DOI 10.2478/pesd-2018-0020 PESD, VOL. 12, no. 1, 2018

TRENDS OF THE TYPOGENETIC PROCESSES IN THE CARPATO-DANUBIANO-PONTIC SPACE. RESULTS IN AGRICULTURE IN NORTHEASTERN AREA CLIMATE CONDITIONS

Jigau Gheorghe[1], Leşanu Mihai[1], Bîrsan Ana[1], Blidari Anton[1], Borş Natalia[1], Plăcintă Nina[1], Cernolev Elena[2]

Keywords: typogenetic processes, climatic conditions, agriculture, north-east of Moldavia

Abstract: The chernozems evolution of the Carpatho-Danubian-Pontic space clearly shows two consecutive phases: climatogenic and anthropo-climatogenic. The latter is characterized by increasing agrogenic impact on soil climate. The soil cover of Carpathian-Danubian-Pontic space is the hierarchical functional system long-time product. Pedogenetic factors → pedogenetic regimes → pedogenetic processes → soil (soil cover). During Pleistocene, the chernozem pathogenesis in the region resumed 13 times, each time starting from the carbonic chernozem phase. Zonal climatic cyclicality has led to the differentiation of chernozem subtypes, determined by the zonal differentiation of pedogenic regimes and typogenetic elemental processes. The current stage of chernozem cleavage in the region began 10-12 thousand years ago. The evolution of soils in the soil was determined by the climate cyclicality and the increase of anthropogenic imputations and involves the succession over time of several phases:

- Cryogenic with poorly developed soil by A (AO) - C Order;
- Early dynamic halocene with developed zonal soil formation;
- Late halocene with climatic evolution of the profile;
- Natural-anthropogenic.

During the last one, four eras were accelerated: natural-anthropo-turbian, natural-anthropic modification, natural-anthropic restructuring and natural-anthropic stagnation. Increasing the anthropogenic impulses led to the modification of the climatic → soil relations in the sense of increasing the degree of continentalisation of the soil climate materialized in the aridization of the soil cover, the change of

[1] Moldova State University, Chişinău, R. Moldova
[2] University of the Academy of Sciences of Moldova, Chişinău, R. Moldova

the sense and intensity of the typogenic processes and the induction of some non-typical elementary processes of the chernozemic pedogenesis.

Introduction. the problem assessing

Currently, the Carpathian-Danubian-Pontic space is in an interglacial period (more than ten thousand years), during which have been attested several cycles of heating, cooling and aridization-humidification (Ahtartev, 2008). Therefore, in the course of halocene, the evolution of soils had a contrasting character in the dynamics, in time and space, of the boundaries of the natural areas (Zolotun, 1974; Uvanov, 1992; Demchin, 1987; Alexandrovschi, 1983; Ghenadiev, 1990). According to paleographic studies in the ancient holocene (11-12 thousand years ago), the Carpathian-Danubian-Pontic region represented a steppe periglacial space that currently has no natural analogues (Climanov, 1978; Neis- tadt, 1983) .culterir, in the early holocene 8-10 thousand years ago), it was replaced by the silviculture landfill, in which a glimpse of gleic forest, hydromorphic soils, derno-gleic soils and marbled soils were formed.

During the Boreal-Atlantic transition, there has been significant climate cooling that has led to the intensification of soil leaching processes.

The Atlantic period was characterized by optimal temperature and humidity ratios, and moderate thermal dynamics. According to the calculations, the temperature is 10C more than the contemporary period and the amount of precipitation 50-100 mm more. In favorable hydrothermal conditions and low natural drainage degree intensive hydromorphic and semi-hydromorphic pedogenesis was developed, which as a result of changing ecological conditions and the development of slow erosion dismantling was replaced by automorphic pedogenesis and the formation of chernozem, dry chernozem, paleosolosomes, 1996).

About 7-5 thousand years ago there are three stages of aridation followed by wetter phases (Spiridonova, 1991). The regional pedogenesis process meaning has also alternated. The leaching periods were followed by periods with the penetration of capillary-water fringe into the soil profile, the hydromorphism development , soils salinisation and carbonation. Wet soils with salinisation, solonization and high carbonation (Ahtârţev, 1997) dominated the depression landscapes.

During the subboreal period, has attested two cooling phases (5.3-4.5 and 3.5-2.9 thousand years ago) and two heating phases (4.5-3.5 and 2.9- 2.5 thousand years ago). During the heating periods, the multiannual temperatures average and the precipitations sum were practically identical to the contemporary ones that favored the silvostepe landfill preservation (Climanov, 1991).

The period 3900-3500 years ago was characterized by wet conditions that led to the replacement, over time, of steppe associations with silvicultural land. Under these conditions the leaching of calcium carbonates and the processes of formation and accumulation of humus in the paleocernozomes intensified. The humus content in these compounds is about 4% and the Cah: Caf ratio = 2.2.

Their evolution was periodically interrupted by intensive periods of salts accumulation with their content increase up to 0.4-0.6% (including toxic salts up to 0.11-0.16%). However, the salt accumulation phase was short-lived being followed by a wetter period that lasted between 3400-2900 years ago and favored the development of the forest steppe, with steppe herb associations growing role in period about 2900-2500 years ago. In such ecological conditions, as the increased drainage degree, poorly salinized paleochernosomes evolved with eloquence processes predominance, and landfills obtained stable features corresponding to the current ones. From the paleochernozomes humifer layer, the migratory forms of the carbonates were leached. The thickness of active humifer layer increased considerably and the humus content was 4.5-5%. Already at this stage paleochernosomes had several diagnostic features characteristic to contemporary chernozems.

In the last 2000-2200 years, soils evolution has gone in the same direction. Within this, the weakly salinized carboniferous paleochernozomes evolved with the genetic line differentiation within: carbonate chernozems → typical low humic chernozems → typical moderate humified chernozems → levigated chernozems → clay-illuvial chernozems.

From the pedogenic theory perspective , the pedogenesis and pedogenic factors synchronized evolution led to quasi-balanced pedogenic factors system formationf → pedogenetic regimes → elementary pedogenetic processes → soil (soil cover) able to function relatively stable in climate change possible scenarios, including those predicted in the following geological period. At the same time, the current evolution of the Carpathian-Danubian-Pontic space soil cover is disturbed by the techno-anthropogenic impact, an increase that involved a new stage in its evolution - a natural anthropic stage. It shows a stable trend to amplify the processes of bioenergetic resources and destructuring degradation, compacting and by hydro-physical degradation. These affect the soil biota activity, and consequently affecting the regional pedogenesis process trend evolution. In this respect, our research shows that already at this stage the hydrothermal and hydrological chernozems regimes evolution of this region develops under two opposing processes action - the agrogenic layer aridization and the underlying neo-hydromorphisation in the aridity-desertification general trend (Jigau et al., 2017).

Starting from this, we aim to study and evaluate the location of agrogenesis-induced processes in chernozems evolution of Carpathian-Danubian-Pontic space within the present trend of climatic conditions. In the work concept, we start from the idea that eventual climate change will not significantly change the evolutionary soils trend. A more important role in their modification belongs to the agrogenous processes.

Objects and study methods

The specified objective outlines the evolving trend of soil resources within the hierarchical complex "pedogenic factors" → pedogenetic regimes → elementary pedogenetic processes → soil characteristics → pedon → soil cover structure. The current status analysis of Carpathian-Danubian-Pontic space chernozems, in these interactions showed that a new phenomenon in the pedogenesis theory is attested in the region - the inadequacy of soil conditions to the climatic conditions materialized in the latter intensification of the extreme manifestations effects: the agrogen layer aridization, increasing drought vulnerability. These relate to the main typogenic processes for care of the chernozem pedogenic essence: (a) the humus formation and accumulation; (b) structuring-aggregation and functional-structural soils organization.

In order to first objectives achieving, a series of literature materials (Liseţkii, 2012) were submitted to synthetic analysis and were systematized agrochemical researches results from 1975-1990 from the Republican Center of Applied Pedology.

For the second objective realization were used the results of chernozems structural-aggregate state dynamics study under various agroecosystems obtained within the SRL "Pedogenetic Processes" of the State University of Moldova in the 2016-2017 period.

The structural-aggregate soils analysis was performed by Savvinov method in undisturbed settlement soil samples of the volume of 100 cm3.

Materials and discussion

According to the pedogenesis biophysical concept, the latter is the product of a elementary processes complex of the mineral substrate biologisation caused by symbiotic interactions between the external (superior plants) and the internal (soil microbiota) biocenosis and materializes in the constitution and development of biological substances circulation (Florea et al., 2014; Jigău et al., 2015).

External biocenosis is the main producer and organic matter source, varying in time and space, which it transmits to soil without which it would cease to exist. Soil biocenosis (edaphone) is an inherent soil component that has the metabolizing and humifying of organic residues role and thus of ensuring the biological substances circulation. In the opinion of Folrea et all, nature itself created this biocenosis to ensure the existence of livestock by carrying out continuous nutrients recycling (Florea et al., 2014). The interactions between them are materialized in quasi-balanced substances and energy exchanges and are the driving force that determines the meaning and intensity of biogeocenoses evolution processes and led to structural-functional organization synchronization of soils and biogeocenoses (Jigău, Bîrsan, 2015).

According to Smaghin (2004) and Popov (2006), the interaction between external and internal biocenosis is ensured through the humic substances fraction that are produced in the decomposition – humification processes of fresh organic residues. This implies the permanent presence need of these substances in soil. Moreover, reducing the amount of fresh organic matter in soil leads to reduction of mobile humic substances content and this leads to the reduction of living biomass in soils. Based on the Table 1 presented data we can conclude that under the conditions of natural steppe ecosystems, the priority role of the humus formation and accumulation in the unidirectional development of all the typogenetic elemental processes and associated to the chernozemomic type of solification with extended fertility reproduction of chernozems and chernozems pedogenesis. More recent calculations have shown that mobile humus mineralization / reduction caused living biomass reduction from 30 t to 2-4 t / ha. This, inevitably leads to volume reduction and composition modification of biological substances circulation and, respectively of vegetal production quantity and quality within biogeocenoses.

In Carpathian-Danubian-Pontic space, the quasi-balanced interactions between internal and external biocenosis are formed at pedological scale of time. In recent 250-300 years they have entered a new phase of debiodologysation of pedogenesis process caused by the substitution of natural biocenoses with agrofitocenoses.

Natural biocenoses substitution with annual agrocenoses with concentrated radicular system in the upper layer (0-15 cm) of soil is the first link within the interdetermined chain of bioenergetic state change of the region soils. This presume a volume reduction of vegetal biomass involved in pedogenesis of about 2-3 and even several times (Table 1.2).

As a result of soil surface divesment by natural vegetation destruction and steppe litter, the soil surface is exposed to direct influx of sun's rays over a long period of time, in connection with the contrast degree increase of temperature regime, especially during the year dry season. According to the researches, the temperature regime moves as a minimum with a more southerly area (Gherasimova, et al., 2000). This leads to mass and soil biotope compozition modification, and consequently to humification process intensity attenuation and intensification of active mineralization of organic residues (Ghilearov, 1974). Increasing the degree of soil climate continentality and agrogenic layer drying leads to specificated effects amplification (Jigău and coaut., 2017; Jigău and coaut., 2018).

Table 1. Stages of anthropogenic transformation of steppe ecosystems within Carpatho-Danubian-Pontic space (Lisetschi, 2011)

Stage features	Anthropogen transformation stage				
	1	2	3	4	5
Durata etapei, ani	2950-1950	2300	70	90-100	50
Plant species	Bridal veil-Fescue	Bridal veil-Fescue	Bridal veil-Fescue associations Pasture	Grained (spring wheat)	Agrocenosis (autumn wheat)
Phytomass entries (F), g/m^2	1210	600	500	148	324
Alienated production amount P),Kj/m^2	40	60	76-101	138-146	745-773
Ratio P/F, Kj/m^2	1:28	1:9	1:6	1:0,97	1:0,40
Humus entries, Mj/m^2/an	5,4	4,5	4,2	0,54	1,55

Tabelul 2. Plant debris input on soil surface and in the 0-20 cm layer (root remnants) in the steppe landscapes (average data based on 400 determinations) (Lisetschi, 2011).

Crop plant	Plant debris mass (F), g/m^2		Energy value, Kj/m^2
	Superficial	Radicular	
Autumn wheat	241	122	6355
Spring barley	171	96	4541
Vetch	159	175	5778
Sunflower	131	214	5527
Corn	73	243	5163
Annual herbs	37	372	6699
Multi-annual herbs	236	255	8606

Agrogenesis also implies a number of factors that affect the soils energy status, among which the most important are:

- Low quality and poorly humus varietal sources;
- Microbiotic biomass considerable reduction in soils as a renewable active humus source from 28-30 t / ha at 1-2 t / ha;
- The "stressed" state of the soil biota as a result of the chaotic dynamics of the quantities, composition and organic residues storage terms;

- Deficiency of the biological nitrogen necessary for carrying out the processes of humus formation;
- The spatial incoherence of the organic waste storage area and the optimal conditions for the humus formation processes due to the intensive degradation of the arable layer;
- Disturbance - anthropogenic degradation of pedofunctional framework (pedofunctional regimes) for humus formation processes development;
- Intensification of humic substances mineralization processes due to soil working and increasing their aeration degree.

Based on the exposed ones , the pedogenic process debiologysation can not be reduced only to humus content reduction (dehumification). Debiologysation is a complex of factors and processes under which the agroecosystems formation and accumulation of humus process has lost its priority role in chernozems functioning, and as a result, a stagnating or regressive trend of evolution has occurred. These are materialized in the accelerated modification of the bioenergetic soil status indices and in the development of a complex soil cover (Table 3.4.5).

From Table 3 we find that in the Nisporeni district 76.4% of all arable land is characterized by <3% of humus content. Of these, 49.3% (practically half of the entire arable fund of the district) is characterized by a humus content of <2%. In Orhei district, 68.2% of the arable land is characterized by a humus content of <3%.

According to the calculations, the arable land in the Nisporeni district over the last 70 years lost about 30% of the initial humus reserves. In Orhei district the losses amount consists 23% (Table 4).

In the established trends context, we note that the 3% value represents the critical threshold of humus content in the chernozems in the Carpatho-Danubian-Pontic space. At contents of less than 3% physical properties (solid phase density, apparent density, total and differential porosity) and hydrophysical values have characteristic values for parental deposits.

The fact that draws attention is that soil with a low (<30 cm) and moderate (30-45 cm) humuso – active layer thickness predominates. This implies the conclusion that agrogenesis leads to humus formation processes concentration in the soil upper segment. In the transition horizon, the intensity of these processes is reduced to a minimum. As a result of intensive humic substances fractions mineralization rich in nitrogen the composition of humus predominates the substances in whose composition the C: N ratio is more than 14: 1.

On multi-year plantations, desoiling processes leads to the formation of reversed humic profiles that are characterized by hunus contents in the 0-30 cm layer below 2%. In Nisporeni district there are more than 90% of the assessed area

Table 3. Index of arable chernozems bioenergetic state.

Indicators of bioenergetic status	Share (%) of bioenergetic surface areas			
	Low and very low	moderate	optimal	high
Nisporeni district				
Humus content in the arable layer	49,3	27,1	23,6	-
Thickness of the humus-active layer (Aph+AmB), cm	19,2	54,8	19,7	6,3
Humifer layer thickness (A+B), cm	0,8	21,3	61,5	16,4
Humus reserves in the layer 0-100 cm,t/ha	29,8	38,6	31,6	-
C:N ratio in humus structure	17,6	63,9	18,5	-
Orhei distict				
Humus content in the arable layer	21,9	46,3	31,8	-
Thickness of the humus-active layer (Aph+AmB), cm	14,0	42,9	31,3	11,8
Humifer layer thickness (A+B), cm	0,9	39,4	50,3	29,4
Humus reserves in the layer 0-100 cm,t/ha	1,5	49,8	48,7	-
C:N ratio in humus structure	14,5	56,8	28,7	-

Table 4. Dynamics of arable land areas according to humus supply degree

Evaluation period	Share (%) of humus-supplied degree area				
	Very low	low	moderate	relative optimal	high
Nisporeni district					
1965-1970	-	58,5	33,3	-	7,2
1970-1975	14,1	50,1	31,9	3,6	-
1975-1980	16,0	53,4	27,4	3,2	-
1980-1985	18,3	56,8	21,7	3,2	-
1985-1990	18,6	57,3	21,2	2,9	-
Orhei district					
1965-1970	-	22,7	55,8	-	21,5
1970-1975	9,0	9,0	43,9	8,5	2,1
1975-1980	8,7	8,7	44,5	7,5	3,4
1980-1985	8,5	8,5	45,5	6,8	3,0
1985-1990	11,0	11,0	33,6	9,3	2,7

and about 80% of them in the Orhei district. On the basis of the above, we conclude that in the context of anthropo-natural pedogenesis, the deviant role in the evolution of the bioenergetic state is due to agrogenesis-induced conditions. At the same time, changes caused by agrogeneze, increase soils vulnerability to erosion

Table 5. The dynamics of fruit plantations areas depending of humus supply degree.

Perioada de evaluare	Ponderea (%) suprafețelor cu grad de aprovizionare cu humus				
	foarte scăzut	scăzut	moderat	relativ optimal	ridicat
Raionul Nisporeni					
1975-1980	-	91,4	8,6	-	-
1980-1985	-	92,9	7,1	-	-
1985-1990	-	93,3	6,7	-	-
Raionul Orhei					
1975-1980	-	79,6	19,2	1,2	-
1980-1985	-	84,0	14,7	1,3	-
1985-1990	-	79,6	17,7	2,7	-

phenomena with water and wind, drought, aridization etc. Aggregate soil formation is a reflection of all four phases interaction. As a result, the aggregated soil structure is an intelligent informative system of many processes of structural-functional soil organization establishing within the whole natural pedogenetic → natural-anthropogenic chain.

According to Lisetschi et al. (2013), the aggregate structure evolution is determined by the pedogenic processes targeted modification that determine the aggregation-structuring process: the formation and accumulation of humus, the calcium carbonates leaching, the modification of mineralogical composition of the finely dispersed fraction. In natural conditions, the humus formation and accumulation process is synchronized with calcium carbons process leaching in relation to their dynamics being determined by the cyclical climatic conditions. Their dynamics over time leads to the grain formation and aggregation of the soil mass. The integrating index of these processes is the 5-10 mm aggregate content. At the same time, the climatic conditions cyclicity determines the wetting-drying, freezing-thawing, heating-cooling, swelling-contraction processes dynamics that cause fragmentation – consolidation of soil mass processes with aggregate formation > 5 mm.

Under agrogenetic conditions, the basic responsible for soil-structuring-aggregation processes undergoes significant changes. The fresh humus intensity process reducing is one of the main reducing reasons of small-scale aggregates forming processes. In addition, the predominant humification process location in the arable layer leads to structuring process reducing in the underlying profile section. At the same time, the continentalisation of the soil climate due to the hydro-physical degradation of agro-cernozems and the continental climate degree increasing reduces the intensity of the calcium carbonate elution processes. As a result, the share of soil aggregates, formed with carbonates participation, increases. Such structural formations have reduced aggregate stability. The soil

Table 6. The dynamics of the structural aggregate status indices of chernozems between Prut and Nistru space during the vegetation period.

Soil	Crop	Depth, cm	At the beginning of vegetation							At the end of vegetation						
			Aggregate content, %						Ks	Aggregate content, %						Ks
			>10 mm	>5 mm	5-1 mm	<1 mm	<0,25 mm	10-0,25 mm		>10 mm	>5 mm	5-1 mm	<1 mm	<0,25 mm	10-0,25 mm	
Typical moderate humiferous chernozem	Corn	0-20	1,40	28,88	58,95	9,17	1,57	97,03	1,54	20,90	48,54	37,70	13,67	3,77	75,33	0,61
		20-40	34,32	68,85	30,42	2,73	1,08	64,60	0,44	31,88	57,42	32,38	7,12	3,68	64,44	0,50
		40-60	19,71	56,89	39,48	3,63	1,55	78,74	0,65	40,58	65,46	29,88	4,66	1,20	58,22	0,42
Typical moderate humiferous chernozem	wheat	0-20	5,72	28,43	61,40	10,77	2,23	92,65	1,57	43,08	65,17	29,25	4,57	2,29	54,62	0,42
		20-40	28,40	58,46	38,94	2,60	0,58	71,02	0,64	40,85	63,17	29,70	7,13	1,56	57,59	0,42
		40-60	20,67	46,96	49,61	3,43	0,95	78,38	0,98	37,15	69,60	28,44	1,92	0,82	62,03	0,40
Typical moderate humiferous chernozem	sun-flower	0-20	13,25	24,25	62,43	13,32	3,17	83,58	1,66	43,84	61,20	24,75	12,01	2,91	52,35	0,33
		20-40	15,89	58,53	38,15	3,32	0,72	82,81	0,67	48,96	77,03	20,06	2,91	0,91	50,13	0,25
		40-60	21,19	53,97	41,05	4,98	1,12	76,66	0,70	14,17	34,82	56,83	8,35	3,28	82,05	1,38
Typical moderate humiferous chernozem	sun-flower	0-20	8,09	38,45	50,77	10,78	3,42	88,49	1,03	11,98	39,43	50,96	9,11	2,83	85,21	1,05
		20-40	22,54	62,87	33,75	3,38	1,51	75,95	0,51	7,88	36,33	58,38	7,29	2,25	89,87	1,29
		40-60	18,38	45,88	46,70	7,42	2,50	79,12	0,88	7,53	44,78	53,10	2,12	0,65	91,82	1,13
Cernoziom tipic moderat humifer	corn	0-20	12,55	36,16	48,01	15,83	3,97	83,48	1,33	20,44	52,37	40,15	7,48	1,59	77,97	0,77
		20-40	32,21	64,44	29,20	5,36	1,91	65,88	0,45	38,37	60,60	34,44	4,92	1,86	60,77	0,57
		40-60	24,05	53,66	41,77	4,57	2,48	73,47	0,78	13,56	41,58	53,70	4,72	1,81	84,63	1,29
Typical moderate humiferous chernozem	wheat	0-20	58,00	79,91	17,43	3,40	1,50	40,50	0,21	33,98	70,67	25,30	4,03	1,69	65,33	0,36
		20-40	44,55	73,44	23,32	3,24	1,86	53,59	0,32	35,74	72,60	25,23	2,12	0,62	63,59	0,35
		40-60	46,52	69,12	27,91	2,97	1,16	52,32	0,40	41,28	69,77	28,10	2,13	0,58	58,14	0,41
Typical low humiferous chernozem	sun-flower	0-20	10,40	38,71	47,52	13,77	4,92	84,68	1,23	15,02	37,01	43,93	19,06	7,75	74,23	1,19
		20-40	27,84	61,37	32,29	6,34	2,34	69,82	0,53	30,00	54,62	37,44	7,94	1,86	68,14	0,69
		40-60	10,09	28,99	50,12	21,49	9,56	80,35	1,73	26,81	54,14	33,89	11,97	2,81	70,38	0,63
Typical low humiferous chernozem	sun-flower	0-20	3,70	31,06	50,55	18,39	5,54	90,76	1,03	21,42	45,36	36,43	18,21	8,02	70,56	0,57
		20-40	14,44	36,18	44,13	18,90	7,85	77,71	0,80	27,14	52,93	35,13	11,94	4,23	68,63	0,54
		40-60	9,27	34,71	44,73	20,56	8,83	81,90	0,81	16,49	36,64	54,38	8,98	2,85	80,66	1,19
Typical moderate humiferous chernozem	sun-flower	0-20	11,01	28,15	59,66	14,19	1,29	87,70	1,48	17,95	49,39	40,30	10,31	3,28	78,77	0,68
		20-40	44,68	75,01	22,63	1,36	0,61	54,71	0,29	57,52	74,87	19,50	5,63	1,55	40,93	0,24
		40-60	32,10	61,01	36,13	2,86	1,00	66,90	0,57	25,56	59,52	33,65	6,53	4,77	69,67	0,51
Typical moderate humiferous chernozem	sun-flower	0-20	2,80	18,37	67,60	21,03	4,12	93,08	2,09	18,40	34,70	39,74	25,49	9,32	72,28	0,66
		20-40	41,85	77,75	20,54	1,71	0,92	57,23	0,26	43,10	83,12	15,96	0,52	0,31	56,59	0,19
		40-60	17,00	49,69	46,52	3,79	1,16	81,84	0,87	27,08	65,68	32,12	2,20	0,76	72,16	0,47

Table 7. Comparative analysis of the soils aggregate structural state under conventional and conservative land use.

Agricultural unit, soil	Depth, cm	At the beginning of vegetation										At the end of vegetation									
		Conventional technology					Conservative technology					Conventional technology					Conservative technology				
		Aggregates content, %.					The aggregates diameter, mm.					Aggregates content, %.					The aggregates diameter, mm.				
		>10	5-1	<1	<0.25	10-0.25	>10	5-1	<1	<0.25	10-0.25	>10	5-1	<1	<0.25	10-0.25	>10	5-1	<1	<0.25	10-0.25
LLC „Hiliuteanul” (Hiliuti, Rascani) Cernoziom levigat-vertic	0-20	15,4	40,5	4,2	2,2	81,4	8,8	44,9	15,4	5,2	86,0	23,3	38,2	12,7	4,3	72,4	5,3	47,4	9,3	2,5	92,2
	20-40	26,5	46,5	6,9	1,8	71,7	32,5	27,1	1,9	0,7	66,8	25,9	35,9	4,8	1,3	72,8	24,7	38,6	4,8	1,5	73,8
	40-60	48,2	24,0	1,5	0,6	51,2	19,3	42,8	3,5	1,1	79,6	30,3	32,5	7,5	1,8	68,0	15,2	40,7	7,0	1,5	83,3
LLC „Valea Parjotei” (Parjota, Râscani) Typical moderate humiferous chernozem	0-20	8,8	53,6	22,6	5,6	85,7	7,0	52,5	16,6	4,0	89,0	22,4	40,4	24,1	7,8	69,7	14,7	43,0	23,2	6,5	78,8
	20-40	3,3	60,0	5,5	1,2	95,6	10,8	37,6	0,5	0,2	89,1	28,0	31,0	10,5	3,1	68,9	23,0	43,5	3,1	0,7	76,3
	40-60	19,3	11,3	3,2	1,8	79,9	7,4	42,9	1,7	0,7	91,9	15,2	43,0	6,1	1,4	83,4	10,1	45,2	2,9	0,9	89,0
LLC „Agrogled” (Taraclia, Taraclia) Typical low humiferous chernozem	0-20	10,4	47,5	13,8	4,9	84,7	3,7	50,6	18,4	5,5	90,8	15,0	43,9	19,1	7,8	74,2	21,4	36,4	18,2	8,0	70,6
	20-40	27,8	32,3	6,3	2,3	69,8	14,4	44,9	18,9	7,9	77,7	20,0	37,4	7,9	1,9	68,1	27,2	35,1	11,9	4,2	68,6
	40-60	10,1	49,5	21,5	9,6	80,4	9,3	44,7	20,6	8,8	81,9	26,8	33,9	12,0	2,8	70,4	16,5	54,4	9,0	2,9	80,7
LLC „Agrosem” (Etulia, Vulcanesti) Carbonatic chernozem	0-20	10,8	30,6	8,9	2,4	86,8	17,4	47,4	8,4	1,7	80,9	14,2	43,9	19,3	5,6	80,2	8,7	52,4	14,3	3,8	87,5
	20-40	23,2	49,4	6,6	1,8	75,0	20,2	45,5	9,5	2,1	77,7	17,6	34,2	13,9	4,8	77,5	21,1	42,3	15,6	6,4	72,5
	40-60	5,4	55,0	23,5	11,6	83,0	6,2	60,7	12,4	4,1	89,6	-	53,3	24,0	8,4	91,6	-	55,5	27,5	19,9	85,1

profile moisture during the cold period of the year leads to scattering to elementary and micro-aggregate particles. They clog pores, cause increased apparent density and reduce total porosity. Soil drying soil leads to formation of aggregates > 7 mm non-typical to the transition horizon (B) of chernozems.

The research (Lebedeva, 2016) finds that aggregate structure processes modification and restructuring in agro-horizons are more intensive in the early agro-genezis phases. In the meantime, the intensity of structural change and restructuring processes is reduced, and structural and aggregate composition is in balance with newly created agro-aging conditions induced by agrogenezis and climate change. Therefore, in the current phase of chernozems evolution the aggregation dynamics is determined by the dynamics of the processes that occur in the soil during the cold period of the year and during the vegetation period.

According to Tables 6 and 7 we find that the general trend of the structural-aggregate state is determined by the aggregates <5 mm constant increase. The content of this fraction varies over the vegetation period in wide ranges of values, and the dynamics of the latter do not outline any laws. The fraction of this more dynamic fraction is> 10 mm. This implies that the origin of aggregates> 5 mm is related to processes of mechanical nature and depends on the humidity and soils compactness state. The latter are indispensable related to climatic conditions, which allows us to conclude that in the natural-anthropic evolution, increases the role of climate change in aggregate soil formation evolution. It concludes that technological solutions are needed to mitigate the impact of climate change and to favor biophysical processes by enhancing soils biological processes. In this respect, we draw attention to the fact that presented in Table 7 data show that the "conservative technologies" practiced in the Republic of Moldova do not achieve this objective, therefore it is necessary to change the paradigm of sustainable technologies by promoting technological solutions capable to ensuring training process and the accumulation of humus in arable chernozems priority role.

Conclusions

Agro-genesis-induced and the more extreme climate conditions disrupt the interactions between of the typogenic processes of chernozem pedogenezis evolutionary trends. As a result, the current state of structural-functional organization determines four models of functional states of the chernozems in the Carpatho-Danubian-Pontic space:

- Progressive-accumulative – characteristic to agricultural use, where the agricultural system provides a positive balance of humus in the agrogenic layer. Such functional state corresponds to soils with a physical degradation minimal degree;
- Modal - dynamically quasi-balanced in which the humus content, its reserves and its composition correspond to the agricultural and agroecosystem system practiced type, to the granulometric composition and to a dynamic-quasi-balanced physical state in which the pedophonic regimes are restored during the vegetation period;
- Regressively-uncompensated – the humus status indices show a continuous decrease trend, and consequently the trend of the structural-functional state of the soils is decreasing;
- Stagnant – humus status indices rise to critical state. In this framework, the indications of structural and functional soil organization are insignificantly detached from the structural-functional organization of the parental storage.

References

Ardelean F., Colda I. (2007), *Causes of climate change - a controversial subject* // Conference Materials: Efficiency, Comfort and Environmental Protection, Bucharest, p.18-26.

Jigau G., Lesan M., Birsan A. (2018*), Chernozems evolution trends: technological factors and adaptation solutions,* National scientific conference devoted to academician B. Melnic 90th birthday anniversary. Chisinau: CEP USM, 251-257 p. ISBN: 987-9975-71-971-1.

Jigau G., Leşanu M., Bîrsa, A. (2017), *Pedofunctional and pedogeographic principles of the fundamentation and implementation of adaptive ameliorative technologies at extreme climate conditions,* Ecology and Protection of Ecosystems, Bacău, P. H.: ALMA MATER, p. 152-153, ISBN:987-606-527-585-0

Rasmussen C., Southard P. I., Horwath W. R. (2005), *Modeling energy inputs to predict pedogogenetic environments using regional environmental databasess,* Journal of Soil Seience Society of America, vol. 69, no. 4, p. 1266-1274.

Alexandrovsky, A. L. (1983), *Evolution of soils of the East European Platform in the Holocene,* Moscow, : P. H. "Nauka", 150c.

Akhtyrtsev, B. P. (2008), *The history of forest-steppe soils anthropogenic degradation in the Holocene,* Bulletin of the VSU, Series of chemistry, biology, p. 80-85.

Akhtyrtsev B. P., Akhtyrtsev A. B., Pryakhin A. D. (1997), *Paleo-soil field research works of Voronezh University,* Archeology of the Eastern European Forest-Steppe, Voronezh, no.10, p.15-24.

Akhtyrtsev A. B., Akhtyrtsev B. P., Yablonskikh L. I. (2006), *History of soil formation and evolution in the Holocene forest-steppe,* Bulletin of the VSU. Series chemistry, biology, p. 68-73.

Genadiev A. N. (1990), *Soil and time: models of development,* Publishing House MSU, Moscow, 30c.

Demkin V. A. (1997), *Paleopedology and archeology*, Pushchino: Onti PSC RAS, 213p.

Demkin V. A., Demkina T. S., Khomutova T. E., Eltsov M. V. (2012), *Evolution of soils and dry steppes climate dynamics of Volga Upland in the last 3.500 years*, Soil Science, 12, p. 12-44.

Jigau G. (2017), *Bio-organic supporting agrotechnologies of expanded reproduction of chernozems fertility*, Agricultural magazine LEADER-AGRO, no. 10 (81), p. 18-21.

Zolotun V. P. (1974), *Soils development of south of Ukraine for the last 50-45 centuries,* Abstract of degree of Doctor of Agricultural Sciences diss. Kiev, p. 74.

Ivanov I. V. (1992), *Evolution of soils in the steppe zone in the Holocene,* Moscow, P.H. "Nauka", 144 p.

Klimanov V. A. (1978), *Paleoclimatic conditions of the Russian Plain and the climatic optimum of the Holocene*, Reports of the Academy of Sciences of the USSR., vol. 242, 4, p. 902-914.

Klimanov V. A. (1996), *Climate of Northern Eurasia in the late Glacial and Holocene. - Author essay*, PhD diss., Moscow, 64p.

Popova, A. I. (2006), *Agrocenoses soils organic matter and its role in the functioning of the soil-plant system,* PhD thesis, St. Petersburg, 406 p.

Lisetskiy F. N. (2008), *Agrogenic evolution of the soils of the dry steppe zone under the influence of the ancient and modern stages of land use*, Pedology, no. 8, p. 913-927.

Lisetskiy F. N. (2011), *Historical and ecological stages of the eastern European steppes transformation*, The modern natural science successes, no. 5, c. 33-36.

Lisetskiy F., Syrodoev G., Goleusov P. et al. (2013), *Climate conditionality of the zonal soils formation of in the Republic of Moldova,* Scientific papers, Moldova State Agrarian University, Chișinau, vol.33. Cadastre and Legal. P. 76-79.

Lisetskiy F. N, Goleusov P. V., Chepelev O. A. (2013), *Development of chernozems of the Dniester-Prut interfluve in the Holocene,* Pedology, no. 5, p. 540-555.

Lykov A .M., Boinchan V. P., Vyugin S. M. (1980), *Organic matter and soil fertility in intensive agriculture,* Moscow, 60 p.

Neishtadt M. I. (1983), *On the question of some concepts of the Holocene division,* Moscow: Publish. House of the USSR Academy of Sciences, Ser. geography. Vol. 2, p. 103-108.

Lebedeva I. I, Bazykin G. S, Grebenikov A. M, Cheverdin Y. I., Bespolov V. A. (2016), *Experience in the integrated assessment of long-term agricultural use on the properties and regimes of agroechernozems in the Kamennaya Stepi*, The Soil Institute Bulletin. V. V. Dokuchaeva, no. 83, p. 77-102.

Serebryanaya T. A. (1982), *On the dynamics of the forest-steppe zone in the center of the Russian plain in the Holocene*, Development of the nature of the USSR territory in the Late Pleistocene and Holocene, Moscow, p. 179-186.

Spiridonova E. A. (1991), *The natural environment Holocene change in the Don river basin. Bronze Age,* Moscow settlement in the monuments system of steppe and forest-steppe. Voronezh, p. 53-55.

Khotinsky N. A. (1982), *Holocene chronographs discussion problems of the Holocene paleogeography,* Development of the nature of the USSR territory in the Late Pleistocene and Holocene, Moscow, p. 142-147.

Chendev Y. G., Ivanov I. V, Pesochina L. .S. (2010), *Trends of chernozems natural evolution of the East European Plains,* Pochvovedenie, 8, p. 675-685.

Popova A. I. (2006), *Agrocenoses soils organic matter and its role in soil-plant system functioning, PhD Thesis,.* St. Petersburg, 406 p.

* * * (2013), *The structural soils state changes in under soil-climatic conditions differences in the land use history*, Proceedings of the Samara Scientific Center of the Russian Academy of Sciences, Volume 15, Nr. 3 (3) p. 998-1002.