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SEASON-RELATED CHANGE OF THE TOTAL CARBON IN NERIS REGIONAL PARK SOIL

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Abstract. Soil degradation directly affects water and air quality and bio-variety and a soil organic matter is, therefore, one of the most important elements. The organic matter is one of the main accumulators of the solar energy which participates in the fundamental processes of ecosystems, determines the physical properties of soil having an influence of the nutrition regime of plants and is vitally important for plant growth. Having entered the soil ecosystem organic matter may: 1) completely self-mineralise thus enriching the reserves of carbon dioxide and minerals; 2) be used for the nutrition of micro-organisms and assimilate in the microbe biomass; 3) be included in newly formed humus matter, i.e. be converted into humus. The analysis of Neris Regional Park soil covered the total carbon which consists of carbon accumulated in the organic and inorganic form. The investigations determined the contents of the total carbon which will be later analysed through modelling and determination of carbon dioxide emissions and velocities of soil degradation.

Keywords: soil, soil surveys, total carbon, CO_2 emissions, Neris regional park, different land use types.

1. Introduction

Global warming and the balance of greenhouse gases that provoke this warming in the ecosphere are currently a worldwide problem. The essence of the problem can be fully understood only when well-organized and broad-minded groups of various professional scientists cooperate. Complexity of this problem is related not only to the hugeness and complexity of the analysed object (Earth's ecosphere) and lack of appropriate data, but also to the absence of suitable methodology needed to solve it. General ideology for the solution of the problem is rather clear, i.e. the balance of greenhouse gases in ecosphere, reduction of its constituent parts related to the emission of greenhouse gases, and, on the contrary, the increase of its constituent parts related to its escape to long-term immobilisation basins. It's clear that the latter are well known – the crust of the Earth, Global Ocean, pedosphere, and land phytomass (Eitminavičiūtė 2008; Baltrėnas *et al.* 2008).

The crust of the Earth is the largest, comprising more than 99.96 % general carbon content in the ecosphere. However, in respect of renewal a person is globally unable to perform that. On the other hand, human's efforts allow to get (from the deep part of earth in the form of organic fuel) and "put" into atmosphere from 5.5 to 7.0 billion tons (5.5–7.0 Gt) of carbon each year. When trying to solve the problem of greenhouse gases accumulation in the atmosphere, scientists usually talk about the immobilisation of carbon in the land phytomass and pedosphere. However, it has to be noted that in general immobilisation of carbon in land ecosystems is at least 3 times smaller than in the Global Ocean; the amount of carbon accumulated in the ocean is 17–20 times larger than the amount in the Earth's flora and pedosphere together. However, the intensity of carbon circulation in the ocean is significantly smaller: land flora phytomass is renewed averagely in 15 years, whereas the ocean CO_2 – only in 300 years. Besides, in regard to the perspectives of global warming, a probable reduction of the CO_2 absorption by ocean can be foreseen. Processes of fertilisation in the land will stimulate this absorption (Добровольский 1998, Baltrėnas *et al.* 2008).

The largest amount of organic carbon on the Earth's surface (hypergenesis zone) is accumulated in the pedosphere: various Earth's soils, including swamps, – from 1500 to 1700 Gt, i.e. taking into consideration degradation of Earth's phytomass related to technogenesis, it is 3.5–4 times more than in the entire Earth's flora. Therefore it is hardly surprising that the progressive plans related to the reduction of carbon amount in the atmosphere and the minimisation of greenhouse effect are currently concentrated on the questions of its immobilisation in soils and plants (Eitminavičiūtė 2008; Baltrėnas *et al.* 2008).

On the other hand, both soils and flora are natural systems that not only bind (immobilise) carbon in the process of biogeochemical cycle but also perform its emission. Therefore, a problem of balance (just on the other level) still remains (Kvasauskas *et al.* 2009). It is sad to admit but this problem here is not less complicated than the one on the first level *atmosphere* (soils+flora). Different soils under different climatic and weather conditions, during different vegetation periods of plants, in different land-use types and under the influence of distinct phytocenoses and microbocenoses differently produce greenhouse gases (mostly carbon dioxide and methane) (Baltrėnas *et al.* 2008; Pranskevičius *et al*. 2009).

Global warming (of any expression and extent) will significantly influence both soil formation and soils that are already formed. It is known that the following processes are closely related to climate: energetics of soil formation, many physical and chemical processes related to soil formation, modes of heat and humidity, types of overground and soil biocenoses, their intensity, types of processes of organic and mineral material accumulation and destruction, as well as soil structure. Their integral part is intensity of carbon circulation in ecosystems, including positive (accumulation or immobilisation) or negative (emission and mobilisation) modes of the intensity and the effect that either reduces or stimulates warming processes. This effect will undoubtedly also depend on the "health" of certain ecosystems, as well as on the level of their anthropogenic transformation and technogenic load (Bukantis 2001; Eitminavičiūtė 2008).

According to soil scientists, the course of soil formation processes is basically influenced by parameters that regulate temperature and humidity conditions, as well as their proportion in soil, i.e. parameters that affect its hydrothermic regime and intensity of microbiological processes (Van Ginneken *et al.* 2007). The latter are related to the annual precipitation, precipitation balance during different seasons, terrain, mountainside position in respect to the transfer of dominated air masses and their exposition. In regard to the landscape geochemistry, the latter is related to the elementary geochemical landscapes and the peculiarities of the migration of water and chemical elements in these landscapes (Baltrėnas *et al*. 2009).

Besides, experts are sure that even slight global warming can reduce cultured plant yield. This yield will become less stable in the lower latitude (the tropic zone) regions. Negative effect will be further increased by more frequent periods of extreme weather conditions (floods, heat, and drought). Longer vegetation period and grain crop yield increased by warmer climatic conditions will stimulate a more rapid loss of organic materials from soil and will increase carbon dioxide emissions from soils (Raich *et al.* 1992).

According to climatic forecasts, we can expect milder and more humid winters, hotter and drier summers, as well as more frequent and more intense natural phenomena related to weather. It may happen that severe outcomes of weather changes will not be felt until 2050; however, we can expect significantly negative effect of extreme weather conditions (more frequent and longer periods of hot weather, droughts and floods) before this date (Robertson *et al.* 1997).

It is known that soil is mostly affected by water. Lack of water has the greatest influence on the increase of the Earth's biomass, i.e. accumulation of general carbon in soil. Pests, diseases and weeds will spread because of humidity imbalance and intensity will increase because of higher temperature and humidity (Juhanson *et al.* 2007). The amount of humus will increase because of the increased biomass of plants (Svirskienė *et al.* 1997). It is also known that when the amount of humus increases, yield fluctuation related to meteorological conditions reduces and the efficiency of used fertilisers increases.

When trying to forecast soil humidity changes according to the results of HadCM3–A1B climate scenario and TM hydrological model, it can be said that during each thirty-year period in the 21st century, soil humidity will be reduced (Stonevičius *et al.* 2008).

Risk of soil erosion arises because of the increased annual precipitation. Experiments performed by Kaltinėnai Research Station of the Lithuanian Institute of Agriculture have discovered the usefulness of antierosive crop rotations and multicomponential grass mixture for the accumulation of soil organic material. According to the average data, after 20 years of research in mountainsides that are steeper than 10°, antierosive grass and crops rotations increased the amount of organic material by 14.7–17.8 %, and multicomponential grass mixture – by even 63.8 %, when compared to grass and crops rotations of low antierosive power in respect of the amount of soil organic material. This almost costless tool stabilises destruction of erosion-sensitive soils not only by protecting soil from negative natural forces (intense rainfalls and winds) but also by stimulating soil carbon accumulation (Jankauskas *et al.* 2006).

Ecosystem carbon respiration exceeded carbon assimilation during growing seasons and dormant periods, resulting in a net flux of carbon dioxide from the biosphere to the atmosphere of between 1.27 and 1.85 kg C m^{-2} for the entire 20-month period (an average loss to the atmosphere of 2.07 to 3.01 g C m^{-2} day $^{-1}$). Crop growth (from 10 January 2001 to 6 June 2001) resulted in a net loss of between 0.22 and 0.32 kg C m^{-2} to the atmosphere (an average daily loss of 1.5 to 2.2 g C m^{-2}), whereas the two seasons of successional growth combined contributed an additional 1.05 to 1.53 kg C m^{-2} to the atmosphere (an average daily loss of 2.2 to 3.3 g C m^{-2}) (Rustad *et al.* 2001).

Large amounts of CO_2 can be eliminated from the atmosphere and accumulated in soil when using such farming technologies as ecological farming; zero or reduced tillage systems when soil destruction is totally avoided or it is reduced; growth of albuminous plants; planting of hedgerows; maintenance of permanent pastures and transformation of tillage into pastures or meadows (Buchmann 2000).

Soil respiration is one of the main sources of CO_2 to the atmosphere, accounting for over 25 % of global emissions (Bouwmann *et al.* 1998). Soil CO_2 efflux is difficult to estimate due to the high spatial variability that characterises it (Fang *et al*. 1998; Stoyan *et al*. 2000; Xu 2001).

The aim of the work is to analyse general carbon changes in soil when emphasising soil degradation and carbon dioxide emissions from soils, as well as influence on climate changes.

Data provided in this article continue the series of publications started earlier (Baltrėnas *et al.* 2008) and related to carbon resources and its balance in Lithuanian soils.

2. Methodology

Soil samples for the measurement of general soil carbon amount were taken in the Neris regional park (Fig 1). This soil sampling methodology is prepared in accordance to the soil sampling protocol prepared by the European Union for the measurement of organic carbon changes.

Samples were taken in the Paneriai forest, at the right downstream bank of Neris near the bridge to Vievis, as well as at the both banks of the Čekonė river. Soil sampling was performed in accordance to autonomous and sub-aquatic landscapes. The general soil sampling methodology is based on the EU protocol and is described in the section of methodology. Coordinates of sampling places were marked with the GPS recipient. The main features of the territory, its plants and terrain were described in detail.

The Paneriai forest was chosen for forest soil sampling. Dense hydrographic network was detected in this soil sampling place. Prevailing flora in the forest sampling place was fir groves with a small amount of leafy trees. Willows and various scrubs dominated in the riverbed. A tilled field (measurements: 40 x 30 metres) was also found in the territory. 3 sampling areas of tillable soil were taken in this place. Distances from the riverbank line to the sampling place were from 10 to 31 metres. The incline from the analysed tillable area to the riverbank line was 1.5 metres. M, M^A, M^B (Fig 1) soil sampling collections were taken for the simulation of tillable soil with the changing use of soil.

Fig 1. The choice of research places for the general carbon measurement

3 (P, P^A, P^B) forest soil sampling areas were taken according to different landscapes. The distance from the simulated tillable soil was 71 metres. Soil samples were taken in the direction of the terrain slope. The distance from the first sampling area to the autonomous landscape bank line was 20 metres. The next area was taken in the middle of the slope with the 17-metre distance from the autonomous landscape bank line. The last area was chosen at the groundwater level. Slope angle was 10^0. The research place in the forest was dominated by firs with birch inserts.

Soil samples near the Čekonė river were taken from the meadow (E and Z areas) (Fig 2). Meadow samples were taken in two areas E and C. Both analysed areas belong to autonomous and superaquatic landscape. Z soil area was taken in the superaquatic landscape. It has to be noted that this is the sampling place at the groundwater level. Soil sampling has shown that the humous soil layer was up to 40 cm. Meadow samples were limited to the Neris river and small Čekonė river that disgorges into Neris perpendicularly to its flow direction. The small river is rather swift at the place where it disgorges into Neris. The slope is up to 39 metres. The banks of the small river and Neris are dominated by alders and black alders, as well as thin scrubs.

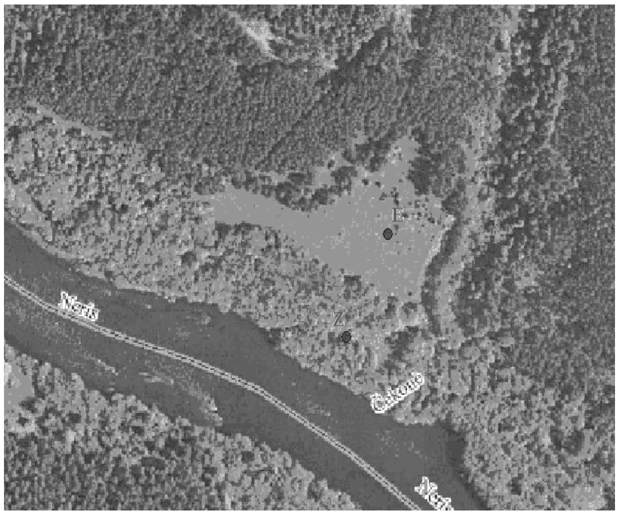

Fig 2. Soil sampling places at the Čekonė river

In order to take soil samples without breaking their structure, 5 cm height and 15 cm diameter metal ring was used. The ring is used in order to achieve the minimum physical soil destruction. Soil samples were then put into polythene bags and numbered.

3. Research results

Forest soil. Investigations of the total carbon in forest soils were carried out in areas P, PA, PB (Fig 1). Research places were selected with the aim of analysing the impact of relief as well. Research place P was chosen in an autonomous landscape, research place PA was selected between autonomous and super-aqual landscape PB. The content of the total carbon determined in research place P in the springtime at a depth of 0–10 cm accounted for 1.26 % (Fig 3). The content of the total carbon in deeper layers varied depending on depth from 0.7 % to 0.38 %, respectively. In the summertime when ambient temperature rose (to 21 ^{0}C during the investigation) the content of the total carbon in soil at a depth of 0–10 cm increased to 16 % of the total carbon content identified, at a depth of 10 – 20 cm to 50.4 %, and at a depth of 20–30 cm to 66.3 %. A larger content of the total carbon was determined at deeper layers during the period of vegetation when the system of plant roots was developing and organic materials were mineralised intensively. With temperature falling the processes of organic matter degradation are slowing down and when temperature reaches minus values they discontue.

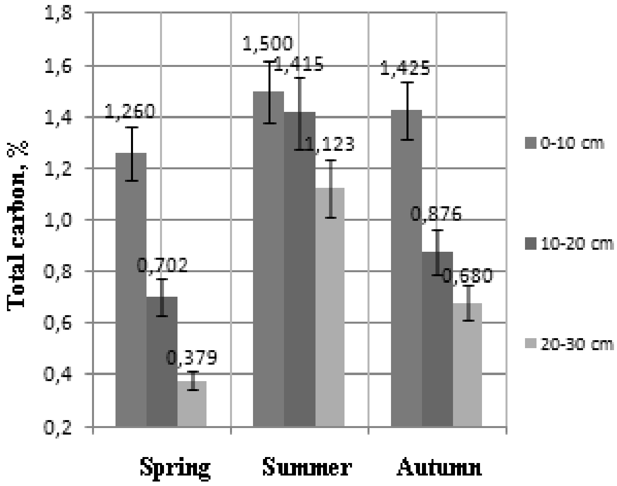

Fig 3. Amount of the total soil carbon in forest soil research place P (Fig 1)

In autumn when ambient air temperature was 18 ^{0}C the total carbon content decreased. At a depth of 0–10 cm the total carbon amount decreased by 5 % of the total determined carbon content, at a depth of 10–20 cm the decrease reached 38.1 %, and at a depth of 20–30 cm – up to 39.4 %. Decreasing ambient temperature and increasing humidity slow down the activities of microorganisms and make anaerobic processes more active. The increased amount of humidity also slows down the release of carbon dioxide which forms during the process of decomposition of organic materials. However, at 18 ^{0}C temperature the processes of organic matter decomposition do not stop, particularly at a depth of 0–10 cm. Large amounts of dead organic mass accumulate in the top soil layer in a leaf-litter. Part of this mineralised mass enters soil and therefore the least decrease of the total carbon amount is at a depth of 0–10 cm.

The amount of the total carbon determined in the springtime in research place PA at a depth of 0–10 cm is larger by 1.3 times at a depth of 10–20 cm, 2.7 times and 3.1 times at a depth of 20–30 cm than that identified in the autonomous landscape (Fig 4).

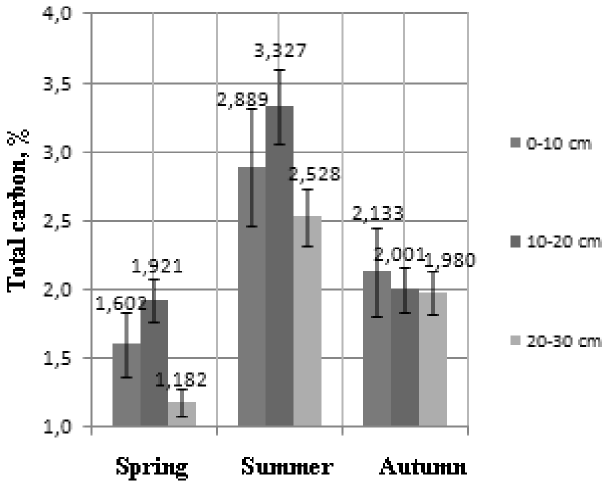

Fig 4. Amount of the total soil carbon in forest soil research place PA (Fig 1)

This shows that, under the impact of water erosion, part of the total carbon is washed away to the places of lower relief. Analysis of the total carbon amount according to depth alone showed that the highest content of the total carbon, 1.92 %, was at a depth of 10–20 cm. At a depth of 0–10 cm the total carbon content accounts for 1.6 % which is by 1.2 times less. The total carbon content determined at a depth of 20–30 cm was 1.18 % or by 1.6 times lesser.In the event of water erosion the top layer of soil is washed away, but relief is distinguished by absorption qualities. A soil layer containing organic matter forms and is later covered with a less fertile layer from deeper layers due to the impact of erosion.The amounts of the total carbon identified in the summertime are also higher compared to results obtained in the spring-time.In the summertime the increase of the total carbon compared to the identified content accounted for 44.5 % at a depth of 0–10 cm, 42.3 % at a depth of 10–20 cm, and 53.2 % at a depth of 20–30 cm. In the summer against spring season, the total carbon content at a depth of 0–10 cm increased by 1.8 times, at a depth of 10–20 cm 1.7 times and at a depth of 20–30 cm 2.1 times.The largest amounts of the total carbon, 3.33 %, were determined 20–30 cm deep. In the autumn season, when temperature fell and the probability of water erosion emerged, the amount of the total carbon evenly distributed in research place PA by gradually descending towards deeper layers. Difference at the depths 10–20 and 20–30 cm became insignificant. Like in the case of other forest soils, a larger content of the total carbon was identified in the top layer.

In the research place PB in question the identified total carbon amount was the biggest compared to research places P and PA (Fig 5). The amount of organic materials drifted by water erosion was the largest even in the case of visual sampling. A low level of ground water also played an important role with regard to the amount of the total carbon in soil. When the humidity content is increased (over 20 %) anaerobic processes start during which carbon is conserved in soil.

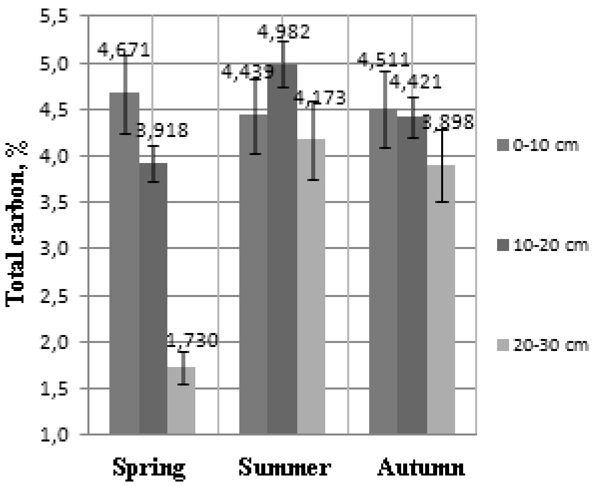

Fig 5. The total soil carbon amount in forest soil research place PB (Fig 1)

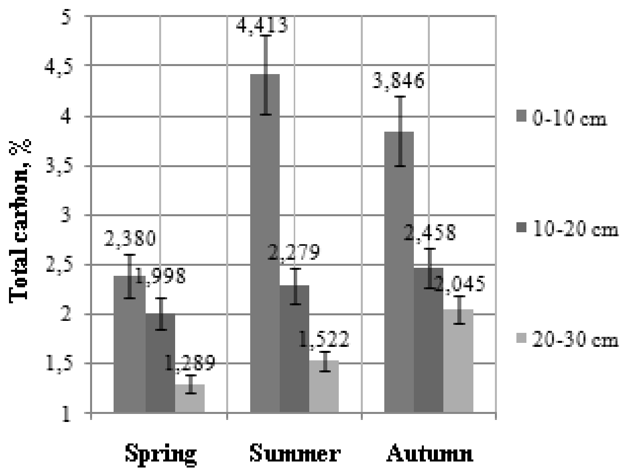

Fig 6. Amount of the total soil carbon in arable soil research place M (Fig 1)

As the performed investigations show, the amount of the total carbon in the top layer of soil is by 2.7 times higher than at a depth of 20–30 cm in the springtime when snow-melting water runs off. This happens not only because of the impact of a soil layer which is formed by outwash but also the creation of a filtration layer starting from a depth of 20 cm. It has been visually determined during sampling that the amounts of sand and pebbles are bigger in deeper layers than in surface layers. This allows a confirmation of the assumption regarding the filtration layer. The data obtained in summer show quite a different distribution of the total carbon amount, i.e. a smaller amount of the total carbon is contained 0–10 cm deep compared to a depth of 10–20 cm. This happened due to the fact that part of organic matter had been mineralized and entered deeper layers. In addition, the total carbon which was not present in the springtime has emerged at a depth of 20–30 cm. The total carbon amount increased 2.4 times in that layer. This can be explained by the filtration layer and the accumulation of mineralized materials inside this layer. Apart from that, it should be emphasised that no active leaching out of organic materials was determined in the summertime. The research place was humid but no water stream was present.

The total carbon amount determined in autumn differed from that identified in summer by 1.6 % at a depth of 0–10 cm, 11.3 % at a depth of 10–20 cm and 6.6 % at a depth of 20–30 cm. The duration of saturation with the total carbon in this research place is quite long. However, with the start of the spring thaw season the major portion of the formed total carbon, 44 % of the total identified amount, drifts away from a depth of 20–30 cm.

Arable soil. Arable soil differs from other soils as it is practically impossible to determine soil horizons in it and organic materials are mixed up through all layers. In addition, both organic and inorganic fertilisers are applied on such soils.

The research places M, MA and MB under review are presented in Figure 1. All research places were allocated in the centre of the field in question.

The total carbon amount identified in research place M in the springtime at a depth of 0–10 cm was by 1.2 times bigger than at a depth of 10–20 cm and by 1.8 times bigger than at a depth of 20–30 cm (Fig 6). The total carbon amount was evenly distributed in soil. In summer when the process of plant vegetation was active the highest amount of the total carbon in soil was identified only at the depths of 10–20 cm. The total carbon amount determined at a depth of 20–30 cm was by up to 1.8 times smaller. Due to active plant vegetation and the growth of the root system the total carbon amount in soil is higher in summer than in spring. Also, in summer the activity of microorganisms is the most intensive if the content of humidity in soil is sufficient. Soil fertilisation particularly accelerates the degradation of organic materials as microorganisms have sufficient nutrients and this encourages even carbon dioxide emissions. In addition, organic materials are more rapidly mineralised on the arable soil due to soil density and enhanced aeration qualities. The accumulated amount of carbon in arable soil is the lowest as the soil itself is impacted not only the wind but also by water erosion. Many countries apply different measures to reduce the impact of erosion and prevent the loss of carbon from soil. As determined during investigations of snow cover in Eastern Lithuania, up to 11 t ha^{-1} is drifted from arable soil together with snow.

As data obtained from instigations in research place M show, soil ploughing has a big influence on the distribution of the total carbon. Soil was already ploughed during sampling. The largest amount of the total carbon was at a depth of 0–10 cm, while at the other depths in question the total carbon content was similar. Compared to the data obtained in the summertime, the total carbon amount increased as much as up to 34.3 % of the total identified amount.

The intermixture of the total carbon amounts in arable soil was most clearly displayed in research place MA (Fig 7). In the springtime, the total carbon amount at a depth of 0–10 cm was the biggest even when compared to the data obtained in the summertime. As regards data from research place M, the average amount of the total carbon at a depth of 0–10 cm accounted for 3.55 %, while at research place MA–1.76 %. Soil fertilisation with organic-origin fertilisers also has a big influence on the investigations of the total carbon. This results in data discrepancies. As determined in research place MA, the total carbon amount at a depth of 10–20 cm changed insignificantly during all seasons of the analysis and its average value stood at 1.18 %. At a depth of 20–30 cm the total carbon content changed insignificantly and its average value was 1.24 %.

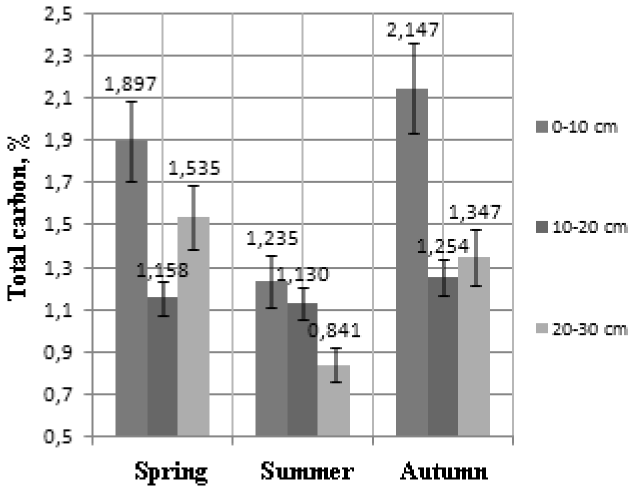

Fig 7. Amount of the total soil carbon in arable soil research place MA (Fig 1)

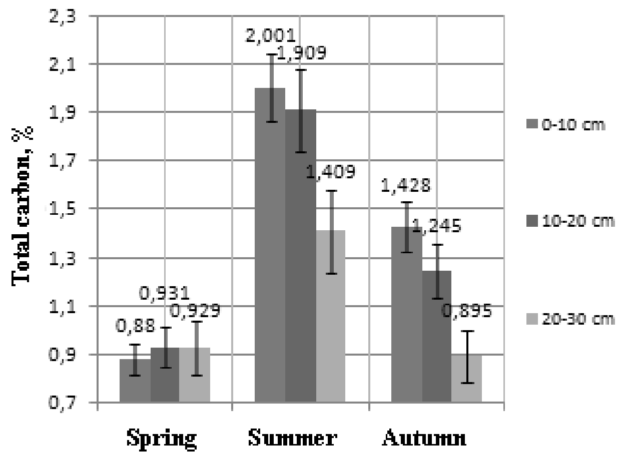

Fig 8. Amount of the total soil carbon in arable soil research place MB (Fig 1)

The investigations of the samples taken from research place MB in the springtime showed a total carbon content of 0.88 % at a depth of 0–10 cm, 0.93 % at a depth of 10–20 cm and 0.93 % at a depth of 20–30 cm (Fig 8). However, the data obtained from the total carbon amount investigations carried out in summer displayed much higher values. In the summertime the increase of the total carbon compared to the identified content accounted for 56 % at a depth of 0–10 cm, 51.2 % at a depth of 10–20 cm, and 34.1 % at a depth of 20–30 cm. The total distribution according to depths is even which is different from values identified in the springtime. This allows an assumption that the activities of microorganisms were intensive during this investigation. In addition, no fertilisers were applied on the soil in spring. Data obtained from the investigations performed in autumn are closer to those received from the spring investigations. The total carbon distribution by depth is even and the values of the total carbon vary from 0.89 % to 1.43 %. Quite a big loss of the total carbon content, up to 28.6 %, was identified at a depth of 0–10 cm compared to the values obtained in the summertime. The decrease of the total carbon at a depth of 10–20 cm accounted for up to 34.8 %, and at a depth of 20–30 cm made up to 36.5 %. The results of the performed investigations show a very diverse distribution of the total carbon both within the field and according to depths. This was predetermined not only by ploughing but also by fertilisation which was not uniform.

Meadow soil Old meadows which are often mowed were selected for the analysis of meadow soils. Dried-up plant residues form in the top soil layer under a vegetal cover in such soils. As determined during investigations, the residues of old grasses in soils become mineralised within around three years. Five research places were selected for the analysis. Analysis in three research places covered the impact of relief on changes in the total carbon, while two research places were chosen in an even meadow.

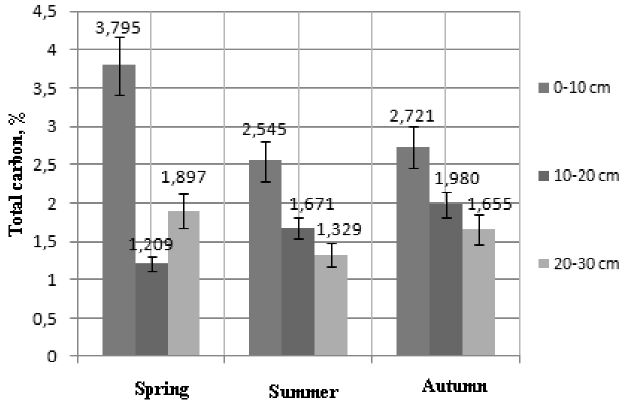

Fig 9. Amount of the total soil carbon in meadow soil research place E (Fig 2)

Research places E and Z used for total carbon investigations belong to an autonomous landscape (Fig 9). In spring compared to summer and autumn the total carbon amount is the largest. The total carbon amount identified at a depth of 0–10 cm in spring was by 1.5 times higher than that determined in summer and by 1.4 times bigger than in autumn. The total carbon amount determined in summer and autumn decreased by 1.074 %. But the total carbon amount identified at a depth of 10–20 cm in autumn is higher, i.e. 0.771 %. The carbon amount in soil determined at a depth of 10–20 cm in the springtime was by 0.7 times higher than in the summertime and by 0.6 times lower than in the autumn season. The change of the total carbon amount in summer and autumn was similar. This allows an assumption that the total carbon amount in soil was balanced. In the process of intensive degradation of organic materials the total carbon content reaches the values identified in spring. Therefore, it is not possible to evaluate the increase of the total carbon without additional investigations to be carried out at the beginning of winter. The total carbon amount at a depth of 20–30 cm was by 1.4 times lower in summer and by 1.15 times lower in autumn than in spring. The obtained data show a similar change of the total carbon content. The smallest change in carbon was recorded at a depth of 20–30 cm. The soil area of the meadow under review is located in a super-aqual landscape. This soil is nearly at the level of ground water. This soil is also supplied with nutrients by water erosion form the autonomous landscape.

The tendencies of total carbon changes in the research place Z in question are similar to those noticed in the analysed research place E (Fig 10). Investigations in research place C were carried out in an autonomous landscape. However, this area is closer to the super-aqual landscape compared to meadow research place C. The total carbon amount at a depth of 0–10 cm in spring is by 1.4 times higher than in summer and 1.05 times higher than in autumn. The total carbon content at a depth of 0–10 cm was decreasing during all the seasons of investigations.

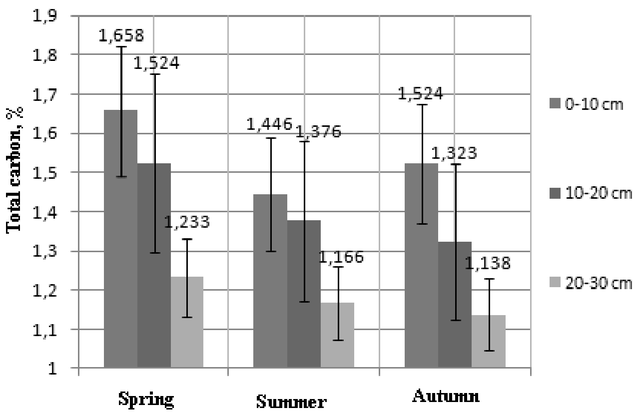

Fig 10. Amount of the total soil carbon in meadow soil research place Z (Fig 2)

Again, this allows an assumption that organic materials contained in meadow soil are degraded only upon the end of the autumn season and therefore only upon carrying out investigations at the beginning of winter it would be possible to obtain the existing amounts of the total carbon. At a depth of 20–30 cm the total carbon content was also decreasing. Investigations performed both in summer and in autumn show lower amounts of the total carbon by 1.1 to 0.9 times. But this is quite a minor change, i.e. from 0.148 % to 0.201 %. A similar situation was observed at a depth of 20–30 cm. Here the total carbon amount displayed minor changes. In summer against spring, the total carbon amount decreased by 0.067 to 0.095 times.

As the data obtained from research place E show, the same tendency prevails even though the increase of the total carbon amount was recoded in research place E from the summer to autumn season. However, the analysis of the seasonal change of the total carbon amount produced a decreasing tendency.

4. Conclusions

1. The performed investigations of the total carbon amounts in arable soil at a depth of 0–10 cm showed a 0.755 % higher amount in autumn than in spring. Samples taken from this soil in the summertime contained 0.076 times larger amount of carbon than those collected in autumn. This portion was either transformed into carbon dioxide or used for a dead plant mass. The increase of the total carbon amount, by up to 0.38 times, was also determined at a depth of 10–20 cm. In the samples taken in autumn the total carbon amount was larger by 0.290 %. The total carbon amount created in summer was by 0.120 % larger than in autumn. However, at a depth of 20–30 cm the total carbon amount was decreasing, i.e. the autumn samples contained by 0.172 % less or by 1.63 times less of the total carbon than at a depth of 10–20 cm.
2. The increase of the total carbon amount was determined at all investigated depths of forest soil. The increase of the total carbon at a depth of 0–10 cm of forest soil accounted for 0.179 %. In the meantime the total carbon amount at a depth of 10–20 cm increased by 1.41 times or 0.252 % compared to the amounts determined in spring. The increase of the total carbon at a depth of 20–30 cm is apparent – 1.089 %. The total carbon amount increased by 4.32 times compared to that identified at a depth of 10–20 cm and by 6.1 times compared to a depth of 0–10 cm. The total carbon amount was higher in the summer than in the autumn season according to a depth, respectively: 0.253 % (0–10 cm), 0.809 % (10–20 cm), 0.422 % (20–30 cm).
3. The decrease of up to 0.094 % of the total carbon was determined at a depth of 0–10 cm in meadow soil. However, the total carbon amount at a depth of 10–20 cm in autumn was by as many as 5.12 times or 0.483 % bigger. In the autumn compared to the spring season, the total carbon content at a depth of 20–30 cm was higher by a mere 0.21 times or 0.1 %. It has also been determined that the content of the total carbon in summer was lower than in autumn at all depths question: 0.128 % (0–10 cm), 0.128 % (10–20 cm) and 0.118 % (20–30 cm). Such a decrease could have been impacted by a well-developed system of meadow plant roots. The analysis of the data obtained from other meadow samples showed the decrease of the total carbon content, 0.016 %, at a depth of 0–10 cm. However, the total carbon amounts in summer increased from 0.251 % at a depth of 0–10 cm to 0.145 % at a depth of 10–20 cm. But the investigations of the total carbon amount carried out in summer showed by 0.072 % lower values than those performed in autumn.
4. In summary of the obtained results it can be stated the total carbon amount received upon summing up all the data obtained from all depths is the largest in forest soil

accounting for 1.520 %. A somewhat smaller content was identified in arable soil (1.223 %) and meadow soil (0.419 %). Comparison of the data obtained from the performed analysis and sources of literature allows a conclusion that cultivation of certain crops in arable soil can produce better results of the total carbon content than in the case of perennial plant soil. Such investigations were carried out in the U.S. which showed the decrease of the total carbon content in soil due to more intensive respiration of perennial plants in soil compared to plants which grew in field.

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