DOI https://doi.org/10.30525/978-9934-588-45-7.17

IDENTIFYING A HOT-SPOT AREAS OF WIND SOIL EROSION IN UKRAINE: ZONAL ALLOCATION[1]

Koliada V. P., Timchenko D. O.

INTRODUCTION

Ukraine is a country that located in south-eastern part of Europe and borders with Hungary, Slovakia and Poland in the west, Belarus in the north, Russia in the north and east, Romania and Moldova in the south, Black and Azov Seas in southern part. The total area of the country is 603.700 km^3. The territory of the Ukraine is mostly flat: near 90% of the whole area is plain; the average elevation of the flat area is 170 m. Carpathian Mountains in the West and Crimean in the South occupy near 5% of the country. The country has a continental climate, varying from low continental in the west and northwest to medium continental in the east and southeast. Precipitation amount on the flat part of territory differs from 300 to 350 mm in the south, from 700 to 750 mm in the northwest, over 1 200 mm in the Carpathian Mountains and from 800 to 1 000 in Crimea[2].

During spring-autumn in the Southeast and Southern parts of Ukraine droughts, dry winds (25–30 days per year), and dust storms (3–8 days per year) sometimes occur. The duration of dust storms varies from a few minutes to a few days. Even in Polissya (Forest Area), the most part of which covered by forests and shrubbery and where portion of cultivated lands is relatively small, raising dust from dry turfs take place even with such wind velocity as 2–3 m/s[3]. Dust emission by wind erosion is the largest source of aerosols, which directly or indirectly influences the atmospheric radiation balance and hence global climatic variations[4].

Approximately 70% of Ukraine occupied by agricultural lands, most of them involved in extensive technologies of agriculture production systems.

[1] Both authors would like to express deep and sincere gratitude to their research supervisors and other outstanding wind erosion specialists, doctors and academics – Bocharov A.P., Shiyatyi E.I., Lavrovskyi A.B., Dolgilevich M.J., Bulygin S.J., Chornyi S.G. and many others for the opportunity to do joint research and provide invaluable results. Their dynamism, vision, sincerity and motivation have deeply inspired authors. It was a great privilege and honor to work and study a wind erosion in Ukraine with them or under their guidance.

[2] Bulygin S. Part 1. 16 Ukraine. *Soil Erosion in Europe* / ed. by J. Boardman and J. Poesen. Chichester : John Wiley and Sons Ltd, 2006. P. 199–204.

[3] Трускавецький Р.С. Торфові ґрунти і торфовища України. Харків : Міськдрук, 2010. 278 с.

[4] Shao Y. Physics and Modelling of Wind Erosion. *Atmospheric and Oceanographic Sciences Library.* Dordrecht : Kluwer Academic Press, 2000. Vol. 23. 393 p.

Climate changes provoke dust storms even in regions with "low" soil erosion risk status before. In both cases appears vivid need to control erosion or prevent it in the beginning, optimize agricultural activity and improve conditions for the preservation and renewal of soil. This studying gives general view on wind erosion damage done to environment and ways of decision according to experimental data obtained from comparison between three different geographical zones of Ukraine. There are south-eastern region – "Steppe" with annual, wide-spread dynamic; central part "Forest-Steppe" and north-west part of region "Polissya" – with some local centres appeared once per 2–3 years. The complexity of such studies as Ukraine soils susceptibility to wind erosion are zonal features of soil differences in different geographical climatic zones and, as a consequence – differentiation of the conditions of their genesis and the properties obtained. For example, in order to qualitatively identify one of the key indicators of soil erosion preventive stability, their connectivity is advisable to separate different model equations for Polissya, Forest-Steppe, Steppe and to determine different constituents of mineral and organic soils.

Aim we planned to achieve – complex of conceptual-functional data with criteria of deflated soils estimation and diagnostic due to climatologic characteristics. Database of the main parameters determining wind erosion appearance were developed. Investigations included influence of climatic factors, identification of main soil indices, technological particularities, perspectives of RWEQ[5], WEELS[6] and WEPS[7] models. The results and methods of researches are verified in laboratory conditions (modelling, chemical and physical tests) and during the field experiments. Received information would be useful support as for scientific institutions so for land-owners and soil protecting governmental or public organizations. Land restoration is common task of humankind and we would be grateful for any source of collaboration in search of new experience, comments and proposals on such outstanding event in soil science.

The main purpose of the work is to determine quantitative indices reflecting potential soil loss in Ukraine and present a hot-spots territory database for zonal allocation according to the levels of wind erosion susceptibility and frequency of dust storms appearance. Our investigations included morphological description of soil profiles, determination of mechanical strenght values, main physical and chemical properties of topsoil vulnerable to erosion process. The following parameters were determined:

[5] Validation of the wind erosion stochastic simulator (WESS) and the revised wind erosion equation (RWEQ) for single events. / R.S. Van Pelt, T.M. Zobeck, K.N. Potter, J.E. Stout, T.W. Popham. *Environmental modelling & Software*. 2004. № 19. P. 191–198.

[6] The WEELS model: methods, results and limitations / J. Boehner, W. Schafer, O. Conrad, J. Gross, A. Ringeler. *CATENA.* 2003. Vol. 52. P. 289–308.

[7] Wagner L.E. An overview of the WEPS (Wind Erosion Prediction System). *Proceeedings of International Conference on Air Pollution from Agriculture operations, Kansas City, MO, 7–9 February, 1996*. Kansas City, 1996. P. 73–78.

toughness, mean diameter of soil particles, pH of saline extract, hydrolytic acidity, total humus content, number of primary soil particles, cation exchange, density and other. The investigations were conducted by route method using the data from permanent experiments of regional research institutions (Lutsk Research Station in Polissya and Donetsk Research Station in Steppe). The climatic index has been calculated for the descriptions of the area ability to cause erosion process[8]. Evaporation value should be determined for every month separately. The following data on long term observation were taken into consideration: average monthly wind velocity, average monthly air humidity, precipitation amount and air temperature[9].

1. Zonal aspects of soils protection from wind erosion

The calculation of the potential soil loss from wind erosion have been based on the soil map of Ukraine at a scale of 1: 750 000 allowed us to arrange zoning of the most erosion-hazardous territory of Ukraine (Steppe and Forest) by the intensity of wind erosion processes. Received material shows that excluding Steppe districts the main part of Forest (Polissya) except belongs to the regions with an average potential wind hazard in which the values of combined climatic index varies from 0.1 to 0.5. Whole information about physico-geographical areas of Ukraine shown below (Figure 1).

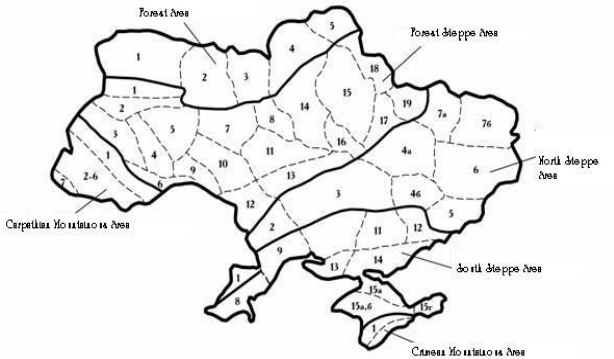

Figure 1. Physico-geographical areas of Ukraine. Zones, subzones, regions and provinces

[8] Chepil W.S., Siddoway F.N., Armbrust D.V. Climatic index of wind erosion conditions of the Great Plain. *Soil.Sci.Am.Proc.* 1963. V. 27. P. 499.

[9] Timchenko D.O. Danger of soils wind erosion in Ukrainian Polesie (Forest Zone). *Collection of Papers by Ukrainian Members of ESSC (Europe Society for Soil Conservation).* 1997. Vol. 3. P. 31–36.

The main soil types chemical and agrophysical parameters such as humus content, soil toughness and density, hydrolytic acidity, the reaction of the soil solution and others according to their geo-zonal location in Ukraine presented below in Table 1.

After detailed studies for the Forest (Polissya) zone, zonal allocation includes:

Table 1

The main parameters of soils according to their geo-zonal location[10]

Soil type	pH	Cation exchange, Mgeq*100g^{-1}	Hydrolytic acidity, Mgeq*100g^{-1}	Base-saturated degree, %	Humus, %	Toughness g*sm^{-3}	Density, g*sm^{-3}
Forest (Polissya)							
Turf-podzol soil	6.3	4.4	2.3	75	1.3	1.5	2.6
Turf soil	5.7	3.3	2.0	62	2.2	1.5	2.6
Forest Steppe							
Light grey soil	5.1	16.5	3.2	81	4.2	1.3	2.6
Grey soil	4.5	20.0	3.5	85	2.0	1.4	2.7
Dark grey soil	7.0	31.5	3.9	89	7.3	1.1	2.6
Podzol chernozem	7.0	22.3	3.3	88	5.2	1.2	2.6
Typical chernozem	7.0	36.3	0.7	98	5.5	1.2	2.6
Steppe							
Common chernozem	7.2	37.1	1.1	97	5.0	1.2	2.7
South chernozem	6.9	36.4	1.6	96	3.6	1.0	2.6
Chestnut soil	7.4	26.5	1.8	95	3.4	1.2	2.6

1. East Polissya area – includes most of Chernihivska and Sumska regions, characterized by generally weak and medium intensity of wind erosion occurrence.

2. North of Central Polissya area – includes the eastern part of the Chernihivska region, the north of the Ivankivsky and Polisskyi districts of Kyivska region, the north of Narodytskyi, Ovrutskyi, Luginskyi and Olevskyi districts of Zhytomyrska region. They are characterized mainly by medium and strong intensity of wind erosion occurrence.

3. South of central Polissya area – includes area from Kyivskyi region in the east to the border of the Forest-Steppe in the west and characterized by weak and moderate intensity of wind erosion.

[10] Polupan N.I. Soils of the Ukraine. Kiev, 1988. Vol. 1. P. 29–43.

4. “Ovruch” loess area – includes the center of Ovrutskyi and Narodytskyi districts of Zhytomyrska region is characterized by weak and medium intensity of wind erosion.

5. “Sarny” erosion area – extending from the villages Rakytne and Berezne on the east of the border between Zarichnenskyi district of Rivnenska region and Manevytskyi district of Volhynska region. It is distinguished by the predominance of strong, very strong and catastrophic intensity of wind erosion.

6. Western Volhyn – area with a characteristic of weak and medium intensity of wind erosion with the exception of drained peat lands with a very dangerous intensity of wind erosion occurrence.

7. “Small Polissya” area, that consisting of three subareas: Eastern – with medium occurrence, Central – from catastrophic to very weak, Western – with low and medium intensity of wind erosion occurrence, which is explained by the location in the foothills of the Carpathians, which also causes a certain tendency to the wind soil erosion.

Some other smaller areas of Kyivska, Chernigivska, Zhytomyrska regions are having higher climatic indices and in Lvivska and Rivnenska regions this index even reaches 2.5. At the same time, southern part of Polissya can be characterized by moderate and weak potential hazard. Thus, Polissya has rather high climatic potential that provides very widespread and intensive manifestations of the wind erosion processes. But wind erosion in Western and Central Polissya has distinctive feature. It is determined by north-western and western winds and takes place on the soils which are not covered by vegetation. In general, the processes of wind erosion in Volhyn prevail over water erosion, with the exception of the Ovrutskyi district of Zhytomyrska region, as well as the area of plateau “Prydesnyanske” of the East Polissya, where the prevalence of water erosion is recorded.

Mentioned earlier Polissya soil features causes sharp decrease of critical wind speed values in the region down to 6–7 m/s (compare to 9–11 m/s at Forest-Steppe zone and 10–12 m/s at Steppe zone[11].

Hence, we still have relatively high potential for the wind erosion in the region. The soils belonging to Forest-Steppe zone stay apart from others. Their aggregates much less destructive then ones of zonal forest soils types. Even if light grey and grey soils are more destructive than the aggregates of Steppe zonal soils, summary conditions of main agricultural indices from greater amount of dark grey and chernozem soils make this zone more resistent to wind erosion.

Taking into account the area of Steppe area of Ukraine, we found that wind deflation processes occur at intervals of 3–7 years with coverage of

[11] Kolyada V.P. Wind Soil Erosion in Ukraine: Prediction and Control. *8th International Soil Science Congress on “Land Degradation and Challenges in Sustainable Soil Management”* : Proceedings Book (May 15–17, 2012, Izmir, Turkey). Izmir, 2012. P. 159–162.

large territories, and in the conditions of Chernihivskyi and Bilmatskyi districts of Zaporizhska region they occur almost every year, but locally within one – several fields.

The annual wind erosion manifestations take place in south-eastern and eastern districts of Ukraine and cover the territory up to 5 mln ha, which are the main districts of grain crops production[12].

According to average annual data, wind erosion processes appears once per 1.5–2.0 years period as dust storms, local processes as mentioned earlier – appear annually (Figure 2).

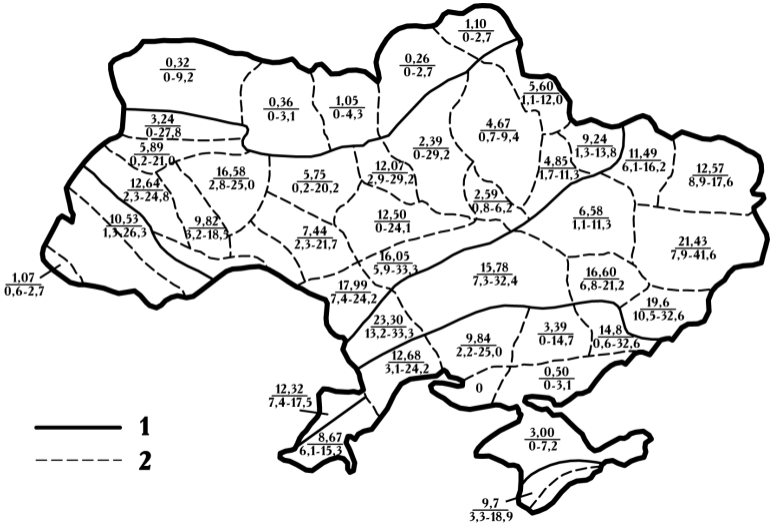

Figure 2. Percentage of medium and high eroded soils in Ukraine with borders of *1* – physico-geographical zones and *2* – local regions and provinces (above – average area index, below – ratio between min and max local indices)

High frequency of dust storms (at the level of 1 fixation in every 1–3 years) in the Steppe of Ukraine is observed along two narrow geographical stripes of settlements.

1. The first one – from the Boikivske village in Donetska region, through the villages of Bilmak, Chernihivka and the city of Melitopol in

[12] Dolgilevich M.J. Extent and severity of wind erosion in Ukraine. *Proc. of International Symposium Commemorating the 50th Anniversary of USDA-ARS Wind Erosion Research.* Manhattan, Kansas, USA, 3–5 June, 1997. P. 1–6.

Zaporizhska region, and then through the village of Ivanivka and the cities of Kakhovka and Gola Prystan, which is in Khersonska region.

1. The second one – from city of Lugansk through the city of Dobropillya of Donetska and then to the town of Sinelnikove, Dnipropetrovska regions. Studies of previous years indicate a gradual decrease in the frequency of dust storms north and south of these bands.

Wind velocity during dust storms reaches 21–26 meters per second or more. Potential soil loss caused by wind erosion ranges from 64 t/ha in Crimea up to 890 t/ha in Near-Azov Lowland while wind velocity has 20% probability of its maximum value exceeds (Figure 3).

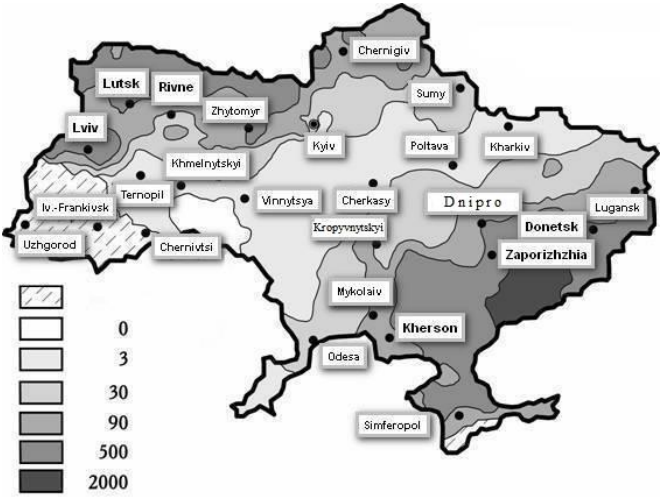

Figure 3. Possible soil loss from wind erosion on Ukraine plain lands, (t / ha per year)

2. Identification of geographical regions

Global climate change increases the role and share of soil deflation in degradation processes. This fact requires intensification of efforts by both land users and, above all, scientists to reduce the impact of this negative phenomenon. The most promising starting point – is the modelling of the wind impact on the land territory, taking into account the updated state of forest strips, changes in the structure of agricultural land, acreage and agricultural technologies. The main indicators used in this case can be divided into three equal groups: climate, soil and economic.

Climate indicators include: wind direction, speed and duration, duration and frequency of dust storms. The wind speed is determined by

meteorological data and calculated by calculating the average maximum speed of 20% security. Other indicators are determined from at least 30 years of observations. Soil parameters included: lumpiness of the surface layer of soil for erosion-hazardous period; soil aggregate connectivity (the magnitude of the inverse of the fracture coefficient and obtained as a percentage of the unit). Economic indicators include: the structure of acreage; type and distribution of crops by area of land; soil tillage systems; the ratio of land, their configuration and area; presence and condition of forest strips, their location.

Attempts to assess soil susceptibility to wind erosion based on the above indicators have been going on in Ukraine for quite some time and are divided into three scientific areas:

1) quantitative and qualitative assessment of the potential danger (susceptibility) of soil to wind erosion, taking into account averaged climatic indicators and the main soil indicators – lumpiness and connectivity of soil aggregates;

2) detection of cyclic conditionality of the occurrence of dust storms in Ukraine and forecast of their possible manifestation according to the long-term forecast of climate and weather changes;

3) forecast of possible soil losses due to the soil-climatic and economic conditions.

The first direction provides an opportunity to identify and clarify the main indicators that influence the dynamics of occurrence and intensity of manifestation of wind erosion processes in specific regions. However, there are not enough specific indicators of soil loss that would allow planning the design of anti-erosion complexes.

The second area of research is aimed at studying the atmospheric phenomena that lead to the manifestation of wind erosion. It is established that the occurrence of dust storms is related to the cyclic activity of the sun, but the methodological base is not well developed and due to the influence of other celestial bodies it is difficult to ensure the accuracy of the forecast.

The third area of application of methods for determining soil erosion in active experiments with aerodynamic installations of different design has allowed to obtain the values of loss of certain types of soil at well-regulated wind speeds and other parameters. Further development of research in this area included the creation of numerous mathematical and empirical models of wind erosion for different regions of Ukraine.

In our study, for zonal allocation of Ukraine territory according to different erosion areas, we took into account the wind regime, the amount of precipitation and its evaporation, the properties of the soil cover and the nature of agricultural use.

To determine the climatic indicator of the potential danger of wind erosion, the dependence of the transported amount of the blown material according to the wind speed was used and is inversely proportional to the

parameter of the effective humidity[13]. The data obtained were approximated through the gradation for the most probable erosion periods in winter and spring according to the following scales: from the very high risk of wind erosion to its absence for the spring and for the winter periods; from the very frequent appearance of dust storms to their total absence.

The number of days with winds of more than 15 m/s, the maximum number of days with dust storms, the climatic indicator of wind erosion potential danger according to W. Chepil were also taken into account, including the calculation of long-term observations of weather stations by the amount of precipitation and their evaporation[14]. The main indicators of the obtained climatic regions were:

1. Compliance with wind erosion for two periods January-March and April-May.
2. The frequency of appearances of dust storms in days by periods.
3. Geomorphological and soil features of the area.

The grouping of erosion areas by the frequency of dust storms (the maximum number of days) included the following gradations: more than ten days – very often, from five to ten – often, from three to five – medium, from one to three – rarely, not a single day – absence. In the text below are listed regions with different risk of soil wind erosion according to the susceptibility to wind erosion, frequency of appearance of dust storms, relief bias of territory and location, soils types.

First erosion region – East "Donbass".

The susceptibility to wind erosion in winter – weak, in spring – strong. The frequency of appearance of dust storms: in winter – often, in spring – very often. Located in the eastern part of the Donetsk Ridge, of the rivers Siverskyi Donets' and Lugan' valleys. The area is strongly dissected by relief. General bias to the east, northeast and south.

Soils: gravell chernozems on the eluvia of dense non-carbonate parent material, chernozems ordinary with eroded medium and low humus content on loesses. In the rivers valleys are soddy-sand and clay-sand soils.

Second erosion region – South "Donbass".

The susceptibility to wind erosion in winter – medium, in spring – strong. The frequency of appearance of dust storms: often in winter, often in spring. It is located in the south-eastern and southern parts of the Donetsk Ridge, on its western offshoots and the eastern part of the "Priazovska" Lowland. The area is strongly dissected by relief. General bias to the south and southwest. Soils: chernozems ordinary with low humus content on loess

[13] Можейко Г.А. Лесо-аграрные ландшафты Южной и Сухой Степи Украины (природа и конструирование). Харьков : Эней, 2000. 312 с.

[14] Bulygin S.Y., Kotova M.M. Soil erosion in Ukraine, quantitative estimation and perspectives of soil erosion reduction. *Collection of Papers by Ukrainian Members of ESSC.* 1997. Vol. 3. P. 12–22.

parent material. Chernozems and soddy gravel soils are found in places on the eluvia of dense non-carbonate parent material (Kalmius-river valley).

Third erosion region – "Priazovs'ka" Upland and Lowland.

The susceptibility to wind erosion in winter – medium, in spring – medium. The frequency of appearance of dust storms: in winter – often, in spring – very often. It includes a ridge (hilly formation) along the lines of Tokmak, Chernihivka, Bilmak villages and general bias along its sides to the north and south. The central and northern parts have a developed relief, the southern part is more flat. Soils: in the northern part – chernozems ordinary with low humus medium and low dense, often carbonate; in the southern part – south chernozems low humus and low humus on loesse parent material; in the south-western part – dark-chestnut partially saline, chestnut solonetz in combination with solonetz on forest clay and loamy parent material.

Fourth erosion region – Black Sea Lowland.

The susceptibility to wind erosion in winter – strong, in spring – strong. The frequency of appearance of dust storms: in winter – often, in spring – very often.

Lowland plain with a general weak biase to the south. It is cut by shallow valleys in the lower parts of flow for such rivers as Dnipro, Ingulets', Ingul, Molochna and Pivdennyi Bug. It includes a subarea with "Oleshkivsky" sands, which are characterized by a very high risk of wind erosion during all periods of the year. Soils: in the northern part – south chernozems with low or even less humus content, in the south – south chernozems partialy saline in the complex with salt marshes on loess parent material. On the left bank of the Dnipro River from Kakhovka to the southwest there are soddy sand and sandy soils in combination with a sands of low humus content.

Fifth erosion region – Transnistria.

The susceptibility to wind erosion in winter – medium, in spring – medium. The frequency of appearance of dust storms: in winter – medium, in spring – often. It is a lowland plain with a general weak bias to the southwest. It is notable for its location in the southern part of a large number of estuaries and lakes. Soils: in northern and north-western part – chonozems ordinary low and medium humus tense and chernozems ordinary with low humus content micellar-carbonate and heavy loam. In the south and in the south-eastern part – the south chonozem with low humus and low humus micellar-carbonate medium and heavy loam.

Sixth erosion region – North-Western part of Crimea.

The susceptibility to wind erosion in winter – strong, in spring – medium. The frequency of appearance of dust storms: in winter – often, in spring – very often. It is located in the north-western part of the Sivash Lowland, the western part of the flat Steppe and the Tarhankut plateau with a general bias to the north and east. Soils: in the northern part – dark chestnut soils partialy saline on loess parent material. In the center are south

chernozems with low humus content on loesses, chernozems and soddy carbonate soils on carbonate parent material. In the south-eastern part – chernozems on heavy clays in combination with chernozems on the eluvia of carbonate parent material.

Seventh erosion region – East Crimea.

The susceptibility to wind erosion in winter – strong, in spring – medium. The frequency of appearance of dust storms: in winter – medium, in spring – often. The territory of the e covers the entire Kerch Peninsula and the south-eastern part of the foothills in the rerosion region includes cities Sudak, Feodosia and Kirovsk. A plain area with a developed relief. Soils: chernozems partially saline on heavy clays in combination with dark chestnut salined soils and solonetz soils (Kerch Peninsula); dark chestnut and south chernozems salined clayey on loess parent material (on ridges), brown mountain forest soils and brown soddy meadow soils (foothills).

Eighth erosion region – Krivorizhs'kyi.

The susceptibility to wind erosion in winter – medium, in spring – strong. The frequency of appearance of dust storms: rarely in winter, often in spring. This area includes offshoots of the Dnipro-River Upland with a general bias to the south and southeast. The relief is well defined. Soils: chernozems ordinary with low and medium humus content and south chernozems with low humus content clay and heavy loam on loess parent material.

Ninth erosion region – North-West "Donbas".

The susceptibility to wind erosion in winter – weak, in spring – weak. The frequency of appearance of dust storms: rarely in winter, often in spring. The elevated area, which includes the central and north-western parts of the Donetsk Ridge. The relief is well developed and has a general bias to the northwest. Soils: chernozems ordinary with medium humus content clay. On the second terrace of the Siverskyi Donets' river – soddy slightly podzolic sandy in combination with soddy sandy and sandy soils.

Tenth erosion region – Left-Bank Lowland Steppe.

The susceptibility to wind erosion in winter – weak, in spring – weak. Frequency of appearance of dust storms: rarely in winter, often in spring. The area includes the northern Lowland Steppe with a well-defined relief and a slight bias to the south. Soils: chernozems ordinary slightly tense with medium humus clay and heavy loam, meadow salty and sod sandy loam soils in the valleys of Samara and Orel rivers.

Eleventh erosion region – Dnieper Steppe.

The susceptibility to wind erosion in winter – weak, in spring – weak. The frequency of appearance of dust storms: in winter – medium, in spring – often. The region covers the Central Dnieper and the north-western part of the Azov Lowland and the biggest northern part of Black Sea Lowland. The relief is well defined, especially in the northern part of the region. Soils: in the northern part – chernozems ordinary heavy-loamy with low-humus content, meadow

chernozems deeply saline, meadow saline, light and medium-clay and soddy sandy loamy. Soddy clayey sandy and clayey sandy in the Dnieper valley. In the south, the southern chernozems with low humus content, often in combination with chernozem-meadow salined and silted clayey soils.

Twelfth erosion region – Right-Bank Northern Steppe.

The susceptibility to wind erosion in winter– weak, in spring – weak. The frequency of appearance of dust storms: rarely in winter, often in spring. The area is located on the south-eastern offshoots of the Dnieper and Volhyn Uplands. The relief is dissected with a general bias to the southeast. Soils: in the northern part – chernozems ordinary mostly tense with small and medium humus content, chernozems ordinary with medium humus content heavy loam and clayey. In the southern part there are chernozems ordinary with low-humus content clayey and heavy-loamy.

Thirteenth Erosion region – Western Foothills and Steppe Crimea.

The susceptibility to wind erosion in winter is weak, in spring – weak. The frequency of appearance of dust storms: often in winter, often in spring. The district occupies a narrow strip that runs from north to southwest through the whole of Crimea Peninsula and covers part of the Sivash Lowland, Central Steppe, part of Crimean Foothills and a small area adjacent to the Kerch Peninsula. Soils: in the north – dark-chestnut salined in combination with chestnut salined and solonetz, southern chernozems with low and medium humus content clayey. In the center – chernozems clayey on carbonate parent material, in the south – brown mountain gravels in combination with soddy carbonate soils.

Fourteenth erosion region – Eastern Northern Steppe.

The susceptibility to wind erosion in winter – absent, in spring – absent. The frequency of appearance of dust storms: in winter – none, in spring – rarely. The area covers a plain lowland with a dense hydrographic network and developed relief.

Soils: chernozems ordinary tense with medium humus content, chernozems ordinary clayey with medium and low humus content. On the second terrace of the Sivers'kyi Donets' river – soddy-slightly podzolic in combination with soddy sandy and mostly sandy soils.

Fifteenth Erosion region – Southern offshoots of Central Russian Upland.

The susceptibility to wind erosion in winter – is absent, in spring – is absent. The frequency of appearance of dust storms: in winter – none, in spring – rarely. The area includes the southern part of the offshoots of Central Russian Upland in Forest-Steppe. It is strongly dissected by ravines and gullies, has a general bias to the southwest. Soils: chernozems typical deep heavy loamy, dark gray podzolized soils, chernozems podzolized medium and heavy loamy.

Sixteenth Erosion region – Crimean Mountains and Salgir-river valley.

The susceptibility to wind erosion in winter – no erosion, in spring – no erosion. The frequency of dust storms appearance: in winter – medium, in spring – often. The area stretches with a strip from south to northeast of the Crimean Peninsula. The total surface cover tilted to the north. In the central and northern parts there is a plain lowland, in the south – mountains and foothills. Soils: chestnut salined in combination with solonetz, dark chestnut salined, meadow-chernozem in complex with meadow salined, south chernozems residual salined, chernozems southern with low humus content, chernozem and soddy carbonate soilson elluvia of carbonate parent material and meadow mountain clayey soils.

Seventeenth erosion region – Southern offshoots of Dnieper-river and Volhyn Uplands.

The susceptibility to wind erosion in winter – no erosion, in spring – no erosion. The frequency of dust storms appearance: in winter – no, in spring – rarely. The area is located within the Southern Right-Bank Forest-Steppe with a well-defined relief and a general bias to the south. Soils: chernosems regraded in combination with chernozems tense heavy-gravelly with small and medium humus content, chernozems podzolised heavy loamy.

In 2019 at the UN Food and Agriculture Organization (FAO) headquarters in Rome, a World Symposium on Soil Erosion was held, which stated the prospects and intensification of research aimed at creating a global world map and wind erosion of soils. In view of this, it seems appropriate to harmonize regional and national methodologies and instruments for the study of wind erosion processes with a unified UN toolkit, in order to develop sharing as a powerful basis for further research. Technical support for countries to increase their capacity to collect, process and simulate soil erosion is also announced[15]. This publication is a part of initial attempts to arrange a set of national soil susceptibility maps to wind erosion and may be developed using a set of data to identify hot spots. Such maps, according to FAO experts, will study the spatial structure of potential sensitivity to soil erosion worldwide, identifying possible hot spots and allowing comparisons between different geographical areas. National soil susceptibility maps to wind erosion should be developed using a set of data that will be used to identify hot spots. Such maps, according to FAO experts, will study the spatial structure of potential sensitivity to soil erosion worldwide, identifying possible hot spots and allowing comparisons between different geographical areas.

CONCLUSIONS

Degradation processes of wind erosion are in process as for Steppe, so for Forest regions in spite of vivid interest of scientists and landowners to

[15] Outcome document of the Global Symposium on Soil Erosion. Rome: FAO, 2019. 20 p.

control or reduce them. The soil protecting techniques have trivial results by the reason of local or rare character, therefore their positive effect is only expected in future with proper scientific approaches such as interactive maps with presented location of erosion regions. For the prevention of erosion that based on an actual soil erosion data, the main efforts should be made in regions with highly eroded soil surface (Steppe Area). In regions with moderate erosion (Forest Area) further intensification of agriculture works is planned. In such an approach, actual erosion frequently does not coincide with the potential danger of the wind erosion spreading dynamic.

SUMMARY

In materials presented an authors general view on wind erosion damage done to environment according to experimental data obtained from comparison between different geographical zones of Ukraine south-eastern region – "Steppe", central part "Forest-Steppe" and north-west part of forest region "Polissya". The complexity Ukraine soils susceptibility to wind erosion and zonal features of different geographical climatic zones on example of 17 erosion regions were determined. A set of quantitative climatic indices reflecting potential wind erosion in Ukraine present a hot-spots territory database for zonal allocation according to the levels of territories susceptibility and frequency of dust storms appearance.

REFERENCES

1. Bulygin S. Part 1. 16 Ukraine. *Soil Erosion in Europe*" / ed. by J. Boardman and J. Poesen. Chichester : John Wiley and Sons Ltd, 2006. P. 199–204.

2. Трускавецький Р.С. Торфові ґрунти і торфовища України. Харків : Міськдрук, 2010. 278 с.

3. Shao Y. Physics and Modelling of Wind Erosion. *Atmospheric and Oceanographic Sciences Library*. Dordrecht : Kluwer Academic Press, 2000. Vol. 23. 393 p.

4. Validation of the wind erosion stochastic simulator (WESS) and the revised wind erosion equation (RWEQ) for single events. / R.S. Van Pelt, T.M. Zobeck, K.N. Potter, J.E. Stout, T.W. Popham. *Environmental modelling & Software*. 2004. № 19. P. 191–198.

5. The WEELS model: methods, results and limitations / J. Boehner, W. Schafer, O. Conrad, J. Gross, A. Ringeler. *CATENA*. 2003. Vol. 52. P. 289–308.

6. Wagner L.E. An overview of the WEPS (Wind Erosion Prediction System). *Proceedings of International Conference on Air Pollution from Agriculture operations, Kansas City, MO, 7–9 February, 1996.* Kansas City, 1996. P. 73–78.

7. Chepil W.S., Siddoway F.N., Armbrust D.V. Climatic index of wind erosion conditions of the Great Plain. *Soil.Sci.Am.Proc*. 1963. V. 27. P. 499.

8. Timchenko D.O. Danger of soils wind erosion in Ukrainian Polesie (Forest Zone). *Collection of Papers by Ukrainian Members of ESSC (Europe Society for Soil Conservation).* 1997. Vol. 3. P. 31–36.

9. Polupan N.I. Soils of the Ukraine. Kiev, 1988. Vol. 1. P. 29–43.

10. Kolyada V.P. Wind Soil Erosion in Ukraine: Prediction and Control / *8th International Soil Science Congress on "Land Degradation and Challenges in Sustainable Soil Management"* : Proceedings Book (May 15–17, 2012, Izmir, Turkey). Izmir, 2012. P. 159–162.

11. Dolgilevich M.J. Extent and severity of wind erosion in Ukraine. *Proc. of International Symposium Commemorating the 50th Anniversary of USDA-ARS Wind Erosion Research. Manhattan, Kansas, USA, 3–5 June, 1997.* P. 1–6.

12. Можейко Г.А. Лесо-аграрные ландшафты Южной и Сухой Степи Украины (природа и конструирование). Харьков : Эней, 2000. 312 с.

13. Bulygin S.Y., Kotova M.M. Soil erosion in Ukraine, quantitative estimation and perspectives of soil erosion reduction. *Collection of Papers by Ukrainian Members of ESSC.* 1997. Vol. 3. P. 12–22.

14. Outcome document of the Global Symposium on Soil Erosion. Rome : FAO, 2019. 20 p.

Information about authors:
Koliada V. P.,
Candidate of Agricultural Sciences, Part-time Docent,
Department of Soil Sciences and Forestry
Lugansk National Agrarian University,
Head of Soil Erosion Control Laboratory,
National Scientific Center "Institute for soil science and agrochemistry research named after O. N. Sokolovsky"
4, Chaikovska str., Kharkiv, 61024, Ukraine

Timchenko D. O.,
Candidate of Agricultural Sciences, Senior Researcher (on pension)