Analysis of environmental assessment of the object "Drinking bottled water plant" in the settlement of Kultuk

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Abstract. Considered is validity of a positive Conclusion of the expert commission on the state environmental impact assessment for the project documentation of the “Drinking bottled water plant” in the settlement of Kultuk approved by order No. 1446-оа dated July 21, 2016 of the Federal Service for Supervision in the Sphere of Natural Resource Use in the Irkutsk region. We analyzed the Conclusion from the point of view of scientific interest, and the results revealed many obvious inaccuracies. The Conclusion states that the production is environmentally friendly, but all comparisons are made with the standards of short-term exposure limit, which are almost an order of magnitude higher than the standards of average daily MPC. It is submitted that during the construction period there will be little pollution, and the calculations are performed separately for areal and off-site work, although they will be carried out simultaneously. The simulation results of the current situation have shown that, taking into account the climatic features of the area during the construction period, the average daily MPC excess will exceed 210 hours and 660 hours respectively in December and July. Yet the short-term exposure limits are set to stay without consequences only for 20 min.

1. Introduction
Recently humanity is increasingly confronted with the threat of degraded living environments. Drastic changes in the environment have reached a critical limit and have led to an acute shortage of quality fresh water in some parts of the world. Reduced tap water quality and increased health-care-seeking behaviour of the population stimulate an increase in the consumption of bottled water. 20 years ago the volume of consumption of bottled drinking water in Russia was 5 liters per year; today it is 5 liters per week [1]. According to RBC (RosBusinessConsulting) [2], the bottled water market is one of the fastest growing consumer markets in Russia. Our region is no exception. For instance, the BAIKALSEA Company brand in the Irkutsk region pumps 300 million liters of water per year from Baikal, which makes up more than half of all drinking and mineral water consumed in the region. The most famous brands produced by this company are mineral table water ‘Irkutskay’ and mineral drinking water ‘Zhemchuzhina Baikal’ [3]. In total, there are about a dozen water industries on the lake, a significant part of the products are sold to Asian countries and, primarily, to China. This research considers the sensational construction of yet another production on Lake Baikal under the name "Bottled drinking water plant" in the village of Kultuk and, namely, the positive SEE conclusion [4].
2. Discussion

The construction of the bottled water plant in Kultuk began in early 2019. The consequences of the plant construction and launch were covered in the media. The authors of various publications expressed concerns about the possible harm to the ecosystem of Lake Baikal. One of the main fears was the opinion of the townsfolk - Baikal will be handed over for plunder and destruction. Is this really so? Let's count. The approximate volume of water in Baikal is estimated in $23 \cdot 10^3$ km$^3$, or $23 \cdot 10^{15}$ L. The plant in the village of Kultuk plans to bottle $528,000$ liters per day, which is $833 \cdot 10^{19} \div 365 \div 2520 \div 365 \cdot 10^8$, that is, one hundred millionth volume of Baikal water is consumed per year. This is a negligible amount. The following comparisons can be made for convincing. One drop of water from a medical pipette is 0.02 ml, there are 12 500 drops in a glass (250 ml), and there are 50 000 drops in 1L. This means that having 2 tons of water ($10^8$ drops), we take one single drop from it (or, having 200 filled ten-liter buckets, we take only one drop from one bucket). Consistent with the data presented, the problem can be represented as follows: there are about $10^{21}$ drops in Baikal, bottle intake per year is about $10^{13}$ drops, which corresponds to one $10^{-8}$ drop. And it is not necessary to calculate for how many years you can scoop up Baikal, as it is an open system with its incoming and outgoing components. Therefore, the issue of the exhaustibility of the lake cannot disturb the minds of the public and should be removed from the agenda. Other questions are much more complicated.

1. Baikal is the property of Russia, and therefore it can not be sold to anyone or bought by anyone. According to the All-Russian Center for the Study of Public Opinion, two-thirds of respondents consider Lake Baikal as the main symbol of Russia. The Russians do not mind watering the world with their unique water. They are against foreign owners in their territory. It is no secret that the Kultuk coast was bought by Chinese, and they own 99% of the projected plant, and 1% belongs to a Russian woman. Probably, it was easier to draw up all the necessary documents in this situation. The State Ecological Expertise Conclusion [4, p. 7] states: "The construction of the plant is of great social importance: this is the creation of additional jobs, the receipt of taxes in the local budget ...". Thus, the problem of local employment will allegedly be solved.

2. Any production is associated with environmental pollution, in this case, in the coastal zone, adjacent water masses, and atmospheric air. "Rare and species of protected plants... were not found. This is due to the proximity of the village and a rather high level of anthropogenic impact" ibid [4, p. 10]. Taking the existing anthropogenic pollution as a background, it is further argued [4, p. 16, 17, 18] that the surface concentrations of pollutants during the operation of the plant will not exceed 1 MPC (Maximum One-Time MPC) at the border of the nearest residential development of Kultuk settlement. However, unfortunately, comparisons are made with the standards of Maximum One-Time (MPC$_{o.t.}$), but not average daily maximum permissible concentration (MPC$_{d.a.}$), which, as a rule, is much more stringent. This tendency for residential areas to compare the concentrations of harmful substances with their maximum one-time MPC is fundamentally wrong and undermines the convincing arguments of the Conclusion [4], as it contradicts the very definition: the maximum one-time MPC is the MPC, which is established to prevent reflex reactions of humans (sense of smell, change in the bioelectric activity of brain, light sensitivity of eyes, etc.) with short-term exposure to atmospheric pollution (up to 20 min) [5]. In the same place (paragraph below) it is written that the highest concentration of each harmful substance in the surface layer of the atmosphere should not exceed the maximum one-time (already without specifying the exposure time). It is evident that such an inaccurate formulation leads to such discrepancies.

3. In the Conclusion [4, see, e.g. p. 19, 20] there are inaccuracies: a. calculation of the pollutant concentrations is carried out separately for areal and not-areal networks, although construction will be simultaneous; b. Slyudyanka (CHPP-2) will supply the necessary amount of electric energy, but energy production will require additional power, generation of which will be associated with
environmental pollution problems; c. and, finally, a meager payment for environmental pollution. And how much is human health?

3. Methods and models
We used data from urgent observations of the Kultuk meteorological station for the period from 1973 to 2017 to assess the anthropogenic impact on the atmosphere, were used.

The village of the same name is located at the southwestern point of Lake Baikal, on a narrow, sometimes swampy, coastal plain that gradually rises from the lake to the foot of the northern spurs of the Hamar-Daban Range. The large mass of water forms a milder climate here. After processing the data of long-term observations for the indicated period, the following result was obtained: mean monthly air temperature of the coldest month (January) in Kultuk is -15.9°C, which is 1.3°C higher than the value indicated in the climate reference [6] for 1966. In summer, the cooling effect of the reservoir causes lower air temperatures (15.5°C in July), compared with equal-latitude stations in the interior of the Irkutsk region and the Republic of Buryatia. It should be noted that the increase in mean monthly temperature in July, in comparison with the materials of reference publications [6, 7], amounted to only 0.3°C.

The southern part of Baikal is located in difficult orographic conditions that affect the change in the speed and direction of wind flows under the influence of mountain ranges, intermountain depressions and river valleys. The average annual wind speed in the village of Kultuk is about 3 m/s. From November to January, the average monthly wind speeds are 1.5-3 m/s higher than the annual average. During this period, thermobaric contrasts between the lake and the land are dramatically expressed on Baikal. In December, the highest wind speeds and the minimum number of calmness are observed (figure 1).

Kultuk is characterized by the presence of wind flows with a western component throughout the year. From June to September, two distinct prevailing wind flows of opposite directions are noted. These are flows of the western and eastern quarters of the horizon.

According to statistical data, in December, the western direction of the winds accounts for an average of 74% (with an average speed modulus of 6 m/s), the northwest – 18% (with an average speed modulus of 5 m/s), the southwest – 4% (with an average speed modulus of 3 m/s), that is, the prevailing winds are mainly dominated by the western component – 96% (see figure 1). This means
that emissions from all coastal enterprises will be directed mainly towards Baikal, gradually dispersing, precipitating and accumulating if the lake is covered with ice.

Wind, as a vector quantity, is characterized by direction and modulus of speed. Averaging was carried out over the indicated time period: firstly, the wind speed vector as a vector (radius vector), in accordance with the rules of transition from the polar coordinate system, in which data of urgent observations at posts are recorded, to the projections of the vector on the axis of the local Cartesian coordinate system with center at the point of observation and, secondly, of the wind speed module. Based on the obtained results, the wind stability coefficient was calculated for the region under consideration as the ratio of the vector mean to its average scalar value (figure 2). The stability coefficient \( q \) shows the relative degree of fluctuation of wind directions over time. The limits of change are from zero to one. To the extremes: \( q=0 \) – all directions of the winds are equally probable and have the same speed, which in real conditions is extremely rare; \( q=1 \) – wind direction remains constant.

In Kultuk, the wind is unstable in the warm season (wind stability coefficient varies between 0.4-0.5). The wind is most stable in the winter months, especially in December \( (q=0.94) \), which is in good agreement with the wind rose diagrams (see figure 1).

![Figure 2. The monthly average wind stability in the village of Kultuk for the period 1973–2017.](image)

On the southern shore of the lake, in the Kultuk - Slyudyanka region, the distance between these settlements in a straight line is just over 6 km, there are many industrial enterprises which already create an increased anthropogenic load [5]. The Conclusion [4] states that, for instance, during the construction period, silicon dust exceeds the maximum one-time maximum permissible concentration, but due to the short construction time (it should be noted that time is not indicated), this can be considered permissible.

For inorganic dust of silicon dioxide (20-70%) the following norms are established: \( \text{MPC}_{o.t.}=0.3 \) mg/m\(^3\), \( \text{MPC}_{d.a.}=0.1 \) mg/m\(^3\) and the third hazard class [5]. Dust by inhalation causes an irreversible and incurable lung disease - silicosis, and the disease progresses even after the cessation of dust exposure [8].

Let us try to deal with this issue, even with SiO\(_2\), using the author's K-model [9, 10]. The model takes into account the climatic features of the terrain through a two-dimensional integral function of the probabilities of the realization of all winds (in direction and module) in a certain period of time and allows calculating the probability of exceeding the established MPC for a certain period of time. Having not any idea of the planned duration of the construction, we will conditionally assign a month. It is clear that the results obtained can be extrapolated or interpolated for a more or less long period, respectively. A possible contamination of the surface air layer was simulated for different months of the year, but the calculations for July — the least favorable and December — the most favorable in
terms of scattering power, are presented as fragments. The calculation step is 100 m. The probability of exceeding both the maximum one-time and the average daily MPC for SiO₂ (20–70%) was considered (table 1). For July, the isolines (figure 3 a, b) of MPC excess with the step of 72 h are given, which corresponds to a probability of 0.1.

| Table 1. The normalized probability of exceeding the MPC and radius of maximum pollution. |
|---------------------------------------------------------------|
| Maximum excess of MPC o.t. (h) / pollution radius (m) | Maximum excess of MPC d.a. (h) / pollution radius (m) |
| December | July | December | July |
| 210 / 200 | 660 / 300 | 718 / 1100 | 720 / 1500 |

Figure 3. Isolines of the frequencies excess of MPC in July: a. MPC o.t., b. MPC d.a.

4. Conclusion

During the construction period of the facility under consideration, when comparing with the MPC o.t., calculated for 20 min for a person's stay in this territory, the established norm is not fulfilled, since in reality the duration of exposure will be from 210 hours to 660 hours per month. When comparing with MPC d.a., the situation is dramatically complicated, since a person will breathe polluted air for a whole month. How will this affect his health?

References

[1] Shishkina V A 2016 The state of the market for bottled mineral drinking water in Russia Vysschaya Shkola 12 30-6 (in Russian)
[2] Healthy lifestyle: global trends and Russian realities - Retail Week (in Russian) 2019 Income accessed online on 20th April 2019 via https://pro.rbc.ru/demo/5c5860a49a7947211e12d8ea
[3] Baikalsea Company Natural water of the Baikal Territory (in Russian) 2019 Income accessed online on 20th April 2019 via https://baikalsea.com
[4] About the approval of the conclusion of the expert Commission of the state ecological examination according to project documentation on object "Plant on production of drinking bottled water". 2016 Order № 1446-od of 21.07.2016 of the Federal Service for Supervision of Natural Resources in the Irkutsk Region p 49 (in Russian)
[5] On approval of hygienic standards GN 2.1.6.3492-17 “Maximum Permissible Concentrations (MPC) of Pollutants in the Air of Urban and Rural Settlements” (in Russian) 2018 Income accessed online on 18th July 2019 via http://docs.cntd.ru/document/556185926
[6] Scientific and Applied Guide to the Climate on the USSR 1991 22(1-6) (Leningrad: Gidrometeoizdat) pp 224-80 (in Russian)

[7] Baikal. Atlas 1993 ed G I Kartushin (Moscow: Roscartography) p 160 (in Russian)

[8] Harmful Substances in Industry 1954 Handbook ed N V Lazarev 2 (Leningrad: State scient-techn publishing house of chemical literature) p 582 (in Russian)

[9] Arguchintsev V K and Arguchintseva A V 2007 Modeling of Mesoscale Hydrothermodynamic Processes and Transport of Anthropogenic Impurities in the Atmosphere and Hydrosphere of the Lake Baikal Region (Irkutsk: Irkutsk State University Press) (in Russian)

[10] Arguchintseva A V and Arguchintsev V K 2015 Mathematical Modeling in Environmental Problems (Irkutsk: Irkutsk State University Press) (in Russian)