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ASSESSING CARBON SEQUESTRATION AND POSSIBLE GREENHOUSE GAS EMISSION WITHIN THE DANUBE DELTA SOILS – PAST AND CURRENT ENVIRONMENTAL CONSIDERATIONS

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Abstract: Soil organic carbon (SOC) sequestration generally occurs in wet ecosystems such as river flood plains and deltas. This paper deals with the carbon sequestration stock in the Danube Delta soils for various depths as based on the existing soil maps and updated materials and discusses about greenhouse gas emissions in order to enable evaluation of future evolution and possible scenarios in the light of global warming. Histosols represent about 28% of the Delta area and contribute with over 55% to the total SOC pool of this ecosystem. The histic subtypes of the Subaquatic Fluvisols, Gleysols and Arenosols also contribute much more to the total SOC pool than the non-histic subtypes. The large and significant SOC differences between mineral and organic soils is a strong reason for preservation of Histosols' area and for renaturation of some less fertile soils from the lowest parts of Danube Delta in order to increase SOC and decrease atmospheric C. Only about 14.5% from the total Danube Delta area was taken for farming, mainly in its western part, where mineral soils or subtypes of organic soils occur. Histosols are especially situated in the maritime, eastern parts of the Delta ecosystem. In cropland areas the soil depth that is mobilized by plowing, disking or other works and from where the plants uptake water and nutrients is at least 0.5 m, and for some crops even from 1.0 m or below. The present paper deals with various soil depths for SOC referenced values, facilitating their use in specific estimation models. Policy makers, decision makers and opinion-formers should promote preservation of the natural landscape of the Delta under the best possible conditions to contribute to an increase in SOC stock. Maintaining the natural SOC stock at the present-day level and enhancing new organic C deposition in the renatured parts of Delta soils could contribute to global warming mitigation in the future. If global warming continues at the present rate or higher rates, the soil water regime will change reflecting the dynamics of sea level rising. This event will most probably accelerate peat formation and increase Histosol area in the lowest landforms across the Delta. Future research is needed for characteristic stationary sites specifically in the cropland area of the Danube Delta to deepen our knowledge regarding the dynamics of SOC.

Keywords: wetland ecosystem, soil C stock, histic soils, Histosols, Fluvisols, Gleysols

1. INTRODUCTION

Carbon sequestration in soils generally occurs in wet ecosystems such as river flood plains, deltas, ponds, lakes and other similar sites. Deltas of large river systems are relatively rare in Europe. Danube, Rhine, Rhône and Po rivers are among the largest in this order in the European Union and some neighbor countries and flow to seas through deltas.

There is high soil variability in river deltas, where both mineral and organic soils develop. Peat soils are formed in deltas and other wetland landforms like swamps, as well as in mountain depressions and low river flood plains. A literature review reveals existence of peat soils in both temperate and cold regions (for instance, Galvin, 1976, for Ireland; Tolonen & Ijäs, 1982; and Karesniemi, 1972; for Finland, Colley, 1950; Boelter 1965, 1968, 1969; and Grigal et al., 1989, for USA, Munteanu, 1996; for Romania, Bauer et al., 2006; for Canada, Beilman et al., 2009; for Siberia, Russia), and warm regions' ecosystems (e.g. Page et al., 2004; and Rieley and Page, 2008; for Indonesia, Huat et al., 2009; for Malaysia, and Lähteenoja et al., 2009; for Amazonia).

Carbon is retained in mire plants through photosynthesis or soil respiration (Kilian et al., 1995; Pancost et al., 2000) and is released through decay processes aerobically from the surface horizons (Chambers et al., 2011), or anaerobically from the deeper horizons releasing methane in the atmosphere (Belyea & Clymo, 2001).

Soil organic carbon (SOC) is also intensively stocked in various environments and land uses, such as forest soils (Liu et al., 2017; Panakoulia et al., 2017; Chatterjee et al., 2018; Eleftheriadis et al., 2018; Parsapour et al., 2018; Paltineanu et al., 2020) or in other fields, flood plains or deltas.

Organic matter (OM) content of peat soils, representing the material that does not remain as dry ash after combustion, is usually estimated by high-temperature loss-on-ignition (LOI) (e.g. Heiri et al., 2001; Boyle, 2004). Total carbon (TC) in soils can also be determined in peat by dry combustion and elemental analysis. SOC content can be directly measured from peat soil samples by combustion after removing carbonates by acidification (Harris et al., 2001). However, in some cases concerning lack of field data, SOC is indirectly estimated using the relationship between SOC and OM content (Ball, 1964; Dean, 1974; Chambers et al., 2011). According to Vitt et al., (2000), the mean SOC content was about 51.8% from OM, and as much as 52.6% from OM after Bauer et al., (2006), as well as between 50.7 and 56.3% from OM after Beilman et al., (2009) depending on the botanical composition of the peat, or even 58% as recommended by Aalde et al., (2006). On average, Gorham, (1991) and Clymo et al., (1998) recommended the SOC value of 52% from OM. Changes in SOC within the mineral soils and organic can be calculated by help of the Tier 2 methodologies reported by Aalde et al., (2006), Lasco et al., (2006), and Verchot et al., (2006). Inorganic carbon (IC) can be quantified indirectly as the difference between TC and SOC (Bisutti et al., 2004; Chambers et al., 2011).

OM and SOC stocks of the soils can be assessed using bulk density. However, to determine peat bulk density is particularly difficult for both topsoil and subsoil (Clymo et al., 1998; Chambers et al., 2011; Chapman et al., 2017). To solve this problem, some scientists developed pedotransfer functions estimating bulk density (BD) as a function of some peat variables and parameters like LOI (or ash content), carbon content, gravimetric moisture content, density of peat or its degree of humification. For instance, Laine & Päivänen (1982) used gravimetric water content from saturated peat soils, while Grigal et al., (1989) developed relationships between BD and LOI for both surface mineral soils and peat soils. For surface mineral soils, Grigal et al., (1989) reported the following relationship:

$$\mathrm{BD} = 0.669 + 0.941 \cdot e^{-0.24 \cdot \mathrm{LOI}},$$

where the coefficient of determination, r^2, was 0.95, while for peat soils:

$$\mathrm{BD} = 0.043 \cdot \mathrm{X} + 4.258 \cdot e^{-0.047 \cdot \mathrm{LOI}}$$

where r^2 was 0.89, with X taking the values of 0 for surface peat (0–0.25 m depth) and 1 for subsurface peat (0.25–1.75 m depth).

The largest delta ecosystem from EU countries, the Danube Delta, was previously geographically, pedologically and floristically explored, among others, by Coteţ (1960), Gâstescu et al., (1983), Gâstescu & Dringa (1989), Munteanu et al., (1989), and by Hanganu et al., (1994). The actually-shaped geomorphological landscape of Danube Delta is a result of the interaction between the Danube River and the Black Sea during the Holocene (Panin, 1974, 1983).

Some Danube Delta soil types were cropped some decades ago and intense transformations occurred within such soils; for instance, the most dramatic changes were found within Subaquatic Fluvisols and Subaquatic Histosols, Gleysols and Histosols, such as organic carbon losses through emissions of CO_2, CH_4 and H_2S (Munteanu, 1996). This author reported that after about 10 years of cultivation, the productivity of the above soils had considerably decreased. If drained, the organic soils, which were found to be unsuitable for arable use, suffer acidification and lose about 5 cm/year from the upper layer through mineralization, or even entirely lose their histic horizon through burning (Munteanu, 1996). However, in spite of the existing documentary materials on the Danube Delta soils, our knowledge concerning the soils' organic carbon stocks is limited.

The main purpose of the present work is to assess the carbon sequestration stock in the Danube Delta soils for various depths as based on the existing soil maps and updated materials. Another purpose is to discuss about greenhouse gas emissions in order to enable evaluation of future evolution and possible scenarios in the light of global warming with regard to the studied ecosystem.

2. MATERIAL AND METHODS

The material used in this paper is represented by the Danube Delta soils from a previous study (Munteanu, 1996), updated and completed with additional recently obtained and older soil data from the study area, which exist in the archive of the National Research and Development Institute for Soil Science, Agrochemistry and Environment (ICPA), Bucharest, Romania.

The soils are synthetically presented using WRB (World reference base for soil resources 2014, Updated 2015) classification. The soils from the lake bottom, classified as Limnosols, according to the Romanian Soil Taxonomy System (SRTS) (Florea & Munteanu, 2012), have been assimilated partially with Subaquatic Fluvisols (Limnic) and partially with Subaquatic Histolsols (Limnic) in WRB.

The soil maps were carried out using soil survey studies based on many soil profiles performed both in mineral soils (94 in Fluvisols, 266 in Gleysols, 156 in Arenosols, 43 in Solonchaks, 11 in Kastanozems and Chernozems, 215 in Subaquatic Fluvisols and Subaquatic Histosols, and in organic soils (226 in Histosols), along with over 4000 soil bores, and also using photogrammetry (Munteanu et al., 1996). The soil layers have also been updated using present-day information resulting from recent observations and measurements in the field. Thus, new soil profiles were dug out and some analyses were done in a few cases where there were some unclear aspects in order to elucidate them.

The permeability is generally an important soil property, especially for wetlands. The permeability of the organic soils is very high (Munteanu, 1996), while that of mineral soils as the ones prevailing in the Delta is medium to high, allowing rapid infiltration of rain water or pollutants to the groundwater, as previously reported by Lacatusu et al., (2019) for flood-plain soils, or generally for similar Romanian soils (Paltineanu et al., 2022). Soil volume and depth in the area are not limited for plants, being either crops or wild flora (Munteanu, 1996), or even for trees in similarly-textured mineral soils (Paltineanu et al., 2017).

The climate of the Danube Delta is intermediate between DFa (boreal, humid continental climate) and BSk (arid, cold steppe) trending to the last term according to Köppen's climate classification system (Geiger, 1961; Beck et al., 2018). However, at the country level, Danube Delta is the most arid (actually semiarid after the aridity index) climate of Romania (Paltineanu et al., 2007) with high values of sunshine hours as for the whole Romanian Black Sea coast (Paltineanu et al., 2002).

The methods used to describe and characterize the soils given in the above study were the current methods for Romania (Munteanu, 1996). We only mention the method used for SOC content (Walkley-Black method modified by Gogoasa, STAS 7184/21-82 standard). Whenever some soil properties were missing for our purpose, they were estimated with such data as recommended in literature, as was the case for bulk density (BD) values for Histosols, where we used the relationships between BD and LOI that were previously reported by Grigal et al., (1989), and as was the case for OM and SOC contents, where we also used the relationships reported by Gorham (1991) and Clymo et al., (1998), who recommended the SOC values of 52% from OM. We then calculated the organic carbon stocks (Mg/ha) for all Delta soils by multiplying SOC contents (% kg/kg) and with soil depth (cm) and BD (kg/dm^3).

Other calculations were done using current statistical procedures, including ANOVA for various soil depths with SPSS14. For the purpose of this paper, the Fluvisols, Kastanozems, Chernozems, Subaquatic Fluvisols, Solonchaks and Solonetz are considered as non-histic (mineral) soils, Histosols are organic soils, while the Gleysols and Arenosols were split into two groups: 1) mineral soils proper and 2) mineral soils with a histic horizon (Subaquatic Histosols were also included in this second group). Further interpretations and comparisons between SOC means were done using Tukey test and especially Duncan`s multiple range test to assess 95% statistical significance between soil groups.

3. RESULTS AND DISCUSSION

3.1. Soil organic C stock before 1996

3.1.1. Spatial distribution of the soil types

Spatial distribution of the soil types and subtypes is depicted in Figure 1. Fluvisols cover 53864.6 ha (14.0% from the Danube Delta area), non-histic Subaquatic Fluvisols (non-histic Limnosols in SRTS) about 34511.5 ha (9%), while Subaquatic Histosols (histic), 25024.1 ha (6.4%). Non-histic Gleysols occupy an area of 49668.3 ha (12.8%) and histic Gleysols 38780.6 ha (10.0%); non-histic Arenosols and sands proper are spread over an area of 29575.4 ha (7.6%), and histic Arenosols 33828.0 ha (8.7%). There are small areas occupied by Solonchaks and Solonetz, only 7933.2 ha (2.1%). Other soil types like Kastanozems and Chernozems are also spread over small surface areas, e.g. 2712.4 ha (0.7%). The Histosols cover the largest area, 109571.1 ha (28.2%). The Histosols, together with the histic subtypes of the other soil types (Gleysols, Arenosols, and Subaquatic Histosols) that are wetland-specific soils, represent about 54% of the area. The main difference between the histic character of some soil subtypes and the Histosols is the 0.5 m thickness of the peat soil horizon. Totally, the soils within the Danube Delta outside localities and Anthrosols account for 385469.1 ha (about 83.6% from the total Delta surface area).

3.1.2. Geographical distribution of SOC stocks in the Danube Delta

The soil data regarding the organic matter content were mainly taken from Munteanu's paper

(1996) and the calculated SOC stocks therefore refer to that period. The geographical distribution of the soil groups, regarding the SOC stocks calculated for the layers of 0.2 m and 0.3 m depths, respectively, is

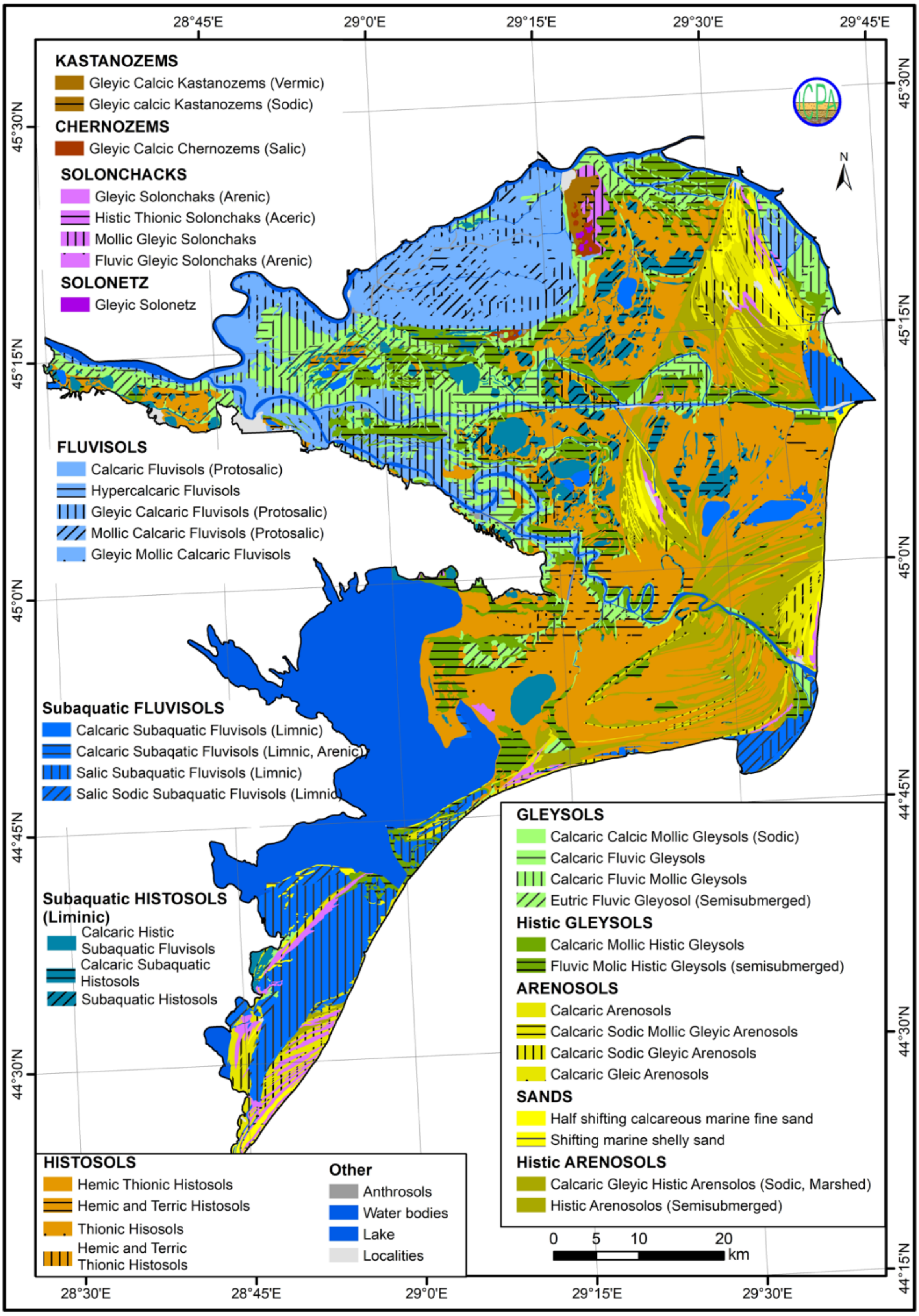

Figure 1. The soil classes, soil types and subtypes from the Romanian Danube Delta (after Munteanu, 1996, modified by using new soil data and observations, as well as WRB classification)

shown in the maps presented in Figs. 2 and 3. These maps reveal that Histosols sequestrated the greatest SOC stocks.

The same pattern of the SOC stocks for the layers of 0.5 m and 1.0 m depths, respectively, can be seen in the maps from Figs. 4 and 5, however in this case the SOC stocks are higher. These maps highlight that the highest SOC stocks are also sequestrated in Histosols, as expected.

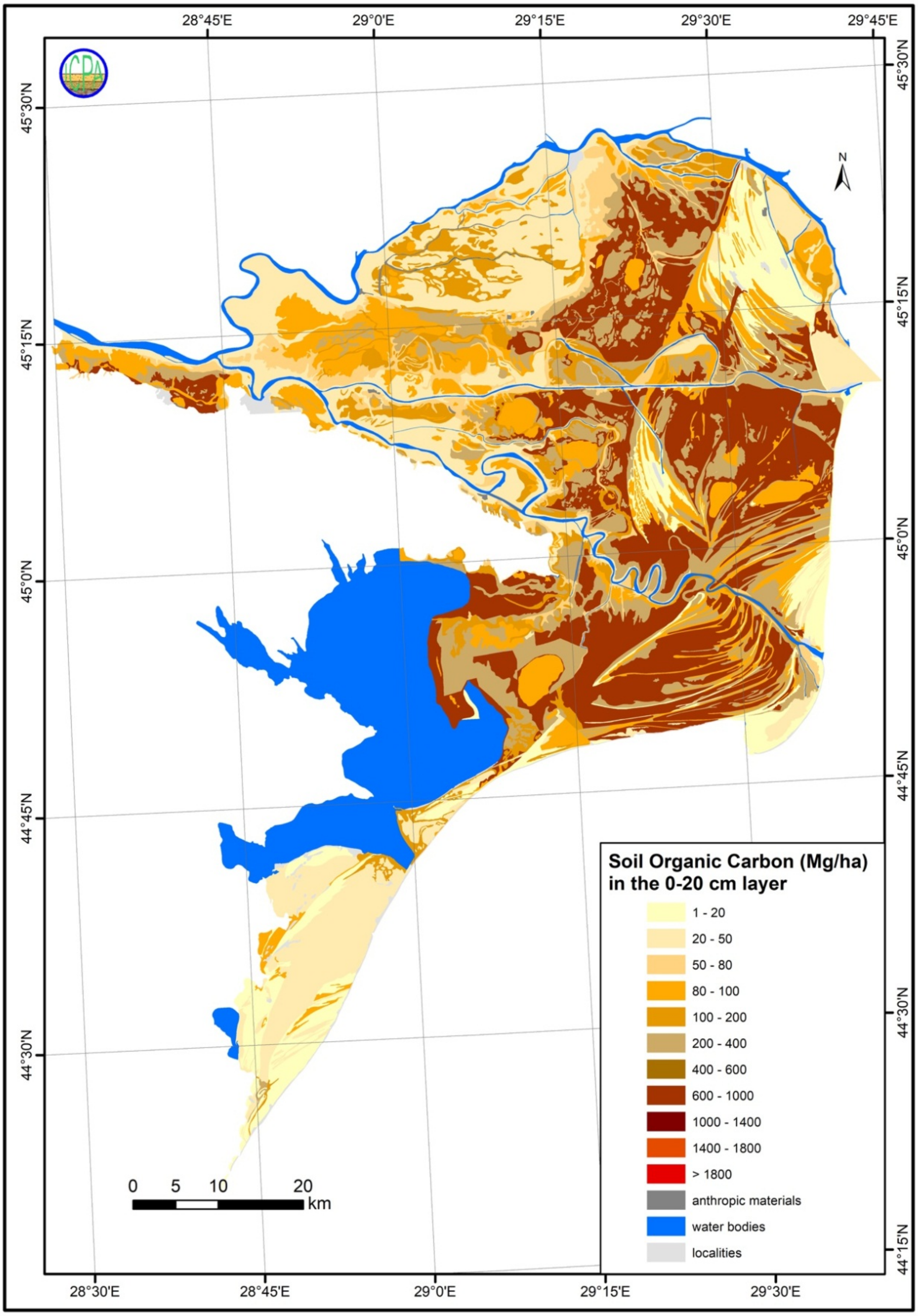

Figure 2. The geographical distribution of the soil organic C stocks calculated for the 0.2 m depth layer until 1996

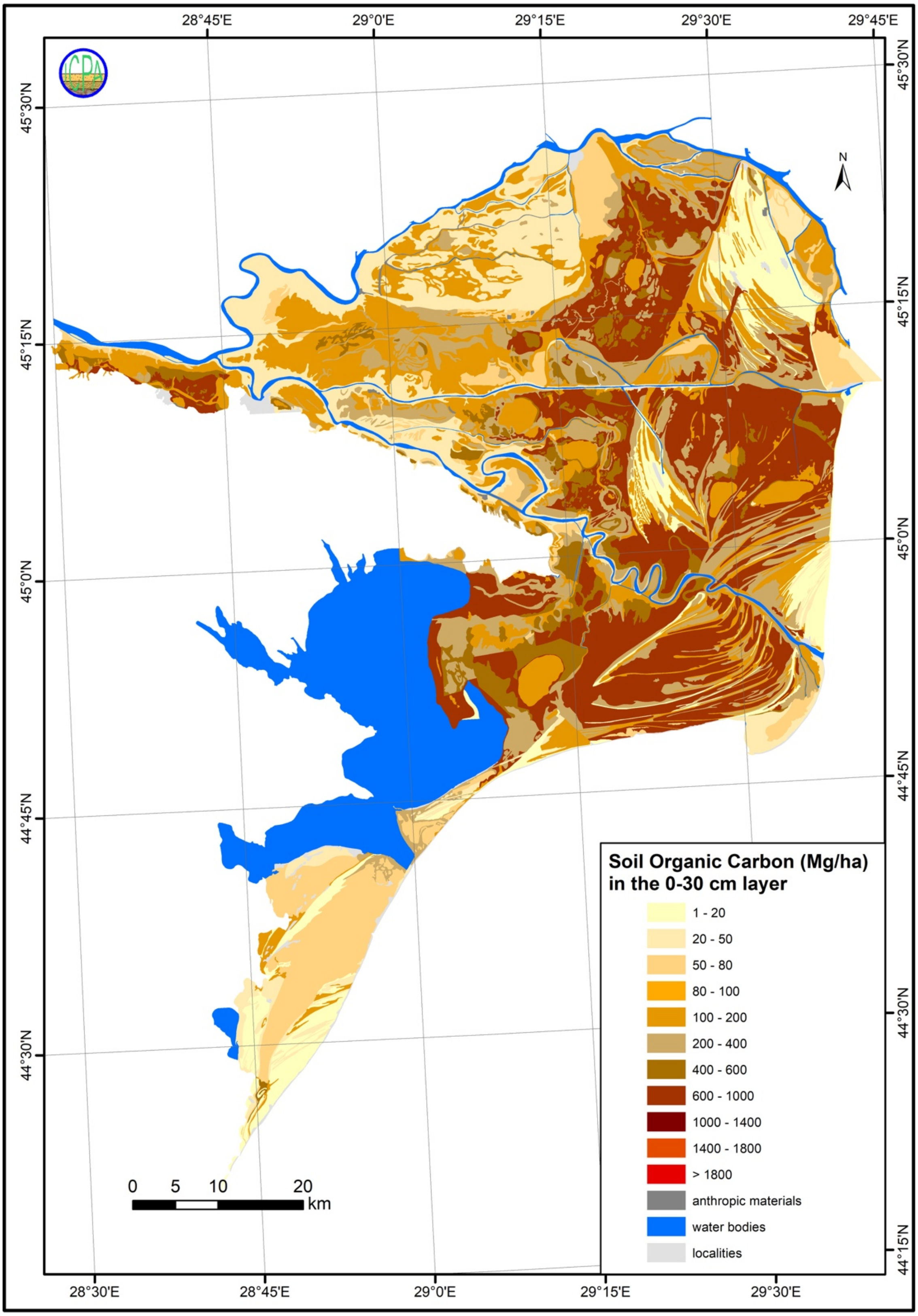

Figure 3. The geographical distribution of the soil organic C stocks calculated for the 0.3 m depth layer until 1996

The last soil depth for which SOC stocks was calculated was 1.5 m (Fig. 6). Only some histic soil groups and Histosols had SOC contents down to 1.5 m. This map practically represents the total SOC amounts of the Delta soils.

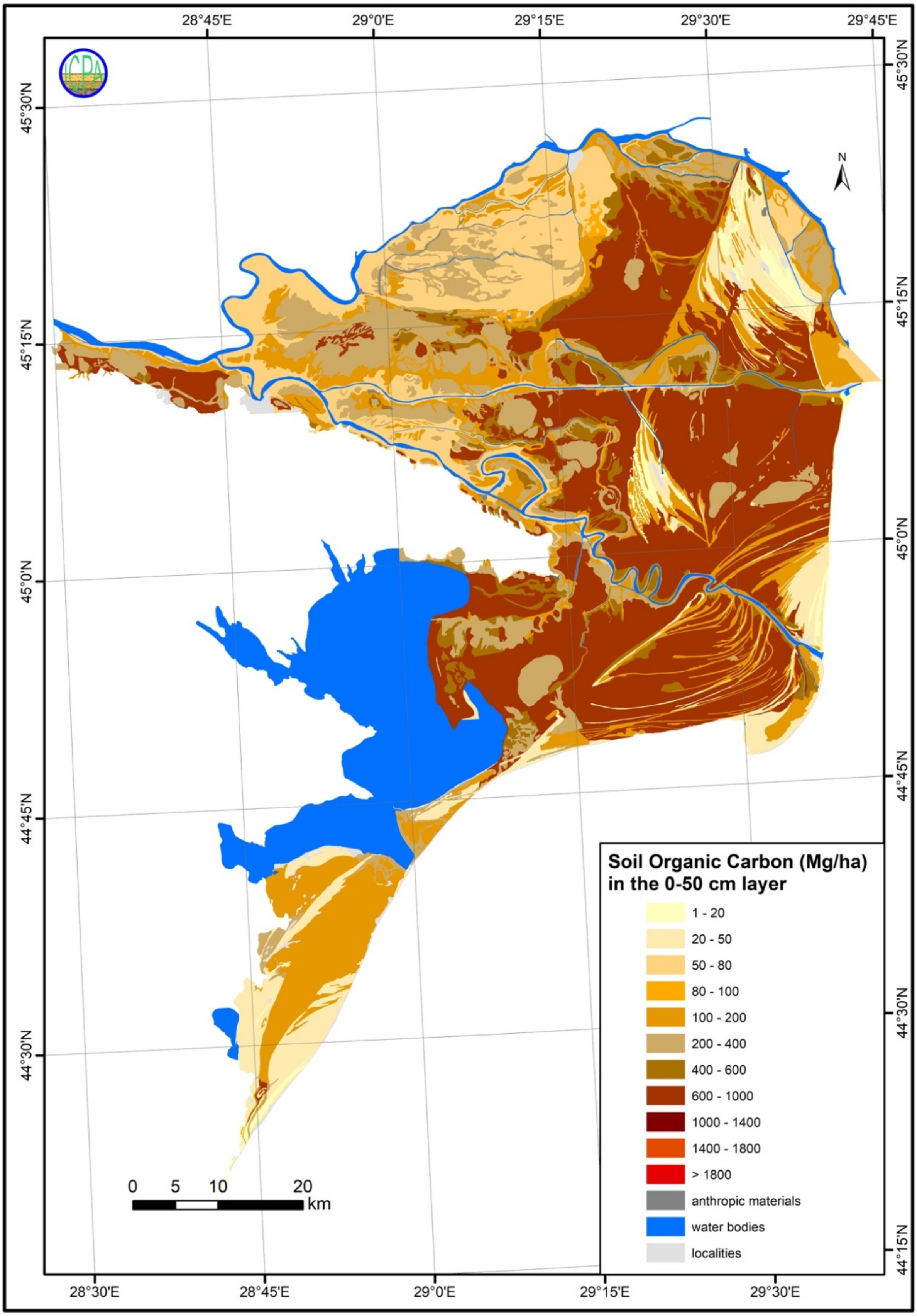

Figure 4. The geographical distribution of the soil organic C stocks calculated for the 0.5 m depth layer until 1996

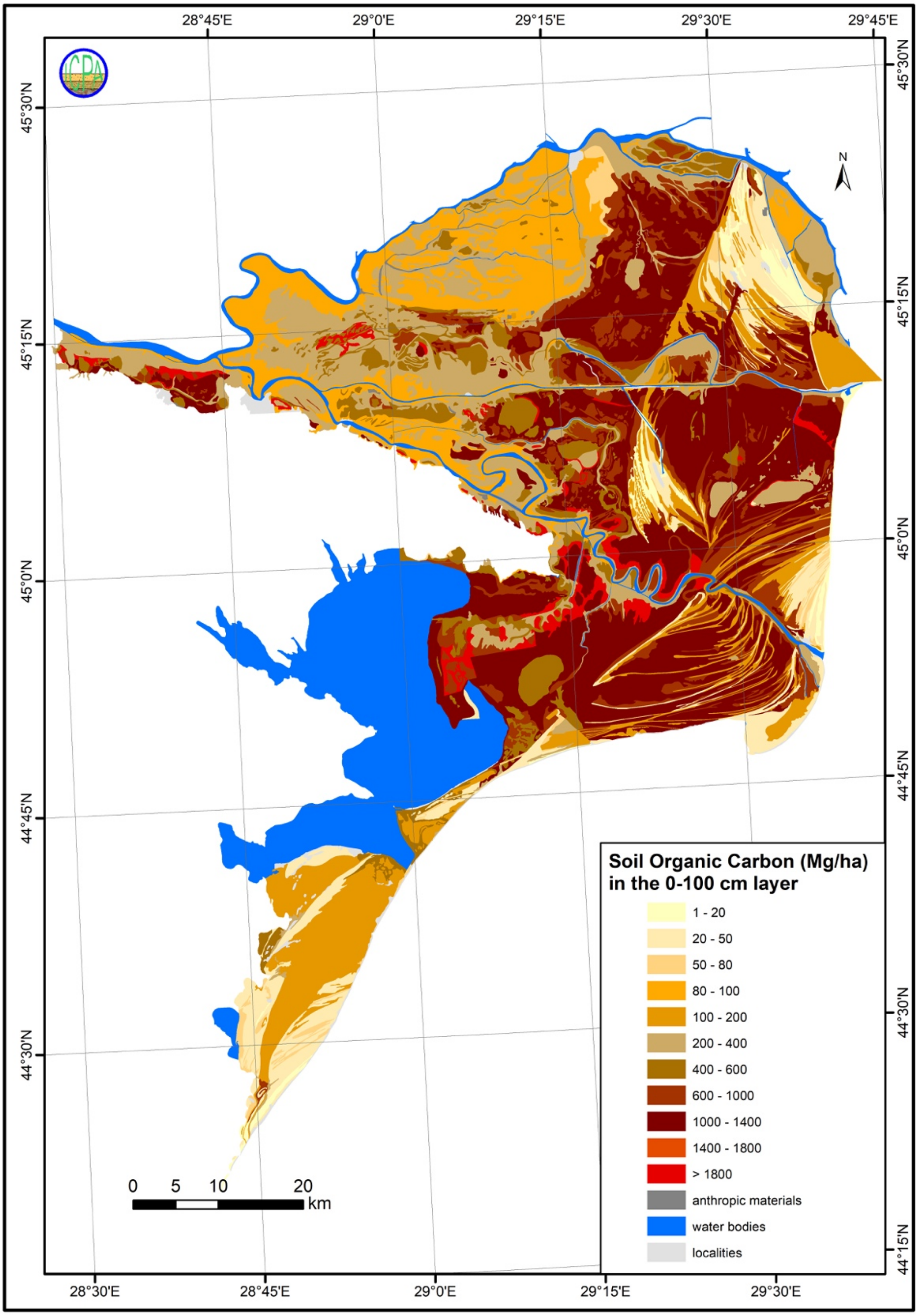

Figure 5. The geographical distribution of the soil organic C stocks calculated for the 1.0 m depth layer until 1996

It can be viewed here that the lowest parts of the landforms, mainly in the eastern part of the Delta where the sea water influence is higher, show the highest SOC stocks, i.e. Histosols and floating peat.

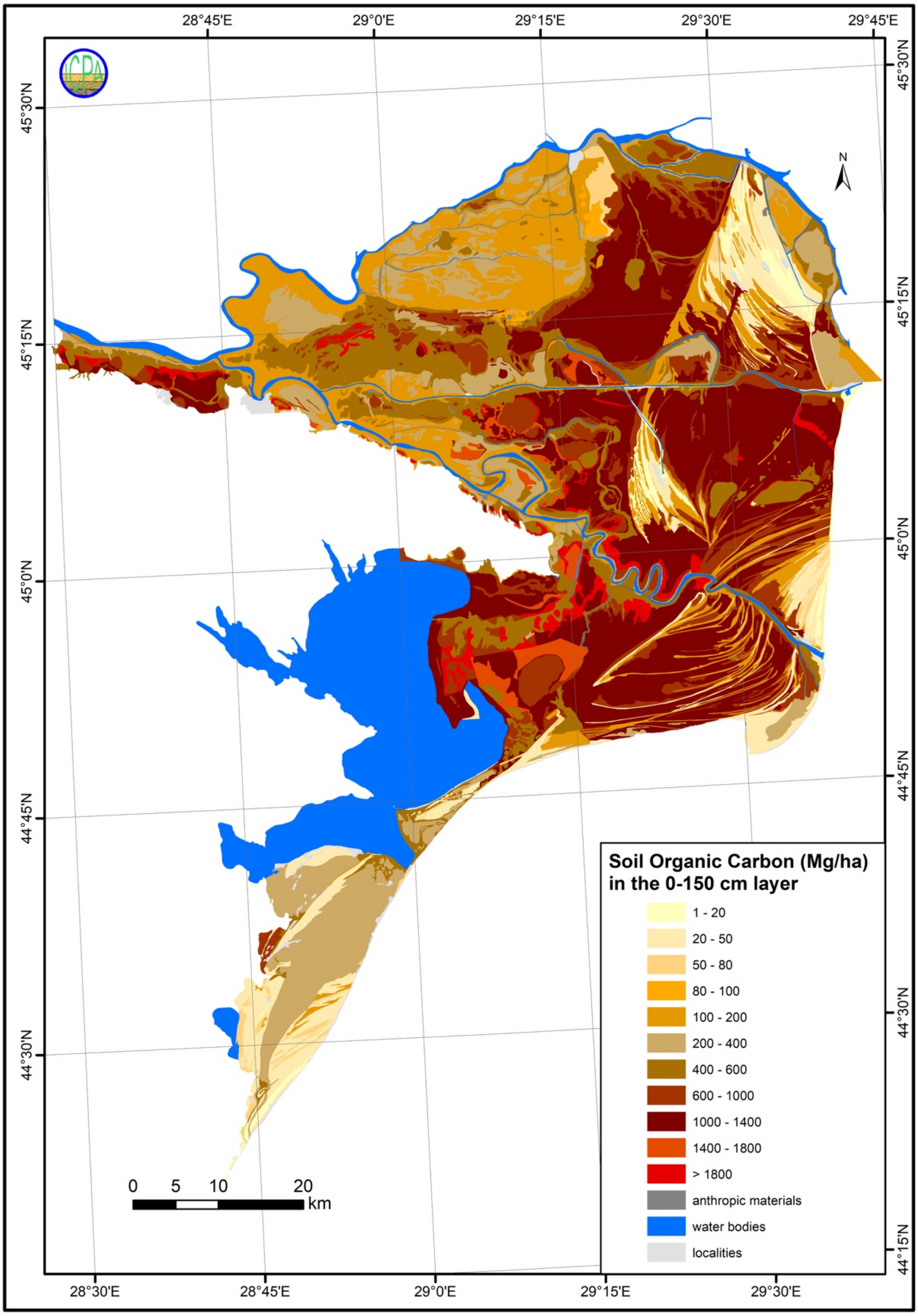

Figure 6. The geographical distribution of the soil organic C stocks calculated for the 1.5 m depth layer until 1996

3.1.3. Comparison of SOC stocks between soil groups

For the 0.2 m and 0.3 m depths, one can view that the eastern part of the Delta soils, where overwhelmingly there are Histosols, contains the highest amounts (about 480 and 600 Mg/ha, respectively) of organic C stocks sequestrated, significantly different from the other soils (Fig. 7). Even if there are not significantly different because of a large variation among the soil profiles' data, the histic soil

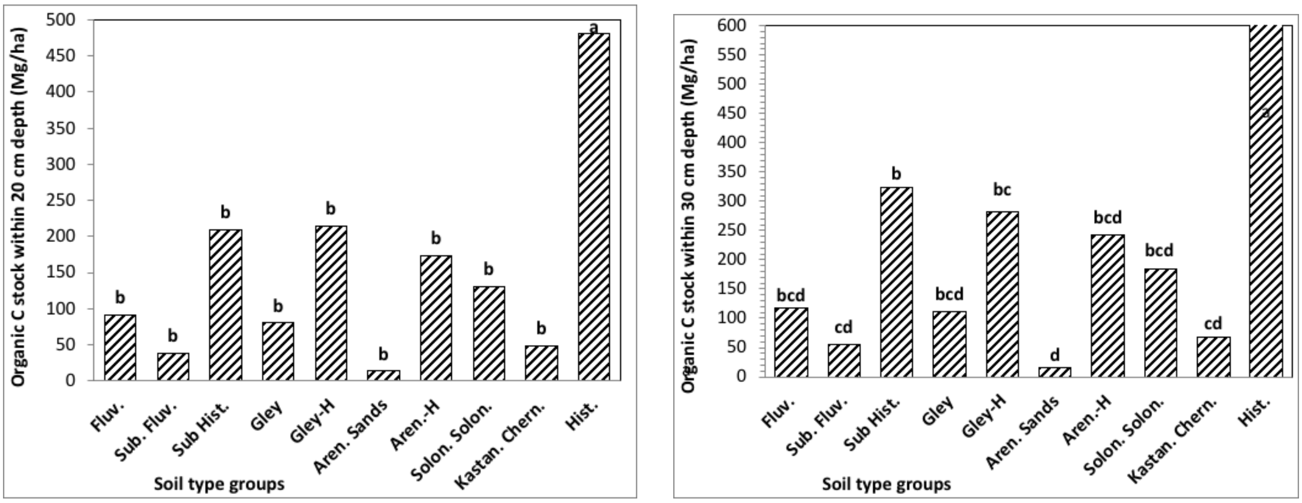

Figure 7. Soil organic C stocks sequestrated for 0.2 and 0.3 m soil depths, respectively, in the Romanian Danube Delta. Note that here and in the following graphs: Fluv.=Fluvisols, Sub.=Subaquatic, Hist.=Histosols, Gley.=Gleysols, Aren.=Arenosols and sands, Solon. Solon.=Solonchaks and Solonetz, Kastan.=Kastanozems, Chern.=Chernozems, letter H written at the end of the Gleyosols and Arenosols shows histic properties as is the case for Subaquatic Histosols; different letters over the graph columns indicate 95% significant differences according to Duncan`s multiple range test

subgroups have much higher SOC stocks versus the non-histic subgroups of the same soil types.

For the 0.5 m and 1.0 m depths there are significant differences between more soil groups than for the previous depths (Fig. 8). SOC stocks are significantly higher in Histosols (about 850 and 1300 Mg/ha, respectively, versus the other groups. Generally, the histic soil subgroups contain at least as much as double SOC stocks versus the non-histic subgroups for the same soils. The non-histic sandy soil (Arenosols) presents the lowest SOC stocks.

Comparisons between soils for the 1.5 m depth are shown in Fig. 9. Again, the Histosols presented the highest (1600 Mg/ha), significantly different SOC contents, versus the others, whereas the Arenosols combined with sands and Kastanozems presented the lowest ones.

Percentage data of the total SOC stocks within the 1.5 m soil depth and surface area of the soil groupings across the Danube Delta ecosystem are shown in Fig. 10. This graph is a synthesis to compare how much each soil group is spread over and to reveal their contribution to the total amount of SOC stocks that was sequestrated in the Romanian part of the Danube Delta. Thus, Histosols represent about 28% of the Delta area and contribute with over 55% to the total SOC pool of this ecosystem. The histic group of the Subaquatic Histosols, Gleysols and Arenosols also contribute much more to the total SOC pool than their non-histic counterparts. The lowest contributions to the above SOC pool are given by the Arenosols, Solonchaks and Kastanozems.

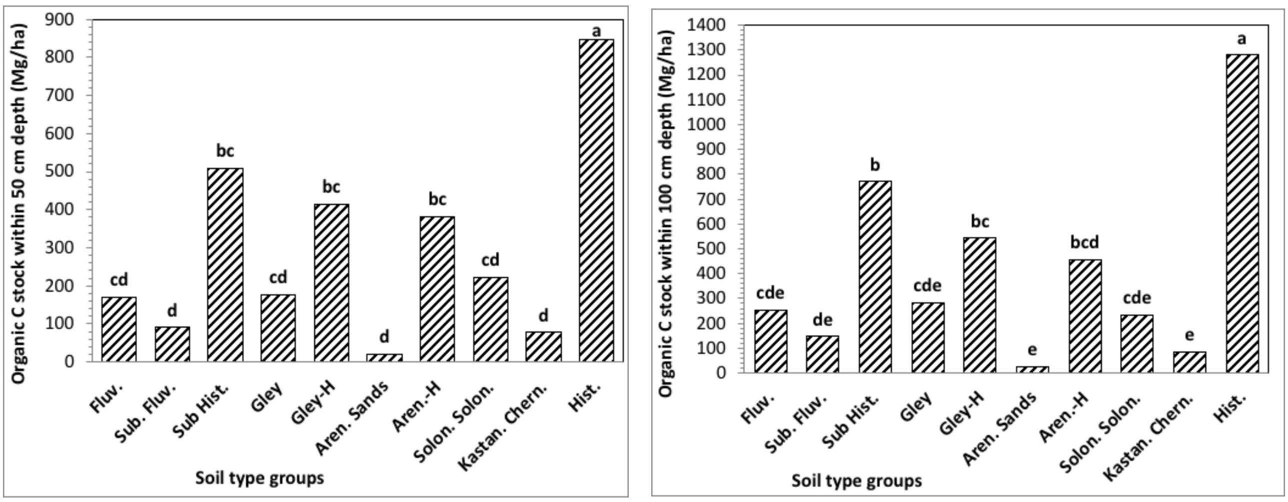

Figure 8. Soil organic C stocks sequestrated for 0.5 and 1.0 m soil depths, respectively, in the Romanian Danube Delta

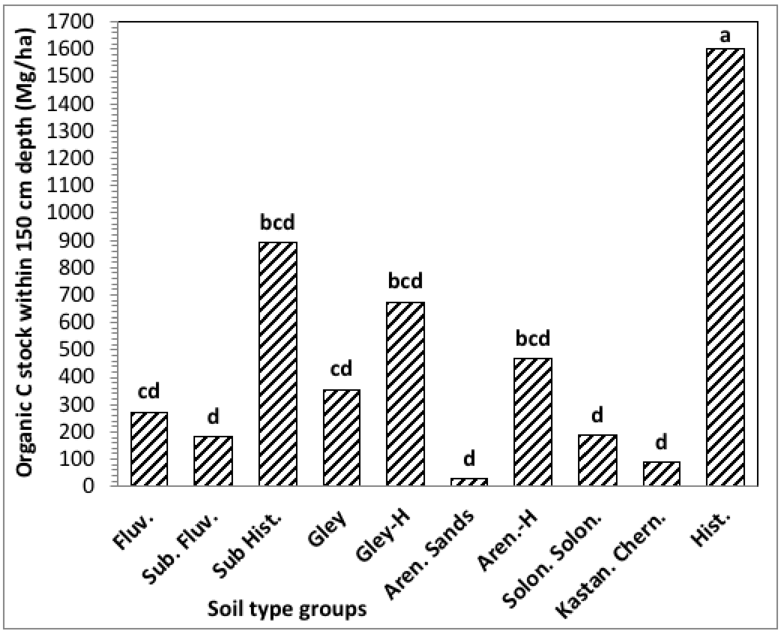

Figure 9. Soil organic C stocks sequestrated in 1.5 m soil depth in the Romanian Danube Delta

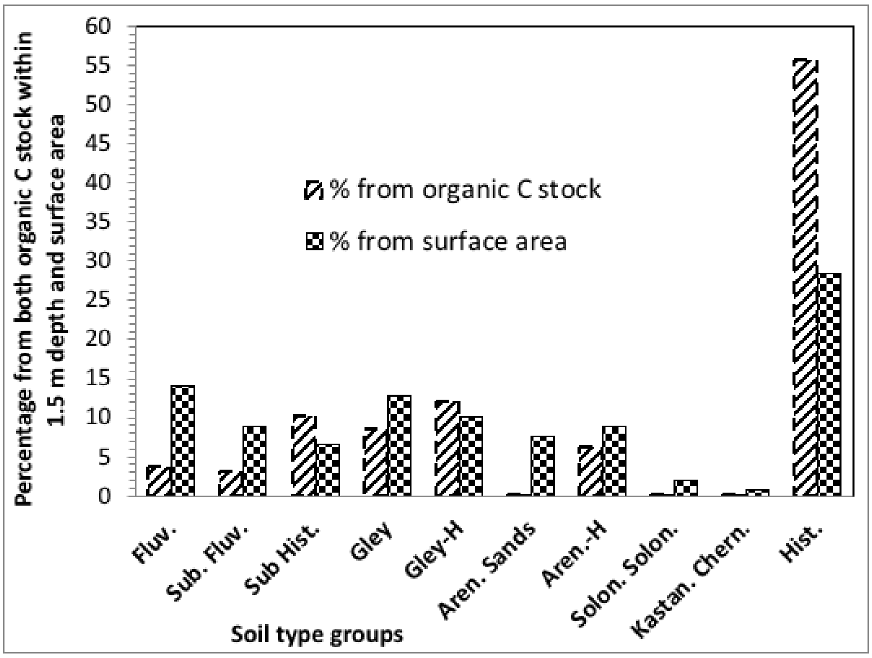

Figure 10. Percentage of the total Soil organic C stocks within the 1.5 m soil depth and surface area of the soil groupings across the Danube Delta

The idea issued from the presented data is that the sequestration of the SOC specifically takes place in the lowest parts of the Delta, where the accumulation of organic matter is maximum due to the high water level and anaerobic conditions, and where there is no other economic activity, such as agriculture. The large differences between mineral and organic soils regarding SOC is a strong reason for renaturation of some Danube Delta areas in order to increase SOC, decrease atmospheric C, and prevent global warming.

3.2. Present-day situation – assessing greenhouse gas emission from the soils

Histosol formation is a long and slow process (Gorham, 1991) and if no disturbing factor appears, such soils reach an equilibrium and a relatively steady-state with the surrounding environment. Thus, the situation described for 1996 is more or less similar with the present–day situation where the man activity has not yet dramatically intervened. Only parts of the Danube Delta, i.e. only about 14.5% from the total area, were taken for farming, specifically during the last 50 years. Cropland with 10.6% and grassland with 3.9% represent the main agricultural land uses in the region, while orchards and vineyards are negligible <0.5%). These farmed land uses are mainly situated in the western part of the Delta that is covered by mineral soils or organic (histic) subtypes of mineral soils. Histosols, keeping their natural state, especially occur in the maritime, eastern parts of the Delta ecosystem. There are also some fish ponds across the area. However, the largest part of the Delta (cca. 85%) remained more or less under natural state conditions.

Land reclamation works such as diking, drainage and, to small extent, irrigation were performed within croplands in time, generally after 1980. The advantage for the soils here is that during summertime, when evapotranspiration is high, water table is relatively shallow and the crops can easily uptake water due to its capillary rise that is present in many soil profiles.

In addition to the economic aspects, some ecological concerns have to be addressed. Thus, a special attention should be given to the land areas that have been converted from native environments to anthropic-influenced lands concerning the estimation of greenhouse gas emission. Specific literature reports that land use types have a considerable effect on SOC, especially in the case of conversion e.g. from grassland and forest land to cropland when about 20-40% of SOC might be lost (Mann, 1986; Ogle et al., 2005). Management practices can also play an important part on SOC storage within a certain land use type, particularly in cropland and grassland (Paustian et al., 1997; Conant et al., 2001; Ogle et al., 2004 and 2005).

Irrigation and drainage modifying the soil water regime, and manure application, erosion control and other management practices can substantially influence the dynamics of SOC in agricultural soils. For instance, drainage of organic soils enhances CO_2 emissions to the atmosphere (Armentano & Menges, 1986), while CH_4 emissions decrease in undrained soils (Nykänen et al., 1995).

Methodologies for estimating national greenhouse gas inventories for multiple land-use categories in some countries were previously reported by Aalde et al., (2006), Lasco et al., (2006) and Verchot et al., (2006), identifying three tiers of methodology that are increasingly complex and robust from tier 1 to tier 3. The reference soil depth for which SOC is calculated in the above studies is 0.3 m, with reference SOC stocks depending on soil type, and with tier 1 as default values. However, in cropland the soil depth that is mobilized by plowing, disking or other works and from where the plants uptake water and nutrients is at least 0.5 m, and for some crops even from 1.0 m or below. With tier 2 soil depth for SOC reference can vary and is correlated with management practices (Lasco et al., 2006). Tier 3 allows considering more soil depths when calculating SOC. The present paper deals with various soil depths for SOC referenced values, as shown above, facilitating their use in specific estimation models. However, a question on gas emission arises, especially for Histosols, concerning the reference SOC where peat depth might reach as much as 2-3 m.

As this paper highlighted, the overwhelming part of the Danube Delta soils was not yet taken for farming. In the future, if the Histosols and histic soil subtypes are not farmed and no drainage works are made, then SOC can still grow to equilibrium, gas emissions remaining low. Overall, the gain of SOC is relatively slow in wetlands rich in organic soils (Gorham, 1991).

Large rivers, like the Danube, offer favorable conditions in their deltas and other wetland areas like flood plains for organic C accumulation.

The most fertile land of the Delta ecosystem, where also land reclamation works were carried out in the past, offers proper conditions for high-standard farming. This is worth for both the current period and for the future one, specifically if population growth and food product crises occur.

Preservation of the current situation on the area with organic soils is the best recommendation that could be done. Renaturation of some areas occupied with the least fertile soils like Solonchaks, Solonetz or even sands, where the ground elevation is very low and water is shallow, would restore the natural environment balanced between the geographical components: water, river deposits, wild flora and fauna, and certainly SOC sequestration. However, such areas are not large now in the Delta ecosystem. If global warming goes on at the present rate or higher rates, the soil water regime will change reflecting the dynamics of sea level rising. This event will most probably accelerate peat formation and increase Histosol area in the lowest landforms across the Delta. Reducing the farming area will then be imposed by nature evolution, but most probable agriculture will be performed on smaller area situated over the highest landforms. Thus, SOC amounts will increase too. The water chemical composition might also change to become more brackish at the eastern part, due to the possible advance of the salty sea water. Nevertheless, pollution of the shallower groundwater in the farming area could also worsen due to the decreasing way of transportation for nitrates or other pollutants (Paltineanu et al., 2021, 2022). Another effect of global warming, if no measures of reducing it is taken will be, among others, the perturbation of phenological phases of crops as recently reported Paltineanu & Chitu (2020).

4. CONCLUSIONS

Because Histosol formation is a low process and generally reaches an equilibrium to a relatively steady-state (Gorham, 1991), the situation described for 1996 (Munteanu, 1996) is more or less similar with the present–day situation where the man activity was weak.

Histosols represent about 28% of the Danube Delta area and contribute with over 55% to the total SOC pool of this ecosystem. The histic groups of the Subaquatic Histosols, Gleysols and Arenosols also contribute much more to the total SOC pool than their non-histic subtypes.

The large and significant differences between mineral and organic soils regarding SOC is a strong reason for preservation of Histosols' area and for renaturation of some less fertile soils from the Danube Delta in order to increase SOC, decrease atmospheric C, and prevent global warming.

Only about 14.5% from the total Danube Delta area has been taken for farming, mainly situated in its western part, with mineral soils or organic soil subtypes suitable for agricultural purposes. Due to the pressure of population growing and food needs increase, these agricultural soils should further be used in farming. Histosols are especially situated in the maritime, eastern parts of the Delta ecosystem. However, the largest part of the Delta (cca. 85%) remained more or less in natural state.

The reference soil depth for which SOC is generally calculated in various papers is 0.3 m, with reference SOC stocks depending on soil type. However, in cropland areas the soil depth that is mobilized by plowing, disking or other works and from where the plants uptake water and nutrients is at least 0.5 m, and for some crops even from 1.0 m or below. The present paper deals with various soil depths, from 0.2 to 1.5 m, for SOC referenced values, facilitating their use in specific estimation models.

Policy makers, decision makers, stake holders and opinion-formers should take this chance to conserve the natural landscape under the best possible conditions to contribute to an increase in SOC stock and a decrease in atmospheric C. To do this, they should convince land owners and farmers to agree with such a solution, in exchange for governmental subsidies covering economical loss for the farmers. Maintaining the former SOC stock at the present-day level and enhancing new organic C deposition in the renatured parts of the less fertile Delta soils could contribute to global warming mitigation in the future. If global warming continues, the soil water regime will change reflecting the dynamics of sea level rising. This event will most probably accelerate peat formation and increase Histosol area in the lowest landforms across the Delta.

Future research is needed for characteristic stationary sites specifically in the cropland area of the Danube Delta to deepen our knowledge regarding the dynamics of SOC.

This study might be used to compare SOC pool sequestrated in the Danube Delta and in other river deltas, especially in large deltas.

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