

## STUDY OF URBAN SOILS SALINITY ON THE EXAMPLE OF THE CENTRAL PART OF С. KREMENCHUK

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Studies the process of soil salinization in the central part of с. Kremenchuk as a result of application of sand and salt mix to combat ice covering. The degree of salinity of the soil was determined by the solid remaining in the soil extract. The selection of soil samples occurred three times: after the first and second appliance of sand and salt mix and in spring. Studies have shown that in winter the content of dry residue in soil extract increases in the soil of the studied area. Its maximum value ranges from 0,23% (Pershotravneva street) to 0,25% (Lenina and Proletars'ka streets) that exceeds the background values in 3,3 and 3,6 times, respectively. The results showed that in spring the desalinization process takes place in the soils of the studied area. The factors that determine intensity of salinization-desalinization, including climate, soil characteristics and so on were considered. Recommendations to prevent salinization of urban soils have been offered.

**Keywords:** sand and salt mix, soil salinization, desalinization.

## ДОСЛІДЖЕННЯ ПРОЦЕСУ ЗАСОЛЕННЯ МІСЬКИХ ҐРУНТІВ НА ПРИКЛАДІ ЦЕНТРАЛЬНОЇ ЧАСТИНИ М. КРЕМЕНЧУК

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Досліджувався процес засолення ґрунту центральної частини м. Кременчук внаслідок застосування піщано-сольової суміші для боротьби з ожеледдю. Ступінь засолення ґрунту визначався за вмістом сухого залишку у ґрунтовій витяжці. Відбір ґрунтових зразків відбувався тричі: після першого і другого використання піщано-сольової суміші і весною. Дослідження показали, що у зимовий період у ґрунтах району дослідження збільшується вміст сухого залишку у ґрунтовій витяжці. Його максимальні показники коливаються від 0,23 % (вулиця Першотравнева) до 0,25 % (вулиці імені Леніна і Пролетарська), що перевищує фонові величини у 3,3 і 3,6 рази відповідно. Результати роботи показали, що у весняний період у ґрунтах району дослідження відбувається процес розсолення. Розглянуто чинники, що визначають інтенсивність процесів засолення-розсолення, у тому числі кліматичні умови, властивості ґрунту тощо. Запропоновано рекомендації щодо запобігання процесу засолення міських ґрунтів.

**Ключові слова:** піщано-сольова суміш, ґрунт, засолення, розсолення.

**RELEVANCE OF WORK.** Urban systems development is accompanied by negative changes in natural ingredients, including soils. They are contaminated by wastages, heavy metals, organic compounds. Their redox potential, water and air characteristics are being changed, acid-base balance is being violated, soil profile and soil structure are being destroyed and degree of its mineralization increases too.

The main reason for the accumulation of soluble salts in urban soils is the use of sand and salt mix as a tool against the ice covering in winter, which has been used for many years by road maintenance services. Influence of mix is combined. Salt in its structure facilitates ice and snow rolling melting and simplifies cleaning of the roadway. Sand makes a road surface rough and provides adhesion of the tires to the road surface before the salt melts snow or ice, reducing injuries and accidents on the roads.

Sand and salt mix is effective and inexpensive, but has some restrictions on use. In the state of solvent salt corrodes shoes, spoils roads' cover, cars' tires, has a negative impact on soil microflora, thus hampers the process of soil formation. Intensive removal of salts from soil can cause contamination of natural waters by salts, which also leads to negative consequences.

The presence of soluble salts creates unfavorable conditions for city vegetation, inhibiting its activity. Soil containing more than 1% of the soluble salts is a saline, where rare plants survive [1]. Because the sand and salt mix includes kitchen salt, hence we can talk about the prevalence of chloride type of salinity – the most harmful to plants. This fact is considered very important because the city vegetation performs important functions: filtering, microclimate, environmental and aesthetic. In this regard, the study of the ecological condition of the soil, including its mineralization is relevant and has a great social significance.

The issue of soil salinity has been previously examined; the causes of the phenomenon, the possible impacts on soils, natural water, flora and fauna have been analyzed [2]. For specific areas have been considered factors including landscapes, which determine the degree of salinization of agricultural soils [3]. Salinization of urban soils hasn't been studied enough yet, so most cities in Ukraine, including Kremenchuk, have not been covered by similar study.

*The aim of the proposed work* is to study the process of roadside strips soil salinization downtown Kremenchuk under sand and salt mix influence, analyze the factors that determine the level and

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recommend alternative ways of dealing with ice covering.

**MATERIAL AND RESULTS OF RESEARCH.** Research object is edaphic component of urboecosystem of Kremenchuk central part – city of regional subordination, district center of Poltava region with a population of 225,000 inhabitants. The city center was elected for research, which is in the highest degree suffers from the effects of sand and salt mix.

Traditional sand-salt mix is a river or open-cast sand, mixed with technical salt (sodium chloride) in a certain proportion. Most sand and salt mix comprises two parts (66%) of sand and one part (33%) of sodium chloride. Sometimes sand and salt mix is made using calcium chloride or bishofit.

Cleaning the coating layer of snow and ice cover or ice rolling in Kremenchuk is done in the further way. First layer is treated with crystalline chemical reagents at a rate of strewing 200-300 g / m<sup>2</sup>. After 3-5 hours of reagents distribution layer of snow and ice cover or ice rolling is chopped off by motor graders.

When the average intensity of the vehicles does not exceed 120 units per hour on each lane, and during snowfall intensity to 5 mm per hour (highest layer of snow that had just fallen) snow cleaning is performed only by snow-plow-brush without the use of chemicals. Depending on traffic and air temperature, cleaning of the roadway without the use of chemicals begins no later than in 0,5 hours after a snowfall and repeats every 1,5-2 hours as snow accumulates.

After snowfall is over final work is performed – sweep and shovel snow. When the average traffic reaches 120 cars per hour, a combined method of snow cleaning by means of mechanization and chemicals is used.

For this paper Kremenchuk downtown was selected to study the impact of sand and salt mix on the ecological state of soils. Research were conducted in the winter and spring of 2013-2014 years. Within the studied winter period municipal trucking companies – 1638 in Kremenchuk harvested and used 667 tons of salt and 886 tons of sand and salt mix [4]. After one snowy night the streets of the city can get up to 30 tons of sand and salt mix.

On each of Lenina, Proletars'ka and Pershotravneva streets during the winter period 2013-2014 years were chosen 10 points (total 30 points), from where were selected soil samples. The points were chosen so as to better track the impact of the factors that determine the level of accumulation of soluble salts in sideways' soils.

Therefore, soil sample points were selected in areas which differed by topography slope, structure of traffic flow, the list of green spaces along the roads, roadway width and so on.

The selection of each sample was carried out in triplicate. Sampling periods were defined as follows: first selection was carried out after the melting of the first heavy snowfall, during which sand and salt mix was begun to apply, it was in the second week of December. The second soil sampling took place in late February, at this time there was accumulation of salts

in the soil. The third soil sampling was conducted in April.

Sampling of soil and their preparation for analysis was carried out with the use of standard techniques [5].

Currently, the main method of studying the saline soil conditions, as salinization and desalinization, is liquid phase analysis of soil and water extracts at different ratios of water and soil.

Herewith for each method its own salinity rating scale is used. In this paper we analyzed aqueous extracts of soil, which gives new information on saline soils, which can not be obtained by studying only the liquid phase.

The degree of salinity of the soil was determined by the size of the dry residue [5]. For this soil extract evaporated and fried in a muffle furnace.

In the first stage of studied physical and geographical conditions of the study area were examined, which in one way or another determine the degree of salinity of urban soils: characteristics of topography, climate, soil characteristics and vegetation [6]. This aspect is considered essential to us, because salinity is not only a result of human activity, but also natural conditions.

Under these conditions, the root cause, determining soil salinity is aridity of the climate, which determines the depth of the soil profile soaking, the total stock of productive moisture. Apart from this factor, salt content in the parent soil, the depth of the salt horizon, its capacity, type of salinity content's chemistry, content of toxic salts – all are important as well [7].

To analyze the level of salinity of soil background research was conducted. As a background internal parts of the city neighborhoods were selected, as Pridniprovskiy Park areas, located at some distance from the roadway and therefore anthropogenic salinization processes are excluded there. The soil was selected of a total 10 background points, and then calculated the average background rate, actual contents of dry residue were compared with.

Most of the work has been devoted to the investigation of salinity in soils of roadside strips. The results of the experimental treatment of soil samples are shown in Figure 1.

Studies indicate accumulation of soluble salts in the soils of roadside ways of the central part of Kremenchuk after the first use of sand and salt mix (December). The maximum content of dry residue in the soil, reaching 0,22-0,23%, observed on the streets of Lenina and the Proletars'ka. Maximum solids rate on Pershotravneva street is slightly lower (0,21%). The paper compares the actual obtained data with background one. The data gathered from Lenina street excess background rates in the range of 1,3-3,1 times, from Proletars'ka street – 1,6-3,3 times, for Pershotravneva street – 2,5-3 times.

The difference in data indeed draws attention, especially on Lenina and Proletars'ka streets. Samples taken from the roadside of Pershotravneva street is characterized by fluctuations of lower amplitude. This fact can have the following explanation. Lenina and Proletars'ka streets have narrow sidewalks. Lawns

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between sidewalks and roadway are narrow and in some areas are not continuous, because some its parts are the squares of 1 m x 1 m dimensions.

Under these conditions, after application of sand and salt mix it's impossible to more or less evenly row snow in piles. Some snow is rowed on the pavement, other – on the lawns, so the amount of soluble salts which hit the ground is different. In some parts of Proletars'ka street the pavement is wider and there are lawns situated on its both sides.

Piles of rowed snow do not interfere with pedestrian traffic as there is enough space for them. In this regard, they are placed more evenly, so the soil receives roughly the same number of reagents.

The second selection of soil samples was held at the end of the winter period. Experimental processing field data showed that the content of dry residue in the soil increased. The highest dry residue in the soil rate was marked out for Lenina and Proletars'ka – 0,25% for Pershotravneva street – 0,23%.

Excess over background rates for Lenina street accounted for 1,9-3,6 times; for Proletars'ka street – 2,7-3,6 times; for Pershotravneva street – 2,1-3,3 times. Divergence of indicators, as well as for samples taken in December form Lenina and Proletars'ka streets is higher, for Pershotravneva street is less.



Dry residue content, % Points of soil selection

Figure 1 – The content of dry residue in soils of roadside areas in the central part of Kremenchuk

1 – the content of dry residue in soil samples selected in December; 2 – content of dry residue in soil samples selected in February; 3 – content of dry residue in soil samples selected in April; location of points of soil selection: points №№ 1-7 – Lenina street; point №№ 8-14 – Proletars'ka street; point №№ 15-21 – Pershotravneva street.

Comparing the results of the experimental treatment of soil samples taken on the first and second stage, it can be concluded that the content of soluble salts in late winter in the soil of roadsides of the central part of Kremenchuk increased.

This is explained by the fact that in the cold season, the soil is mostly in the frozen state, that's why the processes such as migration, infiltration, soil solution, and hence the removal of soluble salts from the soil are impossible.

In soil samples taken in spring, the content of solid residue decreased. The highest values are in Lenina and Proletars'ka streets – 0,23%, for Pershotravneva street – 0,21%. Excess over background rates for soils collected in Lenina street is in the range of 1,4-3,3 times, for street Proletars'ka street – 2,1-3,3 times for Pershotravneva street – 2,6-3 times.

Studies have shown that the highest rate of solids (Proletars'ka street) – 0,25% – does not suggest these soils are saline, as these are soils with solids of 0,3% [5]. But this fact still causes concern because in the future this trend might intensify.

In addition, after the melting of snow and ice soluble salts can get into the Dniper river, which may result in catastrophic consequences.

Analysis of the results obtained for the three stages of the study evidences about salinization and desalinization, that are most dynamic soil processes. In winter time the salinity was observed – the accumulation of soluble salts in the soil profile, which

is not offset by the removal of salts beyond. According to the findings, salinization maximizes its intensity in late winter.

As mentioned above, the reason for the accumulation of salts in the soils of the central part of Kremenchuk is the use of sand and salt mix to combat ice covering. Cars also make some contribution to soil contamination of roadside ways when they spray snow saturated by reagent passing by.

Accumulation of salts has also contributed to the fact that snow can be wrapped on the sidelines for a long time. It's necessary to note that snow taken out of the city, also causes a number of environmental problems, including pollution of soil cover and water.

Our studies show that desalinization process of the soil of central part of Kremenchuk takes place in spring – the destruction of salt horizons and making salt out of the soil profile. The factors, such as: soil thawing, heavy soil washing by rain, the start of the growing season of plants – all contribute to the soil desalinization.

The rewarding experience of other countries should be used to reduce the threat of urban soil salinity. The best way to deal with ice covering is a timely snow removal.

For example, most European countries are now almost completely abandoned the use of chemical reagents for snow and ice melting. Salt is only allowed in hazardous roads areas. As an alternative to sand and salt mix can be considered fine-grained material

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(gravel, rock particles), which is also economical and environmental, as being reused.

In some countries, the mix of sand and hot water to combat ice covering is used. Hot sand dwells into the snow and makes the surface rough. This treatment lasts for 3-7 days with daily number of vehicles of 1,500 units, or until a new snowfall takes place.

**CONCLUSIONS.** The studies show the negative consequences of the use of sand and salt mix to combat ice covering on motorways. Due to the use of reagents is the process of soil salinization, which becomes more intense with each successive use of chemicals.

The highest degree of mineralization was observed in soils of Proletars'ka street, the lowest – in Pershotravneva street soil. In spring, the soil in roadside areas observed desalinization. Intensity of salinization-desalinization depends on climatic conditions, groundwater level, the efficiency of municipal services, the characteristics of soils, vegetation, geomorphological features of the area. Salinization and desalinization of urban soils are two opposing soil processes that constitute a single dynamic system.

Maximum contain of solids in soil extract indicates that soils of the study area can not be classified as saline soils. However, the trend is negative, since the use of chemicals can result in consequences beyond its limits, including mineral natural waters and soils.

To reduce the risk of biosphere components salinity the most effective strategy would be a rejection to the use of salt to combat ice covering (it's needed to optimize the performance of municipal services) or use another method, such as gravel or stone particles.

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**ИССЛЕДОВАНИЕ ПРОЦЕСС ЗАСОЛЕНИЯ ГОРОДСКИХ ПОЧВ НА ПРИМЕРЕ ЦЕНТРАЛЬНОЙ ЧАСТИ Г. КРЕМЕНЧУГ**

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В работе исследовался процесс засоления почвы центральной части г. Кременчуг результате применения песчано-солевой смеси для борьбы с гололедом. Степень засоления почвы определялся по содержанию сухого остатка в ґрунтовой вытяжке. Отбор почвенных образцов происходил трижды: после первого и второго использования песчано-солевой смеси и весной. Исследования показали, что в зимний период в почвах района исследования увеличивается содержание сухого остатка в ґрунтовой вытяжке. Его максимальные показатели колеблются от 0,23% (улица Первомайская) до 0,25% (улицы имени Ленина и Пролетарская), что превышает фоновые величины в 3,3 и 3,6 раза соответственно. Результаты работы показали, что в весенний период в почвах района исследования происходит процесс обессоливания. Рассмотрены факторы, определяющие интенсивность процессов засоления-обессоливания, в том числе климатические условия, свойства почвы и тому подобное. Предложены рекомендации по предотвращению процесса засоления городских почв.

**Ключевые слова:** песчано-солевая смесь, почву, засоление, обессоливание.

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