SOIL CONSERVATION AND ECOLOGICAL ARRANGEMENT OF AGROLANDSCAPE

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The decrease of the supplies of soil resources and the deterioratoin of their quality - is a global problem, settlement of which becomes the barest necessity for humanity, because of absence of any alternative. The destruction of soils under the influence of water and wind erosions leads to the losses, which cannot be supplied by soil formation process in an economically acceptable period. Yearly on a global scale 25,7 billion tons of soil are lost beyond the permissible level (adopted in the USA) because of erosional processes [1].

Near the Black Sea of Ukraine - a naturally-economic region, which consists of 4 administrative regions, the geographic natural laws of augmentation of destructed lands correspond to the general increasing of rainfall and spring erosional losses of soil in the direction from the South to the North, and for the steppe zone also from the East to the West (the table).

The distribution of the destructed arable lands and the rates of the erosional losses of soil near the Black Sea of Ukraine

Regions	The annual erosional soil losses ths t	t/ha	The eroded areas of the arable, %	The part of the gullies in the areas of arable, %
Odessa	17215	8,6	58,5	1,02
Kirovograd	17188	9,9	48,3	0,50
Nikolaev	21162	12,5	69,2	0,82
Cherson	18232	10,8	95,4	0,35

The main natural laws of the distribution of the arable lands destructed by erosion correlate well with geomorphological, climatic, soil conditions and with the peculiarities of agricultural use. But sometimes there is not direct correspon-

dence between the degree of destruction of arable lands and the intensity of erosion, which is important in soil conservation progection. The highest intensity of water erosion is on the border of the wooded steppe zone and a north subzone of the steppe, in some districts of reaches 15-22 t/ha in a year.

The models worked out in the science about erosion allow to make a retrospective estimation of the dinamics of speeds of soils' erosions in the region also. The rated value of rainfall and spring erosion losses of soil on the territory near the Black Sea of Ukraine before an agricultural period - 0,5 t/ha in a year can be interpreted as a value of geological (normal) erosion. The protective cover of the soil's surface on the zonal groups of vegetation was 60-90 %. Moreover the maximum of the protective cover (June - July) coincided in time with the maximum of the introannual distribution of the values of a hydro-meteorological parameter of rainfall erosional losses, that were generalized according to ten meteorological stations of the region.

In 1889 the erosional losses of soil were not more than 4 t/ha in a year judging from the degree of cultivation of the territory near the Black Sea of Ukraine and from the determined structure of crop rotations. With the mordern structure of field crop rotations (the part of cultivated crops, in particular, grew ten times comparing with the XIX c) the value of the accelerated erosion reached averaging 8 t/ha in a year and thus the erosion destruction of the lands near the Black Sea of Ukraine increased comparing with the before agricultural period seventeen times because of rainfall erosional losses.

The experience of the soil conservation arrangement of the agrolandscapes of the erosiowely dangerous territories shows the particular importance of a scientific basis of the basic normative indices - the permissible erosional losses of soil and the norms of reproduction of quantity and quality of soil resources. The main defect of the traditional way of finding of the permissible soil losses' values (T-level) - their weak differentiation depending on the concrete natural and economical conditions and static character during the time. Because

of this working out of models of optimization is perspective for management of a soil resource during the time and for correction of the permissible soil losses' values depending on the practices of land tenure results. An original method of approach in this dicection was worked out in the USA [6] . It gives an opportunity to plan the gradual descending of the permissible erosional losses during the time depending on the erosional "wear" of soil. But the key idea of the method - a rooting depth of soil - is abstracted from the soil-genetic conceptions and doesn't let to take into account quality of a soil resource. The more general approach, based on bonitet of soil, supposes use of the criterion - the optimal supplies of a soil resource [4] . If to compare its value with the initial supply of a soil resource the three scenarioes of soil conservation protection of the structure of agrolandscapes can be defined.

The increasing of the initial supplies of a soil resource over the optimal value allowes the tolerance to non-balancing (by pedogenesis) of the results of the water-erosive process'es desplay during a controlled period of time. Moreover, with such a scenario the speed of pedogenesis cant be a criterion of the projection against erosion [2] . The average tolerable soil loss ($\Delta D_{er(tol)}$) during the interval of time ($t_1 - t_2$) are calculated according to the following equation:

$$\Delta D_{er(tol)} = d_{t1} - d_{t2} / t_1 - t_2, \qquad (1)$$

where $d_{t1,2,\ldots n}$ - the deepness of a humus horizon on the moment of time $(t_{1,\ldots n})$:

$$d_{tn} = \frac{[(D_h\bar{H})_{opt} - (D_h\bar{H})_{init}](1 - e^{-\beta t_n})}{p\,\bar{H}_{0-10}}, \qquad (2)$$

where $D_h\bar{H}$ with the indexes "opt" and "init" - the optimal and the initial values of a soil resource (product of the deepness of a humus horizon and contents of humus in it); $\bar{H}_{0-10}$ - the contents of humus in a washing layer, %; p - the coeffici ent of exceeding of the contents of humus in a solid discharge comparing with the initial value (fluctuates from 1,2 (leaced chernozem) to 3,2 (irrigated dark-chestnut soil), approximate-

ly forms 1,7); β - parameter, depending on the ecological limits (possibility of gully erosion, rate of silt-filling of water reservoirs, worsening of quality of water). The value $(D_h\bar{H})_{opt}$ is grounded by the discovery of the connection between the bonitet of soil and yield of 15 agricultural crops for some kinds of soil. With such an approach many of the ecological requires to lend tenure, first of all those which are connected with preservation of deepness'es optimum of the fertile layer of soil are realised. The tendency of overstating of the soil loss tolerance, which is displayed now, is connected with inclusion of the rooting depth of soil into the calculations of the whole deepness, which differes from the earlier works, in which the proving was held taking the solum depth A into account.

The soil loss tolerance must be calculated according to the concrete soil characteristics (D_h, H) and the established structure of crop rotation on the concrete periods of time. For example, during the first 10 years with the average values of the initial supply of the soil resource and $\beta = 0{,}005$, the yearly soil losses tolerance (t/ha) will be for typical chernozems 4,7-8,3 (middle-deep), 8,3-12,0 (deep); for ordinary chernozems 7 (deep), 4 (middle-deep), 2,3 (minor soil); near 1 - for southern chernozems.

For the soils with the bonitet, close to the optimum, it is worth while to preserve their fertility, allwing the erosional losses, comparable with the rate of soil formation process.

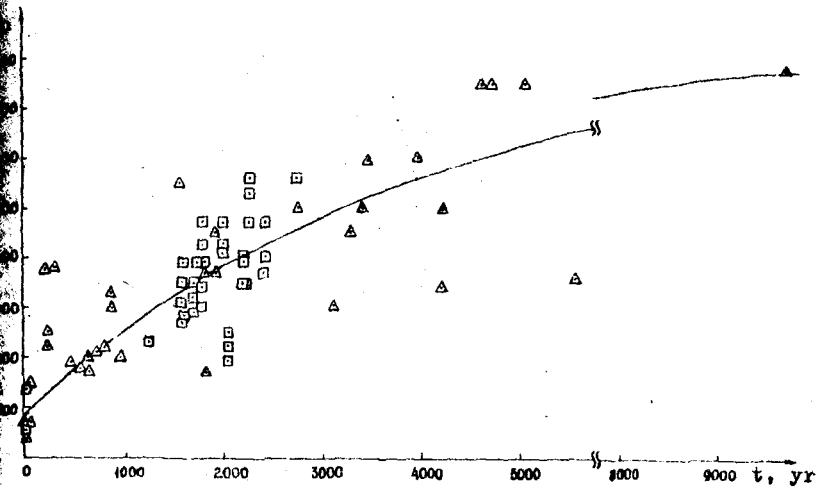
The estimation of the rate of soil formation in the steppe zone in the Nort of the territory near the Black Sea was held according with the earlier descovered general regularity of formation of the humus horizon of the Russian plain's soil's zone types on the rocks of a loamy soil structure [3]. Except the generalization of the literary facts the complex of chronopedological researches on the archaelogical monuments of the age of bronze (XII - XI c. B. C.) and the early iron (Scythian, ancient Greek, Roman, Sarmatian, early Slavonic settlements, defensive ramparts, barrows) was held in the Lower Dniester, Lower South Bug and the Steppe Crimea. The approxi-

mation of the empirical figures (68 definitions), illustrated in the figure, made it possible to get the analitic expression of the dependence of the deepness of the humus horizon (D_h, mm) of the southern chernozems and the dark-chestnut soils on the time of the pedogenesis (t, years):

$$D_h = 850\ (1 - 0{,}905 \cdot e^{-0{,}00024t}). \qquad (3)$$

The dependence of the speed of humus formation from its deepness can be defined from this equation. The traditional way of definition of "soil loss tolerance", which is connected with getting of average estimation of pedogenesis'es speed during the considerable time interval, leads to involuntary negation of the dependence speed of humus horizon formation from its deepness. But soil, being bio-mineral system, has a sufficiently powerful self-regulation mechanism. This causes the necessity in differentiation of pedogenesis'es speeds depending on deepness of humus horizon. With some part of convention, which is connected with the differences in the location, moist regime, receipts of organic substance, such estimations can be got with the help of comparison of the corresponding deepness of eroded, eroded by blowing and different ages' soils' deepness. In particular, for slightly-, moderately- and severely eroded soils of the steppe in the North of the territory near the Black Sea the average speeds of humus horizon formation in natural conditions (with the volume weight 1,2 g/cm^3) can be 0,4, 0,8 and 1,4 tons per hectare per year accordingly.

The got estimations differ considerately from the suggested N. Hudson (1971) rate of soil formation - 0,8 mm per year ≈ 8 t/ha, considered to be the highest limit of the soil loss tolerance for conditions of the USA. Notwithstanding the objections of many of specialists this estimation is likely, because it reflects the time of 1 inch's pedogenesis during 30 years. It is important to illustrate on this example the frequently commited sistematic error, when the speed of pedogenesis, which was got according to the early stages ofsoil specialization's development is carried on the full profile soil or similar to it. That is why "soil loss tolerance", which are



Dependence of humus horizon of chernozem southern and dark chestnut soil's (Dh, mm) deepness of time soil formation (t, year):

⊡ - the facts, given by the author; Δ - literary facts.

Identified with the average speed of humus horizon formation during the whole period of pedogenesis, for slightly eroded soils appear to be overraised an order. The higher speeds of pedogenesis for moderately- and severaly eroded soils reflect the potential opportunity of the quicker reproduction of their resource power under the condition of getting the optative (zonal) quantity of organic substance and the corresponding regime of soils' moist.

Under the conditions of modern intensive agriculture it is difficult to value the speeds of humus horizon formation, which is connected with the conciderable dinamics of agricultural systems, activation of erosions and other reasons. It is obvious that this question can not be solved out of touch with the peculiarities of reproduction of organic substance. Inthe chernozem zone, where the problem of humus state's regulation

is discussed as the provision of sufficient (not managed with the special means) level of the part of humus in the soil for preservation of favourable water-physical, technological and phytosanitary qualities of soil, estimation of cultural pedogenesical process ransits more into the sphere of quantative, but into the sphere of qualitive estimation of soil resources, mainly in bounds of cultivate horizon.

The condition of preservation (at least, for the nearest perspective) of slightly and much part of moderately erosed soils' bonitet can be reached by optimization of factors of management to the values that could provide the simple reproduction of soil resource. Putting the indicated condition on the Shvebs H.I. model [5] and formalising the bonitet as a product of humus stocks on a cultivated horizon ($\bar{H}$) and its deepness (D_h, mm), we'll get the calculated plan of tolerance soil losses:

$$\Delta D_{er(tol)} = \frac{D_h(\Delta\bar{H}_{rec} - \Delta\bar{H}_{min} - \Delta\bar{H}_{ren}) + \bar{H}^{*}\Delta D_f}{p\gamma D_h \bar{H} + \bar{H}_{0-10}}, \quad (4)$$

where $\Delta\bar{H}_{rec}$ - the receipted component of the humification with the help of crop residues and fertilizes, t/ha per year; $\Delta\bar{H}_{min}$ - the mineralizative losses of humus, caused by agricultural carring out of nitrogen, t/ha; $\Delta\bar{H}_{ren}$ - losses of humus as the result of its natural renewation, t/ha; $\bar{H}^{*}$ and $\bar{H}_{0-10}$ - the supplies of humus on the cultivated horizon and a layer 0-10 cm, t/ha; $\bar{H}$ - the contense of humus in the erosing layer of soil, %; γ - the weight by volume layer 0-10 cm, g/cm^3; ΔD_f - the rate of natural soil formation, mm per year; p - the coefficient, reflecting the overraising of humus contense in a solid discharge comparing with the initive value in the erosed layer.

When the values of erosed soil are not big and there are no ecological limitations (untolerant speed of basins' silting, aggravation of water quality, recreative value of a territory, high erosional danger etc.) the problem of their acceptance as of the soil loss tolerance without worsing of the quality of a soil resource can be settled, making calculations and optimizing the conditions according to the equation (4). The phenomena of regulation are the parameters $\Delta\bar{H}_{rec}$ (because of increa-

ng of the part of organic fertilizers and quantity of ground root residues (inter mediate cultures, the bigger height straw's cut, green manure), increasing of importance of crop sidues humification's coefficient, using the nitric fertili-rs, more effective utilization of organic manures, making it biohumus), $\Delta\bar{H}_{min}$ (with the help of optimization of sown eas' structure and planning of crops, $\Delta\bar{H}_{ren}$ (with the help of culcation of minimum soil cultivation).

For the rational utilization of erosed soils the elaboration the scheme is necessary, which will determine the dinamics resoiling measures and their effectiveness. The normative ndexes of widened reestablishment of humus for the conditi-ns, close to natural pedogenesis, were got on the basis of the sults got in the process of mathematical modelation of humus ccumulation. Among the initive facts were more than 400 defi-itions, reflecting the results of many years and long-term (more than 50 years), experiences with organic fertilizers and resoiling crop rotations, the results of studies of young soils n technogenic landscapes, dynamics of humus contense of soils ccording with their age, discovered with the help of radio-car-onic, historical, archaelogical methods. The are used two ap-roaches for the choosing of approximate equation - determina-ional and probabilistic, which showed their uncontradictory. The determinational approach is used on the basis of similarity of curves of humus accumulation dinamics during 2 000 years to the logistical view, used in biology and ecology for description of the dynamics of populations. The distribution of Raley is used in the realization of probabilistic approach. The integral curves of humus accumulation, culculatied according with the equations allowed to estimate the speed limits of humus accu-mulation for the main types (subtypes) of soils. During the first 10 years the norms of humus accumulation's yearly speeds for chernozems of different erosional degree are 0,14-0,16 %, for dark chestnut soils - 0,06-0,09 %. With the humus accumu-lation, the speeds of its increase considerately descend. In the whole the humus accumulation and humus formation processes are synchronously and after the lapse of 500 years the main pe-riod of humus profile formation finishes. The management over a

process of reproducing of a soil resource can be done according with the H.I. Shvebs' equation [5] :

$$\Delta(D_h\bar{H})_t = \left[(D_h\bar{H})_{opt} - (D_h\bar{H})_{init}\right](1 - e^{-\beta t}). \quad (5)$$

The effectiveness of resoiling methods, estimated according to the equation of humus balance must approach to the top speed of humus accumulation, which is reached when the values of the parameter β are 0,029-0,030 for chernozems and chestnut soils. It will give the oppurtunity to explain the optative doses and periodicity in carrying in of organic fertilizers at the cultivated eroded soils and to forecast the time of a soil resource's optative supply's formation under the influence of meadowing, forest improvement and other measures of soil restoration.

The comparison of normatives with the estimations of erosional intensity allows to base the complex of measures, wich have anti-erosion, anti-deflation and soil conservation orientation. But more often it is necessary to transit to more radical arrangement of agrolandscape's structure. Such a problem appeares in the projection of agricultural systems, based on the contour-improvement arrangement's principles. These systems, solving the main problem - the regulation of runoff on slope and erosional losses, create the basis for strengthening of ecological orientation in agriculture. On some stages of projection this is - taking microzonal conditions into account and increasing in productivity because of the full realization of soil-climatic force and possibility of descend in technogenical loads, this is the making of ecological diversity in agrolandscape etc. The new territorial structure of agrolandscape must be organizing basis for the transition from soil-water conservational arrangement of the territiry to the landscape-ecological agriculture, which occupies the whole agricultural districts. It should consist of not only naturally-economic massifs, connected with landscape units of corresponding classes, but also of protected territory, buffer zones, radial ecotone system. Boundaries of anti-erosional (contour) organization's regulations on the arable lands must be joined with the other

lands and the line elements in agrolandscape (forests, pastures, haylands, flood plain meadow, gullies). The transition to the new type of agriculture - landscape contour-improvement - is not only perfection of territorial organization of the land use, but also making of basis for full use of mechanizms of landscape's self-regulation in functioning of naturally-economic systems.

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