, I., Andó, A., Kuti, L., Sebők, A. (2014): Toxic elements in the groundwater of Budapest — Central European Geology, Vol. 57/3, pp. 297-305. ISSN: 1788-2281 **(7 pont)**

## **2. Full-text professional, promotional communication or study published in professional journals (accepted for publication)**

## **3. Peer reviewed book/notes (excerpt) (printed or electronic), promotional book**

## **4. Congress publications (in print or electronic format - only for ISBN, ISSN or other certified publications)**

4.1. Full-text communication, published in an occasional (non-periodical) congress publication, in a foreign language, in a peer-reviewed form:

Sebők, A., Czinkota, I., Fekete, Gy., Dálnoki, A. B. és Grósz, J. (2016): Humuszoldat adszorpciós és deszorpciós kinetikájának meghatározása homokos talajon oszlopkísérlet segítségével, Talajvédelem különszám 2017, pp 251-260 **(3 pont)**

Belayneh G M, Sebők A, Waltner I (2020): A field-level study of soil penetration resistance, moisture content and infiltration  
In: Jakab Gusztáv, Csengeri Erzsébet (szerk.)  
Water management: Focus on Climate Change. ISBN: 9789632698922  
Konferencia helye, ideje: Szarvas, Magyarország, 2020.01.01. Szarvas, pp. 24-29. **(5 pont)**

Sebők A, Czinkota I, Dálnoki A B, Waltner I, Grósz J (2019): Long-term reduction effects to the extractable soil chemicals  
In: Jakab Gusztáv, Csengeri Erzsébet (szerk.)  
XXI. Századi vízgazdálkodás a tudományok metszéspontjában: II. Víz tudományi Nemzetközi Konferencia. 366 p. ISBN 9789632698083

Konferencia helye, ideje: Szarvas, Magyarország, Kiadó: SZIE Agrár- és Gazdaságtudományi Kar, 2019.03.22. Szarvas, pp. 349-355. **(5 pont)**

Sebők A, Labancz V, Makó A, Dálnoki A B, Barna Gy, Czinkota I (2018): Reduktív környezetben inkubált talajok aggregátum stabilitásának vizsgálata lézer-diffraktometriás módszerrel  
In: Bakacsi, Zs; Kovács, Zs; Koós, S (szerk.) Talajtani Vándorgyűlés : Absztrakt és program füzet : Talajhasználat - funkcióképesség  
Magyar Talajtani Társaság, (2018) pp. 17-18. **(1 pont)**

4.2. Full-text publication, in an occasional (non-periodical) congress publication, in Hungarian, published in a peer-reviewed form

Sebők A, Nemes A, Czinkota I, Balázs Á (2018): Talajszemcsék ülepedése sós környezetben  
In: Füleky György (szerk.)  
XIV. Kárpát-medencei Környezettudományi Konferencia. 397 p.  
ISBN: 9786150016450  
Konferencia helye, ideje: Gödöllő, Magyarország, 2018.04.05-07. Gödöllő, MAG Mezőgazdaságért Alapítvány, pp. 279-283. **(3 pont)**

Sebők A, Czinkota I, Nyíri B, Bosnyákovics G, Gulyás M (2018): Analysis of Soil Organic material in UV-VIS Spectrum  
In: Kende Zoltán (szerk.)  
17th Alps-Adria Scientific Workshop: Abstract book. 169 p.  
ISBN: 9789632697345  
Konferencia helye, ideje: Hnanice, Csehország, 2018.04.09-14. Gödöllő, SZIE Egyetemi Kiadó, pp. 114-115. **(2 pont)**

4.3. One-page abstract in foreign or Hungarian language based on a presentation or poster in an edited scientific journal or a special issue

Sebők A, Grósz J, Waltner I, Czinkota I (2018): Humuszanyagban bekövetkező változás mezőgazdasági területeken vízborítás hatására  
In: Jakab Gusztáv, Tóth Attiláné, Csengeri Erzsébet (szerk.)  
Alkalmazkodó Vízgazdálkodás: Lehetőségek és kockázatok. Víz tudományi Nemzetközi Konferencia. 313 p. ISBN: 9789632697369  
Konferencia helye, ideje: Szarvas, Magyarország, 2018.03.22. Szarvas, pp. 170. **(1 pont)**

**5. Communications in congress publications (printed or on electronic media - for non-certified publications)**

- 5.1. Full text article in foreign languages
- 5.2. Full text article in Hungarian language
- 5.3. One page summary in foreign or Hungarian languages

Dálnoki A B, Gulyás M, Rétháti G, Sebők A, Tolner L, Köles P, Czinkota I (2021): Az EDTA hatása a talaj potenciálisan toxikus elemtartalmára  
In: Rétfalvi, Tamás (szerk.) „TERMELJÜNK EGYÜTT A TERMÉSZETTEL! – AZ AGRÁRERDÉSZET, MINT ÚJ KITÖRÉSI LEHETŐSÉG”: PROJEKTZÁRÓ TANULMÁNYKÖTET. Sopron, Magyarország : Soproni Egyetem Kiadó pp. 487-490. **(1 pont)**

Szilágyi A, Horváth E, Kolár A, Centeri Cs, Nagy P, Simon B, Kovács E, Sebők A (2019): Comparison of some ecosystem service related soil characteristics of conventional, organic and permaculture farms in Szentendre Island, Hungary: an explorative case study  
In: Zdruli, P; Sallaku, F; Costantini, E; Dazzi, C (szerk.) Soil's contribution to people : from food to life supporting services : Book of Abstracts and Field Excursion Napoli, Olaszország : Le Penseur pp. 96-96. **(1 pont)**

Sebők A, Nemes A, Czinkota I, Labancz V (2018): An optical approach to quantify the impact of various salt-ions on the sedimentation of suspended sediment in freshwater. Poszter, 2018 August 12-17: 21th World Congress of Soil Science, Rio de Janeiro, Brazília **(1 pont)**

Makó A, Földényi R, Tóth J, Kardos A, Herczeg E, Barna Gy, Hernádi H, Sochan A, Ryżak M, Bieganowski A, Czinkota I, Sebők A, Bakacsi Zs, Kovács Zs, Koós S (2018): A lézerdiffrakciós mérés technika talajfizikai célú alkalmazása. In: Bakacsi, Zs; Kovács, Zs; Koós, S (szerk.) Talajtani Vándorgyűlés : Absztrakt és program füzet : Talajhasználat - funkcióképesség. Magyar Talajtani Társaság pp. 16-17. **(1 pont)**

Földényi, R., Czinkota, I., Sebők, A., és Marton, A. (2017): Huminanyagok UV-VIS spektruma és a Weisbull-féle sűrűségfüggvény, 6. Környezetkémiai szimpózium, Bakonybél, 2017. október 12–13., pp 16. **(1 pont)**

Czinkota, I., Rétháti, G., Tolner, L., Dálnoki, A. B., és Sebők, A. (2017): Széles körben használatos adszorptívum csere izoterma levezetése és használati lehetőségei, 6. Környezetkémiai szimpózium, Bakonybél, 2017. október 12–13., pp 31. **(1 pont)**

Rétháti, G., Czinkota, I., Sebők, A., és Tolner, L. (2016): Kationok (Pb<sup>2+</sup>, Cu<sup>2+</sup>, Zn<sup>2+</sup>, Co<sup>2+</sup>) talajon történő szimultán megkötődésének jellemzése, 5. Környezetkémiai szimpózium, Tihany, 2016. október 6–7., pp 23. **(1 pont)**

Sebők, A., Rétháti, G., Varga, D., Füleky, Gy. és Tolner, L. (2016): Comparing study about the methods to measure the copper sorption capacity of soils, 15th Alps-Adria Scientific Workshop Mali Lošinj, Croatia, 2016 Április 25-30. **(2 pont)**

Rétháti, G., Varga, D., Sebők, A., Füleky, Gy., Tolner, L. és Czinkota, I. (2015): Talajok rézmegkötő képességének vizsgálata oszlopkísérletek segítségével, 4. Környezetkémiai szimpózium, Tata, 2015. október 8–9., pp 27. **(1 pont)**