Bulletin of the Georgian Academy of Sciences, vol.172, No 2. pp,344-346
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Ecology

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Estimation of Statistical Relationship Between Precipitation Amount and its Mineralization

Presented by Member of the Academy Ts.Mirtskhoulava, June 25, 2005

Abstract: Statistical relation between the quantity and the salt load of precipitation exists only for of urban areas. The above relation is described as a linear regression equation displaying the inversely proportional dependence between the parameters. The substances washed down to the Earth with rainfall to a great extent provoke worsening of the topsoil as a result of which a harmful effect on the quality of the soil, sea, and fresh water reservoirs are expected.

Key Words: Atmospheric air pollution; mineralization of precipitation; admixtures; aerosols.

Atmospheric precipitation is known to facilitate the process of circulation of mineral substances in the natural environment representing the basic self-cleaning means for the atmosphere. According to the latest data obtained as a result of studies of precipitation mineralization domain, assessment of the contribution of these substances made to the trans-boundary transfer of industrial aerosols as well as to pollution of both the atmosphere and the of Earth surface, appears possible [1]. At the same time, an increase of precipitation amount must be a result of their salt load decrease. This fact wa mentioned in corresponding scientific papers not but once [2]. However, such assertion due to the present state of the atmosphere, cannot be universally true and it requires an additional special study.

For calculation purposes, methods of statistical analysis used for determination of the relationship between two random variables were used [3]. H – is taken at a i - is a□predictor representing the total mean monthly precipitation, while predictant representing the total number of ions in the mean quantity of mineral substances.

Table 1 shows the basic findings of the above analysis carried out for the settlements throughout the East Georgia. The i -square deviations of the□□□and□H□items given in series are as follows: I - values of scattering of empirical points□□parameters under consideration, bSiH - regression and correlation coefficients.□beyond the regression line, rHSi and The numerators in the fractional exponents given for each of the observation stations show the values of the statistical parameters of the annual course in the long-term mean monthly quantities while the dominators show the parameters of the variable quantities under consideration, calculated from the sample series obtained as a result of n-pair single observations.

Table 1. Statistical analysis of the dependences between precipitation quantities and total ion concentration

Observation stations	Statistical characteristics					
	n	sH	sSI	sSiH	rHSi	bSiH
Sukhumi	12	37.0	2.9	2.7	-0.36	-0.03
	43	55.6	7.3	7.1	-0.23	-0.03
Chakvi	12	36.0	3.4	3.0	-0.51	-0.02
	41	132.9	6.8	6.2	-0.39	-0.02
Tbilisi	12	21.0	9.9	6.7	-0.72	-0.34
	30	23.1	20.5	17.7	-0.45	-0.40
Gudauri	12	39.7	20.5	17.7	0.19	0.02
	38	66.9	7.1	9.4	0.19	0.02

As it is shown in the Table, all the observation stations, except of Gudauri, display a negative value of correlation coefficient pointing out to an inversely-proportional dependence between the parameters under consideration, whereas for Gudauri a direct proportionality is found. Based on a variance analysis, correlation coefficients for Sukhumi, Chakvi and Gudauri were drawn up, and the possibility of their assuming as random variables was determined. Thus, we can state that in Tbilisi, the relationship between the long-term average monthly values of both the precipitation and the total quantity of the ions known to play a peculiar role in the precipitation mineralization will only show a slight difference against standard values. This relation can be expressed by the following equation [4]:

$$Si = 51.9 – 0.34H \quad , \quad (1)$$

where Si and H are correspondingly long-term mean monthly values of the total ions and precipitation quantities..

Determination of the relationship between the precipitation quantity and the amount of mineral substances washed down by the precipitation is of a particular interest. The statistical characteristics obtained as a consequence of long-term observations carried out at the observation stations [1] throughout the Caucasus Region and intended for the assessment of relationship between the values under study are shown in Table 2.

Table 2. Characteristics illustrating the relationship between quantities of precipitation to be observed throughout the Caucasus region and of mineral substances washed down with precipitation

Substance	Statistical performance							
	n	M, t/km2 per year	H,mm	sM	sH	rHM	Fr	sMH
SO42-	10	8.3	1270	3.67	810.0	0.70	7.69	2.61
Cl-	_	3.0	_	2.38	_	0.82	16.30	1.36
HCO3-	_	8.3	_	3.35	_	0.80	14.22	2.01
Na+	_	1.8	_	1.15	_	0.81	15.53	0.67
Si	_	28.5	_	12.63	_	0.87	25.25	6.19

Si	_	26.1 (mg/l)	_	8.12	_	-0.71	8.07	5.77

Ihe variable quantities under consideration are closely connected to each other Table 2. Both the high values of the correlation coefficient and the F1 parameter value, the latter to be found above the one-percent level, should be believed as a further confirmation of the above-mentioned relation. The indices given in the Table, are the positive values of the correlation coefficient (with the exception of the values shown in the lowest row) that are of a particular interest as those pointing to a directly-proportional relationship between the amount of the washed-down mineral substances and the precipitation quantity. As to the lowest row, the given values are obvious illustration of the presence of an inversely-proportional dependence, the statement perfectly corresponding to the basic indices brought in Table 1.

Thus, according to the indices (Table 2) we can conclude that an increase of the precipitation quantity does predetermine an increase of the absolute quantity of the mineral substances washed down onto the Earth surface with the precipitation whereas in such a case the corresponding specific quantity values will be less.

When used for the purpose of assessment of potential damages the atmospheric air pollution can bring to the natural resources, the above results still are to be revised and corrected. The corrections to be made will in their main include evaluation of the pollution level to be to be observed on the surface of the topsoil and caused by the precipitation-caused washing down mineral substances, atmospheric impurities. For example, judging from the absolute quantity of the mineral substances that would normally be washed down (roughly up to 20 tons per sq. km per year), vast metropolitan regions distinguished by the highest air pollution level, appear not to be named among those falling into the areas suffering from heavy washing down of mineral substances whereas the regions characterized by a relatively pure and hence healthy environment (such as coastal areas) appear to have the above parameter exceeding 40 tons per sq. km per year and thus requiring special attention from the ecological point of view.

Besides the above, given the fact that the atmosphere is capable of “self-cleaning”, the impurities washed down to the Earth surface would generally remain there for a long time what will predetermine a permanent increase in the quantity. Owing to diverse chemical reactions going on in the nature, those substances would bring potential dangerous from the first moment already what in its turn would cause drastic worsening of the surface of the topsoil. As a result, negative changes in the soil, the sea, and the fresh water reservoirs are to be expected.

REFERENCES

1. G. Gunia, L. Kartvelishvili. Bull.Georg. Acad. Sci., 159, .2, 1999, p.288-290.
2. O. P. Petrenchuk. Experimentalnieicledobaniaatmosfernogoaerozolia – Leningrad, 1979, 264 p.(Russian).
3. G. Korn, T. Korn. Cpraboshnik po mathematicedlianaushnixrabotnikov I ingenerov. – Moscow, 1968, 720 p.(Russian).
4. G. Gunia. VoprosimonitoringazagriazneniaatmosfernogovozduxanateritoriiGruzinckoi CCR. – Leningrad, 1985, 84 p.(Russian).

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