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Analysis of the current situation and tendencies of further development of worldwide and local science "safety of water"

Abstract

The article contains short analysis of the current situation and development tendencies of worldwide and Kazakhstan «water safety» science. There is an explanation of scientific definition "water safety", of its traditional aspect (in relation with water volumes) and of ecological aspect (in relation with quality of natural water). Special attention was paid for regional peculiarities of water problems in Kazakhstan, i.e.: high deficit of water resources; exceptional pollution of the territory; exceptional self-cleaning capability of the territory and water objects. It is pointed out, that the whole complex of scientific investigations on territory self-cleaning due to wind-distribution of wastes, has not been taken by both worldwide and republican science. There were made local investigations only. Kazakhstan surface waters are of extremely self-cleaning capability, based on hydrobionts, hydro-chemical characteristics and climate conditions: continentality, high amplitude of water and air temperature fluctuations, aridity of the territory (moisture deficit), high sun radiation, severe winter cold, calcium and magnesium carbonate setting, heavy-metals co precipitating.

Keywords: safety of water, hydrochemistry, quality of natural water.

Introduction

Studying the chemistry of water objects in Kazakhstan, the scientists meet such a definition as «water safety». Scientific definition of «water safety» has two aspects. *The First one* is traditional, relates to *the volumes* of natural waters, not quite correctly called as water resources; the safety here relates to rivers spring flood and *high water levels* in lakes and storage water reservoirs; in this case population and economy objects are under flooding by surface waters and water logging by ground waters. The first aspect also includes safety, related to shallow water-supply reservoirs, when population and economy objects are of serious water lack. *High-water and low-water* were of traditionally *natural matter*, as human beings always settled close to rivers, lakes and seas. At the end of age XX high-water and low-water appeared due to anthropogenic reasons, in accordance with growth of population and products manufacture (i.e. wastes of manufacture), due to overregulation of river flow.

The second, ecological aspect of water safety related to the *water quality* in water supply sources, and in recent years – to the natural water quality in total, as bad water quality affects both population, economy and nature objects; incl. water biocenosis, and also stream riparian forests and irrigated areas. The second aspect is absolutely caused by anthropogenic reasons and can be rated as a negative consequence of *scientific-technical progress*.

The first aspect of water safety is described in works [6,10]. Recently water is considering as *critical resource*, and its deficit in Central Asia is considering as a reason of international conflicts [4]. In the proposed article some regional peculiarities of water problems in Kazakhstan are shown in relation with the second aspect of water safety.

Regional peculiarities of water problems in Kazakhstan

1. *Water resources famine*. «Stability index of water resources to anthropogenic load» is calculated as ratio of removed water volumes to recovered ones (K coefficient). When K>0,40 the load is very high, when K >0,60 – is hazardous high. Such loadings have never been achieved worldwide, except in some countries of North Africa (Chad lake) and in

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Kazakhstan. In Kazakhstan such coefficient is equal to 0,78, and in Aral sea basin it increases one unit (due to the reuse of the water along the river).

There is one more visual index of territory water supply, i.e. so called *depth of runoff*, defined as rate of recovered water resources to the river or lake basin square; it can easily be compared with well-known climate index – *depth of precipitation*. For example for desert zones of Priaralie and Pribalkhashie *depth of precipitation* changes from 100 till 150 mm/year, achieving zero, when it is drought. Mean *depth of runoff* in Kazakhstan is equal to 42 mm/year, changing from 100 mm on Balkhash lake basin up to zero in closed basins of Sary-Arka (Central Kazakhstan).

2. *Outstanding pollution of the territory.* This factor depends on both scientific-technical progress achievements and pure subjective factors. The author of the article, Proff. Tursunov A.A.., as a former member of Scientific-technical council of the USSR Ministry of Power and as a member of the Middle commission by the Ministers council of USSR, knows quite well, that majority of technical managers of former USSR considered Kazakhstan as the "unbounded space". That is why here were located ecologically harmful manufactures, such as open mines of Sokolovsko-Sarbay, coal pits of Ekibastuz, Hydroelectric power plants of Ekibastuz, Baikonur cosmodrome and other giants of Soviet economy. Zyryanovsk, Ust-Kamenogork, Almaty and Shymkent cities have the most polluted atmosphere worldwide, breaking many Western Europe "records".

All this is a consequence of abovementioned subjective mistake in planning and locating manufacture forces of the former USSR.

But there is other *mistake*, with more dangerous consequences, but is not discussing much. During the period of Tsar Russia, and especially during last 70 years of soviet period, almost all the *Kazakh auls* appeared to be settled, and *cattle-breeding*, priority sphere of Kazakhstani economy, was not nomadic any more. The tendency became stronger in last 10 years due to the development of small farms, which take a lot of efforts trying to became stable due to uncontrolled exploitation of nature resources– pastures, dry farming, and river basins resources.

Here we can give the pollution numbers, collected during last 100 years, for every person or for every square meter. Such calculation trials show really panic situation [4] and cause perplexity of our foreign colleagues [1,2]. It is actual, that many people can not understand, how the Pri-Aral population can survive, how such cities as Ust-Kamenogorsk and Almaty can function. But there is third, positive factor, which can partly save the situation.

3. *Outstanding self-cleaning ability of the territory and water objects*.

Self-cleaning of the territory is defined by wind distribution of wastes. In Kazakhstan it is being studied the wind regime (P.K. Kozhakhmetov), atmosphere pollution volume, by industrial wastes mainly (T.B. Eserkepova), from the side of desert landscapes and dumps (O.Ye. Semyonov and others). But the whole set of scientific investigations on territories self-cleaning ability due to the wind wastes distribution is not taken in both worldwide and the republican science. Nevertheless, there are some local investigations of the matter [1,3].

The results of scientific reports and special long-term experimental investigations of nature water shows, that surface waters of Kazakhstan-river flows, lakes and reservoirs have outstanding self-cleaning ability, and this ability is based on hydrobionts and climate conditions: continentality, big amplitude of water and air temperature fluctuations, territory aridity (moisture deficit), high sun radiation, hard winter frost, etc. Hydrobionts of rivers and lakes of Kazakhstan precipitate pollutions and other mineral compounds twice a year. Also twice a year there are intensive processes of chemical self-precipitation of salts from Balkhash lake water. It is proved by specials investigations on isothermic precipitation of salts and freezing processes [8,9]. In total, the influence of abiogenous factors onto hydrobionts development and also their metabolism are among the weakly studied and puzzled tasks. In Kazakhstan nowadays these problems are being studied separately in biology and geography sciences.

As special investigations showed, the above mentioned processes of double water desalination mainly based on shallow lakes of Kazakhstan. The depth of these lakes is lower, than half-length (15 m) of usual wave of 1,0 m high. When it is storm, the height and length of the wave grow accordingly up to 3,0 and 4,5 m, that is why there is intensive wind intermix of the water in depth, the reservoir appeared to be ataxic and the water is actively saturated with oxygen throughout the depth. In such res-

ervoirs there are no carbon dioxide at all, especially in bottom water layers; the appeared carbonates precipitate at once. In *deep-water reservoirs* in bottom water layers carbon dioxide appears, rises upwards, meets precipitating *carbonate salt,* generates soluble *bicarbonates*, i.e. here there is a special *mechanism of return salts into the water*, that increases its mineralization. As we can see, such mechanism does not exist in shallow, ataxic water reservoirs, and it defines their outstanding hydro-chemical peculiarity – quite early appearance of *carbonate-calcium balance.* In deep-water reservoirs, mostly in damp spheres of Earth, such balance is achieved by mineralization equals to 10 g/l; only after that chemical self-precipitation of salts starts. In huge seas and oceans mineralization level increases up to 30 g/l. In shallow reservoirs self-precipitation starts at 1 g/l. In damp regions precipitation level increases evaporation level, sun rays are not so hazardous, winters are not so cold. That is why worldwide experience and the standards, developed mainly for damp regions, can hardly be applied for arid dry zones, particularly for Kazakhstan nature waters.

Note, that outstanding self-cleaning ability of water objects, multiplied by multiple recovery of water, is a very important factor of water safety. But it is important to use it in a right way. So called *ecological flow* in lower reach of river should be not less, than half of annual mean value, moreover, it should be distributed throughout the year by «natural» hydrograph keeping spring floods and low waters.

Application of system approach and old traditions of nature management of native population of Eurasia

The next important question is application of system approach and old traditions of nature management of Eurasia native population, supporting their water safety. Let's try to answer the question through fund materials and literature [2,5,10,12].

The hydroecology powerful tool is *System analysis*, which is recommended to use while studying complicated nature objects, using strict rules of precise mathematic sciences, taking into account definite objects and phenomenon of the System, stating strict causal effects between them, dependable and undependable variables. Such system analysis should conclude *initial, substantial level of* native objects investigating. Only after that it is reasonable to start various formalized investigation methods: stating correlations bonds (if there are such), building various regression formulaes (if in investigating diapasone of parameters fluctuations, the real relations can be changed by linear function), developing various mathematic models (if such models are supported by well-prepared initial data, i.e. have information support).

In real life we often see deviations from above-mentioned rules: investigators are usually in a hurry, start formalized calculations, without completing supporting level of investigations and without clearing all the case details. In this case such deviations cause mistakes, or lead to useless labor expenditures of whole groups of investigators. For example, climatologists of all countries for a long time are searching for simple liner relations between air middle temperature and various geophysical parameters: content of carbone dioxide in atmosphere (CO_2), sun activity, radiocarbon formation speed, etc. As a result, the Worldwide meteorologist congress, in year 1985 in Fills (Austria) gave mistaken forecast: expected huge climate warming in Earth North hemisphere by 3,5-4,5 ^{0}C (and dryness of arid zones) appeared to be much less (0,5...1,0 ^{0}C); and in fact it is grew colder and moist [7, 11].

Other example of mistaken forecast: fall of stage of Caspian sea was demonstrated by former USSR hydrologists. And again, instead of fall we can see sharp increase of the level, which increased by more, than 2.0 m during recent 20 years. In this case there wasn't taken into account mutual influence of two huge drainless water reservoirs of the Earth – Caspian and Aral seas. This mistake had enough discussions among scientific public of former USSR.

The third mistake will be taken from more actual sphere. In 80th years of last age, when it was obvious, that Aral sea level catastrophically decreases, Union specialists proposed to block the Berg sea channel with land dam, in order to keep Small sea level on a higher marks. But officials and scientists, occupied with consequences of «Perestroika», were deaf to these proposals.

This useful idea was recovered in 90th years and was called: «The project on increasing capacity of Syrdaria river and advanced speed of keeping safe North (Small) Aral». The authors of the project didn't take into account scientific recommendations and made two mistakes: first, they defined Small sea

mark on a very low level, 42,0 m only (scientific proposal was 46,0 m, i.e. 4 m. higher); second, the concrete by-wash construction for flush of water excesses into Big Aral was built directly in Berg channel, not at Kulandy cape, on the west of Small sea, where were traces of sea channel from Small sea into the Big sea.

As a consequence of the pointed mistakes, Small sea filled the very first year after the Berg channel was blocked and the excesses of relatively sweet water together with fish resources had to be evacuated through the by-wash. If it was built, by hydroecologs proposal, on western part of Small sea, then there had to be evacuated very salty water, and sweet water of Syrdaria, together with fish, would be kept safe in Small sea, causing its sweetening. Then the authors of the project urgently wrote «second stage of filling» of Small sea and they rose dike crown. But concrete by-wash construction, which building cost huge amounts of money, still was in Berg channel, and kept evacuating sweet water together with fish resources; some time later it would be covered with sand drifts of Syrdaria. Analysis of cosmic shots of recent years shows, that on a south coast of sea channel, where Syrdaria river falls, huge sand bank appeared, and some time later it will block the channel and concrete by-wash construction.

The money funds on building mistaken construction will be dug into sand, and new construction will be built on western channel, as it was proposed before by hydroecologists.

Above we pointed three the most developed mistakes, appeared due to neglect to precise science laws. In such neglect we can see above mentioned features of modern psychology: to live in a hurry, to get any result before the others do, excessive confidence and unwillingness to think about consequences of possible mistakes… For instance, geographers like drawing various graphs and defining the tendencies and trends of studying magnitudes, and often it is made without taking into account cyclic fluctuations and non-linearity of real relations. Mathematicians, vice versa, like building various mathematic models: statistics models of «black», «gray» and other colored boxes. These models are precise adjustments for existing data. The forecast on these models cannot be given, as it leads to gross errors. So, the System Analysis is a powerful investigation tool, especially when the case is concerning studying such complicated nature systems, as hydroecology systems. But for development of System Analysis it is not enough to have knowledge. The developer should not be hurried; he should show «eastern wisdom». System analysis effectiveness was demonstrated during discussion of concrete problems of Aral, Balkhash and other drainless water reservoirs of Central Asia.

Let's stop on one System analysis conclusion on the objects, studied by hydroecologists, concerning traditions and ecology sights of local Eurasian population. National traditions are not archaic. In case of nature management, these traditions are based on multi-ages experience of people and environment communication. May be, our ancestors didn't have deep scientific knowledge on nature systems, but intuitively, through trials and mistakes of many generations, they found optimal nature management for the local nature conditions. As the nature conditions changed slightly during last 1000 years, then the experience of our ancestors can not be ignored easily, as it was described above concerning Aral sea. We have to conclude bitterly, that ways of nomadic management and pasture technology by shariah basics do not exist any more. Last age of years 60...70th there was some break in ecology consciousness of our people. Almost all the auls were settled and gradually collected piles of litter. Now both Russian settlements and Kazakh auls strongly settle on small banks, directly in «water protection zone». Rare high-water and spring floods can not clean all the wastes; i.e. their trails are stretched throughout the river valley and distributed all around the steppe with the winds. Now it is often case, when, gloried in songs, *bidaiks* are buried under the piles of litter, which is clear on photographs from cosmos.

Conclusions

Scientific definition «water safety» has two aspects. The first, traditional one, relates to the volumes of nature water. The second one, ecological, is in connection with water quality in water supply sources and with nature water quality in total. Recently the water is considering as critical resource, and its deficit in Central Asia – as possible reason of international conflicts.

Regional peculiarities of water problems in Kazakhstan are: high deficit of water resources, outstanding level of the territory pollution, exclusive self-cleaning ability of the territory and water objects. The outstanding self-cleaning ability of water

objects, multiplied by multiple recovery of water, is an important factor of water safety. Ecological flow in rivers should be not less, than a half of mean annual value, and it should be distributed within the year by «natural» hydrograph with conservation of high-waters and low-waters.

Application of system approach and Eurasian population traditions of nature use, should allow supporting their water safety.

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