Atoms and ecology: Saving the Aral Sea and its river regions

Can nuclear energy help solve a widening catastrophe?

by Yu.A. Scherbakov

Day by day, as the once rich blue waters of the Aral Sea in Central Asia disappear, the region's ecological balance is changing with catastrophic consequences. Winds and rain that used to bring precious moisture to the land now annually spread some 75 million tonnes of heavy, salty dust instead, affecting the climate and polluting the fields and rivers. Herbicides, pesticides, and other chemicals that have been washed into the Sea over the years have ended up in the air, posing serious health problems to the population. Already there are reports of women giving their children milk that has been poisoned and of children and adults dying of leukaemia, liver, and kidney diseases because of such conditions.

Over the past quarter century, the shoreline of the Aral Sea has receded dramatically, leaving a naked seabed of an estimated 26 000 square kilometres. Largely responsible are heavy withdrawals and diversion of water from the Sea's two main tributaries, the Syr–Darya and Amu–Darya rivers. As the Sea has dried, fishing and navigation have died, and once productive agricultural land has been eroded.* The situation threatens to become a large-scale and widening disaster unless a solution is found and put into action.

Unfortunately, solutions that have been proposed so far may only aggravate the situation. They chiefly involve bringing new supplies of water from Northern rivers, or the Volga. On the contrary, water should be removed from this region before polluted subsoil waters completely destroy the remaining fertile lands in the Amu–Darya and Syr–Darya valleys. In Ashkhabad, a town 500 kilometres from the Sea, water now lies only 1.5 metres below the soil surface, and pastures and fields are perishing. The greatest part of the 120 cubic kilometres of water from the Amu–Darya and Syr–Darya rivers finds its way into the soil.

According to G.N. Peshenin, an Uzbek researcher, 113 000 cubic kilometres of water—more than 100 Aral Seas — already have accumulated underground. Agriculture now is only possible with over–watering, so that the saline subsoil water is temporarily forced down by fresh water before seeding. After harvesting, when watering is stopped, the soil is invariably again soaked with saline water. Yet none of today's Aral Sea projects involves lowering the level of water beneath the soil.

A nuclear desalination complex

There is a solution that has been overlooked, one that in my opinion is possible to implement in the USSR, where the level of nuclear development is high. It already has been convincingly demonstrated at the Caspian Sea, not far from the Aral Sea. Eighteen years ago an atomic power plant with the most advanced fast neutron breeder, known as BN–350, was built in the town of Shevchenko, and it is still working without any serious accidents. In my view, its long trouble–free operation is due to the fact that it has been under the constant supervision of the Ministry of Atomic Power. The reactor not only provides 120 000 cubic metres of fresh water per day but also generates 150 megawatts of electric power for the town.

A proposed solution to the Aral Sea problem would build upon this experience. A complex of atomic power plants (about 6–10 reactors of the VVER–1000 type or preferably the fast–breeder reactor BN–800) should be built on the northwest coast of the Aral Sea, namely on the Ustyurt plateau. The plants could supply fresh water to Central Asia regions and generate electric power for pumping subsoil water back into the Aral Sea.

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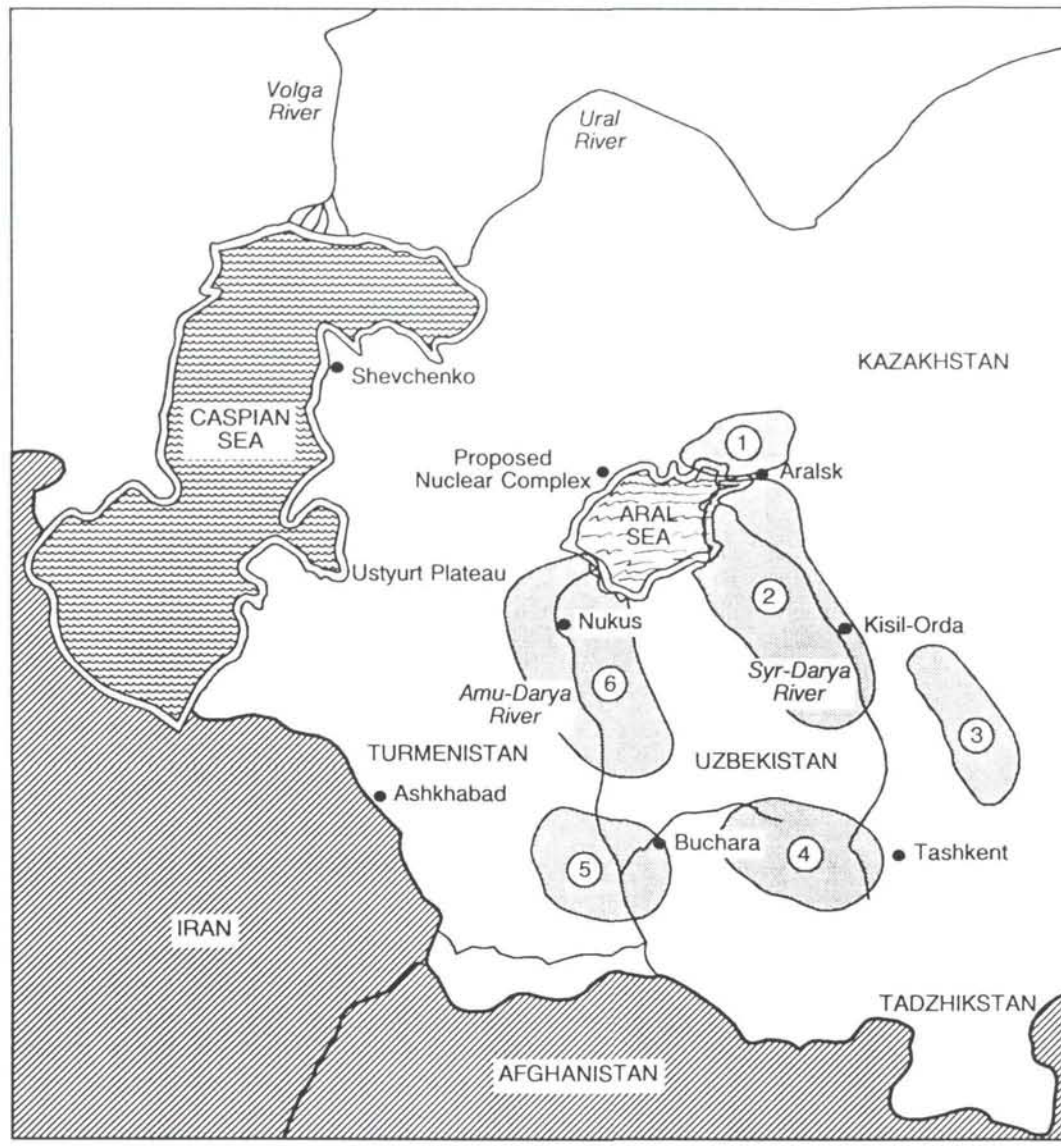
* See "Requiem for the Aral Sea," by Norman Precoda, *Ambio*, Vol. 20, No. 3-4, (May 1991).



Most of the water from the Amu–Darya and Syr–Darya rivers ends up in the soil instead of the Aral Sea, which is drying. Subsoil reservoirs of saline water have formed in six extensive areas, as indicated by the numbers on the map. The proposed nuclear complex would be located along the sea coast in the Ustyurt plateau.

VVER–1000 reactors are successfully operating in Voronezh, Zaporoshie, and Tver, among other sites, and BN–type reactors are operating in Balakovo and on the Mangyshlak Peninsula.

Salinity of water in the Aral Sea, which lies on the 60th meridian from Greenwich on the territory of Uzbekistan and Kazakhstan, has increased to 30 grams per litre. This is not much different than the salinity of the Caspian Sea where the Shevchenko plant is operating.

The Ustyurt plateau, where the proposed power plants would be built, is well–suited for the complex. It is not a densely populated region and is rather far from seismically active zones that embrace Tashkent, Ashkabad, and Gazli. Apart from the town of Komsomolsk–on–Ustyurt with a population of about 30 000 people, and several small settlements, hundreds of kilometers of surrounding lands are uninhabited. This arid plateau with hills as high as 200 metres would allow reactors above 70 metres high to be placed underground, as once recommended by the late Academician A.D. Sakharov.

The optimal place for the plants would be along the sea coast about 100 kilometres from Komsomolsk–on–Ustyurt, near the border of Uzbekistan and Kazakhstan where the Aral Sea's depth is the greatest. Transportation needs could be served by adding a rail line to connect two existing railways that are approximately 425 kilometres apart and run north and south.

The cost for such a complex would be about 3–5 billion rubles, based on estimates of atomic power costs calculated by the late V.A. Legasov. Another 6–10 billion rubles would be necessary for the desalination systems, and several millions of rubles for building the industrial base and transport network, and living and social facilities.

For safety and other reasons, personnel would live 100–200 kilometres from the atomic

complex and work in long-term shifts, as Academician N.A. Dollezhal has proposed.

The complex's thermal power would be used to desalinate water. At least 2 million cubic metres of fresh water could be produced each day, which is approximately 250 liters per person or enough for eight million people. Desalinated water would cost about 0.67 rubles per cubic metre.

Of course, experts would make more accurate estimates during the design of the nuclear desalination complex. Noteworthy is that it usually has taken 60 months or less to build an atomic power plant in the USSR.

The proposal for a desalination complex in this region reflects increasing interest in such projects, particularly among countries in the Middle East region where Saudi Arabia already is a leader in this field. In the Mediterranean region, demand for fresh water is estimated to be 10 million cubic metres per day. A number of countries have expressed interest in the wider use of nuclear power for desalination purposes.* It should be remembered that nuclear desalination systems offer environmental advantages over fossil–fuelled plants. If conventional thermal power plants were to be used to desalinate one million cubic metres of water, some two million tonnes of carbon dioxide, 20 000 tonnes of sulphur oxide, and 6000 tonnes of nitrogen oxides would be released into the atmosphere every year.

Replenishing the Aral Sea

Currently the Aral Sea is divided into two reservoirs that contain less than 450 cubic kilometres of water, compared to its previous level of 1050 cubic kilometres. The sea level already has fallen by 13 metres and continues decreasing by 0.7 metres a year. To replenish the Sea, at least 60 cubic kilometres of water would have to be pumped into it every year, in view of the fact that the Sea loses more than 20 cubic kilometres a year by evaporation.

If all electric power generated by the atomic complex is used for drawing subsoil water from tables 100 metres deep, one can expect more than 100–150 cubic kilometres of water to be pumped back into the Sea every year. The Aral Sea could thus be filled in about 4 years.

To bring the pumped water into the Sea, concrete canals could be built in river valleys where underground reservoirs are found. *(See map.)* Naturally, this water would be saline; the Aral Sea will never regain its previous composition of water.

Extensive water pollution from agro–chemicals imposes other considerations. Water would have to be pumped from the least polluted sites using several hundred heavy–duty pumps. According to estimates of K. Salykov, more than 118 000 tonnes of poisonous chemicals have been deposited in the region over the last 20 years. The contaminated soil would have to be removed and replaced with fresh soil. Also necessary are improvements in the region's system of canals; measures to reduce the flow of useless water now released into sand; and elimination of the cotton and rice monocultures.

Energy and ecology

Today nuclear plants safely supply a high share of electricity in many countries; in the case of France, for example, the nuclear share exceeds 75%. In the USSR, where the nuclear power programme is under review, electricity demands are great, with electric power consumption in Russia running twice as high as in Europe. Yet in the lingering post–Chernobyl climate of public opinion, the words "nuclear power" make people tense and support can be difficult to achieve.

In the Aral region, however, it is possible to think that the proposed investment will allow a radical nuclear solution because the need is so great. Ecological conditions are severe, and nuclear energy would solve major problems. The investment in the proposed nuclear complex also would develop the electricity supply system to meet the demand for energy in a region having a highly industrious labour force and the USSR's largest and fastest population growth. The complex could supply power to the Kazakh, Uzbek, and Turkmen republics, specifically contributing to more intensive development of manufacturing industries and to wider use of refrigeration for foodstuffs. It also could supply power to the gas–producing Caspian Sea region, to the Urals, to the European part of Russia, and to some Siberian regions.

In this case, nuclear power provides a workable solution—on both ecological and energy grounds.

* See "Nuclear desalination: Experience, needs, and prospects," by A. Barak, L.A. Kochetkov, M.J. Crijns, and M. Khalid, *IAEA Bulletin*, Vol. 32, No. 3 (1990) and *Use of nuclear reactors for seawater desalination*, IAEA TECDOC —574, Vienna (1990).