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Geoinformation modeling of dust emissions in the area of phosphate fertilizer production factory

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Phosphogypsum (PG) is a by-product of phosphoric acid production, a valuable raw material for reclamation of acidic soils, for remediation of soils contaminated with oil products, a source of rare-earth elements (REE). The use of PG has a positive effect on the development of plants, on the value and quality of yield. Most of the PG produced at the present time is stored in phosphogypsum dumps (PGD), which are a source of pollution of the environment, since the dust particles from dumps can be transported over significant distances. To assess the impact of PGD on the environment and agricultural production it is necessary to identify zones of priority distribution of dust particles and their accumulation in the soils of the surrounding areas. In recent years, geoinformation modeling (GM) have been used to analyze dusting of different types of dumps. There are very few studies on the possibility of using such technologies for modeling the dusting of PGD.

We carried out GM of dust emissions in the impact area of phosphate fertilizer production factory in Balakovo (Russian Federation).

The chemical composition of PG samples was determined for whole samples and fractions most susceptible to dusting – <100 μm. The determination of the total REE composition was carried out by ICP-OES method. REEs content in samples of PG is 30-60 times higher than the Clark values for soils. The predominant indicator elements are La, Ce and Nd, the content of which reaches 500-3000 μg/g. The distribution of microparticles in the fine fractions was analyzed using a laser particle size analyzer from ultrasound-stabilized suspensions. In the aqueous suspension PG aggregates disperse to particles <1 μm, forming in turn several size groups. Local maximum contents form particles with sizes 0.03, 0.14 and 0.67 μm.

The data allowed using the GM to allocate zones of priority distribution of dust particles and their accumulation in the soils surrounding the PGD area. Dusting simulations were performed for particle sizes 8-1, 1-0.1, 0.1-0.05, 0.05-0.03, 0.03-0.01 and <0.01 mm. The results of spatial modeling of the weighted sum of the relative concentration of dust particles indicate that particles up to 0.1 mm predominantly move in northeast, north and southwest directions, particles 0.1-1 mm predominantly fall in northeast direction, particles 1-8 mm - in north direction.

Correlation analysis showed that the results of dusting modeling are in good agreement with the

spatial distribution of REE. The greatest correlation between the weighted sum of the relative concentration of particles of the analyzed size is noted for the content of La and Ce (correlation coefficients 0.74 and 0.68 respectively). Validation of the model was carried out in a field. Joint analysis of the constructed maps and field data showed that the map of the weighted sum of the relative concentrations of analyzed particles well reflects the spatial variability in the soil content of La and Ce.

The results of modeling can be used to assess the impact of PGD on the surrounding area and its soil cover.

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