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THE HISTORY OF EROSION ON THE NORTHERN PONTO-MEOTIAN DURING THE PERIOD OF INTENSIVE AGRICULTURE

A.Yu. **Sidorchuk,** V.N. **Golosov**
Laboratory of Soil Erosion and Fluvial Processes, Geographical Faculty
Moscow State University, 119899 Moscow, Russia

SUMMARY

The semi arid climatic conditions occur at the lands along Russian, Ukrainian and Moldovan shores of Black and Azov seas. The first period of agricultural use of this territory coincide with Greek colonization in VII c B.C.IV c A.D.. After IV c A.D. natural steppe landscapes were usual. Up to the end of XVII c the area of arable lands did not exceed 2%. In XVIII c the Northern Ponto-Meotian was gathered to Russia and stage of intensive ploughing had started.

The information about main natural factors of erosion, land use and area of arable land was collected for the period 1696-1980.

The soil erosion rates were calculated for different periods with the use of modification of USLE.

The area of arable lands increased up to 12-16% of the territory during the period 1696-1796, but the rate of sheet erosion was less then 0.03 t/ha year. The end of XIX c was the main period of rapid increase of Ponto-Meotian lands exploitation. The area of arable lands achieved 29,798,000 ha in 1887. The mean rate of erosion was up to 2.3 t/ha per year for the period 1796-1887.

During XX c the area of arable lands in this territory increased to 42,075,000 ha. The change of land use technology promoted dramatic increase of the rate of erosion up to 6-7 t/ha per year on average for the whole area.

The calculation were checked by the field investigations on small catchments in the Kalaus river basin using Cs-137 method and evaluation of sedimentation in the ponds.

1. INTRODUCTION

The territory of Northern Ponto-Meotian along the Russian, Ukrainian and Moldovan shores of Black and Azov sea has its northern boundary along the isoline of dry index P/E = 0.5 and P-E = - 400 mm (P - mean annual precipitation, E - evaporation).

For purposes of this paper it will include Moldovan Republic (area 33 760 sq.km), Odessa (33 313 sq. km), Nikolayev (24 719 sq.km), Kirovograd (24 588 sq. km), Crimea without mountains (26-945 sq. km), Kherson (28 325 sq. km), Dnepropetrovsk (31 923 sq. km.), Zaporozhye (27 185 sq, km.), Donetsk (26 516 sq. km.), Lugansk (26 685 sq. km.) districts of the Ukraine and Krasnodar (83 278 sq. km.), Stavropol (79 723 sq. km.), Rostov (100 967 sq. km.) and Volgograd (112 935 sq. km.) districts of Russia with total area 660 862 sq. km. mainly within the Black sea basin (fig.1).

The processes of erosion on the Northern Ponto-Meotian are most clearly manifested in sheet and rill erosion on slopes. On a qualitative level, the history of the development of erosion in the northern Ponto-Meotian is well known (SOBOLEV, 1948). However, the quantitative characteristics of change in the intensity of erosion have been little

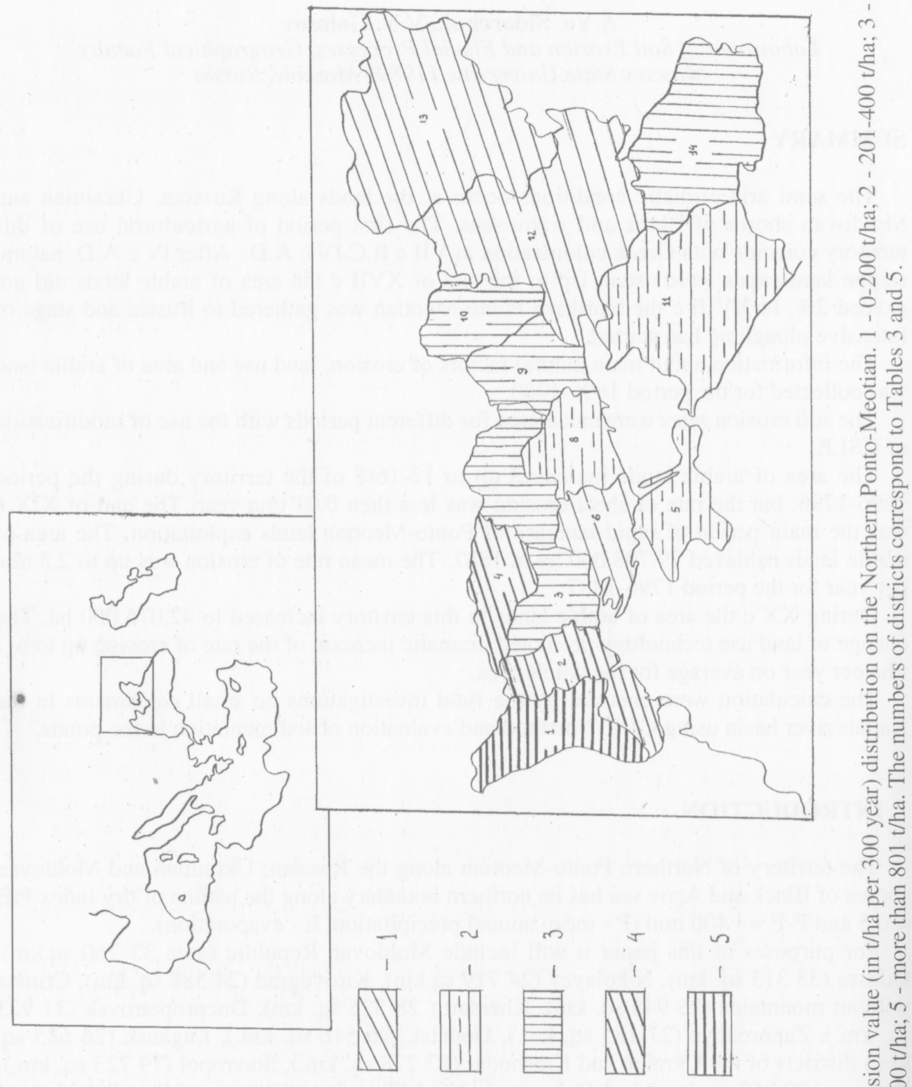

Fig 1 - The erosion value (in t/ha per 300 year) distribution on the Northern Ponto-Meotian. 1 - 0-200 t/ha; 2 - 201-400 t/ha; 3 - 401-600 t/ha; 4 - 601-800 t/ha; 5 - more than 801 t/ha. The numbers of districts correspond to Tables 3 and 5.

studied. At the same time data on changes in the most important factors in the processes of erosion make it possible to provide a qualitative description of the history of the development of erosion processes, and to estimate their quantitative characteristics for a number of given points in time.

2. INVESTIGATIONS OF SHEET AND RILL EROSION ON SLOPES

Archaeologists and historians have shown that land-tillage was established in Ponto-Meotian at the period of Greek colonization in VII c B.C. At the western boundary the Nikony and Tyra towns were situated at the coast of Dniester bay (from VI c B.C.). At the eastern part the Fanagoryja town was situated at the Taman peninsula, and Tanais town was situated in the Don River mouth.

Wheat, vegetables and grapes were the main types of agricultural production. The fields had an area about 4.0-4.5 ha in small villages, and up to 27 ha near main towns (so the slope length was not less than 500-600 m). The fields of large dimensions were used for grapes. Artificial terraces were constructed in the areas with poor soils and the fields were divided along horizontals into long narrow strips about 3 m wide with stone walls. This constructions show the evidence of soil erosion and soil conservation works.

After invasion of nomads IV c A.D. and destruction of Greek states in Ponto-Meotian the long period of nomads population established. Natural steppe landscapes were usual for this territory. The only types of soil destructions were nomads war roads and steppe fires. In the war roads the soils became more shallow and compacted. The area of these roads could extend to several hundreds of ha. But the latest ploughing destroyed the signs of this type of erosion.

Up to the end of XVII c the area of arable lands did not exceed 2%. In XVIII c the Northern Ponto-Meotian (so called New Russia) was gathered to Russia and a stage of intensive ploughing started. But till the middle part of XIX c. The area of arable land did not reach 10%. Then the area of arable land increased very rapidly, especially on the western and central parts of Ponto-Meotian and became as much as 30-40% by 1861. This process had started in the eastern part of Ponto-Meotian only in 1930.

In 1887 V.Dokuchaev compiled the map of chernozem soils of cultivated area of New Russia, showing the humus content in soils for the second half of the 19th century. According to this map (see ALAYEV *et al.*, 1990), the most fertile soils with a mean content of humus in the tilled stratum of 7 to 10%, occupied an area in the Stavropol and Krasnodar districts between the Black and Caspian seas, and also at the Dniester-South Bug Rivers interfluve, on land only lightly cultivated. Chernozems with a humus content of 4 to 7 % lay at the Azov seas shores and Middle Don River Valley. In the remaining area, mainly along Dnieper and Don Rivers, in Crimea and Kherson districts soils with less than 4% humus predominated.

A comprehensive picture of the distribution of eroded soils in the Ponto-Meotian for the late 1930s may be obtained by analyzing S.S. SOBOLEV's map (1948). The map shows in percentages the areas suffering an average degree of erosion. These can easily be identified in a field study of soil erosion. By that period the most severely eroded arable land in the Ponto-Meotian lay on the right bank of the Don (the Donetsk ridge), along the west bank of Dnieper and at the Tissa-Dniester-South Bug Rivers interfluves.

Here 20-30% of the total area of tilled and fallow arable land was eroded. Regions with average erosion amounting to 10-20% of the area included the South Bug-Dnieper interfluve and south Crimea. At the remaining territory the soil erosion only begins to give some visible effect.

Since the early 950s, observations of the intensity of rainfall erosion have been made at Moldovan hydrometeorogical station. The observations were organized on a few plots and watersheds. The results of observations show the large differences between erosion from potatoes and sugar bean fields, where annual soil erosion rates are 30-35 t/ha and corn fields, where the same rates are 10-15 t/ha (VANIN *et. al,* 1980). Soil erosion observations in Rostov district showed that rainfall soil erosion rate can reach 50-70 t/ha, but annual rates are 5-6 t/ha only (POLUECTOV, 1984).

F. LISETSKIY (1991) showed, that in Odessa district 46.9% of arable land is eroded, and on 1.02% of them gullies occur. These numbers for Kirovograd district are 48.2% and 0.5%, and for Nikolaev district are 41.4% and 0.82%. The mean annual rate of soil erosion was established as 8 t/ha.

3. PAST AND PRESENT FACTORS CONTROLLING EROSION

The soil loss volumes from rainfall for different periods of time were calculated using modernized form of Universal Soil Loss Equation (hereafter USLE) (LARIONOV, 1984). The main factors of soil erosion which use in USLE, are: (a) Geomorphic factors, especially slope gradient and length; (b) Climatic features, especially intensity and duration of rainstorms; (c) The resistance of the soils to erosion; (d) Vegetation as protection to the soil; (e) Land use and its impact on erosion potential.

3.1 Geomorphic factors

A picture of the erosion potential of relief, the most variable factor, was obtained from large-scale topographical maps with the random net of measurement points. This made it possible to obtain the most realistic descriptions of slope length and gradients, as well as the distribution of land classified according to the severity of erosion within these areas (LITVIN, 1987). The influence of relief on erosion is proportional to the length and inclination of slopes. The distinguishing feature of this factor is the high degree of regional variability, both at the micro and macro levels. Frequently the amplitude of variation in the erosion potential of relief (LS) for adjacent areas of the Ponto-Meotian is comparable to the amplitude of variation in the rainfall erosivity throughout the region. The right and left banks of the Dnieper, and Don, where the difference in LS amounts to an order of magnitude, serve as examples. The lowest mean LS values are mostly found in the central Black Sea Plain (0.21).

The highest values are found in the Volyno-Podol'sk uplands (3.5-4.0) (Table 1).

Table 1 - The morphological caracteristics distribution in typical geomorphological regions of the northen Ponto-Meotian (by LITVIN, 1987)

Geomorfological region	Mean maximum slope %	Mean slope length	Mean LS value	LS values distribution (n % of arable land area)					
				0-1	1-2	2-3	3-4	4-5	>5
Podol'sk Highland	7.6	419	3.5	28.5	10.8	16.0	13.0	8.0	23.7
Black Sea plain	0.8	616	0.2	98.4	0.8	-	0.4	0.4	-
Stavropol upland	5.19	600	2.68	50.5	6.3	5.7	6.1	4.3	27.1

Almost the same situation are observed in the south-eastern part of Ponto-Meotian, where differences between LS values of Stavropol upland (LS 2.5-3.0) and surrounded areas of Krasnodar plain and Sal'sk steppe (0.2-0.4) are very high.

Although slope shape is rather stable in time, length of cultivated fields was changed in time due to land use change.

Comparisons of large scale topographic maps from the 18th and 19th centuries, based on recorded areas of plots of land belonging to peasants and landowners, allows some inferences to be made about variations in the length and gradients of slopes under cultivation.

Up to the end of the 18th century, when the population of Ponto-Meotian was small, abundant land allowed ploughing to be restricted to gentle slopes. As a result, the length of the slopes could not exceed 150-220 m. Settlement and the area of ploughed land increased rapidly in the second half of the 19th century and at the beginning of the 20th century, (DUBROVSKII, 1975).

In the period 1918-1928 land was distributed between farmers by plots, and so the length of flow lines on slopes, and often the length of the slope as well, were 1.5 to 3 times less than at present. During the period of collectivization started in 1928, and up to the beginning of the 1950s, there was a considerable enlargement of fields. In this period, however, the length and inclination of ploughed slopes did not reach their maxima on the steppe. This occurred in the period 1950-1970 when mean length of the fields increased up to 400-600 m, with the incorporation into the crop rotation of steep sections of slopes with inclinations of at least 10 degree. There was some amelioration of this trend on the steppe where long slopes of up to 1000 m were subdivided by planting of forest shelter belts.

3.2 Climatic Factors

The rainfall energy and its erosive capacity, expressed by the rain erosivity (R) of the USLE, is closely correlated with the amount of rainfall. The distribution of rainfall, and so of R, is variable over the Ponto-Meotian, but there is a tendency for it to increase from east to west at the line Volgograd-Kishinev from 4 to 14 units and from north to south at the line Volgograd-Stavropol from 4 to 16 units (LARIONOV *et al.*, 1987).

Variation with time of summer rainfall has been analyzed by BORISENKOV *et al.* (1988). They showed little change of rainfall during the 17th-20th centuries (Table 2)

Table 2 - Relative changes of erosivity (in % of recent value) on the Northern Ponto-Meotian during the period of intensive agriculture

Years	1980	1950	1887	1861	1796	1696
% of recent erosivity	100.	95.	96.	87.	96.	96.

3.3 The Soils

Soils differ in their susceptibility to erosion, depending on their mechanical composition, humus content and structure. A commonly used index of erodibility is the K factor in the USLE.

Chernozems of the northern part of territory with a high humus content are the most resistant with values of erodibility factor K= 0.8-1.2 t/ha per one erosivity unit. At the western and southern part of territory the humus content is lower and K value increase to

1.5-2.1 t/ha. The resistant of chestnut soils of eastern districts are 2.6-2.8 t/ha (KIRYUKHINA, PATSUKEVICH, 1991).

The degree of change with time of the soil resistance to erosion was small in the pre-agricultural period. The rate of formation of the humus horizon of chernozems is 0.4-0.45 mm/yr, and chestnut soils 0.2-0.3 mm/yr (GENNADIEV *et al.*, 1987).

Intensive agriculture has resulted in the loss of fertility of soils. One of the most important changes has been dehumification, reducing both the soils agricultural productivity and resistance to erosion. This decrease of humus content in soils of Ponto-Meotian do not exceede 1-2% since 1887 (DOKUCHAEV's investigations), and only on Moldovan uplands and in Rostov district it is more than 4% (PRIPUTINA, 1989).

3.4 Vegetation cover and arable land area

The soil-retaining properties of crops and the effects of cultivation systems (factor C) were determined according to crop rotation and cultivation systems. Thus, according to ZHARKOVA and LARIONOV (1986), C factor changes in Ponto-Meotian from 0.29 to 0.40. The crop rotation systems and arable land area changed significantly during the late 100 years on the Ponto-Meotian territory (Table 3).

The potential for erosion increases from natural steepe landscapes to ploughed land and so this transition and the extent of ploughed land are important indicators of the likely erosional state. Reliable agricultural data for Ponto-Meotian were obtained during a General Survey between 1766 and the end of the 19th century (TSVETKOV, 1957). This period showed a gradual increase in the arable land area. The three-field and clearing-burning systems of rotation was at this time applied over most territory.

After general collectivization beginning in 1928, crop rotations changed to multi-field. Field sizes increased because the area of fallow land was reduced, and tractors were introduced. Development began in the virgin lands of the pre-Caucasus and the lower Don. By the end of the 1950s a change in the structural and hydrological properties of soils began, resulting particularly from increased loading from machines, and reflected in increased runoff and erosion. An almost doubling of the weight and size of tractors continued the process of making tilled soils more susceptible to erosion.

The last two decades (1970 to 1990) have seen yearly variations of only 1-2% in the area of cultivation in the Ponto-Meotian. Disc ploughing in 10-15% of the chernozem zone has increased the resistance of these soils to erosion.

4. CHANGE OF EROSION RATE ON THE NORTHERN PONTO-MEOTIAN DURING THE PERIOD OF INTENSIVE AGRICULTURE

The schematic map entitled "The Structure of Erosion-Prone Land in the European Part of the USSR" (BELOTSERKOVSKY *et al.*, 1991) shows the average severity of erosion, and the relation between area and the varying rate of erosion for farmland. The rates of slope erosion on Dnieper Valley is 12-14 t/ha/yr; at Dnieper lowlands is 0.5-2.0 t./ha/yr. Southern uplands stand out as having the highest soil-loss rates (Stavropol and Volyno-Podol'sk uplands, 15-20 t./ha/yr, in Moldaviya approximately 22-25 t/ha/yr). At the central Black Sea Plain soil losses are less than 2 t./ha/yr. The distribution of annual soil erosion rate on administrative districts is shown in the Table 3.

The applicability of empirical formulae and the compatibility of their results have been checked several times by field studies using the correlative deposit method and the Cs-

Table 3 - Changes of erosion factors values and erosion rate on the Northern Ponto-Meotian during the period of intensive agriculture

Region		years					
		1980	1950	1887	1861	1796	1696
1. Moldaviya	a)	63.48	67.68	61.00	34.70	32.70	16.70
	b)	0.48	0.48	0.56	0.56	0.60	0.44
	c)	4.60	4.60	3.20	3.20	3.20	3.20
	d)	11.49	11.646	8.553	3.066	3.220	-
2. Odessa	a)	63.73	60.07	77.60	41.70	10.70	0.00
	b)	0.37	0.49	0.39	0.39	0.39	-
	c)	4.10	4.10	1.23	1.23	1.23	-
	d)	6.362	6.882	2.343	.436	.013	-
3. Nikolayev	a)	70.55	70.35	77.60	41.70	10.70	0.00
	b)	0.35	0.47	0.37	0.37	0.37	-
	c)	0.87	0.87	0.26	0.26	0.26	-
	d)	5.078	6.352	1.689	.194	.008	-
4. Kirovograd	a)	79.02	83.84	77.60	41.70	10.70	0.00
	b)	0.36	0.48	0.38	0.38	0.38	-
	c)	1.85	1.85	0.56	0.56	0.56	-
	d)	8.26	11.082	2.393	.371	.029	-
5. Crimea	a)	49.31	35.81	63.50	16.60	3.00	0.00
	b)	0.36	0.48	0.38	0.38	0.38	-
	c)	1.46	1.46	0.44	0.44	0.44	-
	d)	3.214	1.031	1.252	.023	.002	-
6. Kherson	a)	61.91	57.64	77.60	41.70	10.70	0.00
	b)	0.36	0.48	0.38	0.38	0.38	-
	c)	0.85	0.85	0.26	0.26	0.26	-
	d)	1.162	.791	.44	.063	.008	-
7. Dnepropetrovsk	a)	65.98	69.58	68.50	30.60	16.10	0.00
	b)	0.38	0.51	0.40	0.40	0.40	-
	c)	1.14	1.14	0.34	0.34	0.34	-
	d)	4.116	5.485	1.292	.091	.018	-
8. Zaporozhye	a)	72.71	72.45	66.00	23.60	5.00	0.00
	b)	0.38	0.51	0.40	0.40	0.40	-
	c)	1.08	1.08	0.32	0.32	0.32	-
	d)	3.619	4.491	.680	.049	.004	-
9. Donetsk	a)	62.37	65.99	68.50	30.60	16.10	0.00
	b)	0.40	0.53	0.42	0.42	0.42	-
	c)	1.06	1.06	0.32	0.32	0.32	-
	d)	4.489	6.001	1.491	.111	.025	-

Table 3 *(continued)* - Changes of erosion factors values and erosion rate on the Northern Ponto-Meotian during the period of intensive agriculture

		years					
Region		1980	1950	1887	1861	1796	1696
10. Lugansk	a)	54.07	53.47	68.50	30.60	16.10	0.00
	b)	0.37	0.37	0.51	0.42	0.42	-
	c)	1.06	1.06	0.87	0.87	0.87	-
	d)	2.848	2.589	3.891	.542	.156	-
11. Krasnodar	a)	52.71	58.38	.00	.00	.00	0.00
	b)	0.33	0.44	-	-	-	-
	c)	0.67	0.67	-	-	-	-
	d)	2.233	3.125	-	-	-	-
12. Rostov	a)	60.75	27.73	46.50	25.70	11.60	2.20
	b)	0.31	0.41	0.33	0.33	0.33	0.33
	c)	0.58	0.58	0.17	0.17	0.17	0.17
	d)	2.523	.498	.318	.089	.028	-
13. Volgograd	a)	51.66	34.13	46.50	25.70	11.60	2.20
	b)	0.36	0.48	0.38	0.38	0.38	-
	c)	0.71	0.71	0.21	0.21	0.21	0.21
	d)	.870	.340	.163	.045	.009	-
14. Stavropol	a)	59.28	66.08	.00	.00	.00	0.00
	b)	0.38	0.51	-	-	-	-
	c)	0.86	0.86	-	-	-	-
	d)	4.779	6.731	-	-	-	-

a) percent of arable land in the district (republic)
b) C factor value
c) LS factor value
d) mean sheet and rill erosion rate t/ha per year

137 method (GOLOSOV, 1991) (Table 4). This inter comparison gave good results for the greater part of the chernozem zone.

Table 4 - Comparison of erosion volume calculated with USLE and measured with using of the correlative deposit method (a), and the Cs-137 method (b) in Kalaus River valley

Stream system	Period of erosion years	Volume of erosion, cu.m calculated	measured	Method
Sukhoy Yar	1918-1988	386	282	(a)
	1962-1988	143	126	(b)
Kambulet	1936-1988	68	55	(a)
	1962-1988	33	33	(b)

Change in the degree of erosion on the Ponto-Meotian may be quantitatively calculated using estimates of change in the principal factors causing erosion: the area under cultivation, precipitation, and land use. In Tables 3 and 5 data are given on change in averaged figures for administrative districts. The calculations of erosion volumes are based on the data of BELOTSERKOVSKY *et al.* (1991) for the estimated current intensity of erosion in the Ponto-Meotian. Allowing for relative change in the value of erosion factors, retrospective calculations have been made to establish the intensity of erosion for the years 1696, 1725, 1763, 1796, 1861, 1868, 1887, 1950, and 1980. The volume of soil-loss for various periods, and erosion depth, have been determined (Table 5, Fig. 1). Since the calculations are for large administrative areas, they reflect only the most generalized features of soil erosion.

During the period from the 18th to the 20th century, erosion was related to the spatial differentiation of erosion factors and the history of the spread of cultivation in the Ponto-Meotian. In the 18th century, for the period 1696-1796 inclusive, the arable land had an area not more than 65000 sq. km. and was concentrated at the North-West and at the North-East of Ponto-Meotian. The whole volume of erosion (calculated) was 660 millions cu.m. and on 97% of arable land the eroded layer did not exceed 10 cm. This is less than natural variability of chernozem (black soil) profile depth. The erosion was highest in the most densely populated and cultivated area of the Moldovan up hills.

In the 19th century (for the purposes of our calculations, 1796-1887 inclusive) the extension of agriculture was most intensive and to the end of the century the arable land area reached 300000 sq.km. Only at the South-East of Ponto-Meotian (Krasnodar and Stavropol districts) the lands were used mainly as pasture. But it was the very beginning of intensive agriculture on this territory, so the total volume of erosion was not too high, about 2850 millions cu. m. On 98% of arable land the depth of erosion was less than 10 cm. The heaviest erosion was in the most long-tilled areas of Moldaviya. Here the eroded layer was more than 10 cm on 29% of arable land and more than 20 cm on 10% of this area. On Moldovan up hills 42% of whole volume of erosion was formed.

In the 20th century (for the purposes of our calculations 1887-1980) the intensity of erosion on Ponto-Meotian reached to maximum. The area of arable land increased not so dramatically, up to 420750 sq. km., mainly due to tillage of fallow lands at the South-East of territory (Volgograd, Krasnodar and Stavropol Districts). But in 1950-70s years the period of ploughing was coincided with the period of erosivity maximum. This complex of factors led to extreme rate of erosion, the calculated volume of replaced soil was 14200

Table 5 - The calculated volume of erosion (in millions cu.m.) and thickness of erosion layer distribution (in areas of arable land, thousand ha) for 18-20th century in the Northern Ponto-Meotian

District	Erosion volume	Depth of erosion 0-10 sm	10-20 sm	20-30 sm	30-40 sm
period 1696-1796 years					
1. Moldaviya	600.3	901.1	202.8	.0	.0
2. Odessa	1.6	356.4	.0	.0	.0
3. Nikolayev	.8	264.5	.0	.0	.0
4. Kirovograd	1.9	241.7	.0	.0	.0
5. Crimea	.2	80.8	.0	.0	.0
6. Kherson	1.0	303.1	.0	.0	.0
7. Dnepropetrovsk	3.7	526.7	.0	.0	.0
8. Zaporozhye	1.0	225.7	.0	.0	.0
9. Donetsk	4.2	437.6	.0	.0	.0
10. Lugansk	26.4	440.4	.0	.0	.0
11. Krasnodar	.0	.0	.0	.0	.0
12. Rostov	14.5	1171.3	.0	.0	.0
13. Volgograd	6.3	1310.1	.0	.0	.0
14. Stavropol	.0	.0	.0	.0	.0
whole territory	661.9	6259.4	202.8	.0	.0
period 1696-1887 years					
1. Moldaviya	1798.3	1470.8	385.8	202.8	.0
2. Odessa	286.6	2584.8	.0	.0	.0
3. Nikolayev	143.5	1918.2	.0	.0	.0
4. Kirovograd	193.1	1753.0	.0	.0	.0
5. Crimea	105.9	1711.3	.0	.0	.0
6. Kherson	44.7	2198.4	.0	.0	.0
7. Dnepropetrovsk	139.3	2186.5	.0	.0	.0
8. Zaporozhye	61.8	1794.5	.0	.0	.0
9. Donetsk	134.5	1816.6	.0	.0	.0
10. Lugansk	387.8	1828.2	.0	.0	.0
11. Krasnodar	.0	.0	.0	.0	.0
12. Rostov	138.3	4695.1	.0	.0	.0
13. Volgograd	77.2	5251.7	.0	.0	.0
14. Stavropol	.0	.0	.0	.0	.0
whole territory	3511.0	29209.0	385.8	202.8	.0

Table 5 *(continued)* - The calculated volume of erosion (in millions cu.m.) and thickness of erosion layer distribution (in areas of arable land, thousand ha) for 18-20th century in the Northern Ponto-Meotian

District	Erosion volume	Depth of erosion 0-10 sm	10-20 sm	20-30 sm	30-40 sm
	period 1696-1980 years				
1. Moldaviya	4115.5	504.2	304.4	1206.1	270.3
2. Odessa	1604.4	1878.9	706.0	.0	.0
3. Nikolayev	1000.8	1452.4	465.9	.0	.0
4. Kirovograd	1529.1	1154.2	739.8	.0	.0
5. Crimea	406.2	1711.3	.0	.0	.0
6. Kherson	201.7	2198.4	.0	.0	.0
7. Dnepropetrovsk	1075.5	1748.7	472.2	.0	.0
8. Zaporozhye	730.3	1727.0	250.0	.0	.0
9. Donetsk	984.6	1357.5	459.1	.0	.0
10. Lugansk	813.1	1648.0	180.2	.0	.0
11. Krasnodar	1369.9	4358.1	503.9	.0	.0
12. Rostov	908.0	6134.0	.0	.0	.0
13. Volgograd	442.9	5835.0	.0	.0	.0
14. Stavropol	2574.1	3697.4	1112.5	.0	.0
whole territory	17756.2	35405.0	5193.9	1206.1	270.3

millions cu.m. On the Moldovan up hills the erosion volume in the 20th century reaches to 56% of the whole erosion for 300 years, in central districts there is 82%, and in south-eastern districts up to 97%. The recent distribution of eroded lands in the northern Ponto-Meotian is mainly the result of last century's destructive processes.

The heaviest erosion, 1810 t/ha for 300 years, has been in the south-western area (Fig 1), in Moldaviya. This extreme value of erosion volume is connected to high erosivity and hilly relief of territory, as well as to the longest history of cultivation. On 65% of arable land the eroded layer exceeded 20 cm by 1980, and on 12% of arable land it was over 30 cm deep.

At the north-western part of Ponto-Meotian on Podol and Dnieper uplands the rate of erosion is also very high and average erosion value is 600-800 t/ha for 300 years. Erosion to a depth of over 10 cm existed at 32% of arable land. On the Donetsk up hills (north-central part of the territory) the rate of erosion decrease due to lower erosivity and erosion value is in the order of 400-500 t/ha for 300 years and erosion layer thickness is more than 10 cm on 22% of arable land.

The lowest rate of erosion exist on the Black-sea, Crimean and Kuban'lowlands due to very gentle relief, and at the north-eastern part of territory due to low erosivity. The average value of erosion is 100-200 t/ha for 300 years and the area with eroded soils is small.

At the East-South of Ponto-Meotian, at Stavropol highlands, the second principal centre of high erosion rate is situated. The high erosivity and relief, intensive agriculture on the long and, in some cases, steep slopes, led to extreme rates of erosion up to 25-30 t/ha per year. The recent erosion value, 535 t/ha is related to very short period of land ploughing, about 100-120 years, and to averaging of erosion volume for all the district area. But even after this period in more than 23% of arable land the loss of soil is more than 10 cm, and this is sufficient thickness for southern chernozems with soil profile depth about 4050 cm.

5. CONCLUSION

The Universal Soil Loss Equation can be used for sheet and rill erosion calculations, as comparison of calculated and measured rates of erosion shows (Table 4). The recent intensity of soil erosion for northern Ponto-Meotian was calculated with USLE for recent space distribution of soil erosion factors (BELOTSERKOVSKY *et al.,* 1991). So the history of erosion on this territory was reconstructed with the use of recent erosion rate values and erosion factors change in time.

The erosivity variation in time did not exceed 10% for the last 300 years and was less than recent. The relief factor was 2-3 times smaller than recent due to more short and gentle slopes under ploughing. The vegetation cover factor was usually more than the present (less protection for erosion) due to more erosion prone crop rotate systems used, expecially during 1950-1970.

Calculations showed, that in the Ponto-Meotian, during the period 1696-1796, a total of 660 millions cu. m of soil were displaced by sheet and rill erosion; in 1796-1887, 2850 millions cu.m; and in 1887-1980, 14200 millions cu.m. The constant increase in the volume of soil-loss per unit of time is due to an increase in the area under cultivation and exploitation of land which is more prone to erosion. Soils in the hillslopes are most affected, particularly in the Moldovan and Stavropol uplands. (Fig. 1). The total volume of soil-loss from slopes on the Ponto-Meotian over the period from the 18th to the 20th century inclusive amounts to 17850 millions cu.m.

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