Analysis of Impact of Novorosсement OJSC on Dust Content

N N Mamas¹, M V Tislenko²

1 Candidate of biological sciences, associate professor
Department of General Biology and Ecology
Kuban State Agrarian University
Named after I.T. Trubilin, Krasnodar
2 Student of the Faculty of Land Management
Kuban State Agrarian University
Named after I.T. Trubilin, Krasnodar

Abstract. This article considers the environmental impacts of industrial production. Russian Federation, Krasnodar Territory, Novorossiysk, Verkhnebakansky, 1 Zavodskaya St. Novorossiysk is located in the moderate climate zone. Cement production generates a lot of dust that damages flora, fauna, and human health. Total emissions per one plant over its lifetime is 1970.1 tons. Prolonged exposure to dust causes such diseases as bronchitis, lung cancer, silicosis, tuberculosis, and tetanus. Dust particles suppress the growth rate and development of plants. The trees around the Novorosсement OJSC factory are severely suppressed. The soil around the factory also experiences heavy technogenic loads. The company has to use special dust filters to prevent air pollution. To reduce the concentration of dust at the industrial factory, it is necessary to create green spaces in the areas where pollutants spread.

1. Introduction
Industrial production plays a big role in environmental pollution. Cement production may use natural and manufactured raw materials. These may include minerals containing the key components of cement: calcium oxide, silicon oxide, alumina, and iron oxide (1).

Cement production makes negative impacts on the environment, especially the air.

This article analyzes the factories of Novorosсement OJSC, as well as product parameters and the impacts on human health and the environment. This article focuses on the Novorosсement OJSC factory located at 1 Zavodskaya st., Verkhnebakansky, Novorossiysk, Krasnodar Territory, Russian Federation. The purpose of this research work is to assess the impacts on cement production dust using the lichen indication method.

Objectives: assess the operation of the sanitary buffer zone, select test sites, and use the bioindication method to determine the dustiness of the air around Novorosсement OJSC.

Verkhnebakansky is located 15 km to the North-West of the center of Novorossiysk, in the mountain-forest area. Tunnelnaya railways station is located 1.3 km from the main production site, considering its location with respect to other facilities. 150 m to the West, South-West, and South-East, there is a residential area with one-storey single-family homes. On the opposite slope, 700 m away, there is the Verkhnebakansky factory. There is a marlstone quarry 500 m away.
Figure 1. Vekhnebakansky on the area’s total evaluation map (drawn in Autocad by M.V. Tislenko).

Novoroscement OJSC is located on a plot officially designated for the location of industrial facilities. The location is well-justified because the factory was a sanitary buffer that reduces the emissions of pollutants in the air. However, it should not be located in residential areas or forests because its activities damage the environment or human health.

2. Materials and methods
Following Order No. 35 of Russia’s Sanitary Inspector of June 9, 2008, on the Establishment of the Size of Sanitary Buffers for PJSC Facilities, and SanPiN 2.2.1/2.1.1.-14 for the Sanitary Buffer Zones, Sanitary Classification of Companies, Structures, and Other Facilities, the sanitary buffer zone was designated as follows:
- 400 m from the production facility to the north, 100 m to the west, 200 m to the south, and 300 m to the east.

We arranged monitoring activities at test sites. (2).
Novorossiysk is located along the coast of the Tsemes Bay for 32 km (Figure 1). Mountains protect the city from the cold air masses from the continent.
The Tsemes river flows through the industrial zone of Novorossiysk and sinks into the bay (8).
To provide a comprehensive description, clarify the climate and environmental conditions.
Winters are mild on the coast of the warm sea, weather changes often, and spring begins early.
Summers are hot and dry, autumns are warm.
Soils around Novorossiysk are humus carbonate.
The forest cover in Novorossiysk is 66%, which is one of the highest figures in the Kuban. The forests around the city are deciduous and upland in character. There are also 45 plant species listed in the Red Book of Russia. The climate is becoming milder, air moisture is increasing, and the landscape is changing (4).
We used the passive lichen indication methods according to A.S. Bogolyubov. We identified the specifics of the lichen flora and determined the lichen cover on trees to assess the relative air purity. Thus, we performed a comparative analysis of air at test sites.
Main stage: monitoring thallophytes and estimating their count. We studied lichens all year-round: in spring, summer, and autumn. We measured the projective cover at the test sites and calculated the
average values of projective cover for the city. We used the total projective cover and projective covers of specific species taking into account lichen sensitivity scales and indices to assess air pollution. Before the research began, we determined the center of the site and put a stake in it. Then we selected 10 trees of the same species and the same height around the center of the site. We used these trees as the reference for the calculation of lichen count.

We used the palette method to calculate the percentage of the projective cover of lichens on trees. Thus, we got a realistic result. Within this method, we used a transparent film frame with squares of 1 cm drawn on it.

We placed the squared film on the tree and counted the number of lichens in each section. If almost all area is covered in lichens, we calculated the number of squares where lichens take 100% of the area. If the lichens took less than half the area, we wrote down 50%. The percentage of the total projective cover (R) can be calculated using the following formula:

\[ R = \frac{(100a + 50b)}{C}, \text{ where } C \text{ is the total number of squares in the palette} \]

3. Results
The fauna around Novorossiysk is quite diverse. Local forests are inhabited by hedgehogs, shrews, moles, hares, and foxes. Jackals are also common in this area. Novoroscement OJSC is one of the largest construction material producers in Russia and the main supplier of cement in the Krasnodar Territory. Its annual output is 4.1 million tons. Environmental production is especially relevant for areas where there are cement production facilities.

Cement production comprises the following stages:
1) raw material production;
2) raw material mix preparation;
3) raw material mix baking;
4) clinker powdering.
Cement production generates a lot of dust that damages flora, fauna, and human health.
Total emissions per one plant over its lifetime is 1970.1 tons.
Prolonged exposure to dust causes such diseases as bronchitis, lung cancer, tuberculosis, and tetanus.

The test sites (0.5 × 0.5 km) were located in four areas around the factory. We selected the following test site locations: along a highway, in a residential area, in a park, and in the industrial zone. After the calculation of sectors and the selection of research trees, we determined the lichen species composition.

We described the experimental sections and selected the projective cover of lichens on trees for the analysis. The first test site was located in a residential area in the western part of the city (Cheremushki microdistrict). The second site was located in the eastern part (near the confectionary factory behind the railroad). The third test site was located at the crossroads in the city center, at the premises of Lyceum No. 34. The fourth test site was located in the southwestern part of the city.

To collect samples, we used the following equipment: a knife to cut lichens off the tree trunks, thin pieces of bark with epiphytic lichens, paper bags of all sizes, and a pencil. The collected lichens were packed in the bag, each containing one lichen from a specific test site. The bags were labeled with the exact collection spot and the person responsible. After that, lichens were air-dried. After that, we determined the lichen species using the reference book.

To assess air purity using formula (1), we calculated the air purity index IAQ.

\[ IAQ = \sum_{i=q}^{n} \frac{Q_iF_i}{10} \]

The toxophobic index - Qi,
The combined cover and occurrence indicator - Fi,
The species count - n.
The air purity index (IAQ) can be characterized by the number of lichens in the test site. Occurrence rates are provided in Table 1.

Table 1. Lichen occurrence assessment (prepared by the authors).

| Indicator          | Palette filling rate | Measurement result |
|--------------------|----------------------|--------------------|
|                    |                      | Test site 1        |
| very low occurrence| ≤ 2%                 | +                  |
| low occurrence     | 3-21%                | +                  |
| medium occurrence  | 21-48%               | +                  |
| high occurrence    | (48-68%)             | +                  |

4. Discussion
To calculate the area of the projective cover for lichens, we used a palette that was attached to the tree on all sides at a height of 1.5 meters. We recorded the area covered by lichens.

This problem can be solved for the entire country and a specific manufacturer using a comprehensive solution (5). If we determine the index, we can speak of the degree of air dustiness and then assess the impact the factory makes on the environment.

We counted the squares where lichens took up more than 50% of the area and considered them to be 100%. These data were recorded in the field log. The projective cover percentage for lichens was calculated using the following formula:

$$ R = \frac{(100a + 50b)}{C} $$

where C is the total number of palette squares covered in lichens.

The areas of all test sites were averaged.

The first site located in a residential district in the western part of the city Cheremushki microdistrict, Dimitrovkoye Sadovodstvo st., only featured woody species.

Apartment buildings are surrounded by holly, American sycamore, small-leaved lime tree, common oak, blue spruce, Oriental spruce, Crimean pine, and Caucasian fir. The first storey includes a ripe and ripening forest stand (comprised of trees over 7 meters high). The trunk diameter is 30-60 cm. The trunk and the branches are covered in lichens, there are cracks in the bark, the majority of which are concentrated at the height of 1-2.5 m. The anthropogenic impact is medium. In Dimitrova St., there is car, trolley bus, and bus traffic, while trucks are banned.

The most widespread lichens from the first site include Parmelia goat Parmeliacaperata (L.) Ach., a belt of Xanthoria parietina (L.). Physciapulverulenta (Schreb. Candelariaconcolor (Dicks.). Small amounts of Xantoria mural (X. parietina) were found on all trees. P. caperata (L .) Ach has a phylloid thallus, partially rosette, and irregular shape (up to 22 cm in diameter). It sticks closely to the substrate in the center. The upper surface is yellow-green (in lit places) or greyish-green (in shadows). The lower surface is brown with dark ridges, the belt of X. parietina (L.) has a thallus of over 2 cm in diameters, shaped as regular orange-yellow rosettes of large, wide, and rounded blades. The tips of the blades are dentate-cut. The central part has numerous lichens with lighter disks pulverulenta (Schreb.). The thallus is shaped like a large regular rosette, olive to dark-brown on the upper side, often with the thick blueish taint that makes it look ashy gray, and the downside is dark with thick dark-grey or black rhizoids. We found a total of 11 lichen species, nine of them foliose and two scaly (candelaria and lepraria).

Other forms of lichens were not found at the test sites.
5. Conclusion

At the eastern test site located near the residential buildings, no significant traffic was registered. There are no highways or railroads around. The flora comprises mulberry trees (Morus), hazel trees (Nux), apple trees (Mālus), and some shrubs that do not house lichens.

Trees of height group III (up to 4 meters high) form the underbrush of scrubs and trees that do not constitute the main tree canopy. The truck diameters vary between 20 and 40 cm. Lichens partially cover the trunk and the branches, and the cracks in the bark. The majority of them grow at the height of 1-2.5 m. There is a low-traffic dirt track at this site. About 80% of the lichens covered fruit trees.

Sometimes, it was possible to see the yellow scattering of Caloplachrysodeta and Candelaria concolor, and leaks of several species: Parmeliaceae: P. sulcata, P. ernstiae, P. caperata, P. ambiguа; Physciaceae: Ph. Caesia, Ph. Distorta, Ph. Tenella, Ph. Adscendens, Ph. Stellaris, Ph. Grisea.

The leak of fruticose lichen Evernia of the Everniaprunastri (L.) Ach. is especially interesting. Thus, we found foliose, scaly, and fruticose lichens.

Another test site is located in the city center, in an area with a lot of transport. At this site, the trees are suppressed, their bark is damaged, and their crowns are thin. Some of the trees have suppressed growth and development parameters. For landscaping, the following species are used: maple (cer platanoides), small-leaved lime tree (Tilia cordáta), black walnut (Juglans nigra), catalpa (Catalpa), birch (Bétula), bird cherry tree (Prúnus pádus). The majority of lichens can be found on maples and walnuts.

The canopy of trees comprises trees from height groups 1 and 2 (underbrush), young forest-forming species of 3-7 meters high. The truck diameters vary between 15 and 45 cm. The trunks are covered in lichens and bark cracks, the majority of which are located at the height of 1-2.5 meters. A total of 6 lichen species were found, 4 of them foliose: Scoliciosporumchlorococcum, Xanthoriaparietina, C. chrysodeta C. concolor, Ph. stellaris.

The fourth test site was located at the crossroads of Shosseynaya st. and Barareynaya st. This site is located near an active railroad and an outbound highway. In the vicinity, about 500 meters away, there is a local polluting factory, the Kartontara plant. A total of three lichen species were found there, two of them foliose: Sc. chlorococcum, X. parietina, Ph. stellaris. We used the combined dot graph to characterize the cover index at the sites, we analyzed the lichen species we found: Sc. chlorococcum, X. parietina, Ph. stellaris.

They have a very low cover rate. Dust particles suppress the growth rate and development of plants.

The trees around the Novorosocement OJSC factory are severely suppressed. The soil around the factory also experiences heavy technogenic loads. We can conclude that the company has a great adverse impact on the environment and human health, and thus, has to use special dust filters to prevent air pollution. To reduce the concentration of dust at the industrial factory, it is necessary to create green spaces in the areas where pollutants spread. Besides, company managers have to comply with environmental requirements. We analyzed all four test sites and found that the purity index for them is 17.9.

All of the elements that are not always found in cement dust have a positive impact on the flora. This is demonstrated by all our research works (8).

The result of the research allows us to make a conclusion about the anthropogenic load on the landscapes of Novorossiysk. Generally, the environmental situation can be classified as satisfactory. Apart from Novorosocement OJSC, there are machinery plants like Krasny Parovozik and Molot operating in the Tsemes Bay area (6).

The air quality index for the fourth site was 17.9, which confirms the calculations for the field resistance index.
The reviewed lichen species characterize urban landscapes as habitats moderately and severely affected by anthropogenic impacts.

6. References

[1] Gagarskaya A T 2017 Assessment of the impact of the cement industry enterprise on environmental components 2017 Step into the future: theoretical and applied research of modern science. Materials of the XIV Youth International Scientific and Practical Conference of Students Postgraduates and Young Scientists pp 50-54

[2] Kosorukova O E, Krylova O E 2019 Environmental pollution by the cement industry 2019 Actual problems of aviation and cosmonautics Collection of materials of the V International scientific-practical conference dedicated to the Day of Cosmonautics In 3 volumes Edited by Yu Yu Loginova (Krasnoyarsk) pp 495-496

[3] Mamas N N, Arsenkina V P 2019 Assessment of the impact of Verkhnebakansky OJSC cement plant on the soil Eurasian Scientific Association 6-3(52) pp 152-154

[4] Mamas N Ecological features of lake Karasun 2020 E3S Web of Conferences 8 Cep. "Innovative Technologies in Science and Education ITSE 2020" p 07009

[5] Mamas N, Verbitsky A, Verbitsky V 2020 New Technological concept of utilization animal and poultry waste 2020 E3S Web of Conferences. Cep. "International Scientific and Practical Conference "Environmental Risks and Safety in Mechanical Engineering" ERSME 2020" p 09011

[6] Mamas N 2019 Environmental situation in Tsemesskaya bay of the city of Novorossiysk In the collection: Ecology of river landscapes. Collection of articles based on the materials of the III International Scientific Ecological Conference Responsible for the issue N N Mom pp 207-211

[7] Mamas N N, Andriyash E N, Morozova A N 2012 Assessment of the influence of waste water in the city of Novorossiysk on water quality in Tsemesskaya Bukhta Ecological Bulletin of the North Caucasus 8 T 4 pp 67-74

[8] Nikolaychuk A M, Vashkevich M N 2019 Bulletin of the Mozyr State Pedagogical University I P Shamyakin 2(54) pp 49-55