Contemporary status of surface water quality of the Aral Sea basin

E. I. CHEMBARISOV & E. I. CHEMBARISOVA

Institute of Water Problems, Uzbek Academy of Sciences, Jacob Kolas St. 24, Tashkent 700000, Uzbekistan

e-mail: root@pwater.tashkent.su

Abstract The problems of the Aral Sea desiccation and associated deterioration in ecology has now acquired a global importance. Estimates of ecological condition have been made using methods of systems and budget analysis, statistics and cartography. Surface water volume and quality in different regions of the Aral Sea basin have been determined together with optimum variants for irrigation systems. Means of decreasing the extent of river water pollution and reducing the number of collector-drainage water discharges into rivers have been developed as well as principles for hydro-ecological zoning of territories.

INTRODUCTION

The independence of the Central Asian Republics and their transition to market economies which has been accompanied by a collapse of links between the CIS (Commonwealth of Independent States) countries, together with the general background of regression in the economic sectors, require new approaches for a more economical use and protection of water resources as well as introduction of new technologies. Given the limited capacities in the region, it is necessary to select short-term priorities that can effectively use the experience, credits and technologies of international organizations and companies. In addition, an integrated utilization of inter-republican water resources, improvement of river water quality and provision of reliable, good quality drinking water is needed.

PROTECTION OF WATER RESOURCES

The main problems of the region are the low quality of drinking water and the ineffective purification facilities in cities, settlements and rural areas. Up to 20–30 years ago, there was no serious drinking water supply problem as surface and groundwater were not contaminated with toxic substances and people could use ponds, wells, and surface water utilising primitive purification devices. Rapid growth in river water mineralization levels and associated contamination has led to widespread degradation of near-river and near-canal fresh water lenses. Wells used by the rural population are contaminated throughout the region by agrochemical pesticides, nitrates, oil products, and in industrial zones toxic metals and organic components are also found (Chembarisov, 1983, 1990, 1994).

Water resource monitoring is carried out by sector: Uzhydromet (the Uzbek Meteorology Agency) regularly monitors water quality in water courses and reservoirs;

Minzdrav (the Ministry of Health, Sanitary Epidemiology Service) monitors the quality of drinking water; Goscomgeologia (the State Committee on Geology) monitors the quality of underground mineral and fresh drinking water; Minselvodhoz (the Ministry of Agriculture and Water Management) is responsible for water allocation to river basins, water intake in canals for irrigation purposes and also monitors quantities of collector-drainage water. Collector waters in upstream areas, as a rule, are returned to the river and in downstream areas are diverted into desert depressions.

Total Aral Sea basin water resources are estimated by experts to be about 120–125 km^3, whilst the total current annual runoff collected according to calculations is about 33–35 km^3, i.e. about 30% of water resources. From this about 21–22 km^3 of collector runoff is included within the Amu Darya basin including the Karakum canal with its Murgab and Tejen irrigation areas. A further 13–14 km^3 is collected in the Syr Darya basin which has mean mineralization levels varying from 1.7 to 6.0 g l^{-1} (Table 1).

OBJECTIVE AND SCOPE

For conditions of optimal and integrated management of water resources to support developing technical and economic levels in Central Asian Countries, it is necessary to have a knowledge of the ongoing nature and quality of water used for water supply together with information on likely future changes. The hydrochemical laboratory of the Institute for Water Problems of the Academy of Science, is charged with resolving these problems including the design of systems, means of prevention, together with limiting and removing contamination and associated exhaustion of river waters.

RESULTS

On the basis of the analysis of the "Hydrochemical Databank" (which includes river water quality data since 1938) and allows estimation of modern contamination levels for river waters, five classes of quality have been identified: good quality, satisfactory quality, danger quality, bad quality and highly dangerous quality. The contamination level of river water quality is calculated using an index method of water contamination (IWC). This index includes six ingredients which should not exceed a maximum admitted concentration (MAC), given base oxygen levels. In this form the index has been sufficient for practical demands. In considering substances which are higher than the MAC value, it is necessary to introduce coefficients (K1 and K2) and when the resultant index of contamination (IC) falls within 0 to 1, water is of good quality; 1–3, considered to be acceptable; 3–5, bad; 5–10, dangerous; and more than 10 is very dangerous.

The results of the investigation have permitted the mapping of "A classification of river waters of Uzbekistan on the basis of quality of drinking water". 8% of the area (having 10% of the population) has a quality of "good water" and the "acceptable" quality area covers 15% (where 16% of the population live). However, the area of "bad" quality covers 41% and carries 50% of the population and the area of "dangerous" quality water is 36% carrying more than 24% of the population of Uzbekistan. Therefore, the resolution of drinking water quality for the territory of

Table 1 Volume and quality of collector runoff.

Irrigation district	Volume of collector runoff (km^3 $year^{-1}$)	Average mineralization ($g\ l^{-1}$)	Main accepting river
Amu Darya			
Vaksh	2.67	1.8	Vaksh
Kafirnigan	0.70	0.7	Kafirnigan
Surhan-sherabad	0.95	2.4	Surhandarya, Amudarya
Turkmen	2.31	3.5	Amudarya
Tuyamuyun	4.71	4.0	Sarykamysh lake
Takhiatash	2.35	4.1	Desert lowlands
Pyandg	1.35	1.0	Kyzyl-su
Karshi	1.22	7.7	Amudarya
Samarkand	0.75	1.0	Zeravshan
Navoi	0.49	2.3	Waste lakes
Bukhara	0.98	4.2	Waste lakes
Murgabad	1.20	10.5	Desert lowlands
Tejen	0.44	14.2	Desert lowlands
Subtotal	20.12		
Syr Darya			
Upper Naryn River	0.10	1.0	Naryn
Andijan	3.60	1.3	Karadarya
Namangan	1.17	1.6	Syrdarya
Fergana	2.70	2.6	Syrdarya
Leninabad	0.35	2.5	Syrdarya
Syrdarya	2.24	2.7	Arnasay
Chimkent	0.19	3.1	Syrdarya
Jizak	0.34	6.2	Arnasay
Tashkent	1.20	1.7	Chirchik, Syrdarya
Kzylkum	0.45	2.0	Syrdarya
Arys-Turkestan	0.05	6.0	Lowlands
Kzyl-Orda	0.20	4.2	Desert lowlands
Subtotal	12.59		
Total	32.71		

Uzbekistan presents a very real problem. The investigation results showed "dangerous" waters not only in the territory of the lower Amudarya where it was expected, but also in the lower Seravshan, where the situation in respect of water contamination will be extremely difficult to solve.

The calculated IC values for the Syrdarya River was 2.8; for the Kashkadarya, 4.0; the Zeravshan, 5.3 and for the lower Amudarya, 5.4. The annual average mineralization for the river Zeravshan above Samarkand is 0.3 $g\ l^{-1}$ but below Samarkand inflows of highly mineralized drainage waters increase the value to 0.5 $g\ l^{-1}$. In the part of the river between Chatirchi to Navai, mineralization increases as a result of wastewater discharges from industrial plants in Kattakurgan and Navoi city. Mineralization of the river further increases to 1.6 $g\ l^{-1}$ below Navoiazot due to additional waste discharges into the river.

The base quality of river water changes essentially from a composition in the mountain regions of sulphate-hydrocarbonate-magnesium-calcium, to a sulphate-magnesium-calcium-sodium composition in the lower reaches. Pesticides consistently have higher levels than the MAC with the maximum concentration of alfa hyxochlorane (GHCG) in the Khatirchi network station being at a level equivalent to 6.2 times the MAC.

Chromium and zinc are also at levels higher than the maximum admitted concentration with particularly high concentrations of these metals in the collectors at Siab and Chaganak. In the Zeravshan river waters, high levels of barium were detected which could present a health hazard.

Organic contamination of river waters was estimated by BOD5 (biochemical use of oxygen during five days). This index was found to be higher than the MAC levels by 1.1–1.2 times in three networks. The Zeravshan River was also contaminated with phenol with concentrations being higher than the MAC levels by 3–7 times. Maximum concentrations in the river Amankutansay yielded an IC index value of 5.3.

Chemical composition of the Amudarya River in the low-lying areas is essentially influenced by collector (or drainage) waters coming into the river from irrigated areas of Surhandarya, Sherabad, Kashkadarya (through the southern collector), and Zeravshan (through the main Bukhara collector) river basins as well as from the Chardgou oasis in Turkmenistan. As a result, the Amudarya mineralization levels in mid-reaches and especially in downstream areas are elevated up to 1.2–1.3 g l^{-1}. Water contamination is caused here by nitrate-nitrogen, oil products, phenol, copper, pesticide, etc., with the cumulative content exceeding MAC.

CONCLUSION

In order to conserve and improve surface water quality in the Aral Sea basin there is a need for safe integrated water measures:

- to organize monitoring networks for water quality and studies of negative change processes;
- to install a "water-safe" zone and shelf line along the river corridors to prevent their pollution and exhaustion and to support a safe sanitation condition;
- to decrease the flow of collector-drainage water into rivers from irrigation fields, by using lower volumes of irrigation water and the substitution of alternative drinking water and energy generating methods such as de-salinization and hydroelectric power;
- to extend water rotation systems for water-supply, to introduce wider use of treatment disinfection to render wastewater discharges harmless;
- to introduce percentage payments for the use of water resources, which would stimulate an increase in the natural capacity of products and water saving technology;
- to introduce radical methods to stimulate organizations and water users including tax incentives for new treatment installations;
- to initiate serious research and practical work on the utilization and purification of river waters given current levels of environmental impact with severe river contamination and drinking water, salinization of pastures, the creation of salty sewage lakes etc.. These problems are closely related to the solution of the problem of preventing the dessication of the Aral Sea.

To achieve the optimal execution to resolve all these hydrochemical problems within the Aral Sea basin and to prevent further ecological deterioration, it will be necessary to apply integrated specialist knowledge from both within the republics of Central Asia and external foreign specialists.

REFERENCES

Chembarisov, E. I. (1983) *Environmental and Rational Use of Water Resources of Aral Sea Basin: Geographic Basin of Nature and Use in Uzbekistan*. Tashkent, Uzbekistan.

Chembarisov, E. I. (1990) Hydrology and ecology conditions of the Aral Sea. In: *Proc. Int. Congress on the Aral Sea, Indiana State University, Bloomington, Indiana, USA.*

Chembarisov, E. I. (1994) Hydrochemistry of river, collector, and drainage waters in the Aral Sea basin. In: *The Aral Sea Basin*, 115–120. NATO ASI Series 2, Environment, vol. 12.